Permeable Pavement: What's It Doing On My Street?

An introduction to permeable pavement alternatives
November 2005

The University of Rhode Island Cooperative Extension in partnership with the Rhode Island Department of Health Source Water Protection Program

Rhode Island Department of HEALTH

UNIVERSITY OF Rhode Island

Table of Contents

An Introduction to Permeable Construction Materials 1
- Block Pavers 2
- Porous Pavement 3
- Plastic Grid Pavers 4

Block Paver Fact Sheets 5
- Aquaterra™ 6
- UNI Eco-Stone®, with an example application 7
- SF-RIMA™ 9
- Turfstone, with an example application 10
- Hastings Checker Block® 12

Porous Pavement Fact Sheets 13
- Porous Concrete 14
- Porous Asphalt, with an example application 15

Plastic Grid Paver Fact Sheets 19
- Grasspave², with an example application 20
- Gravelpave² 22
- Geoblock Porous Pavement System 23
- Grassroad Pavers⁸ Plus 24
- Tufftrack Grass Pavers 25
- Netpave 50, with example applications 26
- Netpave 25 29
- Turfguard 30
- Advanced Turf, with an example application 31

An Introduction to Permeable Construction Materials

Whether you're a Town board member, a professional contractor, or a homeowner with a driveway, a little information about permeable pavement can explain why you might want to consider this popular alternative construction material.

A wide range of permeable materials have become more readily available and widely used over the last two decades as alternatives to conventional road construction materials. These have proven to be practical, cost-effective, and environmentally sustainable due to their ability to reduce urban stormwater runoff. Because these permeable materials allow water to pass through the surface (in the case of porous asphalt and porous concrete) or through void spaces (in the case of concrete or grid pavers), both runoff volume and water quality impacts are reduced. That keeps nuisance flooding down, recharges groundwater supplies, and helps to keep drinking waters healthy.

These permeable pavements are appropriate for a variety of uses, such as pedestrian walkways, overflow parking areas, parking lots, and residential roads. For best success, a few key factors must be considered when undertaking a project involving permeable alternatives. For example:

1. Choose the correct paver for the task at hand. Permeable pavement options vary based on light, moderate, or heavy use. Therefore, it is imperative to choose the right material for the expected use.
2. Prepare the subbase. Choose the appropriate subbase preparation for the application.. , The type of subbase used and depth of the subbase materials determines the amount of infiltration provided, as well as durability over time. In locations with numerous freeze-thaw cycles, poor soils or an extremely cold climate, a thicker subbase is usually required. Install properly. In many cases, the manufacturer will install, oversee the installation, or recommend certified contractors.
4. Understand and carry out maintenance requirements; it's critical to the durability of permeable materials.

This technical bulletin describes the range of permeable pavements currently available to help you evaluate alternatives that will best suit your needs. The permeable pavement information presented in this manual is organized according to strength and durability: 1) Concrete block pavers have the highest load bearing capacities, followed by 2) porous pavement and then 3) plastic grid pavers. We begin with a one-page overview of these three types, followed by more detailed information on various products available under each group with case studies of constructed projects. For more information, contact local distributors. This bulletin may not include all products available, nor does it constitute an endorsement of any product. Any errors or omissions are the sole responsibility of the authors.

Block Pavers

These pavers are constructed primarily from concrete. They interlock with one another but leave open, void space between the pavers to permit water to infiltrate into the underlying gravel reservoir. The thickness of the gravel subbase, and the type of material used to fill in the void spaces, determines the amount of infiltration permitted. A typical concrete block pavement installation consists of a soil subgrade, a gravel base, a layer of bedding sand, and the grid pavers. The void space around the pavers can be filled with either gravel or soil and grass.

Block pavers are recommended for use in parking lots, overflow lots, residential streets, medians, driveways, sidewalks, fire lanes, pedestrian plazas, and roof ballast. Proper site preparation, installation, and maintenance are *key* to the block pavers' long-term success. Examples of some of the concrete block pavers that are described in greater detail on the attached sheets are shown below.

Fire access paved with Hastings Checker Block

Driveway paved with Turfstone

Parking lot paved with SF-

Driveway paved with Aquaterra

Porous Pavement

Porous asphalt and porous concrete are very similar to their conventional counterparts, but they are mixed without the fine particles (i.e. those less than 600 μ) to allow for the passage of stormwater through the surface. After the water passes through the porous surface, it is temporarily stored in an underlying crushed rock storage reservoir and slowly released into the underlying soils. A geotextile filter fabric is placed on the floors and sides of the recharge bed to prevent fine soils from migrating into the bed.

The load bearing capacity of porous pavement is less than conventional pavements because of the absence of the fine particles. Therefore, large commercial vehicles should not be permitted to park in lots paved with permeable materials. Porous pavement projects require less stormwater pipes and inlets than conventional pavement, and detention basins are not required.

The long-term success of any porous pavement project is dependent upon proper site positioning, design, construction, and maintenance. A failure to properly test for soil drainage capacity and water table height, to leave paved areas unprotected from construction-related sediment losses, or to ignore recommended periodic maintenance can result in their premature clogging and failure. The use of these materials is recommended for passenger vehicle parking lots, overflow or event parking areas, roadways with light traffic (i.e. residential subdivision streets), bike paths, and pedestrian walkways.

Porous asphalt pathway at Swarthmore College. (Source of photograph: Cahill Associates)

Porous asphalt parking lot at University of Rhode Island.

Porous concrete sidewalk at Penn State University (Source of photograph: Cahill Associates)

Plastic Grid Pavers

These pavers are constructed primarily from recycled plastic materials. They can be filled with either gravel or soil and grass, with the former being a better choice for more frequently used areas.

Due to their flexibility plastic grid pavers can be used on sites with uneven terrain, but they do not have as much intrinsic strength as concrete pavers. The plastic grid pavers' load bearing capacity ranges from 24,000 lbs/ft ^{2} to 823,680 lbs/ft^2. They do not require drains, detention or retention ponds, or any other associated drainage facility, but proper site placement, installation, and maintenance are *key* to their overall success. For example, it is important to avoid directly routing large volumes of runoff from adjacent impervious areas onto the grid pavers, because that could clog them with sediment and deposit salt on the vegetation in the winter. Plastic grid pavers are recommended for use in parking areas, residential driveways, fire lanes, emergency access roads, golf cart paths, sidewalks, and bike paths.

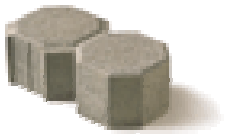
Driveway paved with Netpave 50.

Driveway paved with Turfguard.

