Rainwater BMPs: Plants, Soil, Irrigation & Regulation

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Rainwater Best Management Practices

- Rain Gardens
- Bioretention areas
- Green Roofs

- Dry Wells
- Permeable Pavement
- Infiltration Pits
- Rain Barrels
- Cisterns
- Downspout filters
- Constructed Wetlands

Regulatory Standards, Guidelines, Codes, Statutes

- International Association of Plumbing and Mechanical Officials, IAPMO, *Water Efficiency and Sanitation Standard* (WE Stand), http://www.iapmo.org/, chapters on rainwater and stormwater (alternate onsite water) standards
  - Provides standards for the construction, alteration and repair of nonpotable rainwater catchment systems
  - Reference table for testing, inspection and maintenance frequency
  - Cross-connection
  - Minimum Water quality standards
- International Codes Council, ICC, https://www.iccsafe.org/, should have recently passed a rainwater collection and use standard
  - Plumbing standards trade groups that oversee plumbing code practices. Covers separate states than IAPMO.
  - Different approval processes for new plumbing standards. IAPMO has its basic rainwater/stormwater standards in place. ICC is developing their standards.

Regulatory Standards, Guidelines, Codes, Statutes

- National Pollutant Discharge Elimination System (NPDES), requirements via a NPDES Permit for treating rainwater and stormwater flowing in the public right-of-way, and dry weather runoff.
- Requirements vary around the country, by state; check with one's local, regional or state water board.
- In Southern California, this Permit requires rainwater and stormwater collection, treatment and onsite use for non-potable uses. https://www.epa.gov/npdes

Regulatory Standards, Guidelines, Codes, Statutes

- Water Infrastructure Improvement Act (H.R. 7279), legislation to H.R. 7279
  - This bill amends the Federal Water Pollution Control Act (commonly known as the Clean Water Act) to allow municipalities to develop a plan that integrates wastewater and stormwater management.
  - Codifies a concept from the Obama administration known as “Integrated Planning,” which can assist communities with meeting their requirements under the Clean Water Act while maintaining their obligation to achieve improvements in local water quality. EPA’s Integrated Planning framework provides communities with a voluntary opportunity to prioritize local clean water investments with the greatest benefit to human health and the environment.
  - The legislation builds on a recent provision that authorized $450 million in stormwater municipal grants to plan, design, and construct stormwater, water recycling, and sewer overflow projects
  - https://www.congress.gov/bill/115th-congress/house-bill/7279
  - https://news.wef.org/water-infrastructure-improvement-act-incorporates-integrated-planning-into-legislation/

Regulatory Standards, Guidelines, Codes, Statutes

- ANSI/ASPE/ARCSA *Rainwater Harvesting Standard 63*, https://www.ansi.org/
- ANSI/ASPE/ARCSA *Stormwater Harvesting Standard 78*, https://www.ansi.org/
- NSF International, standard 350 for alternate water use, http://www.nsf.org/search/search-results/search?keywords=350&XID=b538784f82b832085f0601ea2ec6458ec95f6879&x=0&y=0
- U.S. EPA, *draft National Water Reuse Action Plan*, https://www.epa.gov/waterreuse/water-reuse-action-plan
- Water Environment & Reuse Foundation (WERF), *Final Report, Risk-Based Framework for the Development of Public Health Guidance for Decentralized Non-Potable Water Systems*, https://watereuse.org/; https://watereuse.org/educate/national-blue-ribbon-commission-for-onsite-non-potable-water-systems/
- HarvestH2O, section on rainwater regulations and statutes around the nation, http://www.harvesth2o.com/statues_regulations.shtml
- Los Angeles County Department of Public Health, *Guidelines for Harvesting Rainwater, Stormwater, & Urban Runoff for Outdoor Non-Potable Uses (Matrix 2.0)*, standards for alternate water uses, http://publichealth.lacounty.gov/eh/docs/ep_cross_con_AltWaterSourcesGuideline.pdf

California Law

- ***Statewide Construction Storm Water General Permit*: Stormwater from construction projects that disturb one or more acres of soil, or that disturb less than one acre but are part of a larger common plan of development**, are required to obtain coverage under the statewide General Permit for Discharges of Storm Water Associated with Construction Activity (also referred to as the Construction General Permit or CGP).
- The CGP regulates construction stormwater based on project-specific overall risk. The CGP requires temporary and post-construction best management practices and measures to prevent erosion and reduce sediment and pollutants in discharges from construction sites.

