

PART 5: GENERAL INFORMATION ON SLUDGE CO-DISPOSAL ON LANDFILL

Part 5 deals with specific restrictions and requirements for sludge co-disposal on a General or Hazardous landfill. The co-disposal of sewage sludge with municipal solid waste on landfills in South Africa is dealt with in the *Minimum Requirements for the Handling, Classification and Disposal of Hazardous waste* and *Minimum Requirements for Waste Disposal by Landfill*. All actions required in the design, operation, monitoring and closure of landfill sites in South Africa are described in these publications. Volume 3 of the Sludge Guidelines (this document) presents procedural guidelines for co-disposal of sludge on landfill.

BACKGROUND INFORMATION

The following apply for wastewater sludge:

- sludge disposed at a site other than the WWTP itself, falls under the definition of waste as stipulated in Section 1 of the Environmental Conservation Act, 1989
- sludge falls under the definition of a high volume/low hazard waste.

Sludge co-disposal in general landfill has the following benefits:

- sludge increase the moisture storage in the landfill and therefore reduce the leachate volumes;
- sludge decrease the mobility of metals due to an increase in pH and precipitation of metals, and;
- sludge increase the compaction density achieved in a landfill.

These benefits also apply to the use of sludge as landfill cover (described in Volume 4) and therefore the beneficial use option should rather be considered.

Sludge co-disposal methods

Area method: Spread sludge as a thin layer on the waste body, cover with a relatively thin layer of waste and compact with a landfill compactor (Figure 10).

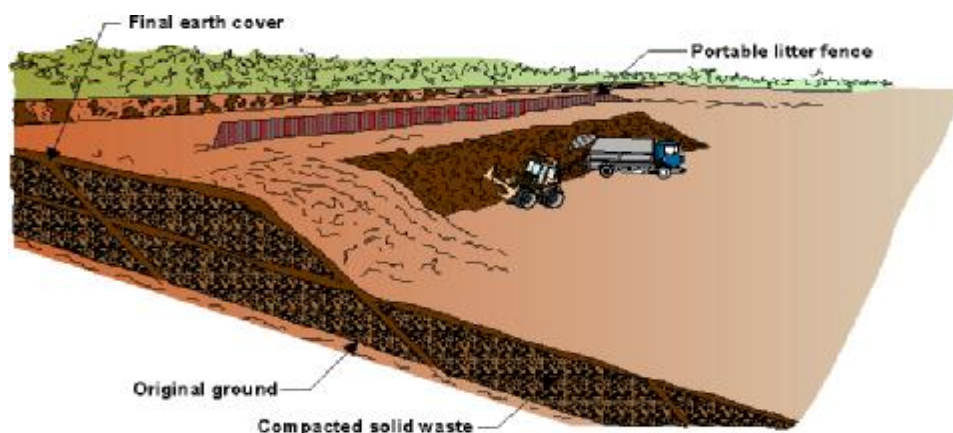


Figure 10: Illustration of the area method of sludge co-disposal on landfill

Toe method: Spread the sludge in a layer at the toe of an advancing cell. Waste is placed at the top of the slope and compacted down the slope to cover the sludge (Figure 11).

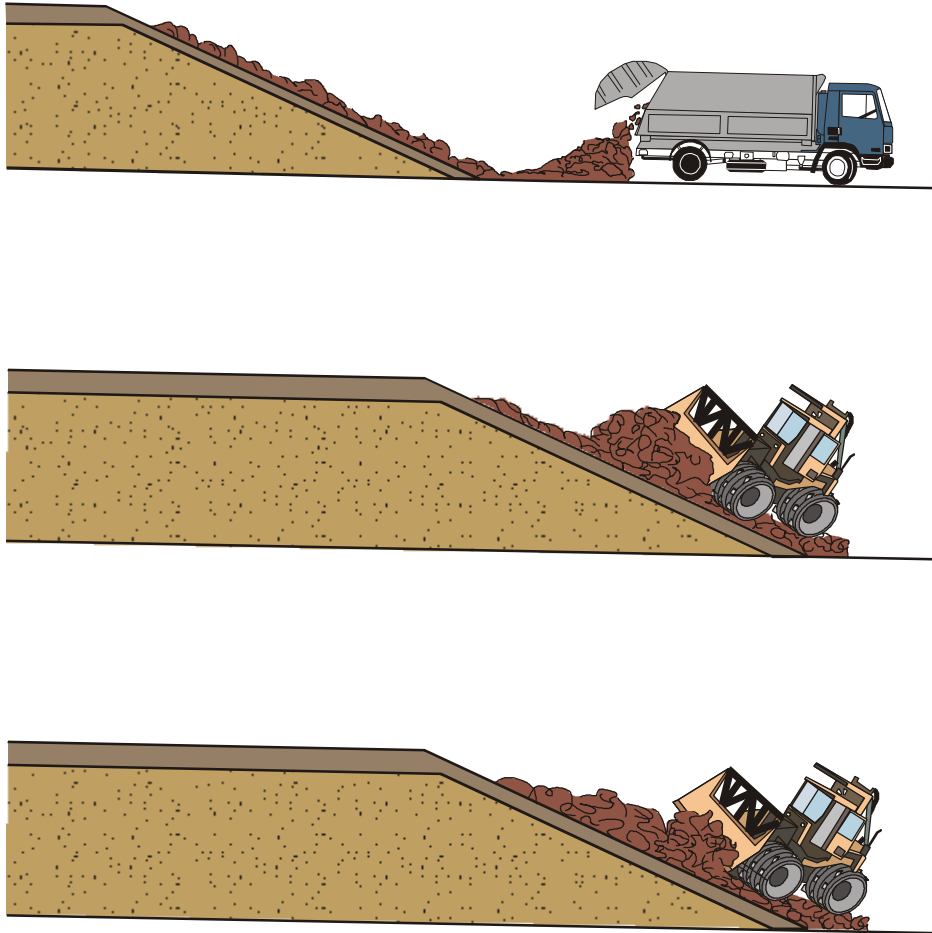


Figure 11: Illustration of the toe method of sludge co-disposal on landfill

Trenching: Sludge is deposited in trenches and filled over with waste immediately after filling (Figure 12).

