



**PAVE  
DRAIN**  
STORMWATER'S ARCH ENEMY

Highest infiltration rate and lowest  
maintenance of any permeable surface...

**What does your pavement do for you?**  
[www.pavedrain.com](http://www.pavedrain.com)



ACF West is the local distributor of PaveDrain  
With Locations at:

15540 Woodinville-Redmond Rd  
Bldg A #400, Woodinville, WA 98072  
(425)415-6115

2505 Frank Albert Rd  
Bldg B #111, Fife, WA 98424  
(253)922-6641

8951 SE 76<sup>th</sup> Dr, Portland, OR 97206  
(503)771-5115



[www.acfwest.com](http://www.acfwest.com)

ACF West Inc. was established in 1986 as a full line stocking distributor of geosynthetic products. We continue to represent manufacturers committed to providing quality materials for the varied demands of the Northwest. ACF welcomes inquiries regarding the selection of correct materials for your project site.

**Geotextiles**

- Woven
- Non Woven
- Polypropylene
- Polyester
- High Strength



**Geogrids**

- Polyester
- Uniaxial
- Biaxial
- Retaining Walls & Slopes
- Base Reinforcement



**Cellular Confinement**

- Base Stabilization
- Earth Retention
- Channel Protection
- Vertical Walls



**Drainage Solutions**

- Sheet Drain, Strip Drain
- Stormwater Detention / Retention / Modules
- Small Footprint
- 95% Efficient
- Adaptable, High Strength



**Asphalt Interlayer**

- Paving Fabrics
- Waterproofing Membranes
- Reinforcement Grid
- Repair Systems
- Engineered Paving Mats



**Barricades Gabion Systems Plastic Sheetting Sediment Bags Grass Pavers**

**Coir Erosion Control**

100% Biodegradable Coir  
 Available in 400,700, and 900 grams / square meter  
 Service life 3-5 years  
 Coir Logs



**Erosion Blankets**

Straw, Coconut, Excelsior, Jute  
 Synthetic & Natural Netting  
 Turf Reinforcement Mats (TRM)  
 Channel Lining



**Hydro Mulch**

Hydraulic Mulch  
 Stabilized Mulch Matrix  
 Bonded Fiber Matrix  
 Flexible Growth Medium  
 Agronomic Solutions



**Sediment Control**

Sediment Fences  
 Straw Wattles  
 Drain Guards  
 GeoRidge Ditch Berm  
 Triangular Silt Dike



**Wheel Wash Systems**

Automated Wheel Wash and Disinfecting Systems  
 Portable & Permanent  
 One, Two & Three Wheel  
 Revolution Systems



**Geomembranes**

ACF West Reinforced HDPE  
 Geosynthetic Clay Liners  
 LLDPE  
 EPDM



**Portland**

8951 SE 76<sup>th</sup> Drive  
 Portland, OR 97206  
 503-771-5115  
 503-771-1161 Fax  
 800-878-5115

**Medford**

3040 Nettie Way  
 Medford, OR 97504  
 541-608-1648  
 541-608-6333 Fax  
 541-261-3167 Cell

**Salt Lake City**

2120 N. Redwood Road  
 Salt Lake City, UT 84116  
 801-521-5141  
 801-521-5144 Fax  
 800-804-1393

**Seattle (North)**

15540 Woodinville-Redmond Road  
 Woodinville, WA 98072  
 425-415-6115  
 425-415-6126 Fax  
 800-423-4567

**Seattle (South)**

2505 Frank Albert Road  
 Fife, WA 98464  
 253-922-6641  
 253-922-6642 Fax  
 800-991-6641

# Low Impact Development

- Is a term used to describe a land planning and engineering design approach to managing stormwater runoff

Overview of PaveDrain

Physical Properties

Testing

Local Projects:

# What is PaveDrain?



## What its NOT?

- ❑ It's NOT a paver
  - It has some of the same characteristics of a paver...



## Permeable Interlocking Concrete Pavements

Selection • Design • Construction • Maintenance

*David R. Smith*

Third Edition



# What is PaveDrain?



❑ It's a *PERMEABLE* Articulating Concrete Block/Mat (P-ACB/M)

❑ It follows the ACB ASTM  
▪ ASTM D 6684 - 04



Designation: D 6684 – 04

## Standard Specification for Materials and Manufacture of Articulating Concrete Block (ACB) Revetment Systems<sup>1</sup>

This standard is under the jurisdiction of ASTM Committee D11.3, Relatively Permanent Building, Its Associated Utilities, the Code of Standard Practices, in the area of Revetment and Joint Systems. A number in parentheses indicates the year of last revision; a number in square brackets indicates the year of last approval; a number in curly braces indicates an editorial change since the last revision or approval.

### 1. Scope

1.1 The purpose of this Standard is to provide specifications for articulating concrete block (ACB) revetment system structural components, material composition and physical properties, manufacturing methods and testing requirements.

1.2 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory requirements prior to use.

### 2. Referenced Documents

- 2.1 *ASTM Standards*<sup>2</sup>
- C 33 Specification for Concrete Aggregates
- C 39 Test Method for Compressive Strength of Cylindrical Concrete Specimens
- C 42 Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
- C 67 Test Methods for Sampling and Testing Brick and Structural Clay Tile
- C 140 Test Methods of Sampling and Testing Concrete Masonry Units and Related Units
- C 150 Specification for Portland Cement
- C 207 Specification for Hydrated Lime for Masonry Purposes
- C 331 Specification for Lightweight Aggregates for Concrete Masonry Units
- C 595 Specification for Blended Hydraulic Cements
- C 618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolans for use as a Mineral Admixture in Concrete
- C 666 Test Method for Resistance of Concrete to Rapid Freezing and Thawing

C 1262 Test Method for Evaluating the Freeze-Thaw Durability of Manufactured Concrete Masonry Units and Related Concrete Units

D 4533 Test Method for Trapezoid Tearing Strength of Geotextiles

D 4632 Test Method for Grab Breaking Load and Elongation of Geotextiles

D 4833 Test Method for Index Puncture Resistance of Geotextiles, Geotextiles, and Related Products

### 2.2 Other Documents:

American Association of State Highway Transportation Officials (AASHTO), 1995, "Standard Specification for Geotextiles," AASHTO Designation M 288, February.

Koerner, R.M., 1998, "Designing With Geotextiles," 4th Edition, Prentice-Hall Publishers, Englewood Cliffs, N.J. p. 761.

### 3. Terminology

#### 3.1 Definitions:

3.1.1 articulating concrete block (ACB) revetment system, *n*—a matrix of interpenetrated concrete block units sufficient for erosion protection. Units are connected by geometric interlock and/or cables, geotextiles, or geogrids, and typically include a geotextile underlay for added retention.

#### 4. Significance and Use

4.1 An articulating concrete block system is comprised of a matrix of individual concrete blocks placed together to form an erosion-resistant revetment with specific hydraulic performance characteristics. The system includes a filter layer compatible with the subsoil which allows infiltration and filtration to occur while providing particle retention. The filter layer may be composed of a geotextile, properly graded granular media, or both. The blocks within the matrix shall be dense and durable, and the matrix shall be feasible and porous.

4.2 Articulating concrete block systems are used to provide erosion protection to underlying soil materials from the forces of flowing water. The term "articulating," as used in this Standard, implies the ability of individual blocks of the system

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee D11.3 on Soil and Rock and is the direct responsibility of Subcommittee D11.35 on Geosynthetic and Surface Control Technology.

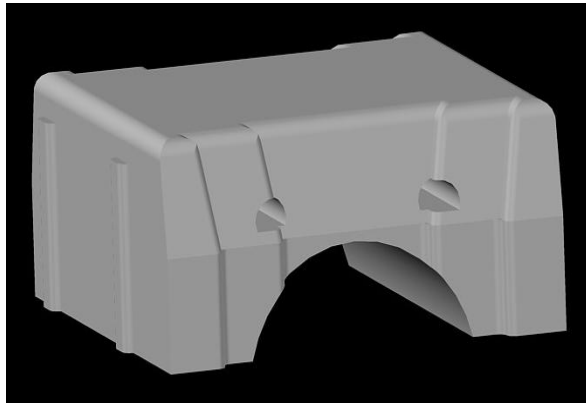
Current edition approved May 1, 2004. Published June 2004. Originally approved in 2001. Last previous edition approved in 2001 as D 6684-01.

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [astm.org/customer-service](http://astm.org/customer-service). For annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.

# Sustainable Stormwater Solution Solve Multiple Problems...With One Product

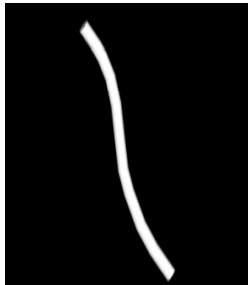


*THE PAVEDRAIN® SYSTEM SERVES THREE PURPOSES:  
It Paves, It Drains AND It Stores!*

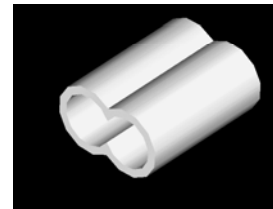


## Individual Block

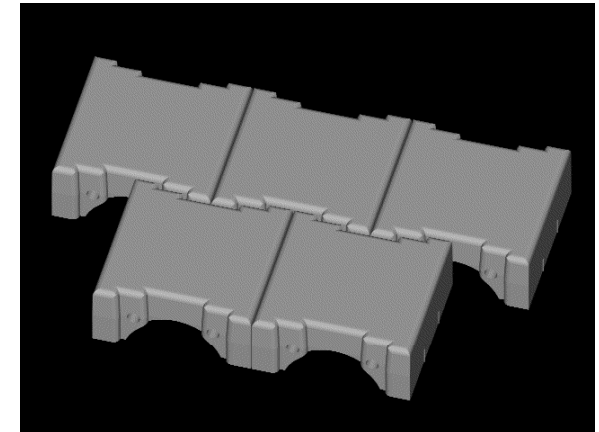
- ❑ 12" x 12" x 5.65"
- ❑ 45 – 48 Lbs. Ea.



## Polyester Cable



## Aluminum Crimps



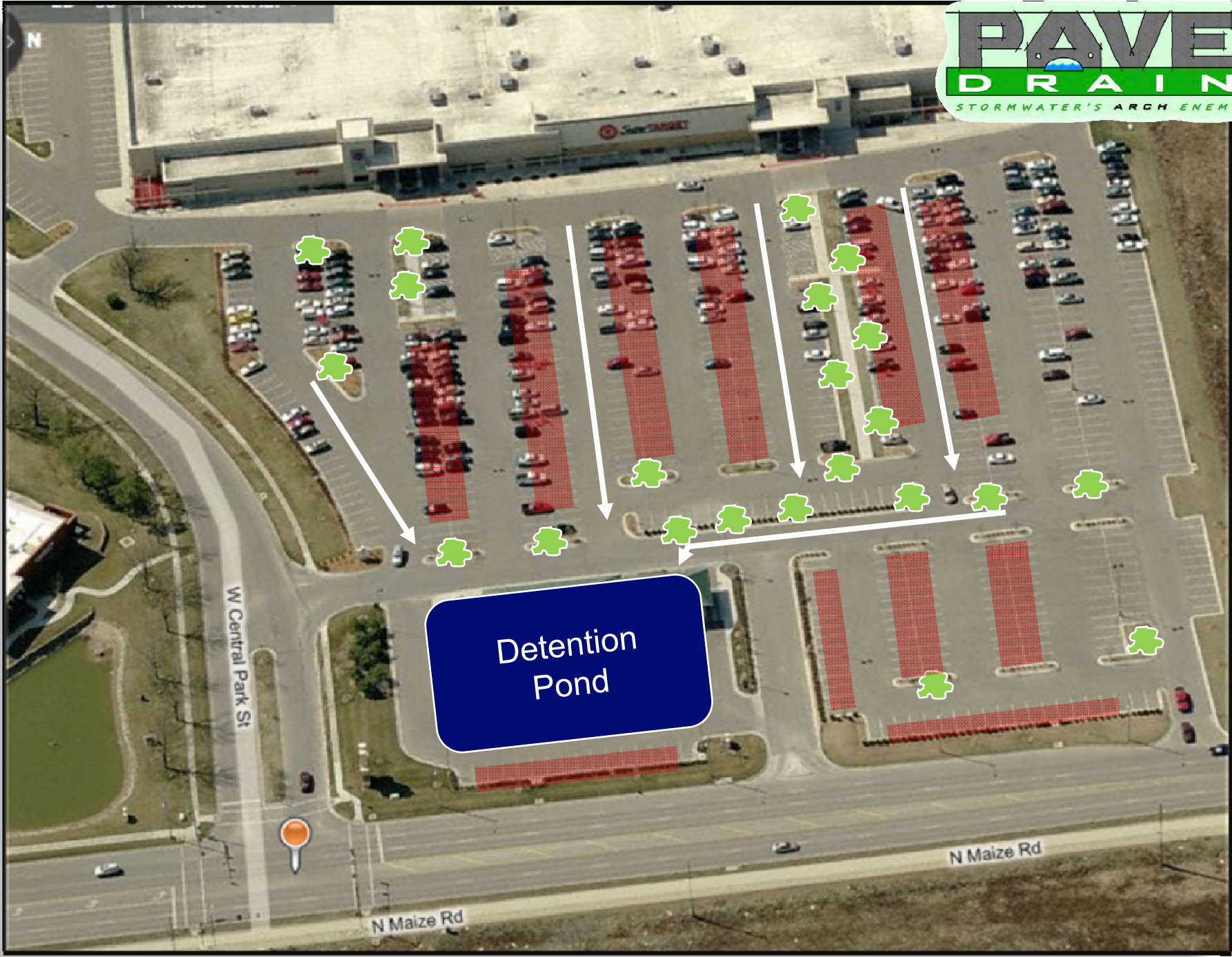
## Assembled Mattress

- ❑ 7' x 17.5' (Typical)
- ❑ 7' x 36' (Largest)

U.S. Patent Nos:  
8,251,607B, 8,366,343  
D609,369S

Other Patents Pending

# It's a new and improved paving system



Detention Pond

W Central Park St

N Maize Rd

N Maize Rd

03/20/06 2:00/1/D



Bladensburg, Maryland Parking Lot AFTER...



