

NRMCA NATIONAL READY MIXED CONCRETE ASSOCIATION

# Concrete Solutions to Storm Water Runoff

Presented To:



**NHWC**  
New Hampshire Water Conference



**NEW HAMPSHIRE  
WATERSHED  
CONFERENCE**  
The Science & Policy of Water

Presented By: Jonathan Kuell, Executive Director:

**NORTHERN NEW ENGLAND  
CONCRETE PROMOTION  
ASSOCIATION**



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## Topics of Discussion

- Properties of Pervious Concrete
- Applications
- Benefits
- Design Considerations
- Placement Guidelines
- Freeze-Thaw Durability
- Project Review

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## What is Pervious Concrete?

- A No-Fines Concrete Mix
  - Coarse Aggregate
  - Portland Cement
  - Water
- Intended for use as an open-graded drainage material



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## Typical Pervious Concrete Mix Design

- 550 – 650 lbs. Portland Cement
  - Fly Ash / Slag Cement substitute acceptable at standard rates
- 27 ft<sup>3</sup> Coarse Aggregate
  - Aggregate size will affect drainage rate
- 0.25 – 0.35 W/C Ratio
  - Sufficient water to display a wet, metallic sheen on the aggregate

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## Pervious Concrete Properties

- 15% to 35% air void content
- 100 to 120 lbs/ft<sup>3</sup> unit weight
- 500 to 3000 psi strength\*
  - Introduction of small amount of fine aggregate can increase strength to 4000 psi (+/-)
  - compressive strength typically *not* used as acceptance criteria. Air void structure and unit weight are used instead.

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## Pervious Concrete Properties

- Drainage rate = 3-5 gal/sec/ft<sup>2</sup>
- Equivalent of 275" to 450" of rain per hour!
  - *More than half of all rainfall is provided in rain events that total one-half inch or less.*
- 6" section with 20% voids holds 1 – 1 ¼" of rain water



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## Typical Applications for Pervious Concrete

- Light Duty Parking Areas
- Nature Trails / Park Pathways
- Greenhouses / Nurseries
- Erosion Control
- Environmentally Sensitive Developments

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## Parking Lots & Pavements: Environmental Disasters

- Almost Total Runoff
- Public Water Needed for Vegetation
- Valuable Water Resources are Wasted
- Runoff Has Chemical Pollutants, Requiring Treatment
- Runoff is Hotter, Damaging Ecosystems
- Rapid, High Volume Runoff Requires Larger Public Drainage Facilities
- Hot Parking Lots Add to Urban Heat Island Effects

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## First Flush

- First 1" of rain
  - Contains contaminants
    - EPA requires collection and treatment prior to release
  - USGS study – Austin, TX
    - High concentration of polycyclic aromatic hydrocarbons (PAH)
    - Attributed to asphalt parking lot runoff
    - Runoff from asphalt-based sealants 10 times higher
    - Runoff from coal-tar based sealants 65 times higher
  - Source:
    - [http://water.usgs.gov/hawqa/asphalt\\_sealers.html](http://water.usgs.gov/hawqa/asphalt_sealers.html)

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## First Flush

- Pervious concrete pavement reduces runoff
  - Cleaner first flush
  - Captured by void structure
  - Minimization of PAH
- Soil chemistry and biology will naturally treat water
  - Oil drips and other automotive pollutants are “attacked” by naturally occurring soil microbes

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## An EPA BMP

- For stormwater pollution prevention
- Lower heat island effect
- Pervious concrete is eligible for LEED credit points for the USGBC Green Building Rating System.

