بيروت، في _____

قرار رقم
المعايير والشروط الدنيا المتعلقة بعملية التخلّص النهائي من النفايات الصلبة

إن وزير البيئة،
بناء على المرسوم رقم 8376 تاريخ 2021/10/10 (تشكيل الحكومة)،
بناء على القانون رقم 216 تاريخ 1993/4/2 (إحداث وزارة البيئة)، لا سيما المادة الأولى منه،
بناء على القانون رقم 444 تاريخ 2002/7/29 (حماية البيئة)،
بناء على القانون رقم 690 تاريخ 2005/8/26 (تحديد مهام وزارة البيئة وتنظيمها)،
بناءً على القانون رقم 80 تاريخ 2018/10/10 (قانون الادارة المتكاملة للنفايات الصلبة)، لا سيّما المواد 23، 24-ا، 24-2ب منه،
وبعد استشارة مجلس شورى الدولة (الرأي رقم 2021/91-2022 تاريخ 2022/2/22، الرأي رقم 2023/61-2024 تاريخ 2024/1/23، الرأي رقم 2023/88-2024 تاريخ 2024/2/22)،

يقرّر ما يلي:

المادة 1 - تحديد المعايير والشروط الدنيا
تحدد المعايير والشروط الدنيا الواجب التقيّد بها بالنسبة لعملية التخلّص النهائي من النفايات الصلبة (بما فيه التحضير وطرق الطمر الصحي) وفق أحكام الملحق المرفق.

يتوجب على كل جهة تتولّى عملية التخلّص النهائي من النفايات الصلبة البلدية (بما فيه التحضير وطرق الطمر الصحي) اتخاذ الاجراءات الضرورية لوضع هذه المعايير والشروط الدنيا موضع التنفيذ.

المادة 2 - الملحق
يعتبر الملحق المرفق بهذا القرار جزءا لا يتجزأ منه.

المادة 3 - حق فرض معايير وشروط جديدة
تحتفظ وزارة البيئة بحق فرض معايير وشروط جديدة او تعديل اي منها عندما تدعو الحاجة.

المادة 4 - الغاء القرارات المخالفة
تلغى كافة القرارات المخالفة لأحكام هذا القرار او غير المتفقة مع مضمونه.

المادة 5 - نشر القرار والعمل به
ينشر هذا القرار ويعمل به فور نشره في الجريدة الرسمية ويبلّغ حيث تدعو الحاجة.

وزير البيئة
د. ناصر ياسين

Non-Hazardous Sanitary landfill operation guidelines

Contents

1 Introduction

This report provides a detailed overview of waste disposal practices in sanitary landfills according to international experience and good practices. Proper landfill operations are an essential service to ensure safe waste and residues disposal taking into consideration human health and safety as well as the protection of the environment. Landfill operation is a complicated and risky work that must be done carefully and under certain procedures to ensure the safe working conditions for landfill personnel and visitors.

The operational guidelines of this report are covering all the procedures and operations in a typical landfill. In any case, and in every different landfill site, these guidelines must be reviewed and updated taking into consideration the specific site's characteristics.

2 Accepted waste

Law Number 80 (Article 24, par.2) defines the different types of sanitary landfills based on the waste input received. According to this law, par. 2d sanitary landfills for non-hazardous waste (NHWSL) are accepting only non-hazardous solid waste of any origin and inert materials (in case of absence of dedicated sanitary landfills for inert waste – see par.2c).

3 Operational procedures

3.1 General Regulations

- The maximum speed for all vehicles inside the landfill area must be 30 km/hr. Traffic regulations for public roads will be valid also in the facility if no other specific guidance and/or traffic sign is in place.
- The staff of the facility shall secure the safe operation of the facility and carry out the necessary maintenance and urgent repairs of the machinery and equipment available.
- The staff of the facility is not allowed to carry out construction works on the site.
- External users (suppliers of waste) shall comply with the instructions and orders of the staff of the facility.
- The suppliers of waste shall accomplish their task and leave the site without any delay. Exemptions can be made only by the order of the staff of the facility.
- The fees for disposal of the waste received are calculated based on the weight, determined at the weighbridge.
- Scavenging and open fire is forbidden at the facility.
- Smoking, eating, and drinking are not allowed outside the designated premises.

3.2 Site records

Maintaining accurate and comprehensive records of landfill operations is essential for the management of any sanitary landfill.

An organised record keeping system should be a standard procedure that should be introduced at the earliest possible time and ideally before the beginning of landfill operation. Records must be registered in daily basis and must be kept safely both in soft and hard copy. Despite the fact that older and already operating landfill sites do not keep records, the establishment of a site record system is still a necessity. Records should be retained throughout the life of the facility, and for the closure and aftercare periods. Documents should be organised, legible, dated and signed by the authorized personnel and landfill's management.

It is recommended that, ideally, records keeping system must include the following:

- copies of all site appraisal and investigation documents, borehole logs etc;
- information and plans on the landfill design and the design of other structures on the site;
- copies of site rules for staff, visitors, contractors etc;
- waste acceptance procedures;
- documentation of inspection records, training and notification procedures;
- a detailed scheme for restoration and aftercare;
- site surveys and void space calculations;
- locations of all landfill gas, ground and surface water and leachate monitoring points, along with sampling protocols;
- environmental monitoring programmes;
- results and interpretation of the results of all environment monitoring;
- names, positions and qualifications of all staff involved in site design, management, engineering and environmental monitoring;
- records kept of quantity, nature and origin of waste accepted into the facility;
- site inspection records; in the case of difficult wastes (e.g. bulky waste, liquid waste, sludge etc.), details of the types and quantities accepted along with a site plan indicating their location;
- details of complaints and remedial actions;
- procedures and records as required regarding safety and health, accidents and fires;
- a copy of the site's planning permission,
- copies of all other official documents relating to the landfill including consents and other certificates.

3.3 General Description of the procedures in the Landfill

All incoming vehicles carrying waste shall pass through the main gate and on to the weighbridge for registration of the weight. At the weighbridge waste in open body trucks is visually inspected for acceptance or rejection and the waste declaration is checked. Incoming waste carried in compaction vehicles or in closed containers is inspected after unloading at the landfill cell for acceptance or rejection. Trucks delivering waste to the facility are not allowed to leave the facility before the delivered waste is accepted.

In case the delivered waste is rejected the waste shall be loaded back into the delivering truck, but if this is not possible, e.g. for compaction vehicles, the landfill staff must remove the incompatible waste and load it in a dedicated container that will exist on site for this reason. The rejected waste shall be transported to a disposal plant approved for that type of waste.

All costs connected with handling of rejected waste (i.e. loading, transportation and disposal) shall be paid by the transport company delivering the rejected waste.

All data on received and rejected waste shall be recorded in the weighbridge software. These data will indicate the type and composition of the incoming waste, quantity (in tons), the origin of the waste (i.e. the producer of the waste) and the waste delivery papers.

3.4 Reception

Incoming traffic enters at the main entrance of the Site and proceeds to the weighbridge. Procedures for receiving vehicles at the weighbridge are as follows:

- Vehicles drive onto weighbridge scale and stop
- The Weighbridge Operator records the date and time, account number (this will reference the waste origin/hauler), waste type, gross vehicle weight, tare weight and the net weight of solid waste in the computer.
- Vehicles are directed either to the incoming loads sampling area or to the active working area of the cell
- At the end of each day the Weighbridge Operator generates a report showing the total tonnage received and the waste origin. The weighbridge computer database allows a number of reports to be generated depending on the nature of the information required in the report.

3.4.1 Waste acceptable for reception at the facility

During the reception procedures the Operator shall ensure, that only waste, which can be accepted at the landfill is admitted and that the waste is controlled and registered before admittance. Prohibited wastes (e.g. hazardous waste, liquid waste etc.) are to be rejected.

The facility can receive only solid waste as listed in paragraph 2**.** The waste must be in a form ready for disposal.

In order to provide efficient operation of the facility the Operator can impose further restrictions with regard to

- the condition and composition of waste
- waste packaging
- preliminary treatment, e.g. sorting

3.4.2 Permission for disposal

Only wastes from waste producers, who have a valid permission for disposal, are accepted.

Together with the first delivery the waste producer must submit an application for delivery of waste to the facility. The application shall state the following data:

- Full name of the organization/company
- Address
- Telephone number
- Managers' names.
- Registration number/code of the truck(s) to be used for delivery of waste to the facility.
- Types of waste to be delivered
- Documentation for the waste disposal approval licensed by the Municipality

After the first delivery the waste producer receives the following documents for admissible waste:

- A registration card containing Client No, which will define the registered names, address, telephone- and truck registration number(s).
- Waste declaration, which specifies the types of waste that the waste producer, is allowed to deliver to the facility.
- Waste collection companies must obtain similar registration cards for each of their collection trucks at the first delivery of waste to the facility.

3.4.3 Non-Conforming Waste Consignments

Non-conforming waste consignments arriving at a waste disposal site may be identified at:

* Site reception;
* Weighbridge;
* Waste inspection facility; and
* Disposal face.

Non-conformances may be due to the documentation being incorrect, insufficient, or inaccurate, or due to the waste not conforming to the documentation, the waste management license, or other legal requirements. The site's management team should compile a written procedure detailing how to deal with nonconforming wastes. All site personnel should be aware of the chain of reporting and the actions to be taken. An area should be set aside for vehicles to be held, pending a decision regarding their future. The regulatory authority should be contacted to provide advice regarding whether the load can be accepted or whether it should be recognized to another location.

In the case of the delivery of large quantities of waste, the facility must be informed in advance. The facility determines the time for the delivery.

3.4.4 Exclusion of waste suppliers

The Landfill Manager can deny suppliers to use the facility if the suppliers intentionally deliver inadmissible waste or repeatedly violates the landfill regulations.

3.4.5 Reception of Waste in Small Vehicles or Private Cars

Private individuals can deliver waste for disposal at the landfill by their transport without prior agreement. The Landfill Operator must direct the relevant vehicles in the incoming loads sampling area for load control.

3.4.6 Control of incoming waste

All waste delivered to the facility shall be controlled by the landfill operator. The control comprises:

- Registration of the waste transportation truck and the waste producer.
- Weighing and registration of the waste.
- Control of delivery documents (i.e. declaration and registration card).
- Direct visual control of the waste for type and composition for compliance of waste type with documentation.
- Waste delivered in open trucks shall be inspected visually at the reception area in connection with the weighing procedure and after unloading in the landfill cell. Waste delivered in closed trucks shall be visually inspected at the landfill cell after unloading and before the waste is compacted and covered.

All information is recorded in the data system, stored and secured.

3.4.7 Registration

Records of all data concerning reception and transport of waste to and from the landfill are registered in the software data system connected to the weighbridge. The operator of the weighbridge and registration system is responsible for the input to the data system of all relevant data for each incoming truck, for each shipment of waste leaving the landfill or being rejected at the gate. Input data will consist of:

- Date and time for the arrival of the delivery to the landfill.
- Data regarding the waste supplier:
    - Full name of the company.
    - Address.
    - Telephone number.
    - Managers' names.
    - Registration number/code of the truck.

Companies delivering waste on a regular basis will receive a registration card as described previously. The above data is encoded in the card and will automatically be recorded in the computer system.

The waste producer and the origin of the waste as stated in the waste delivery papers

If the waste is delivered in trucks that have no registration card the above-mentioned data shall be recorded manually.

3.4.8 Weighing and registration of the waste

All incoming and outgoing trucks carrying waste shall pass over the weighbridge and be weighed and registered. Data from the weighing procedure (including data for rejected waste and waste transported from the landfill) shall be recorded in the data system.

Persons specifically trained in its use shall operate the systems. A special instruction manual for operating the data recording system will be prepared for the staff by the supplier of the weighing system/software.

The manufacturers' operation manuals for the individual units shall be adhered to strictly.

Each weighing procedure shall as a minimum comprise:

- Truck registration number
- Owner of the truck
- Waste origin/producer
- Waste type
- Weight of the waste.
- Acceptance/non-acceptance of the waste at the landfill
- The place - Cell no - of disposal of each load.

Data from each weighing procedure shall be recorded in a database. At the end of each day a back-up copy of the weighing of the day shall be produced on an external storage unit i.e. USB flash drive, compact disc (CD) etc.. The back-up files shall be stored in the Administrative Building.

Not later than by the end of each month the records of the month are printed and inserted in the site recordkeeping file kept by the Site Manager of the landfill.

3.4.9 Rejection of Waste

If the control shows that the waste is not in compliance with the types of waste permitted to be disposed at the landfill, then the waste shall be rejected.

- If the waste is still on the delivery truck, the driver will be required to return the waste to the producer of the waste. The waste producer can then perform a pre-treatment (e.g. sorting) in order to bring the waste into compliance with the types of waste for which he has an approved declaration and which will allow the landfill to receive the treated waste.

- If the waste is already unloaded at the landfill cell, but not yet compacted and covered, the waste shall be loaded back into the truck and returned to the waste producer at his expense.
- In case it is not possible to re-load the waste into the truck (e.g. when the waste has been delivered in closed or compacting trucks) the waste will then be loaded into an open container and returned to the waste producer or the transporting company at his expense.

If more detailed analysis of the waste is required before final acceptance or rejection, the waste load temporarily rejected and is returned to its producer for storage until final decision can be made.

All cases of temporary and final rejection for waste reception must be registered in the site record keeping file.

For all incidents where a delivery is rejected, the Site Manager must issue a violation statement and inform the competent authorities.

3.4.10 Waste Supplier Departing the Facility

For conforming waste the truck driver will receive a confirmation of the delivery. The receipt documents will indicate the basic delivery data, the delivered quantity (tons) and the fee for receiving the waste at the facility.

Fees are calculated automatically by the data system.

All vehicles departing the landfill area shall be inspected and cleaned in the wheel washing facility.

3.5 Waste Transport at the Landfill

3.5.1 Traffic

After control and registration at the entrance the operator of the weighing bridge directs the driver of the truck to the landfill cell for unloading of the waste.

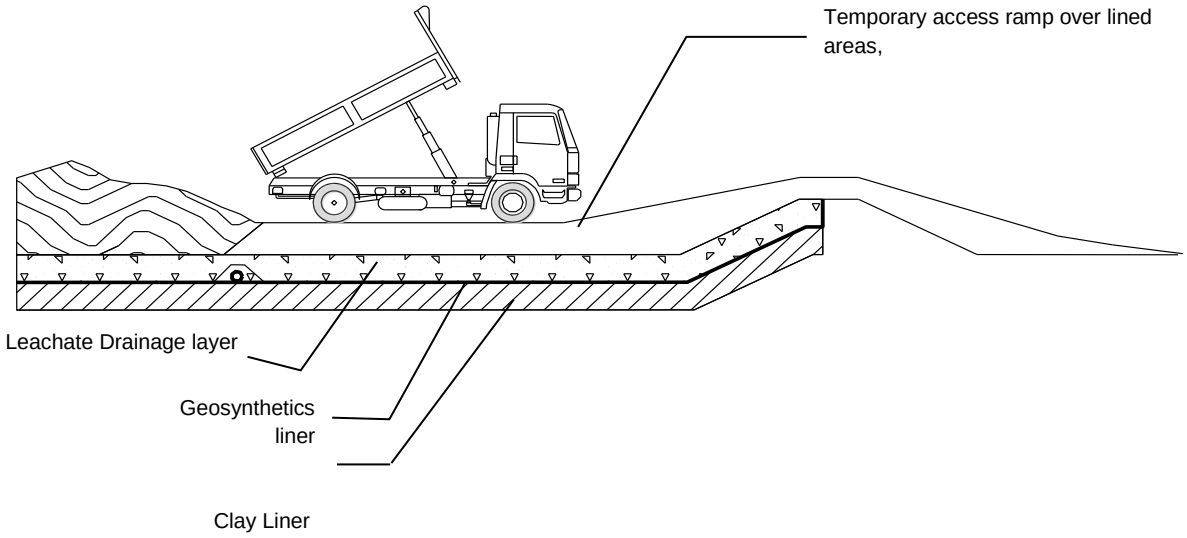
The common Traffic Regulations are valid inside the facility area. The speed limit for all vehicles is 30 km/h maximum.

