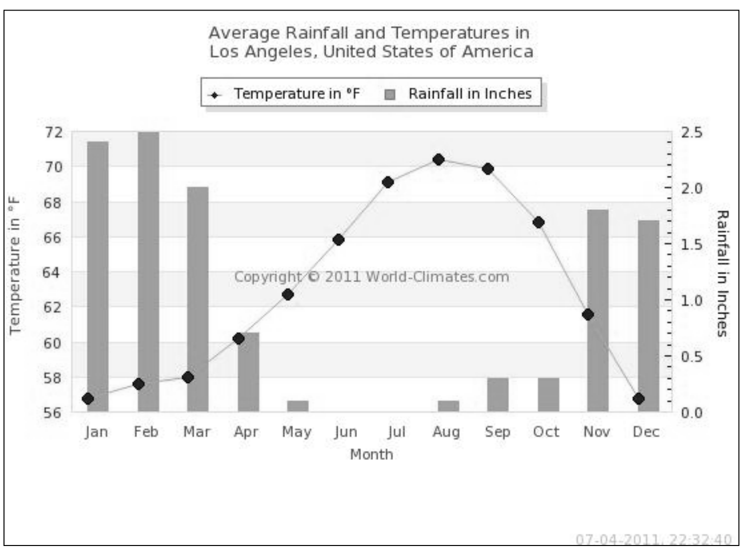
Irrigate Properly

Introducing:

- Allowable Depletion
- Irrigation Intervals
- Total Irrigation Run Times
- Precipitation Rates & Runoff Elimination

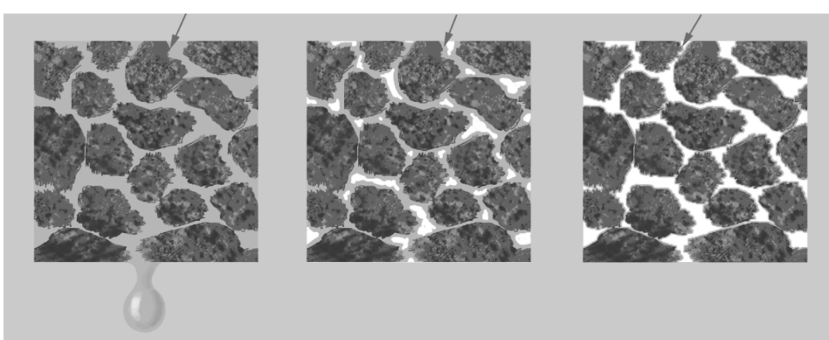


If this isn't enough water for your garden as designed,
or if the water isn't arriving when the plants need it most…

Supplemental Water Is Required

1. Amount of water in the soil and available to the plants at any given time. (Soil Water Holding Capacity, Plant Available Water)
2. Rate at which plants remove water from the soil. (Evapotranspiration, Plant Water Requirement)
3. Amount of water that doesn't make it into the soil during an irrigation cycle. (Precipitation Rate, Soil Intake Rate)
4. Quality of water used for supplemental water. (Salinity)
5. Design and efficiency of irrigation being used to provide the water. (Irrigation Efficiency, Irrigation Water Requirement, Emitter Discharge Rate)

The Purpose of Irrigation Is to Maintain OWL



No Oxygen Too much Water Anaerobic Life	Balanced Oxygen Balanced Water Aerobic Life	Plenty of Oxygen No Water No Life

How Much Water in Soil Is Available to Plants as They Transpire?

FIELD CAPACITY

PERMANENT WILTING POINT

Irrigation's role is to replace water to maintain OWL

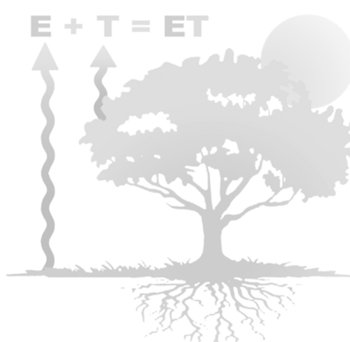
Remember Your Sponge (Good Soil Structure)

Living Soil structure both allows water to drain from too wet soil AND helps soil to hold water when it starts to dry out.

How Much Water in Soil Is Available to Plants?

SATURATION **FIELD CAPACITY** PERMANENT WILTING POINT

The Amount of Soil Water Depends upon How Much the Plant Evapotranspires



Each day, ET removes water from the soil and plants (Daily Plant Water Requirement or DPWR)

Irrigation must refill the gaps in the soil structure with water when the biology <u>begins</u> to get stressed out.

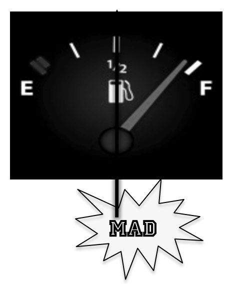
When does the biology get stressed out?

Biology and Plants Get "MAD"
(*Managed Allowed Depletion*)

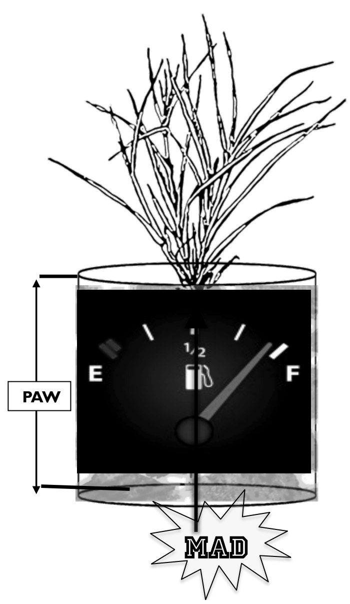
When 50% of the Plant Available Water has been depleted from the soil by DPWR, plants are getting **MAD.**

When the % of water in the soil by volume is less than MAD, the plants are getting stressed out and MAD! It is time to irrigate and refill the soil to bring it back to Field Capacity.

