

# Before Bioretention

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## LID Site Design and Drainage

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# Topics

- Hydrology for Stormwater Treatment and Flow Control
- LID Site Design
  - Self-treating and Self-retaining Areas
  - Use for Pervious Areas of Site
  - Use for Dispersion to Landscape
- Pervious Pavements
  - Criteria
  - Economics
- About Green Roofs
- Harvesting and (Re)use



# Hydrology

- 💧 Stormwater NPDES Objectives
  - 💧 Reduce long-term pollutant loading
  - 💧 Maintain pre-project flow rates and durations
- 💧 Low Impact Development Objective
  - 💧 Mimic natural hydrology
  - 💧 Achieve similar runoff volumes and time of concentration
- 💧 Design based on continuous record of rainfall and runoff
  - 💧 Consider all sizes of runoff events
  - 💧 Account for antecedent conditions



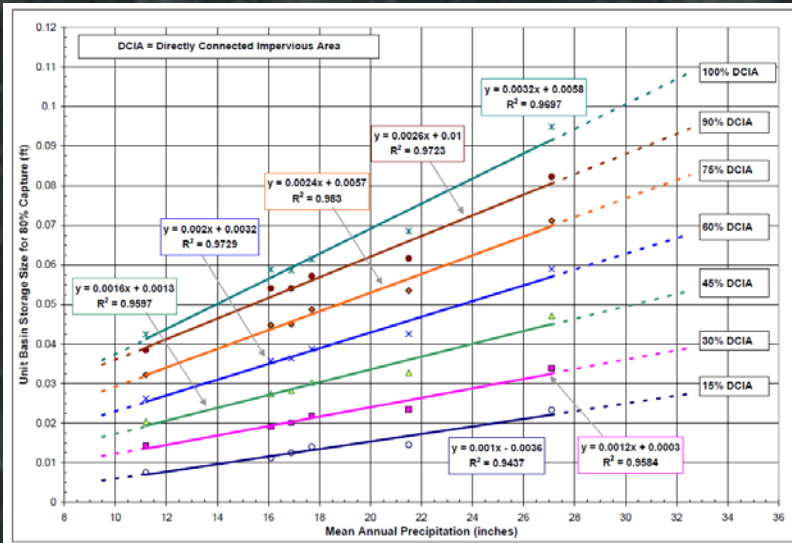
# Detention Basin Sizing

Rainfall Record	
Hour #	Gage
1	0.00
2	0.02
3	0.01



Vary V until  
80% is detained  
and 20% overflows

48-hour  
drawdown



**Largest storm retained**  
 ≈ 85<sup>th</sup> percentile, 24 hour  
 ≈ 0.5" - 1.0" storm depth



# Flow Duration Control

Hour #	Flow (cfs)
1	0.0
2	0.0
3	0.1
4	0.1
5	0.0
6	0.2
7	1.5
8	0.6
Etc.	



