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DESIGN & OPERATIONS REPORT PROPOSED NORTH RENFREW LANDFILL SITE

Prepared For:
THE NORTH RENFREW WASTE MANAGEMENT BOARD

Prepared By:
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TABLE OF CONTENTS

List of Tables

List of Figures

Note that Figures 6 and 7 are modified in the Addendum. The updated versions are available there.

Design and Operations Report
Proposed North Renfrew Landfill Site

1.0 INTRODUCTION

1.1 BACKGROUND

The North Renfrew Waste Management Board (the "Board") represents the collective interests of the municipalities of Chalk River, Deep River, and the Townships of Rolph, Buchanan, Wylie and McKay, all located in the north part of Renfrew County, Ontario. This represents a current population of about 7,000 people.

The Board has completed and submitted to the MOEE for approval (under the Environmental Assessment Act) the planning for a proposed new waste management system that will serve these municipalities for the next twenty five years. One integral component of the new waste management system is the establishment of additional disposal capacity for a total quantity of approximately 75,000 tonnes of solid, non-hazardous residential, industrial, commercial and institutional waste produced within the municipalities. Note that this is a net quantity that will remain after an aggressive diversion effort (including a 3R's program) that is also part of the proposed waste management system. Details of the waste management plan may be found in the Board's EA submission entitled *Waste Management Planning Environmental Assessment Report* (May, 1996).

The Environmental Assessment document also traces the planning decisions that led to the Board's selection of the AECL/Chalk River Site as the preferred site for the new landfill capacity (hereafter referred to as the proposed "North Renfrew Landfill Site"). This site was selected following a careful and thorough search process that featured extensive public involvement and considered all aspects of the environment. At various stages of the site selection, decisions were made regarding the conceptual design and operation of the landfill. This report builds upon those earlier planning stages. Again, the reader is referred to the EA report for details.

This present study represents the more detailed conceptual design and operating plans for the landfill that are normally required to support an application for a Certificate of Approval, under the province's Environmental Protection Act (EPA), to actually build and operate the site.

1.2 OBJECTIVES

As explained above, the overall objective of this report is to provide the conceptual design and operating plans required to support an application for a Certificate of Approval to build, operate and close the North Renfrew Landfill Site, in accordance with Part V of the Environmental Protection Act.

More specifically, the objectives also include the following:

a) to further develop the original natural attenuation landfill design concept in more detail to suit the current, more detailed understanding of the site conditions;
b) to detail how the site will be operated on a day-to-day basis;
c) to outline proposed procedures for site inspection, maintenance, record keeping and reporting;
d) to develop appropriate environmental monitoring programs for the landfill;
e) to demonstrate the feasibility of contingency plans, should the monitoring ever show unexpected and unacceptable impacts; and
f) to describe how the site will be closed.

1.3 OVERALL APPROACH AND REPORT ORGANIZATION

The report is organized as follows:

Section 1: This section contains an introduction and discusses the objectives and scope of the report.

Section 2: Is an overview of the site location, setting and the general basis for the natural attenuation design concept.

Section 3: Discusses the types and quantities of wastes that are to be disposed of at the site.

Section 4: Describes the design aspects of the landfill site.

Section 5: Outlines the proposed manner in which the site will be operated on a day-to-day basis.

Section 6: Deals with site inspection and maintenance procedures.

Section 7: Outlines the proposed environmental monitoring procedures for the site.

Section 8: Presents contingency plans for the site to deal with unexpected and unacceptable impacts that might be identified through the monitoring.

Section 9: Deals with record keeping and reporting procedures.

Section 10: Describes the closure and post-closure maintenance/monitoring of the site.

2.0 DESIGN BASIS

2.1 SITE LOCATION AND SETTING

This section describes the location and setting of the proposed North Renfrew Landfill Site. Much of the information on the site setting is summarized from the accompanying report *Ground Water and Surface Water Assessment, North Renfrew Landfill Site* (Gartner Lee, 1996). The reader is referred to that report for further details.

2.1.1 Location and Surrounding Land Uses

The proposed North Renfrew Landfill Site is to be located in Lot 5, Concession 11 of the Town of Deep River. Figure 1 illustrates the site location and surrounding features.

The site is accessible from Bagg's Road, either from north or south. However, Bagg's Road is presently an unmaintained sand-surfaced trail over most of its length.

Figure 2 is a property ownership map. It shows that Atomic Energy of Canada Limited (AECL) essentially owns and controls all of the land east of Bagg's Road (plus Lot 5 in the "key" of land west of Bagg's Road). West of Bagg's Road the land is privately held and rurally zoned. AECL's land in this area is undeveloped and restricted to general public access, while the private lands to the west include a variety of rural and rural residential uses. The nearest residence is located about 750 m to the west of the site.

An archaeological investigation has been conducted on the site, and it concluded that the landfill development will not impact upon archaeological or heritage resources (Ballentine, 1996).

2.1.2 Topography and Physiography

The site is located in the Ottawa River Valley, on a large sand delta formed in the valley during the last major glacial period.

At the site, the topography on the west side of Bagg's Road slopes gently down to the east from elevation 170 to 150 mASL (*Above Sea Level*). Starting about 100 m east of Bagg's Road, there is a more pronounced slope easterly down towards Maskinonge Lake at about elevation 114 mASL. Figure 3 is a Site Plan showing the topography that was established by total station survey in the winter of 1995/96 by Janota Patrick and Associates Ltd.

2.1.3 Surface Water Drainage

The site is located within a single drainage sub-basin that flows to the north-east into Maskinonge Lake. The limit of the sub-basin is shown in the Site Plan (Figure 3). It is an unnamed sub-basin within the greater Maskinonge Lake Drainage Basin that eventually drains into the Ottawa River at Chalk Bay, about 10 km south-east of the site.

In the upper part of the sub-basin, mainly west of Bagg's Road, the gentle slope and sand soils tend to promote rapid infiltration and there is little in the way of permanent drainage features. One exception is the small creek that crosses the site near its south end and continues over the small escarpment down to Maskinonge Lake. The creek is more-or-less permanent, depending on the season. However, the drainage in the creek is mainly from the large swampy area off-site to the west, at the head of the basin. As it flows across the upper part of the site, the creek runs about 2 m above the measured water table, so it is primarily a surface water drainage feature East of Bagg's Road. Below the small escarpment, it picks up some ground water seepage before ponding up in a series of small wetlands near Maskinonge Lake.

It is also worth noting here that during the previous EA investigations, the creek was carefully examined by an aquatic biologist from Gartner Lee Limited, who concluded that it did not contain significant aquatic species or habitat (it is poorly accessible due to several small, rocky waterfalls) and that it could be re-routed in its upper reaches without significant aquatic ecosystem effects, if needed.

There are no known surface water uses on-site or in the downstream area. In fact, all of the surface water on-site and downstream, including Maskinonge Lake, is contained within AECL land that is restricted to public access (i.e., no fishing, camping or water sports are allowed).

2.1.4 Geology and Hydrogeology

The site investigations reveal that the Pre-Cambrian bedrock slopes to the east and southeast beneath the site. The northern edge of the drainage sub-basin is defined by a low ridge of bedrock outcrop at surface. From there, the bedrock surface dips downward to more than 18 m below surface beyond the south edge of the proposed landfill property near BH#4. The bedrock surface is also very much lower at the shoreline of Maskinonge Lake than it is west of Bagg's Road (by more than 17 m).

The surficial soils on all parts of the site west of Bagg's Road were found to be a uniform, fine-grained sand. The sand ranges in thickness from more than 18 m at the south end of the site at BH#4, to 4.5 m further north at BH#7. Even further north, the surficial sand disappears altogether at the exposed bedrock ridge at the northern limit of the drainage basin. Test pits to the south of the bedrock ridge confirm that the sand thins out onto its flanks.

Where deeper boreholes penetrated through the surficial sand, at BH#3, #5 and #6, a silt layer was found ranging in thickness from less than a metre to more than four metres. Beneath the silt, a thin sand and gravel unit of less than about 2 m in thickness was found lying on the bedrock surface. The only exception to this pattern was at BH#7, where the silt layer was missing. This may indicate that the silt layer pinches out where the bedrock ridge rises along the northern edge of the drainage sub-basin.

Below the small escarpment west of Bagg's Road, hand auger holes (BH#8 and #9) in the low-lying areas revealed a surficial sandy silt that likely represent the basal till in the area.

