Geomembranes and Geosynthetic Clay Liners (GCLs)

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Geomembranes are essentially impermeable polymeric lining materials used as fluid barriers in geotechnical engineering applications. Geomembranes can have a smoother or textured surface. The textured surface provides enhanced friction characteristics which can be important in certain applications.

Geosynthetic clay liners (GCLs) are made of a thin layer bentonite clay between two layers of nonwoven geotextiles. GCLs are used in containment applications, often in conjunction with a geomembrane.

Why Geosynthetic Containment Systems?

Since the 1950s, engineers have successfully designed containment systems with a wide assortment of geomembrane and associated geosynthetic products in the effort to protect water resources. The use of geomembranes and geosynthetic clay liners (GCLs) has increased over the years as traditional liners, such as concrete, asphalt, as well as compacted clay soils, have proven ineffective in the prevention of fluid migration into subsurface soils.

U.S. government regulations requires the use of geomembranes in many cases to meet minimum containment criteria established by the Solid Waste Disposal Act, Subtitle D of the Resource Conservation and Recovery Act (RCRA), the Clean Water Act and Superfund. Continued research and development by numerous manufacturers has resulted in a wide range of available geomembrane and GCL products to meet these standards. Refined geomembrane and GCL manufacturing as well as installation quality control procedures ensure these guidelines are met.

Recent studies provide further support for these stringent requirements as the total seepage measured through monitored geomembrane installations is extremely low. Total seepage is insignificant when geomembranes are used in conjunction with underlying geosynthetic clay liners.

Solid Waste Landfill Containment

Landfill applications for geomembranes and geosynthetic clay liners (GCLs) include their use as bottom liners for waste and leachate containment, cut-off walls as well as landfill closures or covers.

While RCRA requires a geomembrane in all hazardous and most municipal solid waste (MSW) landfills, GCLs are often used with the geomembrane to form composite liners. MSW landfills typically require a single composite liner comprised of a leachate collection and removal system, as well as a geomembrane overlying either a GCL or compacted clay soil. Hazardous waste landfills generally require double-liner systems (two geomembranes), often incorporating both GCLs and compacted clay soil.

Coal Ash Storage Sites

Although coal ash disposal sites are not regulated by RCRA, some coal ash storage sites use geomembranes and GCLs as liners and for containment. These storage sites also use geosynthetic drainage composites to dewater the coal ash slurry, allowing the coal ash to be recycled in the manufacture of other products such as gypsum (wall board stock) or used to enhance/extend concrete manufacture.

Caps and Closures

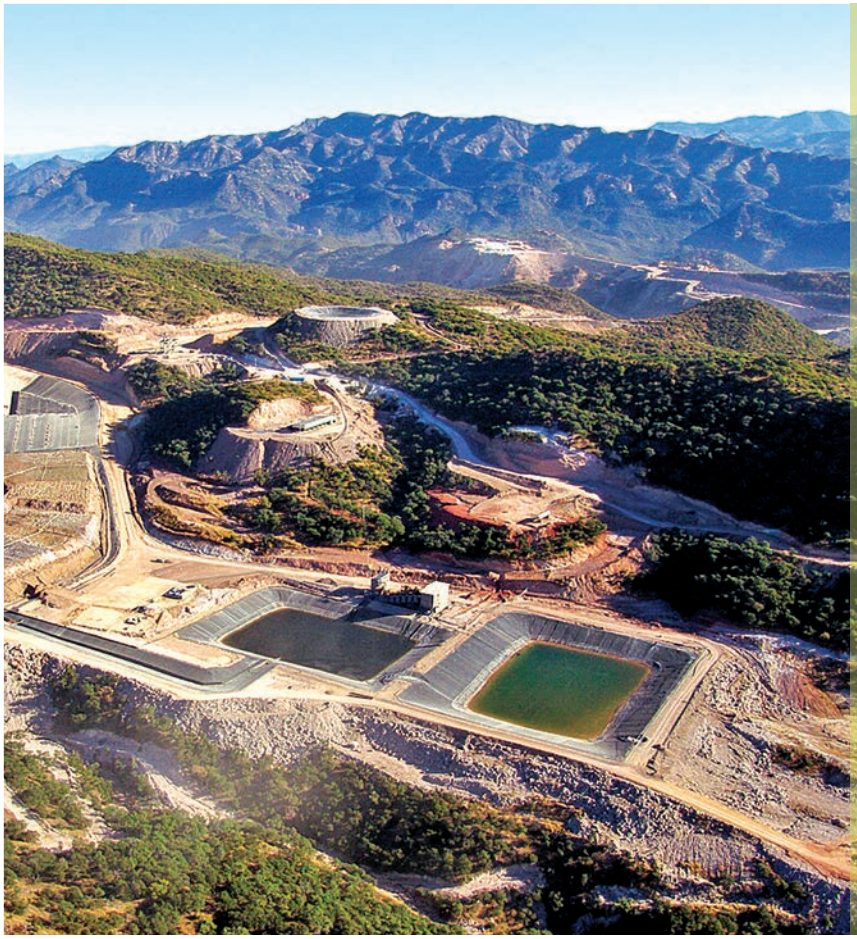
Geomembranes are used for landfill caps to prevent fluid migration into the landfill, thereby reducing or eliminating post-closure generation of leachate and the associated treatment costs. The cap is also designed to trap and properly vent the gases generated during decomposition of organic wastes. Similarly, the closure system can prevent the seep of any fluids from the refuse body to the landfill surface. Often GCLs are added beneath the geomembrane for added protection.

