

Today's

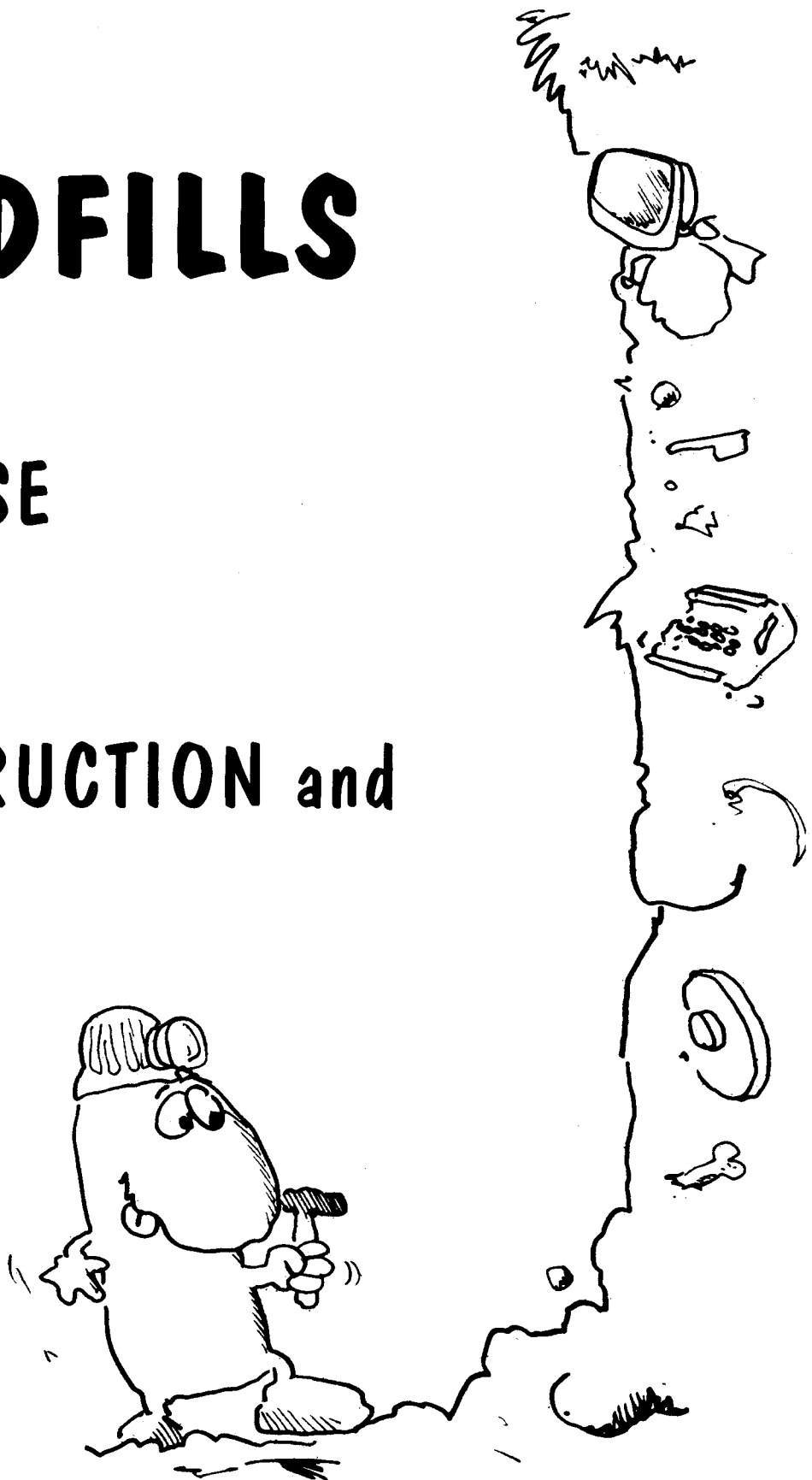
# LANDFILLS

PURPOSE

DESIGN

CONSTRUCTION and

CARE



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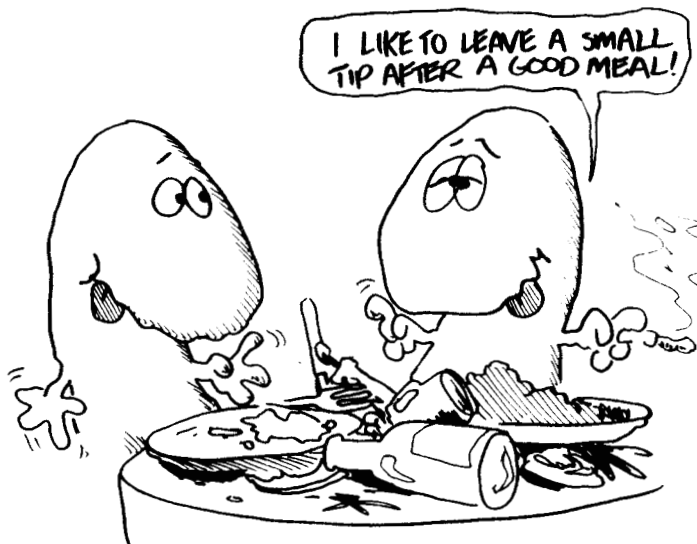


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# LANDFILLS

FRUSTRATING LIVING IN THE 1990S...



