AirPave®

By AirField Systems

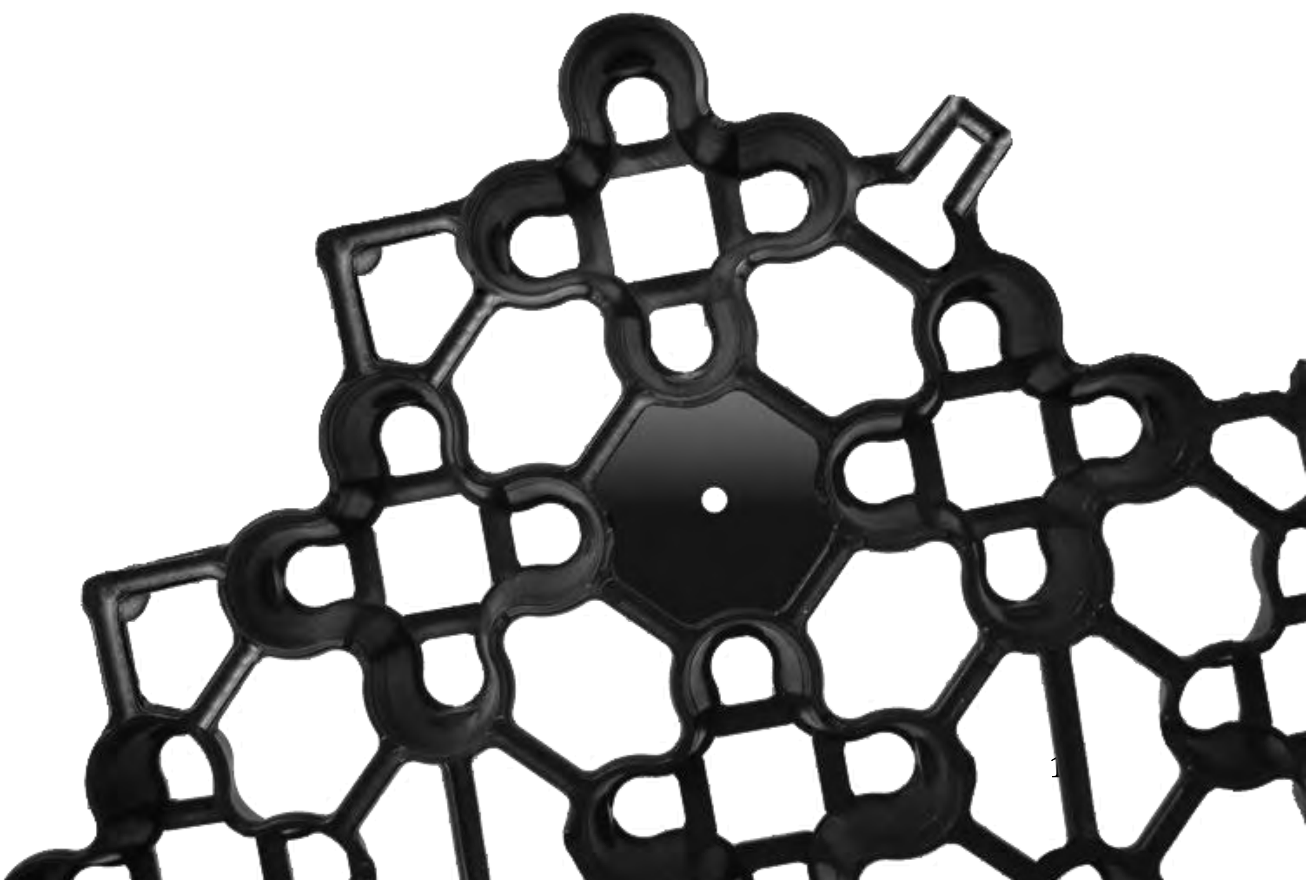
Porous Flexible Paving Submittal Package

Feb 2015

Asphalt base AirPave unfilled and still withstands the load of a fire truck.

CSI # 32 12 43 Porous Flexible Paving

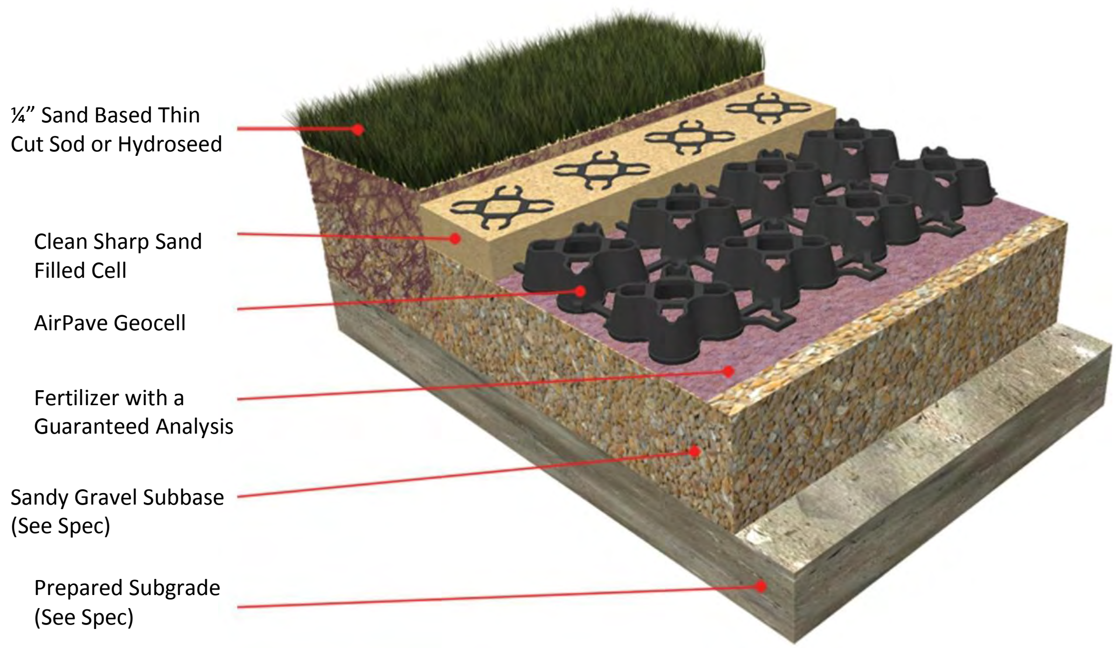
6,747psi. / 971,568 psf. Sand Filled



AirPave

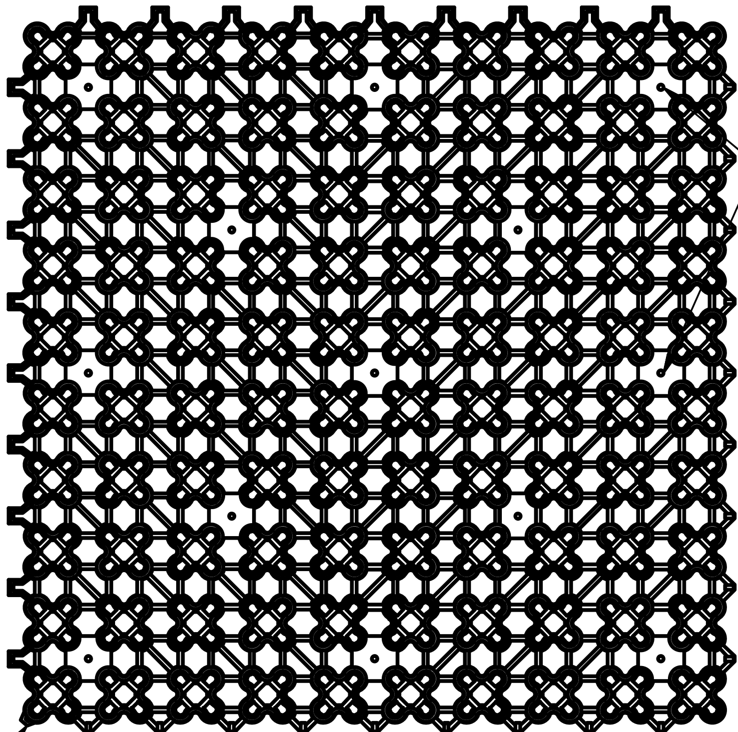
By **AirField Systems**,

A flexible porous paving and drainage system for grass fire lanes, reinforced turf paving and swales. With over 400 installations AirPave is 233psi unfilled, **6747psi sand filled** and is made of 100% recycled content which can contribute to LEED™ points. AirPave can ship more than 91,000 sqft per truck load and 798 sqft per pallet with each part weighing only 3.1 lbs. **AirPave can save the owner up to $0.80 per square foot or more over our competitors**. **CSI# 32 12 43**



Benefits of an AirPave grass paving system include:

- A 40% or more material cost savings over our nearest competitor and over 1,000 more PSI
- Up to 45% cost savings on shipping, compared with rolled grass paving systems
- AirPave has been installed in over 400 flexible porous paving projects
- 100% recycled injection-molded copolymer polypropylene plastic units with an impact modifier added to achieve a (NO-BREAK) plastics classification and a minimum 3% carbon black added for UV protection
- Loading capability is equal to 233 psi empty capacity and **6,747 psi** when filled with clean sharp sand, over an appropriate base depth that provides adequate support for project design loads.
- AirPave is shipped palletized at 7 sq. ft. per part 114 parts per pallet and approximately 798 sq. ft. per pallet. Unit weight = 3.10 lbs, volume = 8% solid



Unit Panel Specifications:

Size:	32" x 32" x 1"
Weight:	3.1 lb
Strength:	233 psi (unfilled)
	6747 psi (filled)
Resin:	100% Recycled (PIR)
	Copolymer with Impact Modifier
	"No Break" Polymer Material
Color:	Black
	(3% carbon black added for UV Protection)

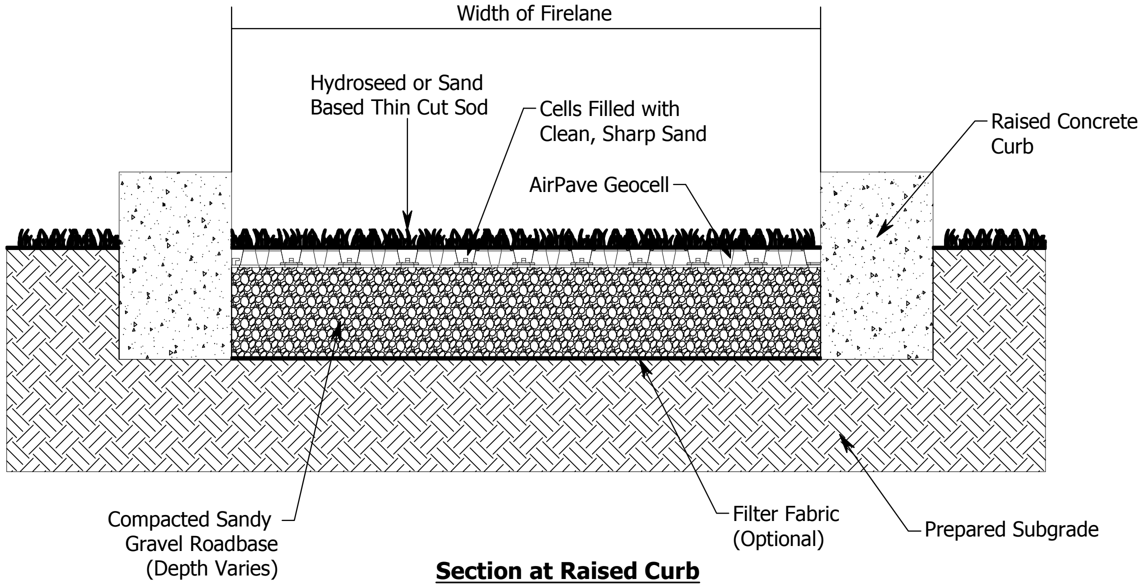
AirPave Cross Section

Scale 0.12:1

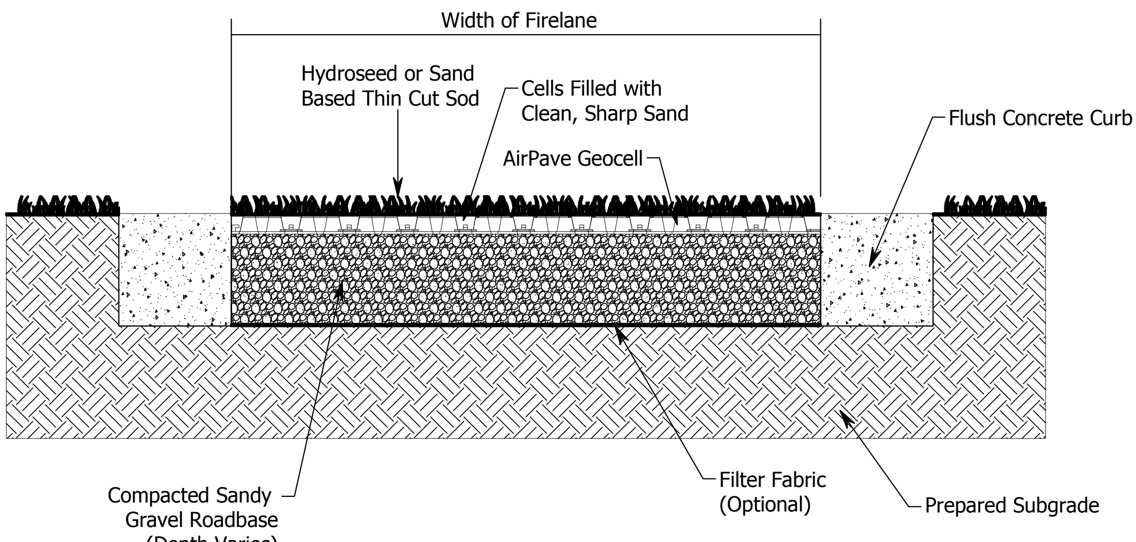
Typical

For AirPave Systems

Airfield Systems, LLC
8028 N May Ave, Suite 201
Oklahoma City, OK 73120
(405) 359-3375



Section at Raised Curb



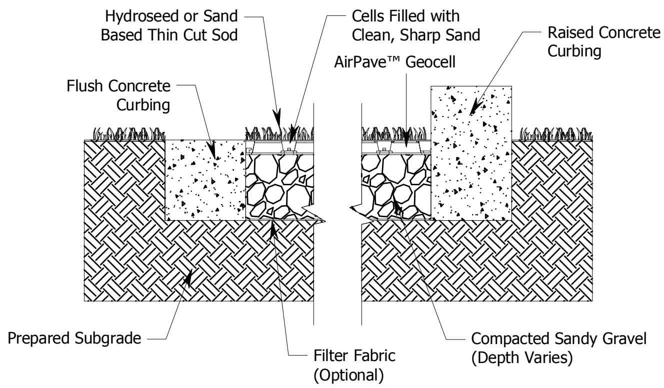
Section at Flush Curb

Airpave Typical Firelane Detail

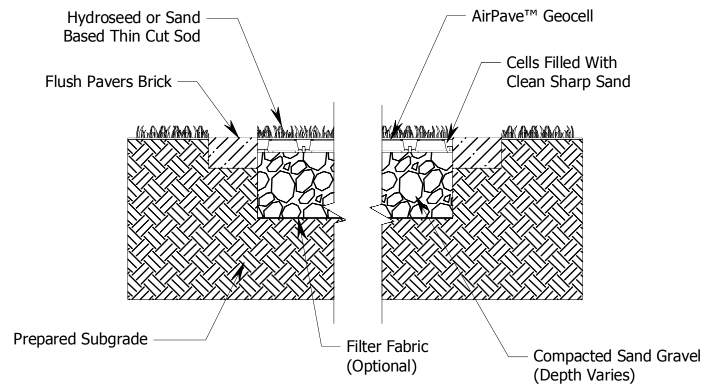
For AirPave Grass System

Airfield Systems, LLC
8028 N May Ave, Suite 201
Oklahoma City, OK 73120
(405)359-3375

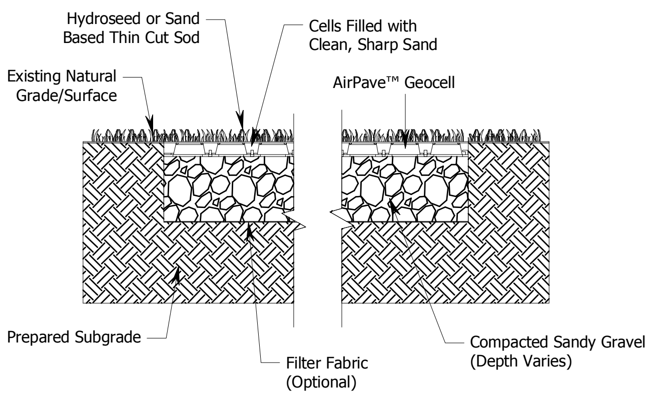
Firelane_Subbase_FLD_002.idw



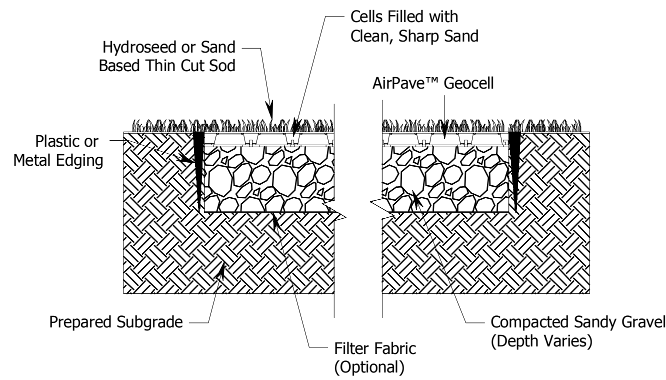
AirPave™ Concrete Curb Edging



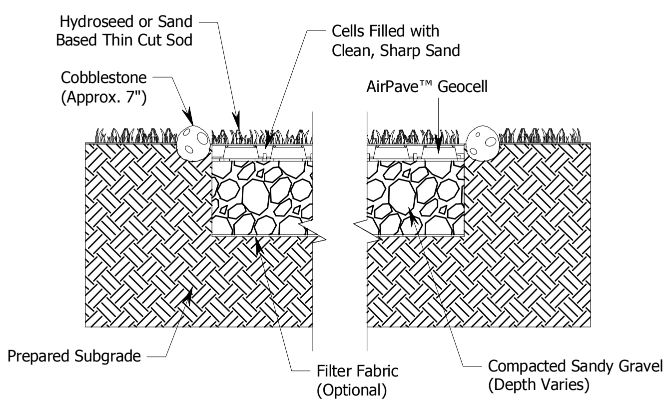
AirPave™ Flush Brick Edging



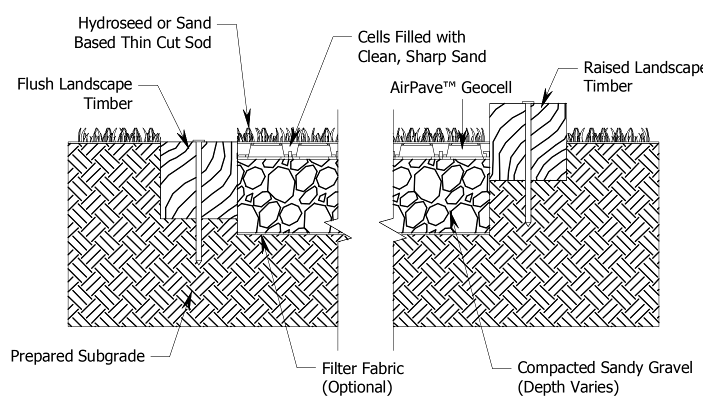
AirPave™ Flush Natural Edging



AirPave™ Metal or Plastic Edging



AirPave™ Cobblestone Edging

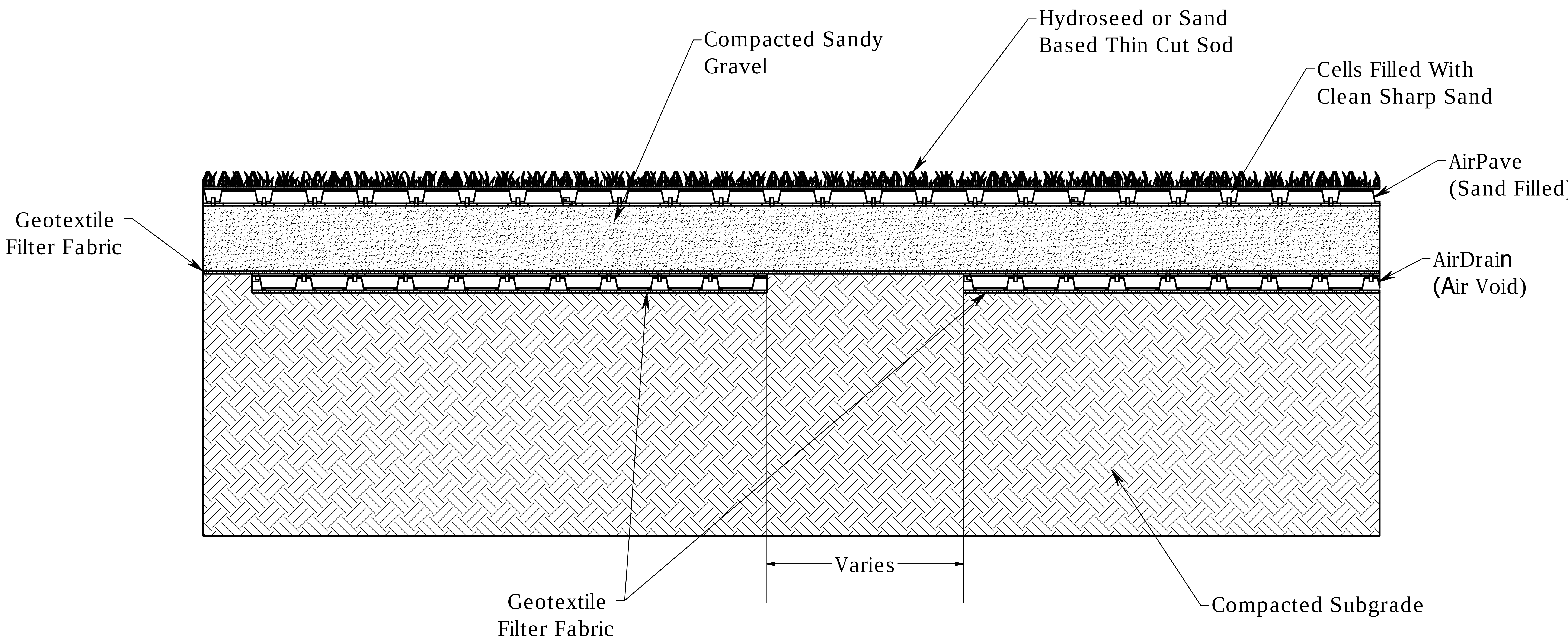


AirPave™ Landscape Timber Edge Raised/Flush

AirPave™ Permeable Edging Options

Airfield Systems, LLC
8028 N May Ave, Suite 201
Oklahoma City, OK 73120
(405) 359-3375

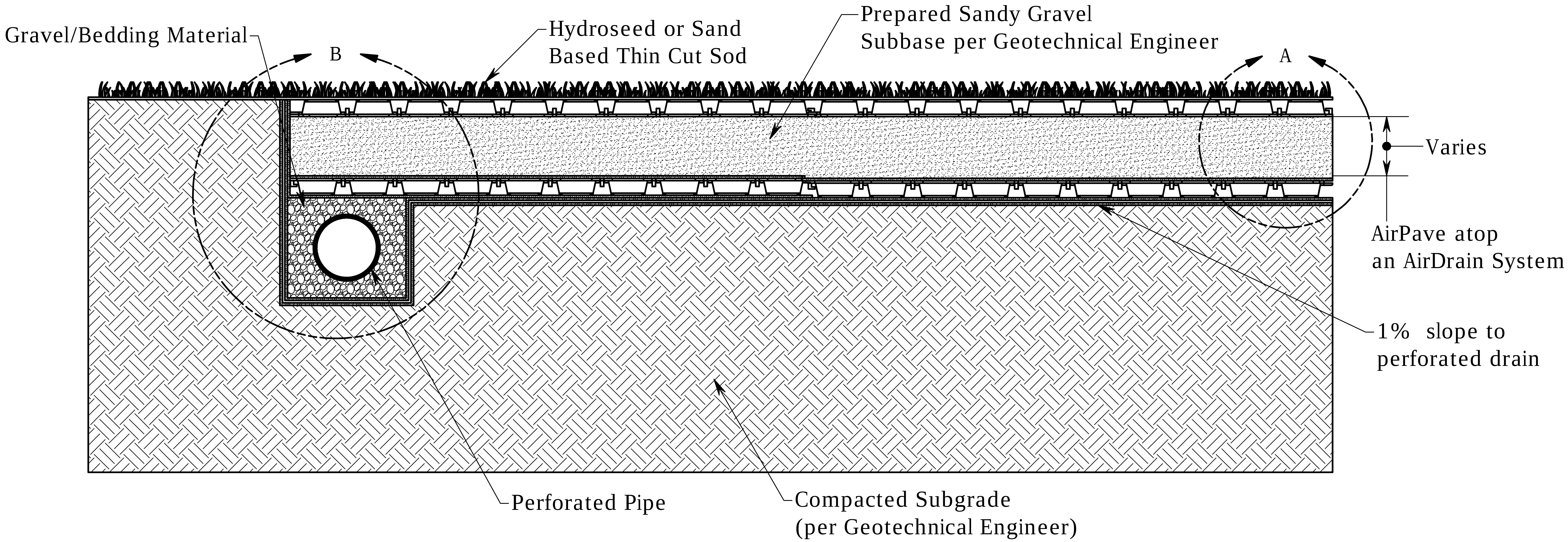
Drawing No: Firelane Edging Options NFL_002.idw

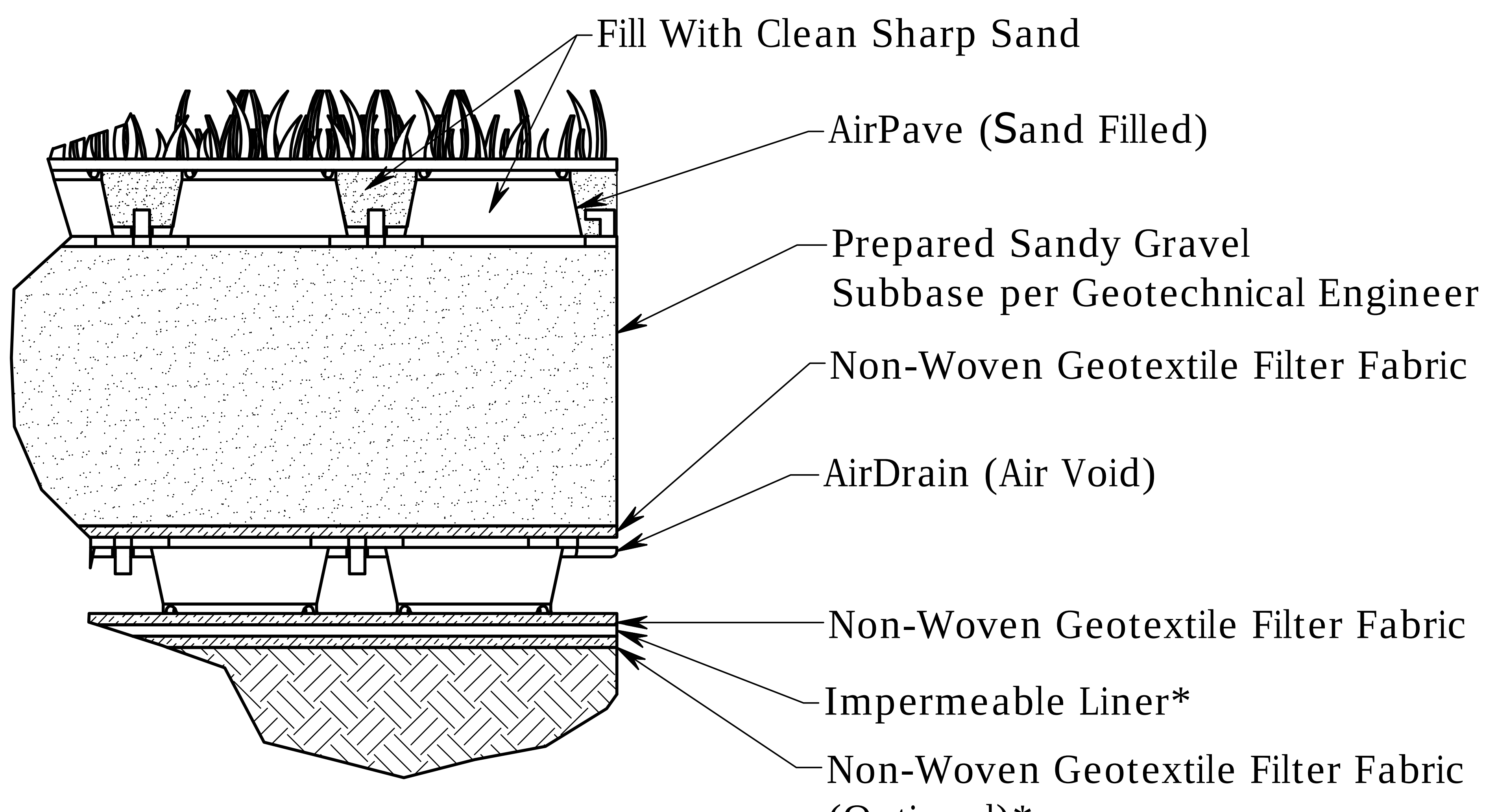


This drawing, specifications and the information contained herein is for general presentation purposes only. All final drawings and layouts should be determined by a licensed engineer(s).

