


# Freezeback Landfill Challenges with Increasing Temperature Models



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- Introduction
- Landfill Characteristics
- Regulatory Climate
- Status



# INTRODUCTION

- Travis Holmes, P.E.
  - Licensed Civil and Environmental Engineer
  - Focus on Water & Sewer and Sanitation Utilities
- Work of Note
  - Underground Utility work - 3 Winters in Point Lay, 3 Winters in Wainwright, 2 Winters in Utqiagvik
  - Ongoing support for NSB Utilities
  - Designs and Operational support for Class 1 and Class 2 Freezeback Landfills



# LANDFILL CHARACTERISTICS

- Landfills
  - Community related landfills regulated under EPA Title 40 Code of Federal Regulations:
    - Part 258 Criteria for Municipal Solid Waste Landfills
  - Engineered and managed facilities for disposal of solid waste.
  - Designed for specific waste streams
  - Must protect the environment from contaminants

- Landfills Classification

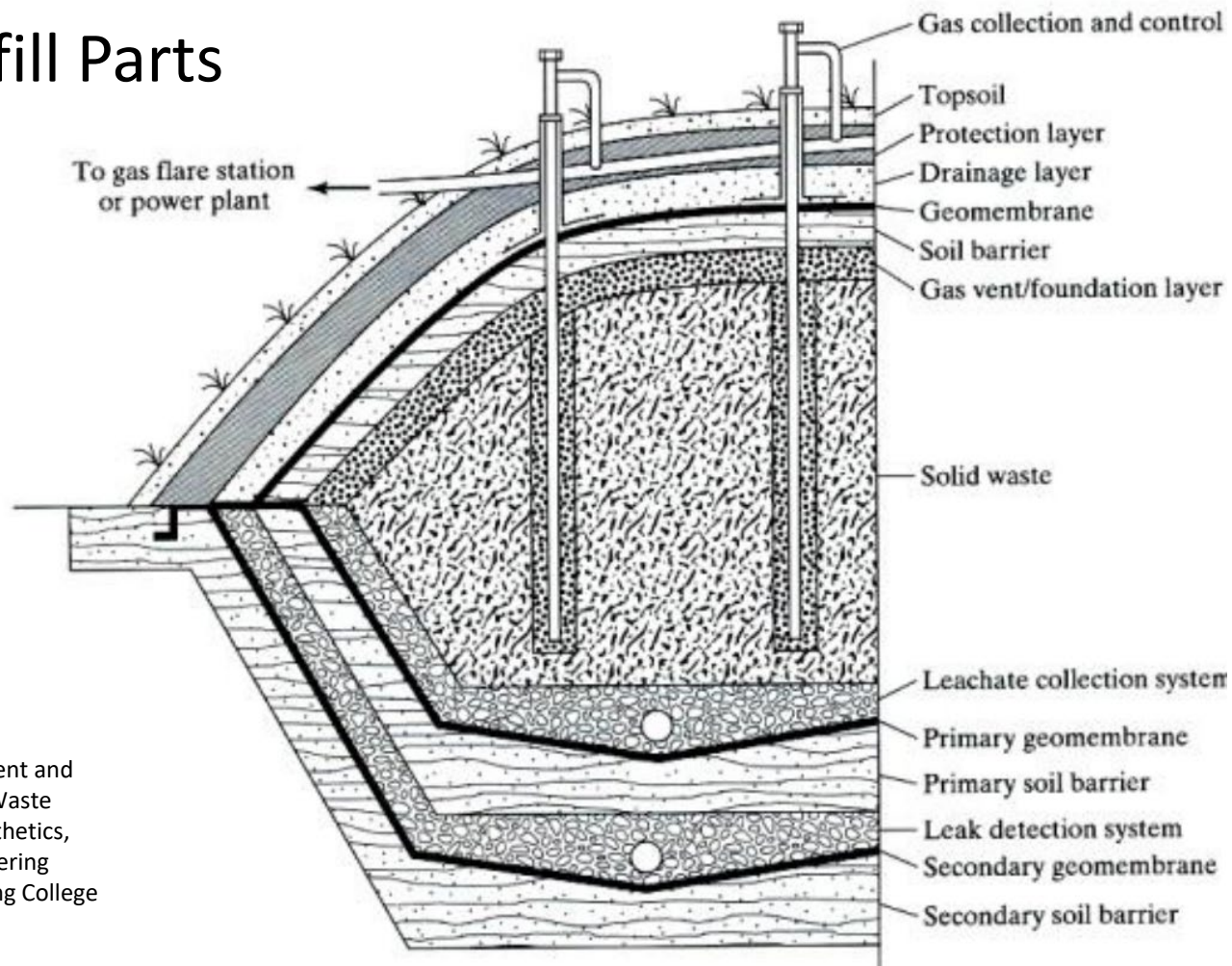
- Type of Waste

- Municipal Solid Wastes
    - Industrial
    - Hazardous Wastes

- Mass of Waste received daily

- Class 1 - > than 20 tons per day
    - Class 2 – 5 tons to 20 tons per day
    - Class 3 – up to 5 tons per day

