HANES® GEO COMPONENTS™

A Leggett & Platt® COMPANY

Porous and Permeable Pavements

Scott Bordeau, CPESC

40 locations U.S.A. and Canada

Porous Pavements

* Rigid, Interconnected Paver Systems
* Turf Protection & Aggregate Stabilization

Vegetated Systems-Infrequent Traffic

GEOBLOCK | Lighter loads
GEOBLOCK 5150 | Heavier loads

Aggregate System-Daily Traffic

GEOPAVE | All Loading

GEOSYSTEMS

Vegetated Porous Pavements

Two Rigid Paver Styles

- GEOBLOCK® & GEOBLOCK ®5150
- Options to Address Frequency, Loading, Budget

GEOBLOCK TURF PROTECTION

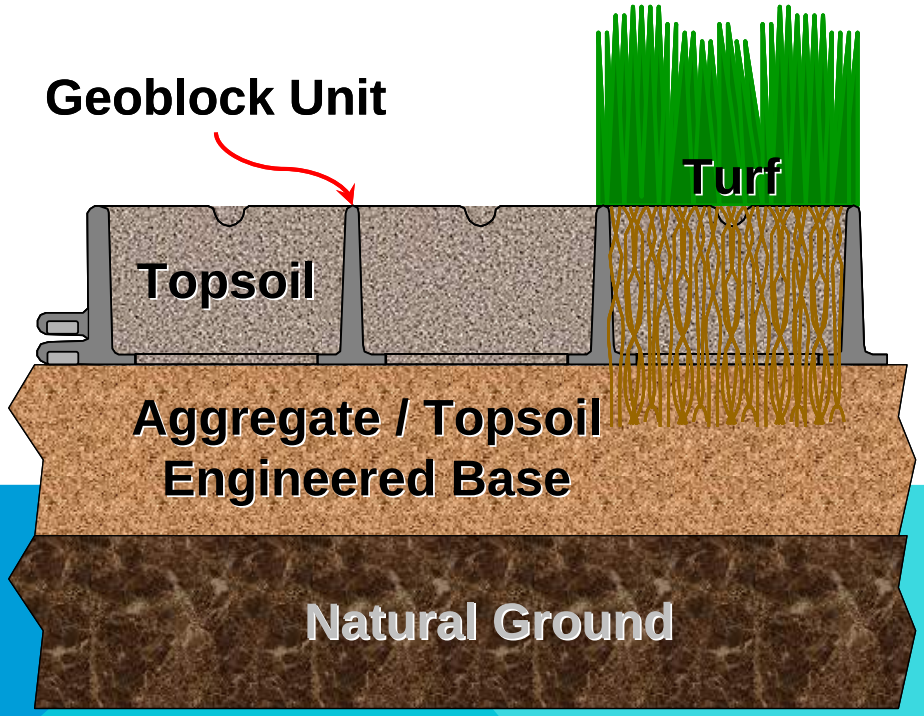
Benefits

- Protects turf in “occasional” traffic areas up to H-20 loading
- Offers aesthetics of green space
- Promotes storm water infiltration:
  - reduces runoff, improves SW quality
  - can reduce SW management fees & need for SW containment facility (ponds)
  - contributes to green building credits in several categories.
- Recycled HDPE

VEGETATED POROUS PAVEMENTS

Common Approach for Success

- Protect Topsoil from Super-compaction
  - Grass Dies from loss of Air and Water Access to the Roots
  - Loading does not Directly Permanently Damage Grass/Consolidation Does



SYSTEM COMPONENTS:

- Geoblock Unit
- Engineered Base
- Selected Topsoil Infill
- Selected Vegetation

GEOBLOCK Turf Protection

Structural Strength & Load Distribution

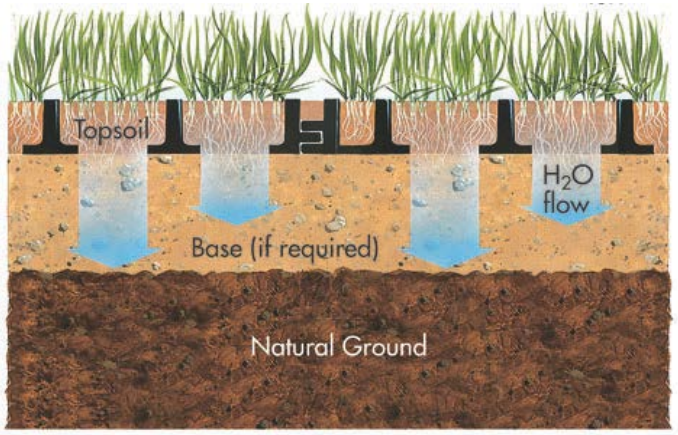
- Rigid, connected cell wall system offers:
  - highest load distribution in industry
  - highest resistance to torsional stresses
  - base reduction (up to 50%)

- no flexural strength, flex under loading.

GEOBLOCK Turf Protection

Healthy Vegetation Growth

- Topsoil infill and component in the base offers:
  - healthy environment for vegetation
  - faster grass growth, springs back quicker after traffic