# The PaveDrain Difference



- ❑ NO Maintenance after 4+ YEARS!!!
- ❑ 78,000 lb. two axel fire truck
- ❑ 550 gallons in 75 seconds





## **Paving the Way in American Manufacturing**

By Nancy Stoner

Posted on February 23<sup>rd</sup>, 2012

*About the author: Nancy Stoner is the Acting Assistant Administrator for the EPA's Office of Water*



On a cold February day, I stood in a driveway in an industrial complex in Bladensburg, MD, just outside the nation's capital. Water from a 500-gallon container was gushing onto the ground in front of me. But rather than forming large puddles and flowing across the parking lot, the water was simply disappearing – not into thin air, but into a special system of permeable pavers called PaveDrain.

Instead of letting rain flow off hard surfaces and carry pollution into local waterways and stormdrains, this innovative product captures it and allows it to slowly filter into the ground. Ernest Maier, a Bladensburg, MD company, manufactures the PaveDrain system and had hosted me for a demo. They are exactly the type of company that President Obama spoke about in his State of the Union address when he laid out a blueprint for an economy that is built to last – one built on American manufacturing, American energy and the skills of American workers.

# Loading Capacity & Massive Infiltration Rates



November 21, 2011

PVDR 1101.00

Mr. Doug Buch  
PaveDrain, LCC  
4880 W. Abbott Avenue  
Greenfield, WI 53220

RE: PAVEDRAIN CONCRETE BLOCK  
STRUCTURAL ANALYSIS FOR AASHTO TRUCK LOADING

Dear Mr. Buch:

We have completed our structural analysis of the PaveDrain concrete blocks and find them capable of supporting AASHTO HS-20 and H-20 truck loading.

We analyzed the blocks as unreinforced concrete arches supporting a uniform truck tire load with impact per AASHTO standards. The arches were reviewed considering both a fixed end condition and a pinned end condition. We used the ASTM D 6684-04 specified minimum compressive strength of 4000 psi for the concrete. The actual tested strength of the PaveDrain units averages 8900 psi which is more than double the strength used in our structural calculations.

As with all vehicular traffic paving systems, the subgrade soil and base preparation for the PaveDrain blocks must be properly prepared and is critical to the performance of the system.

Sincerely,

PENNONI ASSOCIATES INC.

Germaine E. Lenz, PE, SECB  
Structural Project Engineer

GEL/gel

Attachment: Calculations (4 pages)

cc: Khaled Hassan, Pennoni  
Charlie Snyder, Pennoni

L:\Projects\PVDR\PVDR1101-Pave Drain H-20 Review\PaveDrain letter 2011-11-21.docx



March 23, 2012

Ernest Maier Inc.  
4700 Annapolis Road  
Bladensburg, Maryland 20710

Attn: Mr. Dan Bishop

Re: Infiltration Testing of PaveDrain

Gentlemen:

In response to your request, CNA has determined the field water infiltration rated of PaveDrain material in accordance with ASTM C1701/C1701M-09. The testing was performed March 9, 2012, at the Ernest Maier Block Company Store located at 4700 Annapolis Road in Bladensburg, Maryland.

Infiltration testing was performed on the PaveDrain material both prior to installation as well as material which had been in place for several months. The material tested prior to installation was fabricated as a "mock up", and the installed material had been in place since May 20, 2011. Test results are attached to this letter. It should be noted that variances between the test results were caused by turbulence of the water used in the test as well as potential variances in pouring rates due to human error. It is our opinion that these discrepancies likely produce a reported infiltration rate which is less than the true rate of the PaveDrain material.

Based on the test results, it is our opinion that the infiltration rate of PaveDrain material is a minimum of 4,000 inches per hour. CNA is available to discuss our results at your convenience. If you have any questions, please contact our office.

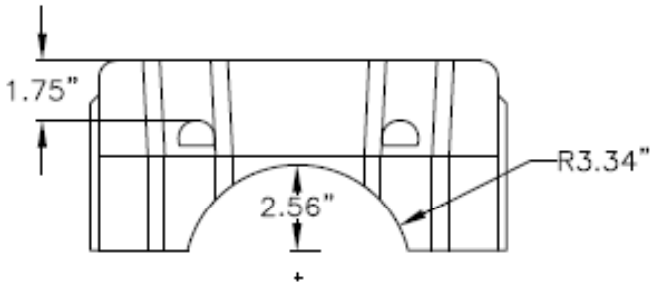
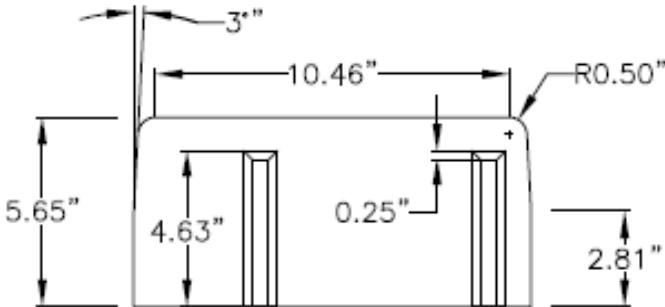
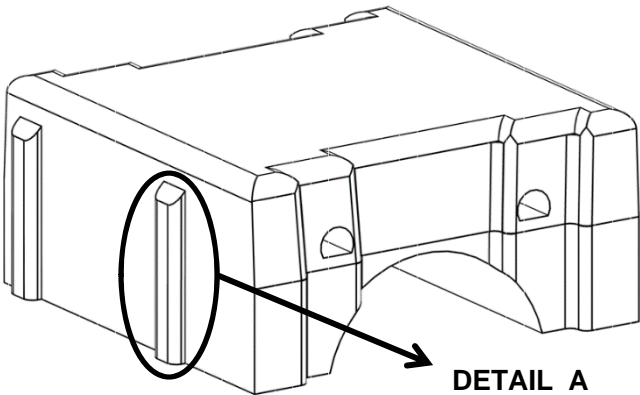


Sincerely,  
CNA, Inc.

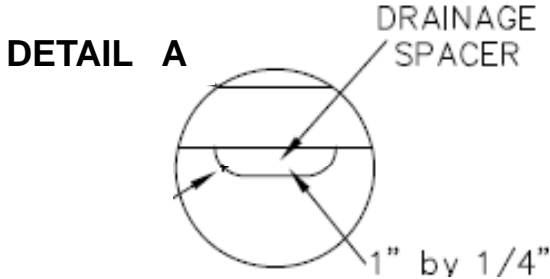
Stephen K. Nolan, P.E.  
President

**4,000 Inches  
per hour.  
(Under Slight  
Head).**

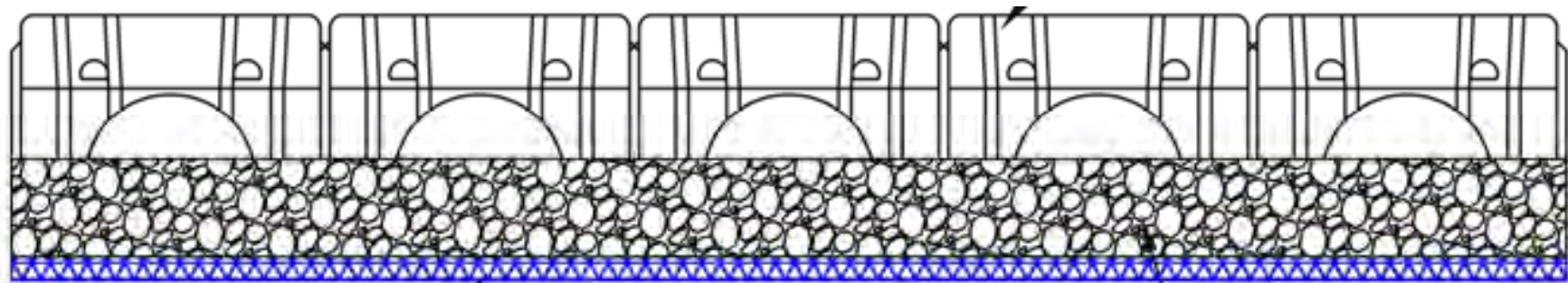
# PaveDrain DIMENSIONS



END VIEW



# Typical PaveDrain Cross-Section



APPROVED GEOGRID  
OR GEOTEXTILE

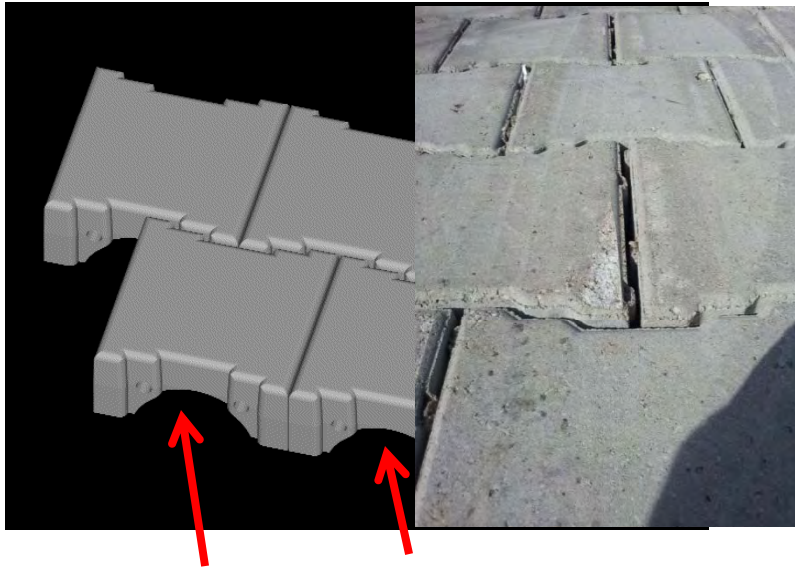
CROSS-SECTION  
END VIEW

6-12" OF BEDDING STONE  
(Thickness to be determined by  
engineer). Stone to be 3/4" -1"  
clean or recycled stone or  
concrete.

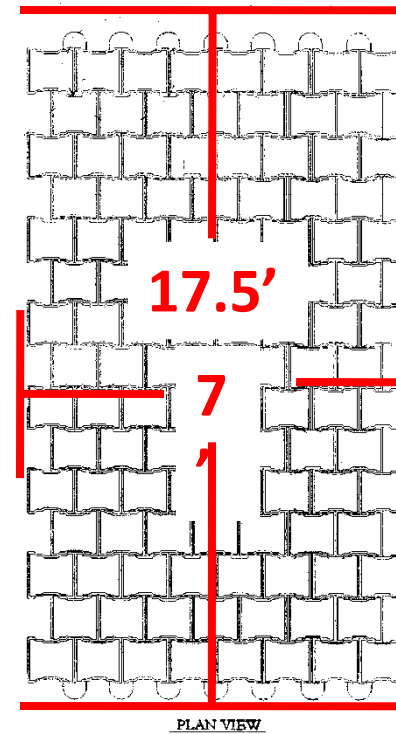


Mat sizes will vary.

All corners are rounded so that no "edge" is created to catch on a snow plow.

