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Solid Waste Management for Northern and Remote Communities

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ACRONYMS AND ABBREVIATIONS

CCME—Canadian Council of Ministers of the Environment

CEQG—Canadian Environmental Quality Guidelines

CRD Waste—Construction, renovation, and demolition waste

E-waste—Electronic waste

ECCC—Environment and Climate Change Canada

ELV—End-of-life vehicle

EPR—Extended producer responsibility

GHG—Greenhouse gas

ICI Waste—Industrial, commercial, and institutional waste

IUCN—International Union for Conservation of Nature

LFG—Landfill gas

MOLO—Manager of Landfill Operations

MSW—Municipal solid waste

PPE—Personal protective equipment

SARA—Species at Risk Act

SWANA—Solid Waste Association of North America

TDG—Transportation of dangerous goods

VOC—Volatile organic compound

GLOSSARY

Composting—a managed, biological process through which organic matter is degraded under aerobic conditions to a relatively stable, humus-like material called compost.[1]

Construction, Renovation, and Demolition (CRD) Waste—refers to waste generated by construction, renovation and demolition activities (e.g., lumber, drywall, metal, doors, windows, wiring).[2]

Contaminating Lifespan—the period of time during which the landfill contains contaminants which could have an unacceptable impact if released to the environment.

Daily Cover—soil that is spread over compacted waste at the end of each working day.

Disposal—the act or process of getting rid of a product or material indefinitely, typically in a landfill.

Diversion—keeping products or materials away from disposal through reuse, recycling, and composting.

Extended Producer Responsibility—a policy approach in which a producer's responsibility—physical and/or financial—for a product is extended to the post-consumer stage of a product's life cycle.[3]

Freshet—spring discharge from melting ice and snow.

Hazardous and Special Waste—materials or substances that because of their corrosive, inflammable, infectious, reactive, and toxic characteristics, may present real or potential harm to human health or the environment.[4]

Industrial, Commercial, and Institutional (ICI) Waste—the waste generated by non-residential sources in a community.[5]

Landfill Cell—a lined area where residual waste is placed, compacted, and covered.

Landfill Gas—a mixture of gases that results from the decomposition of organic waste in landfills and that is composed primarily of methane, which is a potent greenhouse gas and potential explosion hazard.

Leachate—the liquid that has been in contact with waste (e.g., landfill cell, compost facility) and has undergone chemical or physical changes.

Legacy Waste—piles of waste that result from past waste management practices and that are typically not segregated or depolluted.

Municipal Solid Waste (MSW)—reusables, recyclables, compostables, and residual waste (i.e., garbage) from homes, businesses, schools, and other institutions.

Municipal Solid Waste Facility—a dedicated area designed for storing, processing, and disposing of waste in an environmentally-sound manner.

Natural Attenuation—the reduction of pollutant concentrations through naturally-occurring biological, physical, and chemical processes.

Open Burning—burning waste in landfills, barrels, open pits, outdoor furnaces, woodstoves, or fireplaces.[6]

Permafrost—soil or rock that remains frozen at least two years in a row.[7]

Recycling—a process whereby a material (e.g., metal, paper, plastic, glass) is diverted from disposal and remanufactured into a new product or is used as a substitute for raw materials.[8]

Residential Waste—waste from households, which include single-family and multi-family residences.[9]

Residual Waste—waste that remains after reuse, recycling, composting, and treatment.

Reuse—the use of a product or material more than once, sometimes with a modification from its original purpose (e.g., turning a scrap tire into a swing or planter).[10]

Source Reduction—the act of preventing the generation of waste (e.g., using reusable bags, buying food in bulk).[11]

Stormwater—water that originates during precipitation events and snow and ice melt.

Tipping Fee—a fee charged at the point of reception for treating, handling, and/or disposing of waste materials which is usually applied on a per-tonne basis.[12]

Waste Management Plan—a document that helps the community to take stock of the existing waste management situation, define goals and objectives, identify appropriate strategies, and evaluate the waste management system so as to continuously improve over time.

White Goods—large appliances, such as refrigerators, freezers, and stoves.

ENDNOTES

1 Environment and Climate Change Canada. 2013. Technical Document on Municipal Solid Waste Organics Processing.

2 Statistics Canada. 2013. Waste Management Industry Survey: Business and Government Sectors 2010.

3 Environment and Climate Change Canada. Extended Producer Responsibility Webpage.

4 Environment and Climate Change Canada. Hazardous Waste and Recyclable Material Webpage.

5 Statistics Canada. 2013.

6 Environment and Climate Change Canada. 2010. Open Burning of Garbage.

7 Natural Resources Canada. Permafrost Webpage.

8 Statistics Canada. 2013.

9 Federation of Canadian Municipalities. 2004. Solid Waste as a Resource: Guide for Sustainable Communities.

10 *Ibid.*

11 *Ibid.*

12 Environment and Climate Change Canada. 2013.

1.0 INTRODUCTION

1.1 ABOUT THIS DOCUMENT

The idea for this document first came about several years ago during informal discussions between representatives from Environment and Climate Change Canada (ECCC) and the territorial governments. Since then, ECCC has been working to deepen its understanding of the complex waste management issues faced by northern and remote communities and has developed this planning and technical guidance document with insight, support, and knowledge from territorial governments, key stakeholders, and a variety of experts. Although the focus of the document is on Canada's territories, the best practices are applicable to communities in the northern parts of the provinces, indigenous communities, and other small communities across Canada.

This document provides guidance on best practices for the planning, design, operation, and eventually, closure of existing or new municipal solid waste (MSW) facilities in northern and remote regions. For the purposes of this document, a MSW facility typically includes the following elements:

- Dedicated areas for processing and storing wastes that have been sorted (e.g., hazardous and special waste, electronic waste, organic waste, recyclables);
- An area for residual waste disposal (landfill cell or incinerator) and/or transfer (storage); and
- Associated infrastructure, such as heavy equipment, a shelter for staff, fencing, and signage.

This document was developed with various audiences and purposes in mind:

- To assist regulators, such as environment ministries and natural resource management boards, in setting waste management policies, issuing permits or licences, and overseeing operations;
- To give community infrastructure departments, senior administrative officers, band managers, and other officials tools to develop waste management plans, allocate resources, and engage with consulting firms as well as service and technology providers;
- To support MSW facility operators in making incremental improvements to their operations; and
- To provide governments and other organizations with practical information for developing public outreach and training materials.

The first two sections of the document (Sections 2 and 3) provide guidance on the waste management planning process, while the latter half of the document (Sections 4 through 9) provides technical guidance on MSW facility design, operation, and closure. Specifically:

- **Section 2** discusses the importance of waste management planning, describes the key steps a community can take to continuously improve its waste management system over time, and includes a framework for prioritizing the recommended best practices;
- **Section 3** provides guidance on site evaluation and selection for a new MSW facility or a new sub-component, such as a landfill cell, or on the assessment of an existing MSW facility or landfill cell to identify potential areas for improvement;
- **Section 4** provides guidance on the general operation of the MSW facility, recommends priority actions that apply to the MSW facility as a whole, and provides examples of conceptual layouts;
- **Section 5** provides technical guidance on the design, construction, and operation of a landfill cell for residual waste disposal within a MSW facility and recommends priority actions;

- **Section 6** prioritizes the remaining major waste types (e.g., hazardous and special waste, electronic waste, end-of-life vehicles, bulky waste, scrap tires, construction, renovation, and demolition (CRD) waste, organic waste, reusable items, and recyclables) and presents best practices in terms of design and operations for each;
- **Section 7** provides an overview of considerations for MSW facility performance monitoring and reporting;
- **Section 8** provides an overview of considerations for closure and post-closure activities that apply to an entire MSW facility or to progressive closure of a sub-component, such as a landfill cell; and
- **Section 9** summarizes the key recommended best practices and suggests next steps for improving waste management in northern and remote communities.

References are included as endnotes in each section, and Appendix A provides additional resources on the various topics covered in this document.

1.2 LIMITATIONS OF THIS DOCUMENT

As with other voluntary guidance documents, users of this document should always take into account their specific local conditions and existing requirements. Although great care has been taken to provide accurate and practical guidance, the information contained in this document is not intended to supersede any local, provincial/territorial, or federal regulatory requirements and should not be seen as a substitute for advice from qualified professionals.

Although generating zero waste is a good aspirational goal, the reality is that despite best efforts to reduce, reuse, and recycle, there will always be some materials to be disposed of. ECCC recognizes that northern and remote communities may have more than one disposal option for residual waste, including:

1. Transfer of waste to a regional disposal facility (refer to Appendix A, Regionalization);
2. Disposal of waste in a landfill cell within the community's MSW facility (refer to Section 5); and
3. Incineration of waste and landfilling of ash on-site (refer to Box 5-1 in Section 5).

With respect to disposal options, the focus of this document is on option 2, i.e. managing residual waste in a landfill cell within the community's MSW facility. This option is profiled since it is likely to be the most common and feasible practice for the majority of communities in northern and remote areas of Canada. Although technical guidance for transfer stations is not included in this document, many of the considerations and principles related to siting, waste screening, segregation, and storage are applicable to a waste transfer system scenario (refer to Appendix A, Regionalization).

The document does not include planning or technical guidance on waste collection systems, although Table 2-1 briefly identifies some of the advantages of curbside collection versus drop-off systems. Nor does it provide detailed information on how to engage the community and raise awareness on the importance of proper waste management which are activities that can play a significant role in the success of any waste management system. However, many resources are available on these topics from government and environmental non-governmental organizations (refer to Appendix A, Waste Management Planning and Public Outreach).

For the purposes of assisting communities in prioritizing improvements to waste management, waste types have been categorized as high, medium, and lower-priority using a risk-based approach. The priority level is based on several factors, such as a waste type's relative risk to human health and the environment, as well as its proportion of the total waste stream. As a result, the recommendations outlined in this document complement, but do not necessarily follow, the conventional 3Rs (Reduce, Reuse, Recycle) hierarchy.

1.3 CONTEXT

Communities in northern and remote regions face unique challenges in managing their municipal solid waste (MSW, refer to Box 1-1) due to climate, geology, population size and distribution, socio-economic factors, and access to services and facilities. As a result of these challenges, some existing waste management practices are not sufficiently protective of human health and the environment. While the principles of environmentally sound waste management are well-documented, these best practices need to be adapted to the distinct circumstances of northern and remote communities.

Responsible waste management requires careful planning, prudent investment, and ongoing management and monitoring. As communities grow in population and economic activity, so do the quantities and types of wastes that require management. As such, waste management policies, programs, and infrastructure need to evolve to take into account the community's needs and available resources.

Waste management planning, with meaningful community engagement, is fundamental to a community's success in improving its practices. Through this process, communities can take stock of their current waste management situation, set priorities and goals, identify and evaluate options, develop and implement a waste management plan, and then track their progress and make adjustments over time. To create efficiencies and expand waste management options, partnerships with neighbouring communities, private businesses, educational institutions, and non-profit organizations should be pursued whenever feasible. Among other benefits, a good waste management plan can reduce costs over the long term, create employment opportunities, and reduce environmental risks and future liabilities for the community.

As part of their waste management system, most communities have access to some type of MSW facility, ranging from basic to more advanced infrastructure, where they can store, process, and dispose of their waste. The proper design, operation, monitoring, and eventual closure of part or all of a MSW facility are integral to the health and safety of the community

BOX 1-1: WHAT IS MUNICIPAL SOLID WASTE?

Municipal solid waste (MSW) or simply "solid waste" are terms used by the waste management sector to refer to reusables, recyclables, compostables, and residual waste (i.e., garbage) from homes, businesses, schools, and other institutions. The term MSW can be applied regardless of the type of settlement (e.g., hamlet, village, town, municipality, First Nation). MSW and solid waste are not to be confused with sewage sludge or biosolids.

and to the protection of the surrounding environment. As such, the ongoing support of qualified professionals and trained personnel is required.

In northern and remote communities, competing infrastructure priorities, limited budgets, and the high cost per capita of building and maintaining infrastructure are an ongoing reality. In response, this document is founded on two guiding principles: (1) taking a risk-based approach to waste management, which means prioritizing infrastructure, operational activities, and waste types to reduce the risks to human health and the environment; and (2) committing to continuous improvement to the waste management system over time.

1.4 CURRENT WASTE MANAGEMENT PRACTICES

Although waste management practices vary across northern and remote regions of Canada, many communities dispose of their waste in unlined disposal sites, sometimes referred to by communities as "dumps" or "dumpsites". These sites and some of their associated operational practices, such as open burning of waste, can be a source of pollution. A handful of communities that are connected by road and are relatively close together have transfer stations for temporary storage of their waste and use a regional landfill for waste disposal.

Waste management practices sometimes include segregation of waste types, i.e., hazardous and special waste, electronic waste, etc. It is common for segregated wastes to accumulate in communities until there is an incentive (primarily driven by economics) to transport them to an appropriate treatment or recycling facility or to treat them on-site. If the incentives are not present, the segregated wastes continue to accumulate.[1]

In recent years, some communities have made great strides in waste management while others have chosen not to adopt more protective policies in the face of competing community infrastructure priorities, such as housing, schools, health care facilities, water and wastewater treatment systems, and roads. Using a risk-based approach to prioritizing certain infrastructure improvements, operational activities, and waste types, as proposed in this document, may be of particular interest to these communities.

1.5 A VISION FOR THE FUTURE

In this document, the term "MSW facility" intentionally replaces common terms like "dump", "dumpsite", "solid waste site" or "landfill", although the MSW facility may include a landfill cell for disposal of residual waste (i.e., the waste that is leftover after reuse, recycling, composting, and treatment). Building on traditional respect for nature, waste can be seen as a resource rather than a source of pollution (refer to Box 1-2).

The waste management approach promoted in this document supports the national vision adopted by Canadian environment ministers in 2014 and its objective to, "address the challenges of remote and Northern communities to improving their waste practices". For some northern and remote communities, the path to achieving this objective is an incremental one but the goals are the same:

- Waste will be sorted, processed, and stored temporarily on-site for reuse, recycling, composting, or treatment;

- Hazardous and special waste and hazardous substances will be kept separate and stored temporarily and safely until proper treatment or disposal;
- The open burning of waste will become a thing of the past;
- The quantity of waste requiring disposal will be greatly reduced and any residual waste disposal on-site will be done in an environmentally-sound manner; and
- Community members and the private sector will be actively engaged in sustainable waste diversion activities.

BOX 1-2: TRADITIONAL AND LOCAL KNOWLEDGE AND WASTE MANAGEMENT

Northerners are resourceful people with a long history of conservation and protection of resources. For example, for the Dene, caribou are life. Their flesh is used for food, and historically, their bones for tools, and their fur for insulation and bedding*. The Dene, like many other Indigenous peoples, were the ultimate recyclers. Over the past 75 years, Northerners have experienced significant changes to their way of life. Just like in the rest of Canada, new lifestyles have changed the type and quantity of waste that is generated. That said, people can return to their roots and draw on their traditional and local knowledge to improve waste management through practices such as reuse, recycling, and composting. After all, many Northerners still depend on the land for country food and have a deep understanding of the importance of keeping the land, water, and air clean.

(*Source: Campbell, Daniel. February 2016. Fence Narrows: How an Ingenious Hunting Practice Let the Tlicho Survive in the Harsh North. Up Here Magazine.)

In short, MSW facilities will become more of a staging area for waste diversion than a final resting place. This shift in waste management practices will require human and financial resources, and its full implementation could be phased in over several years. Nevertheless, there are many simple and relatively low-cost, yet effective, changes that MSW facility operators can begin making today and in the near term, such as improving segregation and signage, depolluting wastes that contain hazardous substances, and reusing materials on-site or within the community.

This document is intended to give decision-makers in northern and remote communities the tools needed to take stock of their waste management practices, prioritize their actions based on the risks to human health and the environment (refer to Box 1-3), and take steps to establish modern MSW facilities and continuously improve their operation over time.

BOX 1-3: THE 3RS FOR NORTHERN AND REMOTE COMMUNITIES

This document proposes a new twist on the 3Rs mantra—Reduce, Reuse, Recycle—by applying a risk-based approach to waste management in northern and remote communities:

- **Reduce risks**—keep hazardous substances out of the landfill cell and do not open burn waste;
- **Reuse**—sell or donate reusable household items (e.g., furniture, clothing) and other materials and products (e.g., lumber); and
- **Recycle**—collect products and packaging for recycling and compost food and yard waste.

ENDNOTE

1 ARKTIS Solutions, Inc. 2012. Foundation Report for a Technical Document on Municipal Solid Waste Landfills in Northern Conditions: Engineering Design, Construction and Operation, p. 24. Prepared for Environment and Climate Change Canada.

2.0 WASTE MANAGEMENT PLANNING AND CONTINUOUS IMPROVEMENT

Developing a waste management system that is successful over the long term in protecting human health and the surrounding environment requires good planning and community engagement. Some northern and remote communities may recognize that their waste management system is not adequate to meet current or future needs, but may feel overwhelmed by the costs and effort required to make improvements. Waste management planning helps a community to:

- Take stock of the existing situation;
- Define goals and priorities;
- Identify appropriate strategies; and
- Develop a plan for implementation, monitoring, and evaluation.

This section identifies key considerations and outlines a step-by-step process for communities to develop and implement a waste management plan, and in turn a MSW facility, that protects human health and the environment and adapts to the evolving needs of the community. Communities are encouraged to retain the services of qualified professionals to assist them as they work through each of the steps.

2.1 KEY CONSIDERATIONS FOR WASTE MANAGEMENT PLANNING

Protecting Human Health and the Environment: There are many ways in which waste management activities can impact human health or become a source of environmental pollution, including the emission of air pollutants from open burning of garbage, the production of greenhouse gas emissions from landfilled organic waste, and the leaching of toxic contaminants from landfills into surface water and groundwater. Handling, storage and disposal of waste require well-planned approaches to avoid immediate and long-term environmental contamination.

Unique Circumstances: Northern and remote communities may require waste management solutions that vary from what is considered conventional in southern regions of Canada. For example, communities without year-round road access may have greater difficulty implementing a recycling program or upgrading a landfill. Additionally, more than half of northern communities have fewer than 500 people[1], which presents a significant financial challenge given the capital and operating costs associated with modern waste management infrastructure. Identifying unique circumstances and taking them into account is an important step in the planning and decision-making process and will help maximize investments and avoid future problems.

Community Engagement and Awareness: "For many communities, the foundation of sustainable community action is working on an issue that reflects a common concern in the community."[2] The success of waste management planning is dependent on whether or not it addresses a common concern in the community. Examples of common concerns related to waste management include clean drinking water, air quality, and children's safety. In addition, establishing a close working relationship with community members and stakeholders in the planning, design, implementation, and operation of a waste management system leads to higher public acceptance, support, and participation.[3]

Youth can also be mobilized to lead change and influence practices in a household. School activities can be a way to identify opportunities to reduce waste and contribute to community goals. More information and tools on fostering sustainable behaviour within the community, such as "community-based social marketing," can be found in Appendix A, Public Outreach.

Partnerships and Synergies: Due to relatively small populations and limited resources, northern and remote communities may find it challenging to provide a comprehensive set of waste management services. Although not practical everywhere, one strategy that some communities have developed to meet this challenge is to regionalize certain services and facilities through the pooling of resources.[4] Partnerships with not-for-profit organizations or the private sector can also be beneficial, as they can be established both within and beyond a community and provide a broader suite of services.

Continuous Improvement: Regardless of the circumstances, the management approach should be to improve the performance of the community's waste management system and MSW facility over time. Communities are encouraged to set improvement goals that reduce risks to human health and the environment. The waste management team should be tasked with: 1) identifying opportunities and ways to improve within the current capital and operating budgets and 2) monitoring and reporting on progress.

Figure 2-1 below summarizes the key steps involved in a continuous improvement approach to waste management planning. These steps are further described in Sections 2.2 through 2.5.

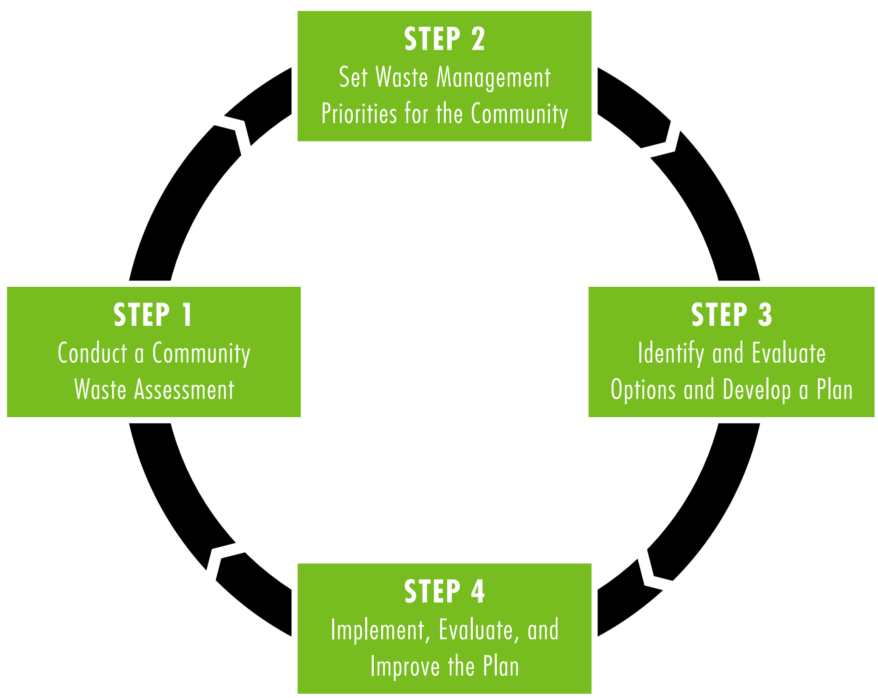
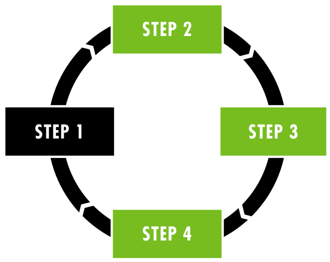


Figure 2-1: Continuous Improvement Approach to Waste Management Planning

2.2 STEP 1: CONDUCT A COMMUNITY WASTE ASSESSMENT



A thorough understanding of the community's waste generation and management processes is essential. A community waste assessment or waste audit should identify basic aspects of the local waste stream, such as quantities, composition, and sources of waste. It should also include an evaluation of current waste management practices and facilities to determine how they can be improved or adapted to meet current and future needs of the community.

2.2.1 CHARACTERIZE THE WASTE STREAM

KEY QUESTIONS:

- What types, quantities, and sources of waste are generated annually?
- How much legacy waste, such as drums, appliances, end-of-life vehicles, and other materials, have accumulated within the community over time and are currently stockpiled?
- What are the longer-term waste generation projections based on population trends and economic factors?

The first task in conducting a community waste assessment is to develop a thorough understanding of the quantities and composition of the waste stream and to develop projections for the waste anticipated over the operating life of the MSW facility (typically 30 years or more). The main waste generators in a community include households and local businesses (i.e., typically excludes industrial activities outside of the community boundaries) and institutions (e.g., schools, hospitals, community centres). The typical residential and industrial, commercial, and institutional (ICI) wastes managed by MSW facilities in northern and remote communities are presented in Sections 5 and 6.

A waste assessment should be conducted for the community to gain the necessary understanding of current and legacy quantities of different types of waste that require management. Given the absence of vehicle weigh scales at the majority of MSW facilities in northern and remote communities, it is recognized that accurate data on the type and quantity of waste entering and leaving the site may not be available. However, several approaches and techniques can be used to produce estimates, including:

- audits of select loads of waste entering and leaving the MSW facility, to establish the type and quantity of waste currently being managed;
- measurements of the footprint and thickness of the existing landfill cell and its age, to estimate the annual residual waste quantity generated and/or annual landfill airspace volume consumed;
- counting or approximating quantities of certain materials already present at a MSW facility (e.g., scrap tires, end-of-life vehicles, bulky waste items) and then estimating annual generation rates; and
- using waste diversion and disposal data from similar communities to produce estimates, such as the data found in Figure 2-2, which presents a typical waste composition for Yukon communities.

Although waste generation data for northern and remote communities is limited, it is known from a recent Statistics Canada survey that Canadians generate an average of about 965 kg of municipal solid waste per year per capita.[5] This figure includes waste that is diverted for reuse, recycling, or composting and waste that is permanently disposed of. Therefore, based on population data for 2015, Canada's territories generate an estimated 114,000 tonnes of waste per year. Table 2-1 presents a breakdown of the waste quantities generated by territory. Please note that these figures do not include large items such as end-of-life vehicles, white goods, and scrap tires.

In terms of waste composition, few waste composition studies have been conducted in northern and remote communities. However, Figure 2-2 presents average disposal data from the City of Whitehorse, Yukon, and a number of surrounding communities. The data are reasonably consistent with those of other waste composition studies carried out in Canada.

