



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

McPherson House
8a Regan Way
Chetwynd Business Park
Chilwell,
Nottingham
NG9 6RZ

www.quarrying.org

© 2021 The Institute of Quarrying

All rights reserved. No portion of this publication may be reproduced, stored in a retrieval system or transmitted at any time or by any means mechanical, electronic, photocopying, recording or otherwise without prior, written permission of the publisher.

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.

For over 100 years the Institute of Quarrying has been supporting people working in the mineral extraction industry. It is the only international professional body for quarrying, construction materials and the related extractive and processing industries. IQ's focus is to be the global leader in standards for the sector, to push innovation and operational best practice, to support the industry in driving healthy, sustainable workplaces and to promote the positive impact of the industry and profession. Being a member of IQ means being part of a global community of industry professionals committed to sharing knowledge and improving industry standards.

GOOD PRACTICE GUIDE FOR HANDLING SOILS

In Mineral Workings

PART TWO: Model Methodology

- Sheet B -

Building Soil Storage Mounds
with Excavators and Dump Trucks

Author: Dr R N Humphries CBIol CSci FRSB FBSSS FIQ
- Blakemere Consultants Ltd & Celtic Energy Ltd

Supporting artwork was provided by R Shelton (H J Banks & Co)
and D Fisher (Blue Room Graphics Ltd).

Preface

The purpose of Sheet B of the guidance is to provide a model method of best practice where excavators and dump trucks are to be used to build soil storage mounds.

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

This soil handling method uses back-acting excavators to build the storage mound in combination with dump trucks to transport the soil. Either the excavator sits on the basal layer and casts the tipped soil into a mound or it sits on the tipped soil and pulls it into a mound. The latter is preferred as it is easier to form the mound. In many cases low ground pressure bulldozers are used to grade and trim the finished mound.

Top- and subsoil(s) are to be stored in separate mounds or in clearly defined parts of mounds, in some circumstances where the topsoil can be easily recovered it may be laid over the subsoil.

The space available for storage in mineral workings is often limited and this determines the 'height' of mounds. For topsoil the preference is for 1 to 3m height in order to minimize the impact of storage on biological processes, whereas for subsoils where the biological activity is lower, subject to safe operations, mounds are often raised to heights of 3 to 5m depending on the resilience of the soils to compaction (see Part One & Supplementary Note 3).

In this soil handling option, the mounds are either built as one 'tier' or 'multi-tier' high. In the single tier only the excavator and if used the bulldozer traffic the tipped soil surface and usually the final surface. Whilst, in the multi-tier mounds it is also trafficked by loaded dump trucks.

Advantages & Disadvantages

Storage vs Direct Placement:

The advantages of storage are:

- i) It gives flexibility in the operation of the mineral site
- ii) Flexibility (i.e. weather and ground conditions) for when it is reused.

The disadvantages are:

- i) There is an high risk of compaction of the soil material by stacking in the mound which later cannot be effectively treated
- ii) There may be significant degradation of biological functions with long-term storage.

Single vs Multi-tier Mounds:

The advantage of multi-tier mounds is that they take less space. The disadvantages are:

- i) With multi-tier mounds there is high risk of severe compaction of the soil material layers by repeated trafficking by laden dump trucks in the building of multi-tier mounds which later cannot be effectively treated
- ii) There may be a longer delay in recovery of the soil's biological functions on replacement.

Suitability

Soil storage is less suitable where:

- i) The subsoil(s) are significantly less resilient to compaction (such as silts and sandy clay loams) and when decompaction treatments cannot be relied upon to be effective because of a risk of soil wetness or operational limitations (such as the unavailability of effective decompaction tools) (see **Part One and Supplementary Notes 3 & 4**)
- ii) The intended after use, environmental and ecosystem services are 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 usually includes the most productive agricultural, horticultural and forestry land, many types of natural habitats, and where water storage/infiltration is of importance for the risk of flooding
- iii) The bed/strip practice using excavators is used (Sheet A) as the compaction caused can negate its benefit
- iv) Multi-tier mounds are used, particularly where the intended after use, and the environment and ecosystem services are 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 usually includes the most productive agricultural and forestry land, many types of natural habitats, and where water storage/infiltration is of importance for the risk of flooding.

