Volume 1 forms part of a series of Sludge Guideline Volumes developed to address the major application and disposal options for sludge. Volume 1 helps to select the appropriate management options for the sludge streams generated by a specific wastewater treatment plant. Once a suitable management option has been selected, the user is referred to the relevant volume that deals with the selected management option (Figure 2).

**Figure 2: Decision-making process to identify the most suitable management option**
Volume 1: Selection of management options

Volume 1 describes the initial comprehensive characterisation of the sludge. Based on the results of the characterisation, appropriate management options can be selected for a particular case. The document directs the reader to the appropriate Guideline volume to use.

Volume 2: Requirements for the agricultural use of sludge

Volume 2 describes the requirements and restrictions related to the safe use of sludge for the production of crops.

This Volume should be used:

- When stabilised sludge is used as a nutrient source and/or soil conditioner at an application rate designed to supply a crop’s nitrogen needs, while at the same time minimising the risk of nutrient leaching. This applies to both commercial as well as to small scale and subsistence farming practices.

- To manage compost containing sludge that is not sold or distributed to the general public for use. Compost that is of such a high quality that it can be distributed to the general public is viewed as "a saleable product", the requirements of which are detailed in Volume 5 of the Sludge Guidelines.

- When sludge is used for municipal parks. If these parks are used by the public, additional pathogen management strategies will apply.

Volume 3: Requirements for the on-site and off-site disposal of sludge

Volume 3 describes the requirements and restrictions related to the on-site and off-site disposal of sludge. The Volume gives detailed requirements and guidance on:

- Managing the phasing out of unlined sludge stockpile facilities;
- Operating existing dedicated land disposal sites; and,
- The rehabilitation and phasing out of dedicated land disposal sites.

Other disposal options, such as:

- Off-site disposal of sludge in a general or hazardous landfill site;
- On-site disposal of sludge in a mono disposal landfill or lagoon; and,
- Disposal of sludge to the marine environment,
are addressed in other guidelines and policies published by the Department of Water Affairs and Forestry and the reader is guided to the relevant sections. The Volume also mentions some waste specific details that should simplify the process.

This Volume should be used for:

- **Managing the phasing out of uncontrolled stockpile facilities.** The Department of Water Affairs and Forestry will no longer accept the indefinite storage of sludge in uncontrolled stockpiles. This practice thus needs to be phased out over time. This Volume assists with the selection of alternative management options and rehabilitating the footprint of the stockpile (if required).

- **Operating existing dedicated land disposal sites.** This Volume assists the reader to determine what the environmental impacts of the current practices are and how to manage an existing dedicated land disposal site to minimise negative environmental impacts.

- **Rehabilitation and phasing out of dedicated land disposal sites.** If a dedicated land disposal site proves to have an unacceptable impact, it will have to be phased out in a responsible manner. This Volume details the steps to be taken to phase out an operating dedicated land disposal site in a responsible manner.

- **Off-site disposal of sludge in a general or hazardous landfill site.** This Volume addresses the co-disposal of sludge in municipal or commercial landfill facilities (both general and hazardous landfill facilities). Sludge disposal in a landfill should adhere to the Waste Management Series. These documents are currently being revised and the user should adhere to the latest edition. This Volume assists the reader to understand the requirements stipulated in the Minimum Requirements by explaining the relevant sections that pertain to the management of sludge in landfill operations. The volume details the process of delisting, dewatering and co-disposal ratio requirements.

- **On-site disposal of sludge in a mono disposal landfill or lagoon.** This Volume addresses the disposal of sludge in dedicated disposal facilities and sludge lagoons. These practices need to comply with the latest edition of the Waste Management Series. This Volume assists the reader to understand the requirements stipulated in the Minimum Requirements by explaining the relevant sections that pertain to the management of sludge in mono-disposal facilities and sludge lagoons. The Volume details the process of delisting, dewatering, liner and closure requirements.

- **Disposal of sludge to the marine environment.** It is unclear whether sludge disposal to the marine environment would be permissible in future. This Volume refers to the latest information on the interpretation of the “Operational Policy for the Disposal of Land-derived Water Containing Waste to the Marine Environment”.

