Addendum No 1
to Edition 1 (1997) of

Permissible Utilisation and Disposal of Sewage Sludge

Compiled jointly by

Water Research Commission

Department of Water Affairs and Forestry
Department of Agriculture
Department of Health

with the assistance of

Sludge Consult

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FOREWORD

The large volumes of sewage sludge generated daily, not only in South Africa but all over the world, creates environmental problems and if not properly treated, impact on human health and the natural environment. The sludge has an inherent low capital value and therefore transporting these large volumes of sludge to landfill disposal sites does not make economical sense. By converting a low-value product into a high-value resource that can be reused is certainly more beneficial for local economies. The beneficial use of sludge is not a new concept in South Africa; the various government departments have always promoted it. The protection of our natural resources, which also include the water and soil, is paramount to sustainable development, while practising sound sludge management practices. This document aims to both promote beneficial use of sludge but also to protect human health and the environment.

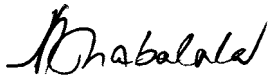
The first edition of the guide *Permissible Utilisation and Disposal of Sewage Sludge* was published in 1997. An invitation was extended to users of the document to comment on the content and its usefulness. The comments received indicated that the objectives of the initial document were not achieved and that further clarification and elaboration of the document were required. This culminated in the development of this addendum to the original *Permissible Utilisation and Disposal of Sewage Sludge (PUDSS)* document.

The document serves to clarify certain issues of the 1997 document, but it also expands on the various routes and options which may be taken for sludge utilisation. Users are informed as to which legislative route should be taken and which government department should be approached as the National Department of Agriculture, the Department of Health and the Department of Water Affairs and Forestry all have their roles to play in the management of sludge.

An attempt has been made in the production of this *Addendum* to PUDSS 1997 to produce a user-friendly guide for local authorities to negotiate the complex network of current legislation governing the disposal of sewage sludges. Ambiguities, which appeared in the original document, have, as far as possible within the scope of the exercise, been removed and the way is now clear for the *Guidelines* to become a working document as it was originally intended.

A committee comprising of representatives from national, provincial and local government, the private sector, and thanks to the sponsorship and support from the Water Research Commission, made the drafting of this addendum to the 1997 document possible.

The original guide and the new addendum are both consultative publications, seeking comments from all concerned parties on the current criteria and approaches adopted, thereby ensuring the updating and improvement of the guide. All users are urged to take a critical view regarding the document in terms of usefulness and appropriateness. It is believed that through the commenting process valuable feedback will be received. Comments should be directed to the Director: Water Quality Management, Department of Water Affairs and Forestry, Private Bag X313, Pretoria, 0001.



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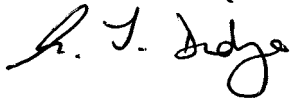

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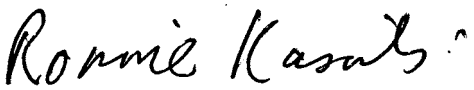

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1. INTRODUCTION

Following the publication of the document "Permissible Utilisation and Disposal of Sewage Sludge (August 1997 Edition 1)" in August 1997 (PUDSS 1997), strong objections were made to certain of the standards contained in the document by a number of the major sludge producers (Metropolitan Councils, other Municipalities and Water Boards). Consequently, the Department of Water Affairs and Forestry (DWAF), in consultation with Departments of Health and Agriculture, decided that a clarifying addendum was required to the document.

A Steering Committee was set up under the auspices of the Water Research Commission (WRC) to facilitate the process of drawing up the Addendum. A consultant, Sludge Consult (a Joint Venture between Africon Engineering International and Stewart Scott (Pty) Ltd), was appointed to provide technical and administrative support.

The objectives of the initiative were threefold, namely

1. To identify specific shortcomings in the PUDSS 1997 and to clarify/rectify those in an Addendum as a matter of urgency so that the guidelines contained in the document can be implemented.

2. To identify research needs required to further the understanding of the sludge reuse and disposal issues in South Africa and to commission research projects based on proposals received from suitably qualified institutions and individuals

3. To re-write the PUDSS 1997 some time in the future if the findings of the research projects indicated that this was necessary. This is a long-term objective and is not expected to be implemented within the next 2-4 years (i.e. before research results and conclusions are available).

This document deals with the first objective. A number of research needs aimed at an improved understanding of the sludge reuse and disposal issues in South Africa (objective 2) have been identified and approved by the steering committee for this initiative. It is envisaged that the high priority research needs will be addressed as part of a WRC programme on sewage sludge reuse and disposal. The results from this Programme are expected to culminate in a revision of PUDS 1997 (the third objective) within a few years.

The Addendum has been drafted in the form of a Decision Flow Diagram designed to guide the sludge producer through the different disposal or utilisation options and to highlight relevant technical and legislative requirements associated with every decision. Referred to here as the Sludge Utilisation or Disposal Decision Flow Diagram (SUDDFD), it has been designed to ensure compliance with the requirements of the following laws:

- The National Water Act (Act 36 of 1998) (NWA)
- The Water Act (Act 54 of 1956) (WA)
- The Environmental Conservation Act (Act 73 of 1989) (ECA)
- The Fertilisers, Farm feeds, Agricultural Remedies and Stock Remedies Act (Act 36 of 1947)
- The Health Act (Act 63 of 1977) (HA)
- The Water Services Act (Act 108 of 1997) (WSA)
- The National Environmental Management Act (Act 107 of 1998) (NEMA)
- Resource Conservation Act (Act 43 of 1983)

Apart from the above acts, the following publications or procedures are also applicable and need to be consulted

- Minimum Requirements: (2nd edn.) 1998
  This refers to the Waste Management Series published by DWAF, which establishes a reference framework of standards for waste management in South Africa in terms of section 20 of the ECA. This trilogy consists of:

  - Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste
  - Minimum Requirements for Waste Disposal by Landfill
  - Minimum Requirements for Water Monitoring at Waste Management Facilities

  Copies of the above can be obtained from:

  The Director: Water Quality Management
  Department of Water Affairs and Forestry
  P O Box X 313
  PRETORIA
  0001

- Water Use Authorisation and Registration Management System (WARMS). This is the registration system used by DWAF for water uses

The Sludge Utilisation or Disposal Decision Flow Diagram is given in Appendix A of this Addendum and is intended to guide a sludge producer or manager through the options available and to indicate specific legal and technical requirements. It should be stressed that it is a guide only and does not relieve the sludge producer from his obligations to obtain all the required permits or licences from the relevant Authorities as indicated and identified in this document.

Being an Addendum to PUDSS 1997 the two documents must be read in conjunction; and where their contents differ the Addendum should be regarded as the correct version.

2. DETERMINATION OF ALLOWABLE INORGANIC CONCENTRATIONS IN SEWAGE SLUDGES

This section can be considered to be the most important modification to the PUDSS 1997 document and significant changes are made to the definition of the allowable inorganic concentrations in sewage sludges as well as to the applicable testing methods to determine those concentrations.

The Table 1 on page 4 of PUDSS 1997 (Table 1 in this document) indicating the maximum allowable metal and inorganic content in mg/kg dry sludge for Class D sludges was arrived at by consensus between the following regulating authorities:

- DWAF (with the protection of the aquatic environment as its main focus).
- Department of Health (with health issues as its main focus).
- Department of Agriculture (they used the Department of Health's values, having accepted that they were generally stricter than those governed by agricultural considerations.

The approach used was to select the most conservative figure presented for each parameter by the three Departments.

Table 1: Consolidated Inorganic Concentration Values as Given in PUDSS 1997

Constituent	Concentration (mg/kg.ds)
Cadmium	15,7 mg/kg
Cobalt	100 mg/kg
Chromium (Cr^{3+})	1 750 mg/kg
Copper	50,5 mg/kg
Mercury	10 mg/kg
Molybdenum	25 mg/kg
Nickel	200 mg/kg
Lead	50,5 mg/kg
Zinc	353,5 mg/kg
Arsenic	15 mg/kg
Selenium	15 mg/kg
Boron	80 mg/kg
Fluoride	400 mg/kg

The main problem with the published table arose from the fact that no differentiation was made in PUDSS 97 between total and leachable fraction concentrations. It is not evident from the text that the figures put forward by DWAF in the table for Copper, Lead, Zinc and Cadmium refer to concentrations of the leachable fraction of the metals in the sludge, whereas those for the rest of the substances refer to total concentrations.

Most sludge producers understandably assumed that the published values referred to total concentrations and objected because adherence to the limits would result in very few (if any) of the sewage sludges produced in South Africa being classified as Type D in terms of inorganic substances. This issue has been debated extensively within the Steering Committee and consensus has been reached on new recommended standards as follows:

2.1 Setting of Maximum Allowable Inorganic Concentrations in Type D Sludges

It was decided that the allowable concentrations would be divided into two groups. The first will be for the leachable fraction of inorganic substances and will address the concerns of DWAF with regard to the contamination of the water environment.

The second will be for total inorganic substances and will address the concerns of the Departments of Health and Agriculture with regard to health issues (zootoxicity) and contamination of soils and phytoxicity.

No limit has been set for the concentration of the leachable fraction of inorganic substances where the allowable leachable fraction concentration is higher than the allowable total concentration.