This can take days, weeks or even months.



At What Level of Soil Water Depletion Do We Need to Add Water?



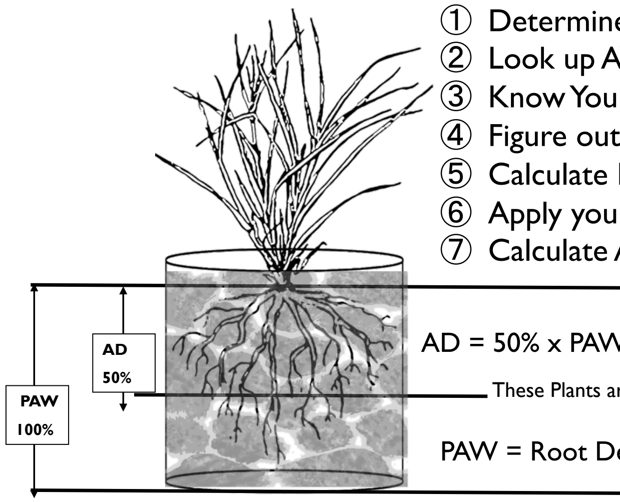
Allowable Depletion (AD) is:

Plant Available Water
x
MAD (%)

When Evapotranspiration has depleted the Plant Available Water to our Allowable Depletion level, we will need to replenish the soil with the volume of water that was depleted. This is when the sum of the DPWR equals Allowed Depletion.

MAD Is NOT FIXED!

1. Determine Soil Type.
2. Look up AWHC from Soil Chart.
3. Know Your Plants.
4. Figure out Root Depth.
5. Calculate PAW.
6. Apply your MAD threshold.
7. Calculate AD.



AD = 50% x PAW

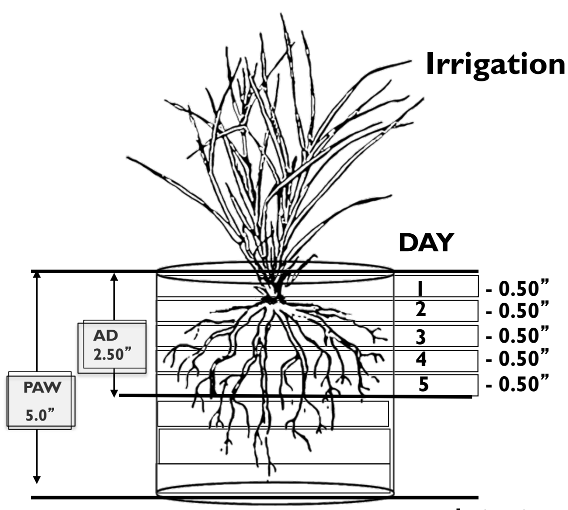
These Plants are MAD at 50% of PAW

PAW = Root Depth x AWHC

When Do We Need To Add Water?

Irrigation Interval in # of days is:

AD ÷ DPWR



AD = 2.50”
DPWR = 0.50”

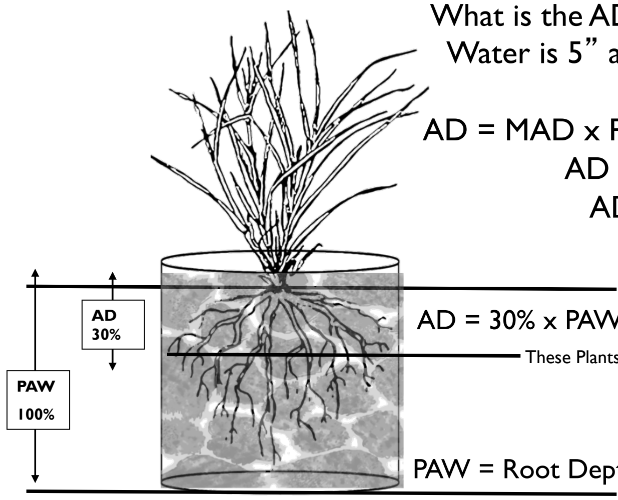
Irrigation Interval Days:
2.50” ÷ 0.50” = 5 Days

It is time to irrigate when the sum of DPWR equals AD.

First, Calculate the Allowable Depletion

What is the AD if the Plant Available Water is 5" and the MAD = 30%?

AD = MAD x Plant Available Water =
AD = 0.30 x 5"
AD = 1.50"



AD = 30% x PAW

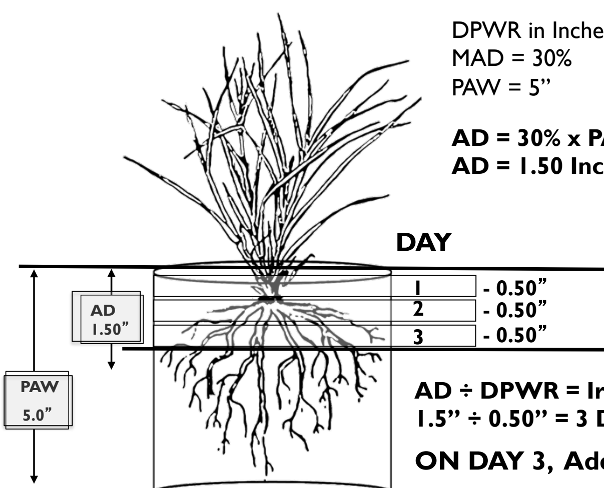
These Plants are MAD at 30% of PAW

PAW = Root Depth x AWHC

Calculate the Number of Days Between Irrigation Events

DPWR in Inches = 0.50"
MAD = 30%
PAW = 5"

AD = 30% x PAW = 0.30 x 5.0"
AD = 1.50 Inches



AD ÷ DPWR = Irrigation Interval in Days
1.5" ÷ 0.50" = 3 Days

ON DAY 3, Add Water

Total Water Needed To Be Added = 3 days x 0.50"/day = 1.50"

How Much Water Do You Need to Apply When Irrigating?