The water table above the small escarpment west of Bagg's Road (i.e., in the area of the proposed landfill itself) was found to generally occur within the surficial sand unit at about 4 m to 6 m below ground surface , although south of the site at BH#4 it is as deep as about 16 m. The ground water flow system is uniform and predictable, with the predominant flow direction being easterly across the site towards Maskinonge Lake, with a slight curve to the south. Discharge from the water table occurs at several places along the escarpment where the water table intersects the ground surface, thus forming the line of small seepage points that are observed. Otherwise, the ground water continues to flow east to discharge in the small ponds below the escarpment. Some ground water may also discharge directly to Maskinonge Lake, although the amounts are probably relatively small because the overburden soils near the lake shore are thin and have low permeability.

The ground water flow rates (average linear ground water velocity) in the surficial sand deposit have been estimated from the testing results at about 21 to 27 metres per year. Based on these, ground water flow times from the proposed landfill to the edge of the escarpment are estimated at 13 to 27 years, while ground water flow all the way to Maskinonge Lake would require about 50 years.

There are no ground water wells downgradient of the site, nor any wells located in the same drainage sub-basin. This is because all of the land on and downgradient of the proposed site is owned by AECL and is restricted access. The nearest private ground water wells would be more than 750 m upgradient of the site in another drainage sub-basin.

The village of Chalk River has a municipal water supply that draws its water from Corry Lake, about 2 km south-west of the proposed landfill site (refer to Figure 1). Corry Lake is located in the Chalk River Basin, whereas the proposed site is in the Maskinonge Lake Basin. The two do not join except downstream at the Ottawa River.

The village of Deep River also has a municipal water supply, drawn directly from the Ottawa River near the town. However, this municipal water intake is well upstream of the location where the landfill site drainage discharges into the river via Maskinonge Lake.

2.2 GENERAL DESIGN CONSIDERATIONS

One of the fundamental design concepts for this site was a decision at an early stage in the Environmental Assessment (EA) that a natural attenuation type of site would be sought. This decision was consistent with the MOEE's Sectoral EA Guidelines, and the rationale included:

a) the high capital, operating and maintenance costs of engineered leachate and gas controls relative to the population and tax base in North Renfrew;
b) the relatively small size of the landfill required; and
c) the high likelihood of finding sites that could provide sufficient natural attenuation capacity for a landfill of this size.

The concept for the natural attenuation design involves the passive venting of landfill gases into the atmosphere through the landfill surface, and the gradual release of leachate into the ground water system beneath the landfill where natural processes of dilution, dispersion, and bio-chemical attenuation could occur in suitably-sized natural attenuation zone surrounding the landfill. No artificial liners or leachate collection systems are needed. To add a further factor of safety to the design concept, discharge of the ground water from the attenuation zone into a wetland area prior to ultimate discharge into the receiving surface water body was preferred, since wetlands have the capacity to further improve or "polish" water quality by natural attenuation processes.

During the planning stages of the EA, estimates of the size of the landfill site, and the corresponding requirements for the size of the natural attenuation zone, were made assuming a highly conservative chloride concentration in leachate of 2,500 mg/L. Chloride was chosen at that stage of the assessment because it is mobile and persistent in ground water, and it is commonly the limiting "critical contaminant" in municipal landfill leachate. The calculations, which are contained in Appendix A of the Task 5 EA report, concluded that a ground water sub-basin of about 68 ha (170 acres) was needed for the natural attenuation concept. The AECL/Chalk River Site was selected on the basis that it offered about this amount of potential attenuation zone, subject to further site-specific confirmation during this current EPA assessment. Furthermore, the discharge from the attenuation zone was through a series of small ponds and wetlands prior to Maskinonge Lake, as desired.

The location of the landfill waste area ("footprint") of the site was proposed during the EA studies to be near the south end of Lot 5. This was based on airphoto interpretation and limited test pitting data that suggested that the soil conditions would be favourable in this location. However, it was recognized that this southerly location would require the diversion of the small creek that crosses the site. Relocation of the site further north on Lot 5 would alleviate the need to divert the creek, but at the time of the EA it was unclear whether the presence of the bedrock ridge along the north end of the drainage basin would limit the soil depth in this area.

Further test pits were conducted to the north during the EPA investigations of the site, as documented in the accompanying report *Ground Water and Surface Water Assessment, North Renfrew Landfill Site* (Gartner Lee, 1996). These investigations identified the northerly extent to which the landfill footprint could be re-located while maintaining more than 2 m of sand depth. Therefore, the Site Plan (Figure 3) shows the revised landfill footprint location and shape.

3.0 WASTE STREAM

3.1 WASTE CHARACTERISTICS AND SERVICE AREA

It is proposed that the Certificate of Approval will allow the landfill to accept for disposal only ***solid, non-hazardous residential, commercial, industrial and institutional wastes generated within the Village of Chalk River, Town of Deep River and the Townships of Rolph, Buchanan, Wylie and McKay.*** Note that in this case the "institutional" waste will largely be non-radioactive wastes from AECL's Chalk River Laboratories, which could represent up to about 40% of the total disposal at the site.

Ontario Regulation 347 (or as amended) provides the legal definition for wastes that can or cannot be accepted for disposal at the site. However, the following provides a partial list based on the Regulation:

Examples of Unacceptable Wastes for Disposal:

a) hazardous wastes;
b) radioactive wastes;
c) bio-medical wastes;
d) corrosive chemical wastes;
e) explosive or highly combustible wastes;
f) sewage sludge;
g) liquid industrial waste; and
h) derelict motor vehicles.

Examples of Acceptable Wastes for Disposal:

a) household garbage (e.g., garbage bags) and debris;
b) yard wastes;
c) construction or demolition debris;
d) garbage from stores and offices; and
e) garbage from schools, hospitals and other government buildings.

Of the acceptable wastes, extensive efforts will be made to divert a large portion from the landfill through one of the following programs that will exist on the site:

a) Blue box recycling bins, including newspapers, cardboard, cans, glass, etc.

b) Leaf and yard waste. These materials will be composted. The only other organic material which may be added to the compost piles are brush and clean wood which have been chipped. No other organic type of materials are to be accepted in the composting operation.

c) Scrap metal recycling. All types of metal products including white goods, derelict cars and other bulk items are to be accepted in the scrap pile with the exception of any materials categorized as hazardous. Appliances containing refrigerant will be separated and the refrigerant removed according to the applicable regulations.

d) Tire recycling. All types of rubber tires are to be accepted in the tire pile.

e) Household waste oils, waste paints and spent batteries are to be bulked in suitable drums/containers and transferred from the site by a properly licenced carrier.

f) Waste wood will be chipped for mulch or compost.

Other diversion facilities may be added at the site as required, or as new technologies and markets become available.

3.2 WASTE QUANTITY

On average, an estimated total of about 4,200 tonnes of waste will be managed at the site each year. Of the total waste, 3,000 tonnes is to be disposed in the landfill portion of the site. The remaining 1,200 tonnes is to be managed by the other facilities such as the composting operation or the various recycling facilities. This results in a twenty-five year total quantity of 105,000 tonnes managed at the site. The specific twenty-five year breakdown amounts to 75,000 tonnes disposed in the landfill and 29,000 tonnes composted and/or recycled.

For waste deposited in the landfill, the associated volumes are estimated at 6,000 m^3 per year and 150,000 m^3 over the twenty-five year site life, assuming a density of 0.5 tonnes/m^3.

4.0 SITE DESIGN

4.1 BASE GRADES

The base grades of the landfill reflect an average depth of excavation of about 2 m below current grade. This excavation depth was chosen during the EA planning process based on a height of about 4 m above grade (exclusive of final cover) and the need to balance cut-and-fill requirements to provide daily and final cover material from the excavated soils. This configuration also ensures that the base of the landfill excavation is above the ground water table, which is about 4 m to 6 m below grade in this area of the site. This not only ensures that the base of the landfill excavation remains dry during construction, but the unsaturated sandy soil beneath the landfill base will assist in the natural attenuation of leachate.

Figure 4 shows the base grade contours. These are considered to be approximate since the landfill will be excavated progressively. The reach of the excavation equipment and the stability of the soils and waste surrounding each new waste trench may dictate the actual base grades (see Section 5.2 below). In this situation, the actual base grades can accommodate some variability since there are no engineered systems to be built within the landfill, and there is a fairly thick unsaturated zone beneath the landfill (i.e., about 2 m or more).

The excavated side-slopes are shown at 4:1 (horizontal to vertical), although again in practice the side slope angles are not critical in such a shallow excavation, and they may be constructed at a steeper angle providing they prove to be stable in the field. However, no access into the excavation should be allowed except with the dozer/compactor if the slope angles are steeper than about 1:1 (or shallower, if the sand does not appear to be stable).

