From: Dan Bishop [mailto:dbishop@emcositesolutions.com]
Sent: Friday, October 26, 2012 10:30 AM
To: Seltzer, Jeffrey (DDOE)
Cc: Stack, Rebecca (DDOE); bquinn03@emcoblock.com
Subject: RE: Publication of Proposed Rulemaking on Stormwater Management and Soil Erosion and Sediment Control

Jeff:

Hello. As we discussed a few weeks ago, we would like to discuss the possibility of PaveDrain having a separate category in your Section 3.4. Permeable Pavement System called "Permeable Articulating Concrete Block/Mats" (P-ACB/M). Maybe P-4 = Permeable Articulating Concrete Block/Mats (P-ACB/M) and P-5 can be the Plastic grid pavers?

Overall, you guys did a fantastic job on your Permeable Pavement Specifications. PaveDrain and other Permeable Articulating Concrete Block/Mats (P-ACB/M) would fall within the Permeable Interlocking Concrete Pavers (PICP) section for the most part. However, we believe there are enough differences to justify another section for P-ACB/M's or at least a subcategory within the PICP section.

Attached you will find the following items:

1. PaveDrain's Unique Features & Benefits

2. Infiltration Calculator
   -You can modify the input cells which are shaded in gray and have blue lettering. The calculator will also quantity the nutrient load reductions based on MDE design guidelines.

3. St. John's College High School in Washington, DC - Project Profile
   a. http://www.emcoblock.com/ This link will take you to the "Total Stormwater Infiltrated Since Completion" for the St. John's College High School.

4. Shaw Group's Flyer and White Paper on P-ACB/M
   -The Shaw Group is international known for their environmental designs and stormwater management practices.

5. HydroCAD Info - http://www.hydrocad.net/ref/pavedrain.htm
   -This is a stormwater modeling software program that includes the parameters for PaveDrain if you desire something more robust than our infiltration calculator above.

6. PaveDrain Specifications

7. PaveDrain Maintenance Recommendations - http://www.pavedrain.com/installation-maintenance

8. Your Section 3.4. Permeable Pavement System Specification with our comments

Any questions, please let me know. I look forward to hearing from you.

Thanks for your time and consideration.

Dan Bishop
Vice President/Team EMCO

PaveDrain Comments on Draft Stormwater Guidebook

Section 3.4 Permeable Pavement:

- **Page 77, List of Design Variants, P-4 Plastic Grid Pavers** - Maybe P-4 = Permeable Articulating Concrete Block/Mats (P-ACB/M) and P-5 can be the Plastic grid pavers?

- **Page 75, Figure 3.4.1, Cross Section of a Permeable Pavement Design** - PaveDrain is large enough to sit directly on #57 stone so we can eliminate the bedding layer.

- **Page 81, Table 3.4.1. Different Permeable Pavement Specifications** - Add section for Permeable Articulating Concrete Block/Mats (P-ACB/M)

- **Page 88, Permeable Pavement Installation** - Add section for Permeable Articulating Concrete Block/Mats (P-ACB/M)

- **Page 90, Construction Inspection** - Add section for Permeable Articulating Concrete Block/Mats (P-ACB/M)

- **Page 92, Permeable Pavement Maintenance Criteria** - Add section for Permeable Articulating Concrete Block/Mats (P-ACB/M)

PAVE DRAIN™

STORMWATER'S ARCH ENEMY

INFILTRATION CALCULATOR

Project Name:	DC Example Project
Address:	Washington , DC
	State: DC
Project Size:	40,000 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]	39.35
Gallons per Square Foot Factor ("GF")	0.62001
Gallons per Square Foot based on Above	24.40
Storage Space per Pavedrain Block[3]	0.095

Rain Event Calculation & Annual Stormwater Infiltration		
State Capital Largest Daily Rainfall - 2011[4]	Washington D.C. 3.33	Inches
Infiltration Rate per Hour Based on Soil		0.50
Target Rainfall Event (Inches/Hour)		5.00
Indicated Gallons of Water on Pavedrain		124,002.00
Excess (Deficit) of Water Storage (Gallons)		91,588.92
Hours to Infiltrate Event in Soil (Rain Event)		10.00
Annual Gallons Infiltrated of Runoff from Direct Rainfall		975,895.74
Hours to Infiltrate Direct Rainfall (Rainfall-Year/Infiltration Rate)		78.70

Storage Calculation	
Storage (CF) [Clean Stone + Pavedrain]	27,164.53
Gallons per Cubic Feet	7.48
Total Storage In Gallons [Clean Stone + Pavedrain]	203,190.72
Total Storage - Infiltration [Rate x SF x GF]	12,400.20
Total Storage in Gallons	215,590.92
Maximum Rain Event Storage [Storage + Infiltration]	8.69

Supplemental Surface	
Roof (SF)	15,000
Impervious Surface (SF)	10,000
Total Supplemental Surface	25,000
Total Gallons for Year	609,934.84
Capacity Required during Targeted Rain Event	77,501.25
Capacity Required during 2" Inch/Hr Event	31,000.50

[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

EMCO SITE SOLUTIONS

EMCO Site Solutions
Stormwater & Driveway Upgrades
Service Road and Turn-Around,
St. John's College High School, Washington D.C.

