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How Should You Be Designing Your Permeable Pavements? – New ASCE Standard

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Applied Research Associates, Inc.

Background

- While permeable pavements have been around for a long time…..1800s in Europe
- North American versions began in the 1960s
- Primary goals:
  - Reduce stormwater runoff
  - Improve water quality
  - Reduce flooding
  - Groundwater recharge

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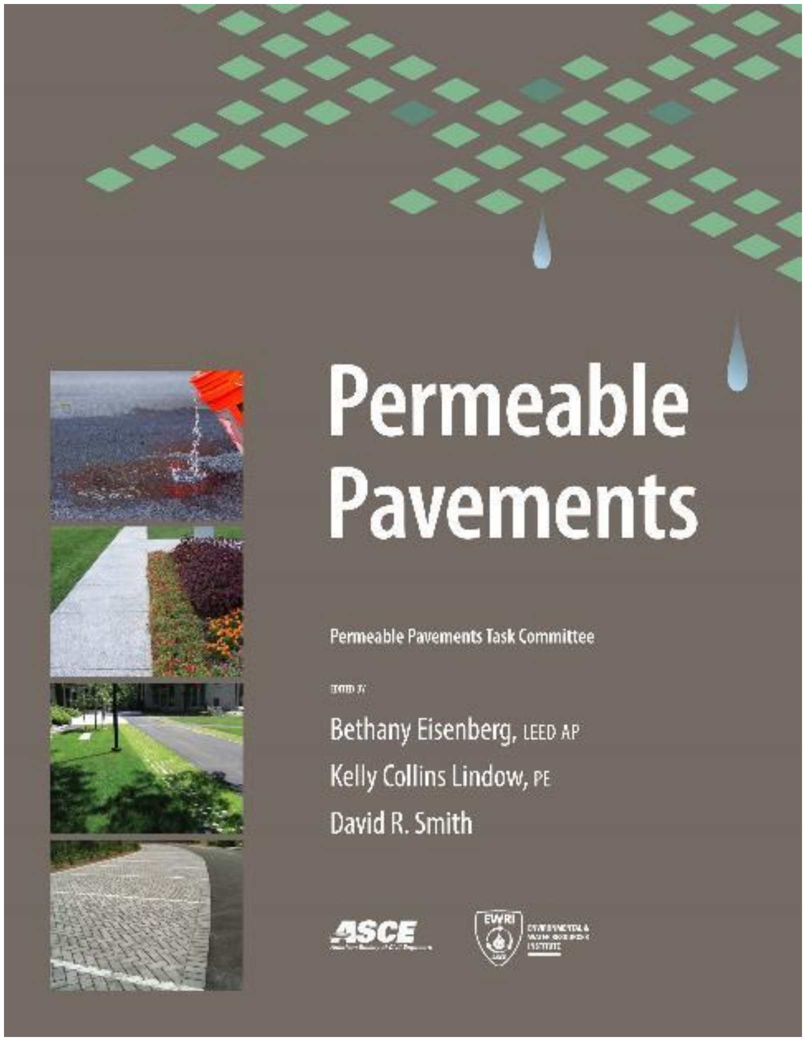
Goal of ASCE Standard

- Maximize value of permeable pavements
- Assess suitability for a particular site
- Structural design
- Hydrologic design
- Subgrade evaluation
- Pavement materials selection
- Design details and construction specifications
- Construction quality control/assurance
- Pavement maintenance

Design, Build and Maintain To Last!

Site Design



CHECKLIST 1 ☑

Design Considerations Common To All Permeable Pavements

☐ **1. REGULATION (Check Requirements and Guidelines)**

- ☐ **a.** Determine if the local regulatory agency allow permeable pavements. If not, determine who can authorize approval.
- ☐ **b.** Determine if these pavements are prohibited in certain areas, such as groundwater recharge zones, karst geology and fill situations.
- ☐ **c.** Determine if there are credits offered to reduce stormwater utility fees, permitting fees, or reduced site development costs for using permeable pavements.
- ☐ **d.** Determine if there are there regulatory hydrologic control or water quality requirements associated with the use of permeable pavements.
- ☐ **e.** Determine if there are there water quality control requirements specific to permeable pavement use.
- ☐ **f.** Determine if there are specific design guidelines or specifications mandated under applicable federal, state, or local regulations.

☐ **2. SITE (Identify Site Conditions)**

- ☐ **a. Groundwater elevation**—The bottom of the permeable pavement base/subbase should be at least 60 cm (2 ft) above the seasonal high groundwater level within the soil subgrade.
- ☐ **b. Groundwater supply**—Identify nearby groundwater supply wells or recharge zones and requirements
- ☐ **c. Floodplains**—The use of permeable pavement in floodplain areas is generally not recommended due to an increased risk of clogging during flood events
- ☐ **d. Bedrock**—Identify bedrock elevations and/or karst geology. Bedrock directly under the permeable pavement base/subbase typically requires the use of an impermeable liner.
- ☐ **e. Soil properties**—Determine soil type and physical properties:
  - Soil Classification—Determine classification of soil borings or test pits on the site.
  - Soils Present—Identify soil types and estimate elevation of aquatard or low-permeability soils if present.
  - Load Bearing Capacity—Estimate the bearing capacity of the underlying soils (CBR, R-value or resilient modulus) and determine the soil support value. Determine requirements for intended vehicular traffic use.
  - Soil Compaction—Specify soil compaction requirements. If the underlying soils have a low California Bearing Ratio (CBR) (<4% soaked CBR), they may need to be compacted to at least 95% of standard Proctor density, which reduces their infiltration rate.
  - Soil Permeability—Identify soil permeability (hydraulic conductivity rate, K) and rate to be used for design and check with local requirements/regulations on methodologies and guidelines. For larger projects with adequate budgets, it may be advantageous to compact the soil subgrade in a test pit or pits and then measure permeability. Identify low permeability soils and constraints.
  - Soil/Groundwater Contamination—Research/identify the presence of any soil or groundwater contamination and how it may affect design. Permeable pavements should not be used in areas of groundwater/soils contamination without an underdrain above the liner.
- ☐ **f. Rainfall**—Evaluate regional rainfall and estimate how frequently the pavement will be inundated and how quickly the pavement will drain based on the ability of the underlying soils to infiltrate water.

Source: © Vanasse Hangen Brustlin, Inc. (VHB)

Template Decision Matrix for Permeable Pavement

1. Primary Considerations

Part 1 Weighting: 60

Project Scoring Guidelines

Consideration	Project Score	Weighting	Weighted Score	A Favorable for Permeable Shoulders	B <<=====================>>	C Not Favorable for Permeable Shoulders
Availability of Capital Funding	B	20.0	12.0		...justify funding	No specific funding available; no requirement to implement
Status of Environmental Approval	B	20.0	12.0		...pending	Application required
Safety	A	10.0	10.0		...ues can be addressed	Significant safety issues
Significant Longitudinal Grades	B	10.0	6.0		...2 to 5 percent	Grades > 5 percent
Depth of Water Table	B	20.0	12.0		...le 0.6-1.5 m (2-5 ft) below	Water table < 0.6 m (2 ft) below subgrade
Geotechnical Risks	B	10.0	6.0		...omplexity	High complexity
Groundwater Contamination Risk	A	10.0	10.0		...Risk	High risk
Total		**100.0**	**68.0**			
	Weighted Total Score:		**40.8**			

Scores are entered based on project information; weighting of factors can be adjusted

2. Secondary Considerations

Part 2 Weighting: 30

Project Scoring Guidelines

Consideration	Project Score	Weighting	Weighted Score	A Favorable for Permeable Shoulders	B <<=====================>>	C Not Favorable for Permeable Shoulders
Stringent Water Quality Standards	B	10.0	6.0	Regulations in place	Limited restriction	No restrictions
Sand use for Winter Maintenance	B	10.0	6.0	No sand use	Used < 2 times/year	Used > 2 times/year
Low Soil Infiltration Rates	A	10.0	10.0	Infiltration < 12 mm/hr (1/2 in./hr)	Infiltration >12mm/hr (1/2 in./hr) < 40 mm/hr (1.5 in./hr)	Infiltration > 40 mm/hr (1.5 in./hr)
Target Design Volumes and Runoff	A	10.0	10.0	Frequent/non-intense storm	Moderate frequency/intensity	Intense storms
Complexity of Geometric Conditions	A	10.0	10.0	Minimal geometric restrictions	Some geometric challenges	Significant geometric restrictions
Risk of Flooding	A	10.0	10.0	None	Occasional	Frequent
Mandates for Water Quality	B	10.0	6.0	Water quality concerns	Some water quality issues	No concerns
Mandates for Stormwater Management	A	10.0	10.0	Stormwater management concerns	Some stormwater management issues	No concerns
Maintenance Protocols	C	10.0	2.0	Proactive maintenance	Reactive maintenance	Minimal maintenance
Shoulder Utilization	B	10.0	6.0	Use for emergency stopping only	Occasional use for traffic	Regular use by traffic
Total		**100.0**	**76.0**	See Table 4.1 for guidance on scoring		
	Weighted Total Score:		**22.8**			

3. Other Considerations

Part 3 Weighting: 10

Consideration	Project Score	Weighting	Weighted Score	A Favorable for Permeable Shou...	B	C ...Favorable for Permeable Shoulders
Interest in Innovation	B	20.0	12.0	Regular innovation implement...		...imal interest
Presence of Utilities	B	20.0	12.0	None		...ical utilities
Impact of Unknown Site Conditions	B	20.0	12.0	Site conditions well known		...site specific information available
Risk of Accidental Chemical Spill	A	20.0	20.0	Limited exposure		...vated risk of spills and elevated risk of groundwater contamination
Owner Experience and Resources	C	20.0	4.0	Significant owner experience	Li... ...er experience	No owner experience
Total		**100.0**	**60.0**	See Table 4.1 for guidance on scoring		
	Weighted Total Score:		**6.0**			

