Field Evaluation of Permeable Pavement Systems for Stormwater Management

WISCONSIN DEPT. OF NATURAL RESOURCES

WISCONSIN DEPARTMENT OF TRANSPORTATION

USGS science for a changing world

Oldcastle Materials

UNILOCK DESIGNED TO CONNECT.

COUNTY MATERIALS CORPORATION

HOMBURG CONTRACTORS, INC.

GRAEF

Madison

icpi Interlocking Concrete Pavement Institute®

Wisconsin DNR

Stormwater Post-construction Technical Standard 1008

- Initial surface infiltration rate = 100 in/hr
- Minimum surface infiltration rate = 10 in/hr
- Restorative cleaning efficiency = 50%
- Underdrain discharge credit
  - TSS = 65% (was 55%)
  - Total P = 35%

Research project will provide data to amend technical standard and *promote standardization of practices*

Permeable Pavement
(1008)

Wisconsin Department of Natural Resources
Conservation Practice Standard

I. Definition

A pavement system designed to achieve water quality and quantity benefits by allowing movement of stormwater through the pavement surface and into a base/subbase reservoir. Examples include *pervious concrete*, *porous asphalt* and *permeable pavers/blocks*.

II. Purpose

This practice may be applied individually or as part of a stormwater management system to support one or more of the following purposes:

- Promote stormwater *infiltration*, groundwater recharge, and stream baseflow preservation
- Reduce the discharge of stormwater pollutants to surface waters
- Reduce stormwater discharge volumes and rates
- Reduce the temperature of stormwater discharges

III. Conditions Where Practice Applies

Permeable pavement systems are an alternative to other pavements and stormwater control measures in areas where mitigating the adverse impacts of stormwater discharges is an objective or requirement.

Permeable pavement systems are most effective in areas where subsoil and groundwater conditions are suitable for stormwater infiltration, and the risk for groundwater contamination is minimized. Appropriate conditions for infiltration are identified in ss. NR 151.124 and NR 151.241, Wis. Adm. Code.

Permeable pavement systems may be used in areas where infiltration is prohibited by regulations or limited by soil or groundwater conditions when *liners* that inhibit infiltration, and subsurface drainage mechanisms, are installed. However, permeable pavement may not be used in industrial storage and loading areas or vehicle fueling and maintenance areas.

IV. Federal, State and Local Laws

Users of this standard shall be aware of applicable federal, state and local laws, rules, and regulations or permit requirements governing permeable pavement systems. This standard does not contain the text of federal, state or local laws.

V. Criteria

A. **Site Criteria** – Evaluate and locate permeable pavement systems in accordance with the following criteria:

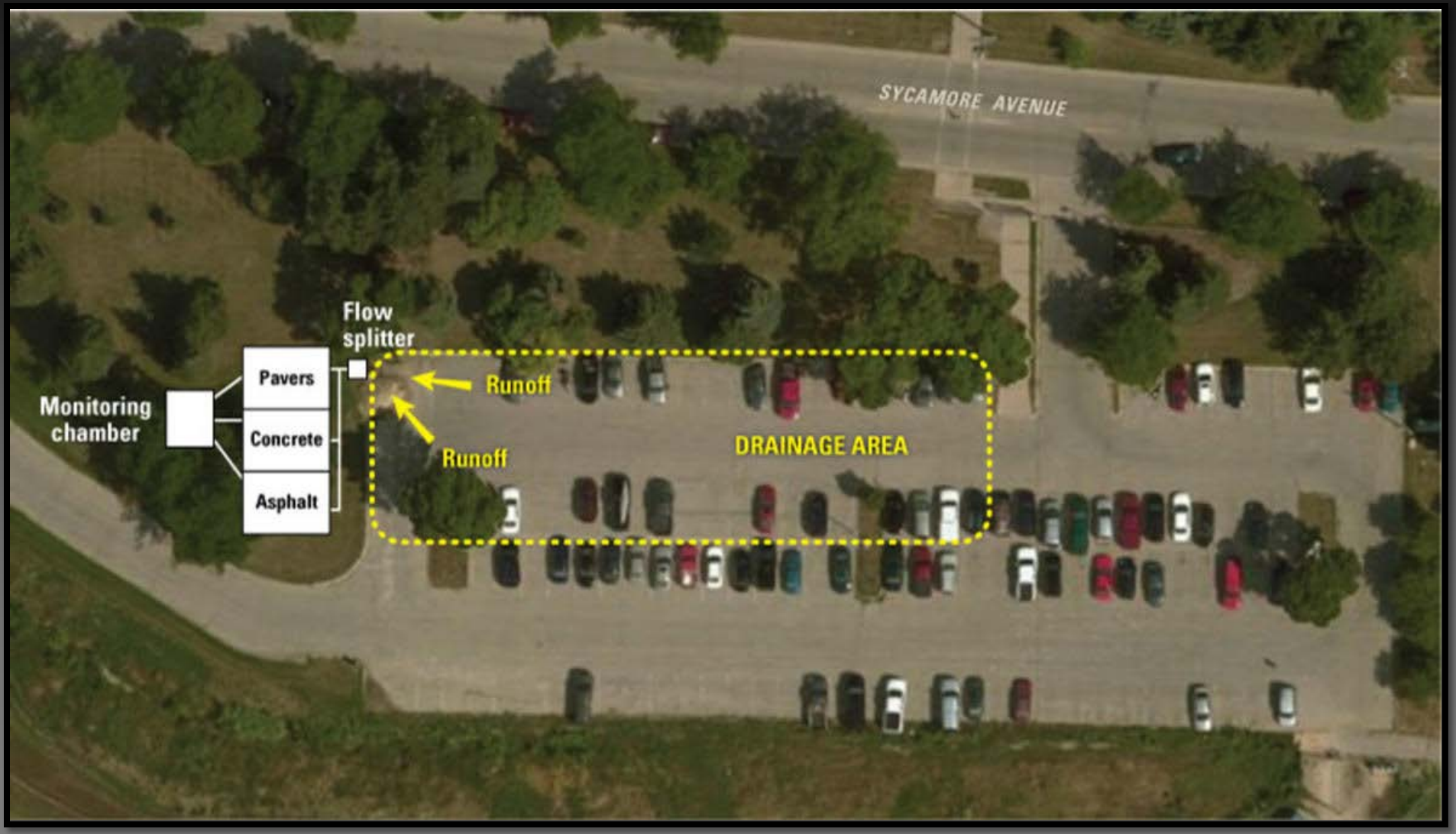
1. For systems that will infiltrate water into the soil subgrade, evaluate the site in accordance with WDNR Conservation Practice Standard 1002 – "Site Evaluation for Stormwater Infiltration".
2. For systems that will not infiltrate water into the soil subgrade, conduct a site evaluation of sufficient detail to establish site-specific conditions, including soil types and depth to *seasonal high groundwater*.
3. If a hydraulic connection is possible, permeable pavement

Conservation Practice Standards are reviewed periodically and updated if needed. To obtain the current version of this standard, download it from http://dnr.wi.gov/topic/Stormwater/, or contact the Wisconsin Land and Water Conservation Association office at (608) 441-2677.