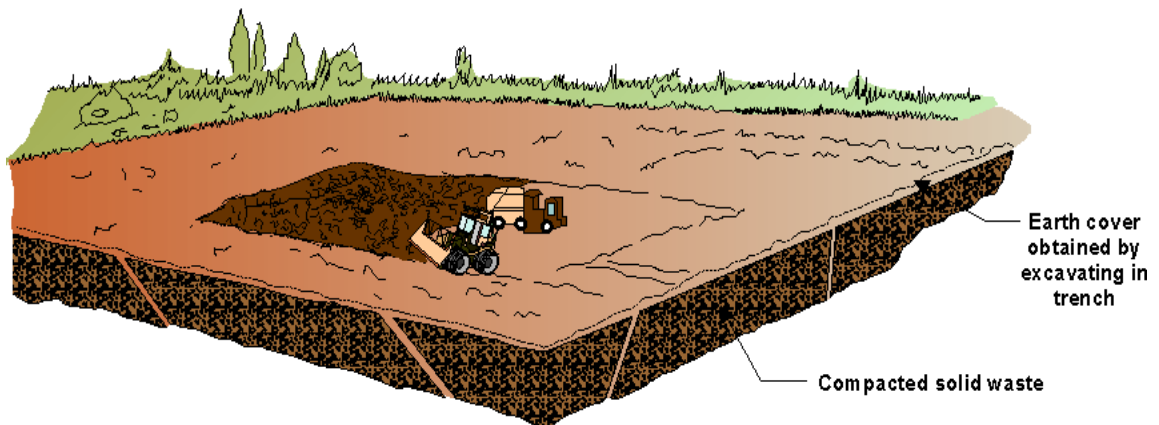


Figure 12: Illustration of the trench method of sludge co-disposal on landfill

Alternative method: This co-disposal option has been researched in SA and found to be a good alternative to other methods. A pile of waste is placed at the toe of the slope. A pile of sludge is then placed against this. A second pile of refuse is then placed against the sludge (i.e. the sludge is sandwiched between two piles of refuse). The compactor then moves these piles up the working face. The advantages of this method are that good mixing is achieved and the compactor does not slip on or sink into the sludge (Figure 13).

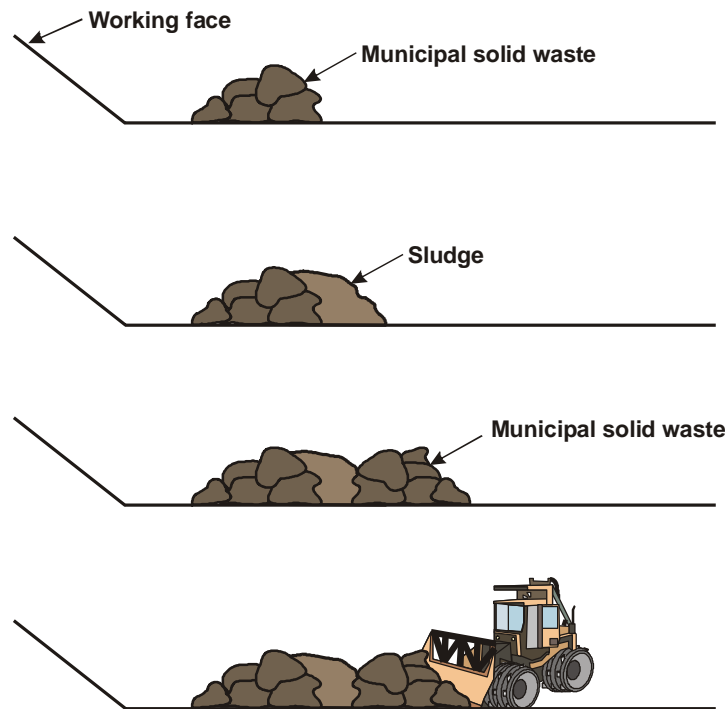


Figure 13: Proposed alternative method for sludge co-disposal on landfill

LANDFILL CLASSIFICATION

The Minimum Requirements detail landfill designs based on the specific landfill classification. Waste type, waste volumes and the water balance determine the landfill classification.

- General waste can be disposed of at general landfill sites denoted G;
- Hazardous waste site are denoted H.

Based on waste volumes, landfills are classed as:

- Communal (C) – sites designed to receive <25 t/day;
- Small (S) – sites designed to receive 25-150 t/day;
- Medium (M) – sites designed to receive 150-500 t/day;
- Large (L) - sites designed to receive >500 t/day.

Climatic and/or site specific water balances are used to determine whether a site has a positive (B^+ ; precipitation exceeds potential evaporation) or negative water balance (B^- ; evaporation exceeds potential precipitation). Sites accepting general waste (municipal and delisted hazardous waste) have a classification describing these three aspects.

Example: GLB⁺ landfill - receives more than 500 tons per day of general waste and is expected to generate leachate more than one year out of five.

Sludge co-disposal affects the classification of proposed landfills, and may only be practised at GMB⁺ and GLB⁺ sites provided that the site is equipped with an appropriate leachate management system. When sludge co-disposal is planned at a B⁻ site, the site should be engineered as a B⁺ site with the appropriate liners and leachate collection system.

Note: These restrictions may be relaxed in certain areas on a site specific basis, if adequate proof is provided to the authorities that no leachate will be generated at the landfill site.

BASIC PROCEDURE FOR CO-DISPOSAL

The **basic procedure** followed for co-disposal is as follows:

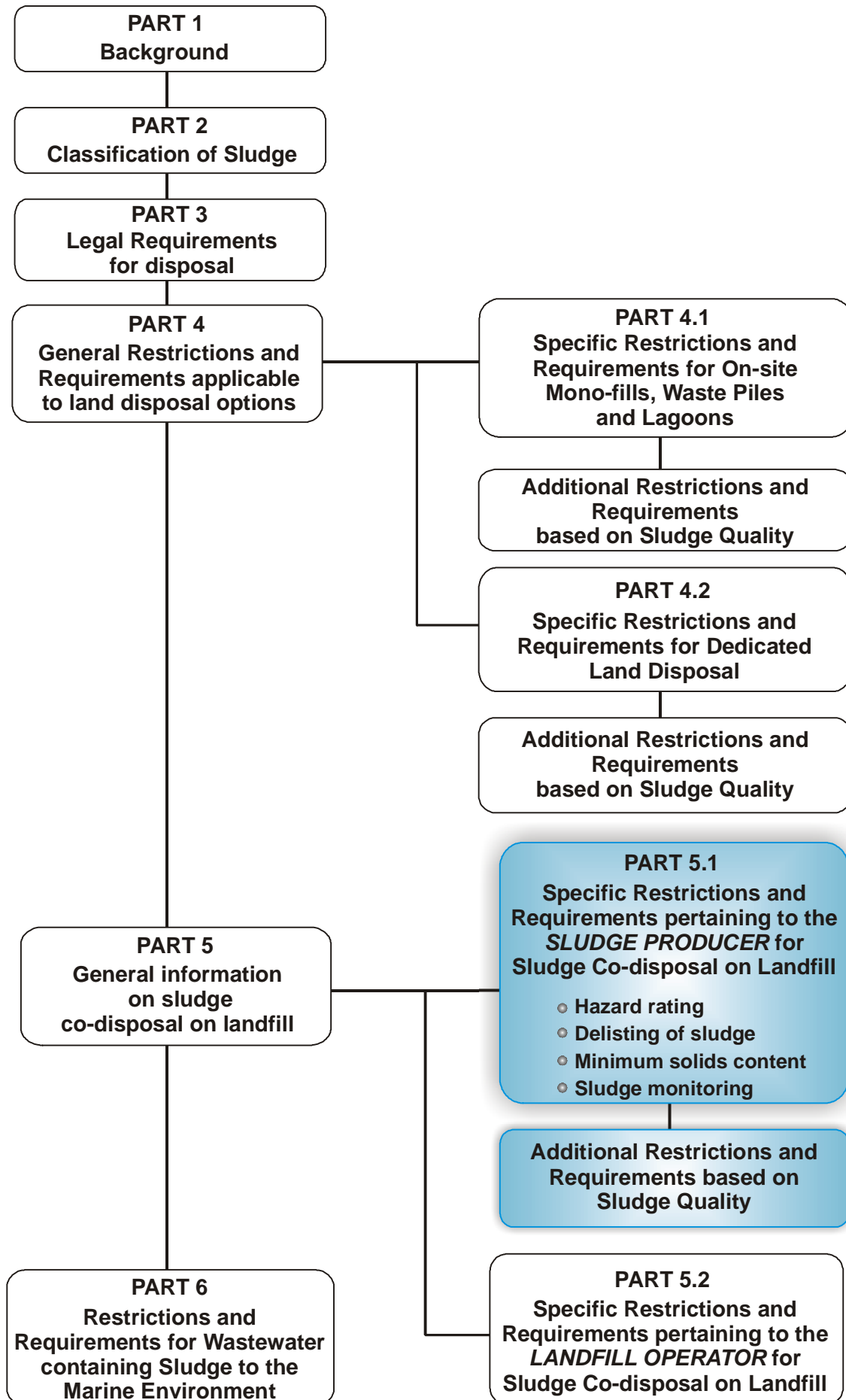
1. Classify the waste;
2. Obtain a hazard rating using test results (in the case of sludge it is the TCLP test);
3. Find the LD₅₀'s and LC₅₀'s for the compounds required (Acceptable Exposure; AE);
4. Calculate the Estimated Environmental Concentration (EEC) and total load; and
5. Determine the hazard rating (HR) and the potential to delist the sludge to a lower HR;
6. HR2 - HR4 waste may be delisted and disposed on a GLB⁺ or GMB⁺ site
7. HR1 waste should be disposed on H:H or H:h sites.

