

**Karaktärisering av slam – Praktisk handledning
för slamanvändning vid efterbehandling av mark**

**Characterization of sludges – Good practice for
sludge utilisation in land reclamation**

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Characterizataion of sludges – Good practice for sludge utilisation in land reclamation

Caractérisation des boues - Bonnes pratiques pour la
valorisation des boues pour reconstitution de sol

Charakterisierung von Sclämmen - Gute praxis des
Sclammeinsatzes bei der Rekultivierung

This Technical Report was approved by CEN on 22 December 2002. It has been drawn up by the Technical Committee CEN/TC 308.

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Foreword

This document CEN/TR 13983:2003 has been prepared by Technical Committee CEN/TC 308 “Characterisation of sludges”, the secretariat of which is held by AFNOR.

The status of this document as Technical Report has been chosen because the most of its content is not completely in line with the practice and regulation in each member state. This document gives recommendations for a good practice concerning sludges for utilisation in land reclamation.

CEN/TR 13983:2003 (E)**1 Scope**

This Technical Report gives indication on sludge utilisation within reclamation programmes of disturbed land.

This Technical Report is applicable to sludges described in the scope of CEN/TC 308; for example:

- storm water handling;
- urban wastewater collecting systems;
- urban wastewater treatment plants;
- treating industrial wastewater similar to urban wastewater (as defined in Directive 91/271/EEC [18]);
- water supply treatment plants;
- water distribution systems;
- sludge derived materials;
- but excluding hazardous sludges from industry.

NOTE Because of the wide range of reclamation sites where sludge use as a soil ameliorate or source of plant nutrients is beneficial, and the different potential final uses of these sites, recommendations for application should be considered on a site-by-site basis. It is far beyond the scope of these guidelines to describe all the possible situations and the individual ways in which sludge could be used. The aim is to address, in a general qualitative way, the key issues which will determine in each particular case whether, how much and which type of sludge can be used.

Planning considerations (clause 5) are emphasised due to the fact that a general scheme can be adopted as a common procedure in nearly all situations.

2 References

EN 1085:1997, *Wastewater treatment — Vocabulary*.

EN 12832:1999, *Characterisation of sludges — Utilisation and disposal of sludges — Vocabulary*.

EN 12255-8, *Wastewater treatment plants — Part 8: Sludge treatment and storage*.

ISO 5667-13:1997, *Water quality — Sampling — Part 13: Guidance on sampling of sludges from sewage and water treatment works*.

ISO 10381, *Soil quality — Sampling*.

CR 13097, *Characterisation of sludges — Good practice for utilisation in agriculture*.

CR 13714, *Characterisation of sludges — Sludge management in relation to use or disposal*.

CR 13846, *Recommendations to preserve and extend sludge utilisation and disposal routes*.

3 Terms and definitions

For the purposes of this Technical Report, the terms and definitions given in EN 12832 and EN 1085 and the following terms and definitions apply.

**3.1
sludge utilisation**

beneficial and harmless use of sludge [based on 3.2 EN 12832:1999]

3.2

land reclamation

improvement or restoration of the natural soil functions of disturbed land e.g. by application of sludge or other humus producing material [3.14 EN 12832:1999]

NOTE According to the ecological aim of the reclamation project, the final intended use can fit into three different approaches:

- 1) restoration, when the closest reproduction of the previous ecosystem or land use (e.g. agriculture) is intended;
- 2) rehabilitation, if the aim is just to achieve an ecosystem/land use similar to the original one;
- 3) new assignment, when there is an attempt to achieve a different use or ecosystem to the one existing before land disturbance.

3.3

disturbed land

land so damaged by human uses or natural causes that has the soil properties and functions drastically impaired

NOTE 1 Examples of disturbed land are given in 4.1.

NOTE 2 Natural soil functions are:

- 1) a basis for life and habitat for people, animals, plants and soil organisms;
- 2) part of natural systems, especially by means of its nutrient and water cycles;
- 3) a medium for decomposition, balance and restoration as a result of its filtering, buffering and substance conversion properties.

4 General considerations

4.1 Properties of disturbed land

Under the general term of "disturbed land" where sludge might be beneficially used, it is possible to find sites of very different origins. Examples of them (in a non-exhaustive list) are the following:

- deep mine spoils (particularly colliery spoils);
- strip mine spoils/open cast mine sites;
- sand and gravel excavation sites;
- construction sites and road verges;
- highly eroded areas and abandoned agricultural soils;
- disturbed urban sites;
- abandoned military areas;
- finished areas of landfill sites;
- former industrial sites;
- deposition sites of dredged materials.

Despite the wide range of situations, it is possible to define some common features, namely:

- they generally present a harsh environment to establish vegetation without treatment;

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- topsoil, if present, is usually deficient in nutrients and lacks organic matter;
- poor physical properties are usually found.

In addition, disturbed sites can often be harmful to the surrounding environment due to their current status. They can cause problems such as water pollution caused by high erosion rates, presence of toxic levels of trace metals, acid leachate, aesthetic impact and other land degradation problems.

