

Porous Concrete Pavement

Martin B. Covington III, PE
Carroll County Government
Storm Water Management Program
Engineer

Disclaimer 1

- Neither I or Carroll County Government endorse any product, supplier or contractor

However

- Conewago Enterprises supplied the material and constructed all the projects in this presentation.

Contacts:

Donald Smith, President

Andrew Brough, Engineer

717-632-7722

Disclaimer 2

- Porous Concrete is not a “silver bullet”
- Porous Concrete is not a magic cure for Storm Water Management Problems
- If anyone tells you that it is don't believe them!!

Porous Concrete does:

- Pass runoff through to the stone base and either:

Good

- Infiltrate it into the ground







Or: Bad!!

- Convey the runoff to the low corner and saturate the fill or discharge the runoff onto the ground surface







Dr Art Miller (Penn State)

- “The infiltration rate through the porous concrete is greater than the 100-year 5 minute rainfall intensity.”
- This means that the porous concrete can pass the peak rainfall intensity of a 1 percent chance storm without pooling on the surface.







Dr Art Miller (Penn State)

- “Thus the limiting infiltration rate for the porous pavement tested would depend on the soil infiltration rate of the soil that supports the pavement”
- To avoid restricting the flow through the concrete the stone base must be as porous as the concrete. $\frac{3}{4}$ to $\frac{1}{4}$ inch stone with no fines does not restrict the flow and can provide the necessary storage



Crusher Run Base

- If someone asks you to allow crusher run base material do not approve it. It will not allow the runoff to pass through. You might as well use ordinary concrete or black top.

Shelter Systems, Westminster Maryland

- Contacts
- Joe & Dwight Hikel
- 410-876-3900









Design and Approvals

- How can you defend approving this?
- What if someone challenges me?

Standard SWM Designs

- SCS Curve Number Method
 - TR-55 (hand)
 - TR-20(computer)

Standard Professional Practice

- Determine the highest runoff rates from a development site prior to development and match or reduce these peaks after development

Requirements

- All jurisdictions in Maryland, and most nationwide, establish recurrence interval storms that must be managed, typically 50%, and/or 10%, and/or 1% annual exceedance probabilities.
- These are commonly referred to as 2, 10, and 100 year storms.
- Likewise the methodology to determine the peaks is established by regulation

Methodolgy

- All jurisdictions in Maryland and throughout most of the nation mandate the use of the Natural Resources Conservation Service (SCS), TR-55 “Urban Hydrology for Small Watersheds”

Dr. Hawkins

- “The Curve Number (TR-55) method owes its popularity among hydrology practitioners to its simplicity, predictability and stability, and to its support by a major United States federal agency”

Approvals

- If you are going to approve a new technique it needs to be justified using standard methods.
- If you approve a new technique designed with non standard methods ,and it fails, how could you ever justify your approval?

