M5 Junction 10 Improvements Scheme

Environmental Management Plan

Annex B.2 Soil Handling Management Plan

TR010063 - APP 9.2

Regulation 5 (2) (q)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

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M5 Junction 10 Improvements Scheme

Development Consent Order 202[x]

Environmental Management Plan

Annex B.2 - Soil Handling Management Plan

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B.2.1. Introduction

Purpose

B.2.1.1 This document forms Annex B2 of the Environmental Management Plan (EMP) (1st iteration) (Application document TR010063/APP/7.3). Annex B.2 is a Soil Handling Management Plan (1st iteration) (SHMP) for the M5 Junction 10 Improvements Scheme (the Scheme). This SHMP (1st iteration) will be updated by the appointed Principal Contractor (PC) into a SHMP (2nd iteration) as required by Requirement 3 of the DCO, prior to commencement of works.

B.2.1.2 The purpose of this outline SHMP is to set out the methodology for managing the disturbance to soil resources during the construction of the Scheme.

B.2.1.3 The SHMP identifies the nature and types of soils that will be affected and provides guidance on soil handling, storage and re-use procedures in accordance with best practice requirements, to support the protection and conservation of the site soil resources for re-use.

B.2.1.4 The scope of this SHMP only includes uncontaminated soils and other naturally occurring material which will be excavated as part of the construction works.

B.2.1.5 The management of Made Ground falls outside the scope of this SHMP and shall be managed in accordance with the Materials Management Plan (MMP) (Application document TR010063/APP/9.1) and Site Waste Management Plan (SWMP) (Application document TR010063/APP/9.2) and relevant environmental and waste legislation[1].

B.2.1.6 Soils typically comprise topsoil (A horizon), and one or more layers of upper subsoil (B horizon(s)) and lower subsoil (C horizon(s)). This SHMP only applies to soils within 1.2 metres below ground level (m bgl) (or less if bedrock is present). Below this depth, natural materials are not considered to constitute soils supporting agriculture or landscaping.

Register of environmental actions and commitments

B.2.1.7 The relevant Register of Environmental Actions and Commitments (REAC) (Application document TR010063/ APP/7.4) that relate to the SHMP are outlined in Table B2-1.

Table B2-1 – SHMP REAC

REAC	Commitment text	**Implementation mechanism**
GS1	To minimise the effect on agricultural quality in temporary land take areas.	EMP (1st iteration) (Application document TR010063/APP/7.3) Annex B2 – Soil handling management plan
GS2	To reduce soil erosion and compaction during construction works.	EMP (1st iteration) Annex B1 – Materials management plan (Application document TR010063/APP/9.1) Annex B2 – Soil handling management plan

[1] DEFRA, Waste Duty of Care Code of Practice, 2018

Guidance documents

B.2.1.8 This SHMP has been prepared in accordance with best practice guidance including:

- DEFRA's Construction Code of Practice for the Sustainable Use of Soils on Construction Sites[2].
- Institute of Quarrying (IoQ) Good Practice Guide for Handling Soils in Mineral Workings[3].
- British Standard BS 3882: 2015 – Specification for topsoil[4].
- British Standard BS 8601: 2013 – Specification for subsoil and requirements for use[5].

Structure of the soil handling management plan

B.2.1.9 The structure of this SHMP is outlined below:

- Section B2.2 – provides details of the requirements of compliance of other documents.
- Section B2.3 – provides a summary of soil movement, soil storage and placement.
- Section B2.4 – summarises the soil resources baseline.
- Section B2.5 – sets out procedures for soil handling and provides guidance for restoration and aftercare requirements.
- Section B2.6 – sets out procedures for inspections and monitoring.

Project team roles and responsibilities

B.2.1.10 The SHMP is to be used as a tool by appointed agents, contractors or sub-contractors acting on behalf of Gloucestershire County Council (GCC) as a method to control, record and audit activities relating to the disturbance of soil resources as part of the Scheme, and to support the management of soil quality for future re-use.

B.2.1.11 The effective implementation of the SHMP requires that roles and responsibilities are clearly defined and understood. Specific job titles, roles and responsibilities will be defined by the PC. However, in relation to soil management and the implementation of the SHMP, it is expected that an Environmental Manager and Soil Specialist would be appointed, whose roles and responsibilities are expected to be similar to those described in Table B2-2 below.

Table B2-2 – SHMP Roles and Responsibilities

Role	Responsibility
Principal Contractor Project Manager	• Overall responsibility for the environmental performance of the Scheme during construction. • Approval for sign-off of the SHMP for the relevant phase of works. • Overseeing and monitoring the implementation of the construction works including the responsibilities

[2] DEFRA, Construction Code of Practice for the Sustainable Use of Soils on Construction Sites, 2009.
[3] The Institution of Quarrying, Good Practice Guide for Handling Soils in Mineral Workings, 2021.
[4] British Standard 3882, Specification for topsoil, 2015.
[5] British Standard 8601, Specification for subsoil and requirements for use, 2013.

Role	Responsibility
	detailed in this SHMP.
Principal Contractor Environmental Manager	• Ensure the requirements of the SHMP are implemented including undertaking site inspections to monitor working practices and assess compliance of contractors. • Ensure the works comply with the relevant environmental legislation, consents, objectives, targets and commitments. • Liaise with client, contractors and landowners. • Seek input from the Soil Specialist where required, to ensure soil management complies with best practice guidance. • Sign off the quality of reinstatement, monitoring and completion of the aftercare programme.
Principal Contractor Soil Specialist	• Provide technical advice on all stages of soil stripping, storage and restoration. • Carry out site inspections and undertake assessment of soil conditions before, during and after works to determine the most suitable soil handling method. Inspect soil reinstatement and undertake monitoring and soil sampling. Produce aftercare reports. • Give tool box talks to site staff on soil consistency testing and soil handling.
All site staff (all contractors and sub-contractors)	• Ensure all procedures and management measures as set out in the SHMP are adhered to. • Attend general soil management awareness training and tool box talks.

B.2.1.12 The Environmental Manager will have sufficient training and expertise in assessing soils, soil conditions and soil handling operations to ensure the measures outlined within this SHMP can be implemented, supervised and monitored effectively.

B.2.1.13 The Soil Specialist shall be a suitably qualified and experienced practitioner with the necessary training and qualifications to meet the applicable minimum competencies set out within the British Society of Soil Science – Professional Competency Scheme[6].

B.2.1.14 This SHMP has been produced to act as a live document and shall be reviewed on a regular basis (at a minimum yearly) by the Environmental Manager and Soil Specialist to evaluate if the prescribed management, maintenance and monitoring regimes are sufficient to achieve its aims and objectives and updated accordingly.

B.2.2. Other requirements

B.2.2.1 The SHMP shall ensure compliance with the requirements set out in the following documents which have been prepared for the Scheme:

- EMP (Application document TR010063/ APP/7.3).

[6] British Society of Soil Science. Working with Soil – Professional Competency in Soil Science. Accessed via: WWS-Complete-Competencies.pdf (soils.org.uk), 2020.

- EMP Annex B1 – Materials Management (Application document TR010063/APP/9.1).
- EMP Annex B4 – Air Quality Management Plan (Application document TR010063/APP/9.4).
- EMP Annex B5 – Landscape and Ecology Management Plan (Application document TR010063/APP/9.5).
- Drainage Strategy (Application document TR010063/APP/6.6).

B.2.3. Soil movement, storage and placement

Soil stripping

B.2.3.1 The Scheme comprises areas of permanent and temporary land take in which soil is required to be stripped for construction works. Details relating to the Scheme are discussed below but may be refined as the Detailed Design progresses.

B.2.3.2 Areas of temporary land take will include site compounds, storage areas and haul roads.

B.2.3.3 The main site compound will be located to the north of the A4019 opposite the Link Road and will comprise an area of 4.5 hectares (ha) currently used as agricultural land.

B.2.3.4 Three satellite compounds will be located on the south side of the A4019, at the southern end of the Link Road and near to the proposed new bridge on the Link Road providing site offices and welfare. Two mobile welfare facilities will also be provided on either side of the motorway for the culvert works. An additional materials storage area will be constructed adjacent to the Link Road. Topsoil stripping will be required prior to construction of these compounds.

B.2.3.5 A temporary haul road will be required along the length of the Link Road, to support the construction of the road, the associated flood mitigation structure and the River Chelt bridge. This will also include the construction of a temporary bridge across the River Chelt, adjacent to the proposed new bridge. Prior to the construction of the temporary haul road, topsoil stripping will be required.

B.2.3.6 Topsoil will be required to be permanently stripped from areas where new road infrastructure (roundabout, slip roads, junctions, the Link Road, areas of A4019 widening, cycleway/footways) are to be constructed. The removal of subsoil may also be required in areas of permanent land take.

B.2.3.7 As part of the flood compensation area located to the east of the Link Road (to the north of the River Chelt), subsoil will also be required to be stripped and removed to reduce levels in the area.

B.2.3.8 The estimated volume of soil resource expected to be generated through the construction of the Scheme is presented in Table B2-3.

Table B 2-3 - Estimates of Excavated Soil Volumes

Earthworks	Reused on-site (t)	Disposal off-site (t)
Excavated Soil	161,404	69,173

Soil storage

B.2.3.9 Soil stripped as part of the Scheme construction works will be temporarily stored in stockpiles for reuse, where possible. The soil storage area will be determined by the PC.

Soil placement

B.2.3.10 Soil will be reused, where possible, within the Scheme for the construction of permanent infrastructure and creation of embankments. Soils will also be used, where possible, to restore areas of temporary land take including compounds, storage areas and haul roads, following completion of the construction works.

Restoration

B.2.3.11 Following the placement of soils, areas will be landscaped to provide a mix of habitats to support biodiversity enhancements within the Scheme. The proposed habitat restoration mitigation will include:

- Replacement of woodland and scrub along the M5 and around the new junction.
- Replacement planting along the realigned sections of the A4019.
- Individual trees to central reserves and verges along the realigned sections of the A4019.
- Hedgerow along the Link Road with supplementary blocks of wood and individual trees particularly around the bridge.
- Species rich grass on low nutrient soil to all embankments and verges, supplemented with bulb planting in some areas.
- Wetland grass and planting to attenuation basins.

B.2.3.12 Further details are provided within EMP Annex B5: Landscape and Ecology Management Plan (LEMP) (Application document TR010063/APP/9.5).

B.2.3.13 Areas of agricultural land which have been temporarily used for construction will be restored to a condition equivalent to their original Agricultural Land Classification (ALC).

B.2.4. Soil resource baseline

Geology

B.2.4.1 The BGS GeoIndex[7] indicates that the superficial deposits underlying the Scheme comprise Cheltenham Sand and Gravel and Alluvium. Superficial deposits are indicated to be absent in the west of Scheme at the Piffs Elm Interchange northbound slip road and in an area south of the Piffs Elm Interchange.

B.2.4.2 The bedrock geology underlying the Scheme predominantly comprises mudstone of the Charmouth Mudstone Formation. Within the southern extent of the M5, interbedded mudstone and limestone of the Rugby Limestone Member are mapped to underlie the Scheme.

B.2.4.3 A ground investigation was undertaken for the Scheme by Geotechnical Engineering between June and September 2021, covering the Piffs Elm Interchange, A4019, proposed Link Road and associated features (e.g. drainage, flood compensation area). The results

[7] British Geological Survey (BGS) GeoIndex Onshore, https://www.bgs.ac.uk/map-viewers/geoindex-onshore/, 2020

of the ground investigation generally confirmed the anticipated geological succession identified from published mapping.

B.2.4.4 The strata encountered during the ground investigation comprised superficial deposits of Alluvium and Cheltenham Sands and Gravels overlying bedrock of the Charmouth Mudstone Formation.

B.2.4.5 Made Ground (silty clay) was recorded in the vicinity of existing roads, embankments and structures. Topsoil was present in areas where Made Ground was absent, recorded as sandy silty clay with rootlets up to 0.4 m in thickness.

B.2.4.6 Further details of the Scheme ground investigation are presented in the ES Chapter 10: Geology and Soils (Application document TR010063/APP/6.8) and the 2022 Atkins M5 J10 Improvements Scheme Ground Investigation Report[8] (Application document TR010063/APP/6.15).

Soil types

B.2.4.7 The 1:250,000 scale National Soil Map of England and Wales, Sheet 5, South West England[9] indicates that three soil associations are present within the Scheme.

B.2.4.8 The map displays soils of the Badsey 2 association present on the Cheltenham Sand and Gravel Deposit, consisting of mainly well drained loamy soils. Soils on the Alluvium of the River Chelt are mapped as poorly drained, clayey soils of the Fladbury 1 association.

B.2.4.9 The soils of the Charmouth Mudstone Formation are mapped as the Evesham 2 association of slowly permeable and seasonally waterlogged calcareous clay soils.

Soil survey

B.2.4.10 Agricultural Land Classification (ALC) soil surveys were undertaken for the Scheme by Askew Land and Soil Limited in December 2020[10], October 2021[11] and May 2022[12] provided within Appendix 10.4, 10.5 and 10.6 (Application document TR010063/APP/6.15) of the ES Chapter 10: Geology and Soils (Application document TR010063/APP/6.8). The ALC soil surveys were undertaken for the following areas within the Scheme:

- December 2020: along the Link Road between the A4019 and B4634. The survey was centred at British National Grid Reference (BNG): 90736, 24599.
- October 2021: along the flood compensation area, located adjacent to the south east of the Piffs Elm Interchange. The survey area was centred at BNG: SO 90461, 25156.
- May 2022: three land parcels adjacent to the north-west of the M5 Junction 10, and along the Link Road between the A4019 and B4634. Parcel A was located adjacent to the north of the B4634 centred at BNG SO 90474, 24035. Parcel B was located approximately 200 m east of Withybridge Lane centred at BNG SO

[8] Atkins, M5 Junction 10 Improvements Scheme. Ground Investigation Report (GIR), 2022
[9] Soils of England and Wales, Sheet 5 South West England, 1983
[10] Askew Land & Soil Limited, M5 Junction 10 Improvements Scheme Preliminary Environmental Information Report (PEIR) Appendix 10.4 Agricultural Land Classification Survey, November 2021.
[11] Askew Land & Soil Limited, Agricultural Land Classification: J10 M5 Flood Compensation Area, October 2021, Project Number C831.
[12] Askew Land & Soil Limited, Agricultural Land Classification: J10 M5 Gloucestershire, August 2022, C884.

90942, 24965. Parcel C was located adjacent to the west of the Piffs Elm Interchange centred at BNG SO 90785, 26213.

B.2.4.11 ALC surveys are planned for the area adjacent to the north of the A4019 between Uckington and the Piffs Elm Interchange.

B.2.4.12 The findings of soil surveys are summarised below, and further details are provided within the individual ALC reports as referenced above.

Soil series and properties

B.2.4.13 The soil series encountered in the ALC surveys reflects the published soil and geology map. The Badsey series, slightly calcareous sandy clay loams with little gleying encountered above 40cm, was present in the northern extent of the survey area (the proposed Link Road).

B.2.4.14 Progressing south, from the Cheltenham Sand and Gravel Deposit and onto the River Chelt Alluvium, the profiles were stoneless, non-calcareous, gleyed clay soils of the Fladbury series. Due to limited land access, the extent of the Fladbury series could not be confirmed but it is anticipated to be present to the edge of the mapped Alluvium.

B.2.4.15 On the southern extent of the survey area, the Evesham series of stoneless, slightly calcareous, gleyed clay soils was encountered.

B.2.4.16 Further details of the soil series and properties encountered within the surveyed areas are provided in Table B2-4.

Table B 2-4 - Summary of soil series and properties

Soil Type	Location	Soil description
December 2020 survey - Link Road		
Badsey 2	Located in northern extent of Link Road.	Dark greyish brown (2.5Y4/2), very slightly stony (2% hard gravel) sandy clay loam over olive brown (2.5Y5/4) sandy clay loam upper subsoil with strong brown (7.5YR4/6) ochreous mottles. The lower subsoil is light brownish grey (2.5Y6/2) sandy clay with strong brown (7.5YR4/6) ochreous mottles.
Fladbury 1	Extent of Fladbury Series unable to be confirmed during survey.	Light olive brown (2.5Y5/3) stoneless clay topsoil over light olive brown (2.5Y5/6) clay subsoil with strong brown (7.5YR4/6) ochreous mottles. The lower subsoil is brownish grey (2.5Y6/2) sandy clay with strong brown (7.5YR4/6) ochreous mottles.
Evesham 2	Located in the southern extent of the site.	(2.5Y4/3) stoneless clay topsoil over light olive brown (2.5Y5/3) clay subsoil. The lower subsoil is olive (5Y4/3) clay with underlying olive (5Y5/3) clay subsoil. Slowly permeable and seasonally waterlogged (Wetness class III).

Soil Type	Location	Soil description
October 2021 survey - flood compensation area		
Fladbury 1 Association	Predominant soil type at the site, extended from south east to north west.	Light olive brown (2.5Y5/3), very slightly stony (1% hard gravel) to stoneless silty clay or clay topsoil over light olive brown (2.5Y5/4) clay upper subsoil. The lower sub-soil (2.5Y5/6) had common ochreous mottles strong brown (7.5YR5/8). Slowly permeable and seasonally waterlogged (Wetness class III).
Badsey 2 Association	North eastern part of the site.	Dark greyish brown (2.5Y4/2), very slightly stony (2% hard gravel), sandy clay loam or heavy clay loam topsoil. The upper subsoil is light olive brown (2.5Y5/3), slightly stony (8% hard gravel), sandy clay loam. The lower subsoil is a light brownish grey (2.5Y6/2) sandy clay and is very stony (70% gravel). Well drained (Wetness Class 1).
Evesham 2 Association	South west corner of the site.	Stoneless to very slightly stony (3% hard gravel) dark greyish brown (2.5Y5/2) clay topsoil. The upper subsoil is a stoneless light olive brown (2.5Y5/4) clay with a few distinct ochreous mottles yellowish brownish (10YR5/8). The lower subsoil is stoneless light olive brown (2.5Y5/3) clay with common, distinct, ochreous mottles yellowish brownish (10YR5/6). Slowly permeable and seasonally waterlogged (Wetness class III).
May 2022 survey – land parcels A, B and C		
Badsey 2 Association	In the north of Parcel A.	Topsoil is dark greyish brown (2.5Y4/2), very slightly stony (6% hard gravel), sandy clay loam. Upper subsoil is light olive brown (2.5Y5/4) slightly stony (8% hard gravel), sandy clay loam. Permeable (Wetness Class 1).
Evesham 2 Association	Within Parcel B and C	Stoneless olive brown (2.5Y4/3) clay topsoil. Upper subsoil is stoneless light olive brown (2.5Y5/3) clay. Lower subsoil is stoneless olive (5Y5/3) clay. Slowly permeable and seasonally waterlogged (Wetness Class III).

Topsoil depth

B.2.4.17 The maximum topsoil depth within the surveyed Scheme area ranged from 22 to 34 cm as summarised in Table B2-5.

Table B 2.4-1 - Topsoil depth

Survey site	Topsoil depth range (cm)
December 2020 survey - Link Road	0 to 34
October 2021 survey - flood compensation area	0 to 34
May 2022 survey - Parcel A	0 to 20
May 2022 survey - Parcel B	0 to 22

Survey site	Topsoil depth range (cm)
May 2022 survey - Parcel C	0 to 30

Topsoil texture analysis

B.2.4.18 As part of the ALC soil surveys, eight topsoil samples were collected and sent to accredited laboratories (NRM Laboratories and Soil Property Testing Ltd) for particle size distribution analysis. A summary of the particle size distribution results is presented in Table B2-6.

Table B2-5 - Summary of texture analysis

Sample Id	Depth (m)	Sand % mm	Silt % mm	Clay % mm	ALC soil texture class
December 2020 Survey					
AB5	Not provided	57	17	26	Sandy clay loam
AB10	Not provided	29	36	35	Heavy clay loam
AB18	Not provided	24	24	52	Clay
October 2021 survey - flood compensation area					
AB9	0 to 0.25	45	27	28	Heavy clay loam
AB11	0 to 0.25	14	48	38	Silty clay
AB15	0 to 0.25	15	44	41	Clay
May 2022 survey Site – land parcels A, B and C					
AB1 (Parcel A)	0 to 0.25	13	32	55	Clay
AB7 (Parcel C)	0 to 0.25	63	18	19	Sandy clay loam

Agricultural land classification

B.2.4.19 The soil survey data[10,11,12] was used in conjunction with the published ALC mapping[13] to assess the ALC grade of the land within the Scheme in accordance with the revised Ministry of Agriculture, Fisheries and Food (MAFF) 1988 guidelines for ALC[14].

B.2.4.20 As summarised in ES Chapter 10: Geology and Soils (Application document TR010063/APP/6.8), the majority of the land impacted by the Scheme is assessed as Subgrade 3a (good quality) and Subgrade 3b (moderate quality) agricultural land. A summary of the ALC grade assessment and approximate agricultural land take anticipated for each area, as presented in the ES chapter 10: Geology and Soils (Application document TR010063/APP/6.8) is reproduced in Table B2-7 below.

[13] Natural England, Agricultural Land Classification Map South West Region (ALC006), 2018.
[14] MAFF, "Agricultural Land Classification for England and Wales: Revised Guidelines and Crietira for Grading the Quality of Agricultural Land.," 1988.

Table B2-6- ALC Grade assessment

Location	Subgrade 3a permanent land take	Subgrade 3a temporary land take	Subgrade 3b permanent land take	Subgrade 3b temporary land take
Land west of the M5	4.61 ha	11.45 ha	3.71 ha	16.34 ha
Land east of the M5	19.52 ha	16.50 ha	18.85 ha	22.76 ha
Land to the north of the A4019	7.43 ha	13.78 ha	None	None
Total	**31.56 ha**	**41.73 ha**	**22.56 ha**	**39.11 ha**

B.2.5. Soil handling methodology

General handling principles

B.2.5.1 High standards of soil handling and management shall be employed throughout all activities which may disturb soil resources.

B.2.5.2 A soil tracking document shall be created and updated when the soil is handled. The document shall include details of soil volumes moved, soil moisture content, weather conditions during each handling stage, location of origin, stockpile locations, stockpile monitoring for each area and details of any unsuitable materials disposed of off-site.

B.2.5.3 All soils shall be handled under suitable weather and soil conditions using appropriate machinery, where possible. All machinery shall have as low ground-pressures as is reasonably practicable for the works.

B.2.5.4 Vehicle movements across soil shall be avoided where possible throughout the construction works. Designated haul routes shall be installed around the site to prevent excessive tracking of the in-situ soil resource. Haul route widths shall be minimised and shall only be wide enough to accommodate two passing vehicles.

