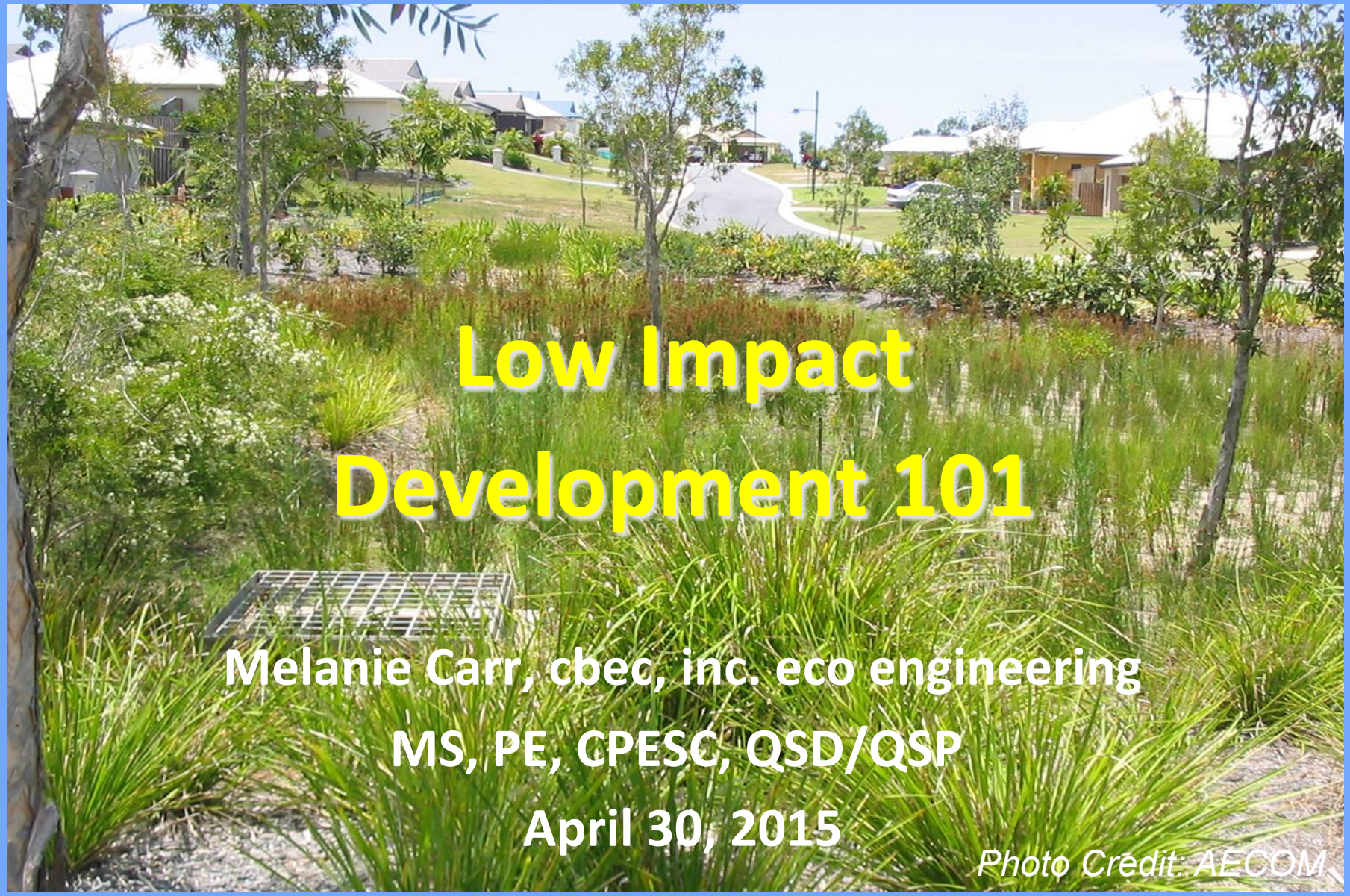


Low Impact Development 101

Melanie Carr, cbec, inc. eco engineering

MS, PE, CPESC, QSD/QSP

April 30, 2015

Photo Credit: AECOM

LID 101 Overview

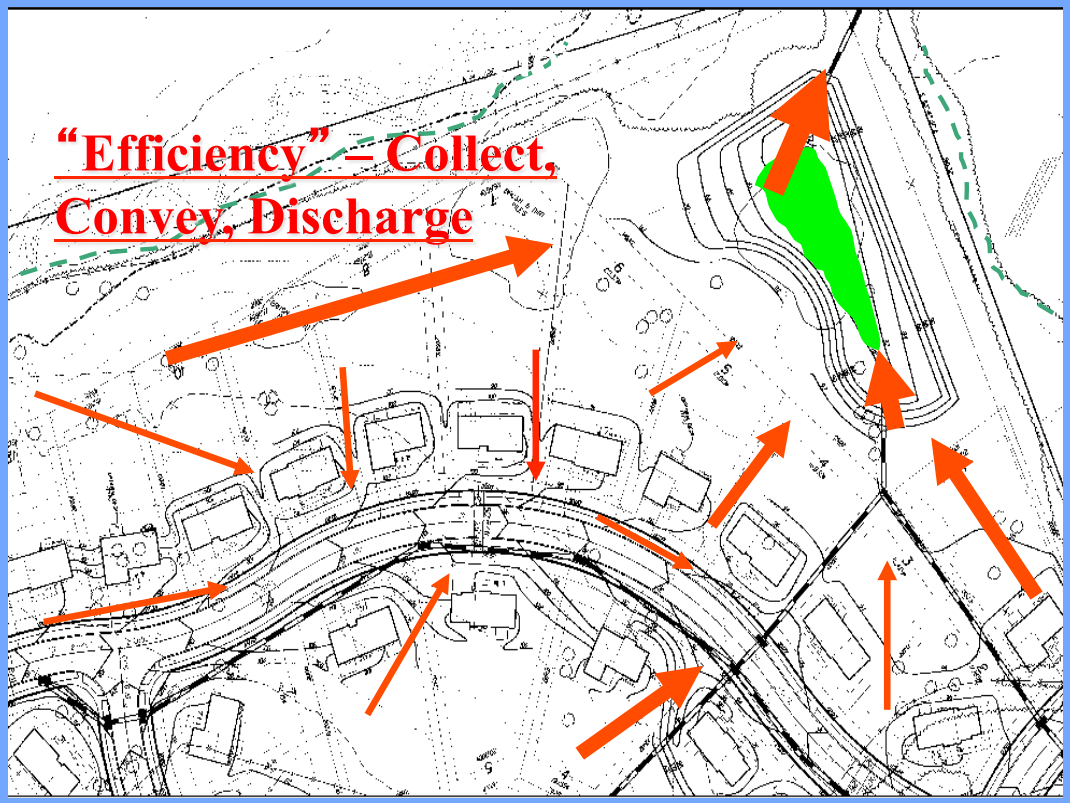
- What is LID?
- Why is LID important?
- LID philosophy, principles, benefits
- Examples of Site Design and Bioretention
- LID National & Statewide context

What is LID? Definition

- **Low Impact Development (LID)**: A total site design approach that conserves and uses existing natural site features and systems integrated with distributed, small-scale stormwater management controls (BMPs) to mimic or recreate the natural water balance for a site.

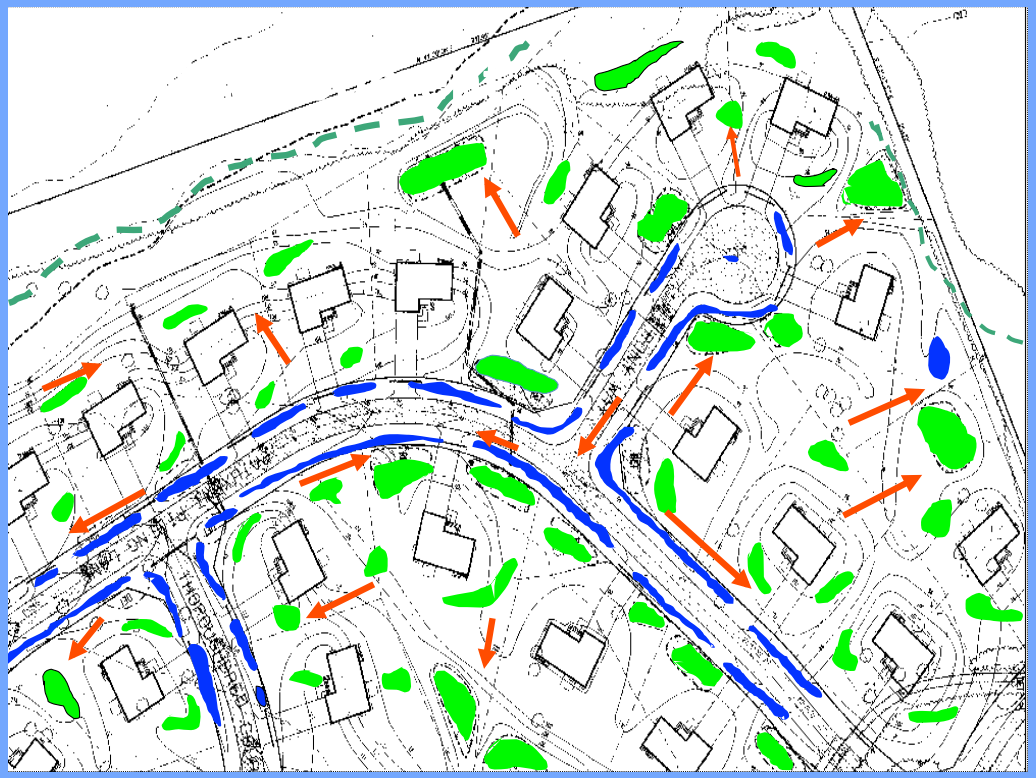
Conventional Stormwater (Old) Approach

- Collect, convey, detain large volumes of stormwater



Low Impact Development (New) Approach

- What is LID?
  - Small-scale, mimics nature
  - Capturing, treating, infiltrating stormwater
  - Disconnected flowpaths, “Slow the Flow”