Societies have always needed places where they can dispose of their rubbish - the "left overs" from every day life. In the Middle Ages most households had a midden or refuse heap, often piled up against the outside kitchen wall (providing insulation) where both human and kitchen waste was dumped.

Rubbish dumps are important historical sites.

Archaeologists use old rubbish dumps from days gone by as a means to find out more about a past culture. Middens near Maori Pa sites tell us what the inhabitants ate; the types of birds and shellfish, as well as information on the containers they used to store food and other precious possessions. Discarded containers reveal many things about ancient cultures and middens hold a record of history within their piles of decayed rubbish.

Before the nineteenth century and the industrial revolution, disposing of rubbish was not the problem that it is today. Because most rubbish came from natural products it broke down readily in a relatively short space of time. Pre-twentieth century consumers did not have the volume of packaging that exists now, much of which is manufactured from non-biodegradable materials and accounts for much of modern landfill content. Prior to the twentieth century, the population was considerably lower so less rubbish was created.

## HOW LONG HAVE WE HAD LANDFILLS?

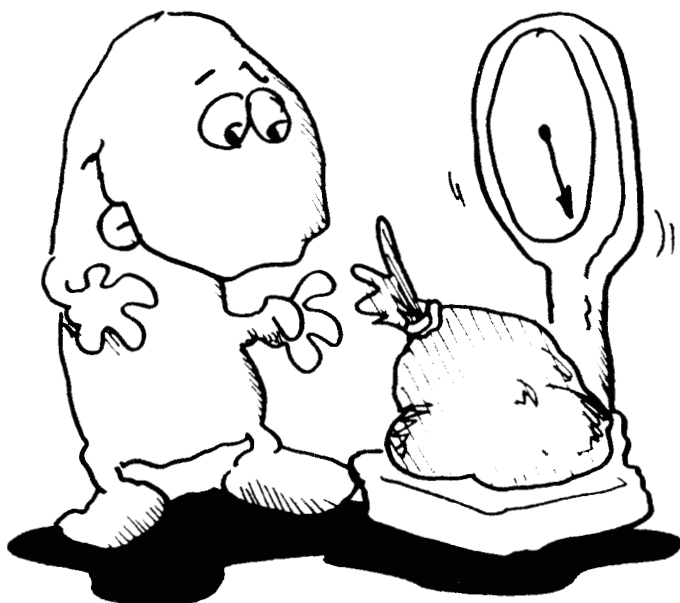
Modern landfills have existed for the last 60 years or more but until only recently were commonly called tips or dumps. These consisted of open pits, which were often old quarries, gravel pits, disused mines and marshlands into which was thrown solid refuse of all description. At irregular intervals, a layer of dirt was spread over the rubbish to reduce smells and vermin and to disguise the contents. Less attention was paid to the treatment of

leachate and gas; by-products from the breakdown of refuse.

The contamination of ground water, streams and coastlines has been attributed in part to untreated leachate being discharged into the natural environment.

### **MUNICIPAL WASTE DISPOSAL IN THE 1990'S**

New Zealanders produce 2.5kg of rubbish per day and Aucklanders alone generate over 400,000 tonnes of industrial, commercial and domestic rubbish a year, most of which ends up in a landfill site, these days known as either a Refuse Landfill or as in the USA, a Sanitary Landfill.



### **WHAT IS A REFUSE LANDFILL?**

Unlike the poorly constructed and managed old fashioned tip, a modern waste disposal facility is highly engineered and constantly monitored throughout its operative life and for many years following closure.

The modern landfill has a liner to contain leachate, a leachate collection and treatment system, a cap to reduce rain infiltration and an extensive monitoring system in order that its effect on the environment and public health is minimal.

### **HOW DOES IT WORK?**

The combination of water and the organic matter in the rubbish creates a chemical, biological and physical process that breaks down the refuse. How this process is managed will determine any possible threat to the environment. The process in a modern landfill is extremely slow because they are specifically designed to control the amount of air and water which enter them. The process is likely to take 30-100 years or more. Some materials break down faster than others, vegetation and food scraps will decompose long before a car or a washing machine, which take many centuries to breakdown.

Some landfill matter is relatively inert and causes no harm to the environment, others release harmful chemicals during decomposition and require careful monitoring.

### **WHO OWNS AND OPERATES LANDFILLS?**

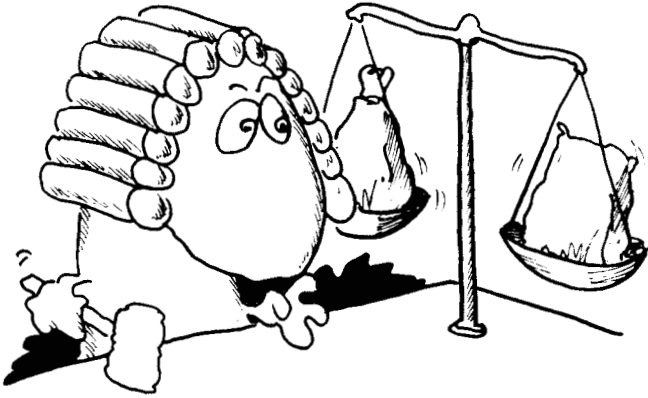
In the past all landfills were generally owned by local authorities. In Auckland private companies own and operate them.

