GRASSPAVE²

BY INVISIBLE STRUCTURES™

GRAVELPAVE²

BY INVISIBLE STRUCTURES™

Introduction

History of Porous Paving

Pebbles, cobblestones, and wood decking structures have been used since the dawn of civilization to reinforce where we walk and the roads we use. Little did we realize that these methods had benefits over the modern trends of sealing up the ground with asphalt and concrete. Porous, permeable or pervious paving—whatever you prefer—became a method for addressing stormwater issues in the early 20th century. Concrete turfblock for grass paving began in the mid-1940s and plastic versions were invented in the late '70s and early '80s. Great advancements have occurred in pervious concrete, pervious asphalt, and other permeable surfaces. We introduced Grasspave^2 in 1982, improving upon these earlier concepts. In 1993, Gravelpave^2 was unveiled, the only product specifically developed for gravel porous paving. Fast forward to this millennium, and Grasspave^2 and Gravelpave^2 are considered by most, the finest porous pavers developed.

Grasspave^2 large rolls and Gravelpave^2 large rolls (not shown) install quickly and conform to the contours of the ground.

Infiltration

Porous paving allows rainwater to percolate through the pavement's surface and back into the ground (infiltrating), where the water is cleaned and returned to ground water supplies. Porous paving improves upon impermeable surfaces, such as concrete or asphalt, which do not allow for this natural filtration. Rain collects airborne and surface pollutants such as sediment, brake dust, chemicals, vehicle exhaust, oil, salts, fertilizers, bacteria, and animal waste. On impermeable surfaces the polluted rainwater runoff (non-point source pollution) is collected, concentrated, and discharged to downstream waters such as streams, reservoirs, and lakes—our drinking water. This runoff also harms vegetation and wildlife with increased water volumes, velocities, and higher temperatures. The Grasspave^2 and Gravelpave^2 systems protect against this dangerous runoff by processing and cleaning the water, thus safeguarding the natural water cycle.

State of the Earth

Invisible Structures, Inc. has developed an entire line of products to address stormwater and environmental concerns. Rainstore^3, Slopetame^2, Draincore^2, and Beachrings^2 can work in addition to, or in conjunction with, Grasspave^2 and Gravelpave^2 to provide your site, home, or office with stormwater and environmental enhancements. Our products can store and collect rain, provide erosion and sediment control, efficiently convey and deliver water, and protect natural areas.

Advanced Technology

The Grasspave^2 and Gravelpave^2 systems are based on a simple, but impressive technology—a series of rings (cylinders) connected on a flexible grid system. The cylinders are engineered to withstand significant structural loads and the grid provides stability, flexibility, and continuity for large areas. The grid system also has the unique ability to be rolled up for easy shipping, handling and installation.

This engineered design allows for any street-legal vehicle (and sometimes larger) to park or drive on our Grasspave^2 or Gravelpave^2 surfaces. The point load pressure is transferred from the top of the ring, through the fill material and cylinders, to the engineered base course.

Wallace Residence, Savannah, GA—Gravelpave^2 creates a wheelchair-accessible surface by stabilizing gravel and supporting tire pressure. 7% dry cement was mixed with gravel before filling rings. Cover photo: Westin Kierland Resort and Spa, Scottsdale, Arizona—Grasspave^2 fire lane and Gravelpave^2 fire lane (concrete widening).

Pentagon Remote Delivery Facility, Arlington, VA—Grasspave^2 was selected for the helicopter landing pads (the four grass squares in center) on the largest "green roof" east of the Mississippi.

The ring and grid structure is 92 percent void space allowing for the healthiest root zone for grass (in Grasspave^2) and more decorative gravel (in Gravelpave^2) for some of the most attractive paved surfaces around. Less plastic means more natural looking surfaces. This technology also makes for better runoff coefficients and better percolation rates.

Exceptional Compressive Strength

When insalled to specifications, Grasspave^2 and Gravelpave^2 will support 15,940 psi – well over the 120 psi highest truck tire pressure allowed on public highways. This is a safety factor of 132 times.

15,940 psi Conversions

2.29 million pounds per sq ft
109,906 kPa
11.2 million kg/m^2
20.6 million pounds per sq yard

Vehicle Loading Examples:

Auto tires: 40 psi
Truck tires: 110 psi
DC-10 tires: 250 psi
F-16 tires: 350 psi
Fire truck with outriggers: 78psi
(An 85,000 lb. truck distributed to four outrigger pads is equal to 21,250 lbs. for each outrigger pad with 12″ × 18″ surface contact with Grasspave^2.)

The University of South Alabama, Mobile used Gravelpave^2 in parking aisles and Grasspave^2 in the spaces.

All these vehicles are well within our 15,940 psi capability. With a sturdy base course design, our rings will easily perform under all conditions. It's also a good design practice to strengthen concrete sidewalks and curbing that will be mounted by fire trucks.

CSI 32 12 43 Flexible Porous Pavers

In 1997 The Construction Specifiers Institute (CSI) came out with a generalized listing (02795) for all porous paving products. However, since performance and application is varied even in the porous paving industry, the 2004 CSI MasterFormat™ has adopted a new number *32 12 43 Flexible Porous Paving*, to recognize that Grasspave^2 and Gravelpave^2 are in a class by themselves.

Best Management Practice

Porous paving is recognized as a Best Management Practice (BMP) by the Environmental Protection Agency, the Center for Watershed Protection, the U.S. Army Corp of Engineers, and countless other federal, state, regional and local authorities. In addition, Grasspave^2 and Gravelpave^2 are often mentioned by name, as the product of choice for many of these agencies.

Applications

Stormwater Management

The Grasspave^2 and Gravelpave^2 systems can easily handle storm water from an intense storm dropping three inches of rain in less than thirty minutes! In one square meter (40″ × 40″) there are 144 rings, two inches in diameter by one inch high. With one inch of fill in the rings and a standard road base of sandy gravel six inches thick, our porous systems will percolate

Bowditch Point Regional Park , Fort Myers Beach, Florida—Gravelpave^2 parking bays blend in with the natural surroundings.

