

THE TRAIL FORUM

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Geosynthetics for Trails in Wet Areas

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Trails on soft, water-saturated soils present special challenges. Improper construction of trails in wet areas leads to soil compaction, sedimentation, multiple trails, and unhappy trail users. Turnpike or puncheon has worked well where rock or wood materials are readily available, but the use of geosynthetics can increase the effectiveness of trail construction methods and offers additional alternatives. Geosynthetic materials have been used increasingly in trail construction over the past 10 years. We present here some guidelines and product information for trail managers.

Geotextile, often called "construction fabric," is primarily used for separation and reinforcement over wet, unstable soils. It can both support loads and allow water but not soil to seep through.

Geonet has a thin polypropylene drainage core covered on both sides with geotextile, which provides more reinforcement in addition to separation and drainage.

Geogrid is a more open polyethylene structure with high tensile strength that can interlock coarse aggregate into the grid structure.

General Guidelines for Geosynthetic Use

Geosynthetics are usually placed directly on the natural ground without prior excavation and covered with trail tread material. Less tread fill can be used over geosynthetic products that are rigid or have high bending strengths because the weight of fill is distributed over a larger area. For example, much more tread fill is required for a single layer of geotextile than for geocell with geotextile. In this example, the cost of importing tread fill must be compared to the increased cost of the geocell.

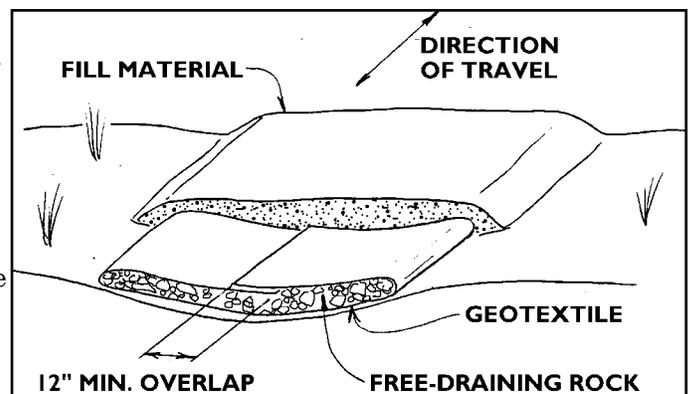
Alternatives that use tread fill should have a crowned surface to shed water quickly, improve stability, and control erosion and sediment. After backfilling, there will be some settlement depending on soil type, level of saturation, and the weight and depth of fill. Additional fill may then be necessary to maintain the crown due to settlement or tread wear. In all cases keep geosynthetics covered to protect them from ultraviolet light and traffic abrasion.

Geotextile or Geonet (single layer)

This basic application places fill on a single layer of geotextile or geonet which (a) separates fill material from saturated soils, and (b) distributes fill weight so less settlement takes place. Since geonets cost more, use them only where drainage and subsurface moisture conditions are worst. Avoid using organic, silty, or clayey soils for trail tread material since little subsurface drainage will occur, and the trail tread will become muddy in wet weather. Rocky soils or crushed aggregate are the best tread materials since they retain much of their strength when saturated. Excess surface moisture can drain off through these permeable materials if the trail is located on a grade or side slope.

Geotextile with Encapsulated Free Draining Rock (Sausage Technique)

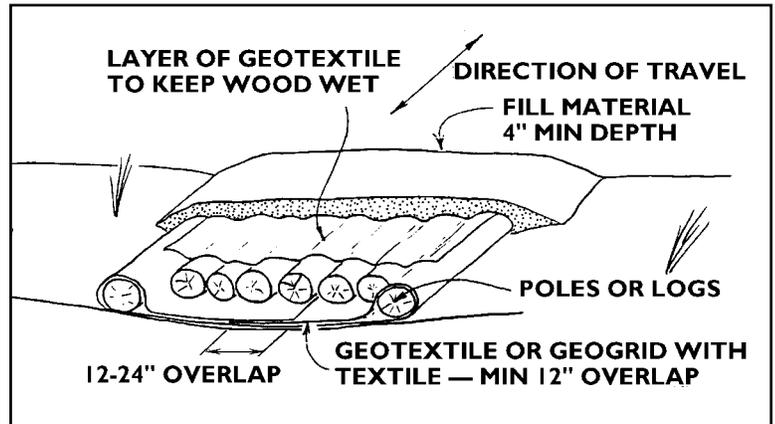
This application involves encapsulating native or free-draining rock in a piece of geotextile and placing fill on top. The geotextile provides separation from the saturated soil, and the rock provides drainage for excess water. One-inch flexible plastic pipe outlets for subsurface water may be desirable where trails are constructed on very flat terrain to avoid the 'bath tub' effect. If the trail has grade, and or if built on a side slope, other drainage options exist.