How Efficient Is Your Irrigation?

We know how much water needs to be added for this irrigation event: **3 days x 0.50"/day = 1.50" per event**

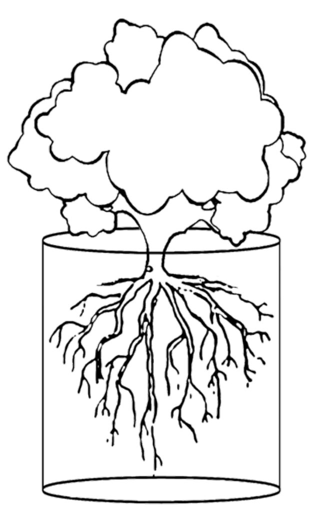
But irrigation is not 100% efficient, so we must APPLY enough water so that 1.50" ends up in the landscape. We must adjust our application amount by the Irrigation Efficiency (IE) or Distribution Uniformity (DU) of the irrigation system by dividing by IE or DU.

1.50" ÷ DU = Water Applied During the Irrigation Event

How much water must be applied if our DU = 60%?

1.50" ÷ 0.60 = 2.50" must be applied with this irrigation efficiency.

What Happens as Root Depth Increases?



Plants of different root depths clearly have different amounts of water available to them. So how frequently do we irrigate for a "mixed border" of shrubs, trees, and groundcover?

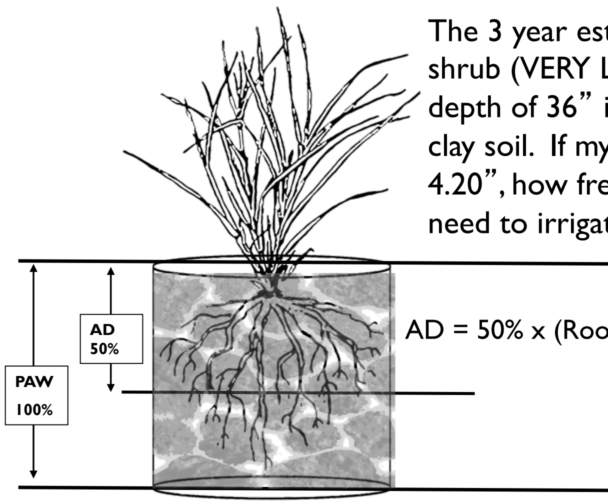
What if parts of the garden are already established?

What if different parts of the property have different types of soil?

When are roots so deep that we can stop irrigating all together?

Let's Apply Our Learning to a Real-Life Situation

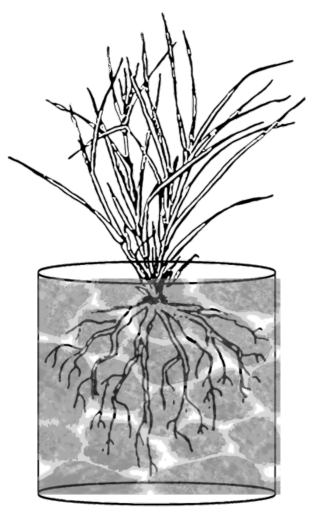
The 3 year established Manzanita shrub (VERY LOW) with root depth of 36" is growing in sandy clay soil. If my monthly ETo = 4.20", how frequently do we need to irrigate?



AD = 50% x (Root Depth x AWHC)

Now Let's Add Irrigation Efficiency

If we have drip irrigation with DU = 80%, then how much water must we apply when we do irrigate?



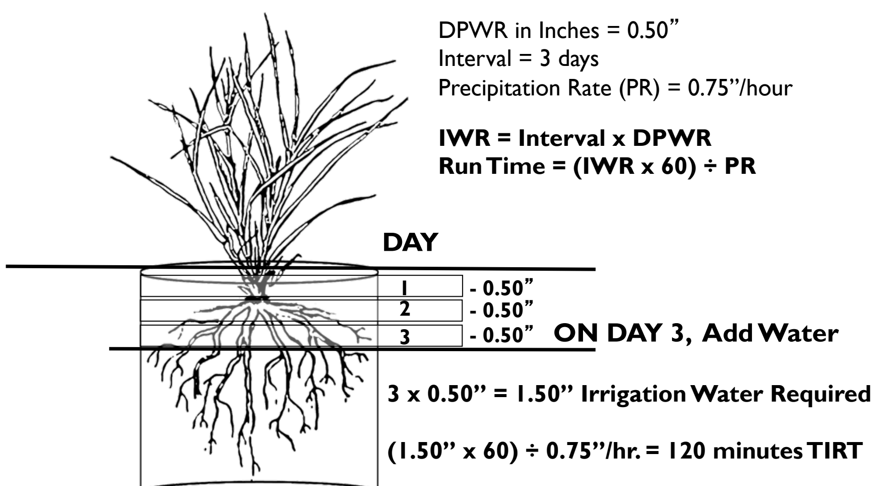
What is the Total Irrigation Run Time (TIRT)?

We have our irrigation intervals. We know how much water needs to be applied per event. Let's figure out how long to achieve our Total Irrigation Run Time (TIRT)?

Irrigation Interval x DPWR ÷ DU=
Irrigation Water Requirement (IWR)

(IWR x 60) ÷ Precipitation Rate (PR) =
Total Irrigation Run Time

How Long Do We Run Irrigation?



Total Irrigation Run Time = 120 minutes every 3 days

Exercise #8
Calculate Allowable Depletion and Irrigation Intervals For This Landscape Scenario

DATA:

Anywhere Annual ETo = 50”
Square Footage of Area = 500 Sq. Ft.
Plant Type = Medium Low Shrub Type
Root Depth = 20”
Soil Type = Clay Loam
MAD = 50%
Distribution Uniformity = 70%

QUESTIONS:

What is the Daily Plant Water Requirement (DPWR)?

