



# Guidelines for the disposal of dangerous and toxic wastes so as to minimize or prevent environmental and water pollution

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R T Rudd

A report of the Committee for Solid and Toxic Wastes  
National Programme for Environmental Sciences

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| TABLE OF CONTENTS                                    | Page  |
|--|-------|
| Titles in this series .....                          | (iii) |
| INTRODUCTION .....                                   | 1     |
| Legal aspects .....                                  | 1     |
| The philosophy of waste disposal .....               | 2     |
| Geology as related to South African conditions ..... | 2     |
| Site requirements .....                              | 3     |
| Investigation .....                                  | 3     |
| Operation .....                                      | 4     |
| Closure .....  | 5     |
| Post closure maintainance .....                      | 7     |
| APPENDIX 1 .....                                     | 8     |
| APPENDIX 2 .....                                     | 11    |

## INTRODUCTION

Modern society is producing ever increasing quantities of dangerous and/or toxic wastes, which require safe and effective disposal if they are not to pose a threat to our water supplies or the environment in general.

These include :

- Sludges and residues containing heavy metals
- Oil sludges
- Toxic synthetic oils and solids which do not degrade easily eg polychlorinated biphenyls, chlorinated hydrocarbons, organophosphates, etc
- Paint residues
- Waste cyanides and other compounds from the metallurgical industries
- Obsolete or surplus agricultural pesticides
- Spent catalysts
- Obsolete or surplus pharmaceutical supplies and chemicals
- Wastes resulting from catastrophes such as factory fires, earthquakes etc, whose composition may not be readily identifiable
- Contaminated process chemicals
- Miscellaneous poisons
- Etc.

Radio-active substances have been specifically excluded from this list as special and unique methods are used to dispose of radio-active wastes.

### *Legal aspects*

Section 23 of the Water Act in effect, says that anyone who "wilfully" or "negligently" does anything which could cause pollution of water is guilty of an offence. The latest version of Section 23 of the Water Act is attached as appendix 1.

The words "wilfully" or "negligently" are stressed in the act and provide the key to the spirit of this section.

It is obvious that these words are intended to encourage the responsible disposal of wastes which could pollute water. This guide is intended to provide pointers to such disposal, and will make it possible to legally provide a waste disposal service for pollutants which may or may not arise from the use of water for industrial purposes. The disposal of wastes or effluents arising from the use of water in industry is of course covered by Section 21 of the Water Act. An amended version of the Act is attached as appendix 2.

### *The philosophy of waste disposal*

This is somewhat similar to the philosophy of war - and probably for similar reasons!

There are three main ways to deal with harmful pollutants, namely :

- Destruction or reduction to harmless wastes where possible, and disposal by normal means : this may not always be possible and requires active research.
- Dispersion to a safe concentration : this poses obvious problems such as a build-up of toxic substances in the environment and the likelihood of side-effects and is sometimes no solution to pollution.
- Encapsulation : permanent encapsulation is considered the best alternative where destruction or reduction is not possible. The capsule must be a skin of impervious, stable, inert material, surrounding the substance in three dimensions. The best material for this purpose is an impervious clay or impervious rock formation.

Destruction or reduction and encapsulation should always be used in conjunction for the safe disposal of hazardous wastes. With the exception of radio-active materials there are few wastes which cannot be either destroyed or reduced to a less hazardous form. Although no remedy exists for the treatment of hazardous wastes, it is possible to classify hazardous wastes and to specify the requirements for treatment and disposal in each category.

The destruction and/or reduction process combined with that of encapsulation has the following advantages over either process alone :

- Toxic or dangerous wastes which have been destroyed or reduced are often still pollutants which should be encapsulated.
- Reduced wastes are often less liable to pollute air or water supplies so that less stringent encapsulation site conditions than those specified are necessary.
- Reduction and encapsulation, as opposed to encapsulation only, of hazardous wastes obviates the possibility that capsules containing dangerous substances are buried only to be unearthed in the future.

