Permeable Paver Streets

Successes and Challenges With Permeable Paver Streets in Illinois

Waukesha County

March 30, 2017

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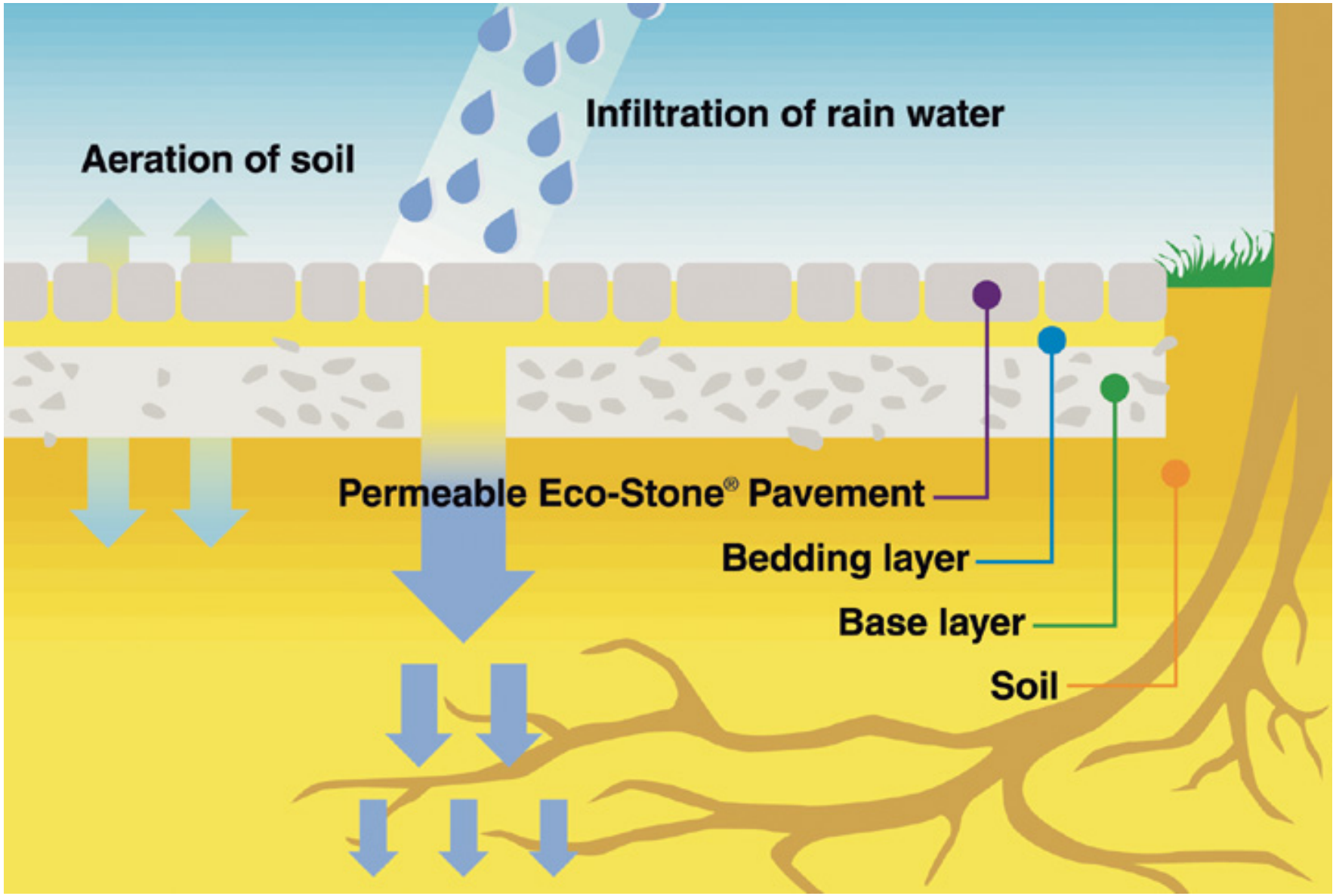
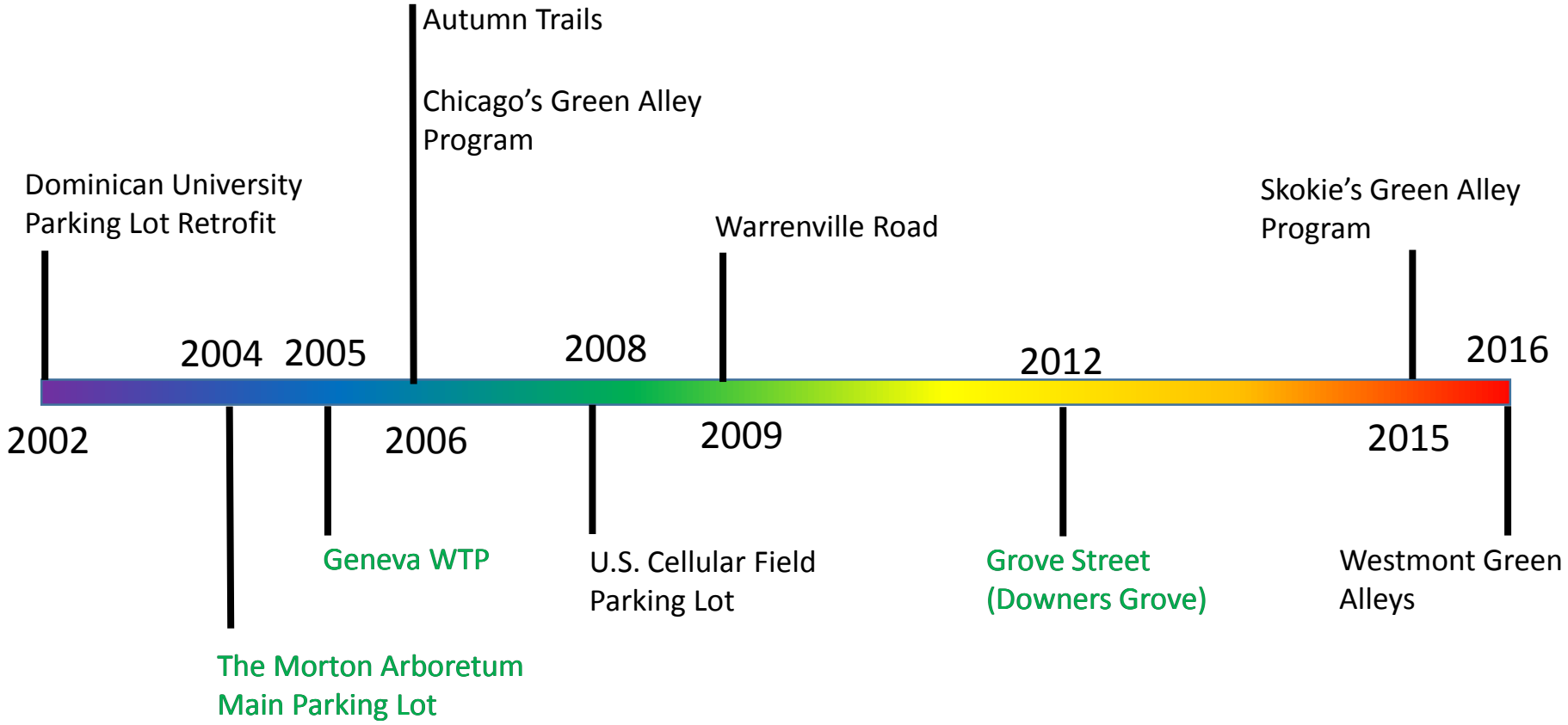
Traditional Pavements