### **SETTING UP A LANDFILL DEVELOPMENT**

<b>Stage 1:</b> <i>Study of a selection of possible sites and choice of most suitable one.</i>
<b>Stage 2:</b> <i>Design drawn and Community concerns addressed.</i>
<b>Stage 3:</b> <i>Applications for consents. Legal Requirements.</i>
<b>Stage 4:</b> <i>If consents granted, construction begins.</i>
<b>Stage 5:</b> <i>Operation of landfill.</i>
<b>Stage 6:</b> <i>Post Closure Care.</i>

## What are the legal requirements for a landfill?

After site selection Landfill operators require Resource Consents for the following activities:



### Water Permit

Consents to take, divert or use ground and /or surface water

### Consents To Discharge Contaminants

These may include

- air/gas/odour
- stormwater
- leachate to ground
- refuse onto land

The discharge and water consents are issued by the regional council with conditions relating to:



1. the design of the landfill including liner systems etc.
2. the monitoring of the landfill to protect the natural environment while in operation and after it has been

closed.

3. the operation and management of the landfill.
4. bonding to ensure:
  - a. the high performance and management of the landfill
  - b. repair to landfill in case of emergencies, for example earthquake or flood damage
  - c. closure or continuance of safe landfill operation in the event of owner insolvency occurring.

A **Land Use Consent** issued by the regional council for the control of earthworks on site.

A **Land Use Consent** issued by the Territorial Local Authority ie city or district council which includes conditions that take into account community concerns. These may:

- a. protect surrounding environs from noise and odours
- b. ensure that the proposed access roads are viable
- c. ensure the aesthetic appearance of the landfill
- d. provide for pest control
- e. decide whether the operation is to be open to the public.

MfE has produced guidelines for the design and construction of landfills. Although these are not mandatory, most local authorities consider them to be the minimum standard that will now be acceptable. In the Auckland Region, USEPA (United States Environmental Protection Agency) regulations are also used to help establish acceptable landfill designs, construction standards, operational practices, and types of wastes to be accepted into the landfill.

The Resource Management Act requires that the long term environmental effects of

the landfill throughout its operation and post closure is monitored until such time as the effects are considered to have little or no impact on the environment.

## SITE SELECTION

Where are landfills sited?

A landfill site may be situated in a natural depression or valley or in areas of low topography, that has a suitable geological profile, preferably with naturally occurring clay which can be utilised as a liner at the bottom of the landfill.

The key to a successful landfill is to identify the best available site, taking into account:

1. the geology of the site
2. hydrological setting; ensuring that the proposed landfill is not near natural streams, estuaries, lakes, flood plains, ground water or the sea.
3. options for leachate disposal and landfill gas.
4. Waste Composition  
The type of waste which will be accepted at the landfill. At the planning stage it is determined whether the landfill will take Municipal Waste only, Hazardous Waste or be a Co-Disposal Facility which takes both.

Further considerations are site accessibility, community concerns, distance from waste and long term management.

## ENVIRONMENTAL CONCERNS

The main concerns associated with a landfill is the containment, control and management of leachate and gas so there are no adverse effects on the environment.

## COMMUNITY CONCERNS

Most people do not want to live in the vicinity of a landfill and the siting of a new landfill is therefore often strenuously opposed by local residents. This is called

the NIMBY (Not in my back yard) Syndrome, created by memories of badly run tips with their associated problems of odour, litter, seagulls, noisy traffic and reduced property values.

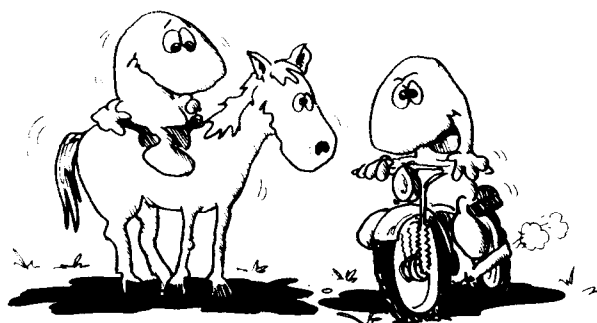


Planning a modern landfill involves consultation with the residents so that their concerns are acknowledged and they have input during the planning stages of the landfill.

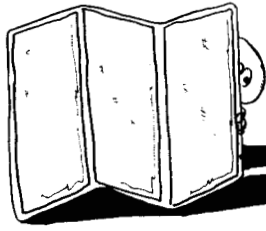
In some recently built landfills a trust has been established which diverts a percentage of the landfill profits for the establishment or improvement of recreation and education facilities in the area. In this way residents benefit from the venture rather than regarding it as an inconvenience to their lifestyles.

The following criteria are taken into consideration to ensure the landfill is acceptable.