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## Cost Advantages

- Savings to Municipalities
  - Reduces stormwater utility fees
  - Minimize upgrade of existing systems to keep up with development
    - Cerritos, CA
    - 90,000 ft<sup>2</sup> Pervious Concrete Parking Lot
    - City saved between \$250K and \$500K
- Savings to Owners/Developers
  - Eliminates need for retention ponds & other costly stormwater management practices
  - Provides for more efficient use of land development

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## Shelter Systems Ltd. Westminster, MD

- Approximately 8 acres of pavement
- Saved \$400,000 in underground drainage construction costs
- Eliminated 1 1/2 acre retention pond



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## Pavement Design Thickness

- Hydrological Design Considerations of pavement & related base materials (stormwater storage capacity)
- Mechanical Properties (load carrying capacity)
- Choose greater thickness of these needs
- Base design important to storage as well
- Hydrological Design software is now available

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## Infiltration Systems

- Developed in 1970's
  - Franklin Institute, Philadelphia, PA
  - Have been used for over 20 years

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- Pervious concrete: 4-6 inches typical
- Open-graded stone subbase: determined by local hydrologic conditions
- Geotext prevents movement of fines into stone bed
- Perforated pipe to capture water & let it drain (optional)

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- Water drains through pavement into stone bed and infiltrates slowly into underlying soil mantle
  - 0.1 – 0.5 in/hr acceptable
  - Total drawdown time should not exceed 5 days

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## Pervious Concrete Placement

Many ways to place pervious, including:

- Roller Screed
- Asphalt Paver
- Laser Screed
- Vibratory Truss Screed

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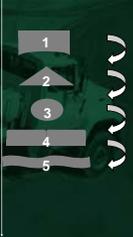
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## Finishing: The Typical Process

- Spreading
- Strike-off
- Compacting
- Jointing/Edging
- Curing



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## Hydraulic Roller



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## Surface Texture

- Important to keep the voids open
- Do NOT use trowels
- Do NOT seal the surface
- No roller marks



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## Pervious Concrete Placement

- Can also use paving equipment
  - May still require side forms
    - Material usually not stiff enough for edges to hold under pressure of compaction
- Conventional asphalt paver provides 90% (+/-) compaction
- For denser surface, follow behind with plate tamp or small roller

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## Curing

- Curing pervious concrete is perhaps more important than curing conventional concrete
- Without curing, surface will dry out and deteriorate easily
- Moist cure (7 days preferred)

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Curing pervious concrete is critical due to the porosity and low W/C ratio

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6 mil poly sheeting for 7 days



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### Durability of Pervious Concrete

- Directly related to proper placement
  - Maintain W/C ratio
  - Proper compaction of pervious surface
  - Proper curing is a must!
  - Specify an NRMCA Certified Pervious Concrete Contractor!

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## Can Pervious Concrete Withstand Freeze-Thaw?

- Proper mix design
- Proper placement
- Proper maintenance



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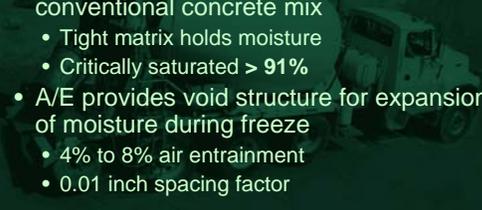
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## Consider Conventional Concrete

- A/E required to relieve pressures in conventional concrete mix
  - Tight matrix holds moisture
  - Critically saturated > 91%
- A/E provides void structure for expansion of moisture during freeze
  - 4% to 8% air entrainment
  - 0.01 inch spacing factor



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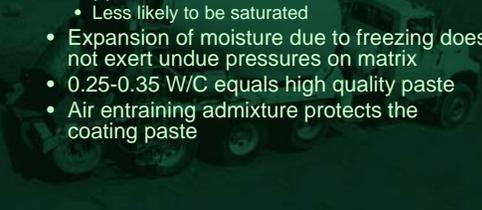
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## Pervious Concrete

- 15-35% void structure means little moisture trapped in matrix
  - Less likely to be saturated
- Expansion of moisture due to freezing does not exert undue pressures on matrix
- 0.25-0.35 W/C equals high quality paste
- Air entraining admixture protects the coating paste



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## Freeze-Thaw Resistance

- Depends on saturation level
- Avoid critical saturation
  - Maintenance
    - Annual cleaning in severe climates
  - Design
    - Infiltration System
    - Secret of success is to provide the water a place to go