4.2 FINAL CONTOURS

Figure 5 shows the proposed final contours of the landfill, including the placement of approximately 0.75 m of final cover over the entire footprint. The final side slopes of the above-ground portion of the landfill are shown at about 4:1 at the perimeter to ensure long-term stability, and about 20:1 across the top of the landfill to promote efficient drainage.

The maximum height of the landfill peak is low enough to ensure that the waste and the equipment working on the top of the landfill will generally remain below the tree height in the area, to provide visual, noise, and litter screening.

4.3 SITE CAPACITY

Using the difference between the base grades (Figure 4) and the final contours (Figure 5), the total site capacity can be calculated. The following lists the relevant figures that have been determined:

Total Area of Landfill Footprint	2.8	ha
Total Volume (*Final Contours minus Base Grades*)	212,250	m^3
Total Final Cover Volume	21,000	m^3
Total Daily Cover Allowance (*at 4:1 Waste to Daily Cover by Volume*)	38,250	m^3
Total Waste Volume	153,000	m^3
Total Waste Tonnage (*at a Density of 0.5 tonnes/m^3*)	76,500	tonnes

Note that the total waste tonnage meets the 25-year planning estimate of 75,000 tonnes of minimum required disposal capacity.

In actual practice, achieving a 4:1 daily cover ratio has been difficult for landfills similar to North Renfrew's that receive relatively small daily waste volumes. Often more daily cover is used. Even with the recovery and re-use of interim cover during different stages of the landfill operation, extra daily cover may need to be added from an on-site borrow source, or a nearby commercial source.

In addition, it is recognized that a 0.5 tonnes/m^3 density will require an aggressive compaction effort relative to most small landfills.

Given the above, plus the uncertainties involved in predicting waste receipt and diversion rates, the designed site capacity listed above should be considered as an estimate only. The actual capacity will be assessed throughout the operating life of the landfill by periodic survey and the site life will be adjusted accordingly.

4.4 LEACHATE CONTROLS

Leachate will be controlled by natural attenuation processes at this site. The attenuation zone where leachate contaminants will be present is shown in the Site Plan (Figure 3). This area will need to be carefully controlled and monitored throughout the operating and post-closure periods. However, precipitation, infiltration and runoff within the entire sub-basin shown in Figure 3 will also contribute to the natural attenuation processes.

The accompanying report *Ground Water and Surface Water Assessment, North Renfrew Landfill Site* (Gartner Lee, 1996) describes in more detail the natural attenuation process and includes analyses to demonstrate that these processes will be effective in controlling leachate from the site.

Because the natural attenuation design does not require engineered controls for leachate management, the issue of *service life* of the engineered controls versus the *contaminating lifespan* of the leachate is not a consideration at this landfill site.

4.5 LANDFILL GAS CONTROLS

Gases generated within the landfill will also be controlled by natural attenuation processes. They will be allowed to vent naturally through the landfill cover and through the sandy soils surrounding the landfill. Since the nearest residence is more than 750 m away, and separated by an outcropping bedrock ridge, there is virtually no potential for gas migration to off-site buildings. However, proper ventilation will be provided for all buildings or enclosures on the site to prevent gas accumulation which could present an explosive hazard.

4.6 FINAL COVER DESIGN

The natural attenuation design of the site is best suited to a permeable, sand cover since it will allow relatively free venting of the gas within the landfill. Furthermore, the leachate attenuation potential of the site has been calculated assuming a permeable sand cover, so a low permeability final cover will not be necessary, except as a contingency plan.

The locally available sandy soil from the landfill excavation will be suitable for both daily and final cover construction. However, the existing topsoil from the site will need to be stripped off and stockpiled, to be replaced on the final cover in order to support the vegetative growth needed to stabilize the sandy soils and prevent erosion. The topsoil may be augmented with compost.

The final cover will be constructed progressively as each section of the landfill is completed up to its final grade. Otherwise, daily or intermediate cover will be used to cover the waste on a temporary basis.

No special construction techniques are required for the final cover construction. The sand material can be spread and graded using a bulldozer. The sand will be placed to a minimum thickness of about 0.6 m, and graded to ensure smooth drainage without low spots. The equipment tracks will be used to compact the sand to prevent large voids.

The topsoil will then be replaced to an equivalent thickness as was removed from the site (i.e., at least 0.15 m). This layer should be spread and graded out evenly, but not overly compacted. If the equipment has overly compacted the topsoil, it will be tilled or raked out prior to planting.

The final cover should then be planted with an appropriate, fast-growing and drought-resistant vegetative cover that regenerates annually. Native species will be the most appropriate and may include meadow grass, vetch, wildflowers, etc. Low shrubs may be used for visual interest, but larger shrubs and trees will be avoided since they could penetrate through the cover and into the waste.

4.7 STORM WATER CONTROLS

The site setting in a permeable sand plain, and the natural attenuation design, means that little in the way of engineered storm water controls will be needed, other than to prevent direct runoff of leachate-contaminated water into the surface water system.

Any storm water or spring melt that comes in contact with the waste will be retained and infiltrated within the landfill working area. Temporary berms, ditches and grading will be used during each phase to ensure that no water that is potentially contaminated by the waste runs off directly overland to the surface water system.

Any storm water or spring melt that falls outside of the landfill working area, or on the completed sections of the final cover, can be allowed to runoff overland or infiltrate outside of the landfilling area, according to the natural drainage of the area. Again, minor berming, grading and ditching may be employed to ensure this segregation, if necessary.

The storm water controls will have to be constructed based on field conditions, but any berming, grading and ditching to be left in place for a period exceeding one month will be stabilized with topsoil and vegetation (as the growing season will allow).

4.8 FACILITY LAYOUT AND FEATURES

4.8.1 Buffer Zone

The MOEE minimum requirement for buffer zone is 30 m from the footprint of waste disposal area, to allow working room for landfill operations. Figure 6 shows the operational area around the landfill. It is a minimum of 30 m in width on all sides of the landfill footprint, as required.

An *additional* 30 m buffer zone width has been provided adjacent to the privately-owned land to the west of the landfill site. This will be owned by the Board but it will not be used for any landfill operations. Existing trees will be maintained in this additional buffer zone for screening purposes, as discussed below.

The buffer zones described above are distinct from the natural attenuation zone discussed earlier.

The landfill footprint is to be identified in the field by permanent markers in at least each corner of the footprint, installed at the outset of the landfill operations. These will provide a physical reference to ensure that excavation and fill do not inadvertently extend beyond the approved fill area.

4.8.2 Visual and Noise Screening

Most of the land surrounding the landfill footprint is currently forested with a mix of mature trees and underbrush. Retention of most of the trees and natural vegetation surrounding the buffer zone will provide visual and noise screening of the operations.

Towards the south end of the landfill footprint, however, there is a gap in the forest cover. To the east side this is not a concern since the gap opens toward Bagg's Road and the land is owned by AECL (restricted access). To the west there is a possible concern with screening since this is private land. Even though there is no residence immediately to the west, the land is used by the owner for recreational purposes. Therefore, additional screening will be provided in this gap consisting of:

a) a row of hedges for initial screening;
b) a second row of fast-growing deciduous trees such as poplar or birch; and
c) a third row of fast-growing coniferous such as red pine for long-term screening purposes.

These features are shown in the Facility Layout Plan, Figure 6.

4.8.3 Site Access, Site Entrance and Traffic Levels

The main access route to the site will be along Bagg's Road, north from its intersection with Plant Road near the AECL gatehouse. Bagg's Road will be re-graded and hard-surfaced on its current alignment to the site entrance prior to operation of the site. A snowmobile trail will also be constructed beside the upgraded section of Bagg's Road to replace the trail that currently uses the road right-of-way.

The entrance to the site from Bagg's Road is shown in the Facility Layout Plan, Figure 6. It will also be hard-surfaced to at least the site entrance gate.

The peak season traffic to the landfill was estimated during the EA studies as follows:

	Peak Daily Traffic	*Peak Weekly Traffic*
Truck Traffic	5 trucks/day	25 trucks/week
Private Vehicle Traffic	80 vehicles/day*	400 vehicles/week*

* *These are very conservative estimates representing short-term peak season only (e.g., spring clean up).*

There will also be a perimeter access road all around the landfill footprint. It will be a two-lane gravel surfaced road. In addition, temporary access roads to and from the waste tipping face will be developed as required. These roads may be gravel surfaced if traction and/or weather conditions dictate.

4.8.4 Site Office

The site office/attendant's shelter will be a small building or possibly a modified construction trailer set near the site entrance (Figure 6) to allow the attendant to check the identification of waste materials of all users as they enter the site. It will not have a permanent basement or closed foundation, to ensure sufficient ventilation underneath the building, thus preventing the accumulation of landfill gases in the building. Standard safety equipment in the site office will include a first aid kit, fire extinguisher and a battery-powered combustible gas detector.