### *Geology as related to South African conditions*

In South Africa, clay is quarried for brick and tile making while rock is quarried for many diverse purposes. Worked-out quarries, in suitable clay or rock formations can, if they are sited correctly, provide ready made sites for disposal of dangerous pollutants.

Clay in South Africa is normally derived from parent shales and volcanics, but may in some cases be derived from tillites.

In general, only shales of the sedimentary series of rocks will provide clayey material. Shales themselves, in their unweathered state are

generally unsuitable, as the normal sedimentary stratification and fracturing makes unweathered shale anything but impervious. Sandstones, quartzites, conglomerates and schists are normally unsuitable, as are dolomites and limestones.

Clays derived from volcanics such as granite, norite, gabbro and dolerite are normally very impervious, and could provide suitable sites. However, where the parent rocks occur in massive form, it may be possible to use holes or quarries sited in the parent rock provided there are no faults, dykes, fracture zones or fissures, or provided it is possible to grout such weak spots.

In Natal, extensive areas of Dwyka Tillite, which can also provide suitable sites, are quarried.

To summarize, brick quarries in clays derived from slate, tillite or volcanics can be considered along with rock quarries in volcanics or in tillite, while quarries in limestone, quartzite, dolomite, sandstones and other sedimentary rocks are highly unsuitable.

#### *Site requirements*

Two apparently contradictory requirements for a disposal site are that it should be centrally sited near producers of dangerous wastes and yet be unobtrusively placed to be aesthetically acceptable.

The site should be such that stormwater may easily be diverted from it, and under no circumstances flow through it. It should be as far as practically possible away from streams or rivers. Ideally, therefore, it should be sited on a ridge and never in a valley or pan.

It should offer easy access to vehicles and be reasonably close to main roads and power and water supplies.

It should be remote from usable or exploited sources of underground water, and must be situated in a suitable geological formation.

As its future use is likely to be circumscribed this is a factor which should be considered.

There should be sufficient space for backup services such as a laboratory and storage tanks, and neutralizing or treatment ponds.

Sufficient impervious material, to eventually cover the waste placed in the site, should be readily available.

Suitably located economic sites of the correct geological formation are difficult to find and synthetically lined and/or constructed sites may be necessary. Also treatment of hazardous wastes may allow them to be disposed of in sites which do not meet with some of these requirements.

#### *Investigation*

Having found a likely site, it should first be thoroughly investigated by a competent geologist, who should, by sinking boreholes if necessary, establish :

- Whether the sides and bottom of the hole are "lined" with at least 5 metres of in situ material with a permeability of not more than  $10^{-7}$  cm/sec.
- Whether any fault zones, fractures, fissures or other weak spots exist where it would be possible for water to percolate into or out of the site.
- The depth and an estimate of usability, ie the quantity and quality, of any underground water underlying the site.
- The depth of the strata, where applicable, together with indications of the likely direction and rate of movement of underground water, if any.
- The best position and direction for the drilling of boreholes to monitor the possible escape of pollutants from the site.
- Recommendations as to action to be taken, eg grouting, if movement of pollutants should be noted in the future.
- Recommendations on the mending of any flaws, fissures, faults, dykes or other weak zones in the site.
- Whether the amount of cover material available on the site is sufficient.

Once a suitable site has been found and the above mentioned facts established, contour plans should be prepared showing :

- the site in relation to its surroundings
- the catchment area(s) of any stormwater likely to reach the site
- the location size and details regarding diversion of stormwater from the site, depending on the catchment area(s) of any stormwater likely to reach the site
- stormwater drains which should be designed to cope with the maximum flow to be expected from the relevant catchment area with a frequency of one in a hundred years, and which should have a freeboard on the side nearest the disposal site of at least 0,6 metres. Sections and grades in areas where the site could be affected by erosion or silting should be designed for "non-silting, non-scouring" velocities at maximum design flow
- the proposed siting of roads, laboratories, storage tanks, etc
- the security fencing and a brief description of security measures
- a brief description of the fill operation.

#### *Operation*

Approval of these contour plans should be obtained from the Secretary for Water Affairs before operations are commenced.