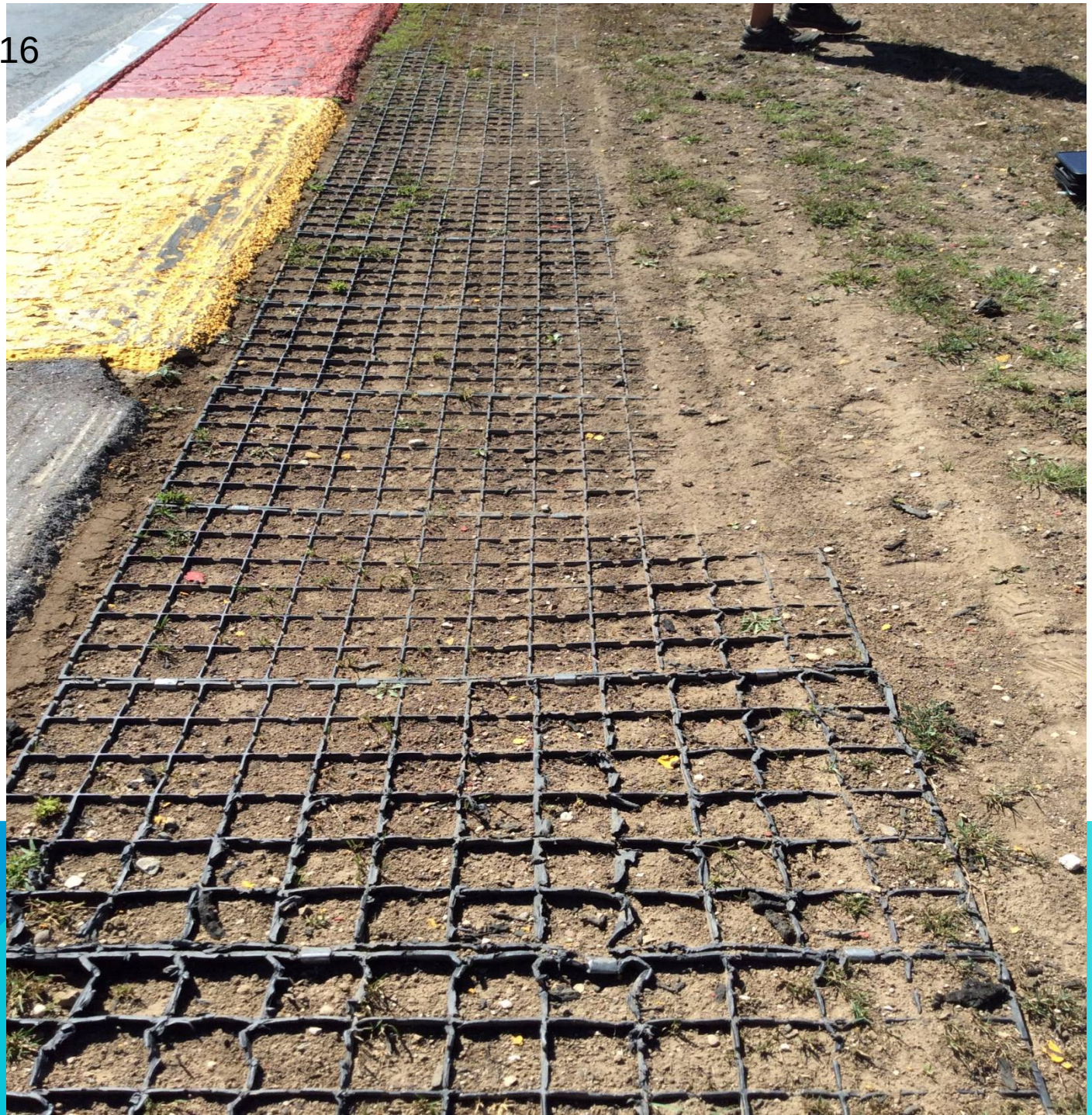


Emergency & Maintenance Access

- Minimal base requirements – minimum excavation
- Geoblock5150 requires 2-3 times less base depth than all other pavers

May 2012

August 2016



Emergency & Maintenance Access

- Grass pavements offer landscape unity with the surroundings.
- Over 30 years of reliable Geoblock installations!

Meet Local Stormwater Requirements

- Green alternative to limit hard surface.

GEOBLOCK Turf Protection

Accommodates Curves

- Easy to offset units to make curves.

Occasional Use Parking

- Frequency depends on climate, soils and vegetation type.

GEOBLOCK Applications

Occasional Use Parking

- Parks, sporting facilities, museums, schools

GEOPAVE

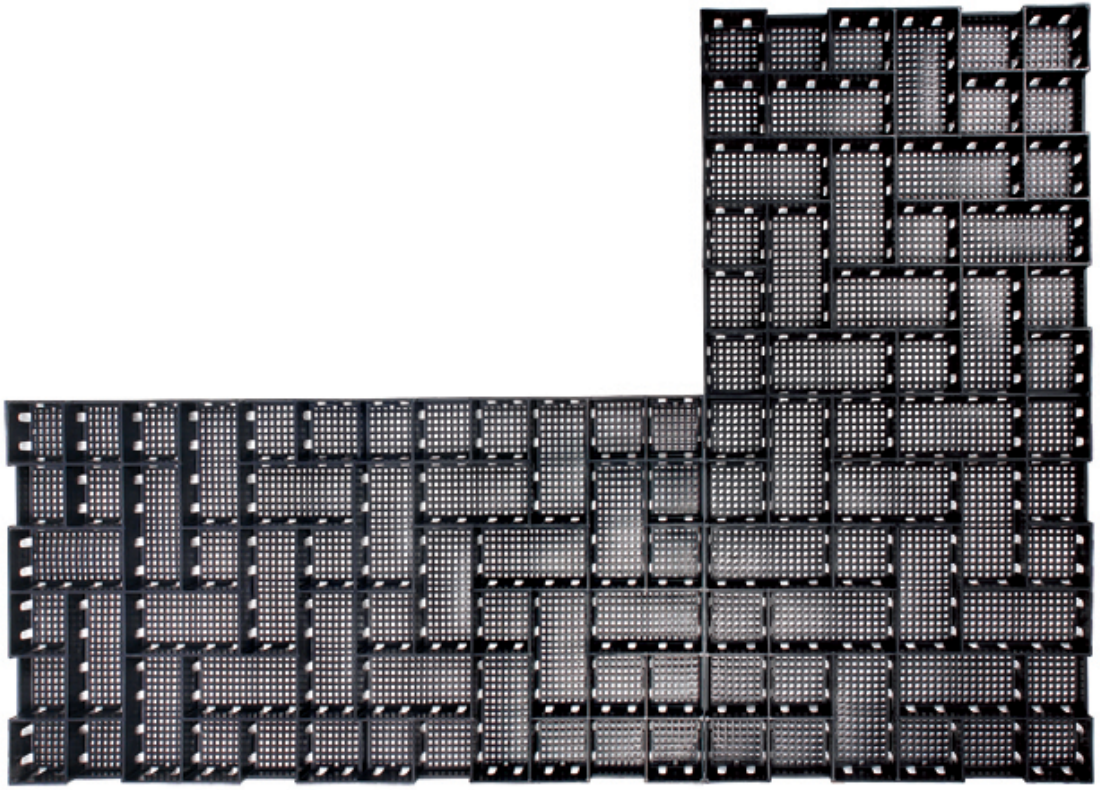
GeoPave Characteristics

- Mesh bottom
- Mouse holes for increased Interlock
- Herringbone design
- 1/2 walls for incorporating clips

GEOPAVE

GeoPave Specifications

- 175 psi crush strength empty
- 1000 psi crush stength filled
- Made from 97% recycled PE
- 2 inch depth
- 20 inch x 40 inch (5.38 sq ft)
- Cell size 3.25 in x 3.25 in or 3.25 in x 6.5 in