August 2012

Contractors: Capitol Hardscapes
EMCO Site Solutions

Products: PaveDrain Performance Pavement
Tencate Mirafi FW402 -
Stabilization/Drainage Fabric

Stormwater management regulations meant that St. John's College High School in Washington, D.C. needed to find a low impact development solution for the development of their cafeteria and library. The civil engineer, Landesign Inc. of Bowie, Maryland, in concert with the project architect, Perkins Eastman, came up with a design to detain and convey both the roof, patio and concrete service road runoff. All combined, the underground storage tank, piping the runoff to daylight, and paving of the service road would cost the school approximately $150,000.

EMCO SITE SOLUTIONS

Ernest Maier's Site Solutions Division presented PaveDrain as an alternative solution to Landesign. By modifying the base depth of clean stone in different areas of the service road and modeling the storage capacity of the arch in the PaveDrain block, Landesign Inc. utilized PaveDrain to solve various point sources issues presented at St. John's.

Upfront Capital Investment	$100,000
Capital Cost per Gallon Infiltrated - Year 1	$0.167
Capital Cost per Gallon Infiltrated - Year 5	$0.033
Capital Cost per Gallon Infiltrated - Year 20	$0.008

A PaveDrain service road could not only infiltrate direct rainfall on the 8,000 square foot service road, but also to infiltrate the rainfall from the 16,500 square feet of roof and patio adjacent to this service road. The PaveDrain solution designed for the stormwater management challenge saved St. John's $50,000 in their upfront construction costs from its original "detain and convey" design and will infiltrate 600,000 gallons or 80,000 cubic feet of rainfall annually.

INFILTRATION ANALYSIS

Project Name: St. John's College High School Cafeteria Service Road
Address: 2607 Military Road NW
State: DC

Project Size: 8,000 SF

Annual Cubic Feet Infiltrated	79,748
Annual Gallons Infiltrated	596,516

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)	24.00
Rainwater per Year in State (inches)[2]	39.35
Gallons per Square Foot Factor ("GF")	0.62001
Gallons per Square Foot based on Above	24.40
Storage Space per Pavedrain Block[3]	0.095

Rain Event Calculation & Annual Stormwater Infiltration		
State Capital Largest Daily Rainfall - 2011[4]	Washington D.C. 3.33	Inches
Infiltration Rate per Hour Based on Soil		0.50
Target Rainfall Event (Inches/Hour)		3.33
Indicated Gallons of Water on Pavedrain		16,517.07
Excess (Deficit) of Water Storage (Gallons)		50,537.12
Hours to Infiltrate Event in Soil (Rain Event)		6.66
Annual Gallons Infiltrated of Runoff from Direct Rainfall		195,179.15
Cubic Feet of Runoff Infiltrated		26,093.47

Storage Calculation	
Storage (CF) [Clean Stone + Pavedrain]	8,632.91
Gallons per Cubic Feet	7.48
Total Storage In Gallons [Clean Stone + Pavedrain]	64,574.14
Total Storage - Infiltration [Rate x SF x GF)	2,480.04
Total Storage in Gallons	67,054.18
Maximum Rain Event Storage [Storage + Infiltration]	13.52

Supplemental Surface	
Roof (SF)	16,450
Impervious Surface (SF)	-
Total Supplemental Surface	16,450
Total Gallons for Year	401,337.12
Cubic Feet of Runoff Infiltrated	53,654.70
Capacity Required during Targeted Rain Event	33,963.22

EST. 1926
ERNEST MAIER Inc.
BLOCK • MASONRY • HARDSCAPING

Project Name: St. John's College High School Cafeteria Service Road
Address: 2607 Military Road NW
State: DC

Project Size: 8,000 SF

Using Maryland MDE Regulations

Potential Drainage Area For Nutrient Load Reduction:

For 1.2 inch storm event:

89,638.41 SF
2.06 Acres

For 1.2 inch/hour storm event we can capture and store runoff from 2.06 Acres

New SWM Practices Calculation - *Event Mean Concentration Method*

			(A)	(B)	(C)	(D)	(E)	(F)
Treated Area (acres)	TN Concentration (mg/l)	TP Concentration (mg/l)	TN Load (lbs/yr)	TP Load (lbs/yr)	TN Load After Reduction (lbs/yr)	TP Load After Reduction (lbs/yr)	TN Difference (lbs/yr)	TP Difference (lbs/yr)
2.06	2	0.30	10	2	7	1	3	1

R = 10.87

- Rainfall Average in Maryland = 40 inches
- Imperviousness = 28% equivalent to Medium Density Residential (based on work by Cappiella, K. and K. Brown, "Impervious Cover and Land Use in the Chesapeake Bay Watershed," Center for Watershed Protection. Ellicott City, Md. 2001); see also "Imperviousness" tab in Nonpoint Source
- Average Urban Pollution Concentrations for TN and TP were cited from the Maryland Stormwater Design Manual, see pp 1.6

- Use the Simple Method (Schueler, 1987) equation to calculate the load:

L = 0.226 * R * C * A where, the following variables apply:

L = Load (lbs/yr)
A= Area Treated (acres)
C= Pollutant Concentration (mg/l)
R= Runoff
0.226 = a unit conversion factor

Where runoff is calculated using the following:

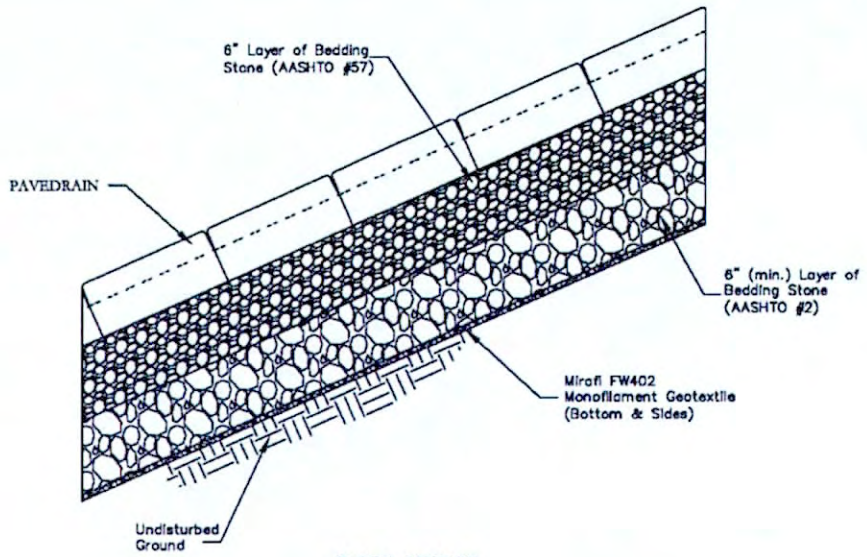
R = P * Pj * Rv where:

P = Annual Rainfall (inches)
Ia = Impervious Fraction (%)
Pj = Fraction of events that produce runoff (usually 0.9)
Rv = 0.05 + (.9 * Ia)

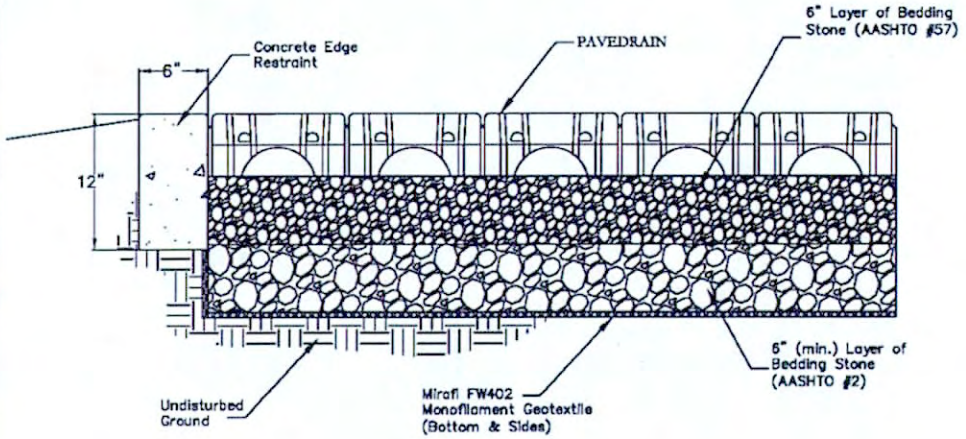
The System Design

For the unique stormwater challenges at St. John's, Landesign engineered a system utilizing a roof runoff drain system that discharged water into the base of the PaveDrain system. At St. John's, the infiltration test showed a soil infiltration rate of .7 inches per hour. In the roof runoff discharge area, Landesign specified a base depth in excess of four feet of #2 stone to accommodate the stormwater from the adjacent impervious surfaces.

Unlike competing systems, the PaveDrain system at St. John's allows the stone base to be used as a "retention and infiltration pond." On other projects with lower infiltration rates, the stone base in the PaveDrain system can be used in detention and conveyance.