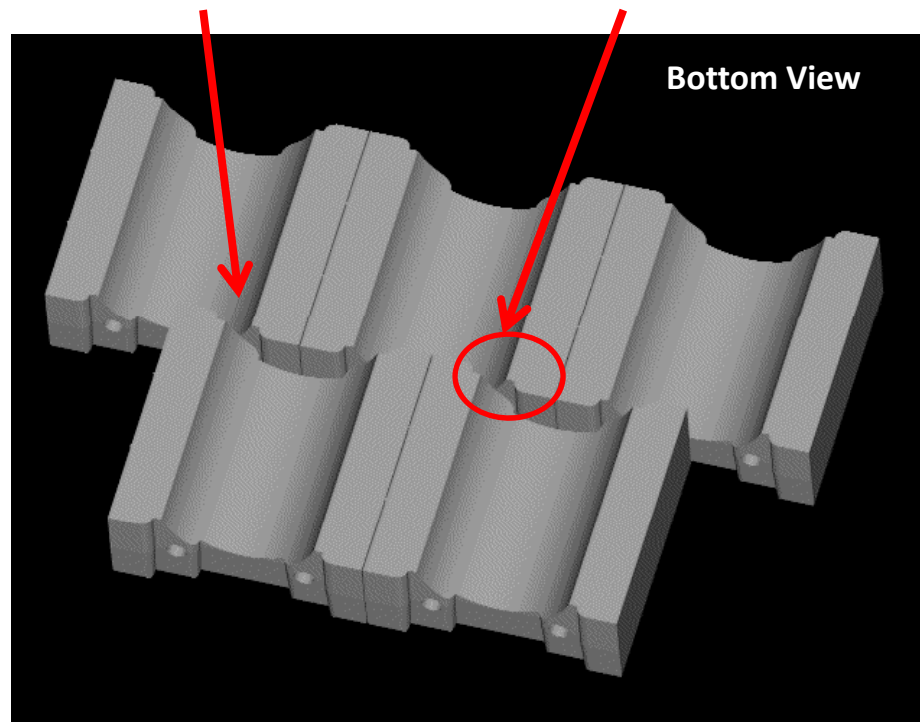


Prefabricated cable ducts will allow large mats to be assembled and lifted into place with equipment.





Continuous flow is allowed among ALL blocks for added capacity.  
This will also allow for lateral water movement for grade changes.







Conventional construction equipment can be utilized for installation



6 - 7 laborers is typical to start.  
Usually ends up at 4-5.

Spreader Bar will be rented to contractors

## TESTING – Rain Simulator



Less than 15 minutes  
following simulated  
rainfall...dry block

8" per hour rain simulation  
test



# Infiltration Rates



March 23, 2012

Ernest Maier Inc.  
4700 Annapolis Road  
Bladensburg, Maryland 20710

Attn: Mr. Dan Bishop

Re: Infiltration Testing of PaveDrain

Gentlemen:

In response to your request, CNA has determined the field water infiltration rate of the PaveDrain material in accordance with ASTM C1701/C1701M-09. The testing was performed at the Ernest Maier Block Company Store located at 4700 Annapolis Road in Bladensburg, Maryland.

Infiltration testing was performed on the PaveDrain material both before and after installation. The material tested prior to installation was fabricated as a "mock up", and the installed material had been in place since May 20, 2011. Test results are attached to this letter. It should be noted that variances between the test results were caused by turbulence of the water used in the test as well as potential variances in pouring rates due to human error. It is our opinion that these discrepancies likely produce a reported infiltration rate which is less than the true rate of the PaveDrain material.



Based on the test results, it is our opinion that the infiltration rate of PaveDrain material is a minimum of 4,000 inches per hour. CNA is available to discuss our results at your convenience. If you have any questions, please contact our office.

**4,000 Inches per hour!!**



Sincerely,  
CNA, Inc.

Stephen K. Nolan, P.E.  
President

# The PaveDrain Advantages



- ❑ Storage ABOVE the Base AND Below
- ❑ Massive Infiltration
- ❑ Lateral Permeability
- ❑ Stable Surface
- ❑ Installation Friendly
- ❑ Integrates with system design for stormwater management:
  - Peak discharge control
  - Water quality control
  - Runoff volume reduction
- ❑ **Maintenance – DOCUMENTED, LOW COST RESULTS**





Center for  
Infrastructure  
Research



**ASSESSMENT OF  
INFILTRATION PERFORMANCE  
AND MAINTENANCE OF  
PAVEDRAIN PAVEMENTS  
FOR TWO APPLICATIONS IN LOUISVILLE, KY**

Hamidreza Kazemi, PhD Candidate  
Thomas Rockaway, Ph.D., P.E.  
Josh Rivard, MUP  
Center for Infrastructure Research  
Civil and Environmental Engineering Department  
University of Louisville

❖ **Monitoring Project**

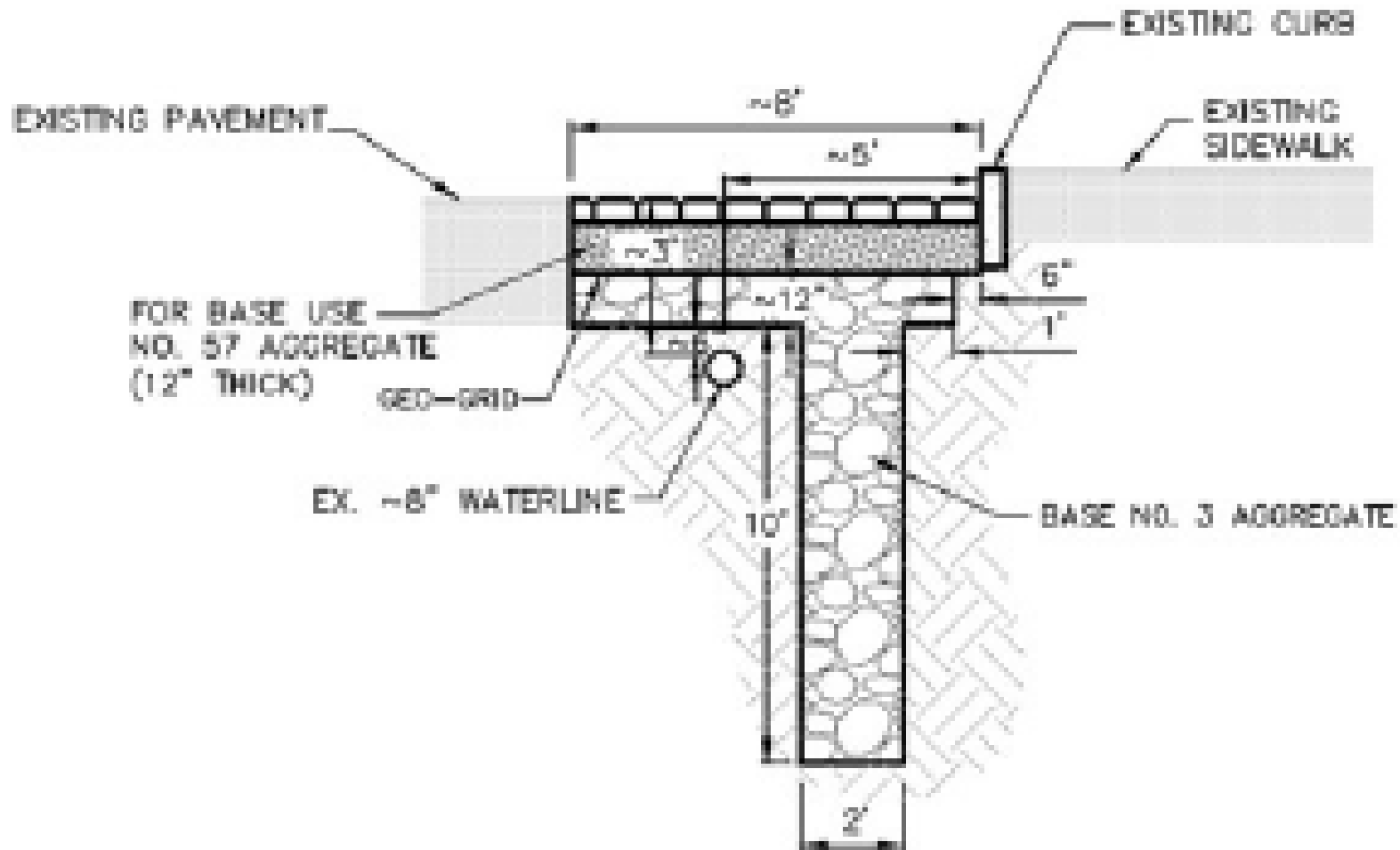
- Multi-year effort to evaluate and establish long-term trends
- Standardize design and maintenance criteria
- Partnership
- USEPA Monitoring of Infrastructure



Green



## ❖ Project Description – Controls 19G & 19H



19G STANDARD CROSS-SECTION



Center for  
Infrastructure  
Research



## ❖ Clogging & Maintenance

- ❑ Electronic Measurements AND...
- ❑ Visual Inspections
  - Clogging advanced from the up-gradient edge towards the down-gradient edge and along the curb
- ❑ Once clogging reached the down-gradient edge the ratio volume decreased to <math><1:1</math>...TIME FOR MAINTENANCE





Center for  
Infrastructure  
Research



## ❖ Project Description – Control 19H & 19G

Characteristic	Control 19H	Control 19G
Drainage Area (acre)	0.27	0.72
Impervious %	59%	61%
Impervious Area: Control's Area	<u>16:1</u>	<u>20:1</u>
Control's Length (ft)	55	120
Control's Width (ft)	8	8



**TREMENDOUS AMOUNT OF DEBRIS  
WORST CASE SCENARIO**



# The PaveDrain Difference – Maintenance



## PaveDrain VAC Head



- 30" diameter
- Weight is under 50 lbs.
- Handle for ease of moving
- Adjustable polyethylene caster wheels

- Continuous suction up to 3,400 CFM, only 1,500 CFM is used.
- Spinning water nozzles displace 1,000 psi. Can be adjusted up to 2,500 psi





Center for  
Infrastructure  
Research



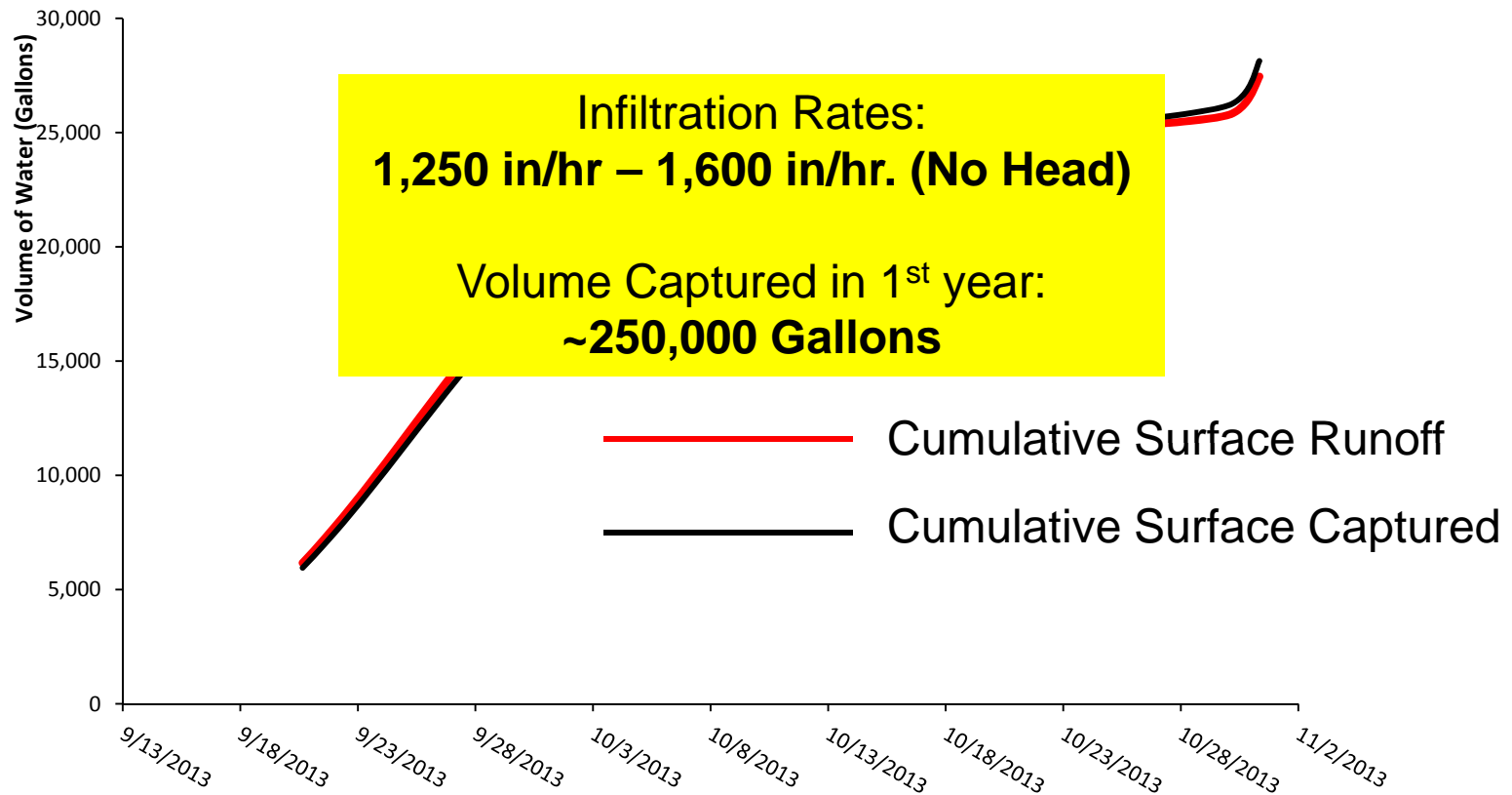
## ❖ Maintenance Effectiveness

- PaveDrain Vac Head



## ❖ Maintenance Effectiveness: Conclusions

- ❑ Results indicate that unclogged and properly maintained PaveDrain® blocks, were able to capture ALL stormwater runoff flowing into controls 19G & 19H



## ❖ Maintenance Effectiveness: Conclusions

- Performance can be restored
- Type of maintenance is important



**If all else fails...**

# Maintenance Advantage



No other system can be mechanically lifted out allowing for the aggregate base to be cleaned and then re-installed!!!!





