What are Porous Pavements?

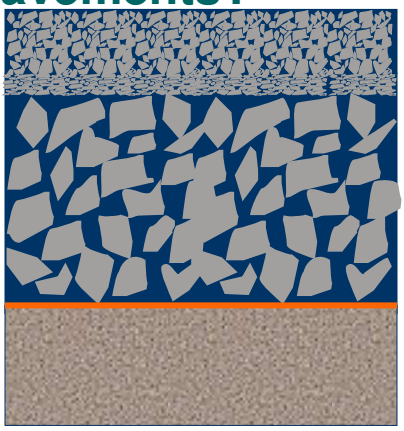
Open-Graded HMA ~ 2 ½"

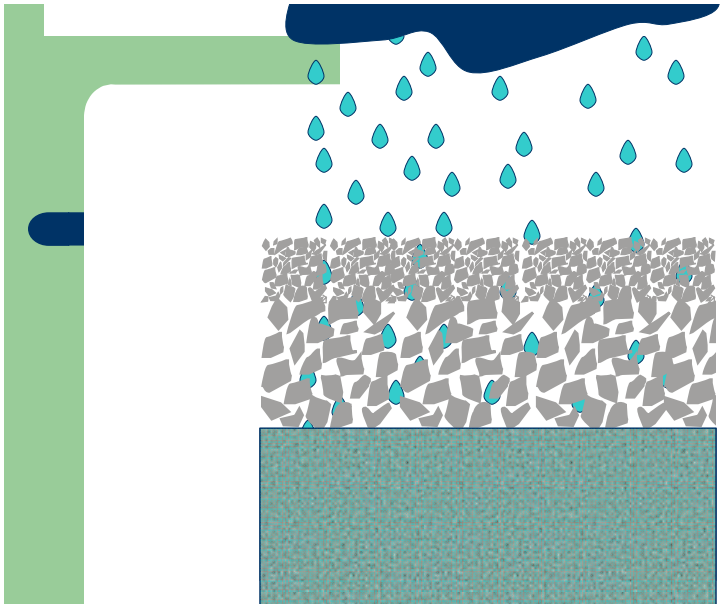
½" Agg. (#57) ~ 1 – 2" Thick

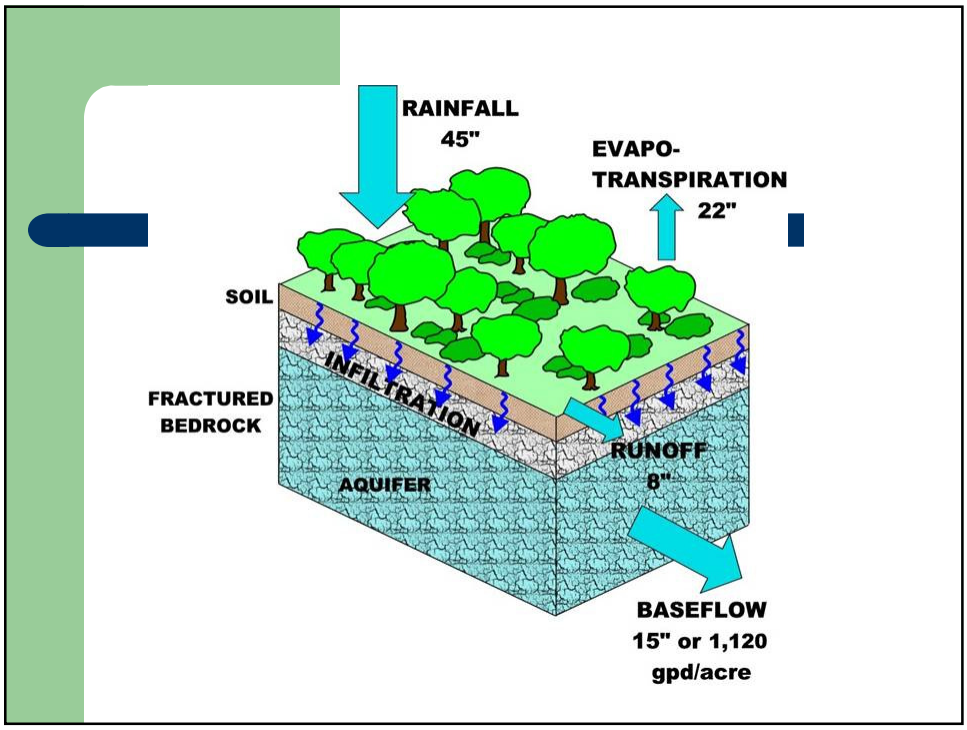
Clean Uniformly Graded 2"-3"
Crushed Agg. (#2) – 40% Voids