**FIGURE 1
UNACCEPTABLE POROUS PAVEMENT DESIGN**

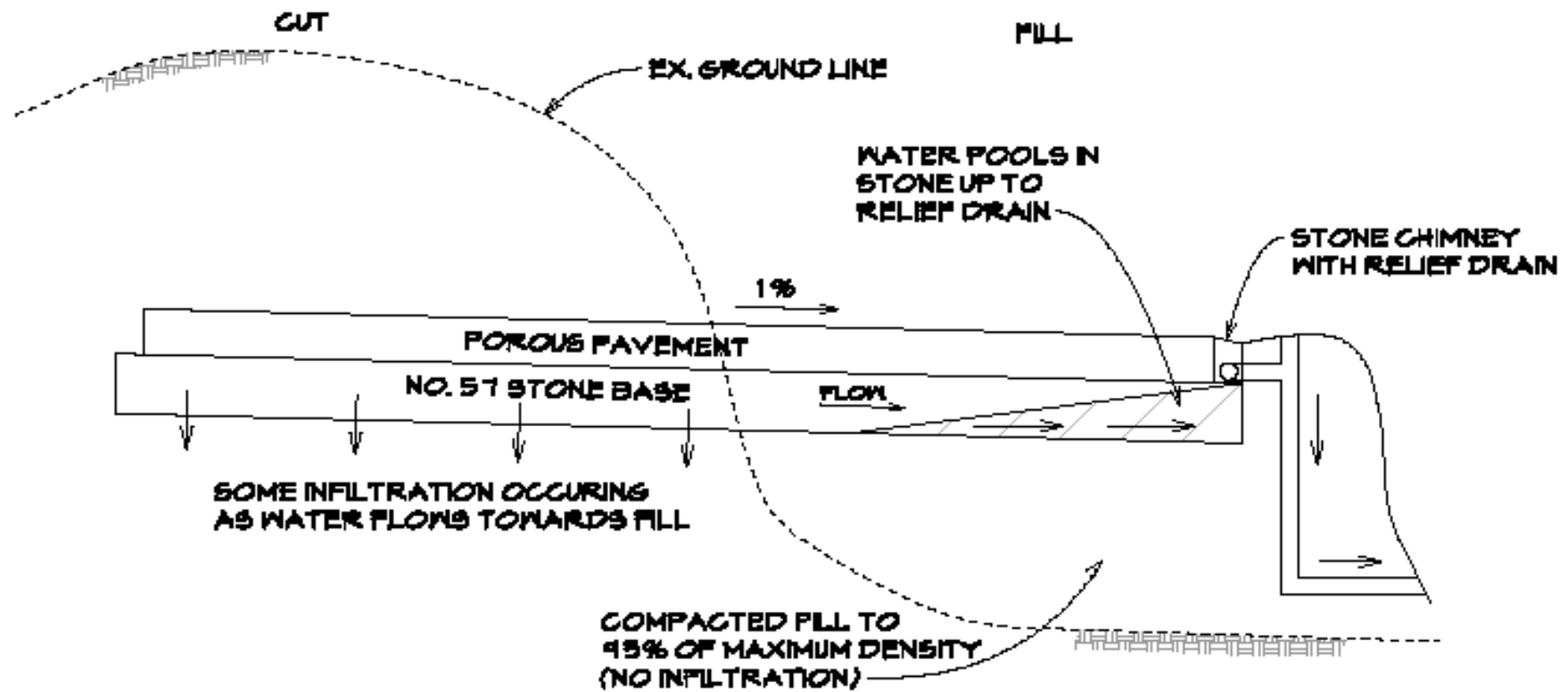


FIGURE 2
BETTER POROUS PAVEMENT DESIGN
(VERY INEFFICIENT)

