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Recommendations to preserve and extend sludge utilisation and disposal routes

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Foreword

This document has been prepared by CEN /TC 308, "Characterisation of sludge".

This document is currently submitted to CEN/BT for publication as a CEN Report.

This document has been endorsed by EUREAU[1)].

1) EUREAU is European Union of National Associations of Water Suppliers and Waste Water Services.

Summary

This report has been prepared within the framework of CEN/TC 308 on Characterization of Sludges. The Scope includes sludges from treating municipal, industrial and food processing wastewaters, sludge from treating raw water to make it potable, and other residues having similar potential environmental impacts. The objectives of the report are to analyse the current situation with regard to sludge management in Europe, and to recommend the approaches to preserve and extend sludge use and disposal outlets for the future.

Sludge is the inevitable residue of treating raw potable water and municipal and industrial wastewaters. However, knowledge of the quantities of sludges produced is incomplete. Treatment of these waters is designed to remove unwanted constituents from the water and concentrate them into a small side-stream - "sludge". The sludge may also contain surplus biomass cultured during biological treatment processes. The objective of treatment is to avoid adverse impacts on the environment and human health when the effluent is discharged into the environment or water is supplied for human consumption. The concentration of beneficial constituents and of pollutants in (and health risks associated with) a sludge depends on the initial quality of the wastewater or raw water, and the extent of treatment required to meet quality standards for effluent discharge, and potable water.

Where effluent quality standards are raised, in order to reduce pollutant loads on the environment, the quantity of sludge produced inevitably increases. To be consistent, the use or disposal of the sludge must also be environmentally acceptable, sustainable and cost-effective. Sludge management typically represents about half of the overall costs of wastewater treatment. Its management will become increasingly complex as environmental standards become more stringent, and if outlets for sludge become more constrained by legislation and public attitudes.

EU policy on waste is to discriminate against disposal and promote waste avoidance, minimisation and recycling. Disposal of sludge to sea was legislated to cease by the end of 1998. Disposal of sludges to landfill, which is currently the major outlet for some sludges in Europe, is widely regarded as unsustainable. Sludge production cannot be avoided (although the quantity can be reduced by treatment) in fact demands for higher effluent quality will generally increase the amount of sludge produced. The only remaining options are recycling or destruction by combustion. Recycling options include use on land as an organic fertiliser or soil conditioner for farming, land restoration, etc. Destruction options include combustion with or without energy recovery, gassification, and using the sludge as a process fuel, with the ash being used or landfilled.

It should always be remembered that many sludges and residues contain beneficial constituents and properties that have very positive environmental advantages. For example recycling phosphate and thus reducing the need to extract primary raw material and extending the life of the planet's reserves.

Some countries have applied a greater level of precaution into the regulatory controls for some sludges in an attempt to build stakeholder confidence, and this has made sludge management increasingly difficult and costly. Nevertheless, sludge must go somewhere, and the challenge for sludge managers is to secure cost-effective outlets for sludge that are sustainable and protect the environment and human health, and to encourage political and public acceptance of this. This will require improvements in sludge quality and the methods of disposal and recycling, which may be achieved through improved up-stream control of the quality of wastewater treated, the adoption of advanced sludge treatment processes, and perhaps changing the formulation of products and other measures to reduce diffuse inputs or sources.

The opportunities for improving the quality of water and municipal wastewater entering treatment plants are limited. For potable water, the source and quality of raw water is usually fixed to the surface and groundwater resources available locally. For sewage, industrial effluent controls have dramatically reduced point source pollution over the last 30 years (in those countries with effective legislation) to the extent that sludge quality is now increasingly dictated by diffuse pollution of water entering the sewerage system from domestic premises and road run-off, and these sources are inherently difficult to control. Industrial recession can also have a beneficial effect on sludge quality when polluting factories are forced to close. For industrial wastewater treatment, the quality of sludge has been improved through the adoption of production processes that generate less waste, and further improvements are likely through developments in industrial process technologies and integrated pollution prevention and control measures.

