Monitored Natural Attenuation Landfills for Remote Municipalities and First Nations Communities

Ali Williams, P.Eng.
Senior Civil/Environmental Engineer
WSP Canada Inc.

October 2, 2024

Section name

About WSP Canada Inc.

Leading Environmental Consulting Firm

Globally 23,000 professionals.

Earth & Environment 6,000 talented experts

WSP recently acquired Golder and Wood to become the leading consulting firm.

Guiding Principles

We value our people and reputation.

Locally dedicated, international scale.

Future focused, challenge status quo.

Foster collaboration.

Empowering and accountable culture.

First Nations Clients

Michipicoten

M'Chigeeng

Whitefish River

Aundek Ommi Kanning

Attawapiskat

- A Monitored Natural Attenuation (MNA) landfill is a recommended option for upgrading existing waste dumps in remote communities.
- Use natural processes in soil to reduce the concentration of landfill contaminants.
- Operations are a proven approach used for decades, cost effective, easy to construct, and accepted by regulators (ISC, federal, provincial and municipal).
- Require specific planning, design, the establishment of contaminant attenuation zones (CAZ), and involve long term monitoring programs.

Presentation Overview

1. Historic Observations
2. Define MNA
3. Regulatory Basis
4. Technical Planning
5. Design Concepts
6. Contaminant Attenuation Zone (CAZ)
7. Site Controls and Upgrades
8. Operational Opportunities/Challenges
9. Planning and Community Engagement
10. Questions

Part 1

Historic Observations of Waste Dump Sites in Remote Communities.

Part 1

Challenges with Existing Dump Sites

Uncontrolled Waste Placement

Waste placement not controlled or maintained

Spread out, not sorted

Waste not buried

Uncontrolled access

Public and animals can freely access the site

Vector and Vermin

Increase spread of litter by wind and animals

Part 1

Challenges with Existing Dump Sites

Waste Burning

Release of noxious substances

Litter Spread

Health and aesthetic impacts to adjacent properties

Environmental Impacts

Litter encroaches on waterbodies

Part 2

Define Monitored Natural Attenuation (MNA)

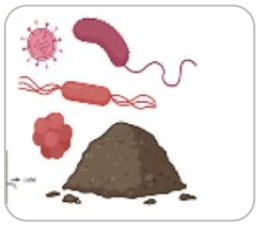
Part 2

What is Monitored Natural Attenuation (MNA)

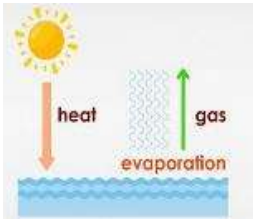
- Natural processes to decrease or “attenuate” contaminant concentrations.
- Environmental scientists monitor site regularly to make sure MNA is working.
- Monitoring involves collecting and analyzing soil and groundwater samples at regular frequencies (quarterly, semi-annually, annually).
- Monitoring data is used to either confirm MNA is working or initiate contingency remediation techniques to meet environmental standards.
- This entire process is “monitored natural attenuation”.

Part 2

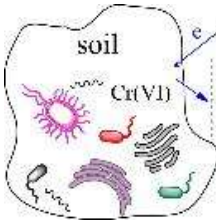
MNA Natural Processes



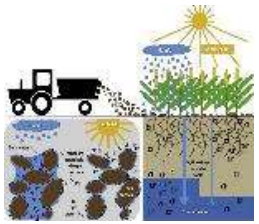
Biodegradation



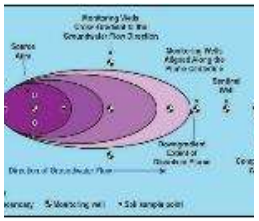
Evapotranspiration



Soil Chemical Reactions



Sorption



Dispersion

Part 2

MNA Strengths and Challenges

Strengths	Challenges
Long established technical basis. Long history of use.	Long-term remediation (years).
Best for site with low-level, localized environmental impacts.	Effectiveness depends on natural environmental conditions.
Cost-effective with respect to construction.	Long-term monitoring program. Finding trained staff to operate and monitor the site. Finding sufficient funding source.
Easy to implement.	Regular environmental sampling (quarterly, semi-annual, or annual).
Low risk when used in the appropriate setting.	Environmental conditions can change and are hard to predict

Part 3

Regulatory Basis

Part 3

Regulatory Documents

Federal

- Solid Waste Management for Northern and Remote Communities, Planning and Technical Guidance, March 2017.
- Guidance Document on Monitored Natural Attenuation for Soil and Groundwater Remediation, amended November 23, 2021.

