

# Minnesota Porous Pavement Research

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**TERRA - MnROAD Open House**

**July 30<sup>th</sup> 2008**



# Typical Stormwater Handling Method

Impermeable  
pavement



Inlet



Outlet



*Culverts*

Detention  
Pond/  
Surface  
Water



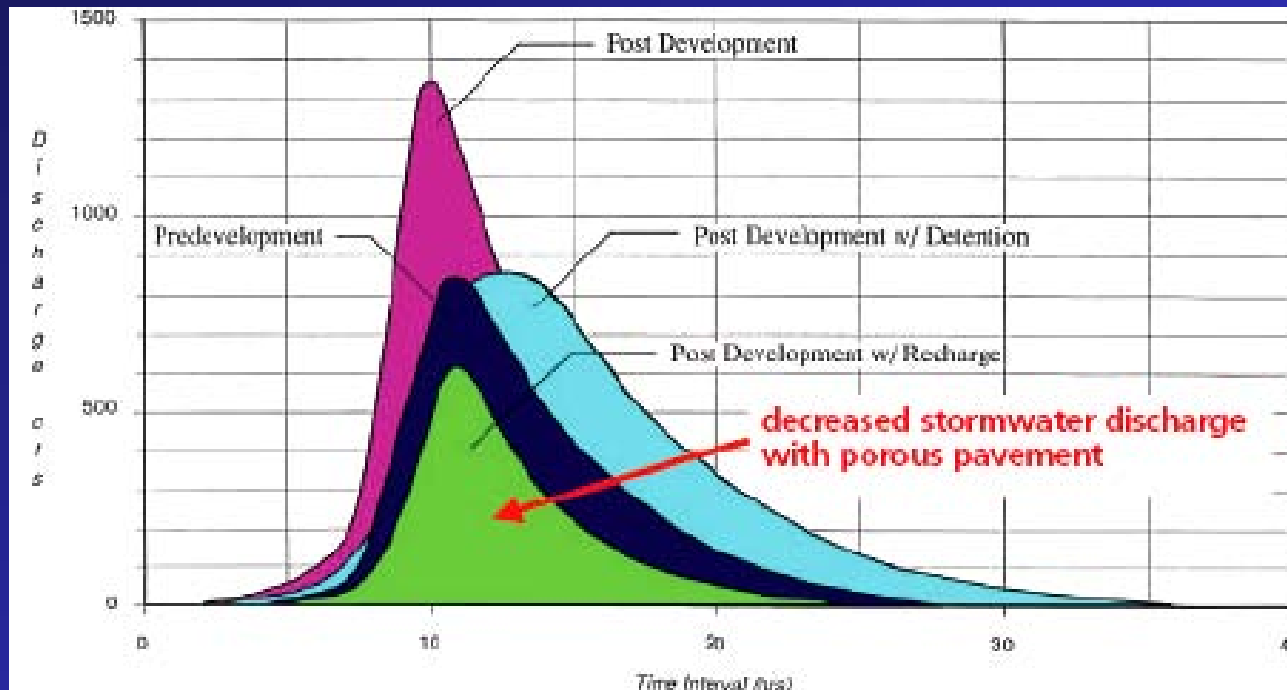
May lead to



Flooding (Missouri Capital 1993)

# An Alternative – Permeable Pavements

- **Permeable Paving** also called **Pervious Paving** or **Porous Pavement**
- Allows vertical movement of water and air through the pavement and base directly into subgrade soils and groundwater.
- Properly designed permeable pavements can reduce the total runoff volumes and peak flow.



Source: Cahill & Associates



# Examples of Permeable Pavements

## ■ Porous Turf

- used for occasional parking
- counteracts the “heat island” with water transpiration

## ■ Single-sized Aggregate

- low traffic areas only, but large potential use
- highly permeable
- least expensive – no binder

## ■ Porous Pavers

- concrete or stone units with open, permeable spaces between the units
- architectural appearance
- can withstand heavy traffic, particularly interlocking paving blocks

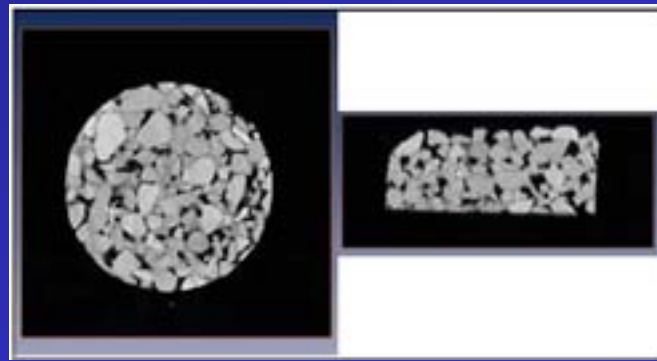
## ■ Porous Asphalt and Pervious Concrete