# 250,000 hours

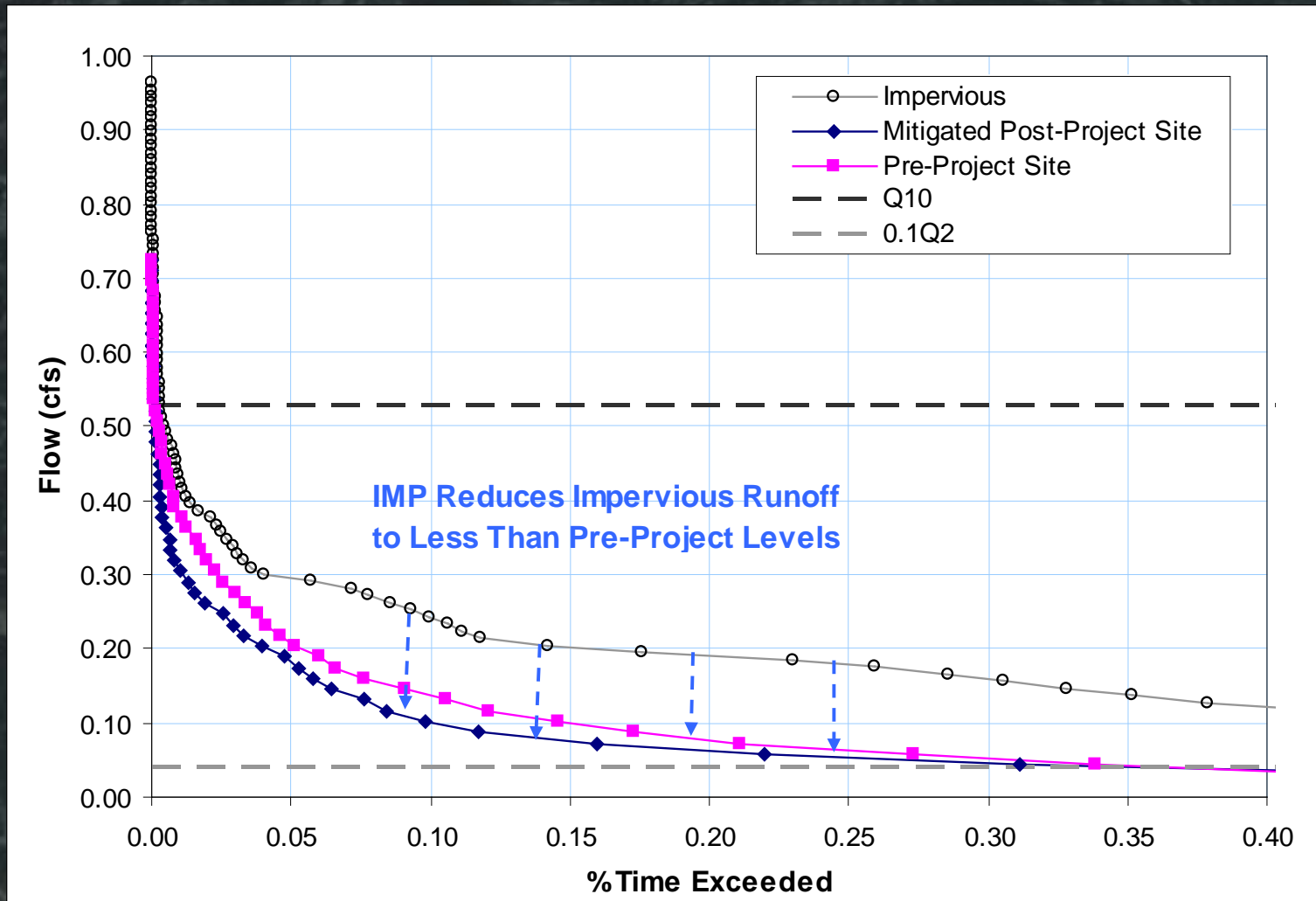
Hour #	Flow (cfs)	Hours exceeded
115241	10.3	0
4598	10.3	1
3672	10.2	2
115242	10.0	3
243581	10.0	4
66058	9.9	5
75291	9.8	6
186540	9.7	7
Etc.		

**This flow exceeded during 2 hours/250,000 hours (0.0008%)**

**This flow exceeded during 7 hours/250,000 hours (0.0028%)**



# Flow Duration Analysis



# LID Site Design

## Principles

- Define development envelope
- Preserve natural features and pervious areas
- Minimize roofs and paving
- Disperse runoff to landscape