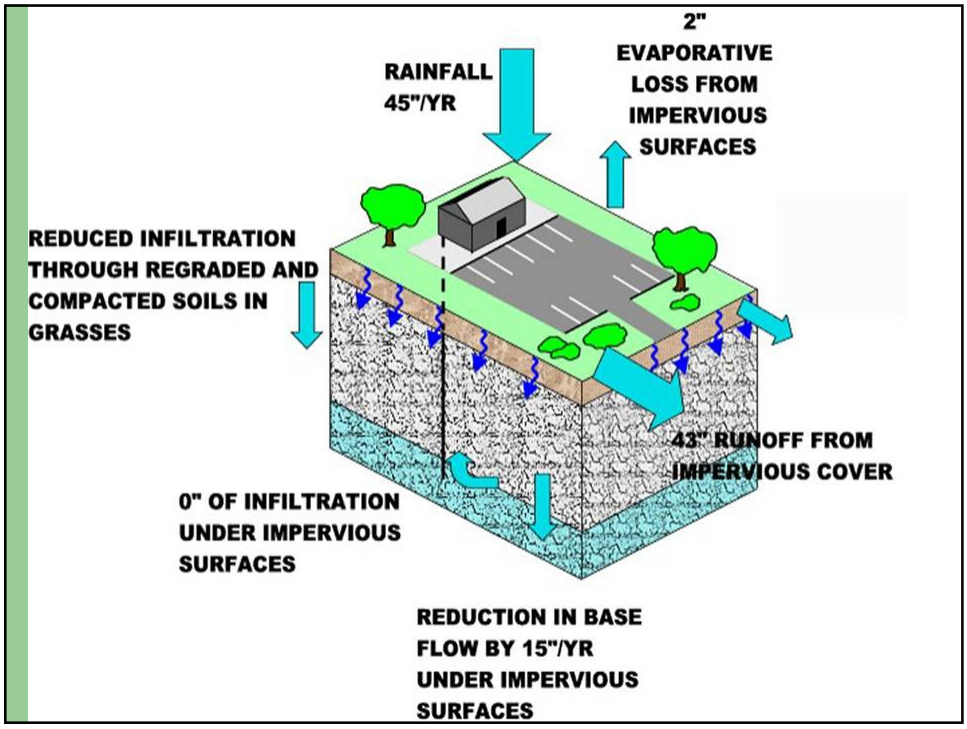
Non-Woven Geotextile

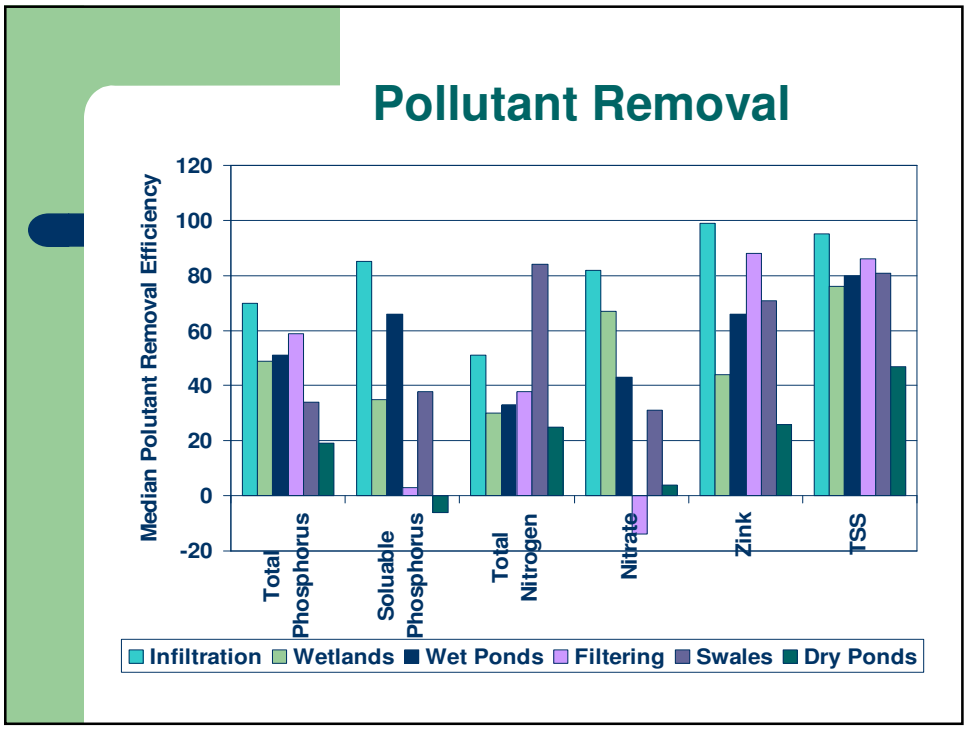
Uncompacted Subgrade



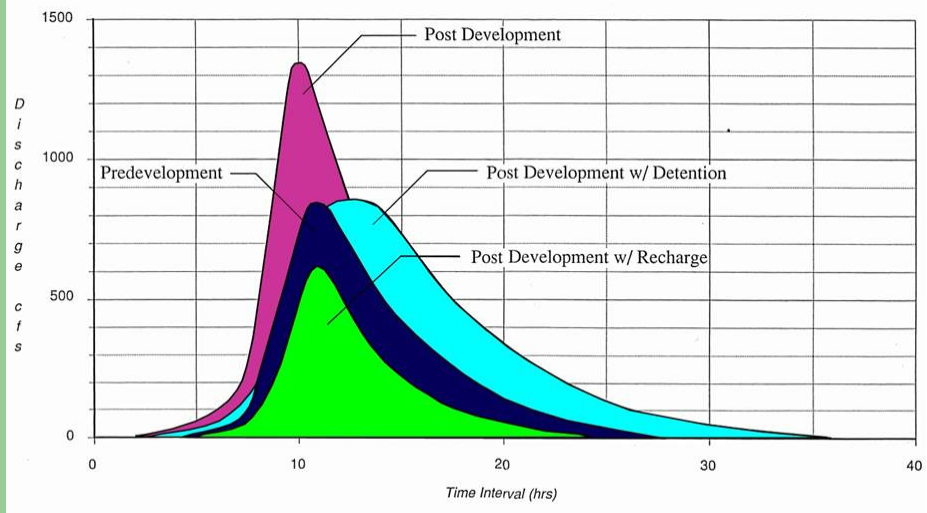



RAINFALL
45"
EVAPO-
TRANSPIRATION
22"
SOIL
INFILTRATION
FRACTURED
BEDROCK
RUNOFF
8"
AQUIFER
BASEFLOW
15" or 1,120
gpd/acre


2"
EVAPORATIVE
LOSS FROM
IMPERVIOUS
SURFACES
RAINFALL
45"/YR
REDUCED INFILTRATION
THROUGH REGRADED AND
COMPACTED SOILS IN
GRASSES
43" RUNOFF FROM
IMPERVIOUS COVER
0" OF INFILTRATION
UNDER IMPERVIOUS
SURFACES
REDUCTION IN BASE
FLOW BY 15"/YR
UNDER IMPERVIOUS
SURFACES


