

Pervious Pavement

Options and Design Guidelines
(with LID example projects)



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SYSTEMS THINKING

Need to think differently about the problem...

- Whole System Design
 - "Site & Project" Relationships
- Integrated Design
 - "Design" Relationships
- Sustainable Design
 - Materials & Systems (relationships)

THE NEW DESIGN PROBLEM

and the Role of the Civil Engineer

- Many biological systems are in decline
- The Civil Engineer has a critical role to play but many are lagging other types of designers in sustainable design interest or implementation
- Civil Engineers need to step up to the plate in an increasing way
- Society needs to ask new questions of Civil Engineers, there are new problems to solve...
- We are smarter than this... we must raise the bar for the performance of engineering solutions and foster innovation

LOW IMPACT DEVELOPMENT

Introduction



LOW IMPACT DEVELOPMENT

Introduction

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-
- "Conventional" Development
 - Addressed major problems and disasters (Crisis Management)

LOW IMPACT DEVELOPMENT

Introduction

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- Low Impact Development
 - Reducing negative impacts on resources
- "Conventional" Development
 - Addressed major problems and disasters (Crisis Management)

LOW IMPACT DEVELOPMENT

Introduction

-
- Sustainable (Zero Impact) Development
 - Maintaining resources
- Low Impact Development
 - Reducing negative impacts on resources
- "Conventional" Development
 - Addressed major problems and disasters (Crisis Management)

LOW IMPACT DEVELOPMENT

Introduction

- Regenerative (Restorative) Development
 - Restoring damaged resources
- Sustainable (Zero Impact) Development
 - Maintaining resources
- Low Impact Development
 - Reducing negative impacts on resources
- "Conventional" Development
 - Addressed major problems and disasters (Crisis Management)

LOW IMPACT DEVELOPMENT

Introduction

L.I.D. Site Design Techniques



- Geometrics & Layout (i.e., "Narrow Streets")
- Porous Pavements (Permeable Surfaces)
- Bioretention (Raingardens)
- Soil Amendments (Compost Amended Soils)
- Rainwater Collection and Reuse

LOW IMPACT DEVELOPMENT

Introduction

Ways to Mimic Nature...

No Catch Basins & No Curbs

- ✓ Sheet Flow Run-off
- ✓ Retain Water On-Site
- ✓ Porous Surfaces
- ✓ Do not Concentrate Flows

LOW IMPACT DEVELOPMENT

Introduction

Use smaller decentralized solutions at the source...

Decentralized Approach
(Small Scale Systems)

vs.

Centralized Approach
(Large Scale System)



LEED

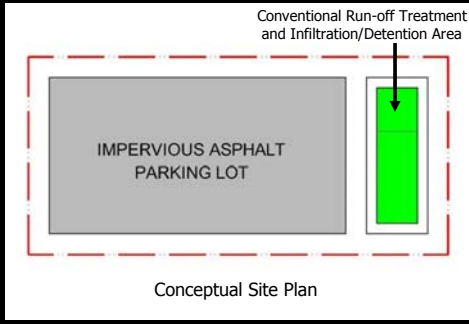
Sustainable Sites

- Pre-Req.: Erosion and Sedimentation Control
- 5. Reduced Site Disturbance (2)
- 6. Stormwater Management (2)



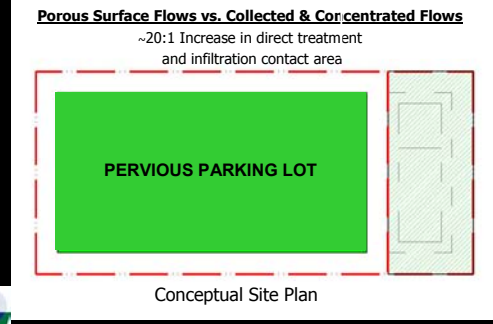
EXAMPLE SITE PLAN

Impervious Surface Reduction Strategies



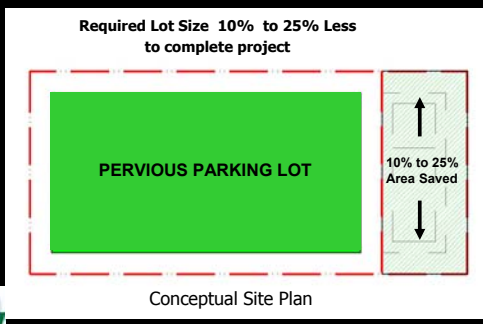
EXAMPLE SITE PLAN

Impervious Surface Reduction Strategies



EXAMPLE SITE PLAN

Impervious Surface Reduction Strategies



POROUS PAVEMENTS

Impervious Surface Reduction Strategies

Permeable (Porous) Surfaces

> Hardscapes

- Porous Concrete / Asphalt Pavements
- Interlocking Concrete Pavers
- Gravel Cellular Confinement Systems