What is the Soil Available Water Holding Capacity (AWHC)?

What is the Plant Available Water (PAW)?

What is the Allowable Depletion?

How many days between irrigation events (Irrigation Interval)?

Exercise #9
Determine Total Irrigation Run Time For This Landscape Scenario

DATA:
Anywhere Annual ETo = 50”
Daily Plant Water Requirement = 0.055 inches / day
Irrigation Interval = 29 days
Precipitation Rate = 0.52 inches per hour
Soil intake rate = 0.48
IE = 70%

Irrigation Interval x DPWR ÷ IE = Irrigation Water Requirement (IWR)
(IWR x 60) ÷ Precipitation Rate (PR) = Total Irrigation Run Time

QUESTIONS:

How much water must be applied in the irrigation event?

Given your Precipitation Rate, how long do you need to run the irrigation to achieve total irrigation water requirement?

If your soil intake rate is lower than the precipitation rate, and you see run off after one hour, how many cycles would you need to avoid run-off?

What Happens to All the Water We Apply to the Soil?

Runs quickly through the soil.

Leaches below the root zone and thus out of reach of the plant.

Fills up depleted moisture in soil and is grabbed by microbes and stored until a dry day.

Pools at some level because of compaction.

Never makes it into the soil at all.

RUNOFF!

Precipitation Rate < Intake Rate = NO RUNOFF

Precipitation Rate > Intake Rate = RUNOFF

Runoff is the water that is not absorbed by the soil during a rain or irrigation event.

What are some ways in which runoff can be reduced while still being able to irrigate a landscape?

How Quickly Can the Soil Absorb Water?

Soil Type	Texture	Permeability Rate	Permeability Class
Coarse	Gravel, Coarse Sand	> 20.	Very Rapid
Coarse	Sand, Loamy Sand	6 – 20	Rapid
Moderately Coarse	Coarse Sandy Loam Sandy Loam Fine Sandy Loam	2 - 6	Moderately Rapid
Medium	Very Fine Sandy Loam Loam Silt Loam Silt	0.60 - 2	Moderate
Moderately Fine	Clay Loam, Sandy Clay Loam Silty Clay Loam	0.20 – 0.60	Moderately Slow
Fine	Sandy Clay, Silty Clay Clay (<60%)	0.06 – 0.20	Slow
Very Fine	Clay (>60%) Clay Pan	<0.06	Very Slow

Maximum Infiltration Rate is expressed in (Inches/Hour)

What happens when water is applied too rapidly or in too great a total quantity for the soil to absorb it?

Information courtesy of UCSC – Soil Permeability Rates for Uncompacted Soil

G3 Protocols: Limit Precipitation Rate

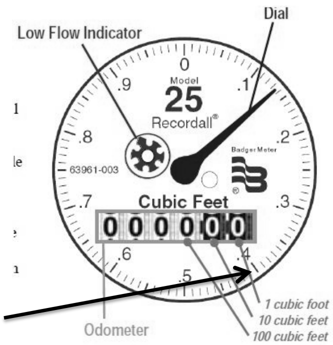
Irrigation systems must be designed and installed so that a Precipitation Rate (PR) of 0.75 Inches Per Hour is not exceeded in ANY PORTION of the landscape.

Since water typically infiltrates into the soil at a rate of 0.75"/Hr. or less, adopting the G3 PR limit prevents runoff and allows water to infiltrate through soil, percolating down to the plant roots where it is needed.

The G3 PR limit is derived from the City of Santa Monica Model Water Efficient Landscape Ordinance (MWELO).

Use a Water Meter to Determine Precipitation Rate

① Observe meter reading at the START of the zone irrigation cycle.
② Observe meter reading at the END of the cycle.
③ Record the Minutes of the irrigation cycle.
④ Subtract the END Reading from the START Reading to get the amount of water in Cubic Feet applied to the zone during the irrigation cycle.



⑤ Multiply Cubic Feet by 7.48 Gallons/Cubic Foot to get Gallons applied.
⑥ Divide Gallons by Minutes to get **Gallons Per Minute (GPM)** for the zone.

Use Gallons Per Minute (GPM) of the zone to calculate Precipitation Rate:

$$PR_{SPRAY/BUBBLER} = (96.25 \times \text{Total Zone GPM}) \div \text{Total Zone Area SF}$$

Calculating Precipitation Rates for In-Line Drip Irrigation (Grid Pattern)

① Emitter Flow Rate = 0.5 GPH (gallons/hr.)
② Emitter Spacing 12”
③ Row Spacing = 15”
④ 231.1 Conversion Factor (converts gallons/hour to cubic inches/hour)

$$PR_{Drip} = (231.1 \times \text{Emitter Flow Rate}) \div (\text{Emitter Spacing} \times \text{Row Spacing})$$

$$(231.1 \times 0.5) \div (12 \times 15) = 0.64\ PR_{Drip}$$

0.64”/hr. < 0.75”/hr.
Acceptable!

Calculating Precipitation Rates for In-Line Drip Irrigation (Grid Pattern)

① Emitter Flow Rate = 1.0 GPH
② Emitter Spacing 18"
③ Row Spacing = 15"
④ 231.1 Conversion Factor (converts gallons/hour to cubic inches/hour)

PR_{Drip} = (231.1 x Emitter Flow Rate) ÷ (Emitter Spacing x Row Spacing)
231.1 x 1 ÷ (18 x 15) = 0.86 PR_{Drip}

0.86"/hr. > 0.75"/hr.
NOT Acceptable!