WI DNR 12/14

[1]Words in the standard that are shown in italics are described in X. Definitions. The words are italicized the first time they are used in the text.

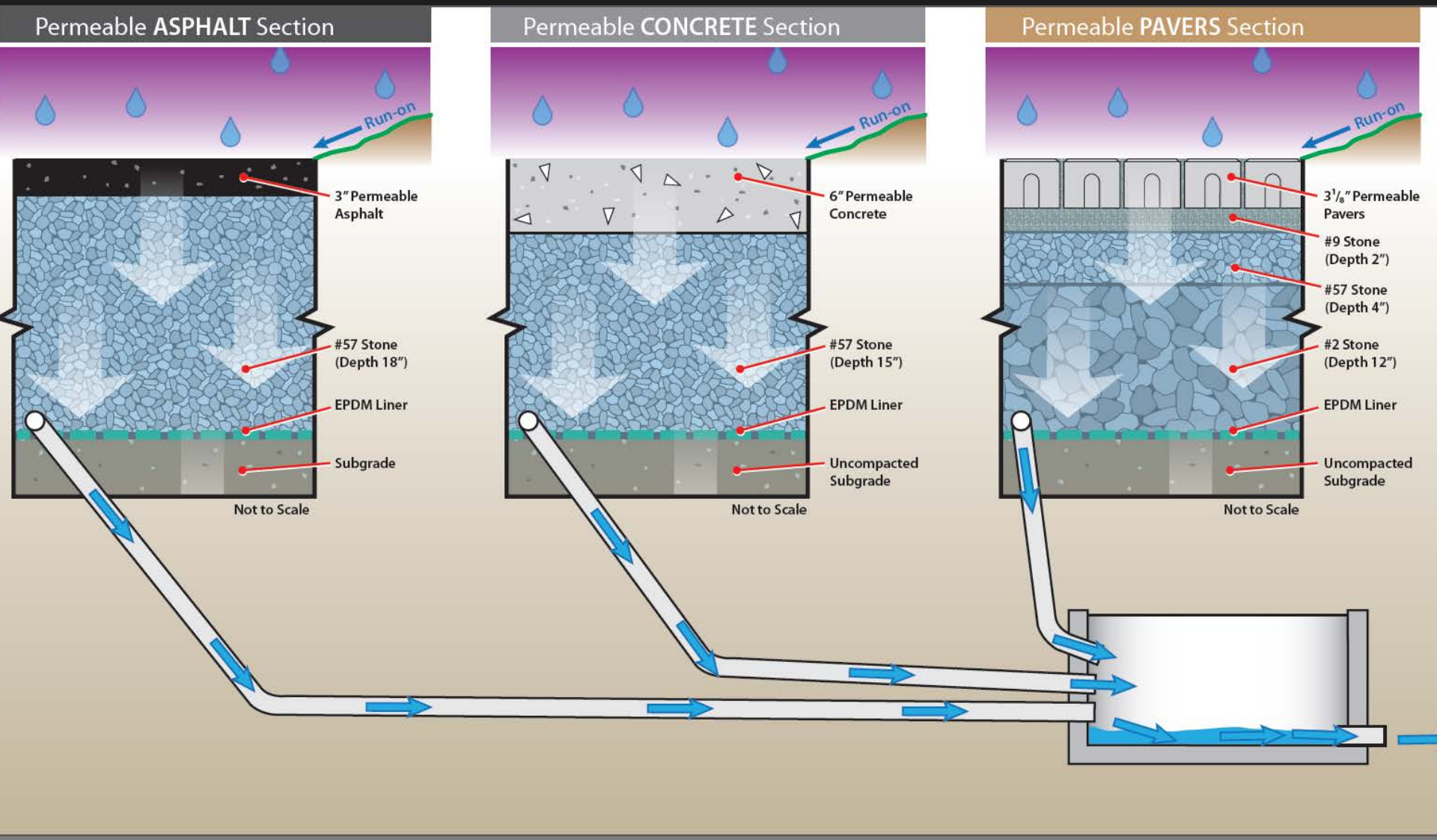
89°30'N
89°18'N
43°09'W
43°03'W
WISCONSIN
Madison
LAKE MENDOTA
To Waunakee
To Portage
To Tomah
To Sun Prairie
To Milwaukee
To Chicago
To Stoughton
To Janesville
To Verona
Dane County Regional Airport
International Ln
Anderson St
Packers Ave
Northport Dr
Stoughton Rd
E. Washington Ave
Aberg Ave
Commercial Ave
Milwaukee St
Fordem Ave
Winnebago
Atwood Ave
Cottage Grove Rd
E. Johnson St
Williamson St
Gorham St
State Capitol Building
University of Wisconsin
Campus Dr
University Ave
State St
W. Johnson St
W. Wash Ave
Blair
Regent St
Park St
Olin Ave
John Nolen Dr
CITY OF MONONA
Monona Dr
CITY OF MIDDLETON
Century Ave
W. Beltline Hwy
Allen Blvd
Old Sauk Rd
Gammon Rd
Whitney Way
Mineral Point Rd
Segoe Rd
Midvale Blvd
Speedway Highland
Monroe St.
Odana Rd
Schroeder Rd
Nakoma Rd
Raymond Rd
Elver Park
McKenna Blvd
Williamsburg Way
Seminole Hwy
Fish Hatchery Rd
0 1 2 MILES
0 1 2 KILOMETERS


SYCAMORE AVENUE
Flow splitter
Monitoring chamber
Pavers
Concrete
Asphalt
Runoff
Runoff
DRAINAGE AREA

CAT

Flow splitter vault

Monitoring chamber



Provided by County Materials Corp.