- Virtually Impervious
- Increase Flooding
- Pollute Streams/Rivers
- Heat Island Effect
- Regular Maintenance/Replacement



Graphic courtesy Unigroup, Inc.

Permeable Pavers in Illinois



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The Morton Arboretum (Lisle, IL)

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The Morton Arboretum

- Sub-base: 24” to 36” (3” crushed agg – open graded*)
- Base: 6” (3/4” crushed agg – open graded*)
- Setting Bed: 1.5” (3/8” crushed agg – open graded*)
- Joint Filler: 3/8” (max) granite chips
- Ecoloc® Pavers

* Aggregate base course materials will vary by state/region availability

Geneva Water Treatment Plant

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Geneva Water Treatment Plant

Geneva Water Treatment Plant

- Sub-base: 12” (min)
- Base: 6”
- Setting Bed: 1.5”
- Joint Filler: 3/8” crushed agg – open graded
- Ecoloc® Pavers

Doerhoefer Park (Downers Grove Park Dist)

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Doerhoefer Park

- Sub-base: 10”
- Base: 4”
- Setting Bed: 2”
- Joint Filler
- Eco-Optiloc™ Pavers

Warrenville Road

Warrenville Road

- Sub-base: 18”
- Base: 4”
- Setting Bed: 2”
- Joint Filler
- Eco-Optiloc™ Pavers

Warrenville Road

- Higher Traffic Volume and Speeds
- Heavy Deceleration
- Localized Setting Bed and Base Course Failure
- Continued Loss of Joint Filler

Grove Street (Downers Grove, IL)