Provincial (Ontario)

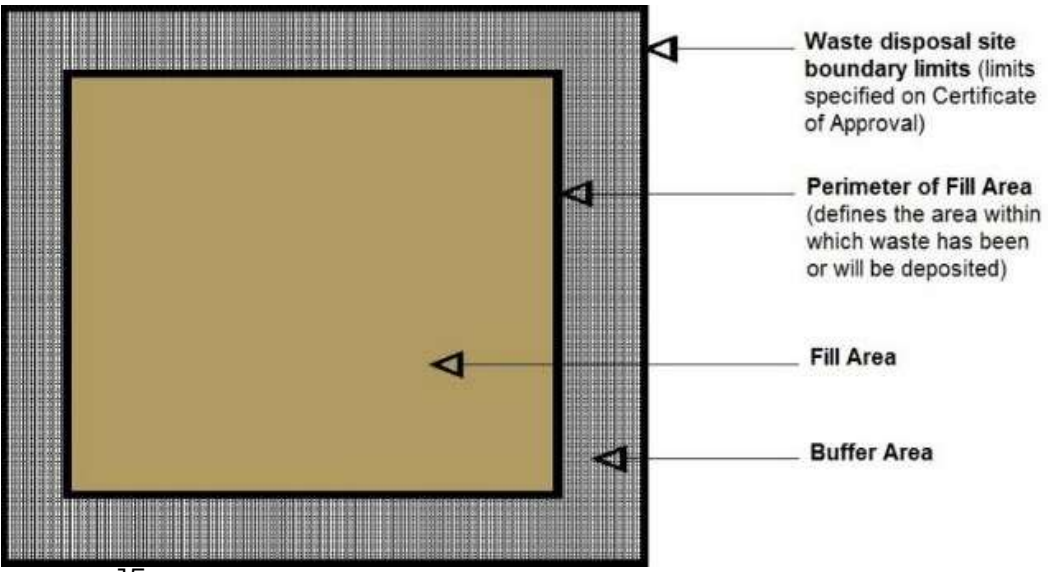
- Regulation 347, Part V of the Environmental Protection Act.
- Ontario Regulation 232/98 (as amended) and Landfill Standards: A Guideline on the Regulatory and Approval Requirements for New or Expanding Landfill Sites, January 2012.
- Guideline B-7 Incorporation of the Reasonable Use Concept into Ministry Groundwater Management Activities, April 1994.
- Procedure B-7-1 Determination of Contaminant Limits and Attenuation Zones.
- Guideline D-4 Land Use On or Near Landfills and Dumps, April 1994.

Part 4

Technical Planning

Part 3

Siting



Federal Technical Guidance, March 2017

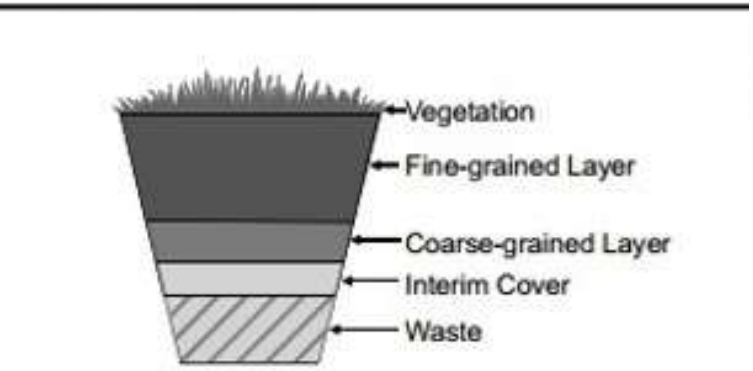
- Landfill base is about 1.5 m above the seasonal high groundwater level.

Ontario Guideline D-4 Land Use on or near Landfills and Dumps, April 1994

- Minimum 30 m buffer zone.
- Restrict placement adjacent to sensitive land uses (agricultural, animal husbandry, residential, cemeteries).
- Health/safety/risk studies within 500 m of a landfill.
- Extend the study zone beyond 500 m in exceptional conditions.