# MANUFACTURING - COLORS



### **About Color**

- The color illustrations on this page are as accurate as photography and printing processes allow. Final selection of colors should be made from several physical samples.
- Shade variations are inherent in colored concrete products using natural materials. Delivered product can vary slightly from physical samples. When installing colored concrete products, units should be selected randomly from several packages simultaneously.
- PaveDrain® is produced with a process utilizing the highest quality color pigments and raw materials available. This process ensures that each PaveDrain® unit is thoroughly saturated with formulated aggregates and color pigment throughout the full thickness of the unit, not just a surface coating.
- All products are produced in accordance with industry accepted standards and applicable specification requirements.

### **About Efflorescence**

Efflorescence is a whitish, powder like deposit that may sometimes appear on the surface of the paving stones. It may appear immediately or within a short time after installation.

Left alone, normal wear and exposure to the elements will dissipate the efflorescence.

Efflorescence is a normal occurrence in all cement based products, as well as many color paving products. Because it is a natural reaction to the proper hydration of concrete, we accept no responsibility or liability for replacement.

If there is a need to remove the efflorescence before it naturally wears away, best results are obtained by using a proprietary efflorescence remover which is available from most mason supply dealers. Do not use muriatic acid.

If a sealer is to be applied to the paving stones, it is recommended that any presence of efflorescence be removed prior to sealer being applied.

\*Color availability subject to change without notice\*

# The PaveDrain Infiltration Calculator



Project Name: City of Milwaukee  
 Address:   
 State: WI  
 Project Size: 30,000 SF

Do you want to use the arch and gap spacing in PaveDrain for storage?  Yes, 0 = No  No

Water Storage Factors	
Void space of #57 Clean Stone <sup>1</sup>	35.00%
Void space of #2 Clean Stone <sup>1</sup>	40.00%
Depth of #57 Clean Stone (Inches)	6.00
Depth of #2 Clean Stone (Inches)	12.00
Rainwater per Year In State (Inches) <sup>2</sup>	32.60
Gallons per Square Foot Factor ("GF")	0.62001
Gallons per Square Foot based on Above	20.21
Storage Space per Pavedrain Block <sup>3</sup>	0.095

Storage Calculation	
Storage (CF) [Clean Stone + Pavedrain]	20,373.40
Gallons per Cubic Foot	7.48
Total Storage in Gallons [Clean Stone + Pavedrain]	152,393.04
Total Storage: Infiltration (Rate x SF x GF)	9,300.15
Total Storage in Gallons	161,693.19
Maximum Rain Event Storage [Storage + Infiltration]	8.69

Rain Event Calculation & Annual Stormwater Infiltration		
State Capital Largest Daily Rainfall - 2011 <sup>4</sup>	Madison 1.09	Inches
Infiltration Rate per Hour Based on Soil		0.50
Target Rainfall Event (Inches/Hour)		6.00
Indicated Gallons of Water on Pavedrain		111,601.80
Excess (Deficit) of Water Storage (Gallons)		50,091.39
Hours to Infiltrate Event in Soil (Rain Event)		12.00
Annual Gallons Infiltrated of Runoff from Direct Rainfall		606,369.78
Hours to Infiltrate Direct Rainfall (Rainfall-Year/Infiltration Rate)		65.20

Supplemental Surface	
Roof (SF)	5,000
Impervious Surface (SF)	10,000
Total Supplemental Surface	15,000
Total Gallons for Year	903,184.89
Capacity Required during Targeted Rain Event	55,800.90
Capacity Required during 2" Inch/Hr Event	18,600.30
Overall Excess (Deficit) of Water Storage (Gallons)	(5,709.51)

Notes & Warnings
-Hours to Infiltrate Event in Soil (Rain Event) Are Acceptable. (Cell H29)
-Warning: Water Storage Deficit. Increase Project Size (Cell C16), Stone Depth (Cell D25).

<sup>1</sup> We have used accepted void percentages from local jurisdictions.

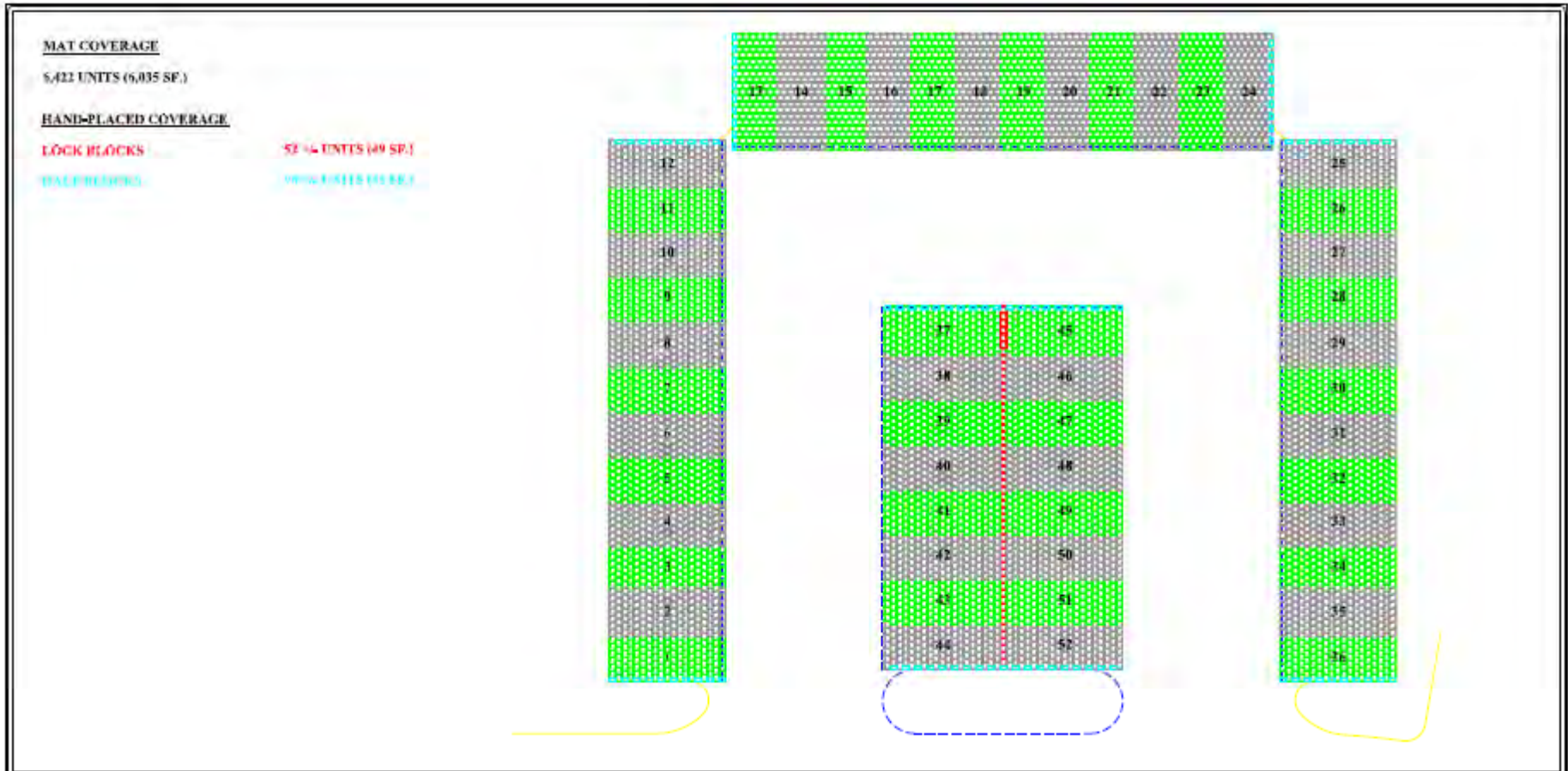
<sup>2</sup> Based on NOAA Website figure.

<sup>3</sup> See sheet "pavedrainvoid".

<sup>4</sup> Statistics on major dtes from NOAA website.



# Des Moines, IA - MLK & Ingersoll Ave.



**MAT COVERAGE**

5,422 UNITS (6,035 SF.)

**HAND-PLACED COVERAGE**

LOCK BLOCKS

52 94 UNITS (49 SF.)

WALL BRICKS

WALL BRICKS (SEE DET.)

<b>MAT TOTAL:</b>	5,422 UNITS (6,035 SF.)
<b>HAND-PLACED TOTAL:</b>	94 SF.
<b>PROJECT TOTAL:</b>	5,129 SF.

**NOTES:**

1. ALL VOIDS GREATER THAN 2" SHALL BE FILLED WITH 4,000PSI CONCRETE.
2. --- INDICATES AREA OF COVERAGE, AS TAKEN FROM DWG FILE PROVIDED BY: COOPER CRAWFORD & ASSOCIATES, LLC.

**DISCLAIMER:**

THE INFORMATION CONTAINED HEREIN HAS BEEN COMPILED BY PAVEDRAIN, LLC AND TO THE BEST OF OUR KNOWLEDGE, ACCURATELY REPRESENTS THE PAVEDRAIN PRODUCT USE IN THE APPLICATIONS WHICH ARE ILLUSTRATED. FINAL DETERMINATION OF THE SUITABILITY FOR THE USE CONTEMPLATED AND ITS FITNESS OF USE AND THE SOLE RESPONSIBILITY OF THE USER. STRUCTURAL DESIGN AND ANALYSIS SHALL BE PERFORMED BY A QUALIFIED ENGINEER.

THIS DRAWING IS BEING FURNISHED FOR THIS SPECIFIC PROJECT ONLY, AND ANY ACCEPTANCE OF THIS DOCUMENT DOES SO IN CONFIRMANCE AND AWARENESS THAT IT SHALL NOT BE QUALIFIED BY WHOLE OR IN PART, FOR APPLICATION TO OTHERS WITHOUT THE CONSENT OF PAVEDRAIN, LLC.

REVISIONS	
DATE	DESCRIPTION

PROJECT NAME:  
**INGERSOLL SQUARE RD, LP  
DES MOINES, IA**

DESIGNED BY:  
**MB**

MANUFACTURER:  
**PAVEDRAIN, LLC**

488 W. ABERNETHY AVE., GREENFIELD, WI 53039  
P.O. BOX 424411 • 909.441.0312  
www.pavedrain.com

**PAVEDRAIN 565<sup>®</sup>  
REVEALMENT UNIT**

DATE: 11/28/15  
DRAWN: JRM  
SCALE: NOT TO SCALE

**P-1**

# Section 1

## Base Preparation

**Open Graded Base & Bedding Course Aggregate:** Should be stone (i.e. AASHTO #57), which weighs approximately 120 pounds per cubic yard. Calculate the depth of stone using the average depth of the stone from point to the lowest point (based on engineered depth calculations). (Add 2 feet to the project area, including an additional 2 feet around the perimeter and for losses).

**Edge Restraint:** Rarely utilized for the *PaveDrain®* System. To be determined by the engineer of record.

**Separation Fabric:** A high strength Geosynthetic such as Mira or *RS580i®*, Tensar® TriAx® or equivalent is recommended to be in reinforcement layer between the AASHTO #57 open graded base and subgrade soil. **The "vertical walls" of your prepared area should be a Geosynthetic as well.** The Geosynthetic must lay flat against the subgrade to be free of wrinkles and over-lap the corresponding piece by NO LESS than 12 inches. ***Geosynthetic is a key component of the PaveDrain® System. The use of a Geosynthetic that is not approved by the manufacturer could be significantly detrimental to the function, performance and design of any project using PaveDrain®.*** PaveDrain, LLC, manufacturers and distributors cannot be held responsible for the any not use an appropriate Geosynthetic between the subgrade and the aggregate material.