The new allowable concentrations are presented in Table 2 below. In order for a sludge to be classified as a Type D from an inorganic concentration perspective, it must satisfy all criteria in the Table.

Table 2: Allowable Inorganic Concentrations in a Type D Sludge

	Leachable fraction Concentration (mg/kg.ds)	Total Concentration (mg/kg.ds)
Cadmium mg/kg	15.7	20
Cobalt mg/kg	-	100
Chromium mg/kg	-	1 750
Copper mg/kg	50,5	750
Mercury mg/kg	-	10
Molybdenum mg/kg	-	25
Nickel mg/kg	-	200
Lead mg/kg	50,5	400
Zinc mg/kg	353,5	2 750
Arsenic mg/kg	-	15
Selenium mg/kg	-	15
Boron mg/kg	-	80
Fluoride mg/kg	-	400

Only sludges complying with both the above values and the bacteriological requirements specified in PUDSS 1997 may be classified as general “Type D” sludges and may be alienated by the sludge producer and used freely subject only to the 8 t/ha/a limit.

The modifications proposed above will change the status quo significantly in terms of the Type D classification of sewage sludges

Note:

- *All the other prescriptions and requirements as detailed in the PUDSS 1997 still apply.*
- *The SLADS programme has been rendered redundant by these developments.*

2.2 Analytical Methods to be Used to Determine the Leachable Fraction and Total Concentrations of Inorganic Substances

There are several different methods for establishing the concentration of inorganic constituents of sludge and there is a lack of conformity in the methods currently being used by different laboratories in South Africa. This adds further uncertainty and confusion to an already complicated situation and it needs to be addressed urgently. It is beyond the scope of this Addendum to specify analytical methods as it is an extremely complex subject and should form part of a separate research study. However, in order to reach some interim degree of conformity, it is recommended that the methods for analysing total concentrations proposed in the Smith and Vasiloudis Report (1989) and incorporated in the Sewage Sludge Utilisation and Disposal Information Document published by the Sludge Management Division of WISA in1993 be adopted until further research can be done. For leachable fraction concentrations of metals, the Toxic Characteristic Leaching Procedure (TCLP) method should be adopted. This issue is addressed further in Appendix B of this report.

The frequency at which the sampling and analysis should be undertaken is discussed in Appendix C of this report.

3. LAYOUT OF THE SLUDGE UTILISATION OR DISPOSAL FLOW DIAGRAM (SUDDFD)

The layout of the SUDDFD is set out in Figs. 1 to 6 attached as Appendix A. It will be seen that it has been arranged in six alternative routes, labelled A to E. A brief description of each route is given below:

Route A: Initial Decision Diagram
This route forms the introduction to the Diagram and covers aspects such as the quality of the sludge being produced on a plant and the legal status of current sludge disposal practices, and leads the user to the various reuse or disposal routes available.

Route B: Use of a Type D Sludge in Agriculture
This route leads the user through the steps to be taken to use a Type D sludge in agriculture.

Route C: Use of a Type A, B or C Sludge in Agriculture
This route leads the user through the steps to be taken to use Type A, B or C sludge in agriculture.

Route D: Use of Type A, B, C or D Sludge in Industry
This route leads the user through the options available and the steps to be taken to use Type A, B, C or D sludge in industry.

Route E: Disposal of Type A, B or C Sludge off the Site of the Works
This route leads the user through the options available and the steps to be taken to dispose of a Type A, B or C sludge at a site other than the site of the treatment works.

Route F: Disposal of Type A, B or C Sludge on the Site of the Works
This route leads the user through the options available and the steps to be taken to dispose of Type A, B or C sludge on the site of the treatment works.

Each of the routes is illustrated on Figs. 1 to 6 on a separate, fold out sheet so that the route can be followed while reading the explanatory notes in Section 4 below.

4. EXPLANATORY NOTES FOR USING THE SLUDGE UTILISATION OR DISPOSAL FLOW DIAGRAM

The decision nodes in each of the routes within the SUDDFD are individually numbered and explanatory notes for each stage of the decision-making process are given below.

4.1 Route A: Initial Decision Diagram (Figure 1)

Stage A1: General Information

It is considered essential that a sludge producer maintain adequate and accurate records of the types, quantities and process quality of sludges produced on the plants under his control. In general, the following is proposed:

Types of sludge to be monitored
It is preferable to monitor each type of sludge generated on a works. For instance, on a biological filtration plant with anaerobic digestion it would be preferable to monitor the raw sludge, the humus sludge and the digested sludge. However, this is not always practicable and the minimum requirement is that the final sludge produced on the plant prior to disposal should be monitored. Therefore, if no tertiary sludge treatment facilities are provided, the sludge generated by the secondary treatment systems shown in Table 3 below shall be monitored:

Table 3: Sludge to be Monitored

Type of plant	Sludge to be monitored
Activated sludge only	Waste-activated sludge
Activated sludge with primary settlement and anaerobic digestion of both primary and waste activated sludge	Digested sludge
Activated sludge with primary settlement and anaerobic digestion of primary sludge only	Waste-activated sludge and digested sludge separately
Biological filtration with anaerobic digestion	Digested sludge

If a tertiary sludge treatment facility is provided, only the sludge from that facility needs to be monitored, provided that data of the secondary sludge quality is not required to optimally operate the tertiary process.

Frequency of Testing, Sampling and Analytical Methods to be Employed.

The frequency of testing required to determine the classification of sludges and the sampling and analytical methods to be used are presented in Appendix A of this report.

Optimising of Sludge Quality Prior to Disposal

It should be noted that it is the responsibility of the sludge generator to ensure that the sludge to be disposed of is as free of harmful contaminants as possible. Every effort should be made to control discharges into the sewer system in order to ensure that as high a class of sludge as possible is produced.

Stage A2: Determination of the Inorganic Quality of Sludge

At this stage, the user should use the data collected in Stage A1 above to determine the inorganic quality of the sludge produced on the works and to establish its potential for classification and optimal reuse or disposal.

It is important to note that the sludge producer should, at this stage, have an idea of the anticipated final reuse or disposal method of the sludge and ensure that the relevant testing procedures are followed to determine the suitability or not of such a method.

Stage A3: Can Improved Control of Industrial Discharges Improve the Quality of the Sludge?

Good industrial effluent control is fundamental to sound sludge management. It is the only practical way to reduce metals in sludge and to improve its value as an agricultural product.

At this stage, the user should question whether the quality of the sludge generated on the Works could be improved, particularly with regard to inorganic substances, by improved control of industrial discharges to his sewer system. It should be pointed out to the industries that there are potentially significant savings available if new developments in waste minimisation practices and technology are employed which will be to the overall benefit of all concerned.

Stage A4: Yes to the Question Posed in Stage A3

If the quality of the sludge can be improved, then the user should implement the necessary steps to achieve this. Once this has been implemented, the quality of the sludge should be re-assessed and further consideration be given to the optimal sludge reuse or disposal of the higher class sludge.

Stage A5: Do you Conform to Relevant Legislation?

At this stage the user needs to establish whether his plant is currently authorised with an approved sludge disposal policy and, if not, to identify the requirements for obtaining a valid licence or authorisation.

The authorisation of sludge disposal practices falls within the following definitions:

General authorisation: This is defined in the National Water Act as follows:

"*The responsible authority, after public consultation, may permit the use of water by publishing general authorisations in the GAZETTE. The use of water under a general authorisation does not require a licence until the general authorisation is revoked, in which case it will become necessary to obtain a licence"*

> ***Note:*** *Water use is defined very widely in the National Water Act and includes "taking and storing water, activities which reduce stream flow, waste discharges and disposals, controlled activities (activities which impact detrimentally on a water resource) altering a watercourse, removing water found underground for certain purposes, and recreation."*

Controlled activity: This is defined in the National Water Act as follows:

"The Minister may declare any activity which is having a detrimental effect on the water resource a controlled activity."

Should the final sludge reuse or disposal method employed on a works comply with the standards required of a Type A, B, C or D sludge respectively, as defined in PUDSS 1997 (and as amended in this Addendum), DWAF will classify its reuse or disposal as a generally authorised activity and a permit or licence will not be required. If the sludge reuse or disposal method does not comply with the requirements laid down for the

applicable classification its reuse or disposal requires an authorisation, which could be a licence or a permit.

If a sludge reuse or disposal method does not classify as a generally authorised activity, it becomes a water use under Section 21 of the National Water Act, and requires a licence.

For example "*Irrigation of any land with waste or water containing waste generated through any industrial activity or by a waterworks*" has already been declared a controlled activity. Sludge, which is irrigated onto land, will thus fall into this category and require a licence.

If the current sludge reuse or disposal practice on a works has been approved in a permit under Section 21 of the Water Act of 1956, it is classified as an existing lawful use, provided that it was physically practised between 1 October 1996 and 30 September 1998. If the above is not the case, an application must be made for a licence if the disposal practice does not comply with the requirements of a general authorisation to dispose of the sludge in terms of the National Water Act.

If the current sludge reuse or disposal practice on a works does not constitute an existing lawful use and the plant is an old investment, DWAF will require a strategy from the responsible authority to indicate the steps and timeframe proposed to render the practice compliant. DWAF needs to be satisfied with this strategy. All new investment plants need to comply immediately.