In order to ensure a safe transportation of the waste at the facility all displayed traffic signs shall be observed. This applies whether it is a signboard or signage on the road surface.

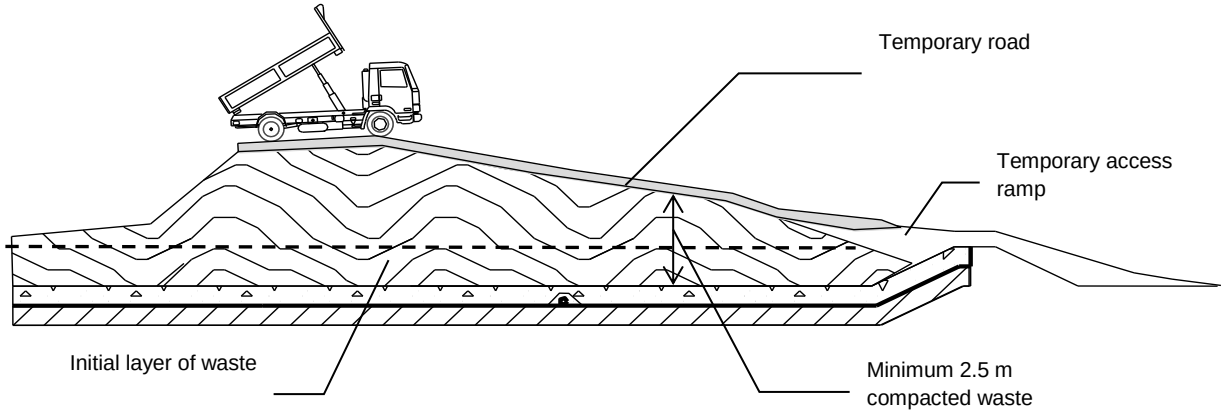
The truck drivers shall at all times comply with requests and directions given by the receiving staff.

3.5.2 Temporary roads

No traffic is allowed directly on top of drainage layer in the landfill cells. The landfill staff shall establish and maintain access ramps and temporary roads over the drainage layer with a min. thickness of 1 m above drainage layer and/or leachate collection pipes.



The landfill staff shall establish and maintain access ramps and temporary roads over the already deposited waste inside the landfill cells, securing the safe access of waste delivery trucks for unloading in the cells. The roads can be established using gravel and/or stone, crushed mineral debris from construction and demolition waste. The thickness of compacted waste below the temporary roads shall be at least 2.5 m.



3.6 Unloading and Control

When the delivery truck arrives at the landfill cell the spotter points out to the driver the exact location for unloading the waste.

After unloading at the appointed position, the bulldozer spreads the waste and the driver together with the spotter visually inspect the waste for compliance with the waste type and composition, which is acceptable in the landfill cell. The delivery truck is not allowed to leave the landfill cell before the waste has been finally accepted or rejected.

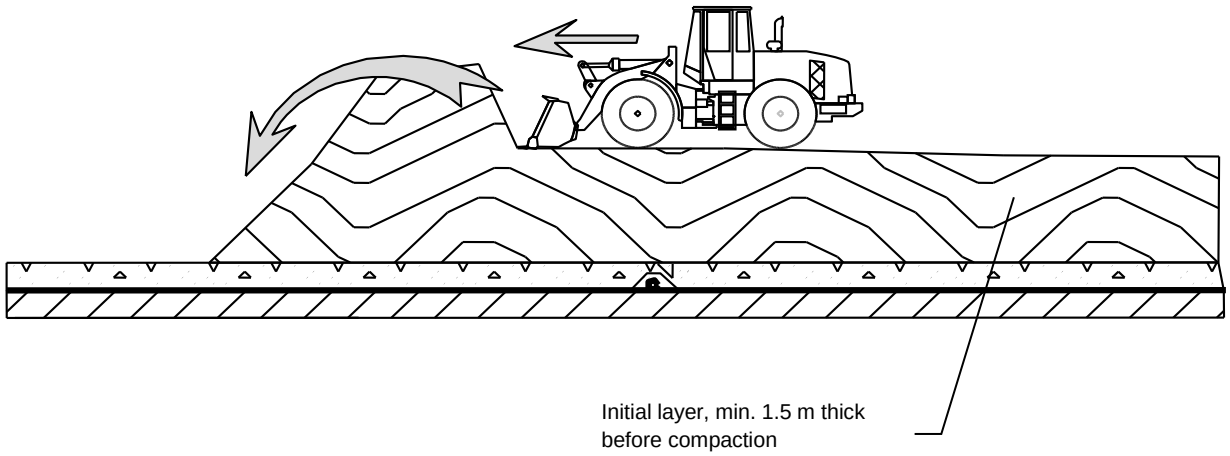
In case the waste is rejected the waste shall be loaded back into the truck and the truck driver shall be instructed to return to the waste producer.

In case it is not possible to re-load the waste into the truck (e.g. when the waste has been delivered in closed or compacting trucks) the waste will then be loaded into an open container and be returned to the waste producer.

3.7 Compaction of the Waste

3.7.1 General - disposal of the first layer of waste

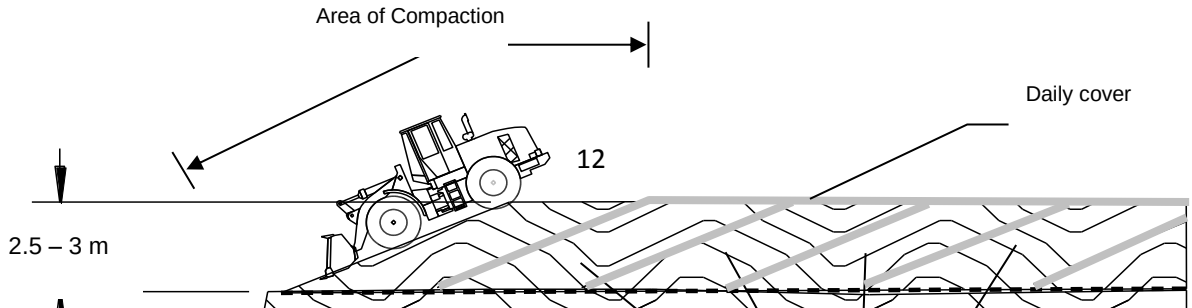
Neither the landfill compactor nor any other vehicles are under any circumstances allowed to drive directly on the drainage layer at the bottom or inner slopes of the landfill cells, as this may cause damage to the drainage pipes or the polymer liner. Therefore an initial layer of mainly fine grained waste without large objects (min. thickness of 1 m), hard or sharp objects, which could perforate the membrane shall be placed before any compaction of the waste takes place. Nor may the initial layer contain sludge or liquid waste. The initial layer is installed using a bulldozer or the compactor to position the waste by "over-rolling" - not pushing -in to a single layer of approx. 1.5 m height before compaction.



After the initial layer has been placed concurrent layers are installed using the compactor or a bulldozer to push the unloaded waste to its final position in the landfill cell and spread it to a layer no more than 0.6 m in thickness. The waste is crushed and compacted by 3-5 passes by the landfill compactor. Larger objects in the waste may require additional passes to be crushed adequately.

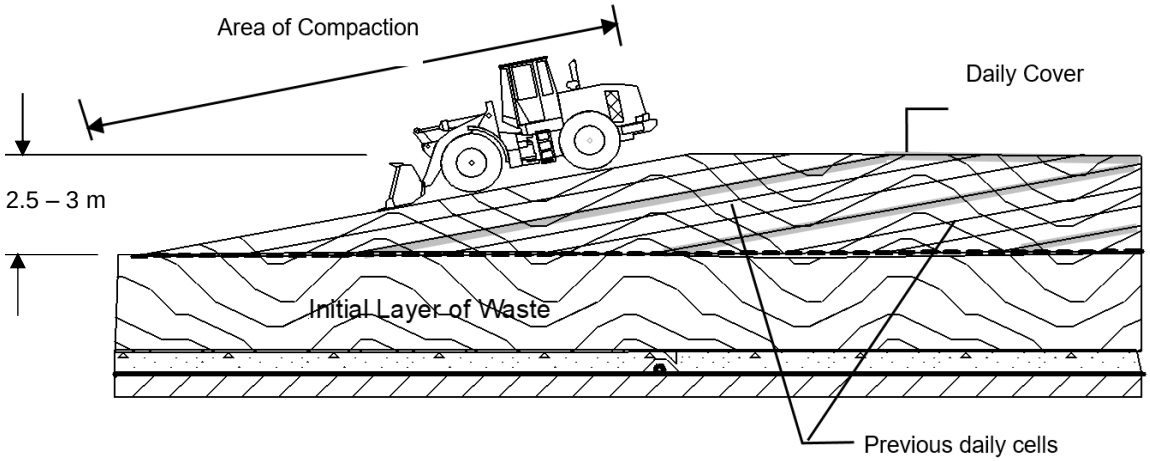
The compacted waste layers are installed with a sloping face to promote surface water runoff and to minimize the total open area of uncovered waste during operation. The installation shall follow the techniques portrayed diagrammatically below.

3.7.2 Face tipping:



The waste is tipped out and compacted into benches. The bench continues level across the cell for a period of days or weeks until the cell is filled in its full width. The height of the cell is 2.5 - 3 m, and the compactor is working down the face of the cell as well as along the surface of the bench.

3.7.3 Onion Skin Tipping:

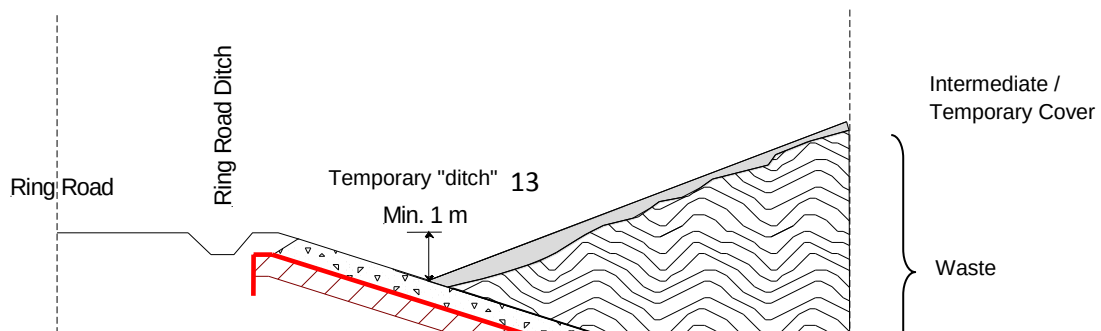


The gradient of the face slope is considerably shallower than for the Face Tipping method, and the compactor operates solely on the face. This method generally results in higher compaction degree of the waste and reduces the risks for litter being blown of the face by the wind.

3.7.4 Counteracting seepage and overflow

Irrespective of the chosen installation technique, the Landfill Manager shall ensure, that neither during filling of the landfill cells, nor after installation of intermediate, temporary or final cover may overflow or seepage of leachate occur, that results in leachate flowing to the surroundings.

Until the top cover system has been installed a temporary ditch shape shall be maintained between the deposited waste and the side of the dike along the surrounding dike and the ring road, see the below illustration:



Each lift of waste shall be installed and compacted with a slight gradient of the near-horizontal surface towards the central part of the landfill cell. This will reduce the risks for leachate inside the waste body to move horizontally towards the outer slopes of the deposited waste and consequently reduce the risks for seepage through the cover system.

3.7.5 Special measures

The operators of any machinery operating in the landfill cells shall pay special attention not to cause damages to inspection wells, gas collection wells or other structures inside the landfill cell. The compactor and other vehicles may not operate within a 2.0 m distance from these structures.

3.8 Disposal of difficult loads

Certain wastes may not fall within the criteria of a hazardous waste. However, they may fall into the category of being a "difficult waste" for the reason that their properties require special arrangements for disposal to landfill. Usually, this means that they cannot be placed with other materials on the working face and compacted alongside other refuse.

Wastes consisting wholly or mainly of animal or fish waste, condemned food, sewage sludge and other obnoxious materials all fall within this category. Other examples of difficult waste include light materials such as polystyrene and dusty wastes. Liquid wastes may arise which can be disposed of to landfill, provided that the quantities deposited are small and that they are of a low hazard.

Examples of low hazard liquids include cement bearing liquids from concrete production facilities and out of specification foodstuffs such as fruit juice

Whether a site should receive difficult wastes is mainly a matter for the operator, but will need to take in account the suitability of both the waste and the site and also be in compliance with any conditions of the waste licence.

Difficult wastes should not normally be deposited directly with other wastes in the working area. Instead they should be placed in front of the working face and immediately covered with other waste. Any obnoxious material should not be located within one metre of the surface or two metres from the flanks or face. Alternatively, disposal in an area of already filled material may need to be considered.

In the case of the disposal of smelly, pumpable liquid wastes, a trench excavated in old refuse can be backfilled with coarse rubble and covered

Dusty waste may need to be delivered in sealed bags. Alternatively, this waste should be sprayed with water.

Additionally, it is a common phenomenon to collect small hazardous waste with the household waste. The first measure to take in this case is to inform citizens regarding the types of waste they can drop in the household waste collection bins.

In case, however, such waste is observed during unloading a load of waste in the landfill, then this kind of waste should be removed manually (using a shovel or the loader if it is for example a large container), and dispose it in a dedicated container, placed nearby.

3.9 Daily and Intermediate Cover

3.9.1 Daily cover

At the end of each working day the working face of the waste shall be covered with free-draining soil or other suitable inert and permeable material, e.g. crushed construction and demolition wastes. The implementation of a daily cover decreases the risks for fires and odours, for windblown litter, and impedes the access for vectors to the waste. When resuming operations the following day, the daily cover is, to the extent possible, scraped off for subsequent reuse.

The daily cover shall be at least 10-15 cm thick in order to cover the waste adequately. Low permeability soils shall be avoided as they can negatively affect leachate transport inside the waste body.

3.9.2 Intermediate Cover:

Intermediate cover is used when filled surfaces are likely to be left for a period of weeks or months before additional lifts of waste are to be added. The cover significantly reduces rainfall infiltration, whilst it effectively reduces the risks for windblown litter. Intermediate cover materials shall be materials as used for daily cover.

The thickness of the intermediate cover shall be 30-50 cm. The area covered by an intermediate cover shall be inspected regularly and as minimum after any heavy rainstorms in order to detect and repair any defects in the cover caused by e.g. erosion.

When resuming operations in the area subject to intermediate cover, the daily cover is, to the extent possible, scraped off for subsequent reuse.