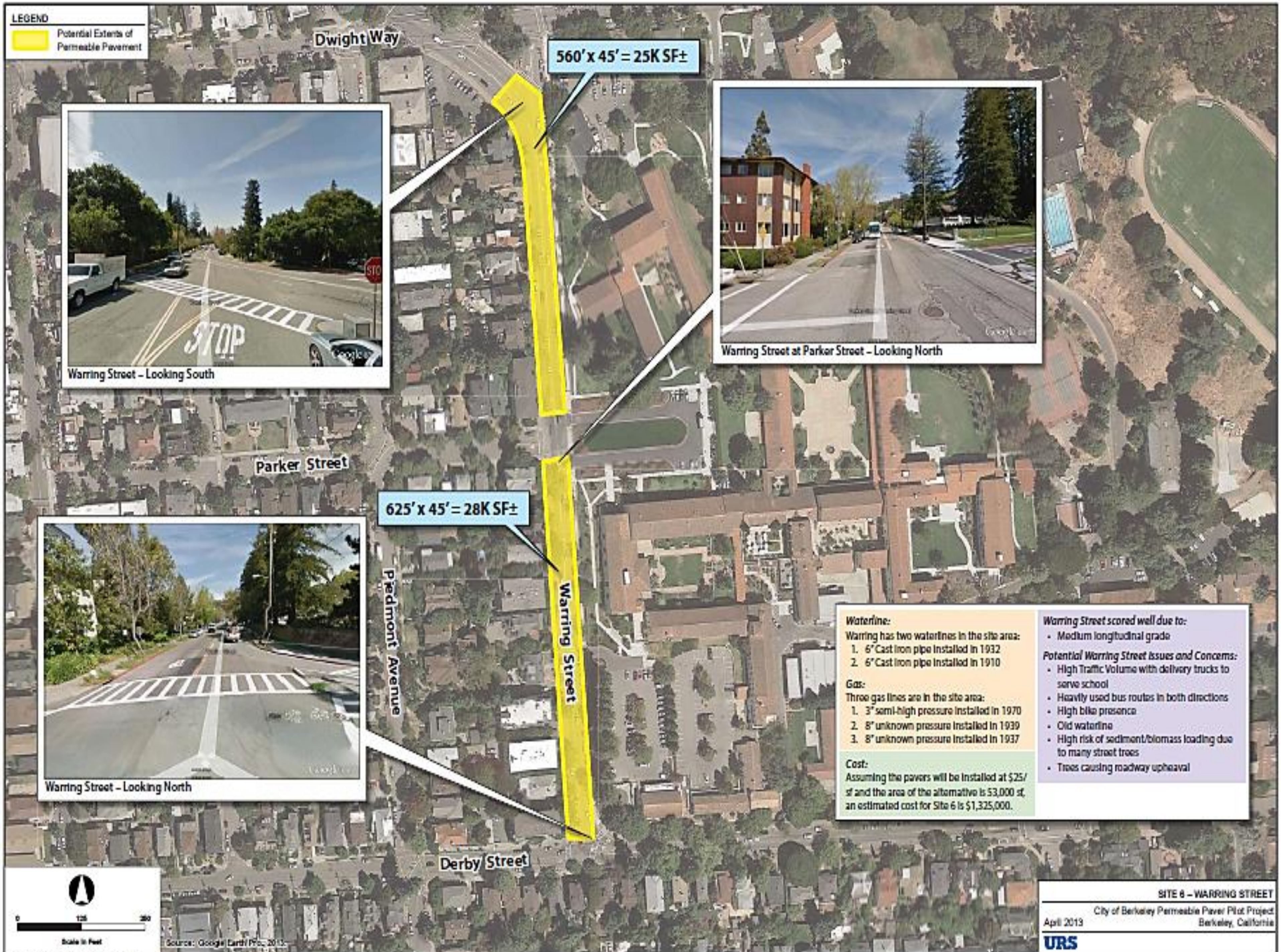
Decision range and scoring guidelines should be "calibrated" to local experience

Sub Totals

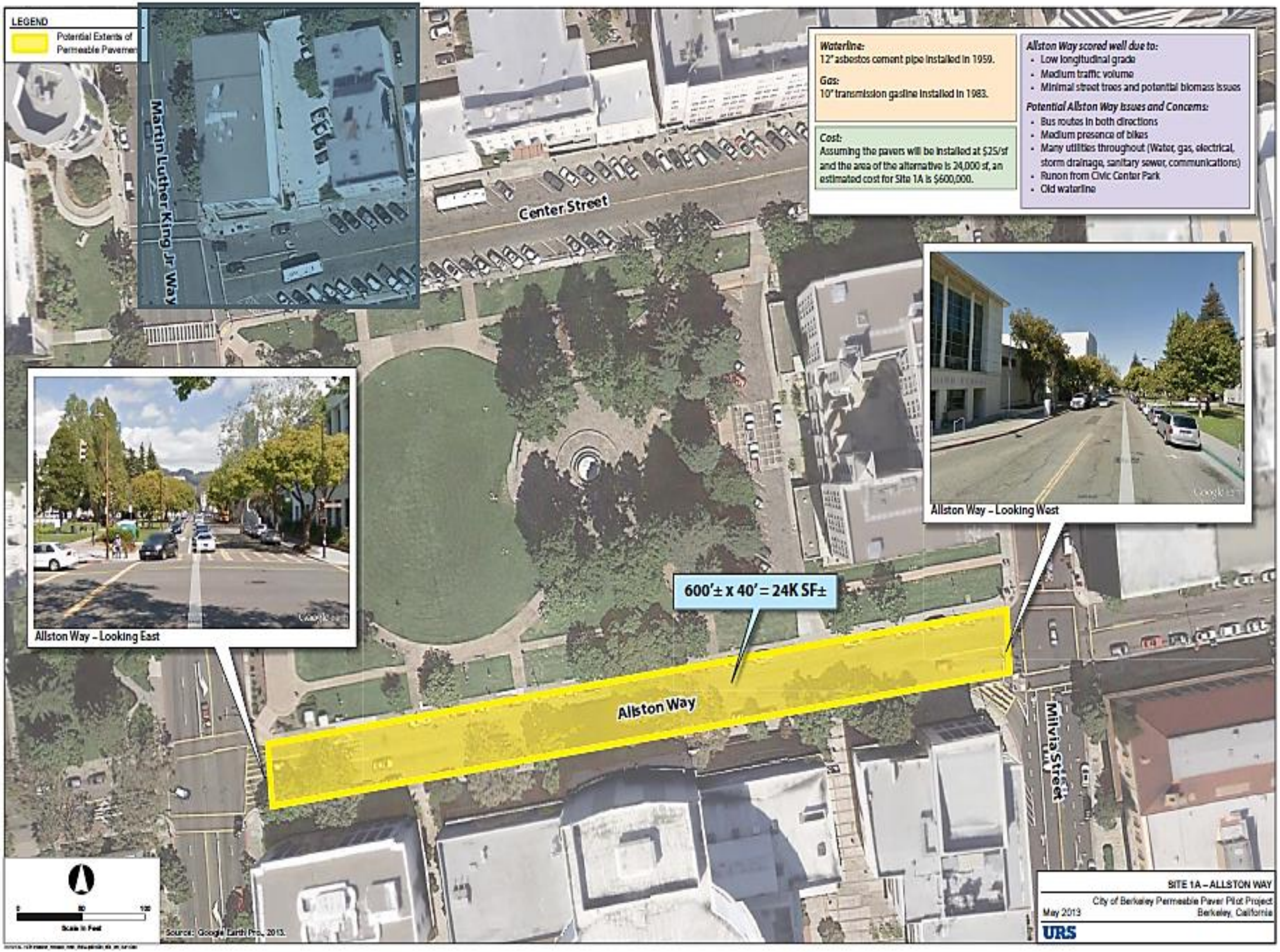
1. Primary Considerations	60	40.8
2. Secondary Considerations	30	22.8
3. Other Considerations	10	6.0
Grand Total Project Score	**100**	**69.6**
Decision		**Can Consider**

Decision Range

From	To	Implement Alternative
0	65	No
65	75	Can Consider
75	100	Yes



LEGEND
Potential Extents of Permeable Pavement
Dwight Way
560' x 45' = 25K SF±
Parker Street
625' x 45' = 28K SF±
Piedmont Avenue
Warring Street
Derby Street
STOP
Warring Street – Looking South
Warring Street at Parker Street – Looking North
Warring Street – Looking North
Waterline:
Warring has two waterlines in the site area:
1. 6" Cast iron pipe installed in 1932
2. 6" Cast iron pipe installed in 1910
Gas:
Three gas lines are in the site area:
1. 3" semi-high pressure installed in 1970
2. 8" unknown pressure installed in 1939
3. 8" unknown pressure installed in 1937
Cost:
Assuming the pavers will be installed at $25/sf and the area of the alternative is 53,000 sf, an estimated cost for Site 6 is $1,325,000.
Warring Street scored well due to:
- Medium longitudinal grade
Potential Warring Street Issues and Concerns:
- High Traffic Volume with delivery trucks to serve school
- Heavily used bus routes in both directions
- High bike presence
- Old waterline
- High risk of sediment/biomass loading due to many street trees
- Trees causing roadway upheaval
0 125 250
Scale in Feet
Source: Google Earth Pro, 2013
SITE 6 – WARRING STREET
City of Berkeley Permeable Paver Pilot Project
Berkeley, California
April 2013
URS



LEGEND
Potential Extents of Permeable Pavemen
Martin Luther King Jr Way
Center Street
Waterline:
12" asbestos cement pipe installed in 1959.
Gas:
10" transmission gasline installed in 1983.
Cost:
Assuming the pavers will be installed at $25/sf and the area of the alternative is 24,000 sf, an estimated cost for Site 1A is $600,000.
Allston Way scored well due to:
Low longitudinal grade
Medium traffic volume
Minimal street trees and potential biomass issues
Potential Allston Way Issues and Concerns:
Bus routes in both directions
Medium presence of bikes
Many utilities throughout (Water, gas, electrical, storm drainage, sanitary sewer, communications)
Runon from Civic Center Park
Old waterline
Allston Way – Looking West
Allston Way – Looking East
600'± x 40' = 24K SF±
Allston Way
Milvia Street
0
50
100
Scale in Feet
Source: Google Earth Pro, 2013.
SITE 1A – ALLSTON WAY
City of Berkeley Permeable Paver Pilot Project
May 2013
Berkeley, California
URS