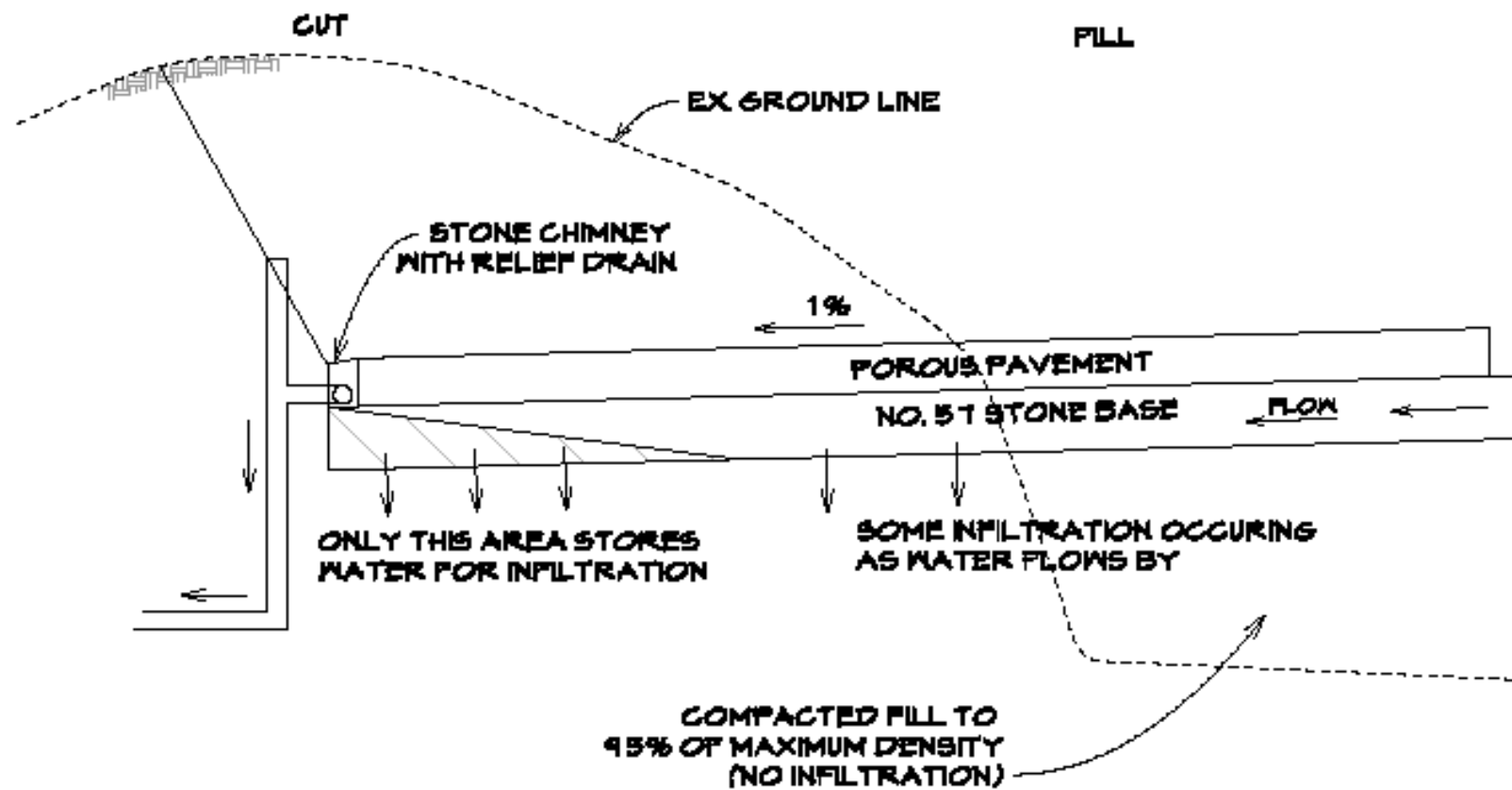
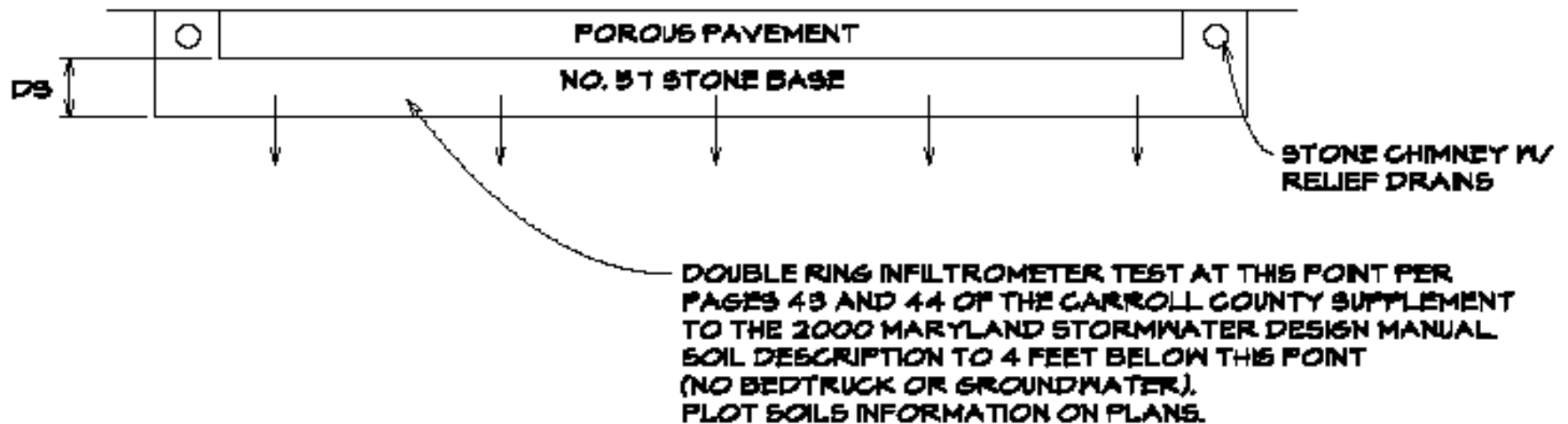