A range of sludge treatment options is available to improve sludge quality and processes have been developed and adopted as necessary, according to local circumstances and legal requirements. These generally focus on reducing the content of water, odour and pathogens in sludge. Technologies are emerging for the removal of contaminants, such as heavy metals, but they are expensive and are therefore not a practicable option at present. In order to secure outlets for sludge in the near future, advanced treatment of sludge may increasingly be required, for instance to have assured pathogen removal, or to produce sludge of high dry solids content to improve the flexibility of use options as a fuel or as a high quality soil additive. These choices will be largely driven by legislation and customer and public pressures, and depend in part on an entrepreneurial management approach. High quality sludge products have a market value, offering the possibility of increased revenues in the future, and this will be an additional incentive to achieve quality assured sludge products, provided that legislation and controls permit such developments.

Currently, only the use of sewage sludge in agriculture is controlled by specific legislation. There are no comparable regulations on the recycling of other sludges, animal manures or organic wastes despite the fact that they are likely to incur the same environmental problems, although they may be subject to more general environmental legislation. Some countries have some integration of environmental standards for sludge and waste use, but none is comprehensive. A uniform and comprehensive approach is urgently needed at the EU level to ensure that all sludges, animal manures and organic wastes are subject to the same consistent control measures. The benefit of this is would be that the environmental loads from some major sources of potential environmental contamination would be controlled and accounted for. One very unfortunate consequence of the present inconsistencies is so called sludge tourism (i.e. the transboundary movement of sludges to regions with less stringent environmental controls).

In a similar way a consistent approach to emissions to atmosphere from all combustion processes (power stations, incinerators, brickworks, cement plants, etc.) and of dust is recommended. These processes can have wide-reaching impacts. Globally atmospheric deposition is the dominant of some elements or pollutants.

In addition to global environmental impacts it is important that the loadings on specific sites are considered to ensure the sustainable use of those sites.

The quantity of sewage sludge produced is very small in relation to other residuals that may be used on land and that have similar potential environmental impacts, but it is the only strictly regulated residue throughout Europe, with specific requirements for quality, monitoring, record keeping and reporting. Such controls are entirely consistent with the avoidance of environmental pollution and risk to public health, but it is now inconsistent that other sludges are not similarly controlled. This is particularly true for livestock wastes, which are by far the single largest source of organic waste (more than 60%). Despite particular examples such as the Nitrate Directive, there is no comprehensive EU control strategy for livestock wastes, but it is the cause of significant pollution, and it is time that this inconsistency was corrected.

Europe has been rocked by food scares. Even though there is no evidence of disease transmission when sewage sludge has been used according to current legislation, absence of evidence is not the same as absence of effect, and it is time that process standards for stabilisation and sanitisation for all sludges used on soils where food is grown are more closely defined so as to avoid another food scare. This is partly a matter of science, but public perception is another very real concern in this area. It should be remembered that no link has ever been proved between disease transmission and the proper use of sewage sludge in accordance with current controls. However a particular concern is "new" pathogens that are starting to appear in some countries, some examples are brown rot in potatoes, which was thought to be restricted to warm climates but is now in Northern Europe, *E. coli* O157, which is tolerated by sheep and cattle but highly infective of humans, and *Salmonella typhimurium* DT104, which can display multi-antibiotic resistance. In order to control these "emerging" organisms and the "traditional" ones, consistent rules for the management of all sludges are needed. Appropriate hygiene standards for sludges can be achieved through adopting quality assured processes which can reliably reduce pathogen numbers to the desired low levels. This is now the approach being developed in the US for livestock wastes, and it is an appropriate approach for all wastewater treatment sludges in Europe, including livestock wastes.

Recommendations

The principal recommendation of this report is that, not withstanding subsidiarity, consistent application of the principles of control are necessary at the European level, to regulate the quality and use of all water cycle sludges (including some other residuals) that have similar potential environmental effects. The development of such measures should consider, and would subsequently support, the following key issues, not in any order of priority :

— give confidence to sludge producers to invest in appropriate technologies to achieve safe, secure and sustainable sludge management ;

— reinforce the precautionary principle in a practical and enabling manner consistent with sustainable development ;

— encourage quality assurance with independent audit and accreditation of sludge use and disposal in order to avoid mistakes and to build confidence in the processes ;

— avoid transboundary problems and market distortions in sludge use and disposal ;

— develop and promote integrated co-treatment of sludges and other organic wastes ;

— promote material cycle integration, with the priority on sludge use on land to conserve organic matter and complete nutrient cycles, combustion as an energy source, or material use such as animal feed, etc. while discriminating against disposal options (material cycle exclusion) ;

— promote acceptance of sludge management and use by all stakeholders ;

— encourage/require improved reporting and publication of data about the use and disposal of sludges to encourage improvement by peer comparison and to promote stakeholder confidence by transparency.

