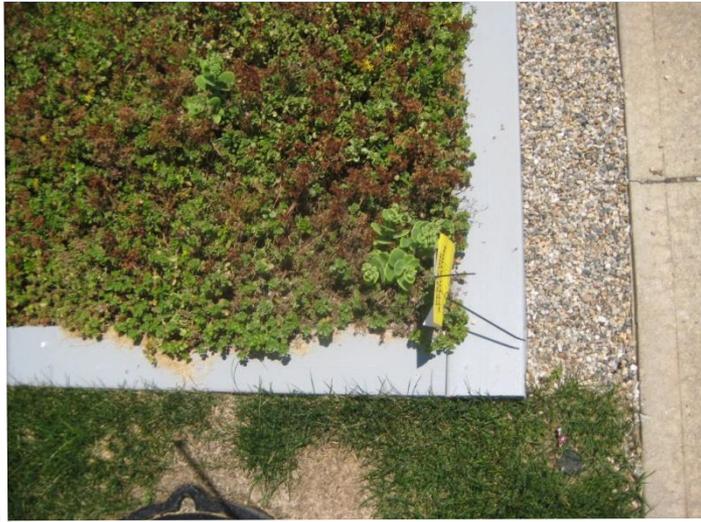


# Effectiveness of Green Stormwater Solutions

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CDM Smith



New England Water  
Environmental  
Association

Stormwater Specialty  
Seminar

Hartford, CT  
May 2, 2012



**CDM  
Smith**

# Effectiveness of Green Stormwater Solutions

- Project Overview
- Green Components
- Effectiveness Testing
- Lessons Learned



# Irene Impacts to New York City



*Rueters Photo*



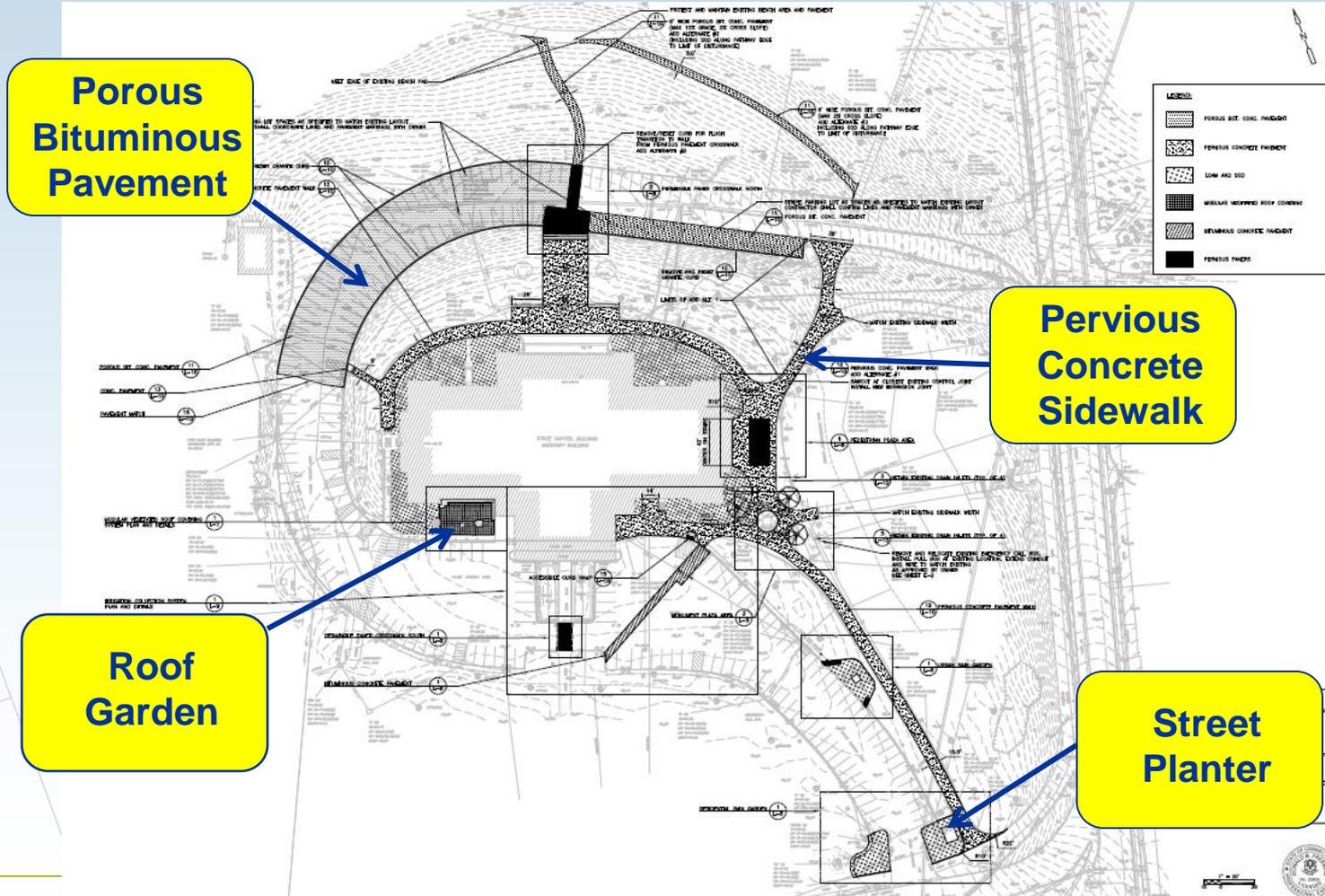
*Associated Press Photo*

# Greening America's Capitols

- Partnership for Sustainable Communities between EPA, HUD, and USDOT to help state Capitols develop an implementable vision of distinctive, environmentally friendly neighborhoods that incorporate innovative green building and green infrastructure strategies.
  - Boston, MA
  - Charleston WV
  - Hartford, CT
  - Jefferson City MO
  - Little Rock, AR