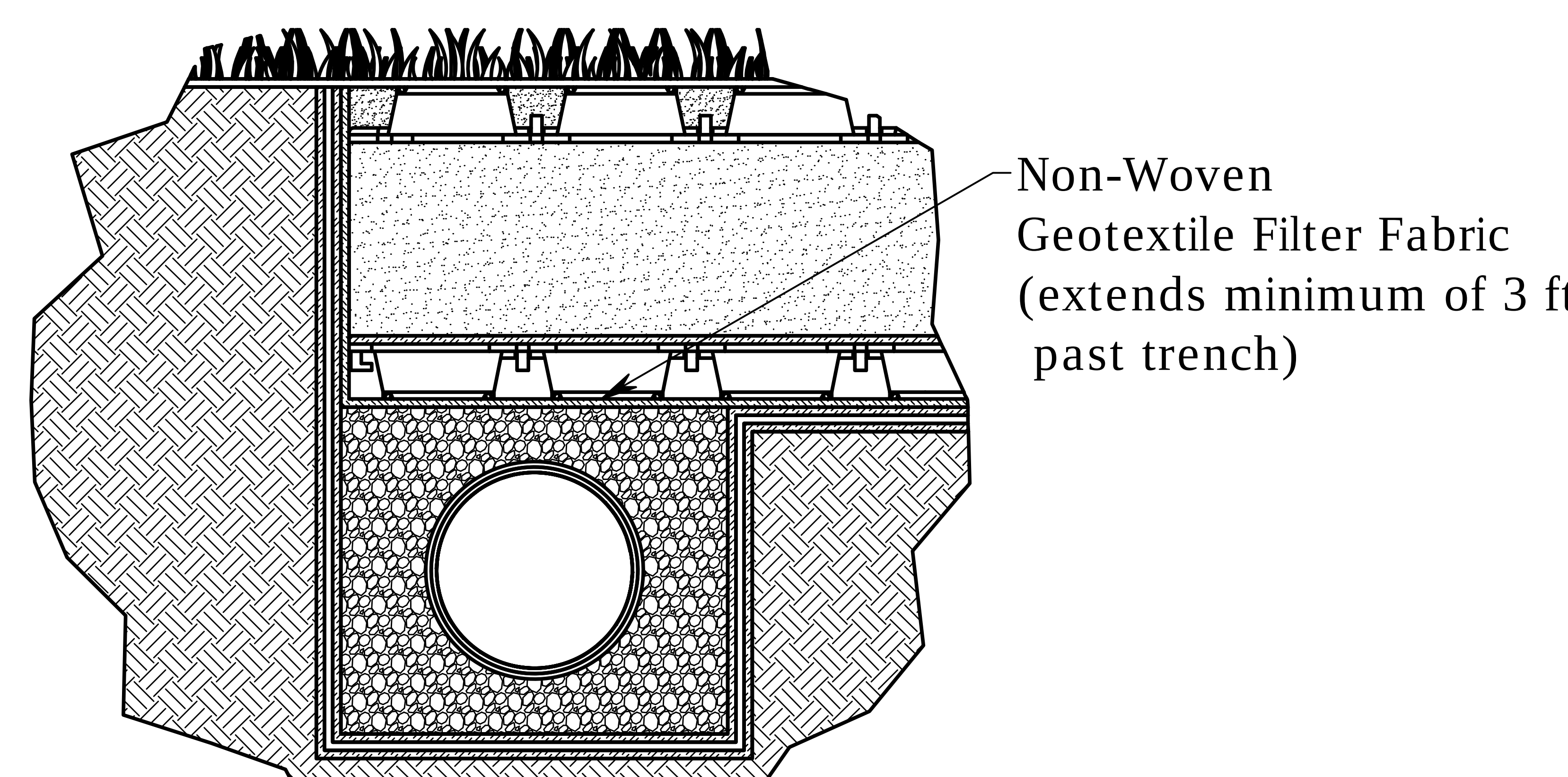
airfield systems

DRAWN Gary	5/22/2012	Airfield Systems	
CHECKED		TITLE AirPave with Permeable Drainage Layer	
QA			
MFG			
APPROVED			
		SIZE C	DWG NO Permeable System_EX_DL_PS004
		SCALE	SHEET 1 OF 1





DETAIL A



DETAIL B

*Per Geotechnical Engineer

Select for poor draining soils or where additional water transport is needed.

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AirField Systems
8028 N. May Avenue, Suite 201
Oklahoma City, OK 73120
Call: (405) 359-3775
http://www.airfieldsystems.com/

DRAWN		Airfield Systems		
Gary	5/20/2012			
CHECKED		TITLE AirPave Permeable Paving atop an Impermeable AirDrain System		
QA				
MFG				
APPROVED				
		SIZE C	DWG NO Permeable System_DL_PS005	REV 12
		SCALE		SHEET 1 OF 1

SECTION 32 12 43

FLEXIBLE POROUS PAVING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Base course of sandy gravel, over sub-base prepared by others.

B. Porous flexible paving and anchors.

C. Sand cover.

D. Turf cover for paver units.

E. Fertilizer

1.2 RELATED SECTIONS

A. Section 31 20 00 - Earth Moving.

B. Section 33 46 19.13 - Underslab Drainage Piping.

C. Section 32 10 00 - Bases, Ballasts, and Paving.

D. Section 32 30 00 - Site Improvements.

E. Section 32 84 23 - Underground Sprinklers.

F. Section 32 90 00 - Planting.

1.3 REFERENCES

A. AASHTO M6 - Standard Specification for Fine Aggregate for Hydraulic Cement Concrete.

B. ASTM C 33 - Standard Specification for Concrete Aggregates.

C. United States Golf Association (USGA) - Greens section sand mix "The Root Zone Mixture."

1.4 SUBMITTALS

A. Submit under provisions of Section 01 30 00 - Administrative Requirements.

B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.

C. Shop Drawings: Submit manufacturer's shop drawings including laying pattern and anchoring.

D. LEED Submittals: Provide documentation of how the requirements of Credit will be met:
   1. List of proposed materials with recycled content. Indicate post-consumer recycled content and pre-consumer recycled content for each product having recycled content.
   2. Product data and certification letter indicating percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content.

E. Samples: Submit two 10 inch square samples of Porous Flexible Paving Units product specified.

F. Manufacturer's Certificates: Certify base course, sand fill materials and products meet or exceed specified requirements.

G. Closeout Submittals: Provide manufacturer's maintenance instructions that include recommendations for periodic fertilizing and maintenance.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer with a minimum for five years documented experience with the products specified.

B. Installer Qualifications: Installer experienced in performing work of this section that has specialized in installation of work similar to that required for this project. Installer must also be able to provide skilled workman with satisfactory record of performance on landscaping or paving projects of comparable size and quality.

C. Pre-Installation Meetings:
   1. Convene a pre-installation meeting a minimum of two weeks prior to start of porous paving systems.
   2. Verify project requirements, subbase and base conditions, manufacturer's installation instructions and coordination with other related work.
   3. Require attendance of parties directly affecting work of this section, including the Contractor, Architect, engineer, and installer. Manufacturer's representative may attend by phone conference as needed.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Protect porous paver units from damage during delivery and store under tarp when time from delivery to installation exceeds 30 days.

C. Keep supplied fertilizer with a Guaranteed Analysis in a dark and dry location.

D. Protect materials during handling and installation to prevent damage.

1.7 SEQUENCING

A. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

1.8 PROJECT CONDITIONS

A. Maintain environmental conditions recommended by manufacturer for desired results. Do not install products under conditions outside manufacturer's absolute limits.

B. Do not begin installation of porous pavements until all hard surface paving adjacent to porous pavement areas, including concrete walks and asphalt paving, is completed.

C. Install turf when ambient air temperature is at least 55 degrees F.

D. In cold weather, do not use frozen materials or materials coated with ice or frost, and do not build on frozen base or wet, saturated or muddy subgrade.

E. Protect partially completed porous paving against damage from other construction traffic when work is in progress.

F. Protect turf paving from traffic until grass root system has matured for at least 3 to 4 weeks. Use barricades to only permit accessible by emergency and fire equipment

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: Airfield Systems, which is located at: 8028 N. May Ave. Suite 201 ; Oklahoma City, OK 73120; Tel: 405-359-3775; Email: request info (sales@airfieldsystems.com); Web: www.airfieldsystems.com

B. Substitutions: Not permitted.

2.2 MATERIALS

A. Base Course: Sandy gravel material from local sources commonly used for road base construction and conforming to the following sieve analysis and requirements:
   1. Sieve Analysis:
      a. 100 percent passing sieve size 1 inch (25 mm).
      b. 90-100 percent passing sieve size 3/4 inch (19 mm).
      c. 70-80 percent passing sieve size 3/8 inch (9 mm).
      d. 55-70 percent passing sieve size #4.
      e. 45-55 percent passing sieve size #10.
      f. 25-35 percent passing sieve size #40.
      g. 3-8 percent passing sieve size #200.
   2. For turf pavers, provide materials nearly neutral in pH (range from 6.5 to 7.2) to provide adequate root zone development for turf.
   3. Material may be either "pit run" or "crusher run." Crusher run material will generally require coarse, well draining sand conforming to AASHTO M6 or ASTM C 33 to be added to mixture (20 to 30 percent by volume) to ensure long-term porosity.

4. Alternative materials such as crushed shell, limerock, or crushed lava may be used for base course use, provided they are mixed with sharp sand (20 to 30 percent) to ensure long term porosity, and are brought to proper compaction. Without added sand, crushed shell and limerock set up like concrete and become impervious.

B. Porous Flexible Paving Units: AirPave Geocell Grass Paving Units.
   1. Materials:
      a. Lightweight injection-molded copolymer polypropylene plastic units using impact modifier.
      b. Plastic is 100 percent post-consumer recycled copolymer polypropylene resin using a polymer impact modifier, with minimum 3 percent carbon black added for UV protection.
      c. Chemical resistance: Excellent.
      d. UV resistance: High.
      e. Toxicity: Non-Toxic.
   2. Performance Properties:
      a. Loading capability is equal to 233 psi empty capacity and 6,747 psi when filled with sand, over an appropriate base depth that provides adequate support for project design loads.
   3. Dimensions:
      a. AirPave Grid: 31.784 inches by 31.880 inches by 1.000 inches or 7.03 SF.
      b. Weight (Nominal): 3.10 lbs per paver grid, 8 percent solid.

C. Paver Unit Anchors: 8 inch Chisel Point Pins 6 gauge BB Wire with 1.5 inch round attached washer, as required by the Architect or licensed geotechnical engineer to secure units in place

D. Sand Cover:
   1. Coarse, well-draining sand (washed concrete sand conforming to AASHTO M6 or ASTM C-33.
   2. United States Golf Association (USGA) greens section sand mix "The Root Zone Mixture."
   3. Other Soil Mix as recommended by the manufacturer.

E. Grass: Coordinate with Section 32 92 26.13 - Stolonizing
   1. Sodding: Sod: Use a 1/4 inch shallow cut rolled sod from a reputable local grower. Species should be wear resistant, free from disease, and in excellent condition. Sod shall be grown in sand or sandy loam soils only with less than 15 percent clay content. Sod grown in soils of clay, silt, or high organic materials such as peat, will not be accepted.
   2. Seeding: Use seed materials, of the preferred species for local environmental and projected traffic conditions, from certified sources. Seed shall be provided in containers clearly labeled to show seed name, lot number, net weight, percentage weed seed content, and guaranteed percentage of purity and germination. Pure Live Seed types and amount shall be as shown on plans. Mulch using wood or paper cellulose types of commercial mulch materials used in hydroseeding operations. Mulches of straw, pine needles, etc. will not be acceptable because of their low moisture holding capacity.
   3. Hydro Seeding: Approved seed mix and mulch using wood or paper cellulose types of commercial mulch materials for hydroseeding operations.

F. Fertilizer: Sustane Natural Fertilizer with guaranteed analysis of 4-4-4+Fe and provided with AirPave paving system.

G. Firelane Signage and Markings: Identify entrance and physical location of firelanes using signs if gates, curbs, bollards, and other built elements do not adequately indicate firelanes; comply with requirements of local fire authorities.

PART 3 EXECUTION

3.1 EXAMINATION

A. Before beginning installation, verify site conditions are as indicated on the Drawings. Notify the Architect if site conditions are not acceptable. Do not begin preparation or installation until unacceptable conditions have been corrected.
   1. Complete all hard surface paving adjacent to flexible paving areas, including concrete walks and asphalt paving prior to installation of flexible paving.

B. Obtain approval of local fire authorities of sub-base prior to installation of base course for flexible porous paving.

C. Ensure that sub-base Specified in Section 32 10 00 - Bases, Ballasts, and Paving is adequate to receive designed base course, wearing course, and the required design loads. Ensure that grading and soil porosity of the sub-base will provide adequate subsurface drainage.

3.2 PREPARATION

A. Subgrade Preparation:
   1. Prepare subgrade as specified in Section 32 10 00 - Bases, Ballasts, and Paving. Verify subgrade in accordance with porous paving system manufacturer's instructions.
   2. Excavate area allowing for unit thickness and the engineered base depth (where required).
   3. Provide adequate drainage from excavated area if area has potential to collect water, when working with in-place soils that have poor permeability.
   4. Provide a subdrainage system as specified in Section 33 46 19.13 - Underslab Drainage Piping.
   5. Ensure in-place soil is relatively dry and free from standing water.
   6. Uniformly grade base.
   7. Level and clear base of large objects, such as rocks and pieces of wood.

B. Base Course: Place base course material over prepared sub-base to grades indicated on the Drawings. Place in lifts not to exceed 6 inches (150 mm), compacting each lift separately to 95 percent Modified Proctor. Leave 1 inch (25 mm) of depth below final grade for porous paver unit and gravel fill.

C. Base Preparation:
   1. Leave minimum 25 mm (1 inch) to 35 mm (1.5 inches) for porous flexible paving units and sand/sod fill to final grade.
   2. Spread all Sustane fertilizer mix at the rate of 25 kg per 100 m2 (25 lbs per 1,000 SF) evenly over the surface of the base course with a hand-held, or wheeled, rotary spreader. Place fertilizer mix should be immediately before installing the porous flexible paving units.

3.3 INSTALLATION

A. Paving Units: Install Porous Flexible Paving Units in accordance with manufacturer's instructions.

1. Install by placing units with connectors and the pinning platforms flush against the prepared subbase with the larger diameter clover openings (cup side down) and pinning platforms facing downwards (grid side down). Place the first unit panel to the field's upper left hand corner. Orient the paving unit materials with the integral indicator tab (painted yellow) to the panel's bottom left hand corner. Proper sequencing and orientation of panels will result in a more rapid installation.
2. Install unit panels across the field in a rowed pattern. Staggering of rows will allow for multiple row completion by a multi-manned crew. Secure the first panel to the base with pins and commence with panels 1-2, 1-3 and so on with one directional pull to secure. After each one directional pull secures the panel connectors together, slightly push back each panel to allow for contraction space at each connector. Verify each integral connector is snapped in place with sufficient contraction room allowed as panel installation proceeds.
3. Once the first row has progressed across the project, start with the second row. By maintaining proper panel orientation, the top edge panel connectors will drop into the previously installed panel receptors after the one directional pull secures the panel.
4. Panels can be shaped to individual field areas as needed with an appropriate cutting device. If you have many parts to trim use a circular saw with a no melt, plastic cutting saw blades.
5. Anchor units to base course on curves, slopes, high traffic areas and any other areas as required.
6. Anchor units using paver unit anchors. Tops of clovers shall be between 6 mm to 13 mm (0.25 inch to 0.5 inch) below the surface of adjacent hard-surface pavements.

B. Sand: Place sand in clovers by back-dumping directly from a dump truck, or from buckets mounted on tractors, which then exit the site by driving over clovers already filled with sand. Spread sand laterally from the pile using flat bottomed shovels and/or wide asphalt rakes filling the clovers. Use a stiff bristled broom for final finishing of the sand uniformly over the clovers. Compact sand by using water from hose, irrigation heads, or rainfall, with the finish grade no less than the top of clovers and no more than 6 mm (0.25 inch) above top of clovers.

C. Grass: Coordinate with Section 32 92 26.13 - Stolonizing and in accordance with porous paving manufacturer's instructions.

1. Hydroseeding/hydro-mulching: Mix a combination of water, seed and fertilizer homogeneously in a purpose-built, truck-mounted tank. Spray the seed mixture uniformly onto the site at required rates. Following germination of the seed, areas lacking germination larger than 20 cm by 20 cm (8 inches by 8 inches) shall be reseeded immediately. Seeded areas shall be fertilized and kept moist during development of the turf plants.
2. Thin Cut Sod: Install directly over sand filled clovers, filled no higher than the top of the clovers. Place sod strips with very tight joints, moistened and rolled to create good contact for growth. Fertilize and keep moist during root establishment (minimum of 3 weeks). Protect from any traffic for a period of 3 to 4 weeks or until the root system has penetrated and established well below the porous paving units.

3. Seeding: Place grass seed at recommended rates per grass type. Place a light dusting of commercial topsoil mix, not to exceed 1/4 inch (25 mm) above the clovers and seed mix to aid germination rates. Fertilize and keep moist seeded areas during development of the turf plants.

3.4 MAINTENANCE

A. Remove and replace segments of porous paving units where three or more adjacent clovers are broken or damaged, reinstalling as specified, so no evidence of replacement is apparent.

B. Maintain grass in accordance with manufacturer's instructions and as specified in Section 32 92 26.13 - Stolonizing Lawns and Grasses.

3.5 PROTECTION

A. Protect turf area from any traffic for a period of 4 to 8 weeks, or until the grass is mature enough to handle traffic.

B. Perform cleaning during the installation of work and upon completion of the work. Remove all excess materials, debris, and equipment from site. Repair any damage to adjacent materials and surfaces resulting from installation of this work.

C. Repair or replace damaged products before Substantial Completion.

END OF SECTION

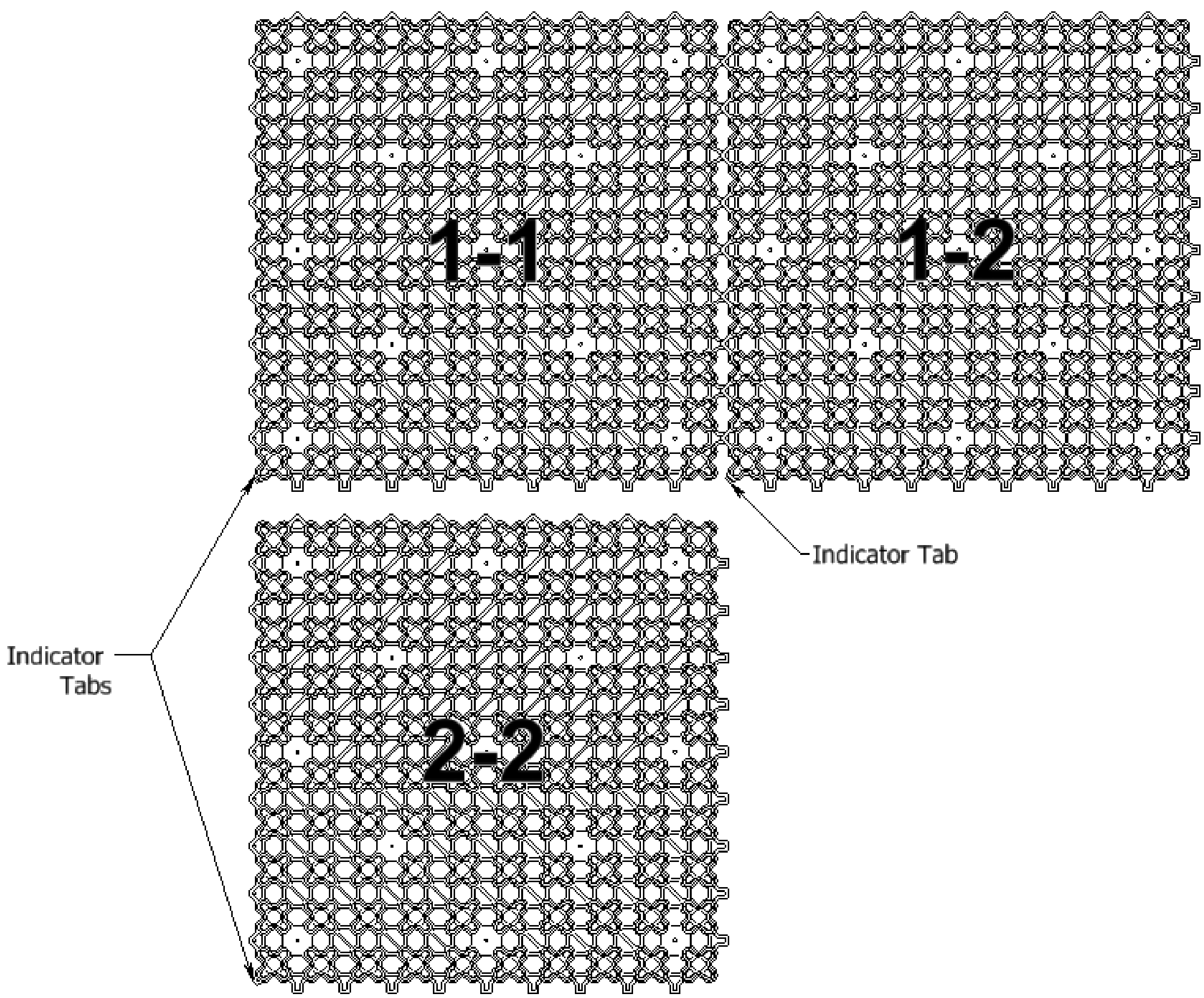
DISCLAIMER: The preceding and following drawings and/or general installation guidelines are provided only to show a concept design for installation and are not instructions for any particular installation. These drawings and general instructions are not complete and are provided only to assist a licensed Geo-Technical Engineer, a Landscape Architect and/or Civil Engineer in preparing actual construction and installation plans. These drawings and instructions must be reviewed by a licensed Geo-Technical Engineer, a Landscape Architect and/or Civil Engineer and adapted to the condition of a particular installation site and to comply with all state and local requirements for each installation site. THESE DRAWINGS AND/OR GENERAL INSTRUCTIONS DO NOT MODIFY OR SUPPLEMENT ANY EXPRESS OR IMPLIED WARRANTIES INCLUDING MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, IF APPLICABLE RELATING TO THE PRODUCT.

Proper Sequencing and Orientation of
AirPave GeoCell Panels for Rapid Installation

Pallet Staging: AirPave pallets cover approximately 798sqft. per pallet and should be staged accordingly within the installation area so that you minimize the amount of time to stage the AirPave grid along the install lines across the project. Typically placing the AirPave every 65 feet across and 15-20 feet back from each other. (Call AirField with questions that you might have about proper staging and installation.)

All Installations must start in the Top Left Corner of the project and work Left to Right to be installed properly.

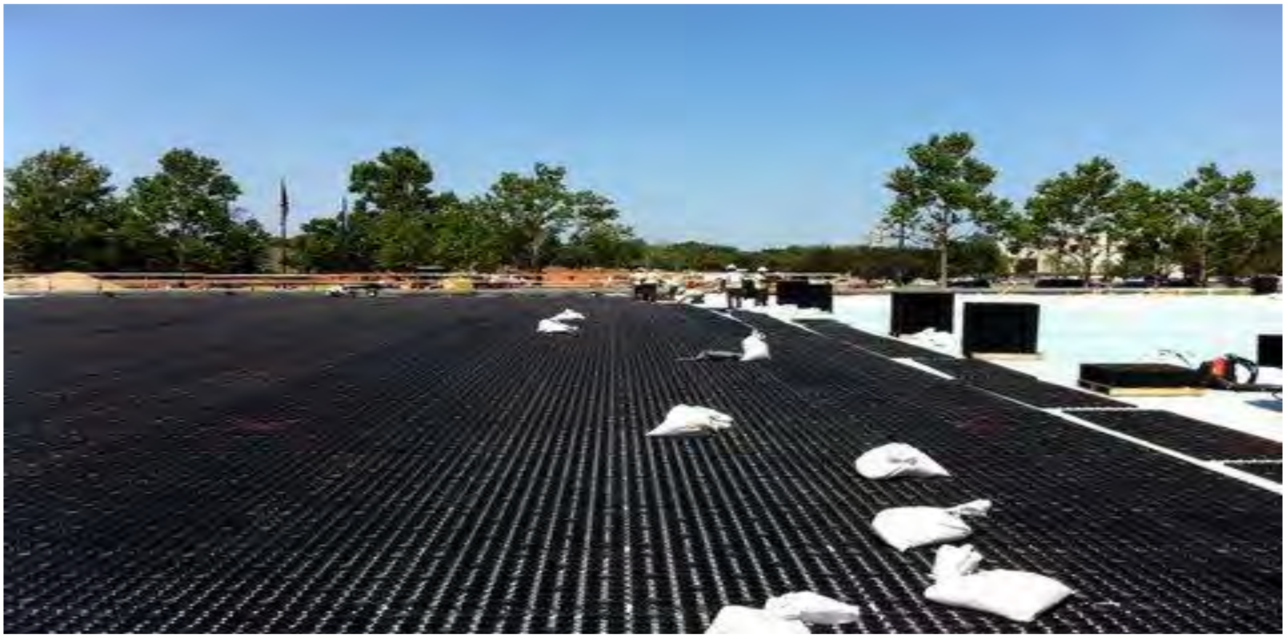
1. Orientate the AirPave GeoCell materials with the integral indicator tab to the panel's bottom left corner (painted yellow). **Install the AirPave units by placing units with connectors and the pinning platforms flush against the prepared subbase. If the female connectors do not go over the male connectors then the orientation is incorrect, please call AirField Systems Immediately at 405-359-3775.**



2. Install the AirPave panels across the field in a rowed pattern. Staggering of rows will allow for multiple row completion by a multi-manned crew.

3. Secure the first panel to the base with pins (Only in AirPave grass pave installations) and commence with panels 1-2, 1-3, and so on with one directional pull to secure. (Optional)

4. Once the first row has progressed across the project, start with a second row. Have a person staging the panels in three's snapped together along the row. The crew can then install the left side of the panel while elevating slightly the top portion (so the male and female connectors don't sync) once the left side has been snapped with a pull along the row direction, the top portion should fall into place and with a bottom vertical pull holding the inside of parts 1 & 3 snap all three parts in place.



5. AirPave panels can be shaped to individual field areas as needed with appropriate cutting device.

   A. If only a few parts need to be trimmed, use tin snips.

   B. If many parts require trimming, set up a table and use a circular saw with a no melt, plastic cutting saw blade.

6. AirPave units placed on curves and slopes shall be anchored to the base course, using 8 inch (203 mm) Chisel Point Pins 6 gauge BB Wire and 1 1/2 (35 mm) round attached washers, as required to secure units in place.

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6.20.14

Delineation and Marking on the AirPave System for Grass Fire Lanes

It is easy for your site to provide delineation to separate handicapped parking spaces, regular parking spaces, fire lane routes, or for other needs. You really have unlimited options to stripe, mark, or delineate the AirPave system for grass paving. Choose your favorite methods based on product, traffic frequency, aesthetics, and function.

Embedded Bricks • Railroad Ties • Raised Concrete Strips
Bumper Stops • Rocks and Other Durable Landscape Material
Bushes • Shrubs • Ground Cover • Landscape Lighting

AirPave Specifications

General Information			
General			
Construction		Injection Molded Copolymer	
Composition		Copolymer Polypropylene Using Impact Modifier	
Dimensions		31.784” x 31.880” x 1.000” (7.03 sq ft.)	
Unit Weight		3.100 lbs.	
Forms		Pellets	
Shipping			
Parts Per Pallet		114	
Pallet Dimensions		33” x 33” x 48”	
Pallet Weight		390 lbs.	
Area Per Pallet		798 sq. ft.	
Pallets Per Trailer		114 (3 wide x 2 tall x 19 deep)	
Area Per Trailer		90,972 sq. ft.	
ASTM and ISO Properties[1]			
Physical		Nominal Value	Test Method
Specific Gravity		0.940	ASTM D792
Melt Mass-Flow Rate (230°C/2.16 kg)		20 g/10 min	ASTM D1238
Mechanical		Nominal Value	Test Method
Density		57.490 lb/ft3	ASTM D1505
Tensile Strength (Yield, 73°F)		2,145 psi	ASTM D638
Tensile Elongation (Yield, 73°F)		16%	ASTM D638
Flexural Modulus (73°F)		100,175 psi	ASTM D790
Compression Strength (73°F)		**233 psi**	**ASTM D6254**
Impact		Nominal Value	Test Method
Notched Izod Impact (73°F, 0.125 in)		-	ASTM D256
Thermal		Nominal Value	Test Method
Deflection Temperature Under Load 264 psi, Unannealed		160°F	ASTM D648
Expansion/Contraction Index[1]			
Temperature	Humidity	Length	Width
100°F	98%	31.881”	31.817”
-5°F	0%	31.765”	31.713”
Change		.116”	.104”
Joint Expansion/Contraction Capacity		.420”	.572”
Safety Factor		362%	550%
Examples of Useage			
Application		Required Strength	Safety Factor
Auto		40 psi	x 168
Truck		110 psi	x 61
DC10		250 psi	x 27
Space Shuttle		340 psi	x 19

[1]Independent laboratory testing conducted by TRI/Environmental, Inc., TSI/Testing Services, Inc. and Wassenaar.

AirPave Highway and Bridge Load Strength

With an unfilled compression strength of 233 psi (1606.47 kPa) and an incredible filled strength of 6,747 psi (46,518.94 kPa) the AirPave GeoCell has been independently tested to exceed AASHTO load requirements for highways and bridges with a multiple safety factor at even the highest level.