- plant mixed
- minimal fine (small) aggregates
- high % of interconnected voids provide porosity and permeability
- often used with permeable base course
- withstands repeated traffic



# Porous Asphalt (PA)

☞ **Open-Graded mix with high porosity** - storm water travels vertically through permeable surface, is stored in open-graded base, and infiltrates into subgrade groundwater directly.



porous asphalt core CT scan

PA surface texture

# Porous Asphalt Types

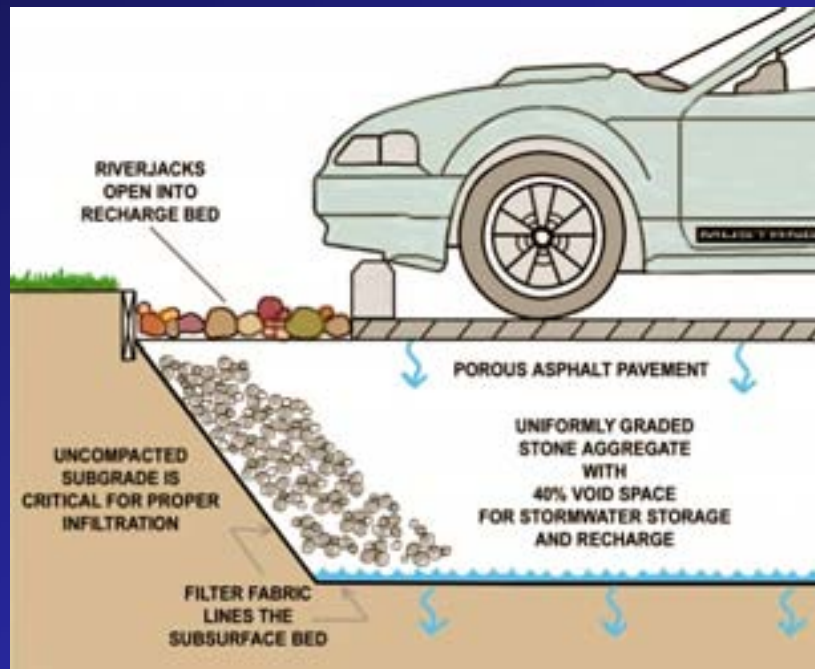
## ■ Porous Friction Courses (PFC) (OGFC)

Usually a thin wearing course of porous asphalt above impervious HMA layer – water drains out laterally.

## ■ Porous Asphalt (PA)

One or more lifts of fully permeable pavement over porous base.

*Full Depth Porous Asphalt Example:*



Source: Cahill & Associates

Pervious Structure allows water to flow through

Open-Graded Storage layer

Geotextile

Uncompacted Subgrade



# Porous Asphalt (PA) In Use Elsewhere

## ■ In the USA

- ◆ Most commonly used in parking lots, trails, hardscaping.
- ◆ Few examples of full-depth PA on roadways.
- ◆ As OGFC or PFC - Common in FL, GA, OR, CA, TX

## ■ In Europe

- ◆ Netherlands (extensive use of PA on roads)
- ◆ Denmark, Belgium
- ◆ Great Britain
- ◆ Sweden (Similar cold-climate research done)
- ◆ France, Switzerland, Italy, Spain, Greece

## ■ Japan

## ■ And Others

- ◆ Australia, Canada, South Africa, Malaysia



## ◆ Potential Benefits

- Reduces stormwater total runoff and storm surges
- Less structures, detention ponds, and right-of-way needed for stormwater mitigation
- Environmental benefits; water quality, runoff water temperature, recycled materials, water & air to plant roots
- Quieter pavement - lower tire & vehicle noise
- Low impact development - Leadership in Energy and Environmental Design (LEED®) credits
- Faster snow melt(?), resistant to frost heave & thermal cracking
- Safety improvements: less splash & spray, glare reduction, less hydroplaning



## ◆ Potential Disadvantages

- ☞ Durability results are mixed elsewhere and not well-studied in cold climates
- ☞ Potential for clogging – leads to loss of permeability, failure of stormwater handling & environmental benefits
- ☞ Clogging incurs regular maintenance – usually pressure spray / vacuuming is employed
- ☞ Higher Costs – construction, maintenance, shorter lifespan. (May be balanced with higher cost of standard stormwater mitigation)
- ☞ Assumed lower structural contribution from porous pavement
- ☞ Increased deicing application needed(?)