TABLE 2-1: WASTE GENERATED IN THE TERRITORIES

	KG/CAPITA (based on 2012 data)	POPULATION (as of July 1, 2015)	ANNUAL WASTE GENERATION (tonnes/year)
Nunavut	965	36,900	35,609
Northwest Territories	965	44,100	42,557
Yukon	965	37,400	36,091
TOTAL		**118,400**	**114,257**

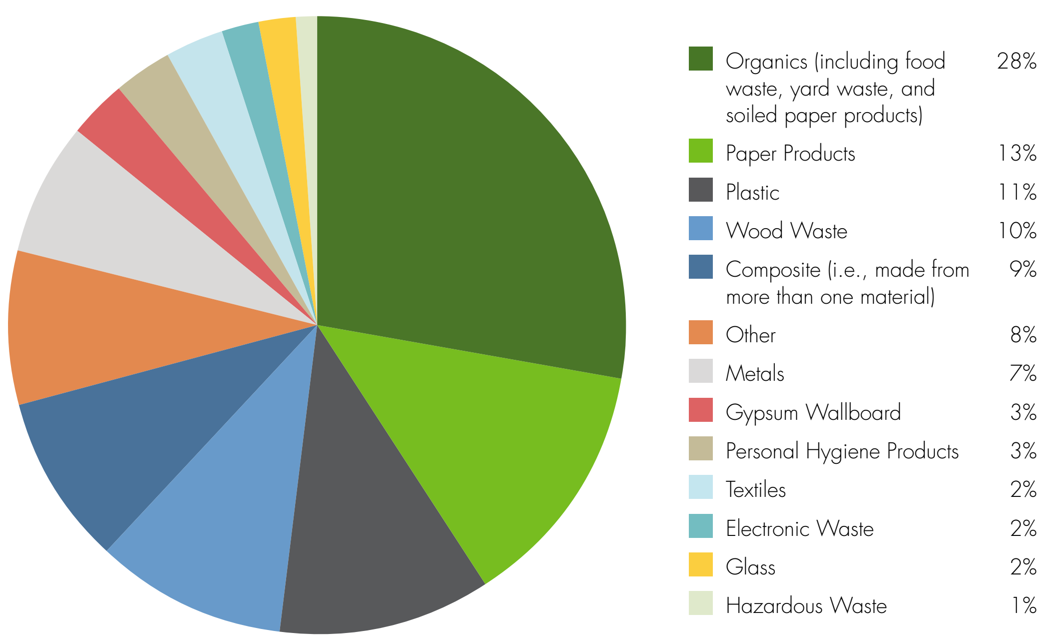


Figure 2-2: Typical Waste Composition in the Yukon[6]

Other sources of waste diversion and disposal data for northern and remote communities could also be consulted, including published research reports, reports from waste management consultants, territorial/provincial authorities and other regulatory bodies. Where vehicle or other types of weigh scales are not available, waste quantities should be converted to tonnage measurements using appropriate conversion factors, as this will facilitate comparisons between waste types and will provide a basis for estimating requirements for off-site transportation of hazardous and special waste, end-of-life vehicles, electronic waste, recyclables, etc. The MSW Management Planning section of Appendix A includes a list of documents that communities may find useful as they undertake a waste audit or estimate waste quantities and composition based on other studies.

Once the waste stream has been characterized (types and quantities), per capita estimates and projections of future waste generation rates should be developed for the expected life of the MSW facility, taking into account the anticipated growth of the community over that time period.

2.2.2 ASSESS THE EXISTING MSW FACILITY AND POTENTIAL NEW SITES

The next task in conducting a community waste assessment is to review the design and operation of the community's existing MSW facility and determine its suitability in meeting current standards and future needs of the community. This should include assessing the current design, operations and performance against applicable legislation and licencing requirements and against the recommended best practices outlined in this document. The information required to complete the assessment may be gathered through a combination of site visits, interviews with current and previous operators, community leaders, elders, and members, and a review of existing documentation on the MSW facility.

KEY QUESTIONS:

- Are there human health (including safety) or environmental concerns associated with the existing MSW facility?
- How do the existing design and operations compare with local regulatory requirements? With the recommendations outlined in this document?
- What materials are segregated and treated/disposed of off-site?
- What materials are disposed of on-site?
- What materials are recycled or composted?
- What is the remaining life of the existing MSW facility in terms of disposal capacity?
- What possibilities exist for upgrading or expanding the existing MSW facility or building a new one?

There are several circumstances in which a community could be required to find a completely new site for its MSW facility, including the following:

- The community does not have an existing MSW facility;
- The existing landfill cell of a MSW facility has already reached its capacity and there is no room for expansion; or
- The existing MSW facility cannot be upgraded.

Details and recommendations for MSW facility siting can be found in Section 3.

2.2.3 IDENTIFY CHALLENGES AND NEEDS

KEY QUESTIONS:

- Based on the waste characterization and MSW facility audit, what are the main challenges?
- What are the current waste management needs of the community? What are the anticipated population growth, economic activities, and waste management needs for the future?

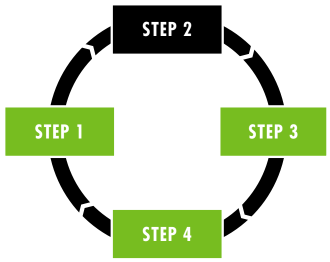
The final task in the community waste assessment is to use the information gathered on the waste streams and current infrastructure and operations (outlined in Sections 2.2.1 and 2.2.2) to identify the specific waste management challenges and needs of the community, including aspects of environmental performance and the management of specific waste types that need to be improved, cost-saving opportunities, capital and operating budget needs, and strategies for enhancing diversion through reuse, recycling, and composting.

The challenges and needs will be different for each community. For example, for one community, it may become apparent that the existing MSW facility does not have sufficient landfill capacity to accommodate the community's waste and that increased diversion and improved operational practices will be required to avoid the siting of a new MSW facility in the near future. For another community, there may be large quantities of legacy wastes (e.g., end-of-life vehicles, drums, white goods, scrap tires) that require off-site transport to an appropriate recycling or disposal facility (refer to Box 2-1). Regardless of their nature or scale, it is important to identify and document all of the community's waste management challenges and needs, to the greatest extent possible.

BOX 2-1: LEGACY WASTE IN THE NORTH

The complex issue of "legacy waste" is a reality for many northern and remote communities. Legacy waste refers to piles of waste, such as end-of-life vehicles, drums, white goods, scrap tires, and other materials, that have been accumulating in and around communities for decades. Some hazardous substances may have unfortunately already leaked out of corroding metals and made their way into the environment. The quantity of legacy waste can be overwhelming for a small community, but the complexity of the undertaking should not be a reason for inaction. Developing a strategy or agreeing on an approach to begin addressing legacy waste is an important step and is essential to any comprehensive waste management plan. For more information, refer to Appendix A, Hazardous and Special Waste.

2.3 STEP 2: SET WASTE MANAGEMENT PRIORITIES FOR THE COMMUNITY



In order to direct resources effectively and develop the needed partnerships, Step 2 of the continuous improvement process is to set waste management priorities for the community based on the challenges and needs identified in Step 1.

To assist decision-makers with prioritization, this document recommends best practices and further categorizes them into high-, medium-, and lower-priority actions using a risk-based approach. The priority actions are focused on reducing risks to human health and safety and preventing the release of hazardous substances to the air, water, and land. Specifically:

- Section 4 identifies high-, medium-, and lower-priority actions that apply to the general operation of the MSW facility;
- Section 5 describes high-, medium-, and lower-priority actions that apply to the landfilling of residual waste; and
- Section 6 identifies high-, medium-, and lower-priority waste types and actions for the remaining waste (e.g., hazardous and special waste, electronic waste, end-of-life vehicles).

Communities should begin to address high priorities in the short term, followed by medium and lower priorities in the longer term, guided by their waste management plan, to continuously improve over time. Throughout the document, the different priority levels are colour-coded: red for high (●●●), yellow for medium (●●), and green for lower priority (●). The framework that ECCC used for prioritizing the recommended best practices is further explained in Table 2-2.

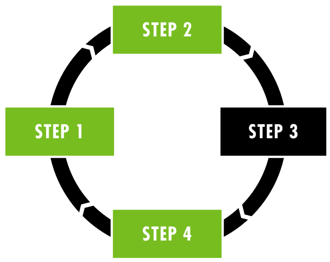
Community engagement and awareness are important components in determining and validating the waste management needs of a community and identifying its priorities. Engagement and awareness initiatives should be undertaken to educate community members, collect information, validate the conclusions, and discuss options. This could take many forms, including outreach materials, public meetings, focus groups, and door-to-door surveys. It is important that responsibilities are clearly assigned to ensure transparent decision making and to support sustained community engagement and awareness.

Impacts on capital and operating budgets are another important consideration in the prioritization exercise. Infrastructure needs to be maintained in order to protect the investment and ensure proper operation.

TABLE 2-2: FRAMEWORK FOR PRIORITIZING THE RECOMMENDED BEST PRACTICES

PRIORITY LEVEL	EXPLANATION
High ●●●	Every MSW facility, regardless of its size and location, should put in place basic infrastructure and implement operational practices necessary to protect the public, facility operators, and wildlife from immediate risks and to prevent the release of toxic substances from the site. High-priority measures include controlled access, trained on-site operators, and segregation and storage of hazardous and special wastes, among others. As a complement to the basic measures, communities may pursue other activities identified in the waste management plan that address important local challenges and needs. The successful implementation of high-priority measures will enable communities to pursue more complex undertakings and longer-term investments.
Medium ●●	Each community faces different circumstances that will determine where efforts should be directed next to further improve protection of the environment, increase resource recovery, and extend the life of the landfill. Medium-priority measures include control of surface and storm water, monitoring of surface and groundwater, further segregation and recycling, and more frequent cover and compaction of the landfill cell. In addition, the waste management plan will identify waste types that are in high quantities or of special concern for the community as well as local environmental risks and partnership opportunities.
Lower ●	Once site security and operational practices are well established and waste diversion and environmental monitoring activities are in place, a community can turn its attention to considering more advanced waste management infrastructure and practices. Lower-priority measures include improving record keeping and reporting, enhancing leachate and landfill gas management, and developing partnerships to improve the economic viability of new diversion and disposal options. These activities will contribute to continuous improvement and benefit long-term objectives.

2.4 STEP 3: IDENTIFY AND EVALUATE OPTIONS AND DEVELOP A PLAN



With validated community needs and priority areas for improvement in hand, it is time to explore options and develop a waste management plan. In fact, in some jurisdictions, the regulators require the development of a waste management plan as part of the permitting or licencing process (e.g., community water licence). Step 3 involves reviewing the findings of Steps 1 and 2, identifying and evaluating options, and developing a waste management plan for the community.

2.4.1 IDENTIFY AND EVALUATE OPTIONS

Based on the identified waste management priorities for the community, the next task will be to identify and evaluate options that can address those priorities. Considerations for these options should include:

- **Meeting existing federal, provincial/territorial, and local regulatory requirements.** Communities should meet the requirements set out in the environmental and other regulations or bylaws that apply to their jurisdiction.
- **Retaining qualified professionals.** Communities should retain the services of qualified professionals to assist in developing feasible options to meet community needs and, if necessary, support the decision-making process. In this case, qualified professionals could include consulting and engineering firms with experience in waste management planning as well as in MSW facility siting, design, construction, operation, and closure.
- **Using appropriate technologies and adopting best practices.** Proven and appropriate infrastructure and waste management technologies should be favoured. For example, communities should check references before hiring consultants or technology suppliers and ask to visit similar waste systems. As others have learned the hard way, if the technology in question is only at the conceptual stage or is only operational on a ship in the middle of the ocean or in some distant city, this may be considered a red flag and communities should proceed with caution.
- **Exploring program and policy tools.** Beyond technical options, there are a variety of waste management program and policy approaches that could be implemented to help address the community-specific challenges and needs that were prioritized in Step 2. Table 2-3 provides some examples that could be considered.
- **Examining funding sources and potential partnerships.** Decision makers should identify funding sources and potential partners for waste management activities. In northern and remote communities, per capita capital and operating costs for all community infrastructure are typically higher than in more populated areas of the south. Facility-level efficiencies and partnerships can create economies of scale and help reduce overall costs. Also, by investing in adequate infrastructure today, communities can avoid costly clean-up and remediation in the future.

  Funding sources to support MSW facility planning, design, construction, and operation may include regional, provincial/territorial, federal, and Indigenous governments as well as non-governmental organizations and the private sector (refer to Appendix A, MSW Management Planning). In addition, tipping fees can be instituted at the MSW facility as a source of revenue (refer to Box 2-2).

TABLE 2-3: POTENTIAL PROGRAM AND POLICY TOOLS FOR ENABLING WASTE MANAGEMENT SUCCESS

TOOL	DESCRIPTION
Capacity Building	• **Operator Training:** Equips operators with the knowledge to safely and effectively operate a MSW facility (e.g., hazardous waste management, spill response). • **Public Outreach:** Promotes adoption of environmentally sound waste management practices (e.g., community litter clean-up days, household hazardous waste collection events, recycling challenges at school). • **Leaders, Champions and Volunteers:** A volunteer waste management committee can be a tremendous asset to a community's waste management system by assisting with diversion programs and public outreach. In communities where there is high turnover, ongoing recruitment of new members can help committees "weather the storm." • **Proposal Writing:** Can help access funding opportunities, more so if broad community support can be demonstrated.
Policies and Bylaws	• **Curbside Collection of Waste:** Improves convenience for residents; collection frequency can be used to shape behaviour and accommodate different budgets; limits public access to the MSW facility and associated liabilities. • **Bag Limits:** Limits number of garbage bags that residents can put out for collection and encourages diversion. • **Tipping Fees:** Charges MSW facility users for disposal of waste and generates revenue for site operations (refer to Box 2-2). • **Landfill Disposal Bans:** Prohibits disposal of certain waste types and encourages diversion. • **Bylaws on Open Burning and Illegal Dumping:** Can help change behaviour if supported by education and enforcement.

BOX 2-2: CONSIDERATIONS FOR TIPPING FEES

A "tipping fee" is a fee usually applied on a per-tonne basis to all wastes delivered to a MSW facility. Different fees may be charged based on the type of waste in a specific load and/or the extent to which waste has been sorted. Since weigh scales are not common in northern communities, fees can be charged by volume instead of by weight. Tipping fees could be applicable to all waste generators, or the community could decide to apply fees to certain generators only, such as businesses. The revenue collected through tipping fees can be used to offset the cost of managing the community's waste, particularly the more complex materials that need to be shipped off-site for proper treatment or disposal.

BOX 2-2: CONSIDERATIONS FOR TIPPING FEES (CONT'D)

However, the transition from being a community that does not charge for waste disposal to one that implements user fees can come with its challenges, at least initially. For example, to help prevent illegal dumping, it may be necessary for the community to develop a bylaw that prohibits disposing of waste in non-designated areas. For the bylaw to be effective, community awareness and enforcement are critical.

Since most illegally dumped waste has some kind of personal information that can be used as an identifier, one community in Canada found a creative solution to its illegal dumping problem. It posted a notice in the lost-and-found section of the local paper whenever illegally dumped waste was found by a bylaw officer, along the lines of: "Mr. Smith, your lost garbage bag was found in the ditch on Old Mine Road. Please come claim it at the Public Works building."

Examples of potential partners and partnership activities include the following:

- There may be opportunities to regionalize services (e.g., waste collection and disposal) and programs (e.g., public education, recycling) and/or share equipment, staff, knowledge, experience, and other resources with nearby communities.[7]
- Community groups may be interested in assisting with operation of a reusable items area (i.e., a free store) at the MSW facility or a thrift store within the community to create employment and generate revenue.
- Community groups may also be interested in conducting public outreach to promote sound waste management practices.
- The community could partner with educational institutions, research institutes, and/or the private sector to explore new programs and technologies not otherwise available due to economies of scale.[8]
- Recyclers may have mobile equipment that can be brought to the MSW facility temporarily and used to facilitate off-site transport of certain wastes (e.g., mobile crushers for end-of-life vehicles).
- Transportation companies may have available capacity and discounted rates for backhauling wastes for recycling or treatment/disposal.

Engaging the community. Through engagement with community members, local businesses, and nearby industries early and often throughout this process, partnerships and available resources may emerge. Community engagement also promotes buy-in for the waste management options.

2.4.2 DEVELOP A WASTE MANAGEMENT PLAN

Once options have been identified and evaluated and decisions have been made with input from the community, the next task is to develop the waste management plan.

The waste management plan should be prepared with assistance from qualified professionals, in consultation with appropriate stakeholders. At a minimum, the plan should:

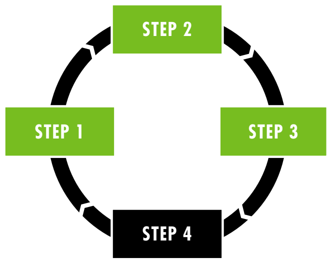
- cover a period of 30 years or more with review and updates every five years, or as appropriate;

- describe the current situation and issues, the steps taken to develop the plan, and any assumptions made;
- include waste characterization data and projections, identify partners, and establish short- and longer-term priorities;
- describe the MSW facility's siting, design, construction, operation, upgrading, and closure and post-closure plans, and demonstrate the connection of those elements to the short- and longer-term priorities;
- demonstrate how the MSW facility will comply with applicable regulations, standards, or bylaws;
- include MSW facility design documents prepared by a licenced professional engineer, with appropriate expertise and experience;
- engage relevant stakeholders (i.e., participation in the planning process); and
- include a communication strategy to foster, support, and sustain community engagement and awareness.

At the end of Step 3, the community should have a formal waste management plan and can proceed with implementation and continuous improvement. In brief, there are many factors that influence the development of a waste management plan (see Figure 2-3).

Figure 2-3: Factors that Influence a Waste Management Plan[9]

2.5 STEP 4: IMPLEMENT, EVALUATE, AND IMPROVE THE PLAN



Although the recommended planning horizon is 30 years or more, reviews and updates every five years (or as appropriate) should be undertaken to allow for continuous improvement and accommodate changes in the needs, goals, priorities, and opportunities of the community. The continuous improvement process should:

- include an evaluation of progress made under the waste management plan;
- compare planned results to actual results;
- revise priorities, if necessary, by working through Steps 1 and 2 of the waste management planning approach;
- develop a revised waste management plan (by following Step 3) to adjust any activities, infrastructure or operational requirements; and
- communicate and implement the revised plan, and restart the continuous improvement process.

For continuous improvement to be successful, all community members and stakeholders need to have access to the waste management plan and the results on an ongoing basis. This provides an opportunity for the community and partners to be kept informed of progress. Examples of measures of success include:

- quantity of hazardous and special waste shipped out for treatment/disposal;
- number of end-of-life vehicles shipped out of the community;
- quantity of compost produced;
- quantity of recyclables shipped out for recycling; and
- number of visits to the free store and current inventory.

Communication, openness, and feedback are critical to the success of a comprehensive waste management plan.

ENDNOTES

1 ARKTIS Solutions Inc. 2012. Foundation Report for a Technical Document on Municipal Solid Waste Landfills in Northern Conditions: Engineering Design, Construction and Operation, p. 3. Prepared for Environment and Climate Change Canada.

2 Carleton University. 2008. The VSP Tool—A Diagnostic and Planning Tool to Support Successful and Sustainable Initiatives.

3 Federation of Canadian Municipalities (FCM). 2009. Getting to 50% and Beyond: Waste Diversion Success Stories from Canadian Municipalities.

4 United States Environmental Protection Agency (US EPA). October 1994. Joining Forces on Solid Waste Management: Regionalization is Working in Rural and Small Communities.

5 Statistics Canada. 2012. Waste Management Industry Survey: Business and Government Sectors.

6 Based on averages from two-season waste composition studies conducted for the City of Whitehorse and surrounding communities in 2010. Prepared by Maura Walker and Associates for the City of Whitehorse, Yukon.

7 Saskatchewan Environment. 2007. Starting a Regional Waste Management System in Saskatchewan.

8 Federation of Canadian Municipalities (FCM). 2009.

9 ARKTIS Solutions Inc. 2012.

3.0 MSW FACILITY SITE SELECTION

MSW facility site evaluation and selection is one of the more challenging and critical activities in the planning process. Northern and remote communities upgrading their MSW facility or preparing a plan for growth will likely face the following choice: expand or retrofit an existing MSW facility at the current location or establish a MSW facility at a new location. In either case, site evaluation and selection should largely be based on the requirements for the residual waste landfill since on-site waste disposal represents the highest risk activity and a potential long-term liability to human health and the environment.

For an existing MSW facility, improvements to the design and operation of the existing landfill should be considered to mitigate these risks and potential liabilities. For a new MSW facility, choosing the best available site will help to mitigate human health and environmental risks.

Sections 3.1 through 3.5 present the recommended best practices when evaluating a current or new MSW facility site and cover the following themes:

- Land;
- Water;
- Wildlife and sensitive ecosystems;
- Transport; and
- Proximity to the community.

It should be noted that minimum setback distances with respect to landfill siting vary greatly from jurisdiction to jurisdiction. Although this document includes a typical range for setback distances where possible, these requirements can be site-specific and will ultimately be determined by local, provincial/territorial, and federal authorities.

3.1 THEME: LAND

There are several key land-related factors to consider when selecting and evaluating a good site for a MSW facility. The first is having **sufficient land area** for various activities and infrastructure, including waste receiving, processing, storage, and disposal areas, internal roads, buildings, as well as surface water and leachate collection and management. It is also important to anticipate community growth rates, duration of storage (i.e., for hazardous and special waste, recyclables, etc.), and desired operating life of the landfill cell. Generally, only sites that have the capacity to accommodate at least 30 years of operation should be considered.

Next, the **topography of the site** and its surrounding area will strongly influence its potential for development as a MSW facility with a landfill cell. Important considerations include site access, drainage/stormwater control, slope stability, potential for soil erosion, visibility of the site from afar, and potential impacts from prevailing winds. Attributes of a good versus a poor site are presented in Table 3-1.

TABLE 3-1: SITE TOPOGRAPHY AND BEST PRACTICES FOR MSW FACILITY SITING

⊗ POOR SITE	✓ GOOD SITE
• Extreme slopes (typically greater than 5:1), which represent increased soil erosion risk, the need for potentially costly re-grading, and longer-term slope stability concerns. • Gullies or depressions that act as a point of water collection during rainfall events unless ditching or other diversion measures are undertaken.[1]	• Adequate level areas for waste receiving, processing, and storage activities. • An existing gradient that allows surface water runoff away from active portions of the site. • A slope of 2% to 10%.

Other key land-related factors to consider when selecting and evaluating a good site include having **fracture-free bedrock or clay**, being in **geologically stable** areas (i.e., away from steep slopes, faults, low-lying coastal areas), and being **permafrost-free or thaw-stable** (refer to Tables 3-2 through 3-4, and Box 3-1).

TABLE 3-2: LAND STABILITY AND BEST PRACTICES FOR MSW FACILITY SITING

CONSIDERATION	BEST PRACTICES FOR SITE SELECTION AND TYPICAL SETBACK DISTANCE	RATIONALE
Geology	Fracture-free bedrock; unfractured clay or clay till	• Local geology and geomorphology influence site stability and the capability of the geologic environment to limit rapid migration of contaminants. Factors of interest include the type of bedrock, the state of weathering, the extent and distribution of faults, bedding planes and joints, and the presence of karst features. All of these factors influence the permeability of the bedrock strata. • In areas where bedrock is present at surface or in areas of thin overburden where groundwater flow may occur in bedrock, attributes of a good site are ideally represented by fracture-free bedrock; heavily fractured bedrock indicates poor site conditions. • In areas of thick overburden, attributes of a good site include unfractured clay or clay till; more porous materials (e.g., gravel, sand or liquefiable clay) indicate poor site conditions.

TABLE 3-2: LAND STABILITY AND BEST PRACTICES FOR MSW FACILITY SITING (CONT'D)

CONSIDERATION	BEST PRACTICES FOR SITE SELECTION AND TYPICAL SETBACK DISTANCE	RATIONALE
Geologically Unstable Areas	Not impacted by unstable areas (100 m)[2,3,4]	• Landfills should be located at least 100 m from geologically unstable areas, which are defined as locations where natural or man-made features pose a substantial risk to the integrity of the landfill environmental control systems or global stability of the landfill. • Typically, unstable areas include lands directly underlain by karst limestone, areas prone to subsidence caused by previous mining activity, areas with weak or unstable subsoils (e.g., collapsible silts, quick clays, liquefiable sands), and areas prone to slope failure (e.g., landslide scarps, avalanche zones, alluvial fans).
Seismic and Wave Impacts	Not impacted by seismic faults or located on low-lying coastal areas (100 m)[5]	• A landfill should not be sited within or in close proximity to geologically unstable areas, such as seismic faults or low-lying coastal areas that could be affected by storm surges or sea level rise. • A landfill should be located at least 100 m from a known fault line that was active (experienced displacement) during the Holocene. • In areas subject to seismic loadings, landfill slopes and environmental controls should be designed in such a way that the systems can withstand anticipated earthquake loadings without experiencing a failure of the fill or of the environmental control system.

TABLE 3-3: PERMAFROST AND BEST PRACTICES FOR MSW FACILITY SITING

CONSIDERATION	BEST PRACTICES FOR SITE SELECTION	RATIONALE
Permafrost	Located on a permafrost-free area, or on thaw-stable permafrost (e.g., gravel, rock)	• Landfills require structural integrity and stability (base liner, slopes, etc.) to offer optimal containment performance and prevent potential off-site migration of pollutants. Since permafrost is a temperature-based ground condition, the consequences of permafrost thawing on landfill infrastructure vary with respect to site attributes and soil type. • Since climate is the main factor controlling permafrost occurrence and thermal state, permafrost may warm and thaw under a warming climate, and potentially accelerate the rate of consequences in poor sites (refer to Box 3-1). The way in which surface water and leachate are managed can also impact the active layer thickness.