3.10 Temporary Cover and Top Cover System

3.10.1 Temporary Cover

The utilisation of a temporary cover reduces the area of exposed waste and thus diminishes negative visual impacts and reduces leachate generation. The temporary cover is used when filled surfaces are likely to be left for a period of 1 year or more. Further the temporary cover is used to cover the waste in the period of time between the final filling height being reached and the final top cover system being established. Materials used for the temporary cover shall be low-permeable - but not impermeable - soils.

The thickness of the temporary cover shall be approx. 50 cm or more. In order to protect the surfaces from erosion and to reduce the risks for drift of dust from the surface, a thin layer of topsoil is applied and seeded using grass and herbs with strong root systems.

In areas where filling operations are resumed at a later stage and prior to installation of the final top cover system, the temporary cover is scraped off for subsequent reuse.

The temporary cover shall be inspected regularly and as minimum after any heavy rainstorms in order to detect and repair any defects in the cover caused by e.g. erosion.

3.10.2 Top Cover System

The top cover system acts as a barrier between the waste and the surrounding environment and reduces the amount of rainwater infiltrating the landfill body and herewith reduces the leachate generation.

The top cover system shall be installed in phases concurrently with stages of the landfill reaching their final filling height. It is recommended, that the task of installing the system is undertaken by a contractor under the supervision of an experienced engineer.

The top cover shall be inspected regularly and as minimum after any heavy rainstorms or snow melting in order to detect and repair any defects in the cover caused by e.g. erosion, sliding, etc.

3.11 Leachate Management System

Leachate management in a sanitary landfill includes the operation of the following units:

- Leachate drainage system (drainage layer and leachate collection pipes at the bottom of the landfill cells)
- Inspection and collection shafts and sumps.
- Leachate pumps.
- Leachate transportation pipes.
- Leachate treatment facility.

During normal operation and provided that the leachate management system has been designed and constructed properly, the relevant equipment and piping is totally self-reliant requiring no input by the site personnel. In any case, the leachate management system must be maintained and cleaned according the guidelines provided in paragraph 4.9 and the instructions of the equipment suppliers/manufacturers.

3.12 Landfill Gas Management

3.12.1 General

The emission of landfill gas is controlled by the operation of the landfill gas management system. The landfill gas management is installed and operating either during the operation of the landfill cell or by drilling at the end of the cell's completion.

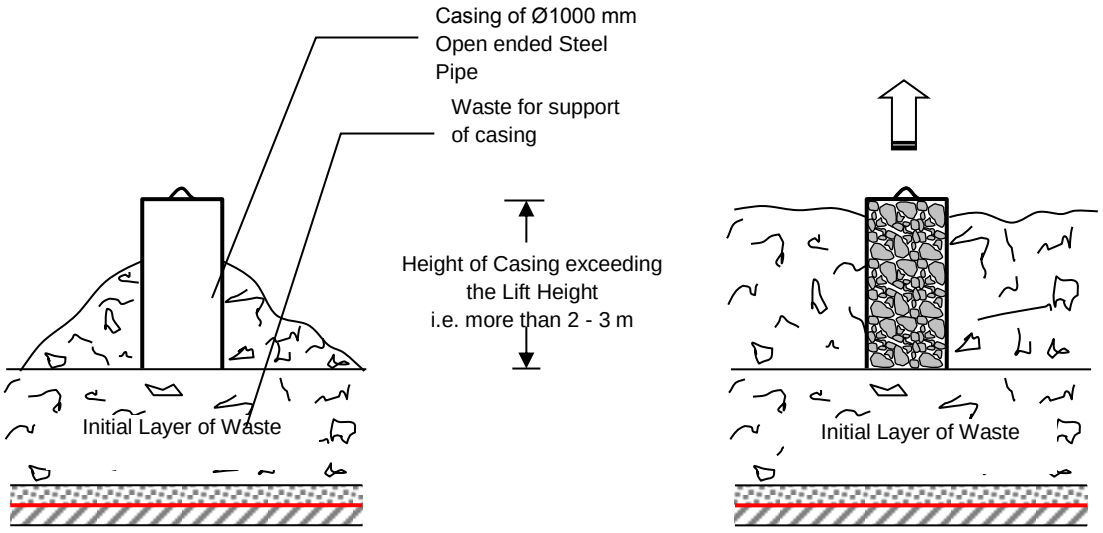
When installed and running at a stable level the gas management system is in principle self-reliant. In order to secure the most efficient gas control it is however necessary, that the Operator of the landfill monitors and adjusts the system on a regular basis.

3.12.2 Landfill gas Collection Wells

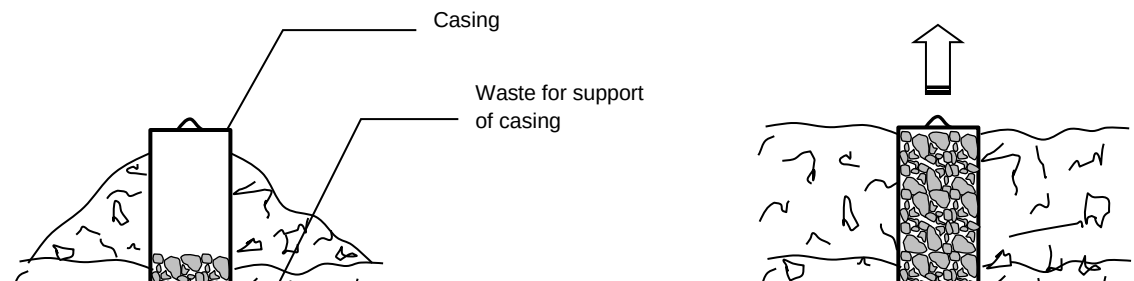
Depending on the landfill design and the landfill development plan, the gas collection wells are constructed either during the operation of the landfill cell or by drilling at the end of the cell's completion. In the first case, landfill gas wells are erected concurrently with the waste volume and after installation of the initial layer of waste at the bottom of the landfill cells. The collection wells should be constructed 2m above the bottom of the landfill cells. The wells shall be established using coarse grained gravel and stones or crushed mineral debris from construction and demolition wastes installed as vertical "chimneys" through the waste body. Installation takes place using a steel tube as casing as described in the following:

The open ended pipe casing is positioned vertically at the surface of the initial layer of waste using the compactor or equivalent machinery, lifting the casing by chains attached to handles welded to the casing. The casing shall be stabilised, e.g. with waste positioned up to the casing.

When the filling of waste reaches the lift height the casing is filled with the gas drain material. The drainage material shall not be compacted as this may impede the extraction of the casing without dislocation of the drainage material.



The casing is lifted corresponding to the height of the next lift of waste, again using chains and the compactor or equivalently suitable machinery. The operations above are then repeated for each lift of the waste up to the last lift before reaching the final filling height in the landfill cell.



In the final lift the vertical gas collection pipe in the centre of the well is installed inside the casing before filling the casing. When the final filling height has been reached the casing shall be removed in which process special care shall be exercised securing, that the vertical collection pipe is not damaged or dislocated.

When the final top cover system has been installed, see the below operations, then the remaining components of the gas collection well shall be installed, according to the landfill design. The initial adjustments of the collection system shall be performed in accordance with the operation instructions given by the supplier of the landfill gas disposal unit i.e. flare or landfill gas exploitation plant.

During the initial operation of the gas collection system it may prove necessary to install additional gas collection wells in order to control gas emissions from the landfill. These can be established by drilling or by excavation from the top of the final landfill body.

The composition of the gas and the pressure inside the wells vary from well to well and over time for the individual well. Each well must be adjusted individually at start-up of operation, and it is further necessary to monitor end adjust the wells later during the operation.

In order to adjust a gas well, it is necessary to know 3 parameters:

- The landfill gas flow and pressure in the well
- The methane content (CH_4)
- The oxygen content (O_2).

3.13 Sludge disposal

Sludge disposal in sanitary landfills, must be executed with great attention and under certain procedures. Sludge produced in a wastewater treatment plant is characterized by big moisture content (usually higher than 70%) which makes waste disposal activities much more complicated and can cause several hazards when disposed of in a landfill like unstable waste volume, increased

leachate volumes etc. For this reason, only dewatered sludge from wastewater treatment plants is allowed to be disposed of in sanitary landfills. The required quality for sludge disposal is that the Total Solid (TS) concentration in the sludge must be more than 50%.

Even in the case of achieving the acceptable water content, dewatered sludge must be managed in certain procedures during waste disposal operation. The most important rule is that it must be always disposed of together with solid waste. The water holding capacity of the solid waste is relatively high. Therefore, a mixed deposit of waste and dewatered sludge is an economically feasible sludge disposal method that eliminates the potential hazards of sludge disposal.

Some guidelines and options for waste and sludge disposal are described below: (see also figures):

1. An important rule for co-disposal is that during the management of the materials on site the appropriate coherence must be ensured so that the mechanical equipment can operate properly and compacts the waste and the sludge in an optimal way.

2. The sludge must be deposited only after a surface layer of solid waste at least 3 meters thick has been formed. Successive deposition of sludge layers should be avoided.

There are two basic disposal techniques, which are applied depending on how the sludge is mixed with the solid waste in a landfill:

1. Mixed deposit: In this case mixing of sludge and solid waste takes place before disposal

2. Deposit in levels. In two or three levels. In this case, the sludge to solid waste ratio is limited to 10% (per volume). In this case, the daily cell building method can be chosen freely since the sludge/solid waste mix can be compacted properly (see Figure 3). Some of the options may be:

- Spreading and compacting by creating different levels of sludge/solid waste mix (see Figure 1)
- Spreading and compacting on one level, by rejecting the sludge before the daily cell working face, so that by spreading waste, sludge is carried away with solid waste, mixing these two materials (see Figure 2).

Based on the above, a proper way of mixing sludge with waste can be achieved and potential operational and health and safety problems in the landfill site can be avoided.

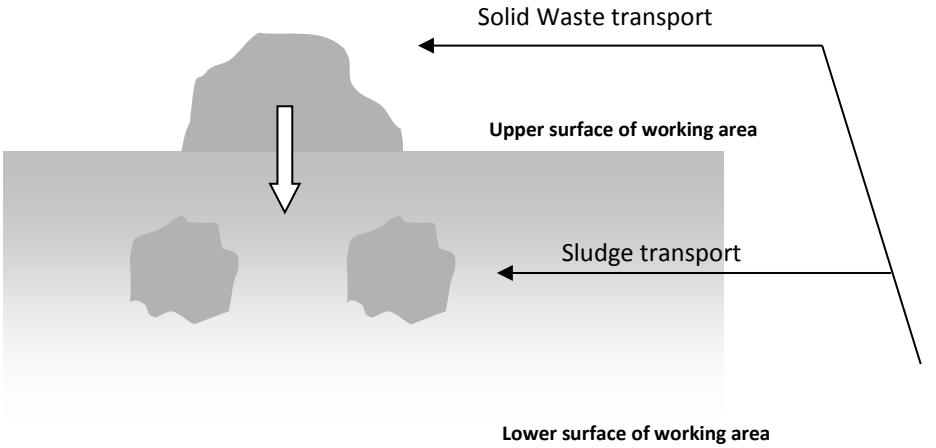


Figure 1: Deposit in different levels of sludge and waste mix

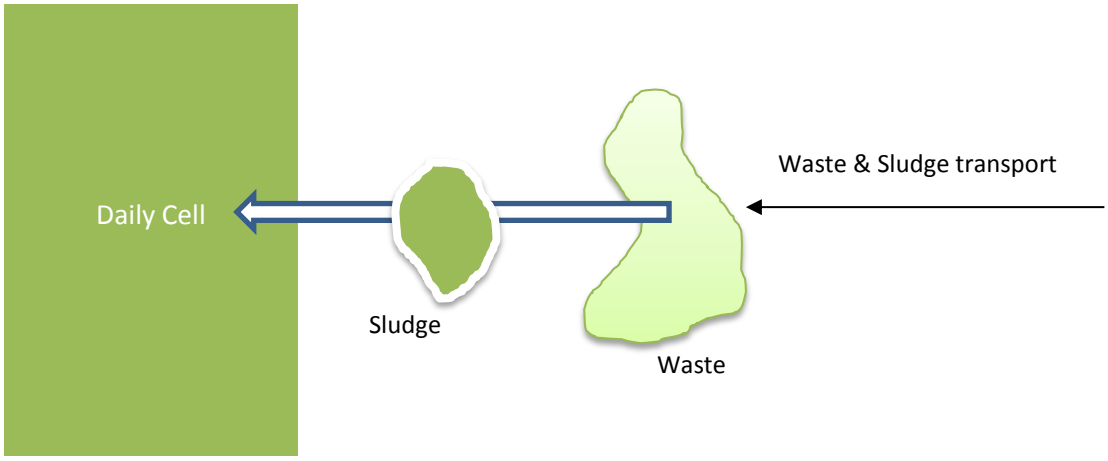


Figure 2: In situ mixing and disposal on one level

3.14 Measures for Reduction of Nuisances

A key item in the effective management and control of landfill operations is the control of nuisances. Unless an operator effectively addresses nuisance related matters on a daily basis, a landfill may become undesired and annoying to local community. Factors such as litter and odour have contributed to the poor reputation of landfill in the past.

The potential impacts of landfill operations on local communities should be considered at the planning stage and mainly in the EIA. In the operating phase all complaints should be recorded, registered and investigated. It is good practice to contact complainants to ascertain the nature and source of the problem so that corrective measures can be taken at the site.

Nuisances which may cause concerns include:

- dust.
- odours;
- litter;
- vermin, insects and other pests;
- birds;
- noise; and
- fires

These potential impacts should be addressed by clear operating procedures with a view to their minimisation. The following sections set out a range of actions available to mitigate the above nuisances

3.14.1 Odour

Offensive odours may arise from:

- Digging activities in previously deposited waste
- Handling of malodorous wastes, e.g. sewage sludge.
- Arial spraying (re-circulation) of leachate, open leachate lagoons or containers
- Emission of landfill gas

The principal means of minimising landfill odours include:

- Effective compaction
- Provision of adequate cover especially the daily cover
- Immediate deposition and covering of especially malodorous wastes
- Effective gas collection and treatment system
- Immediate deposition and covering of excavated wastes
- Prevention of stored leachate becoming anaerobic

3.14.2 Dust

Dust is a very often problem in all landfills (especially during summer). In addition, localised difficulties may be created by the disposal of dusty wastes. The emission of dusts may be mitigated by using water sprays. The surfacing of access roads with materials such as concrete and tarmac allows mechanical sweeping, which in itself can be used to removed deposited materials prior to the creation of dust problems on drying.

Emission of dust may occur under windy conditions:

- During unloading of waste
- During installation of cover materials
- When driving on dry, unpaved areas
- When driving on paved but poorly cleaned areas

The Landfill Manager shall organize the operations at the landfill in such a way, that emission of dust is kept to a minimum. The following measures can be used:

- Surfaces with dry soil and service roads are sprinkled with water.
- Transportation activities are restricted to the service roads
- Paved service roads are cleaned by sweeping.
- Sprinkling of dry soil or waste during excavation and reposition
- Landfill areas with temporary cover area seeded with grass.

3.14.3 Litter

A frequent reason for complaints from residents living near landfill sites is litter blowing outside the landfill area. The perimeter fence installed around the landfill site helps to contain litter and prevents it from being scattered to adjacent properties. Daily clean-ups, particularly at the end of the working day, limit the quantity of litter that can be carried to adjacent properties.