Part 3

Sizing



Capacity

- The amount of waste to be disposed.
- The amount of daily and interim cover soil used.
- Measured in cubic meters.

First Nation Community Waste Generation Rate

- OFNTSC Waste Audits show that a typical person in a First Nation community disposes of 229 to 329 kg/person/year.
- Average 263 kg/person/year.

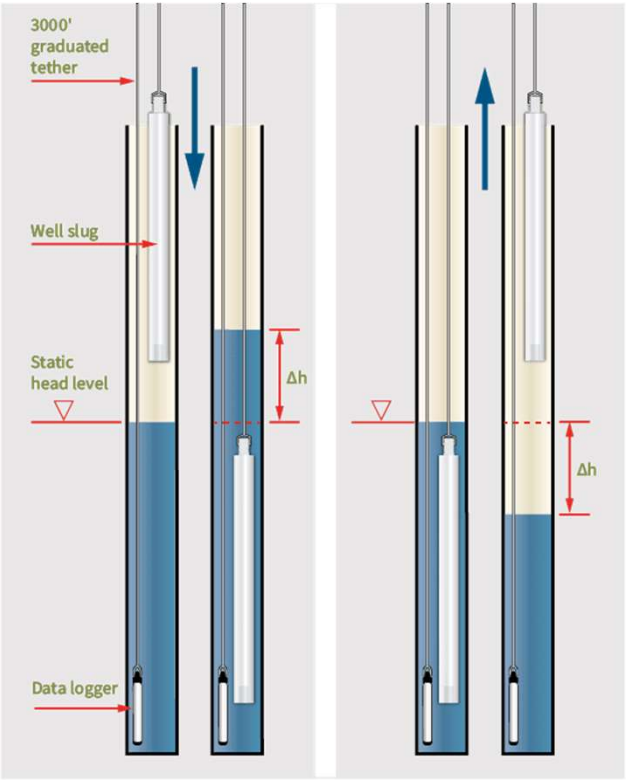
Part 5

Design Concepts

Part 5

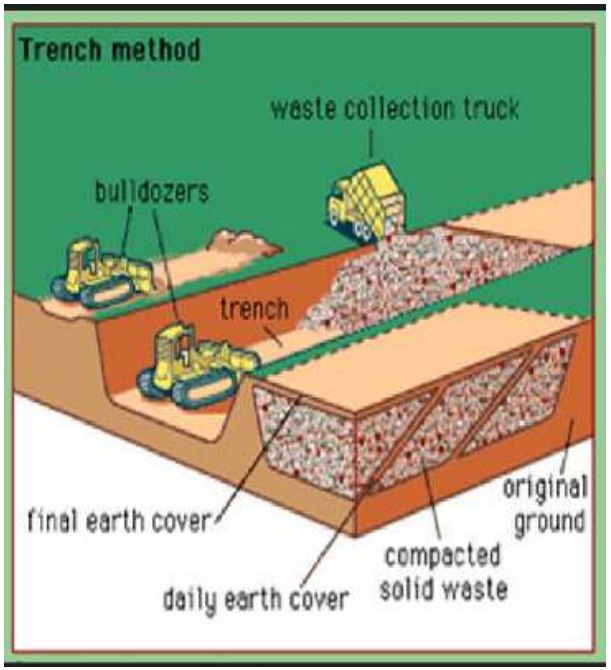
Soil Permeability

Soil type	Permeability k (m/sec)	Reducing permeability
Gravel	>0.1	
Sand	$0.1 - 10^{-4}$	
Silt	$10^{-4} - 10^{-8}$	
Clay	$<10^{-8}$	

