Guidance on Minimum Approaches for Improvements to Existing Municipal Waste Dumpsites

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2001
ABSTRACT

The guidance presented in this report is intended to specify, in physical and quantitative ways, the steps that municipalities and others agencies should follow to move from uncontrolled, open dumping of solid wastes to more controlled intermediate practices. Each aspect of disposal site development and operation has been given a measurable minimum standard, which, if achieved, could be regarded as achieving improved operations to the level of 'controlled dumping'. This is the second stage in the widely acknowledged four-stage development path from open dumping to full sanitary landfill operations.

Keywords

REFUSE DISPOSAL
WASTE MANAGEMENT
GUIDELINES
YUGOSLAVIA
DEVELOPING COUNTRIES
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Acknowledgements

The following groups and individuals contributed to the preparation and review of this document. Their advice and assistance is gratefully acknowledged.

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1. Introduction

The guidance presented in this report is intended to specify, in physical and quantitative ways, the steps that municipalities and others agencies should follow to move from uncontrolled, open dumping of solid wastes to more controlled intermediate practices. Each aspect of disposal site development and operation has been given a measurable minimum standard, which, if achieved, could be regarded as achieving improved operations to the level of 'controlled dumping'. This is the second stage in the widely acknowledged four-stage development path from open dumping to full sanitary landfill operations.

The guidance presented was developed initially in response to a request from the UN Interim Administration in Kosovo (UNMIK). They sought advice from the WHO Regional Office for Europe on two issues: 1) to provide details on practical approaches, using locally available resources, to end uncontrolled open dumping; and 2) to specify and quantify what was meant by an improved, better-controlled land disposal operation.

The guidance is designed for decision-makers and technical personnel in public authorities, municipal waste organisations, regulatory bodies and waste contractors. The quantitative and measurable information given could form part of an engineering specification for contractors upgrading and converting open dumps to better operations where resources are only available at the present time for adopting intermediate level land disposal.
2. Common Waste Disposal Situation in Middle-and Lower-income countries: the Kosovo example

Solid waste management in Kosovo is considered to have distinct differences from other places in the Balkans. The amount and composition of, in particular, municipal and commercial waste is different from other countries with the similar economic situation. The presence of high quantities of packaging from reconstruction activities, re-equipping homes and the operations of international bodies is very obvious. New landfills alone are not the solution to follow a sustainable development.

Kosovo is part of Europe and many experts from other European countries, notably from the European Union (EU) member states, are assisting its reconstruction and development. There is broad agreement that the methods and standards required within the EU should be the guiding principles followed and applied in a sustainable step-by-step manner, in accordance with the economic development and ecological awareness of the population.

The EU regulations for sanitary landfill are very ambitious and their implementation is still incomplete in EU member states. Therefore, it is foreseen that sanitary landfilling will remain the longer-term goal and in the shorter term upgrading existing disposal sites into better operations will also be pursued.

Almost all waste disposals in Kosovo are by ‘open dumping’ to land. Each municipality operates one or more open dumpsites situated close to principal towns and are widely regarded as uncontrolled and unsafe operations. The municipal dumpsites are often poorly sited, on fire and operated by inexperienced or disinterested staff. Only a handful of these sites have access to bulldozers and each site should be either immediately closed or rehabilitated into better-managed operations. At present, there are only limited resources for upgrading or replacing these dumpsites and, equally, limited funds and technical competence to operate and maintain land disposal sites that have been upgraded.

Encouragingly, a GTZ team has demonstrated successfully at Pristina dumpsite what can be achieved if the limited available resources are used wisely to improve the site. These guidelines summarise the minimum, modest design and operational measures that are expected to be met when converting open dumps into ‘controlled dumpsites’ where they cannot be replaced immediately.

In parallel, UNMIK and the European Agency for Reconstruction (EAR) have announced recently an intention, as funds permit, to replace eventually the municipal dumpsites with landfills of a more ecological (instead of modern) type. A replacement programme of around two years is the time estimated to identify, design and construct new, regional ‘engineered landfills’ that approximate to the engineering standards generally recognised in the EU member states. It is unlikely sufficient resources will become available for the time being to develop and operate highly sophisticated ‘sanitary landfills’, such as those constructed in some higher-income countries.
Independently of UNMIK and the EAR it is known that a small, engineered landfill has been constructed with bilateral donor funds in Podujeva. Two further small, engineered landfills using bilateral donor funds are under development for Peja and Fushë Kosova. The engineered landfill in Peja will be completed and put into operation by February 2001 and the municipality will receive an additional six months of technical assistance in landfill operations from the donor.

In addition, Danida has rehabilitated a large, existing dumpsite in Mitrovica into an engineered landfill.