- Landfill Parts



Source: Ground Improvement and  
Ground Control including Waste  
Containment With Geosynthetics,  
Department of Civil Engineering  
Guru Nanak Dev Engineering College  
Ludhiana, 2011



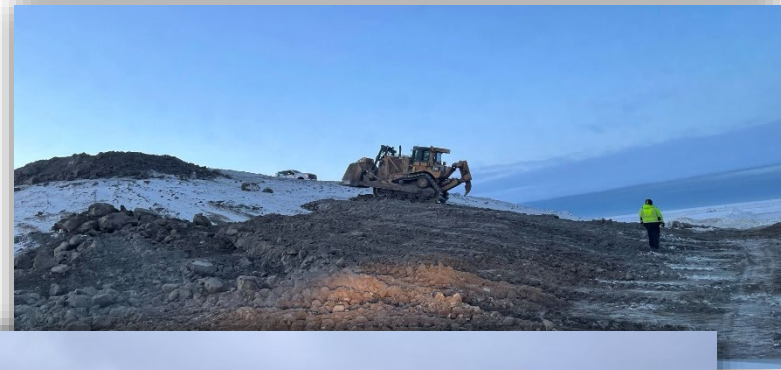
- Freezeback Landfills
  - On Permafrost soils
  - Defined by 18 Alaska Administrative Code 60.228 as
    - Landfills that are designed, developed and operated to prevent permafrost degradation and to ensure all the waste will freeze with the permafrost
    - After landfill closure, the waste will remain frozen.
    - Closed landfill must protect the underlying permafrost
  - Waste is intended to be encapsulated, and not decompose
  - Six Class 1, 2 & 3 Landfills were approved under these regulations

- Freezeback Landfills Exemptions
  - Containment liner
  - Leachate collection system
  - Ground Water Monitoring
  - Methane Collection System

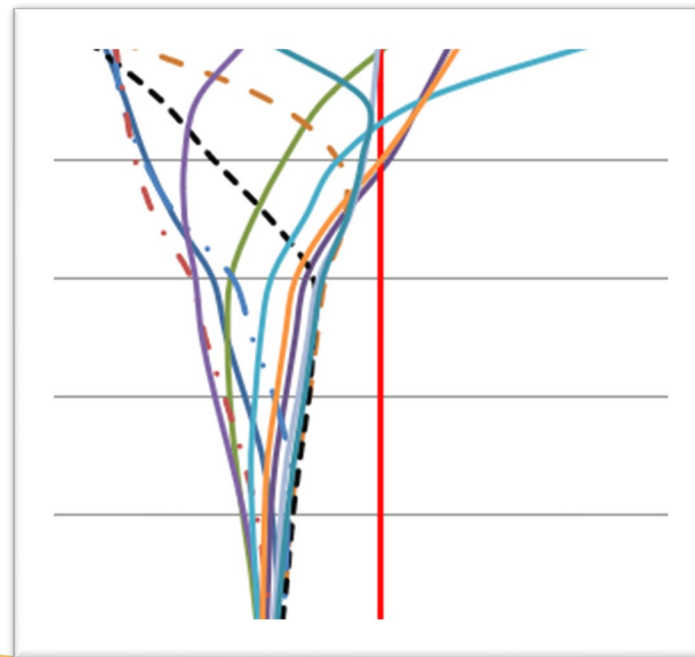
- Freezeback Landfill Characteristics
  - Thick gravel pad
    - Insulate permafrost to offset decreased albedo
    - Sloped to drain precipitation
    - No containment liners or leachate collection systems



- Freezeback Landfill Characteristics (cont'd)
  - Thick Closure Cap
    - Encapsulate and Insulate Waste and increase albedo
    - Shed precipitation and manage erosion
    - Low-permeability to prevent moisture intrusion and heat transfer
    - Soil types define cap thickness based on thermal properties
    - No membrane liner