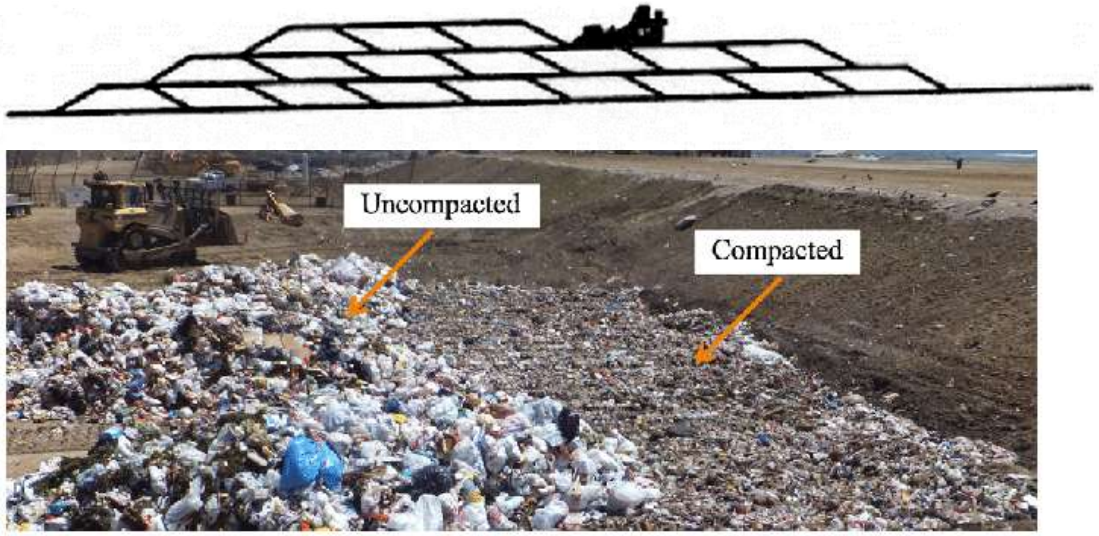


Part 5

Landfilling Methods



Below Ground: Trench Fill



Above Ground: Area Fill

Part 3

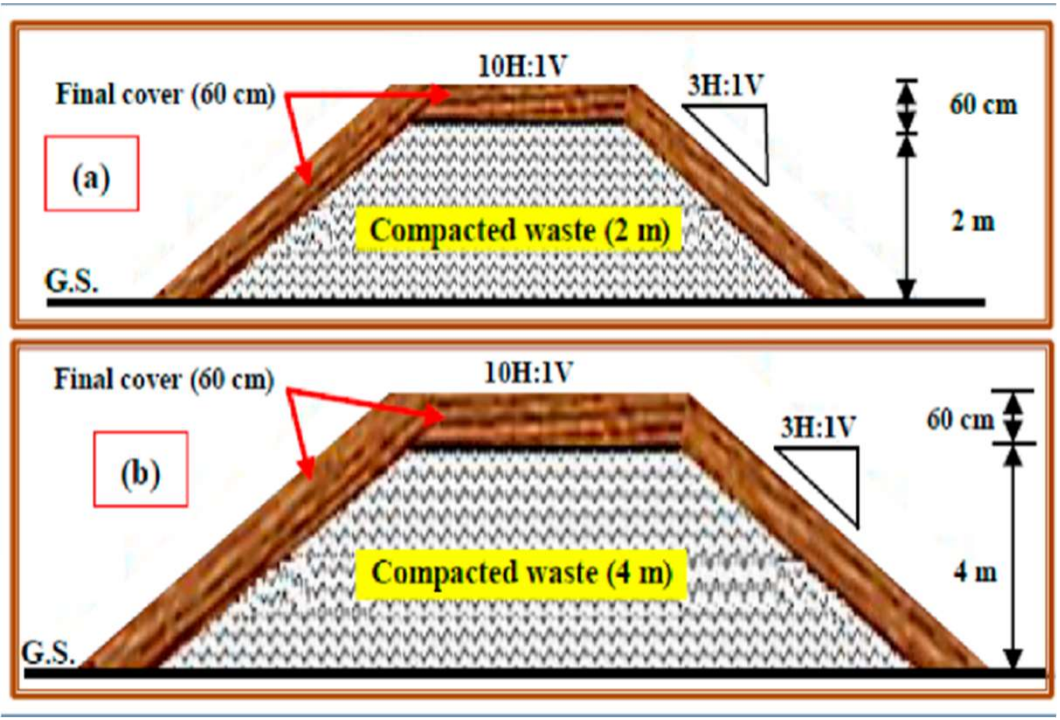
Buffer Zone

O.Reg. 232/98

- Buffer zone is part of the landfill site that is not waste fill area.
- Shall be at least 100 m wide at every point.
- Can be at least 30 m wide at every point if there is written justification that:
  - Adequate space for vehicle entry, exit, turning and parking.
  - Adequate space for all anticipated structures, equipment and activities.
  - Sufficient to ensure landfill does not have unacceptable impacts outside the buffer zone.