# **LRRB 878 MnROAD Porous Asphalt Project**

**To study the Durability, Maintenance Needs,  
Hydrologic Benefits, and Environmental  
Considerations of a Full-Depth Porous  
Asphalt Pavement in a Cold Climate.**

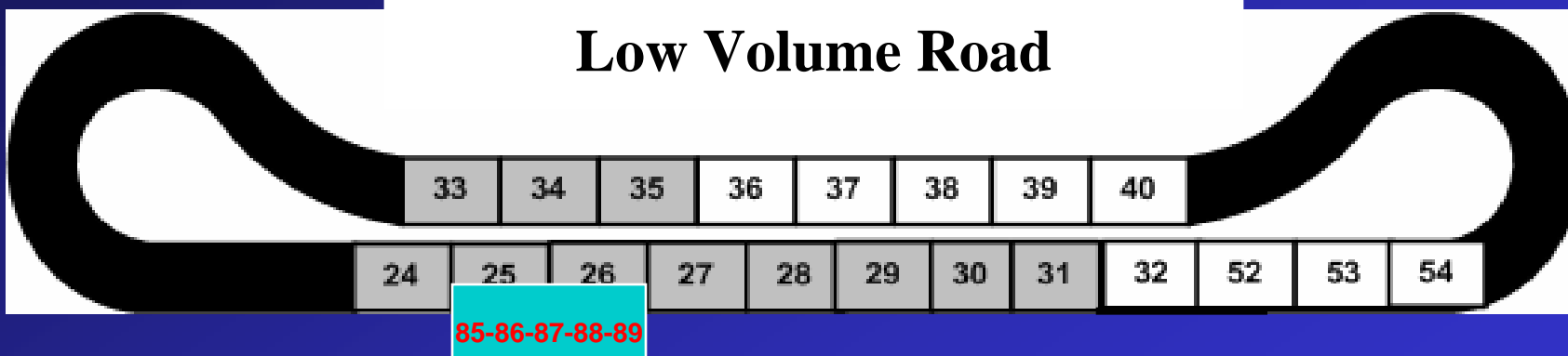
**Construction - Summer 2008**

**Project Ends - Fall 2010**



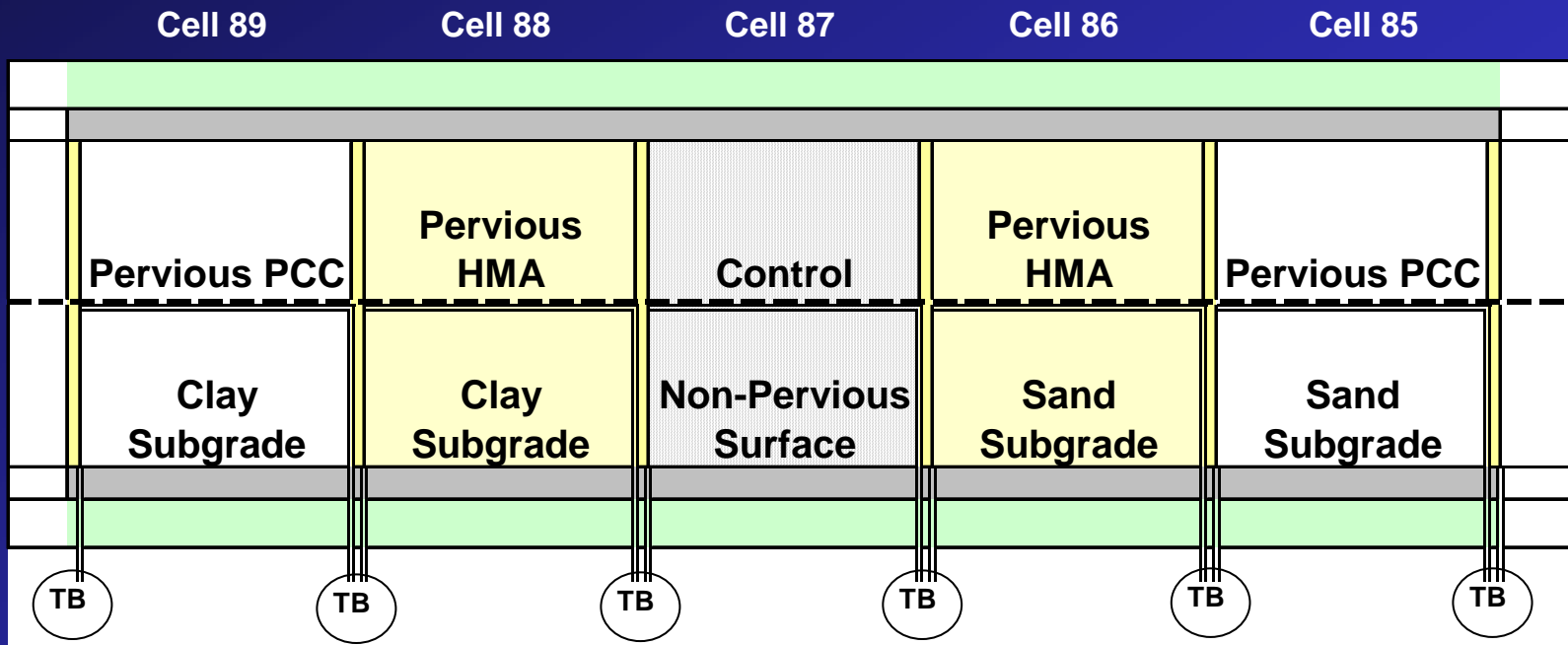
# LRRB 878 MnROAD Porous Asphalt Project