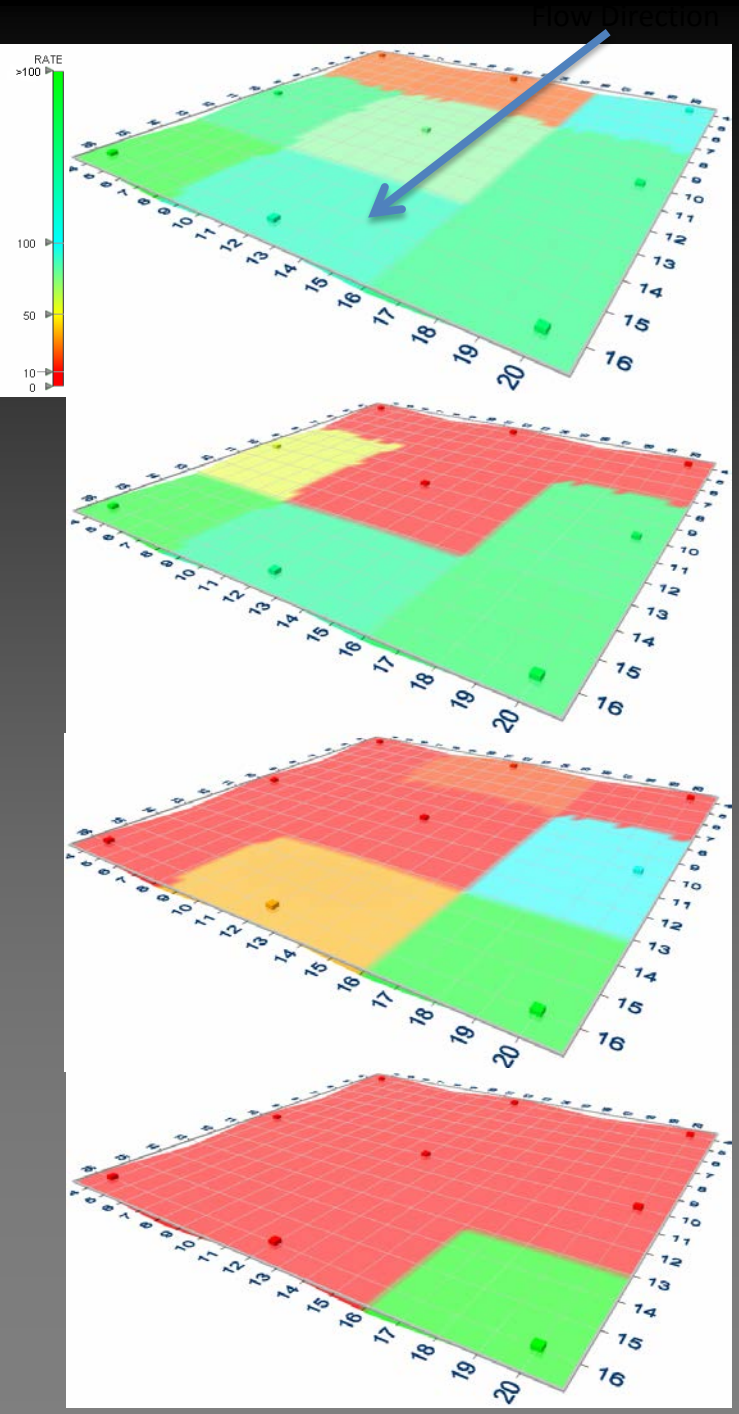
Preliminary Results

- Infiltration rates
- Restorative maintenance
- Water quality
- Temperature

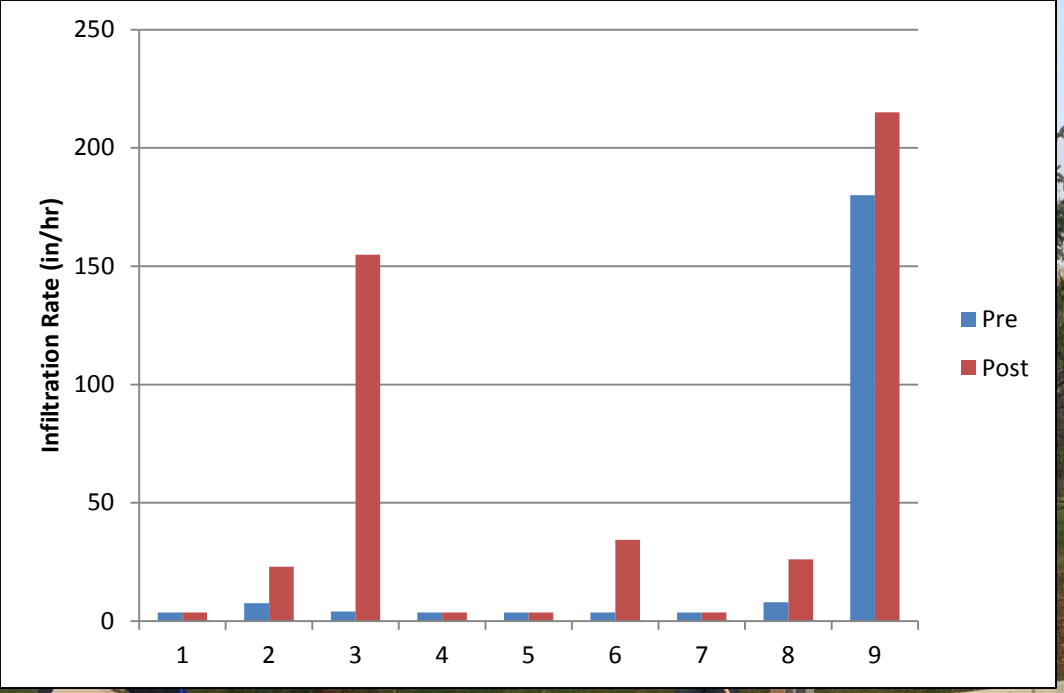
Infiltration rates

- Falling head permeameter test (ASTM-C1701)