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Decision Support Tools

A. Primary Evaluation Criteria

Part A Weighting: 60

	Consideration	Performance Score	Weighting	Weighted Value	Performance Scoring Guidelines: Low = 0.2	Medium = 0.6	High = 1
1	Significant Longitudinal Grades	High	20.0	20.0	Grades > 5 percent	Grades of 3 to 4 percent	Grades < 3 percent
2	Geotechnical Risks	High	15.0	15.0	High complexity	Medium complexity	Low complexity
3	Presence of Utilities	Medium	25.0	15.0	Waterline > 50 years old	Waterline between 30 and 50 years old	Waterline < 30 years old
4	Traffic Volume (ADT)	High	20.0	20.0	High Traffic Volume	Medium Traffic Volume	Low Traffic Volume
5	Presence of Bike Paths	High	20.0	20.0	Regular/designated use	Occasional use	No use
	Total		**100.0**	**90.0**			
			Weighted Total:	**54.0**			

B. Secondary Considerations

Part B Weighting: 40

	Consideration	Rating	Weighting	Weighted Value	Performance Scoring Guidelines: Low	Medium	High
6	Groundwater Contamination Risk	High	20.0	20.0	Existing contaminants present	Potential for contaminants	No contaminants present
7	Soil Infiltration Rates	Low	20.0	4.0	Infiltration < 0.5 in/hr	Infiltration >0.5 in/hr < 1.5 in/hr	Infiltration > 1.5 in/hr
8	Potential for Sediment/Biomass Loading	High	20.0	20.0	Significant risk of sediment loading	Potential risk of sediment loading	No risk
9	Target Design Volumes and Runoff	Medium	20.0	12.0	Intense storms	Moderate frequency/intensity	Frequent/non-intense storm
10	Risk of Flooding	High	20.0	20.0	Frequent	Occasional	None
	Total		**100.0**	**56.0**			
			Weighted Total:	**22.4**			

Sub Totals

A. Primary Considerations	60	54.0
B. Secondary Considerations	40	22.4
Grand Total	**100**	**76.4**
Decision		**Yes**

Decision Range

From	To	Implement Alternative
0	65	No
65	75	Can Consider
75	100	Yes

Project Suitability

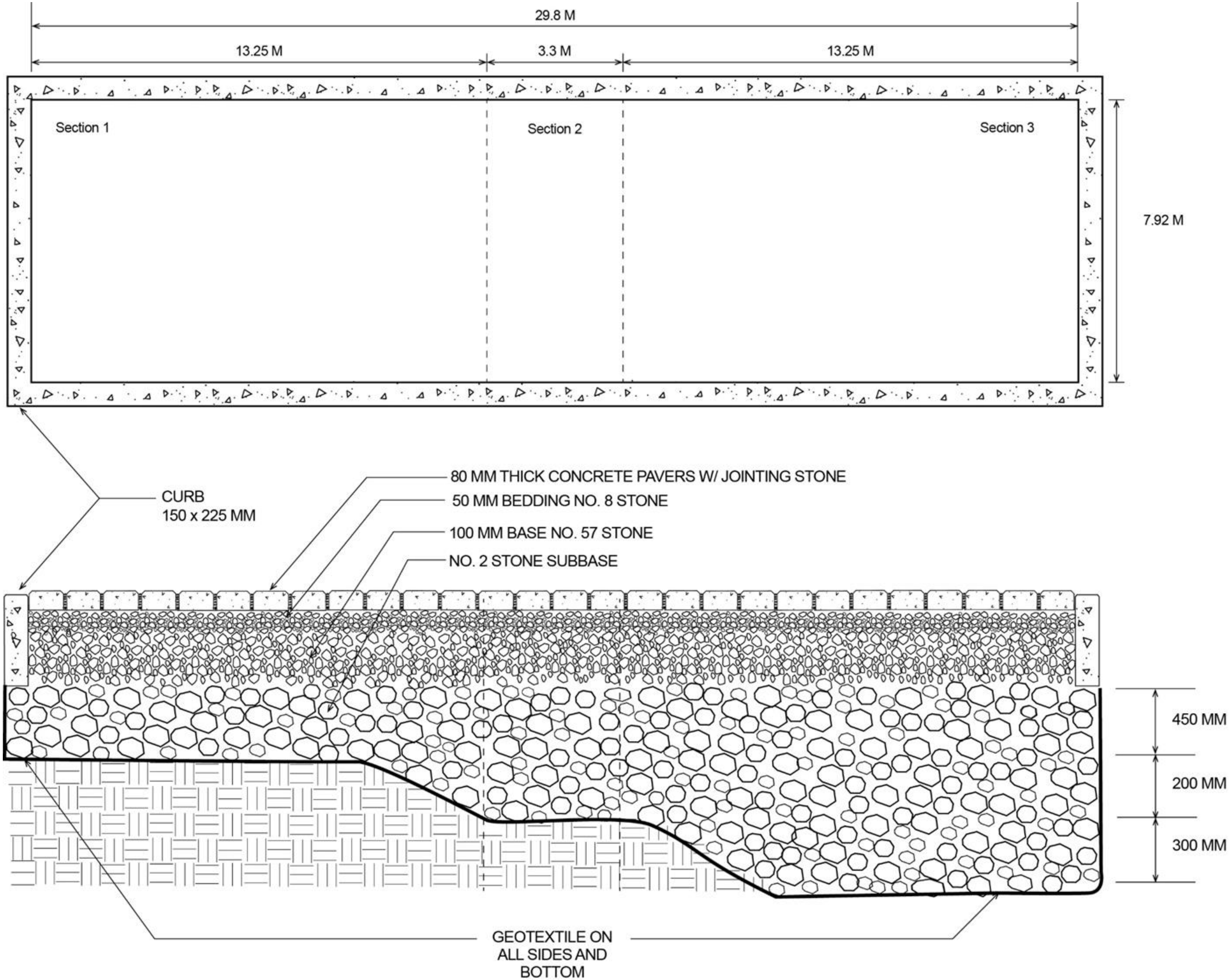
Site No.	Location	Positive	Negative
1	Center Street	No trees, low traffic	Bike lanes, bus traffic, slope,
2A	Addison West	No trees, little slope	Buses, utilities, contributing area (park)
2B	Addison East	No bikes, no trees, no buses	Heavy trucks, steep, possible soft soil?
3	Hopkins Triangle	Low slope, low traffic	Buses
4A	Cedar West		High speed, buses, steep, many trees, BART, many utilities
4B	Cedar East	Minimal trees, no bikes	Buses, residential area
5	Hopkins Street	No bikes, good pavement	Many trees, buses, downspouts in curbs, high traffic, narrow road
6	Warring Street	Many trees, flat slope	Very high traffic, buses, utilities
7	Allston Way	Some contributing area	Occasional buses

Project Suitability

Site No.	Location	Primary	Secondary	Total	Evaluation
1	Center Street	43.2	28.8	72.0	Can Consider
2A	Addison Street West	44.4	28.8	73.2	Can Consider
2B	Addison Street East	26.4	25.6	52.0	No
3	Hopkins Triangle	44.4	25.6	70.0	Can Consider
4A	Cedar Street West	21.6	25.6	47.2	No
4B	Cedar Street East	40.8	25.6	66.4	Can Consider
5	Hopkins Street	40.8	25.6	66.4	Can Consider
6	Warring Street	26.4	25.6	52.0	No
7	Allston Way	54.0	25.6	79.6	Yes

Need: Validated Base Thickness Charts

Design Tables for PICP
Accelerated Pavement Testing
UC Pavement Research Center



29.8 M
13.25 M
3.3 M
13.25 M
Section 1
Section 2
Section 3
7.92 M
CURB
150 x 225 MM
80 MM THICK CONCRETE PAVERS W/ JOINTING STONE
50 MM BEDDING NO. 8 STONE
100 MM BASE NO. 57 STONE
NO. 2 STONE SUBBASE
450 MM
200 MM
300 MM
GEOTEXTILE ON
ALL SIDES AND
BOTTOM

Summary of Rutting Models

Layer	Rut Model[1]	Moisture Condition	Model Parameters		
			a	b	c
Combined bedding & base	$RD_{BB} = a \times h\_SB + b$	Dry	0	4.0	-
		Wet	-0.012	13.1	-
Subbase	$RD_{SB} = (a \times SSR^{b}) \times N^{c}$	Dry	3.10E-06	2.70	1
		Wet	3.10E-06	2.70	1
Subgrade (Silty clay)	$RD_{SG} = (a \times SSR + b) \times N^{c}$	Dry	0.03	-0.01	0.5
		Wet	0.03	-0.01	0.5

[1] RD_{xx}, rut depth of xx layer (BB=surface (paver, bedding and base); SB=subbase; SG=subgrade), mm;
h_SB, thickness of subbase, mm;
SSR, shear stress/strength ratio at the top of the layer;
N, load repetition;
a, b, c, model constants.

Summary of Rutting Models

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PICP Design Tool

Input

Structure & Materials

Layer	Moisture Condition	Thickness (mm)	Stiffness (MPa) [1]	Poisson's Ratio	c (kPa)	ϕ (°)
Surface (80 mm concrete paver plus 50 mm #8 bedding and 100 mm #57 base)	Wet	230	87	0.35	-	-
	Dry		110	0.35	-	-
Subbase (ASTM #2)	Wet	450	73	0.35	0	30
	Dry		122	0.35	0	45
Subgrade (Clay)	Wet	-	37	0.35	9	15
	Dry		60	0.35	15	25

Climate

Number of Days in a Year When the Subbase has Standing Water (Wet Days) [2]
50

[1] The wet stiffness to dry stiffness ratio can be assumed as 0.8, 0.6 and 0.6 for surface, subbase abd subgrade layers, respectively.

[2] Seasons when the subbase has standing water.