4.8.5 Site Utilities

Electrical service will not be extended to the site, since this will represent a major cost. Battery and solar energy technology will be used to provide the power and light for the site, and the site will only be operated during the daylight hours. A fuel oil burning stove will be provided to the site office for winter heat. A battery-powered cellular phone will be provided for the site attendant.

The attendant shelter will be equipped with a washroom with non-potable water and septic system. Bottled water will be supplied for drinking.

4.8.6 Fencing and Signage

The site will have two sets of locking gates, one at the turn-off of Bagg's Road and the second gate at the immediate entrance to the site. These will be secured whenever the site is closed.

Chain link fence, a minimum of 2 m high, will be installed in the immediate vicinity of site entrance, adjacent to the main entrance gate at the landfill. This 2 m high chain-link fencing will extend across the gap in the trees. In addition, similar fencing will be installed in the gap in the forest along the back (west) side of the landfill along the private property line, and along the south side of the landfill to the north of the small creek. This is at the request of the private property owner who wants to discourage the movement of bears to the south and west of the landfill. The extent of the 2 m fencing is shown in the Facilities Layout Plan (Figure 6).

Around the remainder of the landfill operational area, post and wire fencing will be used to identify the landfill and warn against unauthorized access.

Signs warning of "Danger - No Trespassing" will be posted at regular intervals along the fence. In addition, there will be signs posted at the entrance from Bagg's Road and at the actual site entrance gate indicating:

a) the name of the landfill;
b) the Certificate of Approval number;
c) the operating hours;
d) the waste acceptance procedures;
e) the terms of public access to disposal (i.e., North Renfrew residents/businesses only);
f) "No Trespassing Without Authorization";
g) schedule of tipping fees; and
h) a contact name(s) and phone number(s) in case of questions, complaints or emergencies.

4.8.7 Layout of Other Facilities at the Site

The Site Facilities Plan (Figure 6) shows the general location of a number of other waste management facilities which will be operated at the landfill site. These are:

a) Scrap Metal Pile;
b) Tire Recycling Pile;
c) Reuse Area;
d) Recycling Area;
e) Composting Area; and
f) Brush and Wood Chipping.

The design of these other facilities is discussed later in the report, in Section 5.7, in the context of their operation.

4.9 SITE EQUIPMENT REQUIREMENTS

The site construction will be contracted, and the contractor will supply the necessary equipment.

The main unit operating full-time at the site is to be a rubber-tired wheel loader with a four-way bucket and a landfill protective package, or a suitable equivalent. This unit will be adequately sized to carry out the following tasks:

a) excavate sand to create or extend working faces;
b) move excavated sand to stockpiles and/or load dump trucks;

c) move or spread waste as it is dumped;
d) compact the waste by multiple passes;
e) obtain daily, interim or final cover materials from stockpiles;
f) spread and compact daily, interim or final cover;
g) grade on-site access roads to the tipping face(s);
h) clear snow from the access roads and tipping face;
i) assist other vehicles in moving around the site in muddy or slippery conditions; and
j) general site house-keeping tasks.

In addition to the above, the contractor will be required to periodically supply ancillary construction equipment when it is needed to ensure efficient site operations. At a minimum, this will consist of: a tracked bulldozer to carry out stripping, clearing, grading and access road construction; an excavator to excavate working areas and construct ditching; and dump trucks to move materials back and forth from stockpiles.

4.10 SITE STAFF REQUIREMENTS

A full-time attendant will be employed by the Board and will be responsible for the following duties:

a) opening and closing the site;
b) checking each vehicle entering the site;
c) collecting waste permits;
d) recording waste volumes and classifications;
e) site data recording;
f) general house keeping;
g) arranging for removal of recyclable materials;
h) monitoring and managing the on-site composting operations; and
i) daily litter collection.

The attendant will also have the following training:

a) familiarity with the requirements of the Certificate of Approval and Design and Operating Plans for the site (copies to be maintained on-site at all times);
b) emergency response procedures;
c) contingency plan procedures; and
d) WHMIS and Regulation 347 requirements and procedures.

The site construction will be carried out by a contractor. The contractor will be responsible for the following duties:

a) clearing and grubbing;
b) excavating the waste trenches;

c) stockpiling the topsoil and cover material;
d) waste spreading and compaction;
e) covering waste daily;
f) operating composting facilities;
g) running brush and wood chipping facilities;
h) maintaining the scrap metal area, tire area and recycling area;
i) maintaining the reuse facilities in an acceptable condition; and
j) maintaining on-site access road and surface drainage.

5.0 SITE OPERATIONS

5.1 HOURS OF OPERATION

The maximum hours of operation for waste disposal that will be included in the Board's application for approval will be 7:00 a.m. to 5:00 p.m., Monday to Saturday, with closure on Sundays and statutory holidays. On days when the site is open, on-site activities other than waste receipt may occur an hour before the gate opens and up to two hours after the gate closes.

The above-noted hours are intended to provide the Board with sufficient operating flexibility to accommodate the public waste management needs without having to amend the Certificate of Approval. However, the Board is also able to further limit the hours of operation, providing that the actual operating hours are posted at the gate. Initially, based on experience with the current site, the landfill is planned to be open to the public Tuesdays to Saturdays from 9:30 a.m. to 3:30 p.m. or 4:00 p.m. The site will not be open on Sundays and Mondays. Additional hours of operation may be provided to the public in the summer months. The added hours could range from 5:00 p.m. to 7:00 p.m. Tuesdays to Fridays.

5.2 LANDFILL PHASING AND TRENCH DEVELOPMENT

The landfill will be generally filled in a sequence from southwest to northeast. This progression was requested by the adjacent private landowner to the west, who wanted the south-western corner of the site where there is currently no forest cover to be landfilled first. That way, future filling activities will occur behind (to the east and north of) the completed first phase.

Figure 7 shows the landfill construction sequencing. The boundaries of the four phases are somewhat arbitrary, but each represents approximately 6 years of capacity, and a landfill footprint size of roughly 1 ha. Within each phase, arrows have been used to illustrate the direction of filling.

Figure 7 shows the general direction of development within each phase. Each phase of the landfill will be developed using the area filling method, although the below-grade, excavated portion will be extended progressively to minimize the amount of excavation that is open, and thus exposed to erosion, at any one time.

Figure 8 illustrates the filling technique for Phase I (each subsequent phase would be similar), while Figure 9 is a sketch of the daily operational procedures. The operation would begin with the excavation of an east-west trench across the full southern edge of the phase, and approximately 30 m wide in a north-south direction (see Figure 7). This initial excavation would be most efficiently dug with an excavator and removed by dump truck to a convenient stockpile location, probably on the Phase II or Phase III area.

The first lift of waste would then be developed across this working face in small sections (depending on the amount of waste received). Each lift would be approximately 2 m in thickness. Vehicles delivering waste would normally drive down a temporary access ramp and unload at the bottom of the tipping face. Periodically throughout the day, the wheel loader would push the material up onto the sloping face and compact it by making several passes up and down the face.

If traction conditions occasionally prevent waste vehicles from entering the excavation to tip at the bottom of the face, then provision should be made to have them temporarily tip at another above-grade tipping face, or tip over the edge or side of the excavation and use the loader to transfer the waste to the tipping face.

At the end of each day (or more often if warranted), a minimum of 0.15 m of daily cover would be applied over all exposed waste. Any areas that are to be left inactive for more than one month will require a minimum of 0.3 m of interim cover. The daily and interim cover would be obtained as needed from the excavation face behind (north) of the waste tipping face. The loader would simply transfer buckets of sand over to the waste. In this way, the filling and excavating will occur roughly in progression; otherwise, material may be occasionally added or removed from stockpile to maintain a reasonably efficient cut-and-fill operation.

Subsequent above-grade lifts would be built up and moved forward progressively in a similar fashion. It is desirable to keep the overall working slope of all of the lifts at no more than about 3:1 (horizontal to vertical) for stability, but otherwise the full height of the landfill should be achieved as soon as practical to allow for final cover to be applied progressively. The waste vehicles will enter the above-grade lifts from each side (i.e., in an east or west direction) to prevent them from having to drive down through the excavation. However, the operation will continue to be by tipping at the bottom of the face and pushing/compacting the waste up the face, since this has proven to provide the most effective compaction technique at other sites.

5.3 ROUTINE WASTE ACCEPTANCE AND PLACEMENT ACTIVITIES

Vehicles entering the site will be stopped by the attendant who will perform a visual inspection of the waste. For each load of waste, the attendant will record the following:

a) the hauler name;
b) approximate volume;
c) waste category; and
d) date received.