The Lincoln Hills Club, Lincoln, California—This amphitheater's grass is reinforced with Grasspave^2 to prevent compaction, and provide a stable, attractive surface for visitors.

approximately ½ inch of rain per hour! A seven-inch section can store 2.4 inches of water (about 20 percent void after compaction). Alternatively, hard surfaces, such as asphalt and concrete, shed 95 percent of storm water.

Aesthetics

As a designer, engineer, contractor, or homeowner, you can be sure Grasspave^2 and Gravelpave^2 can deliver a more beautiful surface and add a unique look to a site. Grass simply looks better than asphalt and decorative gravel has been used for centuries in landscaping. Space constraints can be dealt with by combining the beauty of grass or gravel with the utility of paving.

Trees and other vegetation not only survive, they thrive with Grasspave^2 and Gravelpave^2. Porous paving has the ability to deliver water, oxygen and carbon dioxide through the cross section—all essential to root survival. Concrete and asphalt suffocate and starve the root zones of water and air. With Grasspave^2 and Gravelpave^2, you can now design in as many trees and plants as your site will allow. Grasspave^2 and Gravelpave^2 prevent compaction while allowing for ample amounts of water and air. Cars can then drive and park below tree canopies. Saving existing, mature trees is also possible with our products—our structures can come within inches of the mature tree trunk without damage. Our mats have the ability to flex with the tree root growth that would otherwise damage and crack hard surfaces.

Environmental Benefits

Grasspave^2 and Gravelpave^2 not only protect the environment, they enhance it. All of our products are made from 100 percent recycled plastic—plastic that goes into improving the environment and not into a landfill. Through bioremediation, porous pavers have the ability to clean pollutants (heavy metals, 96–99 percent; suspended solids, 95 percent; phosphorous, 65 percent; nitrogen, 82 percent, hydrocarbons, up to 100 percent) out of stormwater. Our products also reduce erosion and soil migration, reduce site disturbance, and contribute to airborne dust capture and retention.

Cooling the atmosphere and reducing the "urban heat island effect" (cities being up to 10 degrees hotter than undeveloped land) are added benefits of Grasspave^2 and Gravelpave^2. Both products can mitigate these increased temperatures. In addition, Grasspave^2 promotes the conversion of carbon dioxide (greenhouse gas) into oxygen and has an "air-conditioning effect."

Driveways

Environmental, economic, and aesthetic enhancements are drawing homeowners and designers to use Grasspave^2 and Gravelpave^2 in driveways. Most residential driveways are good candidates for our porous duo because of the reduced speed and limited frequency of traffic. Our products can add beauty to residential and commercial driveways.

Parking Lots

Parking for churches and synagogues, stadiums, arenas, and overflow at shopping centers, campuses, parks and more are ideal for Grasspave^2 and Gravelpave^2. These sites generally support large numbers of vehicles but only on periodic basis. Stormwater management and green space can be combined with parking, reducing maintenance, real estate, and development costs. A great design idea is combining durable Gravelpave^2 drive aisles with attractive Grasspave^2 parking bays.

Pedestrian, Horse Trails and Bicycle Paths

Garden paths, greenhouse aisles, sidewalks, park paths, and wilderness trails paved with Grasspave^2/Gravelpave^2 provide a stable surface for strollers, bicycles, wheelchairs, and horses. There are no puddles or mud and traction is very good. Tree roots break up hard surface sidewalks, but our mats flex to accommodate such shifts and gradient changes. Plus, with the high proportion of air, roots are discouraged from moving upward. Mountain bikers will not be able to tear up paths reinforced with Grasspave^2/Gravelpave^2. Our products can resist the destructive forces of mountain bikes, allowing your trails to be reopened to bikes.

Fire Lanes

By far, the most common application for Grasspave^2 and Gravelpave^2 installations is for fire lanes. Our long and established history of providing safe, well-constructed fire lanes began in 1982 with our first installation in Snowmass, Colorado, near Aspen Ski Resort. Since then, we have firmly established credibility for this application. Tests have been conducted by several fire departments in Aurora, Colorado and Irvine, California. Nearly every major U.S. metropolitan area has accepted and used Grasspave^2 in a fire lane. You will most likely find a fire lane installation in your area.

All fire fighting vehicles can safely navigate even a wet Grasspave^2 or Gravelpave^2 surface. In a 1983 test this 100-foot ladder truck was lifted off the Grasspave^2 by rear outriggers, and no ruts were caused by either outriggers or tires. The ladder was extended, rotated, and loaded with no depressions in the road surface.

Apartment complex, Concordville, Pennsylvania—Several overflow Gravelpave^2 parking lots encompass the majority of the perimeter area on the west and south sides of the property. Grasspave^2 (not shown) is installed on site in two grass fire lanes.

Grasspave^2 Installation—Mats can be rolled out in minutes!

~35m^2 (~400 sf) per man hour! – For all steps shown below.

Place and compact sand and gravel base course.

Apply Hydrogrow mixture.

Roll out Grasspave^2.

Fill rings with clean sharp concrete sand.

Hydroseed or lay sod.

Roll sod with heavy roller.

Ready for use after two mowing cycles.

Use a regular lawn mower for maintenance.
Do not aerate!

The Grasspave^2 porous pavement system is comprised of a sandy gravel base course, Hydrogrow soil amendment/fertilizer mixture, the Grasspave^2 ring and grid structure, sharp concrete sand, and grass seed or sod.

Grasspave^2 Installation Procedures

This installation section is only intended as an overview. Please review our Grasspave^2 Technical Specifications (available at www.invisiblestructures.com or call 800-233-1510) for comprehensive installation instructions.

Excavate a space for the base course as determined by site soils and loading requirements. Place and compact sandy gravel which should be a mixture of clean sharp sand and gravel varying in size but not exceeding 3⁄4 of an inch. To check porosity, use a hose to see that water flows into the base and drains away. Add subsurface drainage as necessary to low spots or locations with poor draining soils. Install irrigation lines and sprinkler heads if necessary.