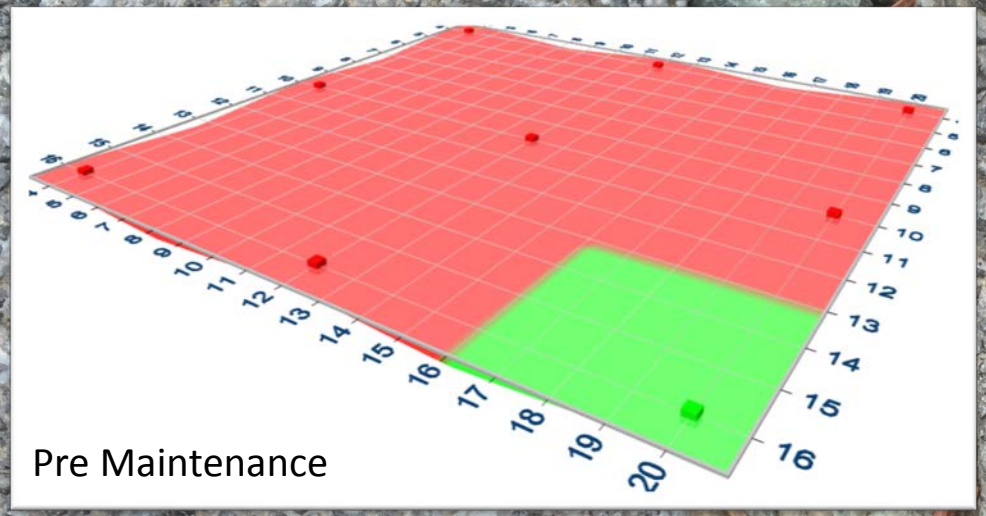
Permeable Pavers



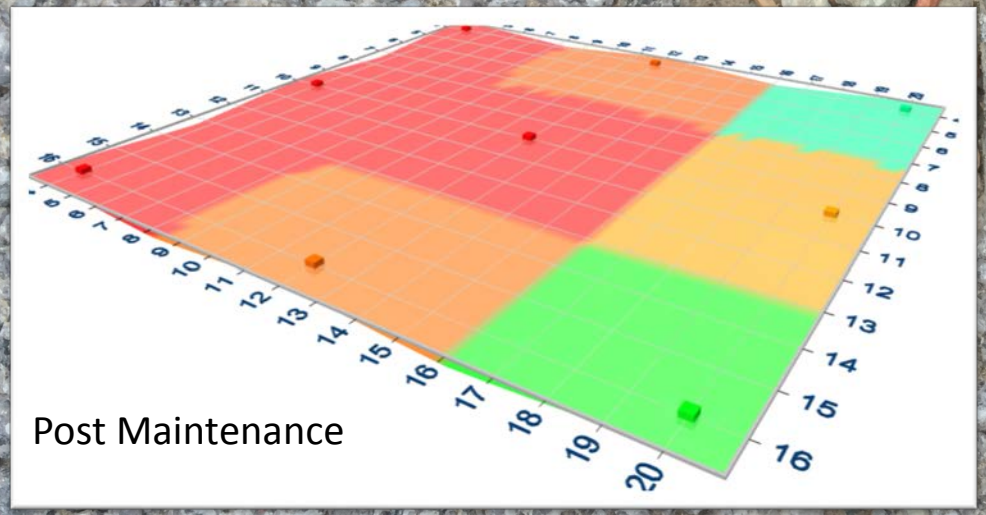
Mean Infiltration Rate (in/hr)	
September 2014	328
May 2015	228
September 2015	76
October 2015	24


