

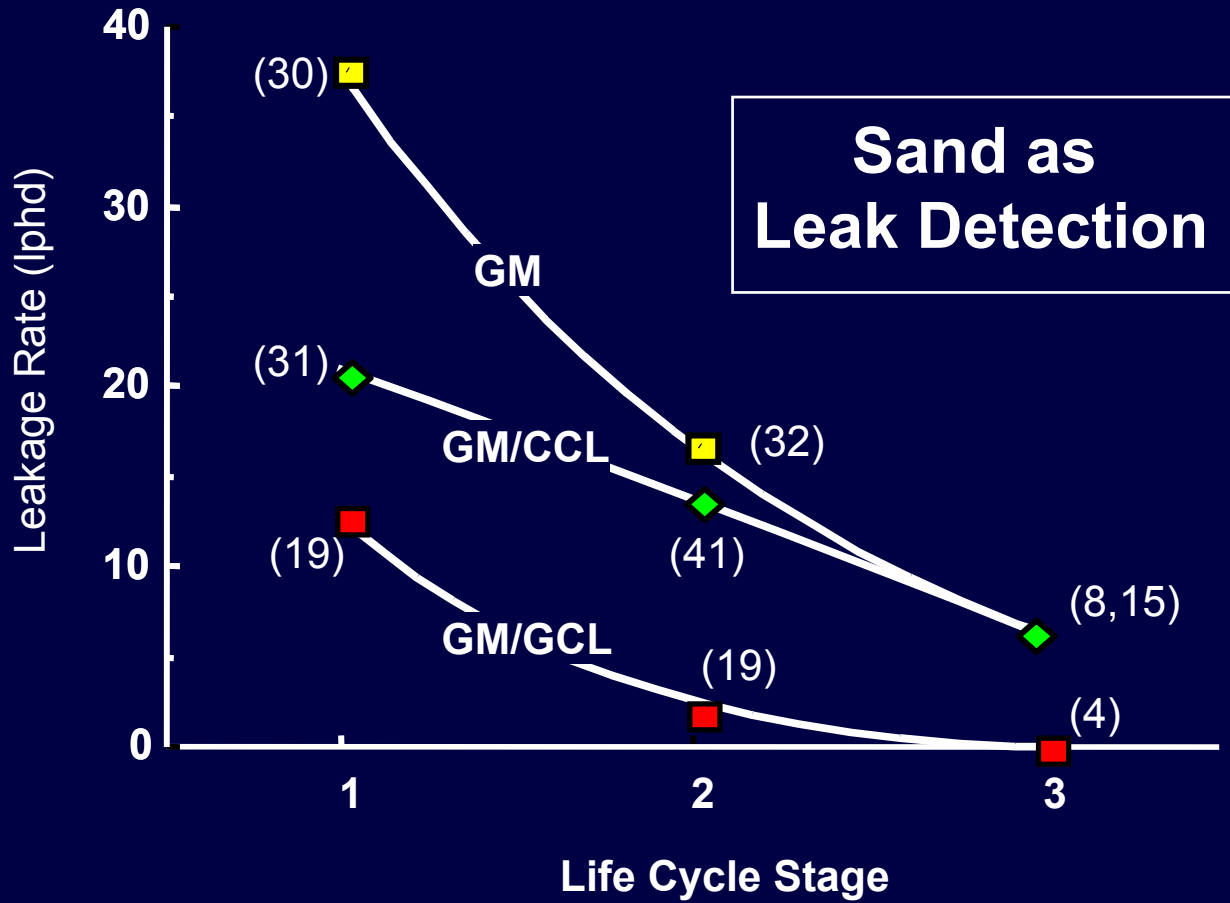
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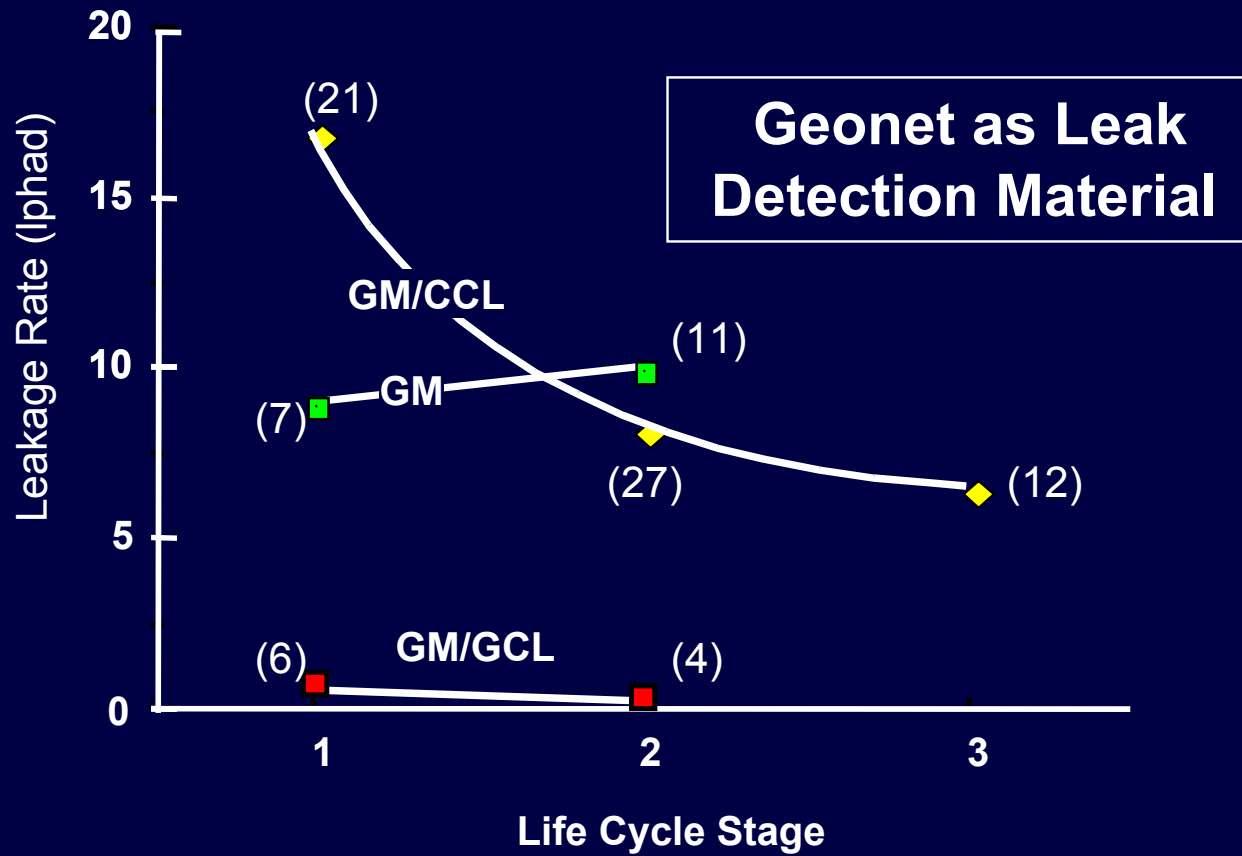
Wet (aka, Bioreactor) Landfills: The Liner System Issues