The following is recommended :

- Waste oils and oil sludges can be used to stabilize the sides and bottom of the site as a first operational step.
- Suitable dry wastes can be spread in layers, used in a "blotting paper" fashion to soak up liquid wastes such as sludges, oils, neutralized solutions etc, and then consolidated.

This procedure requires a ratio of about 4:1 dry, non-hazardous waste to liquid waste. This means that rare and valuable hazardous waste sites are rapidly filled primarily with non-hazardous materials. In the case of aqueous waste, sludge de-watering techniques provide economically advantageous alternatives to the absorption method.

- Facilities should be provided for mixing acid and alkali wastes, or cyanide and chrome wastes etc, as a means of de-toxifying or neutralizing wastes prior to placing.
- Measures must be taken to minimize odours and vermin, fly and mosquito breeding.
- Users of the site should provide typical analyses of each load of waste for the authority running the site.

The authority must, by taking snap samples and analysing them, satisfy itself as to the correctness of the data supplied, and must by suitable means also ascertain the quantity of each load being brought in. Records of customers and quantities and contents should be kept and be available for inspection. It is a good idea to issue each customer with a receipt for each load brought in, to enable them to satisfy the authorities and also assist the latter with control.

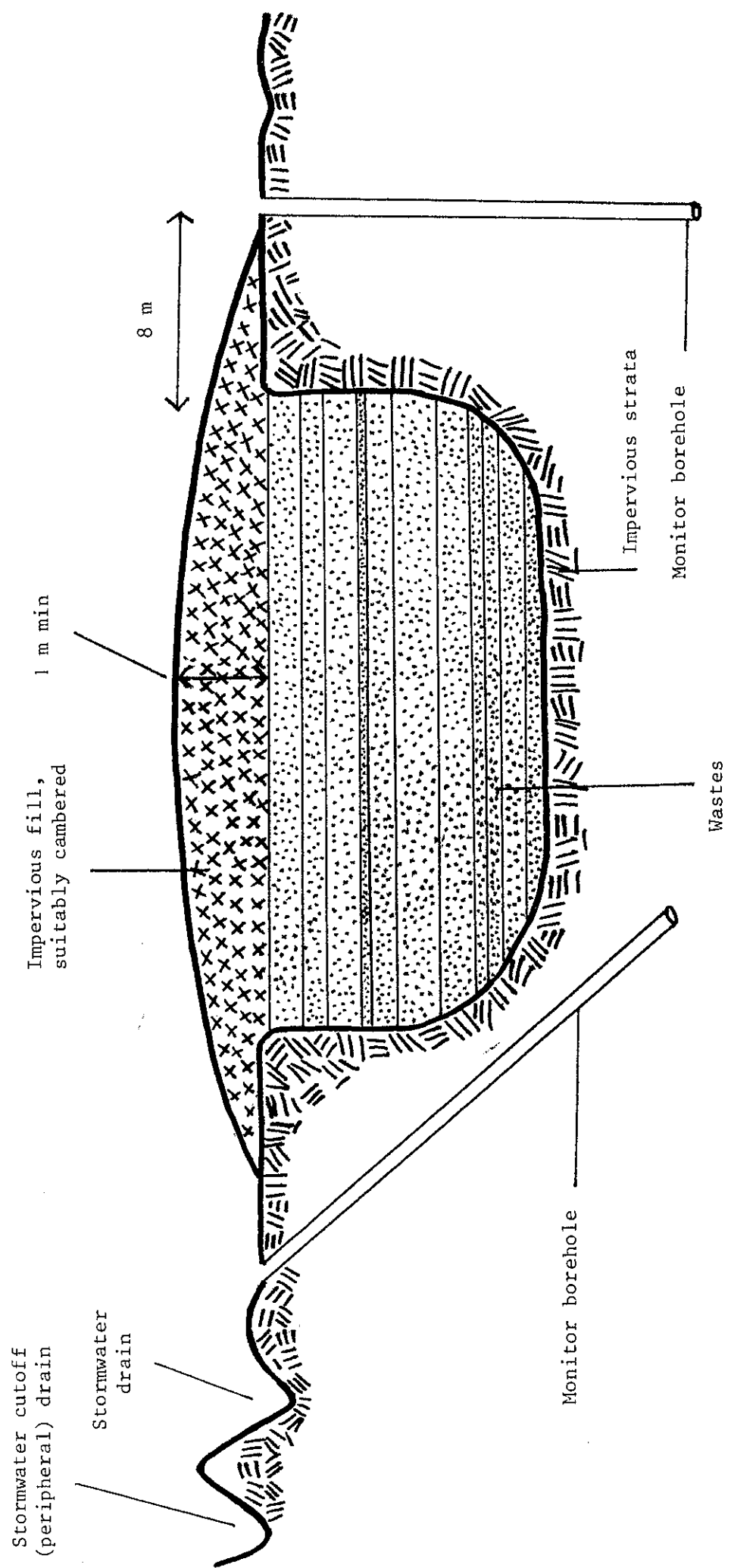
Records should also be kept of solutions which have been neutralized or de-toxified. Steps should be taken to prevent air pollution from smells, dust and possibly toxic gasses.