- Freezeback Landfill Characteristics (cont'd)
  - Thermal Monitoring
    - Verification that waste remains frozen
    - Confirmation of cap thickness/insulative properties







# REGULATORY CLIMATE

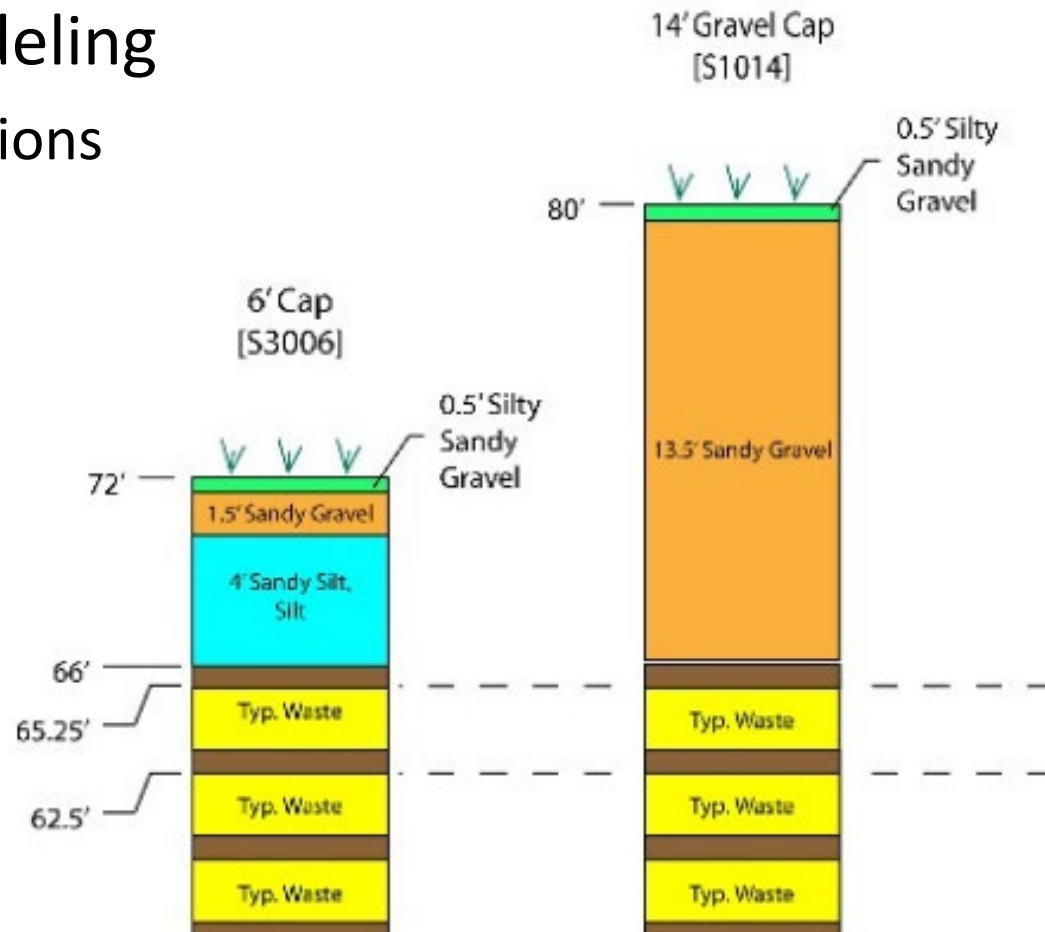
- Freezeback Landfill Authorizations Required
  - Planning
    - Service Area
    - Determine waste stream characteristics and waste generation
    - Define airspace volume and landfill life
    - How the landfill would be closed, used and monitored
  - Design
    - Pad Thicknesses
    - Containment structures
    - Slope Stability/Erosion Control
    - Site specific hazards: seismic, ground water, airports
    - Thermal stability

- Past Freezeback Landfill Authorizations
  - Required thermal modeling to prove permanently frozen waste was achievable.
    - Regulators did not set criteria on waste thermal models other than engineer to show wastes remaining frozen.
    - No climate models or period was prescribed by regulators.
    - Models were accepted that indicated permanently frozen with anticipated materials for closure.