TRANSPORTATION OF SLUDGE

Due to the potentially high microbiological content of sludge, it should be handled as a hazardous waste (containing infectious substances) during transportation. The following aspects should receive attention during the transportation of the sludge from the WWTP to the off-site disposal site:

- Identification of waste - the transporters must be provided with accurate information about the nature and properties of the load.
- Documentation - the transport operator must be provided with the relevant transportation documentation.
- Hazchem placard - the transport operator must be supplied with the appropriate Hazchem placards which should be properly fitted to the vehicle.
- Protection against the effect of an accident - the sludge generator - or his representative, i.e., transporter - must ensure that adequate steps are taken to minimise the effect an accident or incident may have on the public and on the environment.
- Notification - all road accidents must be reported to the Department of Transport on the prescribed documentation and a full report should be sent to the Local Authorities, the Competent Authority and the Department of Water Affairs and Forestry.

DOCUMENT ROADMAP



PART 5.1:

SPECIFIC RESTRICTIONS AND REQUIREMENTS PERTAINING TO THE *SLUDGE PRODUCER* FOR OFF-SITE CO-DISPOSAL OF SLUDGE ON LANDFILL

The specific restrictions and requirements pertaining to the sludge producer is described in this section. The sludge producer needs to comply with these restrictions and requirements before the sludge leaves the WWTP.

HAZARD RATING

The toxicity of the sludge must be determined before disposal. This is called Hazard Rating. Hazard Rating for disposal takes into account the toxicity (LD₅₀), ecotoxicity (LC₅₀), carcinogenicity, mutagenicity, teratogenicity, persistence, environmental fate and Estimated Environmental Concentration (EEC) of the waste. The Hazard Rating indicates the risk posed to humans and the environment by the disposal of the waste. The Hazard Rating differentiates between a Hazardous Waste that is fairly or moderately hazardous and one that is very or extremely hazardous. The Hazard Rating also indicates the class of Hazardous Waste landfill at which the waste may be disposed (Table 22).

TABLE 22: DIFFERENT HAZARD RATINGS AND THE APPROPRIATE LANDFILLS FOR DISPOSAL

H:H landfill	H:H or H:h landfill
Hazard Rating 1 - extreme risk	Hazard Rating 3 - moderate risk
Hazard Rating 2 - high risk	Hazard Rating 4 - low risk

- Sludge with Hazard Rating 1 must be disposed of at an H:H site. In exceptional cases, it may be disposed of on an H:h site, with written permission from the Competent Authority. An H:H site is more stringently designed, operated and monitored than an H:h site. This permission will specify volumes and other necessary parameters.
- If sludge is to be co-disposed at an H:H landfill site, the sludge is to be regarded as hazardous waste and treated in the same way.

Note: Sludge originating from domestic WWTP is a high volume, low hazard waste. This implies that, although the sludge may contain highly toxic substances like mercury (Hg), the concentrations are usually low. The organic nature of domestic wastewater sludge is conducive to the adsorption of toxic elements and metals. It is for these reasons that a predictive leaching test show that only small concentrations is in the soluble form and will typically not leach under normal landfill conditions. It is recommended that all sludge be tested using the TCLP test to determine the potential for delisting to a lower HR.

DELISTING OF SLUDGE

All sludge types may be disposed of at appropriately lined GMB⁺ and GLB⁺ landfills, provided that it passes through the delisting process. A schematic presentation of the delisting process is shown in Figure 14. Although sludge may not be co-disposed on G:B⁻ landfill sites under normal circumstances, the sludge producer could apply for relaxation from the authorities if proof is provided that no leachate will be generated due to the co-disposal of sludge.

Delisting is based on the estimated environmental concentration (EEC) and the acceptable exposure (AE) of a particular pollutant. The determination of EEC establishes potential exposure to target populations or organisms. A TCLP analysis of the sludge should be done before delisting. The TCLP method is presented in Appendix 1.

The EEC is the concentration of a hazardous substance that may migrate from the disposal site, based on the assumption that the total mass of the hazardous substance disposed of on one hectare of a disposal site will leach into one hectare of groundwater with a depth of 15 centimeters underlying the disposal site within one month. The EEC of the substance in the waste is calculated in grams disposed of per hectare per month multiplied by a factor of 0.66.

Therefore, $EEC \text{ (ppb)} = \text{g/ha/month} \times 0.66$

A waste may delist if the EEC of a substance is equal to or less than one tenth of the LC₅₀ for that specific substance. The LC₅₀ or acute eco-toxicity is the concentration at which a substance would kill 50 per cent of organisms if it were disposed of directly into a body of water. If the concentration of the hazardous substance does not exceed ten percent of the LC₅₀, it represents an Acceptable Exposure (AE) to the environment (also called the Acceptable Risk Level or ARL) that would cause a mortality incidence of one in three hundred thousand (1:300 000) in the aquatic environment.