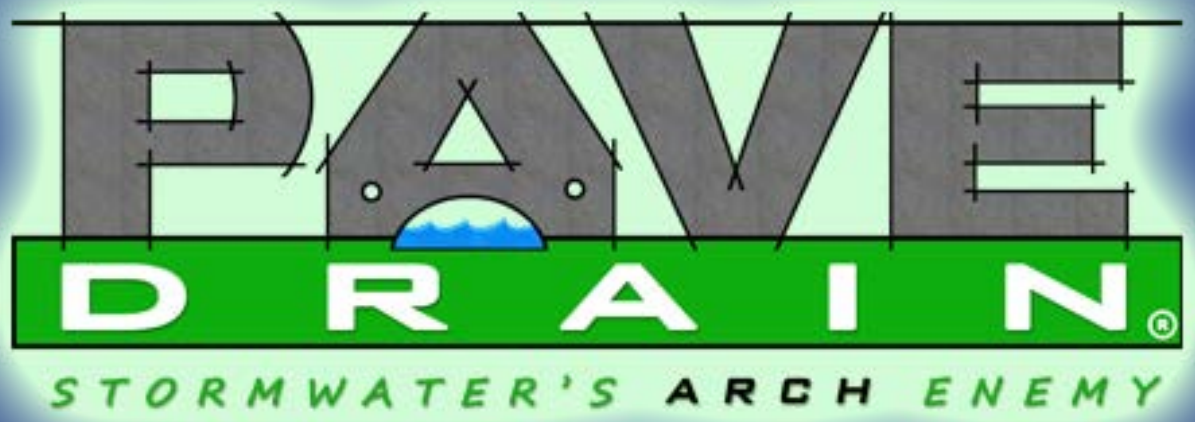


GEOPAVE INSTALLATION

GEOPAVE INSTALLATION

GEOPAVE INSTALLATION

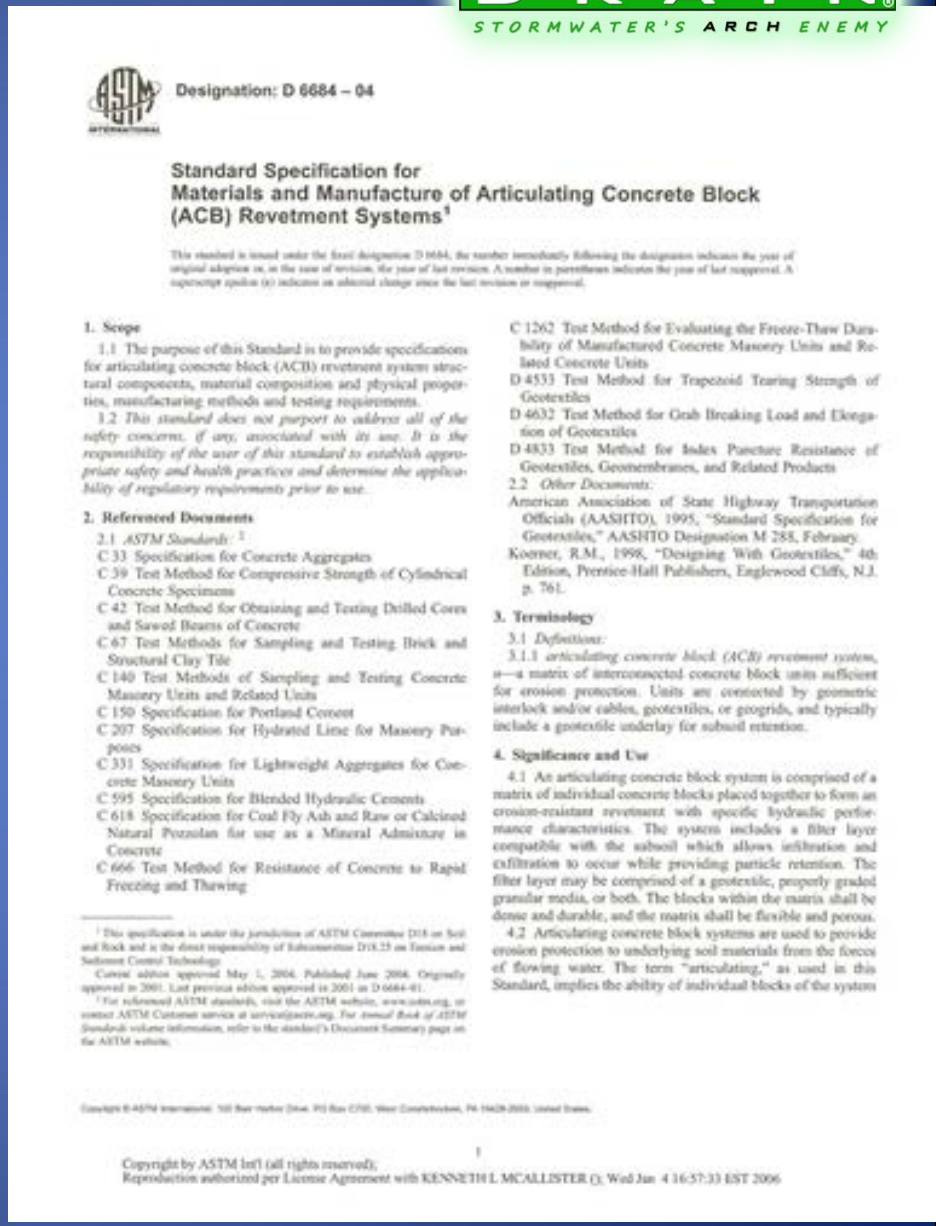
Roadway Grassed Shoulder Protection


P.A.VE
DRAIN®
STORMWATER'S ARCH ENEMY

What is PaveDrain?

- It's a *PERMEABLE* Articulating Concrete Block
- (P-ACB)

- 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[1]

This standard is issued under the fixed designation D 6684; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

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:* [2]

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 Pozzolan 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, Geomembranes, 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 interconnected 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 subsoil 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 exfiltration to occur while providing particle retention. The filter layer may be comprised of a geotextile, properly graded granular media, or both. The blocks within the matrix shall be dense and durable, and the matrix shall be flexible 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

[1] This specification is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.25 on Erosion and Sediment Control Technology.

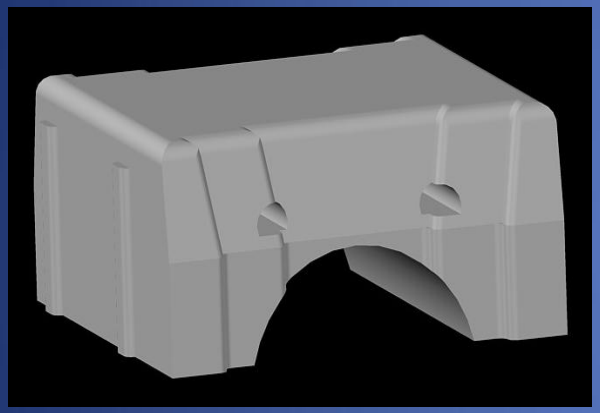
Current edition approved May 1, 2004. Published June 2004. Originally approved in 2001. Last previous edition approved in 2001 as D 6684-01.

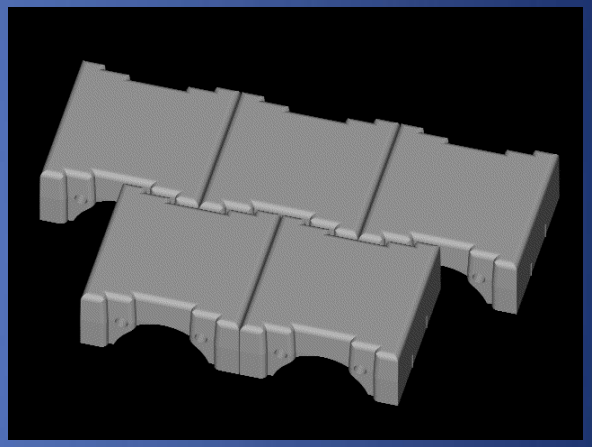
[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.