The priority in securing sustainable management of all sludges is establishing consistent standards based on sound scientific principles that protect human, animal and plant health and the environment (including soil and its fauna and flora). This would include formulating appropriate sludge quality standards and an appropriate strategy for maintaining sludge use and disposal during the period whilst they are phased in. Such standards would lead to industry developing the technologies by which these can be achieved reliably and cost-effectively.

There has been a huge amount of scientific research into the effects of sludges, especially sewage sludge. Development of an integrated approach should be based on risk assessment. Quality standards should be set according to the precautionary principle, to ensure environmental protection and sustainable development. The exercise should also be conducted in the context of expansion of the EU and the situation of the new members. There should be a commitment to the necessary research and operational surveillance to establish the rigorous scientific basis for standards and technologies that are appropriate for securing sludge use for the long term future. A new regulatory regime should be designed to encourage and enable beneficial use of sludges in line with the EU waste strategy, to ensure the integration of sludge within material cycles, and should discriminate against disposal. This should be backed by quality assurance with independent audit to avoid mistakes and validate compliance. Independent accreditation is also desirable to give confidence to the processes.

1 Introduction

Increased material flows in the environment are a natural consequence of development, however, for sustainable growth the flows particularly of wastes have to be managed in order to conserve resources and protect the environment.

The promotion of sustainable growth respecting the environment is one of the primary objectives of the Treaty on European Union. Article 130 r (1) of the Treaty lays down that action by the Community relating to the environment shall be based on :

— the precautionary principle ;

— the principles of preventive action ;

— rectification of environment damage at source ;

— the polluter should pay.

The principles of preventative action require that the European Community must first address itself to waste avoidance and minimisation before considering waste recovery, recycling and how waste should ultimately be disposed of if none of the previous options are feasible. The basic principle of action must be to support and ameliorate the valuable components in wastes and reduce the presence of harmful substances.

CEN/TC 308 "Characterization of Sludges" considers that water cycle sludges are part of the material flows. These sludges include :

1) Wastewater sludge/sewage sludge of household and municipal origin ;

2) Industrial organic wastewater sludge from :

— potato processing ;

— slaughterhouses ;

— sugar beet processing ;

— animal food production ;

— dairy farming ;

— livestock farming ;

— fish processing and canning ;

— tanneries ;

— pulp and paper industries ;

— olive oil production ;

— pharmaceutical production ;

— fruit and vegetable processing and canning ;

— soft drinks production breweries ;

— vinification ;

— alcohol and alcoholic liquors production ;

- gelatine and glue production ;
- malt factories ;
- margarine and fat production ;
- starch production ;
- biological production of drugs ;
- other ;

3) Water works sludges ;

4) Sludges from the sewerage network ;

5) Cesspool and septic tank sludges (night soil).

The implementation of the Urban Waste Water Treatment Directive (91/271/EEC) will dramatically increase the amount and quality of municipal and industrial wastewater treatment throughout the European Union. Inevitably, the production of sludge will increase and this will require appropriate treatment and disposal. However, this is occurring over a period when there is a number of important changes to European and national waste management policies that will impact all of current sludge use and disposal options. The challenge of the next 10-20 years is to identify the sustainable balance between sludge production, recycling and disposal, and the protection of human and environmental health in an affordable, sustainable and acceptable manner.

Identifying secure and cost-effective disposal and use outlets for sludges (and wastes in general) in the European Union, which are also publicly and politically acceptable, has become an increasingly difficult and complex issue. Some outlets will be prohibited (such as sea disposal from the end of 1998) and all other outlets are facing increasing restrictions (agriculture, landfill and incineration), yet the amount of sludge produced in the EU is increasing rapidly, by at least 50% by 2005. Public expectations of environmental protection are high and the principle of recycling is widely acknowledged as sensible, yet the use of sludge, particularly sewage sludge, barely achieves public acceptability.