The rock may be single size material from pea gravel to cobbles (3-12") or a mixture of rock material that does not contain silt or clay. The free-draining rock can be placed to a thickness equal to the largest rock if only drainage is desired. If reinforcement is also needed, at least 3" of rock is recommended. The geotextile is wrapped over the rock layer with a 12" overlap to ensure encapsulation, since settlement of saturated soil can pull the overlap joint apart.

Geotextile with Poles, Logs

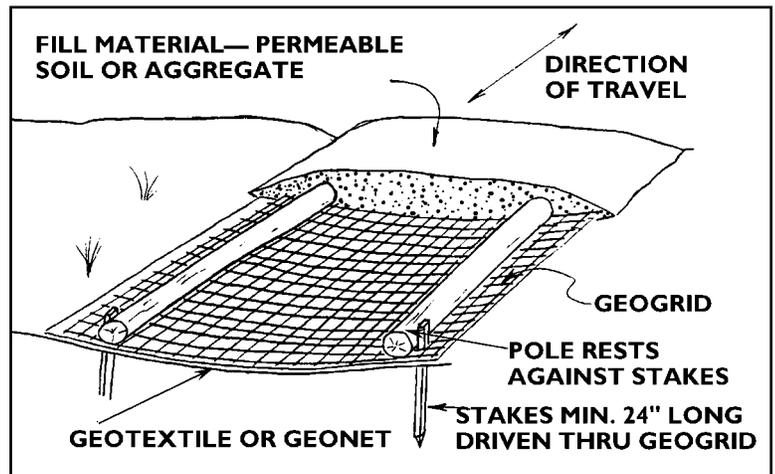
This turnpike application involves wrapping poles, logs, or saplings in geotextile with the poles parallel to the trail. This structure requires less fill and resists being pushed down into soft soils. No subsurface drainage is provided with this design, but longitudinal drainage may occur along the poles if the trail slopes. Another approach is to cut logs to the trail width and place them crosswise, but it does not use log bending strengths as effectively and is more labor intensive. Use an outlet pipe to provide drainage where trails are on a grade or side slope.



Soil settlement is minimal because the wood structure is light weight; the bending strength of wood distributes the weight of fill and traffic; and wrapping trees together with geotextile distributes loads. This method is attractive for areas with wood but not much rock for drainage, and for swampy areas where flotation and bending strength of wood is used. Wood must be kept constantly wet or dry to control rotting. A layer of geotextile down the centerline over the logs will help keep them saturated and securely positioned below the trail tread surface.

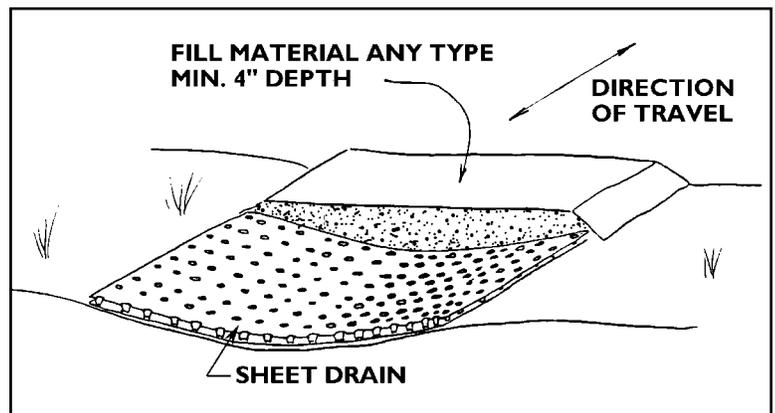
Geogrid with Geotextile or Geonet

Geogrid placed on top of the geotextile or geonet adds bending strength to the system, and decreases settlement and amount of fill material required. Very little drainage is required with this design unless geonets are used, or if the tread material is permeable (rocky soils or crushed aggregate). The geogrid should be pulled taut to remove wrinkles prior to staking. The stakes and poles provide some pre-tension of the grid, to better utilize its strength. The geotextile or geonet provides separation from the saturated soil and keeps the drainage paths along the bottom of the fill material from clogging.