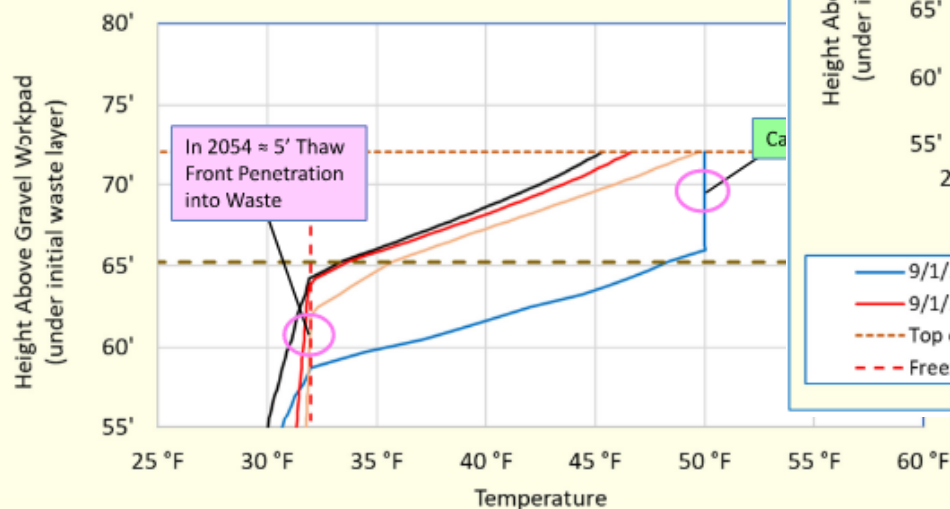
- Regulatory Change
  - 2017 ADEC announced by Public Notice intent to remove Freezeback Landfills from the regulations.
  - The Public Notice was rescinded, but the regulators increased scrutiny on landfill proposals.
  - Design Implications
    - The bar is <sup>HIGH</sup>
    - No climate forecast horizon is set
    - No prescription for temperature or precipitation models
    - Likely wise no upper limit for temperatures set
    - Confidence is low for 20 year models let alone 50 year or greater

- Thermal Modeling
  - Sample sections



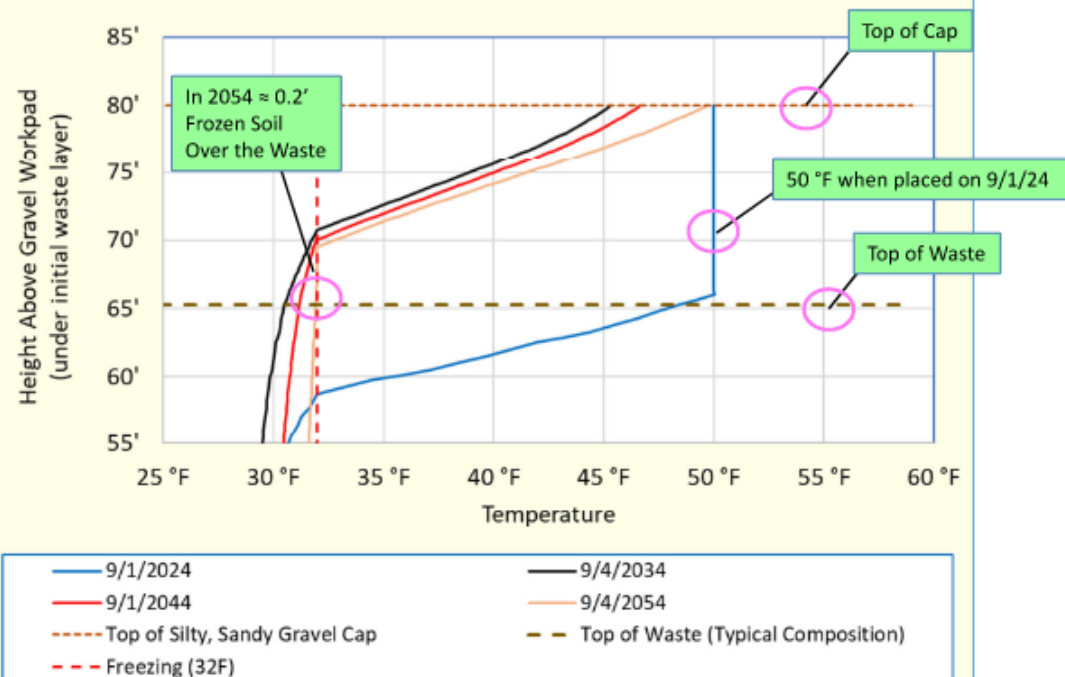
- Thermal Modeling
  - Sample Analysis

NSB Oxbow Landfill. Predicted Temperatures Profiles close to the top of the Cap: 0.5' Silty, Sandy Gravel over 5.5' Gravel