Council Directive 75/442 EEC on waste, as amended by Council Directive 91/156/EEC, sets out the following objectives for waste management to be adopted by Member states :

- increased prevention and reduction of waste through the development of clean technologies as well as of products that can be used or recycled ;
- recycling and recovery of waste as secondary raw material ;
- use of waste as a source of energy ;
- recovery and disposal of waste without endangering human health or the environment.

Where the production of waste cannot be avoided, the second priority of EC Directive 75/442 EEC is the use of waste as secondary raw material or for energy production. The use of "sludges for utilisation" constitutes an instrument of importance to both waste management and national economies. The measures taken to this end intend that :

- amounts of waste are reduced, thus reducing the reliance on landfill disposal ;
- primary raw materials and energy are conserved and, hence, the pressures on the environment and the landscape are eased.

The general waste management policy of the EC is summarised by the hierarchy which gives priority to waste avoidance and minimisation, recycling and recovery of materials and energy, and considers landfill disposal as the least favoured option. The basis of a Community strategy for sludge could be the positive adoption, through policy and action, of the principles of this hierarchy, since this is conceived to be the basis of sustainable development. Since sludge production cannot be avoided if effluent and water quality standards are to be met, then minimising the quantity of sludge for recycling is the highest feasible objective within this hierarchy.

Usefulness is a essential principle of Directive 75/442/EEC, and both harmlessness and usefulness are prerequisites for the use of wastes.

In different European countries, there are various initiatives to maximise the use of sludges but there are no uniform guidelines or measures. TC 308 was founded due to the lack of, and differences in, technical guidelines on the investigation and evaluation of waste for recycling. Working Group 3 of TC 308 was established to establish uniform principles for the future utilisation of sludges and specifically to undertake the following :

— identify appropriate contacts within each country covered by CEN ;

— develop a questionnaire to derive information on type, quality and outlets of sludges ;

— identify current and prospective sustainable methods of reducing, handling, utilisation and disposal of sludges ;

— produce a report to CEN on recommendations to preserve and extend sludge utilisation and improve other disposal routes.

This report addresses the last and considers issues of sludge quality criteria, classification for disposal/utilisation options, quality assurance, comparison with other wastes and the development of a European strategy on sludge. More detailed recommendations are provided by specific codes of practice developed by Working Group 2 (listed in Annex A).

TC 308 defines sludge qualities and the factors which control them. The TC does not set out limit values when defining qualities, although the principles may be established by which appropriate standards may be set. There is scope to extend the range of standard methods available for measuring sludge quality. Sludge quality criteria can be used to classify sludge as to its suitability for particular use or disposal option and this has been undertaken by allocating priorities to particular properties according to outlet. Assignment of numerical standards must be done locally, but within the EU framework, because of the complex social, political, geographical, climatic and scientific factors which determine where they are set.

It is imperative that the suitability of all types of sludge for use and disposal, and their associated potential environmental impacts, are evaluated according to uniform criteria. Impacts in this context do not necessarily imply readily quantifiable “damage”, they also refer to increases in the background concentrations of contaminants throughout the environment, which may lead to an overall degradation of the environmental quality, possible unforeseen and long-term impacts, and positive environmentally enhancing aspects. Hence the need for a precautionary approach to setting standards to protect air, water and soil to ensure sustainable development.

Providing residue/waste producers and recyclers, and the competent authorities with relevant and uniform guidelines will help ensure that pollutants are not purposefully, or as a side effect of use, channelled into the ecosystem by way of dilution or non-specific binding. A uniform framework would also ensure that the most appropriate sludge management option can be selected for local conditions that not only provides consistent environmental protection but also avoids unnecessarily stringent restrictions that could prejudice sludge recycling and force sludge to be disposed of in a less sustainable manner.

Thus the priority must be to :

— improve the sustainability of existing outlets ;

— ensure optimum sludge utilisation in the future ;

— find new useful outlets.