Stage A6: Is the Works Due To Be Extended?

If the answer to A5 above is yes, the user needs to decide if the plant is due to be extended. If it is not to be extended, proceed to stage A7. If it is to be extended, go to stage A8. All new capital investments including extensions of old facilities are regarded as new works.

Stage A7: Continue with Current Reuse or Disposal Method.

If the current disposal or reuse has been authorised via a licence or permit, the current disposal utilisation method may continue unless otherwise determined by DWAF. It should be noted that only in exceptional circumstances do permits or licences have an indefinite validity

Stage A8: Application for Permit or Licence

If the plant being considered is a new investment or if no valid permit exists under Section 21 of the Water Act of 1956 or if the plant is to be extended or operational procedures are to be changed, it is essential that the full procedure for authorisation be adhered to as follows:

- An EIA is required under Section 21 of ECA
- A licence application is required under Section 21 of the NWA and Section 20 of the ECA

The regulations list the following which have direct implications for sewage treatment works:

> *"Schedule 1: The construction and upgrading of-*
>
> *1 (n) sewage treatment plants and associated infrastructure.*
>
> *All activities associated with the above will be required to follow the Environmental Impact Assessment Process and defined by GN R 1183. The level of assessment will be determined by the nature and extent of the specific project. The following categories depict the assessment range:*
>
> *1. Motivation for Exemption from following the EIA Process*
> *2. Scoping Assessment*
> 3. *Environmental Impact Assessment."*

The Environment Conservation Act (ECA) does, however, specify a specific process that is required for the disposal of waste. Section 20 of the ECA stipulates that no person shall establish, provide or operate any disposal site without a permit issued by the Minister of Water Affairs and Forestry. Other government departments to be consulted during the permitting phase will include the Department of Health, as well as the Department of Agriculture, who will assist in identifying critical areas of soil conservation potential.

If the plant being considered is a new investment, or if the plant is to be upgraded, the EIA permitting and authorising process will be applicable. Licence requirements in terms of the National Water Act and Section 20 of the ECA will be applicable in all aspects.

Although no formal environmental permit is required in terms of the ECA (except Section 20) for existing operations and the disposal of treated or untreated sludge, the principles of environmental management as stipulated in Chapter 2 of the NEMA should apply.

Stage A9: Classify Sludge in Terms of Inorganic Content.

The inorganic content of sludges is considered to be one of the key issues as to whether the sludge can be classified as a Type D or one of a lesser quality (ie Type A, B, or C).

Based on the criteria defined in Section 2 above and the results of the monitoring of the specific sludge, an assessment can be made as to whether or not the sludge has the potential to be classified as a Type D. Once this watershed classification has been made the further treatment requirements can be defined.

Stage A10: If Potentially Type D, will the Sludge be used in Agriculture, Industry or be Disposed of?

There are three main disposal options for sludge. It can be utilised in agriculture, in industry or it can be disposed of in an environmentally acceptable manner.

If the answer is agriculture the user should proceed to Route B.

If the answer is industry the user should proceed to Route D.

If the answer is disposal the user should proceed to Stage A14.

Stage A11: If the Sludge cannot be Classified as Type D because of Inorganic Contamination, can Mitigation Procedures Reverse this Classification?

There may be certain exceptional cases where a simple process or procedure can mitigate a problem inorganic substance in the sludge to allow compliance with the Type D classification. Dilution with other organic material may be an example of such a procedure.

If the answer is yes the user should proceed to Stage A10.

If the answer is no the user should proceed to Stage A12.

Stage A12: Choice Between Reuse or Disposal of Type A, B or C Sludge

At this stage the user must decide whether the sludge can be reused beneficially or if it should be safely disposed of. Judgement must be used in making this decision because if sludge is marginally unsuitable as a Class D product, it can still be utilised in agriculture albeit under more strict control. The most noteworthy aspect of this stricter control is the fact that the sludge producer may not alienate ownership of the sludge and will have to continue to monitor and approve the utilisation of the product. This is not necessarily a serious problem because a limited number of well-controlled large contracts with agricultural consumers can still be beneficial. Certain industrial uses for the sludge also require only marginal control and should be considered.

If the choice is reuse the user should proceed to Stage A13.

If the choice is disposal the user should proceed to Stage A14.

Stage A13: Choice Of Agricultural or Industrial Reuse of Type A, B or C Sludge

There are currently only two options for the beneficial reuse of sewage sludges: either as a fertiliser come soil conditioner in agriculture or for some kind of industrial use. At this stage the user must decide which of the two options to pursue.

To facilitate control of the final reuse by bodies other than the sludge producer, a guideline for a contractual agreement between the producer and the final disposer is given in PUDSS 1997.

If the choice is agriculture the user should proceed to Route C.

If the choice is industry the user should proceed to Route D.

Stage A14: Choice Between On-Site or Off-Site Disposal of Type A, B or C Sludge

At this stage the user has to decide whether he is going to dispose of the sludge on or off the site of the works. There is an important difference between the manner in which on or off site disposal of sludges is authorised. Details of the differences are given in Stages E1 and F1. In general, on-site disposal is controlled in terms of Section 21 licences of the NWA, whereas off-site disposal is permitted in terms of Section 21 of the ECA. The user should consult DWAF before a decision is reached in this regard.

If the choice is for off-site disposal the user should proceed to Route E.

If the choice is for on-site disposal the user should proceed to Route F.

4.2 Route B: Use Of Type D Sludge In Agriculture (Fig. 2)

This Route leads the user through the steps to be taken to use a Type D sludge in agriculture.

Stage B1: Stabilisation and Disinfection of the Sludge.

The inorganic content of sewage sludge is only one aspect that determines its ultimate classification. The other two aspects requiring attention are the stability and the bacteriological quality of the sludge. Sludge will have to undergo some form of stabilisation and disinfection treatment in order to comply with the requirements of a Type D sludge.

Stage B2: Can the Sludge Economically Be Classified As Type D?

The treatment steps required to achieve a Type D classification should at this stage be assessed from both a economical and technological standpoint and the decision taken as to whether it is feasible to treat the sludge to such a high standard.

If it becomes evident that the sludge cannot be classified as Type D for economic or technical reasons, the user should proceed to Stage A11.

If the sludge is to be treated as a Type D, the user should proceed to Stage B3

Stage B3: Register the Sludge as Fertiliser

Before the Type D sludge can be used freely for agricultural or domestic use, it must be registered as a fertiliser in terms of the Fertilisers, Farm feeds, Agricultural Remedies and Stock Remedies Act.

Stage B4: Product Marketing

The potential producer of agricultural products from sewage sludges must be aware that the resultant product will have to be actively marketed in order to produce a reliable revenue stream. There is an inherent reluctance by consumers and farmers to utilise products emanating from sewage sludges and this will have to be overcome by professional marketing.

4.3 Route C: Use Of Type A, B Or C Sludge In Agriculture (Fig. 3)

This route leads the user through the steps to be taken to reuse a Type A, B or C sludge in agriculture.

Stage C1: Permits and EIA Plus Input from Departments of Agriculture and Health

Input and possible permitting from the Departments of Agriculture; Health; and Water Affairs and Forestry will be required for the disposal of sludge on agricultural land. In keeping with the principles and requirements of NEMA and ECA, adequate EIA studies should precede the activity, to identify the potentially detrimental effects which the activity might have on the environment, and stipulate management solutions to minimise identified negative effects.

Stage C2: Treatment or Mitigating Engineering

It may be prescribed by the relevant permit requirements and the findings of the EIA that certain treatment or mitigating engineering measures are required before sewage sludges can be utilised for any of the identified purposes. These could, for instance, involve pre-liming of agricultural soil to raise the pH or the provision of deep cut-off trenches around the agricultural area to be fertilised.

Mitigating engineering steps will be site- and use-specific and will be identified in the EIA and prescribed in the permits.

Stage C3: Edible/Other Crops

This distinction is drawn in Table 2 of PUDSS 1997 which illustrates some crops in Table 2.

Stage C4: Other

This is a reminder to sludge producers that other agricultural uses of sewage sludges may develop in future and innovative options should be sought.

4.4 Route D: Use Of Type A, B, C Or D Sludge In Industry (Fig. 4)

This Route leads the user through the options available and the steps to be taken to use a Type A, B or C or D sludge in industry.

Stage D1: Permits EIA

In keeping with the principles and requirements of NEMA and ECA, adequate EIA studies should precede the activity, to identify the potentially detrimental effects which the activity might have on the environment, and stipulate management solutions to minimise identified negative effects. Where sewage sludge will be utilised in processes such as cement manufacturing where gas emissions are regulated, all requirements and permitting with respect to the Atmospheric Pollution Prevention Act, Act 45 of 1965, must be implemented. All by-products and final residues must be disposed of in accordance with section 20 of the ECA.

Stage D2: Treatment and/or Mitigating Engineering

The mitigating engineering or pre-treatment procedures required before sludge can be reused in industry will be purpose and use specific for different applications. These procedures will be identified as part of the EIA study and will be imbedded in the relevant licences or permits.

Stage D3: Brick Making

The use of sewage sludges in the manufacturing of bricks is a well-proven process and has been implemented with great success for many years in Port Elizabeth. This is an industrial use that should be considered wherever possible, but quality standards, operational procedures and other practical considerations will have to be pre-determined by means of pilot plant work.