Apply the Hydrogrow mixture that is included free with your order. Hydrogrow is a specialized soil amendment and fertilizer mixture designed exclusively for our Grasspave^2 system.

Roll out Grasspave^2, aligning the side hole fasteners over the side pegs. The warmth of the sun will relax the plastic so it lays flat. Cut the grid between rings using pruning shears. Incorporate the cut pieces in other areas, as needed, keeping the distance between the rings uniform.

Fill rings with clean sharp concrete sand (AASHTO M6 or ASTM C-33) using large rakes and brooms so that the tops of the rings show when done. USGA Greens mix is also acceptable.

Lay turf over the rings. On warm days, wet the sand first to lower sand temperature and provide moisture for grass roots. Seeding and hydromulching is also an accepted vegetating method at this stage. Repeated hydromulching/seeding may be necessary.

Roll sod with heavy roller to eliminate air pockets and make sure roots are in contact with the sand fill. Water lawn as usual according to climatic requirements.

Whether the area has been seeded or sodded, wait to drive on grass until two mowings have been completed, by which time the root system will be established and the sod pieces locked into place. In an emergency such as the need for fire truck access, grass may be driven on immediately after installation.

Use a regular lawn mower for maintenance. There should be no paver parts protruding through the surface that would damage mowers. Do not aerate!

Place and compact sand and gravel road base.

Roll out Gravelpave², aligning the snap fit fasteners.

Secure mats with anchors provided (size and type may vary).

Fill rings with clean gravel.

Compact gravel with vibrator roller or flat plate compactor (not shown).

Gravelpave² Installation—

Gravelpave² Size/Shape Fill Requirements

You will need 1¼″ of gravel fill, compacted. Be careful to order enough for the compaction process and choose a gravel size that will nest well into the rings. We have found that 3/16″ uniformly sized crushed stone and sometimes 3/8″ with limited small sharp screenings (#40 to #100 screen) works well. We DO NOT recommend pea gravel, even though it is often very attractive. Pea gravel will migrate out of the rings. A visit to your local quarry is suggested. We have found that some geological areas of the United States have limited types of sharp gravel available. It has been necessary to import gravel from a neighboring state, but remember the amounts are relatively small—the top one-and-a-quarter inch of the cross section. Gravel should be as free of fines as possible. To maintain porosity, avoid soft stone materials with low durability that will break easily.

Other Fill Materials for Gravelpave²

Please ask our staff for assistance with this category since it is use-specific and often experimental. Ground rubber, crushed glass, crushed brick, and many other materials can be useful as attractive fill materials for various applications. Thermoset (epoxy, polyurethane, etc.) binders may be cost prohibitive for most projects, but offer unique design possibilities, including clarity, color enhancement (wet look), flexibility, and durability.

Our technical support staff will assist with selection of gravel sources. The photographic samples shown on this page will help you narrow your gravel choices. Should you have questions concerning the selection, please submit a small sample for approval prior to specifying or securing the materials.

Mats can be rolled out in minutes!

Gravelpave² Installation Procedure

This installation section is only intended as an overview. Please review our Gravelpave² Technical Specifications (available at www.invisiblestructures.com or call 800-233-1510) for comprehensive installation instructions.

Prepare sandy gravel base course to a depth as determined by a soils engineer. Compact with a vibrating plate compactor or use a heavy motorized roller for large jobs. To test porosity, water with a hose and check to see that water drains readily through the base course before installing the Gravelpave² mats.

Roll out mats with the grain (in the same direction) so that the snap fit fasteners can be used with neighboring mats. To fit around boxes and curbs, cut the grid between the rings with pruning shears and scissors or a small portable electric hand saw.

Fasten the mats together using the snap fit fasteners that are molded into the product inserting the prongs into the rectangular openings. Tuck the fabric underneath the fasteners to keep joints closed. A quarter-inch nut driver head (6 mm) fits nicely over the fastener to compress the pieces together. A piece of lumber placed under the Gravelpave² mat will provide stability to aid in fastening.

Supplied anchors must be used to secure the mats to the base. Hammer anchors with washers at a rate of one anchor per six rings in both directions. Use extra anchors around the perimeter of the Gravelpave² install and in high traffic areas. Reciprocating hammers can be used to speed up the anchoring process. Anchors should be placed inside the rings as close to the center as possible. Begin anchoring from one corner in a radial pattern.

Gradually place gravel fill (see suggested fill material on facing page) into rings by using a front-end loader and shaking out the fill as the machine drives forward. Carefully lower the bucket when empty and back up while dragging it *above* the rings to smooth out the gravel, finishing with a stiff broom. Wheel barrow and shovel works well for small jobs. Contractor tip—you can store excess material for future maintenance, top dressing as may be necessary. Use rakes and/or push brooms to distribute the gravel fill to a level slightly above rings so that compacting the fill will not uncover the rings.

Use a vibrating plate compactor or large driving roller again to compact the gravel fill. Additional gravel may be necessary to finish filling the rings. Compact again until the material appears solid in the rings. Wetting the gravel may help it to interlock.

Drive on the installation when finished. If car tires make a pattern, there may be too much gravel or it may need additional compaction. It is expected that tops of the rings may be visible. If sides of the rings show, then add more fill material and repeat the compaction process.

Golf Industry

Gravelpave² and Grasspave² golf cart paths give the look of a natural path through trees, along fairways, and around greens. The flush surface requires no trimming or edging. Traction is excellent with Gravelpave² and Grasspave² traction is slightly better than grass. Grasspave² and Gravelpave² can enhance your golf cart staging area, pedestrian traffic area, parking lot, road shoulder, and maintenance yard.

Automobile Dealership Displays

Car dealerships have discovered that Grasspave² and Gravelpave² are perfect for automobile display areas. Dealerships now have an option when it comes to adding paved areas for car transport and display. Dealerships like the "soft" attractive look grass and decorative gravel provide.