The reclamation of disturbed sites constitutes a need in any soil protection policy, interpreting soil protection in its broader sense to include erosion control, avoidance of toxicity and improvement of soil capacity to support plant growth.

The final goal of a reclamation programme is to re-establish the drastically disturbed soil functions of these sites in such a way that the final intended use is possible (e.g. a self-sustaining and diverse vegetation in landscaping or a productive soil for agricultural use). The rapid establishment of a vegetative layer is essential since soil cover is a key element in initial site stabilisation. In this initial goal, sludge can be considered as a suitable product.

4.2 Value of sludge in land reclamation

The biological, chemical and physical qualities of different sludge types depend on the composition of water from which they are derived and the extent of processing they receive during water and sludge treatment. The relative importance of sludge quality criteria varies according to the utilisation option. In the case of its use as a material which improves the natural soil functions or to create a topsoil substitute mixed with other materials in reclamation of disturbed sites, the value of sludge rests on two main components:

- **organic matter** - Organic matter improves the poor physical conditions of disturbed soil by improving soil structure and structural stability, permeability and water holding capacity. The high organic carbon content also provides an energy source for stimulating functioning microbial communities, modulates the nutrient uptake and acts as a pH buffer;
- **plant nutrients** - Generally, the nutrient content of sludges is mainly in organic forms and are thus released slowly providing a gradual supply of nutrients (e.g. nitrogen and phosphorus in sewage sludge). The organic fertiliser characteristics of sludge are advantageous since a nutrient reserve for long-term plant growth can be applied in one application, but account must be taken of the possible pollution due to nutrient losses.

Typical municipal sewage sludge nutrient contents are given in annex A.

The application of sewage sludge, or other sludges having similar properties, can "kick start" soil processes, stabilise soil structure and provide the reserves of plant nutrients that are necessary for successful land reclamation. Other kinds of sludges may not be able to achieve this effect without supplementing with plant nutrients but can be valuable because of other properties, for example, their pH adjustment capabilities (e.g. lime sludges from drinking waterworks) or their role as soil texture modifiers (e.g. adding silt to excessively drained coarse textured soils).

Although sludge can be used at different stages (during site working and in site aftercare), sludge use in land reclamation usually implies a single two step operation: application of a suitable amount of sludge and revegetation of the treated area.

Despite the recognised beneficial role that sludge can play in reclamation projects, when it is properly managed, and the numerous successful experiences reported in bibliography [3], [4], some potential environmental effects should be taken into account when using sludge. Such effects, if appropriate measures are adopted, are usually negligible when compared to those present on site prior to reclamation. The use of sludge in land reclamation programmes can constitute in certain situations the best option from the environmental and economic point of view.

The beneficial use of sludges is a balance of benefit against risk. Therefore, the general principle that should prevail is that the sludge utilisation in land reclamation should be compatible with any future land use. Consequently a conservative approach in the application rates and sludge quality requirements should be adopted. Land reclamation should be considered just like another outlet in sludge land application programmes and all the environmental and public health issues, particularly those regarding soil and water protection, should be observed. Disturbed sites for reclamation result from many former uses and may be restored for various future uses; which will require appropriate standards to be adopted.

The aim of this guideline is to maximise benefits from recycling the valuable resources present in sludge or sludge derived products, whilst reducing the potential for adverse environmental effects.

4.3 Legislation framework

There is a general lack of specific regulations in relation to the use of sludge in land reclamation at the European and National levels.

However, different regulations can contain provisions applicable to certain aspects of sludge use for reclamation purposes which should be consulted to achieve compliance. These regulations vary between countries but they are usually within the legislation framework defined by:

- waste legislation;
- fertiliser legislation;
- environmental protection legislation;
- water legislation;
- soil protection legislation;
- mining legislation.

According to the criteria stated in these regulations, sludge use can be restricted in specific areas (e.g. because of current metal concentrations in soil, nature reserves or nitrate vulnerable zones). It should be noted that, under this framework, the legal status of different sites (e.g. areas under mining or military law) can influence the planning and implementation of reclamation measures. Notification and/or approval of application programmes, record keeping and submission of reports to pertinent authorities can be legal requirements for sludge use in land reclamation.

The priority of recycling over other disposal routes in the waste management hierarchy and the duty to reclaim particular sites after exploitation, are also stated as general criteria.

The requirements of EU Directive 86/278/EEC [16] on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture" and the national regulations related to sludge application for agricultural purposes do not apply systematically to the use of sewage sludge nor to other sludges in the scope of this guide in land reclamation. Nevertheless, sometimes the provisions of these regulations are adopted or taken as "reference values", especially if the final intended use of the disturbed site is agriculture. In such cases, the specified criteria for sludge and soil quality and maximum application rates can have to be observed. However, the revision of EU Directive 86/278/EEC is likely to include reclamation activities.

Despite the lack of legislation, there are relevant codes of practice and technical requirements at national or regional level (for example, see [1], [2], [10]).

4.4 General strategic evaluation

An evaluation of the different options for sludge final disposal or utilisation should be done as part of the general strategic planning of sludge management (see CR 13714) and in this comprehensive exercise, land application of sludge can be the preferred option. It is recommended that a quality control system for the whole procedure of evaluation is developed, according to authorities requirements.

