

MIRO - MIST
Soil handling & restoration in quarries
Best environmental practice guidelines

1. Introduction

A considerable amount of literature is now available detailing guidance on the handling of soils for quarry restoration. The literature has developed over many years, but in an increasingly organised nature in recent decades. The information exists in many forms and from a number of sources, but very often not specifically addressing soil handling for quarry restoration. Thus, information may be hidden within various documents covering the restoration of mineral workings in general (including opencast coal) or land restoration in general. Specific documents do exist however covering soil handling or restoration to agriculture in detail, and restoration of quarries in general.

The information relating to soil handling for quarry restoration needs to be accessed by various organisations at a number of key stages during the planning, operation and restoration of a quarry. This access-need has an effect on the manner in which information on soil handling appears within guidance documents and literature. At the planning stage, information relating to wider environmental issues associated with soil handling may also need to be addressed and mentioned in planning applications and public enquiry literature (e.g. measures to mitigate against soil erosion or details of soil manufacture). During the operation and restoration phases, specific information on the movement procedures is needed. Following restoration, the ‘aftercare’ period requires information detailing tillage operations specific to disturbed, and invariably, damaged soils.

The national guidance document to which most planning applications would refer, in the first instance, when outlining soil handling operations at a mineral extraction site, would be the former Department of the Environment’s document, Minerals Planning Guidance 7¹. Local (county) minerals plans may have further guidance and specific requirements needing consideration. These documents provide a soil handling framework around which site specific conditions will need to be developed. The quarry manager, the local minerals planning officer and any contractors and consultants involved with soil handling will need to develop these additional conditions. More general guidance documents such as the Soil Code² can further be used and in specific cases, scientific papers used to source more detailed information.

The quarrying industry has produced its own guidance documents under the auspices of the Institute of Quarrying³, which covers planning and restoration for sand and gravel extraction sites, and under the Minerals Industry Research Organisation (MIRO), which covers quarry reclamation in general⁴. The former Department of the Environment produced two guidance documents, Guidance on the Good Practice for the Reclamation of Mineral Workings to Agriculture⁵ and Reclamation of Mineral Workings to Agriculture⁶, specifically relating to reclamation of mineral workings to agriculture and more recently, MAFF published a series of individual pamphlets, Good Practice for Handling Soils⁷ outlining soil handling guidelines for a number of operational situations.

Specific problems encountered with the handling of soils within the quarrying industry are very often the lack of soil and particularly space during operations at small quarry sites. In addition, lack of personnel dedicated to soil handling and land restoration issues in general will make the need for clear, specific guidance essential.

This document covers techniques now widely accepted as ‘good practice’ for soil management and handling, but specifically within the context of the quarry situation. Reference is made to other, more general, guidance documents and also relevant legislative

documents required for consultation. An overview is provided of the planning and practical procedures needed in relation to the manufacture and use of synthetic soils within quarries.

2 Soil management

Soil management covers a broad range of tasks which need to be undertaken before, during and after the mineral extraction phase at a quarry. The tasks generally fall within soil assessment, soil handling and aftercare. The best practice guidance is generally the same for a small and large quarry site, the main difference being space restrictions on a small quarry requiring very careful planning and possibly longer periods of soil storage compared to a larger quarry site.

2.1 Soil assessment

Within the overall task of soil management at a quarry site, soil assessment in the first instance is crucial to be able to plan soil handling operations and design the restoration. An assessment of soil resources will also be needed for the planning application. The soil assessment will require a survey of the soil quantities available for restoration and this may additionally require an assessment of the quality of the agricultural land which a soil occupies. Ultimately the assessment needs to determine the soil type (texture mainly) and depth which will allow for volumes to be calculated. Within the confines of a small quarry, careful planning of soil handling and storage is crucial and information on soil type and volume needs to be accurate to plan the logistics of all operations.

2.2 Soil handling

Soil handling operations, over the complete working lifetime of a quarry, require soil removal from undisturbed land, placement into storage mounds, removal from storage mounds and finally restoration to their final position followed by tillage operations. Best practice guidelines for the above operations are available for quarries, sand and gravel extraction sites, mineral workings in general and in detail for any operation requiring soil handling operation (References 3,4,5,6 and 7). These documents cover a range of situations differing in environmental setting and machinery type used.