SLOPE–SECTION
SIDE VIEW



CROSS–SECTION
END VIEW

PAVEDRAIN
STANDARD DETAIL
ST. JOHN'S SECTIONS
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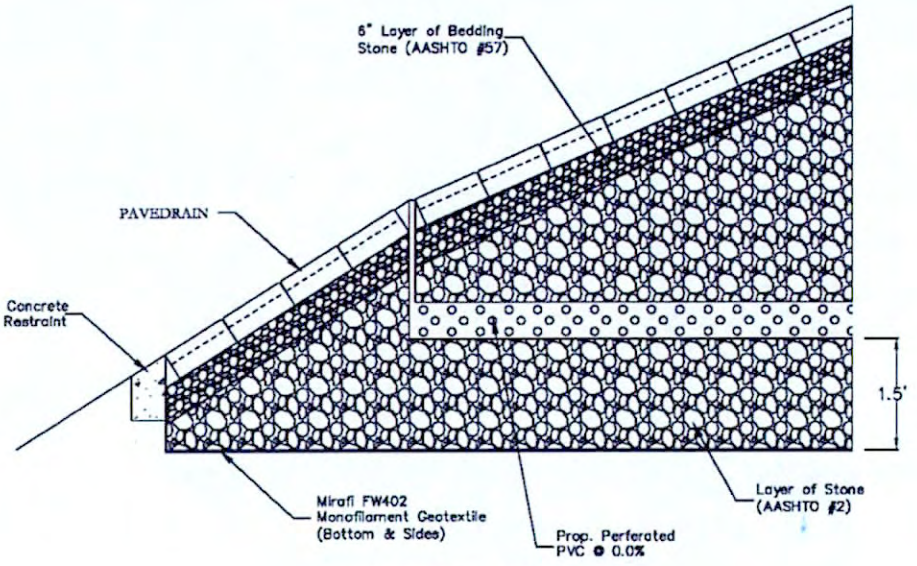
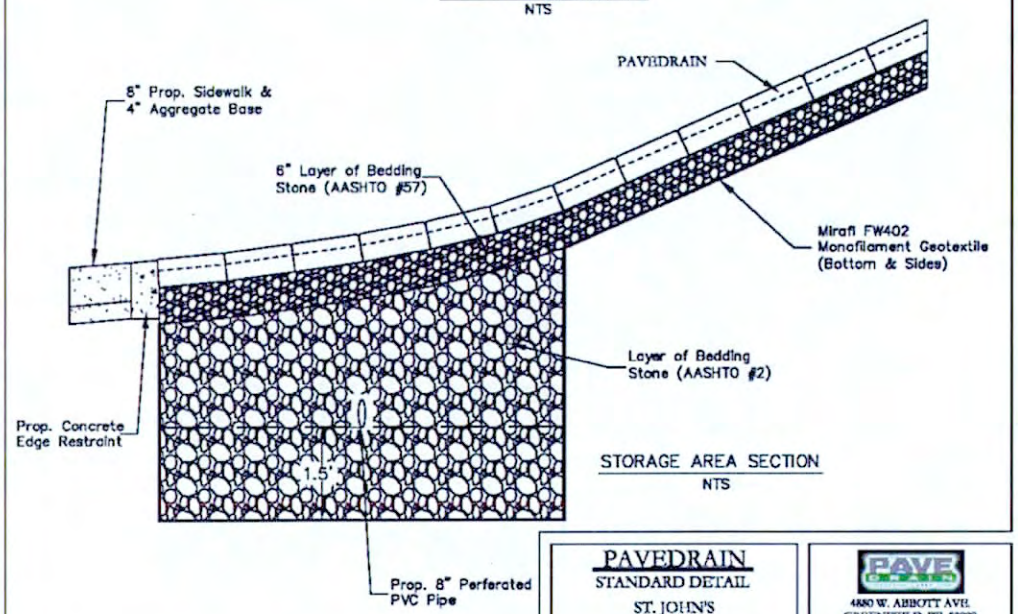
(414) 423-6531
WWW.PAVEDRAIN.COM



STORM DRAIN SECTION
NTS



STORAGE AREA SECTION
NTS

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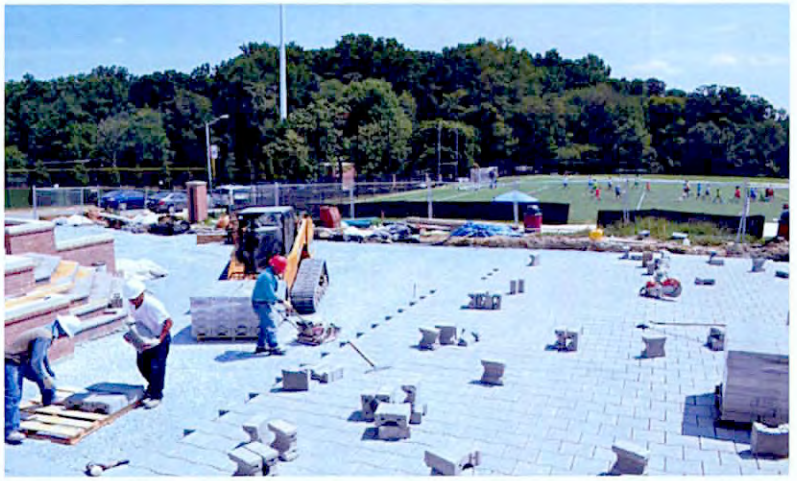
First, the site was excavated down to the required stone depth, then Tencate Mirafi FW402 monofilament geotextile was installed directly on the native subgrade.

Next, AASHTO #57 stone was placed on top of the geotextile and then compacted and graded to design specifications.



Completed driveway area graded and compacted to a level surface before placement of PaveDrain.

PaveDrain blocks were hand-laid to minimize expense and reduce congestion with typical large construction equipment.

PaveDrain as a Stormwater Management Solution

The service road behind the cafeteria required a sturdy surface capable of daily abuse from large food delivery and garbage haulers. The surface of over 8,000 sq. ft. is used to drain over 16,500 sq. ft of additional impermeable surface on the site. The service road also acts as overflow parking during sporting and other events at the school.

PaveDrain is Performance Pavement™

About some of the Project Participants:

ST. JOHN'S
COLLEGE HIGH SCHOOL | Est 1851

Faithful to the charism of St. John Baptist de La Salle, St. John's College High School is an independent Catholic college preparatory school whose mission is to provide an excellent academic and Christian education in an environment that welcomes diversity, enlightens our students, and forms the foundation of an education that lasts a lifetime.

St. John's is a community of faith and zeal with dedicated Lasallian educators committed to the spiritual, academic, cultural, physical and moral development of every student. Rooted in Christian values, the Lasallian experience at St. John's prepares young men and women for a life of leadership, achievement and service to the community.

stjohnschs.org

Landesign

ENGINEERS * SURVEYORS * PLANNERS
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BOWIE, MARYLAND 20716
(301) 249-8802

Landesign, Inc. was founded in 1988 for the practice of engineering, land surveying and land planning. We are a multi-disciplined firm involved in all forms of surveying and engineering work in the Baltimore, Washington, D.C., and Virginia. We take great pride in the fact that we meet, if not exceed our contractual obligations, even when very rigid or unrealistic time frames are required in the fast paced construction industry.