Part 3

Soil Cover



O.Reg. 232/98 Minimum Requirements

- 60 cm (2 feet) thick of low permeability cover soil.
- 15 cm (6-inches) thick of topsoil.
- Vegetative cover suitable to local conditions.
- Landfill side slopes typically 3 horizontal to 1 vertical or flatter (above ground)
- Landfill top slopes at a 5% grade from shoulder to peak.
- 4:1 volume ratio of waste to daily/intermediate soil cover.

Part 6

Contaminant Attenuation Zone (CAZ)

Part 6

Definitions

Disposal Site

- Disposal Site: Areas that receive waste (including the buffer zones).

Contaminant Attenuation Zone (CAZ)

- Property designated to allow the natural attenuation of contaminants from the disposal site so that it does not impact the reasonable use of the adjacent property.

Adjacent Property

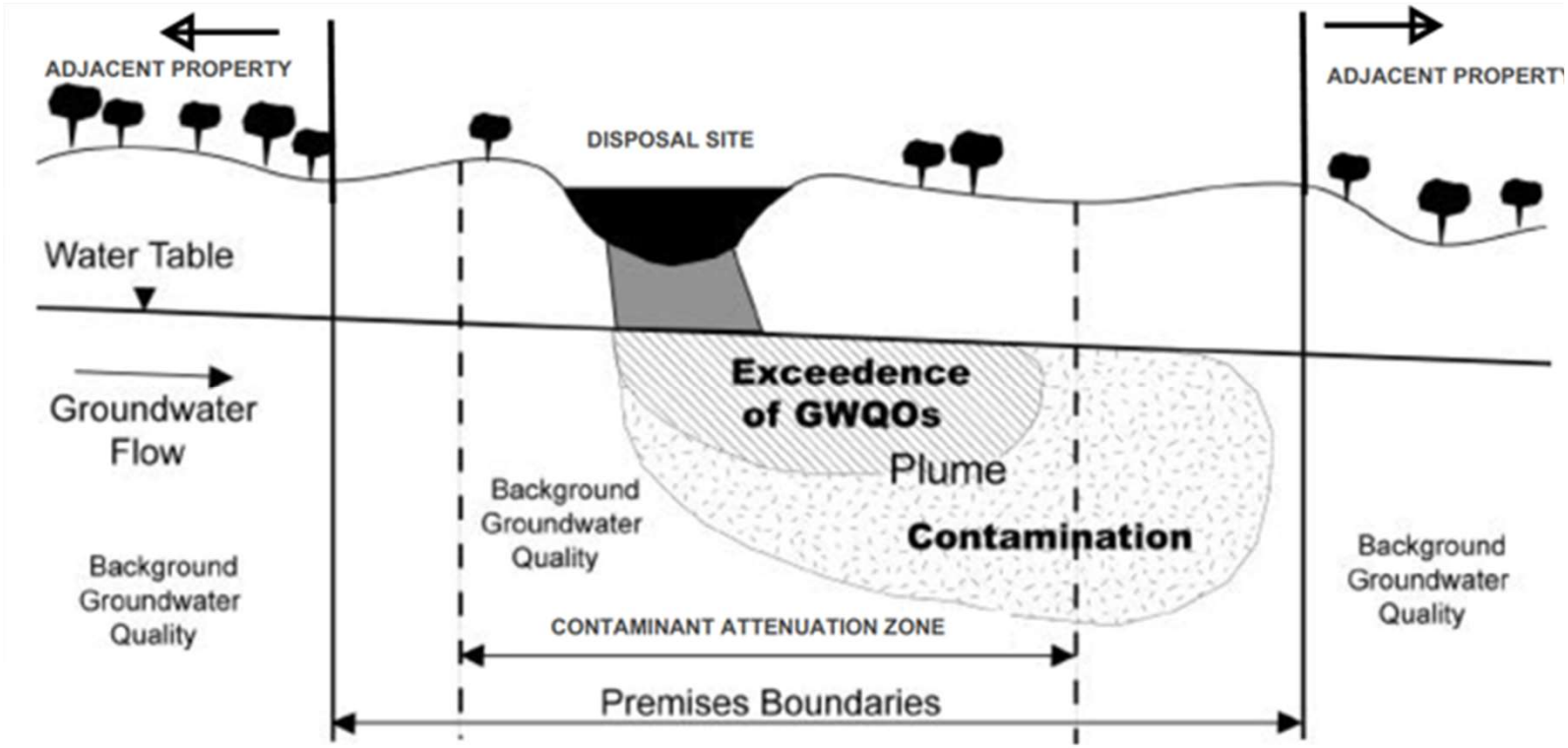
- Land bordering the disposal site or the CAZ

Groundwater Quality Objectives (GWQO)

- Provincial based numerical standards representing satisfactory concentrations of chemicals protective of surface or ground water.

