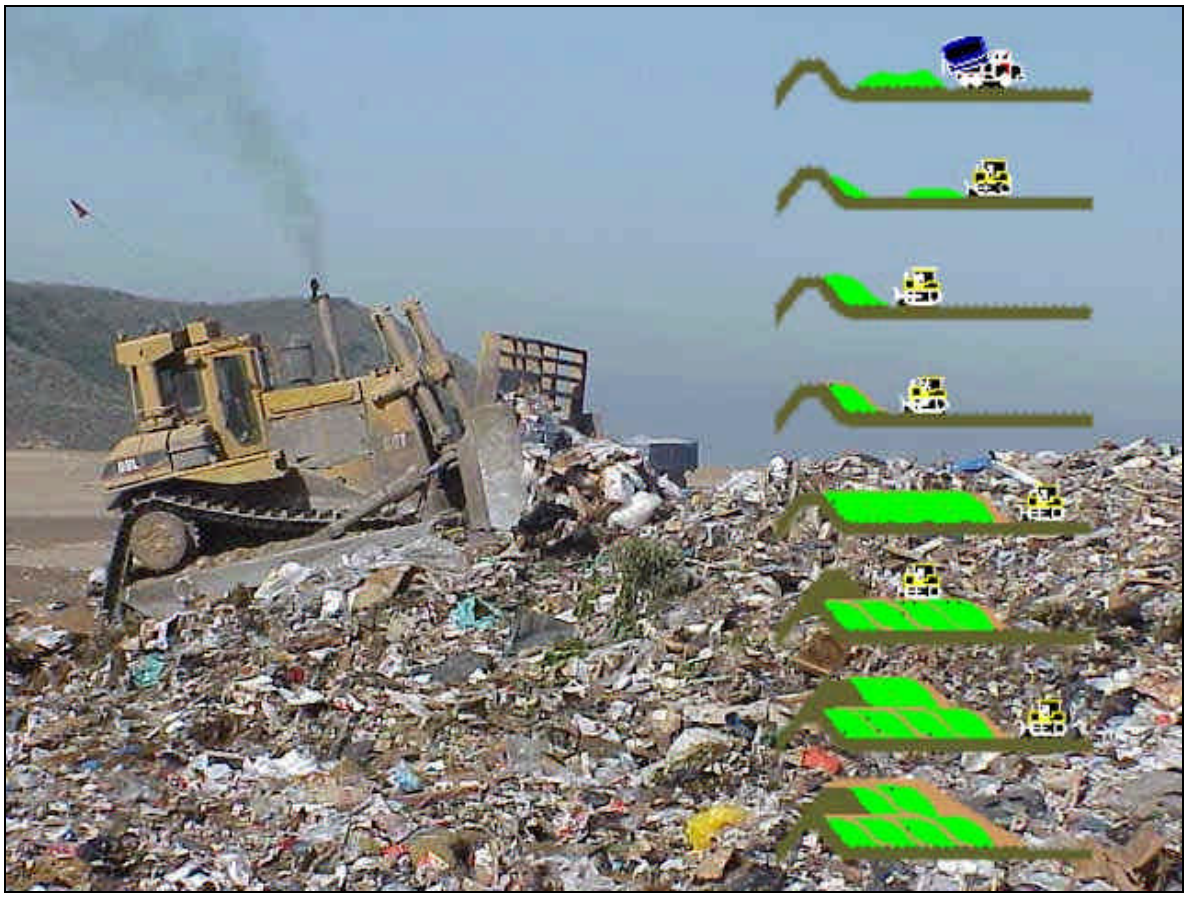
Guidelines for the Planning, Design, Operations and Maintenance of Modified Solid Waste Sites

in the Northwest Territories

by R. Kent, P. Marshall, and L. Hawke



Northwest Territories Municipal and Community Affairs

Guidelines for the Planning, Design, Operations and Maintenance of Modified Solid Waste Sites in the NWT

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Forward

This project serves to update the Guidelines for solid waste management in the Northwest Territories for the Government of the Northwest Territories Department of Municipal and Community Affairs.

The deliverables are in two separate reports: these guidelines and the background analysis report entitled *Updating the Guidelines for the Planning, Design, Operations and Maintenance of Modified Solid Waste Sites in the NWT.*

For context and rationale of directives found in the guidelines, reference may be made in the background analysis report.

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1. INTRODUCTION

1.1 PURPOSE

This document is to guide planners, designers, operators and regulators of modified landfill facilities in the Northwest Territories.

The document is organized in sections based on the sequences taken when developing a new, or expanding an existing modified landfill facility. Each section provides technical information followed by the associated regulatory requirements.

1.2 GOALS

These guidelines promote effectiveness and efficiency of municipal solid waste (MSW) management, thereby reducing the over-all cost of planning, design and operations and maintenance (O & M) of landfill facilities while ensuring the protection of public health and the environment.

These guidelines focus on objectives and principles rather than numerical limits. The latter are presented as recommended guides to summarize the available and current literature.

1.3 DEFINITION OF A MODIFIED LANDFILL

Modified landfilling is a method of disposing solid waste on land in a manner that protects human health and the environment. Applying engineering principles, solid waste is confined to the smallest practical area, reduced to the smallest practical volume and covered routinely with a cost-effective layer of earth.

1.4 OPEN BURING IS NOT ACCEPTABLE

There are adverse health, safety and environmental risks from open burning as a method of waste control. Open burning of hazardous wastes will release toxic substances into the atmosphere, potentially causing immediate health and environmental effects. This may adversely affect fire-fighting efforts. These substances may also harm the local ecosystem.

Burning can also spread quickly beyond the initial area, becoming a much larger problem. Pressurized vessels, such as aerosol cans and propane tanks, are an explosion hazard and can become grenade-like projectiles.

Open burning of municipal solid waste is not acceptable, except for clean wood and paper.

When burning these specific materials, the wastes should be moved to an area separate from the working landfill. Permitting for burning is required from RWED. Burning should only be done on days with very light wind or no wind.

Reader are referred to the RWED website - http://www.gov.nt.ca/RWED/eps/index.htm

1.5 OBJECTIVES OF SOLID WASTE MANAGEMENT

Communities should adopt the 3R's of solid waste management: reduce, reuse, and recycle. The objective of these activities is to divert as much waste from landfill as is appropriate to the opportunities that exist. To meet this objective, four major considerations must be addressed: public health and safety, environmental protection, costs and aesthetics.

1.5.1 PUBLIC HEALTH AND SAFETY

Public health impacts may arise at all stages of solid waste management from collection to transport to disposal. The main concerns are (1) communicable diseases transmitted from human faecal wastes disposed via honey bags; (2) uncovered wastes promoting infestations of disease vectors (bacteria, insects, and rodents); and (3) the release of carcinogens and respiratory irritants from the incomplete combustion of open burning.

The *Public Health Act* (*Public Health*, R.S.N.W.T. 1988, c. p.12) and its *General Sanitation Regulations* (R.R.N.W.T. 1990, c. p.16) require that adequate solid waste facilities be provided and maintained so that there are no odours and no breeding of flies.

Regulations stipulate garbage containers to be provided and emptied regularly (Section 24) and facilities must be situated:

- 90 metres from public roads, railways, right-of-ways, and cemeteries;
- 450 metres from housing; and
- A distance from water sources that ensures the protection of drinking water.

Enforcement of the Public Health Act is through the Chief Medical Health Officer and the appointed Medical Health Officers and Health Officers. Contravention of the Act and its regulations by landfill operators could result in an order to comply, which if refused may render the operator liable on conviction to a fine or imprisonment (Section 23).

Solid waste facilities may increase the risk to public safety by attracting birds. Flocks of birds in an area can pose a hazard for aircraft traveling in that same area. For this reason Transport Canada established a guideline separation distance of 8 kilometres between a modified landfill and an airport. However, this guideline is often not practical in the North, so an alternative guideline (*Establishing Guidelines for the Separation of Solid Waste Disposal Sites and Airports in the Northwest Territories* (Soberman, *et. al.* (1990)) allows for a minimum setback of 3 kilometres. The location of all new solid waste sites is subject to approval by the Transport Canada.

1.5.2 ENVIRONMENTAL PROTECTION

Proper siting, design, and maintenance and operations of modified landfill facilities are fundamental in minimizing the environmental impacts associated with solid waste disposal. Particular to the NWT are potential environmental impacts such as:

- Surface water and groundwater contamination; and
- Improperly stored hazardous wastes.

The Environmental Protection Services (EPS), Department of Resources, Wildlife and Economic Development (RWED), GNWT, administers the Environmental Protection Act (*Consolidation of Environmental Protection Act*. R.S.N.W.T. 1988, c. E-7) and various associated regulations and guidelines. This Act stipulates that contaminants may not be discharged to the environment (Section 5). The Act also contains provisions for permits and licences, in accordance with the regulations.