California Law

- ***Statewide Industrial Storm Water General Program***: Industries with stormwater from industrial activity areas are regulated by the Statewide Industrial General Permit.
- The Industrial General Permit requires industry owners to implement the best technology available to reduce pollutants in their stormwater discharges.
- In addition, industrial stormwater dischargers are required to develop a stormwater pollution prevention plan and monitor it in accordance with regulatory levels specified in the statewide permit.
- The Statewide Industrial General Permit regulates over 10,000 industries in California.

California Law

- *2019 California Green Building Standards Code, Title 24, Part 11*
- CHAPTER 4 - RESIDENTIAL MANDATORY MEASURES 4.106.2
- Projects less than 1 acre of soil
  - Retention basins
  - Filter or wattle
  - Compliance with a local ordinance

California Law

- *2019 California Green Building Standards Code, Title 24, Part 11*
- CHAPTER 5 - NONRESIDENTIAL MANDATORY MEASURES 5.106.1
- Projects less than 1 acre of soil
  - Compliance with a local ordinance
  - Best Management Practices (BMP's) (construct in dry weather; preservation of natural features; drainage swales; mulching; hydroseeding; slope erosion control; protect storm drain inlets; perimeter silt fence; sediment trap; stabilized exits; wind erosion control)
  - Good housekeeping BMP's to manage construction equipment, discharges and wastes (dewatering; material handling and waste mngt; stockpile mngt; manage washout areas; control fueling to staging area; off-site cleaning of equipment; spill prevention and control)

California Law

Title 23 Chp 2.7 Model Water Efficient Landscape Ordinance

- Water budget calculations
  - Maximum Applied Water Allowance (MAWA)
  - Stormwater features are not classified as ‘special landscape areas’
- Soil Preparation, Mulch and Amendments
  - Required mulching, friable soils, slope stabilization
- Irrigation
  - In mulched planting areas, low volume irrigation is required as defined by ANSI standard, ASABE/ICC 802-2014. “Landscape Irrigation Sprinkler and Emitter Standard”
- Grading Plan
  - Designed to minimize soil erosion, runoff, and water waste

California Law

Title 23 Chp 2.7 Model Water Efficient Landscape Ordinance

- Strongly recommends that landscape areas be designed for capture and infiltration capacity that is sufficient to prevent runoff from impervious surfaces (i.e. roof and paved areas) from either:
  - the one inch, 24-hour rain event or (2) the 85th percentile, 24-hour rain event,
  - and/or additional capacity as required by any applicable local, regional, state or federal regulation

California Law

Title 23 Chp 2.7 Model Water Efficient Landscape Ordinance

- It is recommended that rainwater (stormwater) projects incorporate any of the following elements:
  - Grade impervious surfaces, such as driveways, during construction to drain to vegetated areas.
  - Minimize the area of impervious surfaces such as paved areas, roof and concrete driveways.
  - Incorporate pervious or porous surfaces (e.g., gravel, permeable pavers or blocks, pervious or porous concrete) that minimize runoff.
  - Direct runoff from paved surfaces and roof areas into planting beds or landscaped areas to maximize site water collection and use.
  - Incorporate rain and rock gardens, cisterns, and other rain harvesting or catchment systems.
  - Incorporate infiltration beds, swales, basins and drywells to collect rainwater and dry weather runoff and increase percolation into the soil.
  - Consider constructed wetlands and ponds that retain water, equalize excess flow, and filter pollutants.