B.2.5.5 Areas of soil to be protected during early construction works shall be fenced off with exclusion signs. Locations of existing field drains and below ground services shall be identified before soil stripping commences.

Handling constraints

B.2.5.6 Handling of soil shall be kept to a minimum and only be undertaken when the moisture state and friability is in a dry and friable condition. This shall be determined by the tests described in Section B2.6.10 to B2.6.13, below. This condition is when soil structures are least susceptible to lasting damage by compaction and smearing.

B.2.5.7 Soil handling shall cease during rainfall that is sufficient to wet the soil surface under the following conditions:

- In light drizzle, soil handling may continue for up to four hours unless the soils are already at / near to their moisture limit.
- In light rain, soil handling must cease after 15 minutes.
- In heavy rain and intense showers, handling shall cease immediately.

B.2.5.8 In the above conditions it is assumed that the soils are in a dry state. Soil handling shall also cease where there is surface ponding if there is frozen ground or the ground is covered in snow.

B.2.5.9 During / after rainfall, field testing shall be undertaken to ensure that the soils are sufficiently dry to be handled. If they are sufficiently dry, soil handling may recommence. Soil handling shall not commence if heavy rain or snow are forecast during the period of soil handling and shall cease in advance of forecast heavy rain or snow.

Field tests to determine soil handling conditions

B.2.5.10 Samples shall be tested to determine the suitability of soil conditions in advance of all soil handling. The field tests of soil shall apply to all soil materials (topsoil and subsoil) that are to be disturbed and re-used, including soils excavated from stockpiles. All tests shall be carried out by the Soil Specialist or a suitably qualified delegate.

B.2.5.11 Soils shall be tested at evenly distributed sampling points within each soil handling unit, the number of sampling points is to be determined by the Soil Specialist. At each sampling point, one sample per soil horizon to be stripped shall be taken and assessed as set out below. Decisions shall be based on at least 80% of the samples passing the particular test. Records of all tests shall be kept.

B.2.5.12 Table B2-8 below sets out the consistency test, in which the Soil Specialist shall attempt to mould a soil sample into a ball by hand. Peat and peaty soils shall not be handled when dry and brittle.

Table B 2.5-1 - Consistency test – part one

Outcome	Result	Action
Impossible because the soil is too hard (dry)	Dry and friable	Handling OK
Impossible because the soil is too loose (dry)	Dry and friable	Handling OK
Impossible because the soil is too loose (wet)	Wet and non-plastic	Not OK to handle
Possible	Go to Part 2 (see Table B2-9)	

B.2.5.13 Table B2-9 below sets out the second part of the consistency test, in which the Soil Specialist shall attempt to roll the ball into a thread of 3 mm diameter on a flat non-adhesive surface using light pressure from the flat of the hand.

Table B 2.5-2 - Consistency test – part two

Outcome	Result	Action
Impossible; the soil crumbles or disintegrates	Dry and friable	Handling OK
Possible	Moist and plastic	Handling OK. Shall be stockpiled separately to the above and shall require reconditioning prior to reinstatement

Soil stripping

Clearance of Existing Vegetation

B.2.5.14 Areas to be stripped of soil or stockpiled upon shall first be cleared of all grass and herbaceous vegetation to a height of 50 mm or less using mechanical means where possible i.e. blading off, scarification and raking. Alternatively, a suitable non-residual herbicide should be applied not less than two weeks before stripping. Herbicide may only be used with the consent of the landowner and as directed by the Soil Specialist.

Stripping Methodology

B.2.5.15 Soil stripping across the Scheme is anticipated to be undertaken using excavators, bulldozers and dump trucks. Soil stripping shall be undertaken in accordance with the best practice guidance provided in the IoQ Good Practice Guide[15]. IoQ guidance sheets for soil stripping with excavators, bulldozers and dump trucks (Sheets A, E and I) are provided in Appendix A.

B.2.5.16 The excavators / bulldozer shall strip routes to the stockpile locations / to existing routes (so the transport vehicles can run on formation level) and shall start stripping closest to the stockpile location to minimise trafficking.

B.2.5.17 The topsoil shall be stripped to the appropriate depths and directly placed into stockpiles where practicable, or otherwise loaded into dump trucks / tracked loaders. Stripping shall be undertaken by the excavator / bulldozer standing on the surface of the topsoil, digging the topsoil and loading into the transport vehicle positioned on the formation level. The transport vehicle shall only run on the basal layer under subsoil where subsoil is stripped.

B.2.5.18 Topsoil must be at the correct moisture and friability state when stripping is carried out (see Section B2.6.10 to B2.6.13). However, there will be occasions where programme constraints require soils to be handled when wet and plastic. In addition, there may be areas where the soils may rarely be in a dry and friable condition (e.g. in low lying areas). Such soils will need to be treated to recondition them prior to reinstatement, typically by placing them in windrows, or as the Soil Scientist advises. Soils which remain wet and non-plastic shall not be handled for agricultural reinstatement. Topsoil must be kept in appropriately sized stockpiles in accordance with best practice guidance for the duration of the required storage time (as outlined in Table B2-10 below).

B.2.5.19 The subsoils shall be stripped separately to topsoil wherever the excavation depth within areas of cut extends to below topsoil and to the appropriate depths. Where subsoils are to be stripped, this shall be done as soon as practicable after topsoil stripping to avoid leaving them exposed to adverse weather.

B.2.5.20 The location from where soils are stripped must be recorded with details of the volume of soils of each type that are stripped and placed into a stockpile. The locations, footprints and volumes of the stockpiles must be recorded.

B.2.5.21 Stripped topsoil and subsoil shall be re-used as soon as is practicable and stored in such a way as to minimise soil structure damage from weathering, construction traffic movements and multiple handling. Areas to be temporarily stripped of vegetation shall be re-surfaced or re-planted as soon as reasonably practicable after the completion of the vegetation stripping to minimise dust generation.

[15] The Institute of Quarrying , “Good Practice Guide for Handling Soils in Mineral Workings.,” 2021.

B.2.5.22 A watching brief shall be undertaken by the Soil Specialist during soil stripping, to confirm that works are being undertaken in accordance with this SHMP.

Drainage

B.2.5.23 The soils are likely to contain agricultural drainage schemes of varying ages. Locations of existing field drains shall be identified before soil stripping commences.

B.2.5.24 The depth of field drains is unknown and soil stripping could affect their condition if they are close to the surface. Any damaged land drains shall be repaired and replaced to ensure continued agricultural use. Existing drainage features located during soil stripping shall be recorded, including their type, depth, size, angle and condition.

Soil storage

Soil segregation

B.2.5.25 Topsoil and subsoils shall be stored separately to each other, and other materials and their locations recorded.

B.2.5.26 Agricultural soils from different field holdings shall not be mixed, to mitigate potential biosecurity issues and the potential degradation of soil quality through mixing of soils from different sources.

B.2.5.27 Soil storage areas for different types of topsoil and subsoil shall be identified prior to construction activities to avoid the mixing of these resources.

Stockpiling general principles

B.2.5.28 Soil handling units, based on texture class, define resilience to structural damage during soil handling. Soil handling units shall be used to prepare maximum stockpile heights as shown in Table B2-10.

Table B 2.5-3 - Soil resilience and stockpile height

Soil handling unit	Resilience to structural damage during soil handling	Soil texture class	Stockpile height (m)
A	High	Light textured soils: sand (S), loamy sand (LS), sandy loam (SL), sandy silt loam (SZL)	5
B	Medium	Medium textured soils with <27% clay content: silt Loam, medium silty clay loam (MZCL), medium clay loam (MCL), sandy clay loam (SCL)	4
C	Low	Heavy soils with >27% clay content: heavy silty clay loam (HZCL), heavy clay loam (HCL), sandy clay (SC), silty clay (ZC), clay (C)	3

Note – Adapted from Environmental Impact Assessment Handbook[16]

[16] J. F. J. M. a. T. T. Barbara Carroll, Environmental Impact Assessment Handbook: A Practical Guide for Planners, developers and Communities., 2019, Third Edition.

B.2.5.29 Stockpile heights shall be restricted to the heights indicated in Table B2-10 in order to alleviate anaerobic conditions arising from compaction and waterlogging as a result of impeded drainage. Stockpile slopes shall not exceed 1 in 2 (approximately 25°).

B.2.5.30 Areas to be used for storing materials other than topsoil shall first be stripped of topsoil. For areas to be used to store topsoil the underlying topsoil can be left in place and should be covered with an organic separation layer such as straw. Stockpile locations shall be recorded on appropriate site plans.

B.2.5.31 Stockpiles shall be located adjacent to stripped areas in order to prevent the migration of material back to the bare area and shall not be situated within the root protection area of any trees. They shall also be sited at least 5 m from watercourses and outside areas with a high probability of flooding. Protection measures shall be used to protect the stockpiles from vehicles / pedestrians potentially compacting the soils.

B.2.5.32 Where soil storage is required for in excess of one year, a storage time limit will need to be agreed with the Environment Agency, in accordance with The CL:AIRE Definition of Waste: Development Industry Code of Practice[17]

Stockpile formation methodology

B.2.5.33 Stockpile formation shall be undertaken in accordance with the IoQ Good Practice Guide[3]. IoQ guidance sheets for building soil storage mounds with excavators, bulldozers and dump trucks (Sheets B and G) are provided within Appendix A.

B.2.5.34 Two main stockpile formation methodologies are anticipated to be used:

- Direct placement into stockpile mounds by excavator.
- Loose-tipping by dump truck/tracked dumper into storage areas, followed by the excavator/bulldozer sitting on the stockpile mound and shaping the soil into a mound followed by levelling off.

B.2.5.35 The transportation vehicles shall directly place the soil into stockpile mounds or loose-tip the soil in heaps, starting at the furthest point in the storage area and working back toward the access point. Excavators / bulldozers shall be used to shape the stockpiles into mounded forms (which will facilitate the shedding of rain) and firm the surfaces to limit erosion and reduce water infiltration.

B.2.5.36 Where multi-tier mounds are required, the surface of each layer shall be levelled and firmed before the next tier is formed. This shall be repeated until the planned stockpile height has been reached.

B.2.5.37 Tracked vehicles shall be used to move the materials to the stockpile locations to reduce soil compaction and soil shall be placed loosely on the bund. No wheeled vehicles shall run on stockpiles of soil that is to be reused.

B.2.5.38 Based on the soil texture class, soil handling units have been identified for the Scheme and have been used to prescribe maximum stockpile heights. Units B and C apply and the stockpile heights for these units are provided in Table B2-10.

B.2.5.39 The soils within the Scheme are indicated to fall into soil handling units B and C. All alluvial and heavy clay soils which require storage should be limited to stockpile heights up to 3 m. All other soils, with sandy clay loam textures, are of higher resilience to handling and stockpile heights up to 4 m are likely to be suitable.

[17] CL:AIRE, The Definition of Waste: Development Industry Code of Practice. Version 2, 2011.

Stockpile maintenance and monitoring

B.2.5.40 The location from where soils are stripped shall be recorded with details of the volume of soils of each type that are stripped and placed into a stockpile. The locations, footprints, volumes and contents of each stockpile shall also be tracked and recorded accurately on plans.

B.2.5.41 Grass mix shall be sown onto the completed stockpiles if they are to remain in-situ for a period greater than six months. This shall be done as soon as practicable after formation with a low-maintenance clover mix to minimise soil erosion, dust generation and to help reduce infestation by nuisance weeds that might spread seed onto adjacent land.

B.2.5.42 The mix to be used for seeding shall be in accordance with the landscaping design for the Scheme, see EMP Annex B5: Landscape and Ecology Management Plan (Application document TR010063/APP/9.5), and agreed with the Soil Specialist in advance of sowing. Where the stockpiles are left unvegetated, they shall be sprayed with water as necessary to prevent dust generation.

B.2.5.43 Stockpiles shall be inspected on a regular basis by the Soil Specialist or a suitably qualified delegate, with the following conditions to be monitored / maintained:

- The stockpiles shall be weed-free. The management of clover and weeds shall be undertaken during the growing season (March to September) by mowing or strimming to control and minimise the spread of weeds. Non-residual herbicide applications may be required for weed control but must be agreed with the Soil Specialist.
- Soils shall be visually monitored and any potential issues (i.e. instability, dust emissions, cross-contamination due to wash-off) noted and escalated.
- The stockpiles shall be monitored for signs of ponding, as indicated by standing water. Where it occurs, temporary drainage measures or regrading shall be put into effect in accordance with the Drainage Strategy (Application document TR010063/APP/6.6).
- The quantity of soils being stored shall be monitored to confirm that this has not exceeded the design proposal.
- Testing may be required at the end of the storage period to ensure the soils are still fit for purpose. Any stockpiled excavated materials that fail to meet requirements may be considered as waste.

Unsuitable or surplus soils

B.2.5.44 Soils that cannot be re-used on site (because they are geotechnically or chemically unsuitable or there is excess volume that is not required for land development) will need to be:

- Managed in accordance with appropriate guidance such as the CL:AIRE Definition of Waste Code of Practice[18].
- Transferred off-site in accordance with Duty of Care and current waste management legislation and guidance[1].

[18] CL:AIRE, The Definition of Waste: Development Industry Code of Practice. Version 2, 2011.

Soil restoration

Nutrient testing

B.2.5.45 Prior to placement of stored soils, nutrient testing of topsoil may be required to confirm that the topsoil is suitable for use as planned.

B.2.5.46 Stockpiles should be sampled (throughout the depth of the stockpile) and tested for nutrients (total nitrogen, total organic carbon and available phosphorous, potassium and magnesium), pH and organic matter (by loss on ignition) in accordance with BS 3882:2015[4] criteria. This will determine whether the topsoil meets 'multipurpose' or 'low fertility' requirements and is suitable for its proposed use. Should the topsoil not meet the criteria, an interpretation report may be required with recommendations for remediation.

Soil placement methodology

B.2.5.47 Soil placement shall be undertaken in accordance with the IoQ Good Practice Guide[3]. A guidance sheet for soil replacement with excavators and dump trucks (Sheet D) is provided within Appendix A. Soil handling conditions (see Sections B2.5.10 to B2.5.13) shall be determined using field tests prior to placement of soils.

B.2.5.48 Prior to excavation of soil from storage mounds for re-use, any vegetation on the stockpiles shall be removed either by mowing / strimming to a height of 50 mm or less, or via non-residual herbicide application, but shall be agreed with the Soil Specialist in advance. Herbicide may only be used with the consent of the landowner.

B.2.5.49 The soil shall ideally be replaced during the summer months and the soils shall only be moved when they are dry / below their plastic limit, to prevent compaction of the underlying soil.

B.2.5.50 Prior to the placement of the excavated soil, the soil surface which it is to be placed on may require loosening to decompact the soil. This shall be undertaken in accordance with the IoQ Good Practice Guide[3] for soil decompaction by excavator bucket (see Sheet N in Appendix A).

B.2.5.51 The soil horizons shall be reinstated to depths consistent with that subsisting prior to construction. Soil layers shall be replaced to the appropriate thicknesses, plus an allowance for settlement.

B.2.5.52 In all cases, the subsoils and topsoil (as applicable and in that order) shall be replaced separately above the excavated surface to create the required landform. A series of strips, progressively marked out on the restored land, shall be used to reinstate the soils. Following tipping of the soil by dump trucks, the excavator shall place the subsoil first with the operational reach of the excavator boom defining the width of each strip. The process is repeated for each subsequent layer until the top layer (topsoil) is placed. When the soil profile sequence within the strip has been replaced, the process shall be repeated on the next strip to be replaced.

B.2.5.53 Soils shall be replaced with minimum vehicular movements to avoid re-compacting the loosened surface. Restoration shall start at the furthest point from the exit to ensure that soils once deposited are not run on by earth moving machinery. Care shall be taken to minimise compaction of the soil by carefully controlling traffic movement along defined routes and working only in dry conditions.

B.2.5.54 Reinstated soils shall not have stones or other debris on or protruding above the surface by more than 30 mm. Any damaged land drains shall be repaired and replaced as required.

Post restoration steps

B.2.5.55 Once the soils have been restored, they shall be loosened to a suitable depth, to tie the topsoil and subsoil together and produce a fine tilth suitable for planting/seeding. The depth of working and the type of equipment used shall be determined by the depth of compaction, which shall be assessed by the Soil Specialist. This can only be carried out in dry conditions and special care will be required to avoid damage to shallow drains if they are present.

B.2.5.56 A seed bed shall be established as soon as practicable after reinstatement with secondary cultivation equipment, as agreed with the landowner, Soil Specialist and Landscape Architect to help stabilise the soil structure.

Aftercare

B.2.5.57 Following restoration, all areas restored to agricultural land use shall enter into a maintenance period of up to 5 years as outlined below. The responsibility for undertaking the aftercare programme and the work required shall be agreed with the landowner, Environmental Manager and the Soil Specialist.

Year 1

B.2.5.58 The soil is likely to be in a fragile condition after reinstatement and all work shall be geared towards restoring its original condition. Timing of cultivation operations will be critical to the success of the restoration, with the soils only being worked when in a dry and friable condition.

B.2.5.59 The fields shall be sown with a suitable crop/grass (as agreed with the landowner) with a good rooting system, as soon as possible after reinstatement of the soils. Vegetation shall be limed, fertilised and sprayed with pesticides as necessary to maximise growth. The quantities of fertiliser required shall be determined, by nutrient analysis of soils collected from the soil bunds prior to soil spreading, to ensure that major soil nutrient levels are sufficient for the proposed crop/grass.

B.2.5.60 At the end of the first year, the land shall be checked for settlement and any hollows shall be infilled by scraping back the topsoil and infilling the hollows with subsoil, before reinstating the topsoil.

B.2.5.61 The drain discharge points shall be checked to ensure they are still clear of vegetation or silt and that all drains are flowing in winter or after wet weather.

Year 2 to 5

B.2.5.62 Scheme areas to be restored to agricultural land shall be monitored each year by the Soil Specialist and Environmental Manager to check the condition of the soil and grass (or other crop as agreed with the farmer) and amelioration work undertaken as necessary. This work is likely to include filling of any settlement hollows, subsoiling to improve soil structure and patching areas of poor growth.

B.2.6. Inspection and Monitoring

Audits

B.2.6.1 The Soil Specialist and Environmental Manager shall be responsible for supervising, monitoring and controlling soil management throughout all stages of the works.

B.2.6.2 On-site inspections shall be carried out by the Soil Specialist or a suitably qualified delegate to monitor progress and to confirm that soil handling, management and

restoration is being undertaken in accordance with this SHMP. On-site visual inspections shall also be undertaken (with an increased frequency during dry weather) to monitor dust and where visible dust emissions are noted beyond the construction boundary, implement measures to reduce soiling from dust.

B.2.6.3 The results of these inspections shall be kept on record within an inspection log.

Non-compliance and corrective

B.2.6.4 If any non-compliances with this SHMP or issues requiring corrective actions are identified, these shall be flagged to the Environmental Manager who shall determine the appropriate course of action.

Records

B.2.6.5 Accurate and up to date records of each stage of soil handling and land restoration shall be kept to ensure that the contents and origins of all soil stockpiles are known when the soils are re-used. This shall include:

- Mapping and tracking of the locations, types and volumes of soil to be stripped.
- Mapping and tracking of the locations, footprints, volumes and type of each soil stockpile.
- Records of all soil moisture tests shall be kept, as per Sections B2.6.10 to B2.6.13.
- Records of compliance with the requirements of the SHMP, derived from audits and other inspections, shall be held at the site office. The Environmental Manager will be responsible for maintaining and managing these environmental records.

Communication

B.2.6.6 Site meetings shall be held throughout the construction and operation works between the Environmental Manager, Soil Specialist and Principal Contractor to ensure that each member of the team carrying out the works is fully briefed as to how each stage of the works will proceed.

B.2.6.7 The Environmental Manager shall proactively engage with landowners / occupants to ensure they are notified in advance of any works on their land and arrange meetings with agent representatives of land owner / occupants as required.

Training

B.2.6.8 The Soil Specialist shall provide training as appropriate to site operatives for daily soil monitoring / inspections but will also oversee technical soil advice and monitoring throughout the soil handling operations.

B.2.6.9 Training shall also be carried out as appropriate following an environmental near miss, incident or complaint.

B.2.6.10 Regular toolbox talks shall be given to ensure that all site staff are aware of the application of soil handling and soil protection procedures.

Appendices

Institute of Quarrying – Good Practice Guidance Sheets

GOOD PRACTICE GUIDE FOR HANDLING SOILS

In Mineral Workings

PART TWO: Methodology

- Sheet A -

Soil Stripping with Excavators and Dump Trucks – Sequential Bed/Strip Practice

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Supporting artwork was provided by R Shelton (H J Banks & Co) and D Fisher (Blue Room Graphics Ltd).

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Preface

The purpose of Sheet A of the updated guidance is to provide a model method of best practice where excavators and dump trucks are to be used to strip soil using the sequential 'bed'/strip by strip practice.

The guidance is intended for use by planning officials, statutory consultees, mineral operators and their supporting teams and specialist consultants, and earth-moving contractors, their site supervisors and machine operators.

Successful soil handling schemes are dependent on the soil resources being clearly identified and the conditions in which they are to be handled. This information should be contained in the Soil Resource & Management Plan (SRMP) and communicated to those involved in its implementation.

Key issues to be addressed are:

i) Avoiding conditions when soils are wet/ plastic during handling
ii) The minimisation of soil compaction caused by trafficking and soil wetness
iii) Using appropriate remedial treatments where these are necessary
iv) Minimising soil loss, and mixing of soil layers or different soil types.

The SRMP should specify the type of earth-moving machinery and soil handling practice, and the soil wetness condition (see Part One of the Guidance) to be deployed to achieve the planned after use, soil functioning, and the environmental and ecosystem services. It is to be communicated in full to all involved and in particular to the supervisors and machine operators by appropriate means; including tool-box talks and site demonstrations. Supervision by trained supervisory staff is essential, as are monitoring and reporting.

The guidance does not specify the size or model of equipment as this is left to the mineral operator and contractor to specify and provide. The machines must be of a kind which are appropriate for the task and the outcomes required, and to be able to carry out the work safely and efficiently.

Should the agreed methodology need to be modified or changed significantly, this should be agreed in advance with the mineral planning authority. The SRMP should include a mechanism whereby unexpected less significant changes can be quickly resolved through consultation between the operator, the planning authority and statutory consultee, and soil specialist.

All persons involved in the handling of soils must comply with all relevant legislation with respect to Health and Safety, in particular the Health and Safety at work Act 1974, and in the case of mineral extraction operations, The Quarries Regulations 1999 and its relevant statutory provisions; in particular those aspects which relate to the construction and removal of tips, mounds and similar structures. These requirements take preference over any suggested practice in this Sheet and the SRMP should have taken these into account.