#### *Closure*

The facility should be filled with wastes to within at least half a metre from the top and then covered with at least one metre of clayey material, having a permeability of not more than  $10^{-7}$  cm/sec. This material should be placed so as to be cambered towards the edge of the facility and should overlap the edge of the old depression by at least eight metres to the point where cover material thickness tapers to zero, as shown in figure 1. The clayey material should be covered with at least 150 mm of topsoil or other suitable soil and planted with grass to prevent erosion. Suitable drains to drain run-off from the fill should be provided around the perimeter.

Use of the site after closure is likely to be circumscribed. A clause in the title deeds, stating that any use of the site after closure be subject to the approval of the Secretary for Water Affairs, is likely to be a requirement.

Figure 1. Waste disposal facility.  
(Rough sketch - not to scale)



Stormwater cutoff  
(peripheral) drain

Stormwater  
drain

Impervious fill,  
1 m min  
suitably cambered

8 m

Monitor borehole

Wastes

Impervious strata

Monitor borehole

Applications to use the site are likely to receive consideration if the authorities feel that the waste and its surrounding capsule will not be unduly disturbed. Various uses come to mind, for example sportsfields, park or garden areas, parking lots, etc.

*Post closure maintainance*

It is expected that bulky wastes used for the "blotting paper" effect will, even after consolidation, settle. This could lead to the shearing of the cover at the edge of the site, and leakage of stormwater into the site. It will therefore be necessary to carry out maintainance until final consolidation has taken place in order to ensure that effective drainage of the site is maintained. Any one who purchases the site after closure, must be warned of this and a further clause must be inserted in the title deeds to ensure that this is done.

Monitoring may be discontinued after closure, provided no pollutant has been detected in the monitor holes in the course of at least five years of operation.

APPENDIX 1

STATUTES OF THE REPUBLIC OF SOUTH AFRICA - WATER  
WATER ACT, NO 54 OF 1956

21. *Purification and disposal of industrial water and effluents*

1(a) The purification of any waste water or any effluent or waste produced by or resulting from the use of water for industrial purposes shall form an integral part of the process of such use and, subject to the provisions of subsection (5), any person using water, including sea water, for industrial purposes, shall purify such water, effluent or waste so as to conform to such requirements as the Minister may from time to time, after consultation with the South African Bureau of Standards, prescribe by notice in the Gazette either generally or in relation to water used for or in connection with any one or more specified industrial purposes or in relation to water derived from any specified public stream or the sea, or in relation to water used in any prescribed area.

(Para (a) amended by s. 5 of Act No 56 of 1961 and substituted by s. 3(a) of Act No 42 of 1975).

(b) Any requirements prescribed under paragraph (a) shall be such as to ensure that the waste water, effluent or waste to which such requirements relate will, after purification in accordance with those requirements, be at least as free of impurities as would have been the case if the purification thereof had been effected in accordance with the recommendation of the said Bureau.