Local Ordinance (Santa Monica)

City's Water Efficient Landscape and Irrigation Standards

Use of an approved and treated alternative water source such as rainwater exempts designer from:

- Plant size restrictions (i.e., amount of turfgrass, high water using plants)
- The overhead irrigation ban for green roofs (may use sprinklers)
- Surface area size restrictions on water features (waterfall, fountains)

Elements: Plant Selection

- Rain gardens:
  - The plants in the ponding area, which is the lowest lying part of the garden, will remain saturated for days at a time. Because of this, install plants that can tolerate “wet-feet” in the ponding area.
  - Other plants need to tolerate drier conditions found on the berm.
  - drought-tolerant species that are adapted to periodic wet conditions may be used as well.
- In most cases, seed is not the preferred method for plant establishment in a bioretention cell. The fluctuating water levels make it difficult for the seed to readily establish, and the random nature of seeding may result in an undesirable plant layout for some situations.
- Instead, it is strongly recommended that containerized live plants be utilized: plugs or 1-gallon for herbaceous plants, 1- to 5-gallon for shrubs, and 5-gallon to 24-inch box for trees. Plant spacing depends on mature plant size and desired density of plant cover.

Elements: Plant Selection

- Trees to use in or near a California rain garden:
  - *Acer rubrum*, Red Maple
  - *Populus tremuloides*, Quaking Aspen
  - *Chilopsis linearis* 'Art's Seedless', Desert Willow
  - *Platanus racemosa*, Western Sycamore
  - *Agonis flexuosa*, Peppermint Tree
  - *Corylus cornuta* var. *californica*, Western Hazelnut

Elements: Plant Selection

- Trees to use in or near a California rain garden:
  - *Acer rubrum*, Red Maple

- Water Use Classification of Landscape Species IV classifies this as a high water using plant for Southern Coastal California
- CA's Model Water-Efficient Landscape Ordinance Maximum Applied Water Allowance may be impacted

Elements: Plant Selection

- Green roofs (extensive):
  - Native or adapted species tolerant of extreme climate conditions (e.g., heat, drought, wind);
  - Low-growing, with a range of growth forms (e.g., spreading evergreen shrubs or subshrubs, succulents, perennials, self-seeding annuals);
  - Possessive of a shallow root system without the chance of developing a deep taproot;
  - Long lived or self-propagating, with low maintenance and fertilizer needs.
  - Plants must be low and hardy, typically alpine, dryland, or indigenous. The plants are often watered only until they are fully established, and after the first year or two, maintenance typically consists of two visits a year for weeding of invasive species, drainage, and membrane inspections.
  - A variety of species and growth forms may be considered for a single roof project to ensure survival and plant growth. In addition, because many perennials and annuals are dormant during part or all of the rainy season, evergreen and cool-season plants should be included to help with rainfall interception and evapotranspiration during the seasons when rains typically occur.

Elements: Soil Selection

Typical Bioretention Soil Medium (BSM) Specs

- 50% Sand (Conforms to ASTM C33 Fine Aggregate)
- 20% Organic Material (Compost or shredded hardwood mulch)
- 30% Topsoil
  - Sand (2.0 – 0.050 mm) 50 – 85% by weight
  - Silt (0.050 – 0.002 mm) 0 – 50% by weight
  - Clay (less than 0.002 mm) 10 – 20% by weight1
  - Organic Matter 1.5 – 10% by weight
  - pH 5.5 – 7.5 (NOTE: pH can be corrected w/soil amendments if outside acceptable range)
  - Magnesium Minimum 32 ppm (NOTE: magnesium sulfatecan be added to increase Mg)
  - Phosphorus (Phosphate - P2O5) Not to exceed 69 ppm / P-index should be less than 25
  - Potassium (K2O) Minimum 78 ppm (NOTE: potash can be added to increase K)
  - Soluble Salts Not to exceed 500 ppm
  - Source: The Low Impact Development Center, Inc., 2003
- **Engineered soil media meeting the specification described above can be expected to have infiltration rates ranging from 25 - 130 in/hr (Hsieh and Davis, 2005).**

Elements: Soil Selection

- Green roof (extensive – most common for Rainwater BMPs)
  - The growing medium is typically made up of a mineral-based mixture of sand; gravel; crushed brick; straw, lightweight expanded slate, clay, or shale aggregate; volcanic rock; pumice stone; scoria; zeolite; diatomaceous earth; perlite; or rock wool.
  - Organic matter may also be added, such as composted sawdust, wood, grass, leaves, clippings, agricultural waste, worm castings, peat or peat moss, or manure
  - The growing medium on extensive green roofs varies in depth between 2–6" with a weight increase of between 12–35 lb/sf when fully saturated or at “maximum density”.
  - Extensive green roof wet weight is approximately 6 to 7 pounds per square foot per inch of depth.
  - **FLL Guidelines for the Planning, Construction and Maintenance of Green Roofing**; The Green Roofing guideline sets clear limits on the content of organic matter, structural and bedding stability, water permeability, maximum water capacity, air content, pH-value, salt and nutrient content and more.