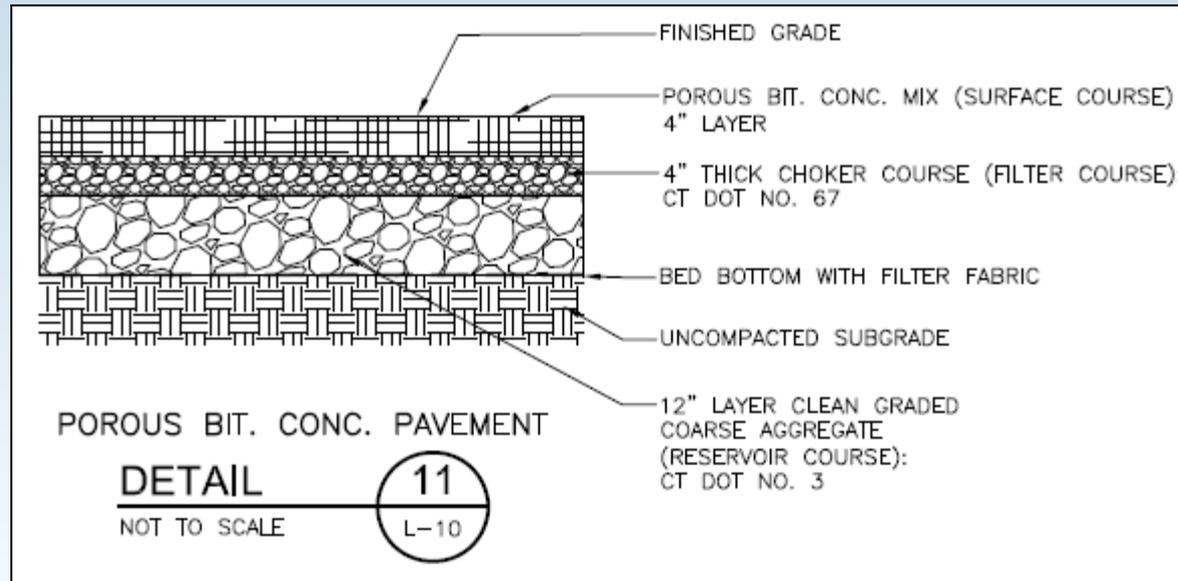
# Plan View of Improvements



# Porous Bituminous Pavement



# Pavement Section

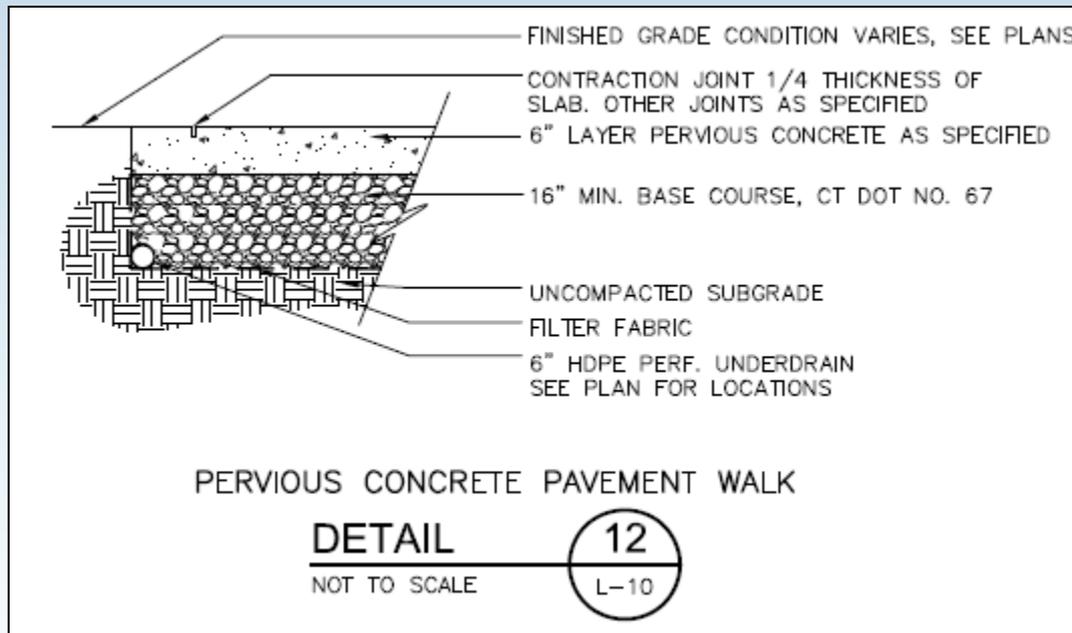


## Porous Bituminous Pavement

# Pervious Concrete Sidewalk



# Sidewalk Section



## Pervious Concrete Sidewalk

# Roof Garden



# Typical Street Planter



# R&D Project

- Goals
- Measure Permeability of Pavement
- Observe Pavement Stability
- Roof Garden and Street Planter Operations



# SAMPLING PROTOCOL

# Pavement Performance Testing Procedures

## Measure Rate of Flow

- Depth of Water
- Time

## Observe Durability

- Raveling
- Rutting
- Settlement



# Permeability Testing Apparatus



# Sampling Protocol for Green Infrastructure

Time required for field work:  
Approximately 4 hours

Weather conditions: Tests  
should not occur if more  
than  $\frac{1}{2}$  inches of rain fell the  
previous day



# Sampling Protocol – Pervious Pavements/Sidewalks Infiltration

## Pervious pavements

- Location of the infiltration test should be on level ground.
- Set the apparatus on the level pavement; press down evenly to seal.
- Step on both sides of the wooden frame to apply even pressure.
- Measure out  $\frac{1}{2}$  gallon of water.
- Pour the pre-measured amount of water into the pipe all at once.
- Start stop watch and measure the time it takes for the water to infiltrate (seconds).
- If leakage occurs, repeat the test.
- Repeat the infiltration test 3 times per each pervious surface. Each test should be at least 1 meter apart.

# Sampling Protocol – Impervious Pavements/Sidewalks Infiltration

## Impervious pavements

- Location of the infiltration test should be on level ground.
- Apply a ring of putty around the bottom of the apparatus pipe, approximately 1 inch thick. Then pre-flatten to  $\frac{1}{2}$  inch thick before placing the apparatus on the ground. Note: if putty is reused from previous tests, be sure to remove pebbles and rocks before reapplying.
- Set the apparatus on the level pavement; press down evenly to seal the putty.
- Step on both sides of the wooden frame to apply even pressure.
- Measure out  $\frac{1}{4}$  gallon of water.
- Pour the pre-measured amount of water into the pipe all at once. Start stop watch and measure the time it takes for the water to infiltrate (seconds).
- Start the stop watch.
- Measure the height of the water column (water level in the pipe to the top of the pipe) and record at time 0, 5, 10, and 20 minutes. Note: the same person should take the measurements each time for consistency.
- Note if any leakage occurs during the test and in between which time periods.
- Repeat the infiltration test 3 times per each pervious surface. Each test should be at least 1 meter apart.