MODEL METHODOLOGY

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

Box B.1 - To minimize compaction:

- strip in advance the soil to basal layer along haul routes and the operational footprint of the storage mound
- dump trucks are only to stand and travel on the basal layer (unless raising the next level in multi-tier mounds)
- the machines are to only work when ground or soil surface conditions enable their efficient operation
- single-tier mounds should be prioritised over multi-tier mounds as it avoids the need for trafficking on the soil being stored
- raise the soil using only the excavator and maximise the mound height before trucks allowed to access upper surface
- in the raising of multi-tier mounds, trafficking is to be confined to the upper surface of the lower tier. This layer will require decompaction on excavation of the mound.

B.2 The timing of the building of the soil storage mounds will be governed by the weather and soil conditions governing stripping (see **Sheets A, E, F, I**). Unless the soils are required to be kept in a wet state (eg peat), the mounds should be sited on dry ground, not in hollows and should not disrupt local surface drainage (Box B.3). Where necessary mounds should be protected from run-off/ponding by a cut-off ditch which is linked to appropriate water discharge facilities. Where the storage mound is in a hollow due to the removal of surface soils, measures should be undertaken to ensure that water is not able to pond within the storage area.

B.3 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.

Box B.2 - To minimize the wetting of soils:

- soil mounds to be built in dry/draining/drained locations and protect from run-off from adjacent areas
- raise the soil mound to maximum height progressively along the axis of the mound, and shape the mound as it is being built to shed water and seal exposed surfaces whenever 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.

Box B.3

Where soils such as peat need to be kept in a wet condition this may require storage in (bunded) cells where receiving rainfall cannot drain.

B.4 The operation should follow the detailed stripping/storage 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.

B.5 Adopting the practices outlined in **Sheet A**, where relevant, remove topsoil and subsoil to basal layer from the haul routes, footprint of the storage mound and any other operating area in advance. The soils should be stored in their respective mounds.

B.6 The dump trucks must only travel within the haul route and operational areas. Typically the trucks should enter the storage area, reverse and tip the soil load starting at the furthest point of the

mound from the point of access. The back-acting excavator pulls up the soil into a mound of the required dimensions (Box B.4). The excavator operates by standing on the mound (**Figure B.1**) or the stripped basal layer. The excavator bucket can be used to shape and firm the sides as the mound is progressively formed to promote the shedding of rain.

B.7 The process is repeated with the tipping of soil against the forming mound, and without the dump truck wheels traversing onto previously tipped material. The operation continues progressively along the main axis of the mound.

Box B.4 - 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 stone free. Where there is a watching archaeological brief, the use of bladed buckets will normally be required.

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.

B.8 Without the trucks rising onto the soil mound, the maximum possible height and width of the mound is related to the boom reach of the excavator (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.

B.9 To raise the mound higher, as a multi-tier mound, the trucks will have to travel on the upper surface of the mounded soils (first tier). In this case the mound should be raised to its maximum height (**Figure B.2**). A ramp will have to be provided for the trucks to rise onto the surface of the first tier, which should be capable of trafficking safely and without difficulty. The next tier would be formed repeating the process described above.

B.10 If further tiers are required, the process would

be repeated. Any exposed edges/surfaces should be shaped using the excavator bucket on the onset of rain during the day, this should include any exposed incomplete surfaces. All surfaces should be shaped to shed water at the end of the day. The final outer surface should be progressively shaped using the excavator bucket or low ground pressure bulldozer to promote the shedding of rain.

B.11 Work should stop in wet conditions (Box B.5) with measures undertaken to shed water from the soil surfaces and to prevent ponding at the base of the mound and on the basal layer. At the start of each day ensure there is no ponding on the basal layers and operating areas.

Box B.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.