For copies of regulations and guidelines, readers are referred to the RWED website http://www.gov.nt.ca/RWED/eps/index.htm

With respect to solid waste facilities, the *Environmental Protection Act* is mainly concerned with hazardous wastes. EPS guidelines are available for specific substances such as waste solvents, antifreeze, asbestos, lead, lead-based paint, other paint and batteries. Hazardous waste receivers must be registered with EPS and follow the guidelines set out in the *Guideline for the General Management of Hazardous Waste in the NWT* (February 1998).

Of particular interest to solid waste disposal is the draft *Used Oil and Waste Fuel Management Regulations* (January 2000) which have provisions for used oil and waste fuel storage, incineration and discharge.

If an infraction is detected by an inspector, the solid waste operator may be issued an order to stop the discharge of a contaminant by a certain date (Section 6) or to repair, remedy any injury or damage to the environment (Section 7 (1)). Contravention of the Act by any person causing or contributing to the discharge, or the owner of the contaminant, may be found guilty and liable to a fine or imprisonment.

1.5.3 AESTHETICS

The aesthetics of modified landfills, namely foul odours and unsightly facilities, are a concern for the public. Solid waste facilities should be sited far enough away from a community such that odours are not regularly detected and the site is not visible by the residents. If possible, sites should be downwind of prevailing winds.

1.6 REGULATORY REQUIREMENTS

1.6.1 MACKENZIE VALLEY RESOURCE MANAGEMENT ACT

The advent of the Mackenzie Valley Resource Management Act and the various aboriginal/government co-management boards has vastly changed the regulatory environment in the NWT. Readers are referred to the appropriate board and website shown in Table 1.1.

Table 1.1: List of Land and Water Boards

Board	Website
Mackenzie Valley Land and Water Board	www.mvlwb.com
Mackenzie Valley Environmental Impact Review Board	www.mveirb.nt.ca
Gwich'in Land and Water Board	www.glwb.com
Gwich'in Land Use Planning Board	www.gwichinplanning.nt.ca
Gwich'in Renewable Resources Board	www.grrb.nt.ca
NWT Water Board	N/A
Sahtu Land and Water Board	www.slwb.com
Sahtu Land Use Planning Board	www.sahtulanduseplan.com

New landfill developments as well as significant changes to existing sites would trigger review by the appropriate Board. The *Mackenzie Valley Resource Management Act* replaces the *Canadian Environmental Assessment Act* in the Mackenzie Valley.

Proponents are advised to contact the appropriate jurisdiction in advance of planning or undertaking any work.

1.6.2 NWT WATER BOARD

The NWT Water Board retains responsibility for the Inuvialuit Settlement Region. New landfill developments as well as significant changes to existing sites would trigger a review.

As of March 9, 2000 the Government of Canada and the Environmental Impact Review Board (EIRB) for the Inuvialuit Settlement Region have outlined how the environmental assessment process of the EIRB under the Inuvialuit Final Agreement may be substituted for a panel review under the *Canadian Environmental Assessment Act.*

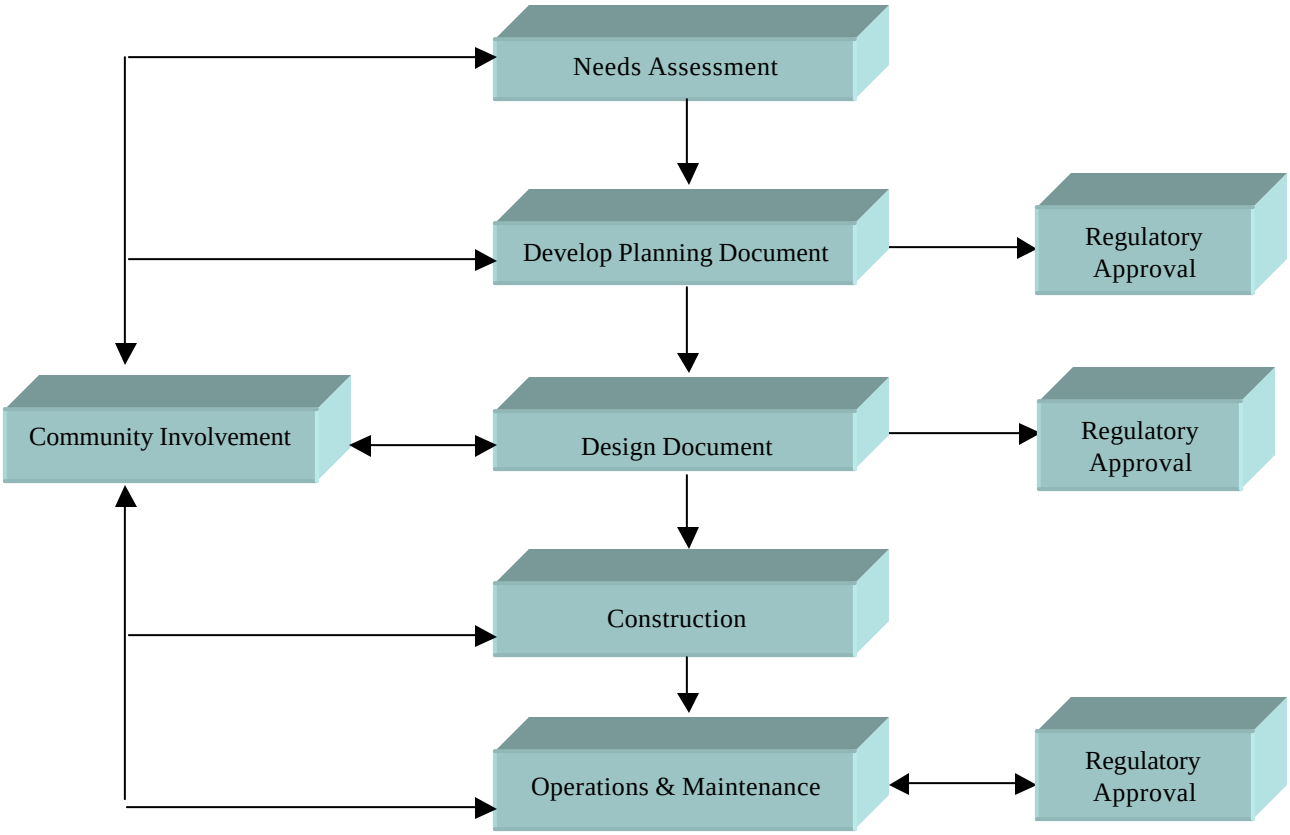
1.6.3 SUMMARY

The applicable regulatory requirements are itemized in Table 1.2: Flow Chart 1.1 summarizes the regulatory process for siting and building a Solid Waste Facility.

Table 1.2: General Regulatory Requirements Associated with Solid Waste Management

Consideration	Acts, Regulations & Guidelines	Authority	Implication
Disease Communicable diseases transmitted from human faecal wastes Uncovered wastes promoting infestations of disease vectors Carcinogens and respiratory irritants from open burning.	*Public Health Act* *General Sanitation Regulations*	Health and Social Services: Chief Medical Health Officer. Medical Health Officer. Health Officer.	Order to comply. If order is refused, liable to fine or imprisonment.
Safety Public safety from hazard to aircraft. Establishing Guidelines for the Separation of Solid Waste Disposal Sites and Airports in the Northwest Territories (Soberman, et al. 1990).	*Commissioner's Lands Act.* *Air Regulations and Aeronautics Act.* *Manual of Airport Bird Hazard Control AK-75-10-000.*	Transport Canada. Municipal and Community Affairs (MACA). Department of Transportation (DOT).	Siting recommendation: 3 km setback of solid waste facility from airport.

Consideration	Acts, Regulations & Guidelines	Authority	Implication
Water Pollution			
Surface water and groundwater contamination.	*Mackenzie Valley Resource Management Act*.	All Land and Water Boards.	Water Licence.
Improperly stored hazardous wastes.	*Northwest Territories Waters Act*.	Department of Indian Affairs & Northern Development.	Enforcement of Water Licence.
	Environmental Protection Act.	Resources, Wildlife, and Economic Development (RWED).	For Acts and Regulations: Order to comply. If order is refused, liable to fine or imprisonment.
	Environmental Information Guide for Industrial Projects on Commissioner's Land.		For guidelines: Recommendations given.
Air Pollution			
Surface water and groundwater contamination.	*Environmental Protection Act.*	RWED.	For Acts and Regulations: Order to comply. If order is refused, liable to fine or imprisonment.
Gas emissions from waste decomposition.	*Guideline for the General Management of Hazardous Waste in the NWT.*	Chief Environmental Protection Officer.	For guidelines: Recommendations given.
Emissions from open burning; and improperly stored hazardous wastes.	*Used Oil and Waste Fuel Management Regulations.*	Inspector.	
Fire			
Open burning at site.	*NWT Fire Protection Act and Regulations.*	MACA / Office of the Fire Marshal.	For Acts and Regulations: Order to comply. If order is refused, liable to fine or imprisonment.
Wildfires.	*Urban/Rural Wildfire Protection Guidelines.*	RWED.	For guidelines: Recommendations given.