Elements: Soil Selection

- CA MWELO soil requirements:
  - 4 cubic yards of compost per thousand square feet to depth of 6 inches (about 22%)
    - Friable soils
    - Typical Biorention soil specs requires a minimum 20% compost
    - Howe do we rectify with most green roof soil specs?
  - 3 inches of recycled organic mulch required on exposed soil surfaces
    - How do we address wood chip mulch applications in rainwater bmps that wash away in heavy rains clogging the outlet pipes?

Elements: Irrigation

- Bioretention cells
  - Will require supplemental irrigation during the first 2-3 years after planting. Drought tolerant species may need little additional water after this period, except during prolonged drought, when supplemental irrigation may become necessary for plant survival.
  - Verify that the maintenance plan includes a watering schedule for the establishment period and in times of extreme drought after plants have been established.
- Rain Garden plants that do not receive regular rain in the first two to three years will need supplemental irrigation
- Green roofs irrigation recommendations from the California Stormwater Quality Association
  - When needed, *subsurface irrigation* should be used to minimize evaporative losses
  - Install a *sub-surface irrigation capillary matting* and supply lines according to design
  - In the arid southwest, regular to *periodic irrigation will likely be required*.

Elements: Irrigation

- Green roofs
  - Factors such as climate and type of plants selected determine the need for permanent irrigation. Most extensive green roofs are designed to function without an irrigation system after an initial start-up period of one to two years.
  - Built-in irrigation systems are more common in Southern California and the Southwest
  - There are a wide variety of irrigation systems:
    - overhead or spray
    - surface or near-surface drip irrigation
    - capillary irrigation
    - base drip
    - trickle irrigation
    - water retention mats