A number of basic requirements have become standard for soil handling in all situations and with all machine types and which ultimately seek to avoid soil mixing, soil loss and soil structural damage (resulting from either or both soil smearing and compaction). In addition to the standard best practice techniques, there are additional points that need noting depending on the type of soil handling machinery in use.

2.2.1 General soil handling best practice

If possible, soil should be removed and then immediately replaced under a 'progressive restoration' methodology thereby limiting the amount stored to that which covers only the immediate mineral extraction area. The soil should not be handled when the moisture content is above the lower plastic limit (LPL) and if using earth scrapers, the moisture content should be at least 5% below the LPL. During all operations and with all machine combinations, the ponding of water should be avoided and no operations should take place during rainfall.

A clear distinction should be made early on between soil which consists mainly of mineral matter and peat which consists mainly of organic matter. Although site-specific conditions relating to soil type, need consideration when planning soil handling, most mineral soils can in general be managed with the same generic guidance. Peat however, needs very careful handling and quite different storage methodology as outlined below.

2.2.2 Stages of soil handling

2.2.2.1 Soil removal

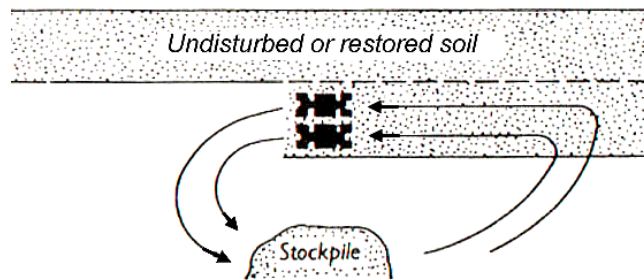
A removal schedule should be developed for the local Mineral Planning Authority (MPA) and should use the soil resources survey to facilitate stripping of the topsoil (approx. 0.2 m), the subsoil (approx 1.0 m) if available.

The mixing of these soil horizons with each and with any overburden should be avoided.

During removal, exposure of soil layers to atmospheric drying can be used as a method of soil moisture control.

Motor scrapers should attempt to collect as thick a layer as possible (but not in excess of a horizon depth) when removing soil and then always using a ‘one-way’ system with the minimum time spent on the layer to be removed (Fig 1).

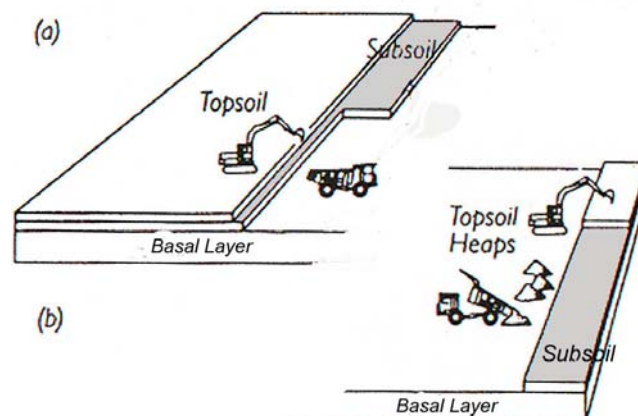
Figure 1. Soil handling with scrapers



Source: Institute of Quarrying³

If dump trucks and excavators are employed, the dump trucks must only operate on the basal layer (overburden) with excavators working only on the topsoil layer (Fig. 2a), except with peat when no machinery should operate on the peat surface.

Figure 2. Soil handling with excavators and dump trucks



Source: Institute of Quarrying³

A 'bed strip' system should be used to remove all soil horizons in a profile, and within a bed, down to the basal layer before rainfall occurs (Fig. 2).

If bulldozers are being used, a site may require draining to reduce soil moisture levels before operations begin.

2.2.2.2 Soil storage mound construction

Mineral soils can be stored in mounds with the topsoil not exceeding 2 m in height and the subsoil limited only by machine operation restrictions. Topsoil and subsoil must be stored in separate mounds. Peat should be stored in bunded lagoons and not mounds in order to prevent dehydration.