Vehicle Type	Maximum Weight Per Axle		AASHTO Load Class	Surface Pressure		Dynamic Load	
	lbs.	kg		psi	kPa	Psi	kPa
ATV (Trail Vehicle Only)	1,200	544.31	-	3	20.68	1.45	30.02
Passenger Vehicle	3,000	1,360.78	H10	7.5	51.71	2.17	44.95
Light Truck	3,000	1,360.78	H10	7.5	51.71	2.17	44.95
Pickup	4,000	1,814.37	H10	10	68.95	2.57	53.25
80 Hp Tractor	5,700	2,585.48	H10	14.25	98.25	3.26	67.35
Service Vehicle	7,000	3,175.15	H10	17.5	120.66	3.78	78.13
100 Hp Tractor	11,000	4,989.52	H10	27.5	189.61	5.38	111.32
Van Delivery Truck	16,000	7,257.48	H15	40	275.79	7.39	152.80
Rural Fire Truck	22,000	9,979.03	H15	55	379.21	9.79	202.57
Large Delivery Truck	24,000	10,886.22	H15	60	413.69	10.60	219.16
Semi Delivery Truck	24,000	10,886.22	H15	60	413.69	10.60	219.16
Garbage Truck (Single Axle)	26,000	11,793.40	H25/HS25	65	448.16	11.40	235.76
Loaded Dump Truck	30,000	13,607.77	H25/HS25	75	517.11	13.00	268.94
Heavy Delivery Truck	32,000	14,514.96	H25/HS25	80	551.58	13.80	285.53
Heavy Semi Truck	32,000	14,514.96	H25/HS25	80	551.58	13.80	285.53
Standard Log Truck	33,600	15,240.70	H25/HS25	84	579.16	14.45	298.80
Concrete Transit Truck	38,000	17,236.51	H25/HS25	95	655.00	16.21	335.31
Garbage Truck	42,000	19,050.88	H25/HS25	105	723.95	17.81	368.49
Dump Truck	43,000	19,504.47	H25/HS25	107.5	741.19	18.22	376.78
Off Highway Log Truck	43,000	19,504.47	H25/HS25	107.5	741.19	18.22	376.78

Permeable Pavement
Axle Loads / Surface Pressure

Vehicle Type	Max Weight / Axle		AASHTO Load Class	Surface Pressure		
	lbs	kg		psi	psf	kPa
ATV (Trailer Vehicle Only)	1,200	544.31		3	432	20.68
Passenger Vehicle	3,000	1,360.78	H10	7.5	1,080	51.71
Light Truck	3,000	1,360.78	H10	7.5	1,080	51.71
Pickup	4,000	1,814.37	H10	10	1,440	68.95
80 HP Tractor	5,700	2,585.48	H10	14.25	2,052	98.25
100 HP Tractor	11,000	4,989.52	H10	27.5	3,960	189.61
Van Delivery Truck	16,000	7,257.48	H10	40	5,760	275.79
Rural Fire Truck	22,000	9,979.03	H15	55	7,920	379.21
Large Delivery Truck	24,000	10,886.22	H15	60	8,640	413.69
Garbage Truck (Single Axle)	26,000	11,793.40	H20/HS20	65	9,360	448.16
Loaded Dump Truck	30,000	13,607.77	H20/HS20	75	10,800	517.11
Heavy Delivery Truck	32,000	14,514.96	H20/HS20	80	11,520	551.58
Heavy Semi Truck	32,000	14,514.96	H20/HS20	80	11,520	551.58
Standard Logging Truck	33,600	15,240.70	H25/HS25	84	12,096	579.16
Concrete In-Transit Mixer Truck	38,000	17,236.51	H25/HS25	95	13,680	655.00
Garbage Truck (Tandem Axle)	42,000	19,050.88	H25/HS25	105	15,120	723.95
Off Highway Log Truck	43,000	19,504.47	H25/HS25	107.5	15,480	741.19
Fire Apparatus Single Axle Weights						
Single Steering Axle	23,000	10,432.62	H25/HS25	95.80	13,800	660.50
Single Steering Axle / Aerial	31,000	14,061.36	H25/HS25	129.16	18,600	890.53
Single Drive Axle	24,000	10,886.22	H25/HS25	100.00	14,400	689.47
Single Pumper Drive Axle	27,000	12,247.00	H25/HS25	56.25	8,100	387.83
Tandem Drive Axle	48,000	21,772.43	H25/HS25	50.00	7,200	344.74
Tandem Aerial Drive Axle	53,000	24,040.40	H25/HS25	55.20	7,950	380.59
Tridem Drive Axle	54,000	24,493.99	H25/HS25	37.50	5,400	258.55
Fire Apparatus surface pressures are per square inch of tire contact area / tire						

Ref: *Pavement Interactive - Online Pavement Design Community / CALTRANS Fire Axle Weights / Dana Corporation - Spicer Fire Equipment Drive Axles*

Comparative Data Sheet - AirPave vs. Grasspave2

December 27, 2012

Feature	AirPave	Grasspave2
Paver Material*	100% Recycled Copolymer with Impact Modifier	100% Recycled HDPE
Standard Size	32" x 32" x 1" (Palletized)	6.6' x 65.6' x 1" (Rolls)
Weight (lbs per sq. ft.)	0.442	0.42
Standard Color	Black	Optional
Load Strength - installed sand filled	6747 psi	5700 psi
Paver Flexibility	Flexible	Flexible
Soil Coverage at Surface - approx.	100%	100%
Root Area at Base of Unit - approx.	92%	92%
Fertilizer included with guaranteed analysis	Sustane Bolster	None
Cutting Tools for Installation	Pruning Shears	Pruning Shears
Interlocking	Yes	Yes
Expansion and Contraction	Yes	No
Labor Skill Level Needed	1 Laborer	Multiple Laborers
Grass Installation Methods	All	All
Water Absorption (Freezing)	None	None
Oil Absorption	None	None
Affects from Turf Chemicals	None	None
Heat Absorption	None	None
Estimated System Install Time per 1,000 sqft.	3.1 hr Full System	3.1 hr Full System

Architects and Engineers Specifying the AirPave System and/or Approving AirPave as an Equal

Reid Middleton
Everett School District
James Monroe Elementary
10901 27th Ave SE, Everett, WA. 98208
Spee West Construction Co.
Aguirre Roden Building Systems

City of Dallas
Jaycee Zaragoza Recreation Center
3114 Clymer St, Dallas, TX. 75212
Speed Fab-Crete Inc.

Mahg Architecture - Larry McGown
Garry Campbell GREENWOOD CITY HALL
Bell Park Community Pavilion
30 Bell Rd. Greenwood, AR. 72936
Circle M Construction Management

Steele Associates - Stephen Hockman
Leo Quiachon CLATSKANIE PUD
Clatskanie Public Utility District Building
495 E Columbia Highway Clatskanie, OR. 97016
P&C CONSTRUCTION

LPA INC
ARCADIA UNIFIED SCHOOL DISTRICT
Dana Middle School
1401 S 1st Ave. Arcadia, CA. 91006
Delmac Construction & Development

BWBR Architects
Jamestown Hospital
419 Street NE Jamestown, ND. 58402
Veit USA

Crafton Tull Sparks & Associates - Craig Thilsted
BROKEN ARROW ISD
Liberty Elementary School
4300 S 209th East Ave Broken Arrow, OK. 74014
Nabholz Construction Corp

Marmon MOK - Shawn Bacon
Bob Holbrook ARCHDIOCESE OF SAN ANTONIO
Mission Concepcion Park
807 Mission Rd San Antonio, TX. 78210
Kopplow Construction

JCJ Architecture & Interiors PC
SUFFOLK COUNTY COMMUNITY COLLEGE
Montaukett Learning Resource Center
121 Speonk Riverhead Rd Riverhead, NY. 11901
EW Howell Co

Little Diversified Architectural Consultants - Martin Mobley
Alan Kirby NEWTON-CONOVER CITY SCHOOLS
Newton Conover Middle School
873 Northern Dr North West, Newton, NC. 28613
John S. Clark Construction

Walter P. Moore & Assoc
CITY OF OVERLAND PARK
Overland Park RCB Repairs
Overland Park, KS. 66204
WCI CO

Tymoff & Moss Architects - Mike Schnekser
PORTSMOUTH CITY PUBLIC SCHOOLS
Simonsdale Elementary School
132 Byers Ave Portsmouth, VA. 23701
McKenzie Construction

Einhorn Yafee Prescott Architects & Engineers PC - David Clemenzi
UNION COLLEGE
Union College
807 Union St Schenectady
AJ Martini

Schemmer Associates
OMAHA PUBLIC POWER DISTRICT
UNMC & OPPD Property Exchange
444 s 16TH St Omaha, NE. 68102
Double D Excavating

Erdy McHenry Architects
Dan ADCO
Vertical Screen
Veterans Way & Johnsonville Blvd Warminster, PA. 18974
IMC INC

Tai Soo Kim Partners Architects - Richard Szczypek
William Hathaway CITY OF NEW LONDON OFFICE OF PURCHASING
Winthrop Elementary School
74 Grove St New London, CT. 06320
Fusco Group

IBI Group - Marek Ottwinowski
The View at St. Joseph Apartment Complex
289-28042 HWY 11, Red Deer County, AB T4S2L4 Canada
Laebon Homes

City of Des Moines Engineering- Ken Trytek
City of Des Moines
Papa Johns Park

Fentress Architects
City of San Antonio-Public Safety HQ
City of San Antonio-Public Safety HQ
South Santa Rosa Street, San Antonio
Hensel Phelps Construction Company

Kaplan McLaughlin Diaz
CA Veteran Affairs
Fresno VA Hospital
2811 west California Ave, Fresno, CA. 93706
Hensel Phelps Construction Company

Bender Wells & Clark
City of San Antonio
Henry B Gonzalez, San Antonio, TX. 1200
Milberger Landscape

Sol Harris Day Architects
Bridgestone Americas Holdings, Inc.
Bridgestone Technology Center
Firestone Pkwy, Akron, OH. 44317
The Ruhlin Company

Waterstreet Studio - Hunter McCardle
Buckingham County School District
Buckingham Upper & Lower Elementary School
40 Frank Harris Rd, Dillwyn, VA. 23936
Blair Construction Inc

Boynton Williams & Associates - Kirk Mackey
Oklahoma City School District
Council Grove Elementary
7721 West Melrose Lane, Oklahoma City, OK. 73127
Crossland Construction

MAHG Architecture - Michael Lejong
Crystal Bridges Museum
Crystal Bridges
599 Northeast J Street, Bentonville AR.
Frank Sharums Landscaping

MAHG Architecture Joel Howell Tulsa OK
Van Buren School District
King Elementary
Van Buren, AR
Frank Sharums Landscaping

Freytag & Associates - Keith Miller
Hardin Houston Local School District
Hardin Houston K-12 Building
5300 Houston Rd, Houston, OH. 45333
Ferguson Construction

Engineers Surveyors & Associates
Meijer Stores
Meijer Outlet Building
Toledo, OH
Todd Alspaugh & Associates

Howerton Engineering & Surveying
New Boston Local School District
New Boston PK 12 Building
100 Lakeview Ave, New Boston, OH. 45662
Rw Setterlin

HSE Architects - Dan Skaggs
Oklahoma City School District
Oakridge Elementary
4200 Leonhardt Dr. Okc, OK. 73115
Raindance Sprinkler

BHC Rhodes
Piper Unified School District 203
Piper Middle School
4420 N 107th St, Kansas City, KS. 66109
JE Dunn

Devrouax & Purnell - Sean Pichon
Maryland National Parks & Planning
Theresa Banks Memorial Aquatics Center
8615 McLain Ave, Glenarden, MD. 20706
Corning Construction Corporation

GS Helms & Associates
Tulsa Public Schools
Webster High School
1919 west 40th St, Tulsa, OK. 74107
Contech LLC

LandDesign Charlotte- Heth Kendrick
University of North Carolina
UNC Phase 11
UNC campus
KBR Building Group

100% Post Manufactured Content

Recycled
The AirPave GeoGrid is made of 100% post-manufactured material, so you can feel good about helping the planet while adding valuable LEED Points to your project. We also add an impact modifier for incredible strength and superior performance in extreme heat and cold - on top of the already durable AirPave design.

AirPave Co-Polymer with an Impact Modifier Performance and Temperature Durability
Attached you will find the specification of the resin used to produce both the 32 x 32 and the 32 x 18 Geo cells. This material is a co-polymer polypropylene that is 100% recycled resin. In order to be able to produce a consistent recycled resin a PIR (post industrial resin) is used for the base resin. This is the only way to produce a consistent material as opposed to a PCR (post consumer resin) which is dependent on the consumer to supply a consistent material. Using the PIR as a base resin 3% carbon black is added to insure good UV stabilization and metallocene (an ethylene base material) is used as an impact modifier.

Impact Modifier
The impact modifier is added in an amount to achieve a 10.0 Notched Izod Impact which comfortably qualifies this material as a NO BREAK material (4.0 and greater are normally considered no break material). The AirPave resin offers an advantage over many ethylene and HDPE products since the AirPave resin is often superior when it comes to pliability, warpage and internal stress related issues. Referring to the attached specification sheet you will notice that all testing is done to specific ASTM Standards.

Resin Blends
AirPave’s blend of resins gives it the ability to perform in extreme temperatures. AirPave does not need a temperature above 50 degrees Fahrenheit to be installed or warmed in the sun to be pliable on site for install. In addition, AirPave's unique resin blend also helps prevent breakage and cracking in extreme temperatures.

August 23, 2006

Mail To:	**Bill To:**
Mr. Charles Blackwood Airfield Systems, LLC 441 S. Fretz, Suite A Edmond, OK 73003	**<= Same**

Dear Mr. Blackwood:

Thank you for consulting TRI/Environmental, Inc. (TRI) for your geosynthetics testing needs. TRI is pleased to submit this final report for laboratory testing.

Project:	**Airdrain Testing Summary**
TRI Job Reference Number:	E2265-09-02
Material(s) Tested:	1 Airdrain Sample(s)
Test(s) Requested:	Dimensions/Mass Density (ASTM D 1505) Flexural Modulus (ASTM D 790) - Resin Plaque Tensile Yield Stress (ASTM D 638) - Resin Plaque Compression Strength (ASTM D 6254) - Unfilled Compression Strength (ASTM D 6254) - Filled

If you have any questions or require any additional information, please call us at 1-800-880-8378.

Sincerely,

Sam R. Allen

Sam R. Allen
Vice President and Division Manager
Geosynthetic Services Division
www.GeosyntheticTesting.com

AIRDRAIN TEST RESULTS

TRI Client: Airfield Systems
Project: Airdrain Testing

Material: Airdrain Sample
Sample Identification: No Label
TRI Log #: E2265-09-02

PARAMETER	TEST REPLICATE NUMBER										MEAN	STD. DEV.
	1	2	3	4	5	6	7	8	9	10		
Dimensions/Mass												
Length (in)	15.90	15.50	16.05	15.95	16.00	15.90	15.67	15.63	15.57	15.70		
Width (in)	15.80	15.60	15.95	15.50	16.00	15.90	15.60	15.67	15.63	15.62		
Square Feet (ft2)	1.74	1.68	1.78	1.72	1.78	1.76	1.70	1.70	1.69	1.70	1.72	0.04
Mass (g)	334	322	326	333	328	331	329	323	325	325		
Mass/unit area (oz/sq.yd)	60.8	60.9	58.2	61.4	58.5	59.8	61.4	60.1	60.9	60.6	60.3	1.1
Mass/unit area (g/sq. meter)	2063	2066	1973	2085	1985	2028	2085	2041	2068	2057	2045	39
Density (ASTM D 1505)												
Density (g/cm3)	0.921	0.921	0.921								0.921	0.000
Tensile Properties (ASTM D 638/GRI GM17, 2 ipm strain rate, Type IV specimen) - Resin Plaque												
Yield Strength (ppi)	2119	2007	2071	2023	2055						2055	44
Break Strength (ppi)	2168	2119	2136	2136	2168						2145	22
Yield Elongation (%)	10	10	10	10	10						10	0
Break Elongation (%)	18	13	18	18	16						16	2
Flexural Modulus (ASTM D 790) - Resin Plaque												
Flexural modulus (psi)	107632	102150	105281	76834	112250	96901					100175	12545
Compression Strength (ASTM D 6254) - Unfilled												
Rib "Layover" Strength (psf)	18641	17984	18148	18542	18689	17982					18331	330
Compression Strength (ASTM D 6254) - Filled												
Rib "Layover" Strength (psf)	> 60,000	> 60,000	> 60,000	> 60,000	> 60,000						> 60,000	

GeosyntheticTesting.com
9063 Bee Caves Road / Austin, TX 78733 / 512 263 2101 / fax: 512 263 2558

A.G. Wassenaar Inc.
Geotechnical and Environmental Consultants
2180 South Ivanhoe Street, Suite 5
Denver, Colorado 80222-5710
303-759-8100 Fax 303-756-2920
www.agwassenaar.com

Summary of Lab Test Results on AirDrain Geogrid

The attached summary represents the load bearing capacity of five three by three cells filled with sand.

Physical Ring Data (inches):

- Overall Gross Area: 8.608″ x 8.608" = 74.098″
- Individual Cell Gross Area: 2.2175″ x 2.175″ = 4.9173 in^2 Gross Area
- *½ Circles w/in cell: radius - 0.4034 = 0.2556 in^2 x 4 individual
- ½ circles w/in cell = 1.0223 in^2
- Net area of single cell = 4.9173 in^2 – 1.0223 in^2 = 3.895 in^2
- Net area of 3 x 3 sand filled cells (9): 3.895 in^2 x 9 cells = 35.055 in^2

Lab Test Data:

Plastic Cells: (Empty) 3x3

- Overall load
  - 17,265 lbs
  - 17,265 lbs/35.055 in^2 = 493 psi

****Sand filled box with (3x3) cells inside**

- Overall load (Average of 3)
  - 500,000 lbs per test section (max. machine load)
  - 500,000 lbs/74.098 in^2 = 6,748 psi
  - Avg. overall deformation of plastic = 0.08″ – 0.11″

Notes:

* -1/2 circles in clover were measured with a caliper on top and bottom and the result was averaged.

** Sand used to fill cells: Oglebay - Norton Industrial Sand, Inc.
Colorado Springs Plant, Colorado Silica Sand (ANSI/NSF61, V13001, 632 JLP)

A.G. Wassenaar Inc.
Geotechnical and Environmental Consultants

2180 South Ivanhoe Street, Suite 5
Denver, Colorado 80222-5710
303-759-8100 Fax 303-756-2920
www.agwassenaar.com

November 27, 2006

Airfield Systems, LLC
441 South Fretz, Suite A
Edmond, Oklahoma 73003

DEC 04 2006

Attention: Mr. Charles R. Blackwood, CEO

Subject: AirDrain Geogrid Load Testing
Client Delivered Samples
Project Number 91954

Dear Mr. Blackwood:

As requested, we have conducted the AirDrain geogrid load testing on the sample sheets submitted to our office on October 30, 2006. The laboratory cut a total of five test samples from the AirDrain geogrid sheet. The dimensions of the five cut samples for compression testing were three cells by three cells. The laboratory tested two cut samples empty to determine the strength of the plastic cells. The other three cut samples were placed in a box. The cells and interior of the box were filled with sand to the height of the geogrid. The cut samples were tested for compression on a Forney 502F-F96 compression machine. This compression machine has a 500,000 lb. capacity and the average load rate was 60,000 lbs./min. The laboratory results are based on the load capacity of the grid without rupture. There are limiting factors in extrapolating the following results given soil bearing capacities.

Sincerely,

A. G. WASSENAAR, INC.

Ryan A. Zoetewey

Ryan A. Zoetewey
Laboratory Manager

Thomas A. Hastings

Thomas A. Hastings, S.E.T.
Field Services Manager

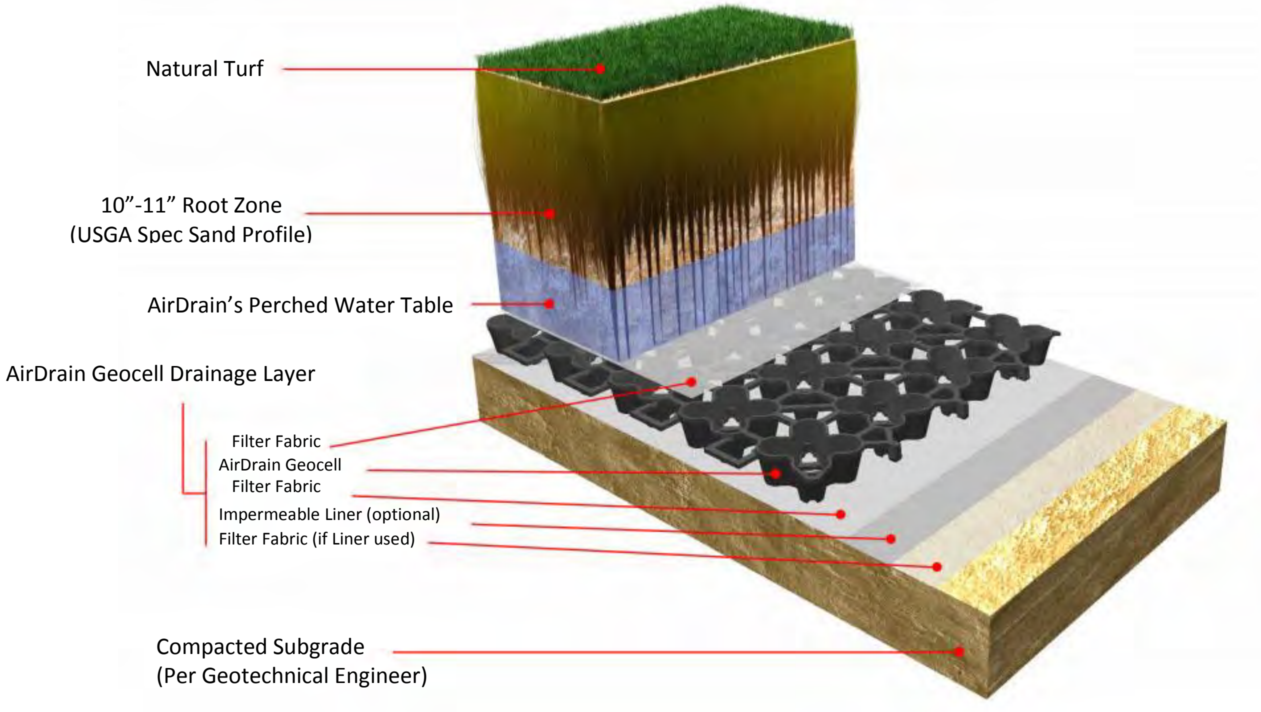
RAZ/TAH/klw

Statement of Services

AirDrain – What drains better than Air?

For Natural Turf

Thru a research project conducted at Texas A&M, it was concluded that you can reduce your irrigation needs using AirField Systems AirDrain. The five year research project was jointly funded by the United States Golf Association and AirField Systems and was a collaborative effort between Texas A&M, AirField Systems and the United States Golf Association. The data from the research showed that the AirField Systems drainage profile provided between one to three more days of plant available water than a **United States Golf Association** recommended gravel and sand profile. Click here for more information about the study titled "A Comparison of Water Drainage and Storage in Putting Greens Built Using Airfield Systems and USGA Methods of Construction".



Benefits of an AirField System Design include:

- 1 to 3 more days of plant available water stored in the root zone (depending on climate)
- Significantly reduces daily irrigation needs (as told to us by our customers)
- Healthier turf / Stronger root system (as told to us by our customers)
- 100% Vertical Drainage under the entire playing surface
- AirDrain is a 100% recycled copolymer with the impact modifier "metallocene" qualifying it as a "No Break" plastic
- Helps eliminate standing water / Simplifies maintenance (as told to us by our customers)
- Minimal site disturbance / Far less excavation and disposal
- Several Installation days are saved over a gravel installation
- Compact shipping that reduces overall storage and transportation costs
- An AirDrain System sand profile creates its own perched water table

Comparison of Putting Greens Constructed with Airfield Systems and USGA Designs

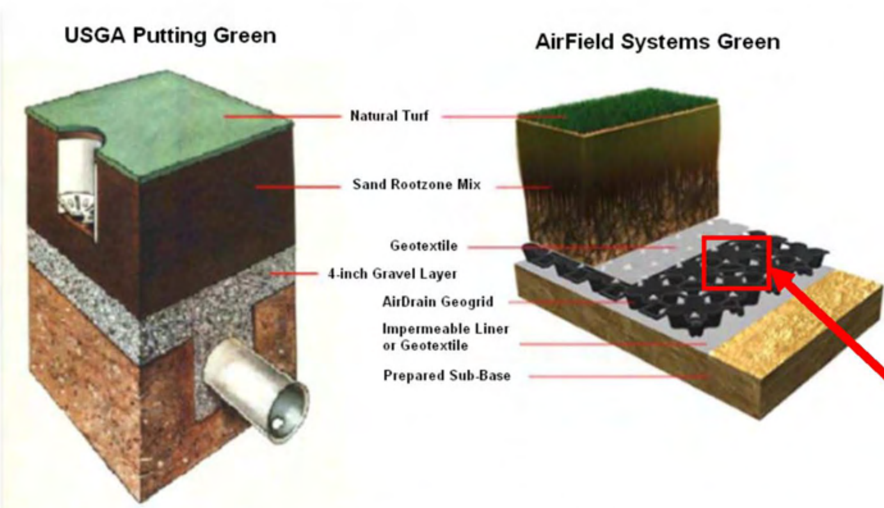
Kevin J. McInnes, Keisha Rose–Harvey, James C. Thomas
Texas A&M Agrilife Research

Turfgrass and Environmental Research Online
Volume 12, Number 4 | July – August 2013

Note: The information in this article has been adapted from the original work published in Crop Science titled "Water Storage in Putting Greens Constructed with United States Golf Association and Airfield Systems Designs" (McInnes and Thomas, 2011, 51:1261–1267) and in HortScience titled "Water Flow Though Sand–based Root Zones atop Geotextiles" (Rose–Harvey et al., 2012, 47:1543–1547). The research was collaboratively funded by Texas A&M University, Airfield Systems (Oklahoma City, OK), and the United States Golf Association.

Airfield Systems offers an alternative to the standard USGA putting green design. Their design utilizes a highly porous, 1–inch deep plastic grid (AirDrain, Figure 1) in place of a 4–inch deep gravel layer. As with gravel, AirDrain allows rapid lateral movement of excess water to drains and thus provides for uniform horizontal moisture content within the root zone. While voids in AirDrain are very effective in transmitting water, they are much too large for the sand in the root zone to bridge for self–support so a geotextile is used atop the grid to prevent infilling of the void space. Use of geotextiles in putting green construction has been controversial due to the perceived potential for clogging of the fabric by migrating fine particles and eventual loss of permeability.

We became interested in the hydraulic performance of the Airfield Systems design after Texas A&M University constructed a soccer field with the Airfield System design in 2002. Anecdotal evidence from field managers suggested that the new field required less frequent watering than the University's football field that had been constructed following the USGA design. While the two fields were constructed with different root zone mixtures and the physical environments surrounding the fields are quite different, we suspected that there may have been a difference in the amount of water stored in root zones on fields constructed with the two designs (i.e., a difference in the vertical distributions of water content in the root zones). We knew from the physics of water in sand that the amount of water stored in a root zone decreases with increasing tension at the bottom of the root zone, and we expected because of the geometrical and physical differences in the designs that there would be differences in water tension at the bottom of the root zones.



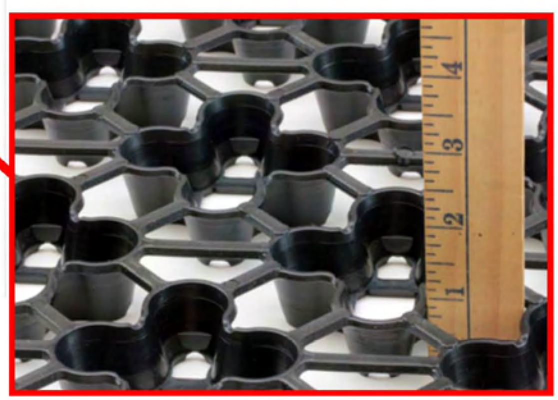
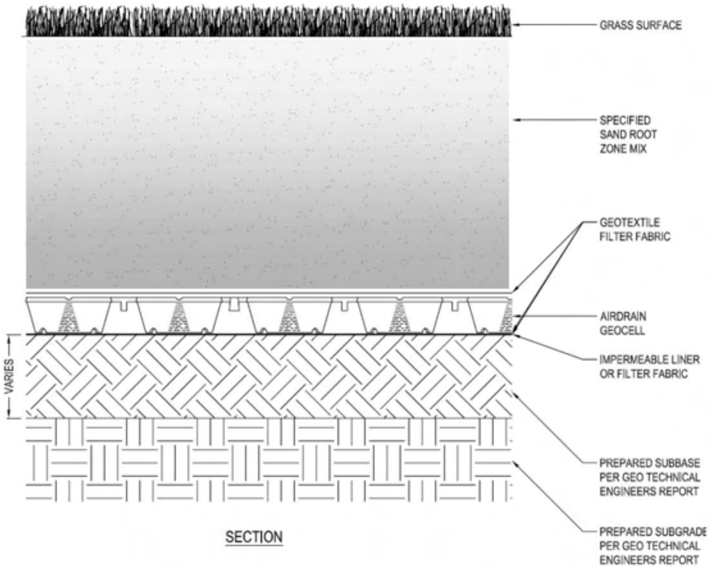


Figure 1. The highly porous, 1–inch deep AirDrain (right) offers an alternative to the 4–inch deep gravel layer in the standard USGA putting green design (above left).



Cross–section of a putting green using the AirDrain instead of a 4–inch gravel layer in a USGA green (Drawing courtesy of AirField Systems).

While the root zone may be saturated above the drainage layer, the water is under tension so the term "perched water table" often used to describe the state of water in the root zone immediately above the drainage layer is a bit of a misnomer. A better term might be "perched capillary fringe." Capillary fringe is the saturated zone above a water table where water is under tension. The further upward from the bottom of the root zone the greater the water tension. As distance increases upward and water tension increases, the root zone eventually begins to desaturate as the largest pores drain. As distance increases beyond this height water content continues to decrease. As a consequence, the tension that develops at the bottom sets the starting tension and determines the thickness of the saturated zone and the amount of water stored in the root zone profile (Figure 2). The depth and hydraulic properties of the drainage layer determine the magnitude of tension that develops at the bottom of the root zone.

AirDrain is 1–inch deep so the maximum tension that can develop at the bottom of the root zone during drainage in the Airfield Systems design would be 1 inch of water. Gravel is typically 4 inches deep so the tension that could develop would be up to 4 inches of water, depending on the hydraulic properties of the gravel and the depth to which sand ingresses pores of the gravel. Water is slow to drain from small pores into large pores, but if both systems were sealed from evaporation the tensions would eventually reach 1 and 4 inches at the bottom of the root zone in the Airfield Systems and USGA design greens, respectively. An occasional finger of sand penetrating the gravel in the USGA design green can lead to an appreciably quicker increase in tension at the root zone gravel interface.