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Volume 4: Requirements for the beneficial use of sludge

This Volume describes the requirements and restrictions pertaining to the beneficial use of sludge. Note that Volume 2 should be used for the agricultural use of sludge at agronomic rates and not Volume 4.

Volume 4 should be used for guidance on the:

- **Rehabilitation of mining waste deposits.** Inorganic waste material such as mine tailings could in some cases benefit from the addition of organically rich material. However, in some cases, the addition of organic material can cause environmental problems. This application must therefore be done responsibly. This volume details the process to follow to use sludge in the treatment of organically poor material such as mine tailings.

- **Using sludge to aid remediation of contaminated soil.** It has been proven that the micro-organisms and the organic material in sludge can enhance the process of bioremediation of contaminated soil. Sludge can be used for both the remediation of hydrocarbon-contaminated soils as well as for the remediation of soils that have been contaminated with inorganic pollutants such as metals. The sludge can also be used as an adsorbent by incorporating it into oil contaminated soil. The sludge will absorb the free oil, which increases the ability of micro-organisms to degrade the contaminant. This Volume gives some guidelines on how to apply sludge for the remediation of contaminated soil.

- **Using sludge as a nursery growth medium.** When preparing nursery growth media, the sludge component may exceed the agronomic rate. This will not cause any detrimental environmental effects as the seedlings and pot-plants are distributed and planted in natural soils. Care should be taken not to expose the public to high levels of pathogens. This Volume gives guidance on the use of sludge a nursery growth medium.

- **Once-off high rate application.** An example of once-off high rate application of sludge is during the construction of golf courses, establishment of vineyards or fruit orchards. This Volume gives guidance on these practices.

- **Covering of landfills.** Sludge could be used as part of the capping material for landfills or as daily cover. This volume gives guidance on these practices.

- **Beneficial land application at high loading rates.** Some crops such as instant lawn can be cultivated using sludge applications much higher than the recommended agronomic rates. The lawn is removed with the sludge attached to the root zone. This means that the topsoil is not removed as the sludge serves as the root support structure. However, these practices must be managed to avoid nitrate leaching and other negative environmental effects. This volume details the requirements for the beneficial agricultural use of sludge at high loading rates.

Several beneficial thermal processes such as brick making or pellet manufacturing also exist. However, the manufacturing of these products includes at least one high temperature step and the product often has a commercial value. For this reason, these processes and products are addressed in Volume 5.
Volume 5 is divided in two parts. The first part addresses the use of thermal methods to manage sludge. The second part addresses the use of sludge to manufacture saleable products. These aspects were combined in one volume, as many of the saleable products include a thermal process in their manufacturing process. For example, the use of sludge in brick manufacturing could be seen as both a thermal process and producing a saleable product.

Volume 5 should be used for guidance on the:

- **Use of thermal methods to manage sludge**
  - **Incineration in dedicated incinerators.** This Volume addresses the requirements for the incineration of sludge with specific reference to the operational requirements and management of the air emissions and the ash residues.
  - **Incineration in furnaces, cement kilns, etc.** Sludge can also be co-incinerated in industrial processes such as industrial furnaces and cement kilns. This volume addresses the requirements for these practices. This will include the use of sludge in the manufacturing of bricks.

- **Use of sludge to produce saleable products**

  The requirements for a saleable product are understandably much stricter than the controlled use of sludge products. Saleable products should be adequately disinfected. For this reason, composting is addressed in both Volumes 2 and 5. Some plants in South Africa, generate compost that is not completely disinfected. For this type of compost, restrictions apply as addressed in Volume 2. For high quality compost destined for the general public, the process requirements and quality criteria are high, but few restrictions apply after the product leaves the manufacturing process. The same principles apply to:
  - **Manufacturing pellets from sludge.** The pellets, which resemble commercial fertilisers, could be enriched with additional plant nutrients.
  - **Manufacturing bricks, paving, artificial rocks and other products.** Many innovative product applications have emerged internationally. Many of these applications are not financially viable in South Africa. However, this volume gives guidance on how to implement such a process in the South African legislative environment.