2. Water which has been used for industrial purposes and any effluent produced by or resulting from such use, other than water or effluent referred to in subsection (3), shall, subject to the provisions of section 11, after purification in accordance with subsection (1), be returned by the user at the nearest convenient point to the bed of the public stream from which the said water was abstracted or, if it was abstracted from the sea, to the sea. Provided that where water has been so used at any place outside the natural watershed of the catchment area of the public stream from which it was abstracted and in the opinion of the water court it is for physical or economic reasons impracticable to return such water or any such effluent to the said stream, such water or effluent may be returned by the user to the bed of some other public stream at a point determined by the water court.

(Sub-s. (2) substituted by s. 3(b) of Act No 42 of 1975).

3. The provisions of sub-sections (1) and (2) shall not apply in respect of a person supplied with water by the Minister or by any local authority or other person or lawfully constituted body having a right to control and supply public or private water, including underground water, within its area of jurisdiction, if the Minister or, as the

case may be, such local authority, person or body or any other local authority has undertaken the duty of disposing of such water or any effluent or waste produced by or resulting from the use thereof after such water has been used by the said person and has been discharged into any channel, drain or sewer under the control of the Minister or the local authority, person or body concerned.

4. Water used for industrial purposes and returned in accordance with sub-section (2), shall not be diminished in quantity save in so far as such diminution is caused by such use.

5(a) Any person or user referred to in sub-section (1) or (2) may apply to the Minister for a permit exempting him from compliance with the provisions of either of those subsections, and the Minister may, after such investigation as he may consider necessary, if he is satisfied that compliance with the said provisions is impracticable in the particular circumstances, grant a permit subject to such conditions as he may deem fit to impose, exempting such person or user from compliance therewith to such extent as the Minister may determine, or authorizing such person or user to discharge any waste water, effluent or waste referred to in subsection (1) in an unpurified state or in such state of semi-purification as the Minister may determine, into any public stream or, as the case may be, into the sea at a point to be fixed by the Minister. Provided that, in the case of an application for exemption from compliance with the provision of sub-section (1), the Minister shall in considering such application have due regard to the regulations made under section 10(1)(d) of the Sea-shore Act, 1935 (Act No 21 of 1935) and section 13(1)(g) of the Sea Fisheries Act, 1973 (Act No 58 of 1973) and shall not issue such a permit unless he is satisfied that -

(i) the condition to be imposed in connection with any such permit will be at least as effective for the purpose of preventing the pollution of public or other water, including sea water, as any conditions or requirements which may have been recommended by the South African Bureau of Standards; and

(ii) any point so fixed by him is in such proximity to the sea that it is unlikely that any person will be prejudicially affected and that the dilution of such waste water, effluent or waste by sea water or other water will be such that neither aquatic nor marine fauna or flora in the public stream or the sea will be detrimentally affected.

(Para (a) substituted by s. 3(c) of Act No 42 of 1975).

(b) Any interested person, other than an applicant for a permit under paragraph (a), may after written notification to the Minister apply to a water court for the cancellation or modification of any permit issued under that paragraph, and the water court may make such order on the application as it may consider equitable.

(c) The Minister may at any time by notice in writing to the holder of any permit issued in terms of paragraph (a), withdraw that permit or amend it in such manner as he may deem fit.

- (d) It shall be no defence in any prosecution for an offence in terms of section 16(1)(j) of the Sea Fisheries Act, 1973 (Act No 58 of 1973), that any act charged was performed under the authority of a permit issued under paragraph (a).

(Para (d) added by s. 3(d) of Act No 42 of 1975).

- 6(a) The Minister may, in prescribing any requirements under subsection (1) or imposing any conditions under subsection (5), also specify the steps to be taken by any person carrying on any mining or other industrial operations, in order to prevent the pollution of public or private water, including underground water or the sea, by seepage or drainage from any area on which those operations are carried on, both while such operations are in progress and after the abandonment thereof.

(Para (a) substituted by s. 3(e) of Act No 42 of 1975).