To test for differences in tension developed at the bottom of the root zones of the two designs, we constructed laboratory–based test cells from 4–inch diameter PVC pipe containing profiles of the Airfield Systems and USGA greens. Using tensiometers, we were able to demonstrate that the tension that developed at the bottom of the root zone in the Airfield Systems design was appreciably less than that in the USGA design. At that point we thought it worthwhile to investigate this finding on a slightly larger scale and a more realistic setting. To this end, we constructed test greens in 14–inch diameter PVC pipe. Three sands and three gravels were chosen such that they covered the ranges from coarser to finer sides of the USGA recommendations for particle size distribution. To create root zone mixtures, the coarser two sands had peat moss added to increase water retention. The finer sand was

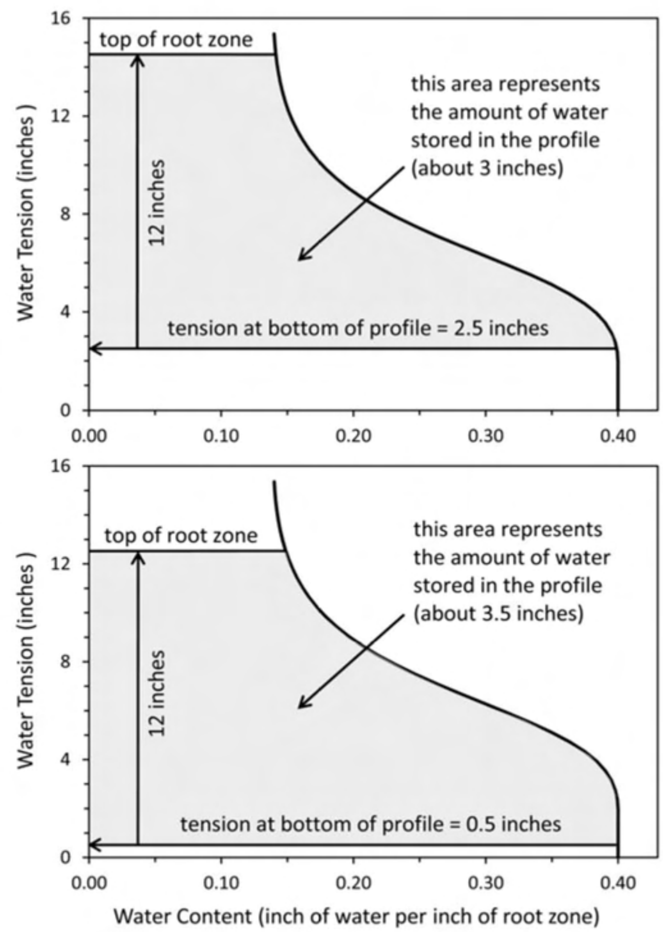


Figure 2. Graphic representation of the dependence of water–holding capacity on tension at the bottom of the profile for a typical root zone mixture meeting USGA recommendation for total, air–filled, and capillary porosities. The curved lines to the right represent the relationship between water tension and water content for the root zone mixture.

Figure 3. Test greens constructed in 14–inch PVC pipe with either gravel or geotextile atop AirDrain as the drainage layers. Both types of test greens contained a pair of porous cups connected to plastic tubing that formed manometer–tensiometers to allow measurement of water pressure or tension at the root zone–drainage layer interface.

not amended. These three root zone mixtures were used in combination with the three gravels to construct test greens of the USGA design. The gravel layer in all of the test greens was 4 inches deep. An intermediate choke layer of coarse sand was not used. The same three root zone mixtures were used in combination with four geotextiles atop AirDrain to construct test greens of the Airfield Systems design. We used the Lutradur polyester geotextile prescribed by Airfield Systems at the time and chose three additional geotextiles that had the same apparent opening size (0.2 mm), but differed in material and/or manner of construction. Manometer–tensiometers were used to measure pressure or tension that developed at the root zone–drainage layer interface of both designs (Figure 3). After the test green columns were packed with 12 inches of the root zone mixtures they were sprigged with MiniVerde bermudagrass supplied by King Ranch Turfgrass–Wharton Farms (Wharton, TX). Following a period to grow–in the grass, a series of experiments were conducted that measured the amount of water stored in the root zone profiles and the water tension that developed at the bottom of the root zones of the different treatments after irrigation and drainage. Vertically oriented time domain reflectometry TDR probes were used to measure the amount of water stored in the root zone profiles (Figure 4).

Periodically during the course of the study, the test greens were watered until drainage was observed and then the amount of water stored in the profiles and the water tension at the bottom of the root zones were recorded for 48 hours. As with our preliminary lab study, we found that the water at the bottom of the root zones of test greens constructed with the Airfield design was under less tension than the water in test greens constructed with the USGA design, by about 2.2 inches of water tension (Figure 5). This lower tension was associated with an increase in water storage of about 0.5 inch in the Airfield System design greens above that in the USGA design greens (Figure 5). This increase in water retention could lead to less frequent necessity to irrigate.

Because of reduced tension at the bottom of the root zone, these results also implied that the tension at which root zone mixtures should be tested for capillary porosity when intended to be used in an Airfield System design green should be reduced to achieve similar

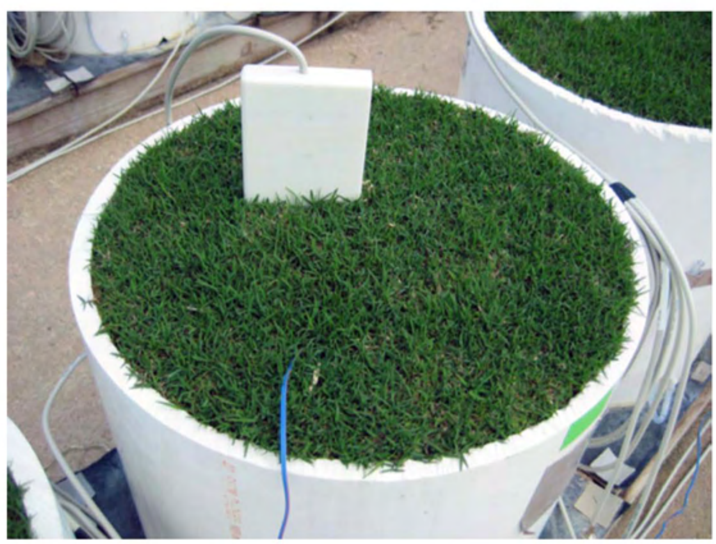


Figure 4. Test green with vertically installed, 1–ft long TDR probe used to measure average water content within the root zone profile.

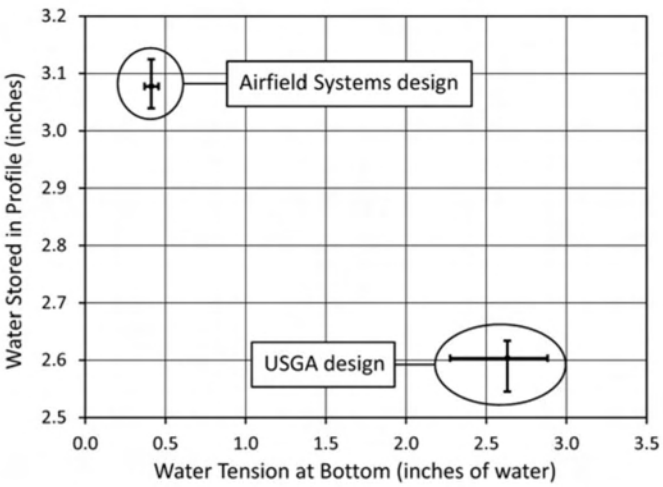


Figure 5. Range in the mean amount of water stored in 12–inch root zone profiles in Airfield Systems (geotextiles atop AirDrain) and USGA (gravels) design test greens 12 hours after irrigation. Means were of the three root zone mixture treatments and variations shown were from drainage–type treatments (i.e., type of geotextile or gravel). Stored water in the profile was measured by TDR and water tension was measured with manometer–tensiometers.

moisture retention to greens built according to the USGA recommendations. In doing so, slightly coarser sand would meet specifications for capillary water retention in the Airfield design. Conversely, sands that push the very fine side of the current recommendations might not meet specifications for air–filled porosity.

The question of whether or not geotextiles used in a green will clog with fines migrating out of the root zone was also studied. To address this issue, we conducted a year–long laboratory experiment to investigate a range of geotextiles that were suited to supporting sand in the Airfield System design and determine whether or not they limit drainage out of the root zone. In this experiment, 6–inch diameter PVC columns were used to contain combinations of 12 inches of three sand mixes with 10 geotextiles held atop AirDrain (Figure 6). Manometer–tensiometers again were used to measure pressure or tension at the sand–geotextile interfaces. Mix 1 had a particle size distribution that ran down the center of the USGA specs. Mix 2 was made by blending Mix 1 with a sandy clay loam (9:1 by mass) and Mix 3 was made by blending Mix 1 with a sand having excess fines (1:1 by mass). Mix 1 and Mix 2 met USGA recommendations. Mix 3 contained twice the recommended amount of very fine sand. The apparent opening sizes of the geotextiles used ranged from 0.15 to 0.43 mm. After the sands were added to the columns they were regularly irrigated. Periodically, the rate that 1–inch of irrigation water drained from a column was measured and the pressure/tension at the sand–geotextile interface was recorded.

For the first six months, any particles that washed out of the sand through the geotextiles were accumulated and analyzed for total dry weight and particle size distribution. At the end of the study, the saturated hydraulic conductivity of the sand–geotextile combinations were measured. Statistical analyses showed that drainage rate, saturated hydraulic conductivity, and mass of eluviated particles were not dependent on the properties of the geotextiles, but rather on the properties of the sands (Figure 7). Most all of the particles that washed out of the columns were of clay and silt sizes. This could be construed as evidence that the geotextiles were sieving out larger particles, but we found that the size of particles in the drainage water was not related to the apparent opening size of

Figure 6. Columns used to measure potential clogging of geotextiles by fines migrating out of the root zone.

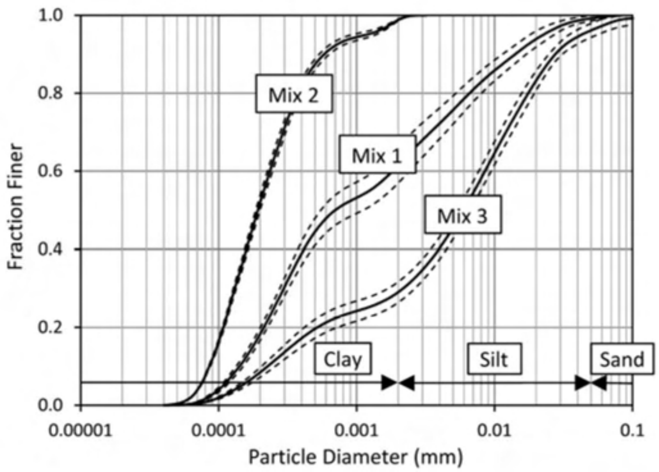


Figure 7. Size distribution of particles washed out of the three sand mixes through the geotextiles. The solid line for each sand mixture represent the mean fraction of particles finer than a given diameter over 30 columns containing the mixture (10 geotextiles with 3 replicates) and the dashed lines represent one standard deviation each side of the mean.

the geotextiles, which it should have been if the geotextiles were acting as sieves (i.e., the geotextiles with the larger AOS would have let larger particles pass, and vice versa, but this did not happen). The geotextiles obviously prevented the passage of particles as their purpose is to prevent migration of the root zone sand into the drainage layer, but it appeared in our study that the sands were responsible for determining the particle sizes leaving the columns.

Drainage rates from the columns containing the sand without added fines increased over the year, presumably because pore channels in the sand were widened when silt and clay washed out of the profile. Drainage rates of the columns containing the two sands with additional fines decreased over the year, but the decrease was not statistically related to the properties of the geotextiles. To test if the sands themselves were clogging, saturated hydraulic conductivities were measured as layers of sand were removed from columns. Since saturated hydraulic conductivity would not depend on the depth of sand in a hydraulically uniform column, any observed changes would be due to difference in the conductivity of the layers removed compared to those remaining. We found that when surface layers were removed the saturated hydraulic conductivity increased, indicating that the surface layers had lower conductivities. This was not too surprising as the majority of inter–particle pores of sand meeting USGA recommendation are smaller than the apparent opening sizes of the geotextiles we tested. In support of our conclusion that the sands were clogging and not the geotextiles, we did not notice a build–up of positive pressure atop any of the geotextiles during drainage, as would have occurred if the geotextile had been restricting drainage out of the column.

In conclusion, the results of our studies gave no reason to prevent more widespread use of Airfield Systems' design as an alternative to the USGA method for putting green construction. Airfield Systems design produces additional water holding capacity above the USGA design, which leads to more plant available water, given the same root zone mixture, and, possibly, less frequent requirement for irrigation. Our data also support the general use of properly sized geotextiles to support sand based root zones in putting greens. Geotextiles with apparent opening size of 0.2 mm worked well in our test greens and a woven geotextile with an apparent opening size twice as large (0.43 mm) retained the root zone sand just as well.

Summary Points

- Water at the bottom of the test green rootzones constructed with the Airfield design was under less tension than the water in test greens constructed with the USGA design (about 2.2 inches of water tension).
- This lower tension was associated with an increase in water storage of about 0.5 inch in the Airfield System design greens above that in the USGA design greens.
- Geotextiles with apparent opening size of 0.2 mm worked well in test greens and a woven geotextile with an apparent opening size twice as large (0.43 mm) retained the root zone sand just as well
- The geotextiles that were tested prevented the migration and passage of the sand rootzone mixture into the drainage layer, but it appeared that the tested sands were responsible for determining the particle sizes leaving the columns.
- The results gave no reason to prevent more widespread use of Airfield Systems' design as an alternative to the USGA method for putting green construction.

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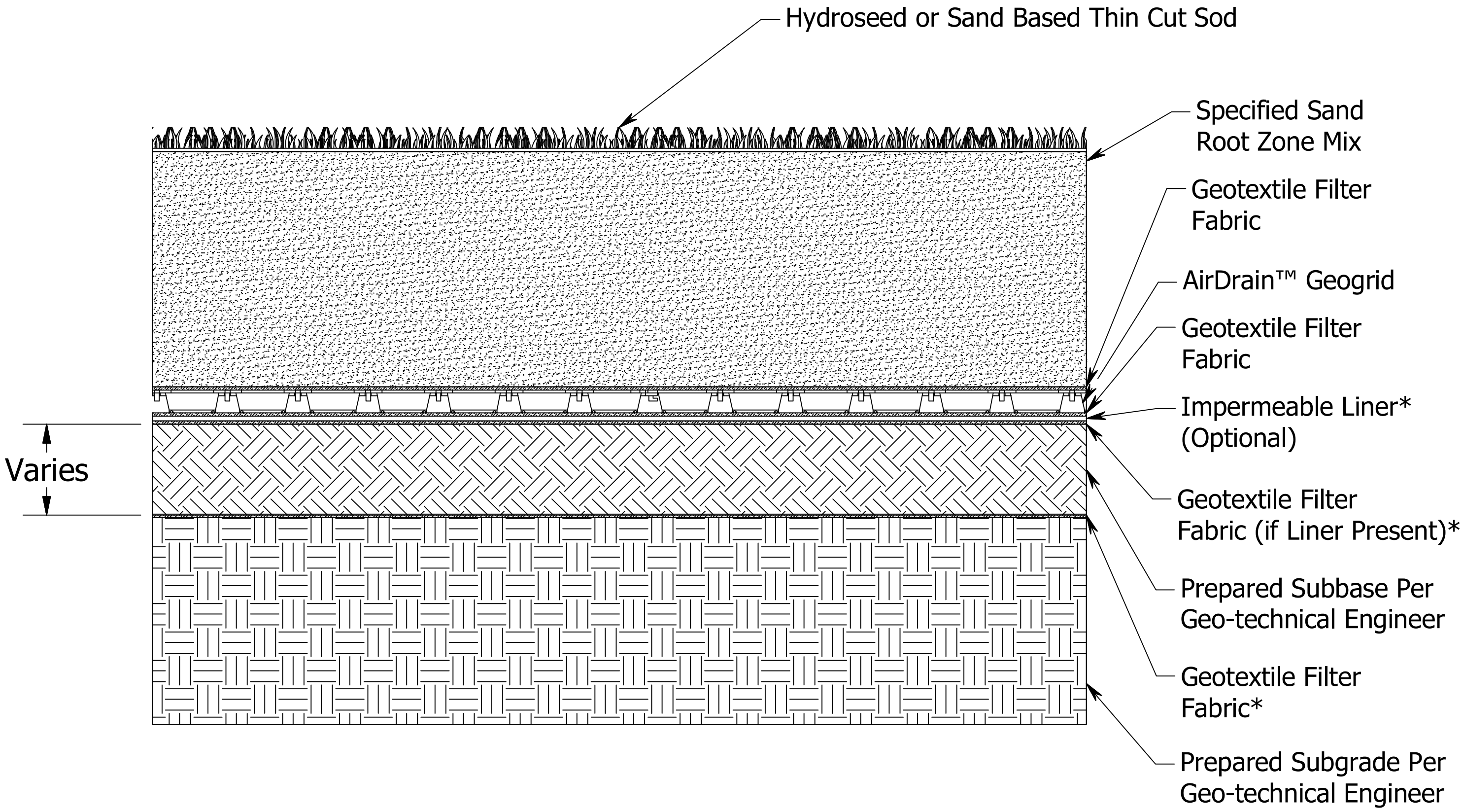
KEISHA M. ROSE–HARVEY graduate student in the Department of Soil and Crop Sciences, Texas A&M University.

JAMES C. THOMAS, CPAg. is senior research associate in the Department of Soil and Crop Sciences at Texas A&M University.

This is a typical drainage profile, your profile may vary.

Check with a Geotechnical Engineer for recommendations for your site conditions and geographical region.



AirDrain™ Natural Turf Typical Detail

AirDrain™ Impermeable Natural Turf Detail

*per geotechnical engineer

Airfield Systems
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Oklahoma City, OK 73120
(405) 359-3775

www.airfieldsystems.com
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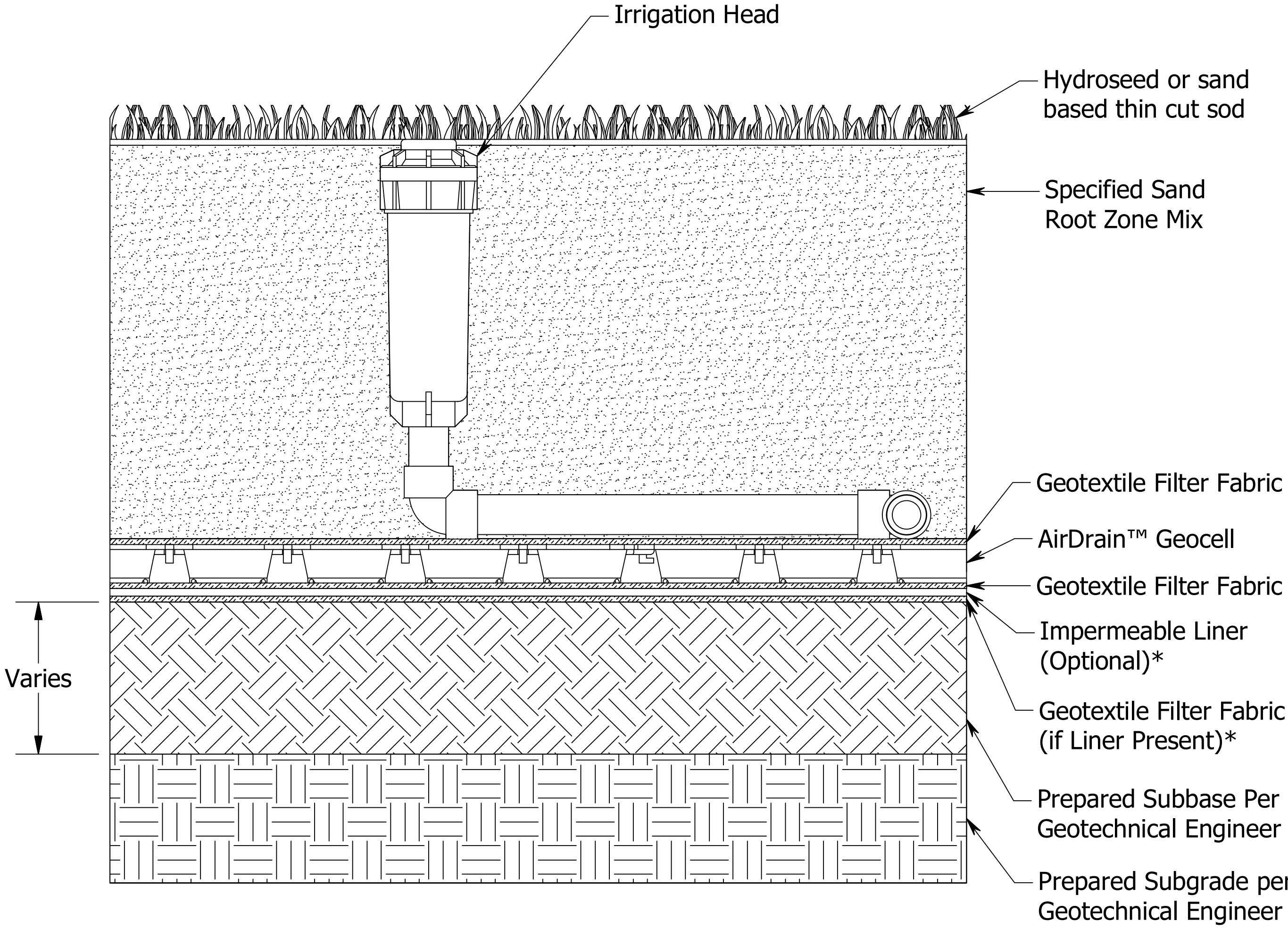

AirDrain™ Natural Impermeable Irrigation Head Detail

*per geotechnical engineer

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(405) 359-3775

www.airfieldsystems.com

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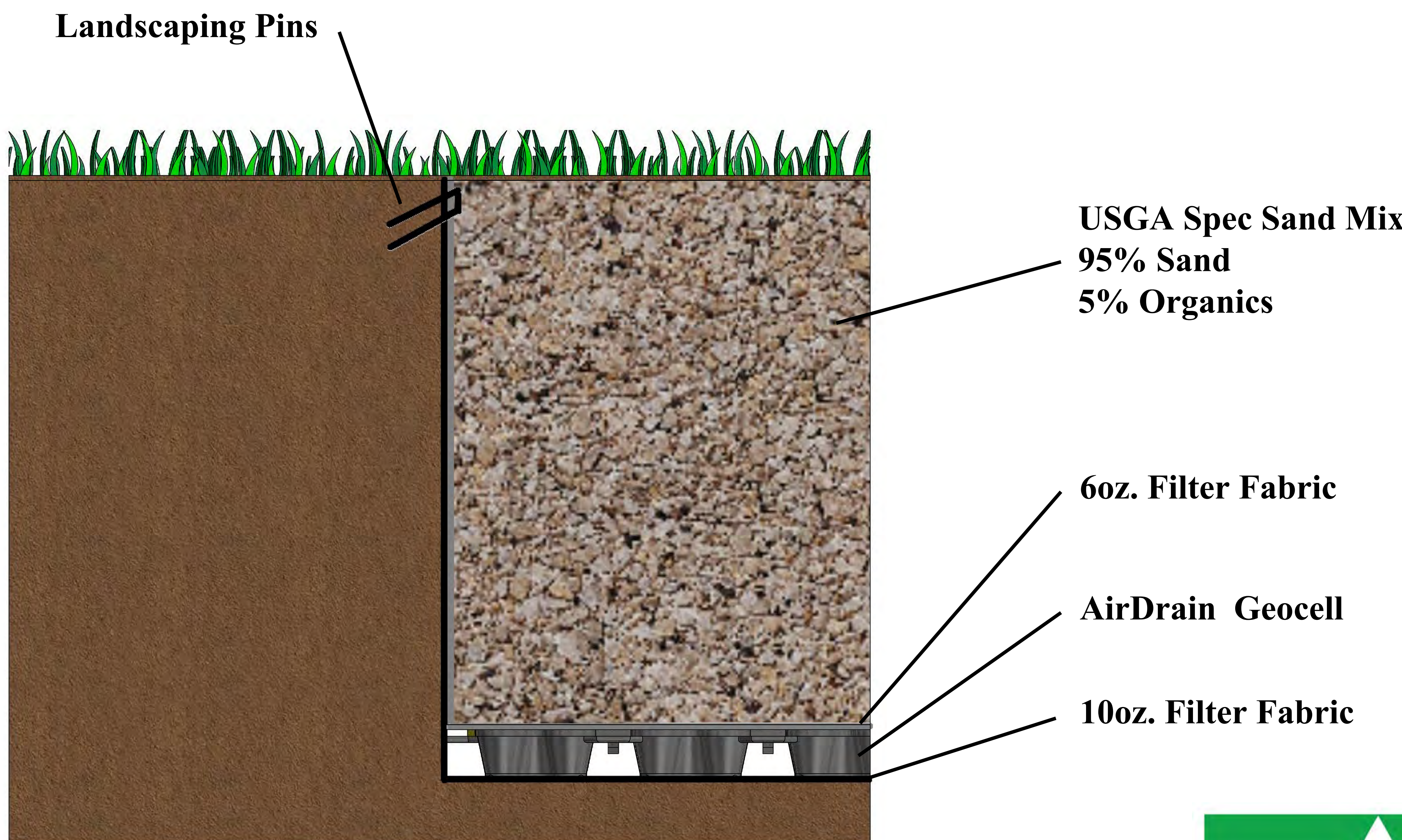
French Drain Application



DETAIL A

airfield systems

DRAWN G. Abdo	3/22/2015	AirField Systems	
CHECKED		TITLE **French Drain Application**	
QA			
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		SIZE C	DWG NO French_Drain_Rev001 / REV
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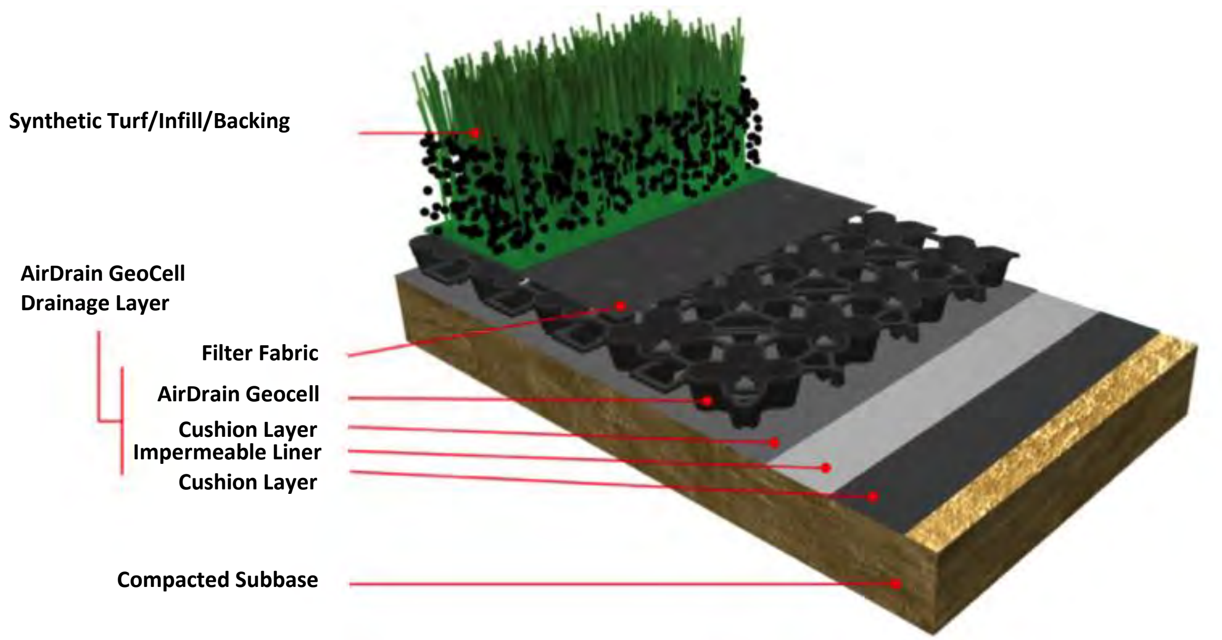
AirDrain – What drains better than Air?

For Synthetic Turf

The consistent **Gmax** and Shock Attenuation properties of the **AirDrain** are major contributors to the safety of your players and the reduction of concussions. Unlike traditional shock pads or e-layers **AirDrain** is 1” high has a 92% air void and a 100% vertical drainage rate which cannot be matched by any other product in the industry.



AirDrain reduces Gmax by [illegible] **(per Architect/Engineer)**

- **18.9% on a gravel subbase**
- **14.7% on a concrete subbase**

Some of the Benefits of an AirField Synthetic Turf Drainage System include:

- AirDrain creates and helps maintain a constant **Gmax** for Synthetic Turf
- ASTM testing proves AirDrain’s shock absorption properties reducing strain on joints and ligaments
- Only needing a **.25% slope** for effective drainage
- Patented expansion and contraction built into every part keeping the grid from buckling
- AirDrain is only limited by the drainage capacity of the profile above it and the exit drains capacity
- AirDrain can be reused when the synthetic turf must be replaced

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Synthetic Turf Athletic Fields built using AirField Systems AirDrain consistently outperform fields built over stone, concrete or asphalt, by reducing the Gmax and shock attenuation an average of approximately 18.9% and 14.7%, and helps keep it there, for the life of the field.

Multiple tests conducted by TSI Testing Services (an approved independent Test Laboratory by the Synthetic Turf Council) using ASTM F355-10a: Standard Test Methods for Shock-Absorbing Properties of Playing Surface Systems and Materials.

Gravel Subbase: with the use of the filter fabrics and AirDrain with infilled synthetic turf reduced Gmax attenuation approximately 18.9% versus Gmax attenuation which employed just the turf + infill system using the same sub base.