1. Tangata Whenua are consulted to ensure acknowledgment and protection of their cultural and ancestral heritage.
2. Restrictions are placed on the proximity of the landfill to recreation and residential areas to minimise noise levels, both during construction and later operation.
3. Pressure on local transport systems is taken into account including the safety



and frequency of pedestrians and cyclists. This will determine the final location and design of access roads.



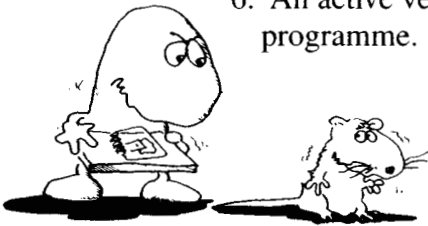
4. Provision for landscaping and or screening the landfill so that noise is minimised and operations are not visible from major highways.

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5. An odour control programme, coupled with the site being constructed downwind of major residential areas, where practicable.



6. An active vermin control programme.



7. The proximity of airfields to avoid bird strike on aircraft.

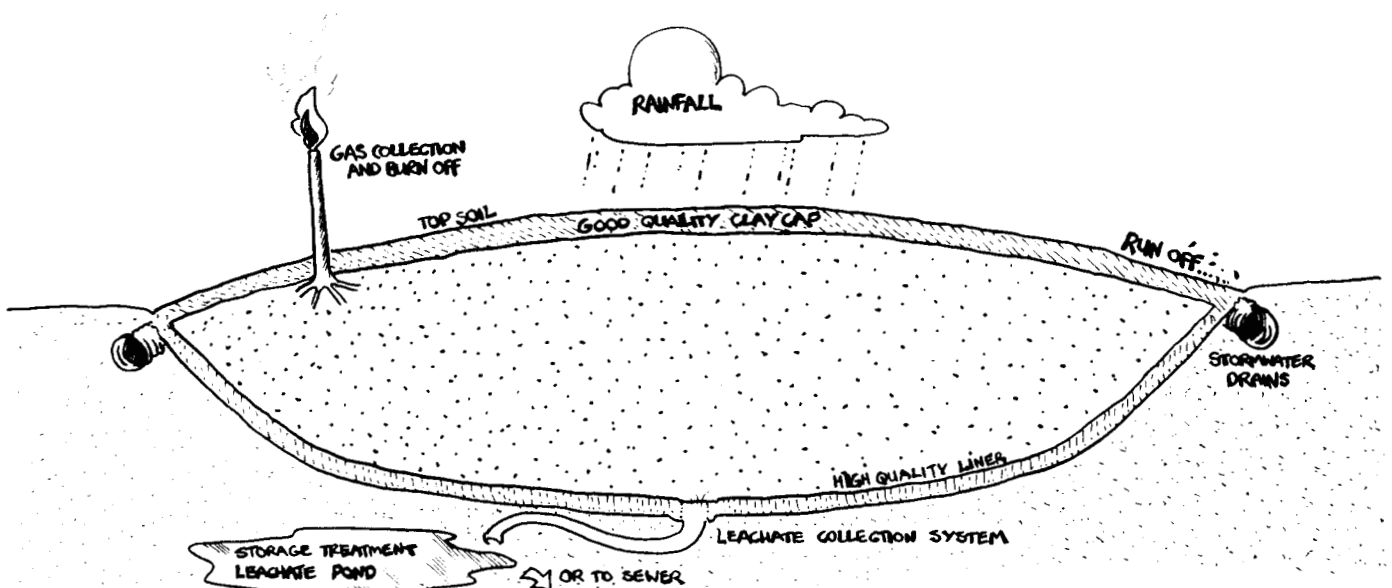
1. The first stage is to construct a liner in order to contain the landfill. The most suitable sites have a natural clay liner, however a minimum acceptable is 600mm of compacted clay with a low permeability coefficient. This acts as a barrier, preventing leachate from the landfill seeping through into the ground water where it could cause contamination. Depending on the site this clay may need to be trucked in. In addition to the clay liner, a plastic liner may also be required for further protection to the surrounding environment. The liner required for landfills that accept hazardous wastes needs to be of a higher standard to ensure containment is achieved.

2. A series of pipes is installed above the liner to collect the leachate at the bottom of the landfill. The leachate is then piped to a leachate storage pond or holding tanks for further treatment.

3. In some cases a series of pipes is installed underneath the liner in order to collect groundwater and prevent it from entering the landfill.

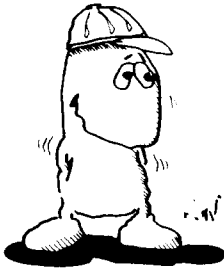
4. A landfill gas collection system is also installed and consists of a series of perforated pipes laid within the refuse connected to a gas well from which the gas will be extracted.

## HOW IS A LANDFILL CONSTRUCTED?



5. A drainage system is installed to collect and divert storm water run-off into sediment ponds, where the sediment contaminated water is settled and tested prior to final discharge.

6. Bunding or embankments are built and trees and shrubs planted to make the site visually attractive and assist in reducing noise. As well, high fencing ensures litter control.



Grass is planted to minimise soil erosion. On site access roads are constructed for the refuse vehicles to use and public access roads built.

Weighbridges are installed at the entrances to record the quantity of refuse that enters the landfill.

