LANDFILL CONTAMINATION

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INTRODUCTION



Who we are.

DST is a multi-disciplinary engineering firm with a service capability that covers a range of comprehensive engineering and consulting projects.

- Geotechnical Engineering Services
- Environmental Services
- Blast Consultation Services
- Building Environmental Services





Local advantage.

- Conveniently located across Canada including offices in Northern Ontario
- The DST-Englobe team is comprised of over 2000 professionals including registered engineers and geoscientists in all provinces and territories.
- The Thunder Bay office is a full service operation with a staff of over 40 qualified and experienced professionals.



Outline

- What is a landfill?
- Typical Landfill Contaminants
- Leachate Generation
- Landfill Gas
- Landfill Nuisance Factors
- Landfill Regulations
- Case Studies



What is a Landfill

Ontario Regulation 347 Definitions:

- Landfill Disposal of waste by deposit, under controlled conditions, on land, and includes compaction of the waste into a cell and covering the waste with cover materials at regular intervals
- *Municipal Waste* any waste, except, hazardous waste, liquid industrial waste, or gaseous waste
- *Hazardous waste* industrial, acute waste chemical, severely toxic, ignitable, corrosive, reactive, radioactive, pathological, leachate toxic waste, or PCB waste,



Landfill Types

Natural Attenuation Landfills

- constructed over natural geological materials (natural clay, sand, silt soils)
- Leachate managed by monitored natural attenuation in subsurface soils

Engineered Liner Landfills

- Liners made out of geotextile, geomembranes, geosynthetic clay, compacted clay or other low-permeable engineered barrier
- Leachate collected through a series of pipe networks and pumped into treatment facilities

Shared Features

- Engineered Cover low permeable covers to limit infiltration / leachate generation
- Surface Runoff Diversion perimeter ditches used to carry "clean" water away from landfill to limit infiltration / leachate generation



Natural Attenuation Landfill



Photo Credit: AC Waste Services Inc. "Efficient Waste Management"

• No liners or leachate collection

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- Natural processes degrades leachate Dilution (diffusion and dispersion) Adsorption Ion exchange Precipitation Biodegradation
- Filtration Vegetative Cover
- Long-Term monitoring plans (20 to 25 years post-closure) track effectiveness of natural attenuation



Natural Attenuation Landfill

- Most landfills in Northern Ontario are classified as "natural attenuation" sites
- Contaminant Attenuation Zone
- Economic and geographic factors
 - Municipal financial resources limited
 - Natural attenuation sites simpler to operate
 - Adjacent land often available for development of a "Contaminant Attenuation Zone"
 - Fewer competing land uses
- Operational method depends on site size, hydrogeology
 - Excavated trenches
 - Above grade fill area



Engineered Liner Landfill



- Engineered Liners
- Leachate Collection & Treatment
- Engineered Vegetative Cover
- Long-Term monitoring plans (20 to 25 years post-closure) track effectiveness of liner systems

Photo Credit: Jason Feathers. "Landfill: A Waste Containment Facility"



Engineered Liner Landfill

- Ontario's Large Municipal Landfills use Engineered Liners (in new cells)
- Economic and geographic factors
 - Municipal financial resources available
 - Engineered sites are more complex to maintain and operate
 - Constructed when adjacent land not available for a "Contaminant Attenuation Zone"
- Operational method depends on site size, hydrogeology, availability of utilities and supply of engineered materials



Typical Landfill Contaminants

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Leachate Generation



What is Leachate

Definition:

- *Leachate* is any liquid that, in the course of passing through matter, extracts soluble or suspended solids, or any other component of the material through which it has passed
- If not properly managed, landfill leachate can cause significant adverse water quality impacts
- Landfills must be designed to minimize the risk of leachate impacts to off-site ground and surface water resources



Indicator Parameter List (O.Reg. 232/98)

Groundwater	Surface Water
Alkalinity, Ammonia, Nitrate, pH Suspended/Dissolved Solids, Sulphate	Alkalinity, Ammonia, Nitrate, Nitrite, TKN, pH, Phosphorus (Total), Suspended/Dissolved Solids, Sulphate
Barium, Boron, Calcium, Chloride, Conductivity, Iron, Magnesium, Sodium	Chloride, Conductivity, Iron
Benzene, 1,4- Dicholorobenzene, Dichloromethane, Toluene, Vinyl Chloride	Benzene, 1,4- Dicholorobenzene, Dichloromethane, Toluene, Vinyl Chloride
BOD ₅ , COD, DOC, Phenol	BOD5, COD, Phenol
	Alkalinity, Ammonia, Nitrate, pH Suspended/Dissolved Solids, Sulphate Barium, Boron, Calcium, Chloride, Conductivity, Iron, Magnesium, Sodium Benzene, 1,4- Dicholorobenzene, Dichloromethane, Toluene, Vinyl Chloride BOD5, COD, DOC, Phenol