LID Applicability

- LID can be applied at various scales

Watershed

Neighborhood

Site

Applying LID

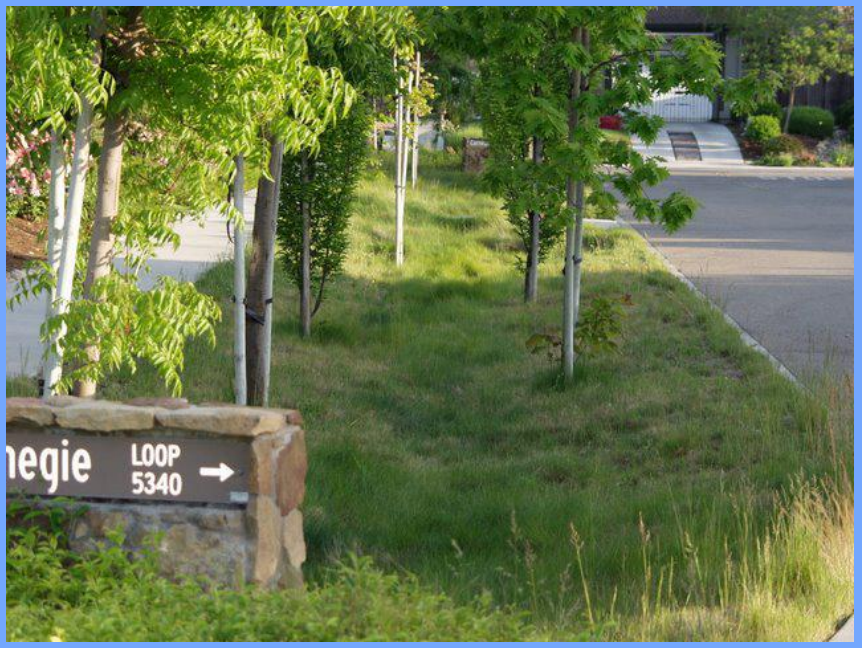
- Watershed/Community-Scale (riparian buffers, smart growth, livable communities)

Image Courtesy of Laguna Creek Watershed Council: http://www.lagunacreek.org/

Applying LID

- Neighborhood-Scale

(green streets, green parking, ponds and wetlands)



Applying LID

LID can be applied to different land use types at various scales:

- Lot-Scale (planters, rain gardens, green roofs, swales, permeable pavements, etc.)

Photo credit: Tahoe RCD

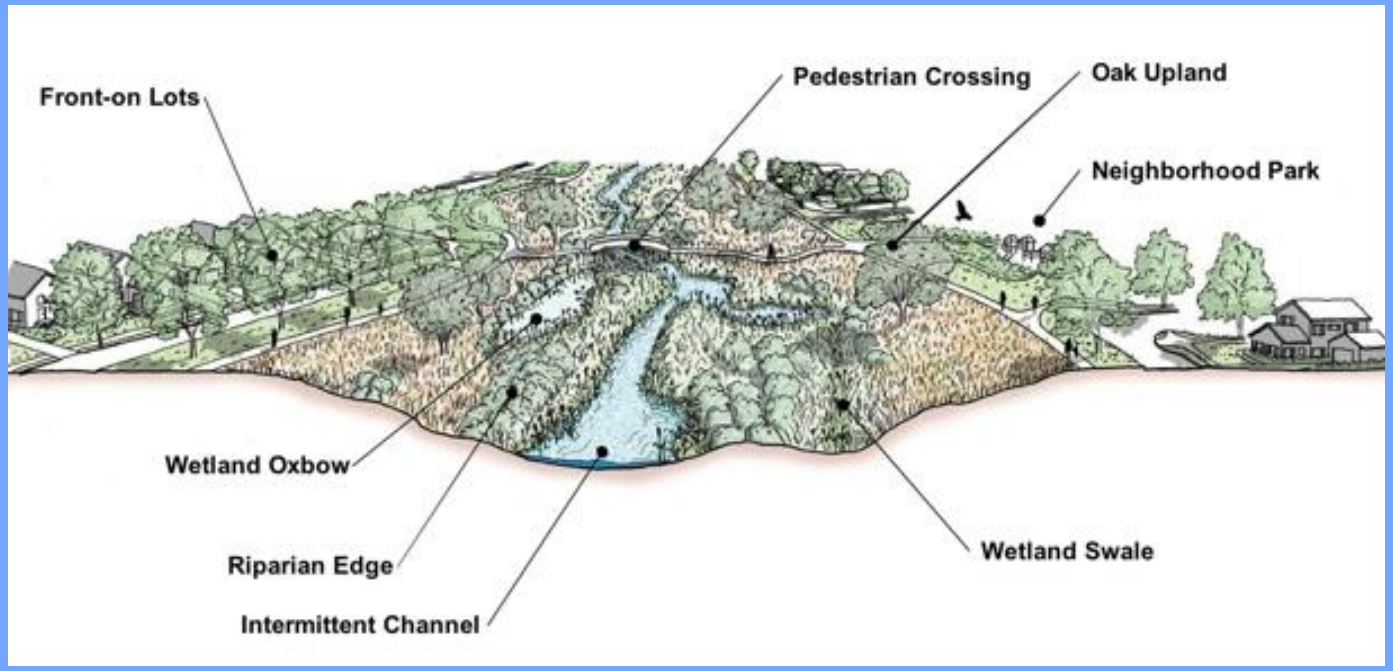
River Friendly Landscaping. org

Applying LID

LID can work for:

- New development
- Infill/redevelopment
- Retrofits

http://cfpub1.epa.gov/npdes/greeninfrastructure/

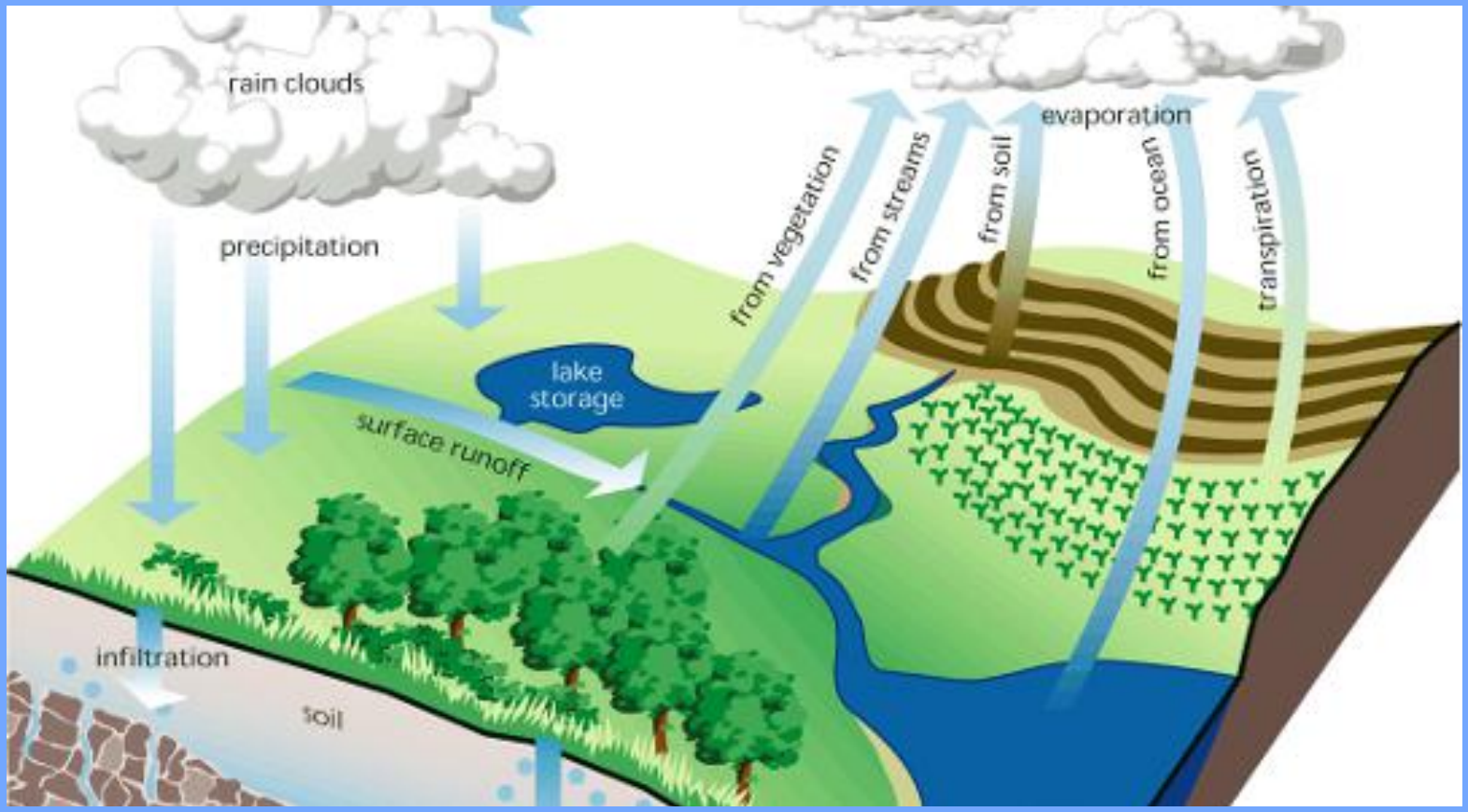


Infill and Redevelopment Projects

- Infill and redevelopment projects are complex because:
  - Sites typically have constrained open space
  - Topography is constrained
  - Service infrastructure is constrained and may limit excavation depths for infiltration
  - Projects are typically more costly than new developments

Why is LID important?