> Softscapes

- Reinforced Grass Surfaces
- Grass Cellular Confinement Systems

> Green Roofs



POROUS PAVEMENTS

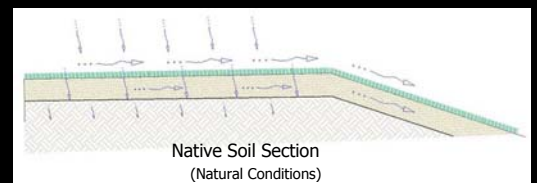
Some Porous Pavement Design Considerations

- Soil
 - soil infiltration rate
 - soil's structural capacity
 - soil's susceptibility to swelling
 - slope stability / basement flooding
- Use
 - high or low traffic
 - Sources of contamination (i.e. industrial)
 - speed
 - maintenance
 - striping

POROUS PAVEMENTS

Impervious Surface Reduction Strategies

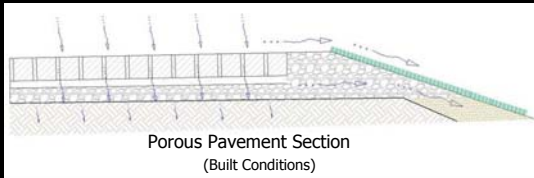
Mimicking Natural Conditions...



POROUS PAVEMENTS

Impervious Surface Reduction Strategies

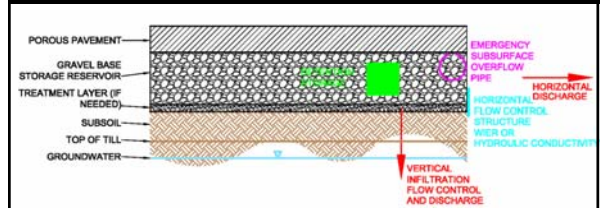
Mimicking Natural Conditions...



Porous Pavement Section
(Built Conditions)

POROUS PAVEMENTS

Conceptual Summary Section

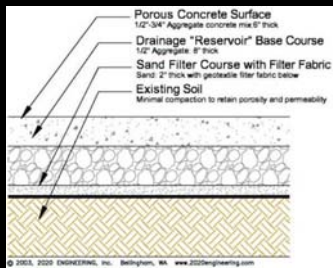


Concepts shown, not all will be present on each design...

POROUS PAVEMENTS

Impervious Surface Reduction Strategies

Stormwater Treatment, Detention/Retention and Flow Control are built into the section...



POROUS PAVEMENTS

Impervious Surface Reduction Strategies



Porous Concrete Pavement

POROUS CONCRETE PAVEMENT

Impervious Surface Reduction Strategies

DESIGN CRITERIA

- Soil
 - ✓ Soil's infiltration rate
 - ✓ Soil's structural capacity (CBR rating)
 - ✓ Soil's susceptibility to swelling
 - ✓ Site location (slope stability)
- Applications
 - ✓ High or low traffic
 - ✓ Sources of contamination (i.e. industrial)
 - ✓ Maintenance
- Mix Design
 - ✓ Strength of section

POROUS CONCRETE PAVEMENT

Example Application



Brandon Regional Hospital - Brandon, Florida -circ 1980

POROUS CONCRETE PAVEMENT

Example Application



1992

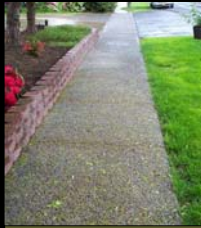
POROUS CONCRETE PAVEMENT

Example Application



POROUS CONCRETE PAVEMENT

Example Application



Sidewalk

Eugene, Oregon

POROUS PAVEMENTS

Example Application



2000

- City of Olympia
- 1500 lineal feet of sidewalk
- Sub-grade: native soil was permeable enough
- Savings: \$110,000 - land acquisition for detention ponds unnecessary