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Landfill Leachate Quality

- Highly variable
- Affected by waste type and cover material
- Typically leachate has the following composition
 - Alkalinity
 - Boron
 - Calcium
 - Chloride
 - Copper
 - Iron
 - Magnesium
 - Manganese
 - Sulphate
 - Sodium
 - Potassium
 - Zinc





Leachate Plume in Sand Developed Over 35 years



Figure 9.25 Plume of leachate migrating from a sanitary landfill on a sandy aquifer; contaminated zone is represented by contours of Cl⁻⁻ concentration in groundwater.



Picture Credit: Groundwater. Freeze, R.A. and Cherry, J.A., 1979

Landfill Gas



What is Landfill Gas?

Ontario Regulation 347 Definitions:

- Landfill Gas Gas produced by the natural biodegradation of organic waste
- Typically emitted to the atmosphere through the landfill cover or after migrating for some distance in the soil below ground surface. Major constituents – methane (CH4) and carbon dioxide (CO2). Small amounts of other compounds such as hydrogen
- Major constituents methane (CH4) and carbon dioxide (CO2). Small amounts of other compounds such as hydrogen
- Minor constituents hydrogen sulphide, mercaptans and non-methane organic
- Landfill gas poses an explosion hazard if it becomes trapped in enclosed spaces at concentrations ranging from 5 to 15 % by volume.



Landfill Gas Limits

Ontario Regulation 232/98:

- less than 2.5 percent methane gas in the subsurface at the property boundary,
- less than 1.0 percent methane in an on-site building, or its foundation, and
- less than 0.05 percent methane (i.e. not present) in a building, or its foundation, which is located off-site

Special Note: monitor for accumulation in utility corridors and leachate management pipes / containment.



Landfill Gas Controls

Ontario Regulation 232/98:

- For small landfills, Contaminant Attenuation Zone can also be used as a buffer area for landfill gas
- Annual monitoring shall be conducted to assess potential for landfill gas migration
- Contingency plans required to manage landfill gas
- O.Reg. 232/98 requires the mandatory collection of landfill gas for sites with a total waste disposal capacity greater than 1.5 million cubic metres (2.5 million tonnes) of waste.



Collection Treatment & Use



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Picture Credit: epa.gov/Imop.basic-information-about-landfill-gas

Landfill Nuisance Factors



Odours, Dust and Smoke





Picture Credits: https://www.scoop.it/topic/landfill-pollution The Goshen News, April 26, 2017



Vector – Wind Blown Litter



Picture Credits: https://www.mwatoday.com/news/green-tips/knot-them-before-you-toss-them.aspx http://www.mettatechnologies.com/BULL.html



Vermin – Animal Transported Litter



Picture Credits: https://www.dailymail.co.uk/news/article-2704876 https://www.cbc.ca/news/canada/north/bears-stalk-landfills-in-whati-inuvik-hay-river-1.2655807



Strategies for Minimizing Nuisances

- Bury waste and apply daily interim cover soil
- Avoid burning waste where possible
- Divert organics, recycling, tires, electronic waste, HHW from general refuse and arrange for off-reserve disposal
- Apply final cover to landfills that have achieved their waste quantities (cover sequencing)
- Other Strategies:
 - Odour misters
 - Litter fences
 - Bear bangers
 - Raptor Controls



Regulatory Regime



Landfill Regulations

Planning Guidelines

- Environment and Climate Change Canada (ECCC), Solid Waste Management for Northern and Remote Communities
- Indigenous Services Canada (ISC), Technical Guide for Consultants Developing Solid Waste Management Plans

Permitting

- C.R.C. c. 960 Indian Reserve Waste Disposal Regulations
- MECP Environmental Compliance Approval / EASR

<u>Funding</u>

- ISC, First Nations Waste Management Initiative
- ISC, First Nations Infrastructure Investment Plans and Reports
- ISC, First Nation Infrastructure Fund