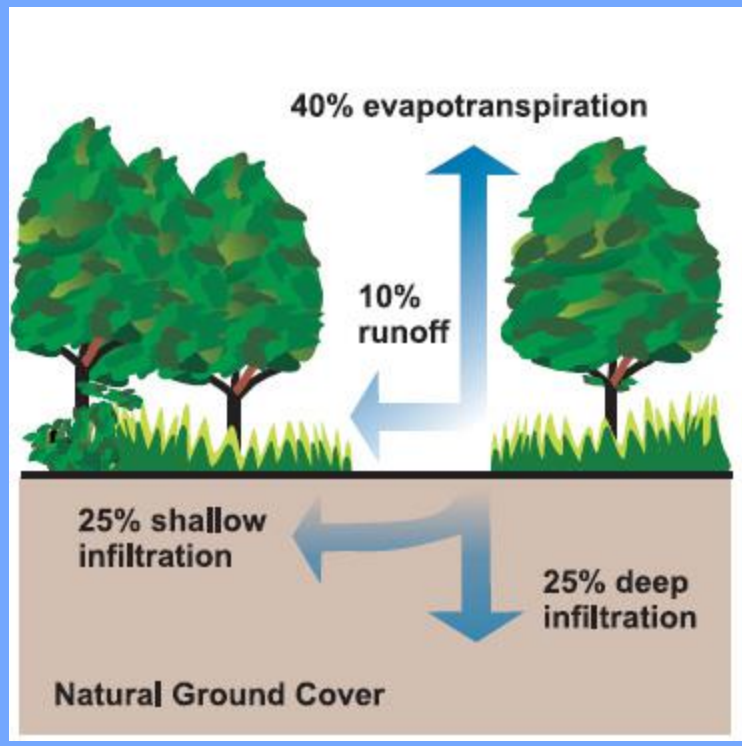
In order to show how LID is important, we must first look at the effects of development on hydrology and stormwater runoff.



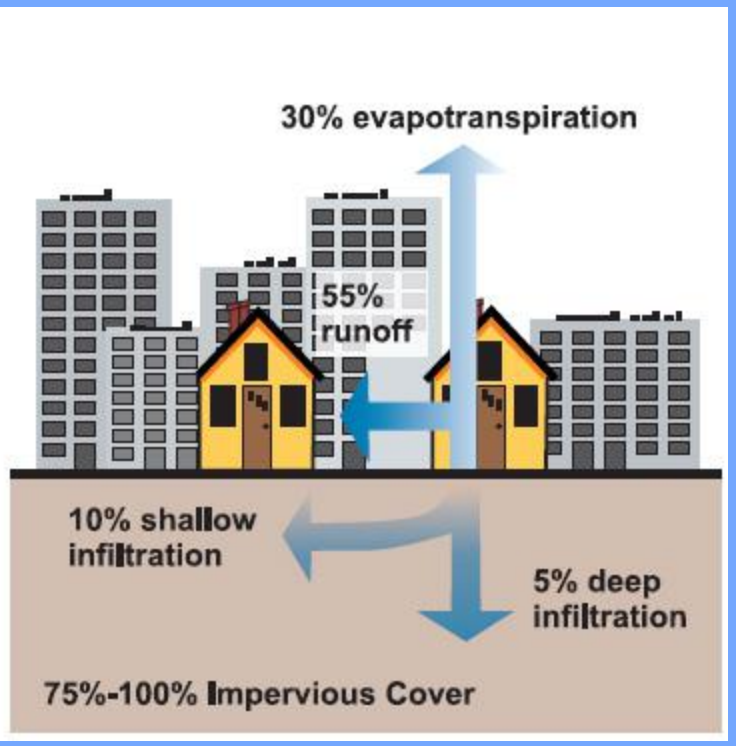
Hydrologic Cycle

What is the problem?

Pre-Development Hydrologic Function



Post-Development Hydrologic Function



USEPA

What is the problem?

Urbanization tends to increase stormwater runoff:

- Peak flows
- Volume
- Frequency

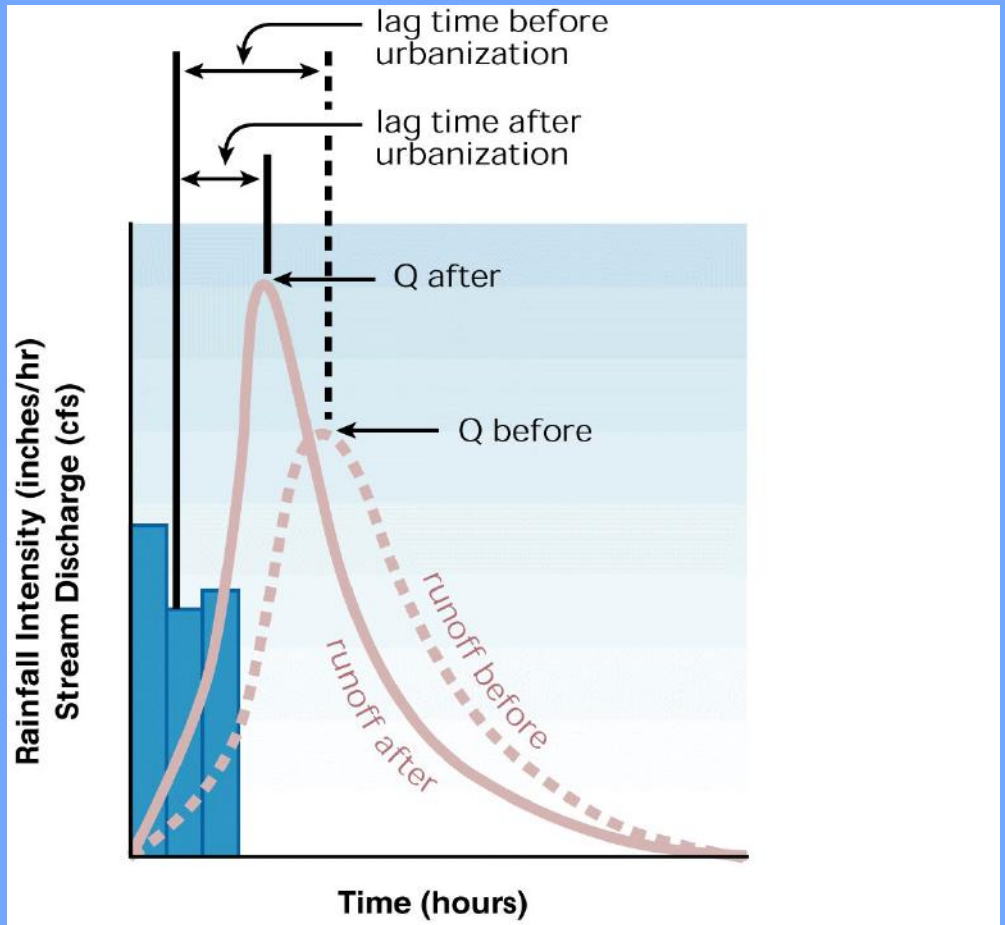
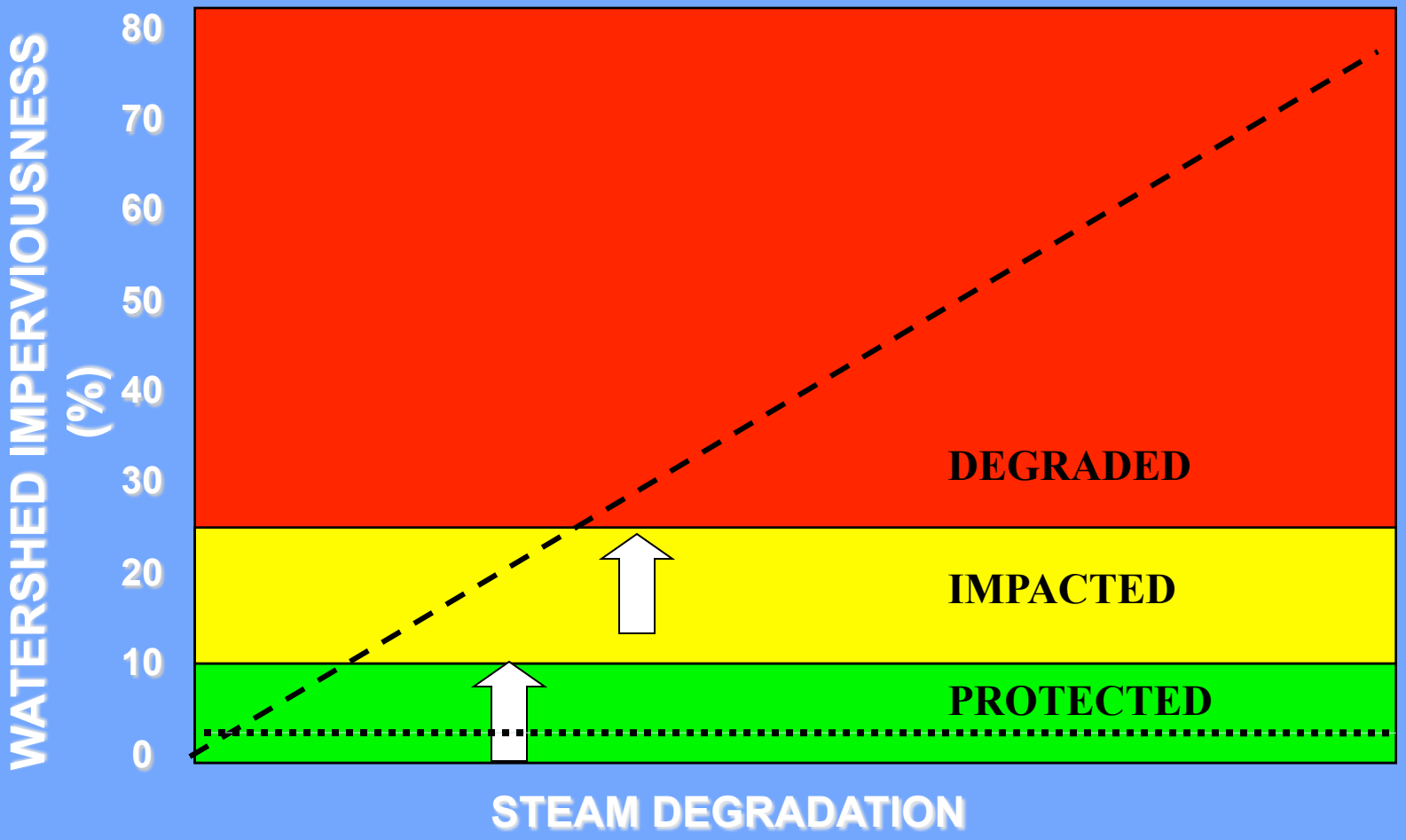