The amount of wind-blown litter can further be substantially reduced by:

- Keeping the working face as small as possible
- Placement and compaction of the waste immediately after unloading
- Installation and maintenance of daily, intermediate and temporary covers
- Supply, installation and maintenance of moveable fencing around the working face
- Restricting unloading on windy days to areas of the landfill cells sheltered from the wind
- Closing the site under exceptionally bad weather conditions

A daily patrol of the landfill site's perimeter, access roadways and adjacent public roadways, should be undertaken. Upon the situation full time litter pickers may be required. If litter has escaped from a landfill site, a priority should be the clearance of domestic properties, farmland where livestock are kept, and the public highway. Strict enforcement of the requirement that all vehicles be properly enclosed or covered should prevent litter on access roadways. Vehicle drivers should be issued with warnings about inadequate covering and should be excluded from using the site if these warnings are ignored.

3.14.4 Pest Control

Pest include rats and other rodents, insects, birds and other animals, each of which can carry disease agents and therefore becomes a health hazard.

The most effective practice in the control of pests is rapid and complete compaction and covering of all waste. The territory of the landfill must be maintained clean and tidy. The accumulation of still water anywhere on the site must be prevented by proper grading, filling low spots, and placing cover soil over waste material.

Rats and mice may be brought into the site with the solid waste. Regular site inspections will indicate the prevalence of these animals. When significant numbers are identified, an experienced pest control specialist should be employed to deal with the problem.

3.14.5 Bird control

Scavenger birds such as starlings, crows, blackbirds, and gulls are most commonly associated with active landfills. They can be a nuisance, transfer pathogens, litter and scraps to neighbouring areas and also be a hazard to aircrafts.

Landfill operations should all aim to reduce the attractiveness of the deposited wastes to birds. Mainly this involves decreasing the potential supply of food by frequent covering of waste disposed.

Many of the methods may have only a short term effect as the birds adapt to the environment in which they find the food. Varying the control techniques may prevent birds becoming accustomed to a single method. Examples include:

- gas cannons to discourage birds from food scavenging;
- visual deterrents including realistic models of the bird's natural predators;
- use of physical barriers such as nets around the working face;
- the utilisation of birds of prey such as falcons
- the flying of kites over the landfill.

The most consistently effective measure is the proper covering of all exposed waste as quickly as possible.

3.14.6 Noise

Nuisance from noise mainly may arise from mechanical equipment operating or moving at the site.

In order to mitigate noise all mechanical equipment shall be kept in good working order at all times. Special attention shall be given to the fitting and maintenance of any sound reducing equipment to vehicles, machinery and fixed plant. The strict enforcement of speed limits will reduce noise from vehicles moving in the area. Another measure for noise mitigation is the adjustment of landfill working schedule accordingly to avoid noise generation during citizens' quiet hours.

3.14.7 Fires

No material should be burnt on or close to the boundaries of a landfill. On no account should litter pickers burn collected wastes on the site. Fires in landfills should be regarded as emergencies and dealt with immediately. Site personnel should notify the appropriate agencies and other emergency response contacts should smoke emissions from the filled material be observed.

Measures for fire prevention and control include:

- training of employees in fire prevention and control;
- prominent posting of emergency response contact numbers (fire service, police, ambulance and other agencies) in landfill buildings and other selected locations inside the landfill area;
- fire extinguishers and two-way radios on all mobile equipment;
- the provision of on-site water supply and, if necessary, water storage and portable watertanks; and
- the provision of firefighting equipment in the site offices.

Fires in landfills are difficult to extinguish. Proper landfill control methods and operational practices afford the best protection against the risk of fires. The most effective fire prevention programme combines "good housekeeping" with constant vigilance by site personnel. Fire prevention must start with advance identification of potentially hazardous areas and trouble spots. Careful handling of fuels and routine clearing of equipment tracks are examples of methods to prevent fires from starting. Site personnel must be alert for incoming loads that show evidence of burning. Loads that

are suspect should be denied entry or immediately segregated and placed in a designated quarantine area. Any waste containing hot ashes should be segregated and quenched or covering material should be immediately applied on it.

If a deep-seated fire is discovered or suspected, the extent of the fire can be verified by measuring temperatures in the area of the fire by means of a temperature probe inserted into pipes driven into the tipped material. Readings should start in the unaffected areas and progressively move towards the area of the fire. The affected area should be marked off by indicator boards.

Attempts at smothering fires by the use of impermeable materials are generally ineffectual and may cause the fire to become deep rooted. Accordingly, the recommended strategy is to dig out the deposited waste and reduce it with water. The area containing the fire may also need to be isolated from the rest of the waste volume by trenching. The trench should then be back-filled with inert material, such as sub-soils.

Deep-seated fires can be dangerous to personnel and machines as the fire may cause the surface of the affected area to become unstable. Personnel or machines should not move over the affected area in these circumstances.

3.15 Management of Surface Water

It is extremely important, that surface water on non-paved areas is drained to the perimeter ditch as fast as possible without collecting in ponds.

Further the effective operation of the ditches shall be secured at all times, ensuring that the collected surface water is directed to the release point only.

4 Cleaning and maintenance procedures

4.1 General

The Landfill Operator shall plan and execute cleaning and maintenance procedures ensuring, that

- The buildings, structures, seeded and planted areas, paved and un-paved traffic areas etc. are maintained clean and proper without damages, that may impede their functionality or appearance.
- All moving or fixed equipment and machinery are maintained clean and in good working condition.
- All service facilities, e.g. leachate management system, fences, service roads etc., are inspected regularly, cleaned and maintained.

All mechanical equipment and machinery used at the landfill must be strictly maintained according to the supplier's/manufacturer's specifications.

Every day at closing time the internal roads and other paved areas shall be inspected, and any spillage of waste shall be collected and disposed of in the landfill cell currently in operation. If necessary the paved areas shall be swept using a street sweeper. During dry periods dust emission shall be controlled by sprinkling the surfaces with water in connection with sweeping activities.

4.2 Fence and Surrounding Areas

The fence, the green belt and the surrounding areas in the vicinity of the landfill shall be inspected and windblown litter removed on a regular basis, e.g. once every week. Collected litter shall subsequently be disposed of in the landfill cell currently in operation.

Registered damages of the fence and gate must be repaired immediately.

4.3 Reception Area

The reception area shall be kept free from dropped and windblown waste, soil/mud and of snow during the winter period.

4.4 Weighbridge

The weighbridge and the weighbridge foundations shall be kept clean and free of spilled waste.

The weighbridges shall be serviced and maintained strictly in accordance with the supplier’s specifications.

The weighbridge shall be controlled and certified on a yearly basis by the competent authority/agency.

Any calibration needed shall follow the directions and regulations given by the above authority.

In the case of any problems with the weighbridge operation, the responsible operator shall immediately inform the landfill manager, who in turn will order the immediate repair works. The above stated competent authority/agency shall be informed of any irregularities of the function of the weighbridge, which may have an influence on the accuracy of the weighbridge results.

At times when weighbridge is out of operation the site manager shall search for cooperation with other facilities that possess an approved weighbridge to enable weighing.

In case of malfunction of the data registration system the weighbridge operator shall immediately inform the landfill manager, who in turn will order the immediate repair works and will inform the supervising authority of the landfill. In such a period the data on delivered waste will be recorded manually. When the data system has been repaired and in operation all the manually registered data shall be entered to the data system.

4.5 Buildings, Structures and Installations

Observed damages to buildings, structures and installations must be repaired immediately.

For all significant incidents a damage report shall be prepared and sent to the supervising authority of the landfill.

The garage and vehicles maintenance area must always be kept clean and tidy for optimal working conditions for the maintenance and repair of facility machinery.

4.6 Equipment and Machinery

Equipment and machinery used at the landfill/transfer stations must be strictly maintained according to the supplier's/producer's specifications. Instructions on the frequency of lubrication, oil change and inspections must by strictly adhered to.

The equipment and machinery must be kept clean and protected from corrosion.

A log-book must be kept for each main element of equipment.

All data regarding service, maintenance and repair of the equipment shall be recorded in the log-books as well as the operating time of the compactor, the bulldozer, the tractor and the pumps.

4.7 Access and Service Roads

The roads must be inspected regularly. Any potholes or other damages must be repaired within the shortest period of time ensuring, that minor damages do not develop in to an extent, which may impede the function of the facility.

By the end of each working day all paved areas at the landfill and the external access road shall be inspected for dust, litter and spillage of waste. If required they shall be cleaned and swept using a street sweeper.

4.8 Dikes and Surface Water Ditches

Dikes must be inspected regularly. Further the surfaces of dikes and slopes shall be inspected after any heavy rainfall. Registered damages in the landfill volume covers, e.g. from surface water erosion, landslides etc., shall be repaired immediately and if damaged the vegetation shall be restored.

In places where the same kind of damage is registered repeatedly special attention shall be given to determine the cause of the damage and to determine appropriate countermeasures. It is strongly recommended that an experienced engineer is consulted in this case.

Surface water ditches shall on a regular basis be inspected and kept clear from waste, vegetation, soil and sand to prevent blockage of the system. The ditches must be inspected at least twice a month and supplemental after any heavy rainfall. Any damages to the lining of the ditches shall be repaired immediately.

4.9 Leachate Management System

4.9.1 General

The following on site incidents may impede the proper function of the leachate management:

- ❖ Intrusion of fine particles in to the drainpipes and subsequent clogging of the pipes
- ❖ Accumulation of sediments at the bottom of the leachate boreholes causing malfunction of the pumps
- ❖ Mechanical malfunction of the pumps
- ❖ Malfunction of the leachate treatment plant

In general the above incidents are avoided by the regular inspection, cleaning and maintenance of the components in the system. The inspections shall comprise:

- Measurement of the leachate depth in the collection sumps, leachate treatment tanks and boreholes
- Visual control of the landfill cell for accumulations of leachate above the drainage layer
- Monitoring of the pumps' operation (operation time, registration of start and stop, registration of unscheduled stops and alarms)
- Registration of the quantities of leachate delivered for treatment at the leachate treatment plant
- Measurements and registration of the leachate treatment performance, i.e. quantity and composition of plant's outflow, separate measurements in every treatment stage etc.

The inspections shall be exercised on a monthly basis and in addition after heavy rain storms or heavy snow melting.

Each incident and pursuant counter measure shall be recorded in a log-book.

4.9.2 Clogging of the drainpipes

Indications of clogging of the drainpipes in the landfill cell can be:

- A rising level of leachate in the inspection well outside the cell and/or visible leachate above the drainage layer.
- Little or no activity in the collection well even after heavy rain or snow melting

The drainpipes shall be flushed using a high-pressure water jet from the cleanout pipes in the perimeter of the landfill cell and/or the leachate collection and inspection wells, ensuring that the drainpipes are flushed in their entire length. If possible a pursuant TV-inspection can disclose whether the flushing has been effective or has to be repeated.

The risk of the drainpipes being clogged is increased during the initial 1-2 years of operation of a landfill cell, and in this period the function of the drain pipes shall be followed even closer.

4.9.3 Malfunction of the pumps

A rising level of leachate in a collection shafts and/or alarms from the control panel for the pump indicates that the pump does not operate adequately.

The pump shall be removed from the well for appropriate inspection for mechanical malfunction and if necessary immediate repair.

The leachate collection wells and boreholes shall be inspected for accumulation of sediments and if necessary emptied using a vacuum tanker / gully emptier prior to reinstallation of the pump. If the pump cannot be reinstalled within 24 hours a spare pump or moveable pump shall be temporarily installed ensuring the function of the leachate management system.

4.9.4 During pump stop

The control panels for the pumps must be always equipped with a visual alarm for breakdowns or stoppages of pumps.

In case of breakdown or stoppage of a pump, and when a pump shall undergo maintenance procedures, the pump in question shall be removed for appropriate repair or maintenance.

In order to remove pumps personnel has to enter the leachate shaft observing at all times the special measures for work in confined areas containing hazardous fumes. These measures are lined out in chapter 8 (safety instructions).

The following procedure shall be followed for removal and re-installation of pumps:

- The power for the pumps shall be switched off before entering the shaft.
- Qualified personnel enter the shaft and from a position at the intermediate platform inside the shaft and closes the stop valves of the pump.
- The pump in question is lifted to the platform, dismantled and removed from the pumping station.
- In case the pump must be removed for more than 24 hours a suitable spare pump shall be installed in its place ensuring the function of the shaft.
- In case sediments have accumulated in the bottom of the pumping well to an extent impeding the re-installation, the pumping well may be flushed using pressurised water through a flexible hose or emptied using a vacuum tanker / gully emptier prior to the re-installation of the pump.
- After installation of the repaired pump the pump is lowered into position.
- The stop valves for the pump are opened.
- After leaving the collection shaft the power to the pump is switched on again.

4.10 Top Cover and other covers

Areas covered by intermediate, temporary or the final top cover shall be inspected at least once every two months for damages, e.g. erosion, slides, cracks or significant subsidence. Seeded areas shall be inspected for signs of vegetation die-off. Inspections shall also be carried out after heavy rain storms and heavy snow melting.

Any registered damages shall be repaired ensuring the continued function of the cover. In places where the same kind of damage is registered repeatedly special attention shall be given to determine the cause of the damage and to determine appropriate countermeasures. It is strongly recommended that an experienced engineer is consulted in this case.

Vegetation die-off may indicate migration of landfill gas through the cover, which may be caused by reduced efficiency of the landfill gas collection system in the area in question or by damages to the top cover. Where the surface of the landfill at the same time exhibits significant subsidence, the reduced efficiency may have been caused by discontinuities in the gas drain layer in the top cover. The efficiency of the gas collection system shall be increased by adding new gas wells to the system. It may prove necessary to excavate the top cover in the subsidence area, level the subsidence and reinstall the top cover.

The vegetation shall be restored following the above repair works.

4.11 Landfill Gas Management

All the equipment used in the landfill gas system (pumps, flare, electricity generator etc.) shall be checked, cleaned and serviced as required by the supplier.

The efficiency of the landfill gas management system can be influenced by condensate accumulated in water traps in the transmission pipes - created by subsidence in the waste - or by excessive accumulation of condensate in the condensate wells. The landfill operator shall check the system for such disturbances whenever the gas flow seems to be reduced and at least once every month.

A progressing accumulation of condensate in a water trap will result in significant and rapid changes in the suction pressure in the pipeline, as the gas passes the water trap in thrusts. During the regular readings of the suction pressure at the in-flow manifold at the pump, the reading will be very unstable, thus indicating a progressing condensate accumulation.

In this case a return-blow procedure shall be performed for the transmission pipeline in question.

5 Monitoring procedures

5.1 Organization of Monitoring System

The operation of a landfill shall be recorded in a monitoring system enabling the Landfill Operator, the Owner and the supervising Authorities to assess landfill performance and if needed to intervene to improve the operational procedures. The monitored data will further enable the Operator and the Owner to document needs for changes in the facility.

The monitoring system comprises the following elements:

- Waste registration/control
- Registration of meteorological data
- Environmental monitoring of:
    - leachate from the landfill body
    - groundwater
    - surface waters
    - biogas
- Estimation of landfill stability and settlement

The Landfill operator is responsible for implementation and periodical revision of the monitoring system at the landfill. The monitoring programme, must follow the proposed landfill design guidelines. Laboratory testing and analysis shall be carried out by competent and certified laboratories.