Flow Chart 1.1: Summary of Process - To Plan, Build, Construct, Expand and Maintain a Solid Waste Facility

2. PLANNING SOLID WASTE FACILITIES

2.1 GENERAL

Planning modified landfills involves an understanding of the current as well as future requirements of communities, and applying engineering principles to design adequate solid waste facilities. Such planning must consider the physical characteristics of solid wastes, siting considerations, surface and groundwater impacts, and projected population growth.

2.2 PHYSICAL CHARACTERISTICS OF SOLID WASTES

For planning purposes, waste volumes, densities, compaction rates and composition of solid waste must be determined for a given community. The following are recognized standards for these waste characteristics in the Northwest Territories. Other standards may be acceptable, but should be justified.

2.2.1 VOLUME

Two community solid waste volume models (MACA, 1986) have been commonly used in the NWT: one to estimate uncompacted solid waste volume generation (m^3) in any given year, and another for the planning horizon.

Total Community Solid Waste Volume (m^3) in Any Year

$$\text{Volume(year)} = 365\ V\ P_1\ (1 + G) + 0.084\ V\ P_1^{\,2}\ (1 + G)^{2n}$$

Total Community Solid Waste Volume (m^3) in a Planning Horizon

$$\text{Volume(horizon)} = \frac{365\ VP_1}{\ln(1+G)}\left[(1+G)^{PH} - (1+G)\right] + \frac{0.084\ VP_1^{\,2}}{2\ln(1+G)}\left[(1+G)^{2PH} - (1+G)^2\right]$$

Where, V = average residential solid waste volume (m^3/person/day)

= 0.015 m3/person/day (FSC, 2000)

P_n = population in n^{th} year (persons); P_1 = population in current year (persons)

G = average community population growth rate (persons/year)

PH = planning horizon (years)

2.2.2 DENSITY

There is a wide range of municipal solid waste densities quoted in the literature. For the NWT, a density of 0.099 tonnes per cubic metre for uncompacted waste is acceptable. Other densities may be acceptable, but should be justified.

2.2.3 MATERIALS COMPOSITION

Solid wastes generated in NWT communities generally have the following composition shown in Table 2.1. Other wastes such as industrial, commercial, hazardous and bulky wastes must be estimated for each community.

Table 2.1 NWT Typical Modified Landfill Waste Compositions (% by weight)

Food Wastes	20.3
Cardboard	9.8
Newsprint	2.4
Other Paper Products	14.8
Cans	4.4
Other Metal Products	6.2
Plastic, Rubber, Leather	14.0
Glass, Ceramics	5.7
Textiles	3.8
Wood	9.9
Diapers	3.8
Dirt	4.9
	100.0

* Details may not add to totals due to averaging and rounding.

2.2.4 INDUSTRIAL AND COMMERCIAL WASTES

The management of industrial and commercial wastes is usually the responsibility of the waste generator. It is often disposed at private facilities, and is covered under separate guidelines and/or Water Licence requirements.

Municipal landfills should not accept industrial and commercial waste unless it conforms with RWED's guidelines on discharge of industrial waste. Readers are referred to the RWED website - http://www.gov.nt.ca/RWED/eps/index.htm

2.2.5 HAZARDOUS AND BULKY WASTES

Table 2.2 lists examples of types hazardous and bulky wastes disposed at municipal solid waste facilities.

Household hazardous wastes may be an issue. Most small communities do not have the capacity or expertise to undertake the management of household hazardous wastes. Further, given the nature of many communities there may be insufficient volume of household hazardous wastes to warrant an aggressive diversion program. Communities entertaining such an issue should undertake an inventory of wastes before embarking on a program.

Readers are referred to the RWED website - http://www.gov.nt.ca/RWED/eps/index.htm

Table 2.2 Examples of Bulky and Hazardous Wastes

Bulky Wastes	Hazardous Wastes
Cars	Oil based Paint
Snowmobiles	Solvents
Appliances	Propane Tanks
Engines	Waste Oil
Tires	Batteries
Clean storage tanks	Oil barrels
	Electronic Equipment

2.2.6 COMPACTION RATES

The recommended compaction rate for a modified landfill is 3:1 (Heinke and Wong, 1990). In practice, this rate varies widely but is the minimum expected for compaction when following recommended operations practices.

2.3 PLANNING HORIZON

New landfills should be planned based on a 40 year planning horizon.

2.4 HONEY BAGS

Where honey bags are still in use, honey bags are to be disposed in a location separate from, and preferably inaccessible from, the salvage area(s).

For planning purposes, the residential generation rate for honey bags is estimated at 0.0015 m^3 per person/day.

2.5 COLLECTION FREQUENCY

The preferred collection frequency for municipal solid waste (MSW) is once every two weeks in the winter, once per week in the summer. Institutional and/or commercial collection frequency associated with MSW should be determined site-specifically.

Where honey bags are still in use the minimum acceptable collection frequency is five days per week with no more than two days between collections.

2.6 COLLECTION PRACTICES

Cost efficiencies can be realized through more efficient routing and municipal pickups.

Collection systems in northern areas are highly sensitive to local conditions, including terrain, seasonal variations in accessibility and community preferences. The interplay of these variables can result in different collection systems being developed in response to ostensibly similar conditions, and in this context it is not possible to produce a meaningful 'recipe' by which these systems can be designed. Despite this variability the following collection principles can be identified as having broad applicability throughout the Northwest Territories:

- The design of an effective waste collection system must consider the size of community, proximity to neighbouring communities, and proximity to landfill;
- The collection system may involve direct haul of waste from residences to landfill, or may include a transfer station where a central landfill is appropriate; and

- Physical waste collection techniques will range from the use of small manual-load vehicles, to semi-automated or automated vehicles capable of handling both residential and commercial wastes.

Each waste collection system must meet technical and financial requirements as well as public preferences and priorities. Convenience to users and level-of-service issues typically play a large part in the selection of the preferred system, and these aspects of waste collection cannot be meaningfully generalized. Technical requirements are susceptible to local geographic conditions (e.g. presence of year-round access), however the following general principles may be used for guidance:

- Waste collection equipment should be selected according to the length of waste haul, frequency of collection, and the types and quantities of waste to be collected;

- In communities where each residence uses an individual garbage can, collection service will usually be most efficiently delivered by 1 tonne compactor-type vehicles;

- In communities where it is feasible for individual bins to service several residences, collection service may be delivered by 3 tonne side loader type vehicles. In this case, 1.15 cubic metre bins would typically be shared between 2, 3 or 4 houses. Operating efficiencies can be achieved in this system, since in addition to being used in the residential sector, the 1.15 cubic metre bins are large enough to be used by many commercial outlets (stores, offices etc), and consequently a single vehicle can be used to collect waste from both residential and commercial collection points;

- Where communities are less than 300 kilometres apart by an all-weather road (or more than 300 kilometres from a landfill), a transfer station may provide the opportunity for cost savings if regional landfills are considered; and

- Small communities with less than 1,000 residences will typically be most efficiently serviced by simple bin-style transfer stations, in which the bins are coated to prevent freezing of waste onto the container under winter conditions. Larger communities may benefit from more sophisticated compactor-style transfer stations, in which mechanical compaction is used to reduce the volume of waste prior to hauling for final disposal.

In general, cost efficiencies will be maximized when the following collection fundamentals can be combined:

- Efficient routing;

- Combined residential and commercial collection;

- Optimized use of transfer facilities (if appropriate); and
- Optimum catchment areas for regional landfills.

2.7 SITING A MODIFIED LANDFILL

Modified landfill facilities should not be visible from the community, should be set back from the airport (8 km federal regulation and 3 km interim regulation), and should be in a watershed that drains away from the community's drinking water source. These siting criteria for the NWT are simple and appear to protect ground and surface water from contamination given the results of Surveillance Network Program (SNP) data analysis for municipal landfills (FSC, 2002).

A checklist follows of factors to consider when siting modified landfill facilities.

