GCL USE IN ALTERNATIVE LINER SYSTEMS OF DOUBLE-LINED LANDFILLS

Since their inception in the 1980s, GCLs have been used in the upper composite of double liner systems with leak detection in a number of landfills. Twelve states require double liner systems for municipal solid waste landfills (MSWLFs) (Koerner, et. al., 1998). The GCL component of the composite liner is often considered to be an alternate to the regulated low permeability compacted soil (or compacted clay liner, i.e., CCL) per 40 CFR 25.8.28(a)(2). This regulation calls for the CCL to be at least 2-ft thick with a permeability of 1×10^{-7} cm/sec, or less. The alternate, in this case GCL, must be equivalent, or superior, in its performance to the CCL.

The underlying leak detection system allows for an assessment of the upper liner's performance. A major study has just been completed for the USEPA, which includes 91 landfills containing 289 single or multiple cells (Bonaparte, et. al., 1999). Three different types of primary liners were involved (GM alone, GM/CCL and GM/GCL) and two types of leak detection materials (sand and geonet). Thus six combinations are available, as shown in Table 1. Data is also available for three different stages during the life of the respective landfill cells (initial, active and post closure).

Table 1 - Leakage Rates from Leak Detection Systems of Double-Lined Landfills (Bonaparte, et. al., 1999)

[All Flow Rates are in Gal/Acre-day (gpad)]

Liner/LDS Type	Type I (GM-Sand)			Type II (GM-GN)			Type III (GM/CCL-Sand)		
Life of Cycle Stage	1	2	3	1	2	3	1	2	3
Average Flow	41	18	6.8	10	11	ND	23	15	6.8
Minimum Flow	0.81	0.0	0.02	0.51	0.15	ND	0.13	2.4	0.0
Maximum Flow	229	158	26	40	38	ND	126	71	29
No. of "points"	30	32	8	7	11	ND	31	41	15
No. of landfills	11	11	4	4	6	ND	11	11	4

Life Cycle Stage: "points" = Number of measuring points (i.e., outlets of single or multiple cells)
Stage 1 – Initial Life
Stage 2 – Active Life
Stage 3 – Post Closure ND = No Detection (of leakage)

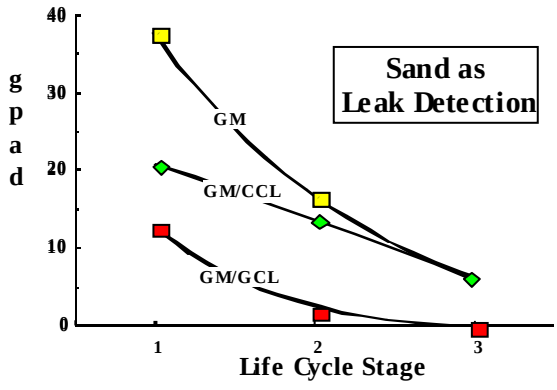
Table 1, Continued - Leakage Rates from Leak Detection Systems of Double-Lined Landfills (Bonaparte, et. al., 1999)

[All Flow Rates are in Gal/Acre-day (gpad)]

Liner/LDS Type	Type IV (GM/CCL-GN)			**Type V (GM/GCL-Sand)**			**Type VI (GM/GCL-GN)**		
Life of Cycle Stage	1	2	3	**1**	**2**	**3**	**1**	**2**	**3**
Average Flow	18	8.9	7.0	**14**	**2.38**	**0.03**	**0.70**	**0.28**	**ND**
Minimum Flow	0.0	0.0	0.0	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**ND**
Maximum Flow	74	54	14	**104**	**30**	**0.10**	**3.6**	**1.0**	**ND**
No. of "points"	21	27	12	**19**	**19**	**4**	**6**	**4**	**ND**
No. of landfills	6	9	3	**3**	**3**	**1**	**2**	**2**	**ND**

Life Cycle Stage: "points" = Number of measuring points (i.e., outlets of single or multiple cells)
Stage 1 – Initial Life
Stage 2 – Active Life
Stage 3 – Post Closure ND = No Detection (of leakage)

The above data is plotted in Figure 1 (for the average flow rates) so as to give a graphic representation as to the effectiveness of the GM/GCL alternate barrier system. Note that the plotted data represents the average flow rates of 289 single or multiple cells monitored for up to 10 years. Readily seen is that the alternate GM/GCL outperforms the standard GM/CCL in all cases and at every life cycle stage. Clearly, the GCLs have a significant influence in reducing leakage through the covering geomembranes.



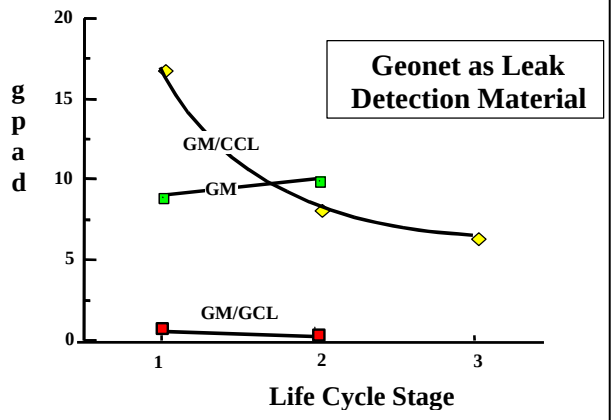


Figure 1 – Leakage Rates for 287 Landfill Cells (Bonaparte, et. al.,)

CONCLUSION

In 1991, when the original EPA regulation on MSWLF liners [40 CFR 258.28 (a)(2)] was promulgated, GCLs were in their infancy. Today, GCLs have been shown to be superior to CCLs in composite liner systems of every common configuration. Based on the results of the Bonaparte study, it can be concluded that a GM/GCL composite liner system defines the current state of the art for minimizing landfill liner leakage.

REFERENCES

Bonaparte, R., Daniel, D. E. and Koerner, R. M., Assessment and Recommendations for Optimal Performance of Waste Containment Systems, EPA/600/R-02/099, December 2002, U. S. EPA, ORD, Cincinnati, OH, http://www.epa.gov/nrmrl/pubs/600r02099/600R02099.pdf