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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 L -

Release & Removal of Stones and Non-Soil Debris
by Excavator & Stone-Rake

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Preface

The purpose of Sheet L of the guidance is to provide a model method of best practice where excavators are to be used to release and remove stones and non-soil debris from the basal layer and replaced soils.

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 stones and/or non-soil debris (e.g. wire rope, concrete blocks) are to be released using an excavator with a ripper claw and/or specialist stone-rake buckets from the basal layer and/or soils during replacement. The methodology can be deployed in combination with the machinery and practices presented in Sheets D, H, J and K.

Advantages & Disadvantages
The advantages are:

i) It is an efficient means of removal of stones; and
ii) It is very flexible with the quick interchange with digging bucket where needed for the removal of intransigent buried material
iii) It can be an effective means of decompaction and cultivation of cloddy replaced soil
iv) It serves to level the soil surfaces.

The disadvantages are:

i) The effective reach of the excavator may limit the width of strips being treated or soils being placed
ii) The effective release of stones from clayey soils is dependent on the soils being in a sufficiently 'dry' condition
iii) The depth of release of material will be dependent on the length of the bucket's 'tines' (elongated teeth).
iv) The size of stones is limited to the spacing of the bucket's 'tines' and may need different bucket sizes where a range of sizes are to be removed in successive soil layers
v) There is a risk of removal of significant amounts of soil adhered to the stones and soil clods when they are hard and dry
vi) There is a risk the removal of stones with dump trucks will result in the recompaction where trafficking the soil layers.

Suitability
This practice is the most suitable for a wide range of after uses and ecosystem services where stones are to be removed or the stone content is to be reduced, and it can be deployed on steep and complex landforms. The occurrence of large hard stones and non-soil debris can affect the agricultural potential of the restoration through interfering with/preventing cultivations and installation of underdrainage. The SRMP will have specified the need and particular requirements, within the soil replacement procedures, site conditions and after use aims.

Alternative methods to that described below can be considered. For example, there is often a preference to use agricultural tractor drawn stone rakes for the topsoil. There may be circumstances that it is economically viable to use soil screens to remove large stones and debris, particularly when the soils have been stockpiled.

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 Release & Removal Operation
L.1 The key operational points to minimise the risk of severe soil compaction and soil wetness are summarised in Boxes L.1 and L.2.

Box L.1 - To minimize compaction:

- Wherever possible the excavator and dump trucks receiving the released stones/non-soil debris are to operate on the basal layer
- The excavator with ripped claw or stone rake is only to work when soil conditions enable effective operation when the soils are in a 'dry' condition.

Box L.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.

L.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 L.3).

L.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 L.4 are to be used to determine whether soil handling should cease or be interrupted with the occurrence of rain.

L.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.

L.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

Box L.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.

records should be kept of operations undertaken, and site and soil conditions.

L.6 The excavator and dump trucks are to stand, work and travel on the soil or basal/formation layer according to the soil replacement practice being used (i.e. **Sheets, D, H, J & K**).

Box L.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.

L.7 The depth to which stones/damaging material can be dislodged and removed and the size of stones/materials depends on the configuration of the 'stone-rake', and the depth to which the soil/basal layer is dug in the procedure (Box L.5). For inert backfilled basal layers, the stone-rake probably can only be used when it has been decompacted first, either by an excavator with a standard bucket (see **Sheet N**) or ripping with tines (see **Sheet O**).

L.8 Where the removal of materials (wire rope, drums, tree roots, concrete lintels, etc) damaging to aftercare operations (e.g. cultivation, under-drainage installation) is not effective with the above stone-rake method, the operation is to be undertaken using digging buckets/ripper claw or tine equipment (see also **Sheets M & O**) to release the material and draw it aside for collection and disposal.

L.9 The release of stones is facilitated by the combing action of the excavator boom/tines on the stone-rake through the soil layer and to a depth required in the SRMP. For 'tines' 150-200 mm long a working depth of about 200-250 mm can be achieved.