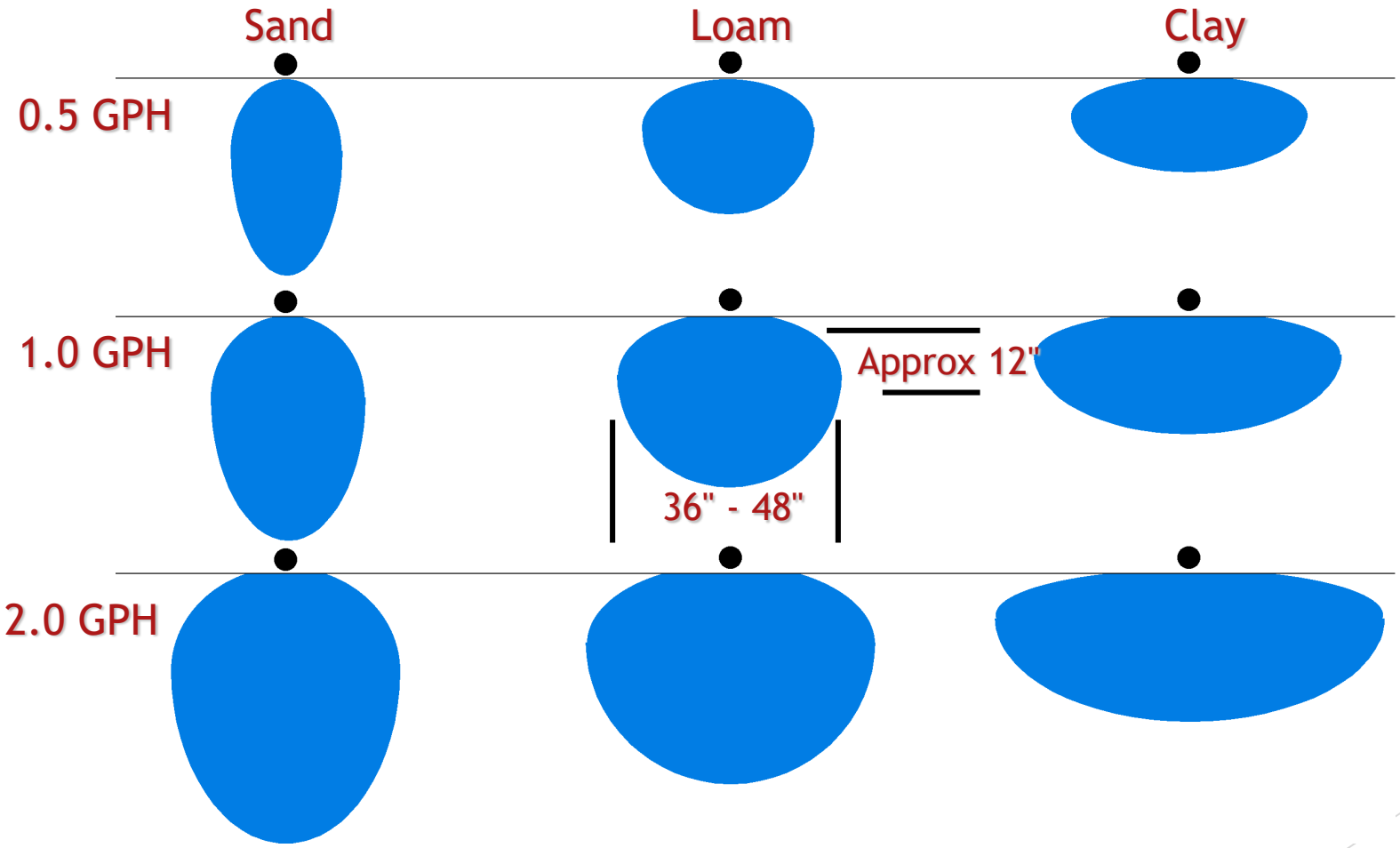
Elements: Irrigation

- Challenges of engineered spaces with drainage infrastructure and specific soil blends that promote high percolation
- Some irrigation manufacturers recommend overhead irrigation for green roofs:
  - Overhead irrigation may deliver greater distribution uniformity over a designed retention area
  - Allows for flexibility as the space changes; soil movement, build-up of organic matter, maintenance of drainage feature.
  - Inline or online micro systems have been tried on green roofs but often fail (not the product the landscape). The high percolation soils fail to move water horizontally with micro drip application and plants suffer in dry periods as a result. Also, the driplines may become damaged during flooding or maintenance practices.

Elements: Irrigation

- Comparison of irrigation efficiency and plant health of overhead, drip, and sub-irrigation for extensive green roofs
  - D. Bradley Rowe∗, Matthew R. Kolp, Sarah E. Greer, Kristin L. Getter Michigan State University, Department of Horticulture, A212 Plant and Soil Sciences Building, East Lansing, MI, United States
  - **“Because green roof substrates tend to be coarse to allow adequate drainage, water does not move laterally to a great extent as it would in finer substrates. For this reason, drip and sub-irrigation may not be the most efficient irrigation methods.”**

Wetting Patterns for Drippers in Idealized Soil Types



Elements: Irrigation

- CA MWELO Irrigation Requirements
  - In mulched planting areas, low volume irrigation is required as defined by ANSI standard, ASABE/ICC 802-2014. “Landscape Irrigation Sprinkler and Emitter Standard”
  - Should this apply to green roof areas or biorentation areas?

Elements: Irrigation

- Green Roof Irrigation options
  - Square nozzles
  - Low angle low trajectory nozzles
  - Fleece wrapped dripline products
  - Multi-Stream Multi-Trajectory Nozzles
  - Micro-Sprays

Elements: Irrigation

- Irrigation controller
  - Needs to be flexible to accommodate the high infiltration rates of the soil
  - Multiple cycle and soaks
  - Soil moisture sensors preferred with weather-based sensors; must be careful when installing a soil moisture sensor in highly coarse media like green roof soil mixes

Stormwater BMP Resources

- California Stormwater Quality Association
  - https://www.casqa.org/resources/california-lid-gi
  - **Low Impact Development Manual for Southern California** https://www.casqa.org/sites/default/files/downloads/socallid-manual-final-040910.pdf

- Green Roof Design and Construction https://www.greenroofs.org/
- http://www.greenrooftechnology.com/fll-green-roof-guideline

- Santa Monica Rain Harvest Rebate Guide and Program https://www.smgov.net/Departments/OSE/Rebates/Rain_Harvest_Rebate.aspx