Utility and Maintenance Vehicle Access

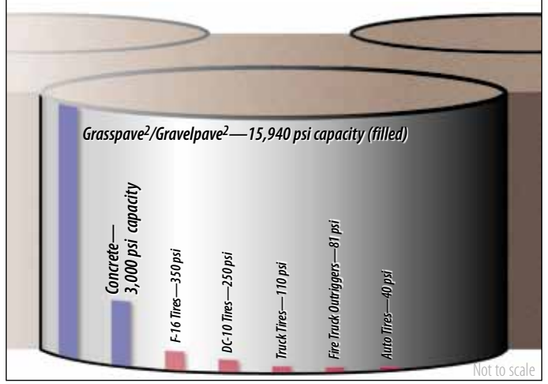
Providing your site with important utilitarian functions without compromising beauty is simple. Grasspave² and Gravelpave² can incorporate a structural road without interrupting your landscaping. No obtrusive concrete or asphalt access roads are necessary to get to window washing areas, pump stations, microwave towers, tanks, or electrical boxes.

Unique Applications

Our mats are installed in some unique and interesting places: Helicopter landing pads, race car display areas, outdoor amphitheater seating, under picnic tables, under concrete pavers (support), airplane display and transport, cemetery marker reinforcement, eave drip lines and more. Installations are not limited to traditional paved areas.

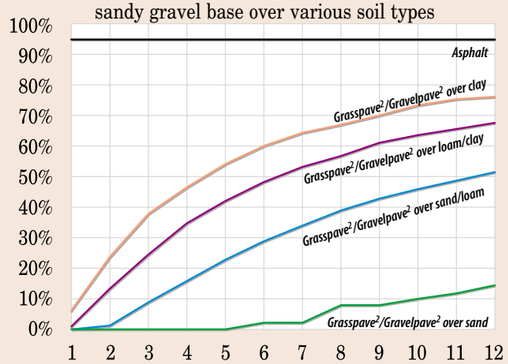
Lab Compression Test Results

Load-bearing capacity of filled Grasspave²/Gravelpave² rings vs. concrete, and vehicle loading examples



Runoff Comparison Chart

Runoff coefficients, Grasspave²/Gravelpave² and sandy gravel base over various soil types



Calculations include GP²/GV²placed over 6" of sandy gravel base course, laid over native soils indicated.

Grasspave² Characteristics

Ring and Grid Structure

Grasspave² is by most accounts the best flexible grass paver made today. Its unique ring and grid structure allow for flexibility, stability, and exceptional grass growth. With 92 percent void space for healthy roots and 100 percent grass coverage, Grasspave² is the industry's preeminent choice. Our installations are hard to find because they are invisible! With so little plastic near the crown of the grass, the blades of grass are not smashed by product. Root development is not interrupted from spreading laterally. The rings are strong and rigid, keeping grass root systems protected from harm. The roots grow directly downward, deep into the sandy gravel base course.

Large Rolls

Our patented systems have a shipping, handling and installation advantage as well—large rolls. Our standard roll size (model 2020) covers 431 sq. ft. (40 m²) and weighs 192 pounds (87 kg). Other roll sizes are available. Installers of our products have repeatedly commented that they enjoy the easy installation. Rolling out Grasspave² is similar to rolling out carpeting and coverage is fast and efficient. The mat system can be easily cut to fit around trees, irrigation, curbing, or other terrain. The rolls have snap-fit connectors to attach to adjacent rolls, making one unified, contiguous system. This unified mat system adds stability and continuity in design. Grasspave² can just as easily be snapped to Gravelpave² to add stability and product variation.

Hydrogrow

Another reason Grasspave² is the industry leader is the addition of Hydrogrow soil amendment, which is supplied with your order. Hydrogrow is engineered to help grass grow in our sand based root zone. The results are amazing and our Grasspave² areas often look healthier than surrounding turf. By using this special mixture in the sand, porosity will be maintained, turf will be attractive, and aeration will not be necessary.

Sand Fill

Grasspave² is the only grass paver on the market specifying sand as part of its cross section. Sand is the best medium to provide water and air to the roots and still provide high compressive strength. The United States Golf Association uses sand for every USGA golf course and nearly every professional and collegiate turf athletic field uses a sand cross section as well. Topsoil (or other organics fill material) in the rings will eventually compact and damage the root zone. Sand negates the need for mechanical aeration, which can damage Grasspave² and other grass pavers.

Strength When Installed

When installed over a thick base course and compacted to 95 percent modified Proctor, sand-filled rings can support 5,700 pounds per square inch (psi) without deflection or compromise to safety. The cylinder is the strongest shape to support compressive loads because it has no corners. Supporting heavy loads with the rings allows us to use less plastic in the product creating a 92 percent void area for root development, combined with strength! Less plastic means a lower cost for you.

Fort Shantok State Park, The Mohegan Tribe, Uncasville, CT—Low-maintenance parking lot stable for cars, strollers, and wheelchairs. This lot is plowed in the winter.

Traffic Frequency
Grass as a surface material can withstand from two to six (varies with grass species and environmental conditions) trips daily over the same spot. This suggests that most parking applications we pave with asphalt today could be paved with Grasspave^2 instead. Vehicles can remain parked on grass for extended periods of time, provided some relief can be given for a few days for the grass to recover.

Lifespan
Grasspave^2 has a projected lifespan of 60 years. Compared to asphalt with a lifespan of 15 years; and concrete with a lifespan of 25 years, Grasspave^2 will save you money on replacement costs.

Irrigation
Grass needs water and you may need to have irrigation installed. Grasspave^2 has a sand based root zone which usually requires slightly more water than a normal topsoil or organic root zone. If golf courses in your area use irrigation systems, you probably should in your Grassapave^2 installation.

Available colors include: Tan, Black, Pewter Grey, Terra Cotta.

Gravelpave^2 Characteristics

Fabric, Ring and Grid
When we developed Gravelpave^2 in 1993, our goal was to provide designers a second option for a porous pavement that can tolerate high frequency and low-speed traffic. By molding our ring and grid structure onto a non-woven polyester filter fabric, we were able to create a new product that contains gravel and prevents particle migration and rutting.