2 Principles of use and Disposal

2.1 Options for sludge use and disposal

The Waste Framework Directive (91/156/EEC amending 75/442/EEC on waste) requires Member States to take the necessary measures to ensure that waste is recovered or disposed of without endangering human health and without using processes that could harm the environment, and in particular :

— without risk to water, air, soil and plants and animals ;

— without causing a nuisance through noise or odours ;

— without adversely affecting the countryside or places of special interest.

Member States shall also take the necessary measures to prohibit the abandonment, dumping or uncontrolled disposal of waste. The Directive incorporates the polluter pays principle and introduces the concept of the waste management hierarchy, which places the priority on waste avoidance, minimisation and recycling and discriminates against disposal. In decreasing order of preference, the hierarchy is :

— avoidance ;

— minimisation ;

— re-use - recycling, energy recovery ;

— landfill.

This general strategy addresses waste management in the context of sustainable development, the principle of which is to replace technologies which are polluting and based on non-renewable resources, by ones which do not consume finite resources and are based on avoiding, minimising and reusing wastes. The aim is to achieve development that is in ecological balance, avoids pollution and preserves biological diversity.

Waste use and recovery incorporates materials recycling, beneficial use on land, and recovery of energy. No one single type of use should automatically be preferred to any other as this will depend on the best practicable environmental option for a particular waste stream in a particular locality.

Priority is given to the use of wastes over other disposal routes, if :

— it is technically feasible ;

— it is environmentally acceptable ;

— it is secure ;

— the cost is acceptable ;

— there are economic advantages from the use or sale of sludge, such as from energy production, sludge-based products, etc.

A range of outlets has been developed for the management of sludges, which includes various recycling and disposal options, and the relative importance of these varies between countries according to local operational and economic circumstances, and national policy and legislation on waste management and environmental protection.

If environmental water quality is to be protected, it is impossible to avoid producing sludge. If tighter effluent quality standards are applied, sludge production will be increased. It is difficult to minimise sludge production without additional sludge treatment to reduce the bulk (e.g. by dewatering, drying, etc.) and solids content (e.g. by incineration, gassification, wet air oxidation, thermal hydrolysis followed by digestion, etc.) of sludge.

Use is the preferred option for wastes, provided that this is compatible with protection of the environment and human health. Landfill disposal is the option of last resort and discriminatory measures are being introduced in many countries to ensure that this principle is followed.

Thus, in broad terms, there are only two possible outlets for sludge (see Figure 1) :

1) reintegration into material cycles ;

   — direct utilisation (agriculture, land reclamation, etc.) ;

   — indirect - modified utilisation ;

      — composting - soil improvers, fertiliser, etc. ;

      — thermal treatment or processing - energy recovery (e.g. fuel production by pyrolysis, incineration, co-combustion as a fuel in power plants and industrial processes such as brick and cement production) and mineral recovery (e.g. vitrified products) ;

2) removal from material cycles ;

   — direct landfill (mono or mixed) ;

   — indirect - modified after thermal processing (disposal of ash, vitrified material).

To select the most appropriate outlet for sludge depends on detailed assessment of sludge quality and the local opportunities for sludge use or disposal. The key sludge quality criteria are :

— chemical ;

— biological ;

— physical ;

— vector attraction (odour, aesthetic consideration, etc.).

The presence of contaminants and/or pathogens in sludges is unavoidable due to the nature of wastewater and potable water production and treatment, since the objective of wastewater treatment is to remove potentially environmentally harmful components into a small amount of sludge so that the larger portion of water can be returned safely to the environment or used for human consumption. This is also the reason why sludges have beneficial uses in agriculture and energy recovery due to the presence of nutrients and organic matter, the latter containing significant calorific value which is released by combustion.

Mitigation measures are adopted which are effective in reducing the significance of undesirable components in sludge, as well as the imposition of specific controls on sludge quality and its use on land (e.g. Directive 86/278/EEC) to avoid uncontrolled and excessive accumulation of contaminants in the soil which may prejudice soil fertility in the long-term.