Block Paver
Fact Sheets

Type of Paver	Applications	Performance	Installation Details	Maintenance	Costs	Local Retailer
Aquaterra™ *Description:* These pavers are small (8.9" x 4.4" x 3.125") impervious concrete blocks that interlock with one another, but leave void spaces between the adjacent blocks to permit the infiltration of water. The void spaces are filled with gravel. The paver is constructed with Portland cement. *Manufacturer*: Unilock Additional information is available online at http://www.unilock.com/Product.asp?Product=114 	Suitable for residential and emergency access roads, driveways and parking lots.	Mean compression strength is greater than 1,584,000 lbs/ft^2 (11,000 psi). In comparison, a concrete slab has a mean compression strength less than 432,000 lbs/ft^2 (3,000 psi). The pavers have a lifetime guarantee and are easy to repair.	Installation requires a contractor. The thickness of the gravel base depends upon the anticipated loads, necessary stormwater drainage, and subgrade soil conditions. For residential uses on adequately drained soil, the gravel base can be omitted and the block pavers placed directly on the sand bedding layer. For heavier vehicle loads or frequent usage, a minimum of 6" of compacted gravel base is recommended. The sand bedding layer is loosely spread by handscreening or with equipment to a depth of at least 1". The pavers are placed in the bedding layer by hand or machine and the void spaces surrounding the pavers are filled with gravel.	Periodic maintenance is required to clean silt and debris from the voids/drainage openings with street sweepers and refill the displaced gravel when necessary Salts and sands should be used sparingly, if at all, for deicing in the winter. A snowplow may be used to clear the surface. The blade does not need to be lifted.	The paver costs ~$ 2.98 per square foot. A project calculator is available online at http://www.unilock.com/ProjectCalculator.asp for estimating project costs.	Unilock New England 35 Commerce Drive Uxbridge, MA 01569 (508) 278-4536 Territory Manager: Matthew Foley Unilock will provide information on at least two authorized contractors that can supply labor and materials to interested parties.

Local projects in Rhode Island include Great Island, Harbor Island, and Boston Neck Road in Narragansett, and Carver Lane and Schooner Cove in Pt. Judith. A private subdivision in Connecticut is also planning on installing Aquaterra pavers in the near future.

Type of Paver	Applications	Performance	Installation Details	Maintenance	Costs	Local Retailer
UNI Eco-Stone® *Description:* These pavers are small (~9”x 4.5”x 3.125”) impervious concrete blocks that interlock with one another, but leave joint spaces (.125”) between the adjacent blocks. The void spaces are filled with gravel. The paver is constructed with Portland cement, and the design of the paver creates voids comprising ~12% of the surface area. Infiltration occurs through the funnel shaped openings created by the notch configuration molded into each unit. *Manufacturer*: Unilock, Ideal Concrete Company. Additional information is available online at http://www.unilock.com/Product.asp?Product=108 and http://www.idealconcreteblock.com/pavers.cfm?id_name=11  	Suitable for residential and emergency access roads, driveways and parking lots.	The average compression strength is at least 1,152,000 lbs/ft^2 (8000 psi) with no individual unit less than 1,036,800 lbs/ft^2 (7200 psi). The pavers have a lifetime guarantee and are easy to repair.	Installation requires a contractor. The thickness of the gravel base depends upon the anticipated loads, necessary stormwater drainage, and subgrade soil conditions. For residential uses on adequately drained soil, the gravel base can be omitted and the block pavers placed directly on the sand bedding layer. For heavier vehicle loads or frequent usage, a minimum of 6” of compacted gravel base is recommended. The sand bedding layer is loosely spread by handscreening or with equipment to a depth of at least 1”. The pavers are placed in the bedding layer by hand or machine and the void spaces surrounding the pavers are filled with gravel.	Periodic maintenance is required to clean silt and debris from the voids/drainage openings with street sweepers and refill the displaced gravel when necessary. Salts and sands should be used sparingly, if at all, for deicing in the winter. A snowplow may be used to clear the surface. The blade does not need to be lifted.	The paver costs begin at \$3.07/ft^2. A project calculator is available online at http://www.unilock.com/ProjectCalculator.asp for estimating project costs.	Conklin Limestone 25 Wilbur Road Lincoln, RI 02865 (401) 334-2330 http://www.conklinlimestone.com Unilock New England 35 Commerce Drive Uxbridge, MA 01569 (508) 278-4536 Territory Manager: Matthew Foley Paver cost is \$3.07/ft^2

UNI Eco-Stone® Example Application - Jordan Cove National Project in Waterford, Connecticut

Site Description: Some of the cul-de-sacs, streets, and driveways in the best management practice (BMP) section of the Jordon Cove National Project in Waterford, CT are paved with UNI Eco-Stone pavers. The Jordan Cove Urban Watershed Section 319 National Monitoring Program Project is a ten year study designed to ascertain how the quality and quantity of stormwater runoff is affected by pollution prevention BMPs used throughout an urban subdivision.

Design Details: Approximately 15,000 ft^2 of the UNI Eco-Stone pavers were installed in the BMP watershed to construct a 6.1 m-wide road (~20 feet), the cul-de-sacs, and some of the homeowners' driveways.

Cost Information: The cost of constructing the road and curbs with UNI Eco-Stone pavers and conventional asphalt was $102,500 and $18,860, respectively. The cost of the driveways and driveway aprons paved with UNI Eco-Stone pavers was $7,896 and $1,318 per lot, respectively whereas the conventional asphalt driveways and driveway aprons cost $1,318 and $280 per lot, respectively. Additional cost information is available online at http://www.canr.uconn.edu/jordancove/bmp_costs.htm.

Maintenance: Periodic maintenance is required to clean silt and debris from the voids/drainage openings with street sweepers and to refill the displaced gravel.

Contacts: Bruce Morten, Aqua Solutions (860) 295-1505 or Aquasoln@aol.com

Photography: University of Connecticut NEMO website (http://www.canr.uconn.edu/jordancove/new_page_4.htm)

Type of Paver	Applications	Performance	Installation Details	Maintenance	Costs	Local Retailer
SF-RIMA™ *Description*: These pavers are small (7.75” x 7.75” x 3.125”) impervious concrete blocks with a total of six spacers along the edges that can either interlock with one another or be placed spacer to spacer for additional void space. The void spaces between the adjacent blocks permit the infiltration of water to the underlying permeable base and subbase materials. When the spacers are placed against the adjacent paver stone a 0.5” joint is formed that can be filled with gravel. When the spacers are placed against other spacers, a 1” joint space is formed that can be filled with soil and grass. The former has ~8.5% open area whereas the latter has ~22% open area. *Manufacturer:* SF Concrete Technology, Inc. Additional information is available online at http://www.sfconcrete.com/products/sfrima/description.html 	Suitable applications for the gravel filled pavers include parking lots, residential roads, driveways, sidewalks and patios. Suitable applications for the grass filled pavers include overflow parking lots, street medians, driveways, patios, and garden paths.	The compression strength is at least 1,152,000 lbs/ft^2 (8000 psi). The pavers have a water absorption maximum of 5%. The pavers have a lifetime guarantee and are easy to repair.	Installation can be done by a contractor or homeowner. The thickness of the gravel base depends upon the anticipated loads, necessary stormwater drainage, and subgrade soil conditions. The overlying bedding layer should not exceed 1” in thickness. The pavers are placed in the bedding layer and the void spaces surrounding the pavers are filled with either gravel or soil and grass, depending on which design (i.e. spacer to side or spacer to spacer) was chosen.	Maintenance includes mowing, irrigation fertilization, and seeding. Intermittent replacement of gravel may be necessary over time. Deicing salts should not be used because it will kill the grass. A snowplow may be used to clear the surface. The blade does not need to be lifted.	The paver costs range between \$3.10/ ft^2 and \$3.20/ ft^2 and are sold in bundles of 67 ft^2. When the pavers are filled with gravel, 2.7 stones are required per sq. ft. When the pavers are filled with grass, 1.9 stones are required per sq. ft.	Conklin Limestone 25 Wilbur Road Lincoln, RI 02865 (401) 334-2330 http://www.conklin limestone.com Hartford Materials 112 Old Pocasset Road Johnston, RI 02919 (401) 942-8857 Paver cost is \$2.56/ ft^2 Riverview 147 Kennedy Drive Putnum, CT 06260 (860) 928-4222 Paver cost is \$3.20/ft^2. but can be less depending on the amount purchased.