Infiltration Rate (in/hr)
250
200
150
100
50
0
1
2
3
4
5
6
7
8
9
Pre
Post

7
8
4
9
5
1
6
2
3



24 inches/hour

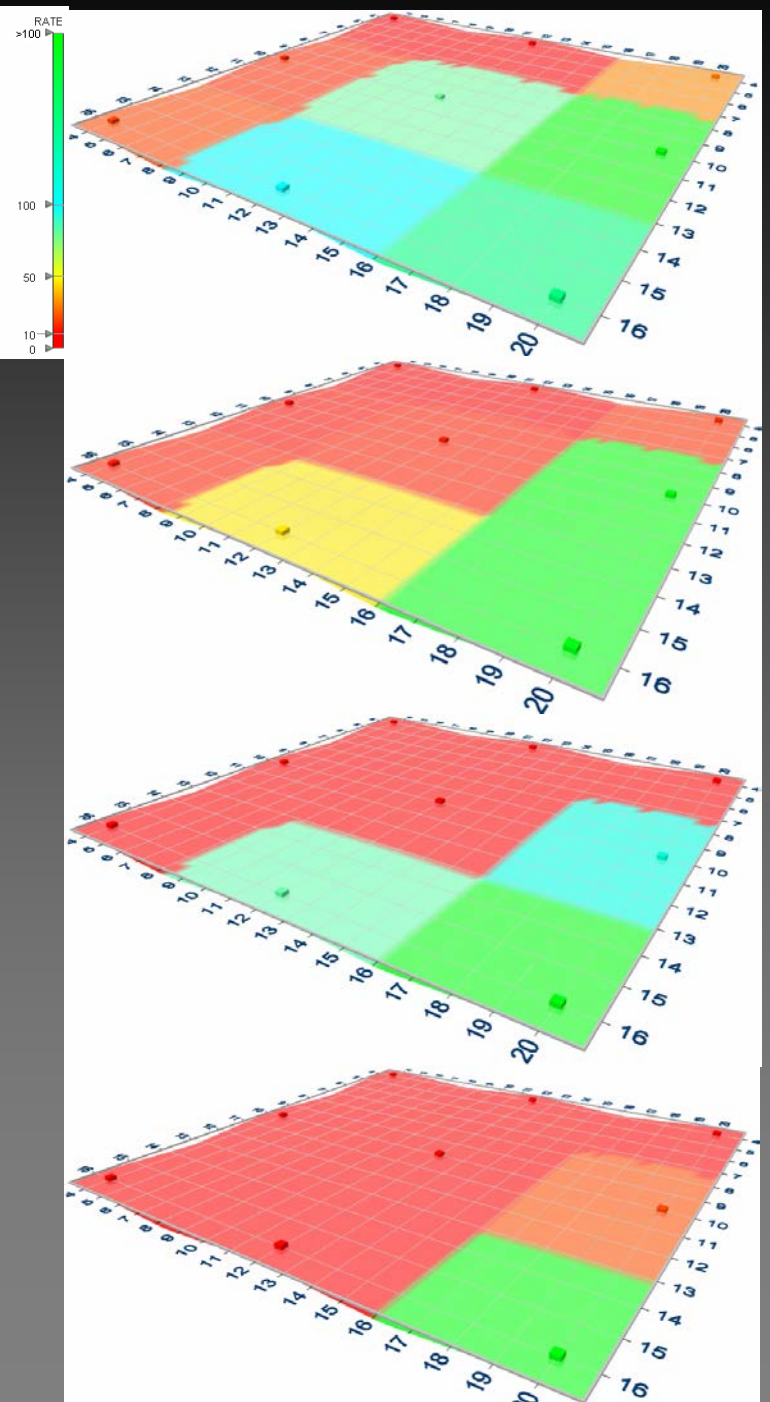


52 inches/hour

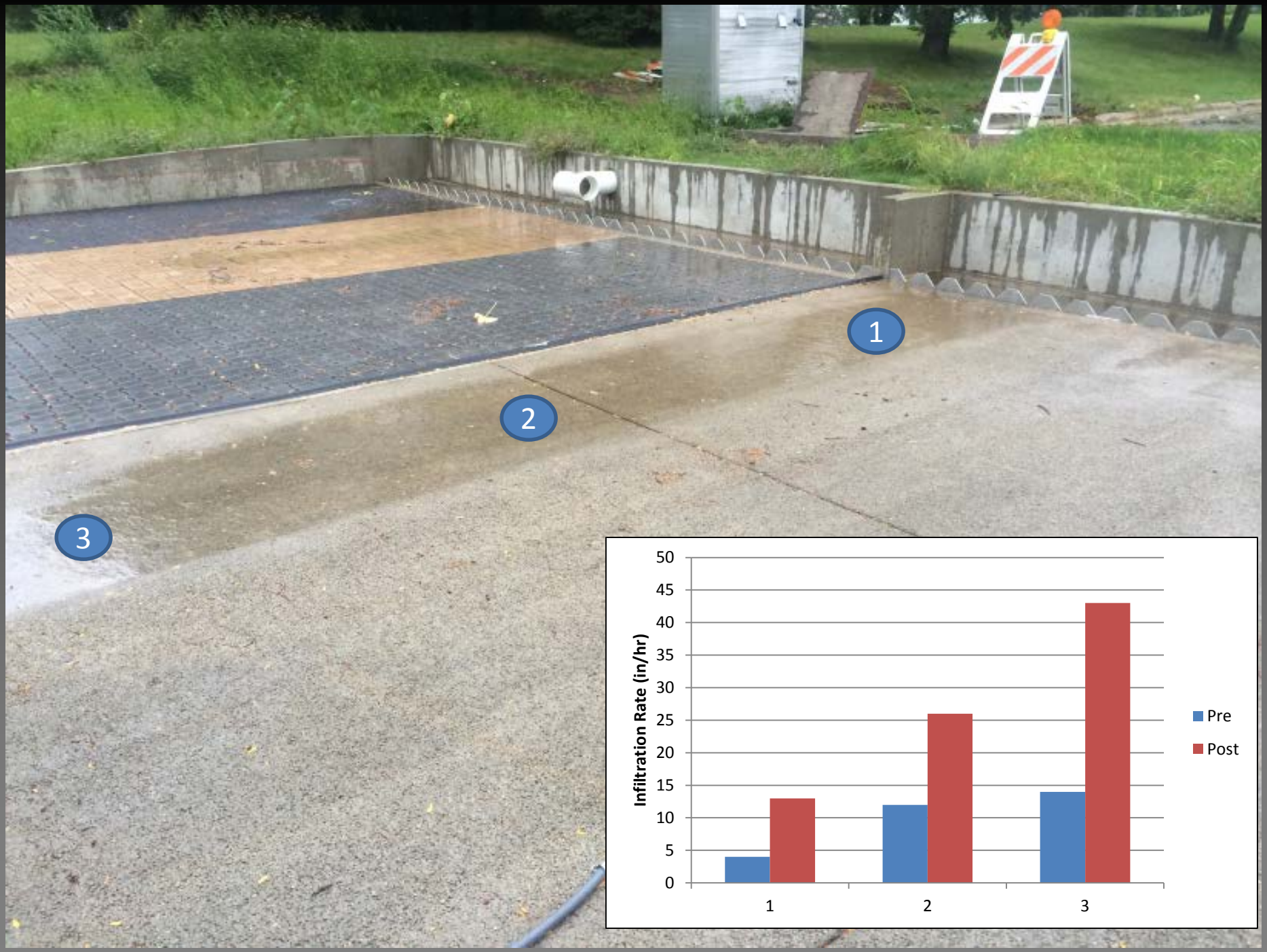
PRE MAINTENANCE

POST MAINTENANCE

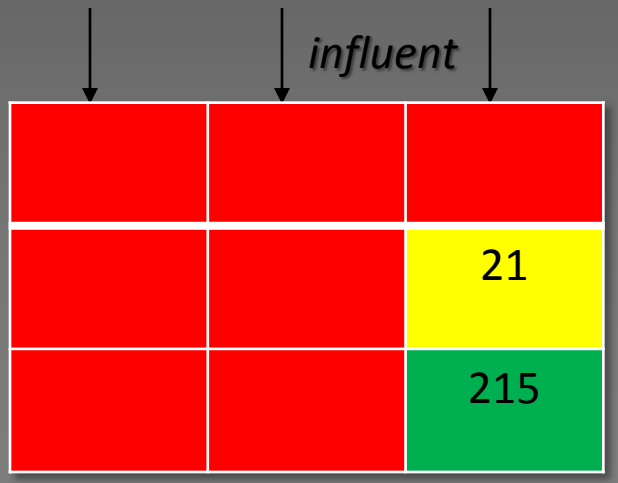
Permeable Concrete



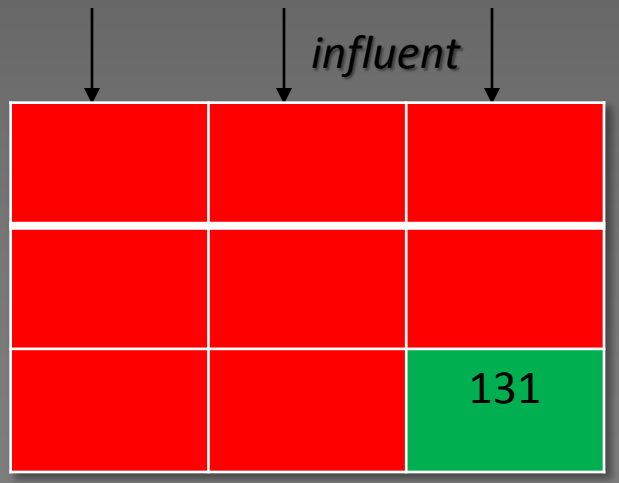
	Mean Infiltration Rate (in/hr)
September 2014	147
May 2015	109
September 2015	107
October 2015	30