Table 2.3: Modified Landfill Siting Checklist

Criterion	Stipulation	Reference
Area sufficient for a facility with a capacity for at least a 40-year life	See model in 2.1.1	These guidelines
Areas in flood plain	Restricted beyond 1 in 200 year return	These guidelines
Climatic conditions of region; geological and terrain conditions of site	Consider and take into account	These guidelines
Cover material availability	Where possible, in a location where cover material is readily available	These guidelines
Distance from airport to avoid hazard to aircraft from scavenging birds	3 kilometres	Soberman, *et al*. (1990)
Distance from community to avoid unsightliness, odour, and smoke	Not visible from community and/or main road (where possible)	These guidelines
Distance from community to minimize construction and maintenance costs of access road	As close as possible while complying with the previous stipulation	These guidelines
Distance from housing	450 metres	*Public Health Act* (1988) and its *General Sanitation Regulations* (1990)
Distance from public roads, railways, right-of-ways and cemeteries	90 metres	*Public Health Act* (1988) and its *General Sanitation Regulations* (1990)

Criterion	Stipulation	Reference
Distance from surface water to minimize fisheries habitat impacts	30 metres from high water mark	Department of Fisheries and Oceans policy
Distance from treeline	10 metres if no burning, 30 metres if burning will occur	Resources, Wildlife and Economic Development policy.
Geotechnical features of the site	Consider and take into account	These guidelines
Located to ensure protection of drinking water	In a watershed that drains away from the community drinking water supply	These guidelines. *Public Health Act* can be applied
Located to ensure protection of national / territorial parks, game and wildlife reserves, special fisheries areas	Restricted	These guidelines
Minimize impacts to land, birds, animals, vegetation	Contaminants may not be discharged to the environment	*Environmental Protection Act (*1988)
Zoning	Accordance with current planning documents	*Planning Act*
Wind direction	Downwind of prevailing winds if possible	These guidelines
Snow Accumulation	Potential considered and addressed through site grading and location of appropriate fences	These guidelines

2.8 MONITORING

2.8.1 GROUNDWATER

To determine whether groundwater monitoring is warranted at a particular site, the following table should be used as a guide. The intent of this approach is to identify conditions that could reasonably be expected to represent risks to ground water. The table is a guide only and local circumstances and professional discretion will dictate the final decision. Disputes or uncertainties should be resolved by a qualified groundwater scientist.

Table 2.4 Assessment of Groundwater Monitoring Need

Need	Criteria
No groundwater monitoring is required if:	❑ Hydraulic barrier greater than 10^{-6} cm/sec, 5 metres thick; and ❑ Population served less than 1000.
Groundwater monitoring may be required if:	❑ Hydraulic barrier less than 10^{-6} cm/sec, 5 metres thick; or ❑ Hydraulic barrier greater than 10^{-6} cm/sec but less than 5 metres thick.
Groundwater monitoring will be required if:	❑ Confirmed hydraulic connection with an aquifer; or ❑ Hazardous wastes are accepted at the site; or ❑ There are indicators of impact with adjacent lands.

2.8.2 SURFACE WATER

All land and water boards will require routine surface water monitoring program. At minimum three sampling stations will be required: upstream; immediately downstream; and at a receiving body. Large sites may require additional stations. Generally, the requirements will be outlined in a licence.

2.9 REGULATORY REQUIREMENTS

A community wishing to develop a new modified landfill, a lateral expansion or landfill closure must undergo the regulatory process which follows.

The community would develop a project description. This document includes what the developer plans to do and how they propose to carry it out. It does not need to be a final design document at this stage but it should include all of the information presented in section 2 of these guidelines.

Alternatively, the engineering planning document could be submitted advising the agency which option has been selected for implementation.

2.9.1 MACKENZIE VALLEY PROCESS

Whether a community is in the Sahtu settlement area, the Gwich'in settlement area or elsewhere in the Mackenzie Valley, the regulatory process and forms are identical. Whatever region the community is located in will determine which Board needs to review the application.

If a community is modifying or closing an existing landfill, the timelines and regulations set out in the original licence must be followed.

Municipal landfill development requires preliminary screening as described in the *Mackenzie Valley Resource Management Act*. This consists of three stages, preliminary screening, environmental assessment and environmental impact review, although most developments proceed to permitting after preliminary screening. Preliminary Screening forms may be found on the MVEIRB website or may be faxed or mailed through the appropriate Board.

If the responsible regulatory authority conducting the preliminary screening feels that the development might have significant public concern or there might be significant adverse environmental impacts, they can refer the licence to the Mackenzie Valley Environmental Impact Review Board (MVEIRB) for an Environmental Assessment. This is a more involved process than the Preliminary Screening and leads to recommendations that would then form a part of the licence or permit requirements. If the MVEIRB determined that there was going to be severe adverse environmental impacts from the development, it has the option to refer the project to a more comprehensive Environmental Impact Review, reject it outright, or approve with conditions to mitigate the adverse effects of public concern.

If reached, this last stage in the legislation involves public hearings and a more detailed, comprehensive analysis. The MVEIRB would take all responses into consideration when determining its recommendations that would then form part of the requirements for licensing. At any time during this process, the public or local government may approach the MVEIRB to request further environmental review or to comment on the proposed plans, recommendations and assessments.

The Minister of DIAND must approve the Environmental Assessment Report and the subsequent licence if it were an "A" Licence, or if a "B" Licence was the subject of a public hearing.

Flow Chart 2.1 shows the regulatory planning process for licensure of a solid waste facility.

2.9.2 NWT WATER BOARD PROCESS

Municipal landfill development requires preliminary screening as described by the *Canadian Environmental Assessment Act*.

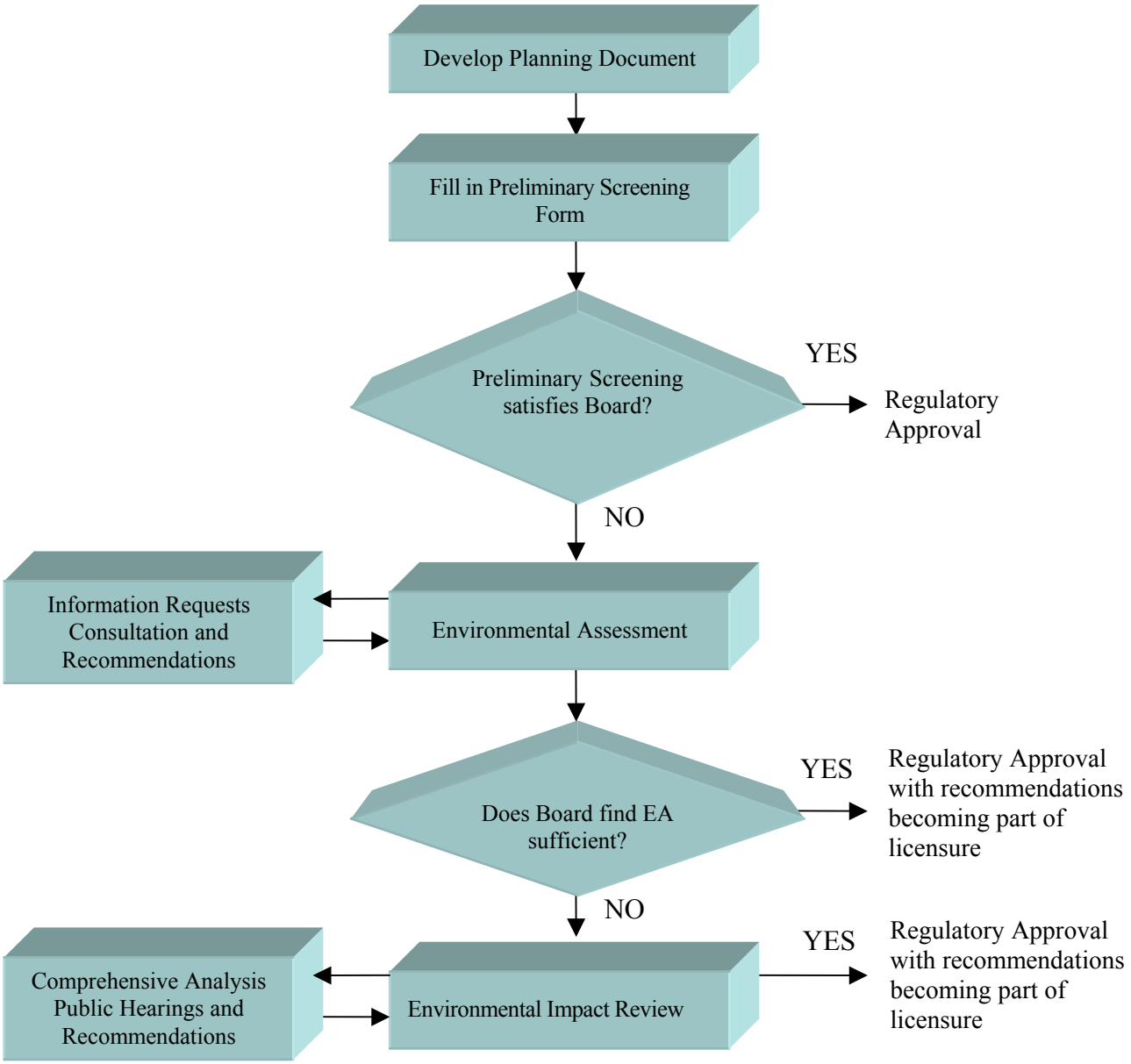
If it is determined that there was going to be severe adverse environmental impacts from the development, the project could be referred to a more comprehensive Environmental Impact Review, rejected it outright, or approved with conditions to mitigate the adverse effects of public concern. The landfill could be the subject of a revised licence, or could require the issuance of a new licence.