Fig. 1



Fig. 2

### LAYOUT & PREPARATION

If individual units are to be installed they will arrive wrapped on pallets. Pallets will weigh approximately 3,600 lbs or less. If the *PaveDrain®* System is installed in mattress form, a mat layout will be provided by PaveDrain, LLC or its representatives. Mat weights and sizes will be determined in advance of shipment. Each mat will be pre-fabricated at the manufacturing facility and delivered to the site ready to be installed.

**NOTE: Before digging, always call your local utility companies to locate any underground utilities.**



### PREPARE SUBGRADE SOILS

For best results, the finished subgrade must be flat and smooth. The subsurface should be firm and not easily rutted. A California Bearing Ratio (CBR) should be established well in advance of the installation. The appropriate Geosynthetic is critical and should prevent rutting. If the subgrade appears weak or damp following the installation of the appropriate Geosynthetic contact a professional geotechnical engineer or local *PaveDrain* representative for further assistance.

Fig. 3



Fig. 4



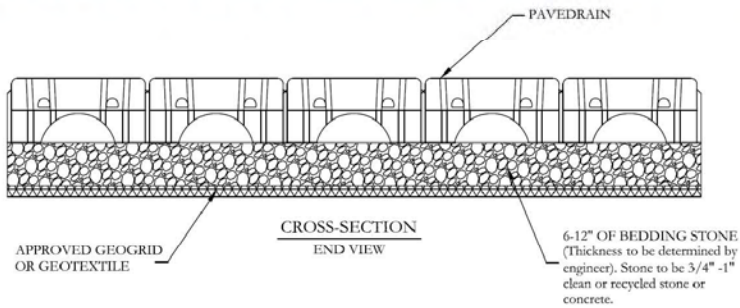
### PREPARATION OF OPEN GRADED BASE

The depth of stone should be determined well in advance of the installation of the PaveDrain® System by the engineer of record based on the CBR and stormwater storage requirements.

Open graded base materials **must** be free of fines. Take care not to track soil onto the Geosynthetic or allow sediment to wash into the excavation during construction.

If it is determined that a rock depth of 6-12" is appropriate for the PaveDrain® System (SEE CROSS-SECTION BELOW) then the following directions should be followed.

AASHTO #57 stone is recommended as the finish layer of stone for most installations. Place the stone on the appropriate Geosynthetic in 6-inch layer(s) and compact accordingly. A vibratory plate compactor in both directions is best for compaction of the final layer of AASHTO #57 stone that will be in direct contact with the bottom of the PaveDrain® units (Fig. 5). There should be no visible movement of the material once compacted and the base should be smooth when completed.

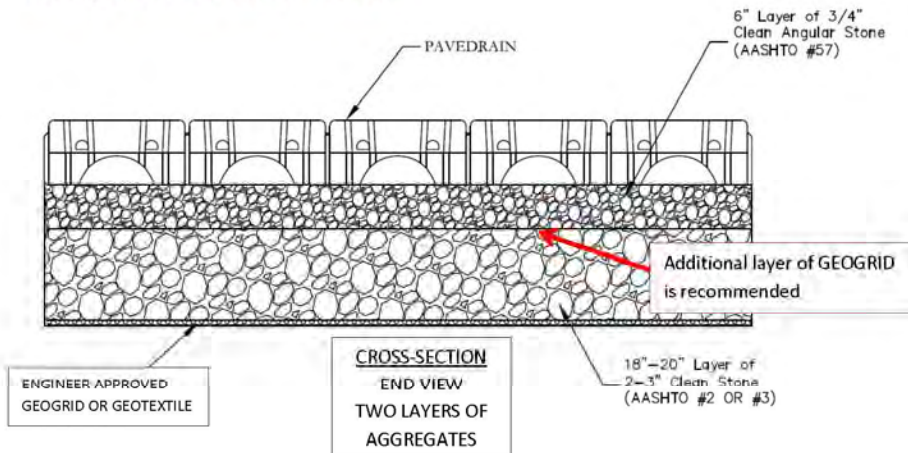


**REMEMBER:** Subgrade preparation is **CRITICAL!** The PaveDrain® System will mirror any discrepancies made with the subgrade.

Fig. 5



If it is determined by the engineer of record that a rock depth in excess of 12" is appropriate for the PaveDrain® System (SEE CROSS-SECTION BELOW) then the following directions should be followed.



## **CRUCIAL TOOLS**

Professional survey equipment is always recommended; other suggested materials are Pipe lasers (if available), marking paint, tape measure, chalk line, block markers/crayons, string line, survey stakes, rubber mallets, 4'-5' pry bars, 4 1/2" angle grinder with concrete cutting blade, masonry saw (wet/dry) with diamond cutting blade, spade and flat shovel, hard-tooth garden rake, Geosynthetic, "peanut" or double roller and plate compactor.

### **\*\*BUMP BAR\*\* – For Mattress Installation**

See Step #5 in the Mattress Installation section below for further details and FIG. 21 for a photo of the bar. Made from 5" x 5" angle iron that is roughly 8' in length.

## **NOTES FOR ENGINEERING**

1. For best results subgrade soil infiltration rates should be confirmed.
2. The bottom of the stone should be a minimum of two feet above the seasonally high water table.
3. Avoid over compacting or contaminating the natural subgrade soils.
4. Under drain piping and storage systems may be used if designed by a qualified professional engineer.
5. For moist or clayey subgrade soils consult a geotechnical engineer.
6. A sieve analysis of the open-graded stone material should be reviewed to confirm it meets the following filter criteria:

Filter Criteria: D15 open graded base / D50 bedding material < 5 and D50 open graded base / D50 bedding material > 2

Where: open graded base = AASHTO #57 bedding material = sieve size for which 15 percent of material is smaller  
D50 = sieve size for which 50 percent of material is smaller.

## Base Preparation



## Base Preparation



## The PaveDrain Installation













## The PaveDrain Installation



## The PaveDrain Installation



## The PaveDrain Installation



## The PaveDrain Installation

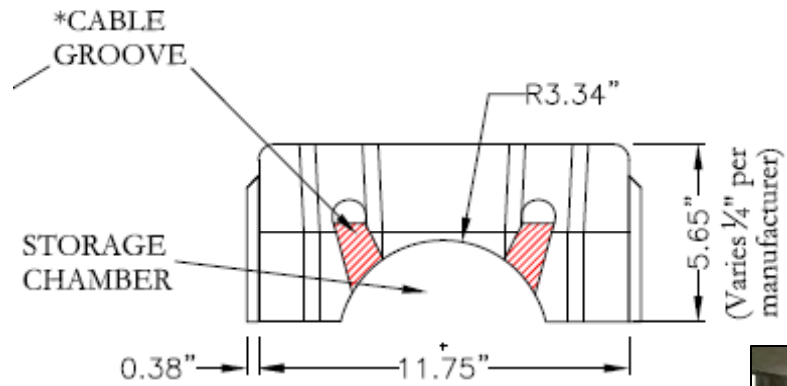


## The PaveDrain Installation





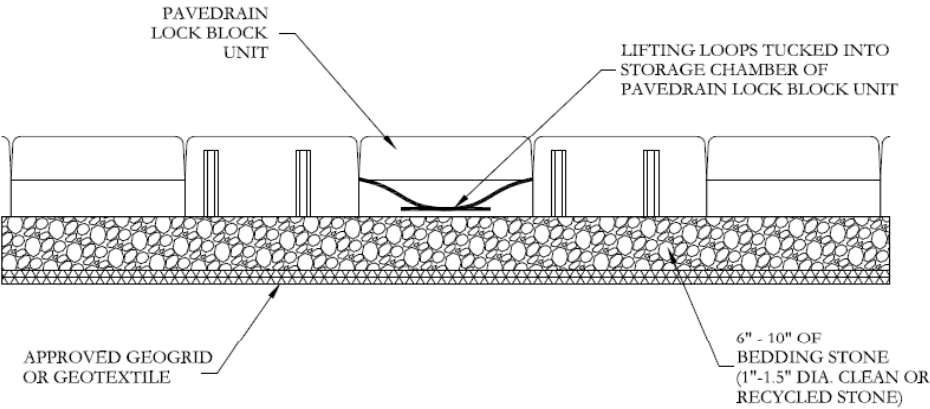
## The PaveDrain Installation



END VIEW



# End-to-End Connection



PaveDrain "Lock Blocks" being placed by hand.





ADA Compliant

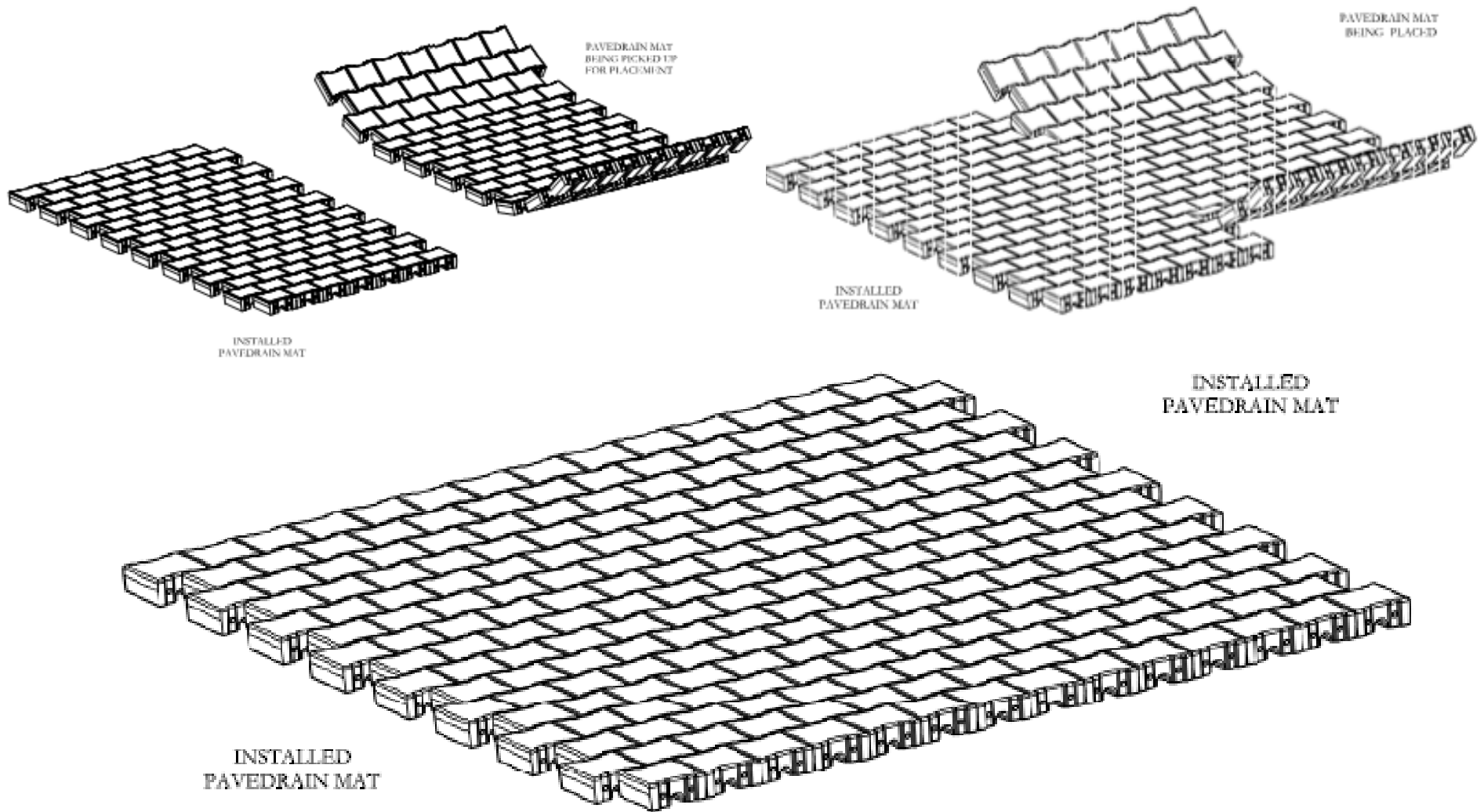
# Des Moines, IA - MLK & Ingersoll Ave.



# Des Moines, IA - MLK & Ingersoll Ave.



“Zippering” the mats together forms a seamless side-to-side connection.