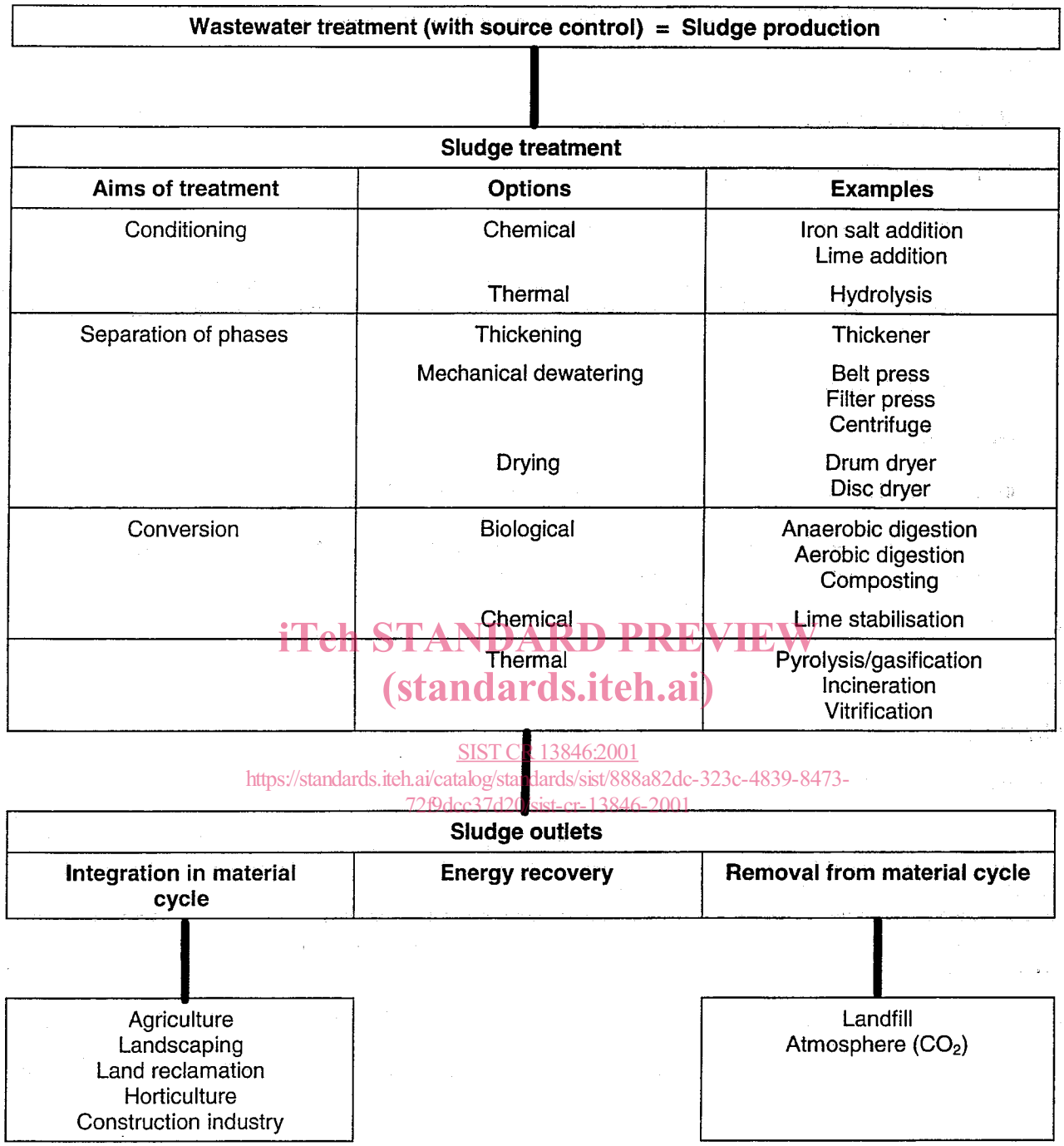

Figure 1 — Examples of options for sludge treatment and disposal

The prevention of the contamination of sewage sludge by controlling the quality of industrial effluent discharge to sewer is well recognised as an essential measure in maintaining good sludge quality (see CEN/TC 308 WG2 Code 2). The principle of up-stream control to avoid contaminating wastewater before treatment and sludge production should be applied to all industries and sludge producers since it encourages wider beneficial use of sludge. Point source pollution control is well understood and widely adopted in the context of sewage, but it is low level contamination possibly from diffuse sources that is difficult to avoid. An approach here is material substitution in products that may contribute to diffuse pollution, for (instance zinc in shampoo). Such sources are of increasing significance to sludge quality, particularly as environmental quality standards for sludge continue to be tightened. This requires further study to understand the type and significance of diffuse sources, and how these may be controlled.