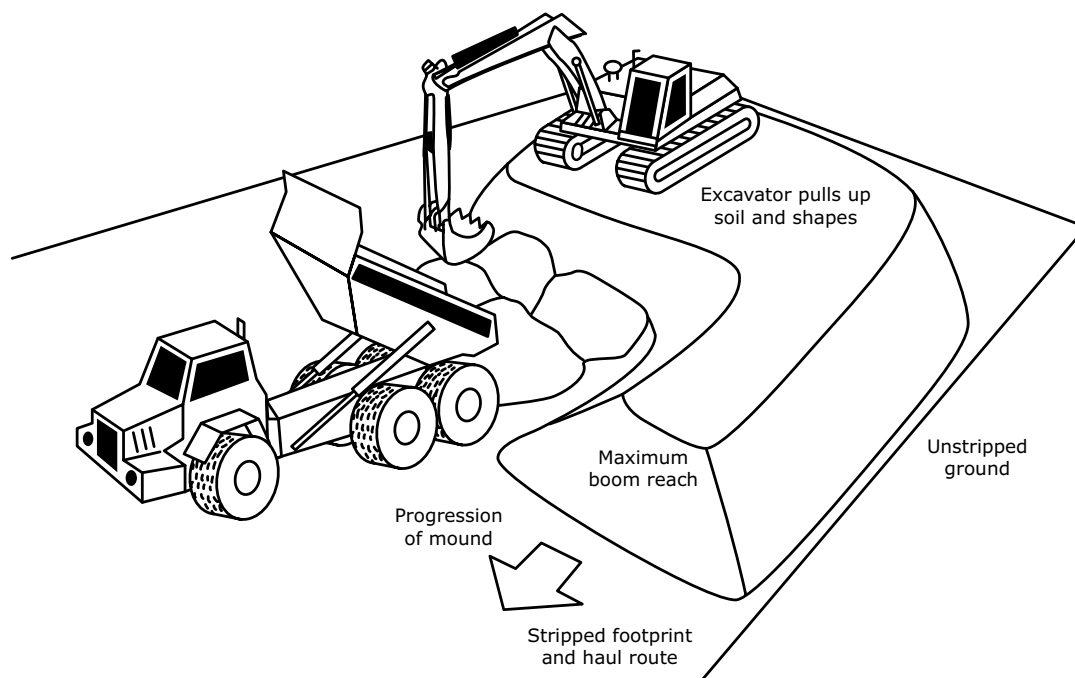


Figure B.1: Soil storage mound construction with excavators and dump trucks: Single tier mound.

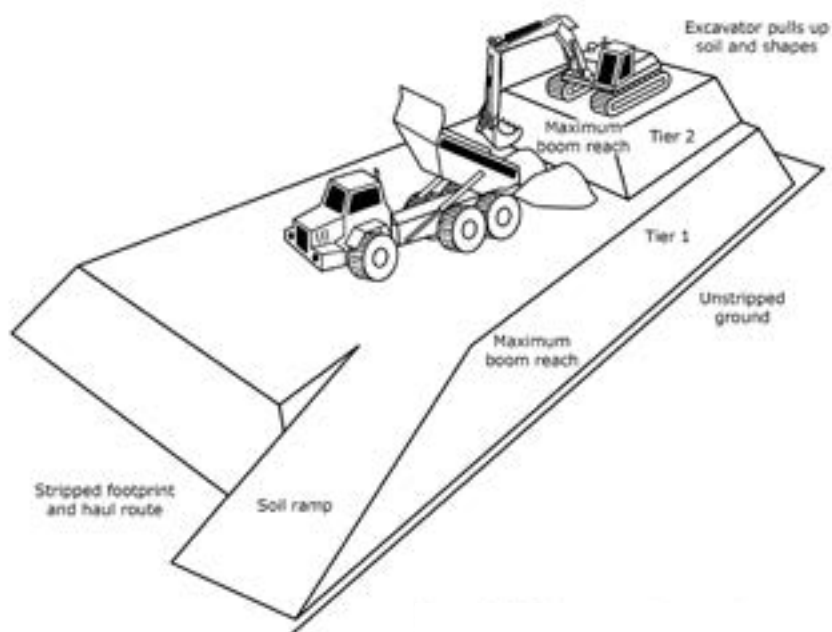


Figure B.2: Soil storage mound construction with excavators and dump trucks: Multi-tier mound.

