


Division of Mines and Mineral Resources — Report 1990/07

Guidelines for tip siting (domestic wastes) and monitoring

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INTRODUCTION

In Tasmania, the disposal of domestic wastes is usually carried out by its deposition on the ground surface (filling of a valley or an old quarry) or by burial in trenches. These methods of waste disposal will probably remain an essential component of a waste strategy for decades. Unfortunately, most of the existing tip sites are situated in an inappropriate geological setting, so that there is a potential for groundwater contamination at many of the sites currently in use.

The purpose of these guidelines is to aid in choosing future landfill sites in locations where significant problems of groundwater pollution are unlikely to exist. Advice on methods for monitoring existing sites are provided in this report, because it is of prime importance to determine whether leachate is infiltrating downwards to the water table and to protect groundwater quality in the vicinity of any tip as far as possible.

Controlled landfills seem to be acceptable methods of disposal but good management is required to prevent environmental damage. Several handbooks, mainly provided by the Department of Environment and Planning, describe successive steps which should be undertaken during the 'life' of a landfill, i.e. deposition, compaction, covering, landscaping and leachate control.

SITE SELECTION

There are two basic disposal methods used. The trench method is preferred for small communities, while the dumping of wastes on the ground surface (e.g. filling of a valley) is used for disposal areas of more significant size. However other factors must be taken into consideration (e.g. depth to the water table and depth to the bedrock) in the selection of sites. Thus, site selection requires the consideration of many parameters. The following criteria describe the major characteristics required to establish that a site is satisfactory.

Investigation should be undertaken on all sites to determine these parameters precisely, if possible before disposal of wastes begins at new tip sites.

Geology

The tip site should be underlain by a low permeability formation of sufficient thickness (e.g. clay) to form an effective barrier to the downward migration of leachate or the upward flow of groundwater from more permeable horizons at depth. These layers may consist of sediments (e.g. Tertiary deposits) or may be the product of weathering of the underlying formation (e.g. Jurassic dolerite). The

permeability of these strata or formations should be very low ($<10^{-7}$ m/s) and their thickness should be at least two metres.

The basement rocks should not have significant discontinuities nor be highly fractured, because the permeability is greatly increased by a high fracture density. Limestone and dolomite (karstic rocks), which may also contain dissolution cavities, are not suitable.

The depth to the bedrock should be at least two metres below the surface or the bottom of the trench, and the bedrock should be overlain by low permeability material. In Tasmania the rock types which are likely to develop clay soils are Jurassic dolerite, shale beds within the Triassic sequences, and Tertiary sediments. The Permian mudstones can sometimes weather deeply, as can mudstone and slate in the Lower Palaeozoic and Precambrian. Granitic rocks when deeply weathered can produce soil with a low permeability. Tertiary basalt can also produce deep clay soils.

All fractured rocks, alluvium, sand and gravel formations, talus and limestone/dolomite should be avoided as basement rocks underlying tip sites. When searching for suitable sites, rocks with the potential to develop considerable depths of low permeability weathered material should be considered to assure protection of any groundwater and to provide sufficient quantity of cover material. Subsurface conditions should be investigated to determine the likely impact of waste disposal on the surrounding environment.

Hydrology

Water bore success rate is very high throughout Tasmania (>50%) for most rock types. Although quality and yields obtained may vary greatly, the use of groundwater for domestic and stock supplies, as well as for irrigation, will obviously increase during the next decades. Particular care should be taken to protect groundwater against contamination.

The depth to the water table should be determined precisely, both for dry and wet seasons, within each aquifer, confined or unconfined, on the future tip site. This parameter is essential to assess the potential for groundwater contamination because it determines the migration time of leachate to the groundwater (time and distance available for biodegradation). This information can easily be obtained by the drilling of a few bores on the tip site.

The level of the water table should be as deep as possible below the surface or the bottom of the trench and preferably should be at least two metres. It is necessary to prevent operations where there is evidence of any water table within the depth of the trench.

The site should not be within 200 m of a bore or well used for domestic purposes or stock watering, or within 100 m of a water bore used for irrigation.

The site should be away from any river, whether perennial or seasonal, or shoreline (>100 m), and water courses should be diverted, if necessary, in the surrounding area. It is very important to prevent water from any source entering the waste mass because this water would be a major factor in leachate generation.

As with groundwater, surface water (rivers, streams or sea) should be protected. Moreover the site should not be subject to flooding (river overflow) more frequently than once in 100 years.

Management

Major management operations which should be carried out are:

- diversion and/or piping of water courses through the landfill site;
- collection of stormwater and runoff water by ditches dug all around the site;
- collection of leachate by a network of drains installed under the tip. Leachate collected should be pumped to a sewage treatment plant or eventually sprayed on the tip area;
- covering wastes dumped with low permeability material to prevent infiltration of precipitation.

Remarks and conclusions

The location of a future tip site should be carefully selected. It would be desirable that operations occur at a major central site (of significant size) rather than on several small sites scattered throughout a municipality. In that way management, as well as control and monitoring, could be greatly improved. Establishment of transfer stations in the remote areas would be necessary to collect wastes, which should then be transported at regular intervals to the central tip depending on the need of the population.