POROUS CONCRETE PAVEMENT

Example Project



Public Alley, Bellingham, WA



POROUS CONCRETE PAVEMENT

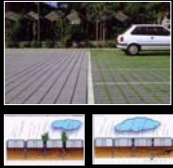
Example Project



Bayview Corner, Whidbey Island, WA

INTERLOCKING CONCRETE PAVERS

Types of Pavers



SF-RIMA



UNI ECOSTONE



TURFSTONE

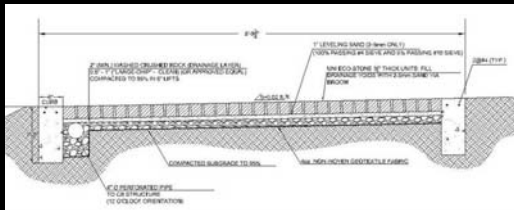
INTERLOCKING CONCRETE PAVERS

Example Project – Site Plan



INTERLOCKING CONCRETE PAVERS

Example Project – Typical Section

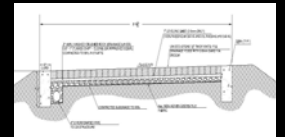


INTERLOCKING CONCRETE PAVERS

Example Project



Residential Driveway, Bellingham, WA



REINFORCED GRASS PAVEMENT

Example Project

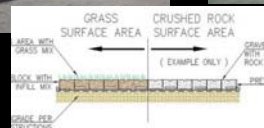


REINFORCED GRASS PAVEMENT

Example Project



Bayview Corner, Whidbey Island, WA



REINFORCED GRASS PAVEMENT

Example Project

Reinforced Grass Pavement
Fire Truck Access



Microsoft Campus, Redmond, WA

REINFORCED GRASS PAVEMENT

Example Project



REINFORCED GRASS PAVEMENT

Example Project



Boundary Bay Brewery, Bellingham, WA

POROUS GRAVEL PAVEMENT

"Gravel Pave 2"



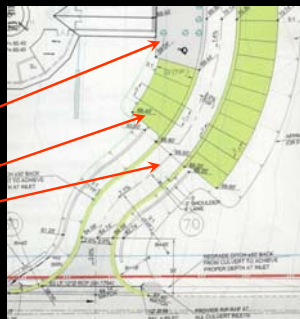
ADA Accessible Trail

POROUS PAVEMENTS

Impervious Surface Reduction Strategies

Pulling it all together...

- > EcoStone handicap parking and building entrance area
- > Grass parking stalls
- > Porous concrete road & parking



PERVIOUS PAVEMENT

Operation and Maintenance

Regular sweeping and cleaning



LOW-IMPACT DEVELOPMENT

Example Project (4 lot subdivision)

L.I.D. Techniques Used:

- Porous Pavement
- Compost Amended Soil
- Raingardens



Rivendell Plat, Whatcom County, Bellingham, WA

LOW-IMPACT DEVELOPMENT

Example Project (4 lot subdivision)



Large Raingarden for handling street run-off



Rivendell Plat, Whatcom County, Bellingham, WA

LOW-IMPACT DEVELOPMENT

Example Project (270 lot resort development)

L.I.D. Techniques Used:

- Porous Pavement
- Compost Amended Soil
- Raingardens



Roche Harbor, San Juan County, WA

LOW-IMPACT DEVELOPMENT

Example Project (270 lot resort development)

Each home site handles stormwater...

- Raingarden Planter Box
- Compost Amended Soils
- Raingarden
- Pervious Pavement



LOW-IMPACT DEVELOPMENT

Example Project (270 lot resort development)

- Raingarden
 - For Handling Parking & Street Run-off
- Raingarden Planting Strips
 - For Handling Street Edge Run-off



Roche Harbor, San Juan County, WA

LOW-IMPACT DEVELOPMENT

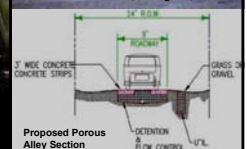
Example "Country Lane" sections



City of Vancouver BC Country Lane Alley Program



Residence, Bellingham, WA



Proposed Porous Alley Section

LOW-IMPACT DEVELOPMENT

Example Project (Municipal Community Center)

- 75,000 sf community center on 10.5 acres
- 100,000sf of porous concrete
- Raingardens
- Infiltration of roof water
- No curbs
- No catch basins
- Pool-water re-use for toilet flushing



Firstenberg Community Center, City of Vancouver, WA

THANK YOU...

Questions



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