All records and results from the monitoring activities shall be kept in the "Landfill Report Book" and shall be available for the competent authorities at any given time.

5.2 Landfill Monitoring System

5.2.1 Waste Registration / Control / Accepted types of waste

Registration and control procedures are detailed in chapter 3, while acceptable types of waste are described in chapter 2.

5.2.2 Meteorological Data

The landfill operator will monitor and record the following meteorological data.

Table 1: Meteorological Data to be monitored

Parameters	**Monitoring Period during the operation**	**Monitoring Period after closure**
Rainfall (mm/day, mm/month)	Daily	Daily
Temperature, min, max and at 14:00 (°C)	Daily	Monthly Average

Wind direction and speed (m/s)	Daily	-
Evaporation (mm/day, mm/month)	Daily	Daily
Relative Humidity	Daily	Monthly Average

This data will be monitored by receiving and filing data from meteorological station installed in the landfill area or the most representative local station(s).

5.2.3 Leachate

Leachate monitoring is very important parameter that represents the proper operation of the leachate collection system and the landfill cell in general. The parameters that will be monitored are the following:

Table 2: Leachate Controlling Period Analysis Period and Parameters

Parameters	Operation Phase	After-care Phase
Leachate Volume	Monthly	In every six months
Leachate composition	In every three months	

The parameters that must be analyzed are pH, BOD5, COD, TOC, SO4, NH4-N, NO3-N, NO2-N, Organic Na, Cl, Fluorine, fluorides, phenols, heavy metals (As, Cd, Cu, Cr, Pd, Hg, Ni, Zn), Total P, phosphate, ammonium nitrogen, organic nitrogen, total solids, suspended solids, dissolved solids, microbiological parameters, odors, opacity, conductivity, temperature, and hydrocarbons

5.2.4 Groundwater

An underground water monitoring system, must be installed in every landfill site. This monitoring system will include the construction of at least 3 monitoring boreholes: one upstream and two downstream. The upstream borehole will establish reference values for the quality of the underground water and the downstream will provide values that will reflect the impact of the landfill cell operation. Therefore the depth of the boreholes will be the necessary that will enable the sampling of the underground water.

For groundwater sampling and analysis the following equipment is necessary:

- A dipmeter (water level measuring instrument)
- Bailers (samplers) for taking samples from deep wells

Both groundwater table level and composition must be monitored every 6 months or sooner (based on the geological and hydrogeological characteristics of the landfill) during the landfill operation and every 6 months during the post-closure and aftercare period. The parameters that must be analyzed are the same as the leachate monitoring system.

The water level in the wells will be monitored, with the use of the dipmeter.

5.2.5 Surface Water

The purpose of the surface water monitoring programme is to document the quality of the surface water discharged from the territory of the landfill and to detect any significant adverse environmental impacts resulting from the landfilling activities.

Monitoring of surface water (if present) shall be carried out at not less than three points, one upstream from the landfill and two downstream. Volume and composition should be monitored quarterly during operation and every six months during aftercare (if the evaluation of data indicates that longer intervals are equally effective, they may be adapted).

The parameters that must be analyzed are the same as the leachate monitoring system.

5.2.6 Landfill Gas

A. Landfill gas surface emissions monitoring

A surface gas monitoring program should be established to detect any emissions through the cover/capping material and fugitive emissions from any gas extraction system present.

Landfill gas must be tested in the atmosphere 5cm above the landfill surface in areas where intermediate or final capping has been applied. Testing should be conducted in a grid pattern across the landfill surface at 25m spacing. Surface gas emissions monitoring should be done during operation on a monthly frequency or sooner if the environmental risk assessment indicates so.

B. Landfill gas sub-surface monitoring

In every landfill, a landfill gas sub-surface monitoring system must be established to demonstrate that landfill gas is not migrating off-site. For this reason, a network of landfill gas monitoring wells must be installed around the perimeter of the landfill cells. The wells should be spaced at sufficiently small intervals to detect any off-site migration to potential receptors. The required spacing and design of the wells will depend upon the environmental risk assessment addressing the source, potential gas migration pathways, and potential receptors. The distances between the wells cannot be more than 50m.

Samples for landfill gas sub-surface monitoring must be taken and analyzed monthly during the operational phase of the landfill and in 6 months frequency during the post-closure and aftercare period.

The parameters that must be measured and analyzed in both surface and sub-surface landfill gas monitoring systems are CH_4, CO, CO_2, O_2, H_2S, H_2, total Cl, total S, N, and total F.

C. Gas accumulation monitoring in enclosed structures

A landfill gas accumulation monitoring program should be implemented to demonstrate that gas is not accumulating at dangerous levels in enclosed spaces on or near the landfill.

Landfill gas is primarily made up of methane and carbon dioxide and must not accumulate in buildings. Methane is explosive in the range of 5% to 15% (volume/volume), and landfill gas can be an asphyxiant in enclosed spaces.

The threshold level for further investigation and corrective action is the detection of methane at concentrations above 1% (volume/volume).

Measurements for gas accumulation in buildings as well as other enclosed structures must be done in monthly frequency with a gas analyzer, the same that will be used for the surface and sub-surface landfill gas monitoring system. The least parameters that need to be measured are biogas amount, CH_4, CO_2, CO and H_2S. Additionally and for the buildings that are closer to the landfill cells gas detectors will be installed with alarm that will be activated when the landfill gas concentration reaches the limit of 1%

For monitoring landfill gas, ten biogas monitoring boreholes have been constructed.

For landfill gas monitoring a portable gas analyser is necessary, in order to measure landfill gas composition (CH_4, CO_2, H_2S, O_2 and H_2), at the monitoring wells.

The gas analyser does not need any other equipment or a special room and it includes a data logger so that measurements can be downloaded and stored into a PC for further processing. Measurements will take place monthly. Note: the measurements are expected to be affected from the operation of other disposal sites in the area

5.2.7 Landfill Stability and Settlement

The appearance and the volume of the landfill waste body shall be monitored on an at least yearly basis to provide information for assessing and reporting the status of the landfill, i.e. the totals for deposited wastes, the remaining capacity and lifetime, etc. Information from the topographical survey is further crucial for the landfill operator for meeting the requirements in respect of the final filling heights and to avoid land sliding or instabilities in the waste body. Registration of settlements provides information on the current status for the decomposition of the waste body.

The topographical surveys and the assessment of landfill stability and settlement should be undertaken by a qualified civil engineer or land surveyor.

A number of benchmarks must be installed, from which the topographical surveys of the landfill surface shall be carried out. The benchmarks shall be installed on outside the waste body and shall be well marked and protected against damages caused by negligence or malice.

Also, in order to measure settlements, the so-called “settlement plates” should be installed on the waste surface (at least in the areas where final waste height has been reached). These plates include a steel plate (4 mm thickness) where a steel pipe (2’’ diameter) is welded. The base of the settlement plates is installed 50 cm underneath the final surface of the cell, secured in its position by a layer of concrete (thickness 20 cm). These plates will be placed accordingly, so as to create a canvas of 25m x25m.

6 Emergency plan

6.1 General

An emergency is an unplanned event when a project operation loses control, or could lose control, of a situation that may result in risks to human health, property, or the environment, either within the waste disposal site or in the local community. Emergencies do not normally include safe work practices for frequent upsets or events that are covered by occupational health and safety. Proper emergency planning and response are important elements of the site Environmental, Health and Safety Plan of a Waste Handling, Storage and Disposal facility, and that help minimize employee exposure and injury.

Emergency situations are defined as events:

- ✓ When danger to the health and safety or for human life are eminent
- ✓ When injury to persons increases the risk to life or mobility.
- ✓ When risk for pollution of the environment is eminent
- ✓ When pollution of the environment has occurred

The Operator of the facility is responsible for:

- ⇒ Establishing and maintaining emergency plans at the site
- ⇒ The education of the staff of the facility in acquaintance with the emergency plans
- ⇒ The training of the staff in ability to follow the emergency plans under such situations.

The content of the emergency plans shall be approved by the competent authorities, e.g. the local fire department or the regional environmental inspectorate, etc.

Keeping self-control and composure is essential in all cases. Thus **the prime objective of the emergency plan is to ensure, that all personnel in an emergency situation are aware of their duties and tasks and will act accordingly.**

In the case of an emergency the Landfill Manager or the appointed representative will be responsible for the initiation of the correct emergency procedures, including contact with any competent authority as may be required according to the plan.

The Landfill Manager or the appointed representative has the authority to cancel an emergency status and to restart the work, unless superseded by a competent supervising authority.

The emergency status can be cancelled after complete elimination of the cause, when there is no longer a risk for reoccurrence or when all possible measures have been taken to ensure safe operation of the facility can resume.

Emergency situations may arise in the case of:

- Traffic accidents, industrial accidents or personnel injuries
- Exceptional storms or thunderstorms

- Fire
- Floods and earthquakes
- Failures in electricity supply
- Other

Training of employees should include site safety, first aid provision and the handling of dangerous materials where appropriate. Since landfill sites can pose dangers to both site operators and users, emergency plans should be laid down. Landfill sites should be regarded as potentially hazardous locations and the operator should have a written safety plan for the site.

All employees and visitors to the site should be made aware of the potential hazards and the safety procedures to be implemented including fire safety

6.2 Emergency Plan Updates

Landfill Operator and supervising authority will review the emergency plan annually and following an emergency incident to ensure that:

⇒ Emergency response procedures for the landfill infrastructure are effective and updated as necessary;

⇒ Appropriate individuals are appointed to manage emergency situations;

⇒ Regular fire prevention meetings are conducted with all landfill employees and the Fire Department; and

⇒ Hold regular safety and emergency meetings with infrastructure employees.

6.3 Emergency Organization

The key to success of the emergency plan is to assign a **responsible person** (H&S Officer or Landfill Manager in case of smaller landfill sites) to take charge of an emergency situation. This person is designated to have the primary responsibility to manage emergency situations at the landfill site. The Landfill Manager is designated as the alternate person responsible.

The H&S Officer will have complete commission for the duration of the emergency. This together with proper training of operating personnel, practice drills to test emergency response activities, and continual review and updating of the plan will be undertaken to ensure an efficient and effective response to any emergency that may occur.

The H&S Officer has the responsibility to:

⇒ Declare an emergency;

⇒ Review and update the emergency response procedures;

⇒ Ensure that all emergency response procedures are appropriate;

⇒ Respond to all emergencies and to contact appropriate emergency response agencies;

⇒ Establish control of the emergency prior to the arrival of appropriate emergency response agencies;

⇒ Direct personnel and site visitors to a safe muster point;

⇒ Liaise with the emergency response representatives upon their arrival;

⇒ Correct any potential emergency or unsafe situations; and

⇒ Complete necessary documentation with respect to emergencies.

The H&S Officer will report any emergency or contingency situations to the landfill supervising authority which will contact appropriate agencies to report incidents related to environmental or health and safety issues related to the emergency or contingency activities.

6.4 Location Map of Emergency response Equipment

The Location Map of Emergency Response Equipment will be a document that should include the list, the location, the appearance of any equipment for emergency report, and instructions to the personnel on how the equipment is operating in case of an emergency. The map should include:

- Alerts and Communication System
- Fire Rescue Equipments
- Emergency Medical Kits
- Emergency Exit, Exit Routes, and Backup Exit Routes

6.5 Personnel Organization and Assignment of Duties and Responsibilities

In case of an emergency event, all landfill personnel will be re-assigned to different emergency response units/operations based on the emergency plan. These units may include:

- Emergency Response Unit
- Fire Rescue Unit
- Notification Unit
- Emergency Medical Unit

Each member of the Landfill personnel must regularly be trained to his/her tasks during an emergency event.

6.6 Classification of Emergency

Emergency events may be attributed to operation errors, human errors, or natural disasters. These emergency events may further lead to damages to the Site and neighbouring environment by fire, ground collapse, chemical spill, waste water leakage or personal illness and injuries. The levels of emergency can be classified into:

- **First Degree Emergency**: **Limited damage**. No traffic regulation or evacuation necessary. Can be controlled immediately. Power of Command→ Landfill manager together with the H&S Officer will take response actions immediately. If the emergency occurs during night-time or holidays, the person on duty should immediately report to the Site Manager or H&S Officer and act as the on-site responsible until the arrival of the Site Manager or H&S Officer.
- **Second Degree Emergency**: **Broader damages** to lives and properties. May require partial traffic regulation, possible evacuation, and external assistance. Power of Command→

Landfill manager together with the H&S Officer, should form a Command Centre near the incident location, state direct orders and follow all necessary procedures in order to control and contain the damages. The Site Manager or H&S Officer should also report current status and request external assistance if necessary.

- **Third Degree Emergency**: **Large damage** area extending beyond the Landfill Site. May require the evacuation of neighbouring residents. Power of Command→ The Fire Department will be in charge. The staff on-site should immediately report to the Site Manager and H&S Officer at the time of incident and assist the rescue mission.

6.7 Evacuation Procedures

In the event that an area or structure at the landfill must be evacuated due to a fire, gaseous, or other situations, landfill employees, customers, and site visitors will be evacuated. Employees and site visitors will exit buildings via the closest exit and will proceed to a designated muster point.

In the event of a fire or gaseous release from active areas of the landfill, the Site Manager or H&S Officer will direct all staff and site visitors to immediately leave the area and proceed to the designated muster point. Visitors will be requested to remain at the muster point until otherwise notified.

The designated muster point is to be designated for each emergency situation according to the nature and the location of the emergency and a safe exit route. A muster point must not be used when it is unsafe or that is downwind of a fire or gaseous release.

The following rules apply to all employees during an evacuation emergency:

- **DO NOT EXIT BUILDINGS THROUGH A SMOKE-FILLED AREA. EXIT VIA AN ALTERNATE EXIT, AND NOTIFY THE EMERGENCY RESPONSES DEPARTMENT.**
- **DO NOT RETURN TO WORK AREA WHEN AN ALARM SOUNDS.**
- **DO NOT ATTEMPT TO RE-ENTER A SMOKE FILLED AREA OR BUILDING, OR AN AREA THAT IS BEING EVACUATED DUE TO A CHEMICAL RELEASE.**
- **DO NOT ATTEMPT TO REMOVE ANY VEHICLE FROM A PARKING AREA OR AREA THAT IS ENDANGERED BY A FIRE OR CHEMICAL RELEASE.**

When the evacuation is complete, the Site Manager or H&S Officer will then proceed to the muster point. Muster points should be designated.

The prime consideration for the Site Manager or H&S Officer is to ensure that all employees and site visitors are safely evacuated. The Site Manager or H&S Officer will:

- ✓ Only if safe to do so, check areas and buildings, including washrooms, to ensure that all individuals have left;
- ✓ Close doors as they move throughout the facility;
- ✓ meet at the muster point to ensure all site personnel have been evacuated;
- ✓ Await for appropriate emergency response personnel; and

- ✓ As required, establish perimeter security, conduct searches, or other actions that may be warranted by specific circumstances.

The guardian of the gate at the time of an alarm will remove the Visitor Log Book and take it to the muster point. The Site Manager or H&S Officer will verify any names appearing in the book as being present or employees who are signed out or away from the facility at the time of the alarm.

Employees and visitors must treat fire alarms as an actual fire and undertake a total and immediate evacuation of the facility. If for some reason, the alarm stops, employees and visitors will always complete the evacuation. In the event of a fire or chemical release, the Site Manager or the H&S Officer e is NOT to conduct searches in the involved areas for their own personal safety. If personnel are unaccounted for, emergency response search and rescue personnel will be informed.