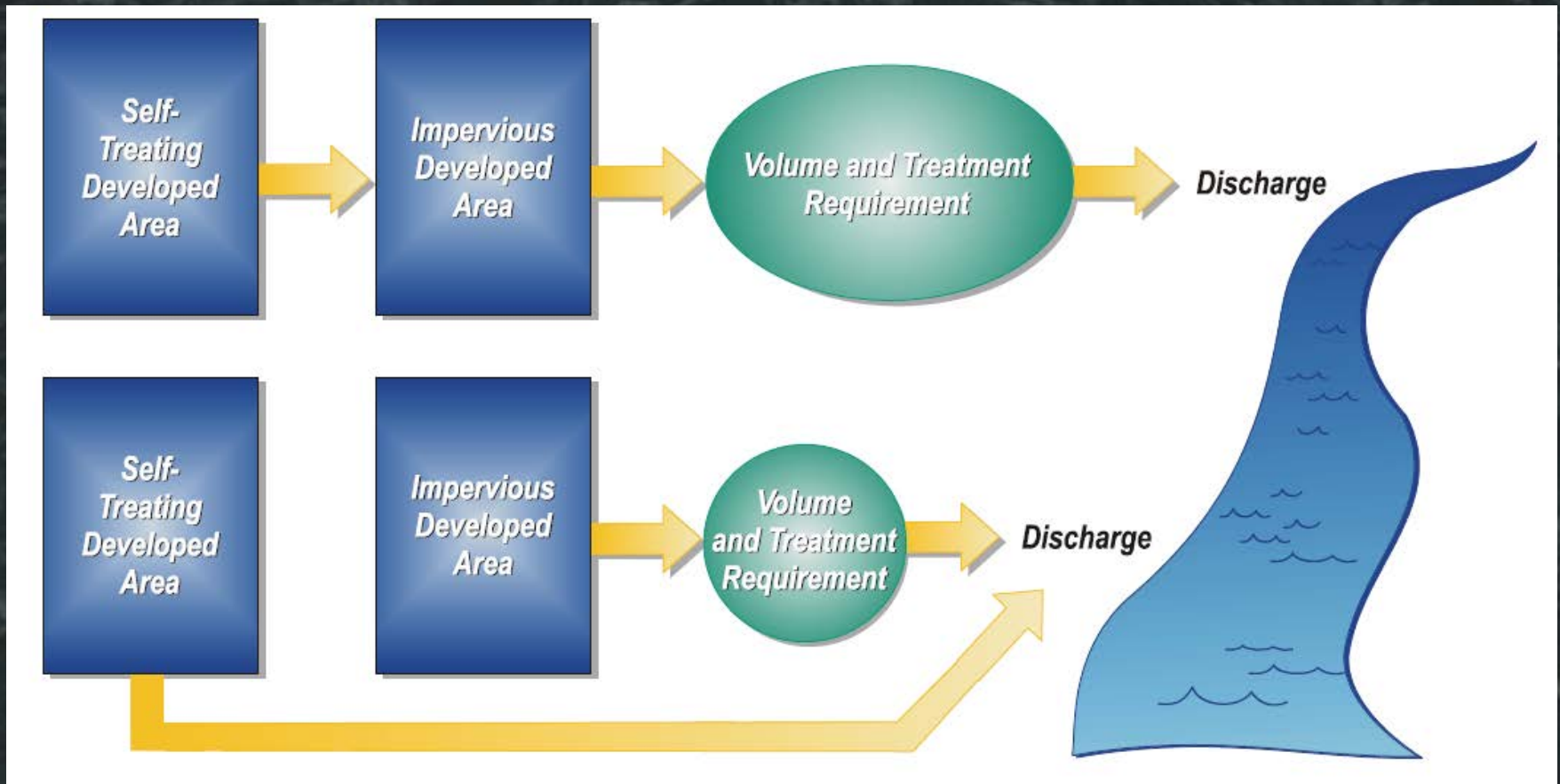
## Problems

- Requires space
- Densely developed hillside sites often require mass grading
- How to quantify and credit for stormwater compliance?