# Des Moines, IA - MLK & Ingersoll Ave.



# Des Moines, IA - MLK & Ingersoll Ave.





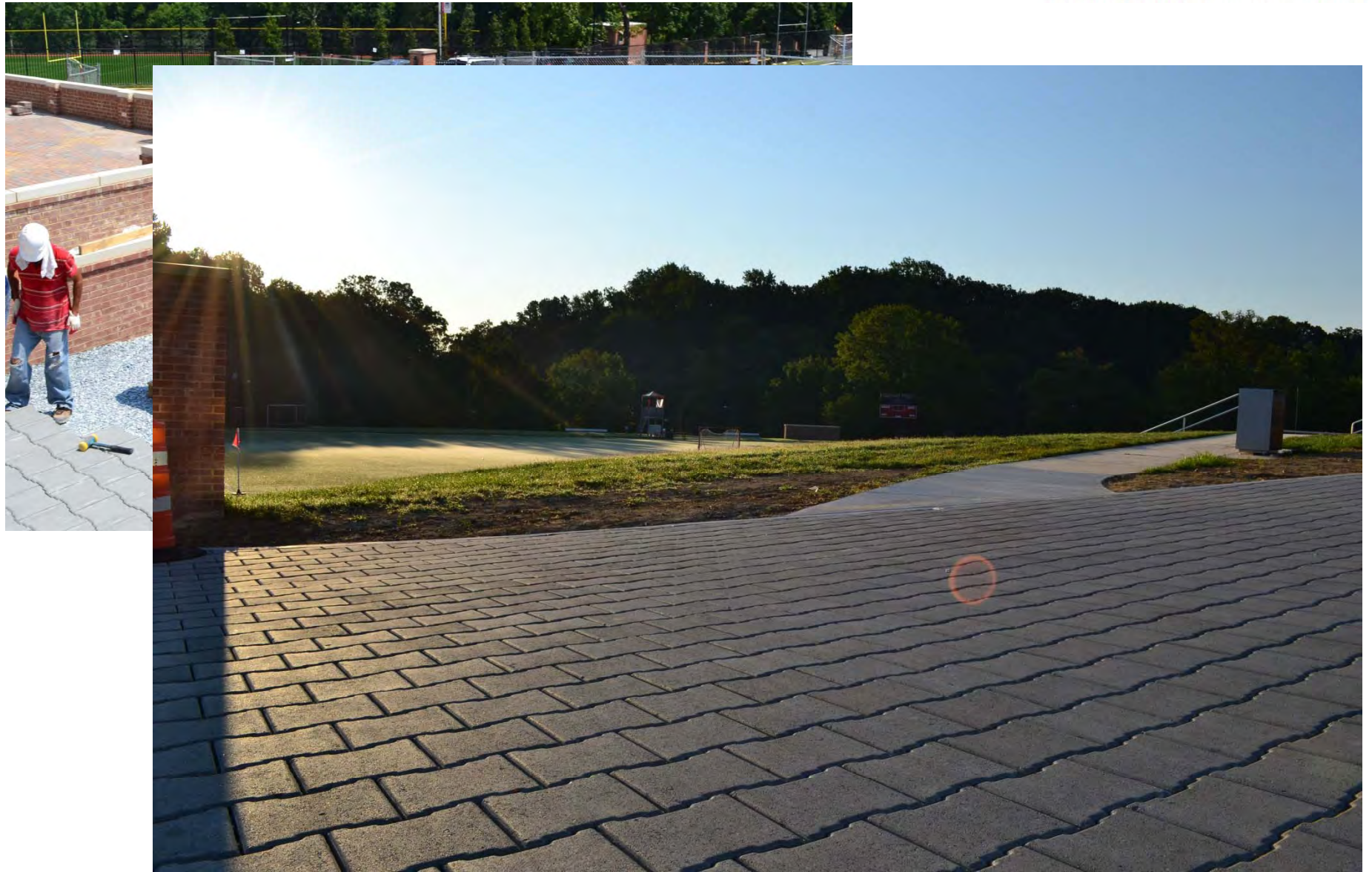
Des Moines, IA - MLK & Ingersoll Ave.



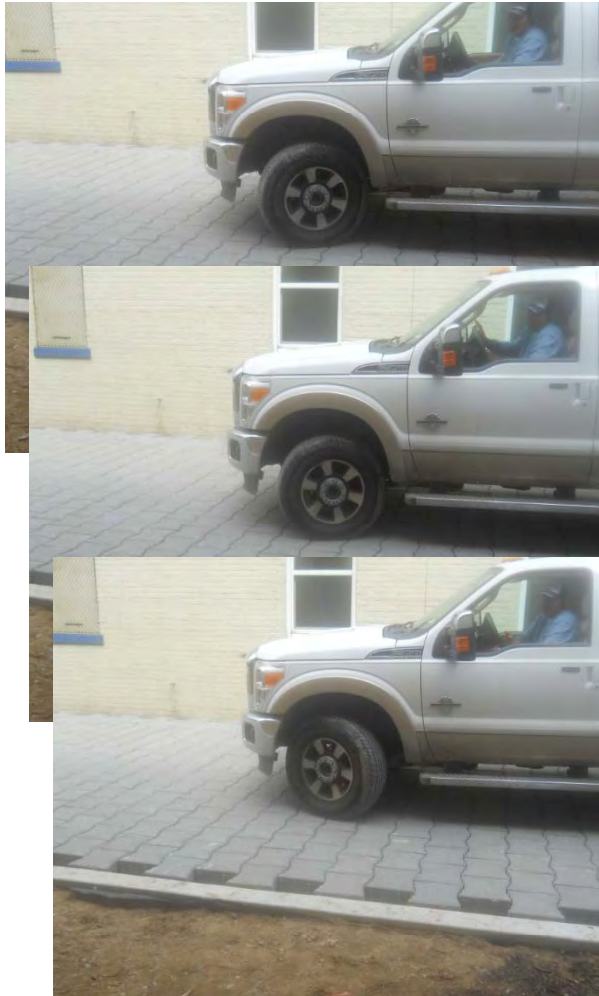
# Des Moines, IA - MLK & Ingersoll Ave.