FIGURE 3

**ACCEPTABLE DESIGN AND INSTALLATION OF POROUS PAVEMENT
(VERY UNUSUAL SITUATION- FLAT UNDISTURBED GROUND)**

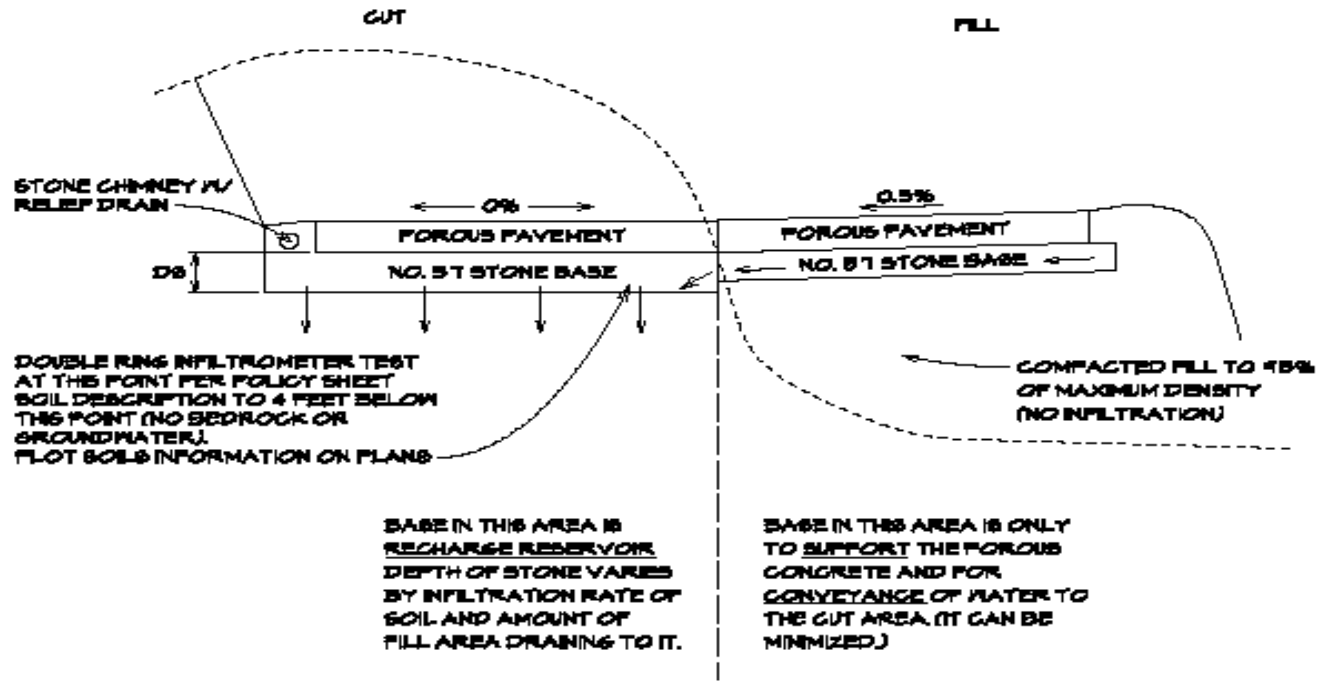


DESIGN

INFILTRATION RATE (In/hr)	(DS) DEPTH OF BASE REQUIRED	
	2 YR STORM $P_2 = 3.1$ in.	10 YR STORM $P_{10} = 5.0$ in.
0.5	9 in.	5 in.
1.0	2 in.	4 in.
2.0	1.5 in.	3 in.
3.0	1 in.	2 in.

FIGURE 4

**ACCEPTABLE DESIGN AND INSTALLATION OF POROUS PAVEMENT
(NORMAL SITUATION - CUT/FILL REQUIRED)**



**FILL SLOPE DRAINED TOWARDS CUT AREA
1:1 RATIO CUT AREA TO FILL AREA**

INFILTRATION RATE (in/hr)	(DS) DEPTH OF BASE REQUIRED	
	2 YR STORM $P_2 = 3.1$ in.	10 YR STORM $P_{10} = 5.0$ in.
0.5	7 in.	12 in. *
1.0	5 in.	10 in.
2.0	4 in.	8 in.
3.0	3 in.	6 in.