Pollutant Removal
Median Polutant Removal Efficiency
120
100
80
60
40
20
0
-20
Total Phosphorus
Soluable Phosphorus
Total Nitrogen
Nitrate
Zink
TSS
Infiltration
Wetlands
Wet Ponds
Filtering
Swales
Dry Ponds

Comparison of Detention vs. Infiltration Design Systems



Porous bituminous pavement

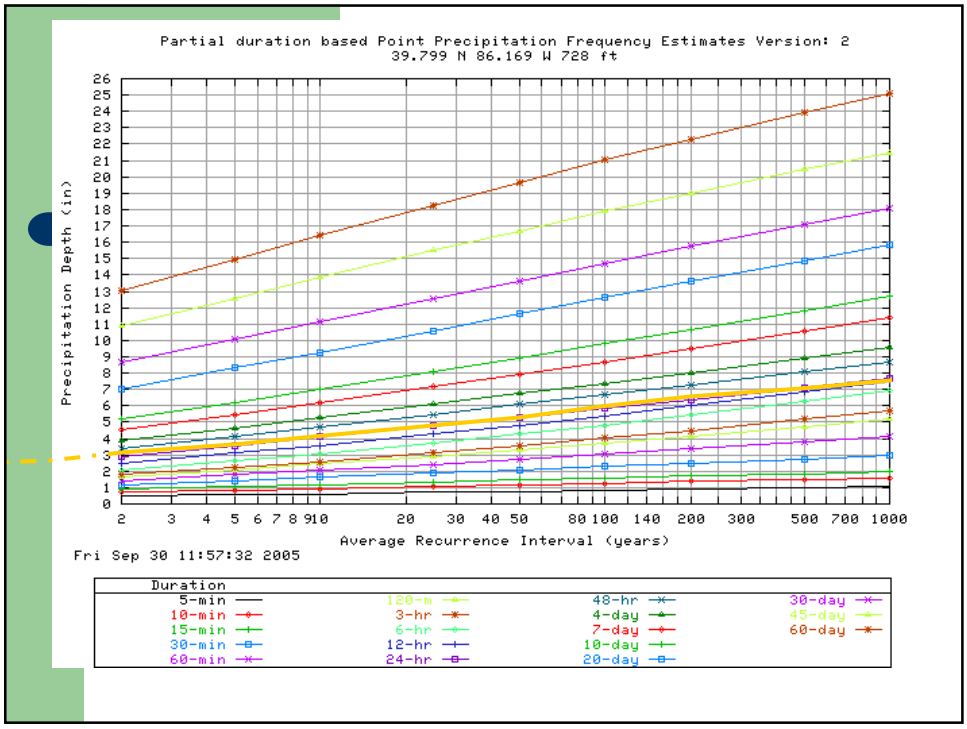
- Developed by the Franklin Institute – 1972
- Tested in pilot projects during 1970's
- Development of geotextiles in 1979
- Current design since 1980
- CA has built over 150 projects since 1980
- Outstanding engineering project - 2000