Traffic

Traffic Volume Calculation	Axle Type	Axle Load (kN)	Axle-Load Distribution (%)	Lifetime Repetition: Wet Season [2]	Lifetime Repetition: Dry Season	Lifetime Repetition: Total	Lifetime Repetition: ESALs	Lifetime ESALs (Millions)
AADT (two-way)	Single	10	3.25	9,959	62,740	72,699	18	0.50
5,700		20	5.97	18,286	115,200	133,486	521	
Percent Trucks, T		30	5.83	17,850	112,456	130,307	2,577	
10.0%		40	4.43	13,568	85,481	99,050	6,191	
Direction Distribution Factor, D		50	3.23	9,896	62,345	72,241	11,023	
0.5		60	2.80	8,574	54,019	62,593	19,805	
Lane Distribution Factor, L		70	3.13	9,594	60,443	70,037	41,054	
0.8		80	2.40	7,363	46,388	53,751	53,751	
Annual Growth Rate, r		90	0.85	2,594	16,340	18,933	30,327	
3.0%		100	0.15	445	2,804	3,249	7,931	
Design Life (years), Y		120	0.03	94	594	688	3,485	
20		160	0.01	31	194	225	3,596	
Traffic Safety Factor, TSF	Tandem	20	1.59	4,887	30,788	35,675	17	
1.0		40	5.79	17,734	111,727	129,461	1,011	
Truck Traffic Volume, *V*		60	6.76	20,729	130,591	151,319	5,985	
2,236,814		80	4.48	13,720	86,437	100,158	12,520	
$V = 365 \times AADT \times T \times D \times L \times (1+r)^{Y/2} \times Y \times TSF$		100	3.42	10,472	65,971	76,443	23,329	
		120	3.86	11,815	74,432	86,247	54,578	
		140	4.12	12,630	79,569	92,199	108,091	
		160	1.94	5,946	37,460	43,406	86,813	
		180	0.29	900	5,670	6,570	21,048	
		200	0.05	154	973	1,128	5,506	

Outcome — Rut Depth

Layer	Moisture Condition	Shift Factor	Rut Depth by Layer (mm)	Expected Total Rut Depth (mm)	Allowable Rut Depth (mm)	Satisfactory ?
Surface (80 mm concrete paver plus 50 mm #8 bedding and 100 mm #57 base)	Wet	1.00	1.1	65.3	25.0	*N*
	Dry	1.00	3.3			
Subbase (ASTM #2)	Wet	1.23	15.0			
	Dry	1.10	25.0			
Subgrade (Clay)	Wet	1.23	9.0			
	Dry	1.10	12.0			

Calculate Rut Depth

Design Subbase Thickness

Summary of Rutting Models

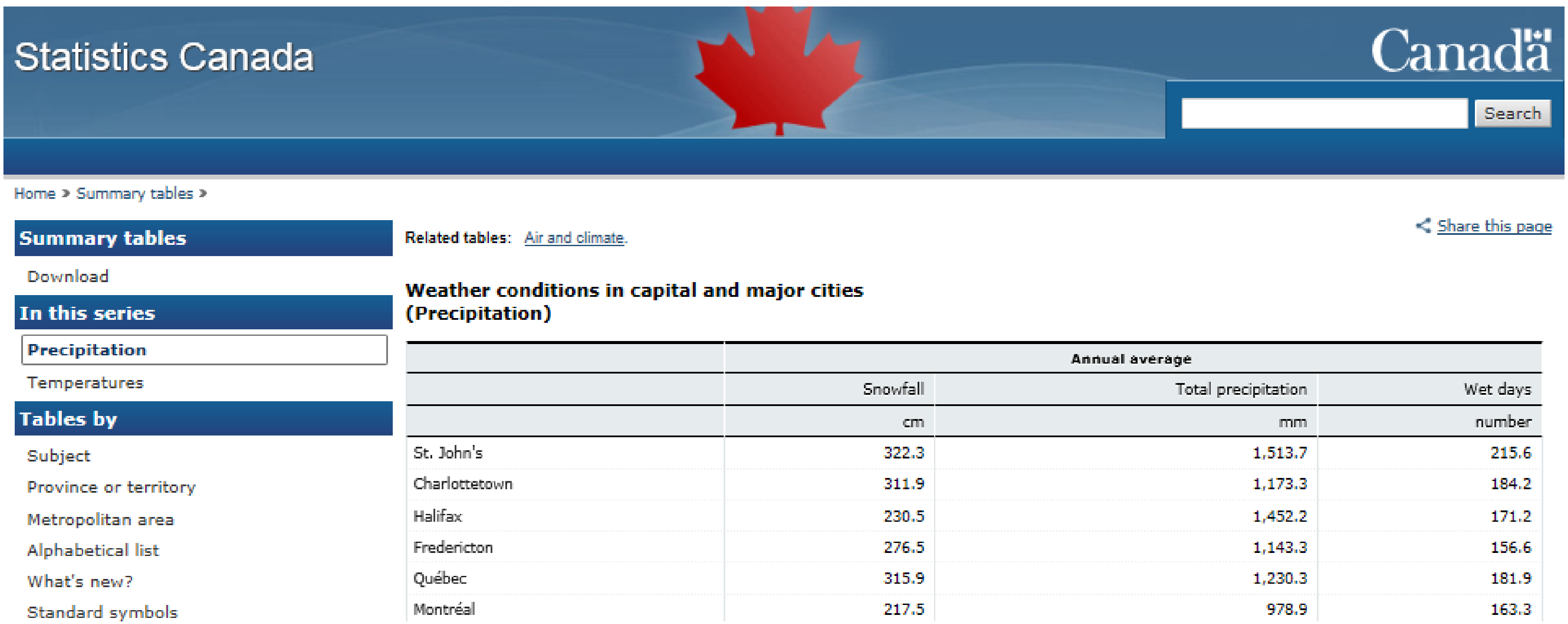
Number of Days in a Year when the Subbase has Standing Water (Wet Days)		50 to 89				90 to 119				120 or more			
Resilient Modulus of Subgrade, MPa (CBR)	Dry	40	60	80	100	40	60	80	100	40	60	80	100
	Wet	24 (1.6)	36 (3)	48 (4.8)	60 (6.8)	24 (1.6)	36 (3)	48 (4.8)	60 (6.8)	24 (1.6)	36 (3)	48 (4.8)	60 (6.8)
Lifetime ESALs (Traffic Index)		Minimum Subbase Thickness in mm for ASTM No. 2 Aggregate 25 mm Allowable Rut Depth											
50,000 (6.3)		175	150	150	150	210	150	150	150	230	150	150	150
100,000 (6.8)		285	180	150	150	325	215	150	150	340	235	150	150
200,000 (7.4)		395	285	185	150	430	320	215	150	450	335	235	155
300,000 (7.8)		455	340	240	160	495	375	275	195	515	395	290	215
400,000 (8.1)		500	380	280	200	535	415	310	235	555	435	330	250
500,000 (8.3)		530	410	305	230	570	445	340	260	590	465	355	275
600,000 (8.5)		555	435	330	250	595	470	360	280	615	490	380	300
700,000 (8.6)		580	455	350	270	620	490	380	300	640	510	400	315
800,000 (8.8)		600	470	365	285	640	505	395	315	660	525	415	335
900,000 (8.9)		615	485	380	295	655	525	410	330	675	540	430	345
1,000,000 (9.0)		630	500	390	310	670	535	425	340	690	555	440	360

Structural Design Example

- Traffic over design life = 196,550 ESALs (say 200,000)
- Subgrade modulus = 36 MPa (3,500 psi)
- For days where subbase has standing water:
  - Establish the design soil infiltration rate, e.g. 25 mm (1 in)/day
  - Correct the infiltration depth by dividing by the contributing drainage area (CDA) ratio (assume all CDA as 100% impervious for estimating purposes), e.g. for 2:1 CDA, corrected depth = 25/2 = 12.5 mm (0.5 in)
  - Count the days that exceed the adjusted daily infiltration depth and add any remaining depth from the previous day that has not drained within 48 hours (or other maximum drawdown time)

Structural Design Example

- For days where subbase has standing water:
  - Find historic rainfall for the year (e.g. statistics Canada)



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What's new?

Standard symbols

Related tables: Air and climate.

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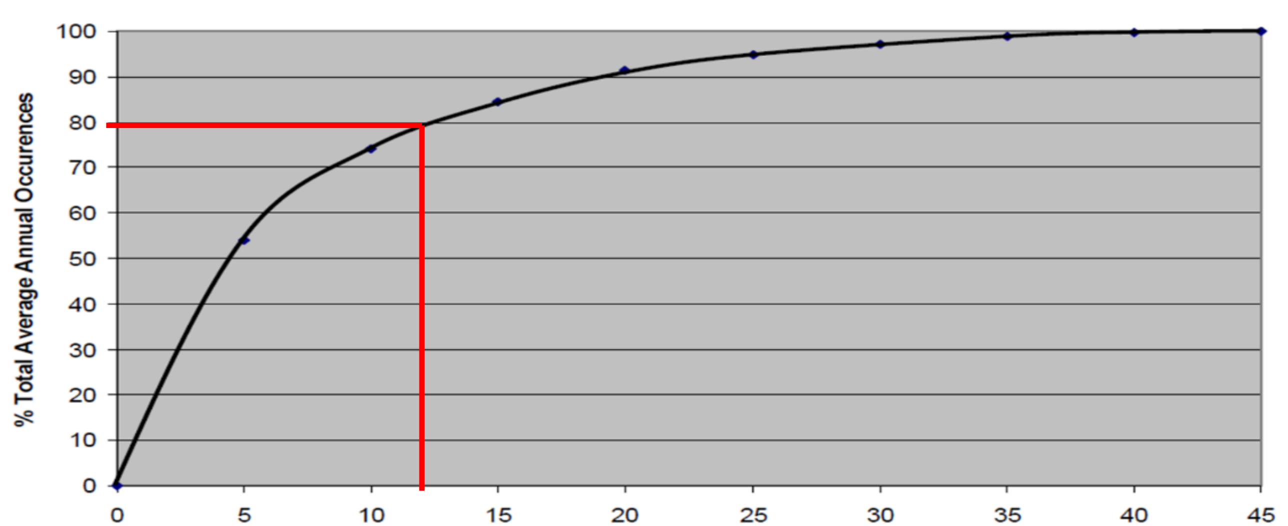
Weather conditions in capital and major cities (Precipitation)

	Annual average		
	Snowfall	Total precipitation	Wet days
	cm	mm	number
St. John's	322.3	1,513.7	215.6
Charlottetown	311.9	1,173.3	184.2
Halifax	230.5	1,452.2	171.2
Fredericton	276.5	1,143.3	156.6
Québec	315.9	1,230.3	181.9
Montréal	217.5	978.9	163.3

