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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

Published in the UK by:

The Institute of Quarrying

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Chetwynd Business Park
Chilwell,
Nottingham
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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.

First Edition published 2021.

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GOOD PRACTICE GUIDE FOR HANDLING SOILS

In Mineral Workings

PART TWO: Model Methodology

- Sheet F -

Soil Stripping with Bulldozers and Dump Trucks
- Windrow Practice

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Version 1 | July 2021 | © Institute of Quarrying

Preface

The purpose of Sheet F 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 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, bulldozers are used to strip the soil by heaping it into 'windrows', and back-acting excavators are used to 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 out parallel longitudinal strips (windrows) where alternative strips of topsoil from each side is pushed to surcharge the windrows acting as temporary repositories. The safe and efficient distance of the bulldozer's push defines the width between the windrows. The topsoil on the retreating surcharged strips is then loaded by excavator into the dump trucks at the loading point on the haul route. On completing, the removal of the windrow the process is repeated for the next topsoil area to be stripped. The process using bulldozers is usually repeated across the area to be stripped of soils until all the topsoil layer is completely removed. Whilst the exposed subsoil layer, if present and to be recovered, can be by the same procedure of windrowing the common and more practical practice is the sequential lifting of the subsoil by the excavator with the trafficking and loading of dump trucks on the basal layer. The following guidance can also be adopted where only a single soil horizon is to be stripped.

Advantages & Disadvantages
The advantage of this machinery combination and handling practice are that:

i) It is a relatively simple operation to undertake and can be quicker than both the excavator combination with the bed/strip and windrow practices.

The disadvantages are several:

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 susceptible to stoppages due to soil rewetting as the transpiring vegetation cover is removed on stripping the topsoil
iii) It is slow react to localised changes in soil types and variation in horizon depth, and can result in the mixing of soil horizons
iv) It is not suited to the stripping of thin and 'patterned' soil layers, and cleanly exposing the top-sub-soil interface.

Suitability
This handling practice is not suitable where the subsoil surface needs to be carefully exposed for archaeological investigations and recording (as opposed to trial sampling).

Whilst the 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 **Table 7, 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

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

Box F.1 - To minimize 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 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 F.2 - To minimize the wetness of the soil and re-wetting of the soil:

- The 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 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.

F.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 F.3).

Box F.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.

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

Box F.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.

F.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.

F.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.

F.6 Demarcate an initial surcharged top-soil strip and the width of the recovered soil as the effective push distance of the bulldozer to the edge of the windrow (BOX F.5).

BOX F.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.

F.7 Within each soil unit the topsoil layer is to be stripped across the area in sequential windrowed strips; the topsoil stripped to its natural thickness without incorporating material from the lower layer. Stripping of the topsoil is to be undertaken by the bulldozer standing on the surface and pushing the soil at its maximum thickness onto the windrow where the excavator loads the surcharged soil into the dump truck.

F.8 The topsoil layer is to be pushed up onto the windrow in the thickest layer possible with the minimal passes possible, whilst maintaining operational efficiency of the bulldozer, to form the low mound (**Figure F.1**). The topsoil should be recovered to the full width of the segment without mixing with sub-soil (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.

F.9 The soil furthest from the windrowed strip should be pushed first, progressively working to the front of the strip (**Figure F.1**). The topsoil is to be loaded into the dump truck stood on the basal layer by the excavator on the surcharged windrow (**Figure F.2**).

F.10 Unless the area is being stripped in segments to maintain vegetation and vegetated top-soil cover to protect as the subsoils from rewetting, the full thickness of the topsoil horizon would be stripped progressively across the area before the subsoil horizon(s) is stripped.

F.11 The subsoil layer(s) is to be recovered by repeating the above process with the bulldozer pushing the subsoil onto the new windrow with the excavator standing on the subsoil and loading onto the dump truck on the basal layer (**Figures F.3 & F.4**).