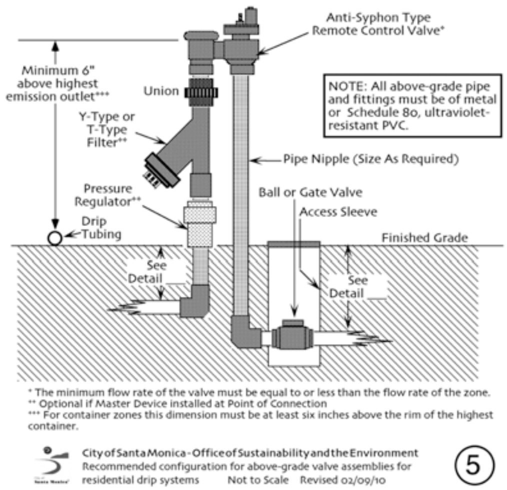
Calculating Precipitation Rates for On-Line Drip Irrigation (Random Pattern)

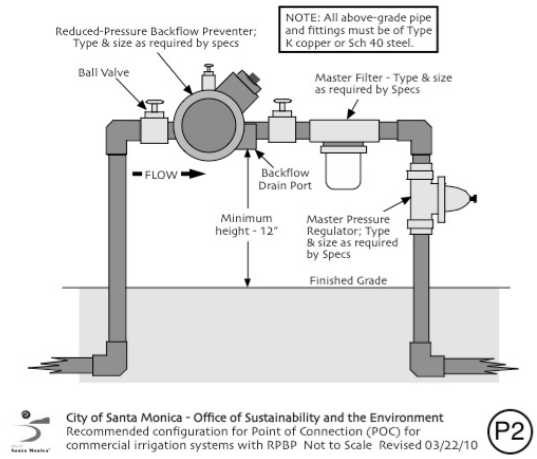
① Total Zone GPM (24' tubing ÷ 1' spacing) x 0.5 GPH ÷ 60 min/hour = 0.2 GPM
② Total Zone Area = 110 square feet
③ 96.25 = Conversion Factor - converts gallons per minute to inches per hour.

PR_{Drip} = (96.25 x Total Zone GPM) ÷ (Total Zone Area)
96.25 x 0.2 ÷ 110 = 0.18 PR_{Drip}

0.18"/hr. < 0.75"/hr.
Acceptable!

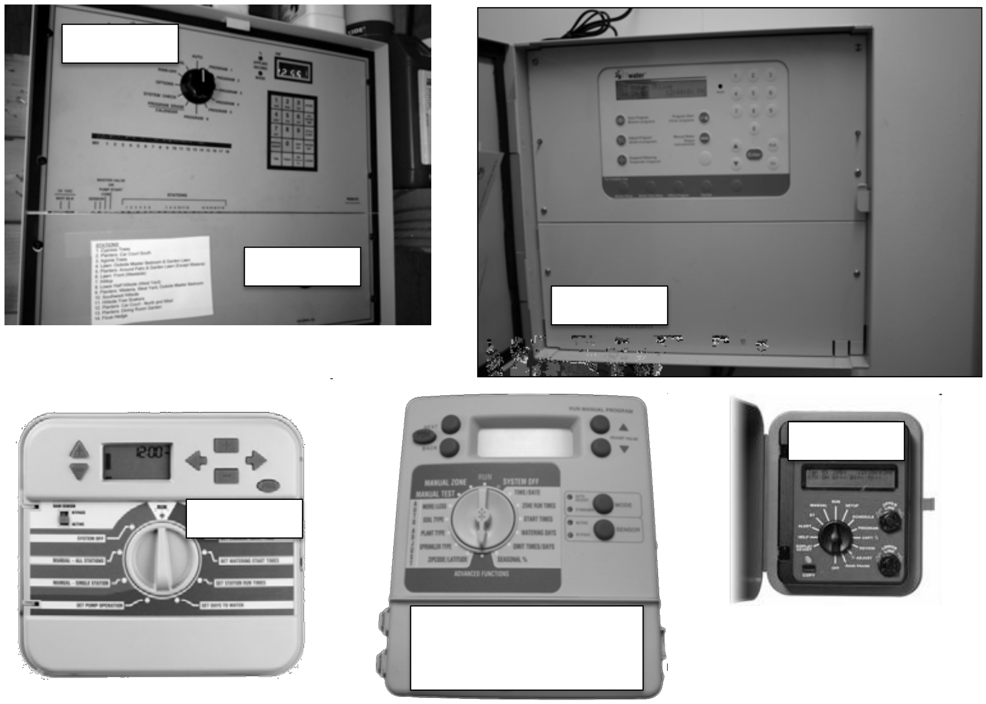
Understanding the Equipment





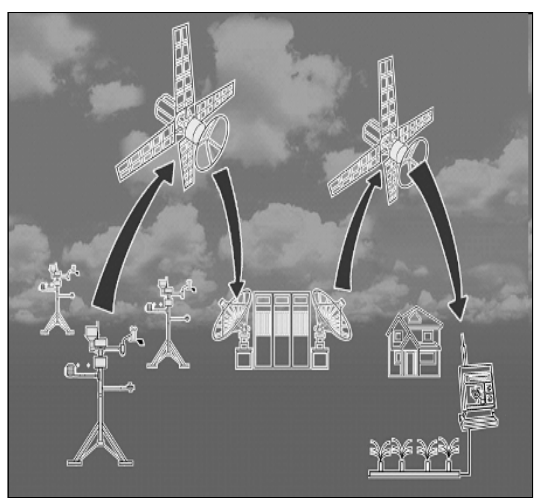
Courtesy of City of Santa Monica

“Smart” Irrigation Controllers



“Smart” Irrigation Controller Requires Data Inputs

① Irrigation Method and Precipitation Rate
② Plant Type
③ Root Depth/Target MAD
④ Percent of Slope
⑤ Soil Type
⑥ Sun Exposure
⑦ Establishment Schedule



The Weather Based Irrigation Controller (WBIC) creates and adjusts the irrigation schedule (run time or watering days) based on inputs and the current weather (ET) conditions.