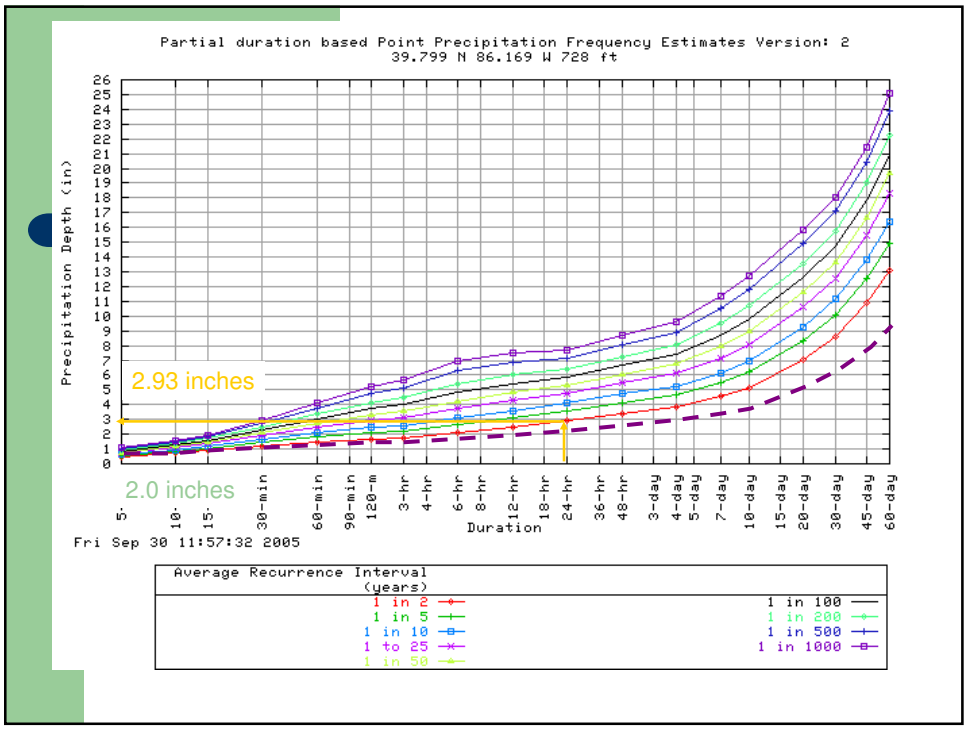
Suitable Site Conditions

- Soil permeability/infiltration rate
  - 0.5”/hour desired, but 0.1”/hour can work
  - Test pits and infiltration measurements needed
- Depth to bedrock > 2’
- Depth to high water > 3’
- Frost
  - Pavement section should exceed frost depth

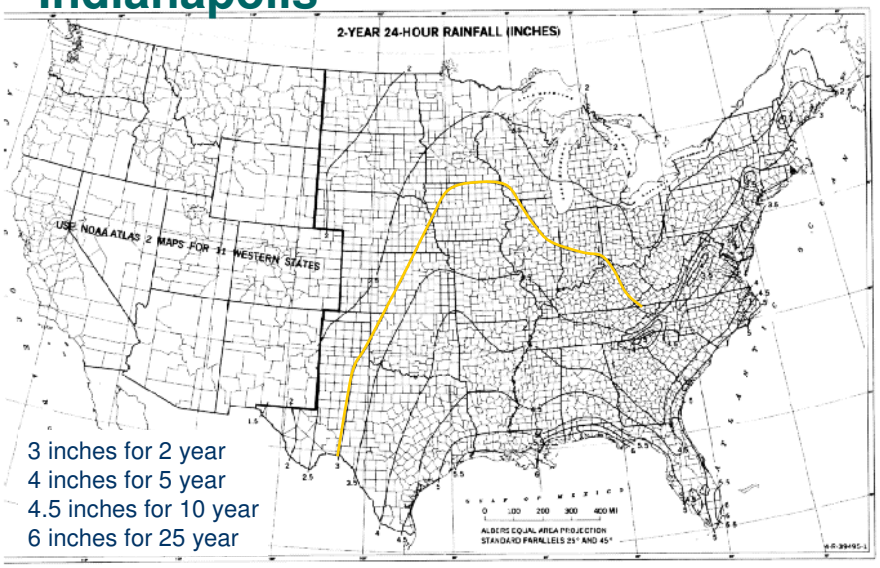
Reservoir Capacity Needed

- Rainfall
  - Typical designs for 2-year/24-hr storm
  - Conservative design for 25-year/24-hr storm
- Meet Local & State runoff mitigation requirements


Partial duration based Point Precipitation Frequency Estimates Version: 2
39.799 N 86.169 W 728 ft
Precipitation Depth (in)
Average Recurrence Interval (years)
Fri Sep 30 11:57:32 2005
Duration
5-min
10-min
15-min
30-min
60-min
120-m
3-hr
6-hr
12-hr
24-hr
48-hr
4-day
7-day
10-day
20-day
30-day
45-day
60-day