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## Snow Packing

- Anecdotal evidence suggests snow-covered pervious clears quicker than impervious surfaces
  - Less need for snowplowing
- Water drains through pavement into stone bed
  - Water does not pond & re-freeze
  - Formation of "black ice" is rare
  - Open-grade beds act as insulation



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## Grocery Store Denver Colorado



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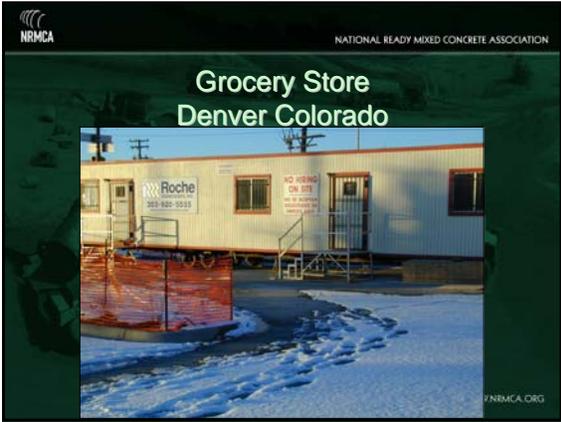
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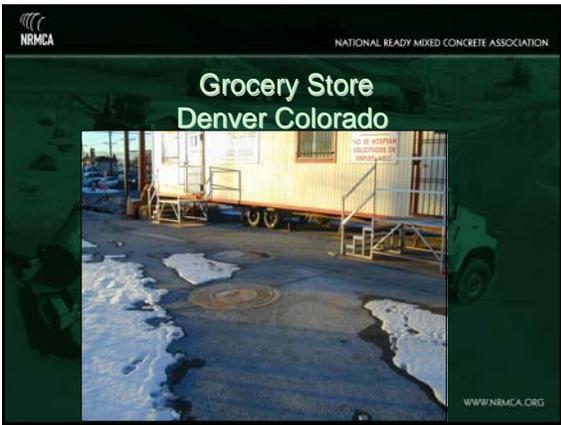
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## Denver, CO

Pervious Concrete      Conventional Asphalt

Sites directly across street  
Photos: 5 min. differential max

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## Study conducted by NRMCA

Results available at [www.nrmca.org](http://www.nrmca.org)

**Freeze-Thaw Resistance of Pervious Concrete**

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## What About Clogging?

- Even if 100% clogged with dirt, pervious concrete will still be permeable
- For maintenance, clean pervious pavement with power scrubber
- And/or power wash

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- Conventional pavement sweeper/vacuum equipment can also be used



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Cleaning can restore 90+% of original permeability



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Let's Look at Some Recent Projects

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- Finley Stadium
  - Chattanooga, TN
- OCT, 1997
- At Issue:
  - Parking lot drainage & contaminated soils
- Total parking lot approximately 6 acres
- Size of pervious area
  - 10,000 ft<sup>2</sup>
  - 10 ½ ft width



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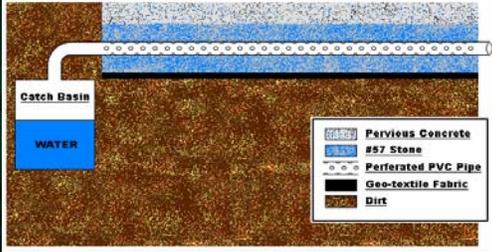
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- 6" stone subbase under entire parking lot
- 4" Pervious Concrete in parking areas
- 200,000 gal. holding capacity
- 400,000 gal catch basin

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Wet Freeze 50 cycles/yr

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- Shelter Systems, Ltd.
  - Westminster, MD
- Placed 2004
- Wet Freeze
  - 90 cycles/yr