Structural Design Example

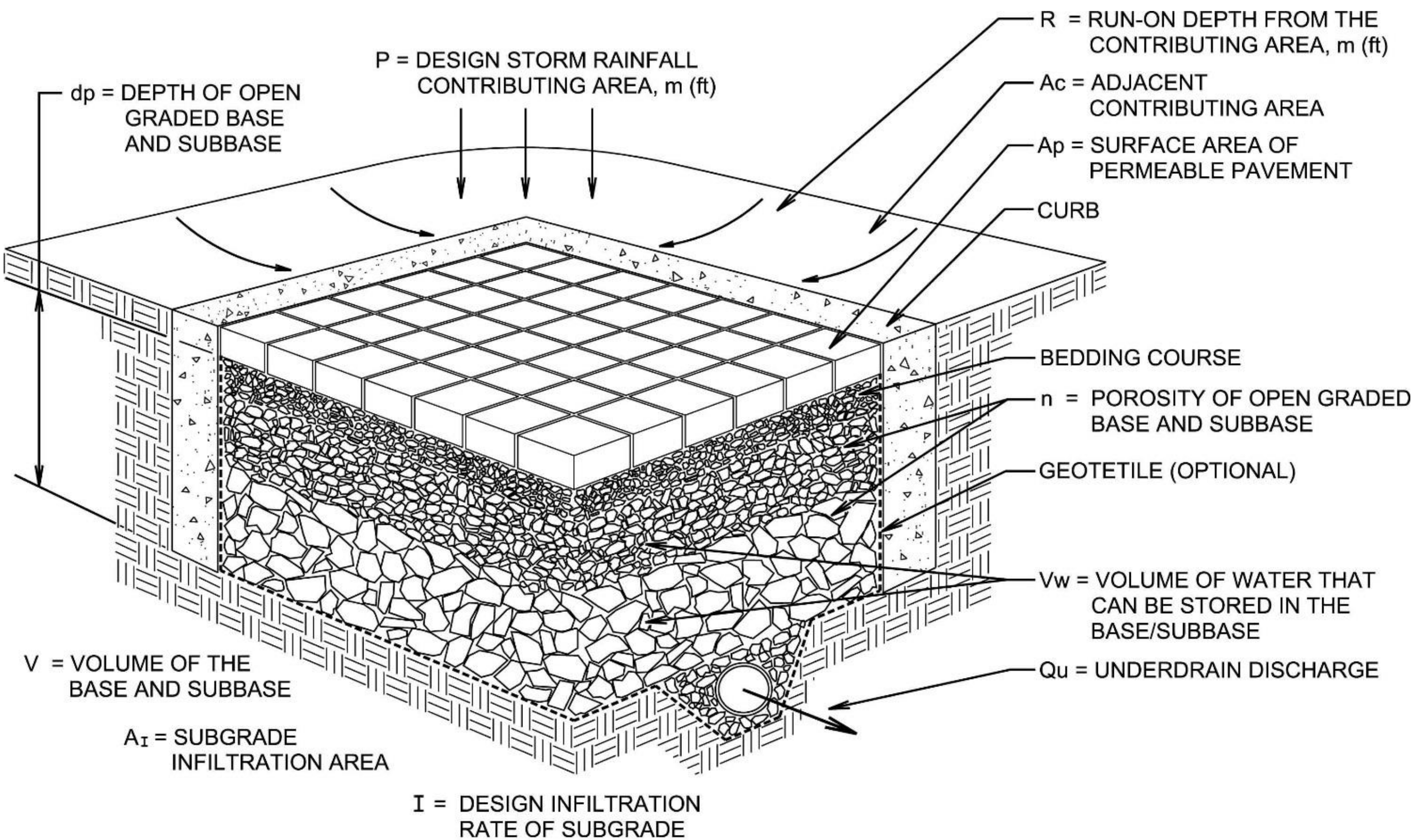
- For days where subbase has standing water:
  - From rainfall intensity curve of total average annual occurrences versus daily precipitation
  - From curve only 20 percent of rain days exceed 12.5 mm (1 in) of rain
  - 139 days of rain x 0.20 = 27.8 days can cause standing water on the subgrade surface



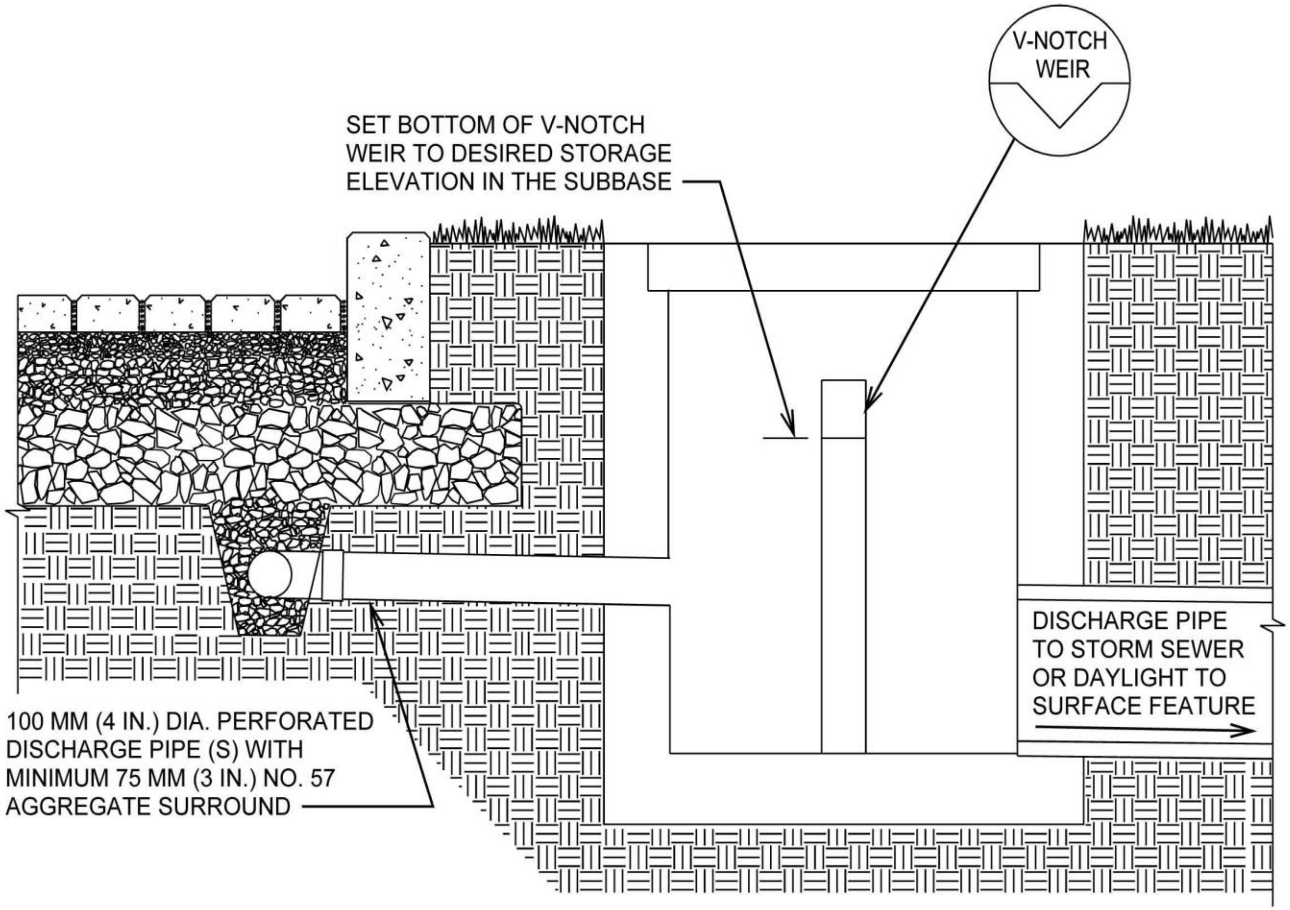
Structural Design Example

Number of Days in a Year when the Subbase has Standing Water (Wet Days)		0 to 9				10 to 29				30 to 49			
Resilient Modulus of Subgrade, MPa (CBR)	Dry	40	60	80	100	40	60	80	100	40	60	80	100
	Wet	24 (1.6)	36 (3)	48 (4.8)	60 (6.8)	24 (1.6)	36 (3)	48 (4.8)	60 (6.8)	24 (1.6)	36 (3)	48 (4.8)	60 (6.8)
Lifetime ESALs (Traffic Index)		Minimum Subbase Thickness in mm for ASTM No. 2 Aggregate 25 mm Allowable Rut Depth											
50,000 (6.3)		150	150	150	150	150	150	150	150	150	150	150	150
100,000 (6.8)		150	150	150	150	210	150	150	150	260	150	150	150
200,000 (7.4)		230	150	150	150	315	210	150	150	365	255	160	150
300,000 (7.8)		290	180	150	150	375	265	170	150	425	315	215	150
400,000 (8.1)		330	220	150	150	420	305	210	150	470	350	255	175
500,000 (8.3)		360	250	160	150	450	335	240	160	500	380	280	205
600,000 (8.5)		385	275	185	150	475	360	260	180	525	405	305	225
700,000 (8.6)		410	295	205	150	495	380	280	200	550	425	325	245
800,000 (8.8)		425	310	220	150	515	395	295	215	565	440	340	260
900,000 (8.9)		440	325	235	155	530	410	310	230	585	455	355	270
1,000,000 (9.0)		455	340	250	165	545	425	325	240	600	470	365	285