A GTZ team has investigated potential sites for new, engineered landfills in Prizren, Suharekë, Rahovec and Malisheva. Recommendations have been made to proceed with the new, engineered landfills in Prizren and Gjakova and to transfer the solid waste from Suharekë to Prizren and from Malisheva and Rahovec to Gjakova.
3. Philosophy of Incremental Improvements

The poor final disposal of solid waste (open dumping) is the most widespread form of waste disposal throughout the world. About three-quarters of the countries and territories around the world use this method of disposal. It thrives because of the mistaken belief that it is the easiest and cheapest disposal method to use in those countries with economies in difficulties or where there is insufficient political will to allocate adequate public resources to improve the prevailing disposal practices.

The deposition of wastes along roadsides and on riverbanks and on marginal lands and then ‘hoping’ it will go away is both naïve and dangerous. It is inevitable that chemical and biological contaminants in waste will pollute the surrounding natural environment and find their way back to humans to affect health, quality of life and working activities.

The traditional thinking in the minds of many waste managers whose municipalities practice open dumping is that it is acceptable because they cannot do anything else. This attitude is misplaced since there are many small improvements that can be made, often at little or no cost, which together can improve noticeably a land disposal operation. Many managers do not view a landfill as a site where productivity is important, even if scavengers operate at the site and are known to generate an income.

Commonly, using the staff, equipment and finance currently available in a different way can make improvements. The improvement of land disposal practices is a step-by-step approach. The approaches taken vary depending on local circumstances but all changes introduced should represent a progressive improvement over open dumping. It is best to identify those parts of the present land disposal operation that are unsafe or unsanitary and adopt ways to improve them using local materials and resources.

The principle of ‘keep it simple’ should be considered for each proposed improvement to an open dumpsite operation. It is often easier to introduce improvements when developing a new landfill but this is not possible when circumstances require an existing facility to be rehabilitated. However, any land disposal improvement should aim to improve one or more of four ‘basic conditions’ that define a better landfill:

1. **Permanent control** (relevant to new and rehabilitated sites)
   
   Sufficient numbers of trained and motivated staff should be based at the landfill to supervise and direct all preparations, site construction and waste placement operations, as well as regular maintenance and record keeping.

2. **Planned waste emplacement** (relevant to new and rehabilitated sites)
   
   Waste should be placed in layers and compacted as part of the emplacement procedure. It should not be dumped over a cliff-like working face. The waste should be deposited in only a small working area and covered daily with sufficient soil material to render it less accessible to pests or blown into the air by winds.

3. **Formal engineering preparations** (most relevant at new sites)
   
   Before receiving new waste for disposal all or some aspects of a better landfill should be constructed from engineering designs developed from local hydrogeological and topographical information. Once constructed, the site should be
operated according to a prepared ‘waste disposal plan’ (also known as a ‘tipping plan’).

4. **Full or partial hydrogeological isolation** (most relevant at new sites)
   It is not possible to isolate waste from the surrounding strata at existing sites. Therefore, the suitable approach is to minimise the working area for waste emplacement and reduce to a minimum the volume of water entering a site.

A site should be located preferably in a low permeability geological stratum to inhibit the migration of leachate off-site into an underlying aquifer. If this is not possible then additional materials could be brought to the site to reduce some of the permeability of the base of the landfill.

The immediate goal should be to meet, to the best extent possible with local materials, resources and finance, the four basic conditions for better landfilling, with a longer term goal to meet them eventually in full. The attainment of highly complex landfill design and construction is not immediately possible. Therefore, small incremental improvements in landfill design and operation over several years are more likely to be achievable than attempts to make a single, large leap in engineering expectations.

It has been argued that the upgrading of land disposal in any country or territory will go through four distinct stages. Each stage will take several years to become the established standard within the waste sector and each represents a significant improvement in safety and environmental impact over the previous stages:

**Stage 1 – Open dumping**
This is represented by the uncontrolled operations seen at the majority of dumpsites in middle and lower-income countries. No consideration has been given to the geological or topographical suitability of the site. Most likely, the location of the dumpsite was chosen because it was the cheapest land available that did not affect interest groups within the municipality. No preparatory earthworks or site engineering has taken place and almost no control is exercised over the site operations or the manner in which the waste is deposited. Fires, pests, unconstrained horizontal spread of the landfill surface and slope failures are commonplace.

*This is the present stage of landfill development found in many middle and lower-income countries and it widely recognised by government authorities that open dumping practices must be brought to an end.*

**Stage 2 – Controlled dumping**
A controlled dump is usually what can evolve quickly from an open dumpsite when it is rehabilitated. The main features of a controlled dumpsite are: to reduce the working area of the site to a smaller and more manageable size; slope and cover with soil exposed waste on unneeded parts of the site; prevent new fires from being started; construct simple measures to intercept surface water; and establish some rules of on-site work with site workers, drivers and scavengers (if the latter cannot be removed).