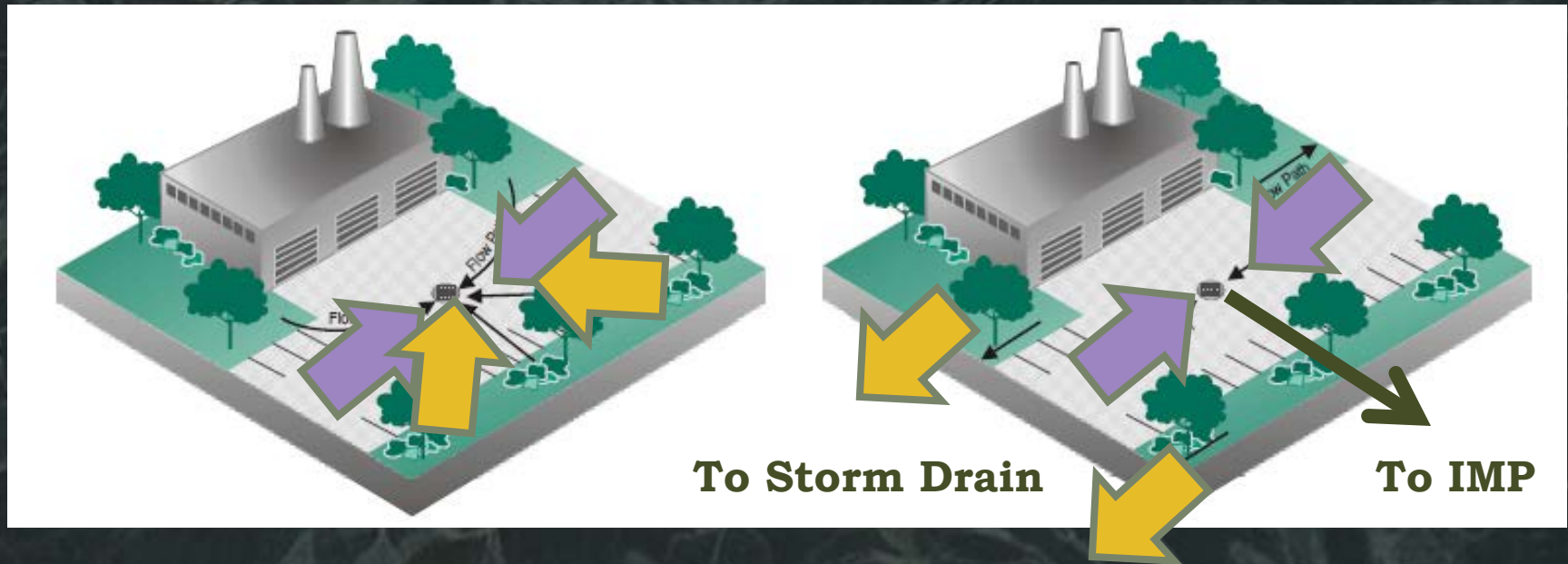




# Self-Treating Areas



# Self-Treating Areas



# Self-Treating Areas

## 💧 Rationale

- 💧 Some portion (40%-80%) of rainfall is infiltrated or evapotranspirated
- 💧 Landscaped areas are at least as effective for infiltration and evapotranspiration
- 💧 Pollutants in rainfall and windblown dust become entrained in vegetation and soils
- 💧 No additional treatment is necessary

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## 💧 Criteria

- 💧 Not more than 5% impervious
- 💧 Runoff does not enter an IMP or another drainage management area
- 💧 Vegetated, stable

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# Self-Treating Areas



# Self-Retaining Areas

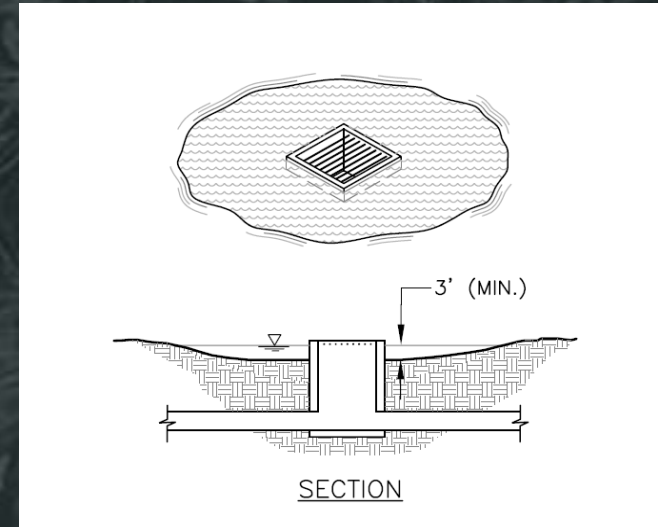
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## 💧 Rationale

- 💧 Produce no runoff from “small” storms
- 💧 Also called “zero discharge” areas

## 💧 Criteria

- 💧 Bermed or graded concave
- 💧 Slopes do not exceed 4%
- 💧 Amended soils and vegetation to maintain soil stability and permeability
- 💧 Drain inlets at least 3" above surrounding grade



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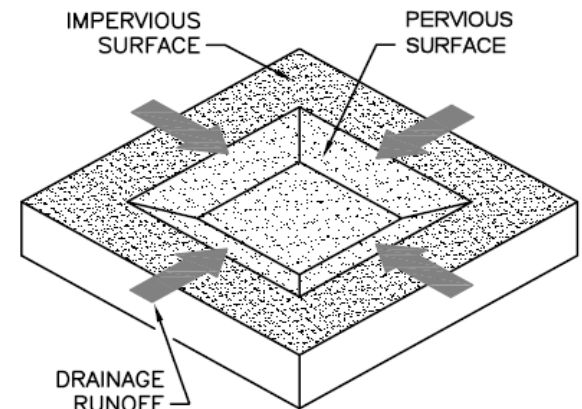
# Draining to Self-Retaining

- 💧 Rationale
  - 💧 Self-retaining areas are capable of ponding and infiltrating some additional runoff

- 💧 Criteria
  - 💧 Ratio is not greater than 2:1 if treatment-only requirements apply
  - 💧 Ratio is not greater than 1:1 if flow-control requirements apply
  - 💧 Provide sufficient ponding/storage depth
  - 💧 Facilitate infiltration