1
2
3
Infiltration Rate (in/hr)
50
45
40
35
30
25
20
15
10
5
0
1
2
3
Pre
Post

April 2016

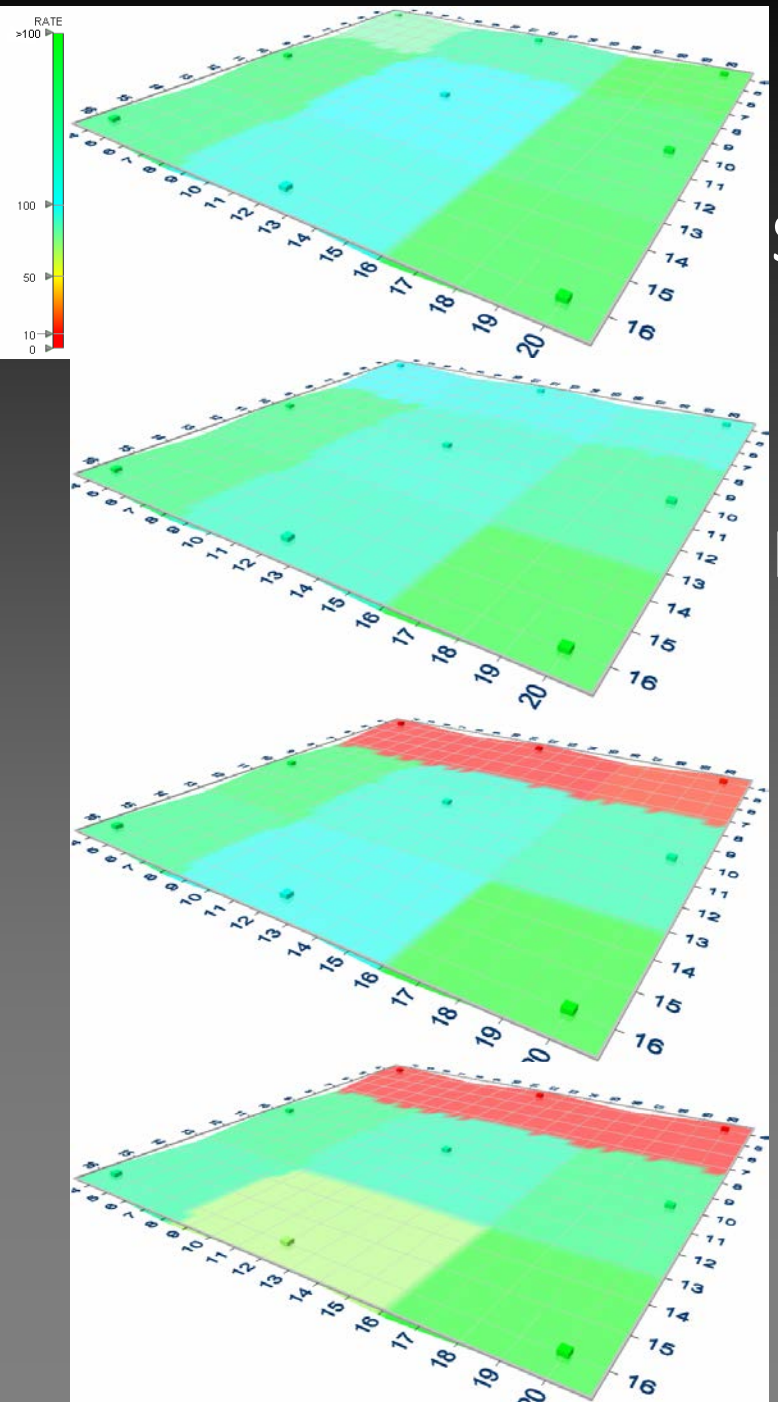


PRE MAINTENANCE



POST MAINTENANCE

Permeable Asphalt



Mean Infiltration Rate (in/hr)	
September 2014	344
May 2015	318
September 2015	159
October 2015	134