- Late Summer 2008 Construction MnROAD Low Volume Road
- Cells 25 & 26 to be replaced with cells 85 - 89

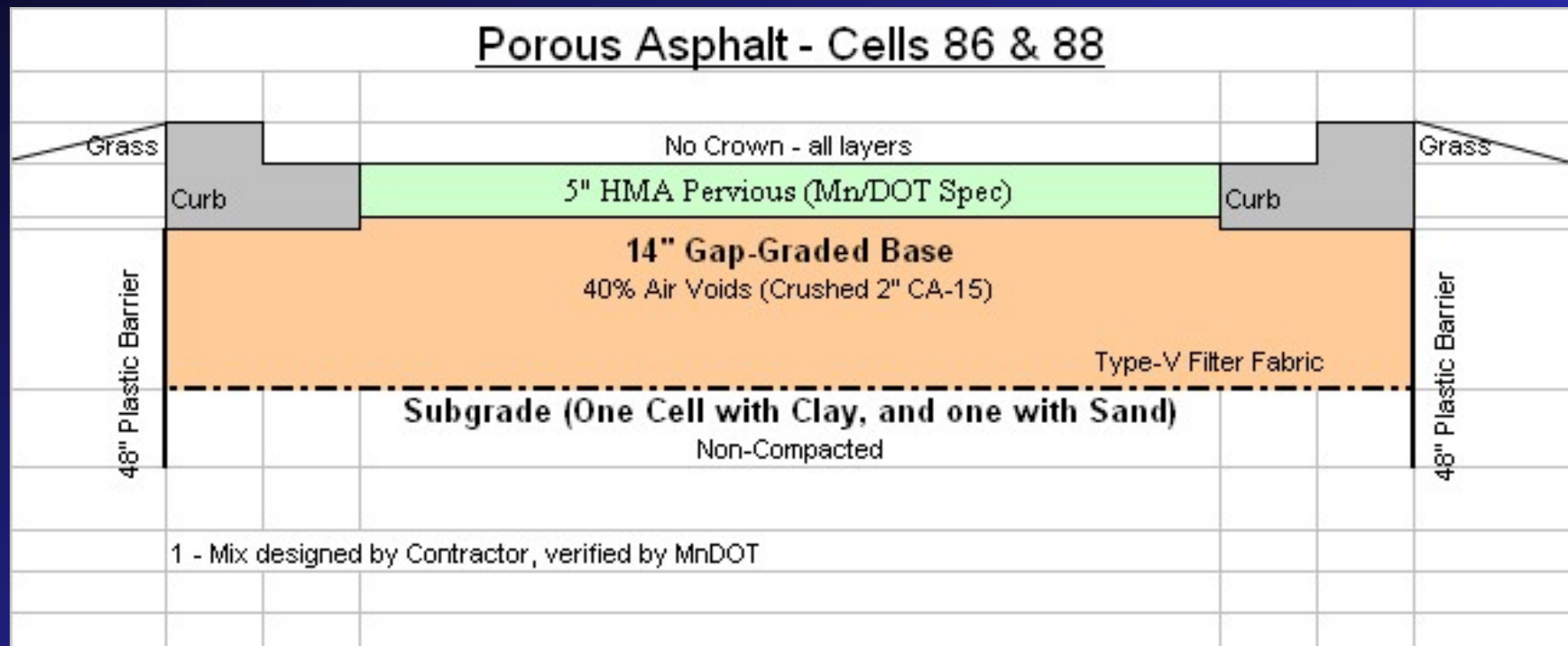


# 2008 Construction MnROAD Low Volume Road

- Two porous asphalt (LRRB 878), and two pervious concrete (LRRB 879) pavement sections; one of each with a clay subgrade, and one of each with sand subgrade.
- An adjacent, impermeable (sealed HMA) “control” section will also be prepared to compare durability / runoff / water quality.



# LRRB 878 Cross Section



# LRRB 878 Research Objectives

- ◆ Evaluate performance; durability and functionality when used on a low volume roadway in Minnesota (cold climate).
- ◆ Study hydrologic benefits and quantify environmental effects.
- ◆ Provide an alternative design tool for pavement designer to effectively manage storm water on local roads.
- ◆ Use performance data to develop mechanistic-empirical design of porous pavements in cold-weather environments.
- ◆ Document necessary maintenance procedures and cost.
  - ☞ When is maintenance required?
  - ☞ Best Practices? How often?



# LRRB 878 Testing Methodology

## Two-year continuous Monitoring; 2008 - 2010

(issues where cold-climate data is lacking have green bullets)

- Pavement performance – distress surveys, friction, fwd.
- Stormwater - flow rate & volume, compare to control cell.
- Document groundwater quality; Heavy Metals, PH, Suspended Solids.
- Monitor and document Subsurface frost and Snow & Ice issues.
- Monitor pavement clogging, test maintenance schemes.
- Noise Testing.

## Instrumentation

- Piezometers, strain gauges, tipping buckets, lysimeters, thermocouples, TDRs, and permeameters.



# LRRB 878 Summary of Porous Asphalt Modified Mn/DOT Specification 2360/2350

(Based on NCAT 2000) (Key Mix Properties in green)