Box L.5

There is a large range of stone-rake buckets and similar tools available for a range of stone sizes typically from 50mm to 150mm. Tine centres of less than 150mm tend to be more prone to clogging when used with clayey sub-soils, making this a practical size limit for stone removal. Where the stones to be removed from top-soils are less than 150mm, but greater than 20mm, 'finer' rakes can be used or a specialist stone picking machine. The removal of these smaller stones may only be required for certain after uses such as horticulture.

L.10 The 'radial' combing action (**Figure L.1**) is used to draw the stones towards the excavator for windrowing and loading into a dump truck for disposal or utilisation elsewhere. The radius is determined by the length of the excavator boom less the standoff to safely 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.

L.11 Where the soil is a very fine texture (clayey) and has a relatively high moisture content, it can be difficult to break down soil clods and release the stones. In these circumstances the soil layer being treated may require cultivation with a bulldozer/ tractor drawn heavy duty discs slightly offset from

the axis of travel.

L.12 Stone removal from the topsoil layer may be delayed until the whole area has been restored. If this option is adopted the use of the bucket method is not appropriate, and a tine cultivation method (e.g. **Sheet M**) should be used followed by removal of the stones by a specialist stone removal machine. If they are only few and large stones, these may be hand-picked and loaded into a tractor drawn trailer.

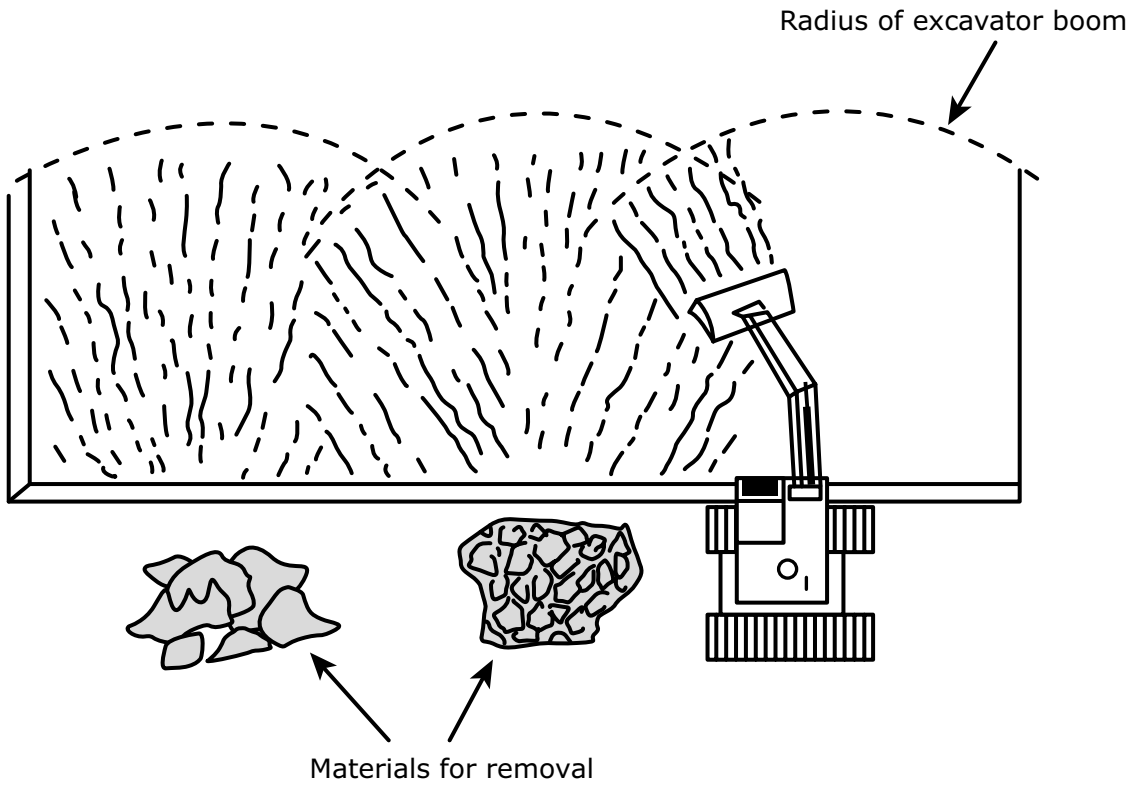

Figure L.1 Radial combing of soil surface to remove stones/damaging materials.