



The Institute
of Quarrying



Good Practice Guide for Handling Soils in Mineral Workings

GOOD PRACTICE GUIDE FOR HANDLING SOILS

In Mineral Workings

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The information in this publication is general guidance on the best practices and approaches to soils guidance. Specialist advice should always be sought if you need more details about what action to take in your own circumstances.

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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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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 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 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:

- Impossible 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.

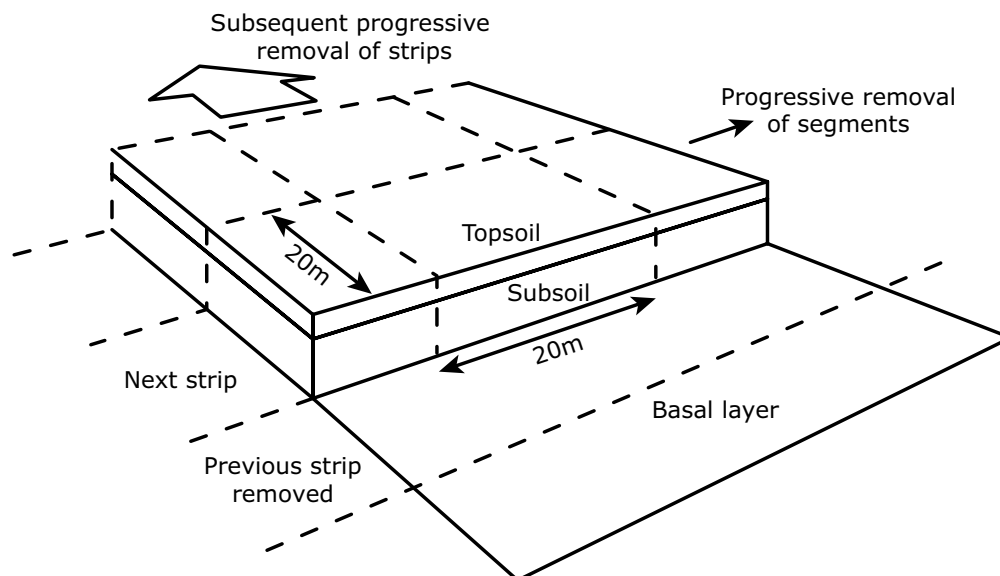


Figure I.1: Soil stripping with bulldozers and dump trucks using modified layer by layer practice.

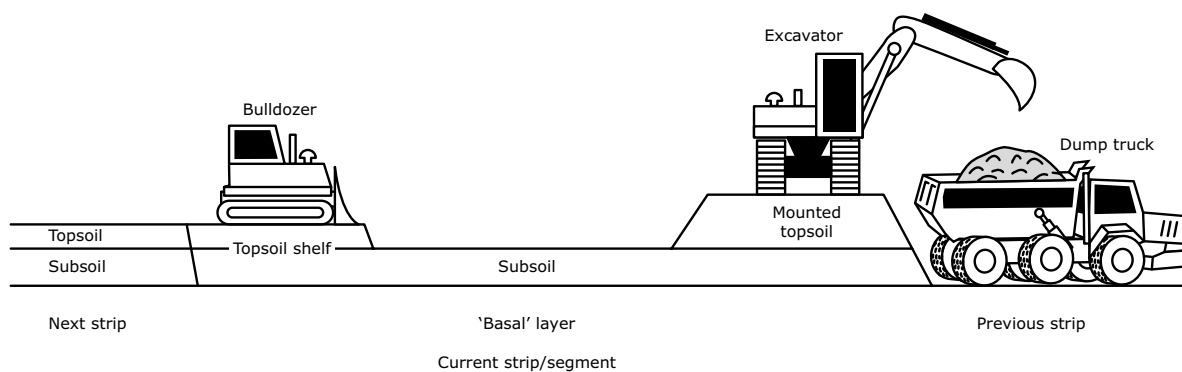


Figure I.2: Soil stripping with bulldozers and dump trucks using modified layer by layer method: Topsoil.

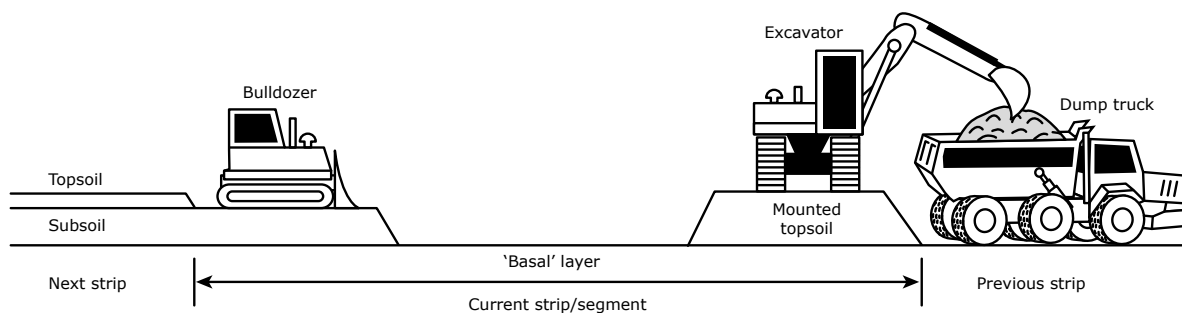


Figure I.3: Soil stripping with bulldozers and dump trucks using modified layer by layer method: Subsoil.