Fig. 1.15 -- A comparison of hydrographs before and after urbanization. The discharge curve is higher and steeper for urban streams than for natural streams.
In Stream Corridor Restoration: Principles, Processes, and Practices (10/98).
Interagency Stream Restoration Working Group (15 federal agencies)(FISRWG).

What is the problem?



ADAPTED FROM SCHUELER, ET. AL., 1992, 2006

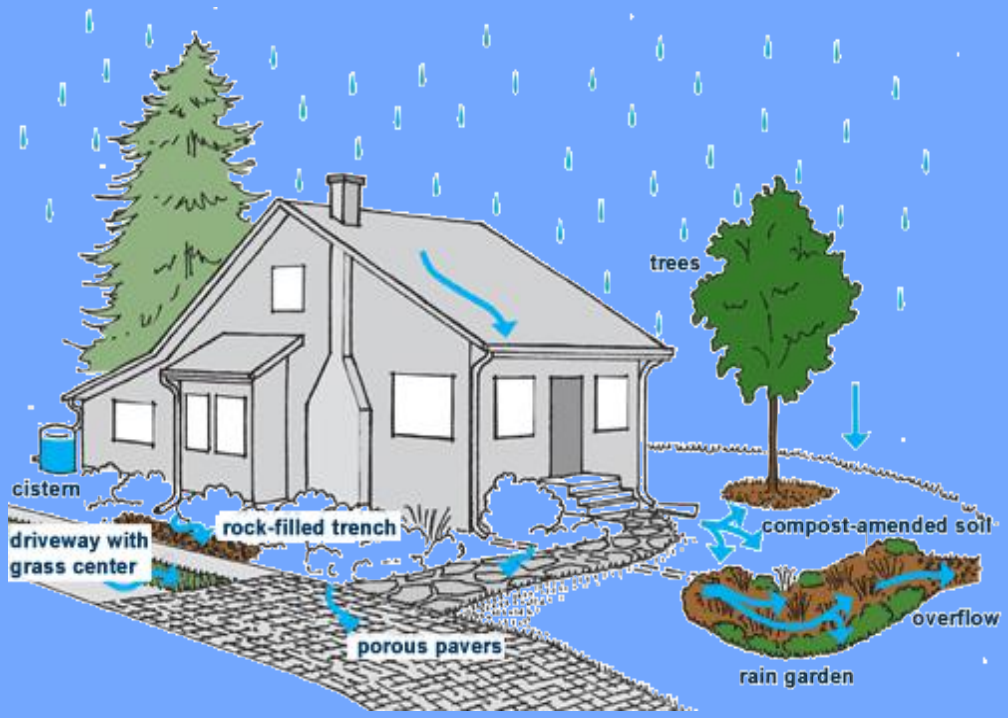
How does LID address the problem?

- Consider main components of stormwater runoff:
  Volume, Flow Path, Timing, Water Quality

  - Volume: Reduces runoff volume via local detention and infiltration by increasing channel roughness
  - Flow Path: Increases length of runoff flow path by disconnecting flow paths (rain spouts, etc.)
  - Timing: Increases localized infiltration, which results in increased time to peak flows
  - Water Quality: Increases sedimentation, filters runoff, and improves water quality in the receiving stream

LID Philosophy

- Stormwater:
  - –Evaporate
  - –Detain
  - –Infiltrate
  - –Treat



LID Principles

- Multi-Disciplinary Process
- Incorporate Site Design Measures
- Incorporate Bioretention

Multi-Disciplinary Process

- Need input from entire design team: Urban Planner, Architect, Civil Engineer, Hydrologist, Geologist, Biologist, and Landscape Architect early in the process as the footprint is being determined

- Involve additional specialties (e.g., ecologist, water quality specialist, geomorphologist) if sensitive habitat resources

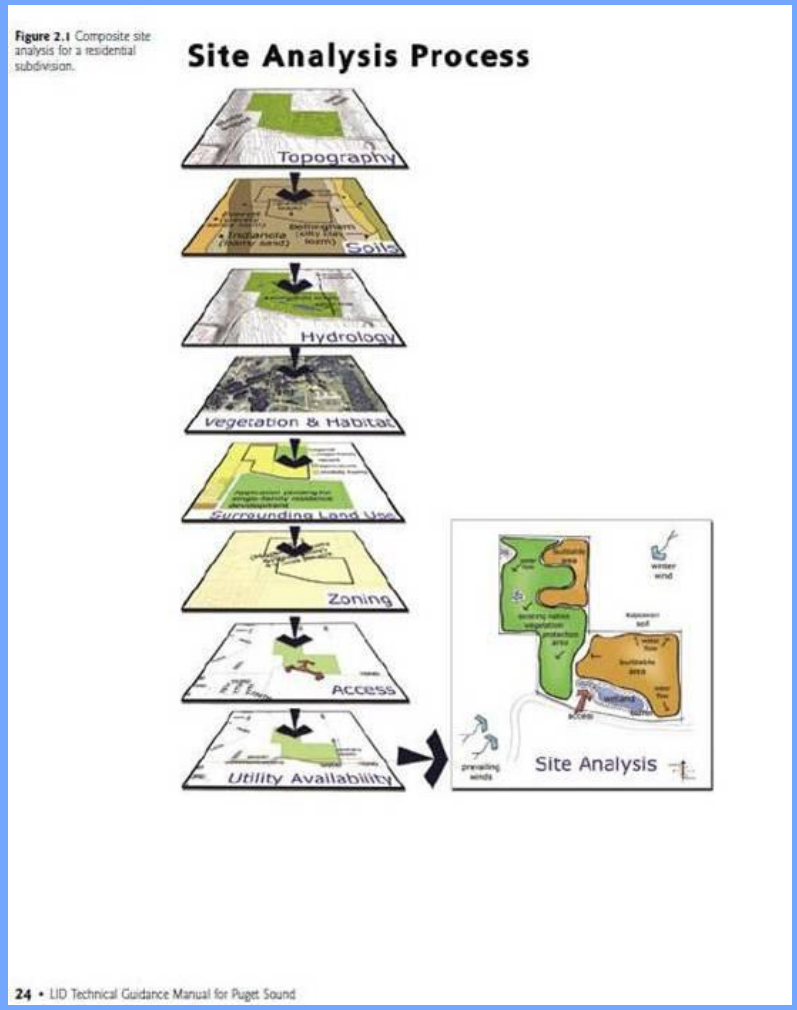
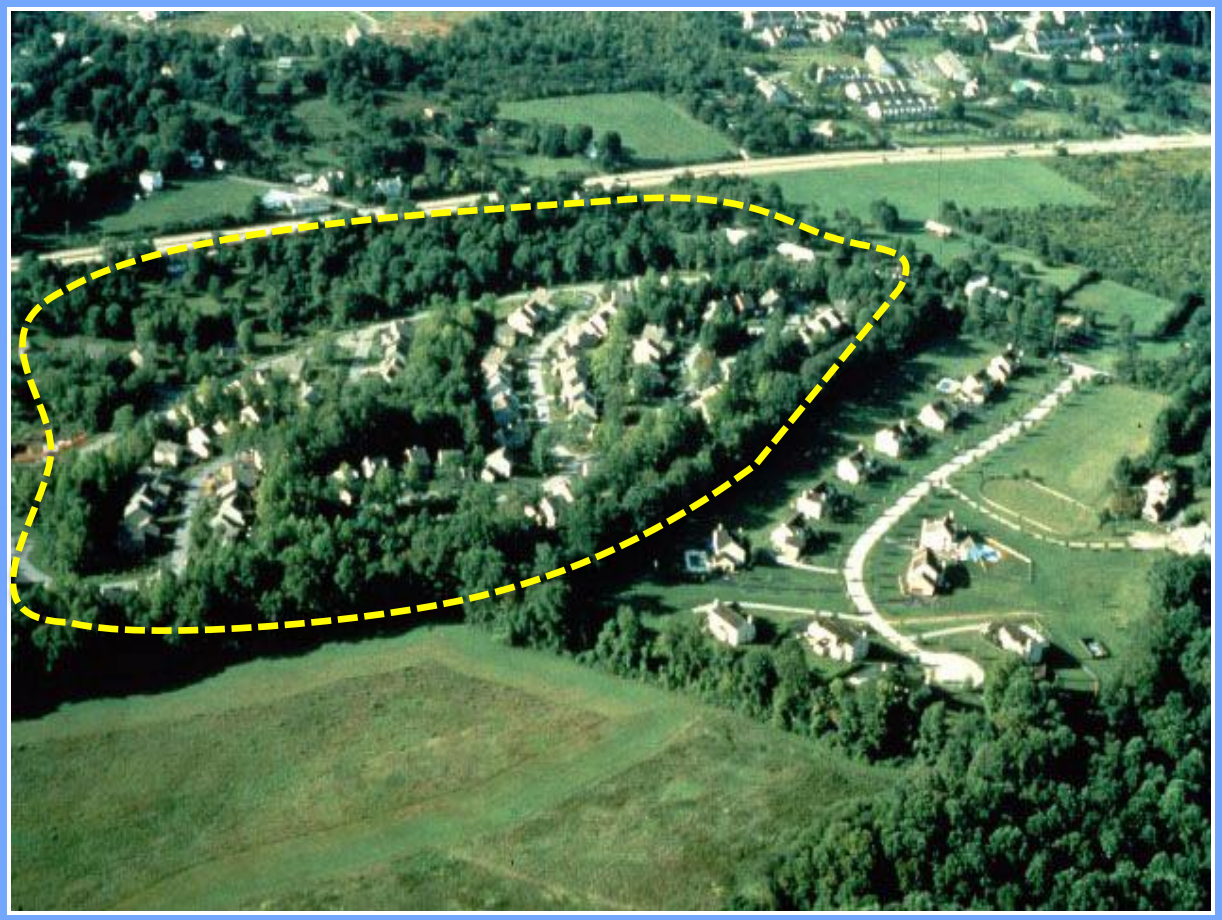


