GEOSYNTHETICS SOLVE WETLANDS MITIGATION PROBLEMS

An unusual combination of geosynthetic materials (geosynthetic clay liner, geogrid and geonet) allowed installation of a liner system in portions of a wetlands mitigation site that were underwater.

Construction on a 32-acre parcel wetlands mitigation site in New Jersey began in November 1991. An aquatic marsh in the center of the site reached a depth of 6 feet to support fish. Persistent wet weather raised the water table into many excavated areas. Because the site was surrounded by sources of infiltrating water, dewatering was impractical. The saturated subgrade soils on the site were too unstable, making it infeasible to construct the originally designed compacted clay liner (CCL).

A needlepunched geosynthetic clay liner (GCL), Bentomat® ST, was approved as a substitute for the CCL. Most of the emergent marsh and hemi-marsh areas were wet but sufficiently stable for subgrade preparation and controlled placement of the GCL. The aquatic marsh area was extremely wet and unstable. Two significant problems had to be solved before GCL placement could occur in this area. First, the consolidation water had to be drained to provide better friction at the GCL and subgrade interface. Second, the overlying cover soil needed to be stabilized to support dynamic loading and to minimize the potential for liner damage during cover placement. These problems were solved through the use of geonets and geogrids.

Instead of placing the GCL on the saturated subgrade, a drainage geocomposite was placed under the GCL at the overlap zone. This allowed consolidation water to drain from the GCL and subgrade interface. The overlying cover soil was stabilized by placing a geogrid over the liner. The geogrid increased the load-bearing capacity of the cover layer and allowed heavy equipment to operate above the liner system without damaging or shifting the GCL panels.

Interestingly, the natural appearance and performance of the wetlands would not have been possible without the use of several different geosynthetic materials.

800.527.9948 Fax 847.577.5566

GFR
GEOTECHNICAL FABRICS REPORT

CASE HISTORY

Geosynthetics solve wetlands mitigation problems

By Bob Trauger and Joe Burgio

An unusual combination of geosynthetic materials and on-site ingenuity was applied to a wetlands mitigation project in New Jersey. The use of Bentomat, a geosynthetic clay liner (GCL), geogrid and geonet allowed installation of a liner system in portions of the site that were virtually underwater.

Introduction

Section 404 of the Federal Clean Water Act establishes a comprehensive regulatory program for protection of U.S. wetlands resources. A key provision of this program is the concept of "compensatory mitigation," where wetlands may be filled only if an equal area of wetlands is created elsewhere. When the Interstate 287 extension in New Jersey was designed, the highway was routed through federally designated wetland areas, requiring the New Jersey Department of Transportation (NJ DOT) to obtain a permit from the U.S. Army Corps of Engineers to legally fill the wetlands within the highway's planned right-of-way.

In 1990 a 32-acre parcel of nearby community-owned property was identified for the mitigation project (**Figure 1**), with the understanding that the NJ DOT would develop the wetlands, monitor it for a period of three years, and then relinquish the site to the Township of Mahwah for its likely use as a public nature preserve. Construction began in November 1991, but persistent wet weather raised the water table into many excavated areas of the site. It became clear that it was not feasible to construct the compacted clay liner originally required for the project. A geosynthetic clay liner (GCL) was approved as a substitute for the compacted clay,

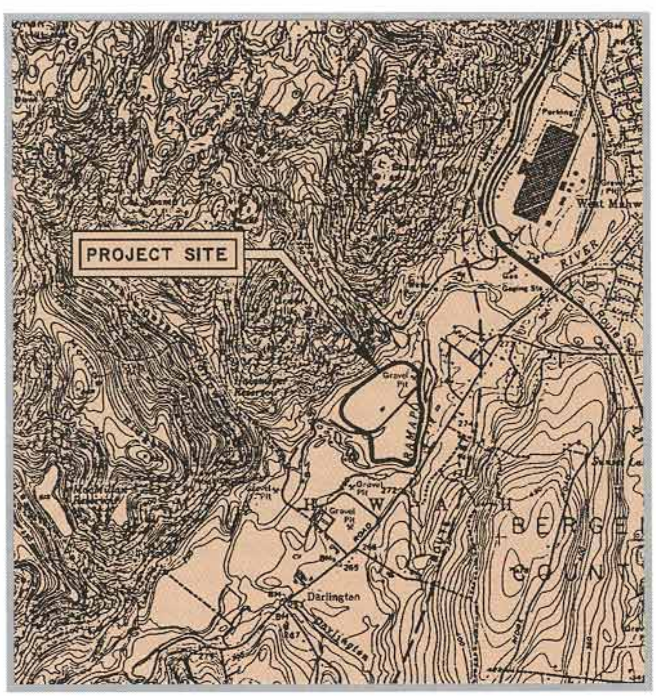

Figure 1. Site location map for Mahwah wetlands mitigation project.