In addition buildings are constructed for staff use including operation offices and equipment storage areas.

### HOW IS A LANDFILL OPERATED?

Transporter vehicles empty the rubbish at the tip face daily, where it is compacted to reduce the volume.

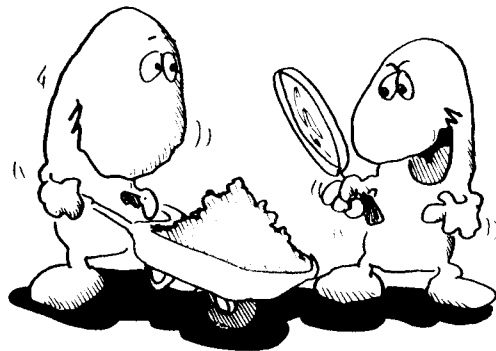
15% - 20% of the soil from the construction works is retained to use as cover material. At the end of each day's operation, a layer of earth is spread over the refuse which keeps rodent and bird infestation and smell to a minimum. If there is insufficient soil, foam can be sprayed to cover the refuse. This process continues every day for as long as the landfill is operating.

### WHAT GOES INTO A LANDFILL?

All the collected refuse that goes into a landfill is Municipal Waste. The individual material that it is made up of is called the Waste Composition. Municipal Waste includes that from both Households and Industries. Organic waste makes up approximately 36% of the waste going to

landfill, Paper 19% and Construction and Demolition Waste 17%.

Some hazardous wastes, such as paint, batteries, oil, pesticides and other material do end up in landfills. Separate education and collection programmes have been established to minimise the risks of this happening. In addition, industrial hazardous wastes are prohibited from being disposed in landfills. Much of this material can be pre treated to make it non hazardous, enabling safe landfill disposal. For householders, it is difficult to monitor the incidence of hazardous wastes in domestic refuse therefore education programmes, including alternative means of disposal, are necessary.



### WHAT IS LEACHATE?

As municipal waste breaks down and decays it produces organic and inorganic chemicals which contaminate the water in the landfill. This is termed leachate. The amount and toxicity of leachate is determined by the amount of water entering the landfill and the type of waste in the landfill. The process of waste breakdown requires some water before it will proceed at a reasonable rate. Rainwater enters the landfill and filters through the refuse collecting dangerous chemicals released by the decomposing rubbish. The more water entering the landfill the more leachate that is produced.

If the leachate is not collected, it will eventually seep through the liner system into the surrounding soil and from there into ground and surface water, contaminating streams and estuaries and

other water bodies. The chemical constituents present can harm aquatic organisms even if present in only very small quantities. Shellfish and fish in estuaries are particularly vulnerable as this is their breeding and spawning ground.

### HOW IS LEACHATE CONTROLLED?

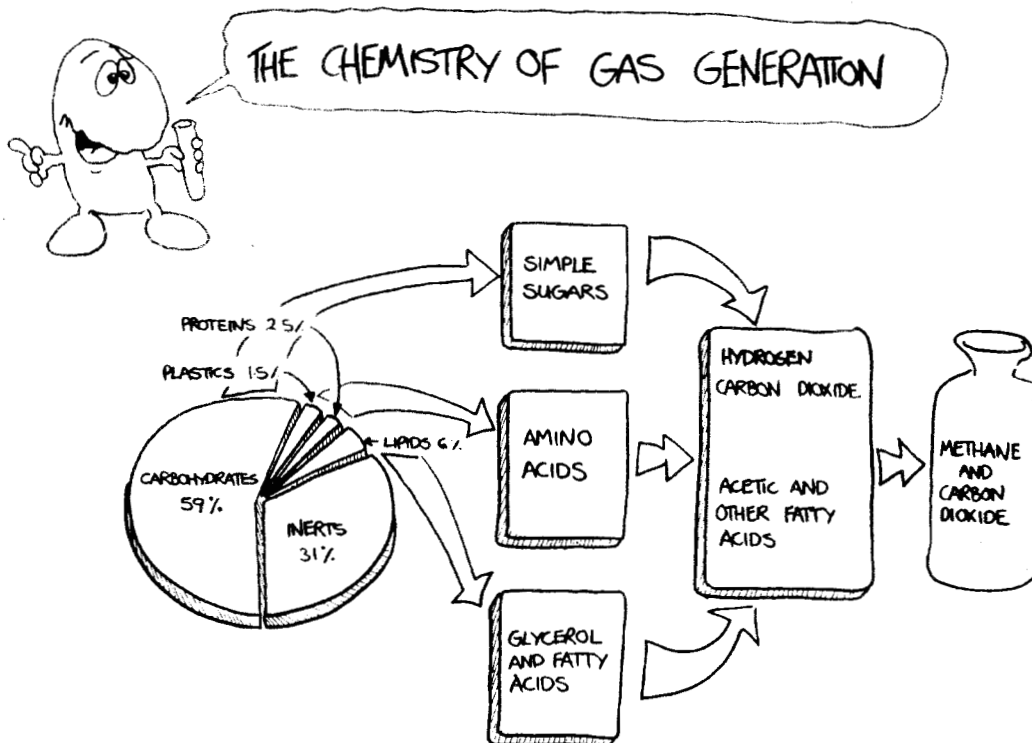
The amount of water entering the landfill is controlled. It is necessary for a percentage of water to be present to facilitate the breakdown of refuse. Some rain enters the landfill during its operation, filtering through the exposed rubbish. This can be controlled by reducing the active working face of the landfill and by placing a compacted clay cover on the landfill sections that have reached their design fill contour areas. After collection the leachate is pumped into a holding tank and collected and transported to a sewage plant for treatment or spray irrigated onto land or undergoes other treatment. Sometimes the leachate sludge is returned to the landfill.