Landfill Regulations

Operations and Design Guidelines

- Regulation 347 General Waste Management (as amended)
- O.Reg. 232/98 New and Expanding Landfill Sites
- ISC, Design Guidance for Small-Scale Transfer Stations

Environmental Monitoring - Soil

- MECP Guidelines for Environmental Monitoring at Municipal Landfill Sites
- CCME National Guidelines for Hazardous Waste Landfills
- CCME Canadian Environmental Quality Guidelines (CEQGs) Canadian Soil Quality Guidelines (SQGs) for the Protection of Environmental and Human Health
- O. Reg. 153/04 Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act



Landfill Regulations

Environmental Monitoring - Groundwater

- Health Canada Guidelines for Drinking Water Quality Summary Table
- Government of Canada Federal Interim Groundwater Quality Guidelines
- O. Reg. 169/03 Ontario Drinking Water Quality Standards

Environmental Monitoring – Surface Water

- CCME Water Quality Guidelines for the Protection of Aquatic Life in Freshwater
- MECP Provincial Water Quality Objectives



LANDFILL CASE STUDY



Sandy Lake First Nation

Purpose Statement

- Sandy Lake First Nation has a population of approximately 2,900 members actively living on-reserve.
- Currently waste is disposed at the Active Landfill Site located approximately 5 km west of the community.
- A Scrap Metal Yard is also located approximately 3 km west of the community
- Objectives:
 - Summarize Solid Waste Management Planning activities
 - Summarize current condition of the Active Landfill and Scrap Metal Yard.
 - Present preliminary options for waste management.
 - Recommend factors for evaluating solid waste management options.



Background

Active Landfill

- It has approximately 30,400 m³ within an estimated area of 1.05 hectares
- This has been used as the community dump for the last 40 years.
- The landfill was expended toward the west side. The east portion of the landfill has been established for 40 years, the west portion was established approximately 20 years ago.
- All types of waste have been dumped here, including but not limited to household waste, medical/clinical waste, electrical waste, hazardous waste, construction and demolition debris.
- There has not been any management or organizing of the waste on site.
- Garbage is burnt on site during November to March every year.





Scrap Metal Yard

- It has approximately 5,400 m³ of scrap metal (360 to 400 vehicles) within an estimated area of 1.05 hectares
- The vehicle/scrap metal yard was first used as a waste disposal site from the 1980s to 1990s, including household waste, metals, plastics, and organic material.
- In the early 1990s, the wastes were covered with native soil.
- It has been used as a vehicle/scrap metal yard since the 1990s, even though people would still dump household waste here from time to time.

Solid Waste Management Plan

- In February 2019, DST entered into an Agreement with Sandy Lake First Nation to prepare a solid waste management plan for the community
- Planning Activities included:
 - Background Review Completed March/April 2019
 - Detailed Site Investigation Field Work Completed May 2019
 - Prepare Solid Waste Management Plan Report (Draft October 2019)



Detailed Site Investigation

- Conducted at Active Landfill Site and Scrap Metal Yard.
- Provides a snapshot of environmental conditions.
- Twelve test pits ranging from 4 m to 6 m deep.
- Six boreholes ranging from 3.8 m to 8.8 m deep.
- Six monitoring wells installed.
- Hydraulic Conductivity Testing.
- Soil, groundwater and surface water samples collected.



Disclaimer

- Preliminary information available.
- Limited based site conditions and number of sample points.
- Data provided is initial snapshot. Not comprehensive

Detailed Site Investigation

<u>Test Pit Results</u>

- Ground Surface to 2 4 m bgs Waste.
- Under Waste to 6 8 m bgs Native clay.

Soil Analysis Results

- One location (LFBH₃) at Active Landfill showed PHC impacts.
- Limited to within landfill limits

Groundwater Analysis

- One location (LFBH₃) showed inorganic metal impacts
- TDS and manganese impacts observed as well
- Scrap metal yard showed metal, TDS and nitrite impacts.
- No evidence impacts outside Landfill and Scrap Metal Yard Limits other than DTS and Manganese.

Surface Water Analysis

- Surface water showed metal impacts.
- Cannot yet be attributed to landfill operations. May be common in Sandy Lake.



Active Landfill



Scrap Metal Yard

What is a Solid Waste Management Plan (SWMP)?