Delisting is regulated by the most hazardous contaminant in a waste stream. The EEC of such a contaminant must be compared to the AE to determine whether such a waste stream will delist or not. The EEC may also be used to determine the total amount, i.e. **Total Load**, of a hazardous substance that may be accepted at a certain landfill site.

Since a single substance can determine the Hazard Rating, treatment can be used to reduce the hazardousness of the substance. Thereafter, the next most hazardous substance will determine the Hazard Rating. Treatment (liming) can thus be used to delist a waste to a lower Hazard Rating or to allow a waste to be disposed of as a general waste. Note, however, that the treated waste will have to be tested and analysed once more to confirm the efficacy of the treatment.

Examples of sludge delisting for co-disposal on landfill are presented in the latest edition of the *Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste*.

MINIMUM SOLIDS CONTENT

General landfill sites may not accept sludge with a solids content <20% mass per mass. This requirement could be relaxed based on site specific investigation or increased depending on the specific landfill site requirements.

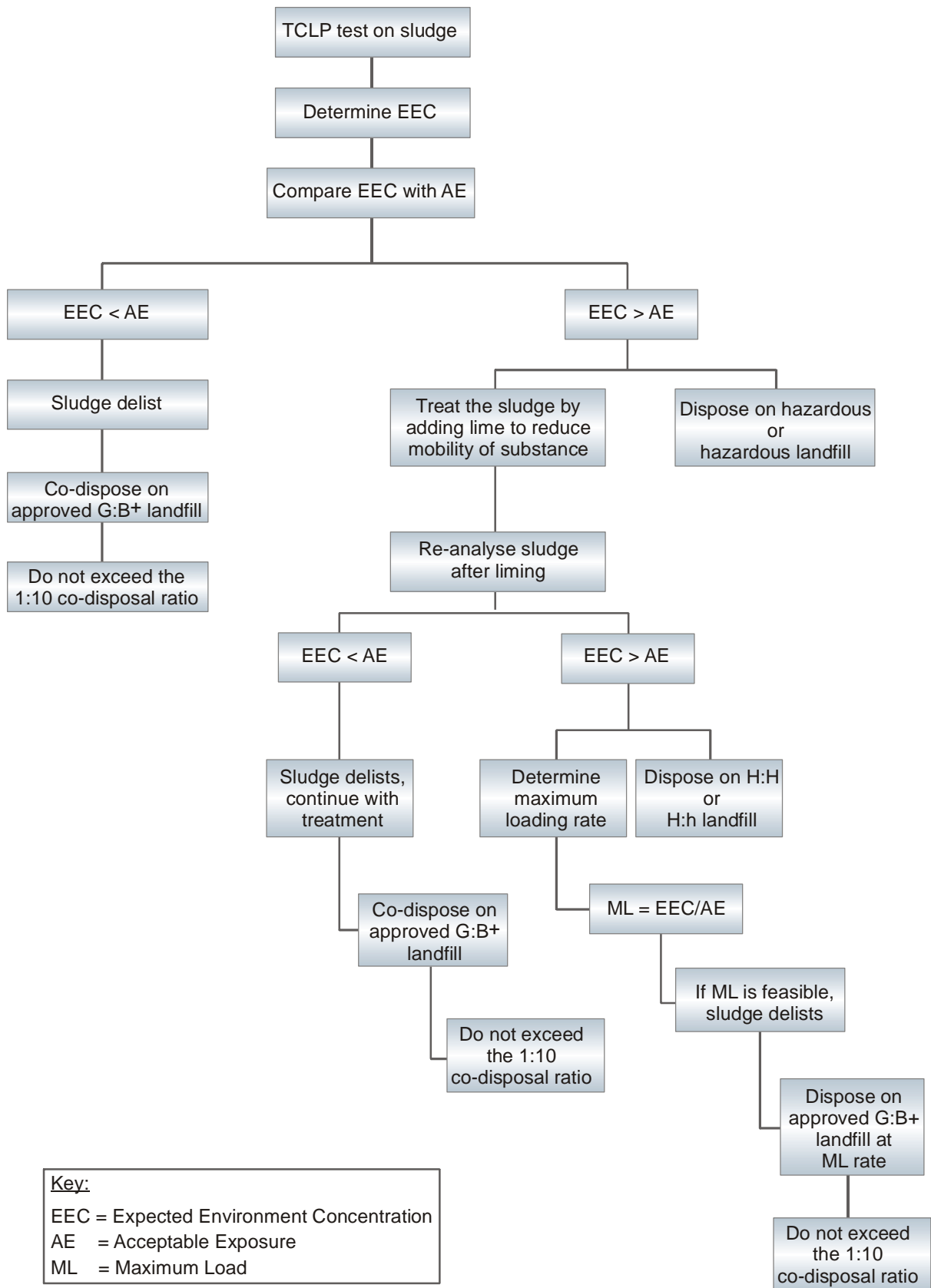


Figure 14: Schematic presentation of delisting process

SLUDGE MONITORING

Sludge should be monitored on a regular basis to ensure that the quality stays within the limits required for co-disposal to landfill. The same sampling analyses and frequency apply as for on-site and off-site land disposal (Table 13). The sampling frequency for monitoring purposes depends on the amount of sludge produced and can be summarised as follows:

- <1 t_{dry weight}/day – yearly;
- 1-5 t_{dry weight}/day – quarterly;
- 5-45 t_{dry weight}/day – biannually;
- >45 t_{dry weight}/day – monthly;

However, the landfill operator may require additional monitoring, especially in the case of Pollutant class b and c sludge that needs to be treated before it can be delisted for co-disposal.