BOX 3-1: PERMAFROST AND WASTE MANAGEMENT

"Permafrost" refers to soil or rock that remains frozen for at least two years in a row. Permafrost is an important feature of Canada's North because it affects hydrology (i.e., the way water moves, how it is distributed, and its quality), the landscape, and ecosystems. The thickness of permafrost varies considerably across the North—from non-existent in some areas to hundreds of metres deep in others. Permafrost is influenced by such factors as climate (e.g., air temperature and snow), vegetation, geology, and human activity (i.e., disturbances).

The warming and thawing of permafrost can make the ground unstable and affect drainage patterns. This has implications for the integrity of MSW facilities, especially landfill cells. As such, permafrost alone should not be relied on to provide long-term containment of pollutants at landfills. Ideal sites for MSW facilities will either be permafrost-free areas or permafrost areas where the rock or soils have a low ice content, reducing the risks of settlement when thawed.

(Source: Natural Resources Canada. 2015. Permafrost; and Government of Northwest Territories, Department of Environment and Natural Resources. Permafrost.)

TABLE 3-4: PERMAFROST AND SITE ATTRIBUTES

⊗ POOR SITE	✓ GOOD SITE
• Permafrost areas composed of thaw-sensitive soils, such as ice-rich silt and clay. Depending on the percentage of ice contained in the ground, these soils can undergo significant thaw-settlement due to the volume change associated with the phase change of ice to water and drainage of excess water. • Exposed massive ice, ice wedges, and ice lenses can melt out entirely, leaving large voids.	• Permafrost-free areas. • Permafrost areas composed of thaw-stable soils, such as rock, free-draining granular materials, or dry ground (i.e., materials of low ice content) that do not settle much when thawed.

The presence of land-based endangered or threatened species can also affect the siting of a MSW facility (refer to Section 3.3).

3.2 THEME: WATER

Some of the key water-related factors to consider when selecting and evaluating a good site include an appropriate distance from the high water table, drinking water sources, and flood plains and the presence of low permeability soils (refer to Tables 3-5 through 3-10).

TABLE 3-5: WATER TABLE AND BEST PRACTICES FOR MSW FACILITY SITING

CONSIDERATION	BEST PRACTICES FOR SITE SELECTION AND TYPICAL SETBACK DISTANCE	RATIONALE
Depth to Water Table	Developed at an appropriate distance above the seasonal high water table (1.5 m–3 m)[6,7]	• Landfills should be developed at an appropriate distance above the seasonal high water table (i.e., regional or piezometric level in uppermost aquifer). The depth to groundwater that is seasonally perched in shallow surficial soils should not be considered in this evaluation. In permafrost regions, there may be different considerations. • Although liner systems are intended to separate waste from groundwater, the liners have the potential to fail, either during the lifespan of a landfill or post-closure. The deeper the water table, the longer contaminants will have to naturally degrade before they reach groundwater. • As excavation of landfill cover material is a common operational strategy, the depth of such excavations should also be carefully considered in terms of hydrogeologic implications.

TABLE 3-6: DRINKING WATER SOURCES AND BEST PRACTICES FOR MSW FACILITY SITING

CONSIDERATION	BEST PRACTICES FOR SITE SELECTION AND TYPICAL SETBACK DISTANCE	RATIONALE
Drinking Water Sources	Should not be located over or upgradient of a sole source aquifer, or adjacent to or upgradient of a surface water drinking water source (300 m –1,500 m)[8,9,10]	• The contamination of drinking water supply wells and sources by waste management operations is not acceptable. The greater the distance a MSW facility site is from active drinking water sources, the more favourable the site. • An evaluation should be undertaken to identify all existing wells, water supply intakes, and other potential sources of drinking water, such as springs and groundwater discharge areas. Consideration may also be given to the potential for future drinking water extraction from an aquifer. A landfill should not be located upgradient or over an aquifer that represents the source of drinking water for a community.

MSW facilities should be located at an **appropriate setback distance from surface water bodies** such as lakes, streams, marshes, and wetlands. Attributes of a good versus poor site are presented in Table 3-7.

TABLE 3-7: SURFACE WATER BODIES AND BEST PRACTICES FOR MSW FACILITY SITING

⊗ POOR SITE	✓ GOOD SITE
• Landfills adjacent to surface water that is present year round. This requires significantly more complex design, management, and operation to protect against runoff, washout, and groundwater and surface water contamination. • Landfills located in gullies or depressions that act as points of water collection during rainfall events or the wet season. • The presence of endangered or threatened aquatic species (refer to Table 3-11).	• For non-drinking water sources, an appropriate setback between a landfill and the nearest lake, stream, river, wetland, or marsh (**30 m–100 m**).[11,12] • This is necessary to protect these surface waters from uncontrolled landfill leachate discharges and to provide opportunity for detection and some natural attenuation in the event that an accidental discharge of leachate occurs through surface pathways (e.g., leachate breakouts) or through groundwater seepage. It also protects the landfill from erosion. • Diversion works, interception ditching, and other flow control measures to reroute the surface watercourse to achieve the desired level of separation.

MSW facilities should also be located an **appropriate distance from ocean shorelines and above sea level**. Landfills should be sited as far away as possible from a coastal shoreline (**100 m**)[13] and above sea level to protect the site from erosion (refer to Table 3-8). The effect of climate change and subsequent sea-level rise should be taken into consideration in siting a landfill in any coastal region (refer to Box 3-2 below).

BOX 3-2: WASTE MANAGEMENT AND CLIMATE CHANGE

There are a number of important links between waste management and climate change. For example, climate change has the potential to impact waste management infrastructure, especially in coastal and permafrost areas. Communities located near sea-level should site MSW facilities on higher ground to reduce the potential for a rise in sea-level to flood or erode any areas where waste is stored or disposed of. Also, the warming of permafrost, exacerbated by disturbance to the surface where waste is stored or disposed of, can lead to ground instability and possible thawing and slumping, which can impact the integrity of engineered waste containment systems (refer to Box 3-1). These scenarios underscore the importance of careful siting. In addition, changes to precipitation quantities and patterns could also have implications for surface water management and leachate production.

Furthermore, waste management can have an effect on greenhouse gas emissions, both positive and negative. For example, landfills are a source of methane emissions, a potent greenhouse gas. Therefore, diverting organic waste from landfills through composting reduces greenhouse gas emissions. Recycling also reduces greenhouse gas emissions since producing goods from recovered materials is a lot less energy-intensive than using virgin inputs. Composting and recycling are discussed in greater detail in Section 6.

TABLE 3-8: FLOOD PLAINS AND BEST PRACTICES FOR MSW FACILITY SITING

CONSIDERATION	BEST PRACTICES FOR SITE SELECTION	RATIONALE
Flood Plains	Outside 200-year flood plain; protected by a dyke or other flood controls; landfill engineered to withstand flooding conditions	• Flooding of a MSW facility could lead to the uncontrolled release of leachate and the wash-out of toxic contaminants into the environment, posing a serious risk to human health and ecosystems. • A MSW facility should not be established on a flood plain subject to a risk of flooding greater than 1 in 200 years, unless that flood plain is protected by a dyke structure or other flood controls that reduce the risk of flooding, or the landfill is specifically engineered to withstand these conditions which could increase capital costs.

In terms of **hydrology and hydrogeology**, sites should be located on low permeability soils at appropriate distances and downgradient from hydrological and hydrogeological features. Ensuring protection of surface water and groundwater resources is a primary concern when selecting the site. Pollution of these resources by landfill leachate can result in long-term environmental and human health concerns. A detailed understanding of the site's hydrology (surface water flow) and hydrogeology (groundwater flow) is required to assess the potential risks. Attributes of a good site versus a poor site are presented in Table 3-9.

TABLE 3-9: HYDROLOGY AND HYDROGEOLOGY AND BEST PRACTICES FOR MSW FACILITY SITING

⊗ POOR SITE	✓ GOOD SITE
• Areas that are considered higher risk or where initial construction is difficult include: – groundwater recharge areas – coastal and estuarine areas – wetlands – areas close to watercourses – areas with a high water table – areas subject to flooding – areas of high soil permeability zones – areas upgradient of a community	• Low permeability soils that will slow the rate of leachate drainage from the landfill and reduce the risk of groundwater contamination. • Dense clay soils are preferred, as their low permeability will allow more time for natural attenuation of leachate to occur.

Communities in areas of high **precipitation** should consider measures to prevent infiltration into the landfill mass (refer to Table 3-10).

TABLE 3-10: PRECIPITATION AND BEST PRACTICES FOR MSW FACILITY SITING

CONSIDERATION	BEST PRACTICES FOR SITE SELECTION	RATIONALE
Precipitation (annual average)	Prevent infiltration of precipitation into the landfill mass	• Landfill leachate is generated primarily from precipitation and thus is influenced by climate conditions such as annual precipitation rates, seasonal temperatures, and evaporation potential. When rainfall falls on a landfill site, it will either be shed from the site as runoff, evaporate, transpire from the landfill surface or infiltrate into the landfill mass to contribute to leachate generation. • The theoretical water balance (precipitation minus evapotranspiration minus runoff) provides a good first approximation of the potential for landfill leachate generation. • In arid and semi-arid climates, leachate may be generated irregularly or only at certain times of the year. • In wet climates, significant quantities of leachate may be produced year round. • Since most of Canada's northern territories typically receive less than 250 mm of precipitation annually,[14] they fall within arid to semi-arid climates and may yield low leachate production. However, it is noted that the spring freshet (i.e., discharge from melting of ice and snow) can represent the majority of the annual precipitation. Other parts of the country, such as northern British Columbia and Ontario, may have higher precipitation levels. • Examples of measures to prevent infiltration of precipitation into the landfill mass include stormwater management, snow clearing, daily cover, and final cover.

3.3 THEME: WILDLIFE AND SENSITIVE ECOSYSTEMS

Some of the key factors related to wildlife and sensitive ecosystems to consider when selecting and evaluating a good site include distance from sensitive species and parks (refer to Table 3-11).

TABLE 3-11: WILDLIFE AND SENSITIVE ECOSYSTEMS AND BEST PRACTICES FOR MSW FACILITY SITING

CONSIDERATION	BEST PRACTICES FOR SITE SELECTION AND TYPICAL SETBACK DISTANCE	RATIONALE
Sensitive Habitat	No sensitive species	• MSW facilities should be located with appropriate or existing prescribed setback distances from areas designated as habitat for sensitive plant and animal species (including threatened or endangered species, such as those identified on the federal *Species at Risk Act* (SARA) List of Wildlife Species at Risk and the International Union for Conservation of Nature (IUCN) Red List of Threatened Species). • Provincial or territorial environment departments can help to identify sensitive and critical habitat. Maps of these areas are generally available from the appropriate provincial/territorial environment offices.
Parks and Protected Areas	Located at an appropriate and respectful distance (100 m)[15]	• Landfills could potentially attract wildlife from sanctuaries, such as provincial, territorial and national parks and other protected areas. Moreover, in some circumstances, noise, dust, and potential odours make operating landfills incompatible with park and protected area use. • Therefore, landfills should be located at an appropriate and respectful distance from park and protected area boundaries.

3.4 THEME: TRANSPORT

Some of the key transport-related factors to consider when selecting and evaluating a good site include the presence of appropriate roads in the vicinity, hauling distances, and being at a safe distance from airports and landing strips (refer to Table 3-12).

TABLE 3-12: TRANSPORT AND BEST PRACTICES FOR MSW FACILITY SITING

CONSIDERATION	BEST PRACTICES FOR SITE SELECTION	RATIONALE AND TYPICAL SETBACK DISTANCE
Roads and Distances	Roads adapted to MSW facility traffic; Short hauling distances	• Hauling distance from the community to the MSW facility could have a significant impact on operating costs. • The same applies to cover material, as accessibility of cover material on a year-round basis may be an issue in remote and northern regions. • Roads leading to the site should be in good condition, constructed to handle the anticipated traffic load, and available in all weather conditions.
Airports and Air Landing Strips	Located in accordance with federal, provincial, territorial, and local airport zoning regulations	• Due to the propensity for landfills to attract birds, a minimum separation distance between airports utilized by turbine powered or piston-type aircraft and landfills containing food wastes should be observed according to federal, provincial, territorial and/or site specific airport zoning regulations (from 3.2 km with bird control measures to 8 km).[16,17] • The separation distance may be adjusted depending on effective bird control measures implemented at the MSW facility.

3.5 THEME: PROXIMITY TO THE COMMUNITY

Lastly, a final factor to consider when selecting and evaluating a good site is the distance from other property boundaries, structures, and sites of cultural significance (refer to Table 3-13).

TABLE 3-13: PROXIMITY TO THE COMMUNITY AND BEST PRACTICES FOR MSW FACILITY SITING

CONSIDERATION	BEST PRACTICES FOR SITE SELECTION AND TYPICAL SETBACK DISTANCE	RATIONALE
Property Boundary	Located at an appropriate distance from other property boundaries and public roads; provides visual screen	• A minimal buffer zone between the operational area of the MSW facility and public roadways and highways should be maintained (**100 m**).[18,19] • A minimal buffer zone between the active landfill face and the property boundary should be maintained (**50 m–100 m**).[20] • Ideally, a visual screen (natural or artificial) should be provided around the site so that the site is not visible from the community or public road (**15 m** within the property boundary).[21] • An appropriate distance (**30 m–50 m**) inside the perimeter of the MSW facility should be used for firebreaks, access roads, leachate management, and monitoring works, as required.
Public Areas	Located at a respectful distance from residences, hotels, restaurants, places of worship or other facilities (**300 m–1,600 m**)[22]	• Because of impacts such as noise, birds, traffic, odour and land value, the landfill portion of a MSW facility is generally incompatible with residential, commercial and public areas. • Long-term surrounding property use (e.g., future residential or commercial development) should be considered prior to siting a landfill. • Consultation with elders, community members, and other relevant stakeholders with regard to the official community plan and/or minimum separation distances is recommended so that the MSW facility is compatible with local plans. • The MSW facility should ideally be located downwind of the prevailing wind direction of the community.
Heritage, Cultural, and Archeological Sites	Located at a respectful distance from a heritage, cultural, or archeological site (**100 m**)[23]	• Sites of heritage, cultural, and archeological significance should be taken into account during the siting process.

ENDNOTES

1 British Columbia Ministry of Environment. June 2016. Landfill Criteria for Municipal Solid Waste, Second Edition.

2 Government of Newfoundland and Labrador. 2010. Environmental Standards for Municipal Solid Waste Landfill Sites.

3 Yukon Government. 2014. Construction Requirements for New Public Waste Disposal Facilities.

4 British Columbia Ministry of Environment. June 2016.

5 *Ibid.*

6 Yukon Government. 2014.

7 British Columbia Ministry of Environment. June 2016.

8 EBA Engineering Consultants Ltd. 2009. Comprehensive Solid Waste Study for Yukon Territory Waste Facilities. Prepared for the Government of Yukon.

9 Yukon Government. 2014.

10 British Columbia Ministry of Environment. June 2016.

11 Government of Newfoundland and Labrador. 2010.

12 ARKTIS Solutions, Inc. 2011. Solid Waste Best Management Guide. Prepared for the Government of Nunavut, Community and Government Services.

13 British Columbia Ministry of Environment. June 2016.

14 ARKTIS Solutions Inc. 2012. Foundation Report for a Technical Document on Municipal Solid Waste Landfills in Northern Conditions: Engineering Design, Construction and Operation, p. 4. Prepared for Environment and Climate Change Canada.

15 British Columbia Ministry of Environment. June 2016.

16 Ferguson Simek Clark Engineers & Architects. 2003. Guidelines for the Planning, Design, Operations and Maintenance of Modified Solid Waste Sites in the NWT. Prepared for Government of Northwest Territories, Department of Municipal and Community Affairs.

17 Transport Canada. 2010. An Aviation Industry Guide to the Management of Wildlife Hazards, Chapter 8—Solutions—The Airport and Surroundings.

18 Yukon Government. 2014.

19 Government of Newfoundland and Labrador. 2010.

20 *Ibid.*

21 *Ibid.*

22 *Ibid.*

23 British Columbia Ministry of Environment. June 2016.

4.0 GENERAL OPERATION OF THE MSW FACILITY

4.1 INTRODUCTION

The first part of this section outlines the role and responsibilities of facility operators and describes best practices for general operations, including site control and nuisance management, operational activities, waste screening and segregation, shipping waste off-site, health and safety, emergency response, wildlife management, and record keeping. The last part of the section summarizes the priority actions for the general operation of the MSW facility and presents a couple of conceptual layouts to show how a MSW facility could evolve over time as improvements are implemented.

4.2 FACILITY OPERATORS

One of the key components of a modern MSW facility is the requirement for a trained operator on-site, on either a part-time or a full-time basis. In addition to carrying out the operational activities described in this section, facility operators play an important role in public safety by being present to receive waste during operating hours and locking the gate when the facility is closed.

The proper operation and maintenance of a MSW facility requires a trained operator to work on-site and the assistance of other personnel and contractors as needed. The MSW facility operator will conduct and oversee a range of activities on a daily, weekly, monthly, and annual basis (refer to Table 4-1). The MSW facility operation and maintenance activities should be documented in a formal operations plan. Good operational practices will:

- reduce risks of environmental and human health impacts;
- generate efficiencies and savings for operational costs;
- maximize public acceptance and public use of the facility;
- maximize waste diversion through reuse, recycling, and composting efforts; and
- reduce safety risks for workers and the public.

Facility operators should be trained and certified through the Solid Waste Association of North America (SWANA) Manager of Landfill Operations (MOLO) course or similar course offered in each jurisdiction. Other training for facility operators and any other front-line staff may include: emergency and spill response, Workplace Hazardous Materials Information System (WHMIS), hazardous waste management, ozone depletion prevention, transportation of dangerous goods, heavy equipment operation, wildlife safety, health and safety, and first aid. Refer to the MSW Facility Operations and Maintenance section of Appendix A for specific training resources.

The operator and any other workers should be provided with appropriate personal protective equipment. A shelter, such as a mobile work trailer, should also be provided to protect workers from the elements. The shelter should be insulated, heated, and equipped with toilet and hand-cleaning facilities.

4.3 BEST PRACTICES IN GENERAL OPERATIONS

4.3.1 SITE CONTROL AND NUISANCE MANAGEMENT

In the interest of public and worker safety as well as environmental protection, signs should be posted at the MSW facility indicating:[1,2]

- where waste disposal is allowed;
- what items are accepted and prohibited;
- that open burning is prohibited;
- hours of operation;
- safety warnings;
- tipping fees charged (if applicable); and
- emergency contact information.

Fences and gates should be installed around the MSW facility to limit windblown debris from migrating off-site, control public access, and restrict wildlife access.[3,4] These fences should be at least 2 m high and consist of a durable material such as chain link.[5] At sites prone to high winds, a portable litter control fence should be placed adjacent to the active face. Gates should be locked when the MSW facility operator is not on-site.

Depending on the distance between the MSW facility and the community, other nuisance issues that may need to be mitigated are dust from roads, soil stockpiles, and waste, as well as noise from collection vehicles and heavy equipment.

A vehicle weigh scale should be considered for MSW facilities accepting greater than 5,000 tonnes of waste per year to track the types and quantities of incoming and outgoing waste. The weigh scale should be maintained in proper working order and meet the requirements of the federal *Weights and Measures Act*.[6]

4.3.2 OPERATIONAL ACTIVITIES

Table 4-1 provides the recommended general operational activities for the MSW facility on a daily, weekly, monthly, and annual basis. The frequency of some activities may need to be higher for larger MSW facilities and in special circumstances. Specific activities related to the major waste types are described in Sections 5 (residual waste) and 6 (remaining waste types).

TABLE 4-1: RECOMMENDED OPERATIONAL ACTIVITIES

RECOMMENDED OPERATIONAL ACTIVITIES	DAILY*	WEEKLY	MONTHLY	YEARLY
Waste screening	X			
Segregate and process waste as described in Sections 5 and 6	X			
Verify that wastes are managed in the designated areas	X			
Compact waste in the landfill	X			
Cover compacted waste in the landfill	X	X		
Clean up any spills	X			
Clear roads and working areas	X			
Record wildlife incidents	X			
Pick up windblown litter		X		
Test and pump standing water			X	
Grade and maintain roads			as needed	
Complete spring clean-up of MSW facility, compact waste, and place intermediate cover (spring and fall)				X
Review operations and maintenance records to assist in planning for the upcoming year				X
Construct a new landfill cell or waste management areas during the summer months if required for the upcoming year				X
Perform sampling (e.g., surface water, groundwater) in accordance with MSW facility performance monitoring plan (refer to Section 7)				X
Complete Annual Report of operations (and submit to the licencing agency, if required)				X

*** Note:** *Refers to days that the MSW facility receives waste. Special considerations may be required for certain weather and climate conditions.*

It should be noted that open burning of waste is not considered an acceptable operational practice due to health and safety and environmental concerns (refer to Box 4-1). Tips for reducing wildlife attraction and for waste volume reduction are provided in Section 4.3.7 and Sections 5 and 6.

BOX 4-1: THE HAZARDS OF OPEN BURNING

Open burning refers to burning waste in landfills, barrels, open pits, outdoor furnaces, woodstoves, or fireplaces. Open burning is much more harmful to human health and the environment than previously thought. Open burning of waste—even seemingly harmless materials like paper, cardboard, yard waste, and construction waste—may release a hazardous mixture of cancer-causing compounds and other toxic substances.

(Source: Environment and Climate Change Canada. 2010. Open Burning of Garbage.)

4.3.3 WASTE SCREENING AND SEGREGATION

The operator should ensure that the MSW facility accepts only the waste that it has been designed and authorized to manage and that all waste materials are deposited in the respective designated areas. Screening waste before it enters the MSW facility prevents unacceptable waste from becoming the responsibility of the facility and contaminating other waste types. Waste screening can take many forms, but gate control and staff presence are essential. A waste screening protocol should be included in the MSW facility's design and operations plan. The fundamentals of successful waste screening are as follows:

- Know the waste generators and haulers (carriers);
- Develop standard procedures for waste screening at the MSW facility (i.e., which waste types are acceptable and from whom);
- Train MSW facility staff in those procedures;
- Practice random load checking;
- Educate generators and carriers on restrictions; and
- Require movement documents for hazardous and special waste acceptance.

If tipping fees are charged, they would be collected at the time of drop-off (refer to Box 2-2, Section 2.4). Once the waste load has been screened and has entered the site, it should be segregated according to waste type and stored or disposed of in the appropriate designated areas. In cases where unacceptable wastes are identified, the operator could assist in identifying local acceptable waste management alternatives for the generators and/or haulers of the unacceptable waste (refer to Box 6-1 and Section 6.2).

4.3.4 SHIPPING WASTE OFF SITE

Some of the waste generated by the community will need to be recycled, processed, treated, or disposed at a waste management facility outside of the community's MSW facility. As such, it will be important for community officials to work with the MSW facility operator to develop a program or protocol for managing these wastes in a timely and environmentally sound manner. For example, some jurisdictions have limits on the quantity of hazardous and special waste that can be stored at the MSW facility or the length of time that these wastes can be stored. Furthermore, due diligence is necessary to ensure that the wastes are shipped to an authorized facility and that all applicable shipping regulations are followed (refer to Appendix A, Hazardous and Special Waste).

4.3.5 HEALTH AND SAFETY

The health and safety of workers and the public at the MSW facility need to be considered. As discussed in Section 4.2, employers should ensure that their employees are trained in safe work practices for the MSW facility. Employers should also provide employees with the necessary personal protective equipment (PPE) to carry out their jobs in a safe manner, such as CSA-approved safety boots (steel or composite-toe and chemical resistant), eye goggles, gloves, hard hat, respiratory gear with proper situational filters (dust, volatile organic compounds or VOCs, etc.), safety vest, and work coveralls. Employees should also be provided access to an eye wash station, a first aid kit, and a fire extinguisher approved by the fire marshal.

The following safety procedures should be implemented in order to minimize health risks to personnel working in and around the MSW facility:

- Equipment should be kept clean;
- Protective clothing and equipment such as gloves, eye goggles, and safety boots should be worn at all times;
- Work clothes should be kept in a designated change room and employees should change into them when they arrive for work. Work clothes should not be worn home. The community maintenance garage should be equipped with laundry facilities to wash work coveralls off-site;
- Hands should be washed frequently and, at a minimum, before eating and after work; and
- Personnel should receive appropriate vaccinations that comply with workers' safety guidelines and should ensure they are kept up-to-date.

Public safety should also be taken into consideration when operating a MSW facility. All hazardous materials should be stored in a secure location away from public access. At the completion of each working day, the MSW facility should be locked to prevent public access, and facility hours should be clearly posted. Scavenging of waste from the active face of the landfill should be prohibited (refer to Section 6.9 for guidance on managing reusable items).

A no-smoking policy should be implemented on-site to prevent explosions and fires. Smouldering material of any kind should not be accepted due to the risk of fire.

4.3.6 EMERGENCY RESPONSE

All MSW facility staff should be trained and equipped to respond efficiently and effectively to emergencies that may occur at the MSW facility, including, but not limited to, fuel spills, chemical spills, and fires.

Emergency preparedness plans should be developed for the MSW facility. Examples of elements that should be included in emergency preparedness plans are presented in Table 4-2. Personnel should be trained on how to implement the plans. Copies of these plans should be kept in collection (if applicable) and operation vehicles as well as in all common work areas.