Sustainable Stormwater Solution
Solve Multiple Problems…With One Product

PAVE DRAIN®
STORMWATER'S ARCH ENEMY

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





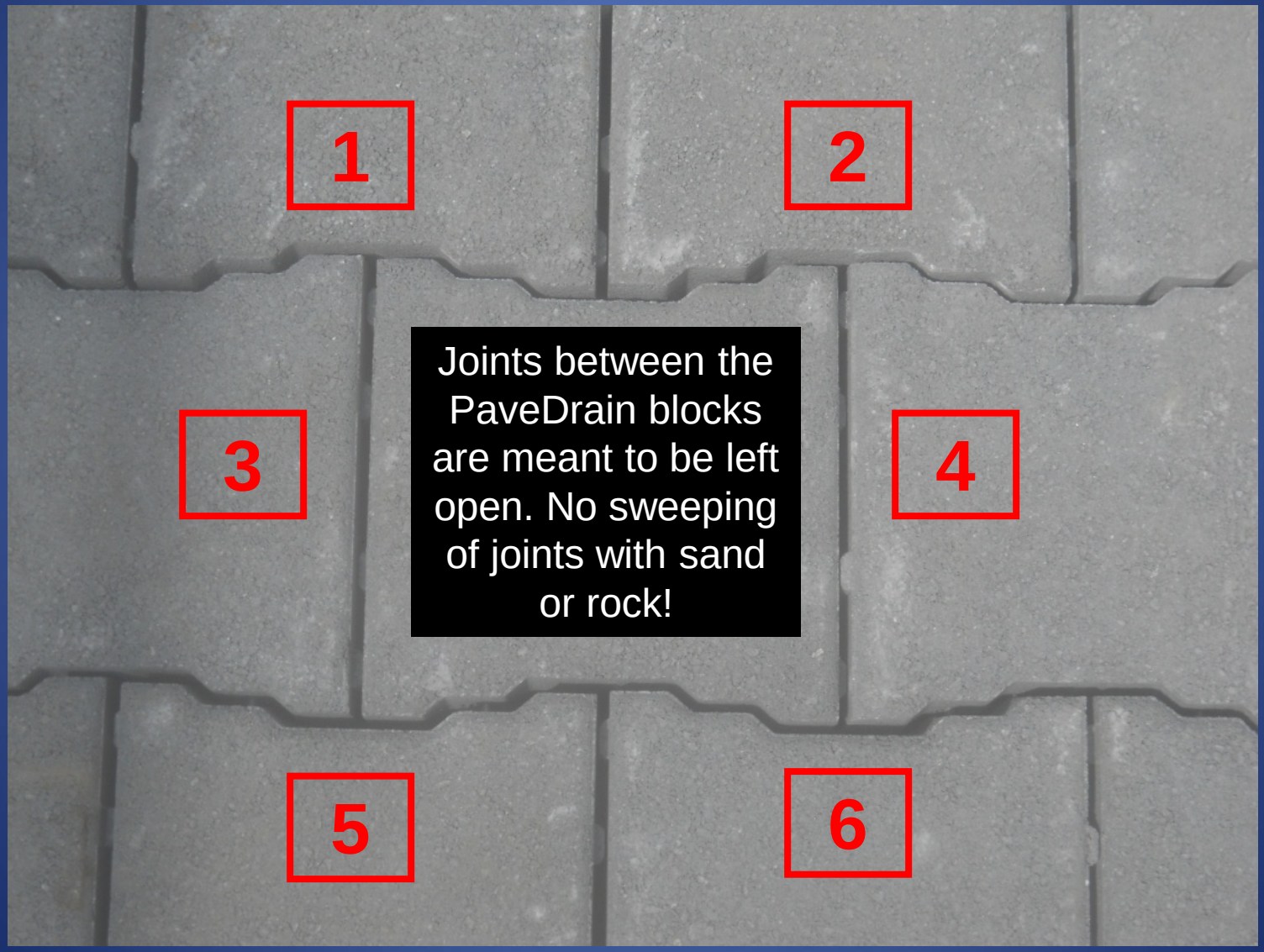
Individual Block

- **12” x 12” x 5.65”**
- **45 – 48 Lbs. Ea.**

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

It’s a new and improved paving system

The PaveDrain Difference




McDonald's
Restaurant
CAT
RAMS CONTRACTING LTD.


HARLEY-
DAVIDSON


Layton Ave Milwaukee WI

Residential Driveway
in Edgerton WI


Shorewood WI


CLOVERLEAF
Landscaping
Incorporated
FOX CITIES
OSHKOSH, WI
235-1200
CLOVERLEAF
Landscaping
Incorporated
Construction ♣ Design ♣ Maintenance
FOX CITIES
Oshkosh YMCA


Habitat
for Humanity
of Oshkosh, Inc.
Oshkosh WI

PAVE DRAIN®

STORMWATER'S ARCH ENEMY

Steel Snow Plow Blade

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

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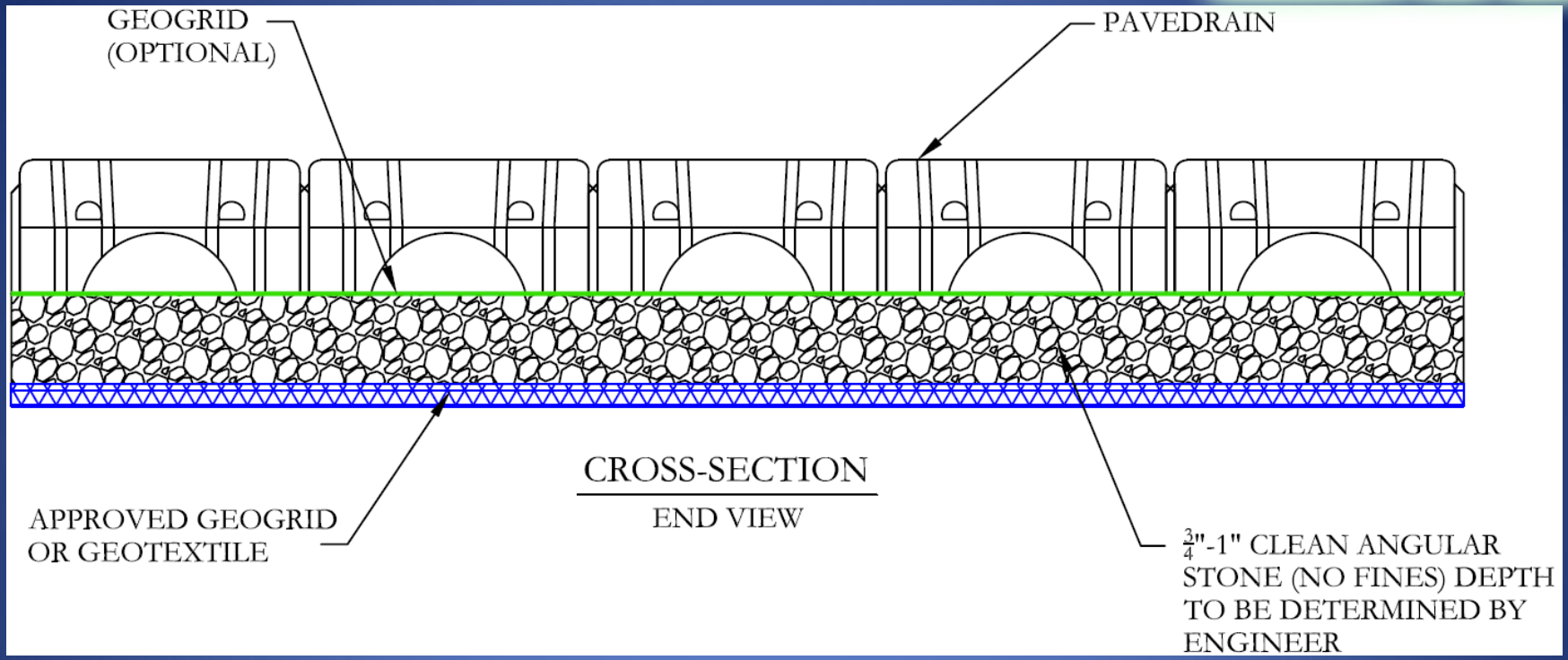
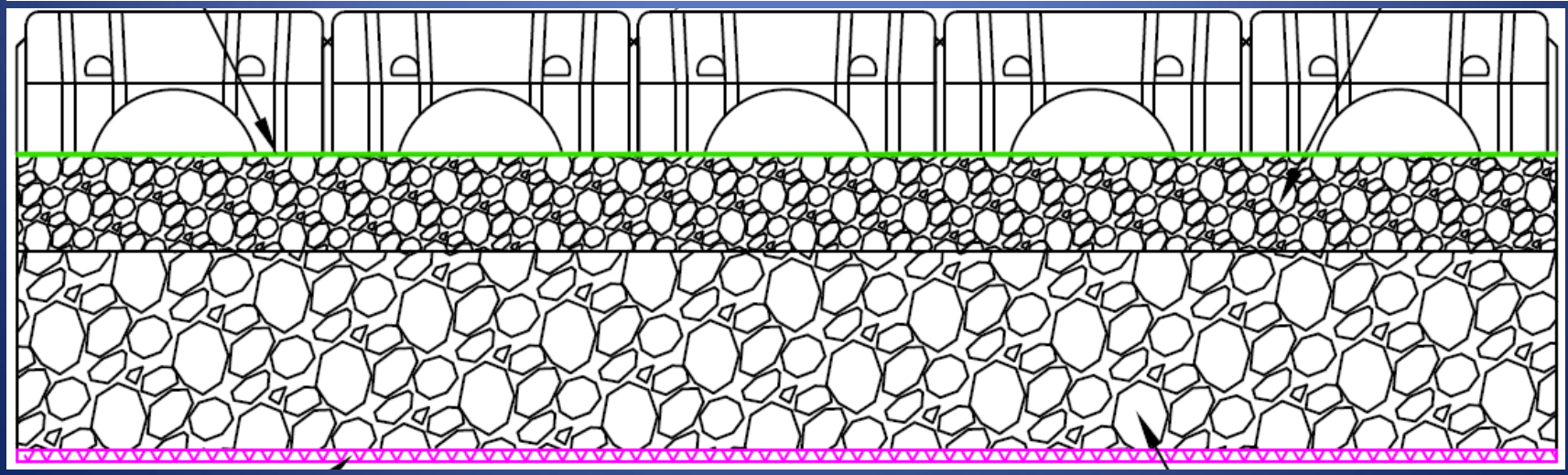
The PaveDrain Difference – Hand Placed

Typical PaveDrain Cross- Section(s)





The PaveDrain Difference

- NO Maintenance after 5 YEARS!!!
- 78,000 lb. two axel fire truck
- 550 gallons in 75 seconds

Infiltration Rates

PAVE DRAIN
STORMWATER'S ARCH ENEMY

CNA
engineers, surveyors & landscape architects

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 i
material in accordance with ASTM C1701/C1701M-09. The testing was pe
Ernest Maier Block Company Store located at 4700 Annapolis Road in Blad

Infiltration testing was performed on the PaveDrain material both
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.