Sheet Drains under Tread Fill

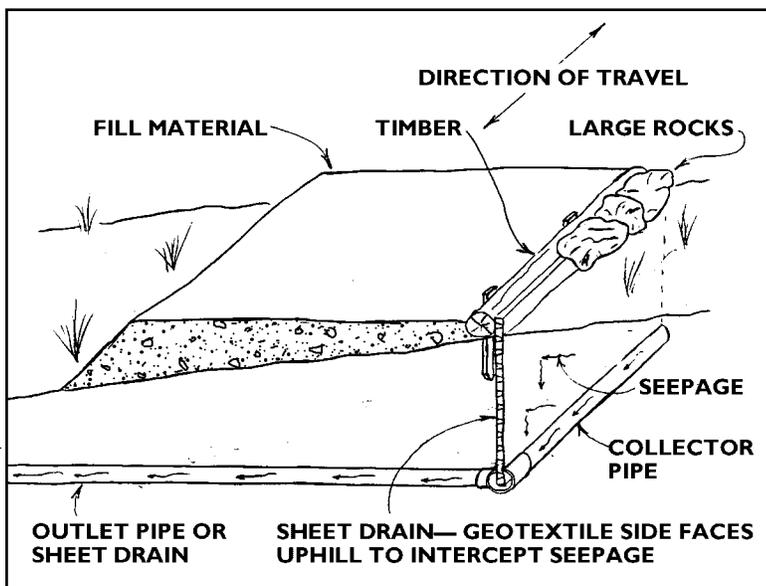
The sheet drain provides separation from saturated soils and distributes the trail tread weight to limit settlement. Install the product with the plastic core side facing up, and the fabric side facing down. This orientation takes advantage of the plastic core compressive strength and the fabric's tensile strength to reduce settlement and fill required. One-inch diameter flexible plastic pipe can be used as a drainage outlet to take full advantage of the drainage capability of the sheet drain.



Sheet Drains Used as Drainage Cutoff Walls

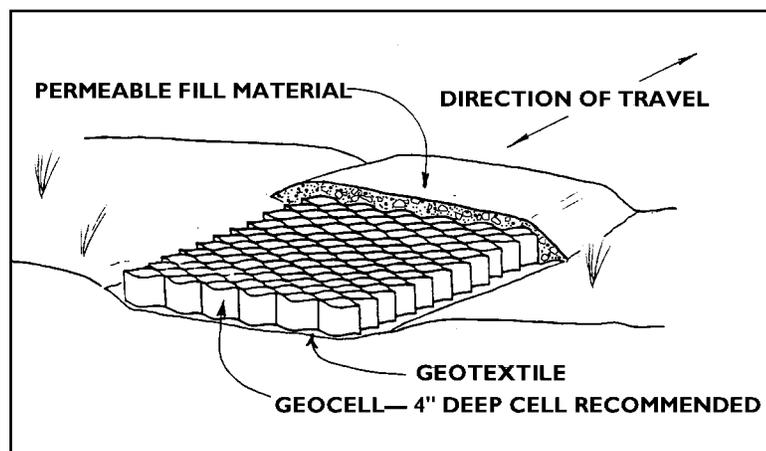
If the trail section is on a side slope where subsurface water saturates the uphill side of the trail, a cutoff wall will intercept surface and subsurface moisture and help drain and stabilize the trail section. This application is especially beneficial where cut-slope sloughing fills in ditches. The sheet drain is placed vertically along the uphill side of the trail within 3 feet of the trail's edge.

Probe the saturated soil with a short length of #4 reinforcing steel to determine the proper depth of the collection pipe and location of the sheet. Collector and outlet pipes can be made from flexible plastic pipe. Keep the top edge of the drain above ground to capture surface runoff moving downslope. Cover the exposed sheet drain with large rocks to protect it from deterioration from sunlight. The collector pipe can be drained into an outlet pipe or with a sheet drain panel under the trail section. This application requires ditching for proper interception and drainage of water. More ditching is normally required on flatter terrain.



Geocell Backfilled with Geotextile and Permeable Tread Material

The geocell provides confinement chambers which distribute the trail tread loads over a wider area and reduce settlement. The net effect is it increases the load bearing capacity of the tread and prevents feet and hooves from punching down into the trail. The geotextile provides separation between saturated soil and the tread fill. There is no subsurface drainage if the trail is on flat ground, but on a side slope, drainage will occur through the permeable tread fill. Sandy or rocky soils, crushed aggregate, or rock are desirable fill for geocells. Geocell itself does not increase the load bearing strength of clay or silt.



GEOSYNTHETIC PRODUCT INFORMATION

The listed manufacturers and products were obtained from the *Geotechnical Fabrics Report, 1995 Specifier's Guide*. The products listed are ones that are readily available. Many other products from these and other manufacturers may be appropriate. Most manufacturers and Geotechnical/Materials Engineers can assist in selecting products if you provide details on soil and moisture conditions, expected loads (light loads for trails), etc.