It is imperative that all employees and visitors remain at the muster point until the Site Manager or the H&S Officer gives permission to return to the respective areas or to leave the site. Upon termination of the emergency, an "All Clear" will be indicated to allow employees and visitors to return to their work areas. Under NO circumstances will an employee or visitor return to the work area prior to receiving permission from the Site Manager or H&S Officer.

6.8 Medical Emergencies

All injuries should be considered important and should be reported as a safety incident to the Site Manager or H&S Officer.

First Aid should be applied that is appropriate to the nature of the injury, and in the event the injury requires medical assistance, the individual should be either taken to a medical emergency centre, or an ambulance service contacted.

A medical doctor should be consulted for all injuries that may result in infections as a result of working with waste materials. This includes injuries such as cuts and scrapes, skin punctures with sharp items, and fire or chemical burns.

If the person injured is a site customer or visitor, employees are to provide any assistance necessary and will apply appropriate First Aid.

6.8.1 Minor Medical Injuries

Prevention

- ✓ Safety Plan and Procedures.
- ✓ Employee Safety Training and Awareness.
- ✓ First Aid Training.

Response

Action	Time Frame	Who?	Resources
Apply appropriate First Aid	Immediately	First Aider	
Recommend injured person consult a	Immediately	First Aider	

physician			
Take injured person to a medical emergency centre or contact an ambulance service if deemed appropriate	Immediately	First Aider	
Review cause of the injury and prepare appropriate mitigating measures	Within 1 month	Site Manager H&S Officer	Site Personnel

6.8.2 Serious Medical Injury

Prevention

- ✓ Safety Plan and Procedures.
- ✓ Employee Safety Training and Awareness.
- ✓ First Aid Training.

Response Plan

Action	Time Frame	Who?	Resources
Assess site conditions for personal safety and safety of others, and take appropriate actions to secure unsafe areas	Immediately	Site Manager H&S Officer First Aiders	Site employees
Attend to the injured person and apply First Aid	Immediately when safe to do so	First Aider	
Call ambulance	Immediately	Site Manager H&S Officer First Aiders	
Stay with the injured person until medical assistance arrives	Duration of medical emergency	First Aider	
Conduct an investigation to determine the cause of the injury and prepare appropriate mitigating measures	Investigate immediately following the incident. Complete mitigating measures within 1 month of the incident.	Site Manager H&S Officer	Site Personnel

6.8.3 Vehicle or Equipment Accidents

All vehicle accidents should be reported and an investigation as to the cause should be carried out. Following the investigation, appropriate mitigating measure should be determined an implemented to avoid future accidents.

Prevention

- ✓ Safety Plan and Procedures.
- ✓ Employee Safety Training and Awareness.
- ✓ Traffic Control Signs.
- ✓ Scale traffic controls.

Response Plan

Action	Time Frame	Who?	Resources
Report the accident to the *H&S Officer*	Immediately	All employees	
If damage is minor, have the vehicle driver report the accident to the police. Take pictures prior to vehicle leaving.	Immediately	Site Manager H&S Officer Landfill Staff	
If the damage is significant, call the RCMP, take pictures.	Immediately	Site Manager H&S Officer Landfill Staff	
If an injury is involved, call ambulance, and implement medical response actions	Immediately	Site Manager H&S Officer Landfill Staff	
Secure the area for a follow-up investigation	Immediately	Site Manager H&S Officer Landfill Staff	
Conduct an investigation to the cause of the accident and prepare appropriate mitigating measures	Within 1 month of the accident	Site Manager H&S Officer Police	

6.9 Fires

Fire Prevention

The H&S Officer will be operating in a manner that will minimize the potential for landfill fires. Fire prevention techniques will include:

- ✓ Thoroughly compacting all waste;
- ✓ Applying daily cover to completely cover each cell's daily waste;
- ✓ Maintaining a comprehensive load checking program to prevent the dumping of hot/burning materials;

- ✓ Maintaining a program of separating the dumping of ash barrels from general waste tipping face;
- ✓ Maintenance around burn pits to keep weeds and grass down to maintain a fire break area; and
- ✓ Ongoing employee training on early fire hazard recognition.

General Fire Response Procedures

Fires may occur at the following locations:

- ✓ Fires in the wieghbridge/administration building;
- ✓ Fires in the equipment maintenance building;
- ✓ Fires in storage areas;
- ✓ Fires at the active landfill working face; or
- ✓ Fires in treed or grassed areas.

All fires will be treated as serious.

All fires will be reported as an emergency situation. Should an emergency occur, employees shall report to the primary muster point. Should the primary muster point be inaccessible, employees shall report to the secondary muster point.

6.9.1 General Instructions

- ✓ DO NOT PANIC, the greatest danger lies not in fighting the fire, but in the panic that arises from a fire. Spend a few minutes getting a control of the situation. A landfill fire will not travel fast, so a 10 minute delay is not going to make any difference to the outcome of the fire. Go through the steps of notifying the appropriate authorities and follow the basic steps in the fire control plan.
- ✓ Contact other nearby employees.
- ✓ Summon the appropriate landfill equipment.
- ✓ Notify the Site Manager or H&S Officer immediately. Follow his instructions.
- ✓ Notify the Fire Department. Tell them the location and type of fire and whether it looks like it will spread out of the immediate area.
- ✓ Notify surrounding property owners, particularly if it appears that the fire could spread beyond the landfill.
- ✓ When the Fire Department arrives, follow their instructions.
- ✓ Do not fight a fire alone.
- ✓ Do not place yourself or others in danger while fighting the fire.

6.9.2 General Fire-Fighting Guidelines

- ✓ For a landfill fire, the fire is better controlled with the use of a dozer and dirt. If it is safe to do so, dig out and isolate the burning waste. Then either let it burn out or cover with dirt.

Lots of water will not necessarily extinguish the fire and can cause more problems than it solves.

- ✓ Do not overuse water. Remember that most landfill fires can be controlled with a relatively small amount of water. In most cases, soil is more effective than water.
- ✓ If two or more water trucks are being used, try to use shifts so that at least one water truck is at the fire at all times.
- ✓ Do not waste time trying to fight a large fire with a fire extinguisher.
- ✓ Do not approach any fire with a tractor unless a water truck is close-by for backup.
- ✓ Never risk personal injury or death attempting to save a machine or building.
- ✓ Remember, SAFETY FIRST.

6.9.3 Small Contained Fires

- ✓ Do not attempt to fight a fire alone.
- ✓ Secure the area and re-direct visitors to a safe area.
- ✓ Work with other site staff to extinguish the fire ONLY if safe to do so.
- ✓ If the fire becomes uncontained, or if it emits toxic fumes, do not attempt to extinguish the fire, and wait for the Fire Department to arrive.

6.9.4 Uncontained Fires

- ✓ Do not attempt to fight the fire.
- ✓ Follow evacuation procedures.
- ✓ Call Fire Department.

6.9.5 Fires in buildings

- **Prevention**

- ✓ Fire alarms in buildings.
- ✓ Staff training and awareness.
- ✓ Coordination with Fire Department..

- **Response**

Action	Time Frame	Who?	Resources
Evacuate the Building	Immediately	All staff	
Call Fire Department	Immediately	Weighbridge Operator Site Manager H&S Officer	
Secure the Area	Immediately	Site Manager H&S Officer	
Contact Supervising Authority	Within the Hour	Site Manager H&S Officer Weighbridge Operator	

6.9.6 Fires at the Working Face

- **Prevention**

✓ Staff training and awareness.

✓ Waste acceptance procedures and policies.

✓ Divert of hot loads from working face.

✓ Application of cover soils to minimize size of the active working face.

- **Response**

Action	Time Frame	Who?	Resources
Evacuate and secure the area	Immediately	Site Manager H&S Officer Operations Manager Equipment Operator	Site employees
Inform Fire Department	Immediately	Site manager H&S Officer Operations Manager	
Isolate burning wastes	Immediately	Equipment Operator Operations Manager Site Manager H&S Officer	Landfill Equipment
Determine nature and extent of the fire	Immediately	Site Manager H&S Officer Equipment Operator Operations Manager	Site staff
Excavate and remove burning waste and soak	As soon as it is determined safe to do so	Equipment Operator Operations Manager Site Manager H&S Officer	Site staff Fire Department Landfill equipment Water truck Water pumps
Confirm the fire is extinguished	Immediate	Site Manager H&S Officer	Fire Department
Review cause of fire and prepare appropriate mitigating measures	within 1 month	Site Manager H&S Officer Supervising Authority	Site employees Fire Department

6.9.7 Stored Material Fires

- **Prevention**

✓ Site security.

✓ Separation of stored materials according to the Fire Code.

- **Response**

Action	Time Frame	Who?	Resources
Evacuate and secure the area	Immediately	Site Manager H&S Officer	Site employees

Inform Fire Department	Immediately	Site Manager H&S Officer	
Determine nature of the burning material and potential for emission of toxic fumes	Immediately	Site Manager H&S Officer	Fire Department
Isolate burning material	Immediately when safe to do so	Site Manager H&S Officer	Landfill Equipment Fire Department
Determine nature and extent of the fire	Immediately	Site Manager H&S Officer	Site staff
Extinguish the fire as appropriate to the nature of the material	As soon as it is determined safe to do so	Site Manager H&S Officer	Site staff Fire Department Landfill equipment Water truck Water pumps
Confirm the fire is extinguished	Immediate	Site Manager H&S Officer	Fire Department
Review cause of fire and prepare appropriate mitigative measures	Within 1 month	Site Manager H&S Officer Supervising Authority	Site employees Fire Department

6.10 Environmental Contingencies

Environmental and operational contingencies may vary in degree of their nature and seriousness, and therefore actual situations will dictate the appropriate actions and responses that should be undertaken. Generally, the response plan includes the following steps:

- ✓ Secure and contain the problem;
- ✓ Verify and validate the problem;
- ✓ Investigate the cause and potential risk;
- ✓ Assess appropriate corrective actions;
- ✓ Implement the corrective action; and
- ✓ Review operation procedures and preventative measures.

6.10.1 Notification

In the event of an off-site release, the Site Manager is to immediately contact the Supervising Authority and provide information on:

- ✓ The nature and status of the release; and
- ✓ Activities and corrective actions being undertaken.

6.10.2 Documentation

All incidents and corrective measures undertaken will be documented and maintained in the operating record.

6.11 Prohibited wastes delivered to the Landfill/transfer station

Prevention

- ✓ Waste Acceptance Policies and Procedures
- ✓ Employee Training and Awareness
- ✓ Load Screening

Response Plan

Action	Time Frame	Who?	Resources
Deny entry of the load	Immediate	Site Manager Weighbridge Operator	Operations Plan and Waste Acceptance Procedures
Determine if load is safe for transport on local roads	1 hour	Site Manager Weighbridge Operator	Supervising Authority
Inform the waste generator of the infraction	1 hour	Site Manager Weighbridge Operator	
Document nature of incident and actions taken	1 hour	Site Manager Weighbridge Operator	Daily Activity Log Book
Review waste acceptance procedures and implement necessary mitigating measures	1 month	*H&S Officer* Supervising Authority Weighbridge Operator	

6.12 Prohibited waste discovered at the Landfill

Prevention

- ✓ Waste Acceptance Policies and Procedures
- ✓ Employee Training and Awareness.

Response Plan

Action	Time Frame	Who?	Resources
Isolate waste and cease operations in the area of the waste	Immediate	Site Manager Equipment Operator	
Construct containment around perimeter of the waste if necessary	Immediate	Site Manager Equipment Operator	Landfill equipment
Determine source of waste, and if possible the waste hauler and generator	1 week	Site manager Weighbridge Operator	Weighbridge records Staff observations
If identified, contact the hauler and waste generator to review options	1 to 2 weeks	Site Manager	
Review waste	1 month	Site Manager	

acceptance procedures and practices, and implement mitigating measures		Supervising Authority	

6.13 Hot loads delivered to the Landfill/transfer station

Prevention

- ✓ Waste Acceptance Policies and Procedures.
- ✓ Employee Training and Awareness.

Response Plan

Action	Time Frame	Who?	Resources
Inform Operator Manager or Equipment Operator, of incoming hot load or Staff	Immediate	Weighbridge Operator	Radio Cell Phone
Direct Load to designated area away from the working face	Immediate	Weighbridge Operator Operating Personnel	
Contain burning material within soil berms	Immediate	Operating Personnel	
Apply appropriate measures to extinguish the fire: wet, smother with soil, or allow to burn out.	Within 1 hour	Operations Manager Operating Personnel	Water truck Water Trailer Landfill equipment
Monitor fire	Duration of fire	Operations Manager	
Remove extinguished material and dispose at working face	2 to 3 days after being extinguished	Operations Manager Operating Personnel	Landfill equipment

6.14 Elevated parameters detected in groundwater monitoring system

Prevention

- ✓ Leachate management systems (liner/leachate collection).
- ✓ Groundwater monitoring program.
- ✓ Environmental auditing.

Response Plan

Action	Time Frame	Who?	Resources
Re-sample to verify or validate	1 month	Operations Manager	Environmental Consultant

			Laboratory
Assessment of the nature and risk of the problem	2 months	Operations Manager	Environmental Consultant
Investigate corrective measures	Determined following assessment of the problem	Operations Manager	Environmental Consultant
Implement corrective measures	Determined following assessment of the problem	Site Manager H&S Officer Supervising Authority	Environmental Consultant

6.15 Leachate seepage through final cover system

Prevention

- ✓ Minimize leachate generation by application of intermediate and final cover.
- ✓ Prohibition of liquid waste disposal.

Response Plan

Action	Time Frame	Who?	Resources
Isolate the area and implement containment to prevent leachate from entering off-site and on-site drainage systems	Immediate	Site Manager Operations Manager	
Investigate the cause of the seep	Within 2 days	Operations Manager	Environmental Consultant
Investigate corrective measures	Within 1 week	Operations Manager	Environmental Consultant
Implement corrective measures	Within 2 weeks	Operations Manager	Environmental Consultant
Review operating procedures and revise if appropriate	2 months	Site Manager H&S Officer Supervising Authority	Environmental Consultant

6.16 Contamination of surface water

Prevention

- ✓ Surface water management plan.
- ✓ Baseline surface water quality documented.
- ✓ Surface water sampling and analysis.
- ✓ Control of surface water releases.
- ✓ Operational controls in active working areas.
- ✓ Employee training and awareness.

Response Plan

Action	Time Frame	Who?	Resources
Investigate cause of surface water contamination	Immediate	Operations Manager	Environmental Consultant
Sample to verify and validate	Immediate sampling Laboratory results the soonest possible	Operations Manager	Environmental Consultant
Identify appropriate corrective actions and implement	Within 1 month	Operations Manager	Environmental Consultant
Review surface water management plan and update and revise if necessary	2 months	Site Manager H&S Officer Supervising Authority	Environmental Consultant

6.17 Leachate generation and flow greater than expected

Prevention

- ✓ Minimize leachate generation by application of intermediate and final cover.
- ✓ Prohibition of liquid waste disposal.
- ✓ Surface water management program.
- ✓ Monitor leachate levels and recovery rates.
- ✓ Employee training and awareness.