F.12 Where there is an upper subsoil to be recovered, if possible it is to be stripped as a windrow in the above manner. The lower subsoil would be recovered by the normal progressive lifting and loading by excavator from the subsoil layer with the dump trucks on the basal layer.

F.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 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.

F.14 Where 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.

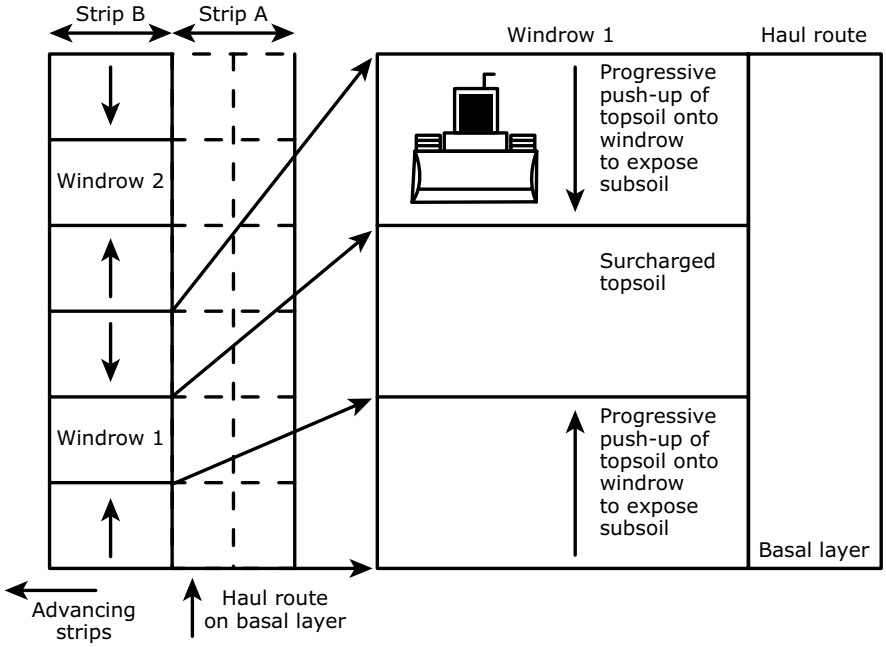

Figure F.1: Surcharging of windrow with topsoil.

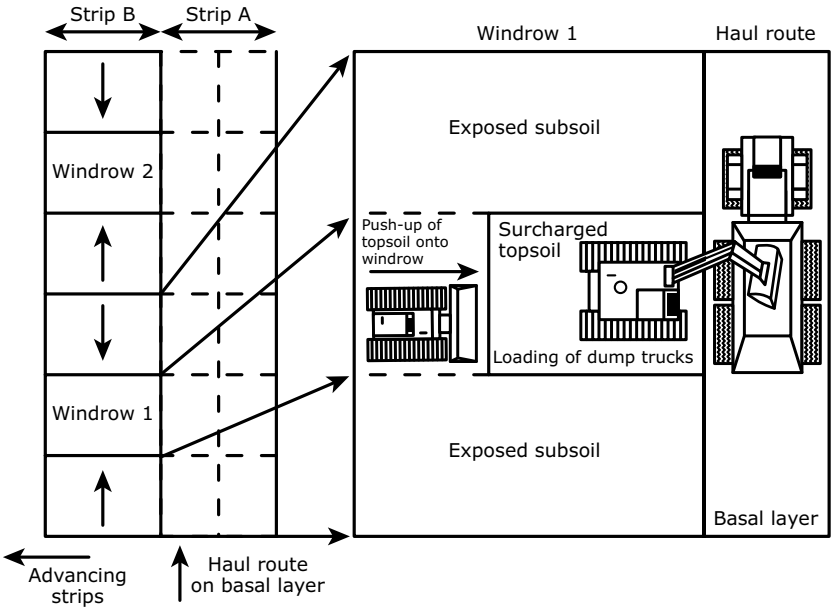

Figure F.2: Retreat of topsoil surcharged windrow and loading of dump trucks.