Local projects in Rhode Island include a 35,000 ft^2 parking lot at the Misquamicut Beach in Watch Hill.

Type of Paver	Applications	Performance	Installation Details	Maintenance	Costs	Local Retailer
Turfstone *Description:* This product is a light duty, lattice, concrete paver with approximately sixty percent impervious coverage. The diamond shaped openings within the lattice pattern can be filled with either soil and grass or gravel. The pavers are 16" x 24" and have three different height sizes (3 cm, 8 cm, and 10 cm). *Manufacturer*: Unilock, Ideal Concrete Block Company, Cambridge Pavers, and Nicolock. Additional information is available online at http://www.unilock.com/Product.asp?Product=112, http://www.ideal concrete block.com/pavers.cfm?id_name=11, and http://www.Hiwayconcrete.com/html/Nicolock.html. 	Suitable for overflow parking areas, emergency vehicle access roads, patios, driveways, spillways, and embankments.	The average compression strength of the Turfstone manufactured by Unilock is 720,000 lbs/ft^2 (5000 psi) with no individual unit less than 648,000 lbs/ft^2 (4500 psi). The compression strength of the Turfstone manufactured by Cambridge is 1,440,000 lbs/ft^2 (10,000 psi). The pavers have a lifetime guarantee and are easy to repair.	May be installed by contractor or homeowners. A gravel base may be required to provide additional stability based on soil type and use expectations. The base is usually 6" of compacted gravel, but can vary based on intended use. Geotextile reinforcement is recommended between the subbase and gravel base for vehicular traffic. The pavers are embedded in ~ ¼ to ½ inch of concrete sand and should not be compacted. The final level of topsoil/gravel should be flush with surface.	Maintenance includes mowing, irrigation fertilization, and seeding. Intermittent replacement of gravel may be necessary over time. Deicing salts should not be used because it will kill the grass. A snowplow may be used to clear the surface. The blade does not need to be lifted.	The paver costs between \$ 2.25/ft^2 and \$2.70/ft^2. A project calculator is available online at http://www.unilock.com/ProjectCalculator.asp for estimating project costs.	Conklin Limestone 25 Wilbur Road Lincoln, RI 02865 (401) 334-2330 http://www.conklin limestone.com Paver cost is \$2.25/ft^2 Unilock New England 35 Commerce Drive Uxbridge, MA 01569 (508) 278-4536 Territory Manager: Matthew Foley Paver cost is \$2.32/ft^2 Hartford Materials 112 Old Pocasset Rd. Johnston, RI 02919 (401) 942-8857 Paver cost is \$2.16/ft^2 Riverview 147 Kennedy Drive Putnum, CT 06260 (860) 928-4222 Paver cost is \$2.70/ft^2 but can be less depending on the amount purchased.

Turfstone Example Application - Purchasing Building, University of Rhode Island, Kingston, R.I.

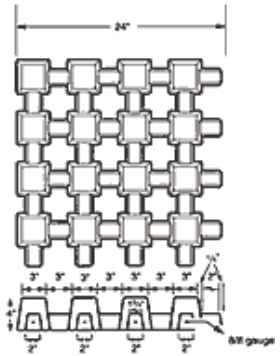
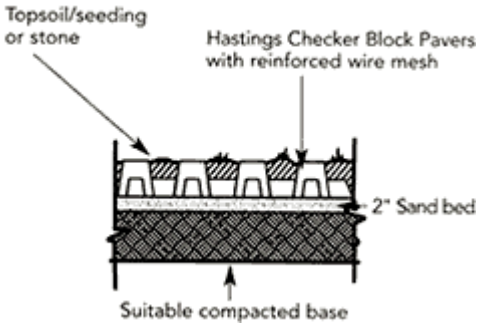
Site Description: An emergency vehicle access road was constructed with Turfstone outside of the Purchasing Building, which is located at the bottom of Flagg Road on the University of Rhode Island's Kingston campus.

Design Details: The area where this access road was constructed is prone to mud formation when the top layer defrosts on a cyclical basis in the spring. The University wanted to ensure a stable foundation for emergency access vehicles.

Maintenance: Regular maintenance includes mowing, irrigation, and fertilization.

Notes: According to David Bascom, Assistant Director of the Landscapes and Grounds Department at the University of Rhode Island, the Turfstone emergency access road is easy to maintain and has held up very well.

Contacts: David Bascom, Assistant Director of the Landscapes and Grounds Department. (401) 874-5515 or b'snest@uri.edu

Type of Paver	Applications	Performance	Installation Details	Maintenance	Costs	Local Retailer
Hastings Checker Block® ***Description:*** This product is a light duty, square shaped (2'x2') lattice concrete paver with small cross-shaped internal openings that can be filled with either soil and grass or gravel. The ratio of grass or gravel to concrete is ~70%. *Manufacturer:* Hasting Pavement Company http://www.hastingspavers.com/chblock.html   	Suitable for overflow parking, service roads, fire access lanes, and tree pits. Suitable for stabilizing embankments along water bodies.	Achieves a concrete strength of 5,000 psi.	A base can be either undisturbed earth or fill compacted to 95% maximum dry density. Sand is placed in a 2" compacted layer over the base. The void can be filled either with crushed gravel or topsoil.	Grass can be maintained using a conventional lawn mower.	The 2' x 2' pavers are sold in bundles of 20, which covers 80 square feet. Price is determined by retailer and size of project.	UBS-United Builders Supply 30 Oak Street Westerly, RI 02891 (401) 596-2831 don't carry; may be able to order PO Box 417 Wyoming, RI 02898 (401) 539 3033 don't carry; may be able to order