Perkins Eastman

Perkins Eastman was founded on the belief that
architecture is a research-oriented process.

Underlying this philosophy is the conviction that with a thorough understanding of each building type's requirements, we could realize the true potential of any project and enrich the quality of life of its users as well as the communities in which they are located.

Perkins Eastman's organizational structure accommodates the different operating and design styles of each of the firm's principals, who work together to critique, strengthen, and reinforce each other's projects. The range of design vocabularies employed for these building types illustrates the diversity of the firm's principals and clients. In this way, the firm leverages its continually growing body of research and industry expertise to provide clients with unique solutions that are thoughtful, well designed, and uncompromised.

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PAVE® DRAIN

STORMWATER'S ARCH ENEMY

SJC ST. JOHN'S COLLEGE HIGH SCHOOL | Est 1851

TENCATE

materials that make a difference

Perkins Eastman

TABLE 1: **Unique Features and Benefits of PaveDrain**

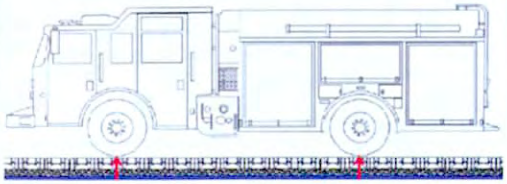
FEATURE(S)	Description	General Benefit	Direct Benefit to Owner
4,000 Inches Per Hour Infiltration Test by Documented 3rd Party Testing 	Amount of water that the PaveDrain System passes per ASTM C1701 infiltration test.	4,000 inches per hous is an unparralleled amount of stormwater infiltrationfor one (1) square foot diameter. No other documented product is capable of this infiltration rate at this time. The is the key performance to the system.	Even if the system is clogged by 50% the owner will still have 2,000 inches per hour of infiltration. This will help to reduce maintenance costs.
Arch 	Pre-formed patented arch located at the bottom of the unit. Gives 20% storage capacity.	A block with a built in arch can hold excess stormwater above the stone base. It becomes the last line of defense for storage volume; allowing for the storage of an inch of rainfall. It also provides some thermal benefits. Open arch chamber keeps a constant temperature for longer times.	A lighter block can help reduce shipping costs. Less trucks means less traffic. Can also help minimize the amount of stone base require if arch is incorporated into stroage design
HS-20/H-20 Loading data 	Rating terminology used to determine if a product passes test to handle heavy truck loads on roads and bridges.	Regulatory clearance for product to be used on surfaces that take on heavy truck loads. Proves that product can withstand weights.	Allows the use of heavy trucks *WITHOUT* special signage or documentation. It makes for a seamless transition from traditional surfaces (asphalt & concrete) to the PaveDrain System. It will save the owner money.

TABLE 1: **Unique Features and Benefits of PaveDrain**

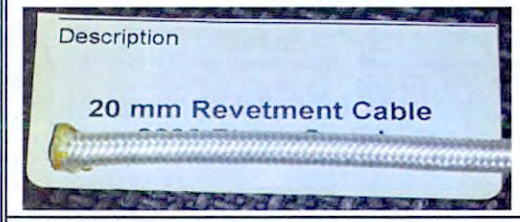
FEATURE(S)	Description	General Benefit	Direct Benefit to Owner
Compressive Strength ASTM INTERNATIONAL Designation: D 6684 – 04	Capacity of a material or structure to withstand axially directed pushing forces. The rating system is determined by Pounds per Square Inch (psi).	The PaveDrain System adheres to ASTM D 6684-04 for minimums in compressive strength which is 4,000 psi.	Block producers will be able to meet and exceed ASTM D 6684-04 for compressive strength (Min. 4,000 psi). Documentation will be provided as well.
Mix Design of Concrete ASTM INTERNATIONAL Designation: D 6684 – 04	Concrete mix design is defined as the appropriate selection and proportioning of constituents to produce a concrete with pre-defined characteristics in the fresh and hardened states.	In general, concrete mixes are designed around local aggregates in order to achieve a defined characteristics for a product (i.e. compression & absorption).	Block producers will be able to meet and exceed ASTM D 6684-04 for compressive strength (Min. 4,000 psi) and absorption (Min. 10 lbs/ft^3).
Polyester Cable (cable for mats) 	Polyester cable is wrapped with a nylon sheath and is completely inert to any environmental or biological degradation. Will not be exposed to UV when fabricated into mats. Has been utilized by ACB industry for 50+ years.	Allows for minimal unskilled labor for efficient installation of product in mattress form. Will also allow for mattress removal at a later date, if required, without degradation.	Mats can be installed with local or municipal crews. Learning curve is only a few mats. Mats could be sized for later removal by municipal crews for repair of underground utilities
 **Unit Spacer**	Two 1/4" wide concrete tabs located on both sides of each PaveDrain unit.	Keeps each unit equally spaced within the matrix of the system and helps with unit interlock. Also facilitates permeability across the system.	Spacers are manufactured as an integral part of the system so that it is impossible to have spacers abut one another no matter which direction the block is installed.