The Minister of DIAND must approve the Environmental Assessment Report and the subsequent licence if it were an "A" Licence, or if a "B" Licence was the subject of a public hearing.

2.9.3 INUVIALUIT PROCESS

In the Inuvialuit Settlement Region, contact the Inuvialuit Land Administration (ILA) for a land use permit application. Filling in this form requires the following information: the approximate size of the landfill, NTS maps, equipment to be used, Fuel/Oil Spill Contingency Plan, etc. Again, this is not the final design document and does not need detailed engineering drawings and such.

After review, the ILA will decide if the land use permit should be issued to the developer or referred to the Environmental Screening and Review process. If referred, Environmental Screening and Review will recommend whether or not the project can safely take place and, if so, under what terms and conditions. The licence application will be suspended until the review is complete and the recommendations are in place.



Flow Chart 2.1: Typical Regulatory Process for Planning of a Solid Waste Facility

3. DESIGNING SOLID WASTE FACILITIES

3.1 GENERAL

To minimize public health and environmental hazards a solid waste landfill is used for land disposal of refuse. This is done by periodically spreading the refuse into thin layers, compacting the refuse by driving over it a few times, and then applying a granular cover material. A *sanitary landfill* requires daily cover of compacted refuse. A *modified landfill* increases the interval between covering operations to once a month or even once a year.

Design and operation is intended to ensure that final landfill form is domed to promote the rapid runoff of surface water.

In northern climates where covering of refuse daily is impractical due to severe winter weather and in small communities that do not have staff and equipment dedicated to disposal operations, a modified landfill operation is the generally accepted standard.

In permafrost regions where ground temperatures are low, biodegradation of solid waste is so slow that it can be considered negligible.

3.2 DESIGN LIFE

All landfills should be designed for a minimum 20-year design life.

3.3 PERMAFROST ENCAPSULATION DURING OPERATION AND CLOSURE

Permafrost can be aggraded into a solid waste site to provide encapsulation. It is accomplished by ensuring that the final cover is thicker than the active layer. Such a design is compatible with any of the methods that follow, and should be considered throughout operation, and at closure.

3.4 AREA METHOD

The area method is selected where rock, a high water table, or permafrost prevents the excavation of trenches.

Wastes are disposed directly on the ground, worked with heavy equipment such as a bulldozer, and packed against a constructed berm, shown in Figure 3-1. As shown later in 4.2.1, soil is added as required and available to provide suitable cover.

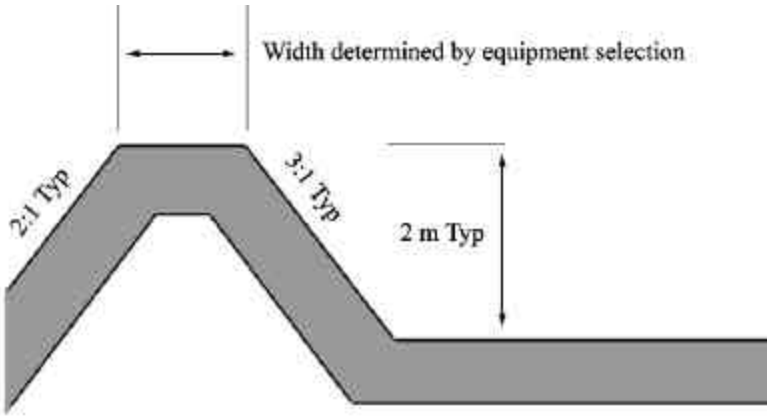


Figure 3-1 Typical Berm Dimensions Used in the Area Method

3.5 DEPRESSION METHOD

A variation of the area method, the depression method uses a natural slope. Wastes are disposed directly on the ground, worked with heavy equipment such as a bulldozer, and packed against the slope. As shown later in 4.2.2, soil is added as required and available to provide suitable cover.

3.6 TRENCH METHOD

The trench method is selected where soil and terrain conditions allow excavation. Where excavations will be shallow, this method can be used in combination with the area method. Trenches would typically be dug during the summer for use during the winter. A typical trench is shown in Figure 3-2.

Wastes are disposed in the trench, worked with heavy equipment such as a bulldozer, and packed. As shown later in 4.2.3, soil is added as required and available to provide suitable cover.

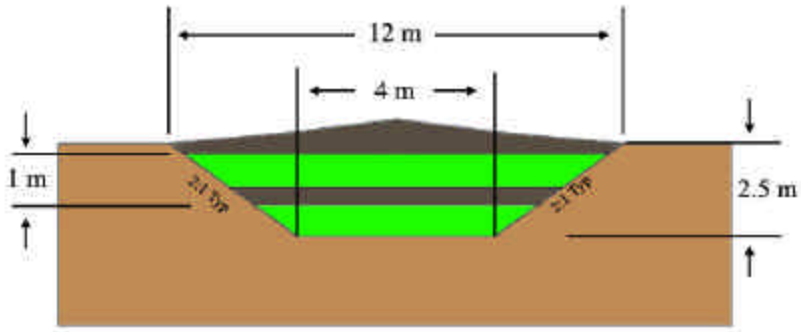


Figure 3-2 Typical Trench Design Parameters

3.7 TYPICAL SITE LAYOUT (BULKY/HAZARDOUS/HONEYBAGS/USED OIL)

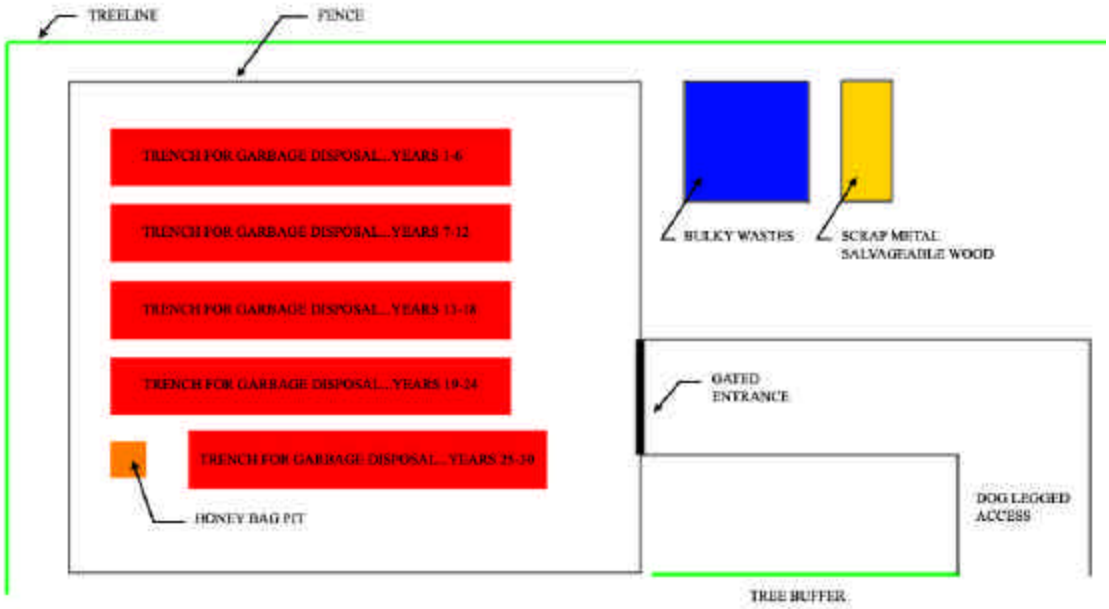


Figure 3-3 Example of the Layout for a Typical Modified Landfill Site

The above figure is an example of modified landfill site using the trench method and shows a possible layout of how waste could be segregated. Note that hazardous waste should be inside a fenced area that is locked to prevent innocent public access.

3.8 MOUNDING TO PROVIDE ADDITIONAL LIFE

With any of the recommended methods, additional life can be added to a site by mounding as shown in Figure 3-4. Slopes should be maintained for safe operation of equipment, prevent erosion, and minimize costs for cover material. Geotextile fabrics will promote slope stability.