TABLE 4-2: EXAMPLES OF ELEMENTS OF EMERGENCY PREPAREDNESS PLANS

TYPE OF PLAN	KEY ELEMENTS
Contact numbers for all types of emergencies	In case of an emergency, the operator should have quick access to the following contact numbers: • Fire department • RCMP detachment • Community first aid/paramedics • Wildlife officer

TABLE 4-2: EXAMPLES OF ELEMENTS OF EMERGENCY PREPAREDNESS PLANS (CONT'D)

TYPE OF PLAN	KEY ELEMENTS
Spill contingency plan	• 24-hour spill response line (specific to region). • A spill contingency plan should be created for activities associated with MSW facility operations, including storage and handling of hazardous materials. • A copy of the plan should always be available at the operator's office and the MSW facility. • Operational personnel should be trained on the plan in order to respond quickly and effectively in the event of a spill.
Fire response plan	• Typically, the community fire department is responsible for creating a contingency plan to deal with fires within the community operation, which will include the MSW facility. Ensure that such a plan exists and record the steps that should be taken by the MSW facility during a fire emergency in accordance with the fire department's plan. • As burning of waste may produce harmful gases, special precautions, such as the use of a respirator, should be taken when responding to fires in and around the MSW facility. • In the event of an uncontrolled fire in the MSW facility, the following steps should be taken: – Immediately evacuate the area; – Keep everyone including operational personnel upwind from the source; and – Contact the fire department.

4.3.7 WILDLIFE MANAGEMENT

Wildlife management at a MSW facility has two main objectives: (1) to keep animals away from the waste for their protection; and (2) to provide a separation between people at the MSW facility and animals that may be attracted to the MSW facility. Wildlife are attracted to MSW facilities because of odours and the potential for a food source. Some waste types attract animals more than others.

Typical wildlife that are attracted to MSW facilities includes:

- **Large predators**—Black, grizzly, and polar bears can become habituated and aggressive toward operators and the public, presenting a safety concern.
- **Smaller predators**—Wolves, coyotes, foxes, wolverines, and stray dogs present a potential danger to the public and operators if they become aggressive; they may also carry rabies.
- **Birds**—Gulls and ravens are mostly a nuisance issue and can create litter issues as they rip apart garbage bags to get at food sources.
- **Rodents**—Burrowing animals such as Arctic ground squirrels and muskrats can cause damage to berms and retention ponds.

There are several mitigation methods to reduce wildlife at MSW facilities. By reducing ease of access to materials that attract wildlife, also known as "attractants" (e.g., food scraps, glycol), the number of wildlife and human encounters can be minimized, thereby mitigating the risk to human and wildlife health and safety. The main methods are:

- Waste separation by type;
- Installation and maintenance of a fence (electrified where possible) around waste types that are or may become animal attractants; and
- Cover landfilled waste and compost piles that present a food source and odour on a frequent basis—the same day the wastes arrive at the site, if possible. In the case of a centralized composting facility, food waste should be covered with a carbon amendment, such as shredded paper or wood chips.

Bears pose the greatest wildlife-related risk to worker safety. It is imperative that all personnel working in and around the MSW facility be properly trained in bear safety. Some wildlife, particularly bears, can become habituated to the MSW facility as a food source. Unfortunately, most often this results in the animal being destroyed.

4.3.8 RECORD KEEPING

There are two main reasons for record keeping:

- It is generally a requirement in MSW facility licences to provide annual reports to the regulator. Record keeping provides the information needed to complete the annual reporting.
- A historical record of the operations, volumes and types of waste managed, investments and costs will provide the foundation for establishing trends to better anticipate future needs of the MSW facility and plan for improvements.

Table 4-3 lists the types of MSW facility records that should be maintained.

TABLE 4-3: RECORDS MANAGEMENT AT MSW FACILITIES

CATEGORY	RECORDS
Activities and events	• Daily, weekly, monthly, and annual activities undertaken at the MSW facility (refer to Table 4-1). • Details of any maintenance undertaken at the MSW facility. • Visits by regulatory authorities. • Wildlife incidents.
Documentation	• Copy of the MSW facility permit or licence. • Copies of all manuals pertaining to the operation and maintenance of the MSW facility (e.g., design and operations plan, spill contingency plan, closure plan).
Reports	• Copies of annual reports submitted to regulatory agencies. • Copies of sampling and analysis reports for surface water, groundwater, leachate, and landfill gas. • Copies of spill reports and related regulations.

TABLE 4-3: RECORDS MANAGEMENT AT MSW FACILITIES (CONT'D)

CATEGORY	RECORDS
Tracking	• Costs associated with operations. • Estimated volume of waste accepted and its generator on a daily, weekly, monthly, and annual basis. Frequency of recording may depend on the size of the operation. A waste generation record should be maintained for each type of waste collected and segregated. Volumes can be estimated using a truck count and recording the truck type. • Estimated volumes of any effluent or liquids discharged to the environment through an accidental spill. • Materials used for construction or maintenance. • Types and quantities of waste transported off-site for recycling, treatment, or disposal.

4.4 PRIORITY ACTIONS

Table 4-4 summarizes recommended best practices that apply to the MSW facility as a whole. They are categorized as high-priority (short-term), medium-priority, and lower-priority (longer-term) actions.

TABLE 4-4: PRIORITY ACTIONS FOR THE GENERAL OPERATION OF THE MSW FACILITY

PRIORITY LEVEL	EXPLANATION
High ●●●	• Ensure operator has appropriate training, personal protective equipment, and a shelter. • Install a fence with a locking gate around the MSW facility. • Limit public access to when the operator is on-site. • Screen incoming loads of waste. • Ensure that waste is segregated and placed in designated areas with clear signage. • Clean up any spills. • Cover wastes that have the potential to generate odours. • Complete maintenance and repairs (e.g., pick-up windblown litter, fix any areas damaged by erosion). • Ensure compliance with regulatory requirements.
Medium ●●	• Control surface/storm water. • Monitor surface water and groundwater (if not already doing so as part of permit or licence). • Install a portable litter control fence.

TABLE 4-4: PRIORITY ACTIONS FOR THE GENERAL OPERATION OF THE MSW FACILITY (CONT'D)

PRIORITY LEVEL	EXPLANATION
Lower ●	• Control and monitor leachate and landfill gas. • Improve operating plans, record-keeping, and reporting. • Implement tipping fees. • Install a weigh scale, where practical.

4.5 CONCEPTUAL LAYOUTS

A properly designed MSW facility maximizes its capacity to accept waste while minimizing its impact on human health and the environment. Each MSW facility may be configured differently, depending on the location, size of the site, quantity of waste expected, and waste management priorities set for the community (refer to Section 2.3).

When planning the layout of a MSW facility, the following general principles should be taken into account. They are based on operational, environmental, and health and safety considerations.

- Waste groupings
  - Managing similar waste types within each priority level together, where common operational practices (receiving, processing and storage or disposal) are required to create operational efficiencies (refer to Table 4-5);
  - Organizing waste types anticipated to be shipped out on a regular basis (e.g., hazardous and special waste, recyclables, metal) in an area suitable for accommodating large ground transport or for organizing sealift operations; and
  - Locating the landfill cell(s) at the back of the MSW facility for visual and odour reasons. If a community selects an off-site disposal option as part of a regional waste management approach, the landfill cell could be replaced by a transfer station, but site access would be an important consideration.
- Safety and convenience
  - Locating the site shelter (e.g., mobile work trailer) close to the MSW facility entrance for oversight;
  - Providing safe and convenient public access to drop-off and pick-up areas (e.g., reusable items); and
  - Restricting public access to higher risk areas (e.g., landfill cell, staging area, hazardous and special waste storage).
- Nuisance
  - Locating organics (feedstock, compost) at the back of the MSW facility for visual and odour aspects, and near the leachate pond (if applicable) to minimize leachate runoff traveling distances for odours and site contamination; and
  - Locating leachate and storm water ponds at the back of the MSW facility for visual, potential odours and discharge location aspects.

TABLE 4-5: WASTE TYPES THAT CAN BE MANAGED TOGETHER

GROUP TYPE	TYPE CHARACTERISTICS	EXAMPLES
Waste with Hazardous Components	• Have special treatment and/or disposal requirements • May require transportation of dangerous goods (TDG) training for transport • Require specialized training for treatment and disposal	• Household hazardous and special waste • Hydrocarbon-containing soils and snow • E-waste • ELVs prior to depollution • Bulky waste prior to depollution
Reusable Items and Recyclables	• Typically does not contain hazardous materials • No odour or nuisance issues	• Reusables • Recyclables
Depolluted Bulky Waste and Other Large-Volume Wastes	• Should not contain hazardous waste • Does not decompose easily • No odours • Potential safety and nuisance issues with tires	• Depolluted ELVs • Depolluted bulky waste • CRD waste • Scrap tires
Organic Waste	• Waste will decompose easily • Potential odour issues • Can be a wildlife attractant • Contributes to landfill leachate and greenhouse gas emissions	• Food waste • Yard waste
Residual Waste, Asbestos-containing Materials, and Animal Carcasses	• Wastes that are not captured through diversion activities	• Mixed garbage from households, businesses, and institutions • Asbestos-containing materials (special considerations) • Animal carcasses (special considerations)

Figures 4-1 and 4-2 present conceptual layouts to illustrate how a MSW facility can integrate the various waste management priorities (refer to Sections 4, 5, and 6) within its boundaries.

Communities facing multiple challenges and needs (refer to Section 2.3) should ideally aim to implement **high-priority actions** for the MSW facility as a whole and for higher risk waste types (refer to Sections 5 and 6). Such actions include:

- controlled access (fence and gate);
- a shelter for staff, such as a mobile work trailer;
- a staging area for bulking hazardous and special waste and depolluting waste (e.g., end-of-life vehicles (ELVs) and white goods);
- a storage area for e-waste and hazardous and special waste;
- a storage area for depolluted bulky waste (alternatively, items like white goods could be marked once depolluted) and depolluted ELVs; and
- a landfill cell to dispose of residual waste and certain hazardous and special wastes (e.g., asbestos-containing materials and animal carcasses).

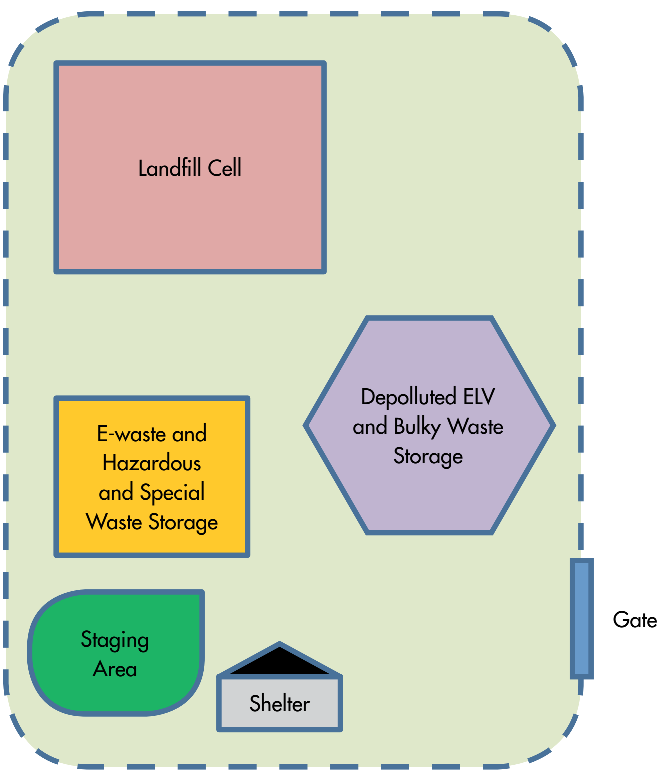


Figure 4-1: Conceptual Layout of a MSW Facility with a Focus on High-Priority Actions (**Note:** not to scale)

Communities already addressing high priorities may want to take **medium-priority actions** for the MSW facility as a whole (refer to Section 4) and for medium-risk waste types (refer to Section 6). Such actions include:

- stormwater management for the whole MSW facility;
- a storage area for reusable items and recyclables; and
- a composting area (can be complemented by backyard composting).

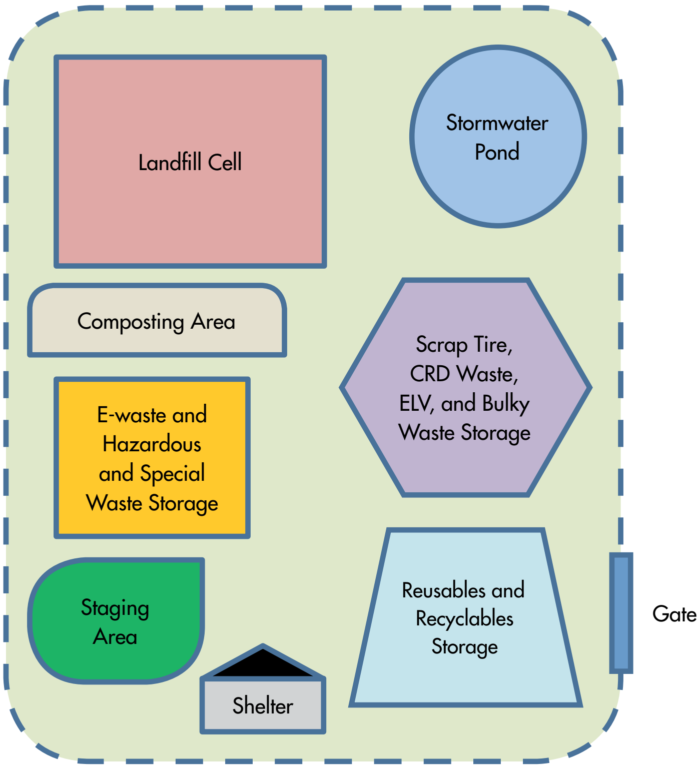


Figure 4-2: Conceptual Layout of a MSW Facility Incorporating Medium-Priority Actions (**Note:** not to scale)

Communities already addressing high and medium priorities may want to take **lower-priority actions** for the MSW facility as a whole and for lower-risk waste types. Such actions include managing and monitoring leachate and landfill gas (if applicable), shipping ELVs and bulky waste off-site for processing/recycling, and accepting additional types and sources of recyclables (includes segregation, storage, and off-site transport). The conceptual layout would remain similar to that presented in Figure 4-2.

ENDNOTES

1 Alaska Department of Environmental Conservation. 2006. Solid Waste Procedures Manual for Municipal Class III Solid Waste Landfills.

2 ARKTIS Solutions Inc. 2011. Solid Waste Best Management Guide. Prepared for Government of Nunavut, Department of Community and Government Services.

3 Alaska Department of Environmental Conservation. 2006.

4 ARKTIS Solutions Inc. 2011.

5 *Ibid.*

6 British Columbia Ministry of Environment. June 2016. Landfill Criteria for Municipal Solid Waste, Second Edition.

5.0 LANDFILL DESIGN AND OPERATIONS

5.1 OVERVIEW OF RESIDUAL WASTE MANAGEMENT

●●● "Residual waste" refers to the waste that remains after reuse, recycling, and composting. The quantity of residual waste to be managed by a community will therefore depend on its efforts and capacity to segregate waste for reuse, recycling, composting, or treatment/disposal off-site.

EXAMPLES	POTENTIAL RISKS
• Waste that remains after segregation and diversion. • For a MSW facility that has limited to no waste segregation and no diversion of reusables, recyclables, and compostables, residual waste will consist of the majority of waste generated in the community (e.g., mixed garbage from households, businesses, and institutions).	**Environmental** • Contamination of groundwater and/or surface water that comes into contact with waste or leachate (i.e., the fluid that forms when liquid percolates through waste). • Air contamination from landfill gas emissions (a combination of methane and other gases generated by landfills), smoke from fires, etc. **Human Health** • Landfill leachate can seep into the ground and/or surface water, which can impact drinking water quality. • Smoke from landfill fires can lead to health impacts in the community. • Landfill gas can migrate into nearby buildings and other structures creating an explosion hazard. • Wildlife may be attracted to this waste. **Other** • Wasted resources, i.e., materials that could be reused, recycled, or composted either within or outside the community are landfilled.

The choice of disposal option for residual waste will have a significant impact on MSW facility site selection, design, and operation. Disposal options include:

- waste transfer to a regional or neighbouring disposal facility;
- landfill disposal in the community's MSW facility (the focus of this section); or
- incineration with disposal of ash in a landfill (refer to Box 5-1).

In all cases, due to the mixed nature of residual waste and its relatively high volume, it is the most costly part of the waste stream to be managed. For example, an engineered landfill requires proper siting, design, construction, operation, closure, and long-term monitoring to prevent adverse impacts to human health and the environment during its contaminating lifespan (i.e., the period of time during which the landfill contains contaminants that could have an unacceptable impact if released to the environment[1]). Therefore, landfill airspace (refer to Section 5.5) is a valuable resource that needs to be conserved to the greatest extent possible.

A community can use the technical guidance contained in this section when designing a new landfill cell, expanding its current landfill cell, or looking for opportunities to improve the operation of its existing landfill cell.

BOX 5-1: INCINERATION—IT'S A COMPLEX UNDERTAKING

Over the decades, some northern and remote communities have looked to incineration (sometimes referred to as thermal treatment, waste-to-energy, and gasification) to help solve their waste management challenges. Waste management infrastructure that relies on some form of incineration technology is a complex undertaking. Incineration is a residual waste management option that requires careful consideration for the reasons outlined below:

- Waste incinerators represent a significant financial investment and require highly skilled operators, extensive maintenance and monitoring, and a well-sorted residual waste that has high energy content and preferably low moisture content;
- When not properly designed and operated, incinerators can be a significant source of air pollutants such as particulate matter, dioxins, furans, and mercury;
- Incinerators should only be used to incinerate the combustible, non-hazardous portion of residual waste (e.g., wood waste, paper, plastics);
- A second disposal system, such as a landfill or an off-site transfer station, is also required to dispose of the ash generated by the incinerator, as well as the non-combustible portion of residual waste (e.g., glass, metals, ceramics);
- If the incinerator ash is deemed to be a hazardous waste (based on laboratory testing), it should be transported to a licenced hazardous waste disposal facility;
- Batch waste systems with energy recovery can lead to the formation of greater quantities of dioxins and furans;
- In many cases, a supplementary fuel, such as oil, may be required to ensure complete combustion of the residual waste leading to higher operational costs; and
- To achieve low moisture content for residual waste, diversion of food waste to another alternative such as composting should be considered.

Based on the above, incineration may not be a practical residual waste disposal solution for many small and/or remote communities. For those communities wishing to consider incineration as part of their waste management system, further guidance can be found in Environment and Climate Change Canada's *Technical Document for Batch Waste Incineration* (refer to Appendix A, Incineration and Open Burning).

(Source: Environment and Climate Change Canada. 2010. Technical Document for Batch Waste Incineration.)

5.2 INTRODUCTION TO LANDFILLS

For the purposes of this document, a landfill consists of an area, referred to as a cell, where residual waste is placed, compacted, and covered, and then closed. For communities opting to operate an engineered landfill within their MSW facility, that is, a disposal site that is engineered to minimize contamination to the surrounding environment, this section presents the objectives of landfills, the types of landfills as defined for the purposes of this document, and their key components.

5.2.1 LANDFILL OBJECTIVES

For existing and new landfills, the primary objective for design and operation should be to contain the waste in a manner that minimizes the risk of off-site contamination by pollutants migrating beyond the limits of the MSW facility's property boundary. Pollutant migration pathways from landfills can include:

- contamination of groundwater and/or surface water that comes into contact with waste or leachate; and
- air emissions, such as landfill gas, smoke from fires, etc.

Off-site contamination risks can be reduced by selecting a good site for the MSW facility (as discussed in Section 3) with characteristics that inhibit migration of leachate off-site, and by designing and operating the landfill to minimize leachate generation and its release to the environment and to minimize and/or control releases of air pollutants.

5.2.2 LANDFILL TYPES

Jurisdictions across Canada have developed different classification systems for landfills. For the purposes of this document, two types of landfill—Class 1 and Class 2—are proposed for northern and remote communities. The two classes are distinguished by the type of base liner and leachate management system as well as the quantity of waste disposed on an annual basis.

- **Class 1 Landfills**—Engineered with a base liner and leachate collection system to contain and manage any landfill leachate and landfill gas. Generally applicable to MSW facilities accepting greater than 5,000 tonnes of waste per year for disposal (i.e., only applies to a handful of northern and remote communities in Canada with populations of about 5,000 or more).
- **Class 2 Landfills**—Engineered to ensure the natural attenuation of landfill leachate; may include a basic leachate collection system. "Natural attenuation" refers to the reduction of pollutant concentrations through naturally-occurring biological, physical, and chemical processes. Generally applicable to MSW facilities accepting less than 5,000 tonnes of waste per year for disposal, provided that certain hydrogeological and operational conditions are met.

5.2.3 LANDFILL COMPONENTS

In order to contain the waste and prevent water infiltration into the waste mass, Class 1 and Class 2 Landfills should include the following components:

- **Landfill base**—Consists of stable soils or rock above the groundwater table and provides the foundation for the construction of the landfill base liner and collection system (where applicable).
- **Landfill base liner**—A low permeability barrier made up of native soils (e.g., clay) or an engineered system that separates waste from the surrounding soil and groundwater and is designed to minimize or slow leachate releases to the environment.
- **Landfill cell**—A landfill using the "area method" of landfilling, which is considered a best practice in many regions. It typically consists of a lined area called a "cell" where the waste is placed, compacted, and covered. The cell is then progressively closed to minimize leachate production and, where applicable, landfill gas emissions.[2] Larger landfills may consist of a series of cells.
- **Leachate management system**—Provides an approach to preventing, collecting, sampling, pumping out, and treating leachate. Works in conjunction with the base liner to prevent leachate from entering the surrounding soils and groundwater.
- **Daily and intermediate landfill cover**—Application of clean soil or approved alternate material on top of the landfilled material to minimize nuisance factors (such as blowing litter and wildlife attraction), to direct stormwater runoff away from the active area of the landfill cell, and to serve as a firebreak within the landfill.
- **Final landfill cover**—Usually consists of a series of layers designed to seal the top of the landfill, promote stormwater runoff, and allow for landfill gas venting. Prior to the placement of a final cover, an interim cover should be used and generally has the same goals as the intermediate cover.
- **Stormwater management system**—Use of berms, ditches, or other methods to direct surface water runoff away from the landfill cell to minimize surface water contact with waste and to minimize erosion.[3]
- **Landfill gas management system**—Where landfill gas generation rates are a concern, landfill gas management typically includes a passive or active landfill gas collection system, a methane destruction system such as a flare or boiler, and monitoring of landfill gas levels in buildings and at the MSW facility perimeter.

5.3 LANDFILL DESIGN

5.3.1 INITIAL STUDIES

Whether upgrading or expanding an existing landfill or designing a new one, the design should be carried out by a qualified licenced professional engineer. The landfill should have a minimum design life of 30 years. At the outset of the project, an initial geotechnical investigation should be conducted to obtain information on the physical properties of the soil and rock at the site. A geotechnical investigation helps determine the suitability of the site and informs the engineering design. It includes:[4,5]

- site inspection of geotechnical conditions;
- sub-surface drilling investigation; and
- soil sampling and testing.

Prior to construction and operation, pre-development soil conditions should be assessed and detailed to aid in the development of reclamation/revegetation plans, which are part of site closure.[6] Waste volume and soil material balance should be examined to ensure an adequate supply of cover material for operation and closure periods (refer to Tables 5-3 and 5-4 and Box 5-2).[7] For landfills constructed on or near existing grade, which is common in permafrost environments, cover material may need to be brought onto the site, influencing the design as well as operation and closure costs.

In addition, a geotechnical analysis of structures that contribute directly or indirectly to containment of waste and water should be conducted in order to ensure that the engineered structures remain stable throughout the design life, including:[8]

- settlement assessment due to potential for ice thawing in soil pores;
- slope stability assessment in relation to loadings, erosion control, slope failure due to earthquakes, floods, etc.;
- seepage and contaminant transport assessment with consideration given to short- and long-term thermal conditions in the subsurface soils; and
- for permafrost regions, thermal regime assessment (spatially and temporally) with consideration for climate change.

A hydrogeological assessment should also be carried out to better understand the interaction between groundwater and geologic conditions of the site including:[9]

- depth to groundwater;
- flow direction;
- gradients;
- estimated travel times to potential receptors; and
- baseline groundwater quality.

5.3.2 BASE LINERS AND LEACHATE MANAGEMENT SYSTEMS

A landfill's base liner is the primary control measure for the protection of soil, groundwater, and surface water. Base liners can consist of compacted soils, synthetic materials, or a combination of the two that meet recommended permeability and thickness parameters. The base liner is typically constructed above the seasonal high water table to facilitate construction and to help prevent the transport of contaminants from the waste mass through groundwater.

Base liner systems typically go hand-in-hand with leachate management systems. As previously mentioned, "leachate" refers to the liquid that has been in contact with waste in the landfill cell and has undergone chemical or physical changes.[10] Typical constituents of landfill leachate include organic compounds, nitrogen compounds (e.g., ammonia, nitrate), phosphate, metals (e.g., iron, manganese), and dissolved solids (e.g., chloride, calcium, and sodium). Leachate management systems are an important part of landfill design and aim to ensure that surface water and groundwater quality surrounding the landfill site will continue to meet established water quality criteria throughout the active life, landfill closure, and post-closure period.