Grove Street

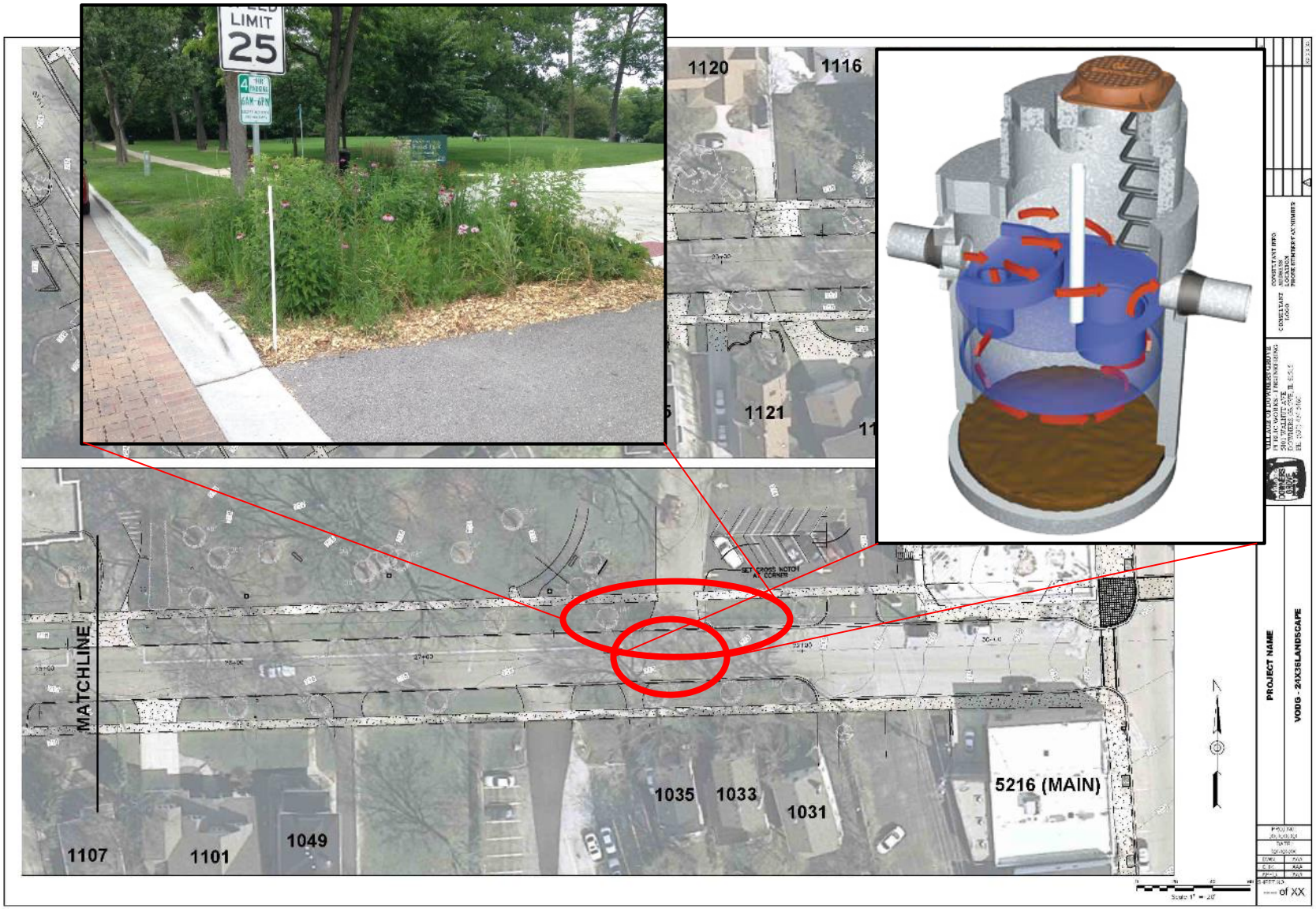
Project Goals:

- Reduce peak flows
- Improve water quality to St. Joseph’s Creek
- Aesthetics (former brick street)
- Life-cycle cost savings
- Traffic calming on Carpenter Street
- Needed to replace watermain

Grove Street

- Geotechnical fabric on Sub-Grade
- Sub-base: 12”
- Base: 5”
- Setting Bed: 1.5”
- Joint Filler
- Eco-Optiloc™ Pavers