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# Recap

- 💧 Self-treating Areas
  - 💧 May be sloped and produce runoff
  - 💧 Runoff goes directly to gutter or storm drain, not to IMPs
- 💧 Self-retaining Areas
  - 💧 Must be bermed or depressed so no runoff is produced
- 💧 Areas Draining to Self-retaining Areas
  - 💧 Observe maximum ratios
  - 💧 Ensure sufficient storage and drainage
- 💧 Bioretention
  - 💧 Engineered facilities built to criteria
  - 💧 Sizing factors down to 0.04 (25:1)
  - 💧 Treatment facilities subject to reporting and verification requirements



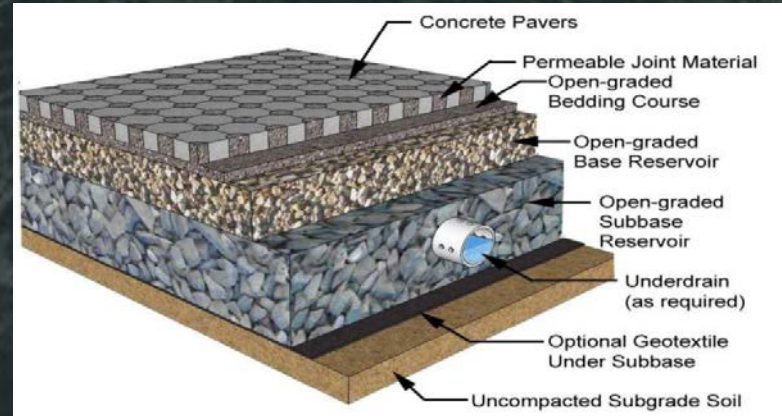
# Pervious Pavements

## ☘ Variations

- ☘ Pervious concrete
- ☘ Porous asphalt
- ☘ Porous pavers
- ☘ Gravel
- ☘ Open pavers
- ☘ Solid unit pavers set on sand/gravel
- ☘ Artificial turf

## ☘ Common Characteristics

- ☘ Require a base course
- ☘ Base course depth varies with soil type
- ☘ More costly than conventional concrete or asphalt
- ☘ Installation on slopes requires careful design





# Pervious Pavements FAQ

- 💧 What runoff factor should be used?
  - 💧 Zero. No runoff is produced in small to medium storms
- 💧 Can pervious pavement be used to avoid a threshold for treatment or for flow control?
  - 💧 Yes.
- 💧 How deep a base course is required?
  - 💧 Follow supplier's recommendations. Designing for structural strength typically provides sufficient storage.
- 💧 Can the base course be underdrained?
  - 💧 Consider omitting the underdrain and relying on infiltration and lateral flow
  - 💧 Outlet elevation minimum 3" above bottom of base course
  - 💧 Underdrain may be routed to storm drain