# Sampling Protocol – Roof Garden and Street Planters

## **Roof Garden**

- A. General health of the plants – visual inspection (good, fair, poor)
- B. Percent cover – each corner 2 x 2 ft area
- C. Note ponding, if any
- D. Take photo of each corner

## **Street Planters (3 locations)**

- A. Measure height of plants within the drainage area (not upland)
- B. General health of the plants – visual inspection (good, fair, poor)
- C. Note ponding, if any
- D. Note general maintenance
- E. Take photo

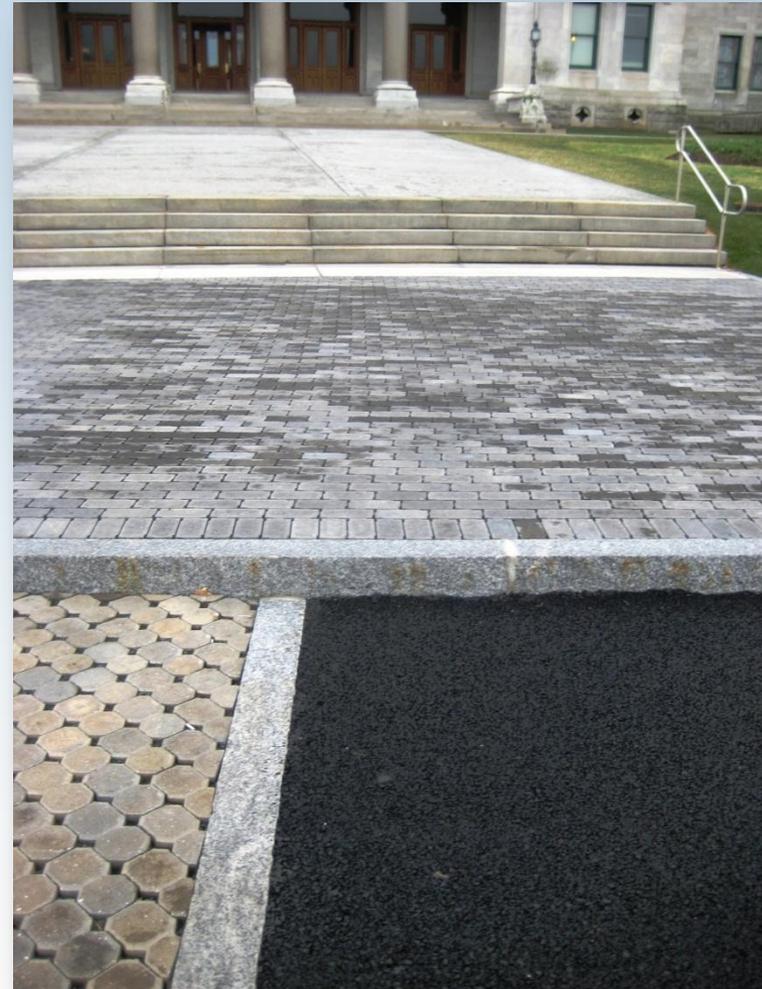
# RESULTS

# Permeable Pavement Infiltration

## Pavement/Sidewalks

- Pick the right location
- Work with experience contractor

Very Effective for Infiltration



# Field Permeability Test Results

Pervious Pavements						
		Height of water column (in)	Infiltration rate (in/hr)	Infiltration rate (cfs/ac)	Average Infiltration rate (in/hr)	Average Infiltration rate (cfs/ac)
Concrete Walkway/Sidewalk	1	9.19	1710.65	1729.03	1600.08	1617.27
	2	9.19	1096.59	1108.37		
	3	9.19	1993.01	2014.42		
Concrete Paver	1	9.19	2605.04	2633.03	2470.16	2496.70
	2	9.19	2289.55	2314.15		
	3	9.19	2515.90	2542.92		
Porous Asphalt/Pavement	1	9.19	1628.15	1645.64	1876.65	1896.81
	2	9.19	1421.14	1436.40		
	3	9.19	2580.66	2608.38		