The purpose and advantages of these operational improvements is that they can be introduced quickly, need little or no additional investment and introduces the concept of ‘control’ and ‘isolation’ into the waste disposal operation.
This is the stage of landfill development that can be achieved in most middle and lower-income countries in the short term at the existing municipal open dumpsites.

**Stage 3 – Engineered landfill**

An engineered landfill is characterised as a disposal site where, through planning before construction or through modifications at an exiting site, there is a gradual and obvious adoption of engineering techniques to control one or more of the following:

- Control and avoidance of surface water entering the deposited wastes by installing a well designed and constructed surface drainage system
- Extraction and spreading of soil materials to cover wastes
- Spreading and compacting wastes into smaller layers
- Collection and removal of leachate away from wastes into lagoons or similar structures. The recycling of leachate back into the wastes should be considered
- Passive venting of landfill gas out of the wastes
- Improvements in the isolation of wastes from the surrounding geology
- New parts of the landfill are prepared before receiving wastes

A clear indication that a municipality has achieved this stage of landfilling is the routine development of detailed engineering designs prior to new landfills being developed. Also, the creation of detailed waste disposal plans showing how the site will be filled with waste and, subsequently, closed. This stage represents the longest transitional period in landfill development since it involves the gradual accumulation within a municipality of engineering expertise and operational experience.

*All new, large landfill sites that are developed should incorporate, wherever practicable, the engineering techniques in this stage of landfill development.*

**Stage 4 – Sanitary landfill**

The development of sanitary landfills, as recognised in high-income countries, involves the continuing refinement and increasing complexity in engineering design and construction techniques started in the engineered landfill stage. This can also involve a radical change in the operational practices at the site if the sanitary landfill is to be operated according to the flushing bioreactor or semi-aerobic concepts. Sanitary landfills typically have many additional features to those found on engineered landfills, for example:

- Pre-planned installation of landfill gas control and utilisation systems
- Extensive environmental monitoring and environmental protection obligations
- An organised and well-qualified work force
- Detailed record-keeping
- Where required, on-site leachate treatment as an additional feature to the leachate collection system
- Closed circuit television
- Wide range of specialised mechanical equipment used
- Complex, multi-layered lining systems to isolate waste from the surrounding geology.
It is recognised that the development and operation of a sanitary landfill in this ultimate stage of landfill development requires considerable capital investment and high operational costs. Many municipalities and territories are not able to achieve and sustain this stage of landfill development in the foreseeable future.

*It is recognised that the full development of sanitary landfills is a long-term goal since sufficient physical and financial resources are only likely to be available in a limited number of places over next few years to reach this standard of waste disposal.*
4. Open Dumpsite Rehabilitation Minimum Standards

The purpose of rehabilitating an existing open dumpsite is to convert it into a controlled dumpsite for the remaining duration of its operational lifetime.

The rehabilitation of an open dumpsite has three distinct stages of remedial activity: planning and designing the remedial works; undertaking the one-time physical improvements at the site; and changes to the subsequent operation at the site. A list of the minimum standards to be achieved by a rehabilitation contractor in each stage is presented in the following sub-sections. Any expected or intended deviations from the minimum standards should be discussed in advance with the appropriate local technical and municipal authorities.

4.1 Rehabilitation design

Minimum requirements have been set for the following preparatory aspects of the planning and design of open dumpsite remedial works.

Waste input rates

An estimate should be made of the approximate quantity of waste that a disposal site receives each day and the general types of wastes that arrive for disposal. Typically, the different waste types will include some or all of the following:

- Municipal solid waste (MSW)
- Healthcare waste (HCW)
- Sanitation waste (for example septic tank contents, night soil, sewage sludge)
- Construction and demolition waste (CDW) (sometimes known as building rubble)
- Market wastes (sometimes known as green waste)
- Slaughterhouse remains and animal carcasses
- Abandoned vehicles
- Large domestic items (bulky waste)
- Commercial waste (sometimes known as trade waste and would also include institutional waste from international organizations and military bases)
- Industrial waste (some of which may contain hazardous chemical compounds).

Waste input rates should be estimated. The simplest to measure and most useful at the beginning of a dump rehabilitation programme is the estimation of the waste volume received at the dumpsite during each day. This can be calculated by counting the trucks arriving at the site and approximating the volume of each incoming load.

Later, it may be possible to supplement volume estimates with weight estimates for incoming wastes. This is not essential at controlled dumpsites. It could be useful where weight-related disposal charges are to be levied and the fees received need to be accounted for. Waste input rates based on weight are expressed in tonnes per day assuming a 365-day working year. Where direct weighing of wastes is not necessary or practicable the weight of incoming wastes can be derived from one of the following approaches:

- Past records compiled by a waste enterprise
Sample vehicle weighing over a limited period using a publicly available weighbridge or portable weighing system
Vehicle counts and approximation of the volume and density of each incoming load
Estimation of local residential population and assume a daily waste generation per person. This approach is relevant for MSW and in a middle-income country an approximate per capita waste generation rate, based on other middle-income places, should be selected from the range 0.5 to 1.0 kg/person/day. Rural communities tend to have a lower per capita waste generation rate than urban ones.