Porous Pavement Fact Sheets

Type of Paver	Applications	Performance	Installation Details	Maintenance	Costs	Local Retailer
Porous Concrete ***Description:*** This product is composed of a specially formulated mixture of Portland cement, uniform open-graded coarse aggregate, admixtures, and water to create a material with 15-25% void space. Water is able to percolate through the void space into the underlying crushed rock reservoir and soil mantle. Impervious concrete and porous concrete utilize the same mixing and application equipment. Additional information is available online at http://www.thcahill.com/pconcrete.html 	Suitable for parking lots, residential streets, plazas, play courts, bike paths and sidewalks. It is much more difficult to get the porous concrete mix right in comparison to porous asphalt. In addition, it is much coarser looking than conventional concrete. Therefore, concrete asphalt is usually a better option for smaller areas where aesthetics are an important factor.	The load bearing capacity of porous concrete is usually between 259,200 and 345,600 lbs/ft^2 (1800-2400 psi). depending on the soils with high permeability, such as sands and sandy loams, have the best ability to carry loads. Porous concrete becomes stronger and more stable when it gets wet. Therefore, it does not deteriorate as fast as other paving materials. Expected lifespan of 15-20 years if properly sited, designed, installed, and maintained.	The porous concrete is installed over a 1" layer of chocker course and bed of uniformly graded, clean washed crushed rock that is usually 18-36" deep. A layer of geotextile fabric separates the crushed rock from the underlying soil to prevent any fines from moving up into the storage bed. The bottom of the recharge bed is excavated to a level surface and is not compacted to allow the water to distribute and infiltrate evenly over the entire bottom bed area.	Vacuum sweeping to remove sediment that has accumulated on the surface. Annual inspection of the surface for deterioration. Potholes and cracks can be filled with patching mixes unless more than 10% of the surface needs to be repaired. Spot clogging may be fixed by drilling 0.5" holes through the pavement layer every few feet. Winter abrasives such as sand or cinders should not be applied on the pavement surface. Deicing salts should not be applied in areas near groundwater drinking supplies, but environmentally benign deicers are permissible. Snowplow blades must be raised ~1" to protect the surface.	The cost of porous concrete is about four times greater than the cost of porous asphalt The cost depends on the amount produced and usually costs somewhere between \$2.00-\$4.00/ft^2. The underlying stone bed is usually more expensive than a conventional compacted subbase, but is offset by the reduction in stormwater pipes, inlets and elimination of detention basins. Generally, porous pavement installation does not require deep excavations and there is less earthwork.	Cahill Associates 104 South High St. Westchester, PA 19382 (610) 696-4150 BETA Group, Inc. 6 Blackstone Valley Place Lincoln, RI 02865 (401) 333-2382 Kevin Read Comprehensive Environmental, Inc. 64 Dilla Street Milford, MA 01757 (800) 725-2550

Type of Porous Pavement	Applications	Performance	Installation Details	Maintenance	Costs	Local Retailer
Porous Asphalt ***Description:*** This product is composed of an open-graded coarse aggregate that is bonded together with standard bituminous asphalt. Unlike conventional asphalt, it does not contain the small fine particles (<600 µ), which permits the infiltration of water through the pavement into the underlying crushed rock reservoir and soil mantle. Impervious asphalt and porous asphalt utilize the same mixing and application equipment. Additional information is available online at http://www.thcahill.com/pasphalt.html 	Suitable for passenger vehicle parking lots (i.e. daily, overflow or event parking), light traffic residential streets, play courts, bike paths and sidewalks. Driveways are usually too small for a contractor to prepare the specialized mix. Homeowners interested in other permeable options are referred to the fact sheets on block pavers and plastic grid pavers.	The load bearing capacity of porous asphalt is less than that of porous concrete. Sufficient asphalt content (5.75% to 6% bituminous asphalt by wt) is essential to pavement durability. Sites that used lower asphalt content show surface scuffing and/or raveling on the surface. Declines in the amount of black ice formation have been reported.	The porous asphalt is installed over a 1" layer of chocker course and bed of uniformly graded, clean washed crushed rock that is usually 18-36" deep. A layer of geotextile fabric separates the crushed rock from the underlying soil to prevent any fines from moving up into the storage bed. The bottom of the recharge bed is excavated to a level surface and is not compacted to allow the water to distribute and infiltrate evenly over the entire bottom bed area.	Vacuum sweeping to remove sediment that has accumulated on the surface. The materials removed by the vacuum must be disposed of properly. Annual inspection of the surface for deterioration or spalling (surface disintegration). Potholes and cracks can be filled with patching mixes unless more than 10% of the surface needs to be repaired. Spot clogging may be fixed by drilling 0.5" holes through the pavement layer every few feet. Winter abrasives such as sand or cinders should not be applied on the pavement surface. Deicing salts should not be applied in areas near groundwater drinking supplies, but environmentally benign deicers are permissible. Snowplow blades must be raised ~1" to protect the surface.	On a yard-by-yard basis, the cost of porous asphalt is about the same as the cost of conventional asphalt (i.e. $0.50-$1.00/ft^2). The underlying stone bed is usually more expensive than a conventional compacted subbase, but is offset by the reduction in stormwater pipes, inlets and elimination of detention basins. Generally, porous pavement installation does not require deep excavations and there is less earthwork. Current installations are average between $2,000 and $2,500 per parking space for parking, aisles, and stormwater management.	Cahill Associates 104 South High St. Westchester, PA 19382 (610) 696-4150 BETA Group, Inc. 6 Blackstone Valley Place Lincoln, RI 02865 (401) 333-2382 Kevin Read Comprehensive Environmental, Inc. 64 Dilla Street Milford, MA 01757 (800) 725-2550

Porous Asphalt Example Application – The University of Rhode Island's Porous Asphalt Parking Lots

Site Description: Two porous asphalt parking lots were built in 2002 and 2003 at the University of Rhode Island to provide 1,000 additional parking spaces near the newly constructed Ryan Convocation Center, a venue for sporting, community, and family events. The University is located on Route 138 in Kingston, R.I. The 800-vehicle lot is located on the northwest side of the intersection of Plains Road and West Alumni Road, and the 200-vehicle lot is located on the northern side of West Alumni Road.

Design Details: The larger porous asphalt parking lot is 5.5 acres, while the smaller lot, which is a retrofit of a pre-existing lot near the former Dairy Barn, is 1.47 acres. The layer of porous asphalt in the two lots is 2.5 inches thick with a slope of less than 2% to allow for maximum seepage through the pavement. Located below the layer of porous asphalt is a 1 inch thick layer of chocker course and 3 to 3.5 feet of uniformly graded, clean crushed rock. The crushed rock has approximately 40% void space to receive, temporarily store, and infiltrate the incoming rainfall and any sheetflow from the adjacent landscaped areas. The crushed rock storage reservoir is separated from the underlying subsurface materials by a layer of geotextile filter fabric. The purpose of this material is to prevent the movement of fine soil particles into the overlying reservoir, which could impede the infiltration of surface water into the storage bed. The entrance areas of the parking lots are paved with conventional bituminous asphalt because of heavier use and sediment deposition from tires as vehicles enter the lot. Landscaped parking lot islands were designed as bioinfiltration areas throughout the parking lot to provide a secondary route of infiltration during intense rainfall and in case the pavement surface begins to clog. The outer areas of the lot are landscaped with trees and grass is maintained around the parking lots' boundaries to keep wind blown dust from nearby agricultural activities and eroded soil from accumulating on the porous asphalt.

Soil excavation and placement of crushed rock.

Stone reservoir surrounded by geotextile filter fabric.

Rainwater infiltrates the porous asphalt yet accumulates on adjacent areas paved with conventional mat

Costs: The construction costs for building the two porous lots totaled $3,033,700. The design fees were approximately 10% of the aforementioned construction costs. Therefore, the cost per parking space was approximately $3,337. It is important to note that this particular project had site specific costs such as the demolition of the Dairy Barn, removal of stone masonry walls, and installation of emergency telephones and security cameras, which would not be encountered in all porous parking lot situations. The construction costs of URI's two porous parking lots were comparable to equivalent sized conventional parking lots.