9/1/2024 9/4/2024  
9/1/2044 9/4/2054  
Top of Silty, Sandy Gravel Cap Top of Waste  
Freezing (32°F)

NSB Oxbow Landfill. Predicted Temperatures Profiles close to the top of the Cap: 0.5' Silty, Sandy Gravel over 13.5' Gravel



9/1/2024 9/4/2024  
9/1/2044 9/4/2054  
Top of Silty, Sandy Gravel Cap Top of Waste (Typical Composition)  
Freezing (32°F)



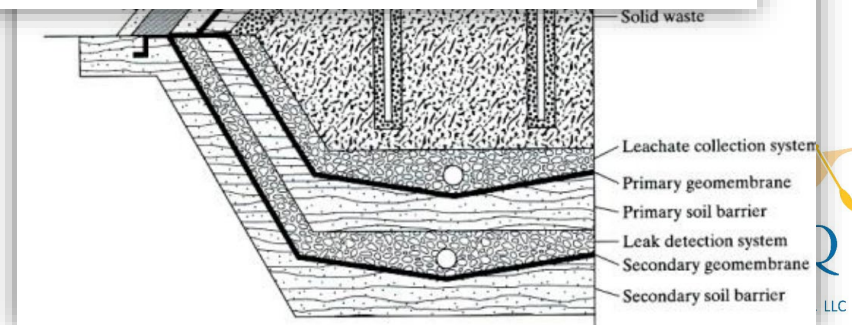
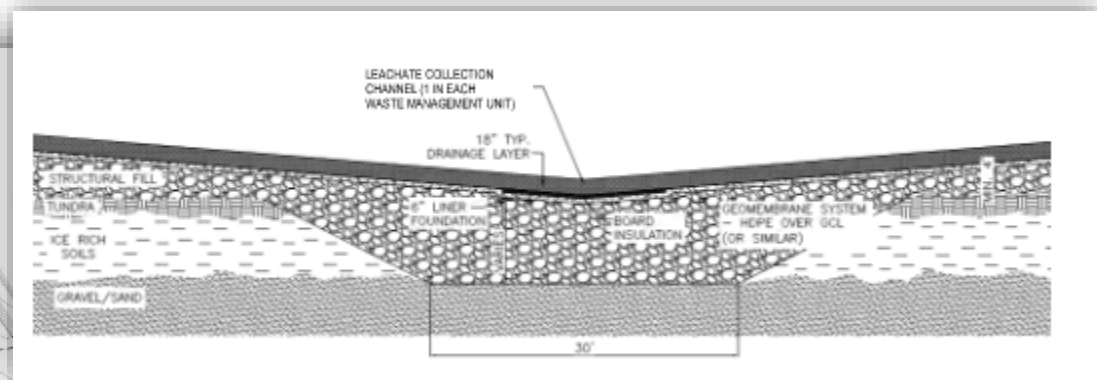
STATUS

- New Freezeback Landfills are virtually eliminated
  - New construction and expansion of landfills follow conventional landfill designs possibly overlapping two differing designs.
  - Operator are updating operating and closure plans in advance of the next permit renewal.

- Operations Impacts
  - New engineering to replace previously approved plans
  - Currently approved freezebacks may require engineering updates every 5 years to address new forecasted temperature data.
  - Uncertainty with shifting design requirements. Expectation is that the closure caps will continue to thicken
  - Facilities will operate and maintain both freezeback and conventional landfills. Both type of landfills are expected to be on the same sites, and possible overlap to maximize airspace usage.

- Design Changes (New Capital Costs)
  - Containment Liner Systems
  - Leachate Collection Systems (GCL&Membrane)
  - Ground water monitoring in permafrost
  - Methane monitoring required at closure

- Design Changes (New Capital Costs)
  - Operating pads thickness is expected to increase by ~50% to accommodate containment and leachate systems





- Operations (new operating costs)
  - Each new design element adds new inspection, monitoring and maintenance routines.
  - New training is required for O&M of new features
  - New laboratory testing is required for leachate

- Unmet Needs
  - The new leachate system creates a new waste stream to manage.
  - Infrastructure is not in place to treat or dispose of leachate in the region. Options include
    - WWTP if leachate is not hazardous
    - Reduction and reinjection into the landfill
    - Injection wells
    - Truck haul to an approved disposal site (viable on road system sites)
    - Barge shipping to lower 48.

- New Development and Operation Costs for Landfill
  - Are expected to increase landfill disposal rates
  - New rate case studies are necessary to capture costs of construction and maintenance involved

*Quyanaq!*