The landfill leachate management approach should consider:[11]

- prevention;
- composition;
- quantity;
- collection;
- treatment;
- discharge location and criteria; and
- sampling and testing.

Leachate generation should be prevented by keeping groundwater, stormwater, and snow away from waste. For Class 1 Landfills, a leachate collection system typically consists of a stone drainage blanket above the base liner with perforated collector pipes leading to a collection sump.[12] For Class 2 Landfills where the conditions are such that leachate infiltration is expected to be minimal, a basic leachate collection system consisting of a graded surface draining to a leachate sump may be required. Leachate is then periodically tested, pumped out, and treated on- or off-site. Prior to treatment of leachate through a community's wastewater treatment system, the additional volume and contaminant loadings need to be considered. The discharge of landfill leachate directly into surface water is not an acceptable practice.

Tables 5-1 and 5-2 present best practices for designing base liners and leachate collection systems for Class 1 and Class 2 Landfills.

TABLE 5-1: BEST PRACTICES FOR LANDFILL BASE PREPARATION AND BASE LINER DESIGN

PARAMETER	BEST PRACTICES—BASE PREPARATION AND BASE LINER
Landfill Base	• To prepare the landfill base, unconsolidated materials are typically removed to a depth of at least 1 m, to the permafrost line,[13] or to 1.5 m above the seasonal high groundwater table,[14] whichever is encountered first. • Typically, a minimum of 1.5 m separation should be maintained between the seasonal high water table and the lowest point of the landfill liner. Alternatively the hydraulic gradient could be controlled through installation of an appropriate drainage and pumping system. Groundwater lowering systems should provide for positive drainage of the groundwater away from the landfill cell.[15] • Organic overburden should be removed from the landfill cell area, stockpiled, and used in restoration and revegetation during closure.[16,17] Other excavated soils may be stockpiled and used as cover material.[18]

TABLE 5-1: BEST PRACTICES FOR LANDFILL BASE PREPARATION AND BASE LINER DESIGN (CONT'D)

PARAMETER	BEST PRACTICES—BASE PREPARATION AND BASE LINER	
Base Liner	Class 1 Landfills[19,20,21] • **Option A:** A compacted soil liner with a maximum hydraulic conductivity of 1 x 10^{-7} cm/s and a minimum thickness of 1 m; or • **Option B:** A composite liner consisting of a compacted soil liner with a maximum hydraulic conductivity of 1 x 10^{-7} cm/s and a minimum thickness of 60 cm, overlaid by an impermeable flexible membrane liner with a minimum thickness of 60 mil, a geotextile, and a 30-cm protective cushion layer (e.g., sandy soil) above the liner to protect it from damage[22] (refer to Table 5-2); or • **Option C:** If low permeability soil is unavailable, a double liner system consisting of two impermeable flexible membrane liners, each with a minimum thickness of 60 mil.	Class 2 Landfills[23,24,25] • Facility located on a natural or constructed substrate that will support natural attenuation of landfill leachate. • Modeling for the complete landfill design (base liner, cover, etc.) should be conducted to demonstrate that leachate will attenuate to the extent that all contaminants will be below the applicable standards at the points of contact with all relevant receptors. • Other factors that may support the use of natural attenuation include: – hazardous and special waste is diverted from the landfill (some exceptions apply); – landfill is located in an arid and/or semi-arid region or measures are put in place to prevent the infiltration of precipitation into the waste mass; – landfill is located in a permafrost region where biodegradation of solid waste is considered negligible; and – low waste generation rates and small landfill footprint. • **Note:** If natural attenuation of landfill leachate is not achievable or if modeling is not possible due to site conditions, the landfill should be constructed with a base liner and leachate collection system in accordance with the recommendations for a Class 1 Landfill.

TABLE 5-2: BEST PRACTICES FOR LEACHATE MANAGEMENT

BEST PRACTICES—MANAGING LEACHATE	
Class 1 Landfill • Leachate generation should be prevented as much as possible by: – stormwater control and diverting surface water around exposed waste through berms, ditches, and retention ponds; – clearing snow out of the waste disposal facility before it melts; – not using snow as cover material; – burying waste above the groundwater table; and – not putting waste into surface water. • The leachate collection and removal system should:[26] – be hydraulically separate from the MSW facility's stormwater system; – function year round; – function effectively throughout the lifespan of the landfill; – be equipped to record instantaneous and total flows; – be chemically compatible with the waste and leachate characteristics; – provide access for inspection, monitoring flow and head, controlling flow, and cleaning; – function effectively under dynamic and static loading events for all development phases; – use geosynthetic fabrics specified for leachate generation/flow into post-closure phase; – prevent the passage of fines into and any blockage of piping systems; and – have minimum hydraulic conductivity of 1×10^{-3} cm/s and maintain less than a 30-cm depth of leachate over the base liner.[27,28,29] • If a double liner system is used, a leachate collection system should be installed above each liner.[30] • A protective geotextile should be placed immediately above the leachate collection layer to limit waste intrusion into the drainage system. • A 2% slope towards the leachate collection point should be maintained to facilitate drainage.[31,32] • If discharge of leachate to a wastewater treatment system is intended, modeling of the system and testing of the leachate should be conducted to determine the potential for impacts to the wastewater treatment system.[33]	**Class 2 Landfill** • Leachate generation should be prevented as much as possible by:[34] – stormwater control and diverting surface water around exposed waste through berms, ditches, and retention ponds; – clearing snow out of the waste disposal facility before it melts; – not using snow as cover material; – burying waste above the groundwater table; and – not putting waste into surface water. • Where the site conditions are such that leachate infiltration is expected to occur, a basic leachate collection system, such as a graded surface draining to a collection point (leachate sump), may be required.

Figure 5-1 shows a typical base liner and leachate collection system for a Class 1 Landfill.

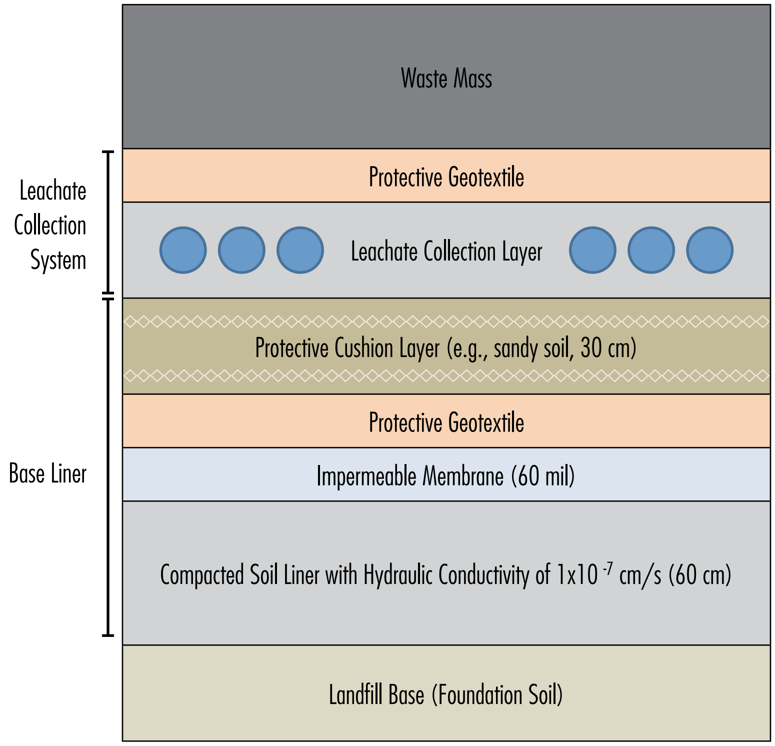


Figure 5-1: Cross-Section of a Typical Base Liner and Leachate Collection System (Option B) for a Class 1 Landfill (**Note:** not to scale)

5.3.3 COVER SYSTEMS

Daily and intermediate cover are integral to the design and operation of both Class 1 and Class 2 Landfills. Among other important functions, cover material serves to contain the waste, prevent water infiltration, reduce wind-blown litter, and prevent wildlife attraction (refer to Box 5-2, Table 5-3, and Figure 5-2).

TABLE 5-3: BEST PRACTICES FOR DAILY AND INTERMEDIATE COVER

PARAMETER	BEST PRACTICES—DAILY AND INTERMEDIATE COVER
Daily cover	• Waste should be properly placed and compacted as it is received and covered on a daily basis (i.e., on the days when the MSW facility receives waste for disposal) with a minimum of 150 mm of soil, or an approved alternate cover material, such that there is no exposed waste (see Figure 5-2 and Box 5-2).[35,36,37] As a general rule, a waste-to-cover ratio of between 3:1 and 4:1 is considered best management practice, that is, for every 3 or 4 truckloads of residual waste, 1 truckload of cover soil is used. • When weather conditions restrict site activity, the waste should be placed and then compacted and covered as soon as possible.[38]
Intermediate cover	• Intermediate soil covering should be completed in spring and fall and should consist of a minimum of 300 mm of soil.[39,40]

Figure 5-2: Rigid Steel Plate Alternate Cover System

BOX 5-2: THE IMPORTANCE OF DAILY COVER MATERIAL

"Daily cover" refers to material (about 150 mm if soil cover is used) that is spread over compacted waste at the end of each working day (i.e., each day the MSW facility receives waste). Some MSW facility operators in northern and remote communities find it challenging to use daily cover in their operations due to weather conditions or because cover material is in limited supply and/or heavy equipment is not always available. However, using daily cover is one of the main elements that sets well-managed landfills apart from open dumps. The purpose of daily cover is to:

- prevent wind-blown litter;
- promote appropriate surface water drainage instead of percolation through the landfill to create leachate;
- prevent release of odours;
- minimize presence of disease vectors (e.g., insects, rodents);
- deter scavenging by birds, bears, and other animals; and
- reduce the risk of fire ignition/spread when landfill is closed and unattended.

Key considerations:

- If using soil, it should be clean, i.e., not contaminated with hydrocarbons and heavy metals. Remediated soil should meet appropriate clean up criteria.
- Alternate daily cover options, such as rigid steel plate systems (refer to Figure 5-2), can reduce the need for soil and maximize the air space used.
- Snow is not an acceptable cover material since it can contribute to leachate production.
- Daily cover can sometimes be scraped off the operational area at the start of the day and reused at the end of the day to preserve cover material and reduce costs.

Once the landfill has reached its final grade, the final cover is installed to:[41]

- cover the waste uniformly and provide acceptable aesthetics;
- control and reduce the infiltration of precipitation and surface water into waste;
- limit erosion by wind and water;
- control release and prevent landfill gas from escaping at other than design points; and
- accommodate settling, freeze thaw cycles, and consolidation of the waste material to avoid ponding of water on the surface.

Best practices for final cover and grading are provided in Table 5-4.

TABLE 5-4: BEST PRACTICES FOR FINAL COVER

BEST PRACTICES—FINAL COVER AND GRADING
• Mounding of waste above the existing grades will increase the life of the landfill without increasing the size of the landfill footprint.[42] • Final cover slopes should be graded to facilitate stormwater runoff away from the landfill.[43] • Landfill slopes should not exceed 3H:1V to ensure slope stability, minimize risks of erosion, allow for safe operation of equipment, and minimize cost for cover material.[44] • An example of a final cover design includes the following elements:[45] – a 60-cm barrier layer with a maximum hydraulic conductivity of 1×10^{-7} cm/s (non-arid) or 1×10^{-5} cm/s (arid); and – a topsoil layer a minimum of 15 cm in depth seeded with native plants (where applicable) to limit erosion.[46] • Alternative final cover designs may be suitable in arid and/or semi-arid regions, in permafrost regions where biodegradation of solid waste is considered negligible,[47] or in communities with very low waste generation rates and small landfill footprints. • For Class 2 Landfills, modeling for the complete landfill design (base liner, final cover, etc.) should be conducted to demonstrate that leachate will attenuate to the extent that all contaminants will be below the applicable standards at the points of contact with all relevant receptors.

5.4 LANDFILL CONSTRUCTION

The following considerations must be taken into account during the construction phase of the landfill.

Pre-construction reports/plans completed by a qualified engineer should include:[48,49]

- final design report(s), i.e., a written record of the project;
- construction drawings, which are detailed design drawings;
- construction specifications, which describe the materials and work required; and
- construction quality assurance/quality control plan which details the inspections and activities that ensure that the design, manufacture, and installation of systems and materials used in the construction and operation of the landfill meet the purposes for which the systems and materials are intended.

Construction of the landfill cell should be carried out:[50,51]

- in accordance with approved engineering design and specifications, that is, the qualitative and quantitative elements used to meet the design objectives;
- following an approved quality assurance and quality control protocol to ensure that the product or structure meets the design objectives;
- under the supervision of a licenced professional engineer (i.e., who have the proper education and qualifications and adhere to a strict code of conduct); and
- in accordance with sound environmental practices for construction activities.

Post-construction reports, plans, and records prepared by a qualified engineer should include:[52,53]

- as-built drawings which revise the original design drawings to account for any changes made in the field;
- project record of addendums, reports, site visit inspections, etc.
- quality control certifications for any liner installation, soil layers, and other required aspects of the landfill; and
- a Certificate of Completion report from the consulting engineer stating that the landfill has been constructed as designed and outlining any deviations from the original design and the rationale for those deviations; the report should include a description of facilities constructed, along with photographic records.

5.5 LANDFILL CELL OPERATIONS

One of the primary goals of landfill operations is to use airspace—i.e., the volume of space available for landfilling—efficiently while minimizing environmental impacts. Compaction significantly reduces the amount of airspace used by maximizing the mass of residual waste that can be placed in a landfill per unit volume. Landfill compaction is a function of the type and weight of the compacting equipment, the thickness of the layers being compacted (known as “lifts”), and the number of passes made. Although smaller landfills generally cannot justify expensive compaction equipment, MSW facility operators can use available heavy equipment to achieve compaction.

To further conserve airspace, it is important to use cover material efficiently. If alternate daily cover systems, such as rigid steel plates, are not available, a waste-to-cover ratio of between 3:1 and 4:1 is considered best management practice; that is, for every 3 or 4 truckloads of residual waste, 1 truckload of cover soil is used. As discussed previously, cover soil can also be reused where practical.

The footprint of the working or active face—the area where residual waste is actively being received for disposal—should be kept as small as practical (typically the width of two garbage trucks side by side) to prevent litter and water infiltration. A summary of best practices for landfill operations with respect to compaction rates, active face sizes, and lift heights are presented in Table 5-5.

TABLE 5-5: BEST PRACTICES FOR LANDFILL CELL OPERATIONS[54]

ANNUAL TONNAGE (TONNES)	TARGET COMPACTION* (TONNES/M3)	ACTIVE FACE WIDTH (M)	ACTIVE FACE LENGTH (M)	LIFT HEIGHT (M)
< 10,000	0.65–0.75	8–10	24–30	1.5–2.0
10,000–20,000	0.75–0.80	10–12	30–36	2.0–2.5
20,000–50,000	0.75–0.85	12–16	36–48	2.5–3.0

***Note:** The number of passes to achieve the target compaction will depend on the type and weight of the equipment. This can be calculated with the help of a landfill engineer.*

Figure 5-3 presents an example of a well-defined active face.

Figure 5-3: A Well-Defined Active Face of a Landfill Cell

To reduce environmental impacts, sub-sections of the landfill cell that have reached their design capacity should be progressively closed using interim or final cover.

5.6 STORMWATER MANAGEMENT

Stormwater is water that originates during precipitation events and snow and ice melt. The goal of stormwater management is to keep water away from the landfill to prevent leachate formation. For both Class 1 and Class 2 Landfills, stormwater management controls should incorporate:[55]

- diversion of stormwater from working areas using trenches, culverts, berms and grading;
- prevention of erosion, siltation, and flooding;
- management of runoff from the facility; and
- removal of sediment from stormwater prior to discharge.

The larger of a 1-in-25-year storm event or snowmelt event should be used in the design of berms and/or ditches that prevent surface water from flowing onto or off the active portion of the facility.[56,57]

During the winter months, snow should be cleared and moved off-site, or at a minimum, away from the landfill cell. Operators should avoid blocking culverts and ditches by snow removal operations.[58]

If a stormwater retention pond is part of the stormwater management system, the stormwater needs to be tested and the results compared to appropriate water quality standards before being discharged to the surrounding environment (refer to Section 7).

5.7 LANDFILL GAS MANAGEMENT

Landfill gas results from the decomposition of organic waste in landfills and is composed primarily of methane, a greenhouse gas that contributes to climate change. Landfill gas can also be an explosion hazard. Since biodegradation of solid waste is considered negligible in permafrost regions, landfill gas generation in those regions is also expected to be very low.[59] In addition, the relatively low quantity of total waste generated and, consequently, small landfill footprints contribute to the low quantity of landfill gas typically generated in these regions.

In communities where landfill gas generation rates are expected to be higher (i.e., due to precipitation and/or higher waste volumes), likely at a Class 1 Landfill, a landfill gas generation assessment should be conducted. Landfills determined to be generating enough landfill gas to cause safety or environmental concerns should develop a landfill gas management plan, which may include collecting and destroying landfill gas through flaring (or energy recovery, where feasible).[60] All emissions should meet applicable regulations.[61]

Reducing the quantity of water that infiltrates the waste mass and diverting organic waste, such as food waste, leaf and yard waste, and paper products, from landfills can reduce landfill gas generation rates over the long term, thus further reducing landfill gas management concerns.

5.8 PRIORITY ACTIONS

Table 5-6 summarizes the recommended best practices that apply to landfilling of residual waste.

TABLE 5-6: PRIORITY ACTIONS FOR LANDFILLING RESIDUAL WASTE

PRIORITY	RECOMMENDED BEST PRACTICES
High ●●●	For a MSW facility with an existing landfill cell: • Prohibit open burning of waste; • Prevent accidental landfilling of hazardous and special waste; • Minimize the footprint of the area where waste is actively received for disposal ("active face"); • Compact and cover the waste; and • Divert water and snow from the waste. For a MSW facility building a new landfill cell: • Hire professionals to ensure that the old landfill cell is properly decommissioned and that the new landfill cell is properly sited, designed, constructed, and operated (see above).
Medium ●●	• Increase frequency of compacting and covering the waste; and • Look for further opportunities to segregate and divert waste.
Lower ●	• Look for opportunities to progressively close portions of the landfill cell (i.e., interim and final cover).

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[39] ARKTIS Solutions Inc. 2011.
[40] Ferguson Simek Clark Engineers & Architects. 2003.
[41] Government of Newfoundland and Labrador. 2010.
[42] *Ibid.*
[43] *Ibid.*
[44] Zender Environmental Engineering Services. 2001.
[45] British Columbia Ministry of Environment. June 2016.
[46] Zender Environmental Engineering Services. 2001.
[47] Ferguson Simek Clark Engineers & Architects. 2003.
[48] ARKTIS Solutions Inc. 2011.
[49] Government of Newfoundland and Labrador. 2010.
[50] ARKTIS Solutions Inc. 2011.
[51] Government of Newfoundland and Labrador. 2010.
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[56] EBA Engineering Consultants Ltd. 2009.
[57] Yukon Government. 2014.
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[61] Government of Newfoundland and Labrador. 2010.

6.0 MANAGEMENT OF MAJOR WASTE TYPES

6.1 OVERVIEW OF REMAINING WASTE TYPES

With a comprehensive waste management plan, a community will need to invest time and effort in implementing new practices for managing several waste types that will no longer be destined for disposal. This section describes best practices for the management of the remaining major waste types including:

- ●●● Hazardous and special waste
- ●●● Electronic waste (e-waste)
- ●●●/● End-of-life vehicles (ELVs)
- ●●●/● Bulky waste
- ●●●/●● Construction, renovation, and demolition (CRD) waste
- ●● Organics
- ●● Scrap tires
- ●● Reusable items
- ●●/● Recyclables

These waste types are presented in order of priority based on their potential risk to human health and the environment and the proportion of the total waste stream that they represent.

6.2 HAZARDOUS AND SPECIAL WASTE

●●● Since the terms "hazardous waste" and "special waste" are used interchangeably in many jurisdictions, this document will use the term "hazardous and special waste" to describe wastes that have hazardous properties. Hazardous and special waste management can be considered a **high priority** for northern and remote communities because households, local businesses, and institutions generate a broad range of products and materials that contain hazardous substances or pathogens. Since these wastes can represent a long-term liability for the community if not properly managed, consideration should be given to their appropriate handling, storage, treatment, and transport.

Each community should determine whether they have the licence and procedures in place to accept and manage these wastes, ensure that employees are adequately trained in the handling procedures, and report on the quantities disposed of (if applicable).

EXAMPLES	POTENTIAL RISKS
• Aerosol containers • Animal carcasses • Asbestos-containing materials • Automotive batteries (i.e., lead-acid) • Glycol (antifreeze) • Honey bags • Household cleaners • Hydrocarbon-containing soils and snow (as determined by testing) • Mercury switches from vehicles, thermostats,and appliances • Mercury-containing lamps (e.g., fluorescent light bulbs) • Paints • Propane tanks • Refrigerants (i.e., from appliances and end-of-life vehicles) • Residues from fuel tanks, heating oil tanks, and drums • Solvents (e.g., paint thinners, nail polish remover, degreasers, polishes) • Used oil and other oily wastes (e.g., oily rags, absorbents for spill clean-up) • Waste fuel (e.g., diesel, gas)	**Environmental** • Hazardous substances and pathogens may be released to the environment, contaminating soil, air, surface water, and/or groundwater. **Human Health** • Hazardous substances and pathogens may seep into the ground and/or surface water supply, which can impair drinking water quality. • Hazardous substances and pathogens may be discharged to the atmosphere, leading to health impacts in the community. • Hazardous and special waste can be highly combustible and explosive.

Communities should not accept hazardous and special waste from large industrial generators (e.g., mines, oil and gas exploration projects) operating outside the community unless their facility is licenced/permitted and equipped to manage these wastes (refer to Box 6-1). That said, there may be opportunities for communities to partner with some of these companies on backhaul programs.

Unsegregated hazardous and special waste piles may pose an immediate risk to human health and the environment. There are many benefits to segregating and managing hazardous and special waste appropriately. These materials require special treatment or disposal to prevent the contamination of the surrounding environment. Some of the materials may constitute a resource if recycling market opportunities can be accessed.

BOX 6-1: KEEPING WASTE FROM LARGE INDUSTRIAL GENERATORS OUT OF COMMUNITY MSW FACILITIES

An increase in resource development activities near some northern and remote communities has led to more waste from large industrial generators making its way into community MSW facilities. An example of such waste is drill cuttings, which consists of solid material removed from boreholes created during oil and gas and mineral exploration. What is the problem with accepting this type of waste?

- Most MSW facilities are not designed or permitted/licenced to handle these types of waste; and
- Any revenue received in the short term for accepting this type of waste may be cancelled out by the costly landfill space consumed and potential clean-up costs in the future.

If an outside company approaches a MSW facility operator about waste disposal, they should contact the appropriate regulatory agencies for guidance. In most instances, the waste will need to be transported to an authorized treatment/disposal facility. This may come at a higher cost to the company, but will protect the community in the long run.

Tables 6-1 and 6-2 present general design and operation best practices for hazardous and special waste management. In addition, communities should ensure compliance with all applicable regulatory requirements (regulations, standards, guidelines, local bylaws, etc.) governing occupational health and safety and hazardous and special waste storage and shipping, such as the *Transportation of Dangerous Goods Regulations*[1] and the *Interprovincial Movement of Hazardous Waste Regulations*[2].

TABLE 6-1: BEST PRACTICES FOR MANAGING HAZARDOUS AND SPECIAL WASTE—DESIGN

AREA/ACTIVITY	HAZARDOUS AND SPECIAL WASTE—DESIGN
Receiving and Short-Term Storage	• Should be designed for public to safely and conveniently drop-off hazardous and special wastes during operating hours. • Should include: – operator oversight, full- or part-time; – security controls to prevent unauthorized entry (e.g., MSW facility fence); – clear signage identifying hazardous and special waste drop-off areas and safe vehicle access; – emergency response equipment; – a flat impermeable surface (e.g., HDPE liner) with secondary spill containment appropriate to the type of hazardous and special waste; and – grading to direct surface runoff away from the receiving/storage area. • Incompatible substances should be stored separately to prevent contamination, fires, explosions, gaseous emissions, leaching, or other discharge. • Containers should be protected from the elements (see Figure 6-1).

TABLE 6-1: BEST PRACTICES FOR MANAGING HAZARDOUS AND SPECIAL WASTE—DESIGN (CONT'D)

AREA/ACTIVITY	HAZARDOUS AND SPECIAL WASTE—DESIGN
Processing and Longer-Term Storage	• In remote areas, sea cans present a best practice alternative to other protective structures (shelters, buildings, etc.) for hazardous and special waste storage. • The area should be designed for ease of access for loading hazardous and special waste for transport off-site. • Sufficient space should be allowed to segregate waste by type. • The area should be flat, and the surrounding area should be graded to direct runoff to the stormwater management pond. • Hazardous and special waste should be protected from the elements (e.g., a covered storage area, sea cans, storage containers (Figure 6-2)). • Larger solid items (e.g., automotive batteries) can be stored on pallets on an impermeable surface, or in a compatible container. • Storage containers should be: – sealable to prevent release of contents and entry of other substances; – made of material that is compatible with the hazardous and special waste it contains; – of durable construction, corrosion- and weather-resistant, and made to resist damage during handling and transportation; – stored in single file (no stacking) unless the containers are designed for that purpose; and – properly labeled with their contents and hazard type. • Liquids should be stored with secondary spill containment, such as bermed liners adapted for northern conditions, or covered structures equipped with a double floor for drainage.