# The PaveDrain Difference – Hand Placed

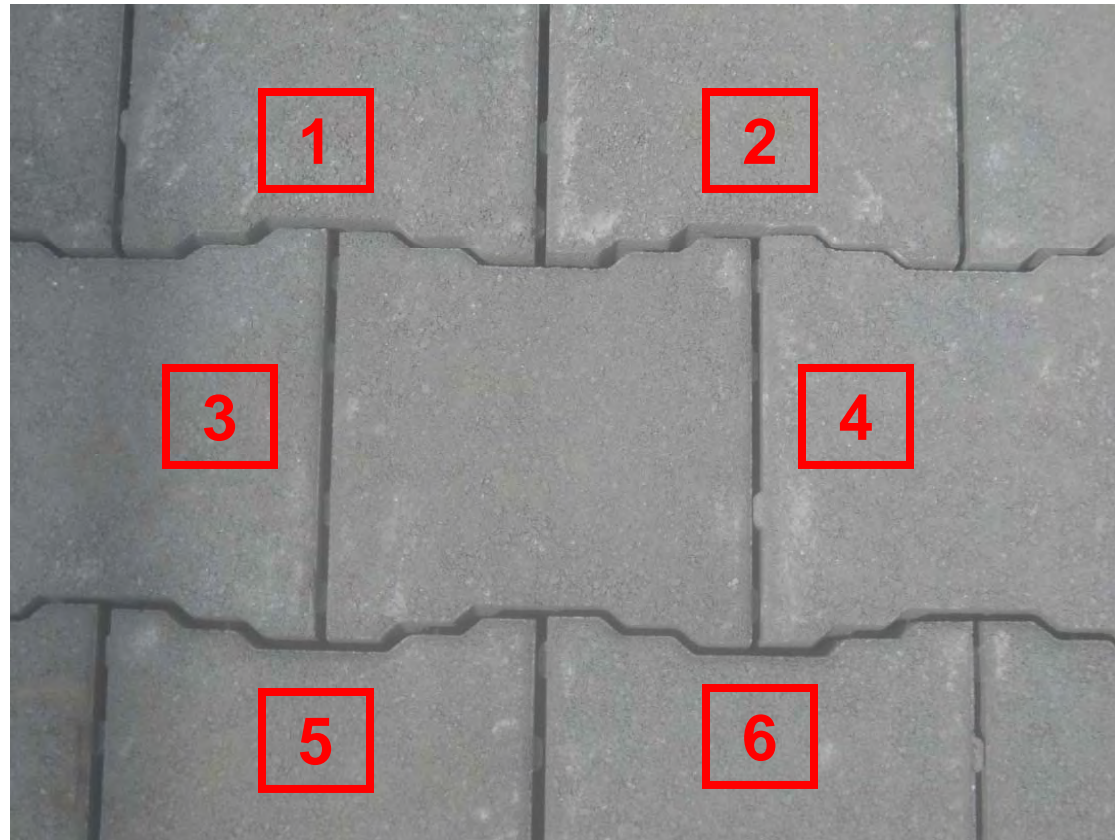


# The PaveDrain Difference



Tread marks left by turning wheel

# The PaveDrain Difference

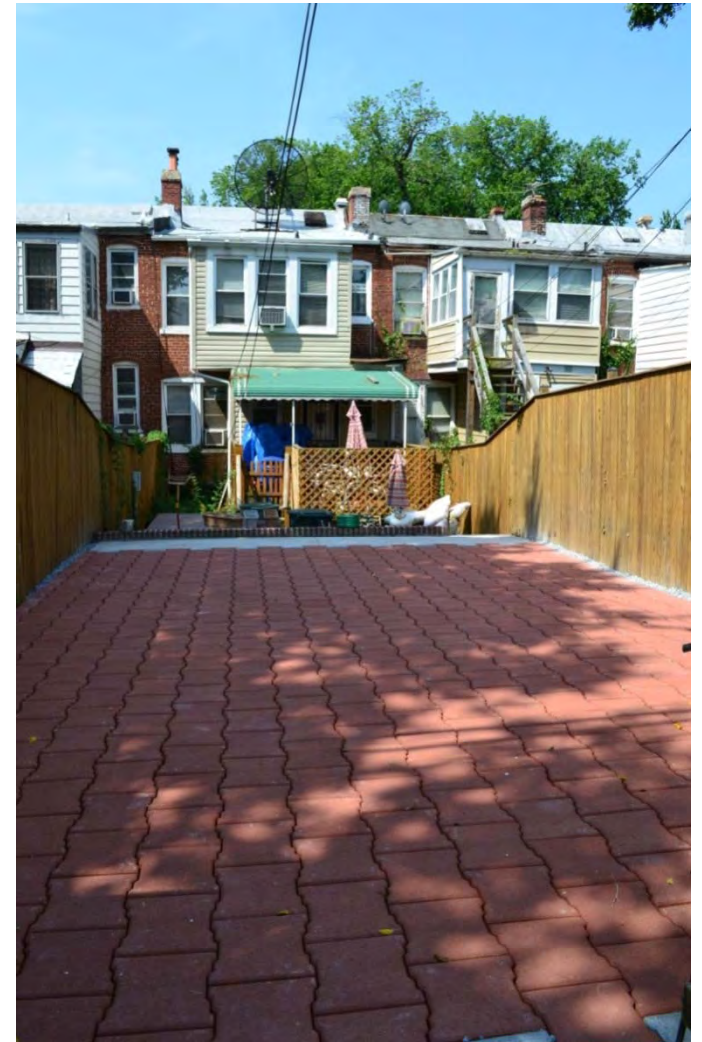


# City Streets – Installed Projects





# The PaveDrain Difference – Unique Projects

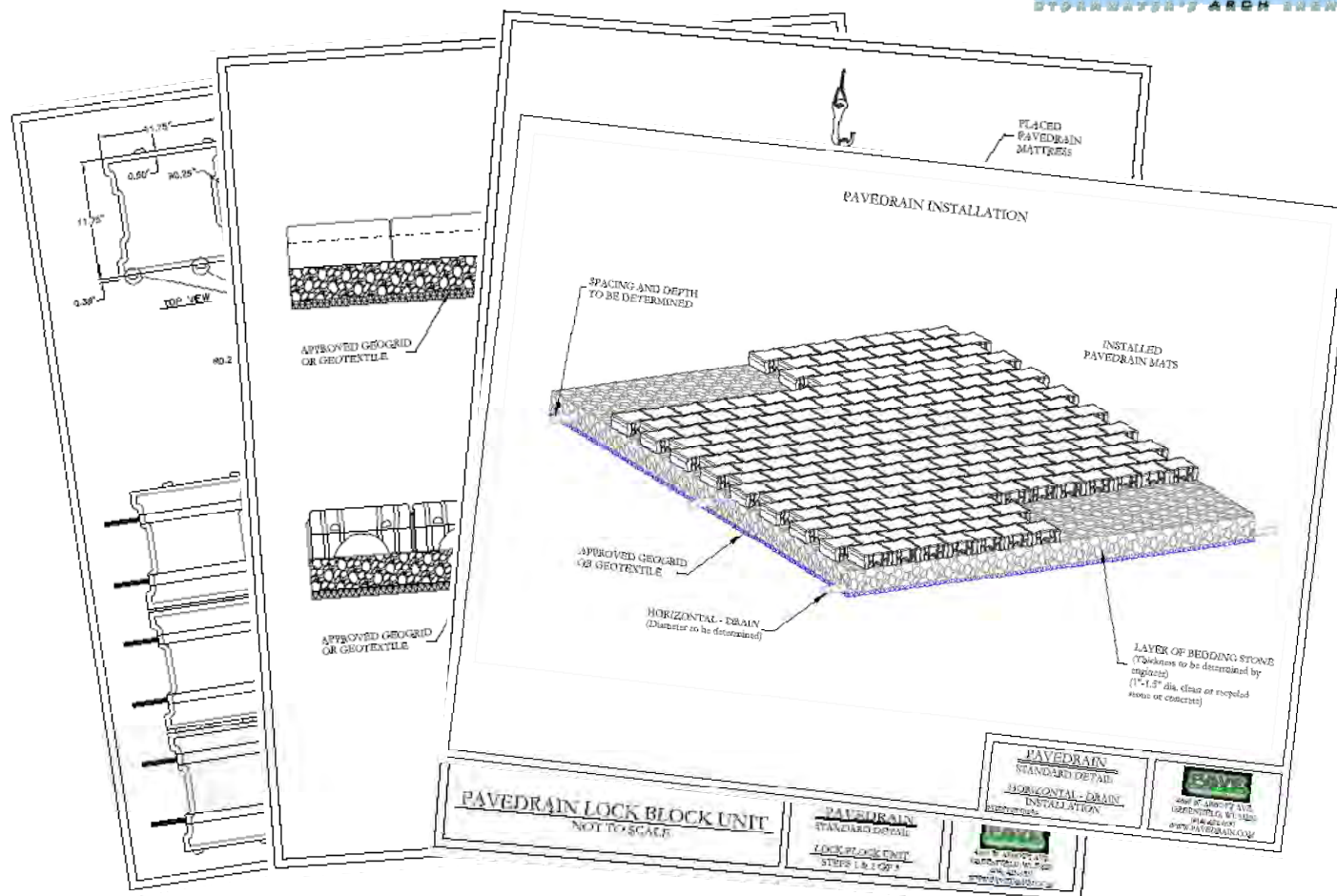




# The PaveDrain Difference – Recent Projects




# What we can provide for you...



# What we can provide for you...



PaveDrain® Permeable Block/Mat



Prepared for E...  
This

PERMEABLE ARTICULATED SPECIFICATION

**PART 1: GENERAL**

**A. Scope of Work**

The contractor shall furnish all labor required and perform all operations of articulating concrete erosion control design and dimensions shown on the drawings.

**B. Submittal**

The contractor shall submit to the engineer for review and approval all research results and calculations in accordance with the specifications for block/mat (P-ACBM) system and materials.

The contractor shall furnish materials, articulating concrete blocks/mats, and connectors to the engineer prior to construction.

The contractor shall furnish materials, literature, shop drawings for the applicable, that are specifically for permeable articulating concrete blocks/mats.

**PART 2: PRODUCTS**

**A. GENERAL**

Permeable articulating concrete blocks with specific of revealment cables. The mats and widths as specified on the drawings.

Individual blocks in the articulating interlock for enhanced stability with an arched storage chamber contract drawings. Parallel to block in a manner which permits mats. Each row of blocks adjacent, row so that any one above and two in the row below.

**Pennon**  
PENNON ASSOCIATES INC.  
CONSULTING ENGINEERS

PVDR 1101.00

Mr. Doug Buch  
PaveDrain, LLC  
4880 W. Abbott Avenue  
Greenfield, WI 53220

RE: PAVEDRAIN CONCRETE STRUCTURAL ANALYSIS

Dear Mr. Buch:

We have completed our structural analysis capable of supporting AASHTO 18K.

We analyzed the blocks as they are with impact per AASHTO standard condition and a pinned oval tire compressive strength of 4000 psi units average 3900 psi with calculations.

As with all vehicular traffic on PaveDrain blocks must be properly installed.

Sincerely,

**PENNONI ASSOCIATES INC.**  
Germine E. Lutz, PE, SPCB  
Structural Project Engineer

GEL/gel

Attachment: Calculations (4)

cc: Khalid Hanson, Pennoni  
Charlie Snyder, Pennoni

11/19/2011 10:51:11 AM - PaveDrain

2011 Avenue E • Suite 100  
Greenfield, WI 53220

**CTL GROUP**

August 15, 2011

Doug Buch  
PaveDrain LLC  
PMB 250 - 2245 S. 76th St.  
Franklin, WI 53132

Phone: 202-999-3463  
E-mail: [groups@pave-drain.com](mailto:groups@pave-drain.com)

ASTM C1543 Solar Reflectance of One Sample  
CTLGroup Project No. 315127 - Gray (PaveDrain) Unit

Dear Doug:

As authorized by you, CTL Group measured the solar reflectance of one sample, submitted by you, in general accordance with ASTM C1543 - 09, Standard Test Method for Determination of Solar Reflectance Near-Ambient Temperature Using a Portable Solar Reflectometer.

The sample, shown in Figure 1, was received at CTL Group on August 11, 2011. The sample was labeled by you as "Gray (PaveDrain) UNIT." The sample was stored at room temperature until it was tested. The top surface of the sample is fairly level and even, and had some whitish-colored marks that were avoided during testing.

On August 12, 2011, the approximately 12 in. by 12 in. by 6-in.-thick sample was divided into three equal strips (each approximately 4 in. by 12 in.) by drawing lines with chalk. The reflectance of the top surface of each of the sample's three strips was measured in three locations. The air mass on the solar spectrum reflectometer was set at 1.5, which approximates the length a beam of sunlight travels through the atmosphere over the continental United States. The measured solar reflectance, average, and standard deviation are reported in the attached data sheets in Appendix A. The measurements are summarized in Table 1.

**Table 1. Average Solar Reflectance, Standard Deviation, and Solar Reflectance Index (Rounded)**

Sample Label	Solar Reflectance	Standard Deviation	Solar Reflectance Index (SRI) <sup>a</sup>
Gray (PaveDrain) Unit	0.37	0.01	21

<sup>a</sup> Assume a correction coefficient of 1.2 W/m<sup>2</sup>/C for medium wind speed and an emissivity of 0.8, which is appropriate for non-metallic opaque building materials.

Control Office: 5405 Old Orchard Road, Suite 200, Columbia, MD 21046  
Franklin, WI • Chicago, IL • Greenfield, WI  
CTL Group is a member of CTL Construction Technology Laboratories, Inc.  
www.pave-drain.com

# What we can provide for you...



**NOTES:**  
 1. ALL MAT ARE AS SPECIFIED ON SPREADSHEET.

- HAND-PLACED AREAS

**DISCLAIMER:**  
 THE INFORMATION CONTAINED HEREIN HAS BEEN DEVELOPED BY PAVEDRAIN, L.L.C. AND TO THE BEST OF OUR KNOWLEDGE ACCORDING TO CURRENT PRACTICES AND THE STATE OF THE ART AT THE TIME OF THE DESIGN. PAVEDRAIN, L.L.C. MAKES NO WARRANTY, REPRESENTATION OR GUARANTEE, EXPRESS OR IMPLIED, AS TO THE ACCURACY, COMPLETENESS AND USEFULNESS OF THE INFORMATION CONTAINED HEREIN. THE USER SHALL BE RESPONSIBLE FOR THE DESIGN, CONSTRUCTION AND MAINTENANCE OF THE PROJECT. PAVEDRAIN, L.L.C. IS NOT RESPONSIBLE FOR ANY DAMAGE TO PERSONS OR PROPERTY, INCLUDING CONSEQUENTIAL DAMAGES, ARISING FROM THE USE OF THE INFORMATION CONTAINED HEREIN.

**ELEVATIONS:**

DATE:	DATE:
BY:	BY:

**PROJECT NAME:** FORD & LOUISVILLE ASSEMBLY PLANT

**PREPARED BY:** M.B. DESIGN GROUP, INC.

**DATE:** 07/24/14

**PROJECT NO.:** 14011

**SCALE:** 1/8" = 1'-0"

**PAVEDRAIN, L.L.C.**

**PAVEDRAIN REVITMENT UNIT**

**DATE:** 07/24/14

**BY:** CB

**SCALE:** NOT TO SCALE

**P 21**

# What we can provide for you...



Project: Ford - Louisville Assembly Plant  
PaveDrain Matress Layout Spreadsheet

Page 1 of 14  
10/8/2011

Creation Date: 10/8/2011

Mat Checklist	Mat #	Mat Length max (ft)	Mat Length min (ft)	Mat Width max (ft)	Mat Width min (ft)	Total Mat Coverage (sq. ft.)	Mat Weight (lbs.)
	1	16.2	16.2	7.5	7.5	121.5	5695
	2	16.2	16.2	7.5	7.5	121.5	5695
	3	16.2	16.2	7.5	7.5	121.5	5695
	4	16.2	16.2	7.5	7.5	121.5	5695
	5	16.2	16.2	7.5	7.5	121.5	5695
	6	16.2	16.2	7.5	7.5	121.5	5695
	7	16.2	16.2	7.5	7.5	121.5	5695
	8	16.2	16.2	7.5	7.5	121.5	5695
	9	16.2	16.2	7.5	7.5	121.5	5695
	10	16.2	16.2	7.5	7.5	121.5	5695
	11	16.2	16.2	7.5	7.5	121.5	5695
	12	16.2	16.2	7.5	7.5	121.5	5695
	13	16.2	16.2	7.5	7.5	121.5	5695
	14	16.2	16.2	7.5	7.5	121.5	5695
	15	16.2	16.2	7.5	7.5	121.5	5695
	16	16.2	16.2	7.5	7.5	121.5	5695
	17	16.2	16.2	7.5	7.5	121.5	5695
	18	16.2	16.2	7.5	7.5	121.5	5695
	19	16.2	16.2	7.5	7.5	121.5	5695
	20	16.2	16.2	7.5	7.5	121.5	5695
	21	16.2	16.2	7.5	7.5	121.5	5695
	22	16.2	16.2	7.5	7.5	121.5	5695
	23	16.2	16.2	7.5	7.5	121.5	5695
	24	16.2	16.2	7.5	7.5	121.5	5695
	25	16.2	16.2	7.5	7.5	121.5	5695
	26	16.2	16.2	7.5	7.5	121.5	5695
	27	32.4	32.4	7.5	7.5	243.0	11391
	28	32.4	32.4	7.5	7.5	243.0	11391
	29	32.4	32.4	7.5	7.5	243.0	11391
	30	32.4	32.4	7.5	7.5	243.0	11391
	31	32.4	32.4	7.5	7.5	243.0	11391
	32	32.4	32.4	7.5	7.5	243.0	11391
	33	32.4	32.4	7.5	7.5	243.0	11391
	34	32.4	32.4	7.5	7.5	243.0	11391
	35	32.4	32.4	7.5	7.5	243.0	11391
	36	32.4	32.4	7.5	7.5	243.0	11391
	37	32.4	32.4	7.5	7.5	243.0	11391
	38	32.4	32.4	7.5	7.5	243.0	11391
	39	32.4	32.4	7.5	7.5	243.0	11391
	40	32.4	32.4	7.5	7.5	243.0	11391
	41	32.4	32.4	7.5	7.5	243.0	11391
	42	32.4	32.4	7.5	7.5	243.0	11391
	43	32.4	32.4	7.5	7.5	243.0	11391
	44	32.4	32.4	7.5	7.5	243.0	11391
	45	32.4	32.4	7.5	7.5	243.0	11391
	46	32.4	32.4	7.5	7.5	243.0	11391
	47	32.4	32.4	7.5	7.5	243.0	11391

**Spreadsheet to communicate with owner, engineer, contractor and supplier!**

### Arch

Pre-formed patented arch located at the bottom of the unit. Gives 20% storage capacity as well as lightening the unit weight without affecting its strength.

### ADA Compliant Gaps

The unit interlock and spacers allow for a gap between each unit no greater than 1/8". This falls under 4.5.4 gratings within the guidelines set by the ADA.

### Beveled Edge

R0.500 Edge located around the top of each unit. Provides a smooth transition between the vertical and horizontal portion of the unit. Allows for snow plowing to transition from block to block.

### Interlocking Shape

Patented shape that allows each unit to positively interlock with one another **without** the use of aggregate between the joints. One unit has immediate contact with six other units.