Maintenance: University personnel are responsible for the maintenance of the porous parking lots. Cahill Associates and Beta Group Inc., the two design firms, recommend vacuuming of the lots at least four times per year with a commercial cleaning unit, maintaining the adjacent vegetation, not applying sand, cinders, or deicing salt to the pavement surface, but using environmentally benign deicers such as Ice Ban instead because of the proximity of the Pawcatuck sole source aquifer, plowing with the blade lifted 1" higher than normal, and inspecting the surface annually for signs of deterioration or spalling.

Notes: According to David Bascom, Assistant Director of the Landscapes and Grounds Department at the University of Rhode Island, there have not been any instances of water ponding on these lots after rainfall events, even very intense ones. However, he has observed some ice buildup following freezing rain events because the water freezes on the surface before it has time to infiltrate through the layer of porous asphalt. He also notes that the environmentally benign deicer Ice Ban does not work as well as more conventional chemicals or salts if it is not applied within thirty minutes of a snow event. The University's maintenance crew has also started to see some surface defects at the northeast corner of the parking lot, which has been attributed to outright abuse from people turning their wheels while their vehicles remain stationary. According to Dan Wible, of Cahill Associates, this type of unraveling is not unique to only porous parking lots, and laboratory research conducted to date has shown that the unraveling does not compromise the drainage capabilities of the porous lots. If one wants to repair the surface for aesthetic purposes, areas less than 50 square feet can be patched with standard asphalt while those greater than 50 square feet should be patched with an approved porous asphalt. Those interested in learning more about the porous asphalt parking lots at URI are referred to *The University of Rhode Island's Permeable Parking Lots.*

Contacts:

Cahill Associates
Dan Wible
104 South High Street
West Chester, PA 19382
(610) 696-4150
dwible@thcahill.com
Porous Pavement Email: porous@thcahill.com

BETA Group, Inc.
Brian Brosnan
6 Blackstone Valley Place
Lincoln, R.I. 02865
(401) 333-2382
Bbrosnan@BETA-Inc.com

Raymond Wilcox
Construction Project Manager
Facilities Services – Sherman Building
University of Rhode Island
Kingston, R.I. 02881
(401) 874-5288
raywilcox@uri.edu

David Bascom
Assistant Director of the Landscapes and Grounds Department
Facilities Services – Sherman Building
University of Rhode Island
Kingston, R.I. 02881
(401) 874-5515
b'snest@uri.edu

Plastic Grid Paver
Fact Sheets

Type of Paver	Applications	Performance	Installation Details	Maintenance	Costs	Local Retailer
Grasspave[2] *Description*: This product is comprised of connected plastic circular rings that can be filled with a soil/sand mix and grass. The pavers have 92% pervious area and are constructed with 100% post-consumer high density polyethylene plastic. The high void space permits excellent root development and storage capacity. *Manufacturer*: Invisible Structures Inc. Additional information is available online at www.invisiblestructures.com 	Suitable for various types of parking lots (i.e. overflow, event employee, handicap), on-street parking, driveways, fire lanes,emergency access roads, utility access, pedestrian access, golf cart paths, and infiltration basins.	Load capacity is 823,680 lbs/ft (5,721 psi, which is nearly two times the strength of 2" of concrete). It has UV inhibitors. In sandy soils, it can absorb up to 6" of rainfall over 24 hours.	Installed on top of a sandy gravel subbase. It is unrolled and pinned into place. The plastic rings and spaces between them are filled with a soil/sand mix and planted with grass. The sand in the mix helps to ensure proper drainage, proper oxygen and carbon dioxide levels, strength and stability.	Maintenance includes mowing, irrigation fertilization, and seeding. Individual grids may need to be replaced overtime. Existing equipment can be used for snow removal as long as skid plates/rollers are adjusted to keep the plow blades 1" above the surface.	The cost is highly variable depending on the size of the project. For a 10,000 ft^2project, the cost will be ~\$2.50/ft^2, which includes the gravel subbase layer, seeding etc. The price of the pavers are ~\$2.00/ft^2	Invisible Structures, Inc. 14704-D East 33rd Place Aurora, CO 80011 1-800-233-1510 www.invisiblestructures.com Distributor in R.I. A.H. Harris & Sons 25 Graystone Street Warwick, RI 02886 (401) 737-5136 www.ahharris.com

Grasspave^2 Example Application – West Farms Mall

Emergency access roads paved with Grasspave^2 have been installed at St. Andrews school in Barrington, R.I., the Naval War College in Newport, R.I., and AMG Headquarters in Beverly, MA. This product has also been used for overflow parking lots; a case study of one in Connecticut is presented below.

Photo of area prior to installation

Completed installation with end islands

Site Description: The West Farms Mall overflow parking lot was built to provide 700 additional parking spaces during the peak seasons, and it was paved with Grasspave^2. The mall is located off of I-84 at exit 40 on New Britain Avenue (Route 71).

Design Details: The overflow parking lot covers approximately 200,000 ft^2, and athletic paint is applied each November to demarcate the parking spaces. A few drains were installed under the Grasspave^2 to ensure proper drainage during very heavy storms.

Cost Information: The total cost of the paving system (including the base layers) was estimated to be less than half of the projected cost of a detention pond that would have been required if conventional asphalt paving was installed.

Maintenance: The overflow lot requires mowing on a regular basis and must be watered and fertilized occasionally. The lot must be plowed in the winter with rollers to ensure that the surface is not damaged. The entrances to the aisles have begun to show some signs of wear and will need to be replaced. The West Farms' maintenance staff is responsible for the year round care of the lot.

Notes: According to the University of Connecticut's NEMO website, Joe Leiberis, West Farms' facilities director, stated that after four years of having the Grasspave^2 overflow parking lot, he no longer worries about it. He is happy with its durability after witnessing how well it can handle the winters, summers, hurricanes, and heavy traffic. Additional information on this particular case study can be found at http://web.uconn.edu/nemo/case_studies/west_farms_cs.htm.