influent

221	180	228
197	70	291

PRE MAINTENANCE

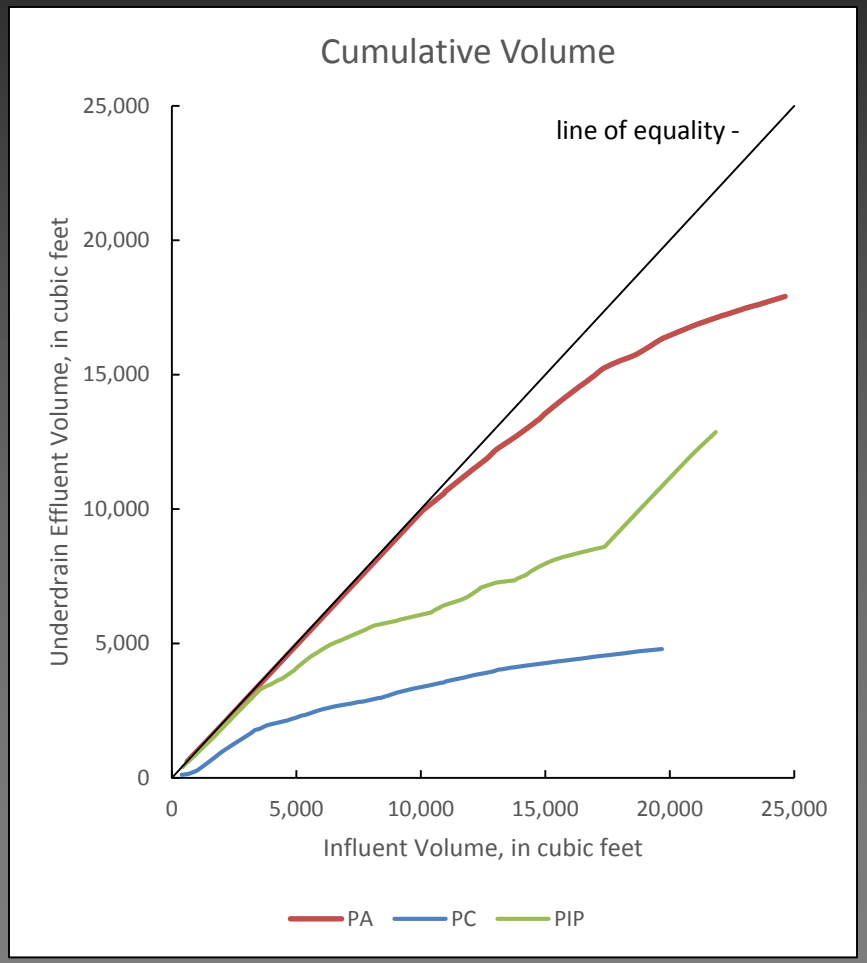
influent

18		
205	155	242
221	33	317

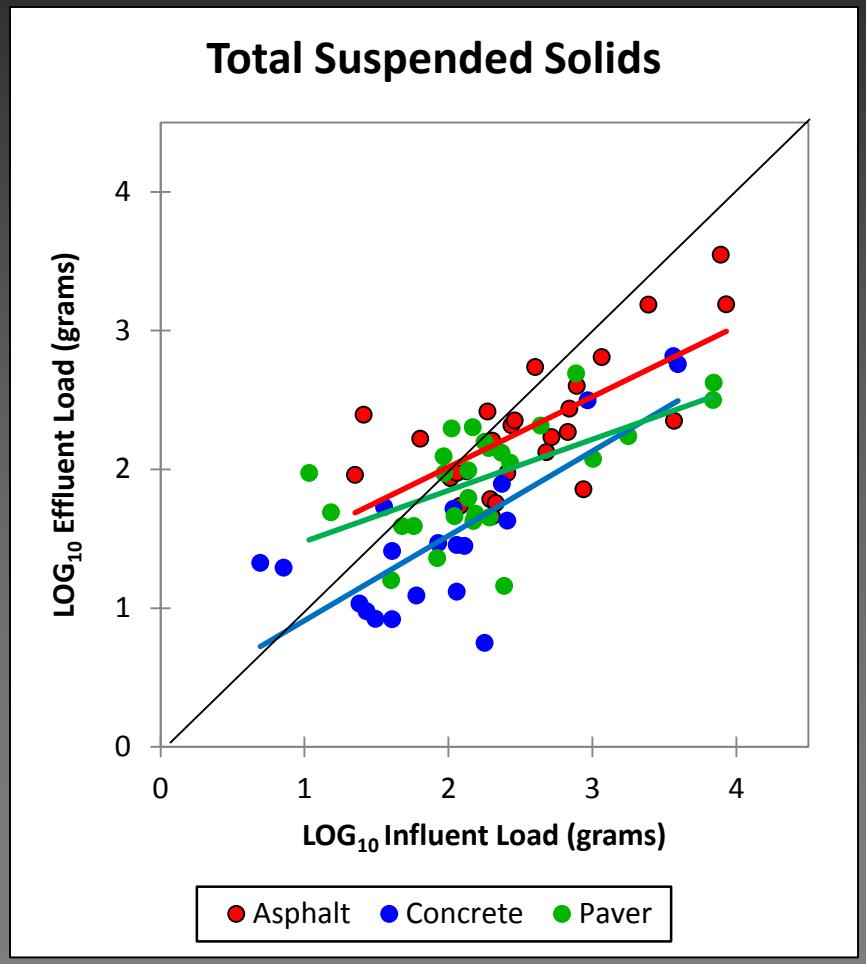
POST MAINTENANCE

Hydraulic Performance Over Time

August 2014 – September 2016



Comparison of Flow Proportional Influent to Effluent Load (underdrain only) in the Permeable Paver, Concrete, and Asphalt Test Plots



Flush test of each surface showed high residual solids loading

	TSS (mg/L)		
Minutes of Flushing	Paver Tile	Concrete Tile	Asphalt Tile
5	358	315	337
10	170	128	144
15	86.4	68.3	38.2

Water Quality Comparison

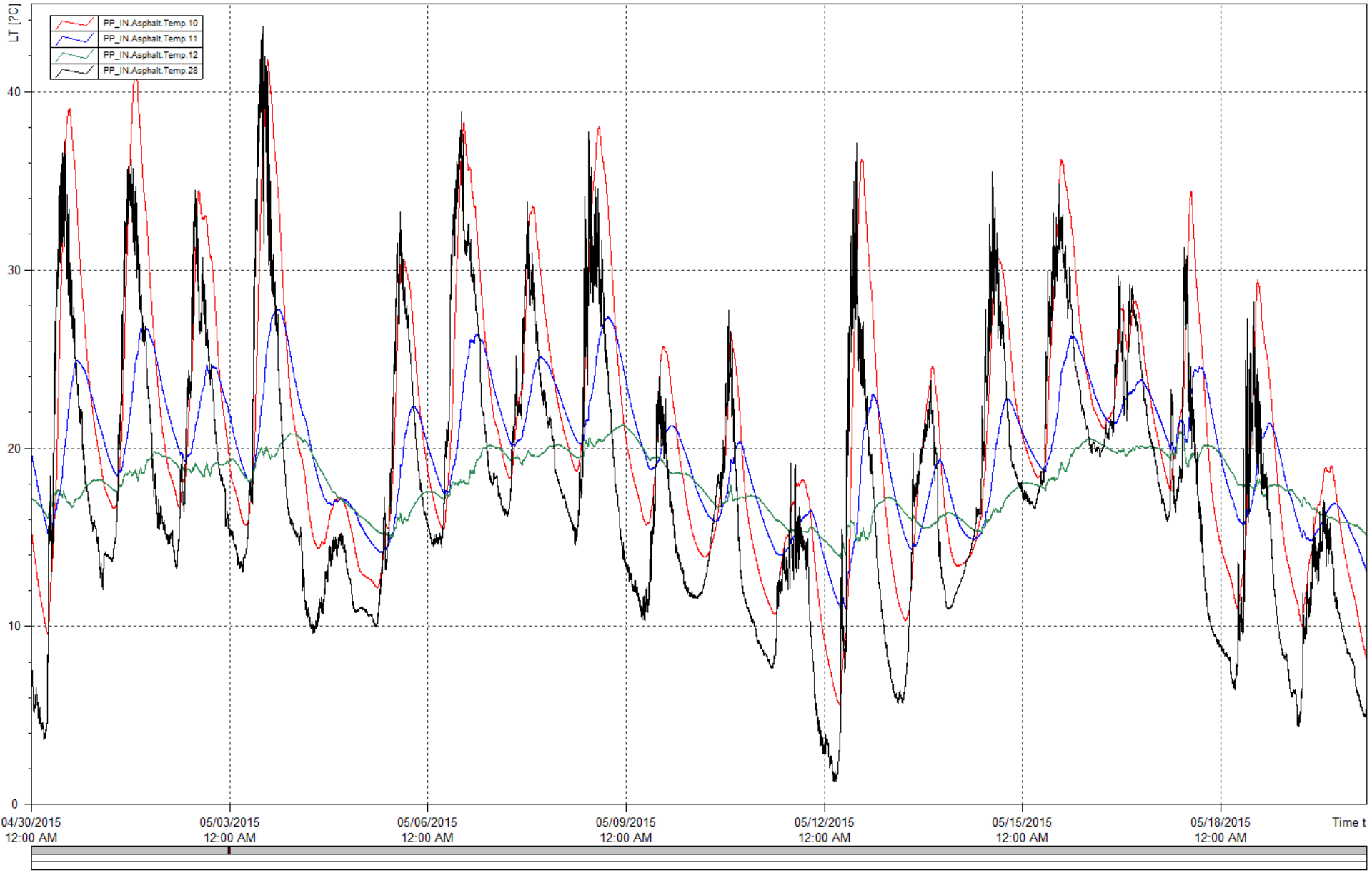
Underdrain Discharge Credit (%)					
			Permeable Surface Only		
Pollutant	WDNR 1008	Other Studies	Pavers	Concrete	Asphalt
TSS	65	32-96	81	80	65
TP	35	20-78	29	51	26
			With Overflow		
			71	59	62
			22	23	21