### WHAT IS LANDFILL GAS?

Decomposing refuse produces gas. Anaerobic bacteria ( which operate

without oxygen) digest the large amounts of organic material in the landfill, which acts as a bio-reactor producing a gas composed of methane (CH<sub>4</sub>) and carbon dioxide (CO<sub>2</sub>). The rate at which it is produced, like leachate, depends on the amount of water in the landfill, the density of rubbish compaction and the permeability of the final capping material. All these contribute to a reduced oxygen content and therefore provide an excellent environment for the bacteria, speeding up the generation of gas. A comparatively dry landfill site will produce gas at a slower rate for a period of 50 to 100 years or more. Landfills with a higher water content produce the gas quantities over a much shorter time, 15-20 years, perhaps up to 50 years.

Over a ten year period it is possible for 1 tonne of domestic waste to produce 100 times its own weight in biogas. Theoretically it is possible to produce 400 cubic metres of gas from 1 tonne of waste. Some estimates suggest that New Zealand landfills give off around 300,000 tonnes of methane every year.



## Problems Associated with Landfill Gas

It is possible for the landfill gas to travel underground or migrate by direct pressure differential or diffusion. Landfill gas is highly explosive and therefore needs controlling. It also has a distinctive, offensive smell that can cause problems to neighbouring landowners, unless properly controlled.

## Effects on the Environment

Both carbon dioxide and methane are greenhouse gases, the proliferation of which is contributing to the heating up of the world's atmosphere and damaging the ozone layer. Gas control and utilisation will minimise the damaging effects of emissions from landfills.

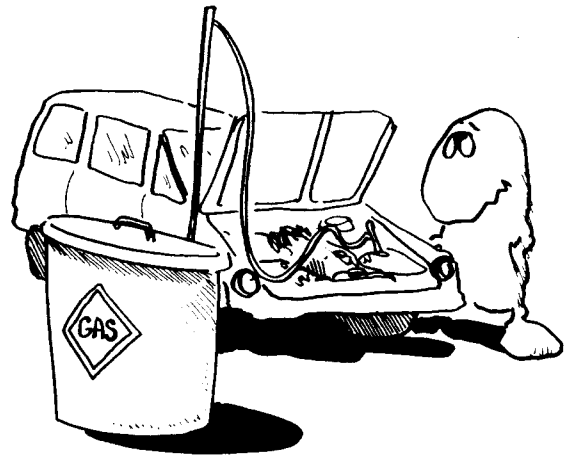
## HOW IS LANDFILL GAS CONTROLLED?

After collection gas is piped into a well from which it is extracted and may be used in one of three ways:



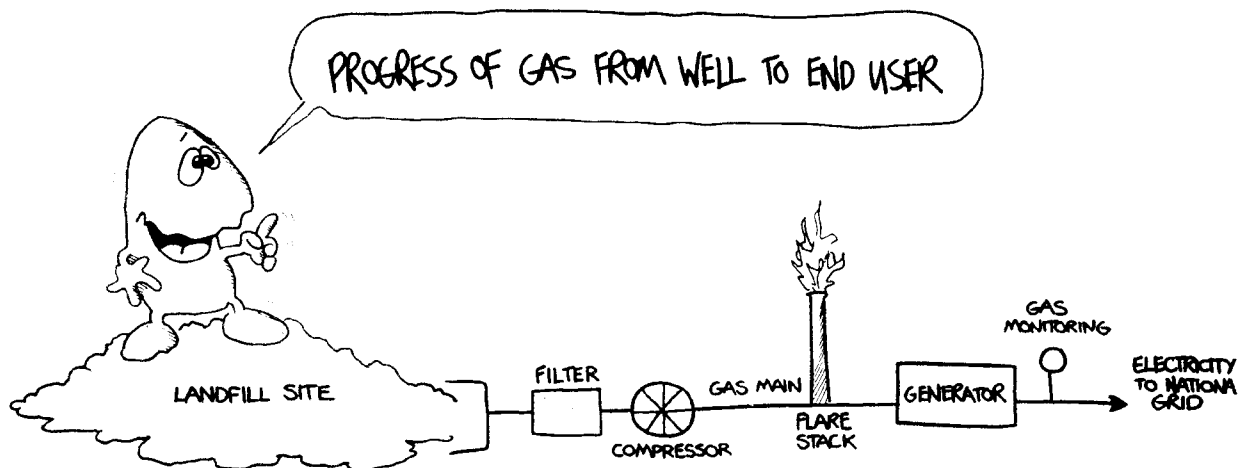
1. Burn off or flares - often done in New Zealand.