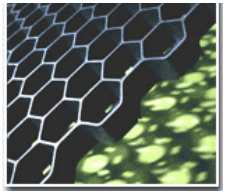
Contacts: Richter & Cegan Inc., Landscape Architects and Urban Designers rcinc@richtercegan.com

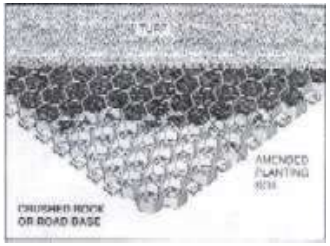
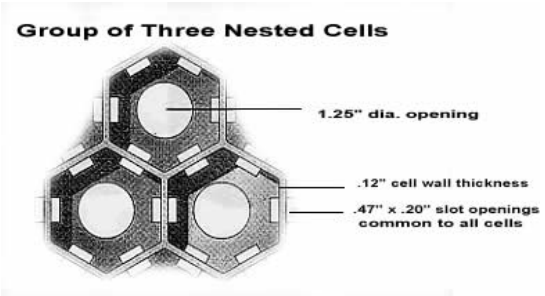
Photography: UCONN NEMO website
(http://web.uconn.edu/nemo/case_studies/west_farms_cs.htm)

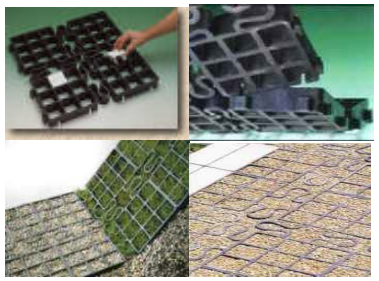
Type of Paver	Applications	Performance	Installation Details	Maintenance	Costs	Local Retailer
Gravelpave^2 *Description*: This product is comprised of connected plastic circular rings that can be filled with gravel. It has a porous geotextile filter fabric backing to hold the small gravel aggregate particles in place. The pavers have 92% pervious area and are constructed with 100% post-consumer high density polyethylene plastic. *Manufacturer*: Invisible Structures Inc. Additional information is available online at www.invisiblestructures.com 	This product should be used in areas where higher traffic will injure the grass. It is suitable for permanent and overflow parking lots, parking aisles and bays, handicap parking spaces, driveways, service and access roads, parks, trails, boat ramps, golf courses, high-use pedestrian areas and infiltration basins.	Load capacity is 823,680 lbs/ft^2 (5,721 psi, which is nearly two times the strength of 2" of concrete). The circular rings when filled with 1" of gravel and placed above a 6" thick standard road base of sandy gravel can percolate approximately 35" of rain/hr.	Installed on top of a sandy gravel subbase. The depth of the subbase is dependent upon site conditions and intended use. The Gravelpave^2 is unrolled and pinned into place. The plastic rings and spaces between them are filled with 1" of gravel.	Replacement of gravel fill over time. Replacement of specific grids over time. Existing equipment can be used for snow removal as long as skid plates/rollers are adjusted to keep the plow blades 1" above the surface.	The price of the pavers are ~\$2.25/ft^2	Invisible Structures, Inc. 14704-D East 33rd Place Aurora, CO 80011 1-800-233-1510 www.invisiblestructures.com Distributor in R.I. A.H. Harris & Sons 25 Graystone Street Warwick, RI 02886 (401) 737-5136 www.ahharris.com

The West Farms overflow parking lot, which was presented in the preceding case study, used Gravelpave^2 for the heavier traveled aisles and is satisfied with the product.

Type of Paver	Applications	Performance	Installation Details	Maintenance	Costs	Local Retailer
Geoblock Porous Pavement System *Description*: This product is a series of interlocking, high-strength blocks (~20” x 40” x 2”) that can be filled with soil and grass. The cellular structure protects the crown of the grass, reduces rutting, and prevents the soil from being compacted. The paver is constructed with up to 50% recycled plastic and has 87% top open area and 40% bottom open area per unit. *Manufacturer*: Geosystems Additional information is available online at www.prestogeo.com. 	Suitable for access roads (emergency & utility access lanes), auxiliary parking areas, driveways, pedestrain walkways, wheelchair access ways, and golf cart path shoulders and aprons.	Total load bearing capacity is 130,000 lbs/ft^2 The product has chemical resistance The 87% top open area per unit and 40% bottom open area per unit allows for high rates of percolation.	To maximize permeability, the pavers should be installed over a rock and sand subbase and filled with sandy loam topsoil. Prior to installation, it is necessary to remove all foreign materials. The recommended subbase ranges between two to six inches depending on the designated loads. Ordinary tools can be used to cut the units and no special fasteners or connection devices are required for installation.	Maintenance includes mowing, irrigation fertilization, and seeding. Minor grid replacement after 10 years.	The prices of the pavers, which are ~20” x 40” x 2” are $2.75 per square ft.	Manufacturer Info. www.prestogeo.com 1-800-548-3424 or (920) 738-1118 Local Distributor Jennian Enterprises 6 Eastman Place Suite 206 Melrose, MA 02176 (781) 665-7915

Type of Paver	Applications	Performance	Installation Details	Maintenance	Costs	Local Retailer
Grassroad Pavers[8] Plus *Description*: This product is comprised of interlocking plastic grid units (48” x 24”) with a hexagon mat design that can be filled with soil and grass. The honeycomb matrix helps to reinforce the soil and protects the root structure of the vegetation. The paver is constructed with high density plastic and is capable of resisting compression, impact and lateral movement. *Manufacturer*: NDS Incorporated. Additional information is available online at www.grassroad.com  	Suitable applications include access roads, driveways, RV access, boat parking areas, sidewalks, & paths	Load bearing capacity on the hexagonal vertical walls is 120,000 lbs/ft^2	Installation does not require a contractor. Homeowners can often do the installation themselves. The pavers are snapped together by the Flex Lock nesting system, and placement times can range as high as 800 sq. ft/hr. After the pavers are placed over a proper subbase, which is site dependent, the pavers are filled with either seed or sod.	Maintenance includes mowing, irrigation fertilization, and seeding. Replacement of sections over time The plow blade should be either raised slightly or outfitted with a flexible rubber bottom piece to ensure that the paver is not lifted from the surface.	The pavers are 4’ x 2’ and sold in packages of 16 or 24. The cost is $43/paver.	Manufacturer Info. NDS Incorporated www.grassroad.com 1-800-726-1994 Warwick Win Water 62 Wyoming Ave. Warwick, R.I. 02888 (401) 732-5151 E.J. Prescott 80 Gilbane Street Warwick, R.I. (401) 738-7611

Type of Paver	Applications	Performance	Installation Details	Maintenance	Costs	Local Retailer
Tufftrack Grass Pavers *Description:* This product is comprised of interlocking plastic grid units (~24” x 24” x 1.5”) with a hexagon mat design that can be filled with soil and grass. The honeycomb matrix helps to reinforce the soil and protects the root structure of the vegetation. The paver is constructed with high density plastic and is capable of withstanding light or heavy vehicular traffic, resisting compression, impact and lateral movement. *Manufacturer:* NDS Incorporated. Additional information is available online at http://www.sitefabric.com/tufftrack_grass_pavers.htm   	Suitable applications include parking lots, overflow parking lots, emergency access roads, driveways, RV parking pads and roadways, pedestrian walkways, bike paths, and golf cart paths.	The empty pavers have an ultimate compression load rating of 98,500 lbs/ft^2. UV inhibitors and chemical resistance.	For heavy load and fire lane access the planting base should be 1” to 1.5” and the sub-base 6” to 8”. For light to medium weight, only a 4” planting bed under the paver is required. The tongue and groove latching system allows for fast assembly. Once assembled the pavers are filled with either seed or sod.	Maintenance includes mowing, irrigation fertilization, and seeding. Replacement of sections over time. The plow blade should be either raised slightly or outfitted with a flexible rubber bottom piece to ensure that the paver is not lifted from the surface.	The pavers are 2’ x 2’ x 1.5” in height. The cost is $20/paver.	Manufacturer Info. NDS Incorporated 1-800-726-1994 Warwick Win Water 62 Wyoming Ave. Warwick, R.I. 02888 (401) 732-5151 E.J. Prescott 80 Gilbane Street Warwick, R.I. (401) 738-7611