Single tier mounds should be used when construction takes place with excavators and dump trucks, as this will minimise compaction.

With motor scrapers a strict 'in out' system should be used to avoid excessive ad hoc travel (Fig. 1).

As with soil removal, using bulldozers may need the site to be drained to reduce soil moisture prior to operations.

2.2.2.3 Soil storage mound removal

Storage mound removal requires the same practices as for mound construction to be followed, however, mounds should not be removed with the aid of bulldozers.

2.2.2.4 Soil replacement

Replacement with excavators and dump trucks requires the excavators to work only from the basal layer (Fig. 2b). Care is needed when tipping from dump trucks so as not to back onto the soil layers or spill soil onto a previous layer. Restored landforms should not be flat.

De-compaction will be needed after replacement with scrapers and bulldozers but also possibly after replacement with excavators. De-compaction should involve deep ripping of each layer following replacement and on the day of the placement of the subsequent overlying layer.

Peat will not in general require de-compaction as for mineral soils.

2.3 Aftercare

Soil handling usually results in some structural and biological damage which can take a number of years to recover. Part of the overall soil management programme therefore includes a mandatory 5 year aftercare period during which the Mineral Planning Authority together with the Department of Environment Food and Rural

Affairs (DEFRA) oversee land management practices with the major aim to improve soil conditions.

The precise aftercare programme details will be site specific but for most agricultural and many amenity sites will involve early drainage installation and then grass cut for animal fodder for at least 2 years, followed by arable agriculture if appropriate. Spring cultivations are, in general, discouraged on the heavier textured soils in order to reduce structural damage.

2. Legislation

Soil management is covered in general by the Town and County Planning Act 1990 and the Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999 for sites over 25 ha., and in sensitive cases below 25 ha. This legislation covers broad procedures relating to the information required by regulatory authorities when assessing planning applications for mineral extraction sites.

Specific details of soil management will be included in various guidance documents (listed in the Introduction) which are issued by Government departments. Guidance within these documents can be stipulated as required practice for soil management at a particular site and this can then be enforced by the Local Planning Authority within a *Decision Notice* following a planning application.

3. Synthetic soil preparation and use

Synthetic soil use (the use of combined soil forming materials) on aggregate extraction sites has traditionally been undertaken whenever a shortage of soils has arisen. The term 'soil-forming materials' has been in existence for many years and refers usually to on-site overburden materials which can be used to help form a profile within 1 m depth of the surface, ultimately for plant growth. The overburden can consist of various mineral matter drift deposits suitable for making soils, with those of a silty or sandy texture usually the most easily handled.

Following placement on an area to be restored, a soil forming material, usually, would then be augmented with some form of organic matter, very often some form of sewage sludge which would need to be imported into the site. Many other different organic matter sources are however now increasingly available to help in the production of synthetic soils for land restoration^{8,9}. Typical materials available include:

- Green waste or other composts
- Paper waste sludge
- Food waste
- River or canal dredgings
- Water treatment sludge
- Farmyard manure
- Wood waste
- Various sewage sludges
- Animal by-product wastes

A number of issues must be addressed before a synthetic soil can be manufactured.

The entire operation would normally need to fall within exception criteria listed within the Waste Management Licensing Regulation 1994 as the Environment Agency will in most cases consider the imported material a 'waste'. The main points to note are that:

- The organic waste amendment must fall within the categories listed within Table 2 of the Regulations
- Only specific quantities of certain wastes can be spread on land.
- If soil is manufactured on the site, up to 20 000 cubic metres can be spread on land.
- The material results in agricultural or ecological benefit.

In addition to the legislative aspects of synthetic soil manufacture and application, practical aspects relating to environmental pollution, plant nutrient management and physically dealing with the materials involved have to be considered.

A crucially important point is the ability to manufacture a soil on-site and hence increase the volume of material that can be applied if needed. This clearly distinguishes between operations where materials can simply be spread directly on the land surface or those used for soil manufacture on-site.