Part 6

CAZ Conceptual Model



Part 6

Good Neighbour Rules

Guideline B- 7 – Incorporation of the Reasonable Use Concept into Ministry Groundwater Management Activities, April 1994

Procedure B-7-1 – "Determination of Contaminant Limits and Attenuation Zones"

- Landfills designed to meet contaminant limits at the property boundary.
- The Ministry's Reasonable Use Guideline sets limits for the allowable concentrations of contaminants based on background groundwater quality and the reasonable use of groundwater on adjacent property.
- The limits are set such that there would not be any significant effect on the use of the groundwater on the adjacent property.

How to Determine a CAZ

1. Current/future GW use
2. Current/future land use
3. GW quality/quantity
4. Leachate quality/quantity
5. Maximum Concentration at property boundary (receptor)
6. Maximum Concentration in landfill waste limits (source)
7. Attenuation capacity and distance
8. Determine CAZ based on attenuation distance in direction of GW flow.

Determination of Groundwater Attenuation Distances for Municipal Landfill Sites, 1995

Part 7

Site Controls and Upgrades

Part 7

Engineering Upgrades

Consolidate

Compact

Cover
(Daily & Interim)

Part 7

Operations Upgrades

Clean Up Litter

Control Access

Control Operations

Part 7

Operations Upgrades

Environmental Monitoring

Track Waste Placement

Progressive Capping and Closure

Part 7

Public Drop Off

Part 8

Operational Opportunities & Challenges

Part 8

Operational Opportunities and Challenges

Operations Item	Opportunity	Challenge
Landfilling	› Convenient central location. › Uncomplicated technology and methodology. › Improves community housekeeping.	› Consistent funding. › Requires regular staff and proper resources. › Consistent, day-to-day, action. › Proper siting and capacity design to take advantage of MNA.
Staffing	› In-community training and employment opportunity. › Trained staff can tremendously improve conditions.	› Initial investment required. › Periodic training (every 5 years min.). › Consistent funding.

Part 8

Operational Opportunities and Challenges

Operations Item	Opportunity	Challenge
Waste Tracking	› Know capacity. › Quantify remaining site life. › Confirm proper placement of waste.	› Annual topographic surveys and grade control staking. › Requires technical consistency › Temptation to skip for cost cutting on inconvenience.
Waste Compaction	› Lower waste footprint. › Increase landfill capacity. › Increase Site life.	› Challenging to achieve a set waste density. › Involves proper staffing, equipment, training and consistency.

Part 8

Operational Opportunities and Challenges

Operations Item	Opportunity	Challenge
Daily, Interim and Final Cover Placement	› Improve landfill appearance. › Reduce wind and animal litter spread. › Odour management. › Limit leachate generation.	› Local cover material sourcing › Engineered cover materials can be expensive to import. › Limited infiltration can extend site life › Improper placement can lead to drainage issues and loss of capacity.
Perimeter Housekeeping (Berms and Fencing)	› Berms/fencing can improve appearance › Control site access › Manage litter	› Weather degradation / erosion › Difficult to deploy in remote areas › May need electrical fence to aid in animal access controls

Part 8

Operational Opportunities and Challenges

Operations Item	Opportunity	Challenge
Environmental Monitoring	› Tracks MNA performance › Identify potential impacts › Early warning trigger to implement contingency measures	› Frequent (quarterly, semi-annual) › Annual reporting recommended › Continues through post-closure › Conditions may change requiring contingency plans