### Infiltration

4,000 inches per hour within a one (1) square foot area. Conducted under the guidelines of ASTM C1701 by a Third Party Testing Firm.

### Worldwide & Local Production

PaveDrain is manufactured using the dry cast method on a typical block machine. This allows us to send our molds to the closest facility to the job. This reduces transportation costs and will benefit local economies.

### HS-20/H-20 Loading

Product passes test to handle heavy truck loads. Conducted under the guidelines of ASTM C140 by a Third Party Testing Firm.

### Compressive Strength

4,000 psi minimum. The capacity of the unit to withstand axially directed pushing forces measured in Pounds per Square Inch. Conducted under the guidelines of ASTM D6684-04 by a Third Party Testing Firm.

### Freeze-Thaw Testing

Tests the durability of the unit for cold weather climates by 100-150 cycles of freezing then thawing each unit in a plain water or water/saline solution. Conducted under the guidelines of ASTM C1262 by a Third Party Testing Firm.

I COME IN  
COLORS  
TOO!

### Installation (ease & speed)

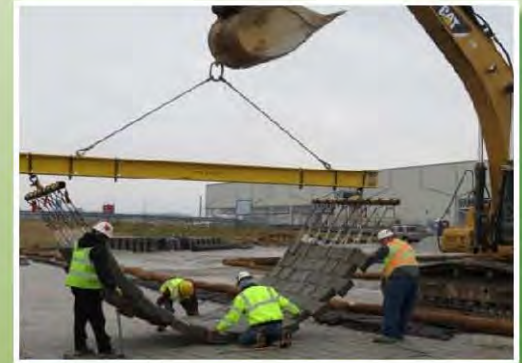
The units can be installed two different ways: (1) Hand placing individual units (2) Mattress Form. Hand placing is common for overhead constraints that do not allow for the use of larger equipment. Customer can tailor the installation to suit each different site with only one product. If the area is small the units could be hand-placed. If an area is larger they can utilize mats.

### Permeability Maintenance

Due to its open joint design, the maintenance associated with the System has been drastically reduced for most applications.

### LEED Credits

Five different credits can be associated with the use of this system: Credits 5.1, 5.2, 6.1, 6.2 and 7.1.



# PaveDrain System



### Headquarters

PMB 292 – 7245 S. 76<sup>th</sup> St.  
Franklin, WI 53132-9041

### Distribution & Manufacturing

Across all of North America  
Visit [www.pavedrain.com](http://www.pavedrain.com) to view

### Contact

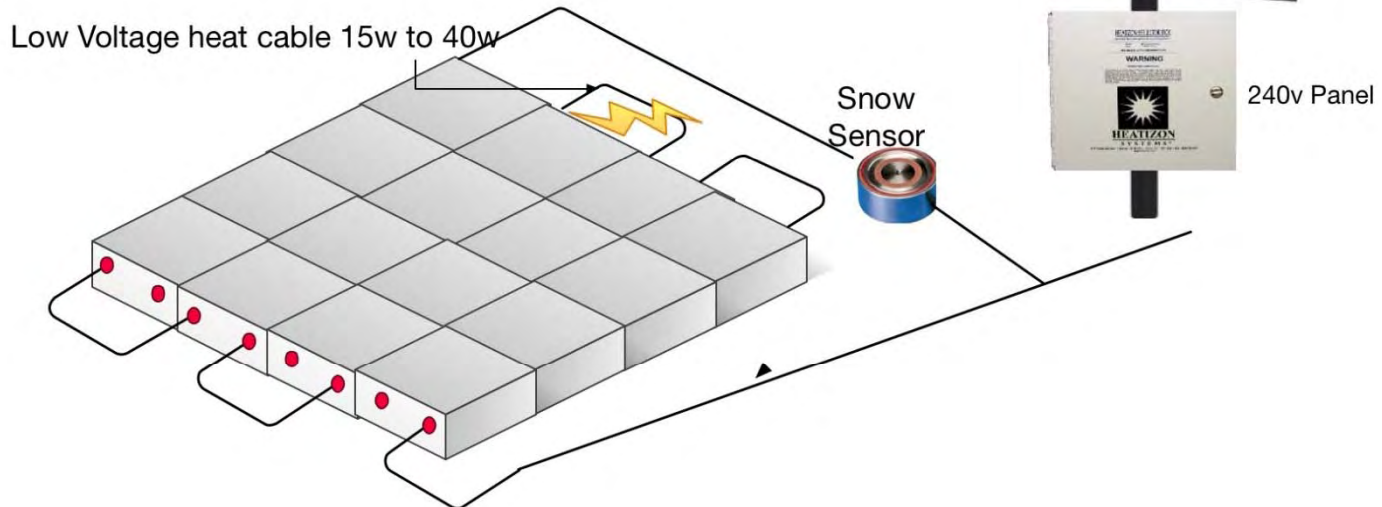
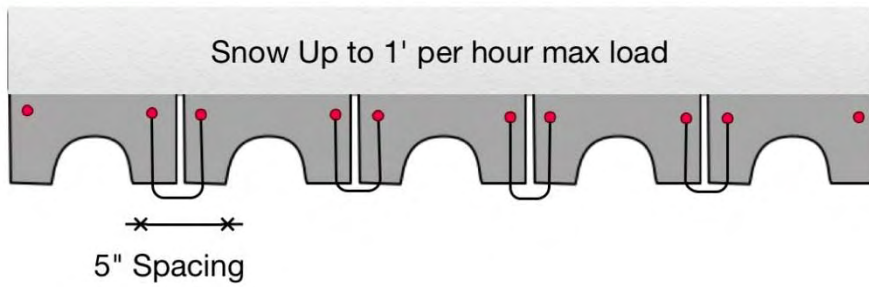
phone: 888-575-5339  
email: [info@pavedrain.com](mailto:info@pavedrain.com)



# The PaveDrain Difference – Heated

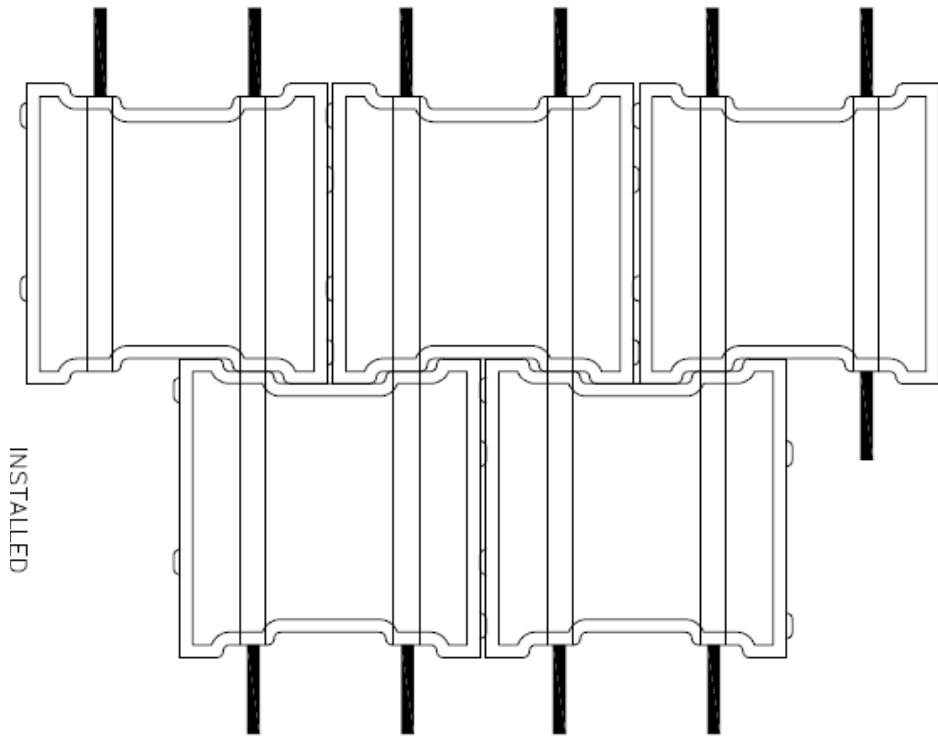


# Radiant Heat

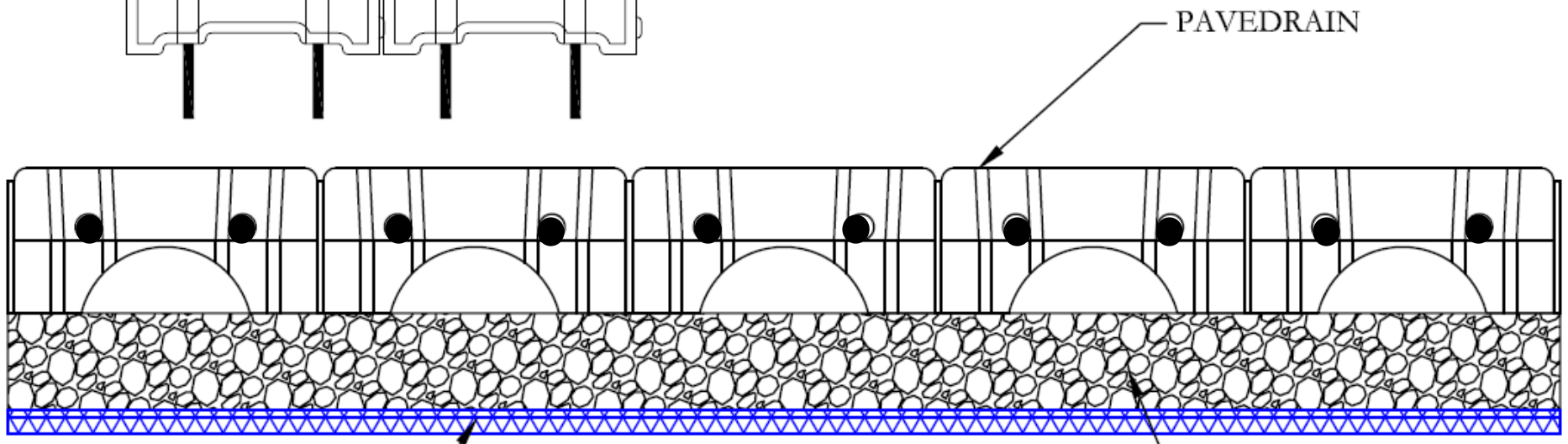




# Radiant Heat



**Six Inch Spacing  
Of Wiring Is The  
Key!!**



The logo for PaveDrain is displayed on a light green, irregularly shaped background. The word "PAVE" is written in large, grey, block letters with a black outline. The letter 'A' is stylized to include a blue and white wave pattern. Below "PAVE" is a green horizontal bar containing the word "DRAIN" in white, bold, sans-serif capital letters. Underneath the green bar, the phrase "STORMWATER'S ARCH ENEMY" is written in a smaller, green, sans-serif font.

**PAVE**  
**DRAIN**<sup>®</sup>  
STORMWATER'S ARCH ENEMY

The background of the image shows a parking lot paved with grey interlocking bricks. A white-painted rectangular parking space is visible, containing a blue square with the white International Symbol of Access (a person in a wheelchair). The text is overlaid on this scene.

**ADA Compliant too!!**  
**PaveDrain...a paving revolution!**















































































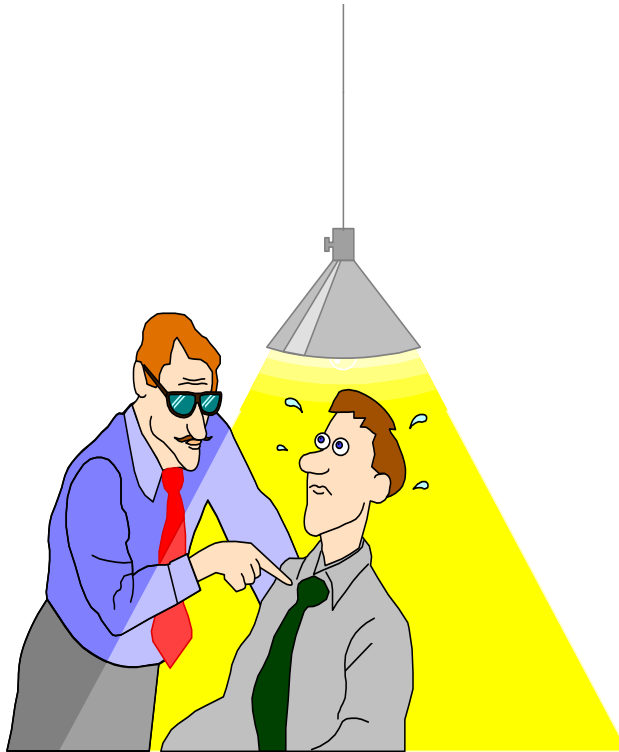




**"This really is an innovative approach, but I'm afraid we can't consider it. It's never been done before."**

# THANK YOU!!!

Questions



Comments