Gravelpave^2 is the only system specifically designed for aggregate containment porous paving. The cylinders displace the load onto an engineered base course and hold the decorative gravel in place. The fabric keeps the top-dress gravel from compacting into the road base, acts as a weed and vegetation barrier, and suppresses dust.

Traditional pavements, including gravel roads, are designed to shed water and keep it away from the pavement's cross-section. Gravelpave^2 is designed to do the opposite—welcoming water down through the system. Plus, Gravelpave^2 will not rut, washboard, or puddle like traditional gravel roads.

Snap-Fit Fasteners
Designed into Gravelpave^2 is a snap-fit fastener, a two-pronged arrow that fits into a rectangular slot. Simply push the slot over the prongs to easily snap together panels of Grasspave^2. To take them apart, just squeeze the prongs together and lift off the slot.

Should the fasteners of one mat not align over the distance of another mat, then anchor pins (or eight inch ring shank nails and large washers) can be used to secure the mats along the seam. Forcing the alignment can cause the mats to ripple and not lay down evenly.

Traffic Frequency
Gravelpave^2 has no limits on frequency or duration of traffic on the system. Park or drive as often as you like on Gravelpave^2. However, speeds should be kept at or below about 20 mph (30 km/h).

Durability
Grasspave^2 and Gravelpave^2 are made from flexible High Density Polyethylene (HDPE) plastic with UV inhibitors, which withstands repeated freeze-thaw cycles and continuous subzero temperatures without cracking. HDPE resists aggressive chemicals such as road salts, motor oils and fuels. HDPE is highly abrasion-resistant and is unaffected by extremes in pH. A well-maintained Gravelpave^2 installation will last 25 years in most climates.

Aesthetics
Part of what draws many designers to use Gravelpave^2 is the ability to have an area maintain a natural look. Many times native soils or gravel can be used as fill material, complementing surrounding areas. Gravelpave^2 is available in four standard colors—black, tan, gray, and terra cotta (custom colors are available at additional cost). Ring colors are intended to blend with the gravel color so they will be less visible should some portion of the rings show. A small amount of excess stone fill should be left above the top of the rings to provide visual cover and additional UV protection. This excess will migrate, but usually not very far.

Size and Shape Requirements for Gravel Fill
You will need one and a quarter inch (3.2 cm) of gravel fill, before compaction. After compaction the gravel should be only be slightly higher than the rings (⅛ inch, 3 mm above). The following criteria for gravel fill will make the most of the systems performance:

- Hard—resistant to breaking, crushing or crumbling
- Sharp and angular (do not use rounded pea gravel)
- Clean, washed (free of fines)
- Size 3⁄16 to ⅜ inch (5 mm to 1 cm)

Other fill material may be used in certain situations, but may be considered use-specific or experimental. Please consult with our technical support staff regarding fill material not meeting the above criteria or for installations requiring "binders."

Invisible Structures—Standard Product Roll Sizes

	Width		Length		Diameter		Area		Weight	
Model	m	ft	m	ft	m	ft	m^2	ft^2	kg	lbs
1010	1	3.3	10	32.8	0.5	1.7	10	108	22	48
2020	2	6.6	20	65.6	0.8	2.7	40	430	87	192

Rolls can be installed manually (2 people advised). Rolls apply to Grasspave^2, Gravelpave^2, Draincore^2, and Slopetame^2.

Denver Tech Center Corporate Client, CO—Curving Grasspave^2 firelanes around both buildings lends opportunity for private outdoor lounge area for employees who can also enjoy the garden view from their office windows.

Dust Suppression

Dirt and gravel roads have the potential to kick up dust and dirt when traversed. Many communities have regulations limiting or eliminating gravel surfaces from new construction. Rest assured, if you design a Gravelpave^2 surface you will be getting a virtually dust-free surface. The clean and washed fill material required to fill the rings will not have any more dust than an asphalt-paved surface. Gravelpave^2's geotextile fabric will prevent the dust-sized particles contained within the base material (existing gravel surface or dirt), from being displaced by moving tire or wind forces.

Oakdale Nature Preserve, Freeport, Illinois—Gravelpave^2 reduces erosion and rutting in this ADA accessible trail.

Industry Advantages

Economic Advantages

Whether you are an engineer, architect, landscape architect, contractor or homeowner you will be concerned with the cost of you project. Grasspave^2 and Gravepave^2 will save you money. Our products will save on design costs, installation costs, component materials, maintenance/operations expenses and lifecycle costs. We can find a way to reduce your site expenses with our porous pavers.

When designing, you may be able to eliminate or reduce stormwater filters, detention basins, conveyance lines, modifying grading requirements, or many other "necessities" associated with asphalt or concrete. A great deal of your stormwater mitigation plan can be built into Grasspave^2 and Gravelpave^2.

Installers have been astounded by the speed and efficiency for which large areas can be accommodated by our large rolls. Unrolling our mats, snap fitting, and cutting is easy and requires no special machinery. Please view our technical specifications (from www.invisiblestructures.com, call 800-233-1510, or available through our partner network) for the installation procedure. A brief installation overview is also on pages 8 and 10).

In addition to cost savings in the design phase, you may be able to eliminate other components during installation such as root protection for trees, grates, manholes, curbing, and tree and vegetation removal costs.

Maintenance and operations costs are significantly reduced over asphalt and concrete surfaces. A. (Andy) E. Lindsey, Director of Grounds Maintenance, University of South Alabama, in his written analysis dated February 18, 1999, compared the cost of our porous systems to asphalt pavement using historical data from university records. The conclusion was a $56,000 savings over 20 years, by using Grasspave^2 and Gravelpave^2.