Site survey
An open dump evolves in a haphazard way across a tract of land. Topographic and walkover site surveys are important requirements to address the following design issues:

- Topography of the existing landform created by the past open dumping of waste
- Topography of the surrounding landscape
- Preliminary inspection of actual or possible off-site pollution that poses a distinct threat to local communities
- Indication from observations, available records or local knowledge of the underlying geology and, if possible hydrogeology, at the site and possible sources of nearby soil cover material
- Derivation of the angles of existing landfill slopes and targeting of those that need stabilising
- Provision of basic mapping of the site upon which remedial earthworks can be planned, the final landform can be developed, the remaining air space volumes can be estimated and, subsequently, the likely remaining site lifetime can be estimated.

Site lifetime
An open dumpsite should not be converted to a more controlled operation if its estimated remaining lifetime is less than one year. Instead, effort should be directed towards identifying a new temporary, better-controlled disposal operation or the development of a larger engineered landfill with an estimated lifetime of more than ten years.

Slope stability
Over-steepened waste slopes should be identified for regrading and the quantity of waste to be moved estimated. Unless there are compelling local geotechnical reasons, in parts of the site not in use no waste side slope should be steeper than 1 in 3 (33% gradient) and top slopes should not be more than 1 in 20 (5% gradient).

Site access
Access to a disposal site from the highway is essential. As a minimum, the access road should permit the passing of two trucks travelling in either direction. Either a two-lane road or a one-lane road with passing places could achieve this depending on the quantity of waste received at the site (See Section 4.2 ‘Access Road’). The access road
should have a top surface that can be kept free from holes and not liable to become flooded by accumulated rainwater.

**Leachate accumulations**

If accumulated leachate is identified on the open dumpsite then a plan should be made to drain or pump the leachate into a prepared lagoon not liable to flooding or recirculated back into the waste. The source of the leachate should be determined and the remedial works defined to prevent leachate accumulations reoccurring in the future. The overall emphasis should be to minimise future leachate production rather than to create large leachate storage facilities.

**Landfill fires**

Open fires should not be allowed at a controlled land disposal site. Where fires exist at an open dumpsite, a plan should be prepared to extinguish them as the rehabilitation work progresses across the site. The method to be used for extinguishing fires should be presented in the plan.

The standard to be achieved is the extinguishing of all surface and shallow fires during the period of site conversion engineering works. Where a deep-seated fire may exist then this should be reported to the relevant technical and municipal authorities so that future site operations can be adjusted to avoid the problems such fires can cause.

**Soil cover**

A local decision has to be made if soil cover is needed. In many places it may not be necessary where the underlying waste has already degraded or contains high proportions of inert and immobile material. Compared to the benefits of a better-controlled operation and improved compaction of waste, soil cover is expensive and may not be that beneficial, especially if the dumpsite is located in a remote area. In a situation where dumpsite volume is limited, the use of soil cover implies less site volume will be available for waste disposal.

Where a decision is made to use cover material then the daily quantity of cover material required should be estimated. This cover could come from various sources: excavated soils from construction projects; unusable CDW that may arrive at the dumpsite; and soil material excavated from other areas (usually known as borrow areas). For the purposes of estimation of the volumes of cover material required each day and over the remaining estimated life of the site, the following minimum depths of cover material should be used.

A minimum of 5 cm depth of daily soil cover should be placed over deposited waste and preferably 15 cm if resources are available. Soils with a higher sand content are better for daily cover since they less liable to cause operating problems for vehicles compared to clayey soils in wet weather.

Intermediate soil cover should be used for areas of the site containing waste but not in use for at least the next three months. A minimum of 25 cm depth of intermediate soil cover should be placed over these areas of deposited waste and preferably 50 cm, if resources are available.
Final cover should be placed over all completed areas of the site containing waste with a sufficient slope in order to limit infiltration of rainwater (see the slope stability section above). A minimum depth of 50 cm of final soil cover should be placed over deposited waste and preferably 100 cm, if resources are available. Clayey soils are useful for final cover since they are better at limiting the infiltration of rainwater.

**Reception area**

A reception area should be clearly defined and of sufficient land area to allow incoming vehicles to be stopped and checked by landfill staff. The reception area should have an entrance gate or barrier to regulate the flow of vehicles on to and from the disposal site and a gatehouse to store waste records and documents and provide landfill staff with protection from unfavourable weather conditions. The reception area should have sufficient space for two trucks to be parked and not interfere with the vehicle movements in and out of the site.