Prices vary throughout the country due to shipping costs, but for comparison purposes prices are shown in dollars per square yard. Price ranges in parenthesis are in dollars per square yard although manufacturers may use other units or full roll quantities. All geosynthetic products can be either field cut or pre-cut by the manufacturer to meet width requirements and weight handling capability.

GEOTEXTILES Manufacturers

<u>Company Name</u>	<u>Phone Number</u>	<u>Product Name/Number</u>
AMOCO	(800) 445-7732	4545
Nicolon/Mirafi Group	(800) 234-0484	140N
Linq Industries	(803) 873-5800	130 EX

Price range: \$.63 to \$.72 per square meter (\$.53 to \$.60 per square yard)

Typical product unit weight: 0.13 Kg/square meter (0.25 lb/square yard)

Notes: These products are non-woven felt-like fabrics that are easier to work with than heat-bonded or slit film products that have a slick surface texture. Compare desired widths with standard roll widths for field or factory cutting. Costs are based on one roll quantities which normally cover 400 to 500 square meters (475 to 600 SY).

GEONET Manufacturers	<u>Company Name</u>	<u>Phone Number</u>	<u>Product Name/Number</u>
	Tenax	(800) 874-7437	Tenax TNT 204042
	Tensar Corporation	(800) 292-4459	DC 4205

Price range: \$3.50 to \$4.60 per square meter (\$2.97 to \$3.87 per square yard)

Typical product unit weight: 0.89 kg/square meter (1.64 lb/square yard)

SHEET DRAINS Manufacturers	<u>Company Name</u>	<u>Phone Number</u>	<u>Product Name/Number</u>
	Mirafi	(800) 234-0484	Miradrain 6000
	Contech	(513) 425-2165	C-Drain 15K
	Presto	(800) 558-3525	Amerdrain 500

Price range: \$6.50 to \$8.50 per square meter (\$5.40 to \$7.11 per square yard)

Typical product unit weight: 2.3 Kg/square meter (4.25 lb/square yard)

Notes: Compare desired widths with standard sheet widths and consult with manufacturers for field or factory cutting. Various core thicknesses are available. For example, Presto makes a product called Akwadrain with a 25mm core thickness with fabric on both sides, that has significantly greater bending strength which limits the settlement in soft soils, and reduces the amount of fill material required.

GEOGRID Manufacturers	<u>Company Name</u>	<u>Phone Number</u>	<u>Product Name/Number</u>
	Contech	(513) 425-2165	Tensar BX1100
	Tensar	(800) 292-4459	Tensar BX1100
	Carthage Mills	(513) 761-4141	FX-3000
	Tenax	(800) 874-7437	MS 300
	Huesker	(800) 942-9418	Fortrac 35/20-20
	Mirafi	(800) 234-0484	Miragrid 5T

Price rRange: \$2.15 to \$4.75 per square meter (\$1.80 to \$4.00 per square yard). Low-cost products are made from polypropylene, higher-cost products from coated polyester. Both product types are adequate for trails

Typical product unit weight: 1.75 Kg/square meter (0.34 lb/square yard)

Notes: Specify desired product widths and lengths for the project application.

GEOCELL Manufacturers	<u>Company Name</u>	<u>Phone Number</u>	<u>Product Name/Number</u>
	Presto	800-558-3525	Geoweb
	AGH	713-552-1749	EnviroGrid
	WEBTEC	800-438-0027	TerraCell

Price range: \$7.50 to \$11.30 per square meter (\$6.30 to \$9.45 per square yard)

Typical product unit weight: 1.55 Kg/square meter (2.9 lb/square yard)

Typical product dimensions: 4" x 8" (Depth x Length) and 20ft x 8ft (Length x Width)

Notes: Specify desired product widths for the project application. The 100 mm (4 inch) cell depth should be adequate for trails - depths from 50 mm to 200 mm (2 to 8 inches) are available. Consult manufacturers for availability of different section widths and alteration of standard section widths to fit your project needs.

This information is taken from a draft report by Steve Monlux of the U. S. Forest Service's Missoula Technology Development Center in Montana. The full report on geosynthetics and their applications for trail construction will be available by October, 1995. For more information on this topic, contact Lois Bachensky, U.S. Forest Service Engineering, Rocky Mountain Region, 740 Simms, Lakewood CO 80225 (303) 275-5199.

The next issue of The Trail Forum will appear in the July issue of Colorado State Trails News. Our planned topic is accessible trails for natural-surface, less-developed areas. Beneficial Designs of Santa Cruz, California, has been doing research on mapping, trail difficulty levels, and improving trail access, and we will report on some of their work and available publications.