The users of this guidance are solely responsible for ensuring it complies with all safety legislation and good practice, including the manufacturer's specifications for the safe operation of the specific machines being used, and that all machines are in a good condition and well maintained and are suitable for the task. It is important that those involved in the operation of earth moving machines are competent and have the necessary training and certification.

Introduction

In this soil handling option, back-acting excavators are used to lift the soil resources and load them into dump trucks for the direct transport to the area being restored or to storage until needed.

The stripping practice involves the sequential separation and removal of the individual layers of soil identified in the Soil Resource & Management Plan (SRMP). It takes the form of advancing vertical slices through the soil profile as successive strips across the soil being removed. Hence the practice is often referred to as the 'Strip' or 'Bed' method.

The upper layer (topsoil) in the strip being removed is lifted first within the safe and efficient operational reach of the excavator boom (which defines the width of each strip). For each subsequent soil layer, if it is to be recovered, the process is repeated until the basal layer (usually overburden or the economic mineral layer) is reached. When the soil resource/ profile sequence within the strip is completely removed, the process is repeated on the abutting area to be stripped of soil. The method can also be adopted where only a single soil horizon is to be recovered.

Normally the excavator operates only from on the soil surface with the dump trucks travelling on the exposed lower non-soil layer. This the preferred operating mode of the excavator as there is a better recovery of the particular soil layer on handling. In some circumstances, such as where, i) the topsoil/ surface layer has a particularly low baring capacity and is prone to compaction (such as peat or organic soils), ii) a thin soil layer lies directly on the mineral layer, or iii) access is limited from the bottom of steep gradients, the excavator will need to operate from the exposed 'basal' mineral/overburden layer or a raised access strip.

Similarly, the normal operation of the dump trucks is on the exposed non-soil basal/overburden layer. In cases where the soil horizon has i) a particularly low baring capacity or ii) where there needs to be enhanced protection of potential archaeological features, the dump trucks may have to operate upon the topsoil which may have to be surcharged.

Advantages & Disadvantages

The advantages of this machinery combination and handling practice are:

i) When the excavator operates only from on the soil surface, compaction is largely confined to the top-soil (which is ultimately more easily treated) and potentially reducing the risk of severe compaction of the subsurface soil layers where the soil is to be directly placed without storage
ii) It is easier to see and react to localised changes in soil types and variation in horizon depth
iii) It is suited to the stripping of thin and 'patterned' soil layers
iv) It offers the most flexibility in respect of short soil drying periods and likely wet weather as it is less susceptible to stoppages due to soil rewetting as a transpiring vegetation cover can be retained later into the stripping programme. It is particularly suited to northerly and western, and upland locations, and particularly when there are uncertain weather patterns.

The disadvantages are:

i) It requires skill and discipline in its deployment, and a high level of supervision, being suited to experienced operators
ii) Without care the bed system may result in a greater mixing of soil horizons
iii) Steep gradient/complex topographies may limit the safe and practical deployment of this machinery combination and handling practice.

Suitability

The excavator-dump truck combination with the bed/ strip handling practice methodology is considered as 'best practice' by Natural England and the Welsh Government for agricultural soils and preferred for all soils. In particular, it is the most suitable of any of the methods available where:

i) The soil is prone to compaction and where decompaction treatments cannot be relied upon to be effective (this incudes peat)
ii) The intended after use, environmental and ecosystem services are dependent on

maintaining (as far as it is possible) the soil functional characteristics such as, porosity and hence drainage and aeration, plant available water capacity, and low resistance to plant root growth. This includes productive agricultural, horticultural and forestry land, but also some natural habitats, and where water storage/infiltration is of importance for risk of flooding. Where the soils are stored prior to replacement some remedial treatment may have to be relied upon.

ii) The bed/strip soil handling method is not suitable where an archaeological surface needs to be investigated as a whole. Subject to approval by the planning authority the method can be used with care where there is a 'watching brief' by an archaeologist, but may have to be abandoned for another approach where important artefacts are detected. However, trafficking may be restricted to the topsoil surface until the subsoil has been approved for removal and taken away.

iii) The placement of the stripped soils into stockpiles is likely to result in compression and compaction and may negate this particular benefit of the handling practice.

iv) As the benefit of the practice lies in the direct placement of the stripped soil it calls for the mineral extraction scheme to be organized to minimize the need for soils storage.

MODEL METHODOLOGY

A.1 Key operational points to minimise the risk of severe soil compaction and wet soil conditions are summarised in Boxes A.1 and A.2.

A.2 The timing of soil handling operations should only take place when the soils are in a 'dry and friable' condition (ie when it breaks and shatters when disturbed rather than smears and deforms) (see **Part One, Supplementary Note 4**). Prior to the start or recommencement of soil handling, they should be tested to confirm they are in suitably dry condition (see Box A.3).

Box A.1 - to minimise compaction:

- The dump trucks should normally only operate on the 'basal'/non-soil layer, and their wheels must not run on to the soil layer/s
- The excavator should normally operate on the topsoil layer
- The adoption of a bed/strip system avoids the need for the trucks to travel on the soil layers
- The machines are to only work when ground conditions enable their efficient operation
- Soils are to be in a 'dry' condition.

Box A.2 - to minimise soil wetness and re-wetting:

- The bed/strip system provides a basis to regulate the exposure of lower soil layers to periods of rain and a means of maintaining soil moisture contents The soil profile within the active strip should be stripped to the basal layer before rainfall occurs and before stripping is suspended
- Measures are required to protect the face of the soil layer from ponding of water and maintain the basal layer in a condition capable of supporting dump trucks
- The area to be stripped is to be protected from in-flow of water, ponding etc. Wet sites should be drained in advance
- The maintenance of a transpiting crop is important, and an appropriate cropping regime should be established for the year of soil stripping
- Before stripping, excess vegetation should be removed; in the case of grassland it should be cut or grazed short and arable crops should have been harvested.

A.3 Soil handling is not to take place during rain, sleet or snow and in these conditions should be prohibited due to unsafe machine operating conditions. Prior to commencing operations, a medium/long term weather forecast should be obtained which gives reasonable confidence of soil handling being completed without significant

Box A.3 - Test for Dry and Friable Soils

Soil tests are to be undertaken in the field. Samples shall be taken from at least five locations on the soil handling area and at each soil horizon to the full depth of the profile to be recovered/replaced. The tests shall include visual examination of the soil and physical assessment of soil consistency.

i) Examination

- If the soil is wet, films of water are visible on the surface of soil particles or aggregates (e.g. clods or peds) and/or when a clod or ped is squeezed in the hand it readily deforms into a cohesive 'ball' means **no soil handling to take place**
- If the sample is moist (i.e. there is a slight dampness when squeezed in the hand) but it does not significantly change colour (darken) on further wetting, and clods break up/crumble readily when squeezed in the hand rather than forming into a ball means **soil handling can take place**
- If the sample is dry, it looks dry and changes colour (darkens) if water is added, and it is brittle means **soil handling can take place**

ii) Consistency

First Test

Attempt to mould soil sample into a ball by hand:

- Impossible because soil is too dry and hard or too loose and dry means soil handling can take place
- Impossible because the soil is too loose and wet means no soil handling to take place
- Possible - GO TO SECOND TEST

Second Test

Attempt to roll ball into a 3mm diameter thread by hand:

- Impossibe because soil crumbles or collapses means **soil handling can take place**
- Possible means **no soil handling to take place**

NB: It is impossible to roll most coarse loamy and sandy soils into a thread even when they are wet. For these soils, the Examination Test alone is to be used.

Box A.4 - Rainfall Criteria:

- In light drizzle soil handling many continue for up to four hours unless the soils are already at/ near to their moisture limit
- In light rain soil handling must cease after 15 minutes
- In heavy rain and intense showers, handling shall cease immediately

In all of the above, after rain has ceased, soil tests shall be applied to determine whether handling may re-start, provided that ground conditions are safe to do so.

interruptions from rainfall events. The soil based criteria set out in Box A.4 are to be used to determine whether soil handling should cease or be interrupted with the occurrence of rain.

A.4 All machines must be in a safe and efficient working condition at all times. The machines are to only work when ground conditions enable safe and efficient operation. Otherwise the operation is to be suspended until suitable remedial measures can be put in place.

A.5 The operation should follow the detailed stripping plan set out in the SRMP showing soil units to be stripped, haul routes and the phasing of vehicle movements. The different soil units to be kept separate are to be marked out and information to distinguish types and layers, and ranges of thickness needs to be conveyed to the operational supervisor/operator. The haul routes and soil storage areas must be defined and should be stripped first in a similar manner. Detailed daily records should be kept of operations undertaken, and site and soil conditions.

A.6 Within each soil unit the soil layers above the base/formation layer are to be stripped in sequential strips with the topsoil layer stripped first, followed by the subsoil layers; each layer stripped to its natural thickness without incorporating material from the lower layers. The next strip is not started until the current strip is completely stripped to the basal layer. The system involves the progressive stripping of the soil in strips (**Figure A.1**).

Box A.5

In doing so, compaction by the excavator is largely restricted to the upper layer of soil, which is more easily treated after the soil has been relaid. The degree of topsoil compaction will depend on the machine's ground pressure, its mode of operation and soil wetness. Smaller wide tracked excavators may cause less compaction.

Box A.6

For hard/stony soils toothed buckets are needed. Where the mixing of soil layers at their interface is to be minimized, a bucket with a 'blade' is preferable where the soil is 'soft' and free of large stones or stone free. Where there is a watching archaeological brief, the use of bladed buckets will normally be required.

Similarly the choice of bucket type, whether it is a standard 'digging'/bulking or wide ditchingtype will depend on the soil strength and stoniness.

A.7 Unless specified in the SRMP, the excavator is only to work on the topsoil layer and the dump trucks are only to travel on the basal/formation layer (Box A.5).

A.8 Stripping is to be undertaken by the excavator standing on the surface of the topsoil and digging the topsoil to its maximum depth, and it loading into dump trucks. The dump trucks draw alongside the exposed soil profile, standing and travelling only on the basal layer (**Figure A.2**). The type of bucket to be used largely depends on the nature of the soil (Box A.6).

A.9 The initial strip width and axis should be demarcated. The strip width is determined by the length of the excavator boom less the stand-off to safely operate; typically, about 3-4m (Box A7). Excavators with long booms ('long reach') can be used, but may be more restricted by gradient limitations, and require skilled and experienced operators.

A.10 Topsoil should be recovered to the full width of the strip without mixing with the underlying subsoil (not more than 20% of the lower horizon should be exposed at the layer junction within the strip). The thickness and identification of the horizon junction must be verified before and during stripping. The full thickness of the topsoil horizon should be stripped progressively along the strip before the underlying subsoil horizon(s), if present, is to be started (**Figure A.2**).

A.11 The (upper) subsoil in the current strip is then to be stripped and monitored in the same manner. The final 25cm of the subsoil layer should be left as a step to protect the adjacent topsoil layer from local collapses. On completion, the process is to be repeated if there is a lower subsoil, and then any other lower layer to be recovered as a soil material (**Figure A.3**).

Box A.7 - Orientation of the Excavator

Usually the excavator is orientated and operates with its tracks at 90^{O} to the axis of the bed being stripped as this is the most stable position.

Whilst the reach of the boom and hence the width of the bed/strip can be significantly increased and the excavator traffickiing over the soil surface decreased by orientating it with the tracks parallel to the soil being stripped, this may affect the stability of the excavator, particularly on a gradient or where soils have a low bearing capacity. Hence its safe deployment needs to be checked before its adoption.

A.12 On completion of the strip, the procedures are repeated sequentially for each subsequent strip until the soil to be stripped is completely removed.

A.13 Where the soils are to be directly replaced (without storage in mounds), the initial strip of the upper horizons will have to be stored temporarily to

release the lowest layer and enable the sequential movement of materials. The stored initial soil material would normally be placed on the lower layer removed from the final strip at the end of the programme or on partially completed profiles if rain interrupted the operation.

A.14 Where the stripping operation is likely to be interrupted by rain, or there is likely to be over-night rain, remove any exposed subsoil down to the basal layer before suspending operations. Make provisions to protect base of current or next strip from ponding/runoff by sumps and grips, and also clean and level the basal layer. At the start of each day ensure there is no ponding in the current strip or operating areas, and the basal layer is to level with no ruts.

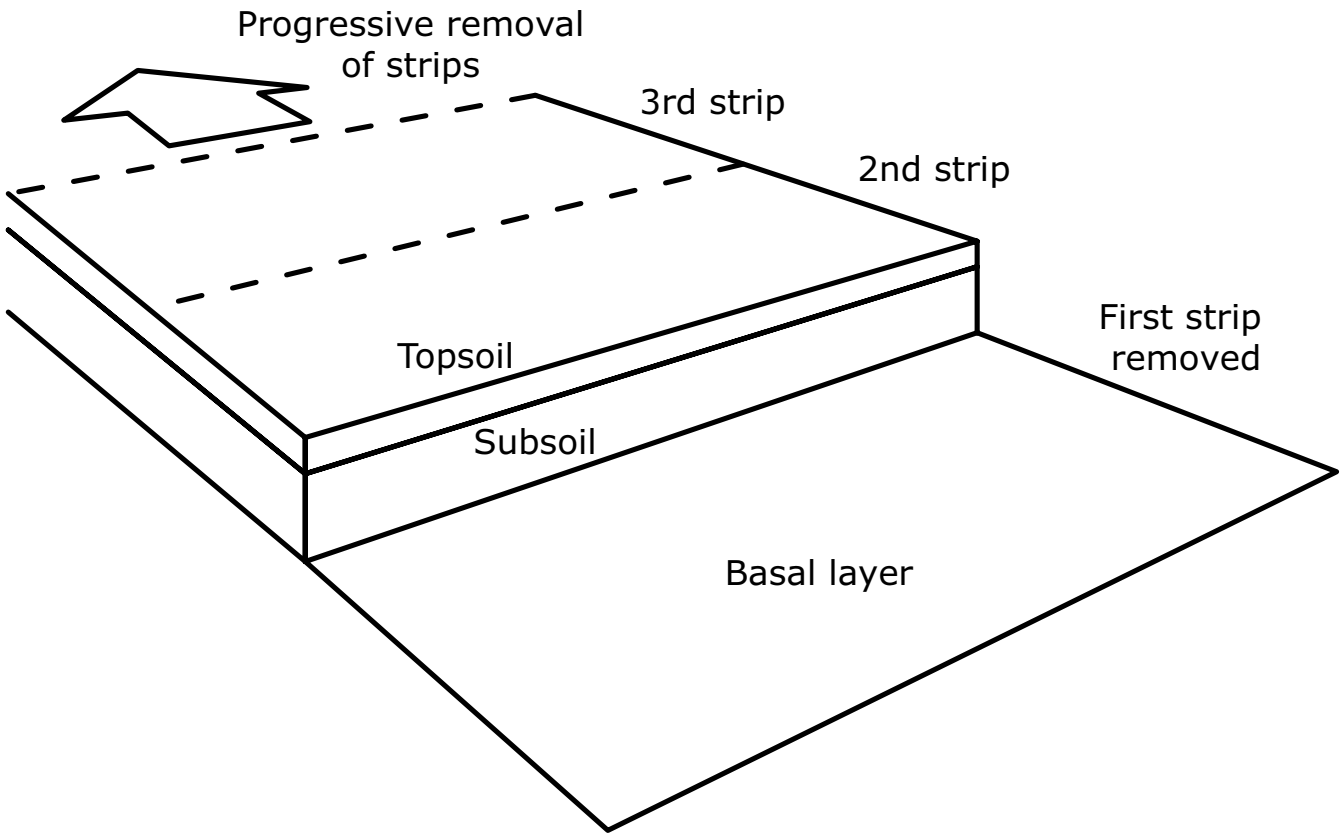

Figure A.1: Soil stripping with excavators and dump trucks: The bed system.

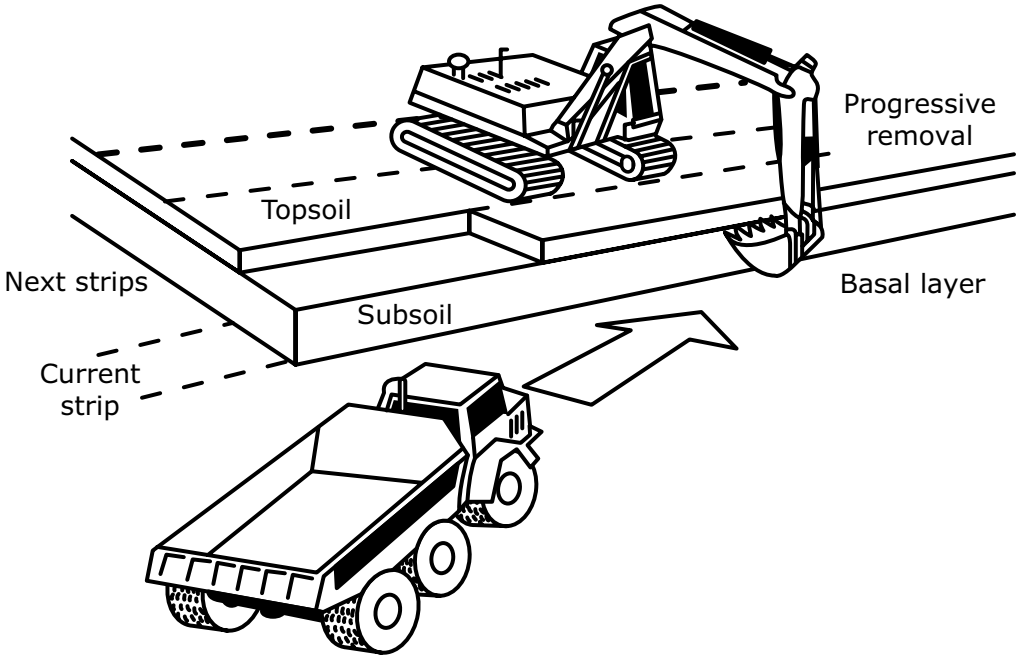

Figure A.2: Stripping with excavators and dump trucks: removal of topsoil from a strip.

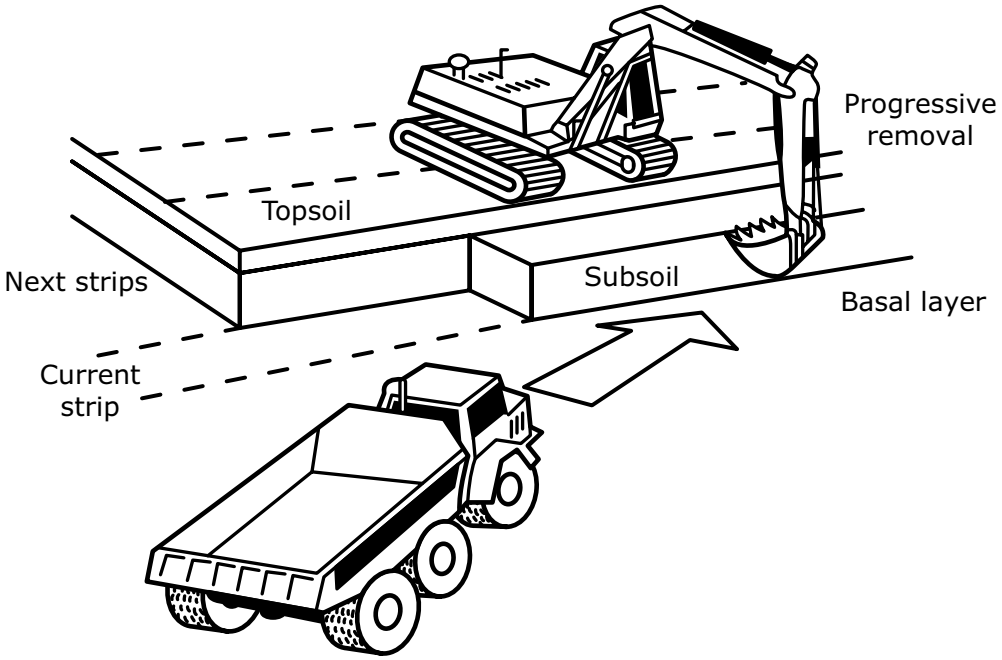

Figure A.3: Stripping with excavators and dump trucks: removal of subsoil from a strip.

GOOD PRACTICE GUIDE FOR HANDLING SOILS

In Mineral Workings

PART TWO: Model Methodology

- Sheet B -

Building Soil Storage Mounds
with Excavators and Dump Trucks

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Supporting artwork was provided by R Shelton (H J Banks & Co)
and D Fisher (Blue Room Graphics Ltd).

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Preface

The purpose of Sheet B of the guidance is to provide a model method of best practice where excavators and dump trucks are to be used to build soil storage mounds.

The guidance is intended for use by planning officials, statutory consultees, mineral operators and their supporting teams and specialist consultants, and earth-moving contractors, their site supervisors and machine perators.

Successful soil handling schemes are dependent on the soil resources being clearly identified and the conditions in which they are to be handled. This information should be contained in the Soil Resource & Management Plan (SRMP) and communicated to those involved in its implementation.

Key issues to be addressed are:

i) Avoiding conditions when soils are wet/ plastic during handling
ii) The minimisation of soil compaction caused by trafficking and soil wetness
iii) Using appropriate remedial treatments where these are necessary
iv) Minimising soil loss, and mixing of soil layers or different soil types.

The SRMP should specify the type of earth-moving machinery and soil handling practice, and the soil wetness condition (see Part One of the Guidance) to be deployed to achieve the planned after use, soil functioning, and the environmental and ecosystem services. It is to be communicated in full to all involved and in particular to the supervisors and machine operators by appropriate means; including tool-box talks and site demonstrations. Supervision by trained supervisory staff is essential, as are monitoring and reporting.

The guidance does not specify the size or model of equipment as this is left to the mineral operator and contractor to specify and provide. The machines must be of a kind which are appropriate for the task and the outcomes required, and to be able to carry out the work safely and efficiently.

Should the agreed methodology need to be modified or changed significantly, this should be agreed in advance with the mineral planning authority. The SRMP should include a mechanism whereby unexpected less significant changes can be quickly resolved through consultation between the operator, the planning authority and statutory consultee, and soil specialist.

All persons involved in the handling of soils must comply with all relevant legislation with respect to Health and Safety, in particular the Health and Safety at work Act 1974 and in the case of mineral extraction operations, The Quarries Regulations 1999 and its relevant statutory provisions; in particular those aspects which relate to the construction and removal of tips, mounds and similar structures. These requirements take preference over any suggested practice in this Sheet and the SRMP should have taken these into account.