2. To generate electricity to either supply the national grid or for use on the landfill site, making it energy self sufficient. In the Auckland Region the Greenmount Landfill in East Tamaki, Rosedale Landfill on the North Shore and Redvale Landfill utilise the gas for electricity generation.
3. Other uses: Landfill gas is used in kilns, boilers and furnaces or upgraded to other fuel eg: liquid natural gas.



## WHAT HAPPENS WHEN A LANDFILL IS CLOSED?

When a landfill reaches the end of its designated life, it is closed and capped with a layer of compacted clay and sometimes plastic sheeting. The capping must be, of at least 600mm thick and have a finished slope to minimise water infiltration. Top soil is added and the area planted in grass or other cover material



that stabilises the soil and improves the appearance of the landfill site.

### POST CLOSURE CARE

Landfills require responsible management after closure to monitor leachate production, landfill gas and stormwater. A clay landfill cap has to be checked regularly for the cracking that can occur when it dries out during hot weather, allowing leachate break out or high water infiltration.

Gas and leachate needs to be continued to be collected and treated.

The collection systems are monitored for clogging from silt, chemical deposits and micro-organisms. The pipes are also checked for corrosion caused by acids and solvents, and crushing from the weight of refuse on them.

The owner of the site is responsible for the management of a landfill site which may continue from between 30 and 100 years after closure. Private operators are financially bonded to ensure compliance with post closure requirements.

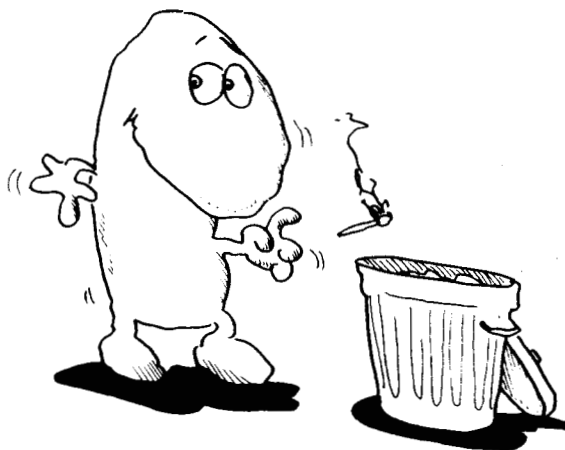


### WHAT IS BALE FILLING?

This is a method of compressing refuse before it enters the landfill. The refuse is compacted into bales about one-fifth the original volume and bound with wire prior to being stacked in the landfill. It is not commonly done in New Zealand.

### ALTERNATIVE DISPOSAL METHODS

Evaluation of alternatives to land filling is an ongoing process as new technology becomes available. Consideration has been given to incineration but it cannot at present compete effectively on a cost



efficient basis with landfills. This may change should future availability of landfill sites become limited.

Composting is being promoted as a viable alternative to landfilling for green garden waste.

### WHAT IS A TRANSFER STATION?

A transfer station is a facility that assists in the disposal of rubbish. Refuse is brought to the station and emptied, sometimes into a specially constructed concrete pit, where it is compacted and then transferred to bulk haulage vehicles such as Tip Taxis, which take it to the landfill. At other sites it is emptied into a jumbo bin and then transported.