**Fencing**

The provision of perimeter fencing is desirable but may not be practicable to install around all rehabilitated open dumpsites. The purpose of simple fencing is to delineate the boundary of a site and to discourage unauthorised vehicular access and straying animals. Simple fencing will not deter scavengers from entering a site. As a minimum requirement all open dumpsites within 0.5 km of communities should be fenced and elsewhere the perimeter either side of the site entrance should be fenced to a distance sufficient enough to prevent vehicles bypassing the official entry point to the site.

The minimum form of fencing to control vehicular access and larger animals should be a stake and wire strand fence or an excavated perimeter ditch and bund planted with fast growing hedge-forming shrubs.

**Scavenging**

Scavenging is the unofficial sorting through of wastes to remove useful items. Inevitably, scavenging is disruptive to controlled and safe land disposal operations. Ideally, it should not be allowed to take place but where difficult economic circumstances prevail it is not easy to eradicate from a disposal site. A policy to tolerate the presence of scavengers requires decisions to be made on how best to accommodate their activities without it interfering with the waste emplacement operations. A decision to eradicate scavenging will imply the need to install additional site security measures.

Where national or local authorities have no formal policy on this issue, it is left to each dumpsite operator to decide on the approach to be adopted on whether to tolerate scavenging or to discourage it.

Where scavenging is tolerated a minimum approach is to separate scavengers from the mechanical equipment emplacing waste. The usual approach is to set up a temporary scavenging area near to the waste emplacement area where trucks can discharge their loads. After the scavengers have finished searching the waste it is bulldozed to the emplacement area. At larger sites a permanent scavenging area, such as a raised platform, could be established and the remaining residues transferred to a truck or container below to be transported to the emplacement area. It is also common to arrange for families or groups of scavengers to be licensed to enter the dumpsite and...
collect one or more types of materials providing no others collect the same materials. The dumpsite should set out the rules that licensed scavengers must follow. These rules should include details on the:

1. Registration of scavengers and issuing and withdrawal of a scavenging licence
2. Powers of the dumpsite Disposal Site Manager and his staff to operate the disposal site
3. Allocation of space in the scavenging area and storage area for recovered materials
4. Frequency of removal of recovered materials from the dumpsite
5. Penalties for interfering with operations at the waste emplacement area and elsewhere on the dumpsite
6. Access to water, toilets, shelter and first aid
7. Times when scavenging is permitted and when it is not allowed.

**Mechanical equipment**

The preparations for dumpsite rehabilitation should include a list of the equipment to be provided to the improved site. Mechanical equipment serves three basic functions at a controlled land disposal site:

- Functions related to soil (excavation, handling, spreading and compaction)
- Functions related to wastes (spreading and compaction)
- Support functions (for example, maintenance of on-site haul roads, water clearance and drainage ditches and removal of trapped trucks from the landfill working area).

The number and type of equipment required will vary depending on the quantity of waste received each day and the resources available to maintain and operate the equipment. Where there are reasonably long distances between municipal open dumpsites, as a minimum, access to the following equipment is required at each site:

- One bulldozer of sufficient size to handle the daily quantity of waste arriving at the site to spread and compact waste and soil cover
- One tractor and trailer to carry soil to the working area and undertake some support activities
- A supply of spare parts and consumable items for the mechanical equipment
- A supply of hand tools including shovels, brooms, wheelbarrows and rakes.

Additional items that would improve further the operation of the dumpsite are:

- One water tank on a trailer (also known as a bowser) with a pump to carry leachate and spray water on roads to control dust
- If soil has to be brought from a borrow area, then a mechanical shovel will be required to excavate the soil cover. Alternatively, a mechanical shovel attachment could be provided for the tractor.

*All of the preparatory aspects of the planning and design of open dumpsite remedial works should be presented to the relevant technical and municipal authorities in a remediation report. This report should also contain a ‘waste disposal plan’ that explains*
how and where future incoming wastes will be deposited and the eventually final landform of the completed site (see also Section 4.3).

4.2 Engineering works

Minimum requirements have been set for the physical improvements involved in the conversion of an open dumpsite to a more controlled land disposal operation.

Slope stabilisation

Where unstable slopes exist these must be regraded before other remedial engineering works are undertaken at the site. A qualified civil engineer must supervise slope regrading and maintaining the safety of disposal site staff and contractors during this hazardous operation is of paramount importance. The slope stabilisation activities should seek to redistribute waste within the confines of the existing dumpsite and not extend the external boundaries of the site.

Extinguishing fires

All shallow and surface fires should be extinguished during the engineering works to convert the site to a controlled land disposal operation. The use of water to extinguish fires should be avoided. Isolation and rapid natural burnout or smothering with soil is preferred.

Area of exposed waste

All exposed and uncontrolled piles of waste should be flattened and compacted into layers. They may also be moved to other parts of the site if this facilitates the creation of the eventual final landform of the site. All uncovered areas of waste not expected to receive new deposits of waste, or at least not in the next few months, should be covered with an intermediate or final layer of soil material. A minimum of 25 cm depth of intermediate or 50 cm of final soil cover should be placed over deposited waste and preferably 50 and 100 cm, respectively, if resources are available.