The users of this guidance are solely responsible for ensuring it complies with all safety legislation and good practice, including the manufacturer's specifications for the safe operation of the specific machines being used, and that all machines are in a good condition and well maintained and are suitable for the task. It is important that those involved in the operation of earth moving machines are competent and have the necessary training and certification.

Introduction

This soil handling method uses back-acting excavators to build the storage mound in combination with dump trucks to transport the soil. Either the excavator sits on the basal layer and casts the tipped soil into a mound or it sits on the tipped soil and pulls it into a mound. The latter is preferred as it is easier to form the mound. In many cases low ground pressure bulldozers are used to grade and trim the finished mound.

Top- and subsoil(s) are to be stored in separate mounds or in clearly defined parts of mounds, in some circumstances where the topsoil can be easily recovered it may be laid over the subsoil.

The space available for storage in mineral workings is often limited and this determines the 'height' of mounds. For topsoil the preference is for 1 to 3m height in order to minimize the impact of storage on biological processes, whereas for subsoils where the biological activity is lower, subject to safe operations, mounds are often raised to heights of 3 to 5m depending on the resilience of the soils to compaction (see Part One & Supplementary Note 3).

In this soil handling option, the mounds are either built as one 'tier' or 'multi-tier' high. In the single tier only the excavator and if used the bulldozer traffic the tipped soil surface and usually the final surface. Whilst, in the multi-tier mounds it is also trafficked by loaded dump trucks.

Advantages & Disadvantages

Storage vs Direct Placement:

The advantages of storage are:

i) It gives flexibility in the operation of the mineral site

ii) Flexibility (i.e. weather and ground conditions) for when it is reused.

The disadvantages are:

i) There is an high risk of compaction of the soil material by stacking in the mound which later cannot be effectively treated

ii) There may be significant degradation of biological functions with long-term storage.

Single vs Multi-tier Mounds:

The advantage of multi-tier mounds is that they take less space.The disadvantages are:

i) With multi-tier mounds there is high risk of severe compaction of the soil material layers by repeated trafficking by laden dump trucks in the building of multi-tier mounds which later cannot be effectively treated

ii) There may be a longer delay in recovery of the soil's biological functions on replacement.

Suitability

Soil storage is less suitable where:

i) The subsoil(s) are significantly less resilient to compaction (such as silts and sandy clay loams) and when decompaction treatments cannot be relied upon to be effective because of a risk of soil wetness or operational limitations (such as the unavailability of effective decompaction tools) (see **Part One and Supplementary Notes 3 & 4**)

ii) The intended after use, environmental and ecosystem services are dependent on maintaining functional characteristics such as soil porosity and hence drainage and aeration, plant available water capacity, and low resistance to plant root growth. This usually includes the most productive agricultural, horticultural and forestry land, many types of natural habitats, and where water storage/infiltration is of importance for the risk of flooding

iii) The bed/strip practice using excavators is used (Sheet A) as the compaction caused can negate its benefit

iv) Multi-tier mounds are used, particularly where the intended after use, and the environment and ecosystem services are dependent on maintaining functional characteristics such as soil porosity and hence drainage and aeration, plant available water capacity, and low resistance to plant root growth. This usually includes the most productive agricultural and forestry land, many types of natural habitats, and where water storage/infiltration is of importance for the risk of flooding.

MODEL METHODOLOGY

B.1 Key operational points to minimize the risk of severe soil compaction and soil wetness are summarised in Boxes B.1 and B.2.

Box B.1 - To minimize compaction:

- strip in advance the soil to basal layer along haul routes and the operational footprint of the storage mound
- dump trucks are only to stand and travel on the basal layer (unless raising the next level in multi-tier mounds)
- the machines are to only work when ground or soil surface conditions enable their efficient operation
- single-tier mounds should be prioritised over multi-tier mounds as it avoids the need for trafficking on the soil being stored
- raise the soil using only the excavator and maximise the mound height before trucks allowed to access upper surface
- in the raising of multi-tier mounds, trafficking is to be confined to the upper surface of the lower tier. This layer will require decompaction on excavation of the mound.

B.2 The timing of the building of the soil storage mounds will be governed by the weather and soil conditions governing stripping (see **Sheets A, E, F, I**). Unless the soils are required to be kept in a wet state (eg peat), the mounds should be sited on dry ground, not in hollows and should not disrupt local surface drainage (Box B.3). Where necessary mounds should be protected from run-off/ponding by a cut-off ditch which is linked to appropriate water discharge facilities. Where the storage mound is in a hollow due to the removal of surface soils, measures should be undertaken to ensure that water is not able to pond within the storage area.

B.3 All machines must be in a safe and efficient working condition at all times. The machines are to only work when ground conditions enable safe and efficient operation. Otherwise the operation is to be suspended until suitable remedial measures can be put in place.

Box B.2 - To minimize the wetting of soils:

- soil mounds to be built in dry/draining/drained locations and protect from run-off from adjacent areas
- raise the soil mound to maximum height progressively along the axis of the mound, and shape the mound as it is being built to shed water and seal exposed surfaces whenever stripping is suspended
- measures are required to protect the face of the soil layer from ponding of water and maintain the basal layer in a condition capable of supporting dump trucks.

Box B.3

Where soils such as peat need to be kept in a wet condition this may require storage in (bunded) cells where receiving rainfall cannot drain.

B.4 The operation should follow the detailed stripping/storage plan set out in the SRMP showing soil units to be stripped, haul routes and the phasing of vehicle movements. Different soil units to be kept separate are to be marked out and information to distinguish types and layers, and ranges of thickness needs to be conveyed to the operational supervisor/operator. The haul routes and soil storage areas must be defined and should be stripped first in a similar manner. Detailed daily records should be kept of operations undertaken, and site and soil conditions.

B.5 Adopting the practices outlined in **Sheet A**, where relevant, remove topsoil and subsoil to basal layer from the haul routes, footprint of the storage mound and any other operating area in advance. The soils should be stored in their respective mounds.

B.6 The dump trucks must only travel within the haul route and operational areas. Typically the trucks should enter the storage area, reverse and tip the soil load starting at the furthest point of the

mound from the point of access. The back- acting excavator pulls up the soil into a mound of the required dimensions (Box B.4). The excavator operates by standing on the mound (**Figure B.1**) or the stripped basal layer. The excavator bucket can be used to shape and firm the sides as the mound is progressively formed to promote the shedding of rain.

B.7 The process is repeated with the tipping of soil against the forming mound, and without the dump truck wheels traversing onto previously tipped material. The operation continues progressively along the main axis of the mound.

Box B.4 - Choice of Bucket Type

For hard /stony soils toothed buckets are needed. Where the mixing of soil layers at their interface is to be minimized, a bucket with a 'blade' is preferable where the soil is 'soft' and free of large stones or stone free. Where there is a watching archaeological brief, the use of bladed buckets will normally be required.

Similarly, the choice of bucket type, whether it is a standard 'digging'/bulking or wide ditching type will depend on the soil strength and stoniness.

B.8 Without the trucks rising onto the soil mound, the maximum possible height and width of the mound is related to the boom reach of the excavator (typically about 3-4m). Excavators with long booms ('long reach') can be used, but may be more restricted by gradient limitations, and require skilled and experienced operators.

B.9 To raise the mound higher, as a multi-tier mound, the trucks will have to travel on the upper surface of the mounded soils (first tier). In this case the mound should be raised to its maximum height (**Figure B.2**). A ramp will have to be provided for the trucks to rise onto the surface of the first tier, which should be capable of trafficking safely and without difficulty. The next tier would be formed repeating the process described above.

B.10 If further tiers are required, the process would be repeated. Any exposed edges/surfaces should be shaped using the excavator bucket on the onset of rain during the day, this should include any exposed incomplete surfaces. All surfaces should be shaped to shed water at the end of the day. The final outer surface should be progressively shaped using the excavator bucket or low ground pressure bulldozer to promote the shedding of rain.

B.11 Work should stop in wet conditions (Box B.5) with measures undertaken to shed water from the soil surfaces and to prevent ponding at the base of the mound and on the basal layer. At the start of each day ensure there is no ponding on the basal layers and operating areas.

Box B.5 - Rainfall Criteria

- In light drizzle soil handling may continue for up to four hours unless the soils are already at/ near to their moisture limit
- In light rain soil handling must cease after 15 minutes
- In heavy rain and intense showers, handling shall cease immediately

In all of the above, after rain has ceased, soil tests shall be applied to determine whether handling may re-start, provided that the ground is free from ponding and ground conditions are safe to do so.

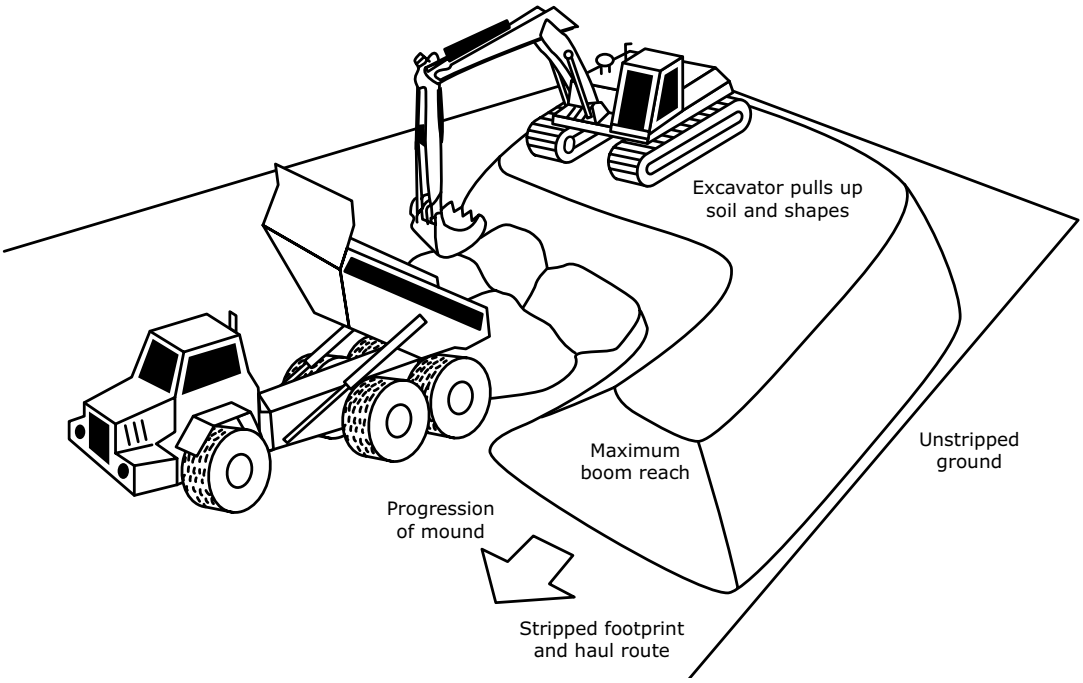

Figure B.1: Soil storage mound construction with excavators and dump trucks: Single tier mound.

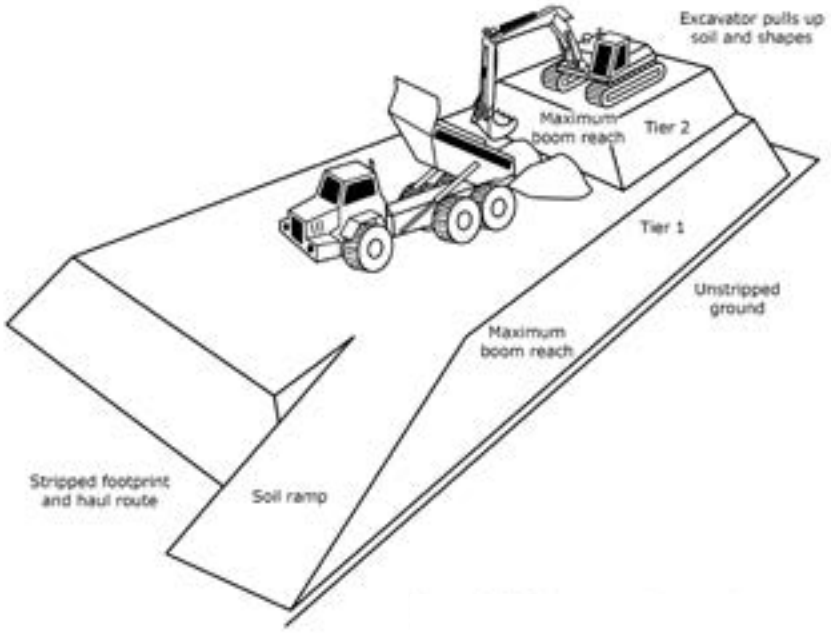

Figure B.2: Soil storage mound construction with excavators and dump trucks: Multi-tier mound.

GOOD PRACTICE GUIDE FOR HANDLING SOILS

In Mineral Workings

PART TWO: Model Methodology

- Sheet D -

Soil Replacement with Excavators and Dump Trucks
- Sequential Bed/Strip Practice

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Supporting artwork was provided by R Shelton (H J Banks & Co)
and D Fisher (Blue Room Graphics Ltd).

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Preface

The purpose of Sheet D of the guidance is to provide a model method of best practice where excavators and dump trucks are to be used to replace soil using the sequential 'bed'/strip by strip practice.

The guidance is intended for use by planning officials, statutory consultees, mineral operators and their supporting teams and specialist consultants, and earth-moving contractors, their site supervisors and machine operators.

Successful soil handling schemes are dependent on the soil resources being clearly identified and the conditions in which they are to be handled. This information should be contained in the Soil Resource & Management Plan (SRMP) and communicated to those involved in its implementation.

Key issues to be addressed are:

i) Avoiding conditions when soils are wet/ plastic during handling
ii) The minimisation of soil compaction caused by trafficking and soil wetness
iii) Using appropriate remedial treatments where these are necessary
iv) Minimising soil loss, and mixing of soil layers or different soil types

The SRMP should specify the type of earth-moving machinery and soil handling practice, and the soil wetness condition (see Part One of the Guidance) to be deployed to achieve the planned after use, soil functioning, and the environmental and ecosystem services. It is to be communicated in full to all involved and in particular to the supervisors and machine operators by appropriate means; including tool-box talks and site demonstrations. Supervision by trained supervisory staff is essential, as are monitoring and reporting.

The guidance does not specify the size or model of equipment as this is left to the mineral operator and contractor to specify and provide. The machines must be of a kind which are appropriate for the task and the outcomes required, and to be able to carry out the work safely and efficiently.

Should the agreed methodology need to be modified or changed significantly, this should be agreed in advance with the mineral planning authority. The SRMP should include a mechanism whereby unexpected less significant changes can be quickly resolved through consultation between the operator, the planning authority and statutory consultee, and soil specialist.

All persons involved in the handling of soils must comply with all relevant legislation with respect to Health and Safety, in particular the Health and Safety at work Act 1974 and in the case of mineral extraction operations The Quarries Regulations 1999 and its relevant statutory provisions; in particular those aspects which relate to the construction and removal of tips, mounds and similar structures. These requirements take preference over any suggested practice in this Sheet and the SRMP should have taken these into account.

The users of this guidance are solely responsible for ensuring it complies with all safety legislation and good practice, including the manufacturer's specifications for the safe operation of the specific machines being used, and that all machines are in a good condition and well maintained and are suitable for the task. It is important that those involved in the operation of earth moving machines are competent and have the necessary training and certification.

Introduction

In this soil handling option, back-acting excavators are used to replace the soil resources tipped from dump trucks at the area being restored.

The replacement practice involves the sequential building up of the individual layers of soil identified in the Soil Resource & Management Plan (SRMP) as vertical slices through the soil profile and advancing as successive strips. Hence, the practice is often referred to as the 'Strip' or 'Bed' method.

The lower layer (subsoil) is placed first within the safe and efficient operational reach of the excavator boom which defines the width of each strip. For each subsequent soil layer, the process is repeated until the top layer (usually topsoil) is placed. When the soil resource/profile sequence within the strip is completely replaced, the process is repeated on the next strip to be replaced with soil and until the whole receiving area is completed. The following guidance can also be adopted where only a single soil horizon is to be replaced.

Unlike the stripping and storage practices, the replacement of soils is usually in concert with other work to remediate soil conditions such as compaction (**Sheets N & O**) and removal of stones/non-soil debris (**Sheets L & M**) to facilitate the intended after use, soil functions, and environmental and ecosystem service provisions. These actions have their own practices which need to be integrated into this model methodology of soil handling. The need for these will have been specified in the SRMP and/or in soil replacement conditions attached to the planning consent, or as determined by the soil specialist during the soil stripping/storage/replacement operations.

Advantages & Disadvantages

The advantages of this machinery combination and handling practice are:

i) Provided the soils are not put into storage mounds, it is the most likely to result in soil profiles with the least compacted soils, which may not require remedial treatment or only minimal of action, as trafficking on the relayed soils is avoided
ii) It can be easier to create localised changes in soil types and variation in horizon depth
iii) It is suited both to the replacement of deep and uniform soils (including peat) as well as thin and 'patterned' soil layers
iv) It is more flexible and quicker in responding to stoppages and restarts due to wet weather
v) There is a greater certainty that a transpiring vegetation cover can be established during the soil replacement programme

The disadvantages are:

i) That it requires greater supervision, skill and discipline in its deployment, and is best suited to experienced operators
ii) Without good control and regular monitoring of soil layer depths, use of profile boards or machine fitted GPS it can be harder to gauge the rate of use of soil resource
iii) There is a risk of some soil 'loss' and mixing of soil horizons at the exposed edges of multi-layered soils as the profile is built up
iv) The bed system involving sequential remedial works may take longer to complete than other practices and machinery options
v) Steep gradient/complex topographies may limit the safe and practical deployment of this handling practice

Suitability

The excavator-dump truck combination with the bed/strip handling practice methodology is considered 'best practice' by Natural England and the Welsh Government for agricultural soils and preferable for all soils. In particular, it is the most suitable of any of the methods available where:

i) The soil is prone to compaction and where decompaction treatments cannot be relied upon to be effective
ii) The intended after use, environmental and ecosystem services are dependent on soils maintaining their functional characteristics such as, porosity and hence drainage and aeration, plant available water capacity, and low resistance to plant root growth. This includes productive agricultural, horticultural and forestry land, many types of natural habitats, and where water storage/infiltration is of importance for the risk of flooding. Where the soils are stored prior

to replacement some remedial treatment may have to be relied upon

iii) As the bed/strip method offers the most flexibility in respect of short soil drying periods and likely wet weather, and can be less prone to delays and stoppages, it is particularly suited the wetter geographical locations

iv) The full benefit of the practice for soils lies in their direct placement, this requires the mineral extraction scheme to be organized to minimize the need for soils storage.

MODEL METHODOLOGY

Basic Soil Replacement Operation

D.1 The following is the basic model methodology using excavators and dump trucks and the bed/strip practice. It is presented here, firstly without any remedial interventions to give clarity of the methodology. Further on the methodology is repeated to demonstrate how the interventions can be integrated in to the soil replacement process.

D.2 Key operational points to minimise the risk of severe soil compaction and soil wetness are summarised in Boxes D.1 and D.2.

D.3 The timing of soil handling operations in England and Wales is set out in **Part One, Supplementary Note 4**. For directly placed soils this will use the in situ soil wetness protocol for soil stripping operations to determine the timing for soil replacement (Box D.3). For soil that has been stored, the relaying operation should be governed by the weather (rainfall) criteria set out in Box D.4. Here, the operation will generally need to be completed no later than the end of September unless the establishment of a satisfactory vegetation cover can be assured.

D.4 Soil handling is not to take place during rain, sleet or snow and in these conditions should be prohibited if unsafe for machine operations. Prior to commencing operations, a medium/long term weather forecast should be obtained which gives reasonable confidence of soil handling being completed without significant interruptions from rainfall events. The soil based criteria set out in Box D.4 are to be used to determine whether soil handling should cease or be interrupted with the occurrence of rain.

Box D.1 - To minimise compaction:

- The dump trucks should only operate on the 'basal'/non-soil layer and not run on the replaced soil layer(s)
- The excavator must only operate on the basal layer
- The machines are to only work when ground conditions enable their efficient operation
- If compaction has been caused, then measures are required to treat it (see **Sheets N & O**).

Box D.2 - To minimise soil wetness and re-wetting:

- The bed/strip system provides a basis to regulate the exposure of lower soil layers to periods of rain and a means of maintaining soil moisture contents. The soil profile within the active strip should be completed including the topsoil layer before rainfall occurs and before replacement is suspended
- Measures are required to protect the face of the soil layer from ponding of water and maintain the basal layer in a condition capable of supporting dump trucks
- The area to be restored is to be protected from in-flow of water, ponding etc. Wet sites must be drained in advance. Before the operation starts the basal layer should be to level and clean.

D.5 All machines must be in a safe and efficient working condition at all times. The machines are to only work when ground conditions enable their efficient operation. The work should only be carried out when the basal layer supports the machinery without ruts or is capable of repair/maintenance. Otherwise the operation is to be suspended until suitable remedial measures can be put in place.

D.6 The operation should follow the detailed SRMP replacement plan showing the soil units to be replaced, haul routes and the phasing of vehicle movements. The soil units should be defined on the site with information to distinguish types and layers,

Box D.3 - Test for Dry and Friable Soils

Soil tests are to be undertaken in the field. Samples shall be taken from at least five locations on the soil handling area and at each soil horizon to the full depth of the profile to be recovered/replaced. The tests shall include visual examination of the soil and physical assessment of soil consistency.

i) Examination

- If the soil is wet, films of water are visible on the surface of soil particles or aggregates (e.g. clods or peds) and/or when a clod or ped is squeezed in the hand it readily deforms into a cohesive 'ball' means **no soil handling to take place**
- If the sample is moist (i.e. there is a slight dampness when squeezed in the hand) but it does not significantly change colour (darken) on further wetting, and clods break up/crumble readily when squeezed in the hand rather than forming into a ball means **soil handling can take place**
- If the sample is dry, it looks dry and changes colour (darkens) if water is added, and it is brittle means **soil handling can take place**

ii) Consistency

First Test

Attempt to mould soil sample into a ball by hand:

- Impossible because soil is too dry and hard or too loose and dry means soil handling can take place
- Impossible because the soil is too loose and wet means no soil handling to take place
- Possible - GO TO SECOND TEST

Second Test

Attempt to roll ball into a 3mm diameter thread by hand:

- Impossibe because soil crumbles or collapses means **soil handling can take place**
- Possible means **no soil handling to take place**

NB: It is impossible to roll most coarse loamy and sandy soils into a thread even when they are wet. For these soils, the Examination Test alone is to be used.