Type of Paver	Applications	Performance	Installation Details	Maintenance	Costs	Local Retailer
Netpave 50 *Description*: This product is comprised of ~20” x 20” x 2” square, flexible plastic grid units with small openings that can be filled with either stone or soil and grass. The cellular structure helps to retain the stone by preventing displacement while the open base enables unrestricted root growth and high levels of infiltration. The paver is constructed with 100% recycled plastic and the units are connected together with ‘T’ lugs and slots, eliminating the need for pins. *Manufacturer*: Netlon Turf Systems. Additional information is available online at http://www.netlon.co.uk/_turfsystems/prod-netpave50.htm 	Suitable for permanent and overflow parking lots, driveways, fire and emergency access roads & bicycle/walking paths.	Load bearing capacity is ~27,870 lbs/ft^2 Product lifetime: 120 years. It has both chemical and ultraviolet resistance.	*Gravel Installation* Remove topsoil and add a DoT Type 1 subbase. The depth requirements range between 7.5-28.5” for fire truck emergency access to 6-21” depth for light vehicles and overflow parking lots. A 0.8-1” thick layer of gravel is placed over the subbase. The pavers are placed on top and additional gravel (preferably 2 to 5 mm) is used to fill the paver cells to the top. The pavers can be cut using either a hand or power saw to fit around obstructions and contours. Pieces that are less than half of the original size should not be used. *Grass Installation* The subbase preparation is the same as above. A 2-3” layer of 60:40 rootzone (sand:soil blend) is placed over the subbase. The pavers are placed on top and 1.6” of the rootzone is placed within the paver’s cells. The finished levels should be 7-10 mm below the top of the cells after settlement. It is important not to overfill the cells. The surface may be used immediately, but it is preferable to let the grass become fully established before use. The pavers can be cut using either a hand or power saw to fit around obstructions and contours. Pieces that are less than half of the original size should not be used.	*Gravel pavers* may require intermittent replacement of gravel and minor grid replacement over time. The plow blade should be either raised slightly or outfitted with a flexible rubber bottom piece to ensure that the Netpave is not lifted from the surface. *Grass pavers* maintenance includes mowing, irrigation, fertilization and seeding. Mower blades should be set high for the first 2-3 cuts.	The prices of the pavers, which are ~20” x 20” x 2” (4 per m^2) range between $2-3 per square foot. The exact price is dependent upon quantity, material and logistics. The subbase material cost varies based on site conditions and depth of the subbase. Grid Tech provides all of the materials and labor as packages. Quotes can be given following site visits. They try to work first and foremost with the native on-site soils.	Grid Technologies Inc. Admiral Gate Tower Suite 507 221 Third Street Newport, R.I. 02840 www.gridtech.com (401) 849-7920

Netpave 50 Example Application - Middletown's Soccer Field

Site Description: The Middletown soccer field parking lot was built in October 1999 and paved with Netpave 50. The soccer field is located at the intersection of Wyatt and Mitchell Lane in Middletown, Rhode Island.

Maintenance: Thomas O'Loughlin, the Public Works Director for the Parks and Recreation Department in Middletown, states that he has to periodically top off the gravel because it tends to wash out overtime. The grid has not deteriorated or failed, and overall he has been very pleased with the results.

Notes: Overall, this has been a successful application, but it does demonstrate the need to ensure that the natural drainage patterns of the site are incorporated into final design plans. According to Arthur Erhardt, the President of Grid Tech, the puddling water and deposition of fine material shown in the center of the parking lot area is due to the fact that the contractors hired to build the lot did not place the storm drain in the correct location or use the soil recommended by Grid Tech. The cars park on both sides of the lot, and as shown in the picture below, the grass continues to grow and in many areas completely covers the pavers.

Contacts:

Thomas O'Loughlin
Public Works Director
Middletown Parks and Recreation Department
(401) 846-2119
publicworks@ci.middletown.ri.us

Arthur Erhardt
President of Grid Tech
(401) 849-7920
info@gridtech.com

Middletown soccer field parking lot shortly after construction.

Middletown soccer field parking lot in June 2004.

Netpave 50 Example Application - Coventry Center Greenway

Site Description: A one hundred foot test section of Netpave 50 was installed by contractors hired by the R.I. Department of Environmental Management (DEM) at the western end of the Coventry Center Greenway bike path in 2003. The bike path is located along the south side of Route 117 in Coventry, and the start of the test section is located just west of the Propane store located on Rte 117.

Costs: The cost of paving this section of the Coventry Center Greenway with Netpave 50 was approximately two times the cost of standard bituminous asphalt.

Notes: An in-house DEM construction crew installed a 50-foot long section of Netpave 50 at the Nicholas Farm Management Area in 2001. Lisa Lawless, an engineer at DEM, stated that the in-house crew did not construct any shoulders and that unraveling began to occur shortly after installation. Therefore, the Coventry Center Greenway test installation was built with a stabilized shoulder and has held up much better. Lisa Lawless stresses the importance of a good stabilized shoulder and adequate gravel cover. The DEM has been very pleased with the test section and is planning on paving the entire western end of the bike path, which is 2.1 miles, with the Netpave 50. The project is scheduled to go out to bid for construction in one to two years.

Contacts: Lisa Lawless, Engineer at the R.I. DEM (401) 222-2776 ext. 4312, llawless@dem.state.ri.us

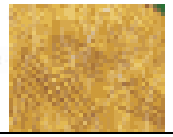
The surface layer was temporarily removed for this photograph to show the underlying plastic grid paver.

Photograph taken in June 2004.

Type of Paver	Applications	Performance	Installation Details	Maintenance	Costs	Retailer
Netpave 25 *Description:* This product is comprised of ~20” x 20” x 1” square, flexible plastic grid units with small openings that can be filled with soil and grass. The open base of the paver enables unrestricted root growth and high levels of infiltration. The paver is constructed with 100% recycled plastic and the units are connected together with ‘T’ lugs and slots, eliminating the need for pins. *Manufacturer*: Netlon Turf Systems. Additional information is available online at http://www.netlon.co.uk/_turfsystems/prod-netpave25.htm 	Intended for use on existing grass surfaces to provide a level of protection intermediate between the Netpave 50 and Turfguard. Suitable for parking lots, driveways, and paths.	It is able to support light traffic on firm ground, but it is not designed to compensate for weak ground conditions where more structured solutions are necessary. Load bearing is ~27,870 lbs/ft^2. To determine if Netpave 25 is suitable, Netlon advises people to drive a vehicle onto the area after a heavy rainfall. If it does not rut, than this product is appropriate. Product lifetime: 120 years. It has both chemical and UV resistance and is resistant to deformation and fracture, and able to conform to irregular surfaces and gradients.	Installation does not require substructure or excavation. It is simply laid upon the grass surface. Prior to installation, the existing grass should be cut as short as possible and depressions should be filled with a blend of sharp sand and topsoil to firm the surface. The Netpave 25 should be laid out from one edge to the opposite side with all of the lugs facing in the direction of laying. The area can be used immediately following installation, but it is preferable to let the grass become fully established before use.	Maintenance includes mowing, irrigation, fertilization and seeding. Mower blades should be set high for the first 2-3 cuts. The plow blade should be either raised slightly or outfitted with a flexible rubber bottom piece to ensure that the Netpave is not lifted from the surface.	Pavers are ~20” x 20” x 1” (4 per m^2) The prices of the pavers range between $2-3 per square foot and are dependent upon quantity, material and logistics.	Grid Technologies Inc. Admiral Gate Tower Suite 507 221 Third Street Newport, R.I. 02840 www.gridtech.com (401) 849-7920