Figure 2.1 Composite site analysis for a residential subdivision.

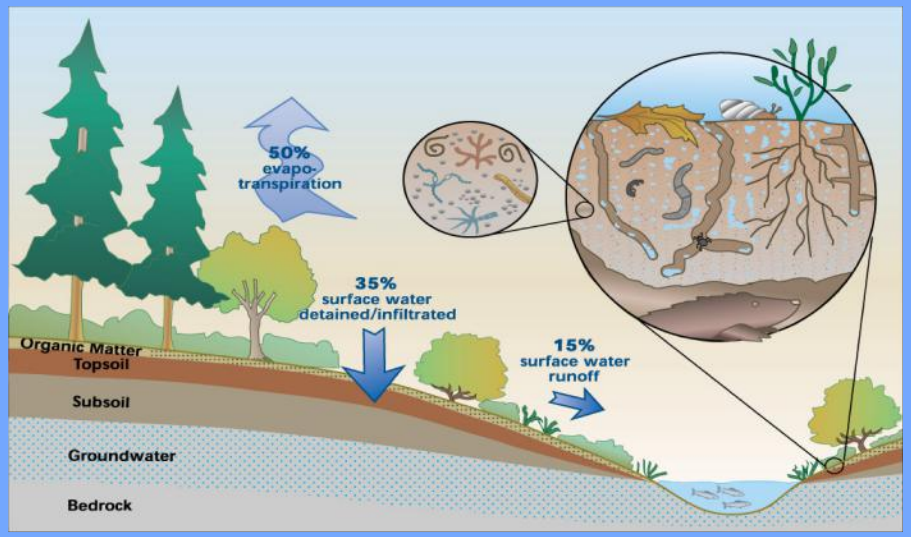
Site Design Measures

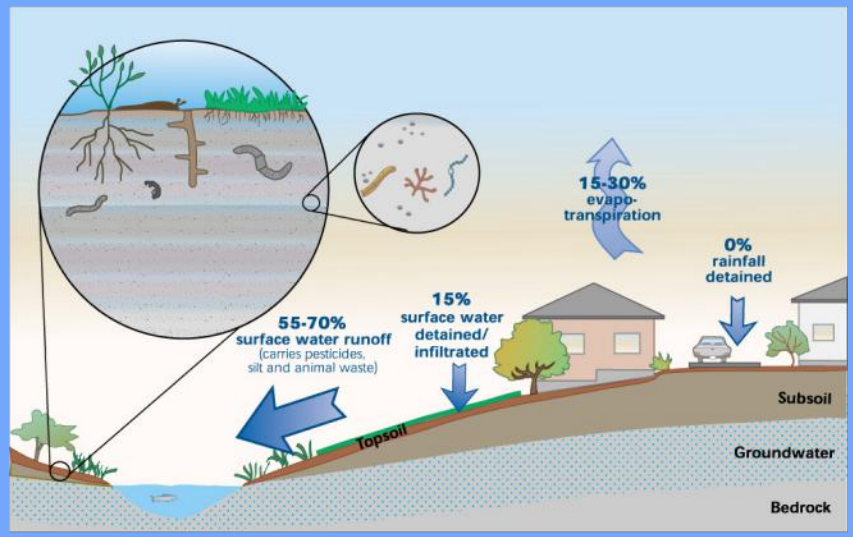
- Stream Setbacks and Buffers
- Soil Quality Improvement and Maintenance
- Tree Planting and Preservation
- Rooftop and Impervious Area Disconnection
- Porous Pavement
- Green Roofs
- Vegetated Swales
- Rain Barrels and Cisterns
- Dry Wells

Stream Setbacks and Buffers



Soil Quality Improvement and Maintenance



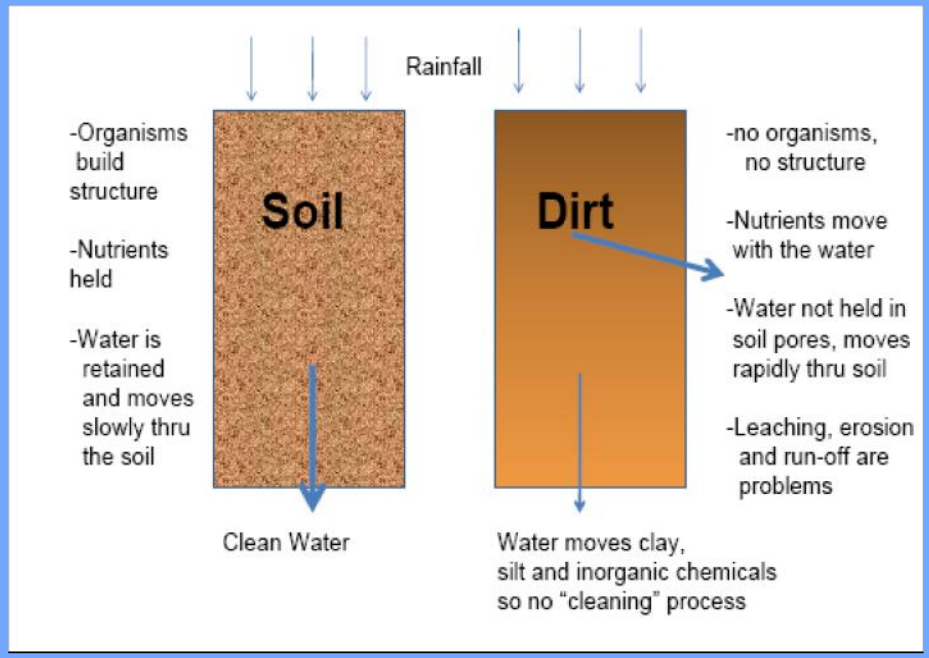


Soil Biology Primer (http://soils.usda.gov)

River-friendly landscaping guidelines (www.riverfriendly.org)

California Native Plant Society (www.cnps.org)

Sustainable Landscape Construction—A Guide to Green Building Outdoors By J. William Thomson and Kim Sorvig