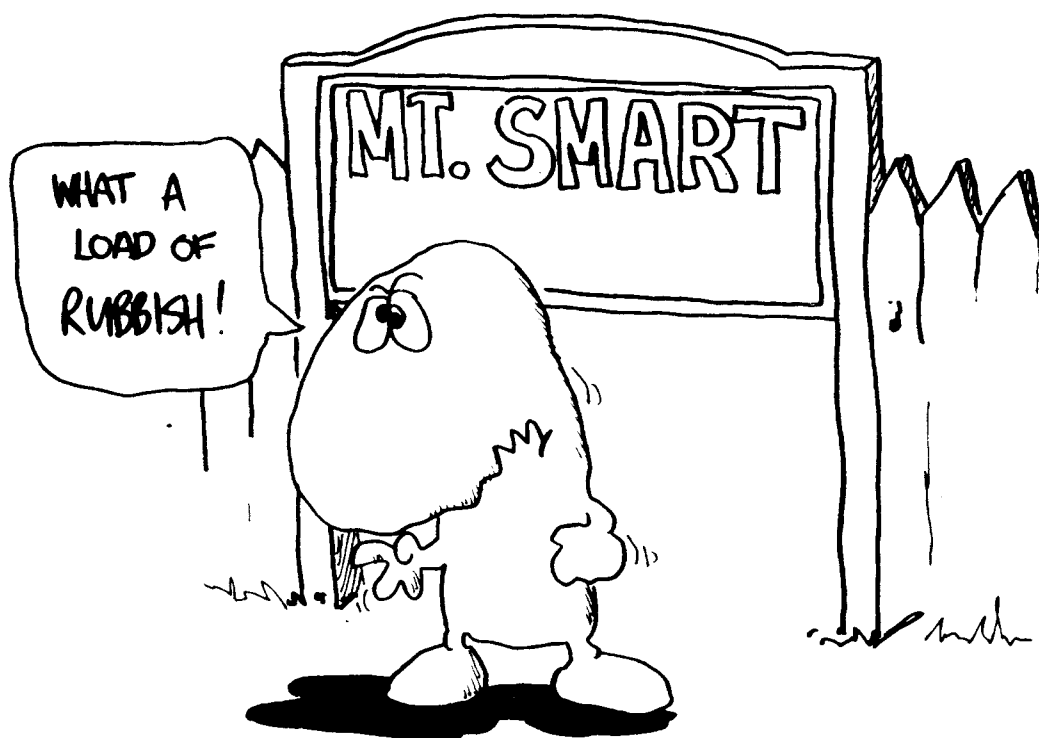
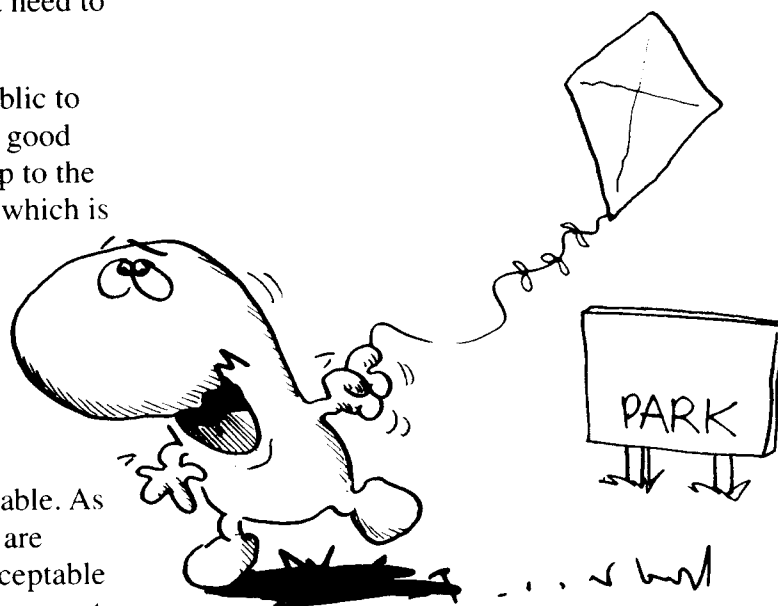
The advantages of a transfer station are:

1. A reduction in traffic at the landfill. Only large commercial waste haulage vehicles enter the landfill. Smaller waste firms and the public use the transfer station. This reduces pressure on the access roads.
2. Less working area at the tip face is required and this allows for better environmental control at the landfill.

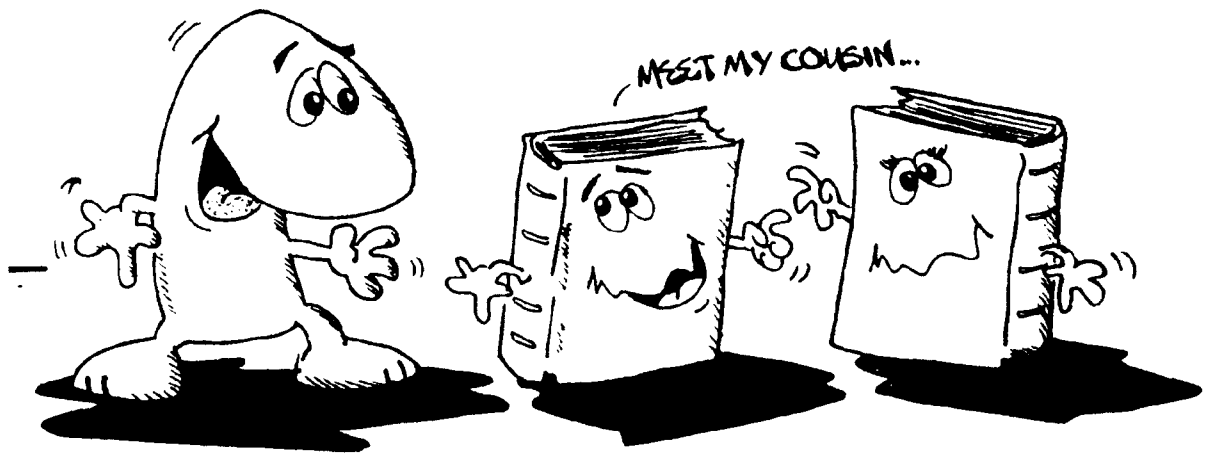
3. Because the refuse is compacted at the transfer station it provides a greater payload for the transfer trailers and reduces the number of trips that need to be made to the landfill.
4. It is more convenient for the public to use a transfer station which has good access roads and paving right up to the pit edge rather than the landfill which is often very muddy.

## CONCLUSION

Landfills are here to stay and will probably always be needed unless alternative technology becomes viable. As long as they are on good sites and are operated in an environmentally acceptable way they remain the most viable means at present for disposing municipal waste. As well, while landfills may inconvenience local residents during their operation, they can have long term advantages. Landfilling is a form of reclamation and the completed landfills are frequently used for recreation areas on sites that were formerly unsightly and dangerous quarries or gravel pits. Mt Smart Stadium in Auckland, once a landfill, is one such example.



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## RELATED READING

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