- (b) Any such person who fails to take the steps so specified within a period determined by the Minister and made known by notice in the Gazette or by notice in writing addressed to such person, shall be guilty of an offence.

7. For the purposes of this section, a local authority which uses water for the purification or disposal of sewage or any effluent or waste referred to in subsection (3), shall be deemed to use such water for industrial purposes.

8. Any person who contravenes or fails to comply with any provision of this section or of any permit issued under subsection (5), shall be guilty of an offence.

(Sub-s. (8) substituted by s. 3 of Act No 79 of 1967).

22. *Disposal of effluents by local authorities*

1. Notwithstanding the provisions of the Public Health Act, 1919 (Act No 36 of 1919), or any other law, but subject to the provisions of subsection (2), a local authority having jurisdiction over the disposal of sewage may, after purifying the effluent derived from the treatment of such sewage in accordance with standards prescribed under subsection (1) of section twenty-one, and with the permission of the Minister, use such effluent for any purpose approved by the Minister or dispose of such effluent for use by any person or discharge such effluent into a public stream.
2. The Minister may in writing, and on such conditions as he may deem fit, exempt from compliance with the provisions of section twenty-one, any local authority which does not dispose of water used for any industrial purpose other than the purification or disposal of sewage.
3. Any local authority which contravenes or fails to comply with any condition subject to which any exemption has been granted to it under sub-section (2) shall be guilty of an offence.

APPENDIX 2

23. *Prevention of pollution of water*

- 1(a) Any person who wilfully or negligently, and, where any provision of section 21 or 22 applies, contrary to that provision, does any act which could pollute any public or private water, including underground water, or sea water in such a way as to render it less fit -
- (i) for the purposes for which it is or could be ordinarily used by other persons (including the Government, the South African Railways and Harbours Administration and any provincial administration); or
  - (ii) for the propagation of fish or other aquatic life; or
  - (iii) for recreational or other legitimate purposes,
- shall be guilty of an offence.
- (b) If in any prosecution under paragraph (a) it is proved that the accused committed any act which could pollute water referred to in that paragraph in any manner mentioned therein, it shall be presumed, until the contrary is proved, that the accused committed such act wilfully or negligently.

(Sub-s. (1) substituted by s. 3 of Act No 45 of 1972 and by s. 4 of Act No 42 of 1975).

- 2(a) The Minister may out of moneys appropriated by Parliament for the purpose, take any steps which he may consider necessary to prevent the pollution, as a result of seepage or drainage from any area on which mining or other industrial operations have been carried on, of public or private water, including underground water, after such operations have been abandoned, and may in his discretion recover the cost or any part of the cost incurred in taking such steps from any person who carried on or is entitled to carry on such operations.
- (b) The Minister or a person acting under his authority may at any time enter upon any land for the purpose of taking any steps referred to in paragraph (a), and may take with him on to such land any men, animals, vehicles, equipment, appliances, instruments, stores or materials, and may erect such camps and construct such works as may be necessary for that purpose.
- (c) No compensation shall be payable to any person for any loss which may be sustained by him in consequence of any action taken under this subsection, except by order of a competent court.

23A. *Prevention of pollution of water through farming operations*

1. If the Minister is of opinion that the concentration of any livestock or any substance or the carrying on of any farming operations on any

land is causing or is likely to cause the pollution of public or private water, including underground water, he may require the owner of such land or the person carrying on such operations to take, at his own expense and within a period determined by the Minister, such steps as the Minister may deem necessary for the prevention of such pollution, and may, if such requirement is not complied with, cause the required steps to be taken and the expenses incurred thereby to be defrayed out of moneys appropriated by Parliament for the purpose, and may recover such expenses from the said owner or person.

2. The provisions of section 23(2)(b) and (c) shall mutatis mutandis apply in respect of any steps contemplated in subsection (1) of this section.
3. Any person who wilfully fails to comply with a requirement of the Minister in terms of subsection (1) shall be guilty of an offence.

(S. 23A inserted by s. 3 of Act No 36 of 1971).