TABLE 1: **Unique Features and Benefits of PaveDrain**

FEATURE(S)	Description	General Benefit	Direct Benefit to Owner
Beveled Edge 	R0.500 Edge located around the top of the unit.	Provides a smooth transition between the vertical and horizontal portion of the unit. Facilitates in the movement of water from the surface down the side of the unit.	Allows for the use of rubber or steel edged snow plows, smooth transition between each unit reduces trip hazard and lowers risk and liability.
Interlocking Shape 	Patented shape that allows each unit to positively interlock with one another ***without*** the use of aggregate between the joints.	Allows one unit to have contact with six other units within the system giving greater resistence to lateral movement without the use of aggregate between the joints.	Visually appealing.
System Permeability	Allows for the infiltration of stormwater runoff across the system by running down the open gaps between each individual unit.	Unit is NOT made of permeable concrete, therfore the water flows down through the systems open gaps where it is designed to flow. This increases flow rate.	The vertical infiltration path provided by the open gap across the system allows for faster infiltration of stormwater runoff.
Permeability Maintenance	Maintenance associated with permeable surfaces such as vacuuming or sweeping at regular intervals.	Due to its open joint concept the maintenance of the PaveDrain System has been drastically reduced for most applications	Decreased Maintenance = Lower Costs
Thermal Capabilities	Unique benefit provided by the patented arch.	The mass of concrete above the arch will absorb heat during the day and radiates it back out at night. In the summer the converse is true. Thus the swing in temperature inside the arch is very mild. Also called the "Adobe Hut Effect"	Due to its lighter color, the "Heat Island" effect can be reduced when compared to traditional asphalt surfaces. The PaveDrain area stays a few degrees warmer across the surface allowing for quicker snow melt and less de-icing or sanding agents.

TABLE 1: **Unique Features and Benefits of PaveDrain**

FEATURE(S)	Description	General Benefit	Direct Benefit to Owner
Freeze-Thaw Testing Designation: C 1262 – 95 Standard Test Method for Evaluating the Freeze-Thaw Durability of Manufactured Concrete Masonry Units and Related Concrete Units[1]	ASTM C1262 covers the resistance to freezing and thawing manufactured concrete masonry and related concrete units. Units are tested either in water or in a saline solution depending on the intended use of the units in actual service.	The procedure described in this test method is intended to determine the effects of freezing and thawing on concrete units in the presence of water or saline solution. The procedure is *not* intended to provide a quantitative measure of the length of service that may be expected from a specific type of concrete unit.	Each individual block producer would provide the documentation proving that the product is made consistently and will meet the specified standards required.
ADA Compliant Gaps Americans with Disabilities	This falls under 4.5.4 Gratings. If gratings are located in walking surfaces, then they shall have spaces no greater than 1/2" (13 mm) in one direction.	Allows for smooth transition between each unit for wheeled devices and heeled shoes.	Keeps each installation compliant under the regulations set forth.
Sustainable Product / Mat Removal	SEE POLYESTER CABLE	SEE POLYESTER CABLE	SEE POLYESTER CABLE
Broken Unit Replacement	Describes the action of removing an individual PaveDrain unit from within the system.	This is done by completely breaking the unit and removing all the broken pieces. The cables stay intact. New block is placed over the top of the cables. Cables now rest in the arch.	Can easily be done by municipal crews.

TABLE 1: **Unique Features and Benefits of PaveDrain**

FEATURE(S)	Description	General Benefit	Direct Benefit to Owner
Unit Pop-Outs 	When a small paver (<5 lbs) works its way out of place due to vibration and loss of aggregate or sand interlock. This is noticable when one or two units are missing in the middle of an application, which can lead to maintenance and liability issues.	Each PaveDrain unit is 5.65" (± 1/8") tall and weighs between 45-49 lbs each. It's unique "hour glass" shape facilitates an interlocking unit together with the next unit. When combined with the use of the cable eliminates any possibility of pop-outs.	Less maintenance and reduced liability.
Installation (ease and speed) 	Fabricating the individual PaveDrain units into mats increases the speed and ease of installation.	PaveDrain 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 equipment. Mattress installation can saves time and labor.	The contractor 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.
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 site.	Local manufacturing reduces transportation costs and will benefit local economies.	The units would be manufactured within a 3 hour or 300 mile radius of the project.

TABLE 1: **Unique Features and Benefits of PaveDrain**

FEATURE(S)	Description	General Benefit	Direct Benefit to Owner
LEED Credits	Leadership in Energy and Environmental Design (LEED) consists of a suite of rating systems for the design, construction and operation of high performance green buildings, homes and neighborhoods.	PaveDrain's general benefits fall mostly under Stormwater and Site development.	Five different credits can be associated with the use of the PaveDrain System: Credit 5.1, Credit 5.2, Credit 6.1, Credit 6.2 and Credit 7.1.
Life Cycle	Longevity of a system or product	Block systems for erosion control have been around for 60+ years. The PaveDrain System coulbe be in excess of 100 years. IF a single block breaks it can easily be replaced. The cable will last as long as the block.	Lower infrastructure costs allowing for more projects to be facilitated throughout the area.

Sustainable Low-Impact Volume Control System™ for Excess Stormwater

Shaw offers a full range of water resources engineering, construction, consulting, and project management services for both public and private clients. We have the experience and technical expertise to provide comprehensive, environmentally responsible, and reliable water resource solutions that result in efficient collection systems, sustainable treatment facilities, and defensible financing strategies.