Concrete Subbase: with the use of the filter fabrics and AirDrain with infilled synthetic turf reduced Gmax attenuation approximately 14.7 % versus Gmax attenuation which employed just the turf + infill system using the same sub base.

Player Safety

The consistent Gmax and shock attenuation properties of AirDrain are a major contributor to the reduction of concussions and the safety of your players. Some factors that might influence a change in GMAX would be an inconsistency of the infill or wear of the synthetic turf fibers. Unlike traditional shock pads or e-layers the AirDrain is 1" high, has a 92% air void and a vertical and lateral drainage rate which cannot be matched by any other product in the industry.

Removal, Recovery, Reuse & Recycling

Once AirDrain has reached the end of its useful life, or "End of Life" (EOL) the owner may still benefit. AirDrain's resins are of such high quality that most plastic recycling facilities will purchase the AirDrain panels on a per pound basis, thus benefiting the owner once more. AirField Systems can also help the owner in facilitating this process.

Benefits of an AirField system include:

- AirDrain creates and helps maintain a constant Gmax for Synthetic Turf
- Shock absorption reduces the strain on joints and ligaments
- AirDrain can be reused when the Synthetic Turf must be replaced
- Can help qualify for LEED and other green building credits
- A smaller carbon and development footprint with reduced site disturbance
- Water harvesting reclamation and reuse is possible
- AirDrain is a 100% recycled copolymer with the impact modifier metallocene qualifying it as a "No Break" plastic
- AirDrain can be made to the following specification "**Flammability UL 94, Flame Retardant, High Impact Polypropylene Copolymer, Black**" for Rooftop applications

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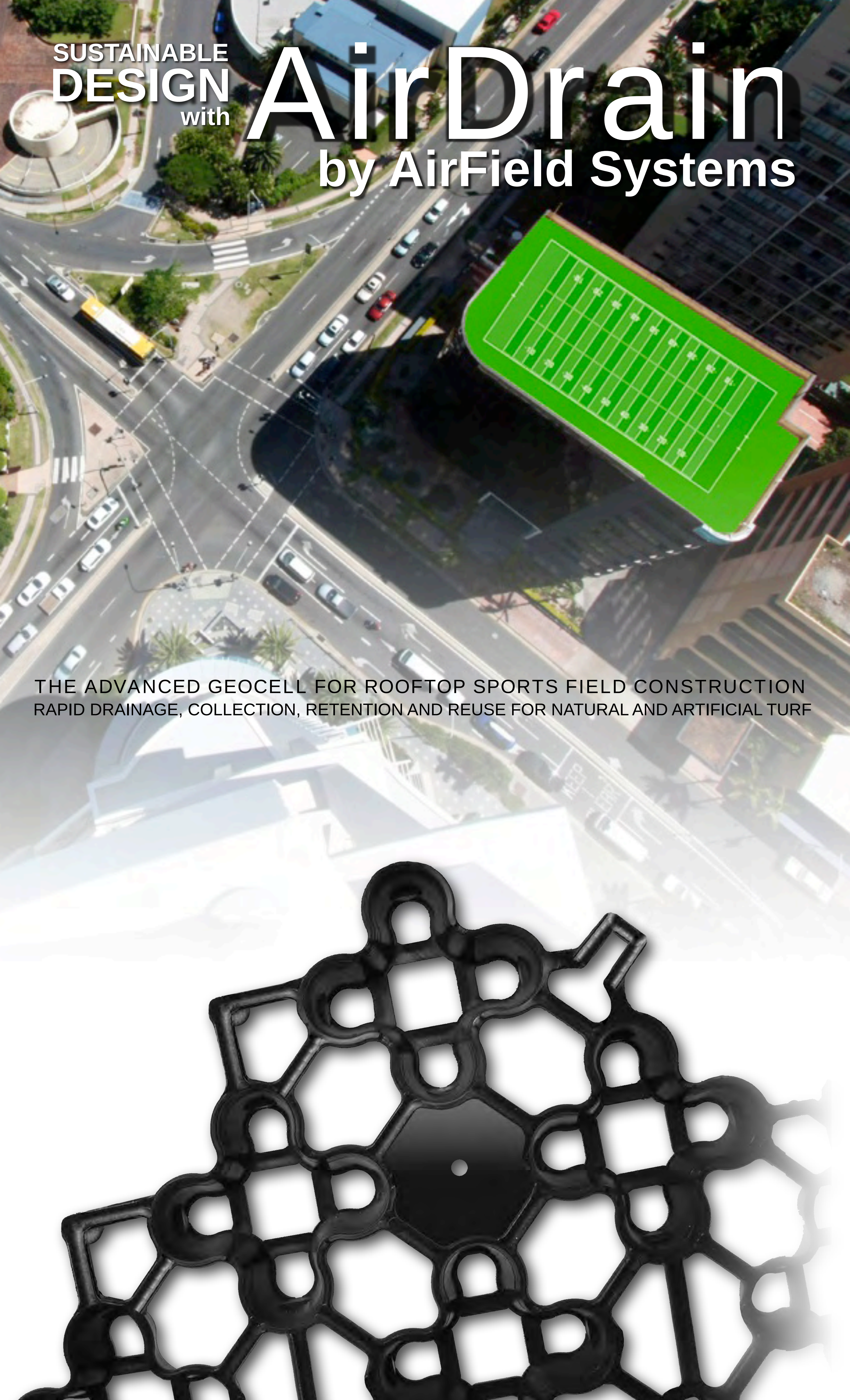

SUSTAINABLE
DESIGN
with
AirDrain
by AirField Systems
THE ADVANCED GEOCELL FOR ROOFTOP SPORTS FIELD CONSTRUCTION
RAPID DRAINAGE, COLLECTION, RETENTION AND REUSE FOR NATURAL AND ARTIFICIAL TURF

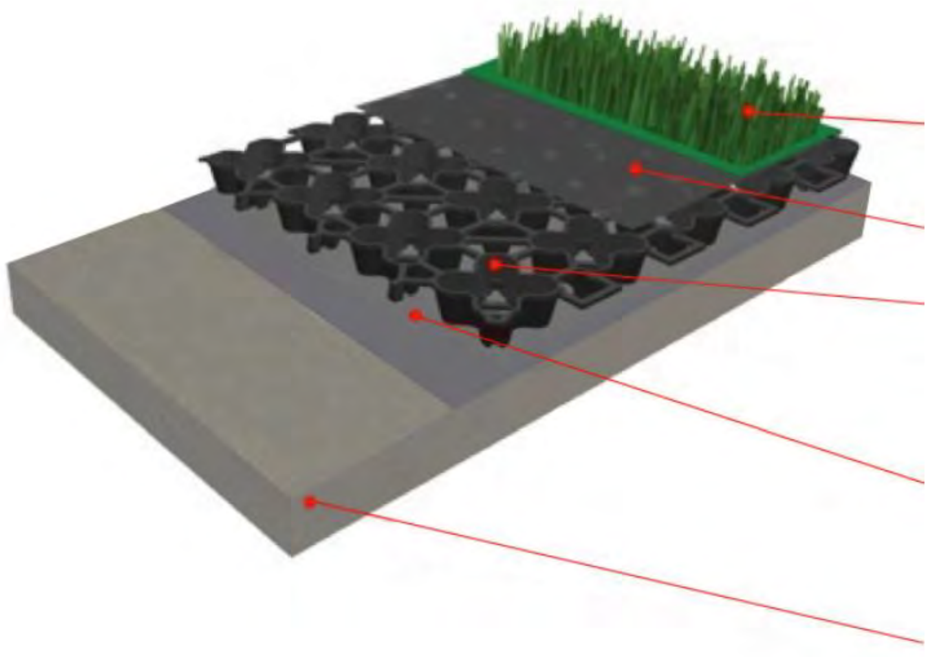
AirDrain – What drains better than Air?

Green Roofing - Synthetic or Natural Turf

With limited space on campus, high schools and colleges are turning to rooftop sports surfaces to create multi-use green areas. Building a rooftop sports field with an AirField System provides drainage under 100% of the playing surface, prevents ponding, and moves water efficiently for reuse elsewhere on campus.

Over 1,000,000 square feet of AirDrain rooftop drainage system installed and counting.

Natural Turf- Chesapeake Energy 74,000 sqft. Synthetic Turf- Escuela Campo Alegre 76,000 sqft. and WPI "Worcester Polytechnics Institute" 174,000 sqft.



Benefits of AirField in a green roofing system include:

- AirDrain creates and helps maintain a more consistent Gmax for Synthetic Turf
- ASTM testing proves AirDrain's shock absorption properties reducing strain on joints and ligaments
- AirDrain can be reused when the Synthetic Turf must be replaced
- Can help qualify for **LEED™** and other green building credits
- A smaller carbon and development footprint with reduced site disturbance
- Water harvesting reclamation and reuse is easy
- AirDrain creates a one inch air barrier on the rooftop increasing the insulating properties.
- AirDrain is a 100% recycled copolymer with the impact modifier "metallocene" qualifying it as a "No Break" plastic. Making it able to withstand extreme heat and cold and still maintain performance.
- Resins can be made to the following specification **"Flammability UL 94, Flame Retardant, High Impact Polypropylene Copolymer Resins"**

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ASTM Testing Proves the AirDrain Synthetic Turf Drainage Doubles as a Drainage Layer and Shock Pad

Whether installed on an aggregate base, concrete or asphalt the **AirDrain** drainage grid helps provide you with a consistent **GMAX** (as seen below) across the entire field. Some factors that might influence a change in **GMAX** would be an inconsistency of the infill or wear of the synthetic turf fibers. Unlike traditional shock pads / e-layer the **AirDrain** is 1" high, has a 92% air void. This unmatched vertical and lateral drainage all but eliminates standing water.

Some of the Benefits of an AirField Synthetic Turf Drainage System include:

• AirDrain creates and helps maintain a constant Gmax for artificial turf (See below)

• Shock absorption reduces the strain on joints and ligaments

• AirDrain is only limited by the drainage capacity of the profile above it and the exit drain

• AirDrain can be reused when the synthetic turf must be replaced

• Can help qualify for LEED and other green building credits

• A smaller carbon and development footprint with reduced site disturbance

• Water harvesting reclamation and reuse is possible

• AirDrain is a 100% recycled copolymer with the impact modifier metallocene qualifying it as a "No Break" plastic

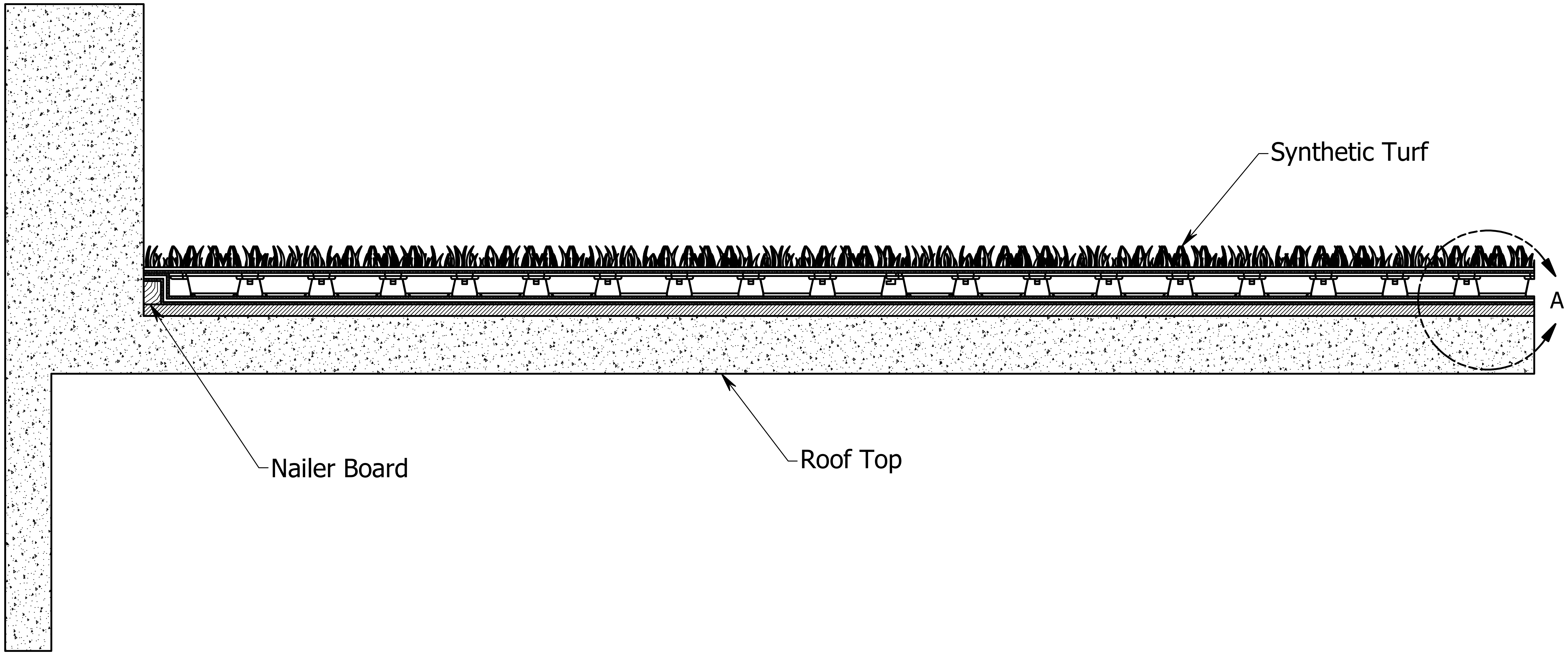
*** **AirDrain** can be made to the following specification "**Flammability UL 94, 30% Fiberglass Reinforced, High Impact, Flame Retardant Polypropylene Copolymer Resins**" for Rooftop applications. FLAMMABILITY @ 0.100 in V-0/5VA* UL94*

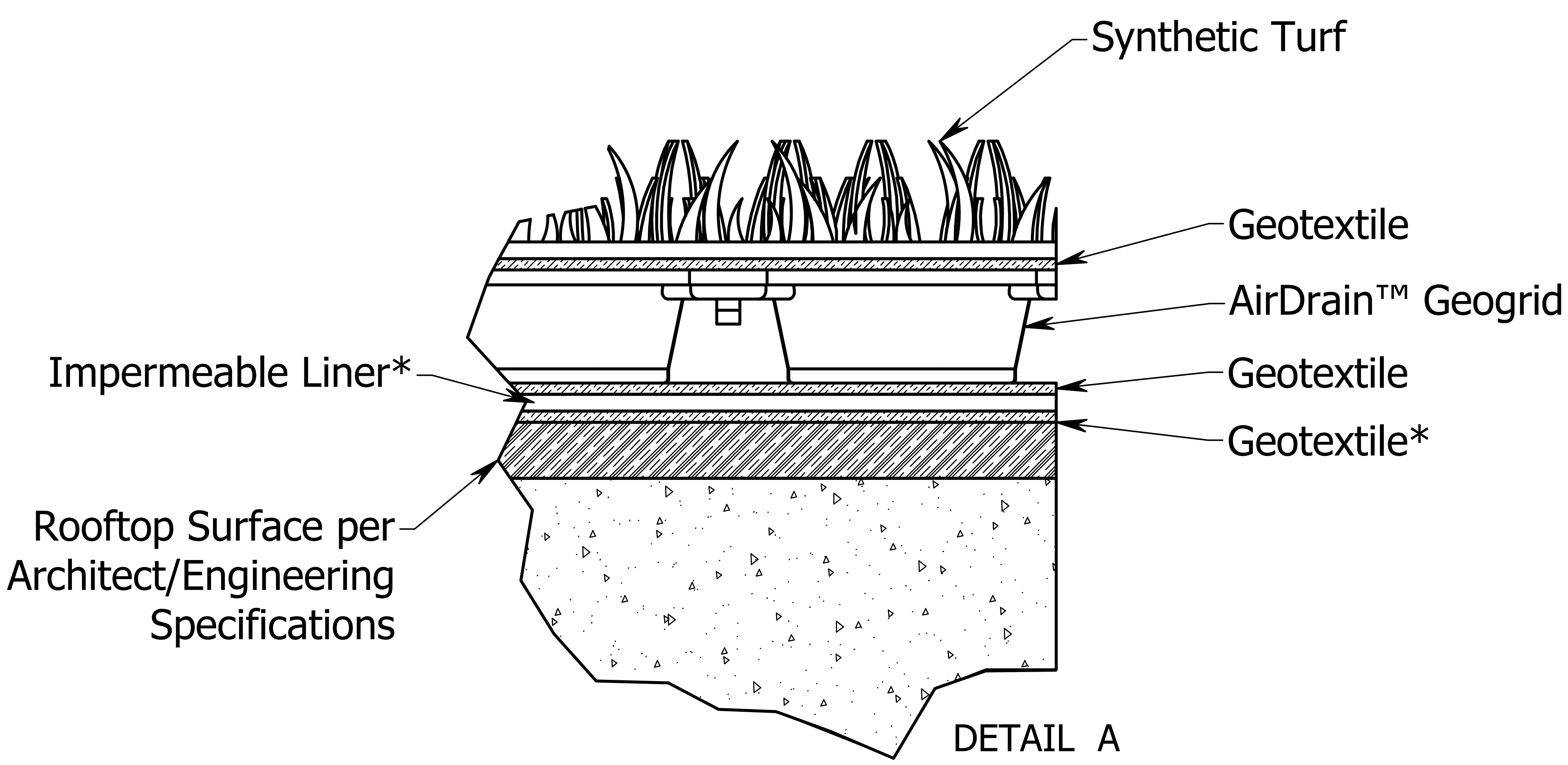
GMAX Results for: Turf - 2 1/2" Slit Film, in filled with 50% Green Rubber Infill and 50% Silica Sand.

The drainage/shock pad and turf underlying substrate consists of a concrete deck/rooftop, coated with a waterproof membrane and 2 separate layers of 5 ounce 100% recycled polyester geo-textile filter fabric.

Test #	Drop No.	Drainmatt Tested	Ft. / Sec.	H.I.C	Peak/Gmax	Avg./Loc.	Drainmatt Average
6	16	AIRFIELD Drop 1	11.7	222	89	105.5	
	17		11.7	289	105		
	18		11.7	292	106		
7	19	AIRFIELD Drop 2	11.7	215	87	103	
	20		11.7	275	101		
	21		11.7	294	105		
8	22	AIRFIELD Drop 3	11.7	249	97	113	Average of all Three 107.166
	23		11.7	308	109		
	24		11.7	333	117		

The Standard Test Method for Shock-Absorbing Properties of Playing Surface Systems and Materials (ASTM F1936-98 American Football Field) testing locations and procedure were preformed. The tests were performed using a Triax 2000 A-1 Missile, tripod mounted Gmax registration unit (www.triax2000.com). This report presents background information on the test procedures, existing conditions, test results and observations





DETAIL A
SCALE .75:1

*Impermiable Liner and or other waterproofing must be specified by a qualified engineer.

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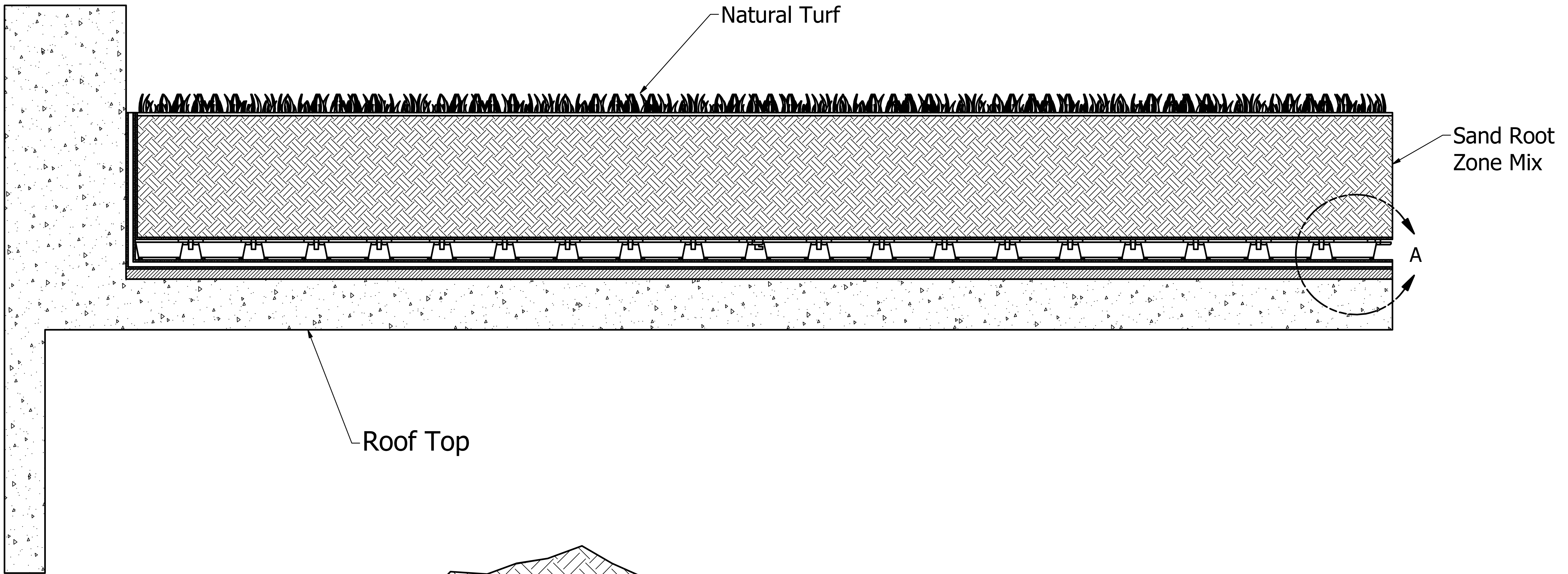
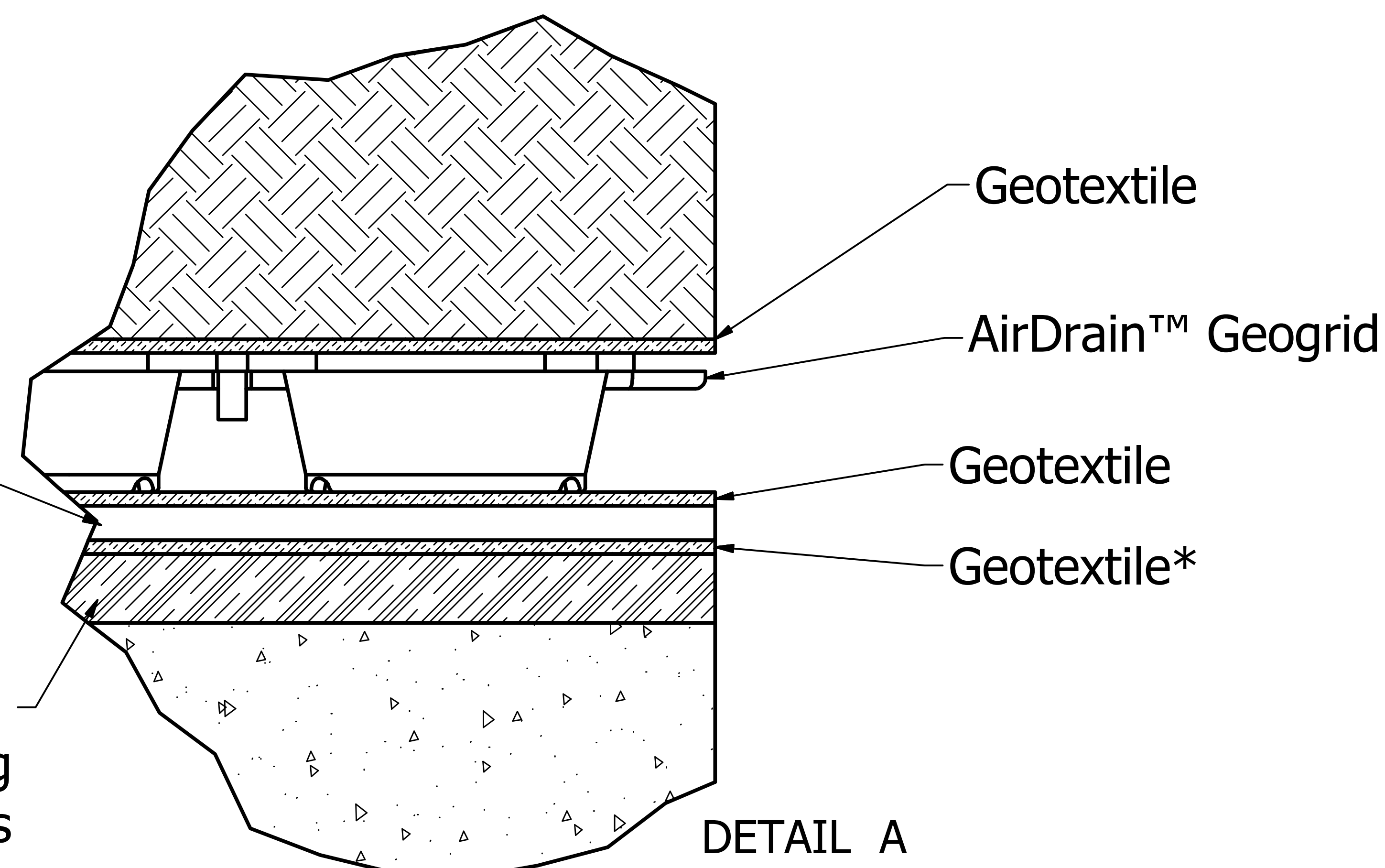
AirField Systems, LLC
8025 N May Ave, Suite 201
Oklahoma City, OK 73120
www.airfieldsystems.com
(405) 359-3375

DRAWN Gary	9/22/2012	Airfield Systems
CHECKED		TITLE AirDrain™ Sythetic Turf Rooftop Drainage
QA		
MFG		
APPROVED		

SIZE	DWG NO	REV
C	Rooftop_Assembly_SYN_ RT_001	2

SCALE | SHEET 1 OF 1





DETAIL A
SCALE 0.75 : 1

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airfield systems

DRAWN Gary	4/2/2012	Airfield Systems
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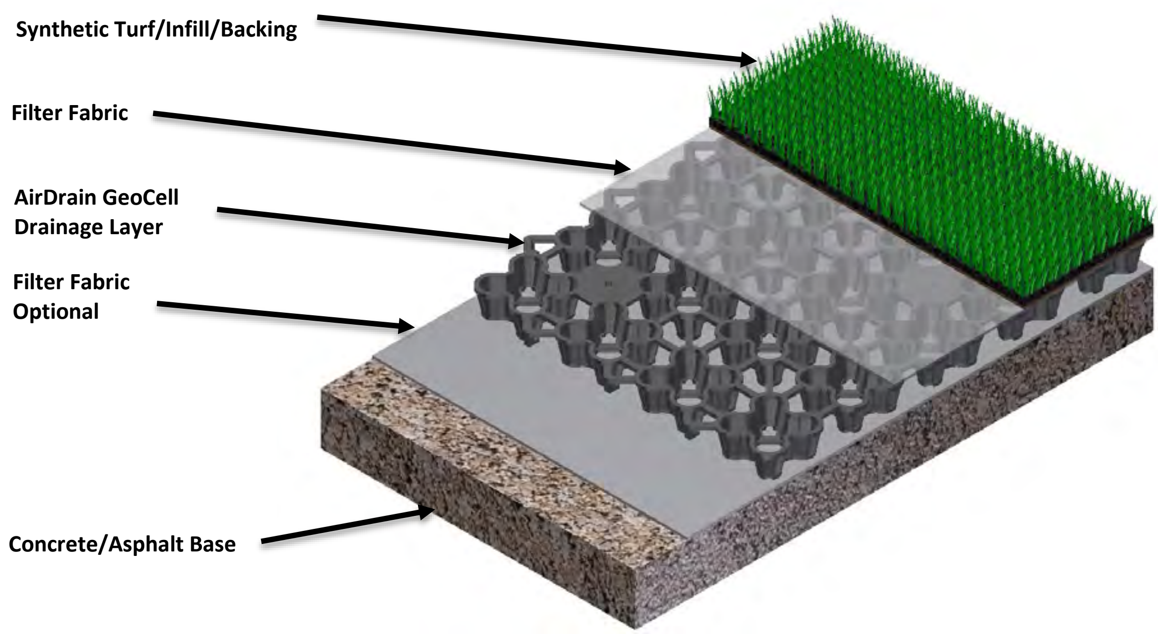
QA		
MFG		
APPROVED		

SIZE	DWG NO	REV
C	Rooftop Assembly RT_004	6
SCALE	SHEET 1 OF 1	

AirDrain – What drains better than Air?

For Concrete or Asphalt Conversions

The consistent **Gmax** and Shock Attenuation properties of the **AirDrain** are major contributors to the safety of your players and the reduction of concussions. Unlike traditional shock pads or e-layers **AirDrain** is 1” high has a 92% air void and a 100% vertical drainage rate which cannot be matched by any other product in the industry.



AirDrain reduces Gmax by [illegible]: **(per Architect/Engineer)**

- **14.7% on a concrete subbase**

Some of the Benefits of an AirField Synthetic Turf Drainage System include:

- AirDrain creates and helps maintain a constant **Gmax** for Synthetic Turf
- ASTM testing proves AirDrain’s shock absorption properties reducing strain on joints and ligaments
- AirDrain moves approximately 50 gallons of water per square foot per minute, all but eliminating infill migration and the maintenance costs involved in grooming the turf
- Patented expansion and contraction built into every part keeping the grid from buckling
- The 1” high 92% Air Void allows the cement to stay dry and extends the life of the turf above
- AirDrain is only limited by the drainage capacity of the profile above it and the exit drains capacity
- AirDrain can be reused when the synthetic turf must be replaced

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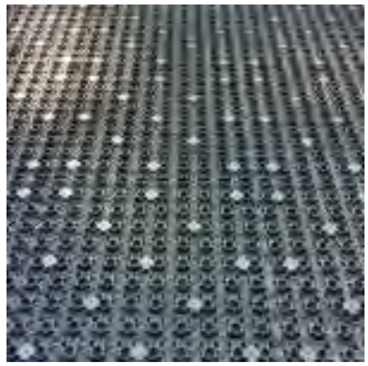
AirDrain for Concrete/Asphalt Conversion **– What drains better than Air?**

Ever wonder what to do with that tennis court, parking lot or paved area that is underutilized and sitting empty throughout the year? By simply installing the AirDrain System below synthetic turf you quickly transform the space into a play area that can be used year round. Take a look at the photos below that show how in 3 days this tennis court conversion dramatically changed the look of this space turning it into a multipurpose green space.