- Describes how Solid Waste will be handled within the community.
- Waste generation projections.
- Waste streams.
- Risks and Priorities.
- Describe and evaluate options.
- Active Landfill
 - Option 1 Landfill Engineered Landfill Cells within Existing Area; Continue Landfilling.
 - Option 2 Landfill Engineered Landfill Closure; Landfill in New Area.
- Scrap Metal Yard
 - Option 3 Scrap Metal Yard On-Reserve Scrap Metal Processing and Off-Site Transportation of Scrap Metal
 - Option 4 Scrap Metal Yard Off-Reserve Transportation and Processing of Scrap Metal.
 - Provides recommendations based on community needs and inputs.

Evaluation Factors

- Environmental Risk
- Complexity of the Option (Ease of Implementation)
- Annual Reporting Requirements
- Community Involvement
- Community Disruption
- Cost of Option
- Other Factors?

Next Steps

- Present most favourable options to the Chief, Council & Community
- Finalize SWMP and DSI and submit.



LANDFILL CASE STUDY



Kiashke Zaaging Anishinaabek (KZA)

Purpose Statement

- Kiashke Zaaging Anishinaabek (KZA) Gull Bay First Nation has a population of approximately 1,394 of which 386 actively live on-reserve.
- On-reserve population expected to grow by 24% (over 460) residents over next 20-years.
- Currently waste is disposed at the Active Landfill Site.
- Objectives:
 - Assess current condition of the Active Landfill.
 - Summarize condition of on-reserve waste management.
 - Prepare 20 year waste generation estimates.
 - Develop options for waste management.
 - Recommend the most favourable option.





Background

The Active and Old Landfills are located approximately 1 km southwest of the KZA community. The landfill sites are located between Gull Bay of Lake Nipigon and the Gull River and are essentially open clearings in the forest.

Old Landfill

- Historically used between 1950 to 1960.
- Known to contain mostly metal debris but has since grown over with vegetation and mature trees.

Active Landfill

- Waste is collected curbside by KZA community members on a weekly basis.
- Accessible to all residents, with no fence or gates.
- No attendant onsite and residents can place their own waste.
- Waste burning.



Detailed Site Investigation

- Conducted at Active Landfill Site and Old Landfill Site.
- Six test pits ranging from 4 m to 6 m deep.
- Ten boreholes ranging from 3 m to 9.8 m deep.
- Five monitoring wells installed.
- Hydraulic Conductivity Testing.
- Soil, groundwater and surface water samples collected.



Detailed Site Investigation

Test Pit Results

- Ground Surface to 4.4 m bgs sand/silt fill and waste.
- 1.8 m to 4.6 m bgs native clay silt.
- 5.0 m to 6.1 m bgs bedrock

Soil Analysis Results

• No impacts above applicable criteria.

Groundwater Analysis

- Dissolved solids, sulphate, mercury, copper, manganese, zinc detected above criteria at source well BHMW7.2
- Copper and zinc detected in upgradient and downgradient wells.

Surface Water Analysis

• Iron detected above criteria upstream and downstream (naturally occurring).



Active Landfill TP2.



Old Landfill TP10B.

Off-Reserve Disposal Site Location

Options explored

- Armstrong Station Landfill Facility
- Municipality of Shuniah Landfill Site
- City of Thunder Bay Solid Waste and Recycling Facility
- R.A. Milne Aggregates Landfill

Recommended Option - R.A. Milne Aggregates Landfill.

- 183 km south of the reserve.
- Willing to enter into a Municipal Type Services Agreement (MTSA).
- Has landfill capacity.
- Tipping fee approx. \$60 per tonne.



On-Reserve Waste Management System

Options explored

- 1. Option 1 Landfill All Waste On-Reserve
- 2. Option 2 Transfer All Waste Off-Reserve
- 3. Option 3 Landfill Existing Waste and Waste Transfer Station for Future Waste



Options Scoring

Scoring: 1 (least favourable) to 5 (most favourable).

Option	Cost	Complexity	Ease of Implementation	Monitoring & Reporting	Opportunity for Community Involvement	Potential for Disruption	Potential for Environmental Risk	Score Total
Option 1	4	5	5	3	5	4	3	29
Option 2	3	5	5	3	5	4	5	30
Option 3	5	5	4	3	5	5	4	<u>31</u>

 Most Favourable = Option 3 Landfill Existing Waste and Waste Transfer Station for Future Waste

Next Steps

- KZA to comment and finalize plan.
- Design, permitting and tender.
- Construction Administration and Inspection.
- Operation & Maintenance.