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 N -

Soil Decompaction by Excavator Bucket

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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.

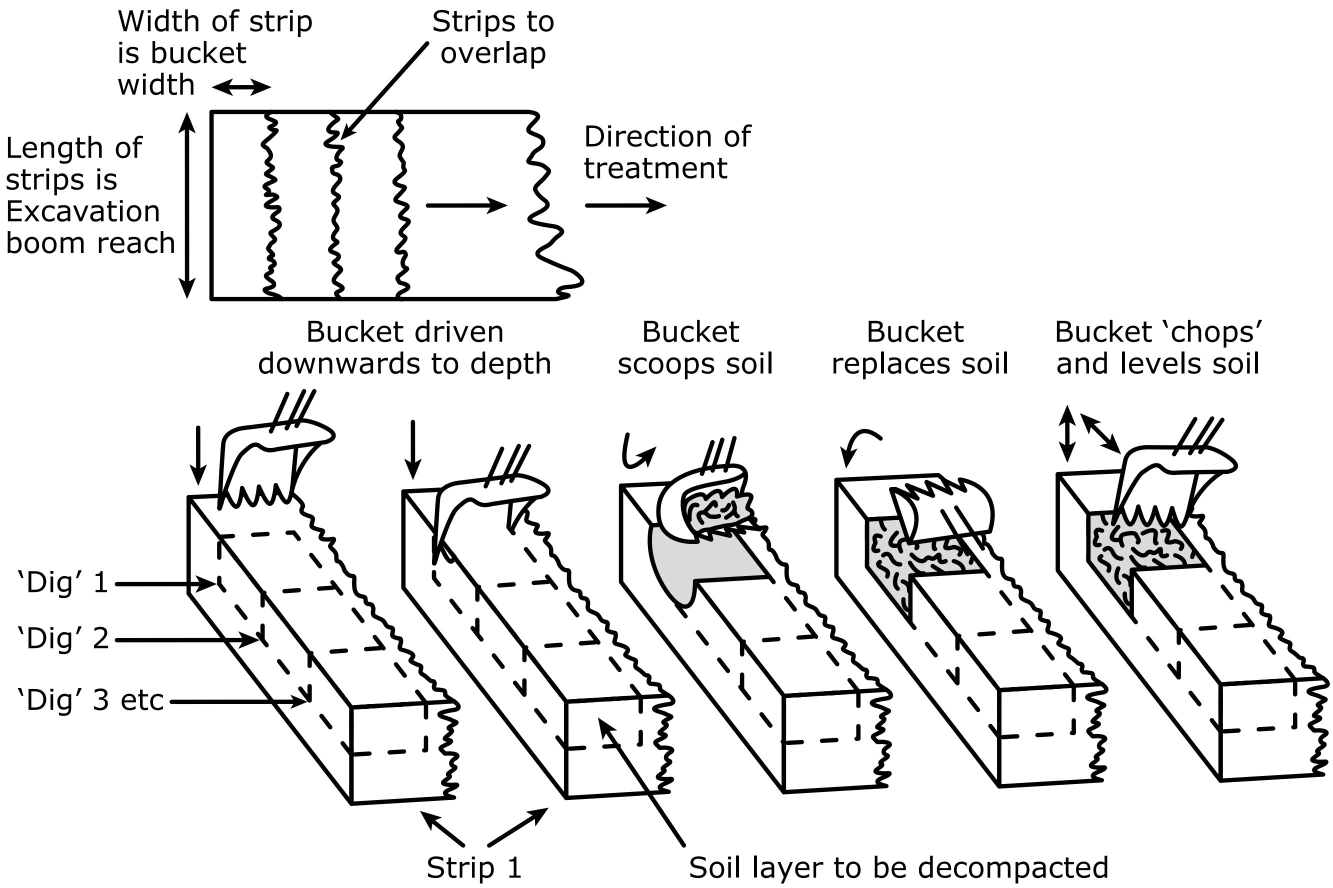

Figure N.1 Decompaction by excavator bucket..

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