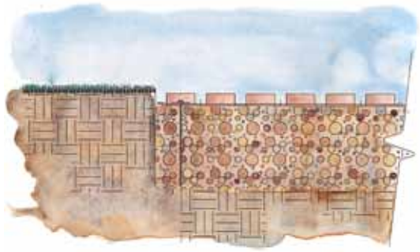
Our products can save you the most money by combining your surfaces' uses into one area. Multiple surface use means savings on real estate, design costs, maintenance, insurance and more. You can have a fire lane that doubles as "green space" for employees or visitors, combine a parking lot with a bio-swale and stormwater mitigation system, and expand your lawn into the driveway. The Grasspave^2 and Gravelpave^2 installations at NRG Stadium, Houston, Texas, pull quadruple duty, providing over seven acres of parking, stormwater mitigation, required "green space," and an outdoor festival site which generate additional income.

As mentioned above, Grasspave^2 and Gravelpave^2 have a longer lifespan than asphalt. Compound the above savings with the longer lifespan, and you can have a lifecycle cost which can save thousand of dollars on even moderately sized installations.

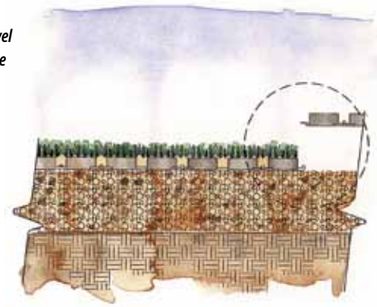
Competitive Advantages

Our porous pavers have advantages over impervious surfaces, but we are proud to compete with any other plastic porous pavers manufactured. Our products are the strongest on the market—15,940 psi installed to specification (2.29 million lbs./ft^2; 109,906 kPa; 11.2 million kg/m^2; 20.6 million lbs./yd^2). Grasspave^2 and Gravelpave^2 have

Compacted sandy gravel road base placed above compacted subgrade, 95% modified Proctor density. Gravelpave^2 rolls are laid, pinned, and filled with clean, sharp gravel.



For Grasspave^2: Compacted sandy gravel road base placed above compacted subgrade, 95% modified Proctor density. Gravelpave^2 rolls are laid, pinned, and filled with clean, sharp gravel.



NRG Stadium (formerly Reliant Stadium / The Astrodome), Houston, TX—30,800 m^2 (317,000 sq ft) of grass porous paving. Provides parking, stormwater management, and a cool-multipurpose surface for festivals and events.

92 percent void space for the best root development and grass coverage (Grasspave^2) and the most volume available for desired fill (Gravelpave^2). Most other plastic pavers come in rigid unit blocks, which are cumbersome to install and difficult to cut and shape. Grasspave^2 and Gravelpave^2 rolls are considered the favorite to work with by installers, for the flexibility, continuity, and speed of installations. Grasspave^2 is the only product on the market specifying sand infill for the grass roots. Sand is recommended as the infill of choice for grass pavers by Professor Bruce K. Ferguson, Univ. of Georgia, author of the book, "Porous Pavements."

Vancouver City Works Yard, Vancouver, British Columbia—main staff parking lot, done in Gravelpave^2.

Fire lane, San Mateo, CA—Many native grasses and other attractive vegetation can be grown in Grasspave^2.

Competing Technologies

Porous paving technology has made great strides not only in flexible plastic pavers but in other areas as well. Permeable asphalt, permeable concrete, interlocking unit blocks, reinforcement mats, and concrete grid pavements, have all improved and advanced to meet the growing demand for environmentally friendly technologies. It is Invisible Structures' firm belief that you should use porous paving, even if it is not our product line, whenever possible. The more you use these technologies, the better accepted they become: If you have to pave, porous pave!

Invisible Structures also contends that while these competing technologies have their place, in most instances, our Grasspave^2 and Gravelpave^2 systems outperform, last longer, require less maintenance, look better, and are easier to install. Check with our technical specialists at 800-233-1510 for the latest data.

Designing for Grasspave^2 and Gravelpave^2

Design for Use

There is an area in your development, site, or home that will most likely benefit from Grasspave^2 and Gravelpave^2. We advise that you take a look at proper use patterns, site conditions, and other specifications to get full advantage and long life out of our products. *Invisible Structures, 800-233-1510, is available for preliminary design assistance and consultation. Please note that other porous paving systems are NOT interchangeable with Grasspave^2 or Gravelpave^2, consult our technical specifications for full installation instructions.*

Considerations for Design:

- High use, low speed, and unlimited traffic volume is optimal for Gravelpave^2
- Low to moderate use, low speed, with recovery time is perfect for Grasspave^2 or Gravelpave^2
- Keep the porous paving area free of sediment and erosion from adjacent areas as they can cause drainage and aesthetic issues. Extra care should be taking for use in swales or berms.
- Slope should be considered. Grasspave^2 and Gravelpave^2 perform the best for all vehicles when the slope is no greater than 8 percent. Light vehicles (golf carts), bicycles, and pedestrian areas can have up to a 20 percent slope. Grasspave^2 in fire lanes should not exceed five percent (consult your local fire departments).
- Check the permeability of existing underlying soils. Percolation rates should be .64 cm to 1.3 cm of water per hour (EPA guidelines).
- The water table should be about three feet (approx. 1 m) below base course in most instances.
- Bedrock should not be closer than two feet (0.6 m) below base course.
- Avoid use of Grasspave^2 and Gravelpave^2 in areas where high speed acceleration or braking and turning occur. Examples are entrances and exits to parking lots that connect to higher speed roads.

If your site varies from these conditions, please consult ISI directly, 800-233-1510, as some conditions can be overcome with design and component adjustments.