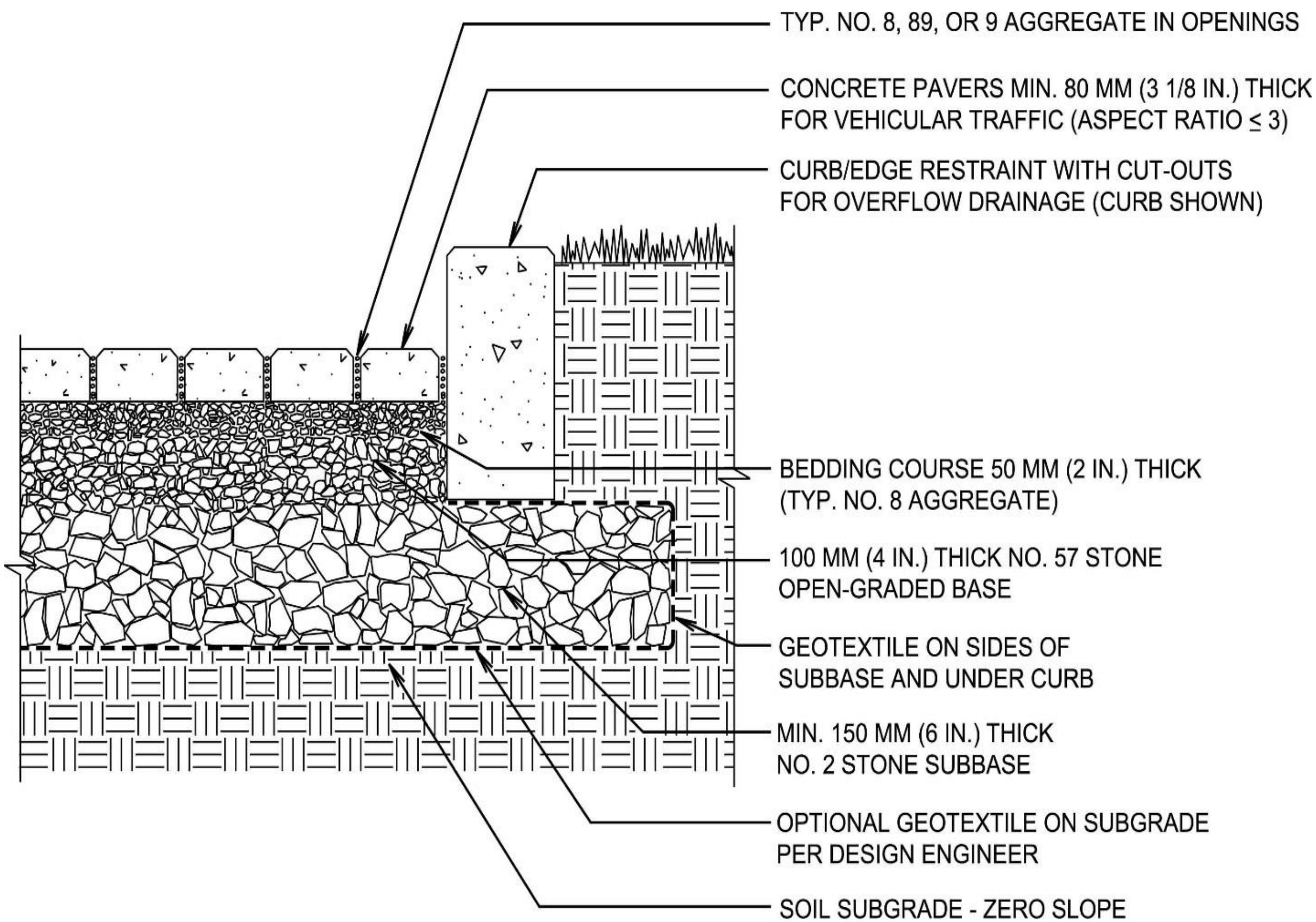
Hydrologic Design - General



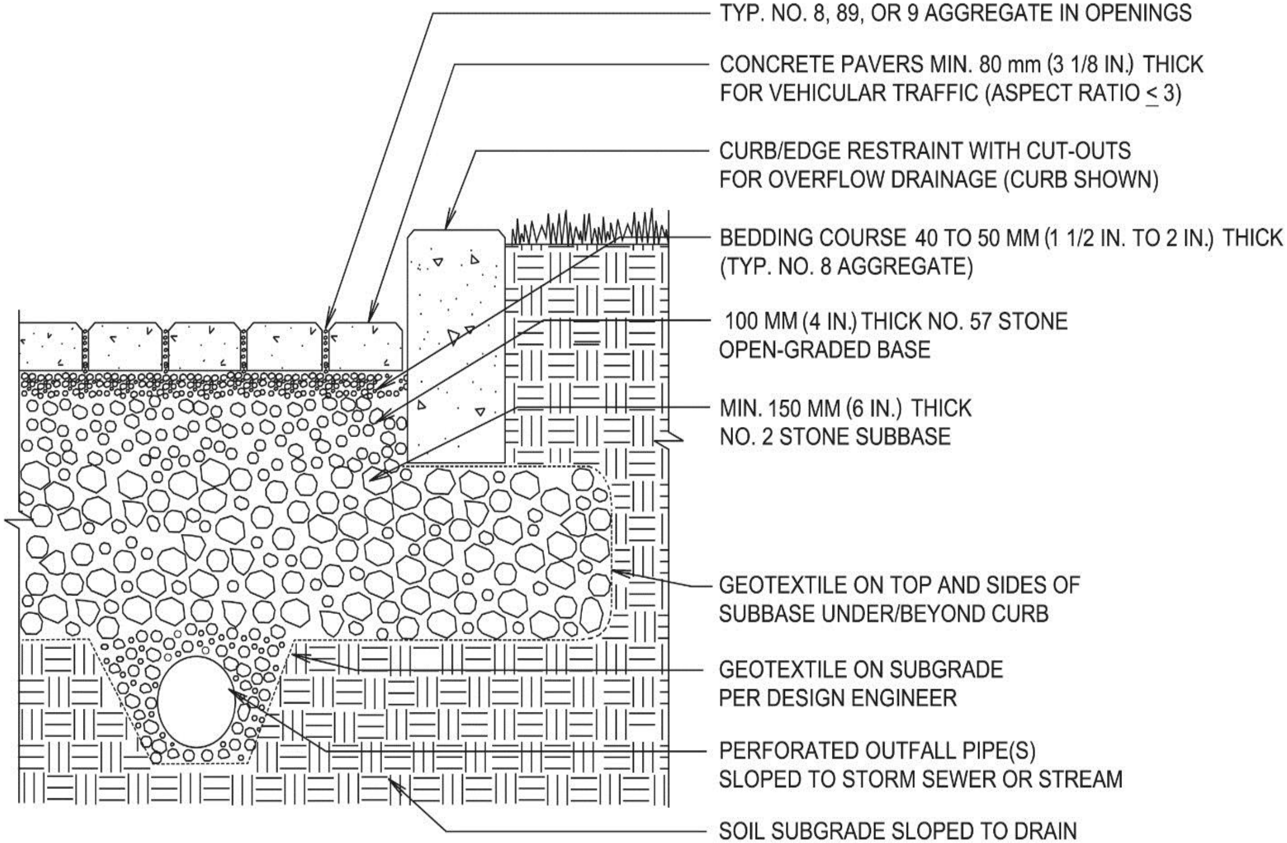
Hydrologic Design – Flow Control



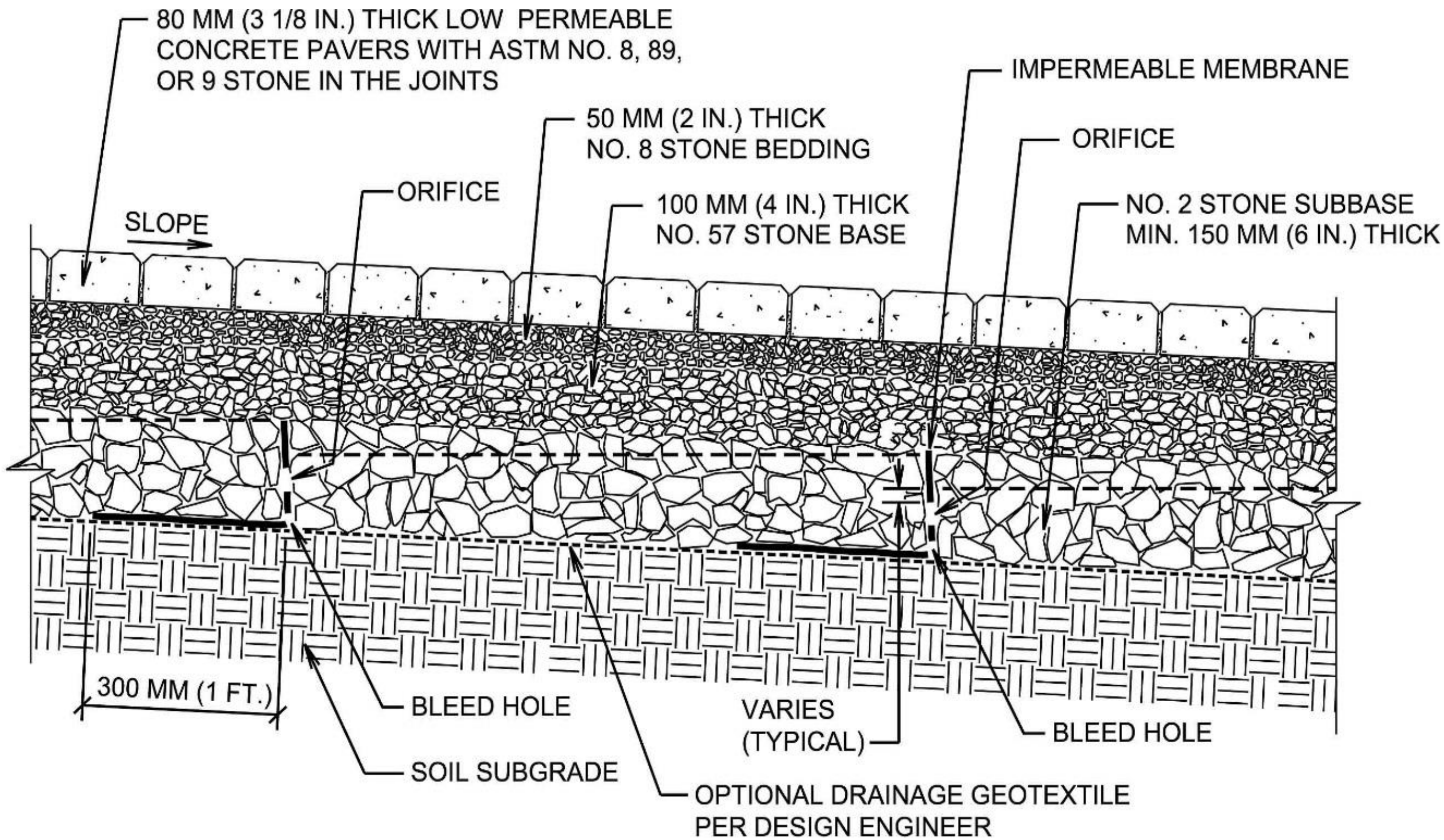
Hydrologic Design - Infiltration



Hydrologic Design - Partial