Grove Street



Grove Street

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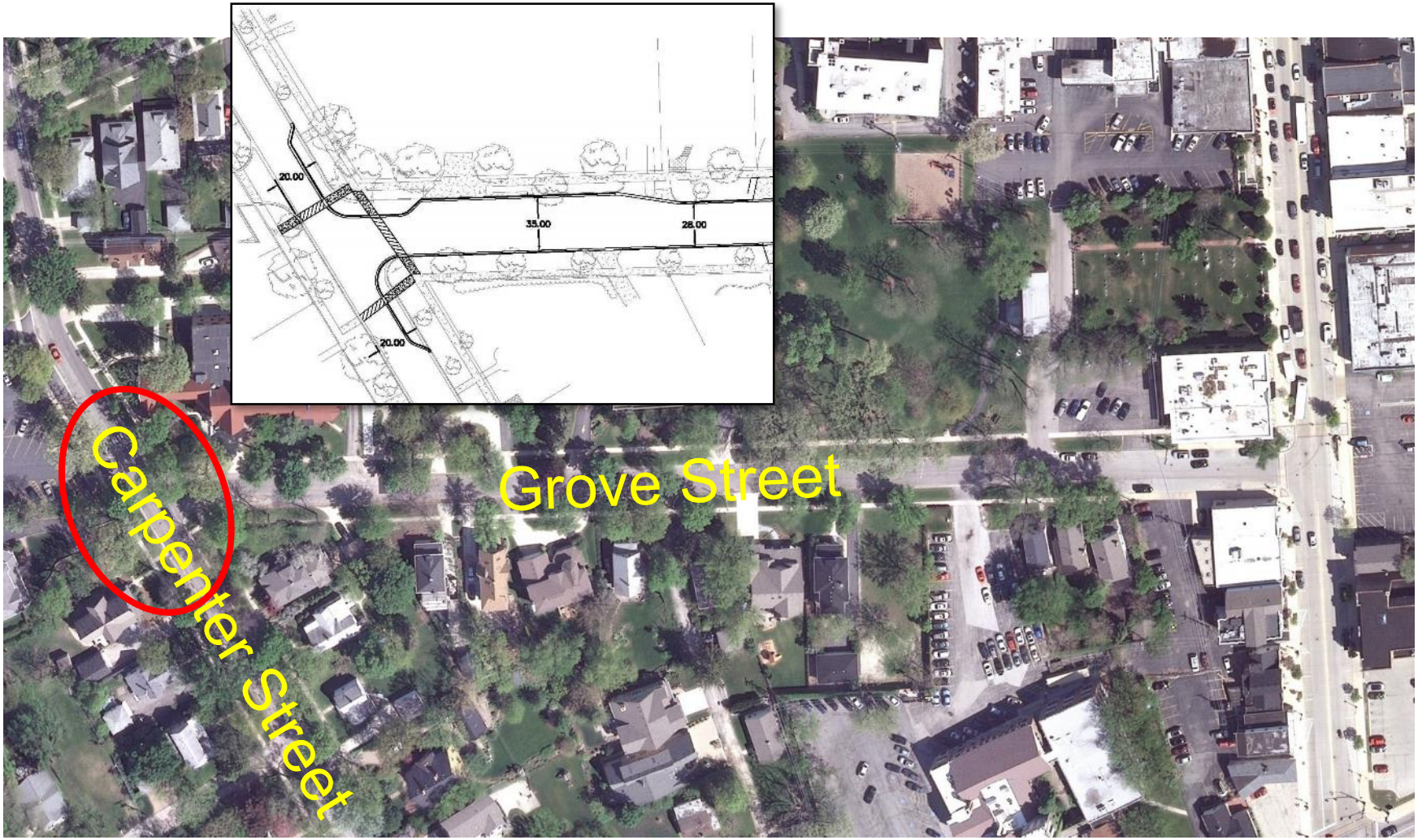
Grove Street

Grove Street

- Village plows with standard steel blade
- Only maintenance thus far is annual replenishment of joint filler (±$1.50/SY)
- Minor settlement around underground utility structures; may require concrete collars

Traffic Calming



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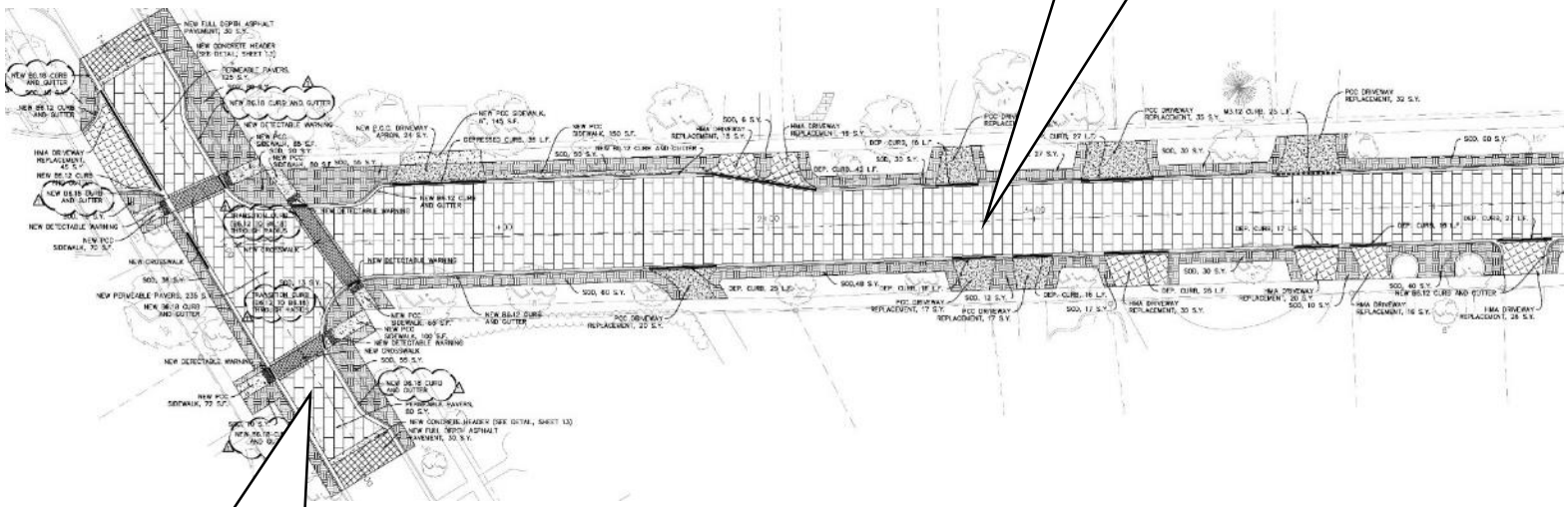
Carpenter Street (Downers Grove)