Response Plan

Action	Time Frame	Who?	Resources
Review precipitation data	1 week	Operations Manager	Site's meteorological station or other representative meteorological station
Check performance with historical leachate levels and recovery	1 week	Operations Manager	
Inspect intermediate cover and final cover systems	Immediate	Operations Manager	
Review groundwater table data	1 week	Operations Manager	Environmental Consultant
Determine probable causes and assess mitigating measures	3 month	Operations Manager	Environmental Consultant
Implement mitigating measures	As determined necessary	Site Manager H&S Officer Supervising Authority	Environmental Consultant

6.18 Excess storm water flow into the active operating area

Prevention

- ✓ Continued inspection and maintenance of surface water management system.
- ✓ Surface water diversion ditches and berms around working face.
- ✓ Application of cover soils.
- ✓ Maintain minimal working face.
- ✓ Employee training and awareness.

Response Plan

Action	Time Frame	Who?	Resources
Cease operations in active area, and develop alternate working face	Immediate	Operations Manager	Environmental Consultant
Construct perimeter berms to prevent run-on	Immediate	Operations Manager	Environmental Consultant
Removal of excess surface water for treatment, disposal, or recirculation as leachate	Within 1 week	Operations Manager	Environmental Consultant
Review cause and identify corrective measures	Within 2 weeks	Operations Manager	Environmental Consultant
Implement corrective measures	Within 2 weeks	Site Manager Supervising Authority	Environmental Consultant

6.19 Breach of the final cover system

Prevention

- ✓ Inspection of final cover (monthly), for vegetative growth, animal burrows, erosion, settlement, or cracking.

Response Plan

Action	Time Frame	Who?	Resources
Identify nature and significance of the problem	1 week	Operations Manager Equipment Operator	
Develop a corrective plan for the breach	2 weeks to 1 month	Operations Manager	Environmental Consultant
Reconstruct the breached area	1 to 2 months	Site Manager Supervising Authority	Environmental Consultant

6.20 Wind-blown litter

Prevention

- ✓ Encourage covers on inbound loads.
- ✓ Maintain small working face as practical.
- ✓ Maintain portable litter catchment fences around active areas.
- ✓ Maintain perimeter fencing.
- ✓ Regular inspection of roads.
- ✓ Litter retrieval program.
- ✓ Employee training and awareness.

Response Plan

Action	Time Frame	Who?	Resources
Review working face and litter catchment fence placement	Immediate	Operations Manager Equipment Operator	
Implement off-site litter pick-up	1 day	Operations Manager	staff
Implement on-site litter pick-up	1 week	Operations Manager	staff
Review litter control program and revise if necessary	1 month	Site Manager H&S Officer Supervising Authority	Environmental Consultant

6.21 Extreme dust emissions

Prevention

- ✓ Control speed limits on on-site gravel roads.
- ✓ Road maintenance. Limit the amount of road maintenance done during dry conditions.
- ✓ Seed soil stockpiles.
- ✓ Cover inbound loads.
- ✓ Special handling procedures for waste loads prone to emission of dust.
- ✓ Employee training and awareness.

Response Plan

Action	Time Frame	Who?	Resources
Apply water to road surfaces as necessary	1 Day	Operations Manager	
Deposit dusty loads in sheltered area	Upon unloading	Vehicle Operator	
Pre-wet waste load	Prior to delivery when pre-arranged with waste	Waste Generator	

	generator		
Cover dusty wastes with other waste or soil	Immediately upon unloading	Operations Manager	
Review waste handling procedures with waste generator for a specific problem material		Site Manager H&S Officer Supervising Authority	

6.22 Landfill gas detected

An emergency situation may arise in case landfill gas migrate to a confined space in a building at the reception area. The gas alarms will give audio signal in case the content of methane increases above approx. 5%.

Prevention

- ✓ Waste acceptance and handling procedures.
- ✓ Waste cover operations.
- ✓ Employee training and awareness.

Response Plan

Action	Time Frame	Who?	Resources
Cut all electrical power to the building in question and evacuate the building	Immediate	Operations Manager Equipment Operator	
Take measures as to ventilate the building until the methane content reaches an acceptable level again	Immediate	Operations Manager	
Assess site conditions for personal safety and safety of others, and take appropriate actions to secure unsafe areas	Within 1 hour	Operations Manager First Aiders	
Call emergency	Immediately	Weighbridge Operator Site Manager	
Review operating procedures and identify appropriate mitigating measures	1 week	Site Manager H&S Officer Supervising Authority	Environmental Consultant

6.23 Detection of strong odours

Prevention

- ✓ Waste acceptance and handling procedures.
- ✓ Waste cover operations.

- ✓ Employee training and awareness.

Response Plan

Action	Time Frame	Who?	Resources
Cover of waste with a strong odour	Immediate	Operations Manager Equipment Operator	
Investigate source of leachate odour	Immediate	Operations Manager	
Review operating procedures and identify appropriate mitigating measures	1 week	Site Manager H&S Officer Supervising Authority	Environmental Consultant

6.24 Extreme weather

Prevention

- ✓ Monitor weather forecasts.
- ✓ Employee safety and response training and awareness.
- ✓ Continuous back-up of computer/scale data.
- ✓ Maintain on and off-site communications systems.

Response Plan

Action	Time Frame	Who?	Resources
Tornado warning - cease all operations and all employees and visitors take immediate precautionary measures	Immediate	All staff Site visitors	Radio Cell Phones
Severe Electrical Storm - stop scale operation and unplug computer equipment, and employees and site visitors should take precautionary measures	Immediate	Weighbridge Operator All staff Site visitors	Radio Cell Phones
Extreme snow storm with no visibility - stop scale operation and unplug computer equipment, and employees and site visitors should take precautionary measures	Immediate	Weighbridge Operator All staff Site visitors	Radio Cell Phones

The Operator or Supervising Authority has the right to close the facility due to any severe weather conditions that may affect the health and safety of the staff and visitors of the facility, without

notice. Should this occur, notice will be posted on the gates as well as through the local radio stations.

6.25 On site spills

Prevention

- ✓ Minimize on site storage of liquids
- ✓ Utilize appropriate containment on site for liquids
- ✓ Prohibition of liquid waste disposal.

Response Plan

Action	Time Frame	Who?	Resources
Isolate the area and implement containment to prevent spill from entering off-site and on-site drainage systems	Immediate	Site Manager Operations Manager	
Investigate the cause of the leak/spill	Immediate	Operations Manager	Environmental Consultant
Investigate corrective measures	Within 24 hours	Operations Manager	Environmental Consultant
Implement corrective measures	Within 24 hours	Operations Manager	Environmental Consultant
Review operating procedures and revise if appropriate	2 weeks	Site Manager H&S Officer Supervising Authority	Environmental Consultant

6.26 Emergency Disasters

Prevention

- ✓ Safety Plan and Procedures.
- ✓ Employee Safety Training and Awareness.
- ✓ Work with local Disaster Response Team
- ✓ First Aid Training.

Response Plan

Action	Time Frame	Who?	Resources
Assess site conditions for personal safety and safety of others, and take appropriate actions to secure unsafe areas	Immediately	Site Manager First Aiders	Site employees
Evaluate local resources and requirements	Immediately when safe to do so	Site Manager H&S Officer Supervising Authority	Site employees Local Municipalities

Contact Emergency Response Liaison	Immediately	Site Manager H&S Officer Supervising Authority	Local Fire Chief Disaster Relief Officer
Identify alternative locations and routes for waste handling	When safe and information is available	Site Manager H&S Officer Supervising Authority	Local Municipalities Other Waste Facilities
Put a short term and long term plan together for handling and trucking of waste	As soon as possible	Site Manager H&S Officer Supervising Authority	Site Personnel Occupational Health and Safety Emergency Response Team

7 Landfill personnel

Landfill activities are characterized from substantial diversity, complexity and health and safety risks that are resulted from the operations with potentially hazardous materials. Therefore it is absolutely necessary a number of competent personnel to be hired and occupied in order to deal with the landfill operations.

An indicative set of landfill staff can include a Site Manager, Operations Manager, Environmental Monitoring Manager, Equipment Operators, Laborers, Weighbridge Operator and Site Guard. In any case and except the mentioned personnel, the landfill owner must have a constant cooperation with doctor that will supervise personnel health status and will provide the staff with the necessary regular vaccination.

The facility staff may be direct employees or subcontractors (direct subcontractors or staff of a private operator). Staff will have access to an adequately lighted and heated shelter, potable water, toilet facilities and radio or telephone communication. General responsibilities and duties of the various staff positions are described below.

7.1 Site Manager

The Site Manager serves as a liaison between the supervising authority and the facility personnel and is responsible for management and integration of the various aspects of the operation of the site. The Site Manager has the authority to make and implement decisions regarding operating conditions and procedures.

Responsibilities and duties associated with this position include, but are not limited to:

- Receipt and interpretation of operational reports
- Submit regularly reports to the supervising authority director/s
- General management of disposal operations
- Daily management of the personnel and their duties, including maintaining the job descriptions for each individual member of the staff.
- Preparation, updating and instruction regarding occupational health and safety technologies, labour hygiene and fire defence.[1]
- Maintaining and improving the professional qualifications of the staff.
- Places into effect, in event of any emergency, the appropriate corrective procedures
- Maintaining compliance with applicable regulatory agencies and public relation activities;
- Submitting the required Annual Reports

[1] Depending on the landfill size and the Site Manager's workload, the health and safety tasks can be delegated to a H&S Officer

The Site Manager shall have the site as his primary employment. He shall be available at the landfill during minimum 80% of the operating hours, in case that the landfill operates in 1 shift. In case of operation in more shifts, deputy site managers must be hired that will refer directly to the Site Manager

7.2 Operations Manager

The Operations Manager is responsible for the general supervision of the day-to-day site operations. Duties include:

- Scheduling;
- Coordination of operation and maintenance activities;
- Routine facility inspections;
- Makes regular inspections to observe and check the operations of the plant equipment.
- Preparation of necessary reports for the Site Manager

The Operations Manager is directly subordinated the Site Manager.

7.3 Environmental Monitoring Manager

The Environmental Monitoring Manager is generally responsible for monitoring compliance of the facility. Duties include:

- Monitoring environmental compliance of the facility
- Ensuring that the site is developed according to the approved design plans
- Recording any variations from the compliance plans; and
- Submitting required reports including the Annual Reports in accordance to the legislation

The Compliance Manager is directly subordinated the Site Manager.

7.4 Equipment Operators

Equipment Operators perform typical daily tasks associated with the operation and maintenance of the facility. These tasks include, but are not limited to the following:

- May build level and excavate land surfaces using graders and other construction equipment.
- Distribution and compaction of waste at the working face;
- Waste inspection
- Loading and placing daily and intermediate cover;
- Maintaining access roads
- Preventative maintenance work;
- Other miscellaneous activities associated with the heavy equipment

- Uses a variety of hand tools and power driven equipment
- Performing a variety of heavy physical labor and semi-skilled tasks to sort and separate retrievable materials from disposal materials.

Equipment operators must be able to:

- Use hand and power tools skillfully
- Perform heavy physical labor requiring strength, dexterity and agility
- Understand and carry out oral and written directions
- Read and write at the level required for successful job performance
- Maintain good public relations with those contacted during work assignments
- Establish and maintain cooperative working relationships
- Operate assigned District equipment
- Apply sound judgment in a variety of circumstances with or without specific instructions

The Equipment Operators are directly subordinated the Operations Manager.

7.4.1 Compactor Operator

The operator of the compactor is at a daily basis and according to the instructions from the Operations Manager responsible for all operations at the tipping front of the landfill, including control of the incoming waste before compaction, maintenance of the compactor, etc.

Knowledge

- Driving license for truck, front loader and bulldozer.
- Operation and maintenance of the machinery and equipment.
- Familiar with the landfilling technology.
- Familiar with the instructions of occupational health and safety, labour hygiene and fire defence.

Responsibilities

- Giving directions for unloading of incoming waste.
- Spreading and inspection of unloaded waste.
- Controlling of and final acceptance/rejection of the incoming waste.
- Final placing, crushing and compaction of the accepted waste.
- Directing the reloading of rejected waste.
- Applying and reuse daily cover materials at the tipping area.
- Cleaning and maintaining the compactor in accordance with the manufacturer's procedures.

- Substituting as a guard on the orders of the Operations Manager if necessary.

7.4.2 Loader Operator

Following the instructions and directions of the Operations Manager and the operator of the compactor, the loader operator shall support operations at the tipping front of the landfill including supply of materials for daily cover, reloading of rejected waste, maintaining internal non-paved access roads and ramps, etc.

The daily duties will also comprise of cleaning and maintenance of the front loader.

Knowledge

- Driving license for truck, front loader and bulldozer.
- Operation and maintenance of the machinery and equipment.
- Familiar with the landfilling technology.
- Familiar with the instructions of occupational health and safety, labour hygiene and fire defence.

Responsibilities

- Reloading of rejected waste.
- Internal transportation of cover materials for daily cover at the tipping area.
- Applying and extraction of materials for intermediate and temporary covers.
- Controlling and maintaining internal un-paved access roads and ramps, including moving of steel/concrete panels used for temporary access on filled-in waste.
- Cleaning and maintaining the front loader in accordance with the manufacturer's procedures.
- Substituting as a guard on the orders of the Operations Manager if necessary.

7.4.3 Bulldozer Operator

Following the instructions and directions of the Operations Manager and the operator of the compactor, the bulldozer operator shall support operations at the tipping front of the landfill including relocation of unloaded waste, handling of materials for daily cover, etc. The operator shall further participate in maintaining internal non-paved access roads and ramps, etc.

The daily duties will also comprise cleaning and maintenance of the bulldozer.

Knowledge

- Driving license for truck, front loader and bulldozer.
- Operation and maintenance of the machinery and equipment.
- Familiar with the landfilling technology.
- Familiar with the instructions of occupational health and safety, labour hygiene and fire defence.

Responsibilities

- Relocation of unloaded waste at the tipping area.
- Grading and maintenance of access roads and ramps.
- Handling of cover materials for daily cover at the tipping area.
- Participating in applying and extraction of materials for intermediate and temporary covers.
- Cleaning and maintaining the bulldozer in accordance with the manufacturer's procedures.
- Substituting as a guard on the orders of the Operations Manager if necessary.

7.5 Laborers

Laborers perform manual work and maintenance activities at the facilities. Typical tasks performed by the Laborers include the following:

- General cleaning and grounds maintenance;
- Building maintenance;
- Seeding and mulching;
- Preventative maintenance;
- Constructing litter fencing;
- Litter picking;
- Minor equipment operation; and
- Snow or rain water removal from walkways and roadways during winter operations

The Laborers may be trained to operate the heavy equipment at the facilities and could be able of assuming the responsibilities of the Equipment Operators when necessary, such as during vacations or illnesses.

7.6 Weighbridge Operator

The Weighbridge Operator is responsible for the clerical work and the activities associated with the waste receiving process, which include, but are not limited to the following:

- Controlling access to the facility during operating hours;
- Weighbridge operation
- Filling and maintaining operation records;
- Directing incoming trucks to the relevant tipping front.
- Auditing waste transportation records to ensure only acceptable waste is delivered;
- Substituting as a guard on the orders of the Site Manager if necessary.
- Other clerical duties, which may include bookkeeping, typing, payroll, and filing

Knowledge

The weighbridge operator shall be familiar with:

- The use of PC-computer systems.
- The specific use of the weighbridge software and database systems.
- The process of control of non-hazardous and hazardous waste and the necessary documentation.
- Preparing outputs regarding, bills statistical data for reports, etc.