Tree Planting and Preservation

- Preserve Existing Trees in Place
- Install Interceptor Trees

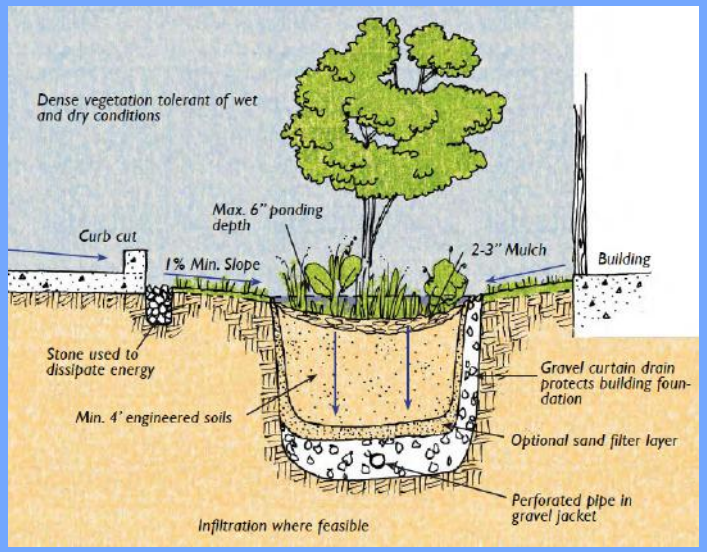
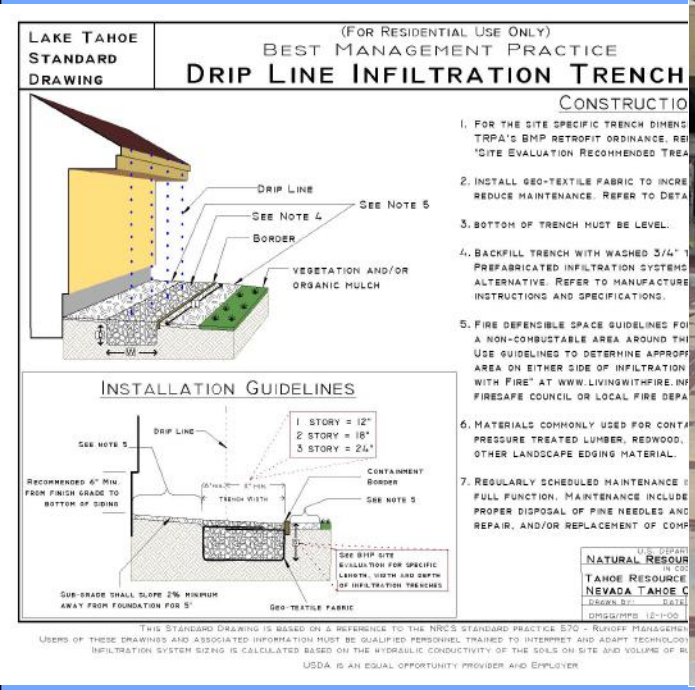


Photo Credit: AECOM

Flow Path and Impervious Area Disconnection

- Disconnect flow path – Curb Cuts
- Disconnect impervious area - Infiltration Trench


LAKE TAHOE STANDARD DRAWING

(FOR RESIDENTIAL USE ONLY)

BEST MANAGEMENT PRACTICE

DRIP LINE INFILTRATION TRENCH

CONSTRUCTIO

1. FOR THE SITE SPECIFIC TRENCH DIMENS TRPA'S BMP RETROFIT ORDINANCE, REI "SITE EVALUATION RECOMMENDED TREA
2. INSTALL GEO-TEXTILE FABRIC TO INCRE REDUCE MAINTENANCE. REFER TO DETA
3. BOTTOM OF TRENCH MUST BE LEVEL.
4. BACKFILL TRENCH WITH WASHED 3/4" PREFABRICATED INFILTRATION SYSTEMS ALTERNATIVE. REFER TO MANUFACTURE INSTRUCTIONS AND SPECIFICATIONS.
5. FIRE DEFENSIBLE SPACE GUIDELINES FO A NON-COMBUSTABLE AREA AROUND THI USE GUIDELINES TO DETERMINE APPROPR AREA ON EITHER SIDE OF INFILTRATION WITH FIRE" AT WWW.LIVINGWITHFIRE.INF FIRESAFE COUNCIL OR LOCAL FIRE DEPA
6. MATERIALS COMMONLY USED FOR CONTA PRESSURE TREATED LUMBER, REDWOOD, OTHER LANDSCAPE EDGING MATERIAL.
7. REGULARLY SCHEDULED MAINTENANCE FULL FUNCTION. MAINTENANCE INCLUDE PROPER DISPOSAL OF PINE NEEDLES AND REPAIR, AND/OR REPLACEMENT OF COMP

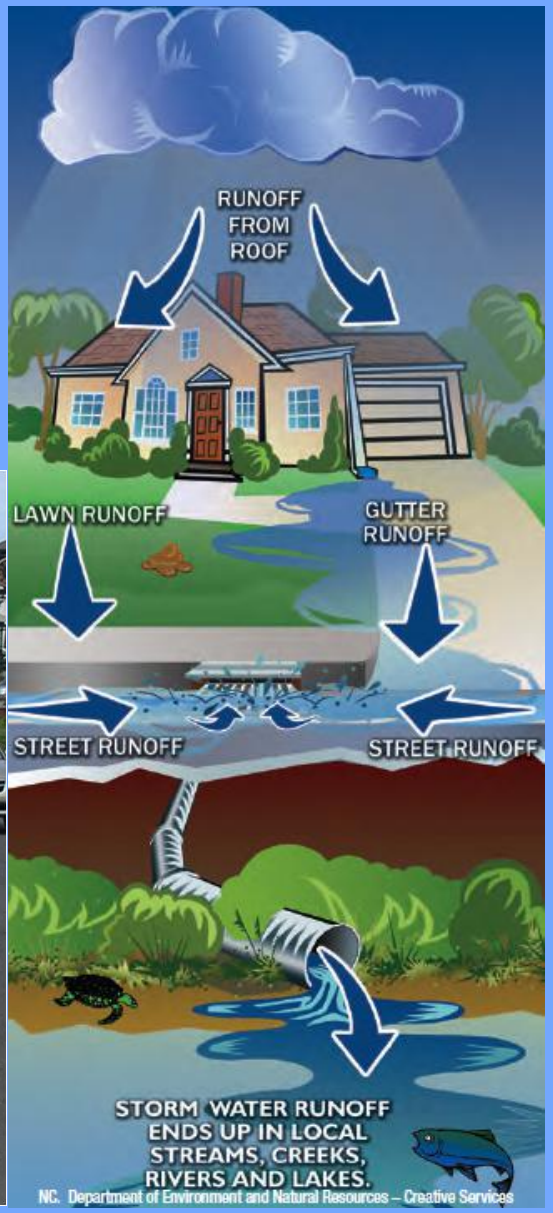
DRIP LINE
SEE NOTE 4
SEE NOTE 5
BORDER
VEGETATION AND/OR ORGANIC MULCH

INSTALLATION GUIDELINES

DRIP LINE
SEE NOTE 5
1 STORY = 12"
2 STORY = 18"
3 STORY = 24"
CONTAINMENT BORDER
SEE NOTE 5
RECOMMENDED 6" MIN. FROM FINISH GRADE TO BOTTOM OF SIDING
TRENCH WIDTH
SEE BMP SITE EVALUATION FOR SPECIFIC LENGTH, WIDTH AND DEPTH OF INFILTRATION TRENCHES
SUB-GRADE SHALL SLOPE 2% MINIMUM AWAY FROM FOUNDATION FOR 5'
GEO-TEXTILE FABRIC

NATURAL RESOUR
TAHOE RESOURCE
NEVADA TAHOE C
DRAWN BY: DATE:
DMSS/MPS 12-1-00

THIS STANDARD DRAWING IS BASED ON A REFERENCE TO THE NRCS STANDARD PRACTICE 570 - RUNOFF MANAGEMEN
USERS OF THESE DRAWINGS AND ASSOCIATED INFORMATION MUST BE QUALIFIED PERSONNEL TRAINED TO INTERPRET AND ADAPT TECHNOLOG
INFILTRATION SYSTEM SIZING IS CALCULATED BASED ON THE HYDRAULIC CONDUCTIVITY OF THE SOILS ON SITE AND VOLUME OF R
USDA IS AN EQUAL OPPORTUNITY PROVIDER AND EMPLOYER



Pervious Pavement

Benefits:

- Reduce peak impacts
- Often unrecognized
- Moderate to good infiltration capacity
- Good pollutant removal

Drawbacks:

- Difficult to install
- Greater excavation – higher costs
- Clogging can be an issue

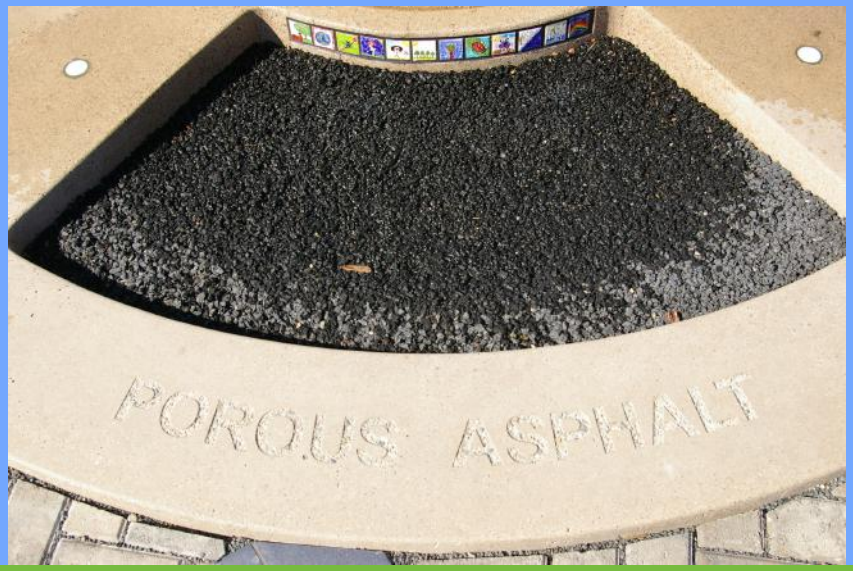
http://www.hotmix.org/index.php

http://www.stormwatercenter.net

http://www.co-asphalt.com

Pervious Pavement

- Elk Grove, CA



Green Roofs

- Green Roof, San Francisco (California Academy of Sciences)