Carpenter Street

Carpenter Street

Grove Street
ADT = 1,000



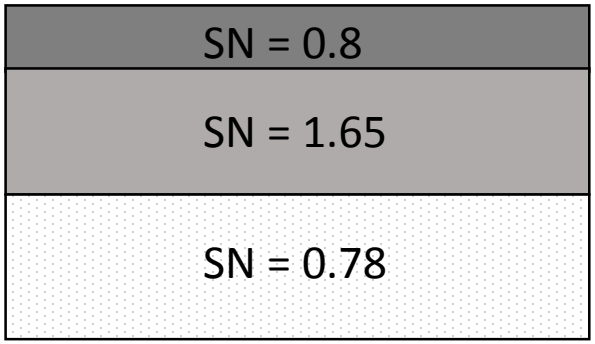
Carpenter Street
ADT = 5,200

Please note…

- This is NOT a class on mechanistic pavement design
- The following slides are for illustrative purposes only to exhibit the challenges and potential solutions developed for Carpenter St.
- Every situation is different and requires a detailed analysis of:
    - Subgrade soils, ground water table
    - Traffic (AADT and % of trucks)
    - Drainage (infiltration, duration and extent of saturation)
    - Cost/Feasibility
    - Other factors
- This is a very dynamic and ever-changing technology! Make use of the extensive research, guidance and case studies that are now available and check for updated information on a regular basis.
- Hire an experienced professional to design your permeable pavement and associated drainage system

Pavement Design

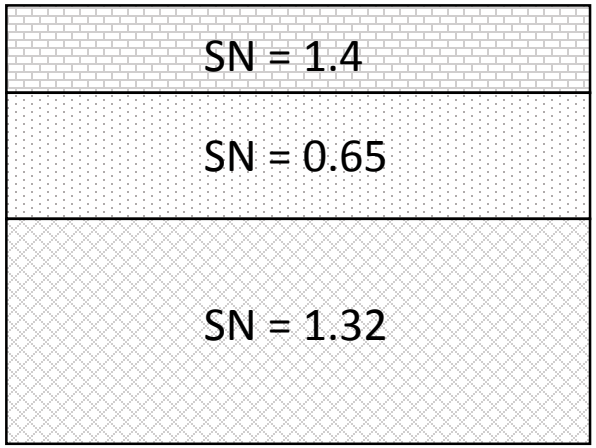
FULL DEPTH ASPHALT



SN = 3.23

- 2” Asphalt Surface (0.4/in)
- 5” Bit. Binder (0.33/in)
- 6” Agg. Base (0.13/in)

PAVERS



SN = 3.37

- Pavers w/1.5” Setting Bed (1.4)
- 5” Agg. Base (0.13/in)
- 12” Agg. Sub-Base (0.11/in)

Research and Guidance

- “Permeable Interlocking Concrete Pavement” - FHWA TechBrief (FHWA-HIF-15-007), January, 2015
- “Development and HVS Validation of Design Tables for Permeable Interlocking Concrete Pavement: Final Report” - University of California Pavement Research Center, December 2014

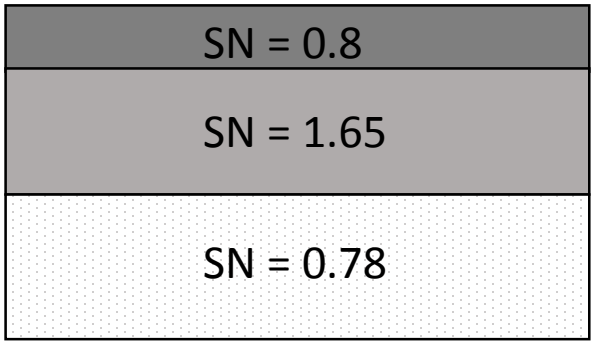
My Grossly Over-Simplified Interpretation of the Current Research and Guidance