Box D.4 - Rainfall Criteria:

- In light drizzle soil handling may continue for up to four hours unless the soils are already at/near to their moisture limit
- In light rain soil handling must cease after 15 minutes
- In heavy rain and intense showers, handling shall cease immediately

In all of the above, after rain has ceased, soil tests shall be applied to determine whether handling may re-start, provided that the ground is free from ponding and ground conditions are safe to do so.

and thickness and conveyed to the operational supervisor/operator. Different soil units to be kept separate are to be marked out and information to distinguish types and layers, and ranges of thickness needs to be conveyed to the operational supervisor/operator. Detailed daily records should be kept of operations undertaken and site and soil conditions.

D.7 The excavator and dump trucks are only to stand, work and travel on the basal/formation layer.

D.8 The soil layers above the base/formation layer are to be replaced in sequential strips with the sub-soil layer(s) replaced first, followed by the topsoil layer, each layer being replaced to the specified thickness. The next strip is not to be started until the profile in the current strip is completed. This is often referred to as the 'bed' or 'strip' system which involves the progressive sequential laying of the soil in strips across the area to be restored (**Figure D.1**).

D.9 The initial strip width and axis is to be demarcated. The strip width is determined by excavator boom length less the stand-off to operate; typically, about 3-4m (Box D.5). Excavators with long booms ('long reach') can be used, but may be more restricted by gradient limitations, and require skilled and experienced operators.

D.10 The preferred type of bucket to place the soils is usually a digging/bulking bucket with an attached blade or a wide ditching bucket, but a toothed

bucket can be used.

D.11 Profile boards should be used to control soil horizon thickness in each strip and overall levels achieved verified using soil pits. Allowances (i.e. a bulking factor) should be made for any settlement that may take place of the replaced loose soil.

Box D.5 - Orientation of the Excavator

Usually, the excavator is orientated and operates with its tracks at 90° to the axis of the bed being stripped as this is the most stable position. Whilst the reach of the boom and hence the width of the bed/strip can be significantly increased by orientating it with the tracks parallel to edge of the soil being spread, this may affect the stability of the excavator, particularly on a gradient or where the basal layer has a low baring capacity. Hence, its safe deployment needs to be checked before its adoption.

D.12 The dump trucks reverse up to edge of the current strip and tip the lowest layer (subsoil) soil, without the wheels riding onto the strip (**Figure D.1**). The dump truck should not drive away until all the soil is deposited within the strip without spillage over the basal layer; this may require assistance from the excavator to 'dig away' some of the tipped soil (**Figure D.2**). The excavator is to spread the tipped soil to full thickness by digging, and using the pushing and pulling action of bucket.

D.13 Each load of soil should be spread following tipping before another is tipped. Should the spread soil comprise of large blocks (>300mm), normally these should be broken down by using the excavator bucket into smaller pieces before the next load is spread. The process is repeated until the strip is completely covered with the required depth of the soil layer (**Figure D.3**).

D.14 On completion of the lowest (subsoil) layer, repeat the process spreading the next layer (subsoil/ topsoil) (**Figure D.4**). Tip the soil by reversing to the outer edge of strip/soil previously laid, but without the truck wheels riding onto the already placed layer (see Box D.6 for deep soil profiles). The soil is to be spread by the excavator to full thickness by digging, and using the pushing and pulling action of bucket described above. Repeat the process progressively along the strip. Profile boards should be used to control the soil thickness in the strip and overall levels.

D.15 Where the profile is made up of further soil layers (subsoil/topsoil) the above process should be repeated on completion of the strip.

BOX D.6 - Soil Profiles Greater Than 1m Thickness

When the replaced soil profiles reach about 1m in height from the basal layer it may not be possible to discharge the load from smaller dump trucks directly onto the previously placed lower layers because of the height of the dump truck body. The preferred solution is to tip the soil against the partially completed profile as heaps without the dump trucks rising onto or reversing into the placed material. The soil material is then lifted by the excavator onto the profile. It is considered preferable to accept some limited soil losses rather than to contaminate the topsoil with overburden. The loss of top-soil is minimised if the basal/ formation layer is kept to level and clean.

D.16 On completion of topsoil layer, the processes outlined above should be repeated for the next strips until the area to be restored is completed. Before the operation starts the basal layer should be to level and cleared of any residual soil.

D.17 At the end of each day the current strip must be completed if rain is forecast. If during a day it is evident that a full strip cannot be completed, then complete the part of a strip that has been started.

D.18 At the end of each day, or during the day if interrupted by rain, make provisions to protect base of restored strip from ponding/runoff by sumps and grips, and also clean and level the basal layer. At the start of each day ensure there is no ponding in the current strip or operating areas, and the basal layer is to level with no ruts.

Method with Integration of Remedial Actions

D.19 Usually there should be less of a need for remedial treatment during the replacement operation with this machinery combination and handling practice (unless the soils were compacted during stripping or storage). Where compaction occurs, treatment will need to be integrated into the replacement process as will the need for the removal of stones or non-soil debris. Both decompaction and the removal of materials are covered in **Sheets L to O**. Where required, the early installation of under drainage can either be integrated sequentially during the replacement of the soils or later during the aftercare period.

D.20 The placement of the stripped soils in storage is likely to result in compaction and negate this particular benefit of the handling practice. Box D.7 sets out some of the remedial options/combinations to facilitate decompaction, and where necessary, the removal of stones and non-soil debris for a final profile comprising a basal layer, subsoil and topsoil layers. Except for Option 3, these actions need to be undertaken sequentially as each soil strip is placed.

D.21 The following is the model methodology integrating the remedial interventions within the bed/strip handling practice.

D.22 The key operational points to minimise the risk of severe soil compaction and soil wetness are summarised in the above Boxes 1 and 2.

D.23 Prior to commencing operations a weather forecast should be obtained which gives reasonable confidence of soil replacement proceeding without interruptions from rainfall events (Box D.4).

D.24 If significant rainfall occurs during operations, the replacement must be suspended, and where the soil profile has been started it should be replaced to topsoil level. Replacement should not restart unless the weather forecast is expected to be dry for at least a full day and the soils are in a dry condition (Box D.3).

D.25 The operation should follow the detailed replacement plan in the SRMP showing the soil units to be replaced, haul routes and the phasing of vehicle movements. The soil units should be defined on the site with information to distinguish types and layers, and thickness and conveyed to the operational supervisor/operator. Different soil units to be kept separate are to be marked out and information to distinguish types and layers, and ranges of thickness needs to be conveyed to the operational supervisor/operator. Detailed daily records should be kept of operations undertaken and site and soil conditions (including the removal of stones and other non-soil debris that needs to be removed), and the results of the effectiveness of the work undertaken, and any need for additional remedial treatments.

Box D.7 - Integration of Decompaction & Stone/ Debris Removal

Option 1: is where the basal layer needs to be treated but is left until the subsoil is placed when both are decompacted together, followed by the decompaction of the topsoil and subsoil layers together (and basal layer) using tines that are long enough. This option is not suited to digging where the soil horizons would be mixed.

Option 2: is where each layer is treated separately by either tines or digging.

Option 3: is where the basal layer is treated or left untreated, followed by the placement of the subsoil and topsoil layers, which are to be decompacted by the use of tines. In the case of deep horizons this option can be limited by the capability of the machinery, the tines or bucket used. This option is not suited to digging where the soil horizons would be mixed.

D.26 The excavator and dump trucks are only to stand, work and travel on the basal/formation layer. Only where the remedial work involves the use of a bulldozer does machinery have to traffic the soil surface being treated, as the excavators work from the basal layer.

D.27 The soil layers above the base/formation layer are to be replaced in sequential strips with the subsoil layer(s) replaced first, followed by the topsoil

layer; each layer being replaced to the specified thickness. The next strip is not to be started until the profile in the current strip is completed. This is often referred to as the 'bed' or 'strip' system which involves the progressive sequential laying of the soil in strips across the area to be restored (**Figure D.1**).

D.28 The initial strip width and axis is to be demarcated. Strip width is determined by excavator boom length less the stand-off to operate; typically, about 3-4m (see Box D.5).

D.29 The preferred type of bucket to place the soils is usually a digging/bulking bucket with an attached blade or a wide ditching bucket. However, where a bucket is being used to decompact soils, it should be a 'digging' type and have teeth or a stone-rake type with multiple tines is to be used.

D.30 Where there is a requirement to treat compaction and/or remove stones/damaging materials in the basal layer, these need to be carried out along the demarcated strip prior to the first layer of soils being laid.

D.31 Decompaction of the basal layer can by digging with the excavator bucket or by bulldozer drawn tines (**Sheets N & O**). Stone removal may require prior ripping/digging to release them from the basal material, followed by the excavator using a stone-rake bucket (the stone to be loaded on a dump truck and removed (**Sheet L**).

D.32 Profile boards should be used to control soil horizon thickness in each strip and overall levels achieved verified using soil pits to verify. Allowances (i.e. a bulking factor) should be made for any settlement that may take place of the replaced loose soil.

D.33 On completion, the loaded dump trucks reverse up to edge of the current strip and tip the lowest layer subsoil without the wheels riding onto the strip (**Figure D.1**). The dump truck should not drive away until all the soil is deposited within the strip without spillage over the basal layer; this may require assistance from the excavator to 'dig away' some of the tipped soil (**Figure D.2**). The excavator is to spread the tipped soil to full thickness by digging, and using the pushing and pulling action of bucket.

D.34 Each load of soil should be spread following tipping before another is tipped. Should the spread soil comprise of large blocks (>300mm), normally these should be broken down by using the excavator bucket to break the blocks into smaller pieces before the next load is spread. The process is repeated from left to right until the strip is completely covered with the required depth of the soil layer (**Figure D.3**).

D.35 Where there is a requirement to treat compaction and/or remove stones/damaging materials in the subsoil layer, these need to be carried out along the demarcated strip prior to the next overlying layer of soils being laid. Decompaction can by digging with the excavator bucket or by bulldozer drawn tines (**Sheets N & O**). Stone removal may require prior ripping/digging to release them from the soil (particularly if it is wet), followed by the excavator using a stone-rake bucket (to be loaded on a dump truck and removed (**Sheet L**).

D.36 On completion of the lowest (subsoil) layer, repeat the process spreading the next layer (topsoil or upper subsoil) (**Figure D.4**). Where the profile is made up of further soil layers (subsoil/topsoil) the process outlined above should be repeated on completion of the strip. Tip the soil by reversing to the outer edge of strip/soil previously laid, but without the truck wheels riding onto the already placed layer (see Box D.6). The topsoil is to be spread by the excavator to full thickness by digging, and using the pushing and pulling action of bucket described above. Repeat the process progressively along the strip. Profile boards should be used and soil pits to verify soil thickness and overall levels in each strip.

D.37 Where there is a requirement to treat compaction in the topsoil layer within each strip as it is completed (see Box D.8), this can by digging with the excavator bucket or by bulldozer drawn tines (**Sheets N & O**). If required, stone removal may require prior ripping/digging to release them from the soil clods, followed by the excavator using a stone-rake bucket (the stone to be loaded on a dump truck

and removed) (**Sheet L**).

D.38 On completion of the topsoil layer the processes outlined above should be repeated for the next strips until the whole area to be restored is completed. Before the operation starts the basal layer should be to level and clean.
D.39 At the end of each day the current strip must be completed if rain is forecast. If during a day it is evident that a full strip cannot be completed, then complete the part of a strip that has been started.

Box D.8

It is important that the decompaction and any stone/debris is removed from the topsoil layer as each strip is completed. Leaving it until the entire area is soiled will mean that the equipment, and in particular where the dump trucks collecting stones, have to traffic the soil surface resulting in compaction of the topsoil and the underlying subsoil.

Decompaction might be undertaken from the topsoil surface once the placing of the soils is completed (see **Sheet O**). However, this only advisable where it is certain that it will be effective and no other earth-moving machinery is to traffic the replaced soil and that soil wetness and weather conditions are suitable (see **Part One, Supplementary Notes 3 & 4**).

D.40 At the end of each day, or during the day if interrupted by rain, make provisions to protect base of restored strip from ponding/runoff by sumps and grips, and also clean and level the basal layer. At the start of each day ensure there is no ponding in the current strip or operating areas, and the basal layer is to level with no ruts.

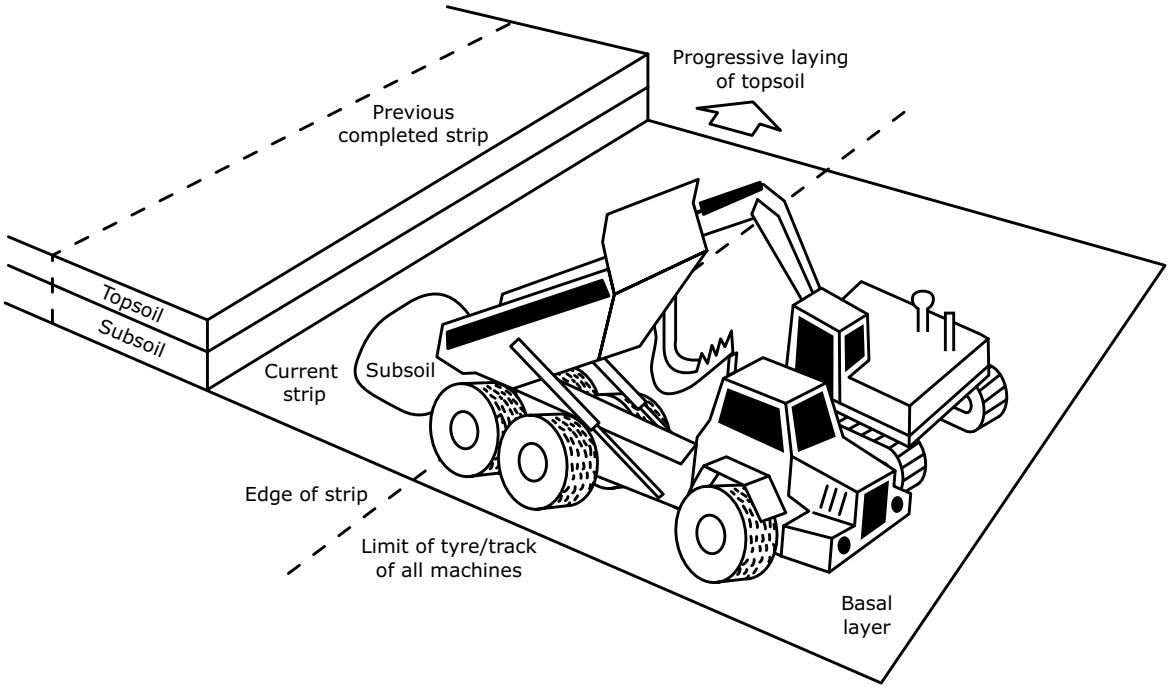

Figure D.1: Soil replacement with excavators and dump trucks: Subsoil layer.

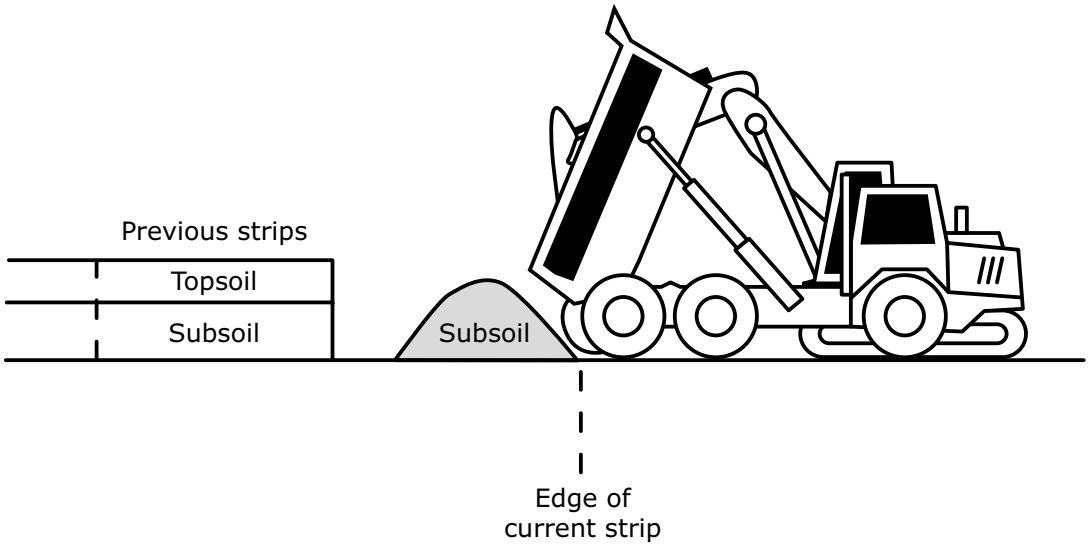

Figure D.2a: Soil replacement with excavators - dump trucks: Subsoil layer.

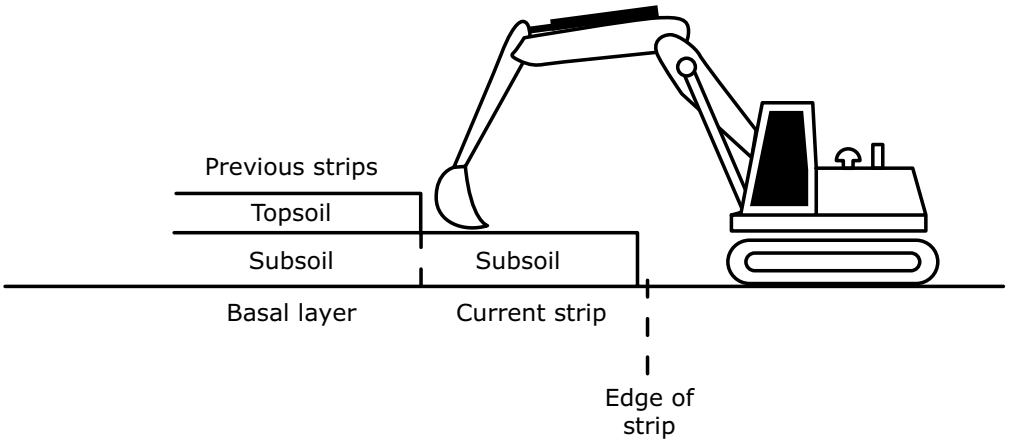

Figure D.2b: Soil replacement with excavators - dump trucks: Subsoil layer.

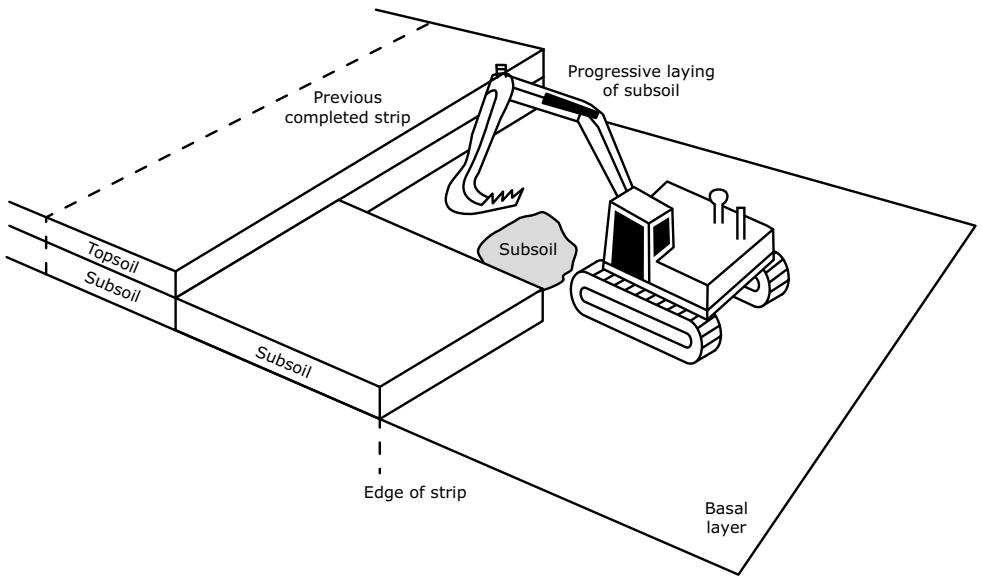

Figure D.3: Soil replacement with excavators and dump trucks: Subsoil progressively laid.

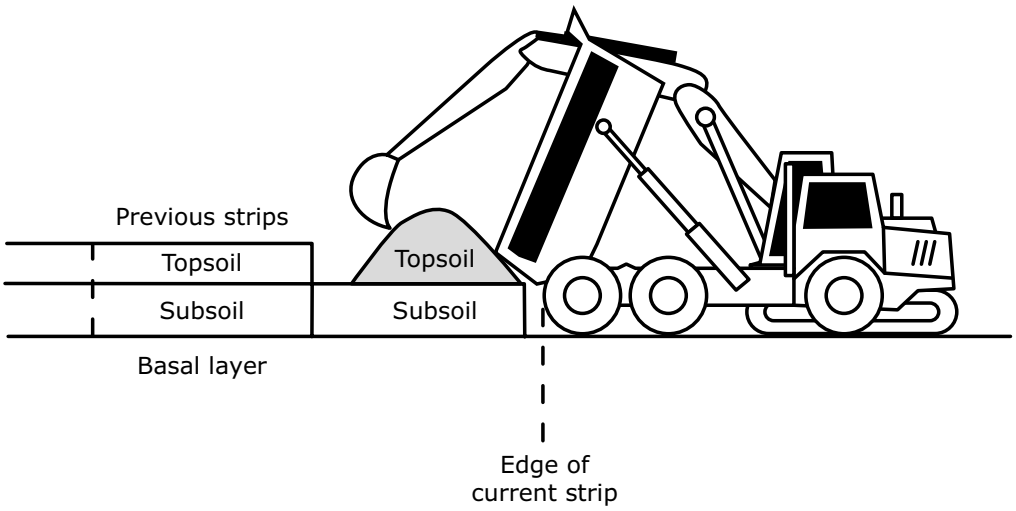

Figure D.4a: Soil replacement with excavators - dump trucks: Topsoil layer.