4,000 Inches per hour!!

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.

STATE OF MARYLAND
STEPHEN KEITH NOLAN
No. 20467
REGISTERED
PROFESSIONAL ENGINEER

Sincerely,
CNA, Inc.

Stephen K. Nolan, P.E.
President

TESTING – 8” per hour. Thirty minutes following test

Pond 3P: PaveDrain - Chamber Wizard Field A

Chamber Model = PaveDrain S6-45 R
Inside= 6.54"W x 2.60"H => 11.2 sf x 12.00"L = 134.9 cf
Outside= 12.00"W x 5.60"H => 67.2 sf x 12.00"L = 806.4 cf

12.00" Wide - 1.0" Nesting = 11.00" C-C Row Spacing

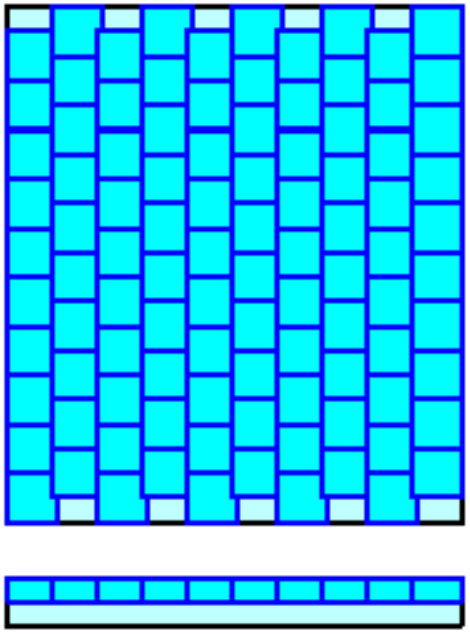
10 Chambers/Row x 12.00" Long = 120.00" Row Length +0.0" End Stone x 2 +6.00" Row Offset = 126.00" Base Length
10 Rows x 12.00" Wide - 1.0" Nesting x 9 = 111.00" Base Width
6.0" Base + 5.60" Chamber Height + 0.0" Cover = 11.60" Field Height

100 Chambers x 134.9 cf = 13,488.8 cf Chamber Storage
100 Chambers x 806.4 cf = 80,640.0 cf Displacement

162,237.6 cf Field - 80,640.0 cf Chambers = 81,597.6 cf Stone x 40.0% Voids = 32,639.0 cf Stone Storage

Stone + Chamber Storage = 46,127.9 cf = 0.001 af
Overall Storage Efficiency = 28.4%

100 Chambers
3.5 cy Field
1.7 cy Stone



The PaveDrain Infiltration Calculator

Project Name:	City of Milwaukee	Do you want to use the arch and gap spacing in PaveDrain for storage?	Enter 1 = Yes, 0 = No: 1
Address:			
	State: WI		
Project Size:	30,000 SF		

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

Storage Calculation		
Storage (CF) [Clean Stone + Pavedrain]		20,373.40
Gallons per Cubic Feet		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[4]	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		303,184.89
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)

[1] We have used accepted void percentages from local jurisdictions

[2] Based on NOAA Website figures

[3] See sheet "pavedrainvoid"

[4] Statistics on major cities from NOAA website

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).

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***

UNIVERSITY OF LOUISVILLE

Center for Infrastructure Research

PAVE DRAIN
STORMWATER'S ARCH ENEMY

❖ Three (3) Types of Maintenance: 2012 - 2013

- ❑ Vacuum Truck
- ❑ Compressed Air
- ❑ PaveDrain Vac Head & Combination Sewer Vac Truck

Maintenance Type	Number of Treatments
Vacuum & Sweeping	1
Pressurized Airjet	3
Vac-Head	1