- Maintaining maximum interlock between paver units can improve overall pavement performance (so keep those joints full!)
- Compaction of the sub-grade can increase pavement performance (without necessarily degrading infiltration depending on soil type)
- Shear strength of permeable pavement base course is significantly decreased due to open graded aggregate and frequent saturation
- Frequency and duration of saturation has a significant impact on minimum design thicknesses required to prevent rutting
- Structural number coefficients for open graded aggregate sub-base and base courses are recommended at 0.06 and 0.09 per inch*, respectively

*Per ICPI Recommendations

Permeable Pavement Design

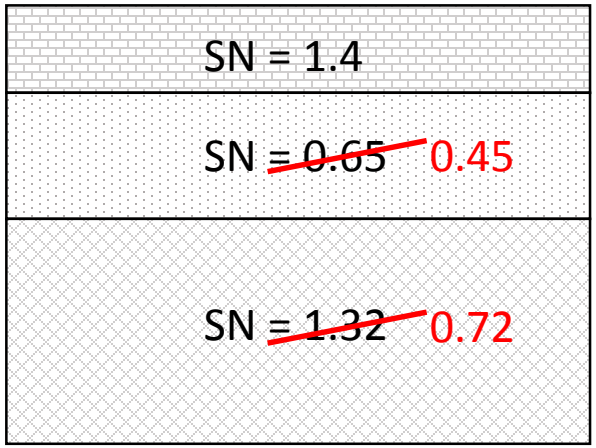
FULL DEPTH ASPHALT



SN = 3.23

- 2” Asphalt Surface (0.4/in)
- 5” Bit. Binder (0.33/in)
- 6” Agg. Base (0.13/in)

PERMEABLE PAVERS



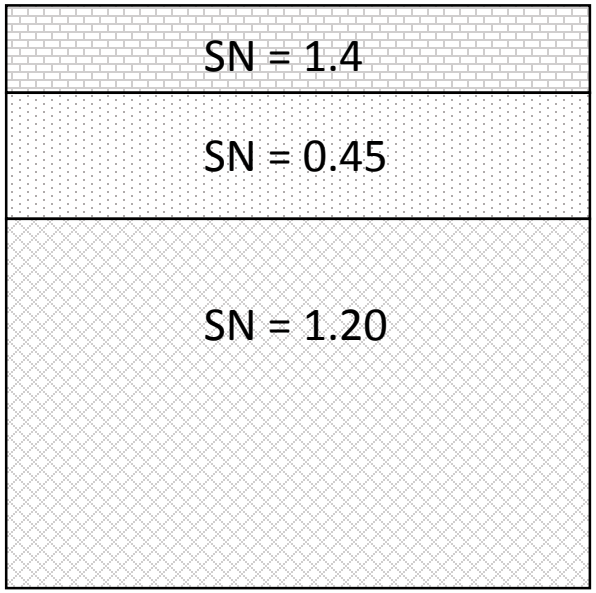
SN = ~~3.37~~ 2.57

- Pavers w/1.5” Setting Bed (1.4)
- 5” Agg. Base (~~0.13/in~~) 0.09/in
- 12” Agg. Sub-Base (~~0.11/in~~) 0.06/in

Carpenter St. Pavement Section Options

Additional Subbase Depth

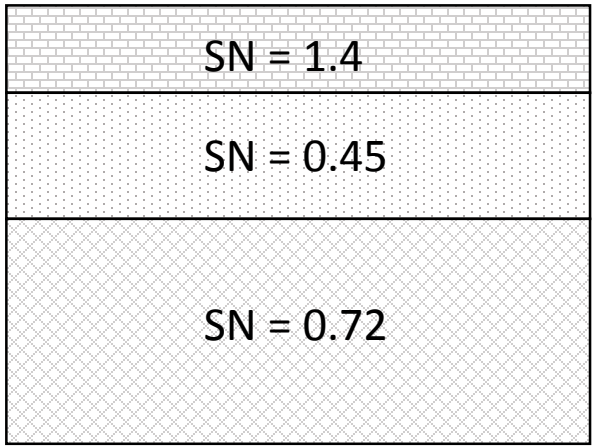
PERMEABLE PAVERS w/Increased Subbase



SN = 3.05

- Pavers w/1.5” Setting Bed (1.4)
- 5” Agg. Base (0.09/in)
- 20” Agg. Sub-Base (0.06/in)