The hauler name will only apply to large loads; small loads by individual homeowners can simply be recorded as "residential". However, the attendant will be responsible for making periodic checks that the wastes have originated from within the landfill service area by questioning the hauler, inspecting drivers licences, etc. Waste loads that cannot be accepted for this, or any other reason must be noted in the daily log along with the reason for rejection.

The waste volume will be determined by visual estimate based on the dimensions of the load, or the dimensions of the container or vehicle.

The waste categories will be selected from the following list:

Mixed Loads:

1. mixed residential;
2. mixed commercial;
3. mixed industrial;
4. mixed institutional;
5. construction/demolition debris;
6. grass, leaves, brush and other yard wastes; and
7. mixed recyclables;

Specific Loads:

8. used tires;
9. waste oils;
10. waste paints;
11. scrap steel;
12. scrap wood;
13. cardboard/boxboard;
14. drywall;
15. soils;
16. appliances ("white goods"); and
17. other _____.

For mixed waste loads, other secondary waste categories will be noted where there is a significant proportion present.

After the waste inspection and acceptance, users will then be directed to the appropriate facilities for unloading (i.e., composting, scrap metal recycling, tire recycling, paint or oil recovery, landfill, etc.).

For waste designated for the landfill portion of the site, users will proceed to the edge of the current tipping face of the landfill to discard their wastes. The daily landfill operations were described previously in Section 5.2.

Burning of wastes will be prohibited. Scavenging is also prohibited except at the designated re-use area and under the direction of the attendant.

5.4 LEACHATE MANAGEMENT

Leachate management will be by the natural attenuation method (refer to Section 4.4). Therefore, no daily leachate management operations will be required.

5.5 GAS MANAGEMENT

Gas management will be by natural attenuation processes (i.e., passive venting; refer to Section 4.5). Therefore, no daily gas management operations will be required.

5.6 STORM WATER MANAGEMENT

The design of the storm water management system for the site was described earlier in Section 4.7. The system will not require any daily operations, other than to modify the local drainage on and around the site using temporary grading, ditching and berms to prevent the overland runoff of leachate-contaminated water from the active landfilling areas. The need for these will be determined on-site by the attendant who will review site drainage periodically and instruct the contractor to perform any necessary work as the development progresses. Also, the planting and maintenance of vegetative cover on all stripped areas, stockpiles, berms and ditches should be reviewed daily to ensure that runoff from the site is not carrying excessive sediment.

5.7 OPERATION OF OTHER SITE WASTE MANAGEMENT FACILITIES

In addition to the landfill operation, the waste site is to include a number of waste management facilities. Their daily operation as well as their design layout is discussed below. Figure 6 shows their locations on the site.

5.7.1 Scrap Metal Pile

An area is to be designated for the stockpiling of all recyclable metals delivered to the site. The contractor will be responsible for consolidating the pile on a regular basis.

The stockpile will be removed from the site by a salvage company on an as-required basis. The salvage company (or other qualified persons) will be responsible to ensure that all ozone depleting substances are properly removed from any items such as refrigerators, freezers, air conditioners etc. prior to being recycled. To facilitate this, these items will be stored separately form the general scrap metal pile and the contractor will remove all doors from the appliances.

Otherwise, there will not be any special design requirements other than ensuring that the area for the stockpile has adequate drainage and that there is easy access for vehicles to reach the pile. The pile will, however, be located within eyesight of the attendant shelter to allow the attendant to easily monitor the materials being discarded in the pile.

5.7.2 Tire Recycling Pile

An area is to be designated for the stockpiling of all rubber tires. The stockpile is to be removed from the site by a contractor arranged through the Pembroke and Area Recycling Board. The cost paid to the contractor is to be offset by a tipping fee charged for tires. Users will be required to obtain a permit before they are allowed to dispose of tires. The attendant will collect the permits from users as they enter the site. It should also be noted that AECL is not expected to deliver tires to the site, rather they are to continue recycling tires independently at their own site.

There will not be any special design requirements other than ensuring that the area for the stockpile has adequate drainage and that there is easy access for vehicles to reach the pile. The pile will, however, be located within eyesight of the attendant shelter to allow the attendant to easily monitor use of the pile. The size of the pile must also be limited to conform to MOEE fire prevention requirements.

5.7.3 Reuse Area

A small area measuring no more than 1,000 m^2 is to be established at the site where users of the site will be directed to place items which may be reusable. This includes items such as lumber, building materials, furniture, sporting equipment, etc. Any materials placed in the area can be removed by any user of the site at no cost. Such a facility allows the materials to be salvaged (as opposed to scavenged). If after a period of several weeks to a month, the item has not been salvaged, the attendant will direct the site contractor to remove it from the reuse area and place it in the appropriate location on-site (i.e., either the wood chipping pile, metal pile or landfill).

The contractor is to be responsible for keeping the area neat and tidy. The attendant is to oversee the contractor's operations and will provide direction to the contractor on an as-required basis.

The perimeter of the reuse area is to be fenced to clearly distinguish it from the waste disposal facilities on-site. It will also be properly graded to ensure good drainage. The surface is to be compacted and may be covered with a thin layer of granular material. The reuse area will also be located within eyesight of the attendant shelter to allow the attendant to easily monitor use of the pile. Depending on the success of the program and the nature of the items, the Board may decide to construct a lean-to, shed, or plastic-covered enclosure for the re-use area. If so, it will be adequately vented.

5.7.4 Recycling Area

A recycling area is to be established in the immediate vicinity of the attendant shelter in order that other recyclable materials can be diverted from the landfill. Materials to be collected include: cardboard and all other paper products, clear glass food and beverage containers, coloured glass food and beverage containers, assorted plastics (i.e., #1, #2, #6 and Styrofoam), metal containers (empty aerosol, food and paint cans) and other materials collected in the local Blue Box program. In addition, suitable drums/containers are to be provided for the bulking of used motor oils, used paints and used batteries (from household sources only). The oil and paint drums are to placed in concrete containment cells that are sized to accommodate the spill or leakage of a full drum. These materials will be transferred off of the site as quantities dictate by a properly licenced carrier.

Users are to be directed to the recycling area by the attendant who is to closely monitor the various bins in order to ensure that cross contamination does not occur. When the depot compartments are full the attendant is to contact a recycling contractor to collect the materials. The recycling contractor will be required to provide bins appropriate for each of the materials.

5.7.5 Composting Area

All leaf and yard waste is to be managed on-site via a windrow-type composting operation. The site design, operation and monitoring will conform with all of the requirements of Ontario Regulation 101, Part V, under the Environmental Protection Act.

Windrow pile(s) are to be placed in a triangular cross section approximately 3.5 m wide by 2.5 m in height with a maximum length of 50 m.

It is anticipated that a maximum of three windrows will be required which will provide a capacity of 650 m^3. Windrows are to be spaced as closely together as possible to minimize cold weather impacts, while still providing the contractor with the ability to completely turn them.

Materials added to the windrow are to be limited to leaf and yard waste. Any limbs greater than 5 cm in diameter are to be chipped with the brush before being added to the windrow.

Clean wood that has been chipped is also to be mixed into the windrows. This will increase the porosity of the windrow which will assist the aerobic decomposition process. The windrows are to be located directly on top of the existing ground and are to be arranged such that there is adequate drainage. In order to minimize the potential for odour problems, the composting operation will be situated in such a way that it maximizes the distance to homes in the vicinity of the site.

The operation of physically turning the windrows is to be performed by the contractor using the same equipment used to compact and cover the waste (i.e., a front-end loader). During the first 15 days that material has been added to the compost pile(s), the windrows are to be turned every third day and the temperature measured each day. Thereafter, the windrow(s) are to be turned at least once a month for a period of not less than 6 months. Temperatures are to be maintained at 60° C where possible. Minimum acceptable temperatures are to be 55° C. If unacceptable odours occur, the windrow(s) will be turned more frequently. The moisture content of the windrows is also to be controlled. During periods of prolonged drought conditions, the windrows will be watered down via importing water in a tanker truck or via water pumped from an on-site source. During heavy snowfalls, the excess snow is to be removed. To prevent potential odour problems, windrows are not to be turned during periods of heavy winds.

The composting process will be complete as early as seven months after the material is added to the pile(s). Depending on the needs of the area municipalities, the finished product can be used as a soil conditioner in lieu of topsoil in public areas such as parks. Before the material can be removed off-site, samples of the compost are to be taken and sent to a laboratory for testing to determine if the material meets MOEE criteria. One or more of the windrow piles is to be designated for use as daily cover material or final cover material at the landfill; therefore, these piles will not be used off-site.