Backflow Prevention

Pressure Vacuum Breaker

Reduced Pressure Vacuum Breaker

Anti-siphon Valves

Backflow Prevention

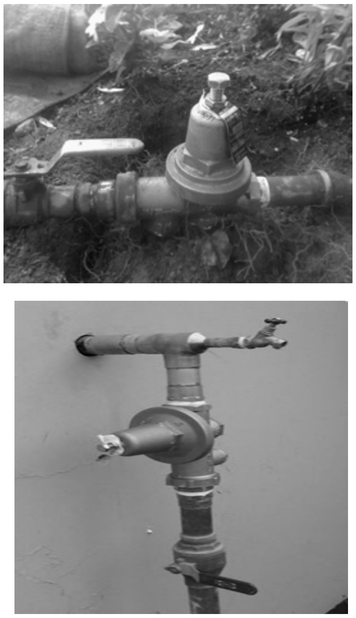
Backflow Prevention – Critical! A device that prevents contaminated water from being sucked back into the water source source should a reverse flow situation occur. Every irrigation system must include some form of backflow prevention.

Master Backflow Prevention – Placed upstream of control valve (more common types). Requires annual inspections:

- Pressure Vacuum Breaker – must be located 12" above highest head (or per code)
- Reduced Pressure Backflow Preventer – can be located anywhere on site, installed 12" above grade (or per code)

Anti-siphon valves – Control valves that have backflow prevention built in. No need for a master backflow system. Typically installed 6" above highest head (or per code).

Pressure Regulation



Master Pressure Regulators

Regulator at Valve

Pressure Regulator

Pressure – describes the flow strength of water through plumbing pipes, measured in pounds per square inch (psi).

Pressure regulators reduce the water pressure coming in from the Water Provider's main water line to a psi that is optimal for irrigation use.

Master Pressure Regulator – can be part of backflow prevention assembly or installed separately. Installed upstream of control valves.

Can also be built into valves, e.g. drip valves, or even spray heads.

Pressure problems:

- Too high – misting, damage to the system, inefficient distribution
- Too low – unequal distribution uniformity, less than optimal sprinkler performance

Control Valves

Globe or Angle valve

Anti-siphon valves - drip

Anti-siphon valves - spray

Control Valves

Used to deliver pressurized water to either sprinklers or drip throughout the system. These can be automatic (regulated by controller) or manually.

They come on one at a time and are designed to irrigate each hydrozone separately.

Globe / Angle Valves – installed below ground. Can be either drip or spray. Require master backflow prevention since they are below grade.

Anti-siphon Valves – Include built-in backflow prevention. Must be installed typically 6" above highest head (or per code).

Low Flow Valves – designed specifically for drip where the output is significantly lower than spray.

Distribution Method - Spray


Rotary Nozzle (or Rotator)


Rotor


Spray

Distribution Method - Drip


Random Pattern – on-line

Grid Pattern – in-line


On-line (or point source)

Bubbler

Distribution Methods

Spray – Considered overhead delivery. Used most frequently for turf, grasses, and groundcover. Requires 'head to head' coverage for best distribution uniformity. Measured in GPM.

- Spray – traditional irrigation method. High precipitation rate.
- Rotary Nozzles (or rotators) – recent technology with a lower precipitation rate than spray. Delivers water in a stream with heavier droplets.
- Rotors – typically used for large areas – turf, hillsides.

Drip – Delivered at surface or subsurface. Used most frequently for trees, shrubs, groundcover. Measured in gallons per hour. Emitters typically 0.5 – 2 GPH.

- In-line – emitters built in with regular spacing (12, 18, 24" etc.) Can be used either for surface or sub-surface.
- On-line (or point source) – emitters punched in tubing at each plant. Recommended for surface use only.

Other 'Good to Know' Equipment

Irrigation Meter

Quick Coupler for Hose

Backflow Prevention at Hose Bib

More 'Good to Know' Equipment

Rain Shut Offs

Soil Moisture Sensor

Digital Equipment Is Always Available

A Soil Probe Works Too!

Overspray Reduced With 24" Setback From Hardscape

Fill the gap between the spray nozzles and the hardscape with drip irrigation or no irrigation.

Design For Zero Runoff

Bubblers ARE NOT DRIP!
Neither are "Soaker Hoses" which can deliver as much as 10 GPM.

Drip irrigation – slowly delivers water exactly where it is needed. No overspray, reduced weeds, zero runoff, most efficient irrigation system. But mind your Precipitation Rate! Poorly designed drip systems can deliver water too fast for soil.

Try To Eliminate Dry Weather Runoff

Hundreds of millions of gallons of potable water run off our landscapes and impermeable urban environment on a **DRY** day.

This runoff carries pollutants directly into our waterways year round.

Observe minutes to runoff. This is the **MAXIMUM IRRIGATION RUN TIME**.

Adjust the irrigation controller to irrigate no more than the maximum run time in any one irrigation event.

Therefore, irrigate in intervals or cycles.

Use Cycle and Soak To Eliminate Runoff

Minutes to runoff (Maximum Irrigation Run Time): 3 Minutes

Recommended Irrigation Schedule: 5 Minutes

Number of cycles to prevent runoff : 5 ÷ 3 = 2 cycles / event

front yard
Cool Season Grass | Clay Loam | Sprinkler

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum Minutes per start time	5	5	5	5	5	5	5	5	5	5	5	5
Start times per week*	3	3	5	7	7	8	8	7	6	5	3	3
Total minutes per week	15	15	25	35	35	40	40	35	30	25	15	15

*Start times per week may not equal days per week. Multiple start times per day may be needed to avoid runoff.