PERMEABLE PAVERS



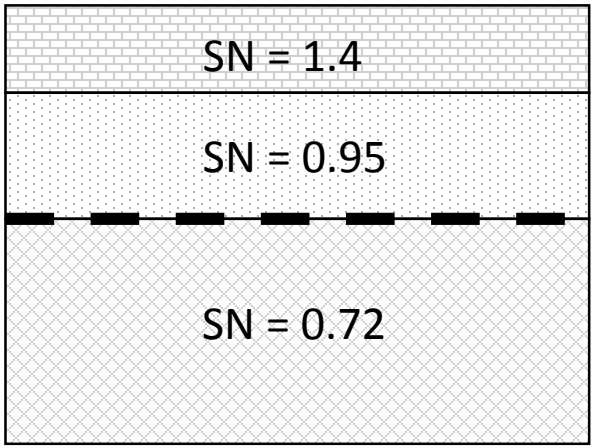
SN = 2.57

- Pavers w/1.5” Setting Bed (1.4)
- 5” Agg. Base (0.09/in)
- 12” Agg. Sub-Base (0.06/in)

Carpenter St. Pavement Section Options

Triaxial Geogrid

PERMEABLE PAVERS w/ Geogrid*

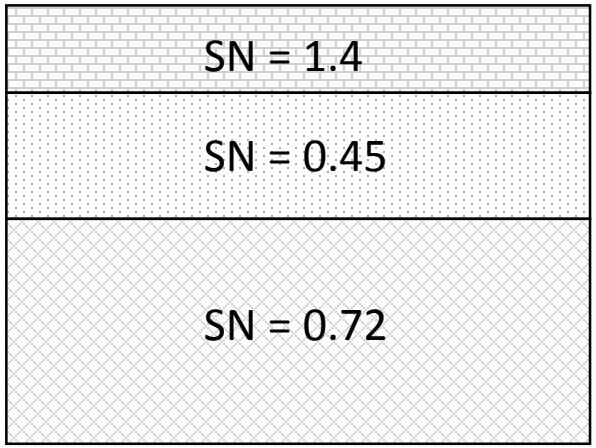


SN = 3.07

- Pavers w/1.5” Setting Bed (1.4)
- 5” Agg. Base w/TX5 Triaxial Geogrid (0.19/in)
- 12” Agg. Sub-Base (0.06/in)

*Analyzed with SpectraPave4-Pro™

PERMEABLE PAVERS



SN = 2.57

- Pavers w/1.5” Setting Bed (1.4)
- 5” Agg. Base (0.09/in)
- 12” Agg. Sub-Base (0.06/in)

SpectraPave4 PRO™ - [Untitled.sp4p]

File Design Options Help

New File | Open File | Save File | Project Info | Printer Setup | Report | Thin AC | Standard AC | Thick AC | Unit Setting | Calculator

- TENSAR
- SPECTRAPAVE4-PRO
- BIAXIAL GEOGRID MODULE
- EXIT

Pavement Optimization Design Analysis - Data Input | Results

Target Traffic (ESALs) = 400,000

Unstabilized Pavement

Layer	Di	ai	mi	SN
ACC1	5.00	0.280	N/A	1.400
ABC	5.00	0.090	1.0	0.450
SBC	12.00	0.060	1.0	0.720
Overall Structural Number (SN)				2.570
Calculated Traffic, ESALs				128,000

Stabilized Pavement

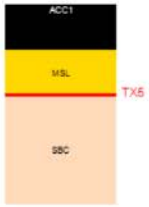
Layer	Di	ai	mi	SN
ACC1	5.00	0.280	N/A	1.400
MSL	5.00	0.189	1.0	0.945
SBC	12.00	0.060	1.0	0.720
Overall Structural Number (SN)				3.065
Calculated Traffic, ESALs				403,000

☑ Round Results

Click Here to Conduct Pavement Optimization Cost Analysis

Thickness (in)
ACC1 5.00
ABC 5.00
SBC 12.00

Thickness (in)
ACC1 5.00
MSL 5.00
SBC 12.00



Tensar

SpectraPave4 PRO™ Software for Subgrade Stabilization and Pavement Optimization, Version 4.6.1, January, 2014
© 1998 - 2014, Tensar International Corporation, 1-800-TENSAR-1, www.tensarcorp.com

Pavement Optimization Design Analysis | Units US | Standard Asphalt Pavement | TWH Edition | 20140219

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Carpenter Street – July, 2016

- Pavement reconstructed as a test pavement
  - Pavers, setting bed and base course removed
  - Triaxial Geogrid (TX5) placed on existing subbase
  - New base course, setting bed and pavers installed
- Through the donation of time and materials by the following corporate partners, the test pavement was reconstructed at no cost to the Village

Carpenter Street – July, 2016

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Carpenter Street – July, 2016