The contractor will be responsible for all physical works associated with the compost operation including: forming the windrows, turning the windrows, mixing chipped brush and wood into the windrows, watering the windrows, clearing excess snow off of the windrows and moving the finished product on-site. The attendant will be responsible for taking temperature measurements and keeping records. Records are to include the source and type of materials, estimated quantity in m^3, all temperature measurements, all dates that the piles are turned and any odour problems encountered.

5.7.6 Brush and Wood Chipping

Brush is to be chipped and then added to the compost operation rather than landfilled. This will help to ensure that the landfill volume used is minimized. In addition to brush, all wood wastes are to be chipped. Again, this will assist to minimize the landfill volume used. Chipped brush is to be mixed

with the leaf and yard windrows. Clean wood that has been chipped will also be mixed into the windrows to facilitate the decomposition process. Contaminated wood can be chipped and mixed with finished compost and/or insitu soil for use as a source of daily cover material.

A large brush and wood chipper capable of chipping materials with nails will be used for the chipping operation. Wood and brush waste are to be loaded into a top mounted hopper via a front end loader. The contractor will be responsible to chip all materials and transport the chipped material to the appropriate facility on-site for further use. The contractor will be trained in regard to the safe operation of the chipping equipment according to the equipment manufacturer's recommendations prior to operating the machinery. A specific area is to be established where the brush and wood wastes can be placed in separate piles which are located fairly close to the brush chipper and the composting operation. To minimize noise from the chipper, it will be situated such that it maximizes the distance to homes in the vicinity of the site. Access to the chipper will also be strictly controlled for safety purposes.

5.8 WINTER OPERATION

Every effort must be made to maintain access to the site during the winter through proper road maintenance. Internal site access roads that are not paved should have a gravel surface to promote stability and traction. Roads will be kept clear of snow during winter periods. The front-end loader can be used to clear snow internally on the site, while municipal snow removal will be extended along Bagg's Road to the site entrance. Sand and salt should be applied as often as necessary.

Sufficient excavation must be prepared in advance of each winter to ensure that there will be enough working area available should weather conditions make excavation too difficult.

The landfill loader may be used to assist trucks to and from the working face in icy or muddy conditions. In the event that vehicles cannot reach a tipping face in the bottom of the excavation, then provision will be made by the site attendant to open an alternative tipping face above-grade, or to direct vehicles to tip into the excavation from the edge or sides and use the loader to transfer waste to the active face (note: stop blocks must be used if tipping from the top of the excavation to prevent rolling over the edge). Any temporary tipping location necessitated by poor weather conditions must be within the approved landfill footprint and must either be incorporated into a previous face through proper cover application, or the waste must be transferred to the current tipping face as soon as possible.

5.9 PEST CONTROL

Small tipping faces and the stringent application of daily cover will limit the access of insects, rodents and birds to the wastes. This process has generally been effective at other local landfill sites, and every effort will be made to improve procedures even further with the new landfill.

Bears are the biggest problem at northern Ontario landfills. As noted previously, taller and stronger fencing will be installed in the rear (west and south) boundaries of the site to limit the bear trace passing to private properties. Also, small tipping faces, use of daily cover, and good housekeeping practices around the site will be employed to discourage bears.

5.10 DUST, LITTER AND ODOUR CONTROL

The relatively remote location of the site, and the heavy tree cover, will limit the potential for dust, litter and odour to become a nuisance to area residents. Furthermore, the predominant wind direction from the north-west is *away from* the village of Chalk River and towards the AECL property, which is uninhabited. Nevertheless, all reasonable steps will be employed during the site operations to limit the source of these nuisances. Measures include:

a) the use of a small active tipping face;
b) regular application of daily and intermediate cover;
c) progressive construction of final cover as areas are brought up to final grade;
d) rapid vegetation of all exposed soils, including stockpiles, ditches and berms (as the growing season will allow);
e) hard-surfacing of the access road up to at least the site gate;
f) cleaning or sweeping of the hard-surfaced roads, if required;
g) gravelling of some on-site working areas where the soils are dust-prone;
h) use of bins or tarps in the recycling/re-use areas for light-weight materials;
i) use of water or other MOEE approved dust suppressants on the working areas, as required;
j) regular turning of the compost piles;
k) temporary suspension of certain construction and filling activities under extremely windy and dry conditions, and/or moving the tipping face to a lower, more sheltered area; and
j) periodic litter collection on the site and in the surrounding areas every two weeks, or more often if required.

5.11 NOISE CONTROL

Again, the relatively remote location of the site and the dense tree cover that will remain around the landfill will limit the noise nuisances in the surrounding area. Operation of the site only within daytime hours will prevent noise impacts during the otherwise quiet night-time period.

In addition, the contractor will be required to maintain all of his site equipment in proper working order, especially the mufflers.

5.12 FIRE PREVENTION

The design and operation of the site (i.e., fire break between the landfill and the surrounding bush; no waste burning, etc.) will limit the potential for fires. Furthermore, the site attendant should employ good housekeeping practices that will further reduce the possibilities of fire. The attendant should review the site operating practices with the local fire department from time-to-time and make any recommended changes.

If a fire should begin accidentally at the site, the local fire department should be alerted immediately. As conditions dictate, the site attendant may be able to control or extinguish the fire using the fire extinguisher from the site office or the site equipment, or he/she may direct the contractor to dump sand on the fire using the landfill loader.

6.0 SITE INSPECTION AND MAINTENANCE

The site attendant will perform a daily inspection of the following aspects of the site operations (on working days):

a) condition of the access road (i.e., potholes, snow removal, etc.,);
b) condition of the fencing, gates and entrance signs;
c) condition of the site office;
d) evidence of any unacceptable wastes or illegal dumping along the access route;
e) adequacy of the daily cover;
f) integrity of the areas under final cover (i.e., settlement, erosion, vegetative growth);
g) condition of the vegetation on and around the working areas;
h) The need for dust control watering on working areas or along the access road;
i) loose litter on-site and/or any off-site litter;
j) unacceptable levels of odours;
k) adequacy of the site drainage to segregate clean and potentially contaminated runoff;
j) evidence of any excessive erosion or sedimentation in the drainage;
k) any evidence of leachate discharge at surface on-site, in the surrounding area or in the drainage courses (other than below the escarpment, which will be included in the monitoring program);
l) condition of the contractor's equipment (especially mufflers and oil/fuel leaks); and
m) general neatness and cleanliness of the site.

The site attendant will note in writing deficiencies in any of the above, and the action taken to correct the situation. These inspection records shall be maintained on file and summarized in the site reports.

The natural attenuation design alleviates the need for any significant degree of routine maintenance on the landfill, other than the day-to-day inspection and responses noted above. Otherwise, normal, routine maintenance on the roads, fencing, buildings and equipment should be all that will be required.

7.0 ENVIRONMENTAL MONITORING

The accompanying report *Ground Water and Surface Water Assessment, North Renfrew Landfill Site* (Gartner Lee, 1996) provides detailed recommendations regarding the necessary ground water and surface water monitoring programs for the site. Note that the Site Plan (Figure 3) shows all of the proposed monitoring locations mentioned below.

Also, it should be noted that the frequency of monitoring and reporting takes into account that the estimated ground water flow time from the landfill to the edge of the escarpment where surface water discharge could first occur is 13 to 27 years.

7.1 GROUND WATER

The proposed ground water monitoring program during the landfill operating period is detailed in Table 1. It is based on the following major recommendations:

a) The addition of one new ground water monitoring nest immediately east of the revised landfill footprint location (shown as BH #11 in Figure 3). The nest should contain a standpipe and a piezometer at an intermediate depth, above the silt layer if it is present at this location.

b) The addition of one new standpipe monitor immediately west of Phase III of the landfill footprint (shown as BH #10 in Figure 3). The installation of monitor can be deferred until one year prior to the commencement of Phase III.

c) Quarterly (seasonal) monitoring of ground water levels in all monitors.

d) Annual or semi-annual sampling of ground water from all monitors (refer to Table 1 for schedule and parameter lists).