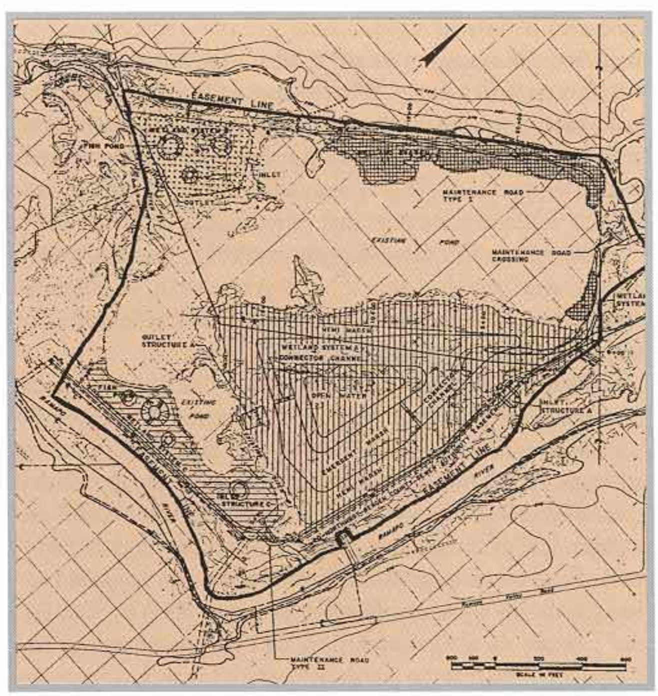

Figure 2. The site is located between the Ramapo River and an existing pond. It was later found that these two bodies of water were hydraulically connected.

Figure 3. Deployment of the GCL on a relatively stable portion of wetlands System A.

Figure 4. Liner installation on wetter, less stable areas of the subgrade required the use of a drainage geocomposite, which was centered beneath the GCL overlaps.

and in particularly wet areas, it was necessary to install the GCL with other geosynthetics for control of water infiltration. Liner construction began in October 1992 and was completed in April 1994.

Wetlands design

It is a difficult undertaking to design and construct a wetlands that is natural in appearance, supportive of a variety of flora and fauna and relatively self-sustaining. The Mahwah project was especially complex, because several types of wetlands were created to maximize biological diversity at the site (**Figure 2**, Systems A, B. C and E). Each of these four wetland areas has a different hydrology and hosts a different range of vegetation. The largest and most varied wetland area is System A, located at the center of the site. The large area of emergent marsh in this system is flooded to a depth of approximately 1.5 feet and will be dominated by nonwoody vegetation that emerges from the water. The aquatic marsh in the center of the site reaches a depth of 6 feet to support fish. This system will be permanently flooded and will contain plants that grow mostly underwater. At the site perimeter, a hemi-marsh was designed to be slightly deeper and wetter than the emergent marsh, a deterrent against human access during dry periods when the emergent marsh may not be entirely flooded.

Although an artificial wetlands should function as naturally as possible, the hydrology of the site must be carefully controlled. The source of fresh water for the new wetlands is seasonal flood water from the adjacent Ramapo River. Inflow and outflow structures near the river allow the water's lateral movement through the wetlands to be controlled and monitored. Vertical infiltration also must be limited to sustain aquatic vegetation between flood events. For this reason, the original construction permit issued by the Corps required that the wetlands contain a 6-inch compacted clay liner with a permeability not to exceed 1 times 10-6 cm/sec.

Figure 5. The GCL was placed over the drainage geocomposite.

Site conditions

The wetlands site is located in Mahwah, N. J., near the interchange of Interstate 287 and State Route 17. This former farmland is adjacent to the Ramapo River on the east and south and abuts a small lake to the west. Data from exploratory soil borings taken in 1989 indicated the water table was approximately 6 inches below ground surface. The borings also indicated the presence of a silty soil that initially appeared to be suitable for construction of the bottom liner. In 1991, another investigation of site conditions was conducted by the general contractor Schiavone Construction Co., Secaucus, N.J. This investigation showed the water table to be 6 feet below grade, indicating that the water table elevation was subject to significant fluctuations.

Unfortunately, an unusually rainy period occurred as construction began, and the water table rose to a level where it eventually infiltrated many excavated areas. It appeared as though the river and the lake shared a shallow hydraulic con-

Figure 6. A biaxial geogrid was placed over the GCL to help stabilize the cover soil.

Figure 8. By excavating only enough soil for the placement of one GCL at a time, infiltration was kept to a minimum.

nection beneath the site, a connection breached when excavation began in System A. Because the site was surrounded by sources of infiltrating water, dewatering was impractical. It also was discovered that the subgrade soil was too permeable to be used for liner construction and too unstable to support construction equipment. For these reasons, Schiavone requested that a GCL be substituted for the compacted clay liner originally required by the permit. This request was approved in the summer of 1992, and GCL installation began in October 1992.