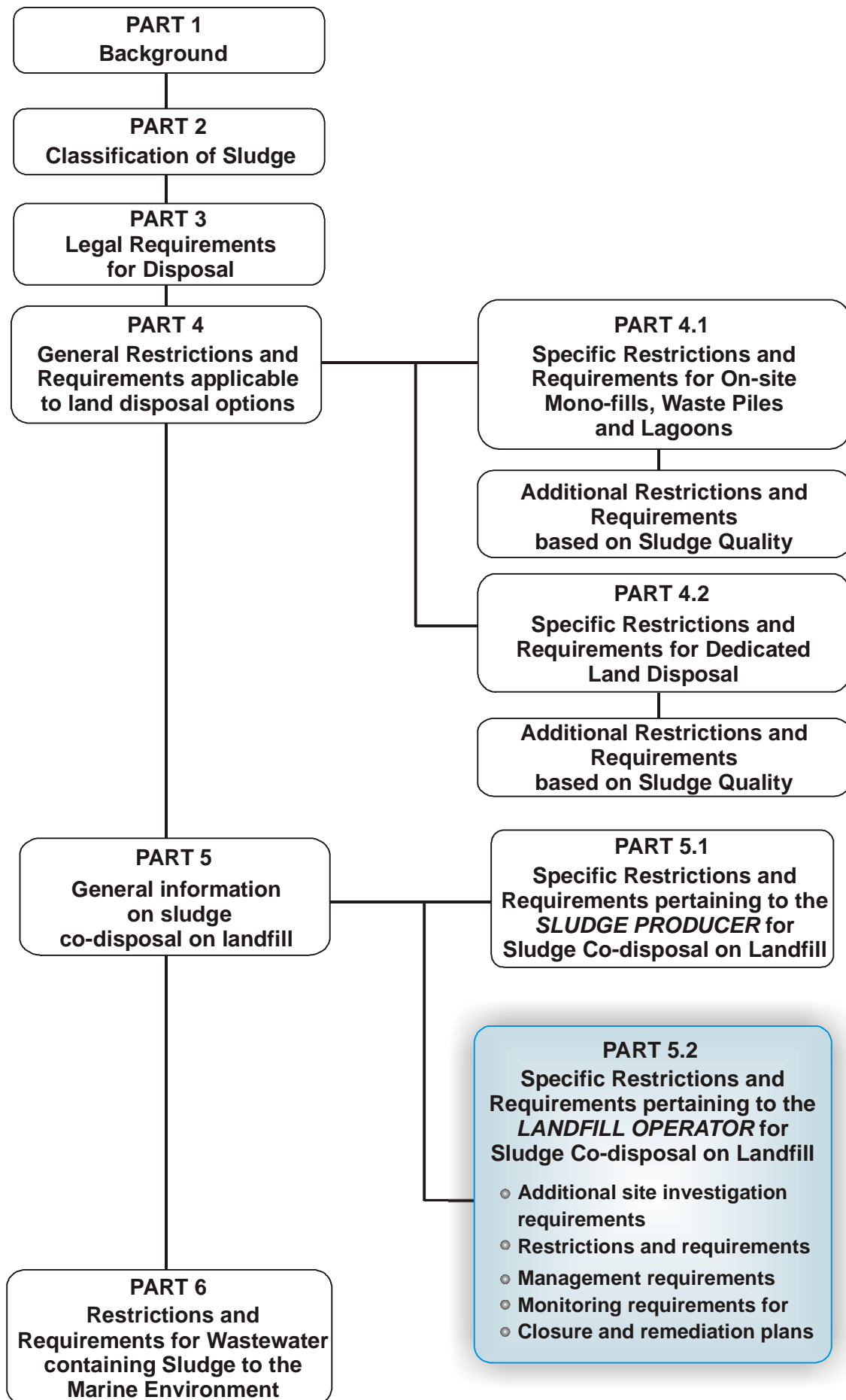
SPECIFIC RESTRICTIONS AND REQUIREMENTS BASED ON SLUDGE QUALITY

Table 23 lists the additional restrictions and requirements for co-disposal on landfill based on the sludge quality.

TABLE 23: ADDITIONAL RESTRICTIONS FOR CO-DISPOSAL BASED ON SLUDGE QUALITY

South African Sludge Classification		Additional restrictions and requirements	
		General landfills	Hazardous landfills
Microbiological Class	A	None	
	B	None	
	C	None	
Stability Class	1	None	
	2	Depending on the reliability of the vector attraction reduction measures implemented, additional management systems may be required.	
	3	Disposal of raw, primary sludge will not be allowed	
Pollutant Class	a	None	
	b	Lime treatment Max load principle	None
	c	Specific lime treatment studies Max load principle	None
<p>Note: The restrictions on Pollutant class refer to the TCLP extractable metal content of the sludge, (Table 4), not the other potential pollutants such as nutrients</p>			

DOCUMENT ROADMAP



PART 5.2:

SPECIFIC RESTRICTIONS AND REQUIREMENTS PERTAINING TO THE *LANDFILL OPERATOR* FOR OFF-SITE CO-DISPOSAL OF SLUDGE ON LANDFILL

Part 5.2 deals with the specific restrictions and requirements pertaining to the landfill operator, should the landfill be permitted to receive sludge for co-disposal.

ADDITIONAL SITE INVESTIGATION REQUIREMENTS

The initial site selection and investigation should be conducted according to the *Minimum Requirements for Waste Disposal by Landfill*. The following components should receive particular attention:

Specific water balance studies

A site specific water balance should be undertaken for landfill sites where co-disposal is proposed. Operators of landfill sites with a negative water balance must prove that no leachate will be generated due to sludge co-disposal.

Site stability assessment

- Site stability assessments are essential to the landfill design. Stability assessments must be done by a professional engineer at sites where sludge co-disposal is practised.
- The spacing and orientation of trenches must be considered in 6-monthly stability assessments. As a precautionary principle the shear strength of sludge should be assumed to be zero.
- As a general rule, trench orientation should be perpendicular to the crest of a landfill and no trenching should occur within 30m of the crest.
- The effective degree of mixing that is achieved with trenching should be taken into account when calculating an acceptable co-disposal ratio in terms of leachate generation.

MANAGEMENT REQUIREMENTS FOR CO-DISPOSAL

All the management requirements as specified in the *Minimum Requirements for Waste Disposal by Landfill: Landfill Operation* (Latest edition) should be adhered to. Only the requirements specific to sludge co-disposal will be discussed in this section.

Sludge analyses/monitoring information

Since the sludge quality is fundamental in the management of the landfill site, the landfill operator should be certain of the sludge quality. This is especially important in cases where the sludge needs to be treated (limed) before it delists. The landfill operator should regularly receive the sludge analyses results and/or monitoring information. Small WWTPs may only be required to monitor on an annual or quarterly basis and this may not be sufficient for the landfill operator in terms of the permit conditions. Therefore, landfill operators may require additional sludge quality data.

Co-disposal ratio

- The co-disposal ratio may not exceed 1:10 (mass of wet sludge to mass of waste)
- Metal concentrations must be considered in the determination of an appropriate co-disposal ratio and based on these, the co-disposal ratio may need to be lower than 1:10

The ratio of 1:10 is an absolute maximum but sludge specific conditions may require a lower ratio (e.g., 1:20 or even lower) depending on the metal levels in the sludge. This possibility must be assessed by carrying out leaching tests according to the TCLP methodology outlined in Appendix 1

The procedure for calculating co-disposal ratios for sludge co-disposal is explained in the Scientific premise document available from the WRC ([Report number](#)).

Note: The limit of a minimum of 20% solids for sewage sludge could be waived on a case-specific basis. However, achieving the higher solids content should be encouraged, although the maximum sludge co-disposal ratio of 1:10 will be retained.

Public access restrictions

No salvaging is permitted at any hazardous waste site or the cell of the general landfill where co-disposal of sludge is practised.

Run-off collection and management

- Run-off and storm water must always be diverted around one or both sides of the waste body, by a system of berms and/or cut-off drains.
- Water contaminated by contact with waste, as well as leachate, must be contained within the site. If it is to be permitted to enter the environment, it must conform or be treated so as to conform to the water quality limits specified in terms of the Permit.
- The basis of trenches and cells must be so designed that water drains away from the deposited waste.
- The contaminated run-off from the landfill must be stored in a sump or retention dam. It may be pumped from the dam and disposed of if it conforms to the water quality limits specified and stipulated in the Permit.
- A 0,5 m freeboard, designed for the 1 in 100 year flood event, must always be maintained in the case of contaminated water impoundments and drainage trenches.
- All temporarily and finally covered areas must be graded and maintained to promote run-off without excessive erosion and to eliminate ponding or standing water.
- Clean, uncontaminated water, which has not been in contact with the waste, must be allowed to flow off the site into the natural drainage system, under controlled conditions.
- All drains must be maintained. This involves ensuring that they are not blocked by silt or vegetation.