- PG64-34 Binder, Minimum asphalt content 5.5% - 6.5% by weight
- No recycled material
- Gradation; 100% passing  $\frac{3}{4}$ , 75% retained on #4 (no Class B aggregates)
- LA Rattler Loss <35% for any individual source
- Mineral Filler allowed / Maximum Draindown  $\leq 3\%$
- Coarse Aggregate Angularity >55% (No Fine Agg Angularity Spec)
- Coarse Aggregate Absorption  $\leq 2\%$
- Voids in Coarse Agg;  $VCA_{max} < VCA_{drc}$
- Flat & Elongated  $\leq 5$  (5:1 ratio)
- Clay Content, Max Spall, % Lumps retained on #4
- Air Voids; 17 - 19% (ensures permeability)
- Placement of Asphalt @ 50F ambient temp, 275F mix laydown temp minimum
- Modified Lottman test; TSR  $\geq 80\%$
- Mix Storage; 90 minutes max
- Mix to be placed with a track paver only
- 10-ton steel wheeled non-vibratory rollers only (1 or 2 passes)
- No vehicular traffic on finished surface for 24hrs, prevent surface contamination



## **Status of LRRB 878 Project - July 2008**

- **MnROAD Phase II reconstruction (2007-2009) continuing**
- **2008 MnROAD reconstruction continued in April (Mainline first)**
- **Preliminary Geotechnical Survey work done**
- **Piezometers installed**
- **Baseline Water Quality Sampled and Tested**
- **Porous Asphalt Mix Design in progress**
- **Expect Porous Asphalt (& Pervious Concrete) Cell construction August or September 2008**



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## Websites & Additional Info;

- <http://www.fhwa.dot.gov/environment/ultraurb/3fs15.htm>  
FHA fact sheet – porous pavements
- <http://www.cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm>  
US EPA Stormwater BMPs
- [www.hotmix.org](http://www.hotmix.org) National Asphalt Pavement Association
- <http://www.dot.state.mn.us/mnroad/index.html>  
MnROAD information



# Thank you