Hydrologic Design - Slopes



General Baffle Construction


CAT


CAT

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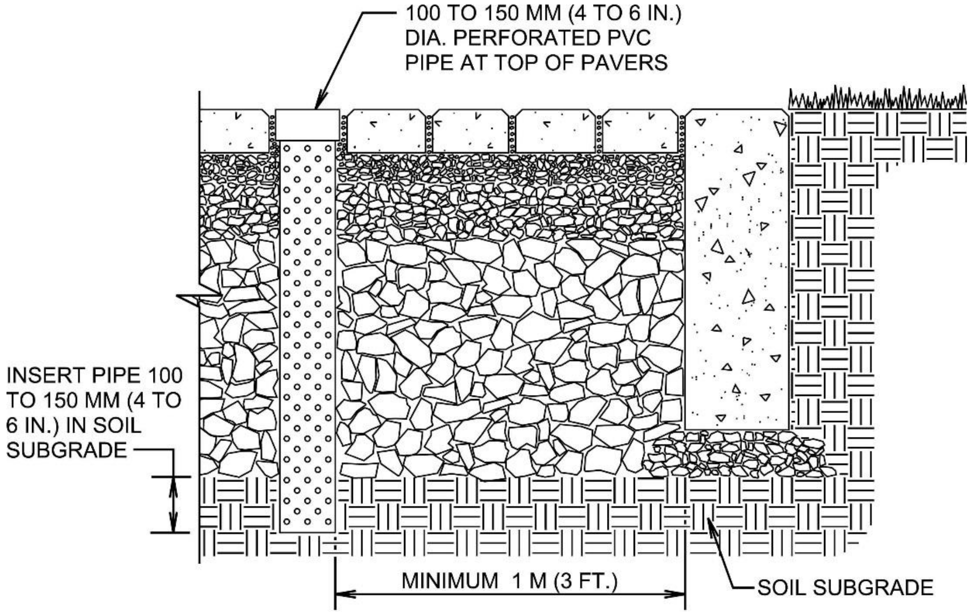
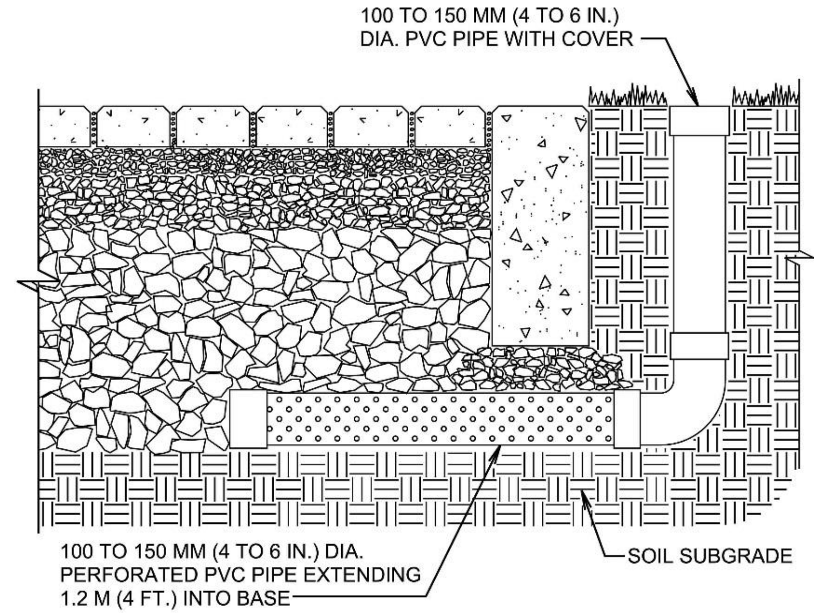
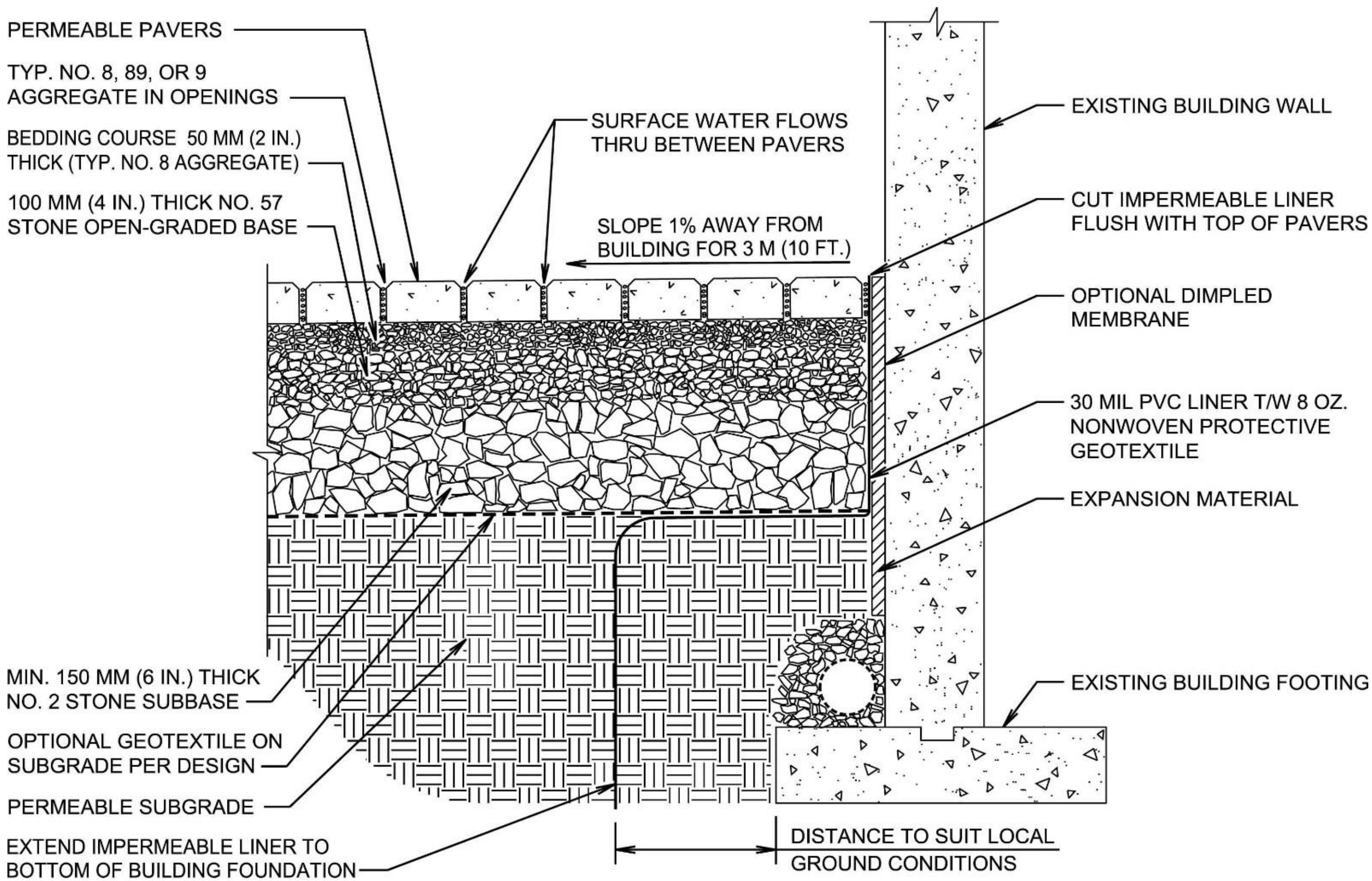
Hydrologic Design - Monitoring

