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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 E -

Soil Stripping with Excavators and Dump Trucks
- Windrow Practice

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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.

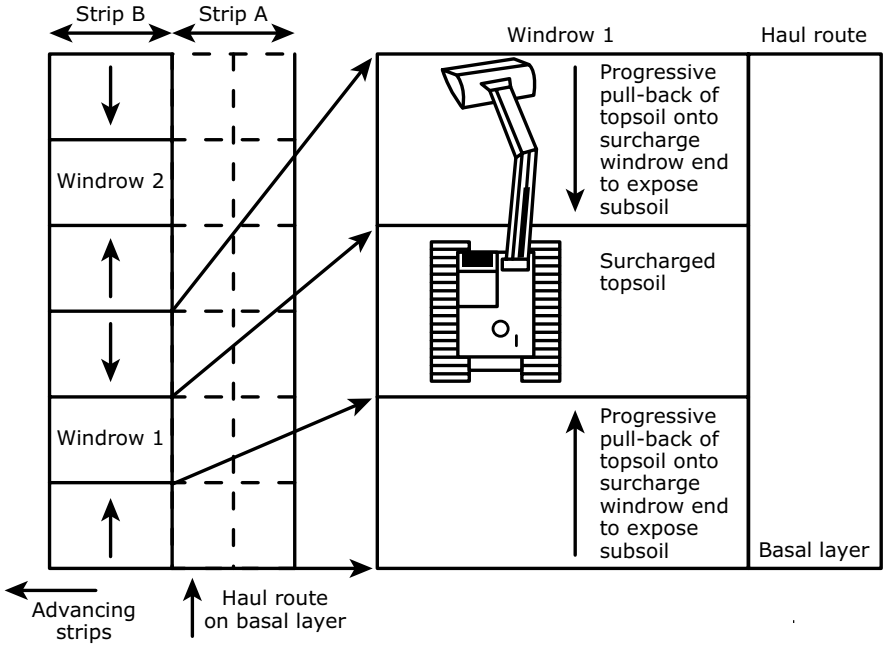

Figure E.1: Surcharging of windrow with topsoil.

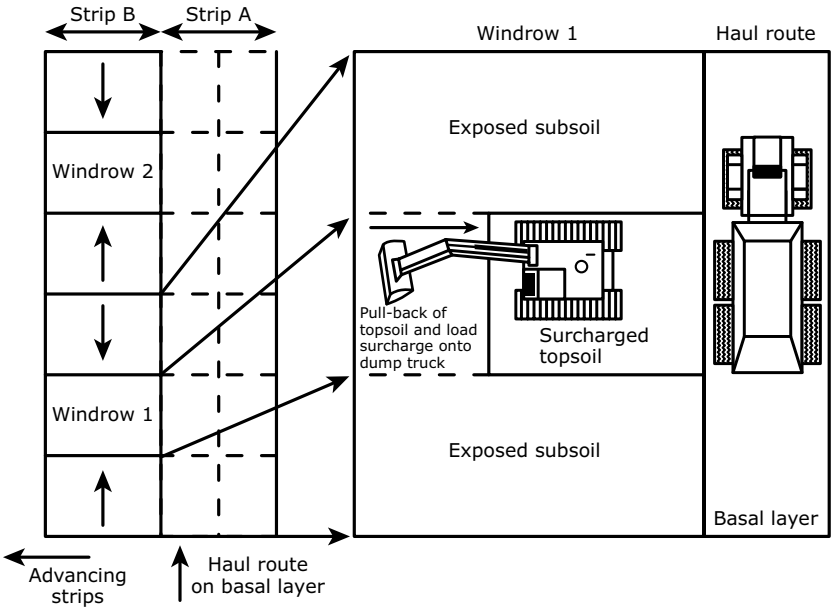

Figure E.2: Retreat of topsoil, surcharged windrow and loading of dump trucks.

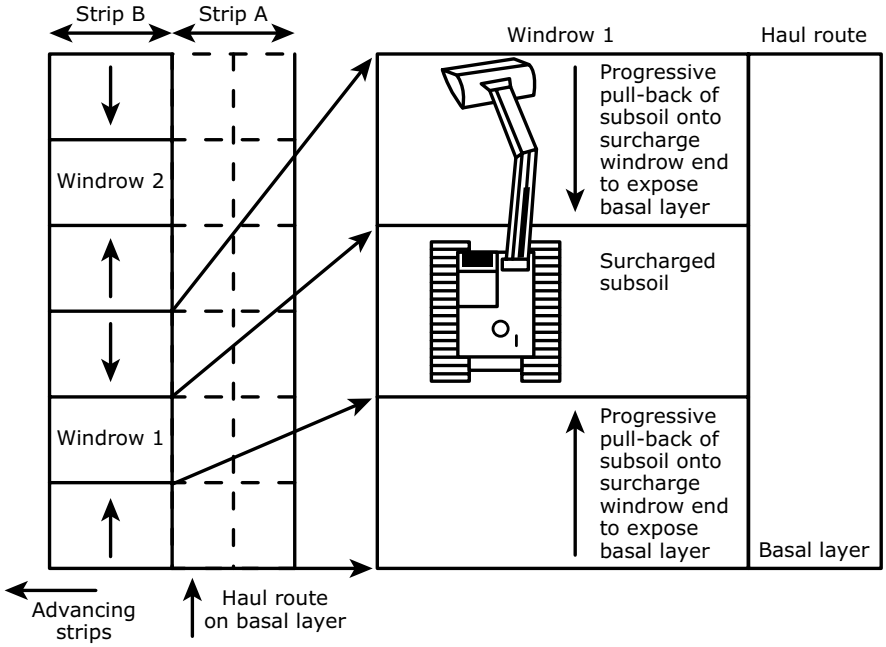

Figure E.3: Surcharging of windrow with subsoil.

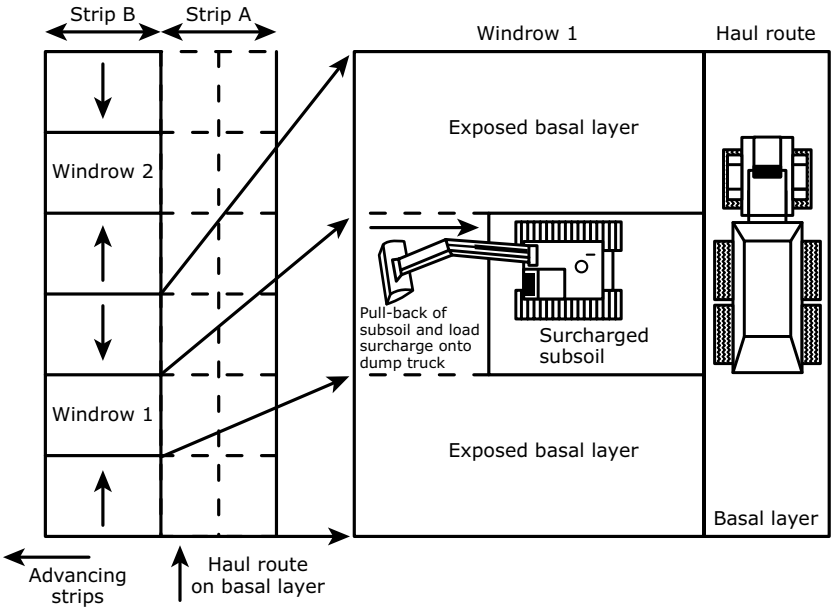

Figure E.4: Retreat of subsoil surcharged windrow and loading of dump trucks.