Suitable sites for waste disposal are relatively common in Tasmania from the geological and hydrogeological point of view. These sites are underlain by soil of low permeability which has developed from the weathering of the underlying formation (e.g. Jurassic dolerite, Triassic sequence) or low permeability deposits (e.g. Tertiary sediments). Bedrock should not be closely fractured, and the depth to the water table (if existing) should be as deep as possible.

Both the trench system and surface dumping method may be used but the depths to bedrock and the water table are the major factors which influence this selection. Large scale operations usually take place by landfilling of old quarries, dry gullies etc.

Finally, a good tip site consists of an area with a suitable geological and hydrological setting, and good management. When these parameters are met, the potential for groundwater and surface water contamination should be very small and the environment should be preserved from any damage.

The site and its final arrangement must guarantee long term security and optimal protection against erosion and instability factors (landslide, rockslide, flooding).

The following handbooks and guidelines provide information on tip siting and management for disposal of domestic wastes:

- *Guidelines for the selection operation and management of refuse disposal sites.* Department of the Environment, Tasmanian Local Government Industry Training Committee (Seminar, May 1987).
- *Environmental guidelines for fish processing plants and associated waste disposal facilities.* Department of the Environment.
- *Environmental guidelines for the disposal of solid wastes by burial.* Department of the Environment.
- *Environmental effects of waste handling and disposal facilities.* Department of the Environment.

MONITORING

Monitoring should be undertaken on many tip sites throughout Tasmania. It would be desirable to develop a monitoring network for all tip areas where there is a significant potential for groundwater contamination, both on existing landfill and on future tip sites.

The purpose of the monitoring is to ascertain whether pollution exists at the site as a result of the dumping of waste materials. Remedial measures can then be undertaken to prevent further deterioration.

Monitoring network (sampling points)

The monitoring network should consist of several water bores drilled in the surrounding area, but mainly downstream of the tip site. These bores or piezometers allow for the measurement of the water table level and the sampling of water.

The number of bores needed varies depending on the size of the tip and the expected potential for groundwater contamination. When several aquifers underlie the tip site, all of them should be monitored. This is possible with the use of multi-level piezometers. Generally it is not advisable to drill any bore through the landfill because of the risk of 'tearing off' a potential barrier (e.g. clay layer) which should prevent leachate infiltration. These bores also provide a means of undertaking pump tests to determine the soil and rock permeabilities. Apart from water bores the monitoring network should include other nearby water sources as references, particularly in areas where uncontaminated groundwater is known. Water courses in the surrounding area, as well as drained stormwater and leachate, should be part of the monitoring network.

Sampling and parameters to be analysed

Sampling of water should be carried out at different periods during the year to get the complete range of the hydrological cycle (dry and wet seasons). The bores making up the monitoring network should be sampled at regular intervals of time (every 3 – 4 months, at least during the first year of study).

During the sampling, physical parameters (conductivity, temperature, pH, water level measurement) should be measured in the field. Water samples should be analysed for the following parameters;

- Major inorganic components of water (cations and anions) Ca^{2+} , Mg^{2+} , Na^+ , K^+ , HCO_3^- , SO_4^{2-} and Cl^- as well as NH_4^+ , NO_3^- , NO_2^- which may be characteristic of contaminated water. The total of these parameters, Total

Dissolved Solids (TDS) or total salinity, should be determined.

- Heavy metals: Hg, Cr, As, Cd, Pb, Zn, Mn, Fe, C.
- Total organic carbon (TOC).
- Organic components: these should be chosen in respect of the likely contaminants but they consist mainly of herbicides and pesticides (agricultural sprays).

The list of parameters to be analysed may vary greatly from case to case, especially for the organic components. Specific analyses may need to be undertaken (e.g. stable isotopes).

Interpretation of results should lead to a better understanding of the hydrogeological setting and should allow the precise determination of the extent of the groundwater contamination (contamination plume).

Various chemical parameters may work as tracers but the most efficient is usually Cl⁻ (chloride) because it is present in very low contents in non-polluted water (in the case of fresh water) and it is not absorbed by clay minerals.

Other parameters may also be used as tracers if the difference between uncontaminated and polluted waters is significant. Interpretation and use of heavy metals and organic components as tracers may be more difficult. In some cases, the ratio of two parameters may be useful.

In conclusion, as many parameters as possible should be analysed during the first sampling to determine which are the most efficient as tracers and pollution indicators, in case of groundwater contamination. One or more among the following parameters may be very efficient: Cl⁻, NH₄⁺, NO₃⁻, NO₂⁻, SO₄²⁻, (Na⁺, K⁺, clay absorption). Total Organic Carbon is often used with success.

When a case of groundwater contamination is reported, the study of its origin, as well as its lateral extent, should provide a good understanding of leachate migration and the flow system. This understanding is necessary to research a solution to improve the situation after environmental damage.

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