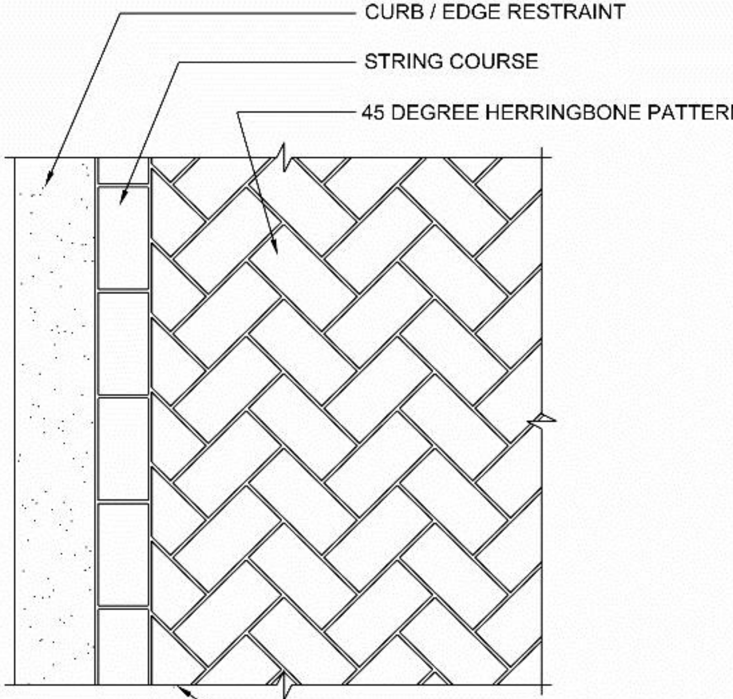


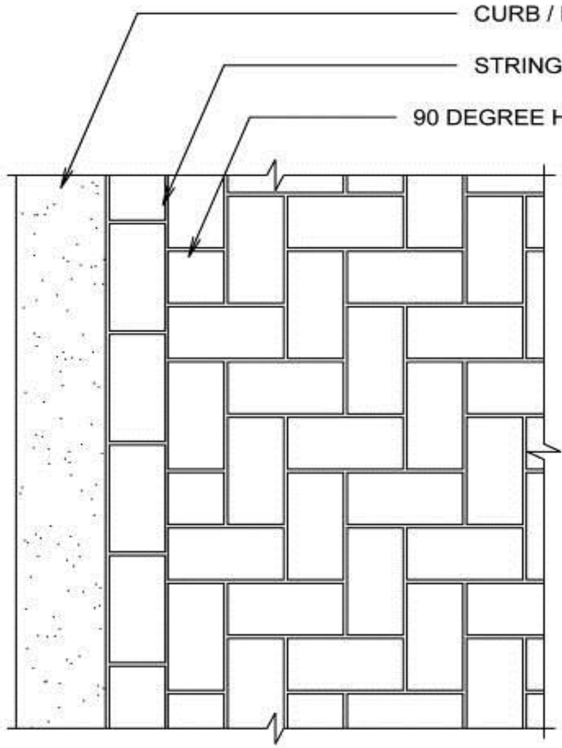


Hydrologic Design - Buildings



Design Details

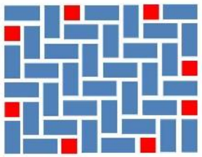




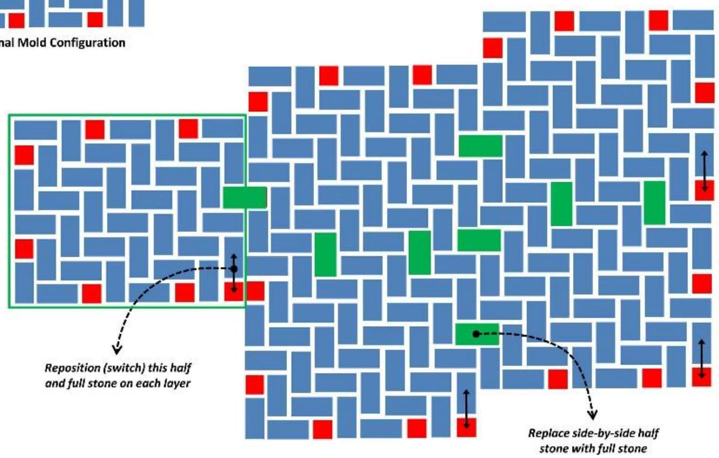
Design Details

True Herringbone Pattern

All half stones can be replaced by full stones, binding the layers together and creating a seamless stitch throughout.

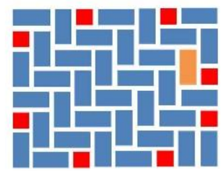


Original Mold Configuration

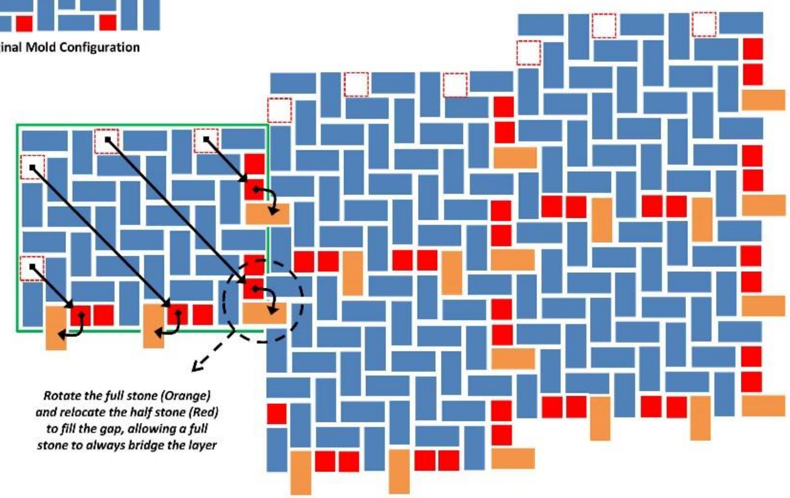


Modified Herringbone Pattern

Make full use of the half stones. Once the layer is in place, rotate the full stone to interlock layers and fill the void with a half stone.



Original Mold Configuration



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Line Marking

Key Construction Features

- A pre-construction site meeting is critical to the success of the permeable pavement installation

Pre-Construction Checklist

- Review erosion and sediment control plan/stormwater pollution prevention plan
- Determine when the pavement will be built in the construction sequence and measures for protection
- Identify aggregate material stockpile locations
- Review test (mock-up) location and criteria for acceptance
- Contractor’s methods for keeping all materials free from sediment during storage, placement, and on completed areas
- Contractor’s methods for checking slopes, surface tolerances, and elevations

Pre-Construction Checklist

- Diagrams of laying/layer pattern, stitching requirements (PICP) and joining layers
- Testing intervals for aggregates, edge restraints and for the surface materials
- Testing lab location, test methods, report delivery, contents and timing
- Contractor's quality control and assurance methods and reporting
- Engineer inspection intervals and procedures for correcting work that does not conform to the project specifications

Light Weight Deflectometer (in-situ test)

- ASTM D2583 for surfaces or D2835 for soils and bases
- Weight dropped onto plate from standard height
- Sensor measures impact load
- Geophones measure pavement deflection
- Estimates resilient modulus or level of compaction via deflection

Underdrain Placement

- Installed in a trench the lowest point of the pavement subgrade
- Surrounded with open-graded aggregate offering protection during construction
- Pipes should be perforated, polyvinyl chloride (PVC), minimum 0.5 percent slope to an outlet
- Pipe spacing and size should be selected to ensure that the pavement does not flood and become completely saturated during storm events

Geosynthetics

- Generally placed vertically against the walls of excavated soil to separate the permeable pavement from adjacent soils
- Polyvinyl chloride or high density polyethylene
- Separates the base/subbase from adjacent pavements / buildings
- May enclose the sides and bottom to create a no infiltration design for water storage and flow control

Pavement Maintenance

- Inspection tasks may include the following:
  - Review maintenance and operations records and incidences to determine if there have been any issues
  - Document general site features, take photographs, etc.
  - Note any surface contamination or clogging
  - Note obvious sources of surface contaminants
  - Identify the extent and severity of any damage or deficiencies (e.g. settlement, ponding, cracked pavers, etc.)
  - Identify any changes in adjacent land use that may impact contributing area runoff

Pavement Maintenance

- Inspection tasks may include the following:
  - Inspect vegetation around PICP for cover and soil stability
  - Ensure edge restraints are performing
  - Check underdrains to ensure that they are still draining water from the pavement structure
  - Check observation wells for water storage
  - If a significant reduction in permeability from the last inspection, complete infiltration testing

Permeability Testing – ASTM C1781-13

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ASTM WK40698

(What is a Work Item? / How to Input to a Work Item)

Work Item: ASTM WK40698 - New Test Method for Determining the Surface Infiltration Rate of Permeable Unit Pavement Systems

Developed by Subcommittee: C15.04 | Committee C15 Home | Contact Staff Manager

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1. Scope

1.1 This test method covers the determination of the field

Work Item Status:

Date Initiated: 01-29-2013

Technical Contact: Craig Walloch

Item: 019

Ballot: COS (13-07)

Permeability Improvements

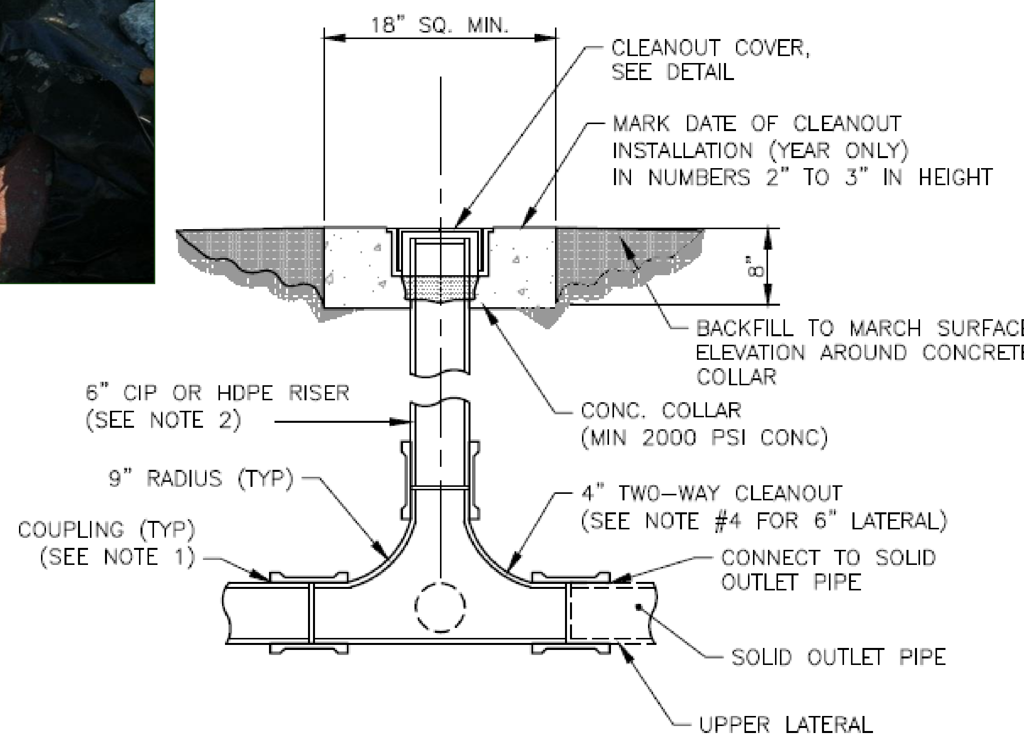
Permeable Paver Joint Aggregate

- Top up of joint aggregate within 6 months of construction

Localized Settlement Repair

- Remove pavers from affected area
- Level bedding layer, add new material as necessary
- Replace pavers and jointing material

Underdrain Cleanout



ASCE Standard Schedule

- Standard is currently out for public comment
- Pubic comment period closes on April 1, 2018
- Committee will review and address all comments and make modifications if necessary
- ASCE editors will complete final review and then public the standard
- Several member of the ASCE PICP standards committee are here at the conference (many thanks for their hard work)

Thank you

Lori Schaus, MASc., P.Eng
Senior Pavement Engineer
Applied Research Associates, Inc.

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