GCL installation

The wet conditions rendered installation of a compacted clay liner impossible and would have greatly hindered the

Figure 7. A detailed illustration of the wetlands liner system, showing the drainage composite at the GCL overlap, the GCL panels and the geogrid.

installation and seaming of a geomembrane. It also was a priority of the DOT to encourage the use of clay-based, "natural" construction materials. The most feasible alternative for this project, therefore, was to install a GCL. The GCL provided the added benefit of reducing the amount and cost of CQA testing for the line system.

During installation, the GCL rolls were suspended from core bar by a tracked backhoe that moved backwards along the intended path of placement (**Figure 3**). The tracked equipment was necessary for better load distribution on the soft subgrade. Adjacent GCL panels were overlapped, and the seams were supplemented with granular bentonite in the usual manner. A 2-foot cover layer consisting of 18 inches of clean backfill and 6 inches of topsoil was then placed over the GCL using the same backhoe.

Geosynthetic solutions solve construction problems

Most of the emergent marsh and hemi-marsh areas of System A were wet but sufficiently stable for subgrade preparation and controlled GCL placement. The aquatic marsh areas of Systems A, B and C, however, were extremely wet and unstable. Although it was possible to deploy the GCL in these areas, the weight of the soil cover and the backhoe on the GCL caused consolidation of the saturated subgrade. Water was rapidly squeezed into the interface between the liner and the subgrade, creating a shear plane that allowed the GCL to slide out of its original position. The wet cover soil placed over the liner also was unable to support the dynamic loading of the backhoe.

Two significant problems would have to be solved before liner installation could continue. First, the consolidation water had to be drained to provide better friction at the GCL and subgrade interface. Second, the overlying cover soil needed to be stabilized to support dynamic loading and to minimize the potential for liner damage during cover placement.

These problems were solved through the use of geonets and geogrids as construction tools, which facilitated liner placement and covering. Instead of placing the GCL directly on the wet and muddy subgrade, a drainage geocomposite was placed under the GCL at the overlap zone. This allowed consolidation water to drain from the GCL and subgrade interface. The overlying cover soil was stabilized by placing a geogrid over the liner. The geogrid improved the load-bearing capacity of the soils and allowed heavy equipment to operate above the liner system without damaging or shifting the GCL panels.

These ideas were tested in January 1993 on a small portion of System A. Representatives of the geosynthetics manufacturers were present to coordinate the test and to provide installation recommendations to Schiavone. First, a roll of drainage geocomposite was placed on the open subgrade. GCL panels then were placed so the overlap was centered in the drainage geocomposite (**Figures 4 and 5**). A biaxial geogrid was placed directly over the GCL, so that it, too, bridged the GCL overlap zone. Lastly, an adjacent GCL panel was placed, and the remaining section of the geogrid was laid over the GCL (**Figures 6 and 7**).

As backfill was placed, water immediately began draining from the geonet's exposed end. Schiavone was careful to place the cover progressively from the GCL overlap zone outward to further relieve hydrostatic pressure beneath the liner. With the geogrid in place over the GCL, the soil cover was able to support equipment loadings, greatly improving the overall stability of the liner/cover system. Based on the performance of this test section, the DOT authorized the use of the supplemental geosynthetics in any areas where they were deemed necessary for GCL placement.

Schiavone took an additional step in addressing the water problems by modifying the sequence of subgrade preparation and GCL placement. Areas excavated below the water table would become flooded more quickly than the water could be pumped out. A short period of relatively dry conditions, however, existed immediately after a cut was made. During this time, Schiavone synchronized excavation, liner placement and covering activities within isolated areas (**Figure 8**). Progress was slow; only 2 to 3 rolls of GCL per day were deployed in these wet areas. But the cut-and-cover technique helped control infiltration. In other areas of the site, the subgrade was unstable though not as wet, and geogrids were used for more traditional subgrade stabilization purposes.

The geonet and geogrid were used for the purpose of facilitating liner deployment and were not designed to provide any long-term drainage or reinforcement functions once installation was completed. Without these materials, however, liner placement would not have been possible.

Project completion

Altogether, 1.3 million square feet of GCL, 345,000 square feet of geogrid and 106,000 square feet of geonet were installed during an 18-month period from October 1992 through April 1994. As parcels of the wetlands were lined and covered, landscapers planted a variety of aquatic plants to initiate the population of the new ecosystem. Additional vegetation is expected to establish itself naturally as so-called propagules of plant matter drift into the wetlands from the Ramapo River inflow structure. Within three years, the wetlands should look entirely natural and densely vegetated. Interestingly, the natural appearance and performance of the wetlands would not have been possible without the use of several different manufactured geosynthetic materials.

About the authors *Bob Trauger, P.E., is technical services manager for Colloid Environmental Technologies Co. (CETCO), in Arlington Heights, Ill. Joe Burgio, P.E., is principal engineer for the New Jersey Department of Transportation, Construction Division, in Mahwah, N. J.*