Stage D4: Cement Manufacture

An attractive disposal method for sewage sludges is to use it, wherever practicable, as a source of heat in a cement kiln. The resultant ash is incorporated in the cement matrix and the metals are inextricably bound in the cement product, thus providing safe long-term disposal of metals in sewage sludges.

Stage D5: Gassification

Gassification is one of the processes being considered for large-scale disposal of sewage sludges in Europe, Australia and elsewhere. It is a process in which high pressure and heat is utilised to transform the sludge into a gas (that can be utilised as a source of fuel), char and useable oils.

Stage D6: Fertilisers

Sewage sludges can be enriched by an industrial process to transform them into high value liquid or solid fertilisers. The enrichment achieved in this way results in the sludge (and, hence, the inorganic constituents) being distributed to land in significantly lower application rates and should be regarded as an effective method of upgrading a Type C sludge to a Type D.

Stage D7: Market Product

Any entrepreneur wanting to create useable products from sewage sludge must be aware that the product will have to be licensed in terms of The Fertilisers, Farm Feeds, Agricultural Remedies and Stock Remedies Act and that extensive professional marketing will be required.

Stage D8: Other

The sludge producer must expect and anticipate the development of other processes and be actively involved in trying to develop new techniques and opportunities for beneficial sludge utilisation.

4.5 Route E: Disposal Of Type A, B Or C Sludge Off The Site Of The Works (Fig. 5)

This Route leads the user through the options available and the steps to be taken to dispose of a Type A, B or C sludge at a site other than the site of the treatment works.

Stage E1: Section 20 Permit

If sewage sludge which is removed from the site of origin for disposal by repeatedly applying it to a specific area of land at a rate exceeding that permissible, it is required that the waste disposal site be issued with a permit from DWAF in terms of section 20 of the ECA. Section 20 (1) of the ECA stipulates that no person shall establish, provide or operate any disposal site without a permit issued by the Minister of DWAF and that the Minister may issue a permit subject to conditions as he/she may deem fit. The permit holder of permitted waste disposal site must ensure the safe disposal of the sewage sludge according to site-specific permit conditions.

Stage E2: Minimum Requirements for Waste Management

The document "Minimum Requirements for Waste Disposal by Landfill" stipulates the procedures, actions and information required when applying for a permit for a waste disposal facility as well as the permit conditions to be followed by the permit holder. (See "Landfill Process", Pg Vii and Section 5.)

The document "Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste" addresses the classification, treatment, delisting and disposal requirements for hazardous wastes.

Sewage sludge other than Type D is generally classified as a hazardous waste in terms of the ECA

The “Minimum Requirements” should be adhered to by both the sewage sludge generator and the waste disposal site owner (who may be one and the same).

Stage E3: Hazardous Landfill

Sewage sludge other than Type D that has not been delisted may only be disposed of on a Hazardous Class (H:H or H:h) waste disposal site. This is normally a very expensive operation.

Stage E4: Delisting of Sludge from a Hazardous to a General Waste.

In order to treat sewage sludge as a general waste and not a hazardous waste, it is necessary to delist it in terms of the ECA. The "Minimum Requirements" gives further details of the process to follow in order to achieve this.

Sewage Sludge (except for a type D sludge) is considered hazardous until proven non-hazardous, mainly because of its heterogeneous composition and relatively high content of heavy metals and pathogens. Thus sewage sludge which has not been delisted would have to be disposed of on a permitted hazardous (H:H or H:h) waste disposal facility and would only be permitted onto a specific Class G (general, non-hazardous) waste disposal facility after it had been delisted as a hazardous waste. Thus, the Sewage sludge manager must follow the classification, treatment, hazard rating and delisting procedures of the Minimum Requirements to determine whether the sewage sludge can be delisted for disposal on a suitable class G waste disposal site. The classification and delisting motivation has to be submitted by the permit holder to DWAF, which will consider the motivation, and if approved, may amend the permit and disposal conditions for that specific disposal facility. It must be noted, however, that the frequency of the hazard rating of the sludge will depend on the consistency of the incoming sewage (seasonal changes and industrial fluxes), the age of the sludge and unexpected events that may influence the chemical composition of the sludge. Thus, the permit holder of a specific waste disposal site will be responsible in this regard.

Stage E5: EIA and Permits

All requirements in terms of section 20 of the ECA will apply.

Stage E6: Treatment and Mitigating Engineering

Forthcoming from the EIA and imbedded in authorisation conditions, certain pre-treatment or other mitigating engineering activities may be prescribed for site-specific procedures. In this respect, typical requirements may be storm water control, pre-liming of soil, cut-off trenches and other procedures to ensure environmentally safe disposal.

The mitigating engineering will be site- and process-specific. The sludge producer should have a very definite scheme or process in mind before an EIA is done.

Stage E7: Co-disposal

This is the process where sewage sludge is co-disposed of with mixed municipal refuse. Permit holders or applicants for waste disposal sites must incorporate the waste load allocations, liquid co-disposal ratios, operating procedures and response action plans into the Environmental Impact Control Report. These procedures are clearly spelt out in the Minimum Requirements and must be followed strictly. The moisture content of the sewage sludge must be known and cognisance taken of its effect on the water balance of the landfill. Generally speaking, the sludge should be digested and dewatered to 25% solids.

A very attractive option for the use of sludge on a landfill site is to mix it with the cover material. This not only reduces the amount of cover material which has to be sourced, but also encourages and enhances the growth of vegetation on the landfill.

Delisting of the sludge is required if the landfill is not licensed as a hazardous facility.

Stage E8: Land Rehabilitation

This is generally referred to as the process where seriously impacted land such as in the vicinity of strip mines, reclaimed mine dumps or borrow pits is rehabilitated on a scientific basis by the utilisation of the potential beneficial soil conditioning impact of sewage sludges.

Stage E9: Sea Outfalls

In certain areas of the country where sea floor shelving and current conditions are favourable, consideration can be given to disposing of the sludge to sea through properly designed and constructed sea outfalls.

Stage E10: Other

This is to alert the sludge producer that the science of safe sludge disposal is a dynamic process with new ideas being generated on a regular basis.

4.6 Route F: Disposal Of Type A, B Or C Sludge On The Site Of The Works (Fig. 6)

This route leads the user through the options available and the steps to be taken to dispose of Type A, B or C sludge on the site of the treatment works.

Stage F1: Minimum Requirements

The accumulation, storage, disposal or utilisation of sewage sludge on the site of origin, is regulated through a licence in terms of section 21 of the NWA. The most recent version of the Water Use Registration Management System (WARMS) and the Minimum Requirements would serve as useful guides in this regard, or the Director: Water Quality

Management of the Department of Water Affairs and Forestry (DWAF) may be contacted at: Private Bag X313, PRETORIA, 0001.

Stage F2: Site Surveys, EIA, Permits

In keeping with the principles and requirements of NEMA and ECA, adequate EIA studies should precede the activity in order to identify the potentially detrimental effects which the activity might have on the environment, and stipulate management solutions to minimise identified negative effects.

Stage F3: Treatment or Mitigation Engineering

The EIA will determine the required treatment or mitigating engineering activities required for site and usage-specific solutions. These steps will be imbedded in the relevant authorisation and the sludge producer will have to comply fully with the specified requirements.

Stage F4: Land Disposal

This is the procedure where repeated high dosages of sludge are applied to land, allowed to dry and ploughed in; the biochemistry of the soil matrix is utilised to break down the organics and oxidise the sludge. This process is also referred to as sacrificial land disposal and will only be considered under exceptional circumstances. This issue must be discussed with DWAF before any decision is made on the implementation of sacrificial land disposal. Strictly in terms of the legislation, the site will have to be licensed as a waste-disposal site and, if the sludge is not delisted, it may have to be licensed as a hazardous landfill.

Stage F5: Wet Storage Lagoons

Lagoons are created and the sludge is pumped into them where it undergoes further bio-chemical stabilisation and thickening. They should be regarded more as a treatment (stabilisation) option than as a final disposal option. Lagoons will also only be authorised under exceptional circumstances and then only as a temporary storage option. Of particular concern, will be groundwater pollution, odour nuisance and final disposal of the sludge once the lagoon is full. These factors will be evaluated when EIA's through Section 21(1) of the ECA, site surveys and permits are considered.

Stage F6: Other

There are other options available, such as incineration, which can be considered.

5. CONTACT ROUTES

The legislation governing the disposal of sludge is complex, being subject to Acts falling under the jurisdiction of the Departments of Water Affairs and Forestry, Health, Agriculture and the Environment and the routes to be followed to define the correct procedures to comply with it can be tortuous. It is considered to be beyond the scope of this Addendum to set out each possible route. Users are advised to discuss their

requirements with the local representative of DWAF in their region as a point of first contact and he or she will be in a position to advise them on the way forward in complying with the legislation.

A list of the addresses and contact numbers of all DWAF local representatives is given in Appendix D to this Addendum.

6. CONCLUSION

An attempt has been made in the production of this Addendum to PUDSS 1997 to produce a user-friendly guide for local authorities to negotiate the complex network of current legislation governing the disposal of sewage sludges. Ambiguities which appeared in the original document have, as far as possible with the scope of the exercise, been removed and the way is now clear for the Guidelines to become a working document as it was originally intended.