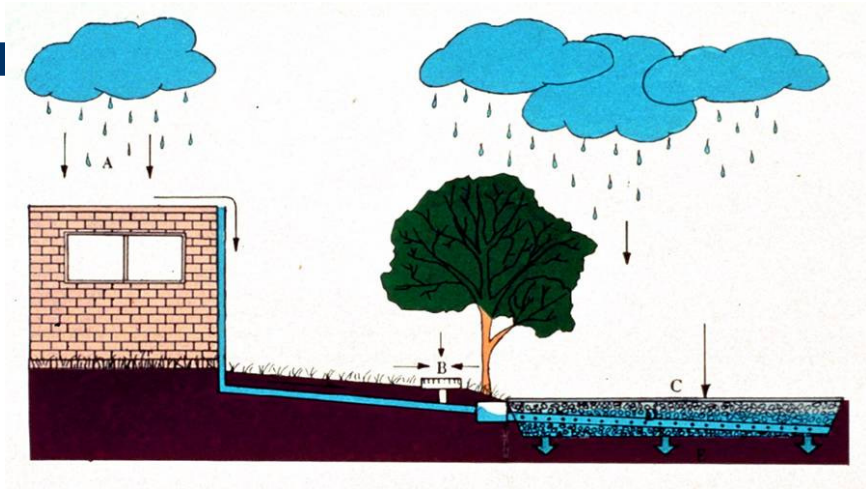

Partial duration based Point Precipitation Frequency Estimates Version: 2
39.799 N 86.169 W 728 ft
Precipitation Depth (in)
2.93 inches
2.0 inches
Duration
Fri Sep 30 11:57:32 2005
Average Recurrence Interval (years)
1 in 2
1 in 5
1 in 10
1 to 25
1 in 50
1 in 100
1 in 200
1 in 500
1 in 1000

Indianapolis



3 inches for 2 year
4 inches for 5 year
4.5 inches for 10 year
6 inches for 25 year

Can Include Roof Water and Runoff Adjacent Land



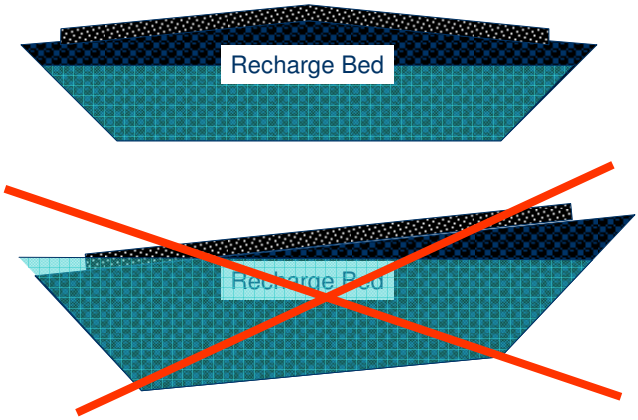
Soils Investigation

- Borings and/or test pits
  - Test permeability
  - Determine depth to high water table
  - Determine depth to bedrock

Basic Design Guidelines

- Slope
  - Limit **surface** slope to 5%
  - Construct **bottom** as flat as possible!
  - Terrace when necessary
  - Use conventional HMA for steeper slopes
- Avoid compacting soils during construction
- Avoid excessive earthwork
  - Design with contours of site

Bottom Should Be Flat



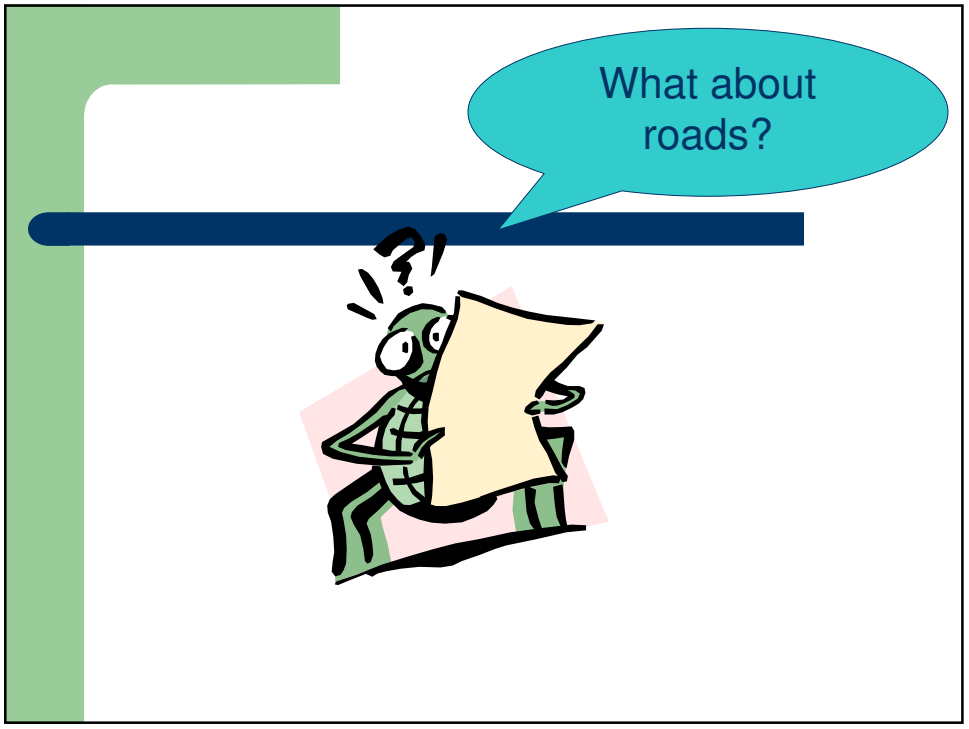
Keys to Success – Design

Usage / Vehicle Loading

Lightly loaded areas

- Parking lots
- Low volume roads (limited truck use)
- Recreational Areas

- Meet structural requirements
- Roads?