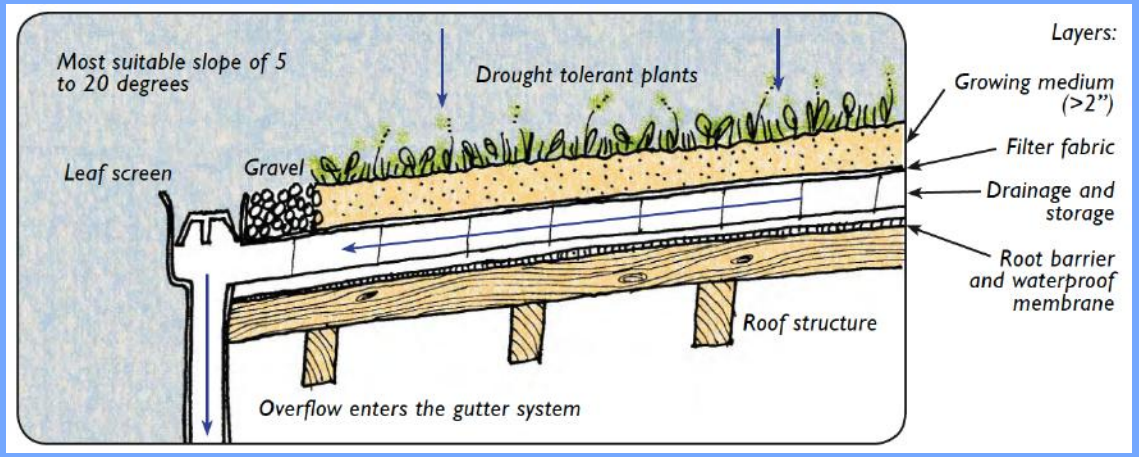
Green Roofs

Benefits:

- Reduce impervious area
- Reduce peak impacts
- Increase insulation
- Aesthetically pleasing

Drawbacks:

- Specialist construction costs high
- Susceptibility to leakage
- Requires greater roof strength



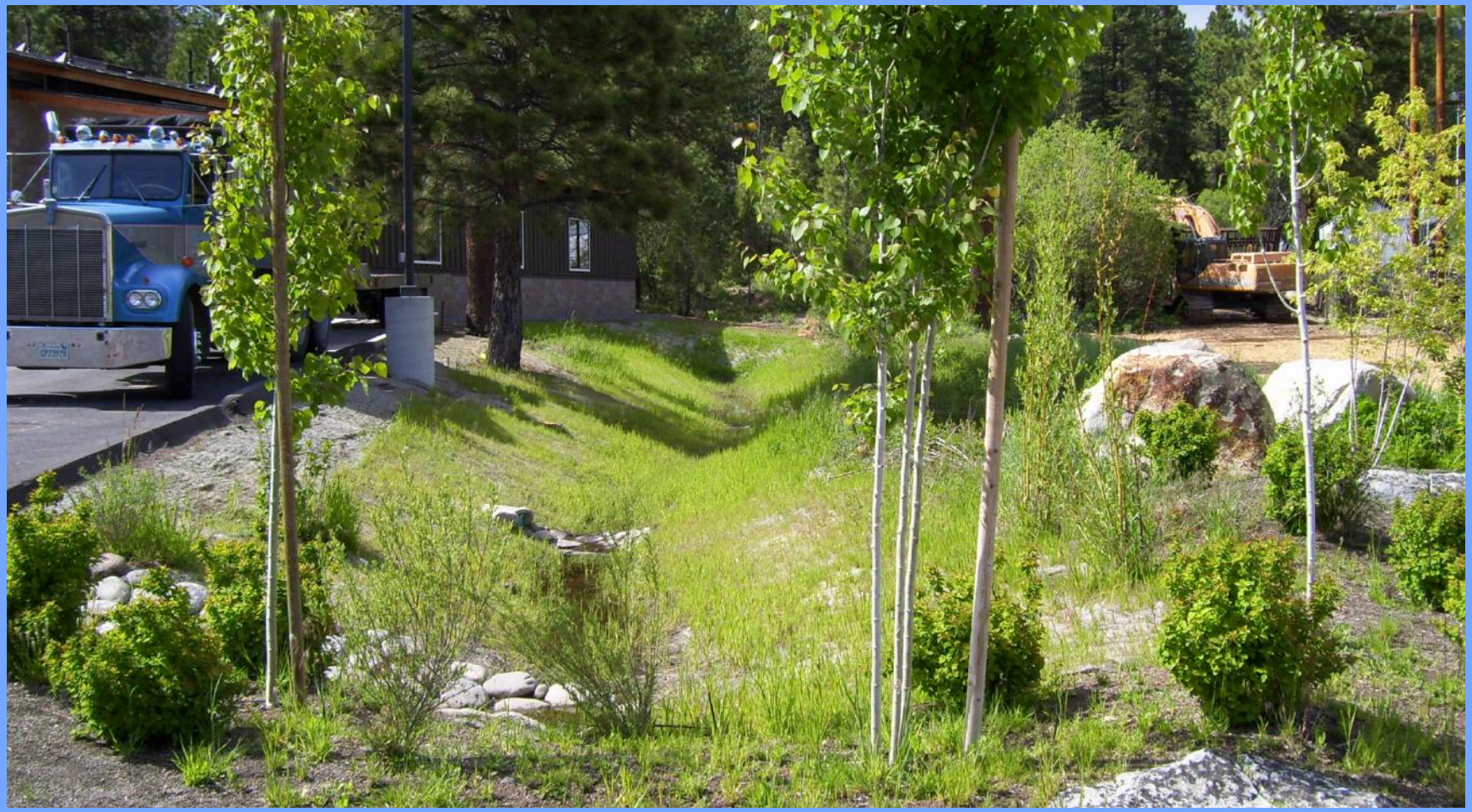
AECOM, 2007

Vegetated Swales

- Provide water quality treatment through filtration
- Increase groundwater recharge through infiltration
- Reduce peak discharge rates and total runoff volume
- Provide a location for temporary water storage

Vegetated Swales

Vegetated Swales

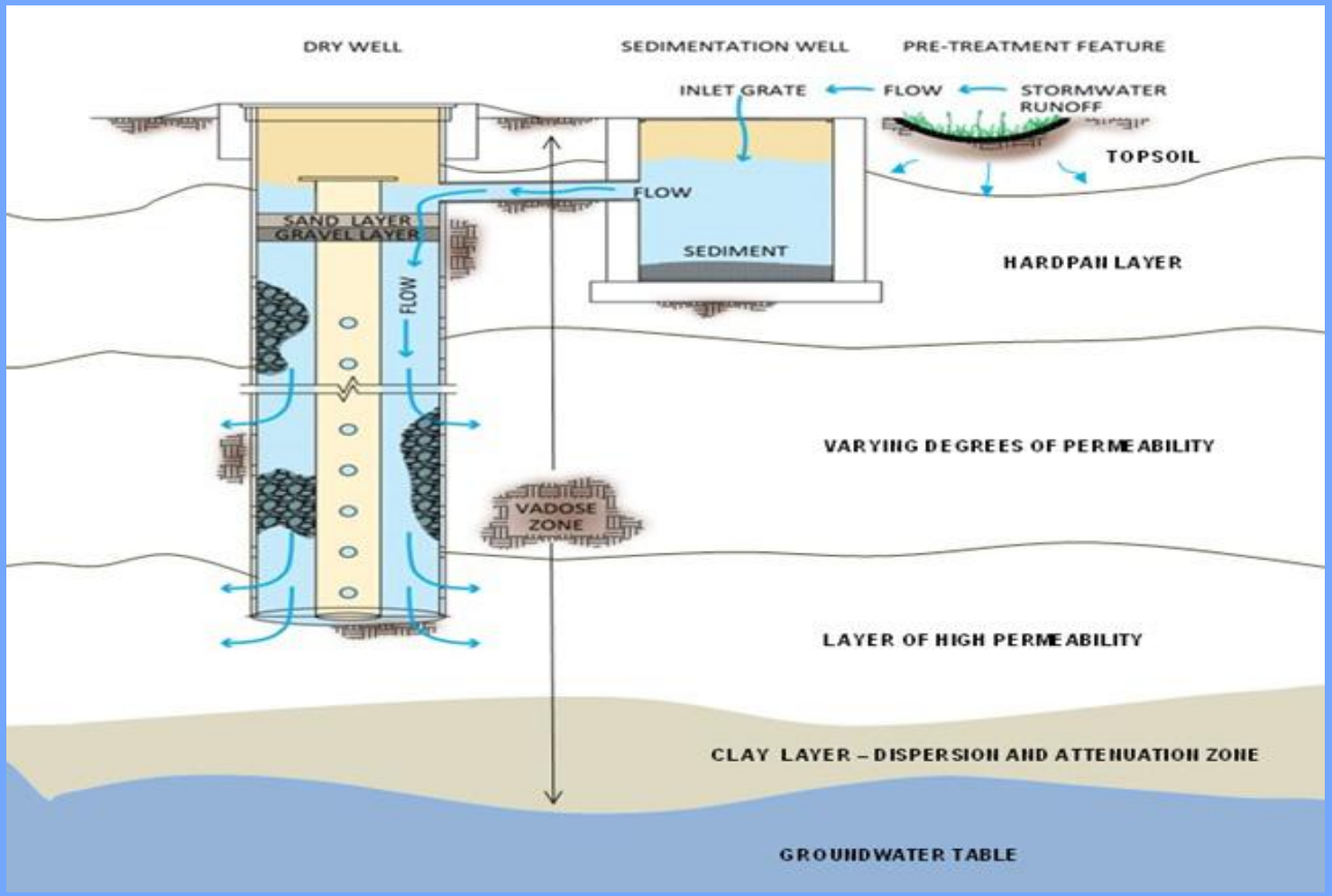


Rain Barrels and Cisterns-Water Harvesting

Dry Wells

- Promote infiltration of stormwater runoff to recharge groundwater
- Receives water from one or more entry points
- Collect, store and disburse water
- Discharges water through small openings
- Bottom of dry well is placed at permeable soils
- Local Examples: City of Modesto, City of Elk Grove