1. Liner system performance
2. Leachate collection design
3. Leachate removal design
4. Filter/operations layer considerations
5. Daily cover soil blockage
6. Final cover considerations
7. Landfill stability issues

1. Liner System Performance

- single composite liner is acceptable accompanied by downgradient monitoring
- GM/CCL, GM/GCL or GM/GCL/CCL
- double liner system performance is outstanding... prefer using it with less emphasis on monitoring
- perhaps even no monitoring unless the ALR is exceeded!!





2. Leachate Collection Design

- k_{\min} of all regulations is much too low!
- the major impediment to retrofitting existing landfills for liquids additions
- recommend $k_{\min} \geq 1.0$ cm/sec
- this is gravel, or GC/sand composite
- if gravel, GM must be protected with GT
- puncture design methods are available



$k \approx 1.0 \text{ cm/sec}$

$k \gg 1.0 \text{ cm/sec}$

3 Leachate Removal Design

- pipe network is both a difficult design and construction item
- high normal stresses (megafills) are suspect w/r to excessive deflection
- higher liner temps for wet landfills is a concern
- periodic pipe monitoring is advisable (currently in 8-states)
- GC designs avoid pipe altogether





4. Filter/Operations Layer Considerations

- smallest voids are most suspect w/r to excessive clogging
- consider avoiding filter over drainage stone; use select waste directly
- take great care in its placement
- forget about operations/protection layer unless it's a GC design – then use sand layer for a operations layer