Installed atop a sealed surface the AirDrain Drainage System provides 100% vertical drainage and a 92% air void beneath the entire surface of your Synthetic Turf all but eliminating infill migration. Raising the turf off of the base also allows the area to be used almost immediately after a rain occurrence since the AirDrain System is only limited by the drainage of the turf above and the exit drain.

With multiple variations of installation profiles available to accommodate fall height requirements the AirDrain System can work for just about any project helping to revitalize your recreation area.

Some of the Benefits of an AirField Synthetic Turf Drainage System include:

• AirDrain creates and helps maintain a constant Gmax for Synthetic Turf
• ASTM testing proves AirDrain’s shock absorption properties reducing strain on joints and ligaments
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• Patented expansion and contraction built into every part keeping the grid from buckling
• The 1” high 92% Air Void allows the cement to stay dry and extends the life of the turf above
• AirDrain is only limited by the drainage capacity of the profile above it and the exit drains capacity
• AirDrain can be reused when the synthetic turf must be replaced

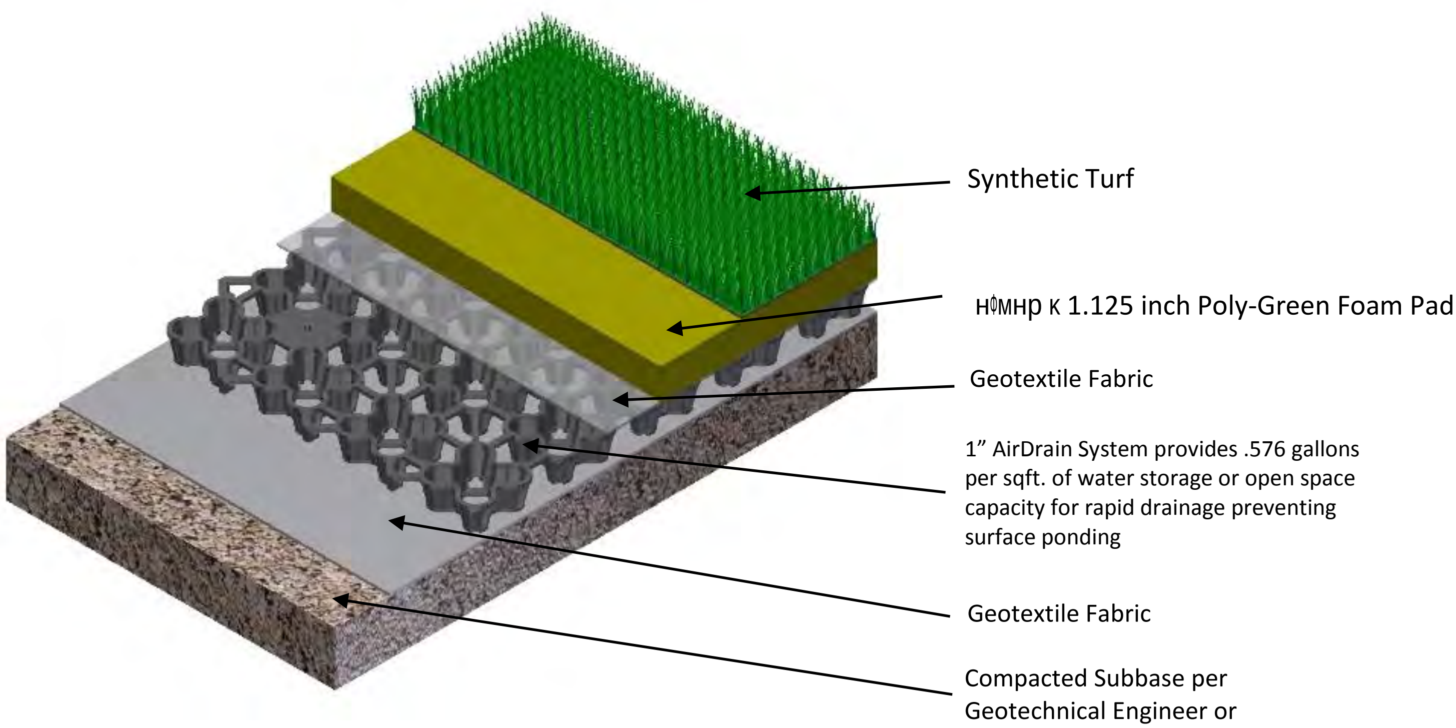
Please contact AirField Systems with any questions or need for information for your next project. **405-359-3775**

AirDrain – What drains better than Air?

Playground Drainage

AirDrain with its 100% vertical drainage and 92% air is designed to collect and re-direct water, actually raising the entire profile 1” off the subbase and bringing gravity into play allowing the area to dry quickly and efficiently. The result is a more stable surface area, reduced expense for repair materials and more play time.

For playgrounds the AirDrain System is placed on the prepared subbase. Whether using loose fill products, such as engineered wood fiber or rubber chips, or using unitary surfaces, such as rubber tiles or poured in place rubber, the playground area needs proper water drainage. Wood chips can be placed directly on top of the geotextile. The filter fabric retains the wood chip particles while allowing water to freely enter the drainage core.



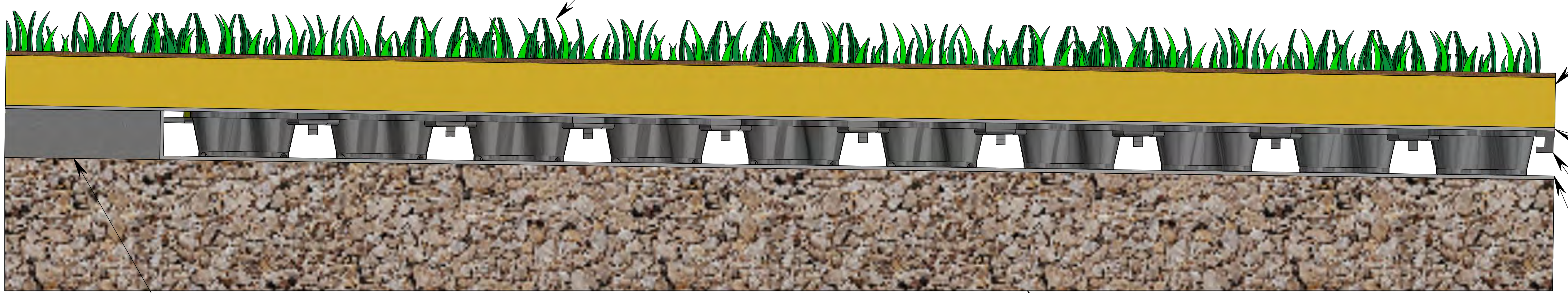
The AirDrain Advantage

Benefits of an AirField AirDrain playground drainage system include:

- AirDrain raises the entire profile 1” off the subbase and bringing gravity into play
- AirDrain’s 92% air-void space for fast and easy water removal
- Consistent **HIC** and **Gmax** for the life of the AirDrain providing a safe play area
- 100% post industrial recycled content
- AirDrain’s quick snap connectors allows for effortless installation
- Minimal site disturbance, far less excavation and disposal
- Compact shipping reducing transportation costs

*This drawing, specifications and the information contained herein is for general presentation purposes only. All final drawings and layouts should be determined by a licensed engineer(s). HIC & Gmax testing are measured in a lab setting and are not site specific.

AirDrain Application with Pad



AirDrainÊ Unit Panel Specifications:

Size:	32" x 32" x 1"
Weight:	3.1 lb
Strength:	233 psi (unfilled)
Resin:	100% Recycled (PIR) Copolymer with Impact Modifier "No Break" Polymer Material
Color:	Black (3% carbon black added for UV Protection)

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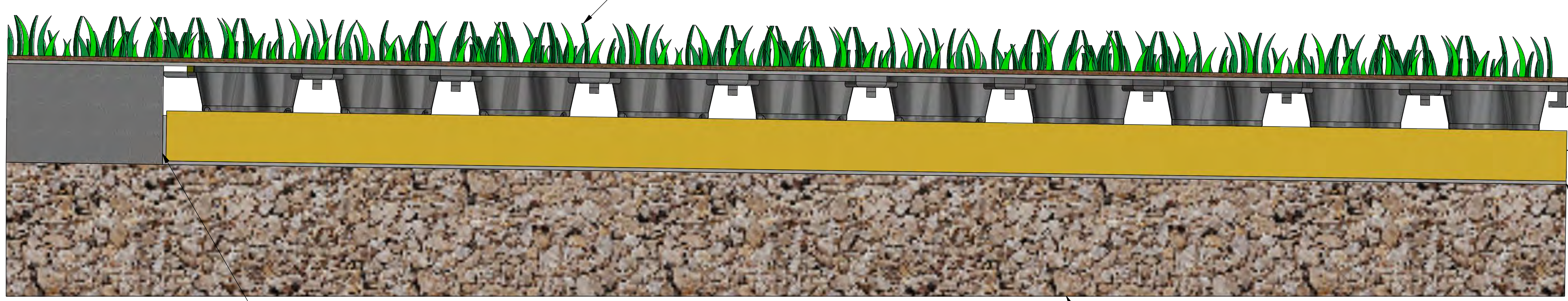
airfield systems®

DRAWN Gary	1/13/2013	Airfield Systems	
CHECKED		TITLE AirDrain Application with Pad	
QA			
MFG			
APPROVED			
The information contained in this drawing is the sole property of Airfield Systems. Any reproduction in part or as a whole without prior written consent is prohibited.		SIZE C	DWG NO Playground_AFS_SP_REV_001 — REV 1Air
		SCALE	SHEET 1 OF 1

AirDrain Application with Pad Below



AirDrainÊ Unit Panel Specifications:

Size:	32" x 32" x 1"
Weight:	3.1 lb
Strength:	233 psi (unfilled)
	6747 psi (filled)
Resin:	100% Recycled (PIR)
	Copolymer with Impact Modifier
	"No Break" Polymer Material
Color:	Black
	(3% carbon black added for UV Protection)

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APPROVED		
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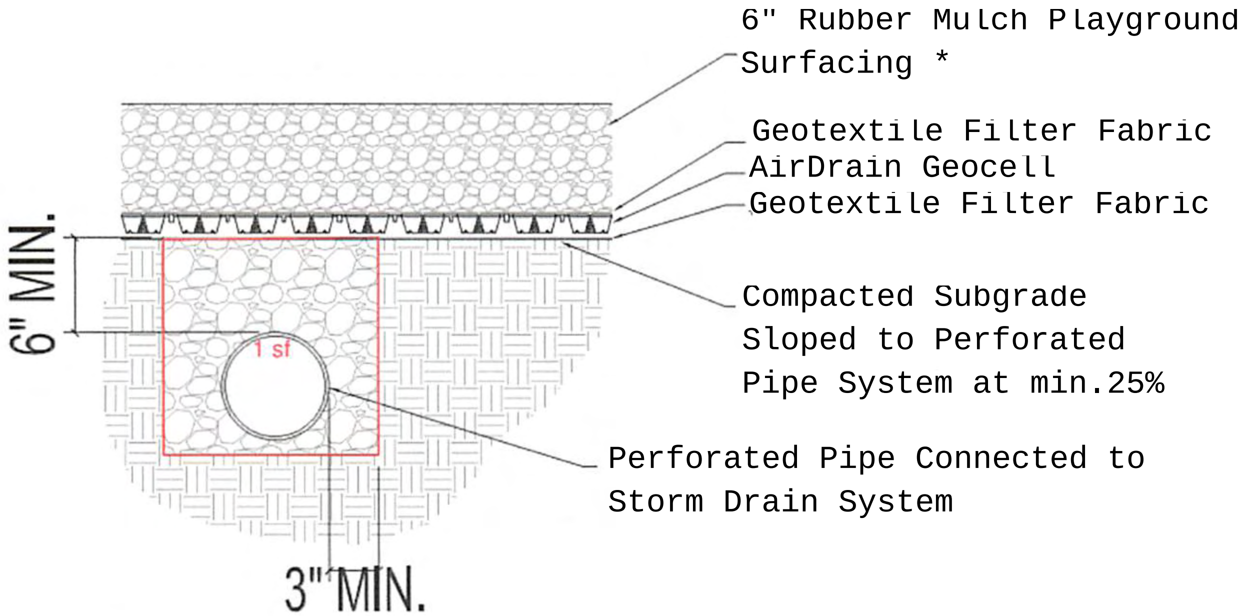


3

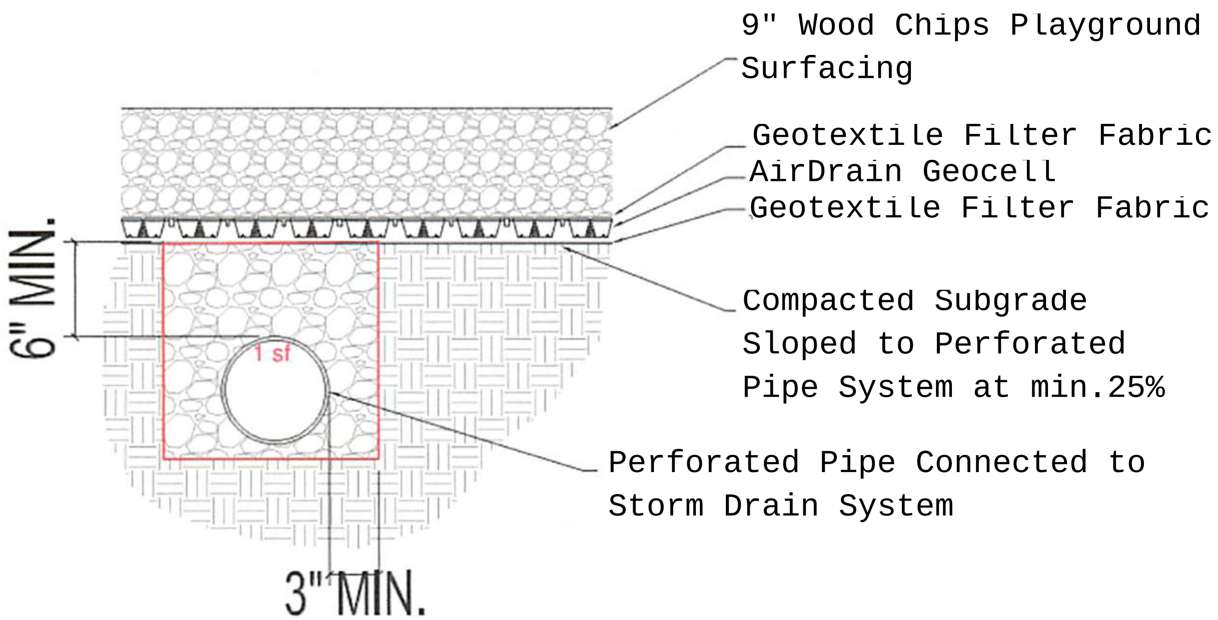
PLAYGROUND SURFACING

AirDrain for Playgrounds with Rubber Mulch Infill

** Compacted at 3" and Again at 6" during installation

Unit Panel Specifications:
Size: 32" x 32" x 1"
Weight: 3.1 lb
Strength: 233 psi (unfilled)
6747 psi (filled)
Resin: 100% Recycled (PIR)
Copolymer with Impact Modifier
"No Break" Polymer Material
Color: Black
(3% carbon black added for UV Protection)

AirField Systems, LLC
8028 N May Ave, Suite 201
Oklahoma City, OK 73120
www.AirFieldsystems.com
(405)359-3375



3 PLAYGROUND SURFACING

AirDrain for Playgrounds with Wood Chips Infill

Unit Panel Specifications:
Size: 32" x 32" x 1"
Weight: 3.1 lb
Strength: 233 psi (unfilled)
6747 psi (filled)
Resin: 100% Recycled (PIR)
Copolymer with Impact Modifier
"No Break" Polymer Material
Color: Black
(3% carbon black added for UV Protection)

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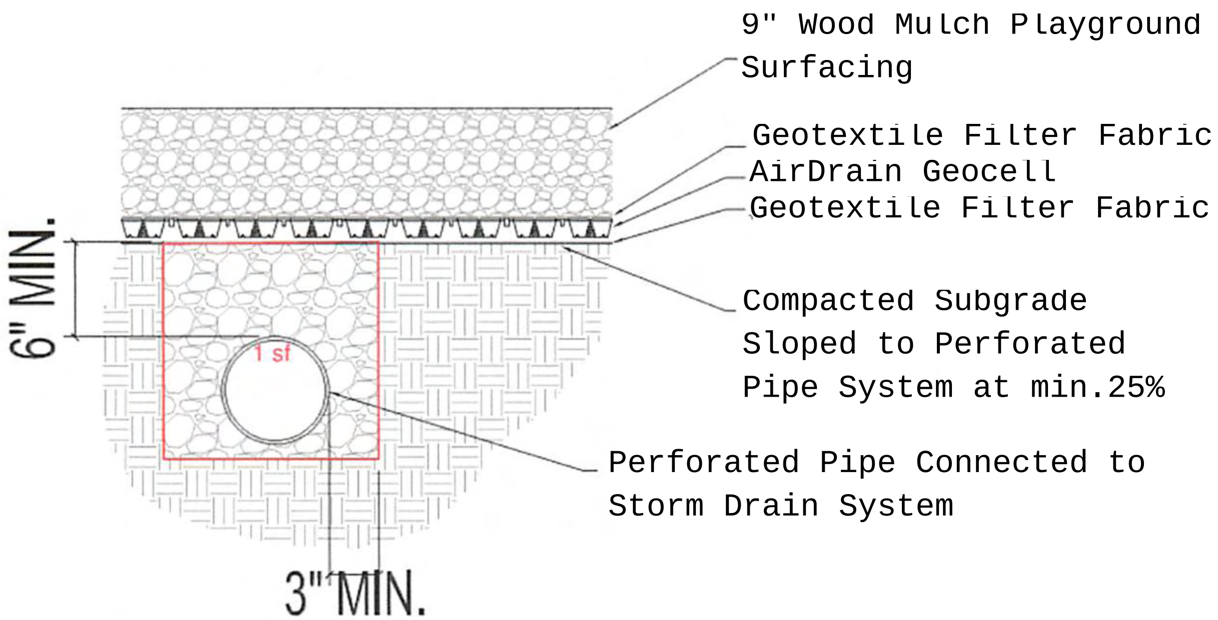

3 PLAYGROUND SURFACING

AirDrain for Playgrounds with Wood Mulch Infill

Unit Panel Specifications:
Size: 32" x 32" x 1"
Weight: 3.1 lb
Strength: 233 psi (unfilled)
6747 psi (filled)
Resin: 100% Recycled (PIR)
Copolymer with Impact Modifier
"No Break" Polymer Material
Color: Black
(3% carbon black added for UV Protection)

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www.AirFieldsystems.com
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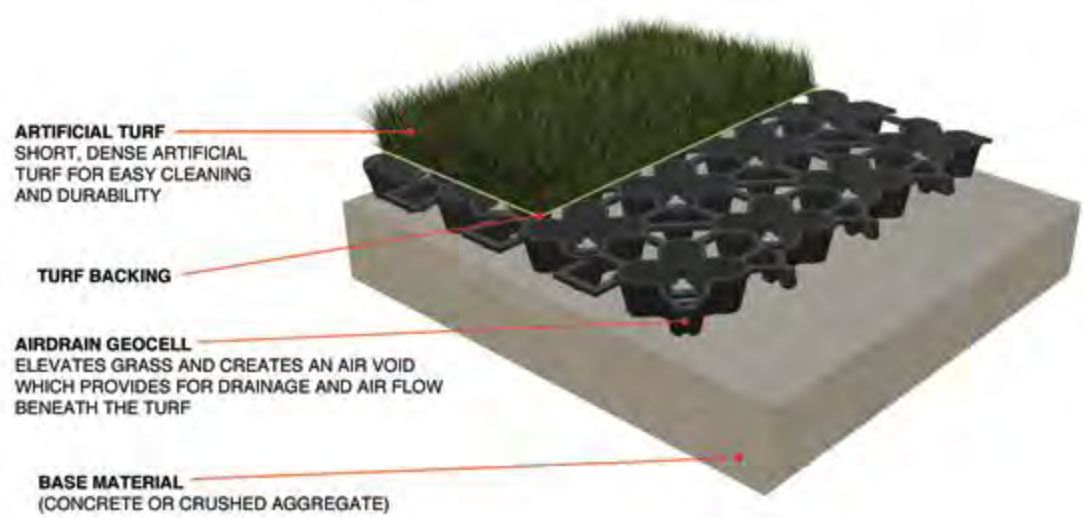
AirDrain – What drains better than Air?

For K9 Areas: Pet Playgrounds, Dog Runs, Kennels and More…..

Tried and true with over 200 K9 areas installed, AirDrain K9 Drainage by AirField Systems is the ideal synthetic drainage system used in dog day care facilities, pet playgrounds, airport dog potties and general use common areas, for dogs all across America.

Made with 100% post industrial recycle content AirField uses the highest quality materials for the AirDrain Geocell. With a 92% air void space underneath your artificial turf, you are able to wash away any unwanted waste left behind if needed by installing a flushing system underneath the grid. This system is easily installed and attaches to any water source with inexpensive pvc piping. Low cost, easy to install, do it yourself drainage, makes AirDrain the ideal synthetic drainage system for kennels, dog boarding and pet facilities, dog parks, vet clinics, and even in your own backyard.

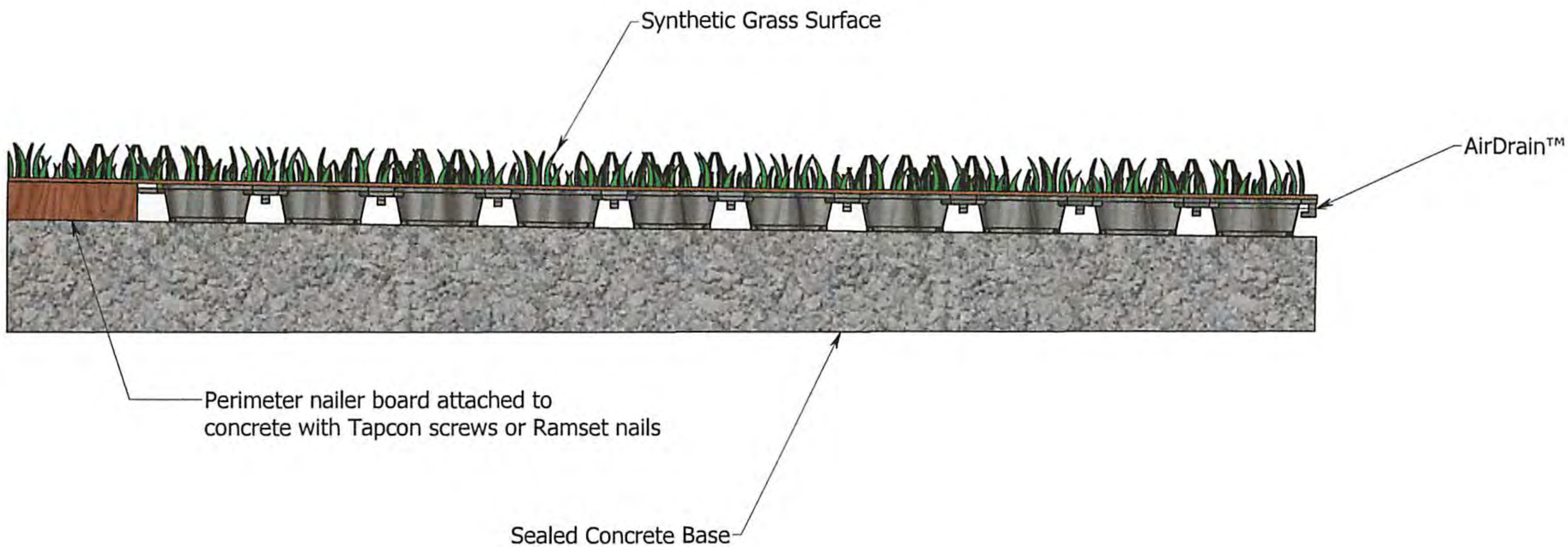
K9 areas are installed every day in public and private facilities across the world. Whether you utilize natural or artificial turf, the AirField System is a stress-free way to turn any common space into a fun place for people and their K9 friends. No more worrying about expensive and destructive gravel drainage and no problems with waste being left behind. An AirField System is the easiest and fastest way to install a K9 recreation area.



Benefits of an AirField drained K9 area include:

• 100% post industrial recycled content
• 92% air-void space for fast and easy waste removal
• Ability to flush the area daily
• AirDrain's quick snap connectors allows for effortless installation
• Minimal site disturbance, far less excavation and disposal
• Compact shipping reducing transportation costs
• Over 200 K9 areas installed around the world

Dog Runs



AirDrain™ Unit Panel Specifications:

Size:	32" x 32" x 1"
Weight:	3.1 lb
Strength:	233 psi (unfilled) 6747 psi (filled)
Resin:	100% Recycled (PIR) Copolymer with Impact Modifier "No Break" Polymer Material
Color:	Black (3% carbon black added for UV Protection)

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DRAWN Gary	8/6/2012	Airfield Systems
CHECKED		TITLE Edge Detail on Concrete Base
QA		
MFG		
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		SCALE — SHEET 1 OF 1

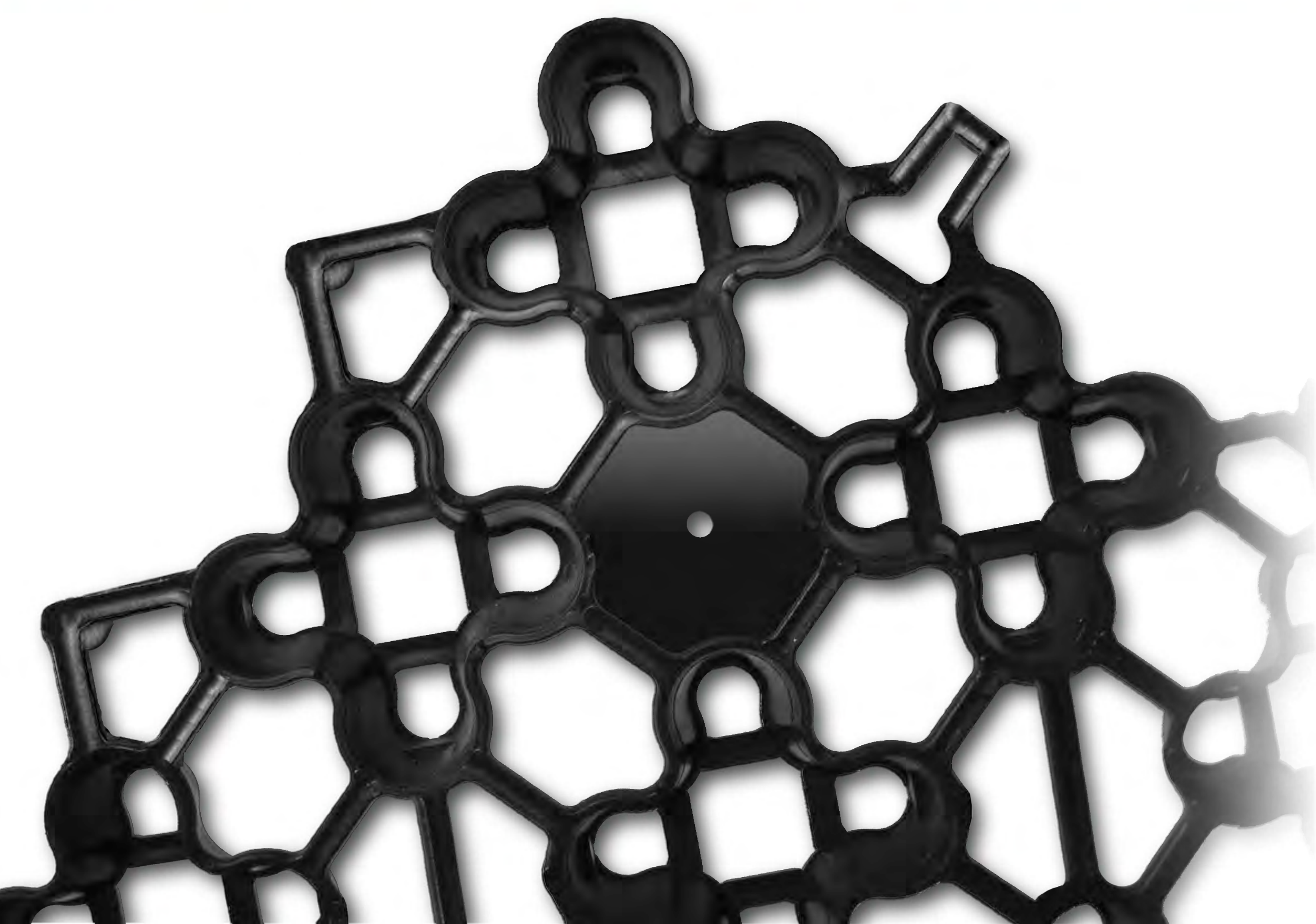
SUSTAINABLE DESIGN with

AirDrain

by AirField Systems

THE ADVANCED GEOCELL FOR MODERN GOLF COURSE CONSTRUCTION

RAPID DRAINAGE, COLLECTION, RETENTION AND REUSE FOR GREENS, TEE BOXES AND BUNKERS



Comparison of Putting Greens Constructed with Airfield Systems and USGA Designs

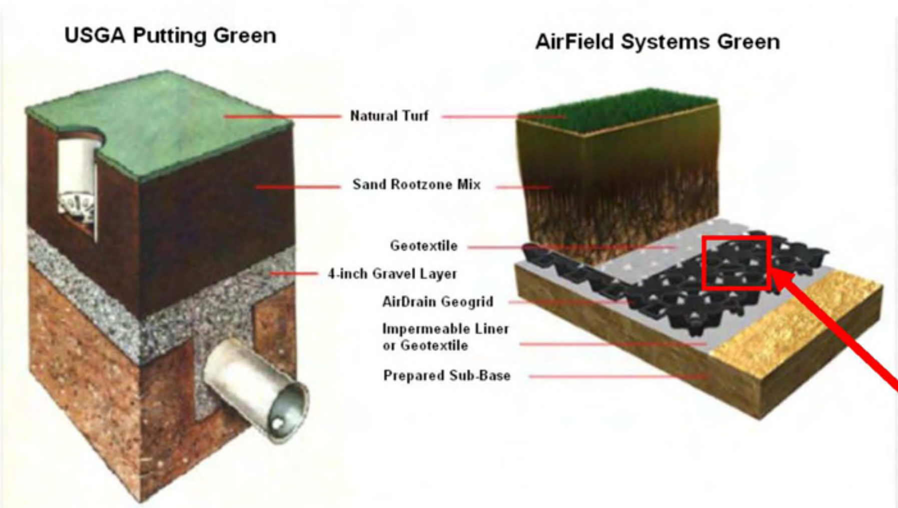
Kevin J. McInnes, Keisha Rose–Harvey, James C. Thomas
Texas A&M Agrilife Research

Turfgrass and Environmental Research Online
Volume 12, Number 4 | July – August 2013

Note: The information in this article has been adapted from the original work published in Crop Science titled "Water Storage in Putting Greens Constructed with United States Golf Association and Airfield Systems Designs" (McInnes and Thomas, 2011, 51:1261–1267) and in HortScience titled "Water Flow Though Sand–based Root Zones atop Geotextiles" (Rose–Harvey et al., 2012, 47:1543–1547). The research was collaboratively funded by Texas A&M University, Airfield Systems (Oklahoma City, OK), and the United States Golf Association.