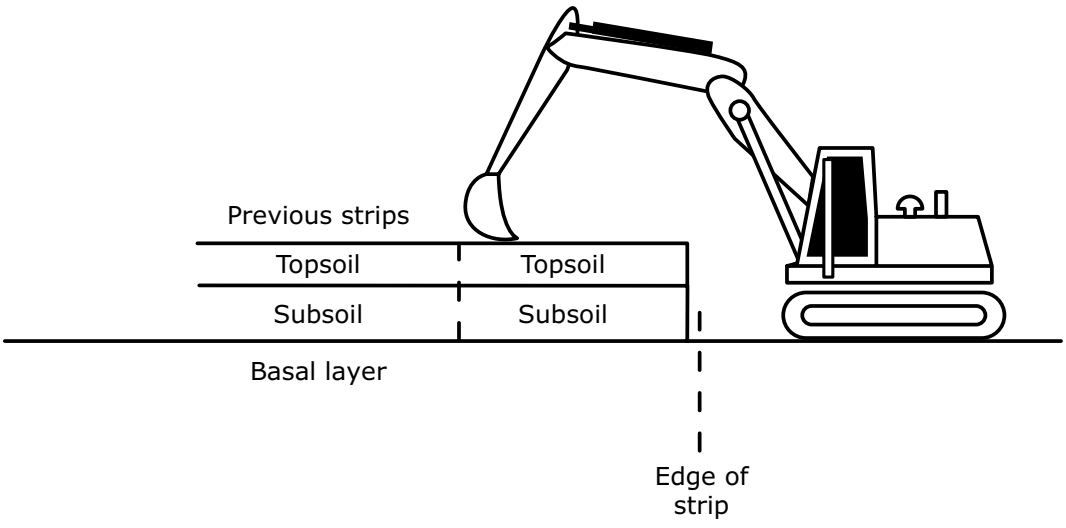

Figure D.4b: Soil replacement with excavators - dump trucks: Topsoil layer.

GOOD PRACTICE GUIDE FOR HANDLING SOILS

In Mineral Workings

PART TWO: Model Methodology

- Sheet E -

Soil Stripping with Excavators and Dump Trucks
- Windrow Practice

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Supporting artwork was provided by R Shelton (H J Banks & Co)
and D Fisher (Blue Room Graphics Ltd).

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Preface

The purpose of Sheet E of the guidance is to provide a model method of best practice where excavators and dump trucks are to be used to strip soil using the windrow practice.

The guidance is intended for use by planning officials, statutory consultees, mineral operators and their supporting teams and specialist consultants, and earth-moving contractors, their site supervisors and machine operators.

Successful soil handling schemes are dependent on the soil resources being clearly identified and the conditions in which they are to be handled. This information should be contained in the Soil Resource & Management Plan (SRMP) and communicated to those involved in its implementation.

Key issues to be addressed are:

i) Avoiding conditions when soils are wet/ plastic during handling
ii) The minimisation of soil compaction caused by trafficking and soil wetness
iii) Using appropriate remedial treatments where these are necessary
iv) Minimising soil loss, and mixing of soil layers or different soil types.

The SRMP should specify the type of earth-moving machinery and soil handling practice, and the soil wetness condition (see Part One of the Guidance) to be deployed to achieve the planned after use, soil functioning, and the environmental and ecosystem services. It is to be communicated in full to all involved and in particular to the supervisors and machine operators by appropriate means; including tool-box talks and site demonstrations. Supervision by trained supervisory staff is essential, as are monitoring and reporting.

The guidance does not specify the size or model of equipment as this is left to the mineral operator and contractor to specify and provide. The machines must be of a kind which are appropriate for the task and the outcomes required, and to be able to carry out the work safely and efficiently.

Should the agreed methodology need to be modified or changed significantly, this should be agreed in advance with the mineral planning authority. The SRMP should include a mechanism whereby unexpected less significant changes can be quickly resolved through consultation between the operator, the planning authority and statutory consultee, and soil specialist.

All persons involved in the handling of soils must comply with all relevant legislation with respect to Health and Safety, in particular the Health and Safety at work Act 1974 and in the case of mineral extraction operations, The Quarries Regulations 1999 and its relevant statutory provisions; in particular those aspects which relate to the construction and removal of tips, mounds and similar structures. These requirements take preference over any suggested practice in this Sheet and the SRMP should have taken these into account.

The users of this guidance are solely responsible for ensuring it complies with all safety legislation and good practice, including the manufacturer's specifications for the safe operation of the specific machines being used, and that all machines are in a good condition and well maintained and are suitable for the task. It is important that those involved in the operation of earth moving machines are competent and have the necessary training and certification.

Introduction

In this soil handling option, back-acting excavators are used to lift the soil resources gathered in 'windrows' and load them into dump trucks for the direct transport to an area being restored or to storage until needed.

The windrow stripping practice, sometimes referred to as the 'peninsular' method, involves the sequential separation and removal of the individual layers of soil identified in the Soil Resource & Management Plan (SRMP). The area to be stripped is divided into spaced parallel strips (windrows) where the soil between them is pulled from each side onto the strip acting as temporary repositories. The safe and efficient operational reach of the excavator boom defines the width between the windrows. The topsoil on the retreating surcharged windrows is then loaded systematically into the dump trucks by the excavator retreating towards the loading point on the haul route. On completing the removal of the topsoil, the exposed subsoil layer(s) is then recovered by the same procedure. The practice of stripping all the top-soil layer before starting the lower soil layers should be avoided as it increases the risk of rainfall events causing longer stoppages. The following guidance can also be adopted where only a single surface soil horizon is to be stripped.

Advantages & Disadvantages

The advantages of this machinery combination and handling practice are that:

i) It is a relatively simple operation to undertake and can be quicker than the bed/strip practice
ii) It can result a lower risk of severe compaction than the soil layer by layer practice, provided the soil is in a dry condition
iii) If the soil horizons are stripped sequentially for each windrow, it offers flexibility in respect of short soil drying periods and likely wet weather as it is less susceptible to stoppages due to soil rewetting as a transpiring vegetation cover can be retained later into the stripping programme. Hence, it can be suited to northern and western, and upland locations, and particularly when there are uncertain weather patterns.

The disadvantages are:

i) Its beneficial effect is dependent on all the soil horizons being stripped as windrows, which may make it a slower more involved operation than the soil layer by layer practice
ii) It requires skill and discipline, and a high level of supervision in its deployment, being suited to experienced operators
iii) Whilst it can result in less soil compaction than other methods, it is likely some will be caused by the excavator moving on the soil during the formation of and operation of the windrows, and hence, there may be reliance on subsequent remedial treatment
iv) Steep gradient/complex topographies may limit the safe and practical deployment of this machinery combination and handling practice.

Suitability

As the methodology involves the excavator operating on each layer of soils to form the successive windrows, there is a risk that compaction can occur and the likely reliance on remedial treatment with this practice. Hence, it is considered to be a less suitable practice than the bed/strip practice for minimizing the risk of soil compaction. The full benefit of the practice lies in the direct placement of the stripped soil and therefore requires the mineral extraction scheme to be organized to provide for this and minimize the need for soils storage.

Whilst it is not considered to be the 'best practice', the windrow practice may be acceptable in circumstances such as where there is a medium to high soil resilience to compaction (see **Table 7**, **Part One**) or the best available where:

i) The soil profile in each designated windrow is stripped sequentially to the basal layer before progressing to the next
ii) The dump trucks do not run on the in situ and the windrowed soils
iii) It is used to recover a single surface soil layer
iv) The intended after use, and environmental

and ecosystem services are less dependent on maintaining their full functional characteristics such as porosity and hence drainage and aeration, plant available water capacity, and low resistance to plant root growth. This may include the less productive agricultural and forestry land, many types of natural habitats, and where water storage/ infiltration is of lesser importance for the risk of flooding. Where the soils are stored prior to replacement, effective remedial treatment may have to be relied upon

v) It is not suitable for soils with a low bearing capacity such as peat or organic soils, or soils having a high water table

vi) It is often considered to be the most suitable of the soil stripping practices available for important archaeological sites (see Box E.1).

Box E.1

Stripping soils in windrows with an excavator is often the preferred practice when archaeological investigations and recording (as opposed to trial pit/trench sampling and 'watching briefs') are required as part of a planning consent. However, there may be a need for a deviation from normal good practice for soils with the excavator and dump trucks trafficking over the topsoil layer used as the haul route, and in some cases the surcharging of the topsoil for further protection of the archaeological feature. In these cases compaction of the topsoil will result and remedial treatment will have to be relied upon.

MODEL METHODOLOGY

E.1 Key operational points to minimize the risk of severe soil compaction and soil wetness are summarised in Boxes E.2 and E.3.

Box E.2 - To minimize compaction:

- The dump trucks should normally only operate on the 'basal'/non-soil layer, and their wheels must not run on to the soil layer(s)
- The excavator only operates on the windrow with the dump trucks only travelling on the basal layer
- The machines are to only work when ground conditions enable their efficient operation
- The topsoil to be surcharged on the windrow as a thick layer as possible whilst maintaining the safe operation
- The soil layers are to be in 'dry' condition.

Box E.3 - To minimize the wetness of the soil and re-wetting of the soil:

- The progressive windrow system provides a basis to regulate the exposure of lower soil layers to periods of rain and a means of maintaining soil moisture contents. The soil profile within the active windrowed strip should be removed to the basal layer before rainfall occurs and before stripping is suspended
- Measures are required to protect the exposed face of the soil layer from ponding of water and maintain the basal layer in a condition capable of supporting dump trucks
- The area to be stripped is to be protected from in-flow of water, ponding etc. Wet sites should be drained in advance
- The maintenance of a transpiring crop is important, and an appropriate cropping regime should be established for the year of soil stripping
- Before stripping, excess vegetation should be removed; in the case of grassland it should be cut or grazed short and arable crops should have been harvested.

E.2 The timing of soil handling operations should only take place when the soils are in a 'dry and friable' condition (ie when it breaks and shatters when disturbed rather than smears and deforms) (see **Part One, Supplementary Note 4**). Prior to the start or recommencement of soil handling they should be tested to confirm they are in suitably dry condition (see Box E.4).

E.3 Soil handling is not to take place during rain, sleet or snow and in these conditions should be prohibited due to unsafe machine operating conditions. Prior to commencing operations, a medium/long term weather forecast should be obtained which gives reasonable confidence of soil handling being completed without significant interruptions from rainfall events. The soil based criteria set out in Box E.5 are to be used to determine whether soil handling should cease or be interrupted with the occurrence of rain.

E.4 All machines must be in a safe and efficient working condition at all times. The machines are to only work when ground conditions enable safe and efficient operation. Otherwise the operation is to be suspended until suitable remedial measures can be put in place.

E.5 The operation should follow the detailed stripping plan set out in the SRMP showing soil units to be stripped, haul routes and the phasing of vehicle movements. Different soil units to be kept separate are to be marked out and information to distinguish types and layers, and ranges of thickness needs to be conveyed to the operational supervisor/operator. The haul routes and soil storage areas must be defined and should be stripped first in a similar manner. Detailed daily records should be kept of operations undertaken, and site and soil conditions.

E.6 Within each soil unit the soil layers above the base/formation layer are to be stripped in sequential strips with the topsoil layer stripped first, followed by the subsoil layers; each layer stripped to its natural thickness without incorporating material from the lower layers. To protect the subsoil from becoming wet during changes in the weather, the next windrowed topsoil strip should not be started

Box E.4 - Test for Dry and Friable Soils

Soil tests are to be undertaken in the field. Samples shall be taken from at least five locations on the soil handling area and at each soil horizon to the full depth of the profile to be recovered/ replaced. The tests shall include visual examination of the soil and physical assessment of soil consistency.

i) Examination

- If the soil is wet, films of water are visible on the surface of soil particles or aggregates (e.g. clods or peds) and/or when a clod or ped is squeezed in the hand it readily deforms into a cohesive 'ball' means **no soil handling to take place**
- If the sample is moist (i.e. there is a slight dampness when squeezed in the hand) but it does not significantly change colour (darken) on further wetting, and clods break up/crumble readily when squeezed in the hand rather than forming into a ball means **soil handling can take place**
- If the sample is dry, it looks dry and changes colour (darkens) if water is added, and it is brittle means **soil handling can take place**

ii) Consistency

First Test

Attempt to mould soil sample into a ball by hand:

- Impossible because soil is too dry and hard or too loose and dry means soil handling can take place
- Impossible because the soil is too loose and wet means no soil handling to take place
- Possible - GO TO SECOND TEST

Second Test

Attempt to roll ball into a 3mm diameter thread by hand:

- Impossibe because soil crumbles or collapses means **soil handling can take place**
- Possible means **no soil handling to take place**

NB: It is impossible to roll most coarse loamy and sandy soils into a thread even when they are wet. For these soils, the Examination Test alone is to be used.

until the subsoil under lying the strip is completely stripped to the basal layer (**Figure E.1**). Stripping is to be undertaken by the excavator standing within the windrow strip and loading the surcharged soil layer into dump trucks.

Box E.5 - Rainfall Criteria:

- In light drizzle soil handling may continue for up to four hours unless the soils are already at/ near to their moisture limit
- In light rain soil handling must cease after 15 minutes
- In heavy rain and intense showers, handling shall cease immediately

In all of the above, after rain has ceased, soil tests shall be applied to determine whether handling may re-start, provided that the ground is free from ponding and ground conditions are safe to do so.

Box E.6 - Choice of Bucket Type

For hard /stony soils toothed buckets are needed. Where the mixing of soil layers at their interface is to be minimized, a bucket with a 'blade' is preferable where the soil is 'soft' and free of large stones or particularly stony stone free.

Similarly, the choice of bucket type, whether it is a standard 'digging'/bulking or wide ditching type will depend on the soil strength and stoniness.

Bladed buckets will be required for soil stripping involving archaeological investigation. Where there is a watching archaeological brief, the use of bladed buckets will normally be required.

E.7 The type of bucket to be used largely depends on the nature of the soil (Box E.6).

E.8 Demarcate the windrow topsoil strips to be surcharged; the width of the soil strip to be recovered between the windrows is determined by the effective and safe excavator boom radius from the edge of each windrow; typically, about 3-4m (Box E7). Excavators with long booms ('long reach') can be used, but may be more restricted by gradient

Box E.7 - Orientation of the Excavator

Usually, the excavator is orientated and operates with its tracks at 90^{o} to the axis of the bed being stripped as this is the most stable position.

Whilst the reach of the boom and hence the width of the bed/strip can be significantly increased and the excavator trafficking over the soil surface decreased by orientating it with the tracks parallel to edge of the soil being stripped, this may affect the stability of the excavator, particularly on a gradient or where soils have a low baring capacity. Hence, its safe deployment needs to be checked before its adoption.

limitations, and require skilled and experienced operators.

E.9 The excavator is only to stand and work on the soil layers when stripping soils, otherwise it is to travel only on the basal/formation layer. The dump trucks are only to operate on the basal/formation layer. The exception is where it is stipulated that they are to traffic the topsoil for the protection of underlying archaeological features (see above Box E.1).

E.10 The top-soil layer is to be pulled up in the thickest layer possible onto the surcharged strip (**Figures E.1 & E.2**). It should be recovered to the full width of the segment being stripped without mixing with the underlying subsoil (not more than 20% of the lower horizon should be exposed at the layer junction within the strip). The thickness and identification of the horizon junction must be verified before and during stripping. The full thickness of the topsoil horizon should be stripped progressively before the underlying subsoil horizon(s), if present, is to be started. On completion of the topsoil windrow and its removal, the above procedures are repeated sequentially for each underlying soil horizon until the area is completely stripped of soil to the basal layer (**Figures E.3 & E.4**).

E.11 Where the soils are to be directly placed without storage in mounds, the initial strip of the upper horizons will have to be stored temporarily to

release the lowest layer and enable the sequential movement of materials.
The stored initial soil material would be placed on the lower layer removed from the final strip at the end of the programme or on partially completed profiles if rain were forecast.

E.12 When the stripping operation is likely to be interrupted by rain or there is likely to be overnight rain remove any exposed subsoil down to the basal layer before suspending operations. Make provisions to protect base of current or next strip from ponding/runoff by sumps and grips, and also clean and level the basal layer. At the start of each day ensure there is no ponding in the current strip or operating areas, and the basal layer is to level with no ruts.

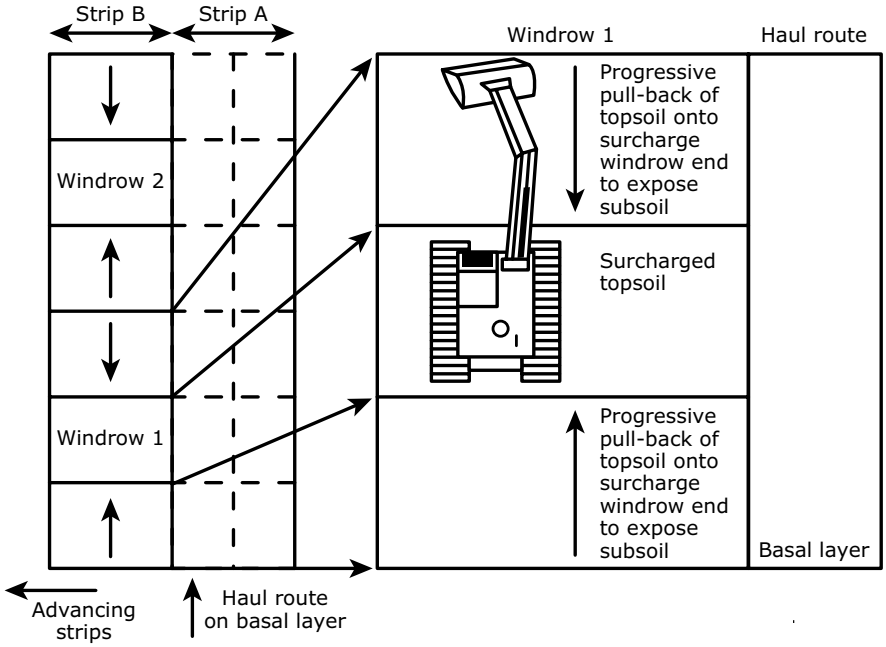

Figure E.1: Surcharging of windrow with topsoil.

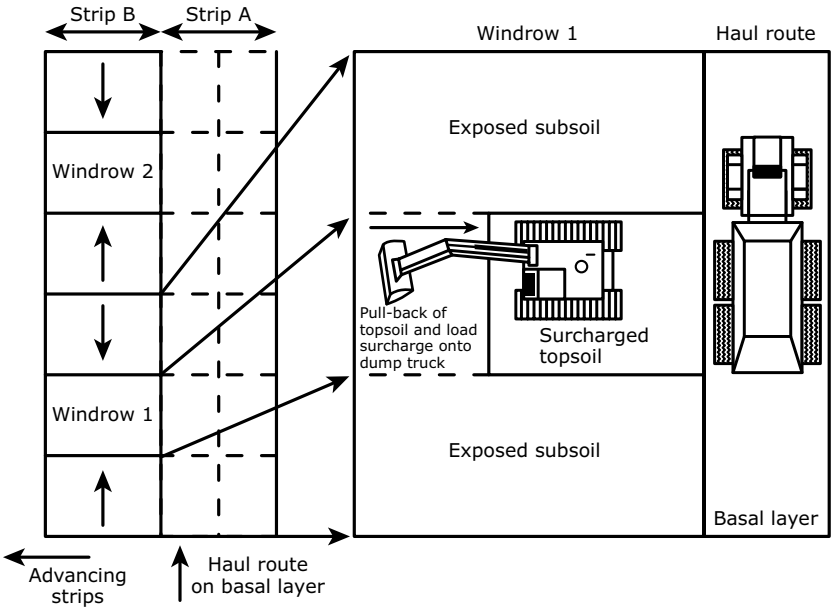

Figure E.2: Retreat of topsoil, surcharged windrow and loading of dump trucks.

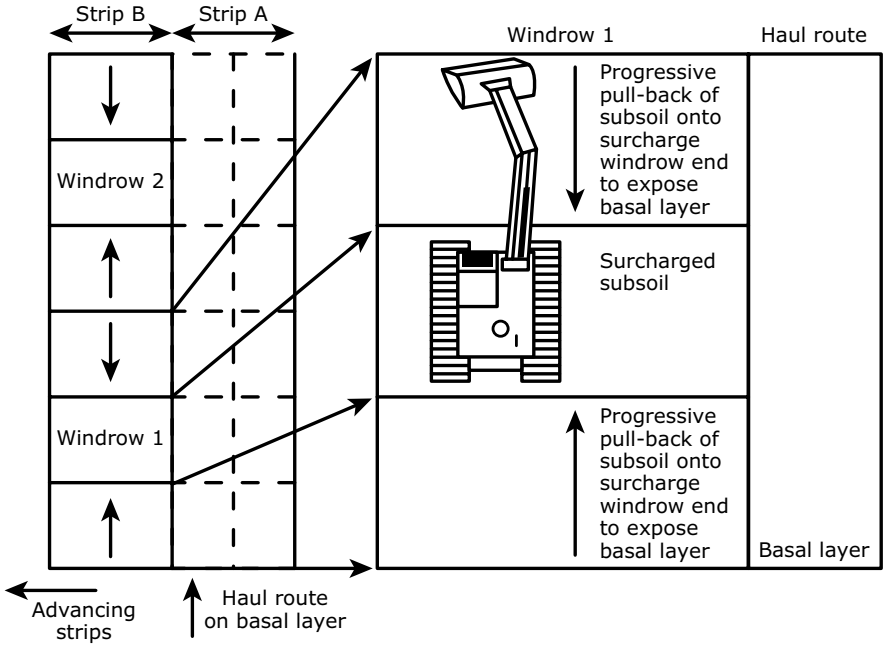

Figure E.3: Surcharging of windrow with subsoil.

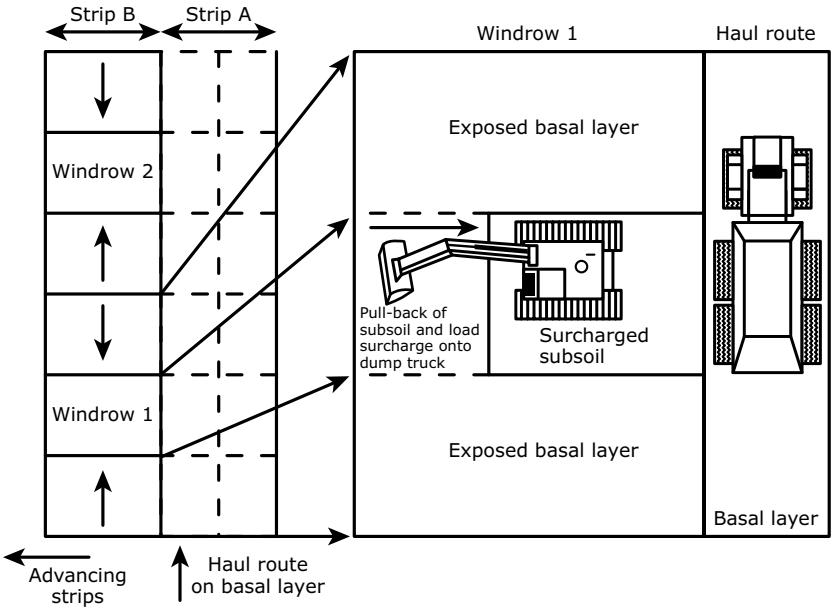

Figure E.4: Retreat of subsoil surcharged windrow and loading of dump trucks.

