

Flexible Membrane Liner (FML) & Compacted Clay Liner (CCL)

Table I

Selected Difference* Between FML & CCL

Characteristic	Geomembrane (FML)	Compacted Clay Liner (CCL)
Materials	Polyethylene (HDPE or VFPE, 97.5% to 98.5%), anti-oxidants and heat stabilizers (0.5%), and carbon black (2% to 3)	Native soils or blends of native soils and bentonite
Thickness	Typically 0.5 mm to 3.0 mm	Typically 300 to 900 mm
Hydraulic Conductivity	1×10^{-14} m/s (effective hyd. cond.)	1×10^{-9} m/s
Speed of Construction	Rapid, simple installation	Slow, complicated construction
Need for MQC and MQA	Factory manufacturing requires monitoring	Naturally found materials or mineral layers requiring no monitoring
Status of CQC and CQA	Relatively simple, straight-forward, common-sense installation procedures. Specialized seaming equipment	Complex procedures requiring highly skilled and knowledgeable people
Field Desiccation Sensitivity	Polyethylene geomembranes have no interstitial void spaces, and therefore, cannot dry out or freeze	CCLs are nearly saturated; can desiccate during construction thus greatly increasing hydraulic conductivity
Availability of Materials	Materials readily shipped to any site	Varies widely from readily available to not available at all
Installed Cost	Typically \$5.00 to \$9.00 per square meter, dependent upon liner thickness and project size	Highly variable estimated range: \$6.00 to \$30.00 per square meter
Experience	Established track record for quality lining and cap projects with experienced crews. Familiarity and experience is geographic dependent.	Has been used for many with great confidence as a liner material

*Table adapted from "Technical Equivalency Assessment of GCLs to CCLs"; Koerner and Daniel (1993); Proceedings of the 7th GRI Seminar, Geosynthetic Liners Systems: Innovations, Concerns, and Design, Drexel University, Philadelphia, PA, pp 255-275.

Note:

MQC = manufacturing quality control
 MQA = manufacturing quality assurance
 CQC = construction quality control
 CQA = construction quality assurance

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Table II

Technical Equivalency Assessment* Between FMLs & CCLs

Category	Criterion for Evaluation	FML probably Superior	FML/CCL probably Equivalent	CCL probably Superior
Hydraulic Issues	Steady flux of water	X		
	Steady solute flux	X		
	Chemical absorption Capacity	X		
	Breakout time Water	X		
	Solute Horizontal flow in Seams	X X		
	Generation of consolidation water	X		
Physical/Mechanical Issues	Freeze/Thaw behavior	X		
	Total settlement		X	
	Differential settlement	X	X	
	Slope stability		X	
	Bearing capacity		X	
Construction Issues	Puncture resistance			X
	Subgrade condition		X	
	Ease of placement	X		
	Speed of construction	X		
	Availability of materials	X		
	Requirements for water	X		
	Air pollution concerns	X		
	Weather constraints		X	
	Quality assurance ((CQA) considerations	X		

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