* BEYOND 12 in. OF BASE, PAVEMENT TENDS TO SINK INTO STONE

FIGURE 5 TR-20 ANALYSIS

**FIGURE 3
SCHEMATIC**

DRAINAGE AREA (DA) = 1 AC.
TIME OF CONCENTRATION $T_c = 0.1$ (MINIMUM TIME)
RUNOFF CURVE NUMBER CN = 48 (ALL PAVEMENT)

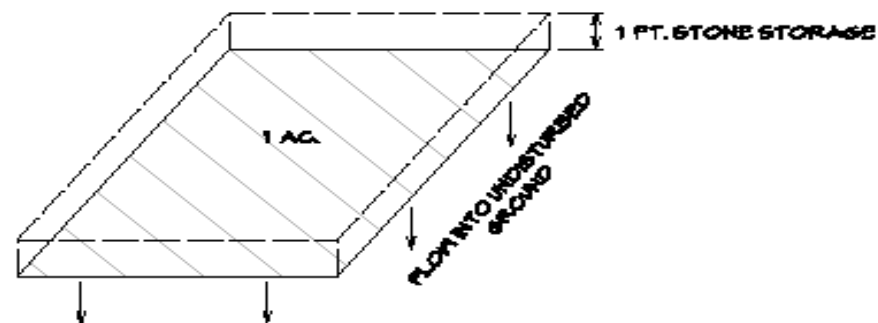
STORAGE RESERVOIR 1 FT STONE
UNDER 1 AC POROUS PAVEMENT
1 AC-FT STORAGE
DISCHARGES 0.5, 1.0, 2.0, 3.0 cfs

**FIGURE 4
SCHEMATIC**

DRAINAGE AREA (DA) = 2 AC.
TIME OF CONCENTRATION $T_c = 0.1$ (MINIMUM TIME)
RUNOFF CURVE NUMBER CN = 48 (ALL PAVEMENT)

STORAGE RESERVOIR 1 FT STONE
UNDER 1 AC POROUS PAVEMENT
1 AC-FT STORAGE
DISCHARGES 0.5, 1.0, 2.0, 3.0 cfs

CALCULATING DISCHARGE RATES FROM 1 AC STONE RESERVOIR



$$Q \text{ (cfs)} = \frac{\text{INFILTRATION RATE (in/hr)} \times \text{RESERVOIR AREA (ft}^2\text{)}}{12 \text{ in/ft} \times 3600 \text{ sec/hr}} = \frac{\text{ft}^3}{\text{SEC}}$$

EXAMPLE: INFILTRATION RATE = 0.5 in/hr

$$Q \text{ (cfs)} = \frac{0.5 \times 43560}{12 \times 3600} = 0.5 \text{ cfs.}$$

Porous Concrete is an Infiltration Practice!

Determining and preserving the infiltration rate of the soil in the cut area is one of the keys to success.

We Make Infiltration Work

- 90% of all infiltration facilities ever constructed in Carroll County still work.

Infiltration in Fill

- The infiltration rate of fill compacted at 95% of optimum is zero.

Infiltration Rates

- Accurate infiltration rates can only be determined by open pit infiltration tests.
- Soil borings are often inaccurate. Does your local Health Department allow borings for septic percolation tests ?
- Please see the handout for CC's Infiltration Test Procedure.

Preserve the Infiltration Rate of the Cut Ground.

- You're putting down a 12" stone base.
- Why do you need to compact the ground?
- Don't do it!

Conclusion 1

- A 1:1 Cut/Fill balanced site
- A minimum infiltration rate of .5" per hour
- 12" of stone base with 40% voids
- The fill area draining onto the cut area

RESULTS:

- Complete Storm Water Management of the runoff from the 10 year storm is provided.

If Higher Rates of Infiltration are Achieved

- Less stone base is required
- Runoff from a greater ratio of fill to cut area can be managed

Conclusion 2

- The SCS TR-55 analysis ,shown here, can be adapted to any combination of cut and fill, infiltration rate, and stone base as long as the fill area drains onto the level cut area.

Bottom Line

- This technique can work and work well.
- Using standard methods it is possible to prove compliance with Stormwater Management code requirements.

The End

Contacts:

- Martin B. Covington III, PE, CFM, DWRE
- 410-386-2205
- mcovington@ccg.carr.org

- Conewago Enterprises
- Donald Smith, Andy Brough 717-632-7722

- Shelter Systems
- Joe & Dwight Hikel 410-876-3900