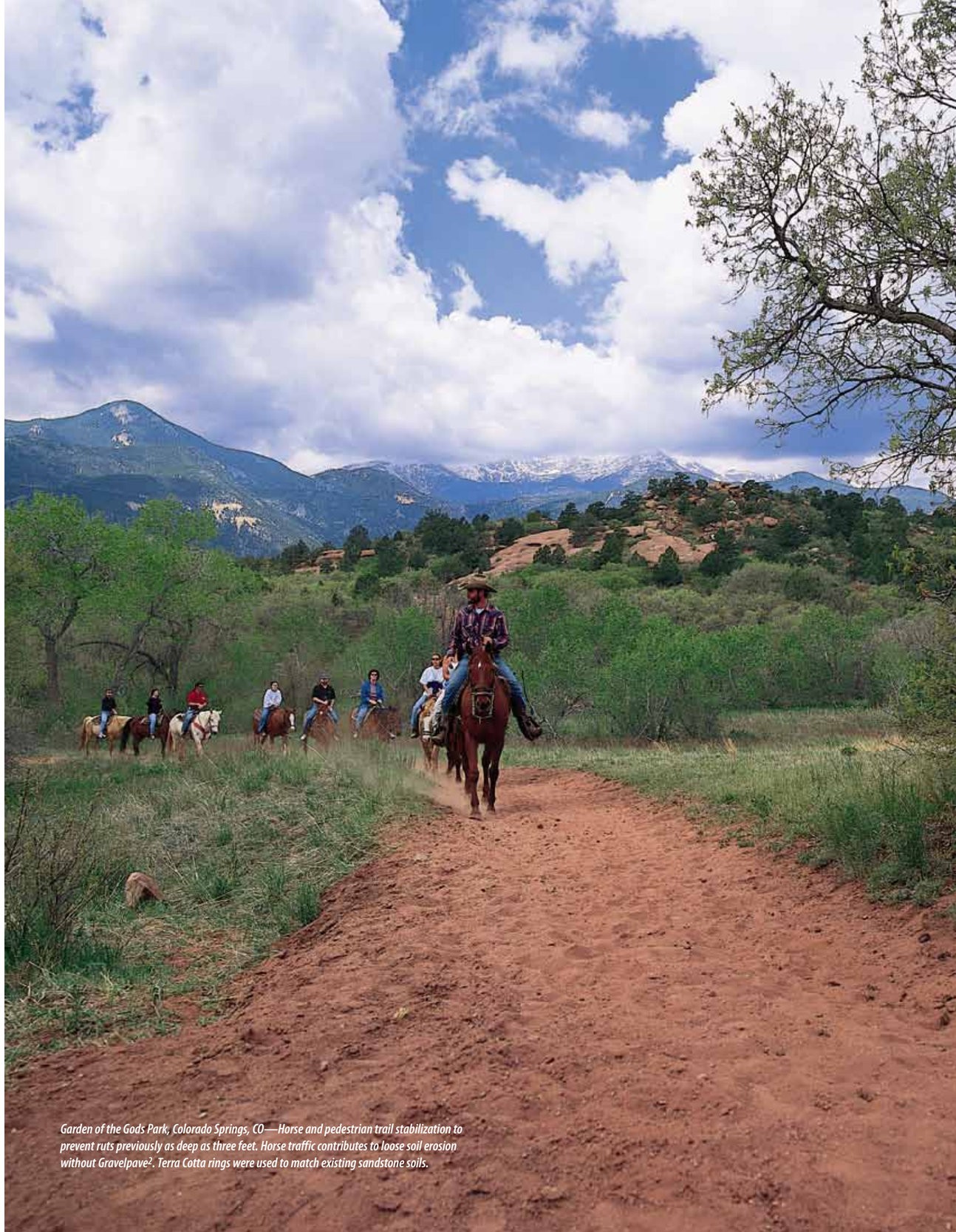
Base Course Design

Calculating the depth and composition of materials for the base course incorporates the same design criteria as for other pavements:

- Load-bearing capacity of native (or fill) subsoil,
- Plasticity or impact of moisture on strength and longevity,
- Frostheave potential, and
- Traffic load, frequency and/or duration.

Sample Base Course Depths

Please consult with a soils engineer for site-specific base requirements. Generally, the depth that is used under asphalt will be the requirement under Grasspave^2/Gravelpave^2. Golf carts and pedestrian traffic may require nothing over sandy gravel soils, and just two to four inches of base course (5–10 cm) over very weak soils. Cars usually need a six- to eight-inch base course (15–20 cm). Buses, trucks, and fire engines can easily require eight to 12 inches (20–30 cm) or more. The use of geotextiles, below the base is not required, but will prevent integration with subsoils and is strongly advised in areas of clay or silt soils and frost heave. *Do not use 100 percent limestone base as limestone will compact and become impervious—If limestone must be used, mix with 25–30 percent sand (AASTO M6 or equal).*



Garden of the Gods Park, Colorado Springs, CO—Horse and pedestrian trail stabilization to prevent ruts previously as deep as three feet. Horse traffic contributes to loose soil erosion without Gravelpave^2. Terra Cotta rings were used to match existing sandstone soils.

Bedding Sand Not Necessary
Do not use a sand setting base with our products. Unlike concrete pavers, bricks, and other rigid pavers—our Grasspave^2 and Gravelpave^2 are flexible and do not require sand to level.

Edge Protection
For aesthetic and maintenance considerations, you may want to design in a durable edging material to separate our porous pavers from adjacent areas of turf or to simply delineate a fire lane or path. With Gravelpave^2, an edging can prevent vegetation from encroaching onto the system and can prevent the gravel fill from migrating at the edge. Steel, aluminum, wood, brick, or concrete are all acceptable edging materials. Keep the edging flush or slightly higher than the porous paver grade.

Maintenance and Operation

Grasspave^2 Maintenance
Irrigation is required in dry climates. Any popular pop-up system can be used. Simply cut out rings to reveal the irrigation head. If golf courses in your area use irrigation systems, you probably should in your Grasspave^2 installation. Be careful not to overwater as this will encourage shallow root development.

Fertilize once a year with an NPK slow-release fertilizer that contains trace elements. There are many brands on the market. Do not aerate! You'll end up with product damage. When installed using sand in the rings, there will not be a compaction problem. Be careful not to use clay-based sods in pedestrian or vehicular traffic areas—use sandy soil sod, or seed and mulch. There seems to be no problem with sod selection for fire lanes. If the Grasspave^2 area has just been seeded or sodded, drive on it only in an emergency.