TABLE 1(a): MONITORING PROGRAM - MONITORING LOCATIONS AND SCHEDULE

Monitoring Location*	Description/ Location	Spring (March)	Summer (June)	Fall (September)	Winter (December)
Leachate/Ground Water					
BH 11-I	Downgradient Piezometer Leachate Indicator	Water Level Sample - List 1	Water Level	Water Level Sample - List 2	Water Level
BH 11-II	Downgradient Standpipe Leachate Indicator	Water Level Sample - List 1	Water Level	Water Level Sample - List 2	Water Level
Ground Water					
BH 1	Upgradient Standpipe	Water Level	Water Level	Water Level	Water Level
BH 2	Lateral Standpipe Next to Stream	Water Level Sample - List 2	Water Level	Water Level Sample - List 2	Water Level
BH 3-I	Downgradient Piezometer Lower Aquifer	Water Level Sample - List 2	Water Level	Water Level	Water Level
BH 3-II	Downgradient Piezometer Base of Upper Aquifer	Water Level Sample - List 2	Water Level	Water Level Sample - List 2	Water Level
BH 3-III	Downgradient Standpipe	Water Level Sample - List 2	Water Level	Water Level Sample - List 2	Water Level
BH 4	Lateral Standpipe along Bagg's Road	Water Level Sample - List 2	Water Level	Water Level	Water Level
BH 5-I	Downgradient Piezometer Lower Aquifer	Water Level Sample - List 2	Water Level	Water Level	Water Level
BH 5-II	Downgradient Standpipe	Water Level Sample - List 2	Water Level	Water Level Sample - List 2	Water Level
BH 6	Upgradient Standpipe West of Phase I	Water Level Sample - List 2	Water Level	Water Level Sample - List 2	Water Level
BH 7	Lateral Standpipe North of Attenuation Zone	Water Level Sample - List 2	Water Level	Water Level	Water Level
BH 8	Downgradient Standpipe Near Lower Wetland	Water Level	Water Level	Water Level	Water Level
BH 9	Downgradient Standpipe Near Lower Wetland	Water Level Sample - List 2	Water Level	Water Level	Water Level
BH 10 **	Upgradient Standpipe West of Phase III	Water Level Sample - List 2	Water Level	Water Level Sample - List 2	Water Level
Surface Water/Seeps					
SW 1	Creek Upstream of Landfill	Flow Sample - List 3	Flow Sample - List 3	Flow Sample - List 3	Flow Sample - List 3
SW 2	Creek - Downstream Top of Escarpment	Flow Sample - List 3	Flow Sample - List 3	Flow Sample - List 3	Flow Sample - List 3
SW 3	Downstream Escarpment Seep South Tributary	Flow Sample - List 2	Flow Sample - List 2	Flow Sample - List 2	Flow Sample - List 2
SW 4	Downstream Escarpment Seep North Tributary	Flow Sample - List 2	Flow Sample - List 2	Flow Sample - List 2	Flow Sample - List 2
SW 5	Wetland Relocated to Main Pond Inlet	Flow Sample - List 3	Flow Sample - List 4	Flow Sample - List 3	Flow Sample - List 3
SW 6	Wetland Outlet to Maskinonge Lake	Flow Sample - List 3	Flow Sample - List 4	Flow Sample - List 3	Flow Sample - List 3

* Refer to Figure 2 for monitoring locations

** To be installed prior to development of Phase III

TABLE 1(b): MONITORING PROGRAM - PARAMETER LISTS

List 1 Leachate Chemistry	List 2 Ground Water Indicators	List 3 Surface Water Indicators	List 4 Surface Water Compliance
Field:	**Field:**	**Field:**	**Field:**
Temperature	Temperature	Temperature	Temperature
pH	pH	pH	pH
Electrical Conductance	Electrical Conductance	Electrical Conductance	Electrical Conductance
		Dissolved Oxygen	Dissolved Oxygen
General Chemistry:	**General Chemistry:**	**General Chemistry:**	**General Chemistry:**
Alkalinity	Alkalinity	Total Suspended Solids (TSS)	Total Suspended Solids (TSS)
		Alkalinity	Alkalinity
Nutrients:	**Nutrients:**	**Nutrients:**	**Nutrients:**
Total Kjeldahl Nitrogen (TKN)	Ammonia (NH_3)	Total Kjeldahl Nitrogen (TKN)	Total Kjeldahl Nitrogen (TKN)
Ammonia (NH_3)	Total Phosphorous (P)	Ammonia (NH_3)	Ammonia (NH_3)
Nitrate (NO_3)		Nitrate	Nitrate
Total Phosphorous (P)		Total Phosphorous (P)	Total Phosphorous (P)
		Biological Oxygen Demand (BOD_5)	Biological Oxygen Demand (BOD_5)
Anions:	**Anions:**	**Anions:**	**Anions:**
Chloride (Cl)	Chloride (Cl)	Chloride (Cl)	Chloride (Cl)
Sulphate (SO_4)	Sulphate (SO_4)	Sulphate (SO_4)	Sulphate (SO_4)
Cyanide (CN)			
Major Cations:			
Calcium (Ca)			
Magnesium (Mg)			
Potassium (K)			
Sodium (Na)			
Metals:	**Metals:**	**Metals:**	**Metals:**
Aluminum (Al) Lead (Pb)	Aluminum (Al)	Aluminum (Al)	Aluminum (Al) Lead (Pb)
Barium (Ba) Manganese (Mn)	Boron (B)	Boron (B)	Barium (Ba) Manganese (Mn)
Beryllium (Be) Mercury (Hg)	Iron (Fe)	Iron (Fe)	Beryllium (Be) Mercury (Hg)
Boron (B) Molybdenum (Mo)	Nickel (Ni)	Nickel (Ni)	Boron (B) Molybdenum (Mo)
Cadmium (Cd) Nickel (Ni)	Zinc (Zn)	Zinc (Zn)	Cadmium (Cd) Nickel (Ni)
Chromium (Cr) Selenium (Se)			Chromium (Cr) Selenium (Se)
Cobalt (Co) Silver (Ag)			Cobalt (Co) Silver (Ag)
Copper (Cu) Vanadium (V)			Copper (Cu) Vanadium (V)
Iron (Fe) Zinc (Zn)			Iron (Fe) Zinc (Zn)
Organics:	**Organics:**	**Organics:**	**Organics:**
Dissolved Organic Carbon (DOC)	Dissolved Organic Carbon (DOC)	Chemical Oxygen Demand (COD)	Chemical Oxygen Demand (COD)
Benzene	Phenol	Phenol	Phenol
1,4 Dichlorobenzene			
Dichloromethane			
Phenol			
Toluene			
Vinyl Chloride			

e) The testing lists should be reviewed on a regular basis and revised in consultation with the MOEE based on the actual observed leachate quality.

f) All monitors will be properly capped, marked and locked. Any damaged monitors will be repaired or replaced as soon as possible.

7.2 SURFACE WATER

The proposed surface water monitoring program during the landfill operating period is detailed in Table 1. It is based on the following major recommendations:

a) The addition of one new surface water monitoring station upstream of the main wetland below the escarpment (shown as SW7 in Figure 3).

b) Quarterly (seasonal) monitoring of the surface water flows at all of the current monitoring stations.

c) Quarterly (seasonal) sampling of surface water at all of the current monitoring stations.

d) Testing of the surface water samples for a suite of parameters consistent with the critical indicator parameters in the leachate (Table 2).

e) The testing lists should be reviewed on a regular basis and revised in consultation with the MOEE based on the actual observed leachate quality.

f) All surface water monitoring stations are to be clearly and permanently marked in the field.

7.3 REVIEW AND REPORTING ON THE MONITORING PROGRAM

It is recommended that a qualified engineer or scientist be retained annually to review the water quality results as they are produced and available. The review will occur at least of four times per year coincident with the frequency of the seasonal sampling.

Reporting of the review will occur each year unless the review identifies a situation that would trigger the need to invoke the contingency plan (see Section 9.1.1 below).

The monitoring and laboratory testing data should also be provided to the MOEE and the Site Liaison Committee as it is available, along with the reports noted above.

The monitoring program should be reviewed every year as well, and modified as appropriate through consultation with the MOEE.

8.0 RECORD KEEPING AND REPORTING

Clear and consistent record keeping will be in placed from the beginning of site development, including the following:

a) waste receipts, including the types and quantities of wastes and their disposition (i.e., landfill vs. diversion);
b) rejected waste loads and reasons;
c) site inspection and response logs;
d) any complaints received and the responses to the complaints;
e) progress of the excavation, filling areas, and progressive final cover installation, on at least a monthly basis; and
f) all monitoring results and interpretation.

Note that the waste receipts at the site will be computerized and that waste haulers subjected to tipping fee will be billed monthly. There will be no cash exchanged at the site.

A site operation status report will be prepared regularly and submitted to the municipalities, the MOEE and the SLC, with additional copies made available in local public libraries. The report will be annual for at least the first five years of operation. Following that time, the frequency of the report may be lengthened, with agreement from the MOEE and the SLC, if the site operations and monitoring results have become routine.