The presence of pathogens in sludges, particularly sewage sludge, depends on the source of wastewater. Infection of man, animals and crops can be avoided by sludge treatment and control of the use of sludge and receiving land. However, the hygienic quality of sludge continues to be a focus of concern, particularly for the large food retailers,

and in order to maintain the security of agricultural use, this may require increasing reliance on thermal and chemical treatment processes to achieve higher acceptable sludge quality standards.

2.2 Principles of option selection and control

The principles of precaution and of proportionality are at the centre of European environmental policy. The establishment of environmental quality objectives and standards within this context is essential to protect the environment and human health for sustained development, particularly where sludge is to be integrated into the material cycle.

For the use and disposal of sludge, this requires knowledge of the constituents of sludge, including their potential hazard to all compartments of the environment, the concentrations at which harm may occur, and what constitute safe levels, in the short and long-term. The precautionary approach is applied where knowledge of effects is uncertain, and even where the effects are well characterised, to select how close or how far maximum acceptable values should be set in relation to levels which may cause unacceptable effects. The latter may be set according to lowest or no observable effect level by toxicology.

Where knowledge is uncertain (for instance where a new contaminant is encountered or sludge is to be used in a novel way), risk analysis is used for defining hazard levels and identifying appropriate safety levels. The level of precaution is subsequently set according to the level of safety required, which in part is dependent upon local or national conditions and political and economic considerations. This helps explain the disparities in sludge quality standards for agricultural use in different countries derived from a common scientific basis, for instance between the United States and Europe (described in Annex D)

When sludge is used on agricultural land, the primary objective is to exploit the beneficial properties of the sludge whilst at the same time protecting the soil, consumers of agricultural products and the environment at large. The precautionary principle reflects continuing and sustainable agriculture and implies that the spreading of sludges can under no circumstances lead to an irreversible or unacceptable pollution of soil, even if it is slow and diffuse.

Where the level of safety required is in excess of what can be achieved (i.e. where a contaminant exists at excessive concentrations and may give rise to unacceptable impacts), then alternative approaches are necessary, either to reduce the concentration at source or to find an acceptable alternative means of disposal.

Use of the Best Available Technology (BAT), (also Best Available Technique) may be regarded as an application of the precautionary principle. The principle of BAT states that environmental disturbances are to be prevented wherever technology allows. As it has been formulated in various international conventions and in the draft directive of the European Community on Integrated Pollution Prevention and Control (IPPC), it includes not only the choice of production technology but also the design, maintenance and operation, as well as the eventual dismantling/destruction of the facilities being assessed. The application of the principle in different countries depends on the formulation of the national legislation, including which criteria are to be taken into consideration concomitantly with the best available technology. Normally, there is some kind of financial consideration - the technology must not be unreasonably expensive. The technology must be developed or proven at a scale which allows its implementation in the relevant industrial context. The USEPA uses what it refers to as MACTs (Maximum Achievable Control Technology) for toxic substances, meaning the technology in use at the best ten per cent of the facilities in question.

The principle of BAT may be used to prevent emissions of pollutants even when knowledge of their environmental impact is uncertain. However, application of BAT is no guarantee for acceptable environmental quality. Alternatively, BAT may necessitate unnecessarily extensive measures. Less expensive solutions may be found if there are effect-related targets, for example stating that certain target values for air or water quality are to be met. However, there is an objection to strategies based on the implementation of measures in order to achieve certain environmental quality targets: they allow pollution up to a certain level with no consequences. The demand for BAT may serve as a means of maintaining low levels of pollution in areas that are relatively unpolluted today. For this and other reasons, most countries now combine effect-related and technology-related requirements.

In recent years the principle of the Best Environmental Practice (BEP) has been established. BEP is a broader concept than BAT, and involves the best combination of measures to restrict environmental disturbances for all kinds of sources. It comprises a number of means beyond the implementation of technological measures, such as information to the general public and consumers, economic instruments, and the establishment of systems for recovery or recycling.