GOOD PRACTICE GUIDE FOR HANDLING SOILS

In Mineral Workings

PART TWO: Model Methodology

- Sheet G -

Building Soil Storage Mounds
with Bulldozers and Dump Trucks

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Supporting artwork was provided by R Shelton (H J Banks & Co)
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Preface

The purpose of Sheet G of the guidance is to provide a model method of best practice where bulldozers and dump trucks are used to build soil storage mounds.

The guidance is intended for use by planning officials, statutory consultees, mineral operators and their supporting teams and specialist consultants, and earth-moving contractors, their site supervisors and machine operators.

Successful soil handling schemes are dependent on the soil resources being clearly identified and the conditions in which they are to be handled. This information should be contained in the Soil Resource & Management Plan (SRMP) and communicated to those involved in its implementation.

Key issues to be addressed are:

i) Avoiding conditions when soils are wet/ plastic during handling
ii) The minimisation of soil compaction caused by trafficking and soil wetness
iii) Using appropriate remedial treatments where these are necessary
iv) Minimising soil loss, and mixing of soil layers or different soil types.

The SRMP should specify the type of earth-moving machinery and soil handling practice, and the soil wetness condition (see Part One of the Guidance) to be deployed to achieve the planned after use, soil functioning, and the environmental and ecosystem services. It is to be communicated in full to all involved and in particular to the supervisors and machine operators by appropriate means; including tool-box talks and site demonstrations. Supervision by trained supervisory staff is essential, as are monitoring and reporting.

The guidance does not specify the size or model of equipment as this is left to the mineral operator and contractor to specify and provide. The machines must be of a kind which are appropriate for the task and the outcomes required, and to be able to carry out the work safely and efficiently.

Should the agreed methodology need to be modified or changed significantly, this should be agreed in advance with the mineral planning authority. The SRMP should include a mechanism whereby unexpected less significant changes can be quickly resolved through consultation between the operator, the planning authority and statutory consultee, and soil specialist.

All persons involved in the handling of soils must comply with all relevant legislation with respect to Health and Safety, in particular the Health and Safety at work Act 1974 and in the case of mineral extraction operations, The Quarries Regulations 1999 and its relevant statutory provisions; in particular, those aspects which relate to the construction and removal of tips, mounds and similar structures. These requirements take preference over any suggested practice in this Sheet and the SRMP should have taken these into account.

The users of this guidance are solely responsible for ensuring it complies with all safety legislation and good practice, including the manufacturer's specifications for the safe operation of the specific machines being used, and that all machines are in a good condition and well maintained and are suitable for the task. It is important that those involved in the operation of earth moving machines are competent and have the necessary training and certification.

Introduction

This soil handling method uses low ground pressure bulldozers to build the storage mound in combination with dump trucks to transport the soil. Top- and subsoil(s) are to be stored in separate mounds or in clearly defined parts of mounds, in some circumstances where the topsoil can be easily recovered it may be laid over the subsoil.

The space available for storage in mineral workings is often limited and this determines the 'height' of mounds. For topsoil, the preference is for 1 to 3m height in order to minimize the impact of storage on biological processes, whereas for subsoils where the biological activity is lower, subject to safe operations, mounds are often raised to heights of 3 to 5m depending on the resilience of the soils to compaction (see **Part One & Supplementary Note 3**).

In this soil handling option, the mounds are either built as one 'tier' or 'multi-tier' high. In the single tier only the bulldozer traffic the soil surface and usually the final surface. In the multi-tier, the mound is also trafficked by loaded dump trucks.

Advantages & Disadvantages
Storage vs Direct Placement:
The advantages of storage are:

i) It gives flexibility in the operation of the mineral site
ii) Flexibility (i.e., weather and ground conditions) when it is reused.

The disadvantages are:

i) There is a high risk of compaction of the soil material by stacking in the mound which later cannot be effectively treated
ii) There may be significant degradation of biological functions with long-term storage.

Single vs Multi-tier Mounds:
The advantage of multi-tier mounds is that they take less space. The disadvantages are:

i) With multi-tier mounds there is high risk of severe compaction of the soil material layers by repeated trafficking by laden dump trucks in the building of multi-tier mounds which later cannot be effectively treated
ii) There may be a longer delay in recovery of the soil's biological functions on replacement.

Suitability
Soil storage is less suitable where:

i) The subsoil(s) are significantly less resilient to compaction (such as silts and sandy clay loams) and when decompaction treatments cannot be relied upon to be effective because of a risk of soil wetness operational limitations (such as the unavailability of effective decompaction tools) (see **Part One and Supplementary Notes 3 & 4**)
ii) The intended after use, and environmental and ecosystem services are dependent on maintaining functional characteristics such as soil porosity and hence drainage and aeration, plant available water capacity, and low resistance to plant root growth. This usually includes the most productive agricultural, horticultural and forestry land, many types of natural habitats, and where water storage/infiltration is of importance for the risk of flooding
iii) The bed/strip practice using excavators is used (**Sheet A**) as the compaction caused can negate its benefit
iv) Multi-tier mounds are used, particularly where the intended after use, and the environment and ecosystem services are dependent on maintaining functional characteristics such as soil porosity and hence drainage and aeration, plant available water capacity, and low resistance to plant root growth. This usually includes the most productive agricultural and forestry land, many types of natural habitats, and where water storage/infiltration is not of importance for the risk of flooding.

MODEL METHODOLOGY

G.1 Key operational points to minimize the risk of severe soil compaction and soil wetness are summarised in Boxes G.1 and G.2.

Box G.1 - To minimize compaction:

- Strip in advance the soil to basal layer along haul routes and the operational footprint of the storage mound
- The soils are to be pushed by the bulldozer to form the mound in as thick layers as possible whilst maintaining their efficient operation
- The machines are to only work when ground or soil surface conditions enable their efficient operation
- The dump trucks should only operate on the 'basal'/non-soil layer, and their wheels must not in any circumstances run on to the tipped soil
- In the raising of multi-tier mounds, trafficking is to be confined to the upper surface of the lower tier. This layer will require decompaction on excavation of the mound.

Box G.2 - To minimise the wetting of soils:

- Site soil mounds in dry locations and protect from run-off from adjacent areas. Drain if a wet location
- Raise the soil mound to maximum height progressively along the axis of the mound and shape the mound as it is being built to shed water and whenever stripping is suspended
- Measures are required to protect the face of the soil layer from ponding of water and maintain the basal layer in a condition capable of supporting dump trucks.

G.2 The timing of the building of the soil storage mounds will be governed by the weather and soil conditions governing stripping (see **Sheets A, E, F, I**). The mounds should be sited on dry ground and not in hollows and should not disrupt local surface drainage (Box G.3). Where necessary mounds should be protected from run-off/ponding by a cut-off ditch which is linked to appropriate water discharge facilities.Where the storage mound is in a hollow due to the removal of surface soils, measures should be undertaken to ensure that water is not able to pond within the storage area.

G.3 All machines must be in a safe and efficient working condition at all times. The machines are to only work when ground conditions enable safe and efficient operation. Otherwise the operation is to be suspended until suitable remedial measures can be put in place.

Box G.3

Where soils such as peat need to be kept in a wet condition this may require storage in bunded cells where receiving rainfall cannot drain. Here, the use of bulldozers is not appropriate for handling peat, and excavators and dump trucks are to be used (**Sheets A – D**).

G.4 The operation should follow the detailed stripping/storage plan set out in the SRMP showing soil units to be stripped, haul routes and the phasing of vehicle movements. Different soil units to be kept separate are to be marked out and information to distinguish types and layers, and ranges of thickness needs to be conveyed to the operational supervisor/operator. The haul routes and soil storage areas must be defined and should be stripped first in a similar manner. Detailed daily records should be kept of operations undertaken, and site and soil conditions.

G.5 Adopting the practices outlined in **Sheets A**, F or I, where relevant, remove topsoil and subsoil to basal layer from the haul routes, footprint of the storage mound and any other operating area in advance. The soils should be stored in their respective mounds.

G.6 The dump trucks must only travel within the haul route and operational areas. The trucks should enter the storage area, reverse and tip the soil load starting at the furthest point of the mound from the point of access.

G.7 The low ground pressure bulldozer pushes the soil into a mound of the required dimensions (**Figure G.1**). The bulldozer is used to shape the sides as the mound is progressively formed to promote the shedding of rain, particularly at the end of each day, but also on the onset of rain during the day. This should include any exposed incomplete surfaces.

G.8 The process is repeated with the tipping of soil against the forming mound, and without the dump truck wheels traversing onto previously tipped material. The operation continues progressively along the main axis of the mound. Without the trucks rising onto the soil mound, the typical height of a mound raised by bulldozer is in the order of 4-6m.

G.9 Work should stop in wet conditions (Box G.4) with measures undertaken to shed water from the soil surfaces and to prevent ponding at the base of the mound and on the basal layer. At the start of each day ensure there is no ponding on the basal layers and operating areas.

Box G.4 - Rainfall Criteria:

- In light drizzle soil handling may continue for up to four hours unless the soils are already at/ near to their moisture limit
- In light rain soil handling must cease after 15 minutes
- In heavy rain and intense showers, handling shall cease immediately

In all of the above, after rain has ceased, soil tests shall be applied to determine whether handling may re-start, provided that the ground is free from ponding and ground conditions are safe to do so.

G.10 To raise the mound higher, the trucks will have to travel on the upper surface of the mounded soils, or long reach excavators used to cast-up the soil. In this case the mound should be raised to its maximum height (**Figure G.2**). A ramp will have to be provided for the trucks to rise onto the surface of the first tier, which should be capable of trafficking without difficulty. The next tier would be formed repeating the process described above. If further tiers are required, the process would be repeated again.

G.11 Any exposed edges/surfaces should be shaped using the bulldozer blade on the onset of rain during the day. All surfaces should be shaped to shed water at the end of the day. The final outer surface should be progressively shaped using the bulldozer blade to promote the shedding of rain.

G.12 Work should stop in wet conditions (Box G.4) with measures undertaken to prevent ponding at the base of the mound and on the basal layer. At the start of each day ensure there is no ponding on the basal layers and operating areas.

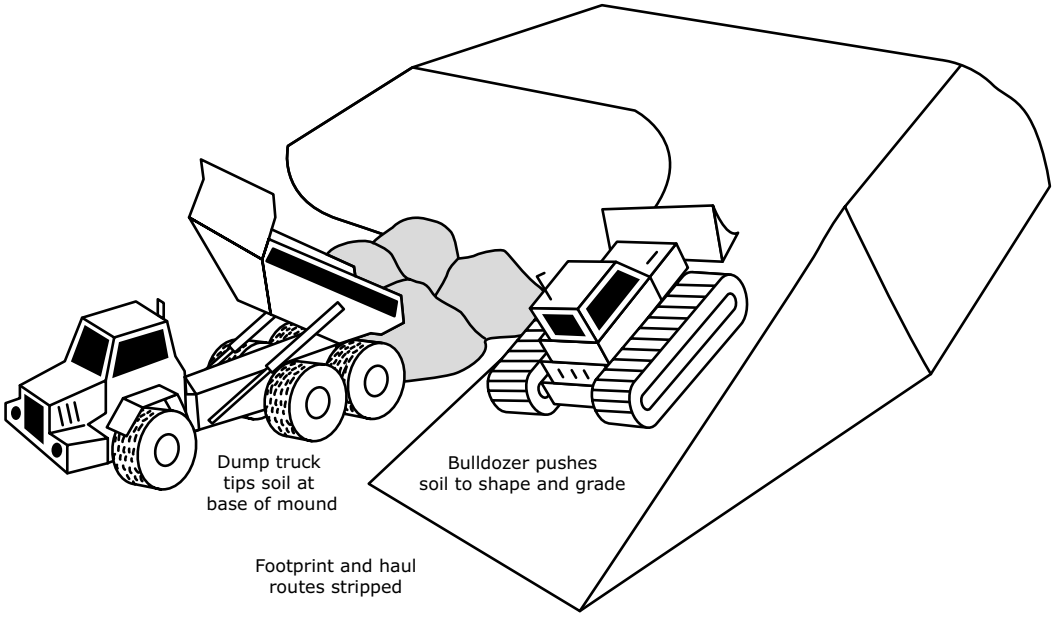

Figure G.1: Soil storage mound construction with bulldozer and dump trucks: Single tier mound.

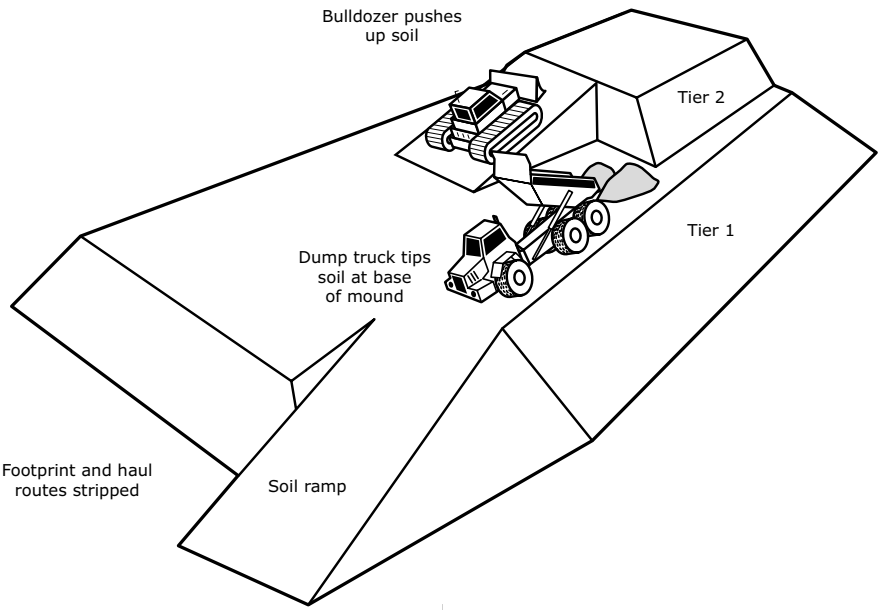

Figure G.2: Soil storage mound construction with bulldozers and dump trucks: Multi-tier mound..

GOOD PRACTICE GUIDE FOR HANDLING SOILS

In Mineral Workings

PART TWO: Model Methodology

- Sheet I -

Soil Stripping with Bulldozers and Dump Trucks
- Modified Layer by Layer Practice

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Supporting artwork was provided by R Shelton (H J Banks & Co)
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Preface

The purpose of Sheet I of the guidance is to provide a model method of best practice where bulldozers and dump trucks are to be used to strip soil using a modified soil layer by layer practice.

The guidance is intended for use by planning officials, statutory consultees, mineral operators and their supporting teams and specialist consultants, and earth-moving contractors, their site supervisors and machine operators.

Successful soil handling schemes are dependent on the soil resources being clearly identified and the conditions in which they are to be handled. This information should be contained in the Soil Resource & Management Plan (SRMP) and communicated to those involved in its implementation.

Key issues to be addressed are:

i) Avoiding conditions when soils are wet/ plastic during handling
ii) The minimisation of soil compaction caused by trafficking and soil wetness
iii) Using appropriate remedial treatments where these are necessary
iv) Minimising soil loss, and mixing of soil layers or different soil types.

The SRMP should specify the type of earth-moving machinery and soil handling practice, and the soil wetness condition (see Part One of the Guidance) to be deployed to achieve the planned after use, soil functioning, and the environmental and ecosystem services. It is to be communicated in full to all involved and in particular to the supervisors and machine operators by appropriate means; including tool-box talks and site demonstrations. Supervision by trained supervisory staff is essential, as are monitoring and reporting.

The guidance does not specify the size or model of equipment as this is left to the mineral operator and contractor to specify and provide. The machines must be of a kind which are appropriate for the task and the outcomes required, and to be able to carry out the work safely and efficiently.

Should the agreed methodology need to be modified or changed significantly, this should be agreed in advance with the mineral planning authority. The SRMP should include a mechanism whereby unexpected less significant changes can be quickly resolved through consultation between the operator, the planning authority and statutory consultee, and soil specialist.

All persons involved in the handling of soils must comply with all relevant legislation with respect to Health and Safety, in particular the Health and Safety at work Act 1974 and in the case of mineral extraction operations, The Quarries Regulations 1999 and its relevant statutory provisions; in particular those aspects which relate to the construction and removal of tips, mounds and similar structures. These requirements take preference over any suggested practice in this Sheet and the SRMP should have taken these into account.

The users of this guidance are solely responsible for ensuring it complies with all safety legislation and good practice, including the manufacturer’s specifications for the safe operation of the specific machines being used, and that all machines are in a good condition and well maintained and are suitable for the task. It is important that those involved in the operation of earth moving machines are competent and have the necessary training and certification.

Introduction

In the past soil layers have been stripped in their entirety one by one. Firstly the topsoil, then the subsoil layers by layer until the basal layer is exposed. The method deployed across the entire area is now discredited because of the likely severe compaction caused by the trafficking of the machines over much of the exposed soil surfaces. However, by restricting the extent of the ongoing process to blocks or wide bands of soil, to enable the dump trucks to travel on the basal layer, there may be instances where this 'modified' layer by layer approach can be deployed.

In this practice, only the bulldozer works on the exposed soil layers to form soil bunds along the exposed edge for loading by an excavator (usually) standing on the mound. This approach was described and illustrated in MAFF Sheet 13 https://webarchive.nationalarchives.gov.uk/20090318025435/http://www.defra.gov.uk/farm/environment/land-use/soilguid/sheet13.pdf.

It is also similar to the bulldozer practice described in **Sheet F**, but without the formation of windrows and the need for the excavator to traffic the surcharged soil to recover and load it into the dump trucks. In this respect it is easier to operate than the windrow practice and likely to cause less compaction.

The following modified guidance can also be adopted where only a single soil horizon is to be stripped.

Advantages & Disadvantages
The advantages of the modified handling practice are:

i) It is very simple to administer requiring little supervision and skill
ii) It can be quicker than both the excavator combination with the bed/strip and windrow practices
iii) It offers flexibility in respect of short soil drying periods and likely wet weather as it is l ess susceptible to stoppages due to soil rewetting as a transpiring vegetation cover can be retained later into the stripping programme. It is particularly suited to northerly and western, and upland locations, and particularly when there are uncertain weather patterns.

The disadvantages of the modified handling practice are:

i) There is risk of compaction of the top- and subsoil layers by the repeated trafficking of the bulldozer, even if a low ground pressure machine is used, as it pushes soil to the windrows. Hence, subsequent remedial treatments are likely to be relied upon
ii) It is slow react to localised changes in soil types and variation in horizon depth, and can result in the mixing of soil horizons
iii) It is not suited to the stripping of thin and 'patterned' soil layers, and cleanly exposing the top-sub-soil interface.

Suitability
Neither the unmodified or modified practice are suitable for sites requiring archaeological investigations and reporting, or for 'watching briefs' during soil stripping.

The layer by layer handling practice, without modification, is not advisable for the conservation of soil resources and functioning. Whilst the modified method is not considered 'best practice', it may be acceptable in circumstances where:

i) The subsoil(s) have a high resilience to further compaction (see **Part One**) and when decompaction treatments can be more relied upon to be effective because of a low risk of soil wetness (low rainfall areas/prolonged dry conditions) or operational limitations (such as the availability of effective decompaction tools)
ii) The intended after use, and environmental and ecosystem services are less dependent on maintaining functional characteristics such as soil porosity and hence drainage and aeration, plant available water capacity, and low resistance to plant root growth. This may include low productivity agricultural and forestry land, some types of natural

habitats, and where water storage/infiltration is of lesser importance for the risk of flooding. Where the soils are stored prior to replacement, effective remedial treatment may have to be relied upon

iii) The soils are placed into storage stockpiles.

MODEL METHODOLOGY

I.1 Key operational points to minimise the risk of severe soil compaction and soil wetness with the modified layer by layer practice are summarised in Boxes I.1 and I.2.

Box I.1 - To minimise compaction:

- The dump trucks should normally only operate on the basal layer, and their wheels must not in any circumstances run on to the soil layer(s)
- The adoption of the strip by strip system minimises the need for the trucks to travel on the soil layers
- The machines are to only work when ground conditions enable their efficient operation
- The soils are to be stripped by the bulldozer in as thick layer as possible whilst maintaining their efficient operation
- The bulldozer should make the minimal number of passes over the soil as possible
- The soil layers are to be in 'dry' condition.

Box I.2 - To minimize the wetness of the soil and re-wetting of the soil:

- The modified strip by strip system provides a basis to regulate the exposure of lower soil layers to periods of rain and a means of maintaining soil moisture contents. The soil profile within the active strip should be stripped to the basal layer before rainfall occurs and before stripping is suspended.
- Measures are required to protect the face of the soil layer from ponding of water and maintain the basal layer in a condition capable of supporting dump trucks
- The area to be stripped is to be protected from in-flow of water, ponding etc. Wet sites should be drained in advance
- The maintenance of a transpiring crop is important, and an appropriate cropping regime should be established for the year of soil stripping
- Before stripping, excess vegetation should be removed; in the case of grassland it should be cut or grazed short and arable crops should have been harvested.

I.2 The timing of soil handling operations should only take place when the soils are in a 'dry and friable' condition (ie when it breaks and shatters when disturbed rather than smears and deforms) (see **Part One, Supplementary Note 4**). Prior to the start or recommencement of soil handling, they should be tested to confirm they are in suitably dry condition (see Box I.3).

I.3 Soil handling (by any machinery combination and handling practice) is not to take place during rain, sleet or snow and in these conditions should be prohibited due to unsafe machine operating conditions. Prior to commencing operations a medium/long term weather forecast should be obtained which gives reasonable confidence of soil handling being completed without significant interruptions from rainfall events. The soil based criteria set out in BOX I.4 are to be used to determine whether soil handling should cease or be interrupted with the occurrence of rain.
The machines are to only work when ground conditions enable safe and efficient operation. Otherwise the operation is to be suspended until suitable remedial measures can be put in place.

I.5 The operation should follow the detailed stripping plan set out in the SRMP showing soil units to be stripped, haul routes and the phasing of vehicle movements. Different soil units to be kept separate are to be marked out and information to distinguish types and layers, and ranges of thickness needs to be conveyed to the operational supervisor/operator. The haul routes and soil storage areas must be defined and should be stripped first in a similar manner. Detailed daily records should be kept of operations undertaken, and site and soil conditions.

I.6 Demarcate an initial width of the 'strip' of soils to be recovered as the modified layer by layer practice.