The status report will be prepared by, or under the supervision of, a qualified engineer and will include the following information:

a) An Executive Summary of the findings, conclusions and recommendations;
b) Site Plans showing the current and final extent of the footprint; contours and cross sections; and any changes to the site layout or monitoring network;
c) Analysis and interpretation of the surface water and ground water monitoring data (unless there is an exceedance of PWQO; see Section 7.3);
d) An assessment of the adequacy of the attenuation zone;
e) An assessment of the physical condition of the ground water monitoring installations;

f) The landfill capacity used during the reporting period and the remaining capacity;
g) The types and volumes of waste diverted from the site by transfer;
h) Any modifications to the design or operation of the site as described in this report; and
i) A summary of complaints and how they were dealt with;
j) The implementation of any remedial works or contingency actions.

9.0 CONTINGENCY PLANS

9.1 CONTINGENCY PLANS RELATED TO LEACHATE

9.1.1 Triggering Mechanism

The environmental monitoring program will be used to identify the time at which contingency plans will need to be implemented, if ever. The "triggering mechanism" for the North Renfrew Landfill Site is based on the MOEE Eastern Region's "Interim Guidance Document for the Development of Waste Disposal Site Trigger for Surface Water" (May, 1995).

Tier I Trigger Level

Any two consecutive surface water samples from the routine annual monitoring program that exceed PWQO, with the exception of aluminum and iron which shall not exceed the pre-development concentrations, will trigger Tier II monitoring, as below. Furthermore, the Board will immediately advise the MOEE District Manager of the situation.

Tier II Trigger Level

Tier II monitoring will consist of consecutive monthly surface water samples for the same locations and list of parameters as the routine quarterly monitoring. The Tier II monitoring results shall be provided to the MOEE District Manager as soon as they are available. Any two consecutive surface water samples from the Tier II monitoring program that exceed PWQO, with the exception of iron which shall not exceed the pre-development concentrations, will trigger the implementation of the appropriate contingency plan(s) and Tier III monitoring, as outlined below.

If the above Tier II monitoring does not show further exceedance, then monitoring may return to the routine program.

Tier III

Within 60 days of the triggering of Tier III (i.e., two consecutive monthly exceedances), the Board will provide to the MOEE District Manager a detailed work plan and implementation schedule for an appropriate contingency to control leachate and Tier III monitoring program to verify the effectiveness of the contingency. Following approval from the MOEE, these will be immediately implemented.

9.1.2 Feasible Contingency Options

The accompanying report *Ground Water and Surface Water Assessment, North Renfrew Landfill Site* (Gartner Lee, 1996) provides details regarding several feasible alternative contingency plans that could be implemented if the ground water or surface water monitoring were to ever identify unexpected and unacceptable impacts, if they cannot be otherwise mitigated via the existing operational controls.

The following provides a review of each of the contingency measures, describing the concept and indicating its technical feasibility. Any one of these are considered to be viable at this site, or in combinations depending on the circumstances.

It should be noted that the landfill will develop slowly over a 25-year period, and the ground water flow rates beneath the landfill are relatively slow at about 21 to 25 metres per year. Therefore, many years of monitoring data will be developed to confirm the performance of the natural attenuation design prior to reaching full capacity and full impact. If necessary, the landfill could be terminated at an earlier stage if the monitoring indicated that the impacts could be unacceptable, rather than implementing any of the following contingency measures.

Primary Contingency Plan

Low Permeability Final Cover

The current natural attenuation design of the site assumes infiltration rates and leachate production equivalent to the natural infiltration rate in the surrounding sandy soils. This is a conservative approach, but a practical one as well since there is no source of fine-grained (e.g., clay) soils on-site from which to construct a low-permeability final cover. (The cut and fill for the site have been balanced to provide for a sand final cover.) However, if unexpected leachate impacts were detected, then one straightforward solution would be to import fine-grained soils and/or synthetic membranes and construct a low permeability final cover (that could be progressively installed). This is technically feasible since there is experience with these types of covers at landfill sites all across Ontario.

A cover of this type could be easily several orders of magnitude lower in permeability than the sand cover currently proposed, this cutting infiltration and leachate production rates significantly. Infiltration rates as low as 5% or less of precipitation are being achieved in Ontario, compared to more than 40% currently assumed here. Such a reduction could achieve an order-of-magnitude better natural attenuation rate in the sub-basin, if necessary.

Secondary or Back-Up Contingency Options

Enhanced Natural or Artificial Wetland Treatment

The discharge of most of the ground water from the sub-basin into the lowlands at the base of the escarpment, prior to discharge to Maskinonge Lake, provides an ideal opportunity for wetland treatment. In fact, the benefits of the natural wetlands that currently exist were recognized in the siting and design of this landfill. However, further engineering work can be done to significantly enhance the attenuation capacity of these wetlands for leachate treatment, if it were required as a contingency. Additional constructed wetlands could also be developed here. This technology is being proven in many parts of North America currently, and there is considerable research and development underway in Ontario as well.

Leachate Re-Infiltration

Leachate re-infiltration would be a reasonable and viable contingency on a short-term basis or in conjunction with other contingencies noted above. Leachate could be collected at points of discharge, such as along the escarpment using french drains or other standard drainage works. Then, the leachate could be pumped back to the landfill footprint area and re-infiltrated via ponds, trenches or infiltration galleries. Leachate re-circulation can provide effective control for certain leachate types. Typical problems such as odours and visibility may not be an issue at this site because it is fairly isolated.

Collection and Treatment of Contaminated Water at the Base of the Escarpment

Similar to the leachate re-infiltration contingency discussed above, this technique would allow for the collection of leachate at easily accessible points of discharge below the escarpment using french drains or other collection drains. However, the leachate could instead be collected, probably in temporary holding tanks, then treated off-site. The Chalk River or Deep River Sewage Treatment Plants would likely be suitable treatment facilities, based on the successful experience with leachate treatment at other sewage treatment plants in the province. However, purpose built treatment or pre-treatment systems, either on-site or off-site, are also technically viable with current technology.

Pumping and Treatment of Contaminated Ground Water from Purge Wells

Purge wells are a proven method of removing contaminated ground water for treatment at landfill sites. The uniform characteristics of the surficial sand deposit at this site should lend itself to

effective purge well design, although numerous wells might be needed because of the high permeability of the unit. On the other hand, only partial removal of the leachate might be needed to allow the natural attenuation concept to return to its designed function. In terms of treatment, the discussion above regarding use of the sewage treatment plants, or purpose-built treatment or pre-treatment also applies here.

9.2 CONTINGENCY PLANS RELATED TO LANDFILL GAS

It is considered unlikely that landfill gas impacts would ever occur at this site, because of its relatively remote location and since the permeable sand soils surrounding the waste and in the cover will allow free venting of the landfill gases. On-site enclosures will be designed to be free-venting.

However, if there ever was a need to control lateral movement of gases from the landfill, then perimeter trenches excavated to at least 2 m in depth (i.e., below the frost depth) or to the depth of the seasonally low water table, lined with filter cloth and backfilled with coarse stone would serve to cut-off and vent lateral gas migration. The tops of the trenches would have to be free-venting (i.e., extend the stone to surface) or riser pipes would be needed. This technology has been used extensively at Ontario landfills and it is therefore well proven.

9.3 OTHER CONTINGENCIES

Other operational contingencies that may be employed, if necessary, include:

a) Litter fencing near the working face if blowing litter cannot otherwise be controlled or collected.
b) Pest control if insects or rodents become a significant problem.
c) The use of electronic fencing if bears become a serious problem.
d) Short-term contract or sub-contract of additional equipment if there are break-downs.

10.0 SITE CLOSURE AND END-USE

After the site has reached its full capacity within approximately 25 years, it will be closed. Site closure will include removal of the attendant shelter and entrance signage. The final cover will be completed and any remaining working areas will be re-graded and vegetated, as required. Fencing and gates will remain along with the "No Trespassing" signs around the perimeter of the site. A sign will be posted near the main gate indicating that the landfill site is closed and providing a contact name/phone number in case of complaints or emergencies.

Ground water and surface water monitoring programs will continue well into the closure and post-closure period to ensure the performance of the natural attenuation processes. However, since a large and lengthy data base will have been compiled by that time, it may be feasible to reduce the extent of the monitoring program, with agreement from the MOEE and the SLC. The monitoring will not be discontinued until the leachate strength has been shown to have declined to the point where it is no longer capable of causing an impact if it were to discharge directly to surface water around the landfill.

The current plan for the end-use of the site will be passive open space with restricted access.

A formal closure plan will be prepared for the site at least six months prior to the actual closure date for approval by the Ministry of the Environment. The Board will consult with the Site Liaison Committee in the development of the closure plan.

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