The remaining area of exposed waste will form the initial working area for the emplacement of incoming waste. This area should not exceed 0.5 hectare for sites receiving up to 250 tonnes per day and one hectare at sites receiving 250 to 500 tonnes per day. Two hectares may be appropriate at large sites receiving well over 500 tonnes per day.

Site access

Roadside waste piles should be removed and the road upgraded to a sufficient standard to permit the easy passage of trucks carrying waste to the site. A minimum would be a one-lane access road with passing places for site receiving less than 250 tonnes per day and a two-lane road for sites with higher daily inputs of waste. At a site receiving over 250 tonnes per day but less than 500 tonnes per day is situated less than 0.5 km from the highway then a one-lane road with passing places may be acceptable if resources are not available to widen it to a two-lane road. If road congestion becomes unacceptable (for example, trucks block the highway trying to enter the access road) then it will become a priority to widen it to two lanes.
The running surface should be firm and not easily disrupted by traversing trucks. A minimum standard for the road surface is compacted earth or similar material with a top dressing of road stone. A durable, asphalt surface would be preferred if resources are available.

**Surface water drainage**

The prevention of surface water entering and accumulating within a land disposal operation is a continuing requirement throughout the life of a site. In topographical situations where surface water may enter the site from upslope areas then perimeter interception ditches (also known as cut-off or interception drains) should be excavated. As a minimum these should be unlined, earth ditches. The drainage ditches should discharge into a local watercourse or identified soakaway area down gradient of the disposal site.

The minimum size (depth and width) of these ditches should be based on similar ditches observed elsewhere in the vicinity of the dumpsite.

If topographic mapping and hydrological information is available then more accurate calculations on the size of the surface waste drainage ditches can be derived. Standard hydraulic calculations are dependent upon the gradient and surface area of the upslope catchments for surface water and the storm frequency chosen. Given the expected limited life of the rehabilitated dumpsites it is suggested that a once in five years return storm is used in the calculations to determine the size of the drainage ditches.

**Leachate management**

If leachate is found to be accumulating at the dumpsite then it should be controlled, together with drainage measures to minimise surface water creating large quantities of further leachate.

Where space and resources are available a leachate storage lagoon should be constructed. The storage capacity of the lagoon should be sufficient to contain all of the accumulated leachate for long enough to reduce its pollution impact to acceptable limits. The period of time necessary to retain leachate in a lagoon where no treatment is undertaken is not known precisely. As initial guidance a retention time of 7 to 14 days should be practical to engineer and the design of the lagoon should include an additional 25% reserve volume. The lagoon should retain a minimum depth of one metre of leachate to increase the potential for evaporation. The lagoon should have outflow drainage into a suitable watercourse via a weir not a manual sluice gate. The latter may be left open permanently.

**Staff training**

Well-managed operations can compensate for weaknesses in site location and design of a disposal site.

If staff are not trained or given clear, written job descriptions then it is not surprising that they show little interest or competence in operating an organised and well run waste disposal operation. It is also for site personnel to understand that with training and defined job descriptions comes the responsibility to perform properly the tasks they are given. Status, pay, employment contracts and working conditions also influence the
ability and willingness of individual members of staff to accept and carry out the responsibilities placed upon them. These personnel issues must be addressed during the rehabilitation of dumpsite but are outside the scope of these Guidelines.

The minimum level of staffing will vary depending on the quantity of waste received and the standard of disposal operation achieved. Suggested staffing arrangements for a site receiving between 250 and 500 tonnes per day are presented below:

- Disposal site manager with sufficient delegated authority to manage daily site activities and access to physical and financial resources to overcome day-to-day operational problems. The manager is also ultimately responsible to operate the site in accordance to the waste disposal plan prepared in the design stage.
- Gatekeeper/office clerk
- Security guards (if considered necessary)
- Traffic marshal directing trucks to discharge waste at the working face
- Mechanical equipment driver(s)
- Manual labourers
- Maintenance mechanic(s) if it is intended to establish a maintenance facility at the disposal site.

An example of a job description for a Disposal Site Manager is given in Appendix 1.

At the conclusion of the engineering modifications to develop a controlled land disposal operation details on the remedial works undertaken should be presented to the relevant technical and municipal authorities in an 'engineering report'.

4.3 Waste disposal operations

Minimum requirements have been set for the future running of the site as a controlled land disposal operation.