SPECIFIC MONITORING REQUIREMENTS FOR CO-DISPOSAL

Monitoring serves to quantify any effect of the operation on the environment, especially the water regime, and act as an early warning system, so that any problems that arise can be identified and rectified. Such problems would include:

- malfunctioning drainage systems,
- cracks in the cover,
- leaking liners, and
- surface or groundwater pollution.

Note: The monitoring requirements in “*Landfill Operation Monitoring*” and “*Water Quality Monitoring*” (*Minimum Requirements for Waste Disposal by Landfill (Latest edition)*) should be complied to.

Operational monitoring

The general objective of operational monitoring is to verify that all aspects of the disposal site, including any leachate management and treatment systems, conform to the required standards and the site Permit conditions. More specific objectives are:

- To ensure that the accepted site design is properly implemented
- To function as a control measure to ensure that the operation conforms to the required standards
- To quantify any effect that the operation has on the environment and, in particular, any effect on the water regime
- To serve as an early warning system, so that any problems that arise can be *timeously* identified and rectified.

The extent and frequency of monitoring will depend on the site classification and will be indicated in the Permit.

For further information see: *Minimum Requirements for Waste Disposal by Landfill (Latest edition)*., “*Landfill Operation Monitoring*”.

Leachate and water quality monitoring

The Permit Holder must ensure regular sampling and analysis of ground and surface water, leachate, the effluent, sludge or concentrates from any treatment system. The Permit Holder must also ensure interpretation of the findings. Records must be maintained of any impact caused by the disposal operation on the quality of the water regime in the vicinity of the site. **This is required in terms of the Permit conditions.** Additional samples may be necessary (Table 24).

TABLE 24: MINIMUM FREQUENCY OF WATER QUALITY MONITORING AT CO-DISPOSAL SITES

Leachate	m (if applicable)
Run-off water quality	d
Surface water quality	m
Groundwater chemistry	3m
Legend: m = monthly; 3m = 3 monthly; d = daily	

Methane monitoring

Landfill gas is a potential explosion hazard, where methane gas reaches concentrations of between 5 % and 15 % by volume of atmospheric gas composition. The risk of gas explosion must therefore be continually monitored. If monitoring indicates that there is any safety risk on account of landfill gas accumulation and/or migration, controls must be considered in consultation with the Relevant Authority.

Air quality monitoring

There is some risk of dust and the escape of contaminants by wind action. Hazardous air pollutants may therefore be dispersed from a landfill site as dust, or as gaseous substances. These have to be monitored separately.

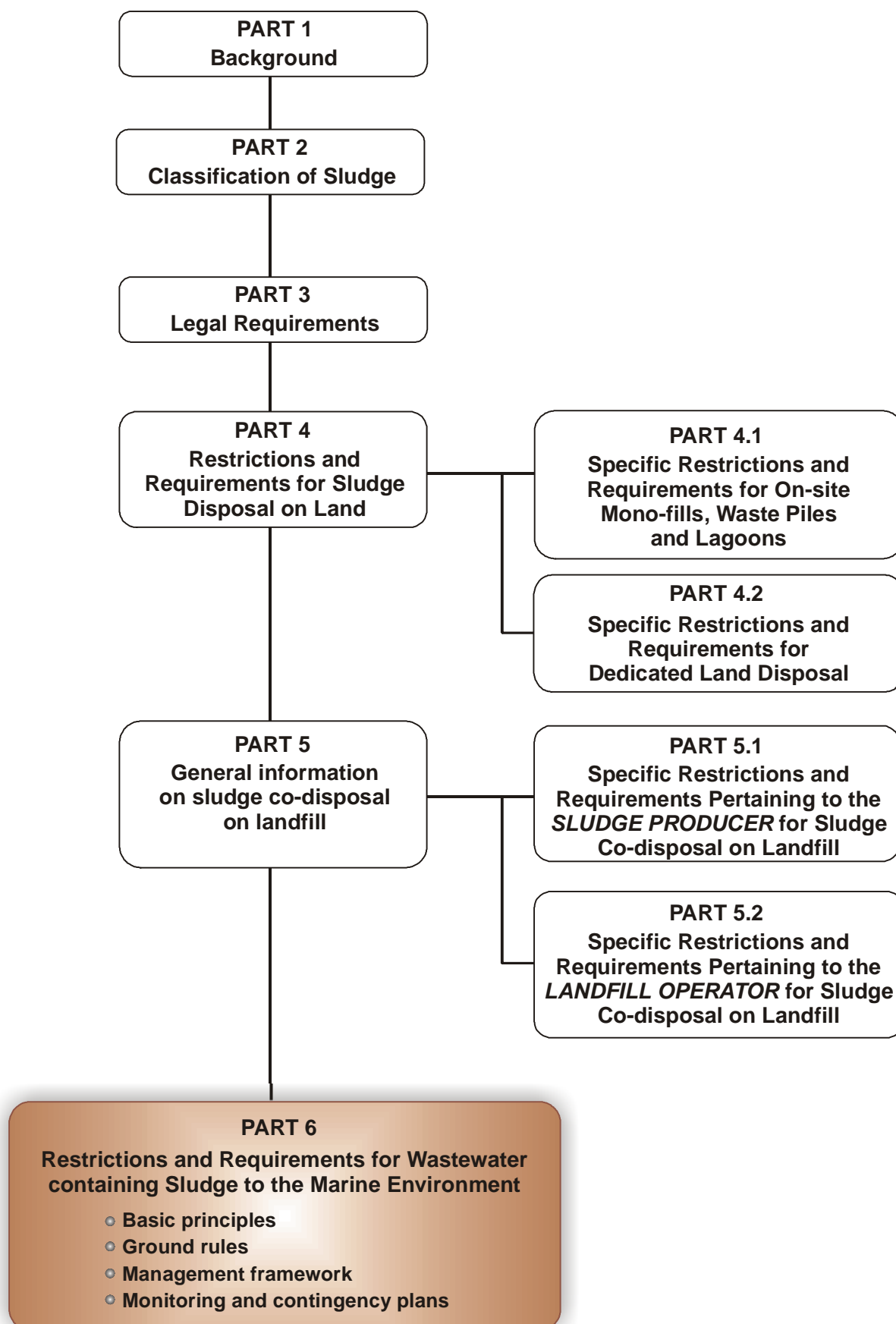
CLOSURE OF CO-DISPOSAL SITES

Note: The section on "*Rehabilitation, closure and end-use*" (*Minimum Requirements for Waste Disposal by Landfill (Latest edition)*) applies.