Where land application is identified as an option, then it is necessary to assess if land reclamation can constitute a feasible and sustainable outlet. The first step is to identify potential reclamation areas, which usually involves different scenarios (see 4.1), by consulting local administrations, mining authorities and by means of land use maps and field surveys.

In this preliminary feasibility assessment a land suitability map should be drawn up. It is useful to evaluate the amount of land requiring reclamation within economic transport distance of sludge production site and the opportunity of co-ordinating future projects.

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Since the use of sludge on a reclamation site is usually a one-off opportunity, a planned sequence of reclamation projects should be managed to ensure the future continuity of the outlet. This strategy can be carried out with consecutive projects at different disturbed sites or with a progressive reclamation project at a single site of sufficient size. Projects are often discrete and will not have the potential for repeat orders. The possibility of small but continuous reclamation schemes for municipalities (roadside verges, urban dereliction...) should be considered.

A sludge management programme based entirely in the use of sludge for land reclamation is uncommon. This outlet usually constitutes a minor but valuable adjunct to agriculture and other options, and is useful for diversifying the recycling opportunities and making sludge management operations more flexible with regard to market changes. However, in certain situations, it can become the main outlet if local characteristics are suitable and a feasible, well designed programme is implemented (e.g. mining areas, small localities surrounded by high eroded areas or without agricultural activity).

Finally, in view of the future restrictions on conventional sludge outlets, land reclamation can be expected to play an increasing role within the recycling options.

4.5 Presentation to potential users

Product presentation to potential users is one of the first actions to be carried out. The main objective of marketing activity is to ensure that sludge use in disturbed land reclamation is perceived as a legitimate beneficial opportunity. It should be taken into account in the marketing strategy that users are likely to be public administrations, mining companies and landscaping or reclamation companies instead of individual owners. This fact implies generally a small user base but with high potential. Therefore it is possible to have regular users and long term arrangements/commercial relationships in which the quality of service is crucial. Success of each and every reclamation job is important to ensure a continuity of reclamation opportunities.

Some recommended tasks are:

- a) a specific marketing support for the reclamation use of sludge. It could include special promotional brochures, field trials, workshops, results of previous experiences, .etc. The creation of products specially prepared for its use in disturbed sites should be evaluated;
- b) technical and scientific advice to support a site-specific planning and operational procedures. This technical support should include agronomic, regulatory and operational aspects and guidance on good practices to be adopted over the whole process;
- c) voluntary agreements between users and sludge producers on the maintenance and/or improvement of sludge quality are desirable to increase the acceptance and to enhance the sustainability of this recycling option (operational best practices to increase the reliability of sludge quality are given in CR 13714);
- d) certificates from a third party can also be beneficial for the market.

5 Preliminary procedures**5.1 Basis of assessment**

The site and sludge specific evaluations for a particular land reclamation situation are key factors in providing all the information required in the following analysis, and as a basis for discussing the necessary operations.

5.1.1 Sludge assessment

Two kinds of assessment in relation to the sludge should be carried out:

- a) Sludge availability
 - location of sludge production sites;
 - types of sludge or sludge derived products available;
 - quantity of sludge produced;

— means of storage.

b) Sludge quality

Sludge characterisation is essential to evaluate the suitability of sludge for its use on specific sites, to determine the appropriate application rates and also to satisfy the requirements of any regulations. Information about origin and treatment procedures are crucial to understanding the sludge quality.

The sludge which is under investigation for its potential use in a land reclamation scheme should be appropriately sampled and analysed. Sludge sampling, treatment of samples and analysis should be performed in accordance to the published standard methods.

Selected sampling methods should ensure in any case the representativity of samples (see ISO 5667-13 for additional information about sludge sampling methods).

Parameters routinely monitored in sludges depend on the origin and type of sludge; they can include:

- dry residue and loss on ignition content;
- pH;
- electrical conductivity;
- organic matter content;
- total, nitrate and ammoniac nitrogen. It should be desirable to evaluate the mineralisation factor for organic N in the sludge for assessing the available N content. This can be performed by incubation procedures or other studies with the soil from the site to be reclaimed;
- total and available phosphorous;
- potassium;
- content of screenings. In order to avoid aesthetic problems of debris on soil under reclamation sludge should be effectively screened;
- trace elements (Cd, Ni, Cu, Zn, Pb, Cr, Hg);
- liming value;
- pathogens;
- any other element or compound required by any regulation.

To achieve better characterisation, the determination of additional agronomic parameters (secondary nutrients) is useful. A risk assessment should be made to decide the need for other parameters (e.g. organic contaminants, Ag, As, Br, Se, Mn, B, Mo, Pt...).

5.1.2 Site assessment

An adequate site assessment will provide information for the analysis process and the development of the application programme in aspects related to environmental issues, site preparation needs, potential end uses, sludge requirements and other technical considerations.

Three kinds of site assessment should be carried out:

a) Land use before reclamation works

- causes of soil disturbance/degradation (e.g. coal strip mining, dumping, erosion...);
- type and quantity of materials involved during site exploitation (inert materials, potential toxic elements...);