Waste disposal plan

A site should be operated in accordance to a waste disposal plan prepared during the rehabilitation design stage. It is appreciated that for the conversion of an open dumpsite to a more controlled operation there may be insufficient time or inadequate knowledge of the site to prepare a comprehensive waste disposal plan. As a minimum requirement a less detailed waste disposal plan should be prepared to provide clear instructions on the following topics related to site operation:

- Size and location of the first and subsequent sequence of areas to be filled with waste after the site has been rehabilitated, leading ultimately to the completion of the site and its final landform. Each waste emplacement area will have a unique reference number indicated on a scale drawing of the site
- Method of waste emplacement and soil covering to be used
- Structure, roles and responsibilities of the management and manual staff at the site
- Procedures for record keeping related to incoming vehicles, waste types and estimated quantities
Procedures for record keeping related to on-site mechanical equipment, other routine maintenance and accident and defects reporting
Traffic control at the site
Fire prevention and smoking rules
Maintenance and repair water drainage ditches
Future earthworks required for example, extension of surface water drainage ditches, removal of leachate accumulations, routine repair of access and site roads
Instructions for dealing with prohibited wastes that arrive at the site reception.

Further information on the minimum requirements for some of the topics to be addressed in a waste disposal plan is given below.

**Site reception activities**

At the site entrance all incoming loads will be registered and, as a minimum, the following details will be recorded for each load: date; time of arrival; vehicle identification number; vehicle owner; description of waste; estimated quantity of waste (weight or volume); waste emplacement area used.

The installation of a fixed weighbridge is not warranted where expected remaining lifetime for the rehabilitated open dumpsites is short (say, 2 to 3 years).

Conceivably, it might be desirable for larger sites (those serving more than 200 000 inhabitants) but only if they fulfil the following strict prerequisites: an estimated operational lifetime of more than 5 years; facilities and spares to maintain the weighbridge equipment in working order; and access to a regular electricity supply.

A waste disposal site should have a sign at the main entrance providing, as a minimum, the following details: name of site, opening days and hours, arrival instructions for drivers, no smoking markings and a short summary of important site rules.

**Waste emplacement and daily soil cover**

No vehicle driver should be allowed to choose where to deposit a waste load. The driver must be directed by the site entrance staff to the current waste emplacement area and discharge only at the location indicated by the traffic marshal at the working face.

The waste emplacement area should have no more than 0.5 hectare of exposed waste at any one time for a site receiving up to 250 tonnes per day (approximately 50 trucks or 30 trucks and 30 trailers) and one hectare at sites receiving over 250 tonnes per day.

A minimum of 5 cm depth of daily soil cover should be placed over deposited waste and preferably 15 cm if resources are available.

**Mechanical equipment maintenance**

A schedule should be prepared indicating the daily, weekly and periodic checks to be made on all mechanical equipment. Reporting forms should be provided and instructions issued on who is individually responsible for the checking of equipment, collation of forms and reporting to the municipality all maintenance requirements.
**Lighting**

The installation of sufficient portable, temporary or permanent lighting should be considered if nighttime working at the dumpsite is underway or planned to begin.

**Environmental monitoring requirements**

At a dumpsite it is extremely unlikely that any environmental monitoring has taken place in the past. Therefore there should be a presumption that the site produces leachate and that this has entered into the groundwater and, if leachate springs are observed, in surface watercourses too. The presence of leachate leaving the site cannot be reduced unless the quantity of the leachate contained with the deposited wastes (and hence the pressure it exerts) can be reduced. This is the purpose of good surface water management and if effective should reduce the rate of leachate release, providing no underground water springs are discharging undetected into the dumpsite.

The function of environmental monitoring at dumpsites should be clarified. Few resources are available for constructing new monitoring points and it is unclear what would be the practical use of environmental data from such monitoring points, given that for the time being the waste has no where else to go than the existing dumpsites.

Therefore, it is recommended that environmental protection or public health authorities undertake initially only surface observations and health protection monitoring. Surface observations would be:

1. To log the presence and distribution of surface discharges of leachate
2. To log the quality of the receiving watercourse and diversity of ecological indicator invertebrate and fish species
3. To check for the presence of vegetation die-back or discolouration around the dumpsite that may indicate lateral gas migration

Public health protection monitoring would be:

1. To monitor, through a public health agency, the water quality in drinking water wells located within a 500 m radius of the dumpsite. If drinking water of poor quality is detected then advice should be sought by the site operator from the public health authorities on how to improve the situation. The monitoring parameters would be those presented in regulations that apply in the country.
2. To monitor the quality of water being used for watering animals and irrigation within a 500 m radius of the site. If the water quality is unacceptable then alternative water supplies should be sought
3. To check for the presence of flammable concentrations of methane gas and asphyxiating concentrations of carbon dioxide gas in subsurface structures around houses and buildings, if vegetation die-back or discolouration extend from the dumpsite
4. To check for the presence of vectors (for example, rodents and insects) breeding on or near to the dumpsite. These could become a disease reservoir and if detected should be eliminated.
Prohibited wastes

The national or municipal authorities may, from time to time, make decisions to prohibit some wastes from being deposited in a controlled dumpsite. A procedure should be put in place at site entrance to intercept prohibited wastes, inform the relevant authorities and redirect the trucks to alternative disposal locations. A list of alternative locations must be provided to the landfill staff.