Research needs to further optimise the reuse and disposal of sludge have also been identified by the Steering Committee and negotiations have been entered into with the Water Research Commission for them to be implemented.

Once the outcome of this research has been published consideration will be given to redrafting PUDSS 1997 to incorporate the findings.

7. LIST OF ABBREVIATIONS

DWAF	Department of Water Affairs and Forestry
ECA	Environmental Conservation Act
HA	Health Act
NEMA	National Environmental Management Act
NWA	National Water Act
PUDSS 1997	Permissible Utilisation and Disposal of Sewage Sludge August 1997 Edition 1
SUDDFD	Sludge Utilisation or Disposal Decision Flow Diagram
WA	Water Act
WARMS	Water Use Authorisation and Registration Management System
WRC	Water Research Commission
WSA	Water Services Act

8. ACKNOWLEDGEMENTS

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Mr L Bredenhann	Department of Water Affairs & Forestry
Prof GA Ekama	University of Cape Town, Civil Eng
Mr KS Fawcett	Cape Metropolitan Council
Mr NE Fortmann	Durban Metro Water Services
Mr PN Gaydon	Umgeni Water – Wastewater Treatment
Mrs M Hinsch	Department of Water Affairs & Forestry
Mr D Makwela	Department of Health
Mr CJ Marx	Africon
Mr AJ Maxwell	Cape Metro Council
Mr FB Stevens	Durban Metro – Wastewater
Dr AR Pitman	Greater Johannesburg Metro Council
Mr GB Saayman	Pretoria Metropolitan Council
Mr DG Devey	Port Elizabeth Municipality
Dr HG Snyman	East Rand Water (ERWAT)
Mr J Snyman (Koot)	Pretoria Metropolitan Council
Mr AT van Coller	Dir Agricultural Water Use Management
Mr JLJ vd Westhuizen	Department of Water Affairs & Forestry
Mr D v Nieuwenhuizen	National Department of Agriculture
Mrs CM Smit	Water Research Commission

9. REFERENCES

9.1 Relevant Acts of Parliament

National Water Act (Act 36 of 1998) (NWA)

Water Act (Act 54 of 1956) (WA)

Environmental Conservation Act (Act 73 of 1989) (ECA)

Fertilisers, Farm feeds, Agricultural Remedies and Stock Remedies Act (Act 36 of 1947)

Health Act (Act 63 of 1977) (HA)

Water Services Act (Act 108 of 1997) (WSA)

National Environmental Management Act (Act 107 of 1998) (NEMA)

Resource Conservation Act (Act 43 of 1983)

Copies of the above Acts can be obtained directly from

Government Printing Works — telephone No (012) 334 4500
Private Bag X85
Pretoria
0001

or

National Library — telephone No (012) 321 8931
P O Box 397
Pretoria
0001

9.2 Relevant Publications

Permissible Utilisation and Disposal of Sewage Sludge August 1997 Edition 1" in August 1997 (PUDSS 1997): Published by the Water Research Commission: August 1997.

Minimum Requirements: (2nd Edition) 1998

This refers to the Waste Management Series published by DWAF, which establishes a reference framework of standards for waste management in South Africa in terms of section 20 of the ECA. This trilogy consists of:

- Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste
- Minimum Requirements for Waste Disposal by Landfill
- Minimum Requirements for Water Monitoring at Waste Management Facilities

Copies of the above can be obtained from:

The Director: Water Quality Management
Department of Water Affairs and Forestry
P O Box X 313
PRETORIA
0001

***Water Use Authorisation and Registration Management System (WARMS)**:*

Published by the Department of Water Affairs.

9.3 Relevant Website Addresses

Department	Telephone No	Web Site Address
Department of Water Affairs & Forestry	(012) 336 7500	www-dwaf.gov.za
Department of Agriculture	(012) 319 6083	www.nda.agric.za
Department of Health	(012) 312 0889	www-health.gov.za
Department of Environment	(012) 310 3426	www-gov.za/envweb

Appendix A

The Sludge Utilisation or Disposal Decision Flow Diagram (SUDDFD)

(Excel Worksheets) to be inserted here, preferably on the outside half of an A3 sheet so that they can be folded out and referred to at the same time as the text.

APPENDIX A: SLUDGE UTILIZATION OR DISPOSAL DECISION FLOW DIAGRAM (SDUDFD)