Roads

- Challenges
  - Cuts and fills
  - Slope
  - Variable soil conditions
  - Utilities
- Limited use

Cost

- Cost of pavement structure more
- May be offset by reducing drainage structure costs

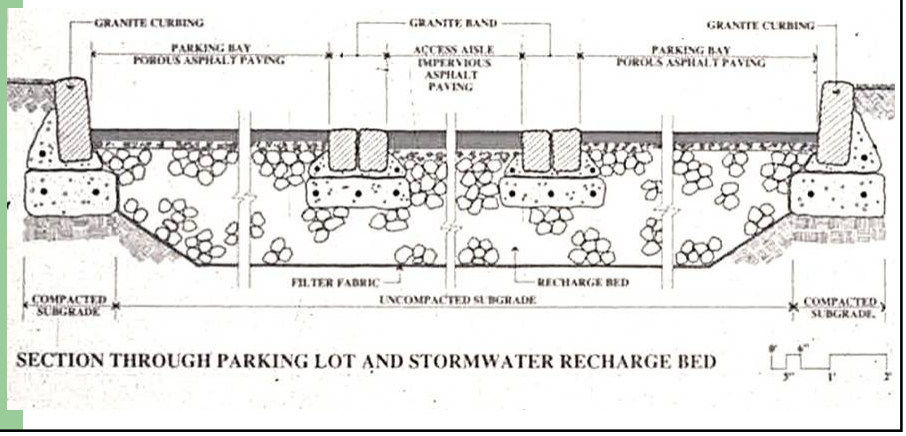
Keys to Success

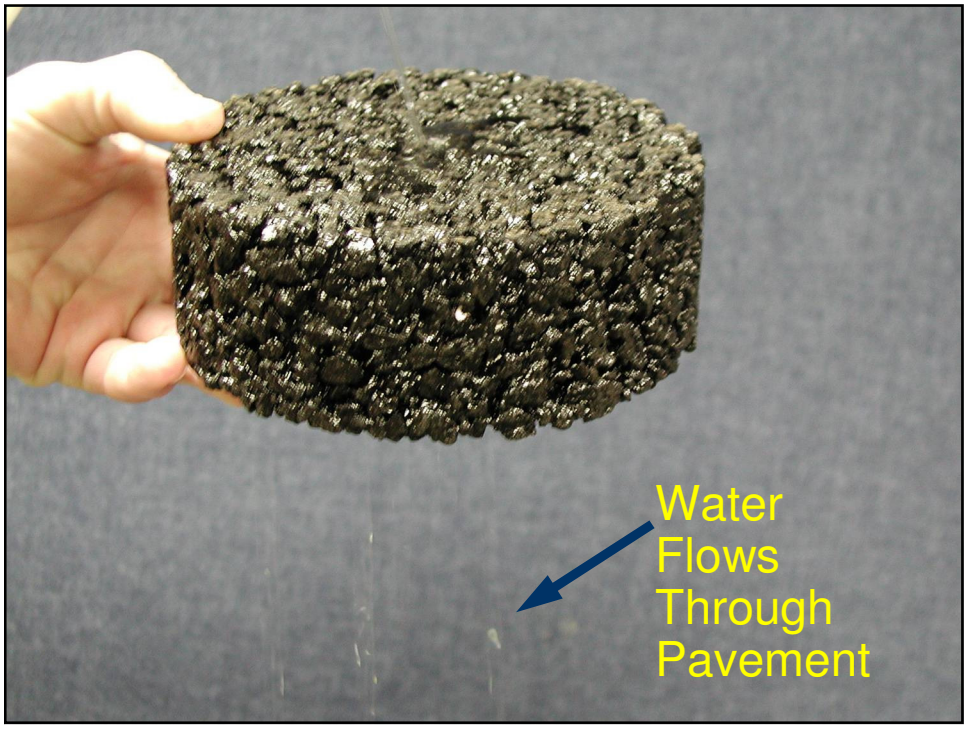
- Make sure site conditions are acceptable
  - Permeability
  - Depth to groundwater and/or bedrock
- Design
  - Bottom of infiltration bed level
  - Limit surface slope < 5%
  - Runoff from adjacent areas will not plug pavement