The objectives of disposal site closure are:

- To ensure public acceptability of the implementation of the proposed End-use Plan.
- To remediate the site to ensure that it is environmentally and publicly acceptable and suited to the implementation of the proposed end-use.

DOCUMENT ROADMAP



PART 6:

RESTRICTIONS AND REQUIREMENTS FOR DISPOSAL OF WASTEWATER CONTAINING SLUDGE TO THE MARINE ENVIRONMENT

While the sea is the ultimate natural sink for many of the wastes generated on land, it is becoming increasingly evident and more widely recognised that it has limitations in its assimilative capacity. Careful management is required to ensure that this capacity is not exceeded and that the vital resources of the sea are not compromised. At the same time it may well be prudent to make use of the ocean's capacity to assimilate wastes in situations where this represents the best practicable environmental option. Achieving a sensible compromise is an ongoing challenge for scientists and coastal managers. South Africa has never seriously considered this route for sludge disposal and it is unlikely that it presents an economically viable or environmentally acceptable option.

Note: Disposal to the marine environment is **NOT** the 'default' option in coastal areas.

The document "*Operational policy for the disposal of land-derived water containing waste to the marine environment of South Africa*" (DWAF, 2004) which was drawn up after extensive consultation amongst competent authorities and stakeholders, and with detailed reference to global experience, outlines DWAF's and DEAT's new thinking on sea discharges. The basic principles and ground rules together with a management framework are presented in the document. A major shift in approach is signalled by the change from an effluent standards approach (i.e. enforcing compliance with effluent standards) to an approach that focuses on receiving water quality objectives which support the maintenance of fitness for use.

Note: Where municipal wastewater receives **preliminary treatment**, sludge is not yet separated from the effluent and thus discharged according to the discharge standards prescribed in the licence. In instances where the receiving environment can absorb such inputs, sludge disposal is essentially taken care of.

However, where effluents receive **primary (partly separated) or higher treatment**, solids are separated from the effluent and need to be dealt with separately. Sludge removed from the wastewater during primary or higher treatment must be disposed of on land according to the relevant Sludge Guideline Volumes or the Minimum Requirements (latest edition) for co-disposal on landfill.

BASIC PRINCIPLES

The Basic Principles provide the broad reference framework or direction within which the ground rules for the disposal of land-derived wastewater to the marine environment, as well as the management thereof, were developed. The basic principles pertaining to the *Operational policy for the disposal of land-derived wastewater to the marine environment of South Africa* (2004) are listed below.

Principle 1: Pollution prevention, waste minimisation and precautionary approach

- Pollution prevention aims at preventing waste production and pollution wherever possible
- Minimisation of pollution and waste at source aims at minimising unavoidable wastes through technical interventions

- Responsible disposal aims at minimising environmental impact through applying the precautionary approach

Principle 2: Receiving water quality objectives approach

The requirements of the aquatic ecosystem, as well as the requirements of the beneficial uses of the water resource, will determine the objectives to be met (rather than following a uniform effluent standard approach as was the case with the General and Special Standard under the previous Water Act 54 of 1956). This principle applies to the marine environment as well.

Principle 3: Integrated assessment approach

The operational policy will adhere to the principles of Integrated Environmental Management, taking cognisance of concepts such as Strategic Environmental Assessment, and Environmental Impact Assessment.

Principle 4: Polluter pays principle

The responsibility for environmental costs incurred for rehabilitation of environmental damage and the costs of preventive measures to reduce or prevent such damage will be shifted to the impactors through, for example, the implementation of a waste discharge charge system.

Principle 5: Participatory approach

Transparent stakeholder participation will be required, not only as part of the decision making, but also through ongoing transparent and open communication on the status quo during design, construction and operations.

GROUND RULES RELATED TO MUNICIPAL WASTEWATER

Ground Rules are derived within the broader context of the Basic Principles and provide more specific rules that will be applied by Government when considering licence applications to dispose of land-derived wastewater to the marine environment. The ground rules discussed below have specific significance for municipal wastewater.

Ground Rule No. 14 - Master plan for water supply/demand and wastewater treatment

South Africa is a water scarce country. Marine disposal of land-derived municipal wastewater (particularly freshwater) will therefore only be considered where it has been evaluated in terms of the Water Services Development Plan for a particular municipal area. This requirement supports the concept of a 'Master Plan for water supply/demand and wastewater treatment', supporting the principles of pollution prevention, waste minimization and the precautionary and integrated assessment approach.

Ground Rule No. 15 - Industrial wastewater management plan

Municipal WWTP receiving industrial effluent will be subject to the Ground Rules for Industrial Wastewater. Service Providers or Local Authorities operating such treatment works will be required to prepare Industrial wastewater management plans.

Ground Rule No. 17 – DWAF Policy regarding Marine outfalls

The new DWAF policy regarding municipal wastewater disposal to sea is clearly stated in Ground Rule No. 17:

- Marine outfalls authorised after 31 May 2004
 - **primary treatment** will be required as a minimum for disposal of municipal wastewater to the offshore marine environment.
- Marine outfalls that were already authorised by 31 May 2004
 - **preliminary treatment** will be accepted as a minimum requirement, provided that the receiving environment is suitable for this marine disposal and that the environmental (or resource) quality objectives are met.
 - future expansions or upgrades to such existing marine outfalls will require **primary treatment** of the wastewater prior to discharge unless it can be proven that key socio-economic factors require otherwise. Nevertheless, environmental (or resource) quality objectives must still be met.

Ground Rule No. 18 – Sludge disposal according to Minimum Requirements

The disposal of sludge arising from wastewater treatment facilities (e.g. primary, secondary and tertiary) must be in accordance with the Minimum Requirements for Waste Disposal by Landfill and the appropriate 'Sludge Guidelines Volume' or any future updates of such policies or guidelines.

Ground Rule No. 20 - Detailed description of the waste stream

An industry, discharging wastewater to a municipal WWTP or directly to the marine environment, will be required to provide a detailed description of the waste stream in terms of both volume (quantity) and quality (i.e. listing all substances present and their concentrations and loads). Where industries discharge wastewater to a WWTP, the water services provider is responsible for obtaining this information from the industry concerned. The DWAF or local authority may also require a detailed inventory of the raw materials, as well as process material, used by an industry.

It will be the responsibility of an industry to supply a detailed description of their effluent to the DWAF. Such information is crucial to the authorisation process both in terms of evaluating potential impacts appropriately, and of evaluating alternative wastewater treatment options.

Toxicity testing will not be considered as a substitute where detailed description of the composition of the wastewater is not available. However, these tests are valuable techniques to be used as supplementary tools for verifying impact assessment studies based on the detailed wastewater composition.

Ground Rule No. 21 - Pre-treatment

Industrial wastewater discharged to a municipal WWTP disposing to the marine environment, will be subject to appropriate pre-treatment. It is the responsibility of the local authority operating the WWTP to ensure compliance in this regard. Appropriate pre-treatment is required to ensure that:

- The WWTP and associated equipment are not damaged;
- Operation of the WWTP and the treatment or re-use of sludge are not impeded;
- Discharge from the WWTP does not adversely affect the marine environment.