Airfield Systems offers an alternative to the standard USGA putting green design. Their design utilizes a highly porous, 1–inch deep plastic grid (AirDrain, Figure 1) in place of a 4–inch deep gravel layer. As with gravel, AirDrain allows rapid lateral movement of excess water to drains and thus provides for uniform horizontal moisture content within the root zone. While voids in AirDrain are very effective in transmitting water, they are much too large for the sand in the root zone to bridge for self–support so a geotextile is used atop the grid to prevent infilling of the void space. Use of geotextiles in putting green construction has been controversial due to the perceived potential for clogging of the fabric by migrating fine particles and eventual loss of permeability.

We became interested in the hydraulic performance of the Airfield Systems design after Texas A&M University constructed a soccer field with the Airfield System design in 2002. Anecdotal evidence from field managers suggested that the new field required less frequent watering than the University's football field that had been constructed following the USGA design. While the two fields were constructed with different root zone mixtures and the physical environments surrounding the fields are quite different, we suspected that there may have been a difference in the amount of water stored in root zones on fields constructed with the two designs (i.e., a difference in the vertical distributions of water content in the root zones). We knew from the physics of water in sand that the amount of water stored in a root zone decreases with increasing tension at the bottom of the root zone, and we expected because of the geometrical and physical differences in the designs that there would be differences in water tension at the bottom of the root zones.



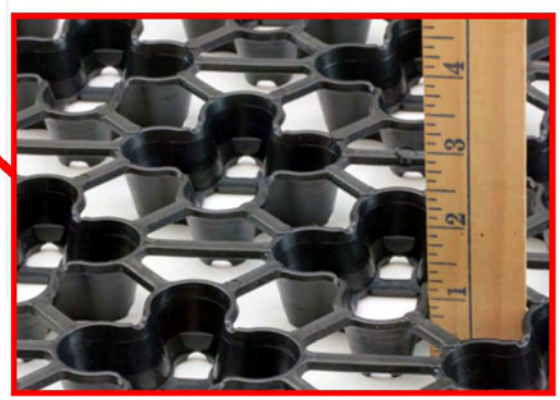
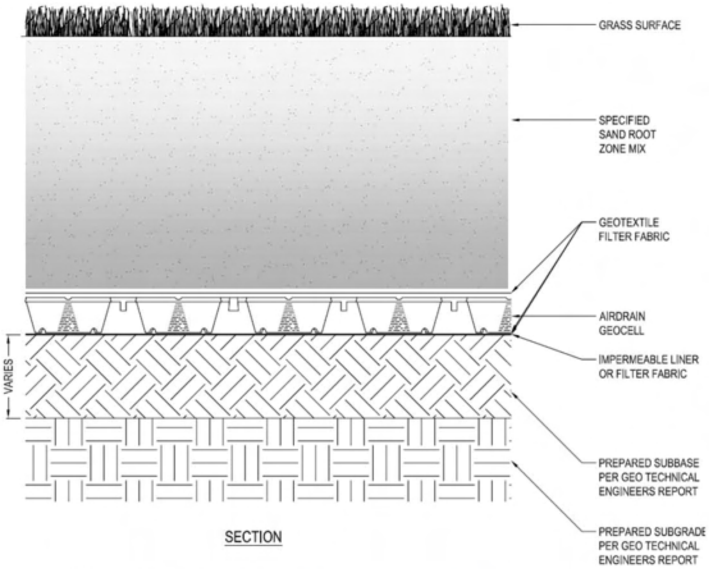


Figure 1. The highly porous, 1–inch deep AirDrain (right) offers an alternative to the 4–inch deep gravel layer in the standard USGA putting green design (above left).



Cross–section of a putting green using the AirDrain instead of a 4–inch gravel layer in a USGA green (Drawing courtesy of [AirField Systems]).

While the root zone may be saturated above the drainage layer, the water is under tension so the term "perched water table" often used to describe the state of water in the root zone immediately above the drainage layer is a bit of a misnomer. A better term might be "perched capillary fringe." Capillary fringe is the saturated zone above a water table where water is under tension. The further upward from the bottom of the root zone the greater the water tension. As distance increases upward and water tension increases, the root zone eventually begins to desaturate as the largest pores drain. As distance increases beyond this height water content continues to decrease. As a consequence, the tension that develops at the bottom sets the starting tension and determines the thickness of the saturated zone and the amount of water stored in the root zone profile (Figure 2). The depth and hydraulic properties of the drainage layer determine the magnitude of tension that develops at the bottom of the root zone.

AirDrain is 1–inch deep so the maximum tension that can develop at the bottom of the root zone during drainage in the Airfield Systems design would be 1 inch of water. Gravel is typically 4 inches deep so the tension that could develop would be up to 4 inches of water, depending on the hydraulic properties of the gravel and the depth to which sand ingresses pores of the gravel. Water is slow to drain from small pores into large pores, but if both systems were sealed from evaporation the tensions would eventually reach 1 and 4 inches at the bottom of the root zone in the Airfield Systems and USGA design greens, respectively. An occasional finger of sand penetrating the gravel in the USGA design green can lead to an appreciably quicker increase in tension at the root zone gravel interface.

To test for differences in tension developed at the bottom of the root zones of the two designs, we constructed laboratory–based test cells from 4–inch diameter PVC pipe containing profiles of the Airfield Systems and USGA greens. Using tensiometers, we were able to demonstrate that the tension that developed at the bottom of the root zone in the Airfield Systems design was appreciably less than that in the USGA design. At that point we thought it worthwhile to investigate this finding on a slightly larger scale and a more realistic setting. To this end, we constructed test greens in 14–inch diameter PVC pipe. Three sands and three gravels were chosen such that they covered the ranges from coarser to finer sides of the USGA recommendations for particle size distribution. To create root zone mixtures, the coarser two sands had peat moss added to increase water retention. The finer sand was

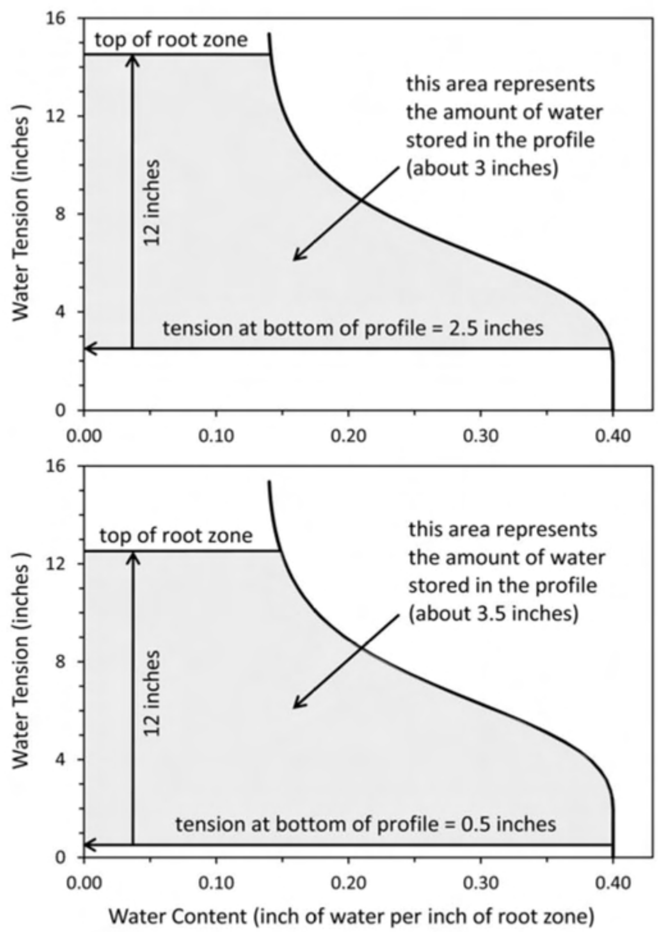


Figure 2. Graphic representation of the dependence of water–holding capacity on tension at the bottom of the profile for a typical root zone mixture meeting USGA recommendation for total, air–filled, and ca–pillary porosities. The curved lines to the right rep–resent the relationship between water tension and water content for the root zone mixture.

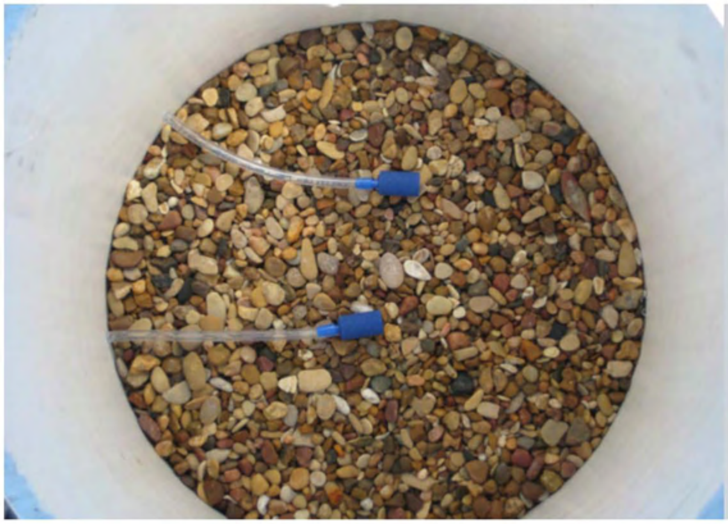


Figure 3. Test greens constructed in 14–inch PVC pipe with either gravel or geotextile atop AirDrain as the drainage layers. Both types of test greens contained a pair of porous cups connected to plastic tubing that formed manometer–tensiometers to allow measurement of water pressure or tension at the root zone–drainage layer interface.

not amended. These three root zone mixtures were used in combination with the three gravels to construct test greens of the USGA design. The gravel layer in all of the test greens was 4 inches deep. An intermediate choke layer of coarse sand was not used. The same three root zone mixtures were used in combination with four geotextiles atop AirDrain to construct test greens of the Airfield Systems design. We used the Lutradur polyester geotextile prescribed by Airfield Systems at the time and chose three additional geotextiles that had the same apparent opening size (0.2 mm), but differed in material and/or manner of construction. Manometer–tensiometers were used to measure pressure or tension that developed at the root zone–drainage layer interface of both designs (Figure 3). After the test green columns were packed with 12 inches of the root zone mixtures they were sprigged with MiniVerde bermudagrass supplied by King Ranch Turfgrass–Wharton Farms (Wharton, TX). Following a period to grow–in the grass, a series of experiments were conducted that measured the amount of water stored in the root zone profiles and the water tension that developed at the bottom of the root zones of the different treatments after irrigation and drainage. Vertically oriented time domain reflectometry TDR probes were used to measure the amount of water stored in the root zone profiles (Figure 4).

Periodically during the course of the study, the test greens were watered until drainage was observed and then the amount of water stored in the profiles and the water tension at the bottom of the root zones were recorded for 48 hours. As with our preliminary lab study, we found that the water at the bottom of the root zones of test greens constructed with the Airfield design was under less tension than the water in test greens constructed with the USGA design, by about 2.2 inches of water tension (Figure 5). This lower tension was associated with an increase in water storage of about 0.5 inch in the Airfield System design greens above that in the USGA design greens (Figure 5). This increase in water retention could lead to less frequent necessity to irrigate.

Because of reduced tension at the bottom of the root zone, these results also implied that the tension at which root zone mixtures should be tested for capillary porosity when intended to be used in an Airfield System design green should be reduced to achieve similar

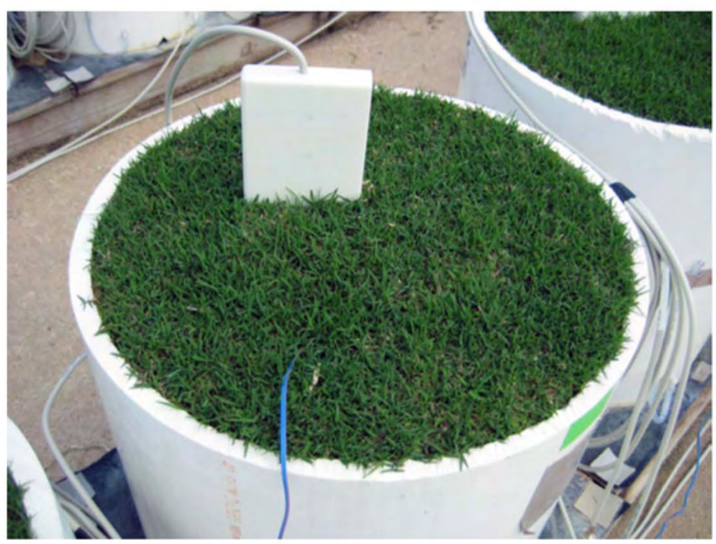


Figure 4. Test green with vertically installed, 1–ft long TDR probe used to measure average water content within the root zone profile.

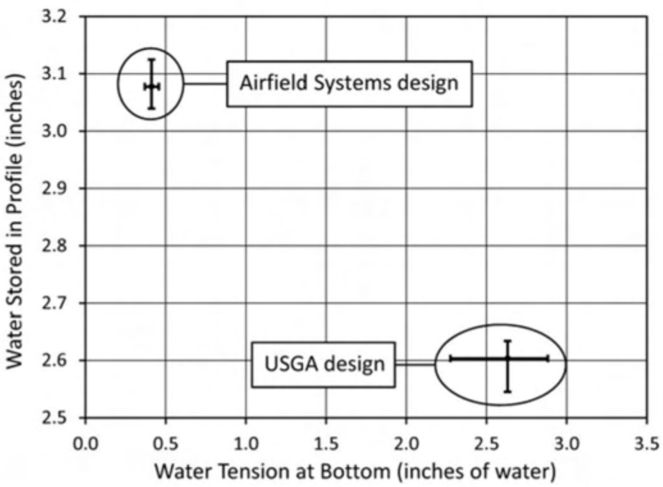


Figure 5. Range in the mean amount of water stored in 12–inch root zone profiles in Airfield Systems (geotextiles atop AirDrain) and USGA (gravels) design test greens 12 hours after irrigation. Means were of the three root zone mixture treatments and variations shown were from drainage–type treatments (i.e., type of geotextile or gravel). Stored water in the profile was measured by TDR and water tension was measured with manometer–tensiometers.

moisture retention to greens built according to the USGA recommendations. In doing so, slightly coarser sand would meet specifications for capillary water retention in the Airfield design. Conversely, sands that push the very fine side of the current recommendations might not meet specifications for air–filled porosity.

The question of whether or not geotextiles used in a green will clog with fines migrating out of the root zone was also studied. To address this issue, we conducted a year–long laboratory experiment to investigate a range of geotextiles that were suited to supporting sand in the Airfield System design and determine whether or not they limit drainage out of the root zone. In this experiment, 6–inch diameter PVC columns were used to contain combinations of 12 inches of three sand mixes with 10 geotextiles held atop AirDrain (Figure 6). Manometer–tensiometers again were used to measure pressure or tension at the sand–geotextile interfaces. Mix 1 had a particle size distribution that ran down the center of the USGA specs. Mix 2 was made by blending Mix 1 with a sandy clay loam (9:1 by mass) and Mix 3 was made by blending Mix 1 with a sand having excess fines (1:1 by mass). Mix 1 and Mix 2 met USGA recommendations. Mix 3 contained twice the recommended amount of very fine sand. The apparent opening sizes of the geotextiles used ranged from 0.15 to 0.43 mm. After the sands were added to the columns they were regularly irrigated. Periodically, the rate that 1–inch of irrigation water drained from a column was measured and the pressure/tension at the sand–geotextile interface was recorded.

For the first six months, any particles that washed out of the sand through the geotextiles were accumulated and analyzed for total dry weight and particle size distribution. At the end of the study, the saturated hydraulic conductivity of the sand–geotextile combinations were measured. Statistical analyses showed that drainage rate, saturated hydraulic conductivity, and mass of eluviated particles were not dependent on the properties of the geotextiles, but rather on the properties of the sands (Figure 7). Most all of the particles that washed out of the columns were of clay and silt sizes. This could be construed as evidence that the geotextiles were sieving out larger particles, but we found that the size of particles in the drainage water was not related to the apparent opening size of

Figure 6. Columns used to measure potential clogging of geotextiles by fines migrating out of the root zone.

TERO Vol. 12(4):6–10 | July – August 2013
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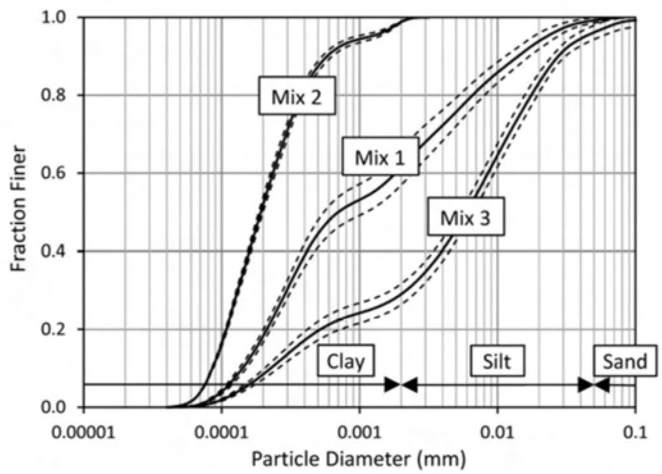


Figure 7. Size distribution of particles washed out of the three sand mixes through the geotextiles. The solid line for each sand mixture represent the mean fraction of particles finer than a given diameter over 30 columns containing the mixture (10 geotextiles with 3 replicates) and the dashed lines represent one standard deviation each side of the mean.

the geotextiles, which it should have been if the geotextiles were acting as sieves (i.e., the geotextiles with the larger AOS would have let larger particles pass, and vice versa, but this did not happen). The geotextiles obviously prevented the passage of particles as their purpose is to prevent migration of the root zone sand into the drainage layer, but it appeared in our study that the sands were responsible for determining the particle sizes leaving the columns.

Drainage rates from the columns containing the sand without added fines increased over the year, presumably because pore channels in the sand were widened when silt and clay washed out of the profile. Drainage rates of the columns containing the two sands with additional fines decreased over the year, but the decrease was not statistically related to the properties of the geotextiles. To test if the sands themselves were clogging, saturated hydraulic conductivities were measured as layers of sand were removed from columns. Since saturated hydraulic conductivity would not depend on the depth of sand in a hydraulically uniform column, any observed changes would be due to difference in the conductivity of the layers removed compared to those remaining. We found that when surface layers were removed the saturated hydraulic conductivity increased, indicating that the surface layers had lower conductivities. This was not too surprising as the majority of inter-particle pores of sand meeting USGA recommendation are smaller than the apparent opening sizes of the geotextiles we tested. In support of our conclusion that the sands were clogging and not the geotextiles, we did not notice a build-up of positive pressure atop any of the geotextiles during drainage, as would have occurred if the geotextile had been restricting drainage out of the column.

In conclusion, the results of our studies gave no reason to prevent more widespread use of Airfield Systems' design as an alternative to the USGA method for putting green construction. Airfield Systems design produces additional water holding capacity above the USGA design, which leads to more plant available water, given the same root zone mixture, and, possibly, less frequent requirement for irrigation. Our data also support the general use of properly sized geotextiles to support sand based root zones in putting greens. Geotextiles with apparent opening size of 0.2 mm worked well in our test greens and a woven geotextile with an apparent opening size twice as large (0.43 mm) retained the root zone sand just as well.

Summary Points

- Water at the bottom of the test green rootzones constructed with the Airfield design was under less tension than the water in test greens constructed with the USGA design (about 2.2 inches of water tension).
- This lower tension was associated with an increase in water storage of about 0.5 inch in the Airfield System design greens above that in the USGA design greens.
- Geotextiles with apparent opening size of 0.2 mm worked well in test greens and a woven geotextile with an apparent opening size twice as large (0.43 mm) retained the root zone sand just as well
- The geotextiles that were tested prevented the migration and passage of the sand rootzone mixture into the drainage layer, but it appeared that the tested sands were responsible for determining the particle sizes leaving the columns.
- The results gave no reason to prevent more widespread use of Airfield Systems' design as an alternative to the USGA method for putting green construction.

DR. KEVIN J. MCINNES is Professor of Soil and Environmental Physics in the Department of Soil and Crop Sciences, Texas A&M University. His research focuses on water and energy transport in soil.

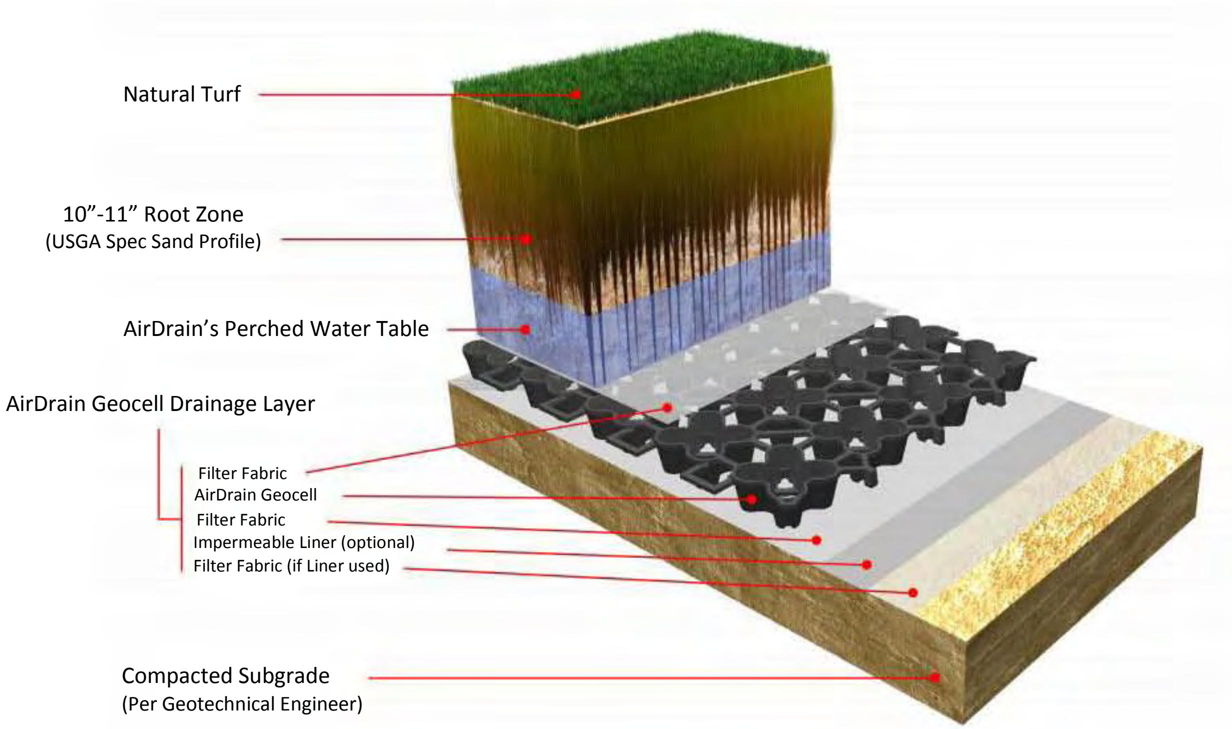
KEISHA M. ROSE-HARVEY graduate student in the Department of Soil and Crop Sciences, Texas A&M University.

JAMES C. THOMAS, CPAg. is senior research associate in the Department of Soil and Crop Sciences at Texas A&M University.

AirDrain – What drains better than Air?

For Golf- Greens, Bunkers, Tee Boxes and Fairways

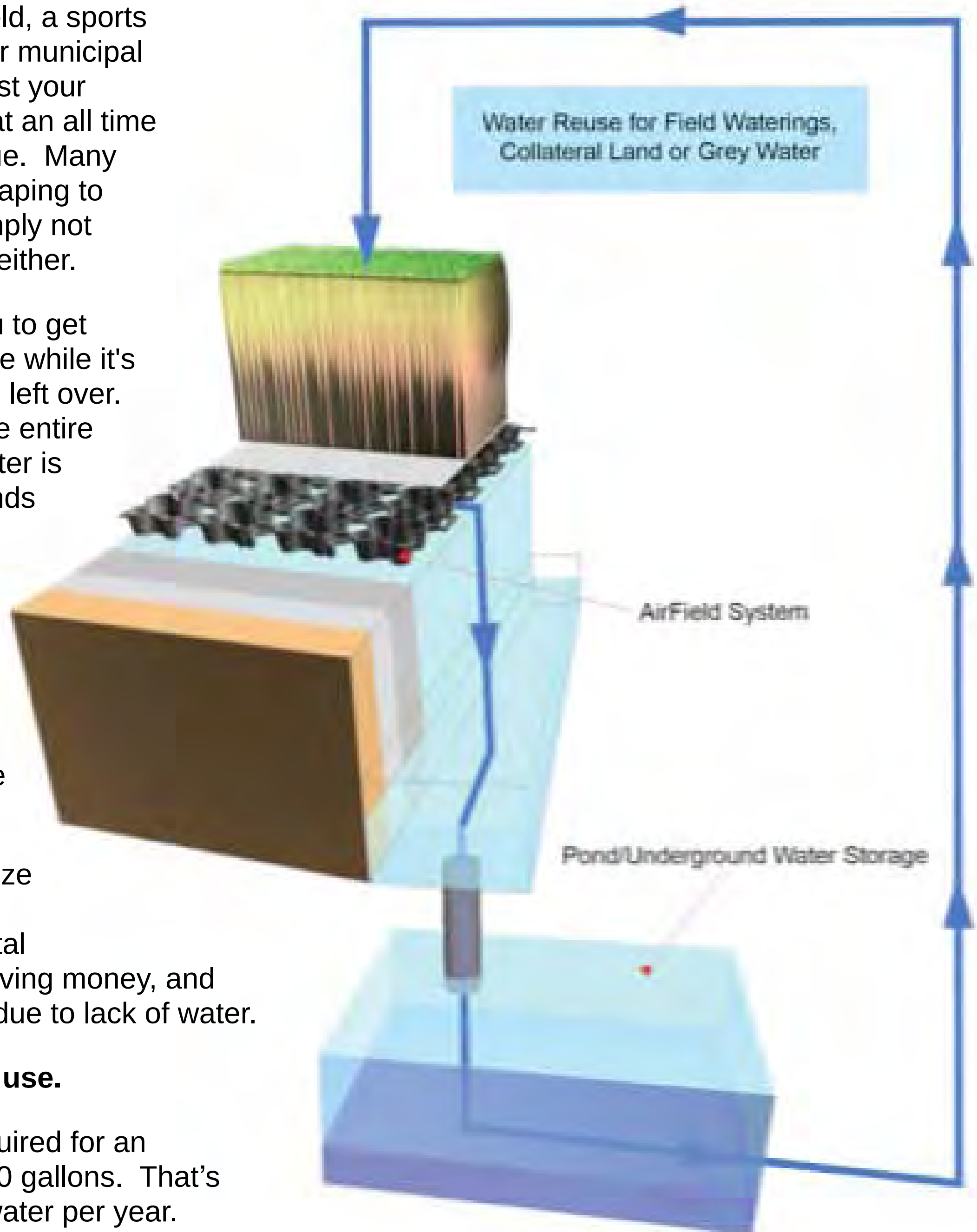
Thru a research project conducted at Texas A&M, it was concluded that you can reduce your irrigation needs using AirField Systems AirDrain. The five year research project was jointly funded by the United States Golf Association and AirField Systems and was a collaborative effort between Texas A&M, AirField Systems and the United States Golf Association. The data from the research showed that the AirField Systems drainage profile provided between one to three more days of plant available water than a **United States Golf Association** recommended gravel and sand profile. Click here for more information about the study titled "A Comparison of Water Drainage and Storage in Putting Greens Built Using Airfield Systems and USGA Methods of Construction".



Benefits of an AirField System Design include:

- 1 to 3 more days of plant available water stored in the root zone (depending on climate)
- Significantly reduces daily irrigation needs (as told to us by our customers)
- Healthier turf / Stronger root system (as told to us by our customers)
- 100% Vertical Drainage under the entire playing surface
- AirDrain is a 100% recycled copolymer with the impact modifier "metallocene" qualifying it as a "No Break" plastic
- Helps eliminate standing water / Simplifies maintenance (as told to us by our customers)
- Minimal site disturbance / Far less excavation and disposal
- Several Installation days are saved over a gravel installation
- Compact shipping that reduces overall storage and transportation costs

Whether it's a single sports field, a sports field complex, a golf course, or municipal landscaping, it's time to harvest your water. Water allocations are at an all time low, and that trend will continue. Many facilities are sacrificing landscaping to keep sports fields alive, or simply not receiving enough water to do either.