Geomembrane and GCL closure systems can also be designed to facilitate future vertical expansion of the landfill, thereby enlarging the landfill capacity. By fully encapsulating the refuse, the completed cap enables the safe and efficient restoration, revegetation, and possible reuse of the land.

Surface Impoundments/ Liquid Containment (Pond Liners)

In 1972, Congress enacted the first comprehensive national clean water legislation in response to increasing public concern for serious and widespread water pollution. The Clean Water Act required the use of geomembrane liner systems in waste treatment lagoons at many publicly operated wastewater treatment plants in order to meet more stringent performance criteria—all in the effort to help protect our nation's waters, including lakes, rivers, aquifers and coastal areas.

The use of geomembranes and geosynthetic clay liners in potable water reservoirs also helps conserve millions of gallons of water annually by minimizing water seepage. These lining products can also be used for practical or decorative pond liners at golf courses, amusement parks, resorts, as well as for agriculture and aquaculture.



Mining Applications

Advanced extraction processes involving chemical solutions and large heap "leach pads" help to economically recover precious metals from low-grade ores. Geomembranes and GCLs under the large leach pads simultaneously prevent the loss of the valuable metal-laden chemical solutions while protecting the underlying soils and groundwater from contamination.

Geomembranes and GCLs are also used to help recapture and recycle the harmful chemicals being used in solution, for treatment ponds, as well as in secondary containment applications. Geosynthetics can also be useful aides in channeling surface water run-off as well as in the prevention of rainwater intrusion into the heap leach pad, thus minimizing solution dilution.

Spill or Secondary Containment

The surface areas and impoundments surrounding aboveground storage tanks at bulk storage facilities (tank farms) are often lined with geomembranes and GCLs to prevent groundwater contamination in the event of a chemical spill. These "secondary containment" systems can be placed over pre-existing concrete or directly on a prepared earthen surface.

Liner systems for secondary containment can be quite sophisticated, using complex designs to attach lining materials to tanks as well as around other structures such as pipes or other liner system penetrations.

Geosynthetic lining systems can be used under tanks in new construction or to simply line the earthen dike impoundments of existing tank installations.

Specialty Containment Applications

Geomembranes and geosynthetic clay liners are also used in a wide variety of specialty applications. One such application is secondary containment for underground storage tanks, where the lining system is intended to prevent groundwater contamination in the event of a chemical spill.

Other uses of geomembranes and GCLs include agricultural waste ponds, radon and methane barriers, floating containment booms, foundation moisture barriers, erosion protection, tunnel waterproofing, tank interior linings, as well as groundwater cut-off walls and temporary covers for crops or contaminated soil. Geosynthetic lining systems offer an economical yet effective solution to virtually any containment or waterproofing application.

Covers for Reservoirs (Floating Covers)

Termed "floating covers," geomembranes can be used over fluid surface impoundments to control evaporation, prevent odors, minimize the emission of volatile organic compounds, as well as to reduce the need for drainage and cleaning. When used over fresh water reservoirs, floating covers effectively prevent contamination by animals as well as airborne particulate, thereby reducing treatment costs.

Geomembrane floating covers can be an important element of an anaerobic digester containment system. While the geomembrane and GCL liner system contain the liquids, the geomembrane floating cover traps the methane gases formed during micro-organism digestion of the wastes for effective gas collection and economical odor control.

Water Conveyance (Canal Liners)

Government agencies such as the United States Bureau of Reclamation indicate that seepage from unlined irrigation canals and waterways may be substantial and costly. With the dwindling availability of water resources for agricultural use in arid and semi-arid climates, geosynthetic materials can play an important role in maximizing crop productivity through irrigation canal water-loss minimization.

Geomembranes and GCLs can be economically employed to reduce the seepage through unlined irrigation canals or waterways. They are effective alternatives to concrete, asphalt or compacted clay soils and can be used as an expedient method to repair poorly performing existing linings or those that are rapidly deteriorating.

Common Types of Geosynthetic Lining Materials

High-density polyethylene	**(HDPE)**
Linear low-density polyethylene	**(LLDPE)**
Polyvinyl chloride	**(PVC)**
Polypropylene	**(PP)**
Chlorinated polyethylene	**(CPE)**
Ethylene interpolymer alloy	**(EIA)**
Ethylene propylene diene monomer	**(EPDM)**
Geosynthetic clay liners	**(GCLs)**
Polyurethane	**(PU)**

Geomembranes and Geosynthetic Clay Liner materials display a wide range of physical, mechanical and chemical resistance properties. Geomembranes can be compounded for greater resistance to ultraviolet light exposure, ozone and micro-organisms in the soil, while GCLs can be produced with various geotextiles for enhanced frictional properties. Different combinations of these properties exist in various geomembranes as well as GCL materials to address a wide spectrum of geotechnical applications and designs.

Several methods are used to join or seam large panels of geomembranes and GCLs, in both factory controlled and field environments. Each material has highly developed quality control techniques and unique characteristics that govern its manufacture and installation. Advanced products, as well as new manufacturing and installation techniques, continue to evolve as the geosynthetic industry steadily improves existing technology and strives to address the future needs of the containment industry.

GMA
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Members of the Geosynthetic Materials Association are available for consultation regarding specific materials, their properties and their applications.

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