Underdrain Discharge Credit (%)						
	Permeable Surface Only			With Overflow		
	Pavers	Concrete	Asphalt	Pavers	Concrete	Asphalt
DP	-30	2	-33	-45	-30	-33
e. Coli	50	77	26	42	57	41

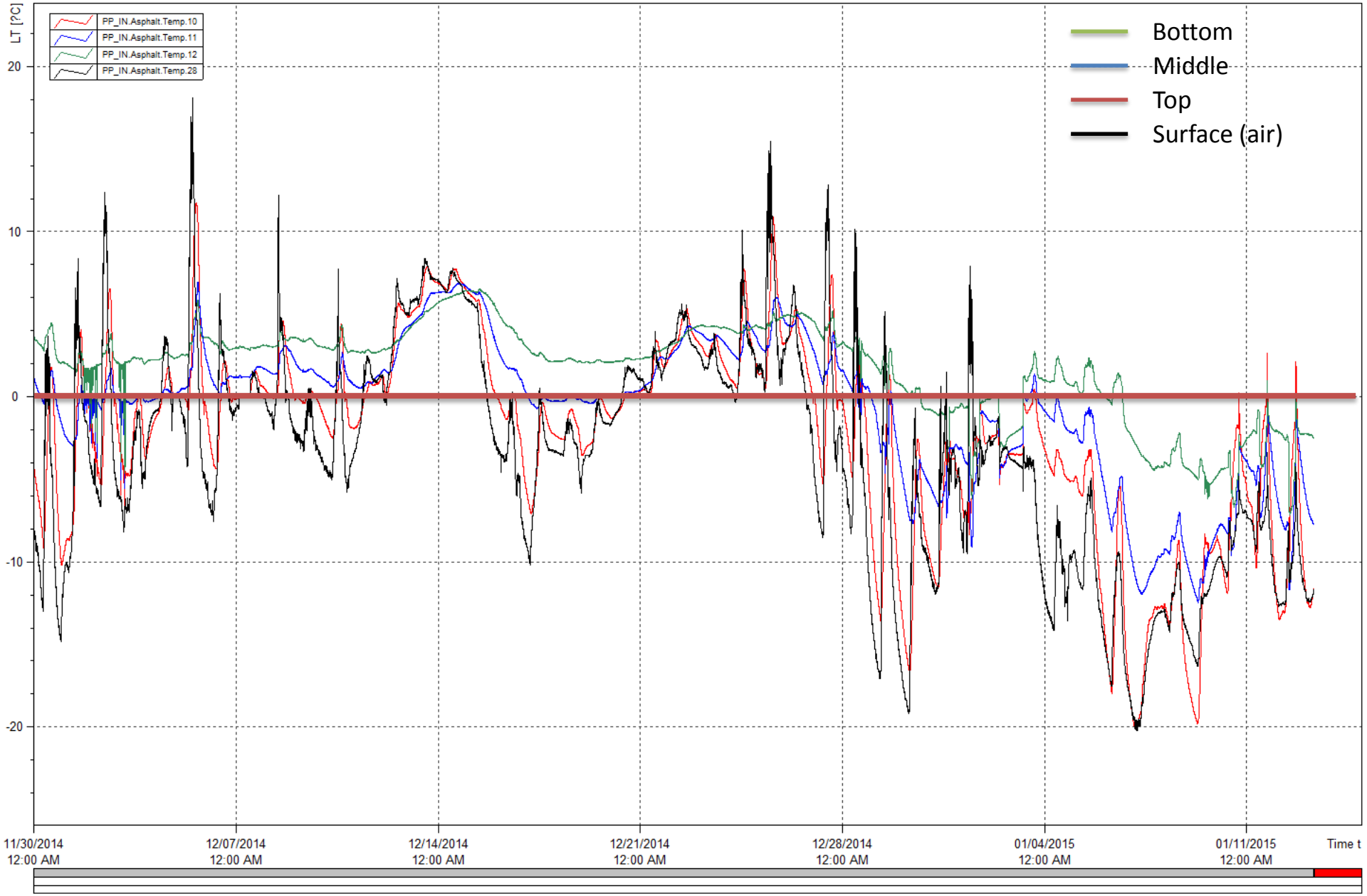
Temperature

- Cools heated runoff during summer months
- Allows meltwater to infiltrate
- Could reduce the need for de-icing agents

Summer Cooling



Winter Warming



Potential for Reduced Road Salt Application?

Future Direction

- Change contributing drainage area to 5:1 (done Sept. 2016)
- Replacement of asphalt
- Resurface parking lot
- Expand constituent list
- New technology/additives

Questions?