UNIVERSITY OF LOUISVILLE

Center for Infrastructure Research

PAVE DRAIN
STORMWATER'S ARCH ENEMY

❖ Maintenance Effectiveness

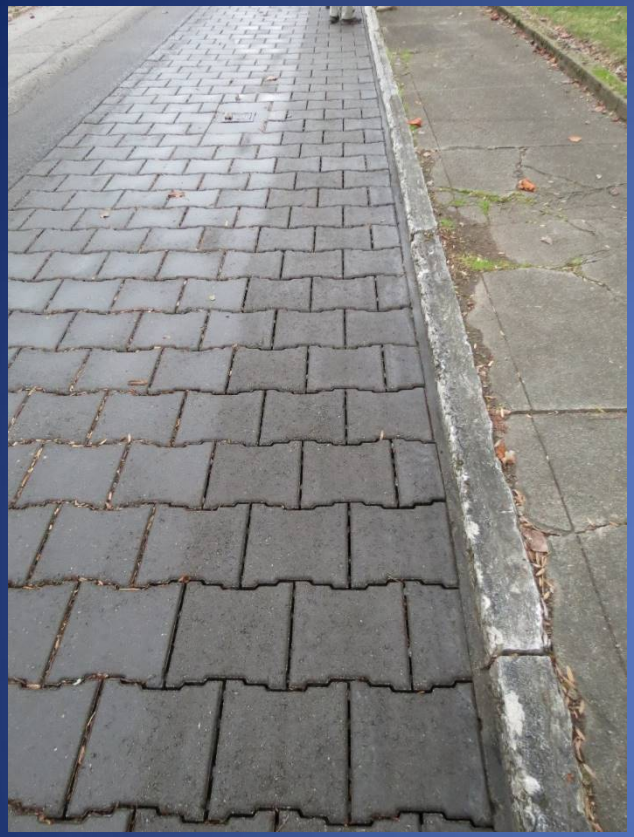
- ❑ PaveDrain Vac Head

PaveDrain Maintenance – FORD Louisville
Elgin Whirlwind VACUUM Truck

FORD Pre-Cleaning

FORD First Pass

PaveDrain Maintenance – City of Louisville
Elgin Whirlwind VACUUM Truck



Washington St. First Pass

Washington St. Full depth of PaveDrain Block

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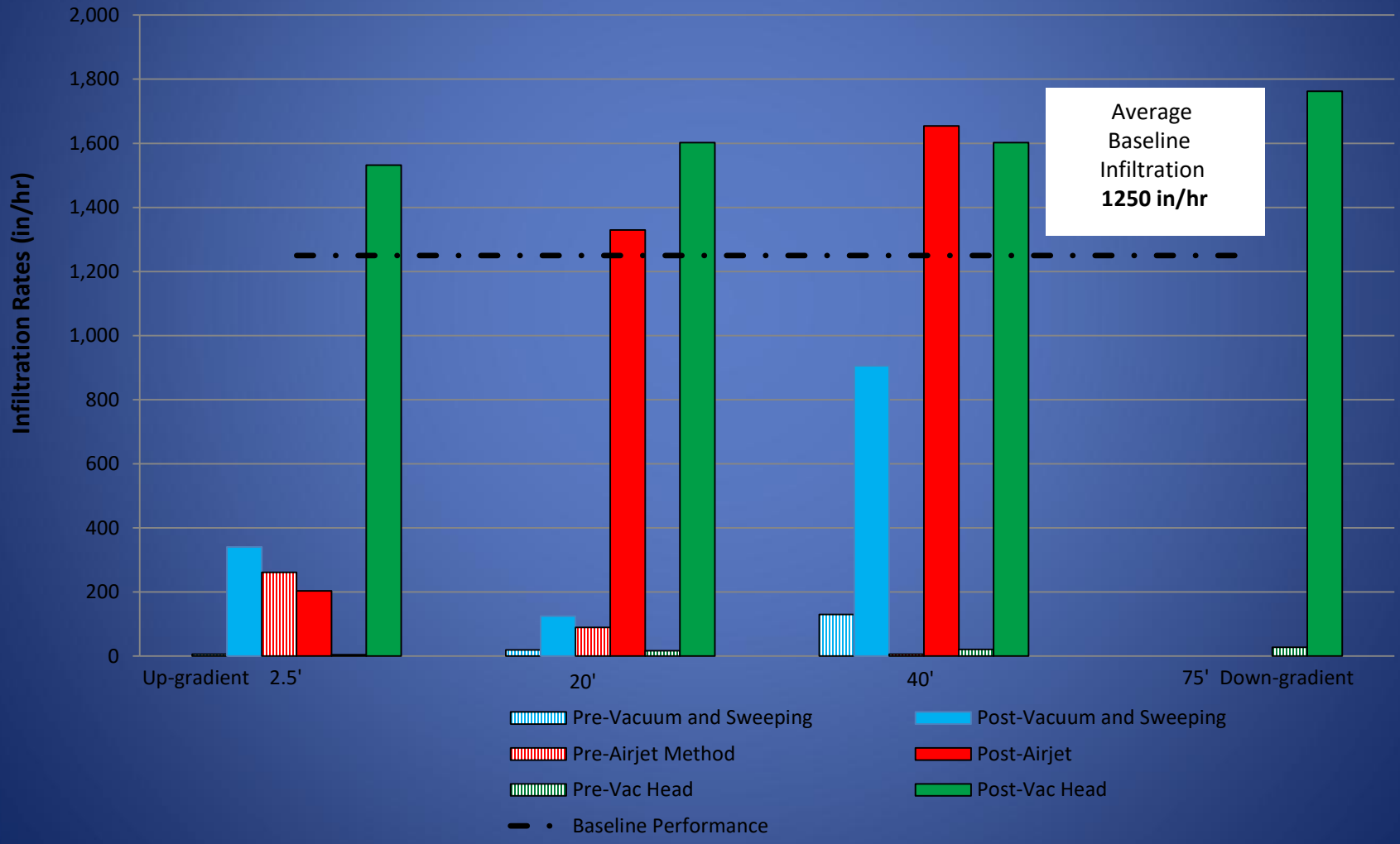
PAVE DRAIN
STORMWATER'S ARCH ENEMY

❖ Maintenance Effectiveness



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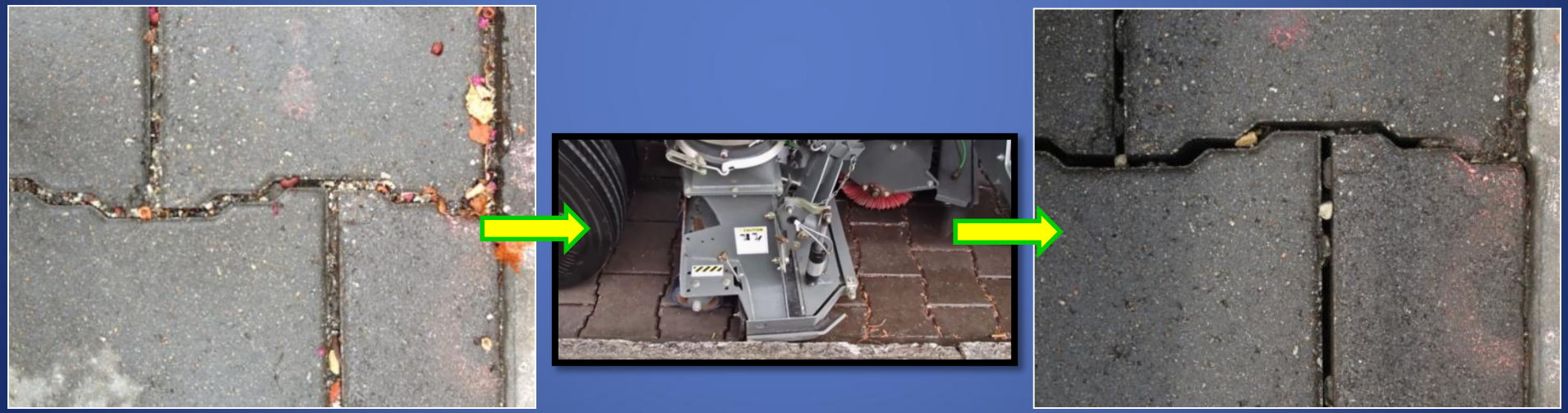
PAVE DRAIN
STORMWATER'S ARCH ENEMY

❖ Maintenance Effectiveness: Conclusions

- ❑ Performance can be restored
- ❑ Type of maintenance is important – NEED VACUUM TRUCK



MANUFACTURING

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.

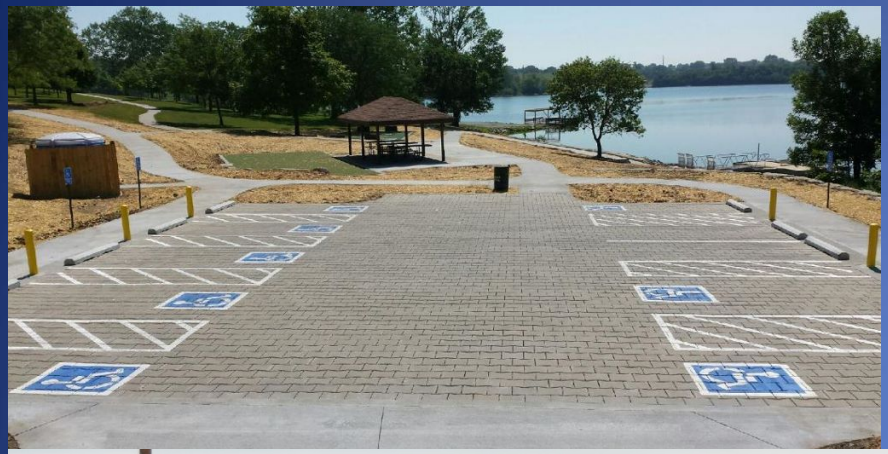
If a sealer is to be applied to the paving stones, it is recommended that any presence of efflorescence be removed prior to sealer being applied.