An AirField System allows you to get more out of the water you have while it's in use, and then reuse what is left over. WIth a one inch void below the entire surface of a field or green, water is quickly routed to retention ponds or underground harvesting tanks for treatment and later use. Taking rain water and paid-for sprinkler water further by collecting it and reusing it is a great way to recycle, but AirField also allows you to use your water more efficiently.

That means you save and utilize water every way you can, lowering the total environmental impact of your facility while saving money, and avoiding continued problems due to lack of water.

Dramatically cut your water use.

The daily volume of water required for an average golf course is 400,000 gallons. That's over 145,000,000 gallons of water per year. With drastic reductions in water allocation today, what will tomorrow bring? Green building with the AirField System creates up to 4 more days of plant available water compared to a gravel drainage profile, and allows you to reclaim water for later use.

With AirDrain as part of your sustainable site design you will enjoy:

• Healthier turf and stronger roots with a nearly perfect perched water table
• Less frequent irrigation
• Reduced damage and loss of play
• Reduced site disturbance during installation
• Dramatically lower carbon footprint and sustainable site impact

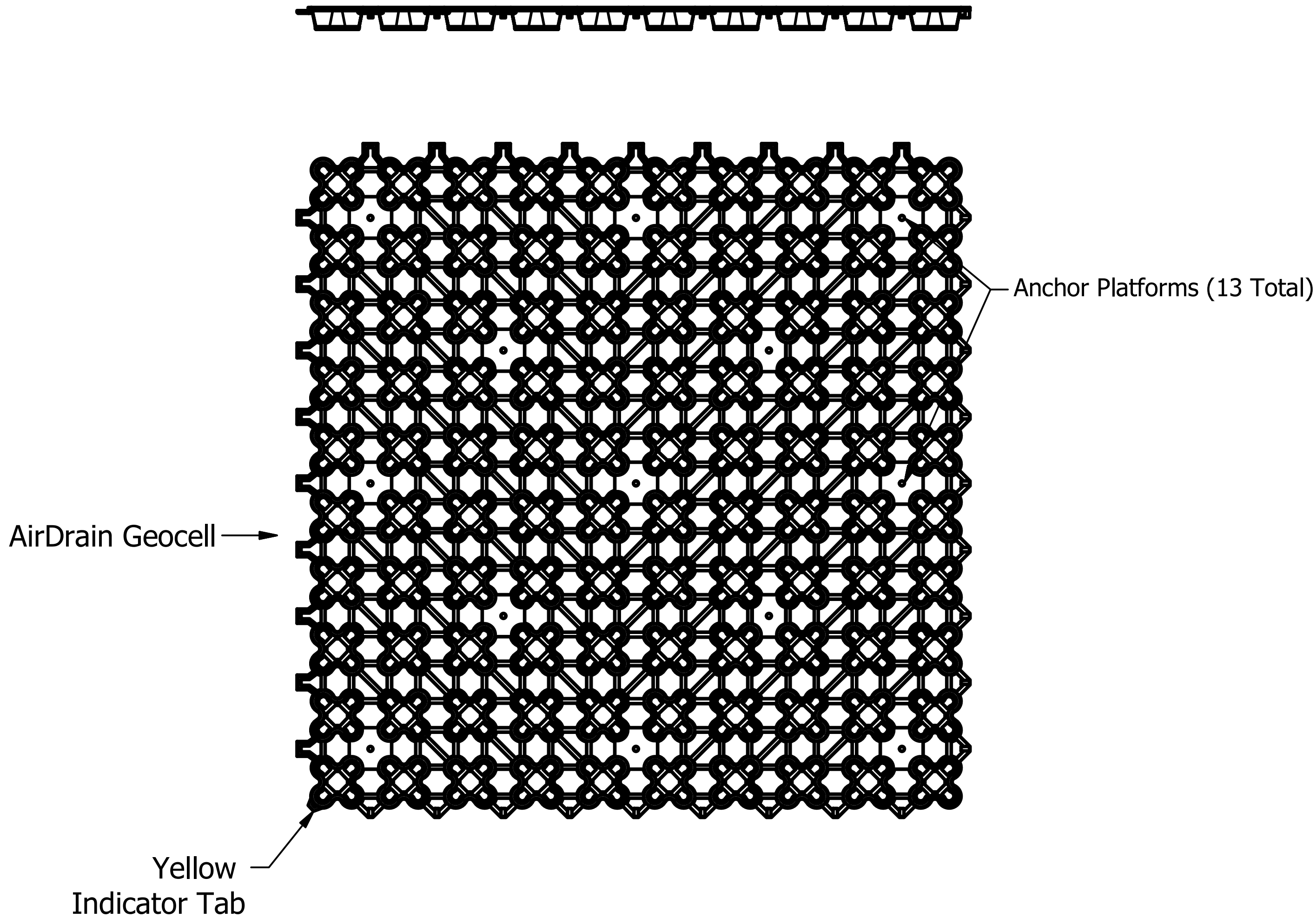
To learn more about sustainable sports field design, contact AirField Systems today.

Corporate Office:
8028 N. May Avenue, Suite 201
Oklahoma City, OK 73120

Phone: (405) 359-3775
Email: info@airfieldsystems.com
Web: www.airfieldsystems.com

Or Contact an authorized AirField distributor:

AIRFIELD PROUDLY SUPPORTS THESE SUSTAINABILITY FRIENDLY ORGANIZATIONS:



Unit Panel Specifications:

Size:	32" x 32" x 1"
Weight:	3.1 lb
Strength:	233 psi (unfilled) 6747 psi (filled)
Resin:	100% Recycled (PIR) Copolymer with Impact Modifier "No Break" Polymer Material
Color:	Black (3% carbon black added for UV Protection)

AirDrain Cross Section

Scale 0.12:1

Typical

For AirDrain Grass Systems

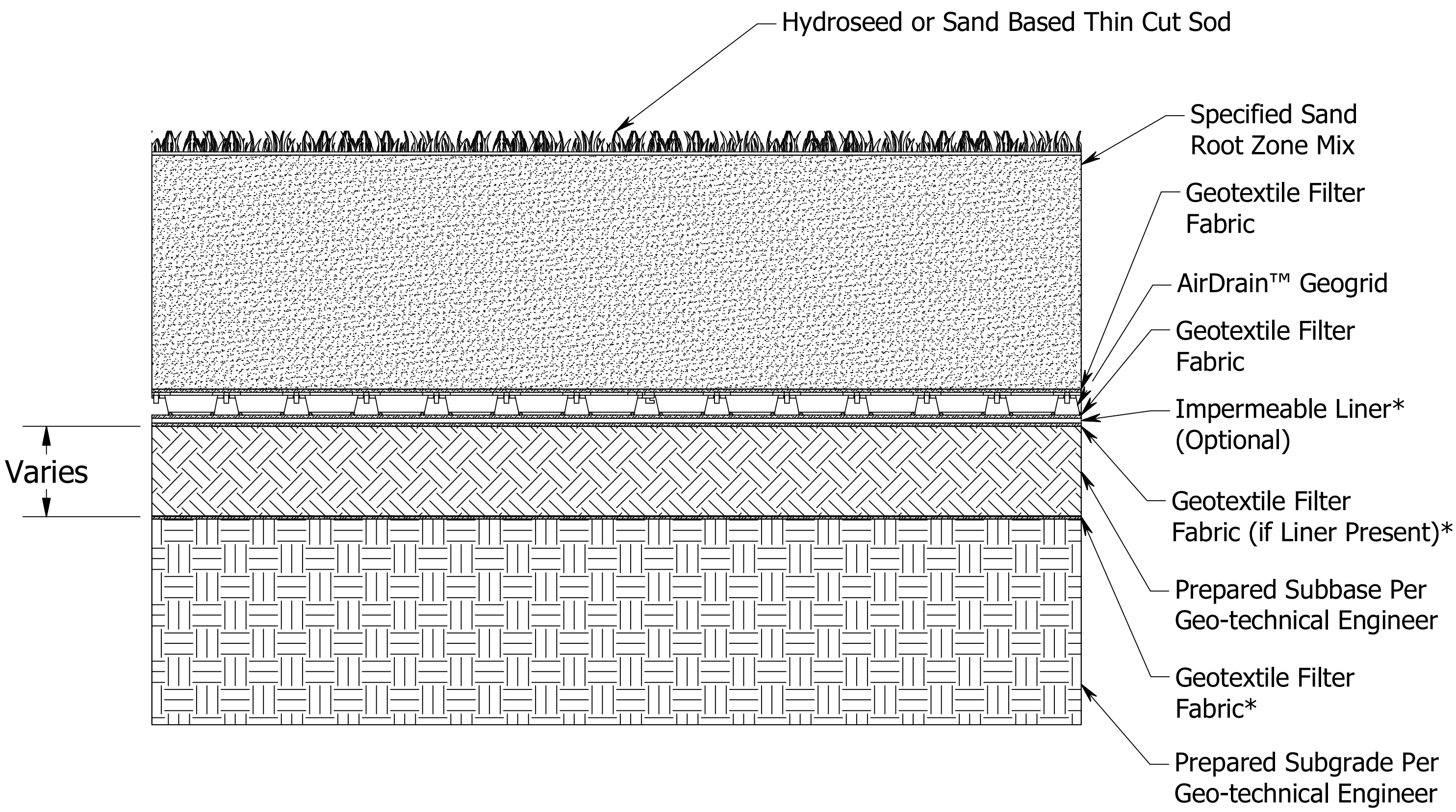
Airfield Systems, LLC
8028 N May Ave, Suite 201
Oklahoma City, OK 73120
(405) 359-3375

www.airfieldsystems.com

Drawing No. ADCS002.dwg

This is a typical drainage profile, your profile may vary.

Check with a Geotechnical Engineer for recommendations for your site conditions and geographical region.



AirDrain™ Natural Turf Typical Detail

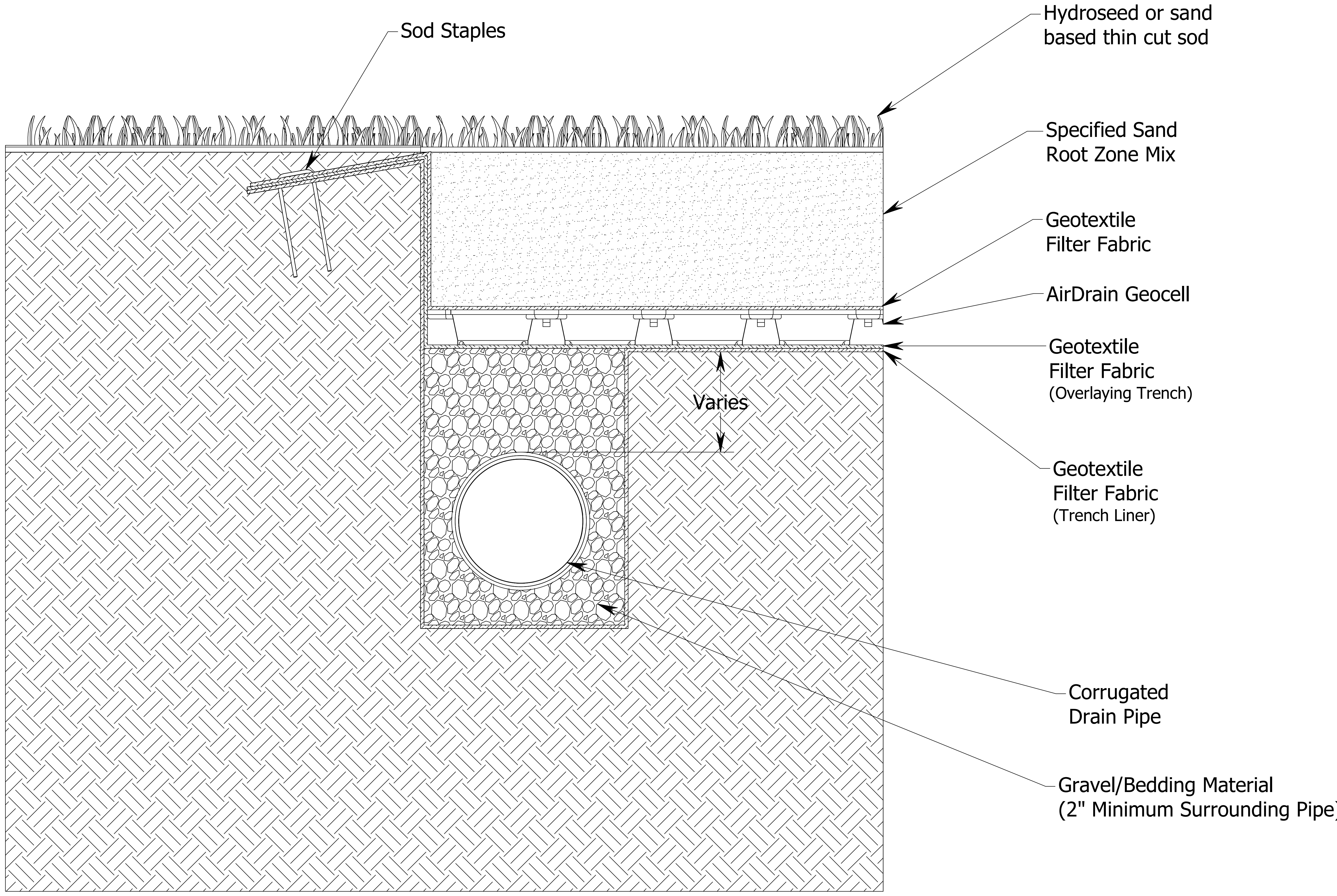
AirDrain™ Impermeable Natural Turf Detail

Airfield Systems
8028 N. May Ave., Suite 201
Oklahoma City, OK 73120
(405) 359-3775

*per geotechnical engineer

www.airfieldsystems.com
Airdrain_Nat_Turf_Typical_Detail_002.idw

airfield systems



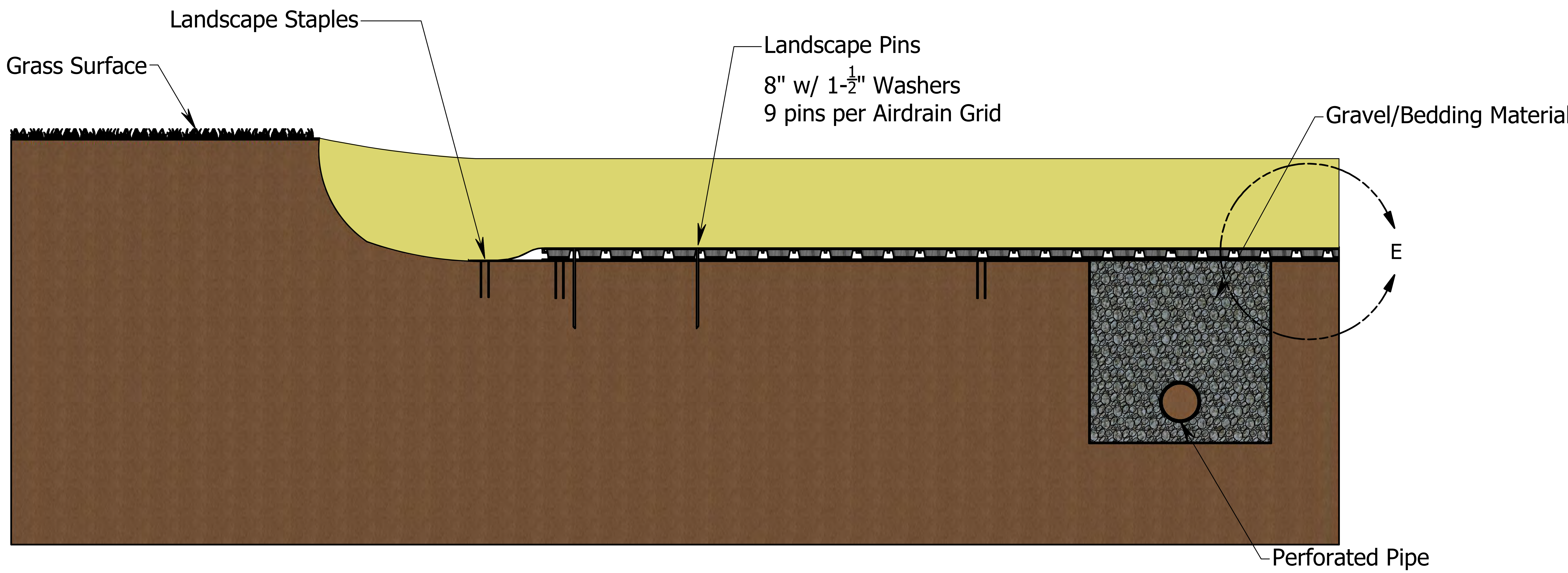
AirDrain™ Natural Edge Typical Detail
Permeable

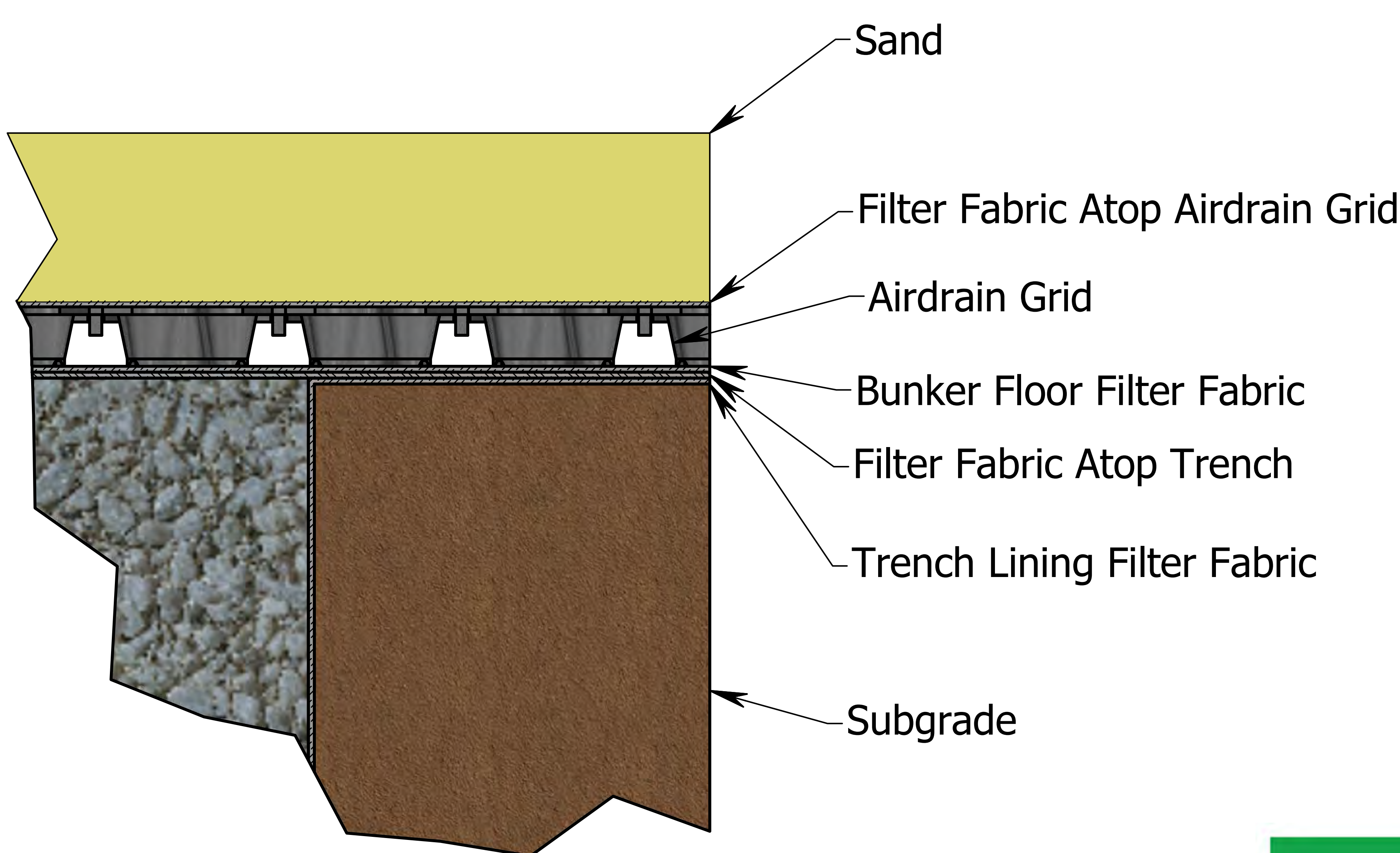
This drawing, specifications and the information contained herein is for general presentation purposes only. All final drawings and layouts should be determined by a licensed engineer(s).

Airfield Systems
8028 N. May Ave., Suite 201
Oklahoma City, OK 73120
(405) 359-3775

airfield systems

DRAWN Gary	8/4/2013	Airfield Systems
CHECKED		TITLE AirDrain™ Natural Edge Typical Detail
QA		
MFG		
APPROVED		
		SIZE C · DWG NO Natural_Edge_PERM_GG_NA001 · REV
		SCALE · SHEET 1 OF 1





This drawing, specifications and the information contained herein is for general presentation purposes only. All final drawings and layouts should be determined by a licensed engineer(s).

airfield systems

DRAWN Gary	12/1/2013	Airfield Systems
CHECKED		TITLE Bunker Airdrain Detail
QA		
MFG		
APPROVED		

SIZE	DWG NO	REV
C	Bunker_Detail2_Color_REV001.ipt	0
SCALE		SHEET 1 OF 1

General Information		
General		
Construction	100% Post-Manufactured Content Injection Molded Copolymer	
Composition	Copolymer Polypropylene Using Impact Modifier and 3% Carbon Black for UV Resistance	
Dimensions	31.784” x 31.880” x 1.000” (7.03 sq ft.)	
Unit Weight	3.100 lbs.	
Forms	Pellets	
Shipping		
Parts Per Pallet	114	
Pallet Dimensions	33” x 33” x 48”	
Pallet Weight	390 lbs.	
Area Per Pallet	798 sq. ft.	
Pallets Per Trailer	114 (3 wide x 2 tall x 19 deep)	
Area Per Trailer	90,972 sq. ft.	

ASTM and ISO Properties [1]		
Physical	**Nominal Value**	**Test Method**
Specific Gravity	0.940	ASTM D792
Melt Mass-Flow Rate (230°C/2.16 kg)	20 g/10 min	ASTM D1238
Mechanical	**Nominal Value**	**Test Method**
Density	57.490 lb/ft^3	ASTM D1505
Tensile Strength (Yield, 73°F)	2,145 psi	ASTM D638
Tensile Elongation (Yield, 73°F)	16%	ASTM D638
Flexural Modulus (73°F)	100,175 psi	ASTM D790
Compression Strength (73°F)	**233 psi**	**ASTM D6254**
Impact	**Nominal Value**	**Test Method**
Notched Izod Impact (73°F, 0.125 in)		ASTM D256
Thermal	**Nominal Value**	**Test Method**
Deflection Temperature Under Load 264 psi, Unannealed	160°F	ASTM D648

Expansion/Contraction Index[1]			
Temperature	**Humidity**	**Length**	**Width**
100°F	98%	31.881”	31.817”
-5°F	0%	31.765”	31.713”
Change		.116”	.104”
Joint Expansion/Contraction Capacity		.420”	.572”
Safety Factor		362%	550%

Examples of Usage		
Application	**Required Strength**	**Safety Factor**
Auto	40 psi	x 168
Truck	110 psi	x 61
DC10	250 psi	x 27
Space Shuttle	340 psi	x 19

[1] Independent laboratory testing conducted by TRI/Environmental, Inc., TSI/Testing Services, Inc. and Wassenaar.

100% Post Manufactured Content

Recycled

The **AirDrain** GeoGrid is made of 100% post-manufactured material, so you can feel good about helping the planet while adding valuable LEED Points to your project. We also add an impact modifier for incredible strength and superior performance in extreme heat and cold - on top of the already durable **AirDrain** design.

AirDrain Co-Polymer with an Impact Modifier Performance and Temperature Durability

Attached you will find the specification of the resin used to produce both the 32 x 32 and the 32 x 18 Geo cells. This material is a co-polymer polypropylene that is 100% recycled resin. In order to be able to produce a consistent recycled resin a PIR (post industrial resin) is used for the base resin. This is the only way to produce a consistent material as opposed to a PCR (post consumer resin) which is dependent on the consumer to supply a consistent material. Using the PIR as a base resin 3% carbon black is added to insure good UV stabilization and metallocene (an ethylene base material) is used as an impact modifier.

Impact Modifier

The impact modifier is added in an amount to achieve a 10.0 Notched Izod Impact which comfortably qualifies this material as a NO BREAK material (4.0 and greater are normally considered no break material). The **AirDrain** resin offers an advantage over many ethylene and HDPE products since the **AirDrain** resin is often superior when it comes to pliability, warping and internal stress related issues. Referring to the attached specification sheet you will notice that all testing is done to specific ASTM Standards.

Resin Blends

AirDrain's blend of resins gives it the ability to perform in extreme temperatures. **AirDrain** does not need a temperature above 50 degrees Fahrenheit to be installed or warmed in the sun to be pliable on site for install. In addition, **AirDrain's** unique resin blend also helps prevent breakage and cracking in extreme temperatures. Giving it the ability to withstand repeated freeze thaw cycles.

Airfield posts its resin content and performance values with ASTM test methods and guide lines to measure the properties of our grid.

Thomas Turf Services, Inc. will Consult on Natural Turf Profiles for AirField Systems AirDrain

Thomas Turf Services

SOIL ANALYSIS AND TURF MANAGEMENT

Mr. Blackwood:

Thank you for your call today and congratulations on your new projects. I would be pleased to work with you and your customers to help select appropriate sands and/or amendments if needed to use with your AirField Systems for natural turf. As you know, we have been pleased with its performance here in Texas and I think we can help others have equally good experiences with it.

Please feel free to have people contact me at the following cell phone, fax, and E-mail address.

Samples may be mailed to me at the address below.

Sincerely,

Jim Thomas

James C. Thomas, Pres.

Thomas Turf Services, Inc.

11183 State Hwy. 30

College Station, TX 77845

Fax: 979-774-1604

Mobile: 979-575-5107

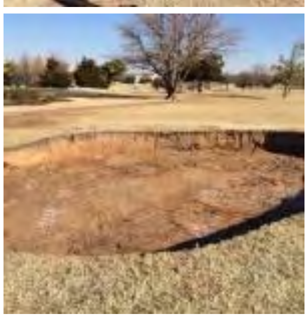
E-mail: soiltest@thomasturf.com

AirDrain Golf Bunker Design

The Greens Country Club in Oklahoma City chose AirField Systems simple Bunker Renovation that was completed with minimal install time and should drain perfectly for many years to come. This golf bunker design can be installed by the existing course grounds crew at your own pace drastically reducing the overall cost of the installs, making it a design that all courses can afford. By raising the sand profile an inch across the entire floor bringing gravity into play in draining the bunker. Effectively making the entire floor of the bunker a drain. The filter fabric and grid is only on the floor of the bunker.

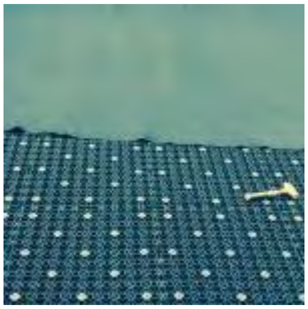
To answer the debate of clogging geotextiles/filter fabrics see the Final Report form the 5 year Study at www.usga.org. Although with the AirDrain Bunker System the entire floor of the bunker is a drain, so even if a few feet of the bunker did clog over a 15 year span you would have the remaining portion to allow for optimal drainage by being able to go vertically through the profile.


Sand removed and base prepared for AirDrain install


Bunker prepared for AirDrain Bunker System


AirDrain 32″x32″ pallets are easily transported to the bunker

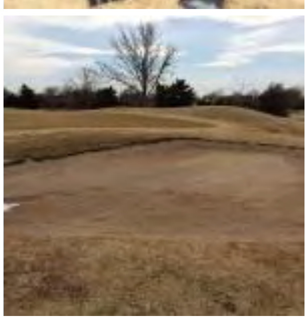

Small installation crew needed with minimum impact to the course


Installed with a layer of filter fabric above and below the AirDrain


Installing the filter fabric lengthwise to minimize the seams


Trimming the filter fabric to fit the bunker walls


Pinning the bottom and top filter fabric together to enclose the AirDrain


Completed AirDrain Bunker

AirDrain Golf Bunker Design and Construction at The Greens Country Club in Oklahoma City.

Update 5/8/14

Superintendent text: Rained 1.5″ last night bunkers drained excellent and didn’t washout!

[Bellerive Country Club](#) host to the 100th PGA Championship, in August of 2018 installed this 7,600 sqft. practice golf green on their Championship Course. They were very pleased with the [AirDrain System for Golf Courses](#) and how quickly and easily it was installed.

After reviewing the findings of the "[Comparison of Putting Greens Constructed with AirField Systems and USGA Design](#)" (the five year research project was jointly funded by the United States Golf Association and AirField Systems and was a collaborative effort between Texas A&M, AirField Systems and the United States Golf Association) they decided to utilize the AirDrain System for Golf Greens for this project. Click here to see [An Alternative to the Gravel in USGA Putting Greens](#).

Major Championships held at Bellerive Country Club

- 1949 Western Amateur Championship - Champion: Frank Stranahan
- 1953 Western Open - Champion: Dutch Harrison
- 1965 U.S. Open - Champion: Gary Player
- 1981 U.S. Mid Amateur - Champion: Jim Holtgrieve
- 1992 PGA Championship - Champion: Nick Price
- 2001 World Golf Championships, American Express Championship - Not Contested
- 2004 U.S. Senior Open - Champion: Peter Jacobsen
- 2008 BMW Championship – Champion: Camilo Villegas
- 2013 Senior PGA Championship

Photos Courtesy of: John Cunningham CGCS - Golf Course Superintendent and Jared Brewster -2nd Assistant Superintendent at **Bellerive Country Club**.