No wastes are prohibited at the present time from deposit at land disposal sites. However, contingency arrangements should be made with respect to the possible prohibition of the disposal to land of infectious healthcare waste, used motor oils, abandoned vehicles, some forms of construction and demolition wastes and chemical wastes designated as hazardous wastes.

Materials recovery and reuse

Two distinct areas away from where wastes are being emplaced should be designated for the storage of scrap metal for resale and the storage of construction and demolition wastes. This latter material could be either recycled for resale if the appropriate crushing equipment is available or used to construct temporary roads over the dumpsite.
5. New Temporary Controlled Dumpsite Minimum Standards

It is possible that new, controlled dumpsites may have to be constructed at some locations before resources are available to develop engineered landfills. As a minimum the guidelines specified in the preceding sections should be met at any new, controlled dumpsite.

In addition, at a new site there is a possibility to improve the standard of the hydrogeological isolation of the waste from the underlying geological strata and undertake better engineering preparations before waste is received. Consequently, the site selection procedures used for new, engineered landfills should be applied to new, temporary controlled dumpsites (see Rushbrook et al 1999).

It is presumed that more than one location will be considered before a decision is made where to locate a controlled dumpsite. It is also presumed that once waste is emplaced at the controlled dumpsite it will not be removed at a later date.

The selection of a location for a new disposal site has a considerable impact on the expenditure and complexity required developing it. A poorly chosen site will require considerably more expenditure than on waste transport, site development, site operations and environmental protection. As much effort as possible should be directed into identifying a site that has:

- A high degree of hydrogeological protection without the need for expensive ground improvements. An underlying clay stratum or similar low permeability soils are regarded as the best potential locations
- A topography that requires only modest civil engineering preparations to make it ready to receive wastes
- A location that is away from incompatible land uses in the nearby vicinity. These are also known as ‘exclusion criteria’.

A distinct list of exclusion criteria should be prepared for each municipality in order to take into account local circumstances. The list should include, but not necessarily be limited to, the following exclusion criteria:

1. A site lifetime of less than two years
2. Requires an access road more than 2 km from a highway
3. More than 10 km from the main urban area where waste is collected
4. On a flood plain or other area liable to flooding
5. In an area of steep slopes liable to landslips, mudflows or avalanches
6. On a groundwater recharge or surface water catchment area for drinking water supply systems
7. Within a military exclusion zone
8. Within 200 m of a village or residential area
9. Within 5 km of an airport runway in the direction of approach and take off
10. Within areas of former military activity where buried ordnance (for example, land mines) may be present
11. Within the exclusion zone for the microwave beam from a transmitter station
12. Within 100 m of a quarrying operation where blasting with explosives is undertaken
13. Areas known to contain collapsing soils or land liable to serious subsidence
14. Areas with seasonally high water tables
15. Geological areas that are heavily faulted and fractured or liable to mineral solution such as limestone and karstic rock formations
16. Wetlands and other areas of ecological significance
17. Within 200 m of historical, religious or other important cultural site or heritage.

It is unlikely that any one location will satisfy conveniently all of the exclusion criteria. Once each potential site has been screened using available data and maps, personal interviews, public comment and walkover surveys, a judgement will be necessary to decide the one that is most suitable. Some of the exclusion criteria may need to be relaxed but the overriding intention should be to identify a site that has as few disbenefits as possible, whilst being relatively easy to prepare to receive wastes.
6. Suggested Reference Sources

Additional detailed information can be obtained on the siting, design and operation of intermediate level land disposal sites in the following publications:


Appendix 1

Example of a Job Description for a Disposal Site Manager

The Disposal Site Manager will be responsible for the daily activities at a disposal site in accordance with general instructions received from a senior manager at the head office with responsibility for all disposal activities of the waste enterprise. The duties of the Disposal Site Manager will include:

- To ensure that the disposal site is operated in accordance with the waste disposal plan prepared for the site
- To be responsible for safety at the site
- To direct and supervise disposal site staff to control the admission of wastes, movements of vehicles within the site, emplacement of wastes in designated areas, compaction of wastes and, when appropriate, the covering of wastes
- To initiate procedures for the proper checking and maintenance of mechanical equipment and to ensuring its security at the site
- To arrange for the supply and stockpiling of cover material, when appropriate, at the site
- To direct and supervise all other activities at the site such as the control surface water, leachate management, site and access road repairs, environmental observations, windblown litter removal and activities of licensed scavengers
- To prepare daily and weekly activity reports and submit them to a senior manager
- To report promptly to a senior manager any developing problems in the areas of personnel, equipment, materials, waste inputs and public complaints.
Guidance on Minimum Approaches for Improvements to Existing Municipal Waste Dumpsites

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