In general, two different 'limiting' criteria may restrict the amount of waste that can be spread on land which is being restored. The Waste Management Licensing Regulation 1994, which are the same for any site, and the Contaminated Land Regulations 2000 which would be site-specific. If the land is being restored to agriculture and once the land had passed beyond the 5 year aftercare period, the Nitrates Directive would need to be adhered to.

If a quarry site does not have a Waste Management License, the Environment Agency will need a Waste Management Licence exemption application to be lodged prior to land-spreading of waste. Within the application, details relating to pollution issues such as nitrogen and metal content of the waste and site specific details such as proximity to receptors such as streams will be needed.

To satisfy the Waste Management Licensing regulations, agricultural or ecological benefit will need to be proved and therefore information on the plant nutrients to be supplied to agricultural plants or mainly soil structural improvements to be imparted for ecological benefit must be quantified. Careful management of plant nutrients and soil structural conditions will be needed for any commercial cropping programme also.

The physical condition of both on-site soil making materials and the imported organic or mineral matter will need to be such that they are able to be applied to land or relatively easily mixed prior to application. Mixing can prove difficult with heavy clay substrate material and wet organic matter. Some pre-drying or other preparation, such as screening or shredding, of either the substrate and/or the organic amendment may be needed.

If a material is being spread directly onto a site then a solid or liquid spreader can apply material which is then mixed into the substrate on the ground with various agricultural machinery to achieve specific desired results such as mixing to depth. If a soil is to be manufactured, this must be undertaken prior to any material being placed on the site surface. The simplest methodology would involve adding a quantity of organic material to

a muck spreader followed by a quantity of inert mineral matter, such as sand, and mixing will take place as these are spread onto the land.

With all synthetic soil manufacturing, whether done on the ground or prior to application, some degree of initial testing and then trial and error pilot studies are essential to satisfy both the regulatory authorities and the site operators' practical achievable goals.

4. Specific legislation and guidance for restoration to agriculture

If a site after use will be agriculture and also waste materials are to be brought onto the site, a number of main pieces of legislation will need to be complied with:

- Environmental Protection Act 1990
- Groundwater Regulations 1998
- Sludge (Use in Agriculture) Regulations 1989
- Nitrates Directive (91/676/EC) 1991
- Contaminated Land Regulations 2000
- The Nitrate Vulnerable Zones (Additional Designations) (England) (No. 2) Regulations 2002

If animal waste of any nature is to be used, even if only as a small fraction of food waste, the Animal By-Products Regulations 2003 will need to be complied with.

Substantial guidance documentation is available to support the above legislation, however, in the first instance most 'good practice' guidance can be found or sourced within the Soil, Water or Air Codes^{2,10,11}. Overall, the legislation and guidance seek to protect soil structural conditions, plant and human health and wider environment. More general soil protection 'good practice' guidance is contained within the Draft Soil Strategy for England and Wales¹² and the Royal Commission document, the Sustainable Use of Soil¹³.

Soil structural protection has been addressed above under 'soil handling' guidance. Other guidance focuses on protecting human health by limiting the accumulation of metals within soil (Sludge (Use in Agriculture) Regulations 1989) by limiting the amount of a metal that can be applied over time. This ultimately may limit the amount of soil amendment material which can be applied each year. With respect to pathogenic material, a risk reduction procedure, dictated by the Animal By-Products Order, must be complied with during and after the compost/soil conditioner production and prior to crop growth. A major instrument of legislation which seeks to protect the wider environment is the Nitrates Directive which has resulted in the designation of Nitrate Vulnerable Zones to protect ground water and surface waters by limiting the amount of nitrogen to a maximum 250 kg/ha per year that can be applied to farmland. However, during the reclamation phase (including the aftercare period) on a quarry, legislation such as the Nitrates Directive is not applicable as the land would not be classified as agricultural. The Environmental Protection Act 1990, would be the main instrument of legislation covering pollution in such cases.

More general soil protection guidance is contained within the ex Department of the Environment document, Guidance on Good Practice for the Reclamation of Mineral Workings to Agriculture⁵.

References

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