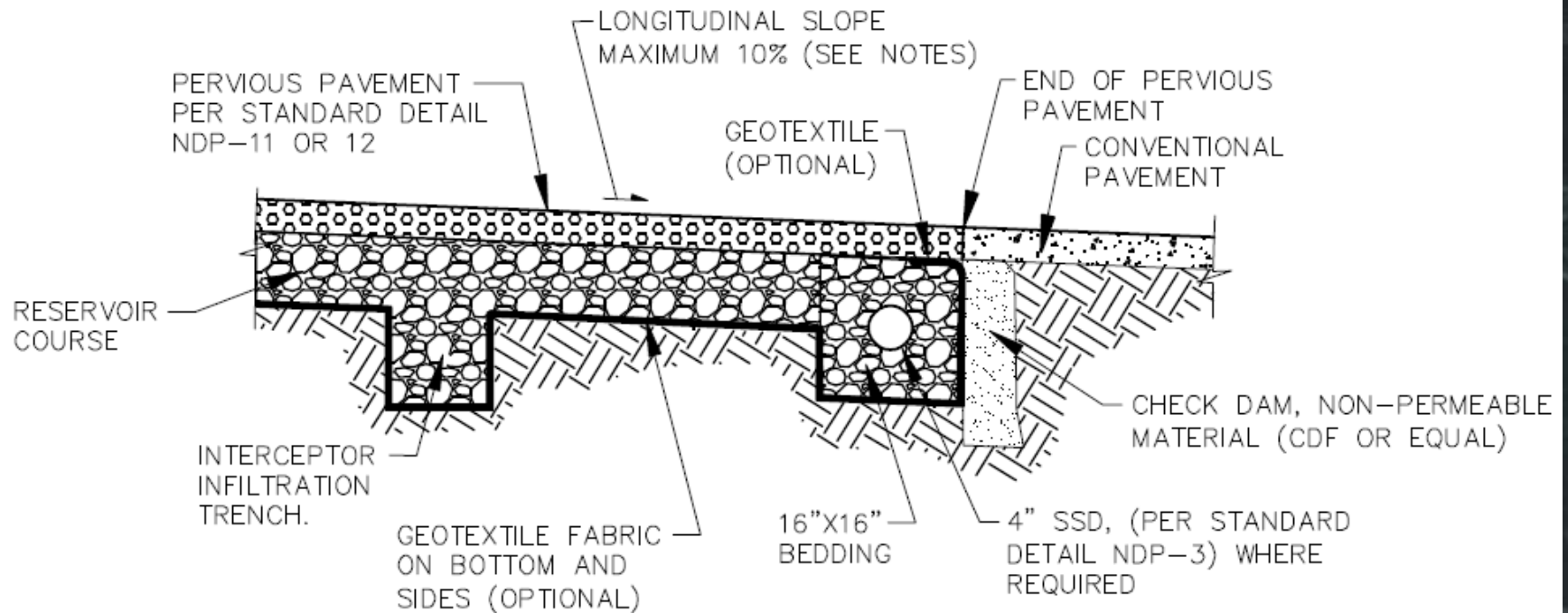


# Pervious Pavements FAQ

- 💧 What maintenance is required for permeability?
  - 💧 Follow supplier's recommendations.
- 💧 Can pervious pavement be used to avoid a threshold for treatment or for flow control?
  - 💧 Yes.
- 💧 How deep a base course is required?
  - 💧 Follow supplier's recommendations. Designing for structural strength typically provides sufficient storage.
- 💧 Can the base course be underdrained?
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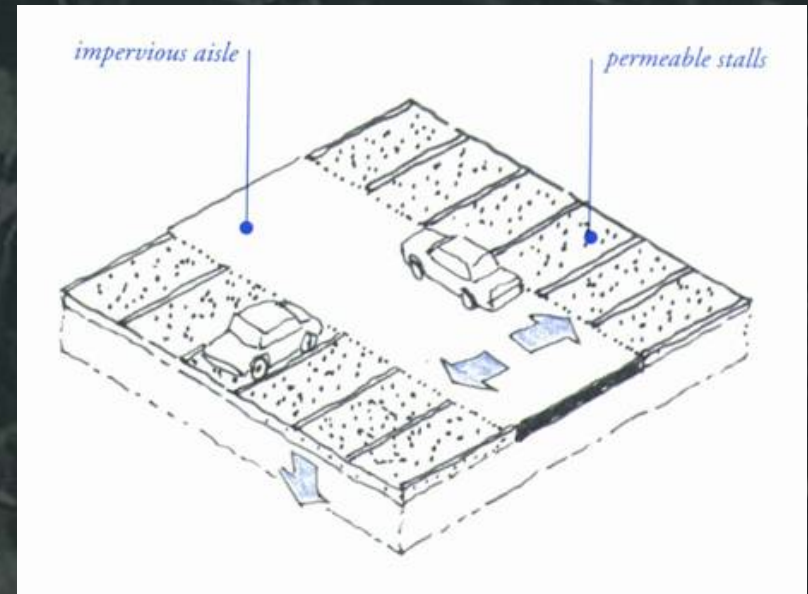


# Installation on slopes



# Pervious Pavements

- ◆ May classify as self-treating
  - ◆ Sloped to street or storm drain
- ◆ May classify as self-retaining
- ◆ May receive runoff from impervious areas
  - ◆ “Areas Draining to Self-Retaining Areas”
  - ◆ Maximum ratio is 2:1 for treatment-only
  - ◆ Maximum ratio is 1:1 for treatment + flow control



# Details

- 💧 Avoid sources of sediment draining on to pavement
- 💧 Minimal compaction of subgrade
- 💧 Rigid edge needed to retain granular pavements and unit pavers
- 💧 For solid pavers, note required  $\frac{3}{8}$ " gap and spec for fill between joints
- 💧 Incorporate vendor recommendations
- 💧 Use industry certified professionals
- 💧 See *Guidebook* for resources



# Green Roofs

- Counted as producing no runoff
- May classify as self-treating
- May classify as self-retaining
- Planting media deep enough to store the treatment design volume
  - Account for impervious areas running on to green roof
- Design media and select plants for healthy vegetation
- Provide irrigation as necessary
- Access required for maintenance
- Recommend to use industry-certified professionals for design and construction



# Harvesting and (Re)use