Gravelpave^2 Maintenance
Potholes will only appear if the base course has not been compacted properly before laying the rings or if the base material is allowed to mix into clay soils below (use nonwoven fabric to keep separate). Should this occur, remove a section by vacuuming the gravel from the rings, unfasten the snap fit fastener, bring the base course to the proper grade and compaction, put the Gravelpave^2 square back in place, anchor, and fill to the top of the rings. Seasonally check the rings in high-traffic areas and entrance lanes for lower levels of fill and replace by sweeping gravel from other areas to bring it level again. Leaves should be raked or vacuumed and not allowed to decay. Organic matter will stimulate weed growth and reduce porosity. To attack any occasional weeds that may locate within the Gravelpave^2 installation, simply spray them with a weed killer (such as Roundup™) and remove them when dead.

Cold Climates Concerns
Porous pavement thaws faster than conventional pavements because it allows melted water to flow directly through the pavement, increasing the temperature in the cross-section

Grasspave^2 and Gravelpave^2 are made from flexible High Density Polyethylene (HDPE) plastic with UV inhibitors, which withstands repeated freeze-thaw cycles and continuous subzero temperatures without cracking.

Private Residence, Houston, TX—Grasspave^2 supported grass sections in this custom home driveway.

Grand Canyon Trust, Flagstaff, AZ—Thirty-car employee parking lot after several years of snow removal and excellent maintenance. Spaces are defined with concrete bumpers.

Fire departments usually require you to plow snow that is over three inches deep. (7.5 cm). Consult with your local fire department for their guidelines.

Educate your snow removal crew to take care not to have the plow blade make contact with the Grasspave^2 or Gravelpave^2 systems. Experienced snowplow drivers can leave a thin layer of snow on the systems or they can attach skids (¾ inch—2 cm) to the bottom of the blades.

Sales and Technical Support Partners

Invisible Structures, Inc. welcomes the opportunity to review designs and answer technical questions. Design details, technical specifications, white papers, and other support material may be downloaded from our web site. See a comprehensive list of project profiles and case studies at www.invisiblestructures.com

In addition to the high-quality, professional, experienced staff at our main headquarters in Colorado, we have excellent partners representing their geographical areas. They are prepared to assist you locally, at all levels, with your project needs. Please contact us or check our web site for your partner name and information.

Contact Information

Invisible Structures, Inc.
303-233-8383
www.invisiblestructures.com
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Grasspave^2 and Gravelpave^2 Patent No. 5,250,340
Held by William Bohnhoff, ASLA.
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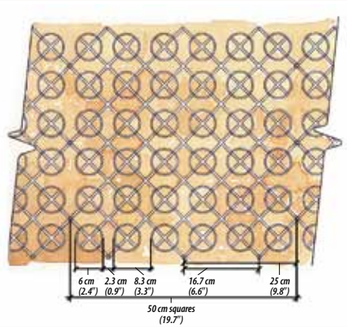
Grasspave^2 is used as a cool, stable surface for picnic tables at a community pool.

City of White Rock Operations , White Rock, British Columbia—Gravelpave^2 is used in the main drive aisle of the works yard and Grasspave^2 is used for the parking bays.



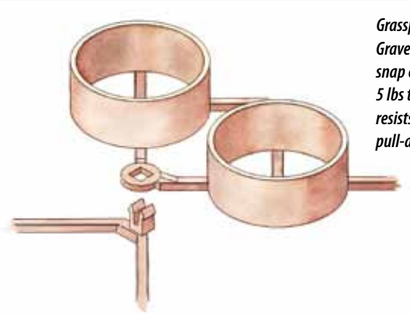
Gravelpave^2: Available in several roll sizes.

Squares weigh 1.97 kg (4.34 lb) each.

Colors: Cashew Brown, Black, Pewter Grey, Terra Cotta.

Resin: HDPE.

Strength: 1120 kg/cm^2 (15,940 psi)



Grasspave^2 and Gravelpave^2: Reusable snap connector requires 5 lbs to connect and resists 70 lbs of pull-apart force.

Glendale Community College, Glendale, Arizona—The Gravelpave^2 fire lane (foreground) and Grasspave^2 fire lane (background) complement the surroundings at the Glendale campus.

Quick Reference Guide for Grasspave^2 and Gravelpave^2		
	GRASSPAVE^2 BY INVISIBLE STRUCTURES™	GRAVELPAVE^2 BY INVISIBLE STRUCTURES™
Description	Connectable ring and grid system	Connectable ring, grid, and integrated fabric
Also Included	Hydrogrow polymer—exclusively for Grasspave^2	Geotextile fabric molded to grid (exclusive to Gravelpave^2) and anchors
Available in Large, Flexible Rolls	Yes, various sizes—see roll chart page 14	Yes, various sizes—see roll chart page 14
Colors	Black	Black, gray, tan, terra cotta, custom colors extra
Components Needed for System	Base course, sand, labor, sod or seed (irrigation is recommended)	Base course, 1¼″ (3.2cm) of 3/16″ to 3/8″ decorative gravel, and labor
Traffic	Low speed, light to moderate	Low speed, unlimited use
Compressive System Strength	Filled: 15,940 psi (2.29 million per sq ft / 109,906 kPa)	Filled: 15,940 psi (2.29 million pounds per sq ft / 109,906 kPa)
Life Span	60 years	25 years
Recommended Maximum Slope	5% fire lanes, 8% car/light truck, 15-20% golf carts, pedestrian use, and trails	5% fire lanes, 8% car/light truck, 15-20% golf carts, pedestrian use, and trails
Stormwater Storage	Yes	Yes
Clean Pollutants through Bioremediation	Excellent	Good
Air-Conditioning Effect	Yes	No
Heat Island Mitigation	Yes—Albedo Number .40	Yes, with light colored gravel fill—Albedo .16
Reduces Runoff and Non-Point Source Pollution	Yes	Yes
Recycled Content	100% recycled HDPE plastic	100% recycled HDPE plastic with recycled remnant fabric
Erosion Control	Yes	Yes
Airborne Dust Capture and Retention	Excellent	Good
Promotes and Retains Tree Growth	Yes	Yes
Recharges Groundwater	Yes	Yes

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Gravelpave^2 and Grasspave^2 Patent No. 5,250,340
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