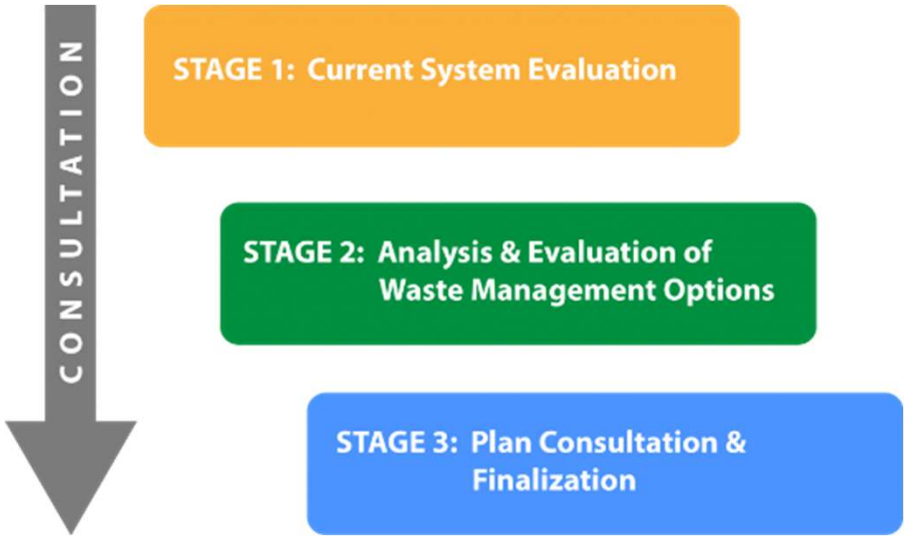
Part 9

Solid Waste Management Plan & Community Engagement

Part 8

Solid Waste Management Plan

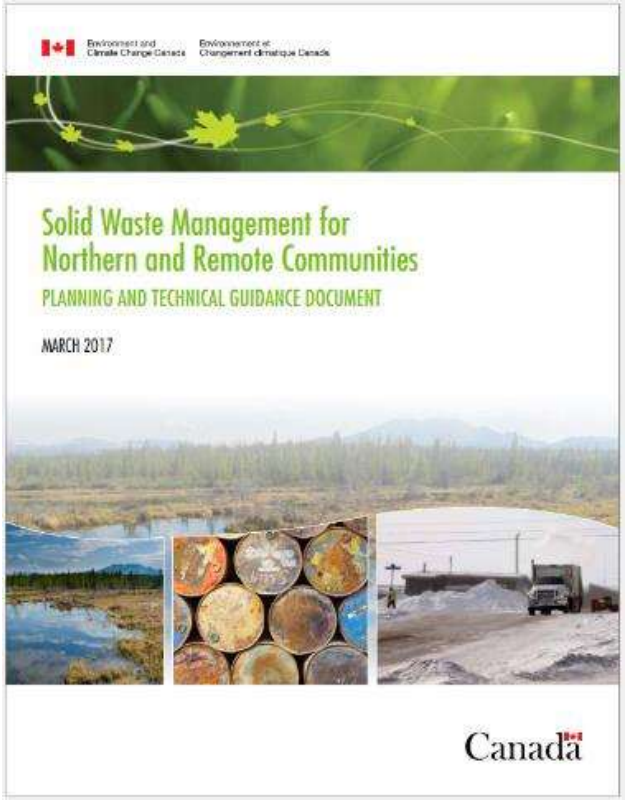
- Fulfill the community specific Terms of Reference
- Provide a guideline for community's use
- Support approval and funding requests



Part 8

Solid Waste Management Plan

- Cost of operation
- Complexity of the Option
- Ease of Implementation
- Annual Reporting Requirements
- Community Involvement
- Community Disruption
- Environmental Risk



Part 8

Community Engagement

Part 10

Questions?

WSP Canada Inc.

About us

We make extraordinary efforts to retain the best professionals and put the highest ethical standards at the centre of all we do

Dedicated to our local communities and propelled by international brainpower.

We know our solutions will shape the communities of tomorrow and help societies thrive sustainably.

We embrace change.

We understand that great achievements come from collaboration.

We are empowered to achievements be client-focused, agile and responsive while at the same time being accountable to our clients and peers.

Contact Information

Ali Williams, B.Sc., P.Eng. (He/Him)

Senior Civil/Environmental Engineer

Email: Ali.Williams@wsp.com

Phone :+ 1 548-255-4055

WSP Canada Inc.
900 Maple Grove Road, Unit 10
Cambridge, ON N3H 4R7 Canada

Thank you

wsp.com