NEBRASKA
DEPT. OF ENVIRONMENTAL QUALITY

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Geosynthetic Clay Liners (GCLs)

This document provides guidance on design and construction quality assurance information needed for GCL liner designs.

GCLs are factory manufactured hydraulic barriers, typically consisting of sodium bentonite clay or other very low permeability material, sandwiched between geotextiles and/or geomembranes. When GCLs are sandwiched between geotextiles they are held together by needling and/or stitching, and are typically 7 to 10 mm thick when hydrated. Some GCL's hold the sodium bentonite to a geomembrane with chemical adhesives.

The Department of Environmental Quality believes that in terms of steady flux of water, the GCL is equivalent to two feet of compacted clay liner (CCL) at 1 X $10E^{-7}$ cm/sec permeability. Therefore, an alternate liner design demonstration is not required when a GCL is substituted for the permeability requirement of the CCL component of a composite liner design. Two feet of the compacted base must support the GCL.

NDEQ has determined that using a GCL as an alternate liner design described above in landfill construction, constitutes a modification. Modifications must be public noticed for 30 days and may require a modification fee.

Design:

Performance data should be provided on material properties and/or studies showing each material's performance, including all physical properties of the material necessary to evaluate its suitability for the site specific use. Examples include:

- Bearing capacity of the material and any design features to prevent failure of the material under load.
- Creep analysis and how the material usage, site design, and/or operation of the site maintain stable slopes. Many of the materials utilize a bonding method to provide structural strength across the GCL. These may be adhesives, stitching, or needle punching. Long-term stability may be highly affected by the type of bonding used in the GCL.
- Stress-strain data necessary to evaluate any mass or differential settlement which can be expected in the site design.
- Site specific data for slope stability is preferred, but published data will be acceptable on slopes no steeper than 4:1 (4 ft. horizontal to 1 ft. vertical) or approximately 14 degrees.

Construction Quality Assurance (CQA)

CQA requirements for GCL's differ from those for a compacted clay liner. Some, but not all, of the considerations to be included in the site CQA plan follow.

Weather:
GCLs should be kept dry during installation. Installation should not take place during high humidity, rain, or other types of precipitation.

Seaming:
Overlapping of the GCL to form seams should be completed according to manufacturer's specifications. The seaming procedures and inspections should be part of the CQA Plan. Bentonite may be needed for seaming, depending on the manufacturer's recommendation. If bentonite is used, the amount must be specified and verified as part of CQA monitoring activities.

Protection:
The GCL should be covered by the fabric membrane liner immediately to protect it from any precipitation that may occur during construction. GCL must be completely protected (no exposure) at the end of each construction day. Equipment travel on the GCL, such as a loader, dozer, scraper, etc. should not be allowed. Manufacturer's recommendations should be followed. If heavy equipment, as defined in the CQA Plan, is to be used for placement of cover material over the GCL, the equipment must be continuously observed by CQA personnel. Manufacturer's recommendations on the vertical separation distance between the equipment and GCL must be followed. Initial lifts of refuse placed on the liner system should be monitored so that no material is placed on the liner that could eventually cause a penetration into the GCL.

Subgrade:
Subgrade must be compacted to 95% of Standard Proctor dry density and be free of sharp objects larger than one inch maximum in any direction.

The subgrade must be free from any chemicals that can damage or cause the sodium bentonite GCL to lose its double layer characteristics. The subgrade must be moistened with potable water. The subgrade must provide moisture for the first hydration of the GCL but should not be so wet as to leave wheel imprints, which prevent intimate contact between the geomembrane, subgrade, and GCL. Moisture in the geomembrane hot wedge joints will prevent good seals.

RESOURCES:

- NDEQ Home Page http://deq.ne.gov/

Contacts:

- NDEQ Waste Management Section (402) 471-4210
- NDEQ Toll Free Number (877) 253-2603
- NDEQ Hazardous Waste Compliance Assistant (402) 471-8308
- Email questions to: NDEQ.moreinfo@nebraska.gov

NDEQ Publications:

- Title 132 – Integrated Solid Waste Management Regulations
  Titles are available on the NDEQ Home Page under "Laws/Regs & EQC", "Rules & Regulations"

Reference list attached

References
Symposium on Testing and Acceptance Criteria for Geosynthetic Clay Liners
Sponsored by:
ASTM Committee DD-35 on Geosynthetics

These will be published as Special Technical Paper's (STP's)

- Swell Measurements of the Clay Component of Geosynthetic Clay Liners – D.B. Narejo
- Internal Shear Strength of a Geosynthetic Clay Liner – T.D. Stark and H.T. Eid
- A Comparison of Sample Preparation Methodology in the Evaluation of GCL Permeability – J. Siebken, S. Lucas
- Tests for Evaluating the Performance of GCLs with Leachate and Other Chemicals – T. Egloffstein
- Correlation of Quality Control Index Tests of Bentonite with Laboratory Tests of GCL Permeability - J. Siebken, S. Lucas
- Interface Shear Performance of Different GCLs and Selection of Strength Parameters for Design – R. Hewitt, C. Soydemir, and R. Stulgis
- Creep Shear Characteristics of Two Types of Needle-Punched, Thermally Locked GCL – J. Siebken, R.H. Swan, Jr., and Z.Yuan
- Long-Term Internal Shear Strength of a Needle-Punched GCL – R. Trauger, R.H. Swan, Jr., and Z. Yuan
- Factors Influencing Laboratory Measurements of the Internal and Interface Shear Strength – R. H. Swan, Jr., Z. Yuan and R.C. Bachus
- Shear Strength Testing for Geosynthetic Clay Liners – R.B. Gilbert, D.E. Daniel, and H. Scranton
- Evaluation of Hydraulic Compatibility of Partially Hydrated GCLs with Contaminated Liquid – J. Mlynarek
- Geosynthetic Clay Liners in Alkaline Environments – J.A. McKelvey III
- Laboratory Demonstration of Geoclay Liner Application in Contaminated Liquids Evacuation – J. Mlynarek and O.G. Vermeersch
- Initial Hydration Conditions Influence on GCLs Leachate Hydraulic Conductivity – G. Didier and L. Comeaga
- Measurements of Hydraulic Conductivity Properties of Geosynthetic Clay Liners Using a Flow-Box –D.E. Daniel and S.J. Trautwein
- Hydraulic Conductivity Testing of GCLs in Flexible-Wall Permeaters – D.E. Daniel and J.J. Bowders
- Rapid Measurement of Hydraulic Conductivity of Geosynthetic Clay Liners Using a Constant Volume Procedure--C.H. Benson and L. Blotz, and S.J. Trautwein
- What is the Acceptable Shear Strength of a Geosynthetic Clay Liner? – U.W. Cowland
- Manufacturing Quality Control of GCLs and Design Criteria - - Kvon Maubeuge
- Specification for GCL – Available Product or Performance? - - J. B. Kirsch and N. Paruvakat and M.J. Cieslik
- Investigation of Cover Soil Properties on Geosynthetic Clay Liner Performance – P.J. Fox and D. J. DeBattista

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3. Boardman, B.T., (1993), “The Potential Use of Geosynthetic Clay Liners as Final Covers in Arid Regions”, M.S. Thesis, University of Texas, Austin, Texas.
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