If you want more detailed information about historical weather conditions, plants soils and sprinkler systems, visit the Wateright Web site.

Make Notes about Sprinkler Performance and Fix Them!

Are sprinklers blocked?

Are sprinklers misting?

Make Notes about Sprinkler Performance and Fix Them!

Are sprinklers broken or sunken?

A Pressure Regulator Will Eliminate Spray Head Misting

Replace Old or Leaking Valves

Use Check Valves on Slopes or Elevation Changes to Eliminate Low Head Drainage

Adjust Sprinklers for Head-to-Head Coverage

Occupational Safety and Health Administration (OSHA)

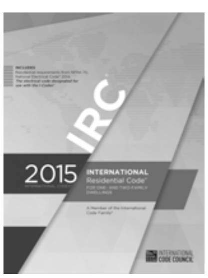
Under Department of Labor

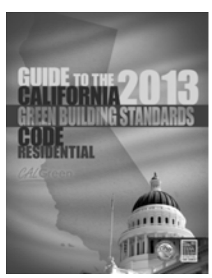
Helps employers and employees reduce on the job injuries, illnesses & deaths

Landscape and Horticulture Services:

- Review ‘construction industry’ standards if work considered ‘building’
- Review ‘general industry’ standards if work considered ‘maintenance’

Electrical & Plumbing Codes





Building codes provide minimum standards for safety, health and general welfare.

Federal	International Commercial Codes: electrical, plumbing, mechanical
State	California Building Standard Codes or Title 24:
	12 parts: Electrical (pt 3), Plumbing (5), Green Building (pt 11)
	AB 1881 - Model Water Efficient Landscape Ordinance (MWELO)
Local	Building & Safety Departments
	Local implementation of MWELO

Recent Innovations

Research & Development ongoing

Check Trade Associations for legislation and technology updates

Water-Sense – products are tested and meet EPA specifications for water efficiency and performance. Check website for latest WaterSense certified products:
http://www.EPA.gov/WaterSense/Products/

Create Permeability and Retention

Introducing:

- Low Impact Design
- Runoff & Run-on
- Permeability, Retention & Catchment
- Passive Rainwater Capture Practices
- Sizing & Placing Rainwater Harvesting BMPs

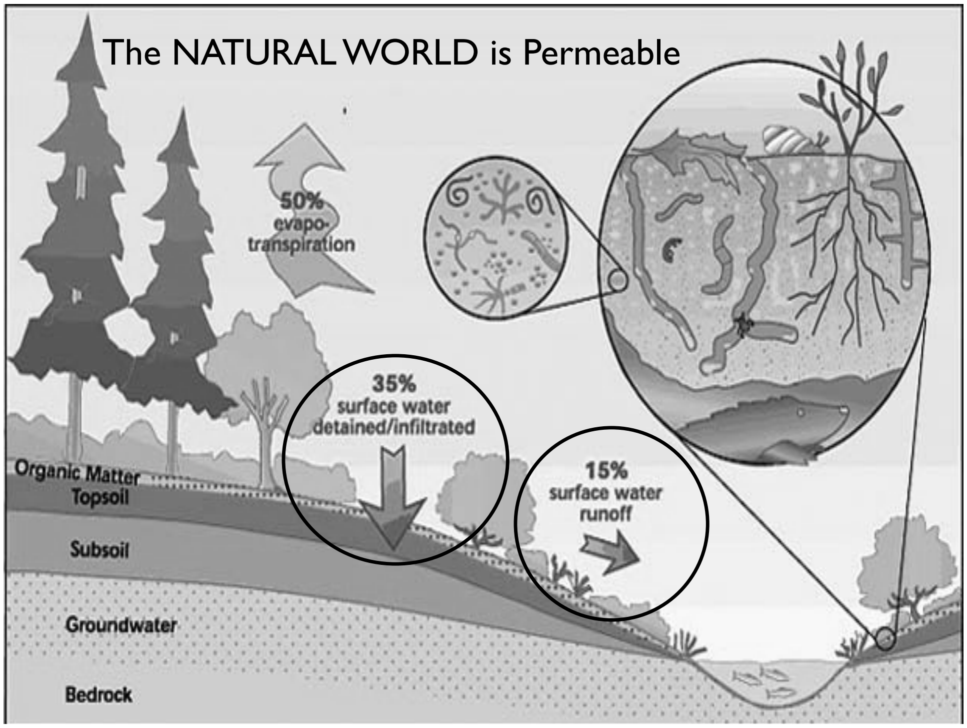
What is Low Impact Design (LID)?

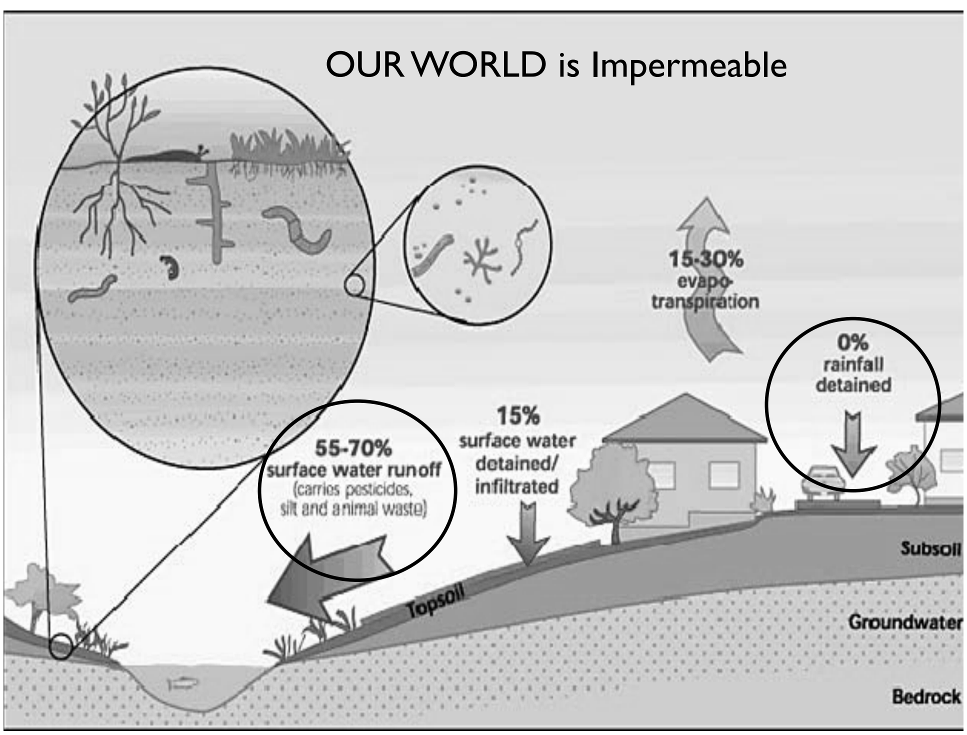
Storm water management to mitigate increased runoff and pollution as close as possible to the source of the pollution.