Keys to success

- Construction
  - Don't compact subgrade
  - Protect from contamination
    - Build porous pavement late
    - Stabilize adjacent areas before construction
- Maintenance
  - Do not sand pavements
  - Install signage to warn maintenance personnel
  - Can patch with conventional asphalt < 10%

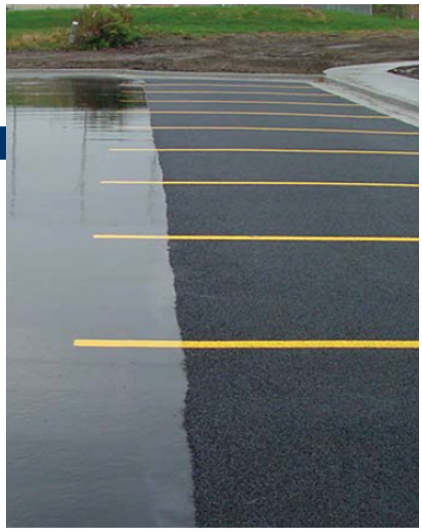
Infiltration Bed at Morris Arboretum





Post Office Lot

- **Porous asphalt in parking area**




Shared Medical Systems
Malvern, PA
1982

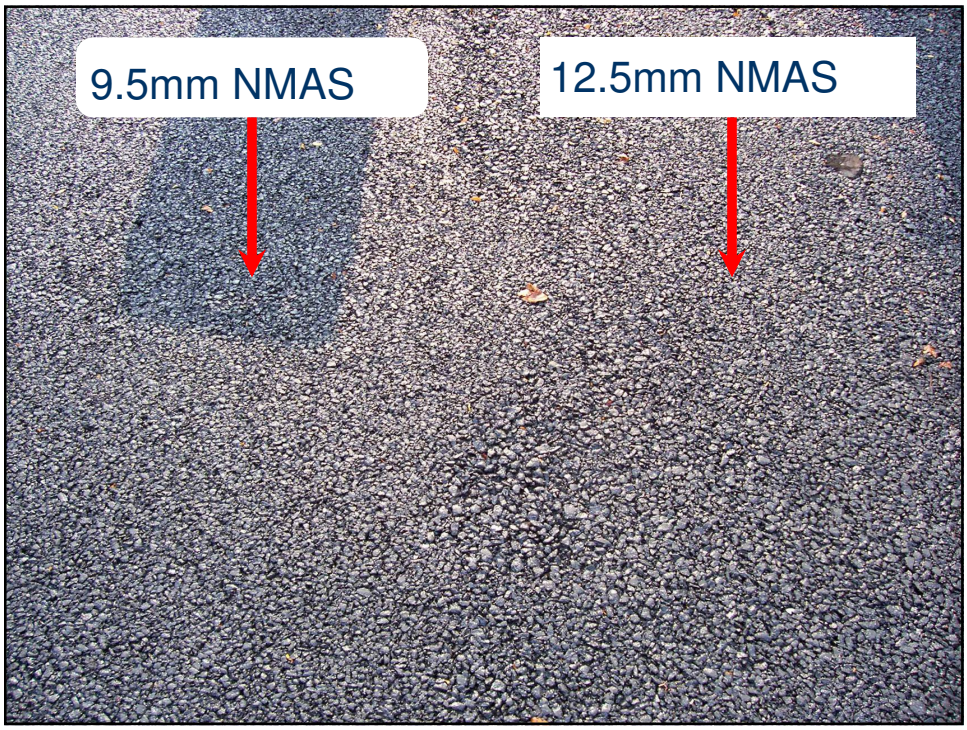

Shared Medical Systems
2002
CAUTION
BUMP


Winter Climate Acceptable


ROADTEC
Milestone
Purdue Horticulture Lot

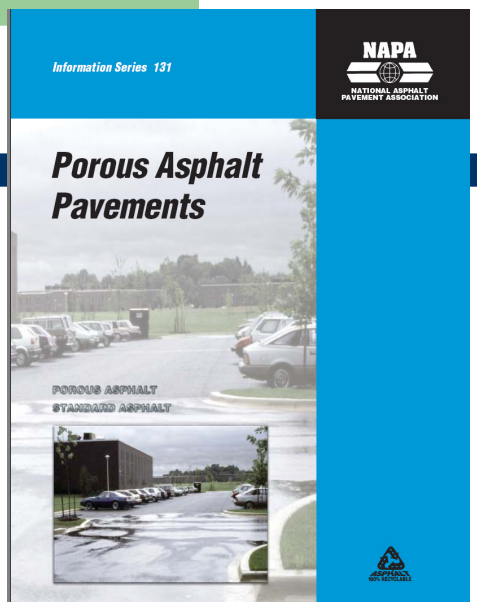

ROADTEC
Milestone


Salisbury Street, West Lafayette


9.5mm NMAS
12.5mm NMAS

"Green Streets" in Oregon Community

Pringle Creek Subdivision, Salem, Oregon



NAPA Guide

Information Series 131

Keys to Success – Construction

- Place reservoir course 1.5 to 3 in. stone (if granular source then 95% double fracture)
- Place 1-2 in layer of ½ in stone to stabilize the surface of the reservoir course
- Place porous asphalt course (2 to 4 in.) usually compacted with 2-3 passes with 10 ton roller.