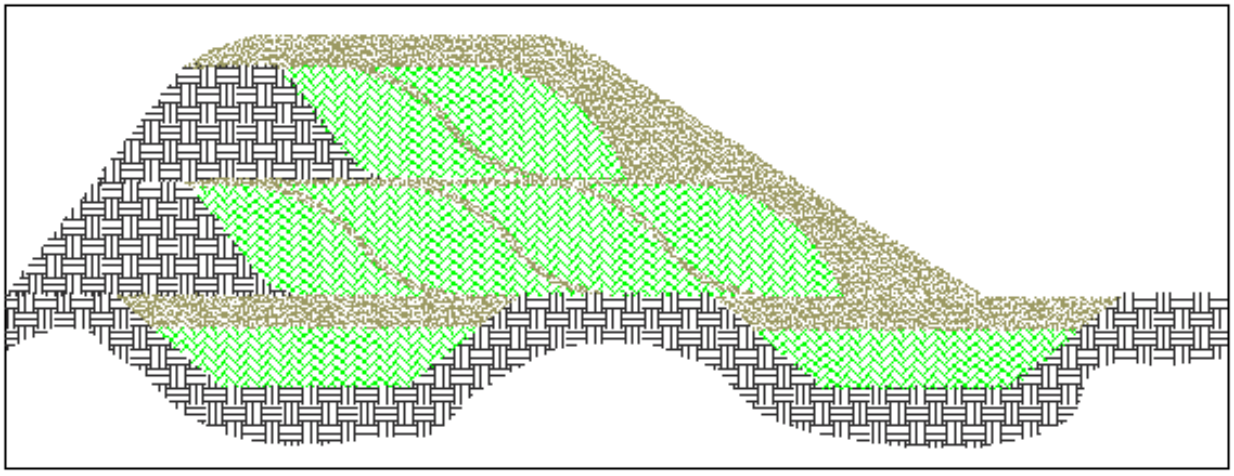


Figure 3-4 Mounding Concept

3.9 FENCING

The installation and maintenance of fencing is recommended at solid waste facilities for the following reasons.

- To control or limit access to the landfill site by community residents;
- To prevent scavenging animals from causing a nuisance and risking the safety of workers and residents; and
- To control the spreading of blowing garbage.

Fencing may be portable or permanent and may be woven or chain linked.

Electric fencing has proven to be an effective deterrent against bears.

Wooden fences are not recommended, as they can be a fire hazard.

Installation of snow fencing is recommended during the winter to reduce snow accumulation within the site. Gating the entrance and providing times for the public to enter the site are also recommended.

3.10 SIGNAGE

Water licences require that signs be posted in the area to advise the public that the site is being used for the disposal of solid waste. All accesses should be posted.

Additionally, signs are appropriate to advise the public of the use of recycling and take-it-or-leave-it facilities, hours of operation, emergency numbers and the like.

3.11 WATER

3.11.1 GENERAL

Flowing water should be prevented from entering the site. Cut-off berms, swails, and trenching are effective diversion methods. Water should not pool on site, rather drain quickly without causing erosion.

3.11.2 SURFACE WATER SAMPLING DESIGN

A water licence will require samples of flowing water as detailed in a Surveillance Network Program. Samples should be collected upstream and downstream of the site. The sample sites should be staked or otherwise marked to ensure representative sampling results.

3.11.3 MONITORING WELL DESIGN

If required, a groundwater monitoring program must have a sufficient number of monitoring wells, installed at appropriate locations and depths, to yield water samples that:

1. Represent the background conditions of the site (usually hydrologically up gradient from the solid waste facility);

2. Represent the quality of groundwater passing through the site; and

3. Detect any contamination of the uppermost aquifer.

The number, spacing and depths of monitoring wells must be based upon the site-specific characterization of aquifer thickness, groundwater flow rate and direction (including seasonal and temporal fluctuations).

Further, the saturated and unsaturated geologic units and fill materials overlaying the uppermost aquifer and lower aquifer characteristics must be taken into account including: thickness, stratigraphy, lithology, hydraulic conductivity, porosity and effective porosity.

Groundwater monitoring wells should be designed to best ensure they detect contamination from the solid waste site, that is, they should not be located at such a distance from the site as to avoid likely contamination.

The system must be designed and submitted by a qualified groundwater scientist.

3.12 HAZARDOUS WASTE STORAGE FACILITIES

Hazardous waste storage areas should be located within a fenced area, separately fenced if possible, away from innocent public access. Based on the inventory of wastes, sufficient and separate storage should be provided. Storage lockers must be CSA or UL approved, maintained under the responsibility of trained personnel. Readers are referred to the RWED website - http://www.gov.nt.ca/RWED/eps/index.htm

3.13 REGULATORY REQUIREMENTS

A community wishing to develop a new modified landfill, a lateral expansion or landfill closure must undergo the following regulatory process.

3.13.1 MACKENZIE VALLEY PROCESS

Whether a community is in the Sahtu settlement area, the Gwich'in settlement area or elsewhere in the Mackenzie Valley, the regulatory process and forms are identical. Whatever region the community is located in will determine which Board needs to review the application. Readers are referred to Table 1.1 for more information.

If a community is modifying or closing an existing landfill, the timelines and regulations set out in the original licence must be followed. Abandonment and restoration must be considered at design and detailed in supporting documentation.

Once completed, the engineering design documents must be submitted for approval.

3.13.2 NWT WATER BOARD PROCESS

If a community is modifying or closing an existing landfill, the timelines and regulations set out in the original licence must be followed. Abandonment and restoration must be considered at design and

detailed in supporting documentation. Once completed, the engineering design documents must be submitted for approval.

3.13.3 INUVIALUIT PROCESS

Once completed, the engineering design documents must be submitted for approval.

4. OPERATION AND MAINTENANCE

4.1 MODIFIED LANDFILL GENERAL CONSIDERATIONS

The cost-effective operation of a modified landfill is the basis for design. Operations are recommended as follows:

- Compaction rates of 3:1 or better are achieved by working a bulldozer or other appropriate heavy equipment over the waste 3 to 5 times;
- Compaction of wastes is undertaken once per week or in combination with collection frequency. Generally, the wastes should be worked and compacted as they are dumped;
- Operations should be undertaken to minimize close-out requirements; and
- Cover material is generalized as 100mm between cells, 300mm on the surface of cells, 600mm as part of close out.

4.2 MODIFIED LANDFILL OPERATIONS

There are three main methods of operating a modified landfill, the area method, the trench method and the depression method.

4.2.1 AREA METHOD

In the area method, waste is emptied out of collection vehicles at the bottom of a short berm. The berm should be 2 metres high. Wastes are worked and compacted against the berm. In the spring or fall, or when the compacted garbage is 3 metres wide, the compacted wastes are covered with 300 mm of granular material. Dry, sandy material is preferred where available. The process is repeated until the landfill is full.

At this point the site can be closed out with a 600 mm cover, domed to promote runoff of water.

Alternatively, a mound can be implemented by packing 300 mm of granular material on the surface prior to beginning the second layer.

Figure 4.1 illustrates the area method for modified landfill sites. The depression method, shown in Figure 4.2, is similar to the area method except that dumping and compacting takes place against a depression or natural slope.

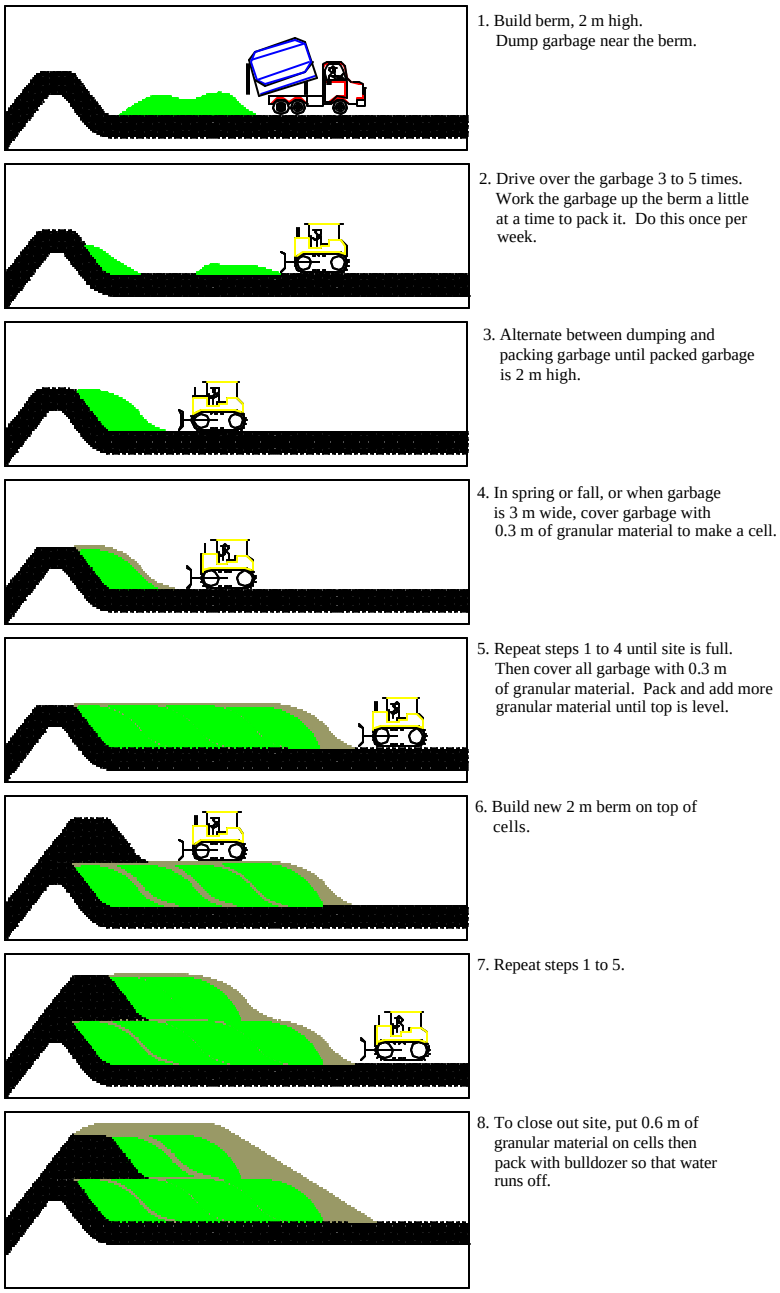
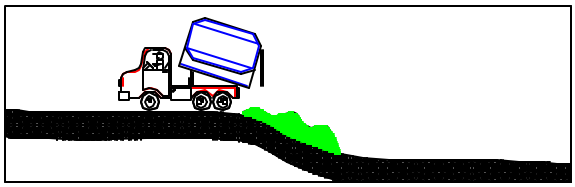
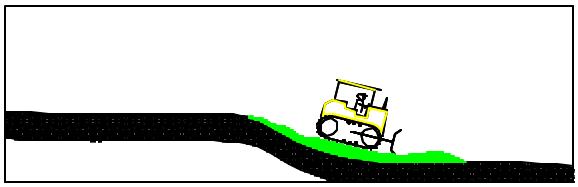