Type of Paver	Applications	Performance	Installation Details	Maintenance	Costs	Retailer
Turfguard *Description:* This product is comprised of plastic mesh that is laid over a pre-existing grass surface. The paver is constructed with polyethylene, which is tough, flexible, long lasting and suitable for occasional access on stable ground. *Manufacturer*: Netlon Turf Systems. Additional information is available online at http://www.netlon.com/__turfsystems/prod-turfguard.htm 	Suitable for occasional access routes for light vehicles, overflow parking lots, driveways, taxiways for light aircraft, and pedestrian walkways.	Tensile strength: 5.8kN/m (397 lbs/ft) Product lifetime: 120 years	Installation does not require a contractor or any groundbreaking. Homeowners can easily install it. To install Turfguard, unroll it and lay it flat on a grass surface that has been leveled out with a 70:30 mixture of sharp sand and topsoil. Anchor in place with Netlon pegs or staples.	Mower blades should be set high for the first 2-3 cuts. Occasional light rolling, irrigation and fertilizion are necessary. Plow blade on casters to ensure that the Turfguard is not damaged.	The Turfguard is available in 30m x 2m rolls (~98 ft. x 6.6 ft) and costs about $390 a roll.	Grid Technologies Inc. Admiral Gate Tower Suite 507 221 Third Street Newport, R.I. 02840 www.gridtech.com (401) 849-7920

Examples in the Northeast: A 2-acre overflow parking lot was constructed with Turfguard at Dorris Duke's farm in New Jersey in the fall of 2003 and spring of 2004. For additional information contact Arthur Erhardt at Grid Tech.

Type of Paver	Applications	Performance	Installation Details	Maintenance	Costs	Retailer
Advanced Turf *Description:* This product is comprised of small pieces of plastic mesh approximately 2”x 4” that are blended with a selected high sand content growing medium to form a stabilized rootzone that can support heavier loads than regular grass. The mesh grids are constructed with polypropylene, which is non-toxic, insoluble, non-absorbent and inert to any of the chemicals likely to be found in the rootzone. *Manufacturer*: Netlon Turf Systems. Additional information is available online at http://www.netlon.com/_turfsystems/prod-advancedturf.htm 	Suitable for event areas, sport playing fields, occasional use access roads, overflow parking lots, airstrips and taxiways, and playgrounds. The advanced turf/high sand blend can be either 4, 6, or 8” thick. The latter depth should be installed in areas anticipating heavier loads (i.e. vehicles)	This product when installed over a proper base and subbase can withstand axial loads up to 12 tons (24,000 lbs). Product lifetime: 120 years	Installation requires a contractor. A sand:soil:netlon mesh blend is placed over an aggregate subbase layer and seeded with grass. The thickness of the subbase is dependent upon vehicle loading and subgrade strength. It usually ranges between 4-20” with greater thickness used in cases of weak subgrade conditions or use by heavy vehicles.	Maintenance includes mowing, irrigation, fertilization and seeding. If the grids migrate to the surface over time, a lawn mower should be able to cut through them. A flame torch can also be used to melt them away, or the area can be top dressed and reseeded.	The advanced turf is $ 1.00 per square foot (at the surface) with 4” depth. This price does not include blending the materials into the soil or installation. The costs of the base, subbase and installation vary based on site conditions. Grid Tech provides all of the materials and labor as packages and quotes can be given following site visits.	Grid Technologies Inc. Admiral Gate Tower Suite 507 221 Third Street Newport, R.I. 02840 www.gridtech.com (401) 849-7920

Advanced Turf Example Application - Brown University's Lincoln Field

Site Description: An advanced turf system was installed in Lincoln Field on Brown University's campus in 1994. Lincoln Field, which is located off of Thayer Street in Providence, R.I., is a low-lying area that was subject to frequent flooding prior to the installation of the ATS.

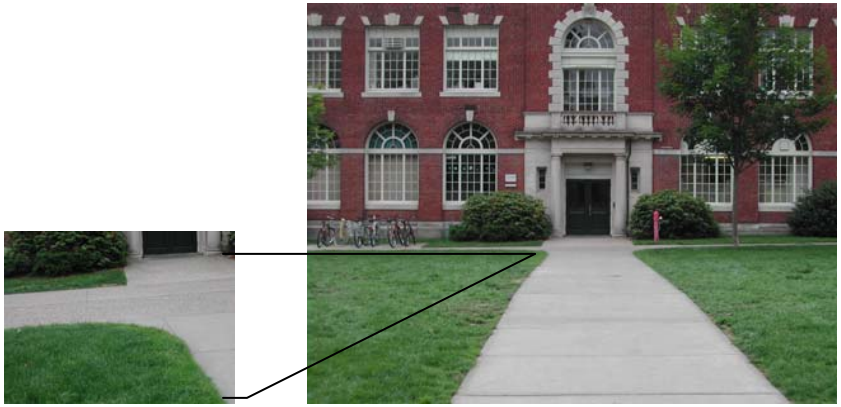
Design Details: A contractor installed eight inches of the advance turf/ high sand content growing medium above properly prepared base and subbase layers. This composite design (i.e. the layer of ATS/sand mix, the subbase and base) took into account the specific conditions of the site and the anticipated use, specifically occasional vehicular traffic and numerous University events.

Maintenance: According to Patrick Vettere, the Ground Superintendent, this area requires a lot more watering than other grass areas on campus. A few grids were visible on the surface in June 2004, but these can either be cut up by a lawn mower or melted with a flame torch.

Notes: Patrick Vettere also stated that it took a while for the organic material to take hold. In hindsight, he believes that they should have probably used a little more organic material. Overall though he is very happy with how well the ATS system has worked and held up over the past ten years.

Contacts: Patrick Vettere, Brown University Ground Superintendent

Lincoln Field prior to the installation (March 1994)



Lincoln Field ten years after installation (June 2004)

ATS poking through soil

University of Rhode Island Cooperative Extension
Nonpoint Education for Municipal Officials
College of the Environment and Life Sciences
Department of Natural Resources Science
Coastal Institute, 1 Greenhouse Road, Kingston RI 02881
www.uri.edu/ce/wq/

Contributing authors: Catherine McNally (Coastal Fellows intern), Lisa DeProspo Philo, and Lorraine Joubert.

Cooperative Extension in Rhode Island provides equal opportunities in programs and employment without regard to race, color, national origin, sex or preference, creed or disability. This is contribution #5000 of the College of the Environment and Life Sciences, University of Rhode Island.

Funded by RI HEALTH, Office of Drinking Water, Source Water Protection Program.