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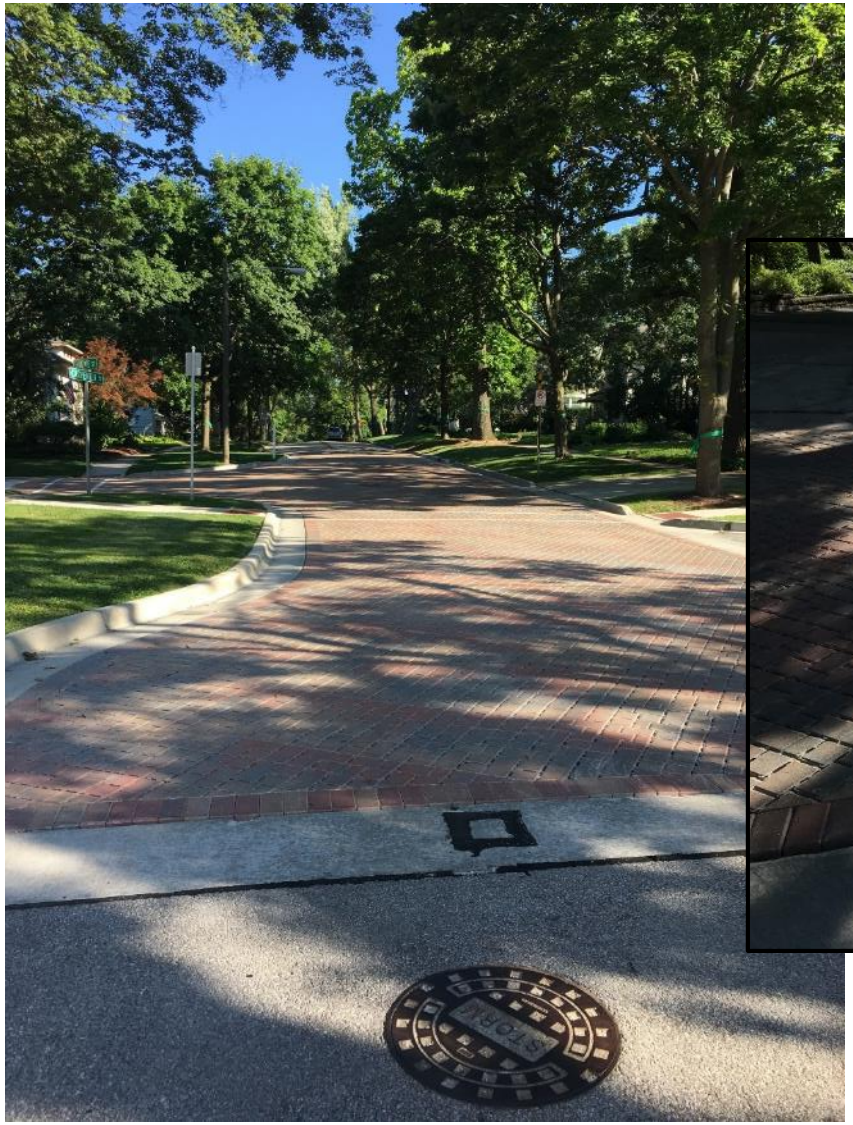
Carpenter Street – July, 2016



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Carpenter Street – March, 2017

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Carpenter Street – March, 2017

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Additional Resources

Design Software

- Permeable Design Pro 2.0 (ICPI)
- SprectraPave4-Pro™ (Tensar)

Design References

- Unilock's "Design Guide and Research Summary"
- ICPI Tech Spec 4 "Structural Design of Interlocking Concrete Pavements for Roads and Parking Lots"
- Caltrans – "Pervious Pavement Design Guidance", May, 2016

- **Coming Soon – ASCE's Standard for Permeable Interlocking Concrete Pavement

Sources

- Li, H., D. Jones, R. Wu, and J. Harvey. *Development and HVS Validation of Design Tables for Permeable Interlocking Concrete Pavement: Final Report*. Tech. no. UCPRC-RR-2014-04. Davis-Berkeley: University of California Pavement Research Center, 2014. Print.
- *Permeable Interlocking Concrete Pavement*. TechBrief - FHWA-HIF-15-007. USDOT Federal Highway Administration, 2015. Print.
- *Permeable Design Pro*. Computer software. Vers. 2.0. Interlocking Concrete Pavement Institute; Applied Research Associates, Inc.; i2b Global, Inc. 5 May 2016.
- *Uni Eco-Stone Family of Permeable Interlocking Concrete Pavers - Design Guide & Research Summary*. Rep. Palm Beach Gardens, FL: Uni-Group U.S.A., 2014. Print.
- *SprectraPave4-Pro*™. Computer software. Vers. 1.2.32. Tensar International Corporation. Web. 10 May 2016.

Questions?

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