TABLE 6-2: BEST PRACTICES FOR MANAGING HAZARDOUS AND SPECIAL WASTE—OPERATIONS

AREA/ACTIVITY	HAZARDOUS AND SPECIAL WASTE—OPERATION
Receiving	• MSW facility users should place waste in a designated receiving area during operating hours, and operator should transfer it to storage area (in a different area). • Alternatively, operator could be on-site during operating hours to receive and process all hazardous and special waste. • The operator should keep area organized and clean up any spilled material immediately.

TABLE 6-2: BEST PRACTICES FOR MANAGING HAZARDOUS AND SPECIAL WASTE—OPERATIONS (CONT'D)

AREA/ACTIVITY	HAZARDOUS AND SPECIAL WASTE—OPERATION
Processing	• MSW facility operator should: – receive proper training; – wear proper personal protective equipment; – clean up any spilled material immediately; – consolidate hazardous and special waste into larger storage containers ("bulking"); – store incompatible substances separately to prevent contamination, fires, explosions, gaseous emissions, leaching, or other discharge; – ensure that containers are protected from weather and the ground is protected from spills; – maintain inventory of types and location of chemicals stored on-site; and – ensure that appropriate safety equipment is located nearby (e.g., fire extinguisher, portable eyewash station).
Storage and Off-Site Transport	• The operator should maintain an inventory of the types and locations of hazardous and special waste stored on-site (critical emergency response information). • Storage containers should be: – stored in single file (no stacking) unless the containers are designed for that purpose; – properly labeled (material, hazard type); – closed at all times except when waste is added or removed, and kept free from water contamination; and – inspected regularly. • Store drums on pallets to prevent corrosion, detect leaks, and facilitate moving. • Hazardous and special waste should be transported off-site to an authorized treatment or disposal facility as frequently as practical for road accessible communities. Sealift communities are bound to backhauling schedules; practically, they may have to organize and coordinate off-site transport when hazardous and special waste containment approaches full capacity. (**Note:** some jurisdictions may limit the volume of material that can be stored).

Figure 6-1: Sheltered Receiving Area

Figure 6-2: Containment for Various Waste Types

Table 6-3 presents a list of processing and storage recommendations specific to certain types of hazardous and special wastes commonly generated in northern and remote communities.

TABLE 6-3: PROCESSING AND STORAGE RECOMMENDATIONS FOR HAZARDOUS AND SPECIAL WASTE

WASTE TYPE	PROCESSING AND STORAGE RECOMMENDATIONS
Aerosol Containers	• Store aerosol containers in tightly sealed containers.
Animal Carcasses	• Includes remains of domestic animals (e.g., livestock and pets), wildlife (e.g., game animals and road kill), and other animals. • Proper disposal is important to prevent transmission of disease and to protect the environment. • For domestic animals, preferred disposal options include cremation (i.e., incineration) where services exist or, where permitted, burial on private land. Carcasses of animals that have been euthanized may contain potentially harmful residues. Proper disposal (incineration) is important to prevent death or injury of scavenger animals, including pets and wildlife. • For game animals, hunters should consult local wildlife authorities and hunting regulations for tips on waste reduction and acceptable disposal methods. • If a dead animal is suspected to have been diseased (e.g., anthrax, avian flu, chronic wasting disease), the MSW facility operator should contact local wildlife authorities or a veterinarian for guidance on disposal options. • Any animal carcasses that are to be disposed at the MSW facility should be buried immediately in a dedicated area of the landfill cell with at least 2 m of cover material to control odours and vermin.
Antifreeze	• Store antifreeze (glycol) containers in tightly sealed containers; do not allow mixing of wastes. In some instances, glycol can be reconditioned locally for reuse.
Automotive Batteries	• In receiving areas, automotive batteries can be placed in plastic bins (see Figure 6-3). • For longer-term storage of automotive batteries, place on wooden pallets. Do not stack more than two layers thick. Separate the layers with a thin sheet of plywood or a few sheets of sturdy cardboard. Once full and prior to shipping, shrink wrap, strap to pallet, and set aside for off-site transport.

Figure 6-3: Temporary Storage of Automotive Batteries

TABLE 6-3: PROCESSING AND STORAGE RECOMMENDATIONS FOR HAZARDOUS AND SPECIAL WASTE (CONT'D)

WASTE TYPE	PROCESSING AND STORAGE RECOMMENDATIONS
Asbestos-Containing Materials	• CRD waste, including materials such as roof felt and shingles, vermiculite insulation, stucco, acoustic tiles, pipe insulation, gypsum board, and sheet flooring, is a potential source of asbestos. • Protection of the public, workers, and the environment from airborne exposure to asbestos waste (i.e., through inhalation) is important for preventing lung disease and cancer. • Where services exist, asbestos waste should be disposed of through a registered hazardous waste management company. • If asbestos waste is to be disposed of at the MSW facility, the following three conditions should be met: 1. The MSW facility has permission from regulatory authorities to dispose of asbestos waste; 2. Asbestos waste arrives at the MSW facility either double-bagged in polyethylene bags of at least 0.15 mm (6 mil) thickness or single-bagged and sealed in a puncture-proof container, such as a plastic or metal drum; and 3. Bags and containers are labeled as containing asbestos waste. • Asbestos waste should then be immediately disposed of in a dedicated area of the landfill cell where it will not be disturbed and covered with at least 50 cm of cover material. The location of the asbestos waste should be well signed, marked with a GPS unit and recorded on a site map of the MSW facility for future reference. • Upon closure of the MSW facility, the final cover over the asbestos waste should be at least 1.25 m thick, and permanent signage should be installed to indicate the presence of asbestos waste.
Honey Bags	• The term "honey bag" refers to a plastic bag containing human sewage collected from homes, cottages, or camps that lack indoor plumbing. Proper disposal of honey bags is important for preventing the transmission of disease. • MSW facility and sewage lagoon operators should avoid handling honey bags directly. • Ideally, generators should empty the contents of honey bags at the sewage lagoon. Empty plastic bags can then be landfilled at the MSW facility. A bin should be provided at the sewage lagoon for empty bag disposal.
Household Batteries	• Separate by type (e.g., alkaline (single-use), lithium ion, nickel metal hydride) and store in a plastic container with a lid. Some organizations provide a recycling service through the mail. Some restrictions may apply.
Household Cleaners	• Store household cleaner containers in tightly sealed containers. Do not allow mixing of wastes.

TABLE 6-3: PROCESSING AND STORAGE RECOMMENDATIONS FOR HAZARDOUS AND SPECIAL WASTE (CONT'D)

WASTE TYPE	PROCESSING AND STORAGE RECOMMENDATIONS
Hydrocarbon-Containing Soils and Snow	• Hydrocarbon-containing soils and snow are those contaminated with gasoline, diesel, and/or other petroleum products. • These materials may be considered hazardous if they exceed certain concentrations of contaminants (e.g., benzene, toluene, ethylbenzene, and xylene or BTEX) or exhibit hazardous properties, such as flammability (i.e., flashpoint), which is determined through analytical testing. Proper treatment or disposal of hydrocarbon-containing soils and snow is important for protecting human health and the environment. • Larger quantities of hydrocarbon-containing soils should be managed by a soil treatment facility (a.k.a. landfarm or land treatment facility) or a registered hazardous waste management company. Please consult Environment and Climate Change Canada's *Federal Guidelines for Landfarming Petroleum Hydrocarbon Contaminated Soils* (2013) for more information on the landfarming process. • Smaller quantities of hydrocarbon-containing soils or snow resulting from spills may be stored in sealed and labeled drums at the MSW facility (subject to local requirements and regulations) for proper treatment or disposal off-site with other hazardous and special waste. • Certain treated soils from a soil treatment facility can be considered for use as cover material at the MSW facility's landfill cell. Decision-makers could consider co-locating the MSW facility with a soil treatment facility to save on transportation costs for cover material.
Mercury-Containing Lamps	• Lamps should be packed in a manner that prevents breakage during storage and transit and that provides containment of mercury vapour or airborne mercury-containing particles in the event of breakage. • Lamps that are received loose or unpackaged should be packed in commercially available containers (e.g., 20-litre pails, 205-litre drums) or alternative packaging that prevents breakage in transit. • Containers should be clearly labeled and should contain lamps only. • It is preferred that lamps be kept whole and unbroken during storage and transport in order to minimize potential human exposure to mercury and prevent releases to the environment. However, in some circumstances it may be necessary or practical to store and transport lamps in a crushed state (refer to Box 6-2).
Mercury Switches	• Store mercury switches in closed unbreakable containers in a secondary container to reduce the risk of releases. Keep separate from other waste, in a cool dry place, and mark with a clear warning sign.

TABLE 6-3: PROCESSING AND STORAGE RECOMMENDATIONS FOR HAZARDOUS AND SPECIAL WASTE (CONT'D)

WASTE TYPE	PROCESSING AND STORAGE RECOMMENDATIONS
Paints	• Use original containers when possible and store on a pallet that is accessible to MSW facility users who wish to reuse paints. Containers should be sealed and leak-free. Dry water-based paint can be disposed of at the landfill cell (metal containers may be recyclable).
Propane Tanks	• Where facilities exist, propane tanks can be returned to the retailer. Otherwise, place propane tanks on wooden pallets—do not stack. Once the pallet is full and prior to shipping, shrink wrap it and prepare it for off-site transport. • Alternatively, empty and purged propane tanks can be managed as scrap metal. Any venting or valve removal should be performed by trained staff with extreme caution.
Refrigerants	• Refrigerants should be removed from appliances by a certified technician (refer to Box 6-3). Store refrigerants in approved cylinders that are designed for the different types of refrigerants.
Residues from Fuel Tanks, Heating Oil Tanks, and Drums	• Residues such as liquids and sludges in large, sealed containers may have hazardous properties that are immediately dangerous due to headspace vapours. It is recommended that only tanks and drums that have been emptied by the generator be accepted at the MSW facility for recycling or disposal.
Solvents	• Store solvent containers in tightly sealed containers.
Used Oil and Oily Wastes	• Remove used oil from containers by draining into 205-litre drums. (**Note:** In accordance with the *Transportation of Dangerous Goods Regulations*, use new or reconditioned UN-certified drums for transport of most liquids). Used oil containers can also be stored in a plastic container similar to that in Figure 6-2. • For filter disposal, eliminate as much waste oil as possible, puncture the top of the filter, set the filter in a tray and let it drain for 24 hours. Crush the filter to increase waste oil recovery. Once finished, place the filter in a storage area. Ideally, filters will be put in an area with secondary containment, which could include bulk bags for filter disposal or plastic bins. • From an air emissions standpoint, the recycling of used oil at an authorized facility is the preferred management method. For MSW facilities opting to recover heat from used oil using an approved burner, the unit should be operated in accordance with the manufacturer's specifications and any applicable local guidelines and regulations.
Waste Fuel	• Waste fuel should be removed from fuel tanks and containers in a well-ventilated area and stored outside. Bulk and store waste fuel in 205-litre drums. (**Note:** In accordance with the *Transportation of Dangerous Goods Regulations*, use new or reconditioned UN-certified drums for transport of most liquids). Do not mix different types of fuel and ensure containers are clearly labeled.

BOX 6-2: DRUM-TOP LAMP CRUSHER DEVICES

Mercury is a toxic, naturally occurring chemical element that can cycle between air, water, land, plants and animals for extended periods of time and may be carried over long distances in the atmosphere. Mercury is useful in a variety of commercial and consumer products, including fluorescent lamps, thermometers and thermostats, and some batteries and switches, among others.

Although it is preferred that end-of-life mercury-containing lamps be kept intact during storage and transport, some MSW facilities may choose to use drum-top crusher devices to reduce the volume of lamps before transport. The use of drum-top crushers is a practice allowed by many provincial and territorial jurisdictions. However, it is important that these devices be equipped with mercury particle and vapour capture systems and be used properly by trained staff to minimize potential risks to human health and prevent releases to the environment. More information on managing lamps is available in Environment and Climate Change Canada's *Code of Practice for the Environmentally Sound Management of End-of-life Lamps Containing Mercury* (refer to Appendix A, Hazardous Waste).

(Source: Environment and Climate Change Canada. 2013. About Mercury; and Environment and Climate Change Canada. 2017. Code of Practice for the Environmentally Sound Management of End-of-life Lamps Containing Mercury.)

BOX 6-3: PROTECTING THE OZONE LAYER

Refrigerants are chemicals used in air-conditioning systems of vehicles and in appliances such as refrigerators and freezers. If not properly managed, these substances are released to the atmosphere and contribute to the thinning of the Earth's ozone layer, which protects us from harmful ultraviolet rays. In recent years, severe ozone depletion has been measured over the Arctic. Some refrigerants are also greenhouse gases that, if released, contribute to the emissions that are changing our climate. For these reasons, refrigerants need to be removed by a certified technician and sent to authorized hazardous waste facilities for disposal.

For communities that do not have a certified technician providing refrigerant removal services within their community, they could partner with other communities to contract out this service to an outside provider on a periodic basis. Alternatively, communities could invest in the necessary equipment and training so that their MSW facility operator could safely perform this task. Information on ozone depletion prevention training is available in Appendix A under MSW Facility Operations and Maintenance.

(Source: Environment and Climate Change Canada. 2010. Depletion of the Ozone Layer.)

In addition to not accepting waste from large industrial generators operating outside of the community (refer to Box 6-1), MSW facilities should not accept biomedical wastes (i.e., waste from medical and veterinary clinics), radioactive materials, or explosives. These wastes require special care, can be highly dangerous if improperly handled, and may generate additional environmental liabilities for the community. Communities should contact the local regulatory authorities for further guidance on managing these waste types. More information is provided in Appendix A, Hazardous and Special Waste.

For references and more specific information on hazardous and special waste and its management in northern and remote communities, including the link to a training video entitled *Managing Hazardous Waste in Your Community* that was developed by the Government of the Northwest Territories and Ecology North, please refer to Appendix A, Hazardous and Special Waste.

6.3 ELECTRONIC WASTE

●●● When electronic products are sent to landfills, their potential value at end-of-life is lost. Gold, silver, and other metals are among the valuable materials that can be recovered. Electronic waste (e-waste) can be considered a **high priority**, since when it is mismanaged, there is the potential for hazardous or toxic substances to be released into leachate or surface water. Industry initiatives coupled with extended producer responsibility legislation have resulted in growing capacity across Canada to recycle e-waste in an environmentally responsible manner.

A wide array of electronic products are more accessible than ever to consumers and residents of northern and remote areas. While innovations such as lightweighting of products and multi-function devices have contributed to reduced material needs per unit, consumer demand and equipment lifespan will continue to place this waste type at the top of the list of waste to be diverted and recycled. Table 6-4 presents an overview of design and operation best practices for managing e-waste in northern and remote communities.

EXAMPLES	POTENTIAL RISKS
• Audio and video players and recorders • Cables • Cameras (i.e., web, digital, analog) • Cellular and smart phones • Desktop and laptop computers • Equalizers/(pre)amplifiers • Modems • Handheld computers and tablets • Printers, photocopiers and scanners • Radios • Speakers • Telephones and answering machines • Televisions and monitors • Turntables	**Environmental** • Hazardous substances found in e-waste (e.g., metals, persistent organic pollutants) may leach into the environment, contaminating soil, surface water and/or groundwater. **Human Health** • Hazardous substances found in e-waste may seep into ground and/or surface water, which can impair drinking water quality and lead to health impacts in the community.

TABLE 6-4: BEST PRACTICES FOR MANAGING ELECTRONIC WASTE—DESIGN AND OPERATIONS

DESIGN	OPERATION
Receiving, Processing and Storage Area • A designated drop-off area should be clearly identified for MSW facility users. • E-waste should be protected from the elements and potential damage (e.g., a covered receiving, processing and/or storage area, sea cans, or the same type of weatherproof storage containers as for hazardous waste (Figure 6-2), etc.). • Design could include storage on pallets (Figure 6-4), in bulk bags (i.e., strong fibre bags that are used as containers), etc. • The type and size of storage area will depend on the quantity of e-waste received each year and the duration of the storage period. • The storage area should be located in a flat area, and the surrounding area should be graded to direct runoff to the stormwater management pond. • The area should be designed for ease of access for loading e-waste for transport off-site.	**Receiving and Processing** • MSW facility users should place e-waste in the designated area and the operator should transfer to storage area (if different from drop-off area). • Alternatively, the operator could be on-site during operating hours to receive and process all e-waste. • The operator should receive training and wear proper personal protective equipment. **Storage and Off-Site Transport** • Storage areas should be clean and free from all other forms of waste. • A separate area should be established to store broken or smashed e-waste (ideally in the hazardous and special waste storage area of the MSW facility). • Large items could be placed on designated pallets and small items in bulk bags/containers on pallets. • Full pallets should be wrapped in plastic and moved to a longer-term storage area. • E-waste should be transported off-site to an authorized recycling or disposal facility as frequently as practical for road accessible communities. Sealift communities are bound to backhauling schedules; practically, they may have to stage and coordinate off-site transport when e-waste storage approaches full capacity or before, on an opportunistic basis.

Figure 6-4: Full E-Waste Pallets, Wrapped and Ready for Off-Site Transport

6.4 END-OF-LIFE VEHICLES

●●● /● End-of-life vehicles (ELVs) contain several hazardous materials and toxic substances that may present risks to the operator due to fire or explosion potential, as well as risks of environmental contamination as they may leak onto the ground, into water (ground or surface water), into the air, and into the surrounding environment. As such, depollution of any ELVs can be considered a **high priority**. Once depolluted, the environmental and human health risks associated with these wastes are lower, and so their final management can be considered a **lower priority** until transportation or environmentally sound dismantling can be arranged.

EXAMPLES	POTENTIAL RISKS
• Boats and outboard motors • Construction equipment (e.g., bulldozers, dump trucks, graders) • Personal use all-terrain vehicles (ATVs) and snowmobiles • Road motor vehicles (e.g., cars, sport utility vehicles and light-duty trucks)	**Environmental** • Hazardous substances found in vehicles (e.g., oils, refrigerant gases, lubricants, antifreeze, mercury, lead) may be discharged to the environment, contaminating soil, air, surface water and/or groundwater. **Human Health** • Substances found in ELVs can be highly combustible and explosive (e.g., fuel). • May present a physical hazard if stored incorrectly (e.g., if unsafely stacked). **Other** • Visual appearance and landscape impacts.

This section presents best practices for managing ELVs in northern and remote communities, including:

- an overview of design and operation best practices for managing ELVs (Table 6-5);
- a set of requirements for processing hazardous materials from ELVs (Table 6-6); and
- a list of specialized equipment required for managing ELVs (Table 6-7).

TABLE 6-5: BEST PRACTICES FOR MANAGING END-OF-LIFE VEHICLES—DESIGN AND OPERATIONS

DESIGN	OPERATION
Receiving and Processing Area • The receiving and processing area should be designed to safely and conveniently drop off hauled ELVs to a clearly identified area. • Depollution of ELVs should be conducted in a staging area with an impermeable surface and secondary containment. • The surrounding area should be graded to direct runoff to the stormwater management pond.	**Receiving and Processing** • Hazardous materials should be removed from ELVs prior to storage and transport off-site. • The first step in processing ELVs should be to remove the items listed below, in the order listed: – disconnect and remove the battery; – remove any refrigerants (by a certified professional only); and – remove fuel. • After these three items are removed, the remaining hazardous materials can be removed (refer to Tables 6-3 and 6-6). The order of removal is not as critical, as long as they are removed prior to storing the ELVs. • Process and store removed hazardous materials as described under hazardous and special waste. • Fuel tanks should either be punctured using a non-sparking tool or removed from each ELV, flattened, packaged or baled, and properly identified for transport off-site. • Crushing the depolluted ELVs using a fixed or mobile crusher will facilitate off-site transport. This can be done before placing the ELVs in storage, or at a later date in advance of the off-site transport.
Storage Area • The size of storage area will depend on the number and types of ELVs received each year and the duration of the storage period. • The storage area should be located in a flat area, and the surrounding area should be graded to direct runoff to the stormwater management pond. • ELVs should be stored in a manner that ensures the safety of workers and the public. • The area should be designed for ease of access for unloading and loading ELVs for transport off-site.	**Storage and Off-Site Transport** • Access to the clean ELVs may be open to the community for salvaging spare vehicle parts. • ELVs should be transported off-site to an authorized recycling facility as frequently as practical for road accessible communities. Sealift communities are bound to backhauling schedules; practically, they may stage and coordinate off-site transport of ELVs when either quantities warrant it or when an economic opportunity arises.

There are a number of hazardous materials that should be removed and properly handled prior to storing the ELVs. Table 6-6 provides processing requirements for the remaining hazardous materials in ELVs. The removed hazardous materials should be processed and stored as described in Section 6.2.

TABLE 6-6: REQUIREMENTS FOR PROCESSING HAZARDOUS MATERIALS FROM ELVs

HAZARDOUS MATERIAL	PROCESSING REQUIREMENTS
Antifreeze	Use dedicated hand pump to remove from vehicle.
Battery	Disconnect battery and remove from ELV.
Brake Fluid	Use dedicated hand pump to remove from vehicle.
Differential Fluid*	Use hand pump or drain from vehicle components.
Engine Oil*	Use hand pump or drain from vehicle components.
Fuel (Gasoline/Diesel)	Use a suction system specifically designed for removal of fuel. Do not use the same system for both gasoline and diesel. Separate systems should be used.
Fuel Tank	Remove fuel from tank. Remove empty tank from vehicle and flatten tank using a wheel loader or dozer.
Lead	Remove battery cable ends and wheel weights from vehicles.
Mercury Switches	Use small flathead screwdrivers and wire cutters to remove assemblies from vehicles. Remove metal mercury pellet from assembly if possible.
Oil Filter	Remove from vehicle, puncture the top of the filter, set filter in tray and let it drain for 24 hours. Crush filter to increase waste oil recovery.
Power Steering Fluid*	Use hand pump or drain from vehicle components.
Refrigerants	Use a mobile refrigerant removal unit to prevent discharge of refrigerant into the atmosphere. This should be performed by a certified professional.
Transmission Fluid*	Use hand pump or drain from vehicle components.
Windshield Washer Fluid	Use dedicated hand pump to remove from vehicle.

***Note:** *Engine oil, transmission fluid, power steering fluid and differential fluid can all be removed using the same hand pump.*

Specialized equipment that may be required to manage ELVs is described in Table 6-7 below.

For more comprehensive steps for processing ELVs, please refer to the resources in Appendix A, End-of-Life Vehicles.

TABLE 6-7: EQUIPMENT REQUIRED FOR MANAGING ELVs

EQUIPMENT REQUIRED	PURPOSE OF EQUIPMENT	SPECIAL CONSIDERATIONS
Brass Blade	For puncturing the fuel tanks without causing sparks.	
Fork-Lift or Fork Attachment for Front-End Loader or Backhoe	To move ELVs from the staging area to the stockpile area.	
Fuel Evacuation Unit—Diesel	To remove diesel from ELV.	Unit should be specifically designed for removal of diesel due to potential fire/explosion risks. Unit should be dedicated for removal of diesel only. Do not use one unit for both gasoline and diesel.
Fuel Evacuation Unit—Gasoline	To remove gasoline from ELV.	Unit should be specifically designed for removal of gasoline due to potential fire/explosion risks. Unit should be dedicated for removal of gasoline only. Do not use one unit for both gasoline and diesel.
Hand Pumps	For removal of various hazardous fluids.	At least four hand pumps are required: 1. Windshield washer fluid 2. Antifreeze 3. Brake fluid 4. Engine oil, transmission fluid, power steering fluid and differential fluid
Mobile Refrigerant Evacuation Unit	To remove refrigerants from vehicle air-conditioning system.	Refrigerants should be removed by a certified technician trained to operate the refrigerant evacuation unit.
Storage Containers	For collection and storage of various hazardous fluids.	Refer to Tables 6-1 and 6-3 for specific container requirements.
Wheel Loader or Dozer	To flatten removed fuel tanks to prevent build-up of potential vapours.	Flattened tanks can be shipped with non-hazardous ELV hulks to an ELV recycler.
Wheel Ramps	To raise ELV high enough to allow for the removal of hazardous fluids.	Wheel ramps should be designed for use with vehicles that are being processed. Always use appropriate safety precautions when working under vehicles.

6.5 BULKY WASTE

●●● /● Bulky wastes consist of large waste items, such as white goods (appliances), mattresses, furniture, scrap metals, fibreglass tanks and boathulks (i.e., engine removed), etc. Certain bulky wastes contain hazardous substances, such as refrigerants in appliances. Depollution of these wastes can be considered a **high priority**. Once depolluted, the environmental and human health risks associated with these wastes are low, and so their subsequent management and transport can be considered a **lower priority**.