7.7 Site Guard

Out of the working hours the landfill site must be closed, the entrance gate must be locked and guarded by a Site Guard. Waste acceptance out of the working hours is only possible by special arrangement with the Site Manager.

The Guard will have a room equipped for the purpose (usually the weighbridge building). The guard will carry out the following activities:

- Security for the area of the site in accordance with the regulations.
- Keeping unauthorised people out of the landfill area.
- Watching for fires and other emergency situations and initiating the measures for their remediation.
- Informing the Site Manager other relevant authorities in case of emergency situations.
- Preparing a monthly report, highlighting any occurred emergencies.

Responsibilities

- Following strictly the orders and procedures of the Site Manager with respect to the security of the site.
- Checking and maintaining the good technical condition of equipment, including communication equipment and weapons.
- Strict execution of the tasks connected with the security of the site.
- Following all instructions of the police and fire safety authorities.

The guard is directly subordinated the Site Manager.

8 Safety instructions

8.1 General tips

Landfills are busy, harsh environments. Working in a landfill may be one of the most challenging things. In order to make sure that workers make it through a shift safely, here are some basic tips that can help:

Work Together

- ☞ Have regular pre-shift meetings with the work team
- ☞ Map out a “plan” for the day
- ☞ Make eye contact with machine operators
- ☞ Be aware, alert, and always ready for the unpredictable

Follow Rules

- ☞ Always wear the appropriate Personal Protective Equipment
- ☞ Read and understand your machines Operation and Maintenance Manual
- ☞ Always perform a walk-around inspection before starting any machine
- ☞ Always follow proper lockout/tag-out rules

Communicate

- ☞ Everyone should discuss the days plan before and after the shift, as well as during breaks and machine handoffs
- ☞ Always inform the next machine operator of how the machine is handling
- ☞ Be sure to maintain communication with those around you as you operate the machine
- ☞ Use eye contact, hand signals, and horn signals
- ☞ Always be sure that your signals have been acknowledged
- ☞ Always report any problems to your supervisor

8.2 Health & Safety

There are inherent hazards associated with the operation of any waste disposal site, let alone one operated in line with international best practice. Historically, accidents at landfills have resulted from the temporary nature of much of the site’s infrastructure – e.g. site roads, sharp bends and steep gradients - and because vehicles and machinery are often operated in confined areas and in close proximity to each other. Reversing vehicles are a significant problem, particularly where staff is required to cross the working area on foot or direct vehicles at the landfill face.

In such circumstances, accidents can be minimized by the implementation of safety and training programmes and by effective site management. These programmes should include the following:

- Identification of potential sources of risk;
- Assessment of the degree of risk from these sources;
- Determination of procedures for addressing the risks;
- Development of procedures to minimise accident/risks when they occur; and
- On-going monitoring to ensure proper implementation of safe working procedures.

In the light of these provisions, the operator should ensure the safety, health and welfare at work of all persons employed on the landfill. This duty should include the following priorities:

- The landfill should be constructed and maintained in a safe condition;
- A safe means of access to the site for staff and vehicles should be provided;
- Plant and machinery should be maintained in a safe condition;
- Risks should be appraised and safe systems of work planned, organised and performed;
- Suitable safety information, instruction, training and supervision should be provided;
- Suitable protective clothing and equipment should be provided and maintained;
- Emergency plans should be prepared and revised as necessary;
- That the presence of any article or substance on the site must not present unacceptable risks to health; and
- Adequate welfare facilities for staff must be provided and maintained.

This chapter sets out the basic requirements of the effective control of health and safety at landfill site. It constitutes general guidance which should be considered and enacted by all site operators.

8.2.1 Personnel

One or more persons must be formally designated for site safety issues, i.e. Site Manager or H&S Officer. Individuals so designated should understand the statutory requirements, be able to act as competent persons under the legislation, and ensure the continued maintenance of a safe system of work. The later tasks should include matters relating to training and supervision. They should be responsible for the identification of hazards and designated managers should transmit such information by verbal or written instructions to the workforce, contractors, site users and site visitors. Designated persons should undertake regular site safety inspections, with written reports of inspections maintained at the site.

8.2.2 Training

Operators should provide suitable training and instruction to site employees, both full time and part time. The operator should also ensure that any contractor working on site is also informed of the hazards and the necessary precautions. There is also a responsibility for persons employing contractors to ensure that the latter are able to act as competent project supervisors in relation to the safety aspects of the relevant design and construction elements of their work. All site personnel should be familiar with contingency procedures in the event of accident, injury, fire etc.

The locations of emergency equipment should be identified during routine employee training. Phone numbers for local police, fire and ambulance services should be prominently displayed for use in the event of an emergency. Next table sets out the format of a possible emergency contact sheet.

Table: Possible format of an emergency response sheet

	Name	Phone/Fax
Supervising authority	.....	.....
Landfill Operator	.....	.....

Site Manager		
Health & Safety Officer	.....	.....
Licensing Authority	.....	.....
Doctor	.....	.....
Ambulance	.....	.....
Hospital	.....	.....
Police	.....	.....
Fire station	.....	

8.2.3 Staffing Levels

All staff and users of the site should be effectively supervised. No site open to receive waste should be manned by one member of staff working on their own. Similarly no unloading of vehicles should occur in the absence of site staff or out of their immediate view.

8.2.4 Medical

Good personal hygiene is essential to workers on landfill sites and other waste management facilities and hence hot and cold washing facilities must be provided. It is suggested that all workers at landfill sites, including those employed temporarily by the operator, or by contractors working on the site, should have adequate protection against tetanus. This protection must be kept up to date, with boosters given at 10 yearly intervals. Workers have to pass mandatory preliminary and periodical medical examination in accordance with the existing requirements.

8.2.5 First Aid

A first aid box should be available on site in a clearly marked location. The contents of the box should be monitored for use, so that supplies are checked regularly by a named individual responsible for its upkeep. The operator should arrange for recognised occupational first aid training, with a minimum of one person with a first aid qualification normally present on site. All staff should be familiar with the first aid facilities available on site.

8.2.6 Personal Protection Equipment

High visibility clothing should be provided and worn by all site staff and visitors. Safety boots and/or wellingtons should be issued to all site workers. They should have steel toecaps and have a steel insert in the sole to resist injury from projections of glass, metal, or other items in the unloaded waste loads. Gloves should be issued as required. The type of glove should be puncture resistant and should be suitable for the relevant task, e.g. litter collection, vehicle fuelling, cold weather conditions. Safety helmets, earplugs and eye protection should be available as necessary. Operatives at landfill sites work in all weather conditions and will need to be provided with suitable windproof wet weather clothing.

When working at the tipping front or any other place in the landfill cells, where waste is handled, the following personal protective equipment shall be used additionally:

- Dust masks or respirator devices.

- Goggles or full face masks.
- Pressurised cabins on the equipment operating at the landfill tipping front.

When working in dark or foggy weather reflective safety jackets or waistcoats must be worn. The Operator of the facility is responsible for providing necessary personal protective equipment as stated above or which might be needed in a specific situation or for a specific assignment.

8.2.7 Landfill Gas

All site staff should be made aware of the possible hazards from landfill gas. Smoking on site should be forbidden except in designated areas in the site cabins. Buildings and other enclosed structures located at the landfill should be designed to prevent the accumulation of flammable gas within them. Facilities to permit the free circulation of fresh air will generally be required, particularly under floors. It is imperative that all cabins, other store rooms and voids such as those below weighbridges and cabins should be regularly monitored for the presence of flammable gas. All service duct entries to buildings should be seen as possible gas pathways and hence appropriately monitored.

Where it has been established that concentrations of landfill gas are above 20% of the lower explosive limit (LEL), the relevant building should be evacuated. Where this level has been observed within site buildings, the installation of continuous landfill gas monitors and an audible alarm is essential. Extreme care should be taken when re-entering buildings which have been previously evacuated. Procedures for the evacuation and re-entry buildings when significant amounts of landfill gas have been observed should be contained in the operator's safety statement.

The unnecessary creation of enclosed spaces on site, such as by inversion of a skip for maintenance, should be avoided on all landfills. Lighting columns may permit the accumulation of landfill gas. Hence they should be sealed at the base and should contain intrinsically safe electrical equipment.

Health and safety issues should have particular priority where any site works involves the disturbance of filled areas. In particular, drilling in deposited wastes may give rise to the evolution of noxious and/or combustible gases. Therefore regular checks on gas build-up should be made as drilling proceeds. Similarly, any trenches constructed for the purposes of gas collection pipes will need to be physically stable and also monitored for landfill gas. On no account should persons enter trenches or other confined spaces without gas monitoring, rescue and other appropriate safety measures. All contractors should be aware of the hazards of working on landfill sites and be suitably experienced to address them.

Instructions should be issued to all employees that no-one should enter any confined space below ground level, such as culverts and manholes, unless an appropriately authorised person has certified that it is safe to do so. Safety precautions for areas where gas may accumulate require that:

- only persons with appropriate experience and training should be involved in entering confined spaces or providing back-up on the surface;
- smoking should not be allowed;

- persons entering a manhole should be equipped with self-contained breathing apparatus;
- persons entering a manhole should have a safety harness and appropriate line manned by at least two other employees;
- other employees at the surface should have spare breathing apparatus and the requisite training in its use; and
- lights or tools to be used in manholes should be intrinsically safe.

If there is any doubt as to safety of an enclosed space, it should not be entered.

8.2.8 Site Infrastructure, Signs, and Barriers

Steep gradients and sharp curves on site access roads should be avoided. If this is not possible warning signs and crash barriers must be provided. Speed limits should be displayed and enforced by the site operator. Vehicles should not travel over unstable areas on a landfill surface, and neither should they travel with their vehicle bodies raised up or being lowered. Sites should be provided with adequate lighting to allow for safe and efficient operation at the tipping area at dawn and dusk in the winter period. Trenches and lagoons used for liquid or sludge disposal should be fenced, or be clearly marked with poles and bunting and each trench should be labelled to indicate the type of wastes allowed to be deposited. When filled, trenches should be covered immediately. Hazard notices should be utilised on the site in relation to deep water, leachate lagoons or steep faces. Physical barriers should be in place to prevent unauthorised access to culverts and other confined spaces. Culverts on landfill sites may be attractive to children and must be subject to adequate security measures to prevent entry.

8.2.9 Work in Confined Areas

When working in confined areas, where hazardous fumes might be present - e.g. sewage/pumping shafts, leachate collection or inspection wells - the staff or any other personnel must follow current regulations for this kind of work. The most important instructions on this matter are briefly described in the following:

- ✓ Work in confined areas may only be carried out having a special permission.
- ✓ Before entering any confined area the levels of hazardous fumes - e.g. CO, CH_4 and CO_2 - must be checked using special gas analysing equipment.
- ✓ No access to a confined area is made by one person alone. At least 2 well instructed workers must be assigned for the job.
- ✓ Any person entering must be equipped with the necessary personal protective equipment (e.g. respirator device, non-metal protective gloves, rubber boots).
- ✓ One of the workers must stay outside and in case of an accident help the other one to get out and if necessary extent first aid.
- ✓ A lifeline shall be attached to the person entering the confined area. The lifeline shall run through a winch on a tripod installed over the opening in to the confined area, ensuring that the outside helper can heave the entering person out of the area.

- ✓ In confined areas, where explosive fumes may be present, all actions inducing risks of creating sparks or flames shall be avoided. Thus the person(s) entering may not wear shoes with metal objects on them, and all use of matches, lighters as well as smoking is forbidden near confined area.
- ✓ When using a respirator device a break of minimum 10 min. must be made at maximum 20 minutes intervals.
- ✓ Anybody suffering from claustrophobia or other health problems, which could prevent them from fulfilling their duties, may not enter into confined areas. In case of the slightest doubt a medical doctor shall be consulted before taking any action.
- ✓ Records must be maintained of all entries to and work in the confined areas.

8.2.10 Hazardous Substances

The operator should ensure that exposure of persons at a landfill to hazardous substances, is minimised or, where exposure cannot be avoided, adequately controlled. Employees should be trained regarding:

- Potential risks;
- Associated preventative measures and precautions;
- Existence of occupational exposure limits;
- Actions to be taken;
- Hygiene requirements; and
- Personal protective equipment.

Landfills represent working environments where employees could be potentially exposed to a variety of different substances. Operator should assess the types of substances likely to be received at his site and identify the risks he poses.

8.2.11 Electrical Hazards

The electricity distribution system should be inspected annually by a qualified electrician. Residual current breakers should be fitted to all power outlets. Electrical equipment located in areas where accumulations of flammable gas could occur should be selected, installed, and maintained in accordance with relevant safety requirements. Overhead power lines may cross the site. These should be either diverted or measures should be taken to ensure that the level of waste does not rise above a level agreed with the relevant authority. At no time should vehicles or equipment be able to get within arcing distance of any electrical cables. All power lines should be signposted by protective barriers. Any damage to these barriers should be dealt with immediately.

8.2.12 Scavenging

Scavenging is the separation and removal for re-use of items such as scrap metal. In the past, it provided a means by which materials were recovered and recycled. The practice is dangerous and interferes with the efficient operation of a landfill. Scavenging is perhaps the greatest single cause of accidents and fatalities at landfill sites, due to the partially obstructed view of drivers of vehicles

when they are reversing. For these reasons, scavengers should be prohibited by an operator wishing to manage its site in line with international best practice.

8.2.13 Traffic and Machinery

General rules for traffic at the premises:

In general rules, which apply to traffic on public roads, also apply on the premises of the landfill.

Additionally an overall speed limit for all vehicles and mobile machinery of maximum 30 km/h shall apply inside the fence.

The Operator of the facility shall display clear markings and signboards stating the directives for all traffic at the premises. Signs stating the overall speed limit must be placed at the entrance gate. Other signs within the premises must show driving directions for the incoming and outgoing vehicles with clear marking of one-way roads and right of way at crossings.

Areas where traffic of transport vehicles and mobile working machinery are mixed and areas, where staff may be working, are potential risk spots. These areas shall be clearly marked for the attention of the drivers and pedestrians, and the speed limit shall be reduced even further.

Vehicles and mobile machinery:

Only vehicles and other mobile machinery that either belong to the facility or have a legal errand are allowed at the premises of the landfill. The vehicles may only move along the internal roads of the facility observing the above stated rules for traffic.

Pedestrians and staff working on the ground:

When moving by foot on the premises or working on the ground all staff and visiting personnel shall always watch out for traffic. Special attention shall be paid to reversing vehicles and to machinery in operation.

Illumination:

The Operator is responsible for maintaining sufficient illumination of trafficked and working areas during working hours.

Use of machinery:

Any machinery may only be used for the purpose it was constructed. The following general rules must be observed:

- Any adjustments of machinery and movable parts of the same may only be done while the machinery is turned off.
- A machine may never be left running idle. The engine shall be turned off and the key removed from the machinery/vehicle, when the operator leaves the machine.
- No machinery or vehicle may be left with movable parts - e.g. the shovel of the front loader - lifted.

- The areas, where vehicles or other machinery usually heats up, shall be kept free from combustible materials to minimise the risks for fire.
- At all times the windows of the cabin of any machinery or vehicle shall be kept clean, in order to ensure a clear view for the operator.