Box I.3 - Test for Dry and Friable Soils

Soil tests are to be undertaken in the field. Samples shall be taken from at least five locations on the soil handling area and at each soil horizon to the full depth of the profile to be recovered/ replaced. The tests shall include visual examination of the soil and physical assessment of soil consistency.

i) Examination

- If the soil is wet, films of water are visible on the surface of soil particles or aggregates (e.g. clods or peds) and/or when a clod or ped is squeezed in the hand it readily deforms into a cohesive 'ball' means **no soil handling to take place**
- If the sample is moist (i.e. there is a slight dampness when squeezed in the hand) but it does not significantly change colour (darken) on further wetting, and clods break up/crumble readily when squeezed in the hand rather than forming into a ball means **soil handling can take place**
- If the sample is dry, it looks dry and changes colour (darkens) if water is added, and it is brittle means **soil handling can take place**

ii) Consistency

First Test

Attempt to mould soil sample into a ball by hand:

- Impossible because soil is too dry and hard or too loose and dry means soil handling can take place
- Impossible because the soil is too loose and wet means no soil handling to take place
- Possible - GO TO SECOND TEST

Second Test

Attempt to roll ball into a 3mm diameter thread by hand:

- Impossibe because soil crumbles or collapses means **soil handling can take place**
- Possible means **no soil handling to take place**

NB: It is impossible to roll most coarse loamy and sandy soils into a thread even when they are wet. For these soils, the Examination Test alone is to be used.

Box I.4 – Rainfall Criteria:

- In light drizzle soil handling may continue for up to four hours unless the soils are already at/ near to their moisture limit
- In light rain soil handling must cease after 15 minutes
- In heavy rain and intense showers, handling shall cease immediately.

In all of the above, after rain has ceased, soil tests shall be applied to determine whether handling may re-start, provided that the ground is free from ponding and ground conditions are safe to do so.

Box I.5

Whilst there can be a lower of a risk of compaction when using wide tracked ('low ground pressure' (LGP)) bulldozers, in some circumstances they may require to traffic the soil surface more than standard machines to achieve the same work rate, and therefore the advantage of their use may be less than anticipated. However, the risk of severe compaction and reliance on remedial treatments may be less with the use of LGP machines.

This is the effective push distance of the bulldozer to bund the soil at the edge of the strip (Box I.5).

I.7 Within each soil unit the soil layers above the base/formation layer are to be stripped layer by layer in the retreating strips/blocks until all the soil is removed (**Figure I.1**).

I.8 The bulldozer is only to stand and work on the soil layer when stripping soils and the excavator on the resulting soil mound, otherwise they are to travel only on the basal/formation layer. The dump trucks are to operate only on the basal layer (**Figure I.2**).

I.9 The topsoil is to be pushed towards the retreating edge and heaped for the excavator to load onto the dump trucks (**Figure I.2**). The topsoil should be recovered to the full width of the segment without mixing with subsoil (not more than 20% of the lower horizon should be exposed at the layer junction within the strip). The thickness and identification of the horizon junction must be verified before and

during stripping. The procedure is repeated until all of the topsoil has been removed.

I.10 The above procedure is then repeated for the sub-soil until all the soil layer has been recovered, and then any subsequent lower layer to be recovered until the basal layer is fully exposed (**Figure I.3**).

I.11 Where the soils are to be directly replaced without storage in mounds, the initial strip of the upper horizons will have to be stored temporarily to release the lowest layer and enable the sequential movement of materials. The stored initial soil material would be placed on the lower layer removed from the final strip at the end of the programme or on partially completed profiles if rain was forecast.

I.12 Where the stripping operation is likely to be interrupted by rain or there is likely to be overnight rain, the soil layer is to be ‘sealed’ by the bulldozer tracking and ‘blading’ the exposed surface. Make provisions to protect base of current or next strip from ponding/runoff by sumps and grips, and also clean and level the basal layer. At the start of each day ensure there is no ponding in the current strip or operating areas, and the basal layer is to level with no ruts.

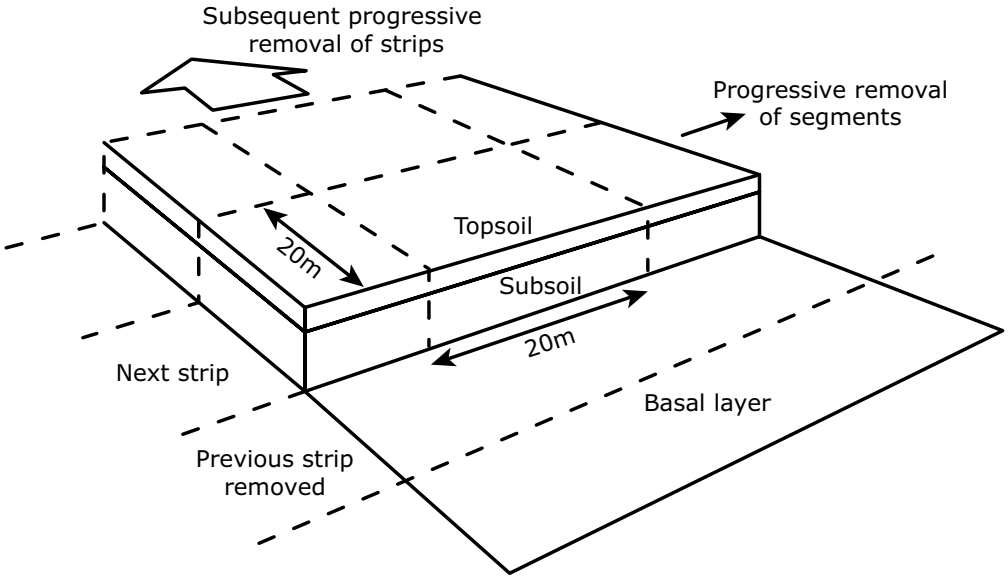

Figure I.1: Soil stripping with bulldozers and dump trucks using modified layer by layer practice.

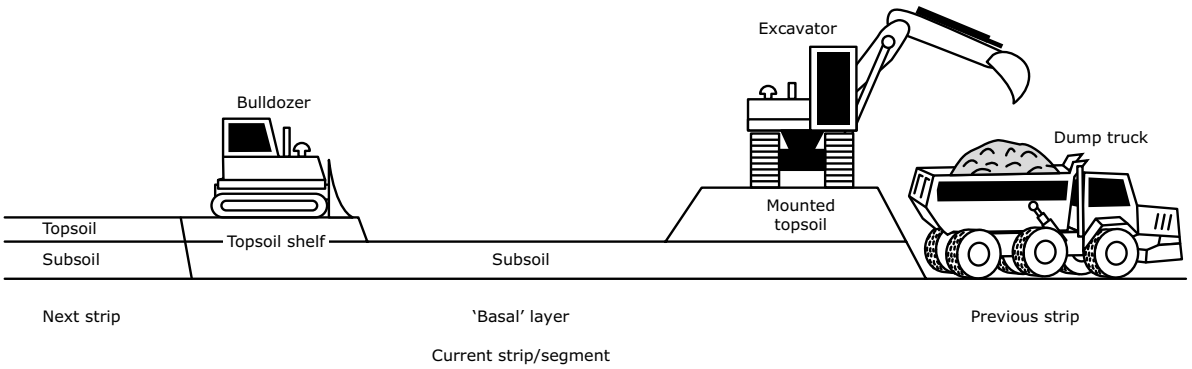

Figure I.2: Soil stripping with bulldozers and dump trucks using modified layer by layer method: Topsoil.

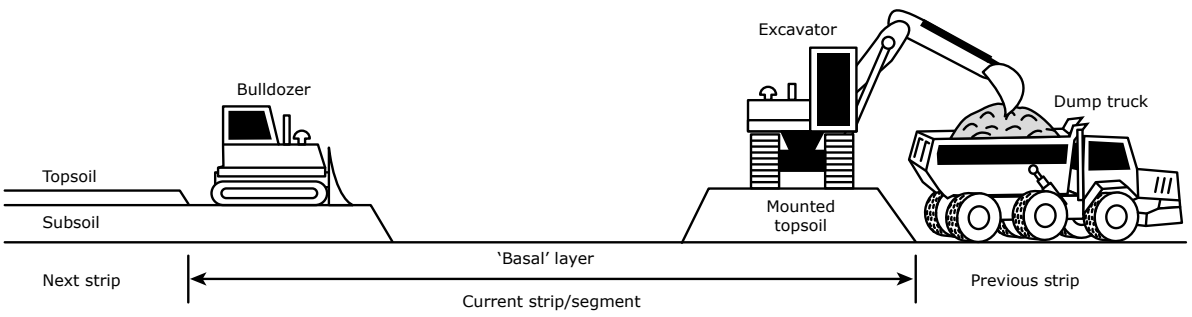

Figure I.3: Soil stripping with bulldozers and dump trucksn using modified layer by layer method: Subsoil.

GOOD PRACTICE GUIDE FOR HANDLING SOILS

In Mineral Workings

PART TWO: Model Methodology

- Sheet N -

Soil Decompaction by Excavator Bucket

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Supporting artwork was provided by R Shelton (H J Banks & Co)
and D Fisher (Blue Room Graphics Ltd).

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Preface

The purpose of Sheet N of the guidance is to provide a model method of best practice where excavators are to be used to decompact replaced soils and the basal layer by digging with a bucket.

The guidance is intended for use by planning officials, statutory consultees, mineral operators and their supporting teams and specialist consultants, and earth-moving contractors, their site supervisors and machine operators.

Successful soil handling schemes are dependent on the soil resources being clearly identified and the conditions in which they are to be handled. This information should be contained in the Soil Resource & Management Plan (SRMP) and communicated to those involved in its implementation.

Key issues to be addressed are:

i) Avoiding conditions when soils are wet/ plastic during handling
ii) The minimisation of soil compaction caused by trafficking and soil wetness
iii) Using appropriate remedial treatments where these are necessary
iv) Minimising soil loss, and mixing of soil layers or different soil types.

The SRMP should specify the type of earth-moving machinery and soil handling practice, and the soil wetness condition (see Part One of the Guidance) to be deployed to achieve the planned after use, soil functioning, and the environmental and ecosystem services. It is to be communicated in full to all involved and in particular to the supervisors and machine operators by appropriate means; including tool-box talks and site demonstrations. Supervision by trained supervisory staff is essential, as are monitoring and reporting.

The guidance does not specify the size or model of equipment as this is left to the mineral operator and contractor to specify and provide. The machines must be of a kind which are appropriate for the task and the outcomes required, and to be able to carry out the work safely and efficiently.

Should the agreed methodology need to be modified or changed significantly, this should be agreed in advance with the mineral planning authority. The SRMP should include a mechanism whereby unexpected less significant changes can be quickly resolved through consultation between the operator, the planning authority and statutory consultee, and soil specialist.

All persons involved in the handling of soils must comply with all relevant legislation with respect to Health and Safety, in particular the Health and Safety at work Act 1974 and in the case of mineral extraction operations, The Quarries Regulations 1999 and its relevant statutory provisions; in particular those aspects which relate to the construction and removal of tips, mounds and similar structures. These requirements take preference over any suggested practice in this Sheet and the SRMP should have taken these into account.

The users of this guidance are solely responsible for ensuring it complies with all safety legislation and good practice, including the manufacturer’s specifications for the safe operation of the specific machines being used, and that all machines are in a good condition and well maintained and are suitable for the task. It is important that those involved in the operation of earth moving machines are competent and have the necessary training and certification.

Introduction

The purpose of this Guidance Sheet is to provide a model method for best practice where an excavator is used to decompact soils and basal/formation layers. Excavators are most likely to be used for this purpose where soils are replaced by excavator (Sheet D), however the methodology can be deployed in combination with the machinery and practices presented in Sheets H, J and K.

Advantages & Disadvantages
The advantages of the methodology are:
i) It is an efficient means of decompaction
ii) The equipment is standardized and readily available
iii) It is flexible with the quick interchange with a stone-rake for the need remove stones or level/cultivate a final surface
iv) It is suited to single shallow soil layer.

The disadvantages are:
i) The deployment adds another level of complexity needed in the soil replacement and skill and discipline in the decompaction procedures
ii) The methodology is significantly slower than the alternative of ripping (**Sheet S**)
iii) The effective decompaction is dependent on the soils being in a sufficiently 'dry' condition
iv) There is a risk of mixing of soil horizons.

Suitability
This practice is the most suitable for a wide range of and uses, soil functions, and environmental and ecosystem services where decompaction is required. It can be deployed on steep and complex landforms. Like with the use of tines (**Sheet O**), to be effective the soil must be dry enough to shatter. The SRMP will have specified the need and particular requirements, within the soil replacement procedures, site conditions land and use aims.

Many former mineral workings have been backfilled with inert waste. Remedial treatments of the infill, by digging or ripping, may not be advisable where these are not to be part of the replaced soil profile and this should be covered in the SRMP. The treatment of former silt lagoons needs careful consideration and consultation with a geotechnical specialist where there is a possibility of breaking through the dewatered and stabilised upper material into the saturated underlying lower material.

MODEL METHODOLOGY

The Decompaction Operation
N.1 Key operational points to minimize the risk of severe soil compaction and soil wetness are summarised in Boxes N.1 and N.2.

Box N.1 - To minimize compaction:

- Wherever possible the excavator is to operate on the basal layer
- The excavator is only to work when ground conditions enable efficient operation
- The operation should only be carried out when the soils are in a 'dry' condition.

Box N.2

- The soil profile within the active strip should be completed to the topsoil layer before rainfall occurs and before replacement is suspended
- Measures are required to protect the face of the soil layer from ponding of water and maintain the basal layer in a condition capable of supporting dump trucks.

N.2 The timing of soil handling operations should only take place when the soils are in a 'dry and friable' condition (i.e. when it breaks and shatters when disturbed rather than smears and deforms) (see **Part One, Supplementary Note 3**). Prior to the start or recommencement of soil handling they should be tested to confirm they are in suitably dry condition (see Box N.3).

N.3 Soil handling is not to take place during rain, sleet or snow and in these conditions should be prohibited due to unsafe machine operating conditions. Prior to commencing operations, a medium/long term weather forecast should be obtained which gives reasonable confidence of soil handling being completed without significant interruptions from rainfall events. The soil based

Box N.3 - Test for Dry and Friable Soils

Soil tests are to be undertaken in the field. Samples shall be taken from at least five locations on the soil handling area and at each soil horizon to the full depth of the profile to be recovered/ replaced. The tests shall include visual examination of the soil and physical assessment of soil consistency.

i) Examination

- If the soil is wet, films of water are visible on the surface of soil particles or aggregates (e.g. clods or peds) and/or when a clod or ped is squeezed in the hand it readily deforms into a cohesive 'ball' means **no soil handling to take place**
- If the sample is moist (i.e. there is a slight dampness when squeezed in the hand) but it does not significantly change colour (darken) on further wetting, and clods break up/crumble readily when squeezed in the hand rather than forming into a ball means **soil handling can take place**
- If the sample is dry, it looks dry and changes colour (darkens) if water is added, and it is brittle means **soil handling can take place**

ii) Consistency

First Test

Attempt to mould soil sample into a ball by hand:

- Impossible because soil is too dry and hard or too loose and dry means soil handling can take place
- Impossible because the soil is too loose and wet means no soil handling to take place
- Possible - GO TO SECOND TEST

Second Test

Attempt to roll ball into a 3mm diameter thread by hand:

- Impossibe because soil crumbles or collapses means **soil handling can take place**
- Possible means **no soil handling to take place**

NB: It is impossible to roll most coarse loamy and sandy soils into a thread even when they are wet. For these soils, the Examination Test alone is to be used.

criteria set out in BOX N.4 are to be used to determine whether soil handling should cease or be interrupted with the occurrence of rain.

N.3 Soil handling is not to take place during rain, sleet or snow and in these conditions should be prohibited due to unsafe machine operating conditions. Prior to commencing operations, a medium/long term weather forecast should be obtained which gives reasonable confidence of soil handling being completed without significant interruptions from rainfall events. The soil based criteria set out in Box N.4 are to be used to determine whether soil handling should cease or be interrupted with the occurrence of rain.

Box N.4 - Rainfall Criteria:

- In light drizzle soil handling may continue for up to four hours unless the soils are already at/ near to their moisture limit
- In light rain soil handling must cease after 15 minutes
- In heavy rain and intense showers, handling shall cease immediately

In all of the above, after rain has ceased, soil tests shall be applied to determine whether handling may restart, provided that the ground is free from ponding and ground conditions are safe to do so.

N.4 All machines must be in a safe and efficient working condition at all times. The machines are to only work when ground conditions enable safe and efficient operation. Otherwise the operation is to be suspended until suitable remedial measures can be put in place.

N.5 The operation should follow the detailed replacement plan set out in the SRMP showing soil units to be stripped, haul routes and the phasing of vehicle movements. Different soil units to be kept separate are to be marked out and information to distinguish types and layers, and ranges of thickness needs to be conveyed to the operational supervisor/operator. The haul routes and soil storage areas must be defined and should be stripped first in a similar manner. Detailed daily records should be kept of operations undertaken, and site and soil conditions.

N.6 The digging radius is determined by excavator boom length less the stand-off to operate; typically, about 3-4m. Excavators with long booms ('long reach') can be used, but may be more restricted by gradient limitations, and require skilled and experienced operators. The excavator bucket is to be maximum capacity of 2.5m^3 and 1.0 m to 1.5m wide cutting edge (blade) with armoured teeth at about 150 mm spacing, 150 mm long and 50mm in section.

N.7 The excavator should stand on and work from the basal/formation layer wherever possible.

N.8 Where the soil layer to be decompacted as a single layer and is less than about 0.5m thick the following procedure is to be adopted. The area to be treated is decompacted as a series of sequential 'trenches' to the depth required (**Figure N.1**).

N.9 Each trench is to be the effective working length of the excavator boom (nominally 3-4m). The trench is started by inserting the bucket 'blade' downwards into the soil to the depth required and keeping this vertical attitude pulled towards the excavator (**Figure N.1**). When the bucket is almost filled it is lifted and the soil tipped into the 'trench' created. The bucket's tines have a ripping action and the pushing of the soil into the bucket has a shattering effect if the soil is dry enough, otherwise it will compress the soil material with no resulting beneficial effect. If the replaced soil in the trench is cloddy, it can be 'chopped' using the bucket's blade. The process is repeated until the trench has been decompacted, then another trench is treated until the whole area to be treated is completed. It is essential each successive bucket 'dig' overlaps with the former both to the back and sides of the trenches. Finally, the bucket cutting edge can be used to lightly grade the finished surface.

N.10 Where the soil layer is deeper than the capability of the bucket (about 0.5m), a 'double-digging' approach is needed. The process is similar to above, but the upper material in the trench is to be cast aside over the adjacent untreated strip ('double digging'). The exposed lower layer is then treated as above and on completion the cast aside upper material is replaced with any necessary cultivation/levelling with the bucket taking place. This method is relatively slow.

N.11 The alternative for deep profiles than 0.5m to be decompacted by the excavator method is to place the soil layer in several successive sub-layers each up to 0.5m in thickness, and to sequentially decompact each replaced layer as described above. The process is repeated until the full soil horizon is replaced to the required thickness and has been completely 'dug over'. This method is also slow.

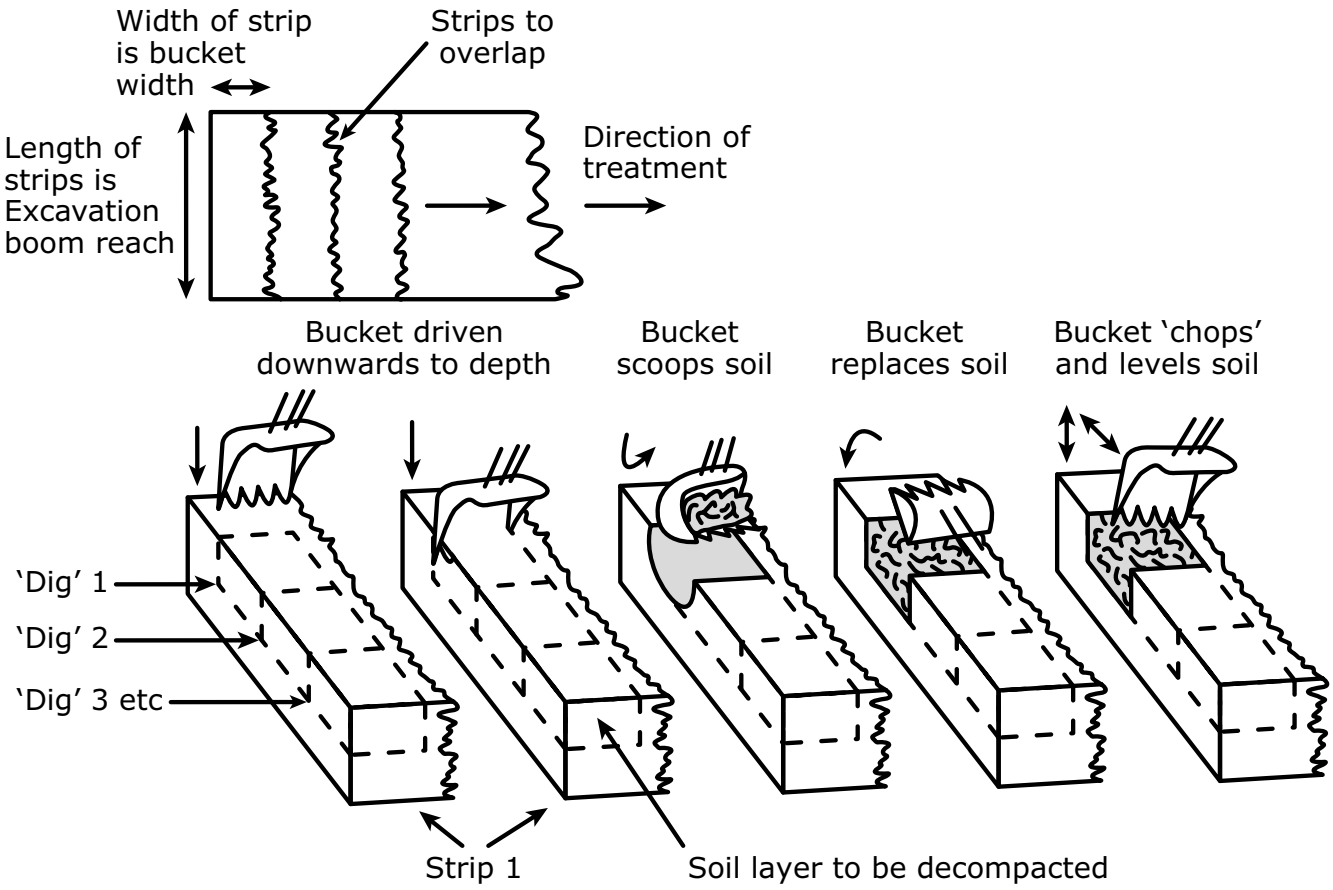

Figure N.1 Decompaction by excavator bucket..

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