Innovative and Sustainable Stormwater Management

Excess stormwater and the associated non-point source pollution impacts municipalities and private developments around the world. Traditionally, stormwater practices involve the collection and rapid conveyance of stormwater runoff, from urban and rural land uses, to receiving water bodies and treatment facilities. These systems are effective until the level of service is exceeded by the rate or volume of runoff. Once the system capacity is exceeded, flooding occurs and property could be damaged. Replacing systems with larger pipes and ponds only raises the level of service until the system capacity is once again exceeded.

SLVS Benefits

- Decreases need for pavement management
- Reduces infiltration and inflow and can lower restoration cost of future utility projects
- Creates pedestrian friendly environments that support economic development
- Provides new trees/planters that store and transpirate stormwater
- Improves water quality of storm discharges (targeting phosphorus, nitrogen, and Total Suspended Solids) and reduces scouring of natural streams
- Creates usable/accessible natural areas that help clean storm water
- Helps eliminate standing water that could create public safety hazards
- Cost competitive and flexible
- Local problems can be fixed without aggravating upstream/downstream conditions
- Can make use of existing collection/conveyance infrastructure
- Requires no purchasing of taxable property
- Not limited by conflicts with other buried utilities
- Integrates green infrastructure practices
- Implementation can be phased to accommodate budgets or other constraints
- Attenuates peak discharges, reducing the flashy nature of urban runoff that damages local streams and receiving water bodies
- Contributes to MS4 stormwater permit and TMDL water quality performance goals

Realizing the need for a more flexible solution to the management of stormwater runoff control and the need for a sustainable, green treatment and storage system, Shaw has engineered a sustainable, low impact, volume control system (SLVS). This system can provide an efficient and effective stormwater management tool that could virtually eliminate the need for costly pipes and ponds. The approach has wide ranging flexibility, which can be applied to small localized flooding problems as well regional watershed management strategies. The backbone of the SLVS green infrastructure tool

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Shaw Sustainability Solutions—The Full Picture

Stormwater Management	• Hydrologic/Hydraulic Analysis • Water Quality Planning and Design • Watershed Management Planning • Storm Water Utility Development • NPDES/TMDL Compliance Strategies • Green Infrastructure Planning and Design • Floodplain Management
Sustainable Program Development	• Sustainability Assessments • Sustainability Policy and Strategy • Program Design and Implementation • Sustainability Metrics and Performance Measurement • Sustainability Management Systems • Sustainability Reporting and Information Management
Waste Management	• Source Reduction/Pollution Prevention • Recycling and Reuse • Material Life Cycle Analysis • Waste Audits
Clean Energy	• Energy Efficiency • Renewable Energy • Alternative Fuels • Fleet Efficiency
Design, Development and Improvement	• Green Building Design/LEED • Green Communities • Green Infrastructure/Low Impact Development • Sustainable Redevelopment • Existing Building LEED • Commissioning
Natural Resource Management	• Restoration • Ecological Land Reuse • Sustainable Redevelopment
Environmental Markets	• Carbon Trading • Nutrient Trading • Wetlands Banking • Ecosystem Mitigation Banking
Carbon Emissions Management Services	• Carbon Footprinting • Mitigation Strategies • Portfolio Development • Asset Representation • Market Valuation/Forecasting

box is a permeable articulating concrete block mat. This product, incorporated with bio-swales, gravel wetlands, infiltration trenches, stormwater tree boxes, and other non-point pollution treatment devices, can provide runoff control and water quality improvements required by federal, state, and local governments.

Depending upon the needs of the municipality or private development, specific elements of the SLVS tool box can be utilized as standalone elements or in a treatment train at strategic locations to:

- Reduce or eliminate flooding
- Achieve prescribed water quality goals and requirements
- Reduce operation and maintenance costs

The flexibility of the SLVS system allows for the installation of green infrastructure practices in a phased, pinpoint approach as opposed to traditional stormwater management practices that require the entire system to be installed or overhauled in order for it to be fully functional. Existing stormwater conveyance systems can easily be integrated into the SLVS systems without increasing pipe sizes or expensive retrofits. Budget dollars can be allocated over time, tangible system impacts can be immediately realized, and business disruption attributed to construction can be reduced.

Construction cost comparisons have shown that the SLVS approach can be equal to or less expensive than traditional stormwater management practices. Another significant benefit of using the permeable articulating concrete block mats and the associated underground storage capabilities is that expensive pavement management and storage pond operation and maintenance programs can be reduced or minimized. As a total treatment train system, the SLVS approach can provide a sustainable, comprehensive, environmentally friendly, regulatory acceptable, and cost-effective stormwater management solution.

Contact

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WHITE PAPER
SHAW SOLVES YOUR STORMWATER PROBLEMS WITH REVOLUTIONARY NEW APPROACH
(Sustainable Low-Impact Volume Control System)

John Ferris, PE and Todd Weik, LA

Traditionally engineers have sought ways to control the large amounts of excess stormwater after the development has already been designed. Up to now the solution has been bigger pipes and ponds. These solutions are expensive and take valuable real-estate off the tax rolls. The trend in green infrastructure seems to help but the magnitude of the many stormwater problems are often too large to effectively be handle by traditional green infrastructure designs.