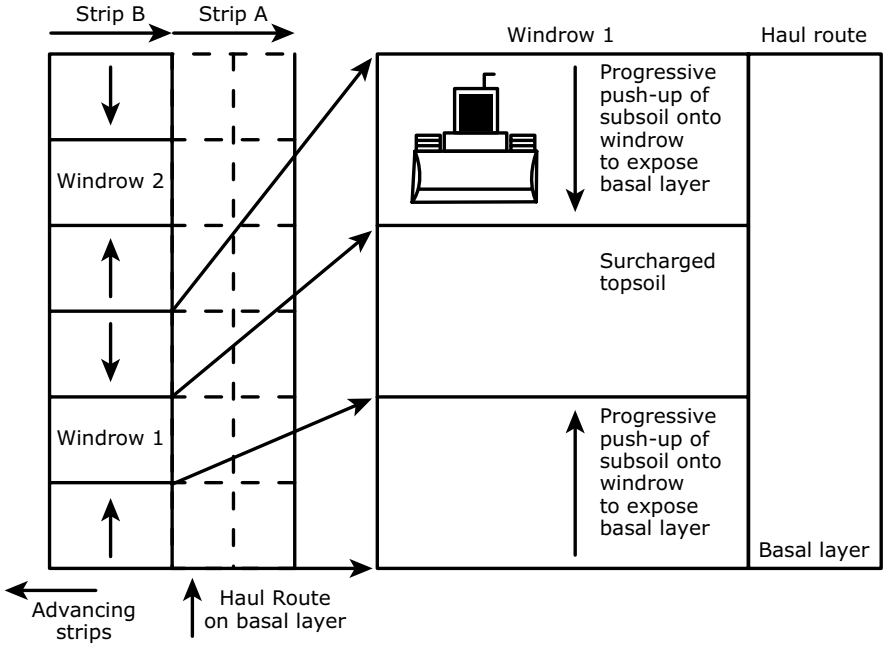

Figure F.3: Surcharging of windrow with topsoil.

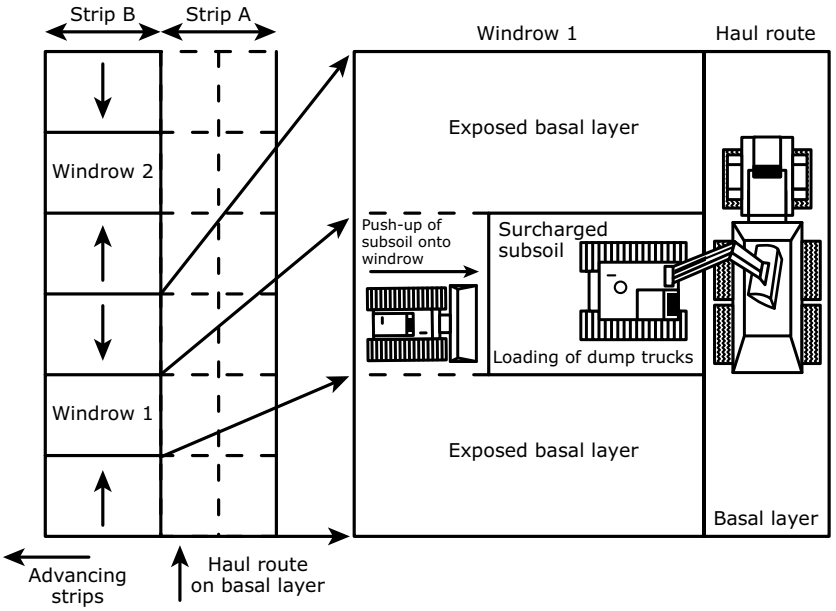

Figure F.4: Retreat of topsoil surcharged windrow and loading of dump trucks.