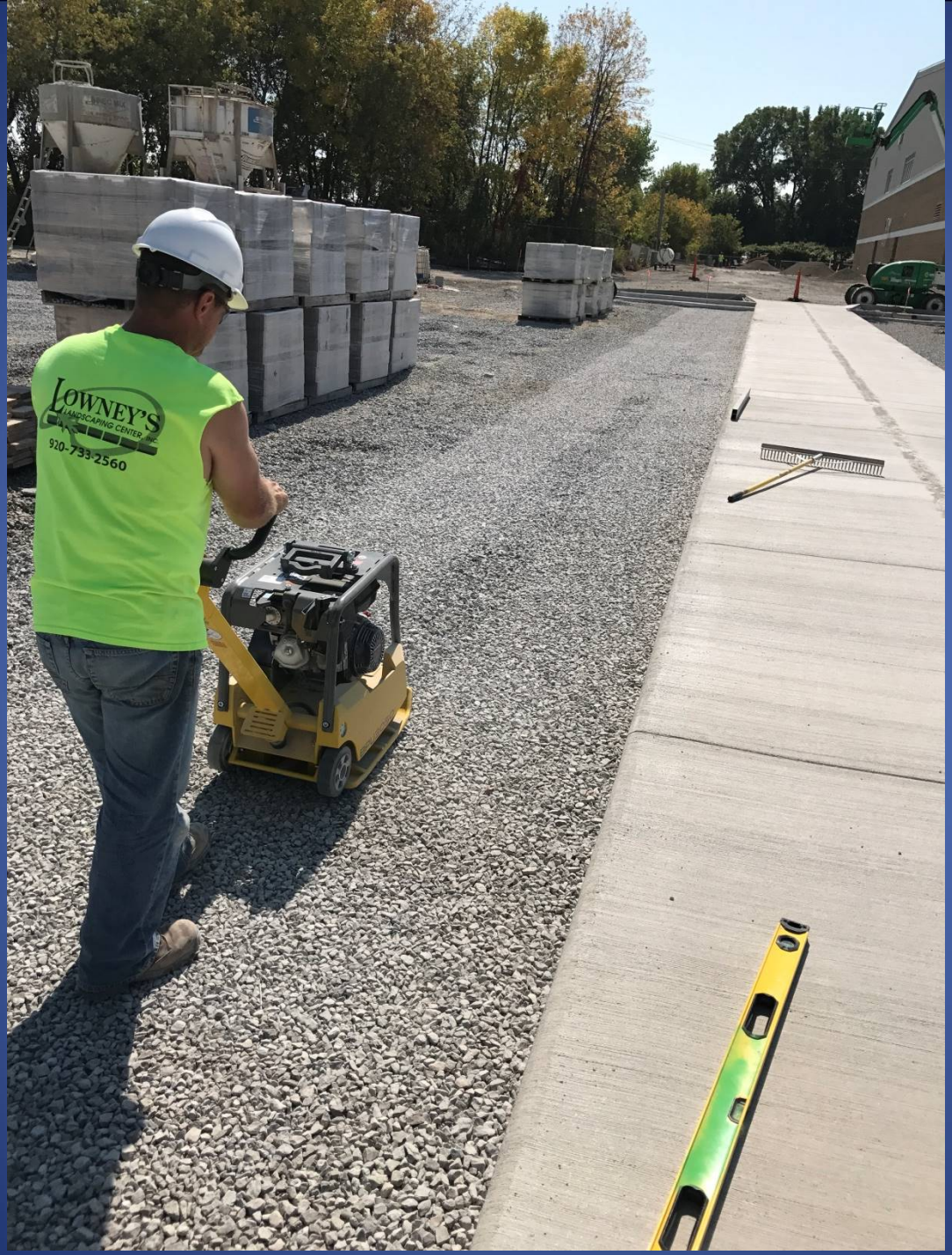
Color availability subject to change without notice

The PaveDrain Difference – Multiple Applications

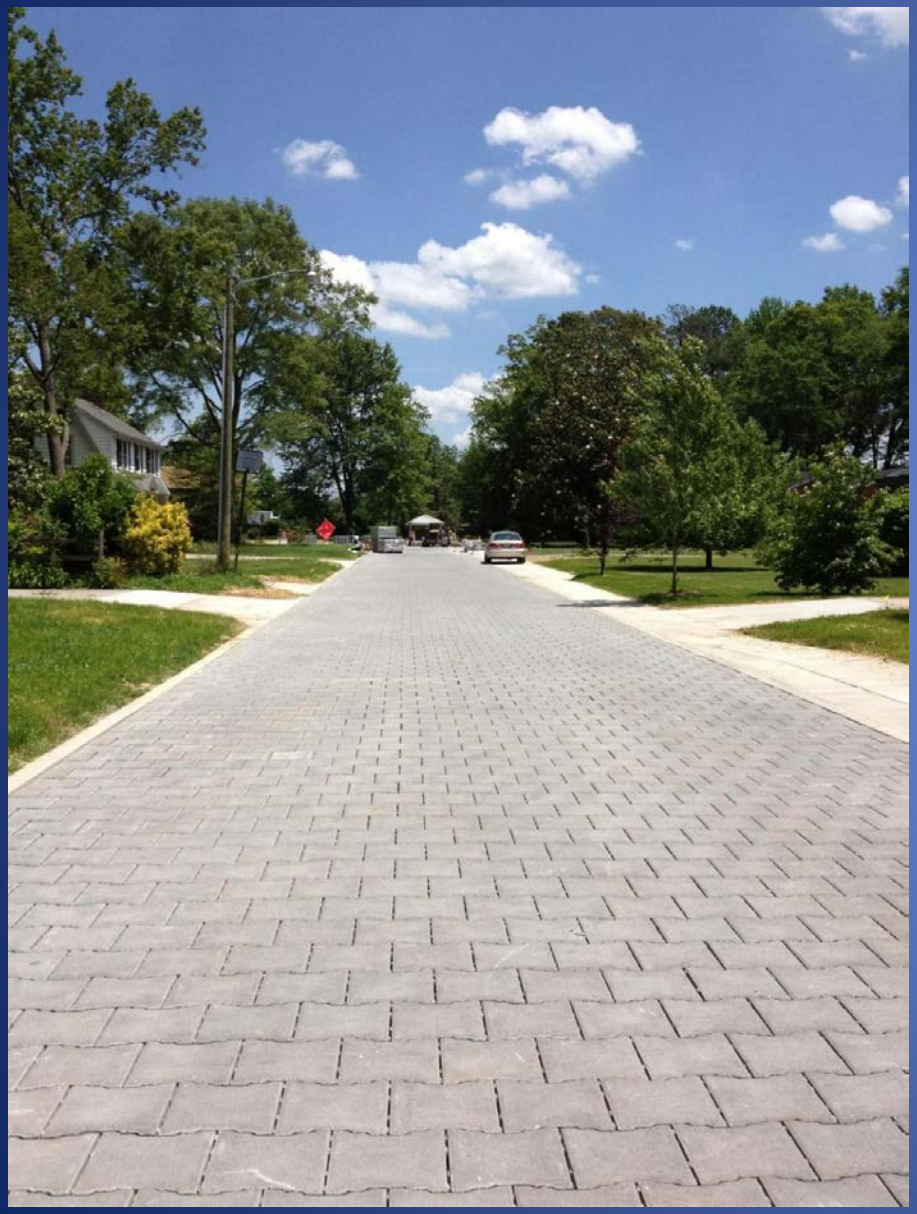
PAVE DRAIN
STORMWATER'S ARCH ENEMY

The PaveDrain Difference – Multiple Applications




LOWNEY'S
LANDSCAPING CENTER, INC.
920-733-2560

The PaveDrain Difference – Multiple Applications



The PaveDrain Difference – Working With Infrastructure

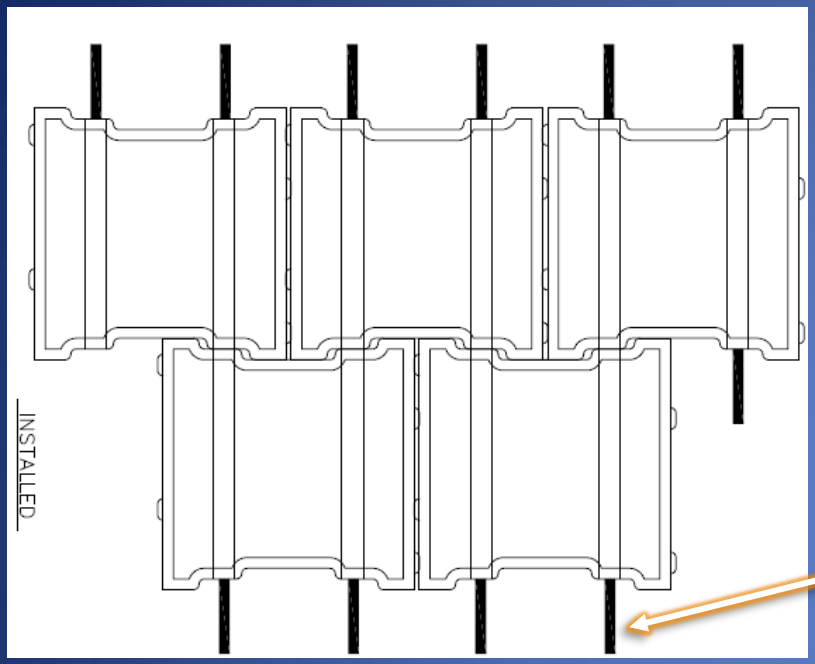
The PaveDrain Difference – Multiple Applications