**This Concept Works....
8 Columns over 5-years showed
constant flow rates!**

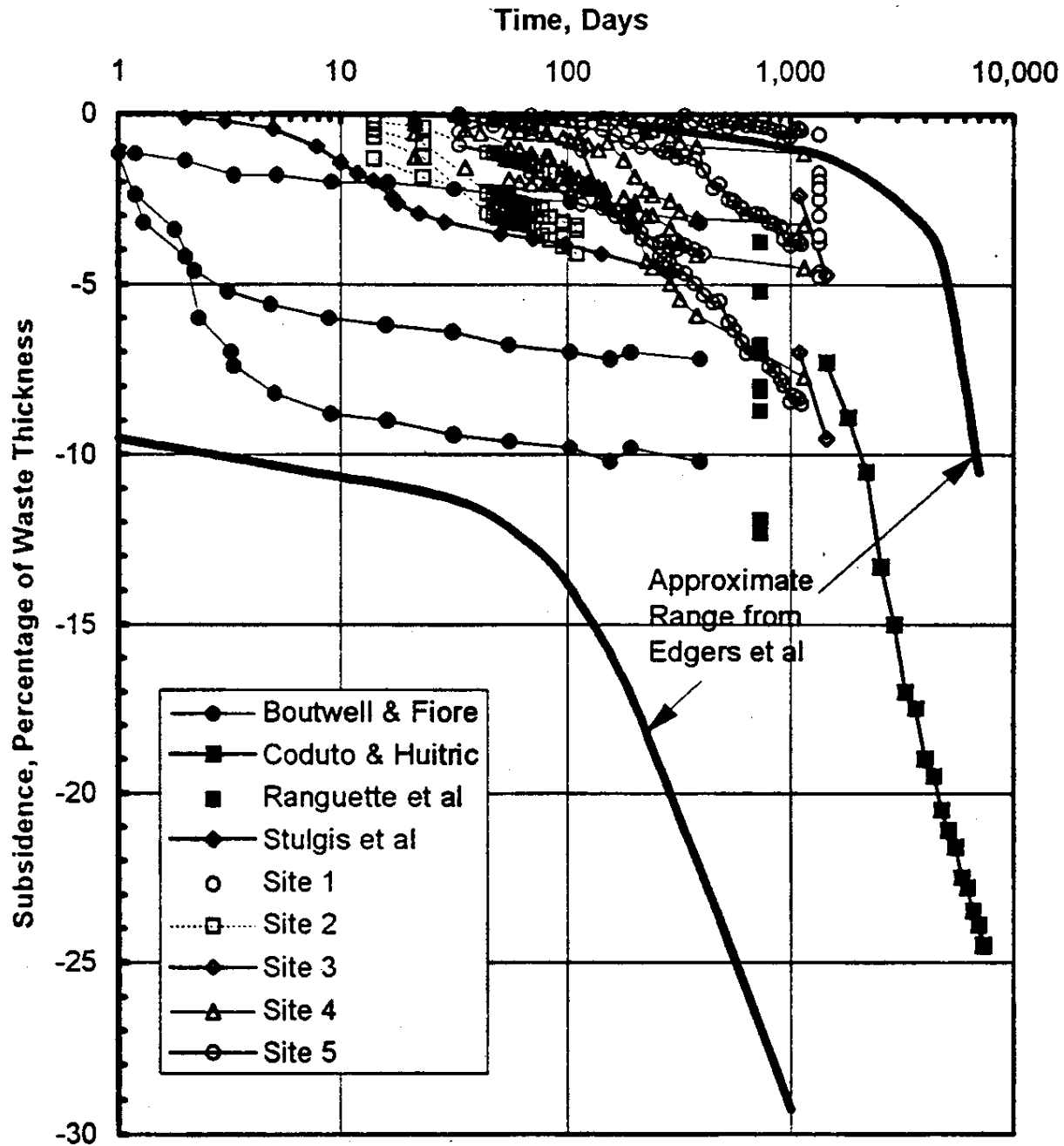
5. Daily Cover Soil Blockage

- avoid silt/clay daily cover soils
- use foam, slurries, sludges or reusable GTs/GMs
- site-specific decision with many options, see EPA/600/R-93/172



6. Final Cover Considerations

- avoid final cover placement until after primary settlement (5⁺-years)
- many temporary options available
- quest is to contain landfill gas, but allow water to enter waste
- then heavy rolling (or DDC) and placement of final cover



Florida Landfill Differential Settlement





**New Jersey Landfill
Differential Settlement**

7. Landfill Stability Issues

- major concern is leachate (hydraulic) head building up on liner system
- generates hydrostatic forces
- design is straightforward if liquid level and shear strengths are known
- geotechnical monitoring within the waste is readily available



**Leachate Injected
Into Backslope**



**Mixed Waste
as a Fluidized Bed**

Summarizing Remarks

1. liner system	<ul style="list-style-type: none">• use double liner system• set site-specific ALR• use monitoring walls if exceeded
2. leachate collection	<ul style="list-style-type: none">• increase “k” significantly• consider $k \geq 1.0$ cm/sec• gravel or GC/sand
3. leachate removal pipes	<ul style="list-style-type: none">• $H > 50$ m challenges deflections• consider periodic pipe inspection• GC design avoids pipe situation
4. filters/operations layers	<ul style="list-style-type: none">• omit filter layer• place select waste on gravel/sand• omit operations layer`
5. daily cover soil blockage	<ul style="list-style-type: none">• avoid silts and clays• consider alternate daily cover material• many options available
6. final cover considerations	<ul style="list-style-type: none">• avoid placement initially• use temporary cover• place final cover after settlement
7. landfill stability	<ul style="list-style-type: none">• concern during placement and afterward• design is straightforward• internal monitoring is necessary

Recommendations

- new wet landfill/cells very “doable”
- done right – everyone wins!
- retrofitting old/existing sites is difficult
- critical issue is “regulatory flexibility”
- permit exceptions and/or regulation revisions are necessary
- it’s time to revisit landfill regulations focusing on wet landfills only!

*Thanks for
Listening*