EXAMPLES	POTENTIAL RISKS
• Fibreglass • Furniture and mattresses • Plastics • Scrap metals • White goods (i.e., appliances once the hazardous substances have been removed)	**Environmental** • Hazardous substances found in certain white goods, drums, and tanks may be discharged to the environment. **Human Health** • May present a physical hazard if stored incorrectly (e.g., if unsafely stacked). • May accumulate stagnant water (a source of odours and breeding ground for mosquitoes). **Other** • Visual appearance and landscape impacts if not landfilled. • Disposal increases landfill space requirements. • Landfilling can result in uneven settling in areas around this waste, which can damage the landfill cover.

This section presents best practices for managing bulky waste in northern and remote communities and contains:

- an overview of design and operation best practices for managing bulky waste (Table 6-8); and
- a set of processing and storage practices for recoverable bulky items (Table 6-9).

TABLE 6-8: BEST PRACTICES FOR MANAGING BULKY WASTE—DESIGN AND OPERATIONS

DESIGN	OPERATION
Receiving and Processing Area • Area should be clearly identified for MSW facility users. • Depollution of bulky items, where required (e.g., appliances and boats) should be performed in the hazardous waste processing area. **Storage Area** • The size of area will depend on the number and types of bulky items received each year and the duration of the storage period. • The area should be divided to allow segregated storage for major waste types and materials (metals, white goods, etc.). • The area should have good signage to instruct MSW facility users. • The area should be graded to direct runoff to the stormwater management pond. • The area should be designed for ease of access for unloading and loading bulky items for transport off-site.	**Receiving and Processing** • MSW facility users should be directed to place bulky items in designated sections or general drop-off area. • Signage should be kept clean and current to assist in directing people to the appropriate area. • The operator should verify that wastes are appropriately placed in designated areas. • Alternatively, the operator could be on-site during operating hours to receive, sort and place bulky items in the designated area. • Hazardous substances should be removed from bulky waste items by trained personnel prior to placing in storage. • If not reused, tanks and drums that contained fuel should be cut or punctured (using an approved no-spark device) to prevent buildup of explosive vapours (although it is preferably that drums be purged by the generator prior to disposal). • Waste that is not reusable or recyclable should be disposed in the landfill cell. **Storage** • Storage areas should be clean and free from all other types of waste. • Wastes should be stored in a manner that prevents accumulation of water in and around the wastes. **Off-Site Transport** • Wastes should be transported off-site to an authorized recycling or disposal facility as frequently as practical. Sealift communities are bound to backhauling schedules; practically, they may have to stage and coordinate off-site transport when storage area approaches full capacity.

TABLE 6-9: PROCESSING AND STORAGE PRACTICES FOR RECOVERABLE BULKY ITEMS

WASTE TYPE	PROCESSING	STORAGE
Fibreglass	• Fibreglass tanks should be cut or broken down to prevent the collection of standing water. • Sewage tanks may need to be cleaned of residual sewage. • Fibreglass boat hulks may have motors and hazardous materials that need to be removed (refer to Section 6.4).	• Store the wastes in a designated area to allow for reuse. • **Note:** fibreglass insulation (e.g., from buildings) should be disposed in the landfill or off-site.
Furniture	• Sort into re-usable and non-reusable furniture.	• Store re-usable furniture in a designated area for reuse. • Non-reusable furniture should be disposed in the landfill cell.
Metals	• Sort by type: steel, aluminum, copper. • Steel drums and fuel tanks should be emptied and cleaned of fuel, sludge and vapour to lessen the fire hazard (preferably by the generator prior to disposal at the MSW facility). • Drums that are damaged and of no future use can be crushed (with drum crusher or bulldozer) or cut up to reduce space requirements using an approved no-spark cutter to prevent igniting a fire and/or explosion. • Refer to Table 6-3 for information on proper removal and handling of hazardous waste associated with scrap metals.	• Store each type of metal in a separate area. • Fuel tanks should be stored cut side down to prevent collection of water in the tank halves. • Steel drums that are in good condition, do not leak, and have a tight fitting cover can be reused in some instances. **Note:** Under the *Transportation of Dangerous Goods Regulations*, steel drums generally cannot be reused for transporting liquids unless they have been reconditioned and are UN-certified, refer to Appendix A, Hazardous and Special Waste. • Otherwise, cleaned drums should be stored to prevent collection of water (i.e., on side). • Crushed and/or cut drums can be stored on pallets ready for shipment off-site.
Plastics	• Segregate the waste. • Drain tanks.	• Store cleaned plastics in a designated area for reuse or recycling. • Plastic can be crushed using a bulldozer or other heavy piece of equipment to reduce space requirements. • Store all plastic in a manner that prevents collection of water in the items.

TABLE 6-9: PROCESSING AND STORAGE PRACTICES FOR RECOVERABLE BULKY ITEMS (CONT'D)

WASTE TYPE	PROCESSING	STORAGE
White Goods	Take to processing area and remove hazardous fluids such as: • refrigerants • mercury switches • capacitors • hazardous fluids (compressor oils, etc.) **Note:** Refrigerants should be removed by a trained and certified technician using specialized equipment. A contractor may be required to remove the refrigerants (refer to Box 6-3). Refer to Table 6-3 for information on the proper removal and handling of hazardous materials found in white goods.	• Once all hazardous materials are removed from the white goods, consider removing doors to prevent accidental entrapment. • Store white goods in a designated area. This area may be unlined. • Group similar appliances together (refrigerators, freezers, washers, dryers, etc.) for easier loading when these items will be shipped to a recycling facility.

6.6 SCRAP TIRES

●● Scrap tires can be considered a **medium priority** since they pose potential environmental and human health risks (e.g., combustibility: once on fire they are difficult to extinguish and the smoke from such fires contains hazardous substances). The risk increases as the tires accumulate, so proper storage and periodic removal or shredding is essential. Additionally, good management practices will help to ensure that landfill space is preserved (i.e., by diverting scrap tires to storage and shipping them off-site), minimize visual appearance and landscape impacts, and minimize potential for scrap tires to accumulate standing water that would be a breeding ground for mosquitoes.

EXAMPLES	POTENTIAL RISKS
• Heavy equipment tires • Light truck and passenger vehicle tires • Personal all-terrain vehicle tires	**Environmental** • Tires are combustible and, once on fire, are difficult to extinguish and generate smoke that contains hazardous substances. **Human Health** • Smoke from tire fires may pose a health risk to the community. • May present a physical hazard if stored (piled) incorrectly. • Tires can provide breeding grounds for rodents and may accumulate stagnant water (a source of odours and mosquito breeding). **Other** • Disposal increases landfill space requirements. • Visual appearance and landscape impacts. • Landfilling can lead to uneven settling and a tendency for the tires to rise to the surface, both of which can damage the landfill cover.

Table 6-10 presents an overview of design and operation best practices for managing scrap tires. It should be noted that pile height and setback distances will ultimately be set by local and provincial/territorial authorities.

TABLE 6-10: BEST PRACTICES FOR MANAGING SCRAP TIRES

DESIGN	OPERATION
Receiving, Processing and Storage Area • Storage piles should be limited in area and height (3 m)[3] to reduce risks of collapse. • Storage piles should contain only scrap tires and be separated by a clear space (15 m)[4] from other tire piles. • Scrap tires are flammable and, once on fire, very difficult to extinguish. For safety reasons, piles should be separated by a clear space and located a safe distance (30 m)[5] from buildings/structures, stored items, and any trees or brush in the area. • The size of storage area required will depend on the quantity of scrap tires received each year and the duration of the storage period. • The storage area should be graded to direct runoff to the stormwater management pond. • The area should be designed for ease of access for loading scrap tires for transport off-site.	**Receiving and Processing** • MSW facility users should place scrap tires in designated area. • The operator should separate tires from rims (place rims in metal reuse/recycling area, ensuring that lead wheel weights have been removed) and ensure tires do not contain water, other liquids or debris. **Storage** • Stockpiling method: scrap tires should be laid flat on ground and stacked so that they overlap in a pyramid-like design for greater stability of the pile. • Storage areas should be kept free of combustible ground vegetation. **Off-Site Transport** • Scrap tires should be reused within the community or transported off-site to an authorized facility for recycling. • Off-site transport should be arranged as frequently as practical (stacking scrap tires in a herringbone pattern optimizes space for shipping).

Specialized equipment that may be required includes:

- fire prevention equipment, such as access to the community fire truck and fire suppression equipment; and
- equipment to remove tires from rims, which is normally available in the community public works garage in small communities, or in private sector garages in larger communities.

6.7 CONSTRUCTION, RENOVATION AND DEMOLITION WASTE

●●● /●● Generated by construction, renovation, and demolition (CRD) activities, this waste type is very diverse and can involve large volumes of materials depending on the scale of CRD activities in the community. For this reason, reuse and recycling options for CRD waste should be considered where feasible as a measure to conserve community landfill space. Generally, CRD waste can be considered a **medium priority**. However, some waste materials generated by CRD activities may contain specific toxic or hazardous materials (e.g., asbestos, mercury) that should be managed separately and that can be considered a **high priority** (refer to Sections 6.2 and 6.3).

One approach to reducing the quantity of CRD waste destined for disposal within the community is to require contractors to sort the materials on the job site, and in some cases, arrange for the backhaul of materials for recycling or disposal as part of their contract. In addition, careful deconstruction will maximize the reuse potential for materials.

EXAMPLES	POTENTIAL RISKS
• Wood • Drywall • Asphalt materials • Cement-based materials • Fibreglass insulation • Metals • Plastics and carpet	**Environmental and Human Health** • Contributes to landfill leachate quantity and quality. • Some wood and other organic wastes found in CRD can contribute to landfill gas generation. **Other** • Disposal increases landfill space requirements. • Wasted resources, i.e., materials that may be reusable inside the community (e.g., wood, metals) are landfilled.

This section contains:

- a list of CRD waste material categories and typical alternatives to disposal (Table 6-11);
- an overview of design and operation best practices for managing CRD waste (Table 6-12); and
- further considerations for recoverable CRD waste processing and storage (Table 6-13).

TABLE 6-11: TYPES OF CRD WASTE MATERIAL CATEGORIES AND TYPICAL ALTERNATIVES TO DISPOSAL

WASTE TYPE	SUB-TYPES	EXAMPLES	TYPICAL ALTERNATIVES TO DISPOSAL*
Wood	1. Wood Products	• Doors • Window frames • Wood flooring • Baseboard trim	• Salvage for reuse/resale (depending on condition)
	2. Clean Wood (i.e., solid wood product not treated with paint, stain, chemicals, or glue)	• Wood offcuts from construction and renovation projects • Other sources of clean wood (e.g., pallets, shipping crates)	• Salvage for reuse/resale (depending on condition) • Chip for landscaping • Use as an alternative fuel (where applicable)
	3. Pressure-Treated or Preserved Wood	• Pressure-treated lumber • Wood treated with preservatives	• Salvage for reuse/resale (depending on condition) • Do not chip for landscaping • Do not burn **Note:** Older treated wood may contain chromium and arsenic, which are toxic
	4. Engineered Wood (i.e., derivative wood products manufactured by binding strands, particles, or fibres together with adhesives)	• Medium-density fibreboard • Composite wood • Plywood • Particleboard • Oriented strand board • Glued veneer/ laminate wood	• Salvage for reuse/resale (depending on condition) • Do not chip for landscaping • Do not burn
	5. Painted, Stained, or Varnished Wood	• All wood types listed above that are painted, stained or varnished	• Salvage for reuse/resale (depending on condition) • Do not chip for landscaping • Do not burn
Drywall		• Wallboard • Plasterboard • Gypsum board	• Salvage for reuse/resale (depending on condition) **Note:** Older drywall and drywall compounds may contain asbestos, which is toxic

TABLE 6-11: TYPES OF CRD WASTE MATERIAL CATEGORIES AND TYPICAL ALTERNATIVES TO DISPOSAL (CONT'D)

WASTE TYPE	SUB-TYPES	EXAMPLES	TYPICAL ALTERNATIVES TO DISPOSAL*
Asphalt materials	1. Asphalt Roofing Shingles	• Roof shingles from buildings	• Use in reclaimed asphalt paving • Use in road bases
	2. Road Asphalt	• Asphalt removed during road works	• Use in reclaimed asphalt paving • Use in road bases
Cement-based materials	1. Brick	• Walls • Patios • Sidewalks	• Salvage for reuse/resale (depending on condition) • Use as base material/backfill
	2. Concrete	• Concrete slabs • Building foundations • Sidewalks • Columns and pilings	• Use as base material/backfill
	3. Masonry	• Masonry block	• Use as base material/backfill
Fibreglass	1. Fibreglass Products	• Water and sewage tanks • Bath tubs	• Salvage for reuse/resale (depending on condition)
	2. Other Fibreglass Materials	• Piping • Insulation	• None identified
Metals	1. Ferrous Metals (e.g., steel)	• Beams, telecommunication towers, structural steel, re-bar, cleaned oil tanks, etc.	• Sell to metal recyclers
	2. Non-ferrous Metals (e.g., aluminum and copper)	• Building siding, doors, blinds, window and door frames, etc. • Piping, wiring, etc.	• Sell to metal recyclers
Plastics	1. Carpet	• Carpet	• Ship off-site for recycling into products such as plastic lumber, carpet pad, and auto parts
	2. Insulation	• Foam insulation board • Foam spray insulation	• Ship off-site for recycling
	3. Other Plastics	• Varied, including plumbing piping	• Ship off-site for recycling

** **Note:** Some alternatives to disposal are subject to access to equipment and processing facilities as well as legal requirements.*

TABLE 6-12: BEST PRACTICES FOR MANAGING CRD WASTE

DESIGN	OPERATION
Receiving, Processing Area and Storage Area • Each recoverable waste type (metals, wood, etc.) should have a designated storage area with good signage to instruct MSW facility users. • The size of storage area will depend on the types and quantities of CRD waste received each year and the duration of the storage period. • The storage area should be graded to direct runoff to the stormwater management pond. • The storage area should be designed for ease of access for loading recoverable CRD waste for transport off-site. • The area should be open to public with safe, easy access for drop-off and pick–up.	Receiving and Processing • MSW facility users should place materials in designated areas. • The operator should verify that materials are placed in designated areas. • Alternatively, the operator could be on-site during operating hours to receive, sort and place materials in the designated areas. • Hazardous and special wastes should be removed from CRD waste prior to placing in disposal or storage. • If not reused, tanks and drums that contained fuel should be cut or punctured (using an approved no-spark device) to prevent buildup of potentially explosive vapours. • Signage should be kept clean and current to assist in directing people to the appropriate area. • Pallets could be left out with representative items to indicate to the public in which area to place their items. Storage/Disposal • Storage areas should be clean and free from all other types of waste. • All materials should be stored in a manner that prevents accumulation of water. • Non-recoverable CRD waste should be disposed in the landfill cell. Off-Site Transport • Recoverable CRD waste should be reused within the community or transported off-site to an authorized facility for recycling or reuse. • Off-site transport of recoverable materials should be arranged as frequently as practical.

TABLE 6-13: PROCESSING AND STORAGE PRACTICES FOR RECOVERABLE CRD WASTE

CRD WASTE TYPES	PROCESSING	STORAGE
Wood	Sort wood into two sub-types: • Clean—unpainted and untreated; and • Not clean—painted or treated.	• Clean wood can be sorted into two sub-types: 1. Wood that can be reused for building purposes, which should be separated and stored under a cover to prevent damage to the wood. Store clean wood in a designated area for reuse. 2. Wood that can be used as firewood, which can be piled in a separate area. • Painted or treated wood can be reused as lumber; do not burn. • Unusable painted or treated wood should be disposed in the landfill or off-site.
Drywall	• Separate material that can be re-used from damaged material.	• Store reusable material in a protected area from the rain. • Damaged material can be compacted/crushed with a loader or dozer to reduce volume, and disposed in the landfill cell.
Asphalt Materials	• Separate road asphalt from other materials. • Crushed asphalt can be used for cover material or as a surfacing material for access roads and site roads at the MSW facility.	• Store materials separately. • Material can be stockpiled up to 3 m in height. • Asphalt shingles should be disposed of in the landfill or off-site.
Cement-based Materials	• Material that can be used as gravel material should be stockpiled for the operator's use for cover material in the landfill. • Larger material can be broken down if equipment is available to do so. • Separate material that has re-bar from material that does not.	• Store re-usable material separately. • Pile material not higher than 3 m.

TABLE 6-13: PROCESSING AND STORAGE PRACTICES FOR RECOVERABLE CRD WASTE (CONT'D)

CRD WASTE TYPES	PROCESSING	STORAGE
Fibreglass	• Fibreglass tanks should be cut or broken down to prevent the collection of standing water. • Sewage tanks may need to be cleaned of residual sewage.	• Store the wastes in a designated area to allow for reuse. • Fibreglass insulation (e.g., from buildings) should be disposed in the landfill or off-site.
Metals	• Sort by type: steel, aluminum, copper.	• Store each type of metal in separate areas. • Fuel tanks should be stored cut side down to prevent collection of water in the tank halves.
Plastics	• No special processing required.	• Store clean plastics in a designated area for reuse or recycling. • Plastic can be crushed using a bulldozer or other heavy equipment. • Be sure to store all plastics in a manner so as to prevent collection of water.

6.8 ORGANIC WASTE

●● Organic waste includes leaf and yard waste, food waste, and soiled paper products. It typically makes up between one quarter to one third of the waste stream. When organic waste decomposes in an oxygen-starved landfill—a process that occurs more slowly in northern climates—it produces a gas (known as landfill gas) composed primarily of methane, a potent greenhouse gas contributing to climate change. In Canada, methane emissions from landfills account for about 20% of national methane emissions.[6] By diverting food, yard, and other organic wastes through composting, landfill methane emissions are largely avoided.

Composting represents an opportunity for northern and remote communities to:

- reduce leachate quantity and improve leachate quality;
- use a local solution to reducing greenhouse gas emissions;
- preserve landfill disposal capacity; and
- produce compost that can be used by residents or in community projects.

Since managing organics is secondary to diverting hazardous and special waste and other hazardous substances from the landfill cell, it can be considered a **medium priority**. In addition, composting can be a viable option for diverting boxboard and mixed paper in communities where setting up a paper recycling program is not feasible. Since organics management has already been covered extensively in other documents (refer to Annex A, Organic Waste), this section briefly highlights key considerations for composting and directs the reader to relevant resources.

EXAMPLES	POTENTIAL RISKS
• Boxboard (in lieu of recycling) • Clean wood (i.e., untreated) • Food waste • Leaf and yard waste • Mixed paper (in lieu of recycling) • Soiled paper products (e.g., tissues, paper towels, soiled cardboard)	**Environmental and Human Health** • Contributes to landfill leachate quantity and quality. • Main contributor to landfill gas generation. • Safety concerns—wildlife is attracted to this waste. **Other** • Disposal increases landfill space requirements. • Wasted resources, i.e., materials that could be processed in the community to create a useful product (compost) are landfilled.

One of the most important decisions in planning an organics recovery program is the choice of processing technology, which will depend on many factors, such as the size of the community, the sources, composition and quantities of organic material to be processed, and the final compost quality requirements. For smaller communities, the most practical approach will likely be to divert organic waste through household waste diversion measures such as backyard composting and vermicomposting. For communities considering this approach, please consult the City of Yellowknife's *Composting North of 60: A Guide to Home Composting in the Northwest Territories*[7]. It is recommended that meat products be excluded from backyard composting to reduce the potential for wildlife-attracting odours.

For larger communities, a centralized composting operation, such as a static pile or open windrow, should be considered (see Figure 6-5). Such an operation could be limited to leaf and yard waste or it could include food waste and paper products. It is recommended that a qualified professional be retained to assist with the planning of a centralized composting operation. For compost facility operator training opportunities, refer to Appendix A, MSW Facility Operations and Maintenance. Some of the main factors to consider when designing such an operation are:

- regulatory requirements;
- type, quantity, and source of feedstocks, including potential partners;
- choice of technology (e.g., passively or actively aerated);
- site location and capacity of the operation;
- program costs and financing including potential economic benefits (e.g., saving landfill space, sale of compost, avoiding use of costly fertilizers);
- meeting community expectations and addressing concerns (e.g., wildlife management, refer to Section 4.3.7, and odours); and
- compost quality and end-uses of the finished compost.

Figure 6-5: Windrow Composting in the Sub-Arctic (note steam coming from top of pile)

For communities considering centralized composting, please consult Environment and Climate Change Canada's *Technical Document on Municipal Solid Waste Organics Processing* (2013)[8], which provides science-based, objective information on the various aspects of organic waste management processing. The document covers a wide range of topics, from the science and principles of composting and anaerobic digestion, to proven processing technologies, biogas utilization, facility design, odour control, and compost quality, as well as other related issues, such as procurement approaches and system selection. Other resources on composting in northern communities and general composting facility operations are provided in Appendix A, Organic Waste.

6.9 REUSABLE ITEMS

●● There are a few different ways for communities to reduce waste. For example, they can tackle it at the source (i.e. source reduction) by buying goods in bulk, bringing reusable shopping bags to the store, and planning meals ahead of time to reduce food waste. In addition, a wide array of items commonly disposed of could, if segregated, be put to use again. The reuse of household and other items can be considered a **medium priority** because it represents an opportunity to engage the community in a low-cost waste reduction effort to save landfill space. Care should be taken to determine whether the items have hazardous or toxic components, in which case they would require special handling by trained staff and appropriate storage. Reusable items should be placed in a sheltered area to protect them from the elements until a new user is found. This section presents an overview of design and operation best practices for managing reusable items in northern and remote communities (refer to Table 6-14).

EXAMPLES	POTENTIAL RISKS
• Clean drums (plastic and metal) may be reused in some instances. • Clean wood—community can pick up for building projects or firewood. • Concrete may be reused on-site. • Furniture, clothing/textiles, books, dishes, toys and other household products in good condition. • Paint may be used as long as it is not frozen. • Pallets may be reused on-site to store certain waste types (e.g., automotive batteries, drums, paint cans). • Scrap tires may be used on-site for marking out waste storage areas or barriers. • Used motor oil may be reused in approved waste oil furnaces. • Vehicle parts may be reused.	• Disposal increases landfill space requirements. • Wasted resources, i.e., items that are reusable are landfilled. • Missed opportunity to engage the community in low-cost waste reduction efforts.

TABLE 6-14: BEST PRACTICES FOR MANAGING REUSABLE ITEMS

DESIGN	OPERATION
Receiving, Processing and Storage Area • The area should be clearly identified for MSW facility users. • The storage area could be located on- or off-site (e.g., community centre). • The area should be open to public with safe, easy access for drop-off and pick-up (Figure 6-6). • Items should be protected from the elements. • The area should be located in a flat area, and the surrounding area should be graded to direct runoff to the stormwater management pond.	**Receiving, Processing and Storage** • MSW facility users should place reusable items in the designated storage area. • The facility operator should verify that reusable items are placed in designated areas. • Alternatively, the operator could be on-site during operating hours to receive, sort and place reusable items in the designated area. • The operator should periodically tidy the storage area and remove damaged and unusable items (e.g., wet/damp, broken).

Figure 6-6: Free Store Concept

6.10 RECYCLABLES

●● /● One of the most challenging aspects of establishing a recycling program in a northern or remote community is the high cost of transporting recyclable materials to markets. For this reason, it was suggested in the previous section that some paper products could be included in composting programs until such time that paper recycling programs are more viable. Diverting recyclables preserves landfill space and replaces the need for virgin materials, and in turn, reduces greenhouse gas emissions. For example, recycling 1 tonne of aluminum cans saves about 10 tonnes of greenhouse gases, even when transportation is factored in.[9]

When considering which types of recyclables to begin with, it is recommended that communities focus on those materials that are covered by product stewardship and extended producer responsibility programs or that have the potential to generate the most revenue (e.g., metals), which can in turn be used to help cover program costs and in some instances, subsidize the cost of recycling less lucrative materials (e.g., paper products, plastics, and glass). Communities should also consider the sources of the recyclables (i.e., households versus businesses and institutions) that they wish to start collecting for recycling. In the context of the other waste types to be managed and the relative risks, diversion of recyclables can be considered a **medium to lower priority**. This section presents an overview of best design and operations practices for managing recyclables in northern and remote communities (refer to Table 6-15).

EXAMPLES	POTENTIAL RISKS
• Aluminum cans, foil, pie plates • Boxboard (e.g., cereal boxes, tissue boxes) • Corrugated cardboard • Glass (e.g., bottles and jars) • Mixed paper • Plastics (e.g., containers and bags) • Scrap metals • Steel cans	**Environmental and Human Health** • Contributes to landfill leachate quantity and quality. • Some materials can contribute to landfill gas generation. **Other** • Disposal increases landfill space requirements. • Wasted resources, i.e., materials that could be recycled outside the community are landfilled.

TABLE 6-15: BEST PRACTICES FOR MANAGING RECYCLABLES

DESIGN

Receiving and Processing Area

- Where curbside pick-up of recyclables is not available, a recycling drop-off centre should be set up; options range from a single drop-off centre located at the MSW facility to a series of smaller drop-off centres located at convenient locations in the community.
- The area should provide for safe, easy access by MSW facility users and should allow them to sort their own materials into large labeled bins (see Figure 6-7).
- The area should accommodate any required processing steps (ranging from placing materials in bulk bags to more advanced processes, such as baling).

Storage Area

- The size of storage area will depend on the types and quantities of recyclables received each year and the duration of the storage period.
- Materials (especially paper and cardboard) should be protected from the weather.
- Storage bins should be clearly labelled, designed for easy transfer/transportation, constructed of metal, and of a size suitable for the material collected.
- The storage area should be located in a flat area, and the surrounding area should be graded to direct runoff to the stormwater management pond.
- The area should be designed for ease of access for loading recyclables for transport off-site.