Figure 4-1 Area Method with a Second Layer

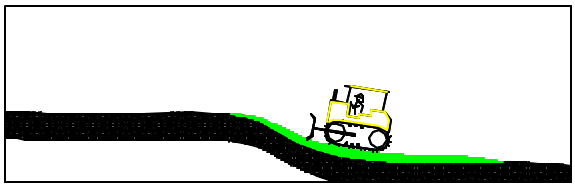
4.2.2 DEPRESSION METHOD



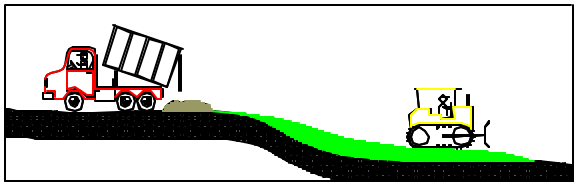
1. Dump garbage near slope.



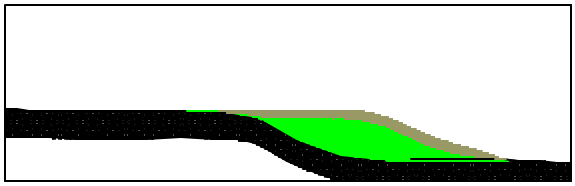
2. Spread the garbage down the slope.



3. Work garbage back upslope a little at a time. Drive over the garbage 3 to 5 times to pack it. Do this once per week.



4. Alternate between dumping and packing until the garbage is 2 m high.



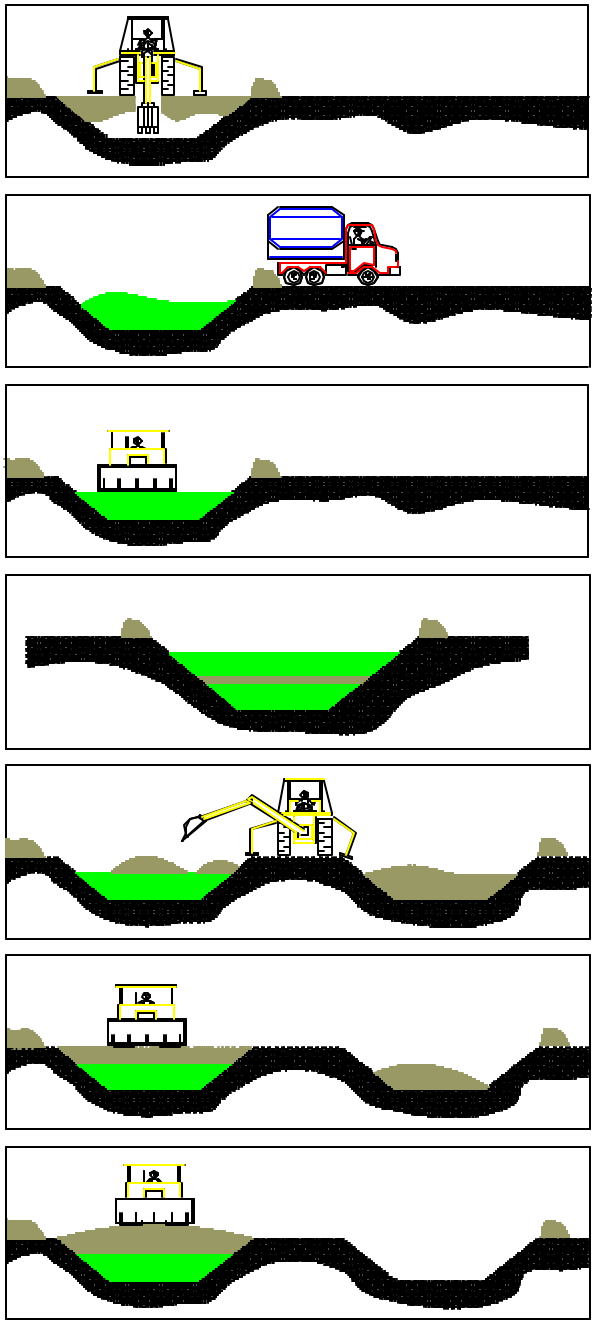
5. In the spring or fall, or when garbage is about 3 m wide, cover garbage with 0.3 m of granular material and pack with bulldozer to make a cell.
Repeat steps 1 to 4 until landfill is full.

To close out site, put 0.6 m of granular material on garbage and pack so that water runs off.

Figure 4-2 Depression Method

4.2.3 TRENCH METHOD

The trench method is the preferred option where the land is suitable for excavation.



1. Dig trench 6 m wide and up to 2.5 m deep. Slope sides to prevent cave-ins. Build wheel stop berm on dumping side, 0.45 m high.

2. Dump garbage into trench.

3. Use bulldozer to pack the garbage by driving over it 3 to 5 times, once per week, until garbage is 1 m high.

4. If trench is deep enough to do more than one layer of garbage, pack 0.3 m of granular material between layers of garbage.

5. Cover garbage with 0.3 m of granular material from new trench when crushed garbage is 1 m high. Make sure to build a new 0.45m wheel stop berm for next trench.

6. Add and pack granular material with bulldozer until even with ground.

7. To close out trench, pack granular material with bulldozer until hard so that water runs off. Add more granular material to make mound 0.3 high in the middle.

Figure 4-3 Trench Method

4.3 HONEY BAG PIT

The honey bag pit should be covered frequently during warm weather with soil and/or lime to prevent the breeding of flies.

4.4 COMMUNITY WORKS MANAGEMENT SYSTEM / MAINTENANCE MANAGEMENT OPERATING SYSTEM

The CWMS/MMOS is a task based maintenance management system developed by GNWT/MACA. The system is made of several parts, each contributing to the overall running of the system. The parts include:

- An inventory of assets to be maintained;
- Quality standards to which assets are to be maintained;
- Maintenance procedures and production levels;
- A work order system to authorize work;
- A maintenance schedule;
- Stock control;
- A method to collect data and report results; and
- A method to develop annual budgets and work programs.

The CWMS is a paper-based system. The MMOS is a computer-based system developed using the identical algorithm as the CWMS.

4.5 MONITORING PROCEDURES

4.5.1 WEIGHT/VOLUME

The annual weight and/or volume of waste disposed should be determined and recorded. Using weigh scales is best practice, however, volumes can be estimated from truck box measurements.

4.5.2 MATERIALS COMPOSITION

The materials composition Table 2.1 may be used to estimate the potential for the effectiveness of diversion and recycling programs. If such programs are to be implemented, then the actual materials composition should be determined. It is noted that consumer trends and new packaging may change the composition over time. Composition studies should be undertaken routinely to understand these changes and how they may affect programming.

4.5.3 HAZARDOUS WASTE STORAGE

All hazardous wastes entering and leaving the site should be identified, inventoried, and logged. No hazardous wastes are to be disposed at modified landfills. Readers are referred to http://www.gov.nt.ca/RWED/eps/index.htm for more details on hazardous wastes.

4.5.4 WATER AND SOIL SAMPLING

Follow the *Guidance Manual on Sampling, Analysis and Data Management for Contaminated Sites – Volume 1: Main Report* (CCME, 1993), and any subsequent revisions.