# Non-Permeable Pavement Infiltration

- Pavement Age
- Location
- Results



# Field Non-Permeability Test Results

Non-Pervious Pavements		Amount of Water	Height (in)	Time (min)	Notes	Infiltration rate (in/hr)	Average Infiltration rate (in/hr)	Average for the site (in/hr)
Sidewalk	1	1/4 gallon	22.5	0				
			22	5		-6.00	-2.00	-1.00
			22	10		0.00		
			22	15		0.00		
	2	1/4 gallon	21.625	0	leakage at edge			
			21.625	5	and on top	0.00	0.00	
			21.625	10		0.00		
			21.625	15		0.00		
Pavement	1	1/4 gallon	22.25	0				
			22.5	5		3.00	1.00	2.67
			22.5	10		0.00		
			22.5	15		0.00		
newer pavement	2	1/4 gallon	21	0	leakage bt 0-2 min			
			21.75	5	about 10%	9.00	7.00	
			22.5	10	MC measured	9.00		
			22.75	15		3.00		

# Roof Garden

## Vegetation

- Percent Coverage

## General Condition

- Drainage
- Maintenance



# Roof Garden Inspection Results

Roof Garden	5-Jul-11
Data Sheet	Larry Murphy
	Mandi Caudill
Visual Inspection	
Overall general health of plants (good, fair, poor)	
good: A+	
Percent Cover	Notes
Each corner (2x2 ft area)	
1. SE corner - 98% cover	
2. NE corner - 98% cover	
3. NW corner - 98% cover	
4. SW corner - 90% cover	dry
Note if any ponding	
no ponding	
Comments/Questions	
looks good	
parts dry	

# Street Planters

## Vegetation

- Number of Plants
- Height

## General Condition

- Drainage
- Maintenance



# Street Planter Inspection Results

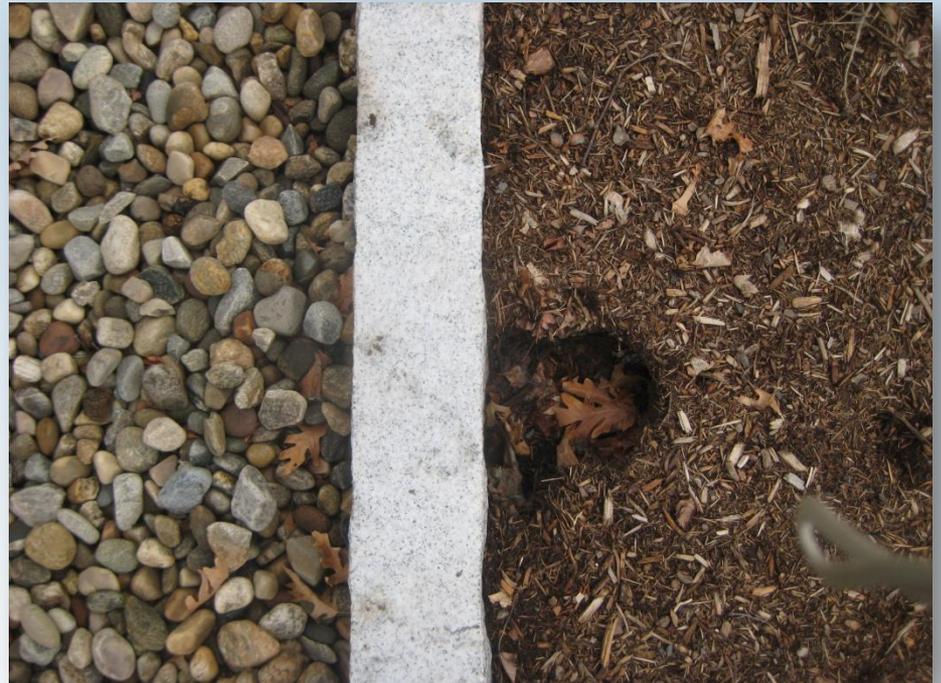
<b>Street Garden</b>		Date	5-Jul-11	
Data Sheet		Name	Larry Murphy	
			Mandi Caudill	
		Site	B	
Plants	Type	Height (in)	Health (good, fair, poor)	Average Height (in)
1	lilies	10	poor	10
5	shrub - A	18	poor	18
8	plant - B	34	good	34

# LESSONS LEARNED

# Lessons Learned

## Street Planters

- Locate at low spot
- Proper Plants
- Maintenance



# Street Planter Not at Low Point



# Street Planter Shaded Area



# Street Planter Non-Shaded Area



# Street Planter Maintenance Needs



# What's Next?

- Continue Sampling
- Improve Equipment
- UHART
- Other Sites



# QUESTIONS?

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