Keys to Success – Construction

- Build porous pavement last
  - Protect from construction debris
  - Protect from soil laden runoff
- Protect site from heavy equipment
  - Don't compact subgrade
- Excavate to subgrade (soft footprint)
- Place filter fabric

Indiana Specifications

- Asphalt Pavement Association of Indiana
- www.asphaltindiana.org

Guide Specification for
Porous Asphalt Pavement

This guide specification incorporates the latest asphalt pavement technologies. It attempts to present the best practices/procedures and processes, but it is not intended to replace sound engineering knowledge, judgment and experience.

All numbered specification references in this document refer to the most recent version of the Indiana Department of Transportation (INDOT) Standard Specifications and current Indiana Test Methods (ITM).

PAP.01 Description
This work shall consist of constructing a Porous Asphalt Pavement (PAP) course comprised of aggregate and asphalt binder mixed in a Hot Mix Asphalt plant and spread and compacted on a prepared surface.

PAP.02 Quality Control
PAP shall be supplied from a certified HMA plant in accordance with ITM 583: Certified Volumetric Hot Mix Asphalt Producer Program. PAP shall be transported and placed according to a Quality Control Plan (QCP) prepared by the Contractor in accordance with ITM 803 – contractor Quality Control Plan for HMA Pavement, and submitted to the Owner Representative prior to commencing HMA paving operations.

PAP.03 Materials
Material shall be accordance with the following:

Asphalt Materials
Performance Graded Binder, PG 70-22, or PG 76-22..... 902.01(a)

Coarse Aggregates shall be Class B or higher 904.03

Fibers .....AASHTO M 325

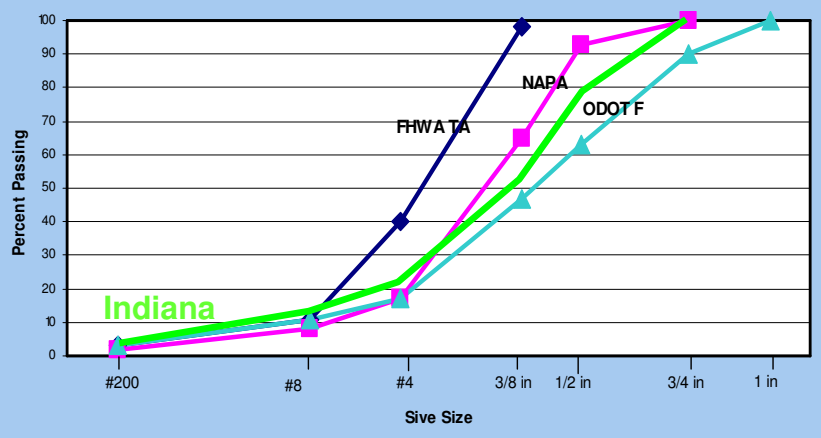
Fine Aggregates 904.02

PAP.04 Mix Design Formula

Mix Specifications

- Based on Section 401 Open Graded
- Aggregates
  - Limestone, Crushed Gravel or Steel slag
  - CAA
    - 90% two face
    - 100% one face
  - LA abrasion
    - 35% max

Porous HMA Gradation



Asphalt Binder

- Binder Content 5.5-6.0%
- Uses stiffer asphalt binder
- PG 76-22
- PG 70-22 with fibers Fibers if needed for drain down
- Thick OG HMA – 2 layers?

Mix Design

- RAP allowed
- Type D Certification
- Gyratory
  - 20 gyrations

Mix Design, cont'd

- Air voids
  - 16% minimum
  - Vacuum sealing method
- VMA
  - 26% minimum
  - Vacuum sealing method
- Draindown
  - 0.3% max

Construction Guidelines

- Surface Preparation
  - Aggregate seated
  - Surface free from soil and contamination
  - Curb faces tacked
- Lift Thickness
  - 2 inches minimum
  - 4 inches maximum

Construction, cont'd

- 2 passes 10 ton roller
- Restrict traffic for 24 hrs.
- Protect porous pavement from contamination.
  - Runoff sediment
  - Construction debris

Maintenance

- Inspect several time first few months during storm events.
- Inspect annually thereafter.
- Pavement surface may be flushed or jet washed.
- Damage pavement can be repaired using dense hot mix provided <10% area.

Conclusions

- Porous pavements offer good alternative to conventional stormwater mitigation
- Site Conditions must be right
- Need to protect pavement from contamination during and after construction
- Properly designed and constructed will last more than 20 years

Primary Benefits

- Runoff control
- Aquifer recharge
- Reduced drainage structures
- More land available for “other” uses if detention facility is NOT needed
- **More friendly to our environment!**

THE HERITAGE GROUP

Thank You!

Heritage Research Group

MILESTONE CONTRACTORS L.P.