OPERATION

Receiving, Processing and Storage

- MSW facility users should place recyclables in designated areas.
- The operator should switch out full bins and prepare materials for shipping off-site (which could range from placing in bulk bags or available containers, to more advanced processes such as baling).
- The operator should keep the area clean and organized and ensure that materials are properly sorted.
- Signs should be clearly labeled for each type of recyclable.

Off-Site Transport

- Recyclables should be transported off-site to an authorized recycling facility as frequently as practical. This may depend on the following variables:
  - the quantity and types of recyclables generated;
  - the cost of transportation and market price for materials;
  - whether the community has year-round road access; and
  - space limitations at the MSW facility.

Figure 6-7: Metal Bins for Receiving Recyclables from the Public

ENDNOTES

1 Transport Canada. 2015. Transportation of Dangerous Goods Regulations.

2 Environment and Climate Change Canada. 2015. Interprovincial Movement of Hazardous Waste Regulations.

3 Government of Yukon, Environment Yukon. October 2013. Tire Storage.

4 *Ibid.*

5 *Ibid.*

6 Environment and Climate Change Canada. 2014. Municipal Solid Waste and Greenhouse Gases.

7 Government of Northwest Territories. Composting North of 60 - A Guide to Home Composting in the Northwest Territories.

8 Environment and Climate Canada. 2013. Technical Document on Municipal Solid Waste Organics Processing.

9 Environment and Climate Change Canada. 2013. Greenhouse Gas Calculator for Waste Management.

7.0 PERFORMANCE MONITORING AND REPORTING

Monitoring the activities and releases of the MSW facility is essential to ensure that it is working as designed and intended and that it is not contributing to unacceptable chemical, physical and biological impacts to the environment. Sources of possible releases include landfill cells as well as processing and storage areas for hazardous and special waste, e-waste, end-of-life vehicles, and bulky waste, among others. The key parameters to be monitored include groundwater, surface water, leachate, and landfill gas (where applicable). The purpose of developing a monitoring plan is to set objectives, measure any environmental releases, and identify when mitigation measures are required.

A monitoring plan should be developed for the MSW facility that reflects its regulatory and unique site-specific conditions and takes into account federal, provincial/territorial, and municipal environmental regulations, local guidelines, sampling parameters, monitoring and reporting requirements, and targets. Performance monitoring activities should be carried out by trained personnel or qualified professionals.

This section provides general considerations for the monitoring plan and each type of environmental media to be sampled and analyzed. It is intended to complement but not supersede applicable regulations. In general:

- Monitoring programs should be established with the goal of detecting contamination from the MSW facility and should be designed by suitably qualified professionals.[1,2,3]
- Sampling and associated procedures for analysis, storage, shipping, etc. should be completed by people with appropriate training and experience.[4]
- The laboratory analyzing samples should be certified by the Canadian Association for Environmental Analytical Laboratories.[5]
- Groundwater and surface water sample collection should be completed according to the most recent version of *Guidance Manual on Sampling, Analysis and Data Management for Contaminated Sites—Volume 1: Main Report* (CCME, 1993).[6]
- In permafrost regions, deep groundwater monitoring may not be practical or possible, depending on site conditions. However, monitoring of the active layer water is possible with shallow wells. Ground temperature monitoring may also be required depending on the MSW facility design.

It is important to keep accurate records for reporting purposes. Frequency of monitoring and reporting to regulatory authorities should be as follows:

- **Class 1 Landfill (refer to Section 5):** Groundwater, surface water, and leachate at least twice per year, and landfill gas quarterly (where applicable).
- **Class 2 Landfill (refer to Section 5):** Groundwater, surface water, and leachate (where applicable) at least once per year.

Reports should include monitoring results, analysis of the significance of the results, and recommendations for future monitoring[7] and/or corrective action if required.

Table 7-1 and Table 7-2 present best practices for monitoring the key parameters.

TABLE 7-1: BEST PRACTICES FOR GROUNDWATER MONITORING

CONSIDERATIONS	BEST PRACTICES—GROUNDWATER MONITORING
To Monitor or Not to Monitor?	• Monitoring may not be required if the population served is < 1000 and the base liner of the landfill includes a hydraulic barrier greater than 10^6 cm/s and at least 5 m thick.[7] However, monitoring should be conducted if there is a confirmed connection between the landfill and an aquifer, if hazardous and special waste has historically been disposed of in the landfill, or if there are indications of impacts to groundwater beyond the property limits of the MSW facility.[8]
Number and Location of Wells	• The groundwater monitoring program should be site-specific and include an appropriate number and configuration of monitoring wells around the perimeter of the site, both up and down gradient, to allow accurate evaluation of the impact of the operation and assessment of any migration pathways. This should include programs for:[9] – assessing baseline groundwater chemistry; – detecting leachate in the groundwater; – measuring the extent and magnitude of leachate contamination, should it occur; – measuring groundwater levels and general hydrogeological conditions on the site; and – quality assurance and quality control (QA/QC). • Groundwater monitoring well numbers, spacing and depths should be based on the characteristics of the aquifer, groundwater flow rate and direction, site size and type of waste deposited.[10,11] At a minimum: – at Class 1 Landfills (refer to Section 5), there should be sufficient monitoring to represent quality of background water as well as downgradient monitoring at points of compliance;[12] – at Class 2 Landfills (refer to Section 5), there should be a minimum of three groundwater wells (one upgradient for background, two downgradient to assess potential impacts).[13]

TABLE 7-1: BEST PRACTICES FOR GROUNDWATER MONITORING (CONT'D)

CONSIDERATIONS	BEST PRACTICES—GROUNDWATER MONITORING
Design and Installation	• Monitoring wells should be:[14,15] – installed hydraulically above and below the gradient direction of the landfill; – installed to a depth which will span the anticipated high and low water table levels; – located sufficiently close to the active disposal area to allow early detection of contamination and implementation of mitigation measures; – appropriately sized to allow proper well development, purging and sampling; and, – retained throughout the lifespan of the facility (active and post-closure periods); as such, wells should be clearly labeled and identified to prevent damage from heavy equipment (consider a creating a physical barrier made out of repurposed materials). • Specifications for well drilling methods, casing, screens, filter packs, annular space seals, ground surface seals, grout, caps, development and purging should be according to recognized standard protocols.[16]
Sampling and Parameters	• Groundwater monitoring wells should be checked for water levels and sampled at least twice each year at the high and low water points (Class 1) or at least once per year (Class 2).[17,18] • Groundwater samples should be analyzed for, at a minimum, routine water chemistry, dissolved metals, volatile organic compounds and dissolved organic carbon. Additional parameters may be added in consultation with a suitably qualified professional.[19] • Groundwater analysis results should be compared against local groundwater standards (e.g., in the Yukon, the Yukon *Contaminated Sites Regulation*) or against the Canadian Environmental Quality Guidelines (CEQG) if no local standard is available.[20] Results should also be compared against background levels (i.e., upgradient results versus downgradient results) and with predevelopment conditions.[21,22] • If one or more parameters are found to exceed the appropriate standard, the owner/operator should select and implement the corrective measure, establish a corrective action groundwater monitoring program, and take any necessary interim measures.[23,24] • In cases where corrective measures are being undertaken, sampling to ensure the measures' success should be continued until compliance with the groundwater standard has been met for three years.[25]

TABLE 7-2: BEST PRACTICES FOR SURFACE WATER, LEACHATE, AND LANDFILL GAS MONITORING

PARAMETER	BEST PRACTICES—SURFACE WATER, LEACHATE, AND LANDFILL GAS
Surface Water	• Surface water monitoring should include programs for:[26,27] – measuring surface water quality upstream of the site, immediately downstream and in a receiving body; – visually inspecting the landfill for leachate seeps; – detecting and measuring leachate in the surface water; and – quality assurance and quality control (QA/QC). • Surface water samples should be collected at the same time as groundwater samples. • Surface water samples should be analyzed for, at a minimum, routine water chemistry, dissolved metals, volatile organic compounds, and dissolved organic carbon. Additional parameters may be added in consultation with a suitably qualified professional.[28] • Surface water analysis results should be compared against local surface water standards (e.g., in the Yukon, the Yukon *Contaminated Sites Regulation*) or against the Canadian Environmental Quality Guidelines (CEQG) if no local standard is available.[29] Results should also be compared to background levels and predevelopment conditions.[30,31]
Leachate	• Class 1 Landfills (and Class 2 Landfills where applicable) should perform leachate monitoring and compare results with downgradient groundwater monitoring wells and surface water samples.[32] • Leachate sampling should be conducted at the same time as groundwater and surface water sampling, and samples should be analyzed using the same water quality parameters as for groundwater and surface water.[33]
Landfill Gas	• Biodegradation of solid waste is considered negligible in permafrost regions.[34] As such, landfill gas generation in those regions is also expected to be very low. • In regions where landfill gas generation is expected, a routine methane monitoring program should be conducted on a quarterly basis[35] within the most permeable strata between the waste disposal areas and the property boundary and any structures that could accumulate landfill gas.[36] • Limits should be as follows:[37] – In facility structures, the concentration of methane gas should not exceed 20 percent of the lower explosive limit of methane (1 percent by volume) at any time; – At the facility property boundary, the concentration of methane gas should not exceed the lower explosive limit of methane (5 percent by volume). • Monitoring and alarm devices for methane and oxygen should be installed within, beneath, and immediately adjacent to all on-site structures.[38]

ENDNOTES

1 ARKTIS Solutions Inc. 2011. Solid Waste Best Management Guide. Prepared for Government of Nunavut, Department of Community and Government Services.

2 Government of Newfoundland and Labrador. 2010. Environmental Standards for Municipal Solid Waste Landfill Sites.

3 Ferguson Simek Clark Engineers & Architects. 2003. Guidelines for the Planning, Design, Operations and Maintenance of Modified Solid Waste Sites in the NWT. Prepared for Government of Northwest Territories, Department of Municipal and Community Affairs.

4 ARKTIS Solutions Inc. 2011.

5 *Ibid.*

6 Ferguson Simek Clark Engineers & Architects. 2003.

7 *Ibid.*

8 *Ibid.*

9 Government of Newfoundland and Labrador. 2010.

10 EBA Engineering Consultants Ltd. 2009. Comprehensive Solid Waste Study for Yukon Territory Waste Facilities. Prepared for the Government of Yukon.

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12 EBA Engineering Consultants Ltd. 2009.

13 *Ibid.*

14 Government of Newfoundland and Labrador. 2010.

15 Yukon Government. 2010. Construction Requirements for New Public Waste Disposal Facilities.

16 EBA Engineering Consultants Ltd. 2009.

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21 *Ibid.*

22 *Ibid.*

23 United States Environmental Protection Agency (USEPA). 2005.

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34 Ferguson Simek Clark Engineers & Architects. 2003.

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37 British Columbia Ministry of Environment. June 2016. Landfill Criteria for Municipal Solid Waste, Second Edition.

38 Yukon Government. 2014.

8.0 MSW FACILITY CLOSURE AND POST-CLOSURE

The purpose of this section is to briefly describe the activities involved in facility closure and post-closure that apply to several different scenarios:

- progressive closure of an engineered landfill cell;
- decommissioning of a disposal site such as an open dump; and
- decommissioning of an entire MSW facility.

This section also discusses the importance of record keeping and financial assurance.

8.1 PLANNING AND MONITORING

There are two phases to consider at the end of the design life of a landfill cell or MSW facility:

- **Closure:** where the area is decommissioned in a manner that promotes revegetation, minimizes leachate, and ensures that any buried residual waste does not pose a physical hazard to people or animals that may use the site.[1]
- **Post-Closure:** where the area is monitored over the long term for evidence of releases to the surrounding environment and maintained to ensure the integrity of the various engineered systems.

A "closure and post-closure plan" should be developed at the time the landfill cell or MSW facility is designed and should be updated over time to reflect current site operations[2] (refer to Table 8-1). In some jurisdictions, regulators require the development of a closure plan (a.k.a. "closure and reclamation plan") as part of their permitting or licencing process (e.g., community water licence).

As discussed in Section 5, it is recommended that active landfill cells be progressively closed as sub-sections of the cell reach final design capacity. This is generally accomplished through placing interim cover on the area. During the closure phase, a final cover system is constructed over the completed landfill cell. A strategy may also be put in place to collect and treat the leachate from the closed landfill cell. In addition, a landfill gas management system may be necessary to remove landfill gas from beneath the final cover system. In the case of the closure of an entire MSW facility, soil testing may be required in areas where certain waste types were processed and stored (e.g., hazardous and special waste, end-of-life vehicles) to determine whether there was any contamination.

The post-closure phase includes environmental monitoring of such parameters as groundwater, surface water, leachate and landfill gas as well as maintenance of the final cover and other related infrastructure. Additional closure and post-closure best practices are presented in Table 8-2.

8.2 RECORD KEEPING AND FINANCIAL ASSURANCE

Complete records of the landfill cell or MSW facility should be kept for reference in the event of future redevelopment of the site or the land surrounding the site. Records should indicate, at a minimum:[6]

- location and footprint of the landfill cell or the MSW facility;
- types of waste disposed;
- dates of operation; and
- any information related to the design characteristics of the landfill cell or MSW facility.

Financial assurance is recommended for closure, post-closure care, and known corrective actions.[3,4] A closure and post-closure fund should be established at the outset of MSW facility operations and contributions should be made to that fund on a regular basis (e.g., annually) to cover closure and post-closure liabilities as they are incurred.

The required level of funding should be determined by a team of qualified professionals with expertise in engineering of closure systems and municipal finances. The closure fund should be established in a financial institution and should be structured such that it accumulates interest on monies deposited in the fund over time.

The closure reserves should be reviewed on an annual basis and the annual funding contribution should be adjusted as necessary to ensure that there will be sufficient funding to implement closure of each phase when required.

TABLE 8-1: BEST PRACTICES FOR DEVELOPING A MSW FACILITY CLOSURE AND POST-CLOSURE PLAN

BEST PRACTICES—CLOSURE AND POST-CLOSURE PLAN
The closure and post-closure plan should include:[5,6,7,8,9,10,11] • a description of the waste(s) composition, placement, volume and tonnage that will remain in the landfill cell, and scaled drawings showing maximum final height of disposal; • final cover design, including type and source of cover materials, installation, thickness, permeability, drainage layers, topsoil, vegetative cover, and erosion prevention controls; • as-built drawings for all facilities, components and installations, including an accurate plot plan, geographic positioning system coordinates and permanent location markers; • mapping of all disturbed areas, borrow material areas, and site facilities; • final survey to mark designated areas, monitoring wells and surface water monitoring locations; • site regrading to facilitate storm water management; • soil testing in areas where waste was processed or stored (e.g., hazardous and special waste, end-of-life vehicles, bulky waste); • appropriate disposal of any waste stored aboveground at the site (e.g., hazardous and special waste, end-of-life vehicles, bulky waste); • contaminated site remediation, if required, such as removal of contaminated soil from an unlined storage area; • removal of infrastructure and equipment; • post-closure leachate prevention and management; • maintaining and operating groundwater monitoring systems, leachate collection and removal systems, and landfill gas controls; • final cover monitoring for stability, erosion and settlement; • a monitoring plan for groundwater, surface water, and erosion and settlement for a minimum post-closure period of 30 years (**note:** 30 years is the average post-closure period, but this may vary depending on the site condition and issues); • if applicable, a monitoring plan for landfill gas, including plans for means of controlling landfill gas and for the maintenance of monitoring systems; • if applicable, a plan for the continued collection and removal of leachate, including maintenance of leachate collection infrastructure; • environmental monitoring systems for leachate, groundwater, surface water and landfill gas; • post-closure infrastructure requirements; • post-closure operations and maintenance (e.g., cover maintenance, vegetation monitoring, storm water management infrastructure maintenance); • contingency plans for fire, illegal dumping and nuisance control post decommissioning; • implementation schedule; • procedures for notifying the public of the facility closure and alternative disposal facilities; • restricting access to the site once closed and removal of any waste that may have been deposited following closure; • current and projected cost estimates to complete decommissioning, and the corresponding details regarding acceptable financial assurance (bond, surety or cash deposit); • the estimated closure cost to carry out closure and post-closure activities for at least 30 years and how this cost will be covered; and future land use goal.

TABLE 8-2: BEST PRACTICES FOR MSW FACILITY CLOSURE AND POST-CLOSURE

PARAMETER	BEST PRACTICES—CLOSURE AND POST-CLOSURE ACTIVITIES
Closure Activities	• Closure timing should be as follows:[12,13] – In general, closure should begin no later than 30 days after a landfill cell receives the final volume of waste, weather permitting; and – After closure begins, all closure activities should be completed within 180 days, weather permitting. • Closure activities should include the following: – Collecting all wind-blown litter from around the site and placing it in the landfill.[14] All uncovered waste should be consolidated in one place, compacted and covered;[15] – Constructing the final cover on any landfill cells that have not already been closed; – Posting signs to indicate that the MSW facility is closed; other signs should indicate the location of the new waste disposal site to prevent future dumping of waste at the closed site.[16] The location of the landfill should be marked on the ground with permanent markers or monuments to show the boundaries;[17] – For landfills on permafrost, installing thermistors to ensure freeze-back takes place; – Obtaining an independent registered professional engineer's certification that closure has been completed;[18] and – Registering the MSW facility as a solid waste facility on land title documents.[19]
Post-Closure Activities	At a minimum, post -closure activities should include the following: • Preparing a post-closure report to document capping and contouring, revegetation efforts, the final disposition of all wastes at the site, and a final site plan that includes locations of all closed cells and photos of the closed site;[20] • Conducting annual inspection and reporting for a minimum of five years after closure, noting all observations related to erosion, surface water drainage, exposed waste and or concerns related to other elements of the closed landfill infrastructure.[21,22,23,24] After five years of closure, if no significant issues arise, a less frequent inspection frequency could be considered; • Continuing the monitoring and maintenance of the waste containment systems and the monitoring of groundwater following decommissioning to ensure that waste is not escaping and polluting the surrounding environment; • Maintaining the integrity and effectiveness of all final covers, the leachate collection system (if present), groundwater monitoring system, storm water management infrastructure, and methane gas monitoring system (if present);[25,26] • Implementing monitoring programs for groundwater, surface water, leachate and landfill gas, as required;[27] • If any problems are discovered during annual inspections, they should be corrected as soon as possible.

ENDNOTES

1 Yukon Government. 2011. Closure Requirements for Solid Waste Disposal Facilities.

2 ARKTIS Solutions Inc. 2011. Solid Waste Best Management Guide. Prepared for Government of Nunavut, Department of Community and Government Services.

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9.0 SUMMARY AND NEXT STEPS

9.1 RECOMMENDED BEST PRACTICES AND PRIORITIES

This document describes key recommendations and actions for making incremental improvements to waste management in northern and remote communities over time. They include:

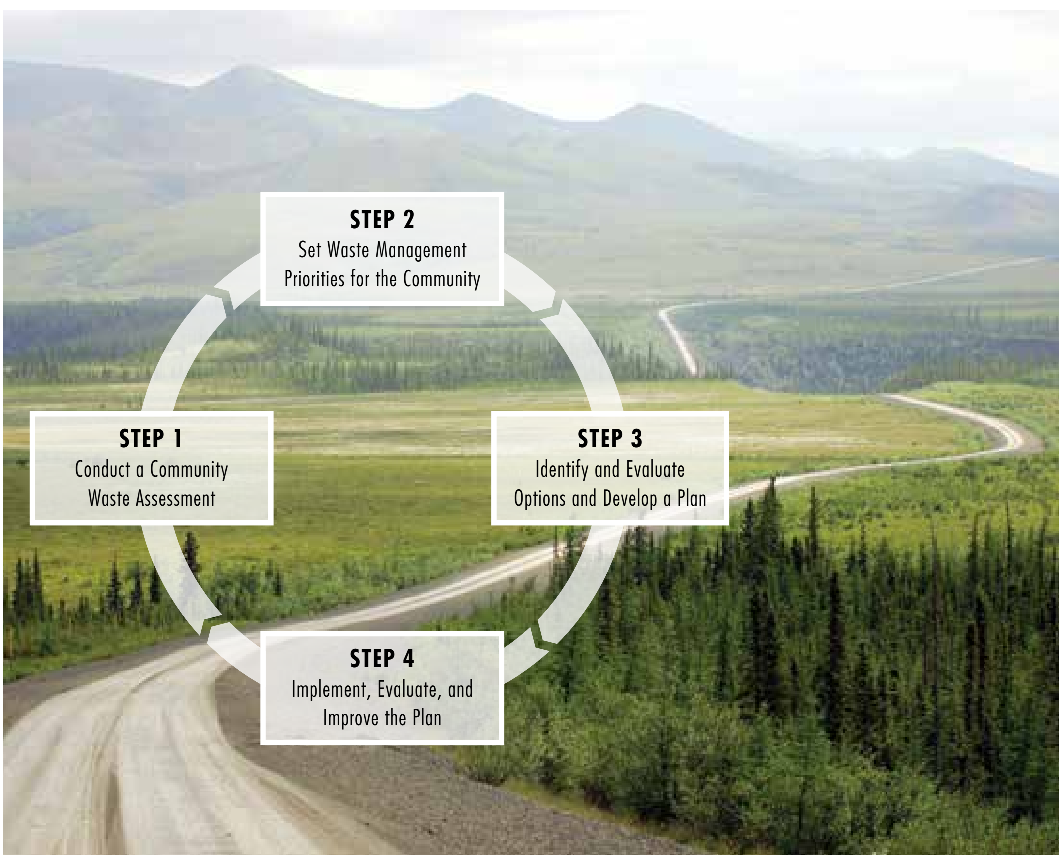
- ✓ engaging the community to raise awareness on the importance of proper waste management and develop a waste management plan i.e., complete a community waste assessment, set priorities, identify and evaluate options, as well as implement, evaluate, and improve the plan;
- ✓ prioritizing infrastructure improvements, operational activities, and waste types to reduce risks to human health and the environment; this approach complements the conventional 3Rs hierarchy of "reduce, reuse, recycle" and provides a starting point for communities that are faced with competing public works priorities, both in terms of budgets and staffing;
- ✓ selecting the most appropriate new site for a MSW facility or making the best of an existing site taking into account various environmental and social considerations;
- ✓ making general improvements to MSW facility infrastructure and operations related to layout, site control, waste screening, managing waste on and off-site, health and safety, emergency response, wildlife management, and record keeping;
- ✓ managing hazardous and special waste, e-waste, end-of-life vehicles, and bulky waste in such a way that optimizes their depollution and temporary storage on-site and facilitates recycling, treatment, or disposal at an authorized facility;
- ✓ managing other waste types such as scrap tires, CRD waste, organic waste, reusable items, and recyclables to take advantage of local reuse and processing options and opportunities for recycling outside the community;
- ✓ in the absence of other disposal options (such as disposal at a regional landfill or through incineration), designing and operating a landfill cell for residual waste disposal that is appropriate for the climate, geology, and size of the community and provides adequate protection of human health and the environment;
- ✓ ensuring compliance with applicable regulations or bylaws within the community and monitoring and reporting to regulators on the performance of the MSW facility, including such parameters as groundwater and surface water, and where applicable, leachate and landfill gas; and
- ✓ during the planning phase, developing a closure and post-closure plan to ensure that human health and the environment are protected over the long term when it comes time to progressively close a landfill cell or to decommission the MSW facility.

9.2 ON THE ROAD TO IMPROVEMENT

As a first step toward improvement, community awareness of the importance of proper waste management could be raised by establishing a volunteer waste working group or organizing community events such as household hazardous waste round-ups, litter clean-up days, and school recycling challenges. Raising awareness of the issues will help with community engagement in the process of developing or updating a waste management plan.

In the **short term**, communities can implement relatively low-cost operational activities such as controlling access to the MSW facility, improving signage, providing staff with training, personal protective equipment and shelter, prohibiting open burning, segregating hazardous and special waste, directing surface water away from waste, and covering and compacting residual waste.

In the **medium to longer term**, communities should increase diversion through reuse, recycling, and composting and invest in capital improvements, designed by qualified professionals, such as base liners, environmental monitoring systems, and other components of engineered landfills and modern MSW facilities. Partnering with nearby communities, businesses, institutions, and not-for-profit organizations can create waste management opportunities that may not otherwise be accessible to smaller communities.



APPENDIX A: ADDITIONAL RESOURCES

Disclaimer: The documents listed in this section are provided for information purposes only and do not constitute an endorsement by Environment and Climate Change Canada.

MSW Management Planning and Continuous Improvement

Waste Management Planning

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- Canadian Council of Ministers of the Environment. April 1996. Waste Audit Users Manual: A Comprehensive Guide to the Waste Audit Process. Available at: www.ccme.ca/en/resources/waste/packaging.html.
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- Saskatchewan Waste Reduction Council. Available at: www.saskwastereduction.ca.

Funding Opportunities

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- EcoAction Community Funding Program, Environment and Climate Change Canada (ECCC). Available at: www.ec.gc.ca/financement-funding/default.asp?lang=En&n=923047A0-1#_05.
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MSW Facility Operations and Maintenance

General

- Alaska Department of Environmental Conservation. Solid Waste Management Regulations, 18 AAC 60, as amended through April 12, 2013, p. 116.
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  - Waste Antifreeze
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www.ec.gc.ca

Additional information can be obtained at:

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