FIGURE 1 **ROUTE A : INITIAL DECISION DIAGRAM**

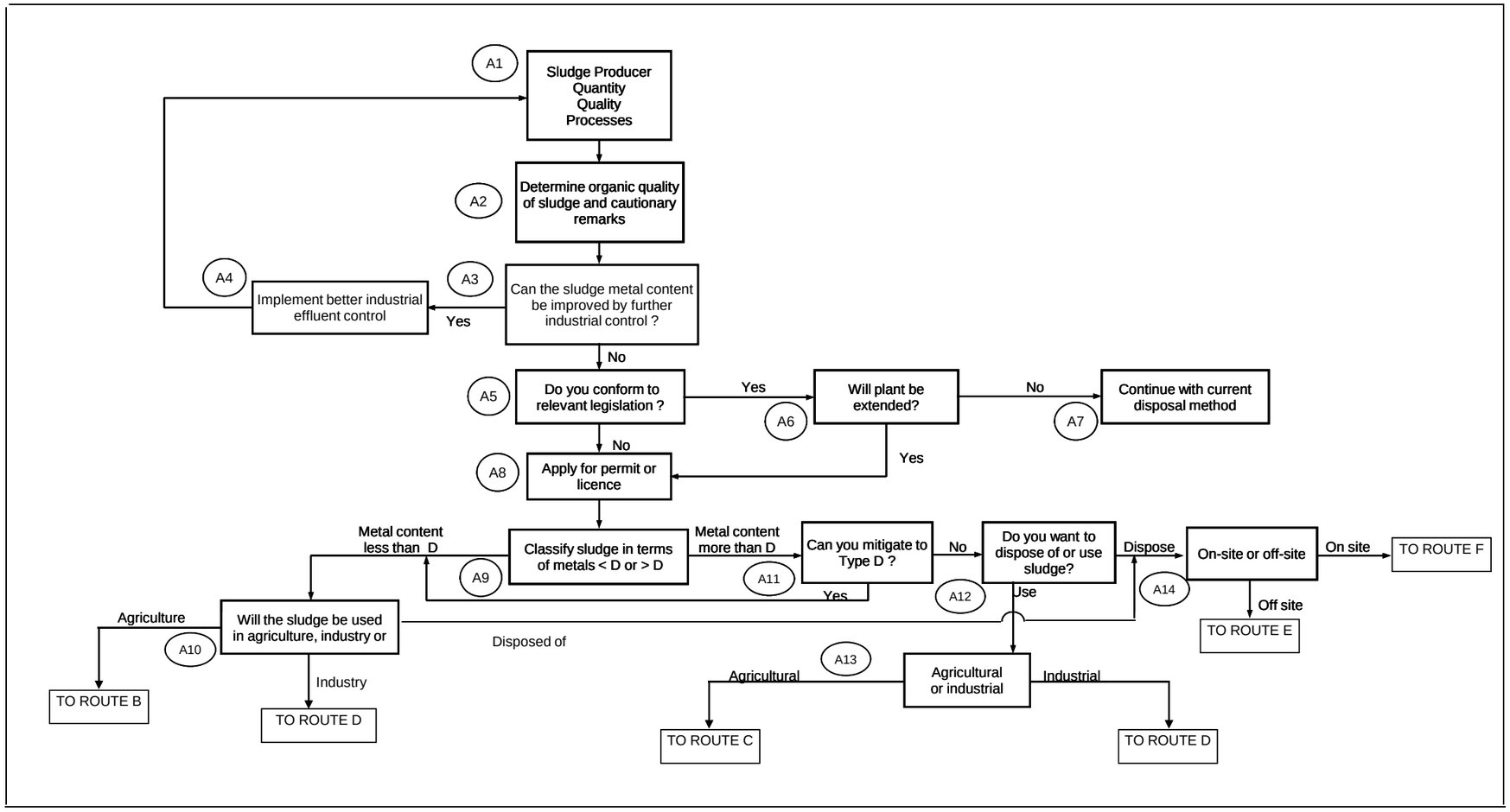


FIGURE 2 **ROUTE B : USE OF A TYPE D SLUDGE IN AGRICULTURE**

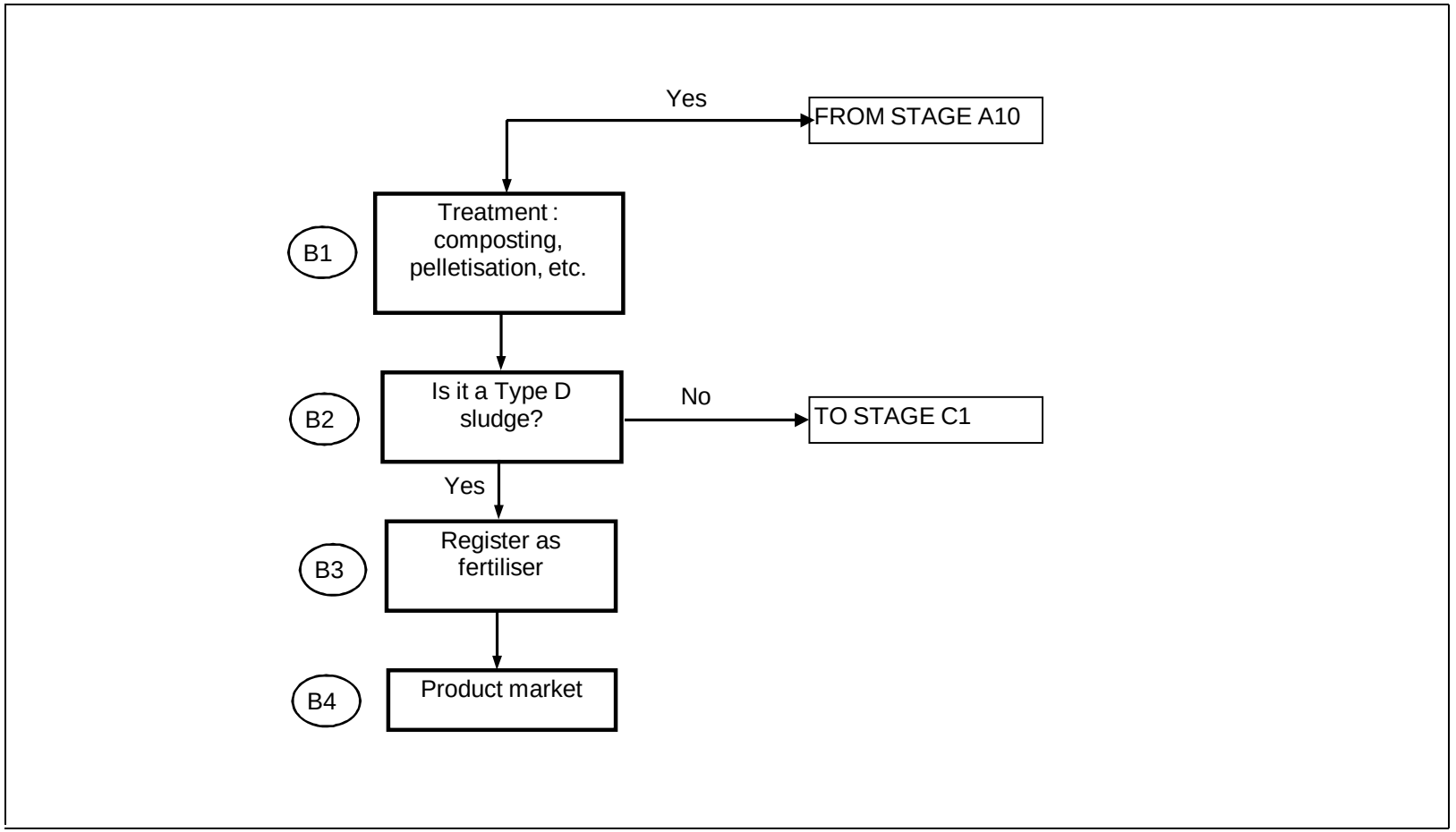


FIGURE 3 **ROUTE C : USE OF A TYPE A, B OR C SLUDGE IN AGRICULTURE**

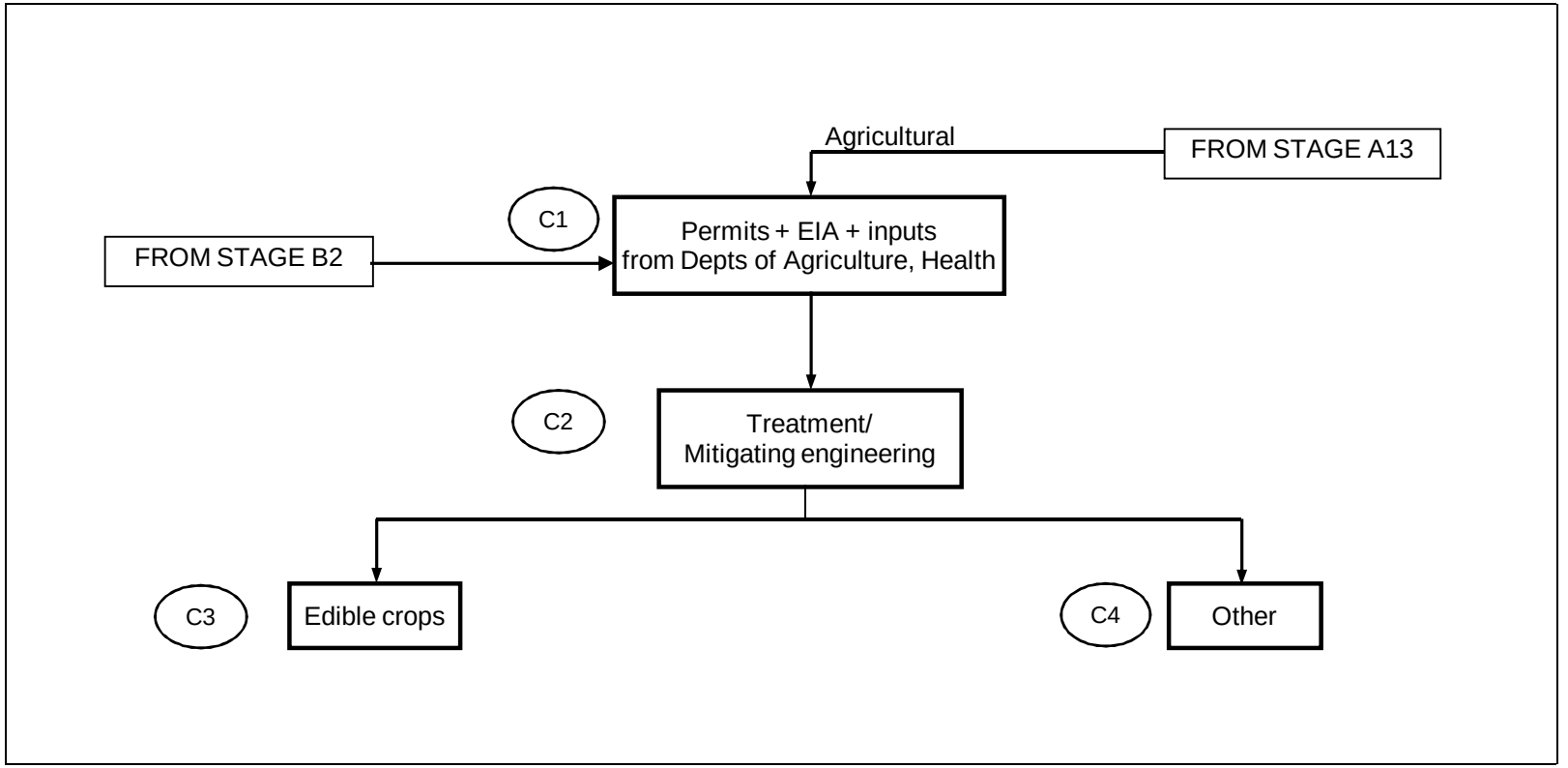


Figure 4 **ROUTE D : USE OF TYPE A, B, C OR D SLUDGE IN INDUSTRY**

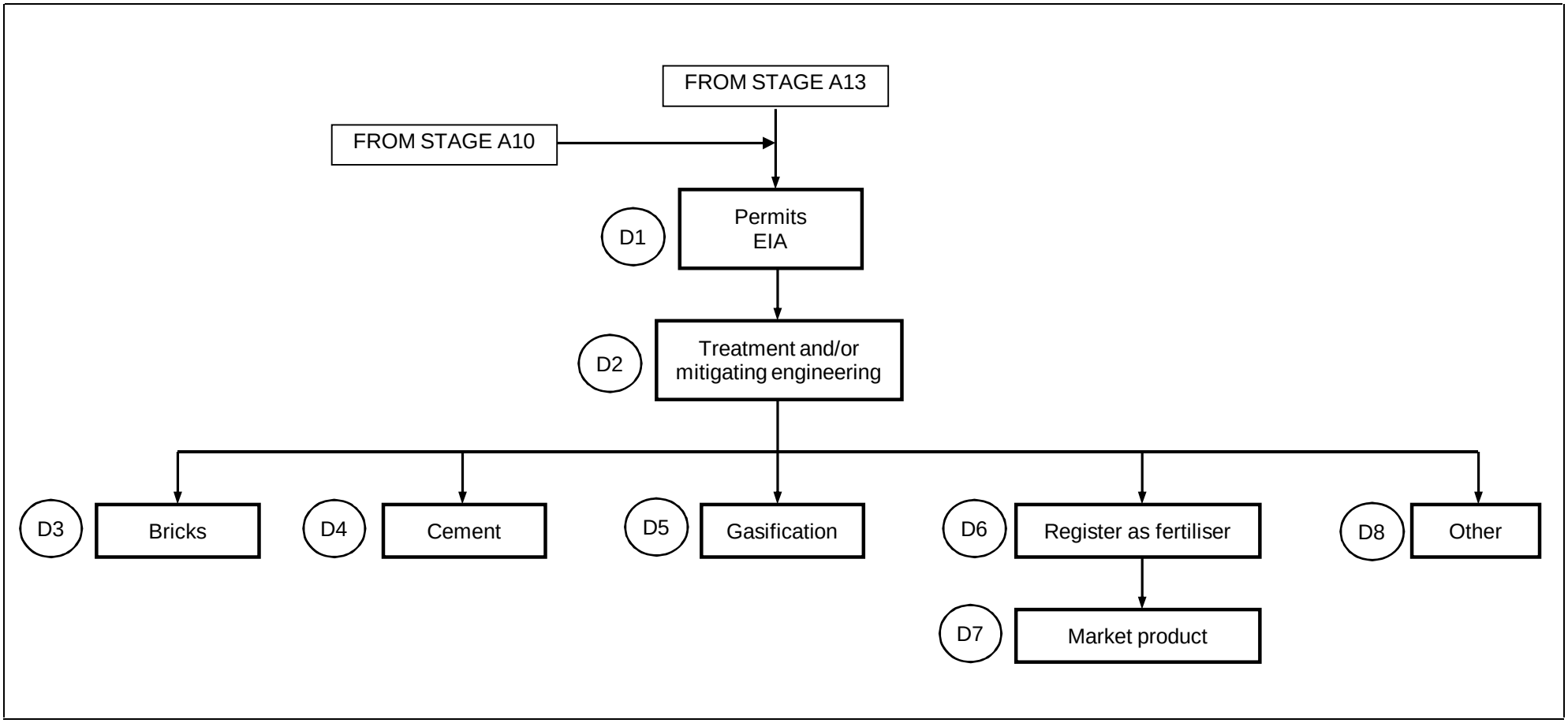


Figure 5 **ROUTE E : DISPOSAL OF TYPE A, B OR C SLUDGE OFF THE SITE OF WORKS**

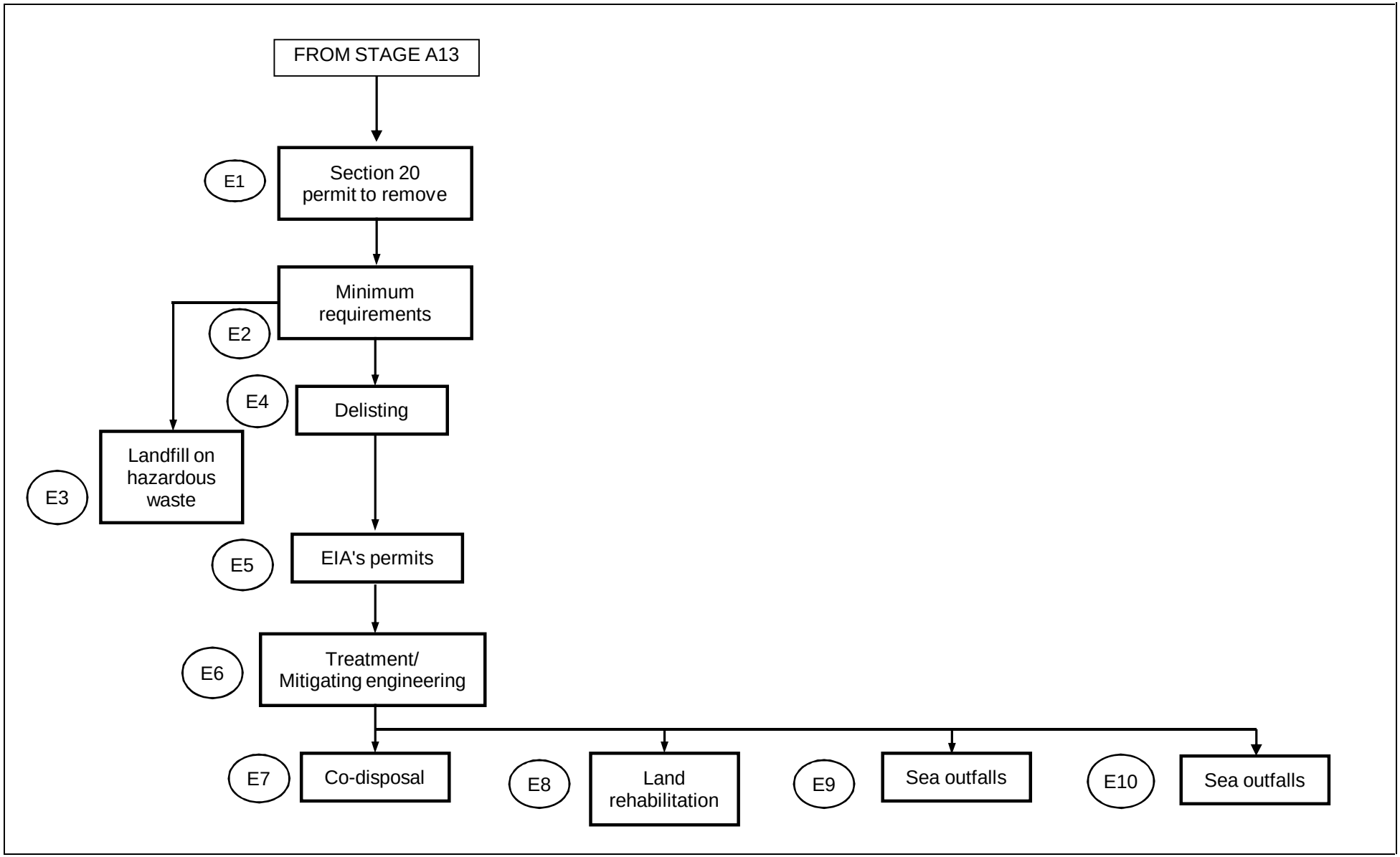
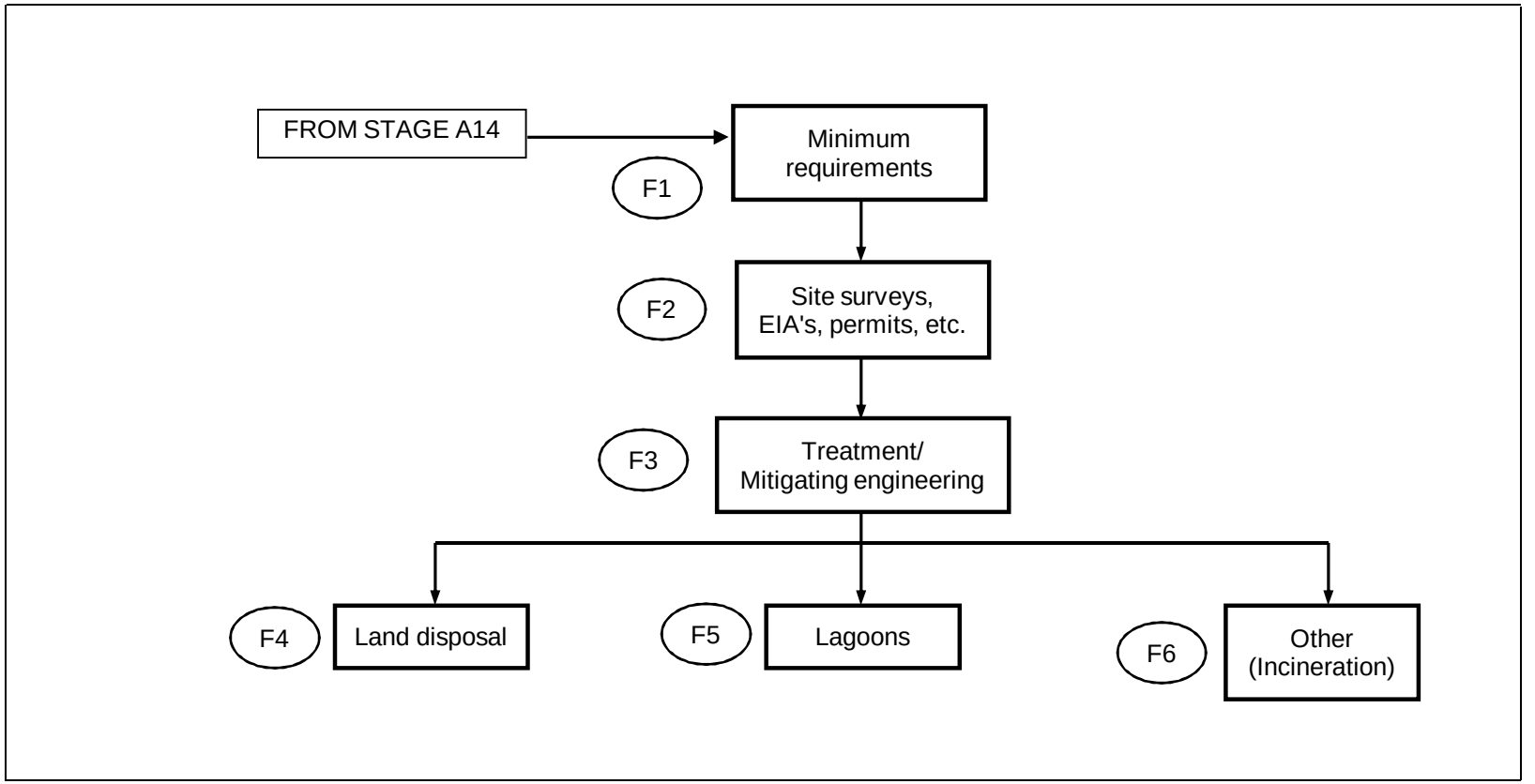


FIGURE 6 **ROUTE F : DISPOSAL OF TYPE A, B OR C SLUDGE ON THE SITE OF WORKS**



Appendix B

Recommended Analytical Methods For Establishing Concentrations Of Inorganic Constituents In Sludge

B1 Analyses of Total Inorganic Constituents (With exception of Boron)

The summarised methods in Table B1 are a list of the methods used by Smith and Vasiloudis (1989). These researchers aimed to establish the most suitable methods to determine the inorganic chemicals and nutrients in sewage sludge. Most of the methods described in the report (Smith and Vasiloudis, 1989) were based on Standard Methods 15th Edition (1980), methods developed by the EPA and other published work. These methods were subsequently incorporated into the 1993 document published by the Water Institute of South Africa, Sludge Management Division which contains the Guide: Permissible Utilisation and Disposal of Sewage Sludge (1991). It is presumed that the same methods were intended for the limits (total) set out in the PUDSS 1997.