Shaw has engineered a strategy that will revolutionize stormwater management. This creative approach integrates multiple proven management practices, engineering their size and locations to essentially eliminate the use of additional pipe and ponds. The design also significantly reduces the cost of maintenance of your pavement.

We call the system SLVS™ (Sustainable, Low Impact, Volume Control System) because it solves the problem of controlling storm water runoff that contributes to common urban storm water problems that include:

- Street Flooding
- Basement Backups
- Combined Sewer Overflows
- Water Quality Impairment

Shaw's revolutionary design approach quickly moves stormwater below ground in specially engineered pavements, trenches and chambers where it is slowly released to an existing collection system, to receiving surface waters or, where soils permit, infiltrated. The design approach is enhanced by a toolbox of improved green infrastructure devices, which bring added value to the community.

SLVS™'s sustainable treatment train comes from the integration of the capital needs and concerns of many city departments; transportation, water, sanitary sewer, urban forestry, environmental compliance and even parks and recreation. The avoided costs from these departments/programs include:

- **Transportation/Roads:** Requires essential no pavement management.
- **Water Department:** Lowers restoration cost of future utility projects.
- **Sanitary Sewer:** Reduced I/I and lower restoration cost of future utility projects.
- **Streetscape:** Creating pedestrian friendly environments that support economic development.
- **Urban Forestry:** Provides new trees/planters that stores and transpirates storm water.
- **Environmental Compliance:** Improves water quality of storm discharges (targeting phosphorus, nitrogen and TSS) and reduces scouring of natural streams.
- **Parks and Recreation:** Creates usable/accessible natural areas that cleans up storm water,

- **Safety:** Avoids standing water that could create a public safety hazard.
- **Revenue:** Takes no property from tax roll and increases property values.

Using the SLVS™ treatment train, Shaw water resource professional can establish the optimal density and locations of green infrastructure improvements that are needed within a drainage area to eliminate stormwater problems. The backbone of the SLVS Toolbox is a sustainable design that stores stormwater below the surface of the street at locations where nuisance flooding occurs or at strategic upstream locations. Pavements over these storage areas may be of a new permeable articulating concrete block/mat (P-ACB/M) or conventional concrete or asphalt. These subsurface devices can store anywhere from ½ inch to over 3 inches of runoff from the contributing drainage area. SLVS treatment train is enhanced by the integration of bio-swales, boulevards, storm trees and streetscapes that can capture an additional ½ inch of stormwater runoff.

In a typical stormwater system designed to convey the 10-year design storm (about 4.5 inches of rainfall), about half of the rainfall will stay on the drainage basin and the other half is runoff that is managed by an existing collection/conveyance system. SLVS's pavement system typically provides enough storage to increase protection to approximately a 25-year design storm. The integration of SLVS landscape elements can capture an additional ½ to 1 inch of runoff, or the approximate equivalent to a 50-year design storm. Finally, with the addition of SLVS's sustainable trench it is possible to capture the runoff from a 100-year design storm.

The basic SLVS treatment train provides TSS reduction in the range of 20% to 30%. However, a SLVS subsurface gravel wetland is capable of achieving over 80% TSS reduction, but more importantly can achieve 60% to 80% reduction in nitrogen and phosphorus.

With over 60 years of stormwater management experience, Shaw's water resource professional will tailor the design of a SLVS™ treatment train that optimizes the number and locations of the devices to meet the specific quantity and quality needs of the community and the drainage area.

The SLVS™ approach provides flexible and cost effective storm water management solutions that can be applied to public or private projects. For example, a traditional municipal road reconstruction and storm water management improvement program costs approximately $12 - $25 per square foot which includes asphalt or concrete roads, catch basins, and conveyance piping for 5 – 10 year storm events. Adding the cost for land acquisition, construction of storage and water treatment facilities, the price increases to $17 - $30 per square foot. Utilizing the SLVS™ approach, the treatment train elements begin at approximately $10 - $12 per square foot for the P-ACB/M, which addresses the paving, runoff conveyance and storage needs of the project. As additional water quality treatment elements are implemented, the costs increase to approximately $20 per square foot. The advantage of the SLVS™ approach is that the system can manage storm water runoff events from common, high intensity, short duration storm events to long duration, 10 – 100 year storm events that are traditionally used for design purposes. The flexibility of the system provides the ability to precisely locate stand alone or treatment train elements anywhere in a watershed. Precision locations allow the municipality or private owner to monitor and analyze the effectiveness of the SLVS™ solutions and evaluate if their particular level of

service or protection needs have been met. This equates to reduced capital outlays and reallocation of annual municipal storm water management budgets.

Shaw's SLVS™ Treatment Train Benefits Include:

- Cost Competitive with far greater benefits and flexibility
- Local problems can be fixed without aggravating upstream/downstream conditions
- The same pavement can be removed and replaced by future trenching projects
- Maintenance easier and more reliable than other porous pavement products
- Can make use of existing collection/conveyance infrastructure
- If necessary, can be limited to the public ROW, requires no purchasing of taxable property
- Is not limited by conflicts with other buried utilities
- Integrates other green infrastructure practices
- Implementation can be phased to accommodate budgets or other constraints
- Attenuates peak discharges, reducing the flashy nature of urban runoff that damages local streams and receiving water bodies.
- Contributes to MS4 storm water permit and TMDL water quality performance goals