Dry Wells


DRY WELL
SEDIMENTATION WELL
PRE-TREATMENT FEATURE
INLET GRATE
FLOW
STORMWATER RUNOFF
TOPSOIL
FLOW
SAND LAYER
GRAVEL LAYER
SEDIMENT
HARDPAN LAYER
FLOW
VARYING DEGREES OF PERMEABILITY
VADOSE ZONE
LAYER OF HIGH PERMEABILITY
CLAY LAYER – DISPERSION AND ATTENUATION ZONE
GROUNDWATER TABLE

Dry Well Construction

- Elk Grove, CA

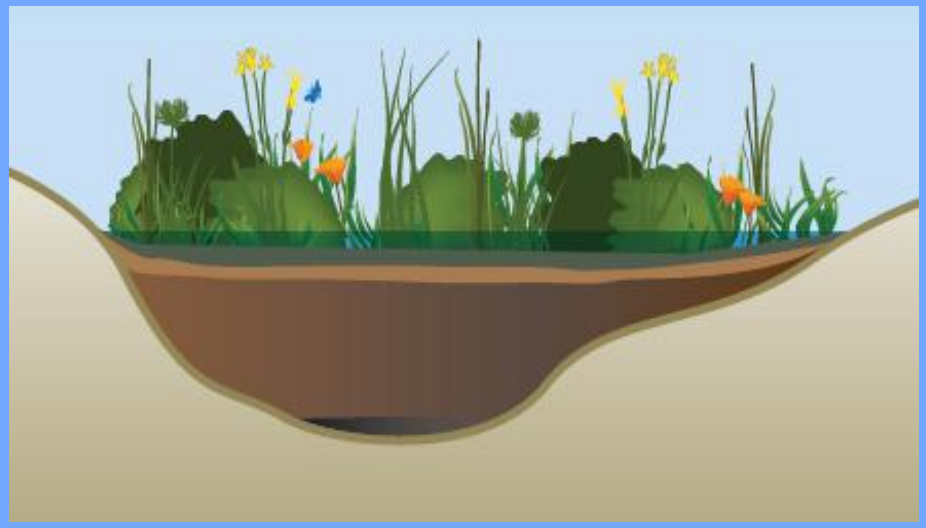
Bioretention-LID Powerhouse

Benefits:

- Good pollutant removal
- Reduce peak impacts
- Aesthetically pleasing
- Moderate to good infiltration capacity

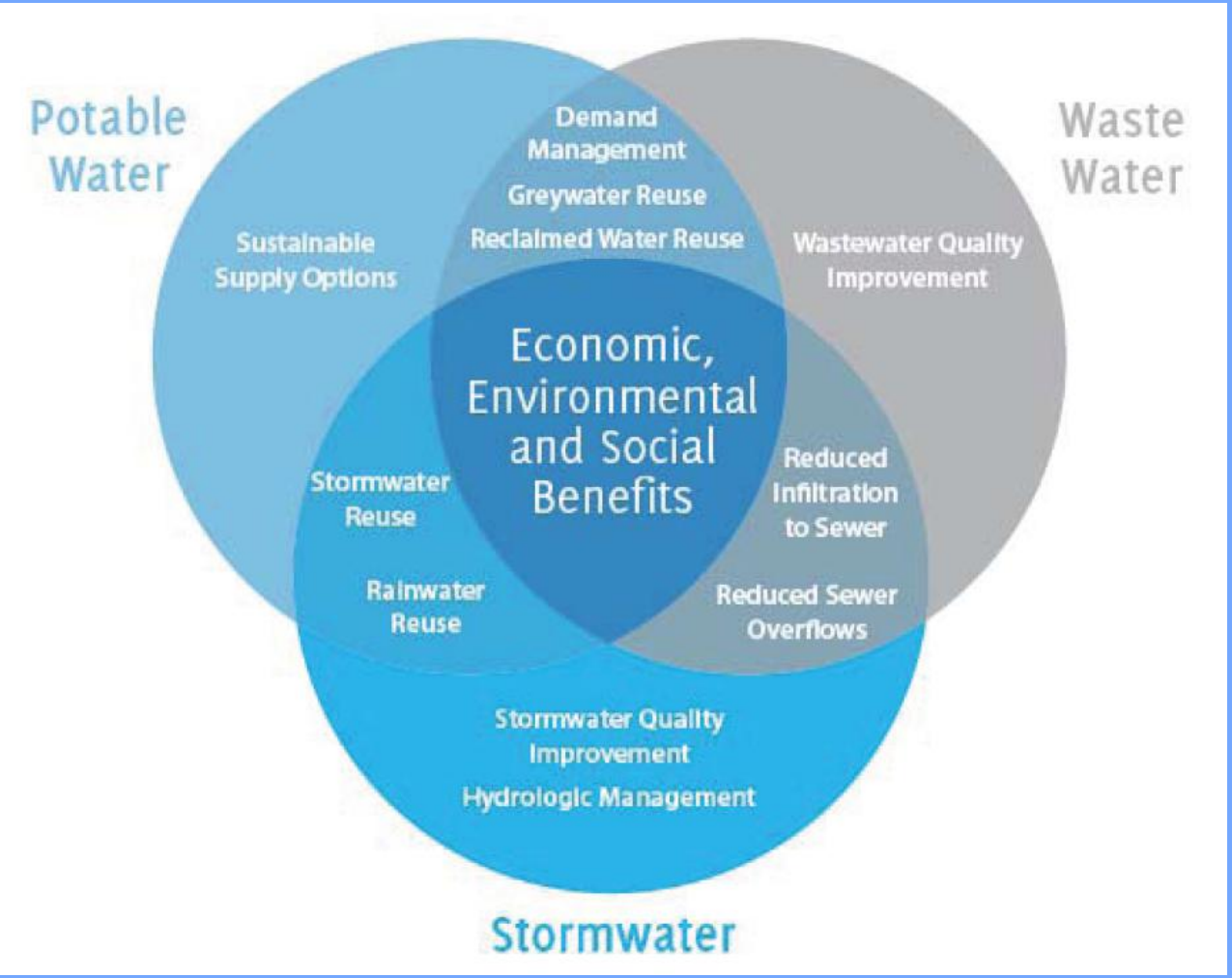
Drawbacks:

- Maintenance cost high
- Landscape workers may need additional training
- Can become unsightly if not maintained
- Possible pollutant loading



Rain Garden

What are the Benefits of LID?



Water Sensitive Urban Design (WSUD), AECOM 2009

Developers/ Builders Benefits

- Reduces land clearing and grading costs
- Reduces infrastructure costs (streets, curbs, gutters, sidewalk)
- Reduces stormwater management costs
- Increases lot yields
- Increases lot and community marketability

Municipality Benefits

- Protects regional flora and fauna
- Balances growth needs with environmental protection
- Reduces municipal infrastructure and utility maintenance costs (streets, curbs, gutters, sidewalks, storm sewers)
- Helps satisfy environmental regulations related to water quality and climate change
- Potentially reduces localized flooding
- Fosters public/private partnerships

Property Owner Benefits

- Preserves and protects amenities that can translate into higher value, more marketable homes and livable communities
- Reduces energy demand and costs due to temperature regulating trees and vegetation
- Potentially reduces localized flooding
- Protects water quality – public health benefit
- Reduces infrastructure costs which can be passed onto property owners
- Compliance with stormwater regulations
- Improved public relations associated with implementing green building strategies

Environmental Benefits

- Preserves integrity of ecological and biological systems
- Protects site and regional water quality by reducing sediment, nutrient, and toxic loads to water bodies
- Reduces impacts to local terrestrial and aquatic plants and animals
- Preserves trees and natural vegetation
- Reduces demands on water supply and encourages natural groundwater recharge

Impediments to LID?

- **Institutional Barriers:** Policies and codes may be outdated
- **Limited Data:** Capital and maintenance costs, performance
- **Public Perception:** "Too expensive", "won't work in tight spaces", "I like my grass", etc.
- **Agency Perception:** Fire responders, maintenance managers, etc.
- **Engineers' Perception:** Proximity to foundations, water under roads

Overcome impediments by providing education and information on LID!

National / Statewide Context

- National Context
  - East Coast
  - PNW
  - Midwest
  - Arid Southwest
- Statewide (CA) Context
  - Southern California
  - Central Coast
  - Bay Area

Questions?

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