The methods described in Table B1 are in some cases outdated and replaced by updated methodology as detailed in the Standard Methods 19th Edition (1995). Many laboratories have adopted these new methods. It is not the intention of this Appendix to persuade these laboratories to revert to the old methods. However, it is recommended that these adopted updated methods be compared to the methods listed in Table B1 to assess whether similar fractions are extracted. For example, if the adopted method includes an acid extraction and ICP analyses instead of AA analyses, it will still be within the same standard for total metal analyses. If, for instance, the adopted method uses an EDTA extraction for chromium, it is not comparable with the chromium method listed in Table B1 and should be changed.

Table B1: Analytical procedure used to determine compliance of sludge to the limits as detailed in the "Guide: Permissible Utilisation and Disposal of Sewage Sludge (1991)" for the determining sludge characteristics.

Determinant	Sample preparation	Extraction or pre-treatment method	Analyses
Total residue	Dry at 103-105°C then at 550°C	None	Gravimetric
PH	Dilute if more that 100g/l solids	None	pH meter
Total Kjeldahl Nitrogen	Dry at 105°C	Digestion in sulphuric acid, potassium sulphate and a mercuric sulphate catalyst mixture. Treatment with alkaline solution of sodium thiosulphate.	Acidometric titration. Ammonia is distilled into boric acid solution and measured by titration with sulphuric acid.

Determinant	Sample preparation	Extraction or pre-treatment method	Analyses
Total Phosphorus	Dry at 105°C	Digest with sulphuric acid and potassium persulphate. Filter and treat with sodium bisulphate solution.	Colorimetric
Calcium	Dry at 105°C	Extract with Aqua regia and filter.	Flame atomic absorption spectrometry using a nitrous oxide-acetylene or air-acetylene flame.
Magnesium	Dry at 105°C	Extract with Aqua regia and filter.	Flame atomic absorption spectrometry using a nitrous oxide-acetylene or air-acetylene flame.
Potassium	Dry at 105°C	Extract with Aqua regia and filter.	Flame atomic absorption spectrometry using a nitrous oxide-acetylene or air-acetylene flame.
Cadmium	Dry at 105°C	Extract with Aqua regia and filter.	Flame atomic absorption spectrometry using a nitrous oxide-acetylene or air-acetylene flame.
Cobalt	Dry at 105°C	Extract with Aqua regia and filter.	Flame atomic absorption spectrometry using a nitrous oxide-acetylene or air-acetylene flame.
Chromium	Dry at 105°C	Extract with Aqua regia and filter.	Flame atomic absorption spectrometry using a nitrous oxide-acetylene or air-acetylene flame.
Copper	Dry at 105°C	Extract with Aqua regia and filter.	Flame atomic absorption spectrometry using a nitrous oxide-acetylene or air-acetylene flame.
Lead	Dry at 105°C	Extract with Aqua regia and filter.	Flame atomic absorption spectrometry using a nitrous oxide-acetylene or air-acetylene flame.
Nickel	Dry at 105°C	Extract with Aqua regia and filter.	Flame atomic absorption spectrometry using a nitrous oxide-acetylene or air-acetylene flame.

Determinant	Sample preparation	Extraction or pre-treatment method	Analyses
Zinc	Dry at 105°C	Extract with Aqua regia and filter.	Flame atomic absorption spectrometry using a nitrous oxide-acetylene or air-acetylene flame .
Mercury	Dry at 105°C	Prolonged oxidation with sulphuric acid, potassium persulphate and potassium permanganate.	Cold vapour generation atomic absorption spectrometry
Arsenic	Dry at 105°C	Digest with nitric acid and ash at 550°C with magnesium nitrate. Extract with hydrochloric acid.	Hydride generation atomic absorption spectrometry
Selenium	Dry at 105°C	Digest with nitric acid and ash at 550°C with magnesium nitrate. Extract with hydrochloric acid.	Hydride generation atomic absorption spectrometry
Molybdenum	Dry at 105°C. Ash at 500°C	Digest at 85°C in dilute hydrochloric acid. Treat with potassium thiocyanate solution.	Colorimetric
Boron	Dry at 105°C	Extract with water and treat with azomethine-H	Colorimetric
Fluoride	Dry at 105°C	Extract with sulphuric acid and treat with ammonium hydroxide solution to remove interfering cations.	Potentiometrically using fluoride ion-selective electrode.

B2 Analyses of Pathogenic Indicators

Table B2 lists the acceptable methods for determining the pathogenic indicator organisms according to *Standard Methods*, 1995.

Table B2: Methods for determining pathogenic indicator organisms (Standard Methods, 1995).

Indicator organisms	Method
Ascaris ova	Filtration/flotation
Salmonella	Enrichment/inhibition
Faecal coliforms	Membrane filter/ m-FC medium

B3 Analyses for Determining the Potentially Leachable Cadmium, Copper, Lead and Zinc Concentrations.

The leachable fraction of the concentration of the metals Cadmium, Copper, Lead and Zinc needs to be assessed using the TCLP (Toxicity Characteristic Leaching Procedure). The TCLP was developed by the US EPA to measure a waste's leachability and hence the risk it poses to the groundwater. The TCLP is used for cases where a waste is co-disposed with organic waste, which could then generate organic acids, which could mobilise pollutants. The TCLP method is described in the Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste (Department of Water Affairs and Forestry, 1998).

B4 References

Ekama GA 1993. Sewage Sludge Utilisation and Disposal, Information Document. Water Institute of South Africa.

Department of Water Affairs and Forestry. 1998. Waste Management Series. Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste.

Guide: Permissible Utilisation and Disposal of Sewage Sludge. 1991. Department of National Health and Population Development, A11/2/5/4.

Smith R and Vasiloudis H 1989. Inorganic Chemical Characterisation of South African Municipal Sewage Sludges. WRC Report No 180/1/89.

Standard Methods for the Examination of Water and Wastewater. 1980. 15th Edn., American Public Health Association, American Water Works Association, Water Pollution Control Federation, Washington, D.C. USA

Standard Methods for the Examination of Water and Wastewater. 1995. 19th Edn., American Public Health Association, American Water Works Association, Water Pollution Control Federation, Washington, D.C. USA

APPENDIX C

Frequency of Monitoring of Parameters

In order for the data to be meaningful the recommended frequency of testing is presented in Table C1 below.

Table C1: Frequency of Testing of Sludge Parameters

Parameter	Units	Frequency of Testing			
		Class A	**Class B**	**Class C**	**Class D**
Solid mass produced	KgDS/d	Monthly	Note 1	Note 1	Note 1
Solids Content	%	Monthly	Note 1	Note 1	Note 1
VSS/TSS	%	Monthly	Note 1	Note 1	Note 1
Ascaris Ova		-	-	Note 2	Note 2
Salmonella		-	-	Note 2	Note 2
Faecal Coliforms		-	-	Note 2	Note 2
Nitrogen	mg/kg	-	-	Note 2	Note 2
Phosphorus	mg/kg	-	-	Note 2	Note 2
Potassium	mg/kg	-	-	Note 2	Note 2
Cadmium	mg/kg	-	-		Note 3
Cobalt	mg/kg	-	-		Note 2
Chromium (Cr^{3+})	mg/kg	-	-		Note 2
Copper	mg/kg	-	-		Note 3
Mercury	mg/kg	-	-		Note 2
Molybdenum	mg/kg	-	-		Note 2
Nickel	mg/kg	-	-		Note 2
Lead	mg/kg	-	-		Note 3
Zinc	mg/kg	-	-		Note 3
Arsenic	mg/kg	-	-		Note 2
Selenium	mg/kg	-	-		Note 2
Boron	mg/kg	-	-		Note 2
Fluoride	mg/kg	-	-		Note 2

Note 1: *Sampling and analysis should take place every eighth day*

Note 2: *Sampling and analysis should initially take place monthly for a period of 6 months to establish the classification of the sludge. Thereafter, sampling and analysis should take place once every four months to ensure continued compliance. Should a sample fail then weekly sampling and analysis of the failed constituent should be introduced until compliance is reached for 6 consecutive weeks.*