4.6 REGULATORY REQUIREMENTS

4.6.1 OPERATION AND MAINTENANCE MANUAL

As part of due diligence, and a compliance item for a Water Licence, the issuing Board will require the preparation of an Operation & Maintenance Manual for the Sewage and Solid Waste Facilities.

The stated purpose of the manual is to assist community staff in the proper operation and maintenance of their waste disposal facilities. It must include:

- A description of how facilities are operated and maintained;
- How often these tasks are performed; and
- Who is responsible for their completion.

The manual must also demonstrate to the Water Board that the community is capable of operating and maintaining their waste sites.

Inspectors will use the community's manual as part of their inspection procedure to ensure that the stated procedures are being undertaken.

The manual is to be developed according to the requirements of the Water Board. For solid waste sites, it shall include but not be limited to the following:

- Location of facilities and proximity to receiving waters;
- Frequency of inspection of dams, dykes and drainage courses;
- Controlling effluent discharge quality;
- Runoff and drainage control within and around the facility, and restoration of erosion;
- Treatment of contaminated drainage;
- Prevention of windblown debris;
- Managing hazardous waste;
- Segregation of domestic, metal and recyclable waste materials;
- Method and frequency of site maintenance; and
- Alternatives designed to prevent burning of MSW.

4.6.2 DUE DILIGENCE

Regulatory compliance requires due diligence. Due diligence may be as defined as:

- Establishing a proper system to prevent contravention of regulatory standards; and
- Taking all reasonable steps to ensure effective operation of that system.

As part of the due diligence program, an internal monitoring and reporting program must be put in place. This program actively promotes the interrelationship between staff and management so that information, resources and finances can be directed effectively.

Documentation is fundamental to the program. Some of the information requirements include:

- The environmental policy;
- Roles, responsibilities and authorities;
- Significant environmental aspects;
- Legal requirements;
- Training;
- Communication within the organization;
- Communication with regulatory authorities;
- Emergency response;
- Monitoring and measurement;
- Audits; and
- Records management.

5. CLOSURE

5.1 GENERAL

Once a landfill has reached capacity, final closure must be completed in a manner that ensures the long-term protection of the environment. Site closure requirements include:

5.2 REGULATORY REQUIREMENTS

All land and water boards require notification of a pending closure. Generally, a plan must be submitted for approval at least six months prior to closure that includes the following information:

- Future land use;
- Leachate prevention and monitoring;
- An implementation schedule;
- Mapping which shows all disturbed areas, borrow material areas, and site facilities;
- Consideration of altered drainage patterns;
- Type and source of cover materials;
- Hazardous wastes including waste oil; and
- Contaminated site remediation.

5.3 FUTURE LAND USE

Any future use of the site should be passive to reduce problems that may result from the stored waste. Recommended uses include:

- Waste transfer station or related storage area;
- Bulky waste storage;
- Passive recreation; and
- Open area.

5.4 INFRASTRUCTURE AND EQUIPMENT REMOVAL (AS APPROPRIATE)

Materials stored for reuse may be landfilled, including tires, wood, metal and the like.

Waste oil and other liquids should be identified and removed.

Batteries and other hazardous materials should be identified and removed.

Any buildings on site should be decommissioned and removed.

Fences should be removed and reused if possible, otherwise landfilled.

Bulky waste should be removed.

5.5 GRADING AND CAPPING

The site should be capped with 600 mm of material and graded to positive drainage. Where readily available, clay material is preferred. The site should be seeded to stabilize the soil and prevent erosion.

5.6 SURVEY

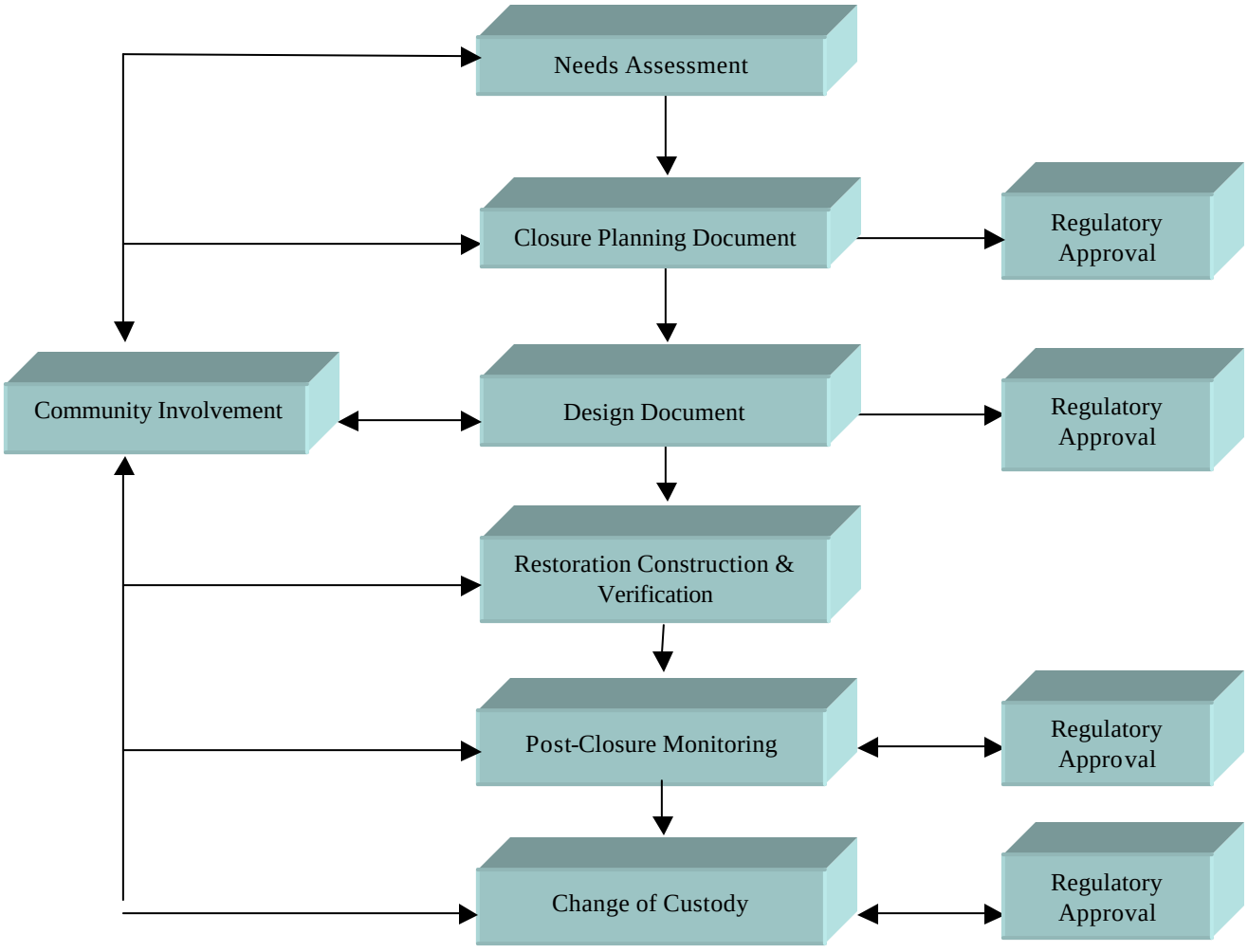
A final survey should be undertaken to mark designated areas, locate monitoring wells and SNP locations, map and document the extent of the site. The survey should be tied to a permanent benchmark if available.

5.7 REGISTRATION

The site should be identified as a Solid Waste Management Facility on the land title documents.

5.8 SIGNS

A sign should advise the public that the site is closed and should indicate alternative facilities. Flow Chart 5.1 summarizes the regulatory process for reclamation of a Solid Waste Management Facility.



Flow Chart 5.1 Summary of Process to Plan, Construct, Monitor and Reclaim a former Solid Waste Facility

6. POST CLOSURE

6.1 GENERAL

Long term care of the decommissioned landfill is important so that the impacts to the surrounding environment are minimized.

For every site, cover material should be allowed to settle and re-graded as necessary. Any cave-ins should be filled in to prevent standing water. Vegetation should be monitored to ensure that it continues to grow. There should be on-going maintenance of drainage pathways and the like.

6.2 INSPECTIONS

A post closure inspection checklist should be filed with the appropriate regulatory body. The checklist should include:

- Inspection frequency;
- Items to be inspected; and
- Compliance requirements.

6.3 POST CLOSURE MONITORING

Operational monitoring shall be continued into the post-closure period until one or more of the following conditions apply:

- It can be demonstrated that the site is no longer releasing contaminants; or
- It can be demonstrated that the site has reached an equilibrium state in which contaminant release poses no unacceptable risk to the environment.

Proponents shall submit a report to the appropriate regulatory body which justifies the cessation of monitoring. Disputes or uncertainties should be resolved by a qualified groundwater scientist.

6.4 REGULATORY REQUIREMENTS

All land and water boards will require routine reporting. Generally, the requirements will be outlined in a licence.

7. REFERENCES

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