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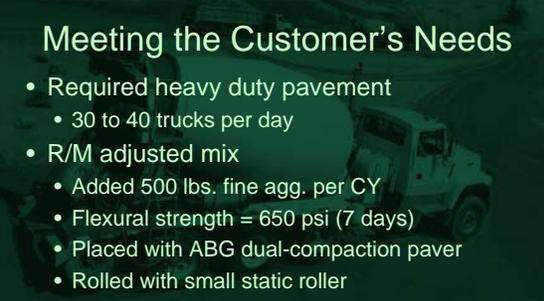
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### Meeting the Customer's Needs

- Required heavy duty pavement
  - 30 to 40 trucks per day
- R/M adjusted mix
  - Added 500 lbs. fine agg. per CY
  - Flexural strength = 650 psi (7 days)
  - Placed with ABG dual-compaction paver
  - Rolled with small static roller



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- Approximately 8 acres of pavement
- Mix design can accommodate 80" of rain per hour
- 10 times intensity of 100 year rainfall event!



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- Saved \$400,000 in underground drainage construction cost
- Allowed owner to close 1 1/2 acre retention pond



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- SR 23
- Sussex, NJ
- July, 1999
- Slope Erosion



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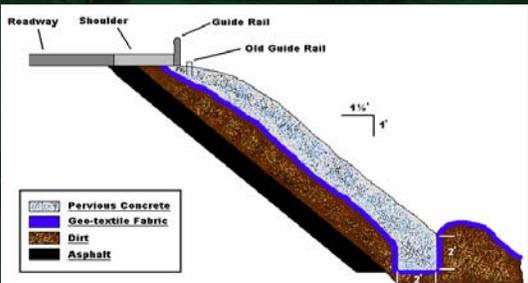
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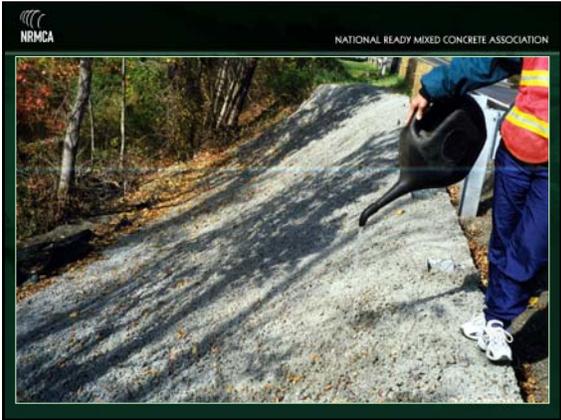
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"Yeah, but,,,"  
"That will never work  
around here"

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May, 2004 Placement  
Williston, VT



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May, 2004 Placement  
Williston, VT



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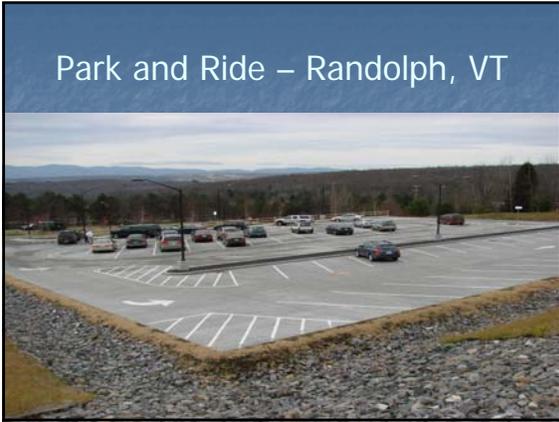
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Park and Ride – Randolph, VT



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Downtown St. Albans, VT



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- Over 1.2 MILLION YARDS of pervious concrete was placed in preparation for the 2008 Summer Games in China

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For further information . . .

- Available from NNECPA



**Pervious Concrete Pavements**

Paul J. Torres  
Michael L. Jones  
David J. Allen




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For further information . . .

- Available from NNECPA



**Pervious Concrete: Hydrological Design and Resources**



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For further information . . .



**Pervious Concrete**  
*When it rains...it drains.*

[www.perviouspavement.org](http://www.perviouspavement.org)

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