Louisville Assembly Plant

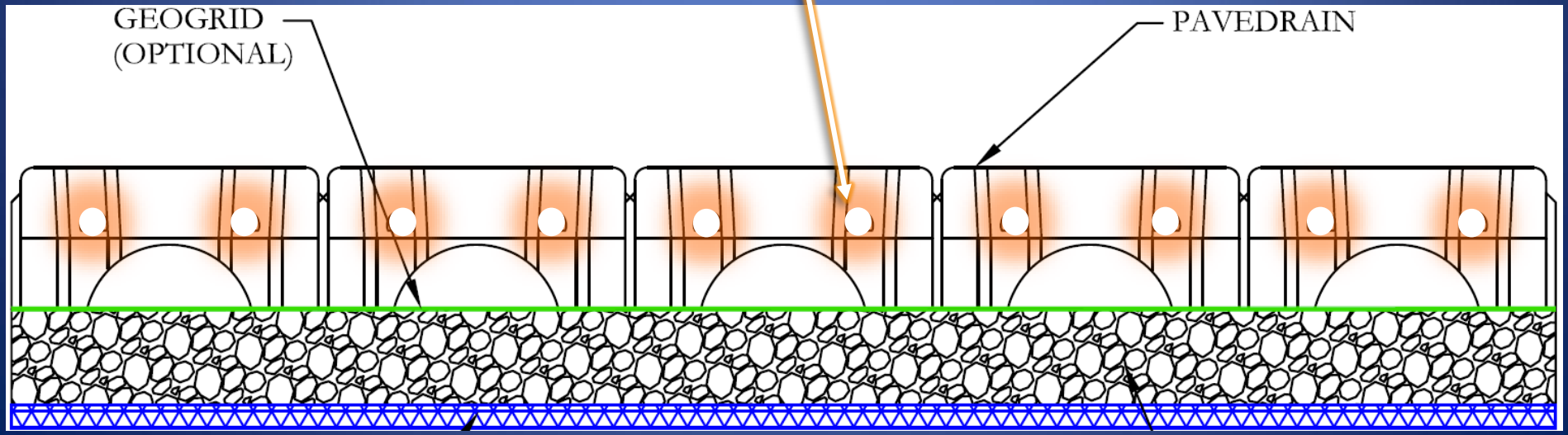
10:1 Drainage Ratio

“PaveDrain Heated”

Radiant Heat With PaveDrain



Six Inch Spacing Of The Wiring Through The Cable Ducts & The Arch Is The Key!



Radiant Heat With PaveDrain


FLEX N FLOW™

- Flex N Flow™ **is comprised of a BASF product called Elastocoast ®**
- Elastocoast® has been successfully used in European coastal protection applications since 2005

- Flex N Flow™ **is comprised of a BASF product called Elastocoast ®**
- Oldest North American installation-2007 Detroit River

- Field Tested Aggregate binder
- High Flex Strength to withstand settlement
- High Void ratio- dissipates hydraulic energy
- UV Stable
- Biologically Inert – NSF 61 Approved
- Flex N Flow is Elastocoast

- Easy to mix, pre-measured A and B components
- 45 minute working time
- Small , medium and large quantities available

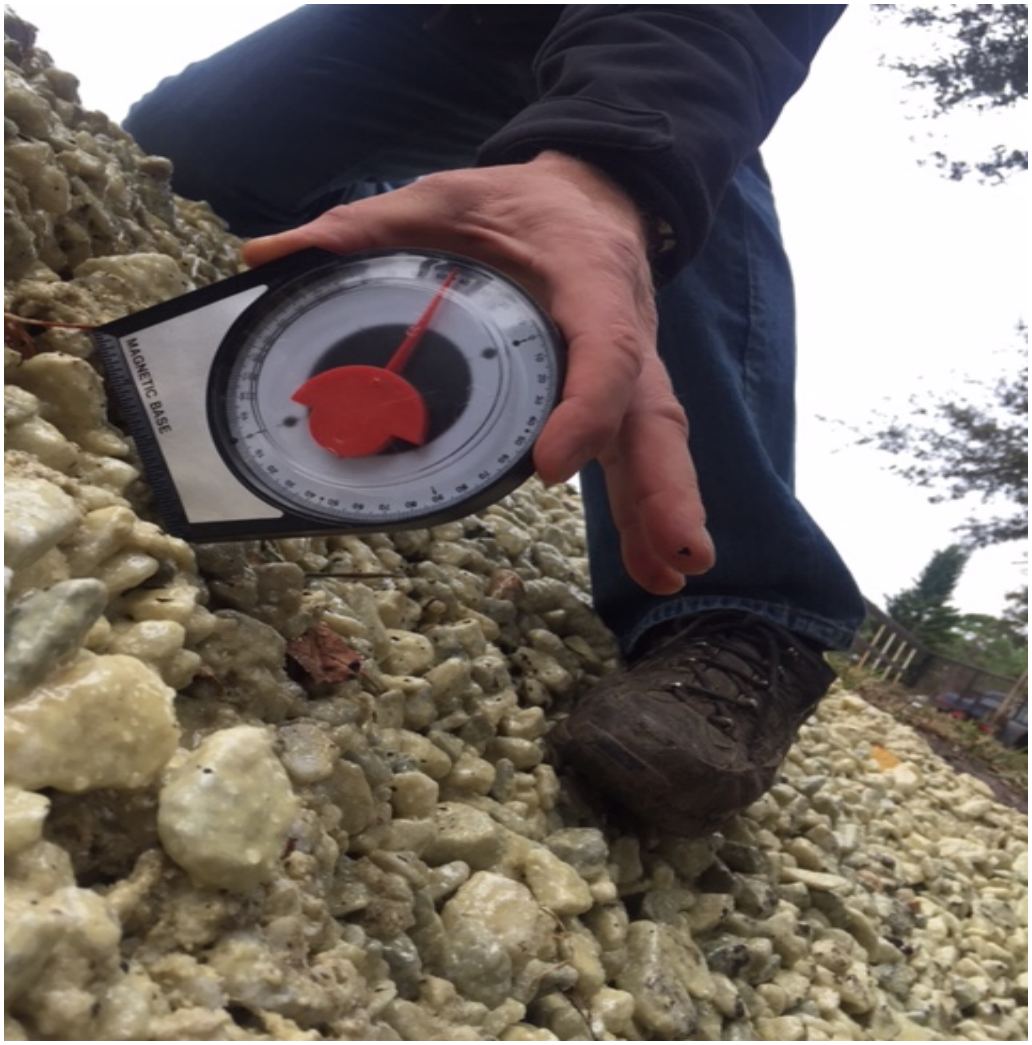
- Mix dry aggregate with pre-mixed binder

Clean up is no problem

- Flex N Flow™ **is available in small and medium sized kits for municipal Stormwater applications®**

Easy clean up

- Flex N Flow™ **solves the age old problem of protecting steep slopes in a natural way ®**



- Flex N Flow™ **solves the age old problem of protecting steep slopes in a natural way ®**

- Natural Appearance using Local Aggregate
- Installation training for new customers available

- Adheres to galvanized, steel , wood and concrete

- Shoreline Protection

- Shoreline Protection

Thank you