MANAGEMENT FRAMEWORK

The **Management Framework** provides the generic and structured approach within which the management and control of the disposal of land-derived wastewater to the marine environment of South Africa, needs to be conducted.

Management institutions and administrative responsibilities

The disposal of land-derived wastewater to the marine environment is currently governed by the DWAF under the National Water Act 36 of 1998. The DWAF works in consultation with other government departments. In the context of this operational policy, water use authorisation under section 21 of the NWA will be required for:

- New applications to dispose of land-derived wastewater to the marine environment;
- Existing discharges of land-derived wastewater to the marine environment that are not considered to be existing lawful water use in terms of Section 32 of the NWA;
- Upgrades, extensions of existing WWTP or industries discharging to the marine environment that were not approved in terms of the original authorisation;
- Change in effluent volume or composition (a licence is issued based on a specific effluent volume and composition, therefore if these change, the discharger legally must re-apply).

Note: Further information on local management institutions is provided in *Operational policy for the disposal of land-derived water containing waste to the marine environment of South Africa: Guidance on Implementation, Section 3* (DWAF Water Quality Management Sub-Series 13.3).

Environmental quality objectives

The area within which this management framework is applied must be determined, taking into account the anticipated influence of the proposed discharge, both in the near and far fields (e.g. an entire bay or ecosystem).

Note: Guidance on procedures to be followed to determine the area boundaries, important ecosystems, beneficial uses and associated environmental quality objectives is provided in *Operational policy for the disposal of land-derived water containing waste to the marine environment of South Africa: Guidance on Implementation, Section 4* (DWAF Water Quality Management Sub-Series 13.3).

Activities and associated waste loads

To ensure that possible cumulative and synergistic effects are taken into account, the waste loads of the activities under investigation, as well as those of existing waste inputs to the study area (both in terms of quantity and quality), need to be defined.

Note: Guidance on determining the specification for different types of wastewater is provided in *Operational policy for the disposal of land-derived water containing waste to the marine environment of South Africa: Guidance on Implementation, Section 5* (DWAF Water Quality Management Sub-Series 13.3).

Scientific and engineering assessment

The objective of this component of the management framework is to refine the environmental quality objectives for a particular marine receiving environment and to establish whether a waste disposal practice that will comply with such environmental quality objectives can be designed.

Note: Guidance on the procedures to be followed in the scientific and engineering assessment of land derived wastewater disposal to the marine environment is provided in *Operational policy for the disposal of land-derived water containing waste to the marine environment of South Africa: Guidance on Implementation, Section 6* (DWAF Water Quality Management Sub-Series 13.3). Where appropriate, a distinction is made between requirements for a pre-assessment and a detailed investigation as specified within the licence authorisation process, discussed in detail in *Section 3 of that document*.

Monitoring requirements

Long-term monitoring plans need to be designed and implemented to enable the continuous evaluation of:

- The effectiveness of management strategies and actions to comply with the licence conditions and design criteria
- The trends and status of changes in the environment in terms of the health of important ecosystems and designated beneficial uses.

Monitoring programs typically become part of the licence issued by the DWAF for a particular discharge under Section 21 of the NWA. Monitoring data must be evaluated against predetermined objectives (Table 25).

Note: An industry, discharging to a WWTP or directly to the marine environment, will be required to provide a detailed description of the waste stream both in terms of volume and quality. Where industries discharge into a WWTP, the WWTP authority is responsible for obtaining this information from the industry concerned.

TABLE 25: MONITORING REQUIREMENTS FOR MARINE DISPOSAL

Compliance Monitoring	
Flow	Wastewater volume
Composition of wastewater	BOD/COD, total suspended solids, particulate organic carbon and nitrogen, inorganic nitrate and nitrite, total ammonia and dissolved reactive phosphate Any other constituents present in the sludge/wastewater that could impact negatively on the receiving environment
Toxicity testing	The frequency of toxicity testing of the wastewater will depend on the actual variability in the wastewater composition
System Performance Monitoring	
Physical inspection of the outfall system (for marine outfalls)	
Hydraulic performance	
Environmental Monitoring	
Setting clear monitoring objectives	Site-specific and dependent on the type of wastewater discharge and the variability in its waste loads, as well as the site-specific physical, biogeochemical and ecological characteristics of the receiving environment and the variability thereof

Contingency plans and mitigating actions

Contingency plans and mitigating actions are required to minimize the risks to the environment in the event of malfunctioning, both during construction and operation. Decommissioning of a wastewater disposal scheme is also addressed.

Note: Guidance on procedures to be followed in the design and implementation of monitoring programs and contingency plans is provided in *Operational policy for the disposal of land-derived water containing waste to the marine environment of South Africa: Guidance on Implementation in Section 7 and 8, respectively* (DWAf Water Quality Management Sub-Series 13.3).

CONCLUSION

The principles of the Waste Management Series (Latest edition) comprising of the *Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste*, *Minimum Requirements for Waste Disposal by Landfill* and *Minimum Requirements for the Monitoring of Water Quality at Waste Management Facilities* have been adopted for sludge disposal on land in Volume 3 of the Sludge Guidelines. Since sludge is an industry specific waste, not all the requirements in the above mentioned documents are applicable to land disposal of sludge. Therefore, only the requirements relevant to sludge disposal were included in Volume 3.

The disposal of sludge to the marine environment is still debated nationally and internationally and the principles of the *Operational policy for the disposal of land-derived water containing waste to the marine environment of South Africa (DAAF, 2004)* have been adopted in Volume 3 for sludge disposal to the marine environment.

Volume 3 of the Sludge Guidelines informs the reader regarding the legal requirements for sludge disposal on land (both on-site and off-site), co-disposal on landfill and disposal to the marine environment. It also states clearly that beneficial use of sludge is encouraged and that sludge disposal would be considered as a last resort. Therefore, sludge producers would need to provide proof of the beneficial use options considered, feasibility studies to implement these options and efforts to improve the sludge quality should that be the limiting factor for beneficial use.

Should disposal be the only alternative management option for sludge, it becomes a 'waste' by definition and restrictions and requirements should be applied to protect the receiving environment. These restrictions and requirements become more stringent with deteriorating sludge quality and the vulnerability of the receiving environment. Especially at existing disposal sites, where the necessary criteria for disposal sites are not met, the management and monitoring requirements increase substantially. The development of closure and remediation plans is introduced to ensure sustained acceptability.

It is recognized that new information is constantly generated and it has been recommended that the Sludge Guidelines be revised every 5 to 10 years. This will allow the South African wastewater industry sufficient time to implement these Guidelines and highlight shortcomings, constraints and operational difficulties. Furthermore, by implementing the monitoring requirements stipulated in these Guidelines, case specific data will be generated that will enrich our local knowledge base.