Landscape design and Best Management Practices (BMPs) promote use of natural systems to infiltrate, evapotranspire, and utilize stormwater.

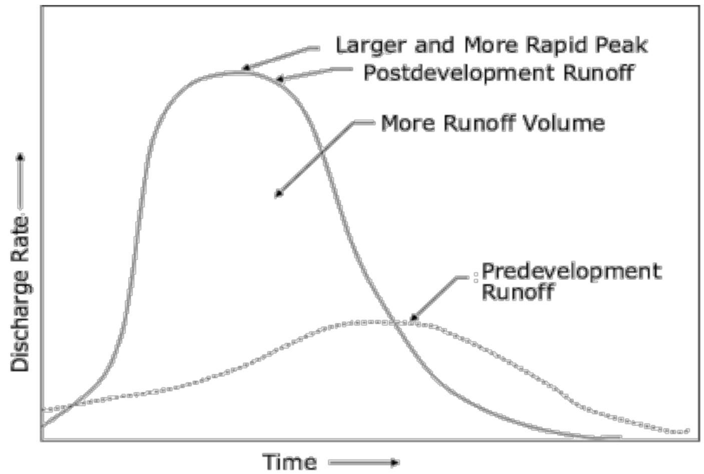
LID seeks to mimic pre-development characteristics.

When infiltration is not feasible, use BMP's to store, detain, evapotranspire and/or treat runoff.


The NATURAL WORLD is Permeable
50% evapo-transpiration
35% surface water detained/infiltrated
15% surface water runoff
Organic Matter
Topsoil
Subsoil
Groundwater
Bedrock


OUR WORLD is Impermeable
15-30% evapo-transpiration
0% rainfall detained
55-70% surface water runoff (carries pesticides, silt and animal waste)
15% surface water detained/ infiltrated
Topsoil
Subsoil
Groundwater
Bedrock

Development Increases Stormwater Volume and Velocity



Source: Reimold, R. J. (1998). Watershed management: practice, policies, and coordination, McGraw-Hill.

Low Impact Design (LID) Principles
Are Watershed Wise Design Principles

Good landscape design takes advantage of the services provided by the site's natural systems.

Natural systems are preserved and restored through LID.

LID principals consider storm water a resource to be conserved on the site and for the region.

Low Impact Design (LID)
Best Management Practices (BMPs)

1. **<u>Downspout Re-direct and Slow, Spread, Sink –</u>** Slow water down from the roof and re-direct downspouts away from underground pipes into landscaped areas.

2. **<u>Permeable Surfaces</u>-** Break up hardscape so water can penetrate back into soil, creating a Living Soil Sponge to absorb the water that falls on the landscaped areas.

3. **<u>Retention of rainwater on site</u>-** Create retention areas, ranging from small divots and dips to large-scale infiltration areas to slow and hold rainwater on site long enough to recharge soil or groundwater.

4. **<u>Cleaning of site runoff to reduce pollution downstream</u>** – Direct rainwater through landscaped areas to slow, sink, and spread as much as possible, and allow any filtered excess to run off the site clean.

The Simplest BMP of All: Mulch


CAMRY

Keeping Soil Alive
Is an Important Function of Low Impact Design

LID is another name for Permeability & Retention. Whether or not the site is appropriate for infiltration (as determined by the city or technical professional), the landscape requires rainwater from all adjacent hardscape surfaces to keep the OWL happy.

Living Soil Is the Key to Low Impact Design

Think Of This Property Like a Mini-Watershed

Remember Your Site is a Mini Watershed

① Define your Total Catchment Area; calculate total sq. ft.

② Identify the highest and lowest points of the property.

③ Note presence of gutters, drains, and french drains.

④ Identify the points at which water runs off the area and points at which water runs onto the area.

⑤ Identify erosion patterns, vegetation, deposits of sediment on the property.

How Much Water Falls On/Runs Off the Landscape?

1. How Big? - How large is the site area?
2. Where Are We? - Where is the landscaped area located? How much rainfall is in this area?
3. What's There? - What kind of surface is in the area?

Separate out the various PERMEABLE and IMPERMEABLE surfaces and calculate the square footage of each of those areas.

These are the Individual CATCHMENT AREAS.

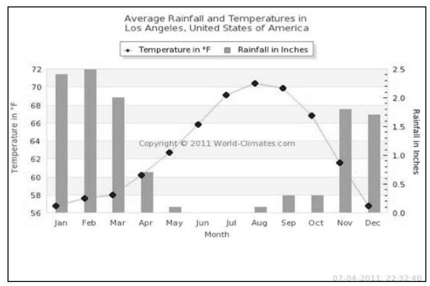
Treat each Catchment Area surface as you would a Hydrozone.

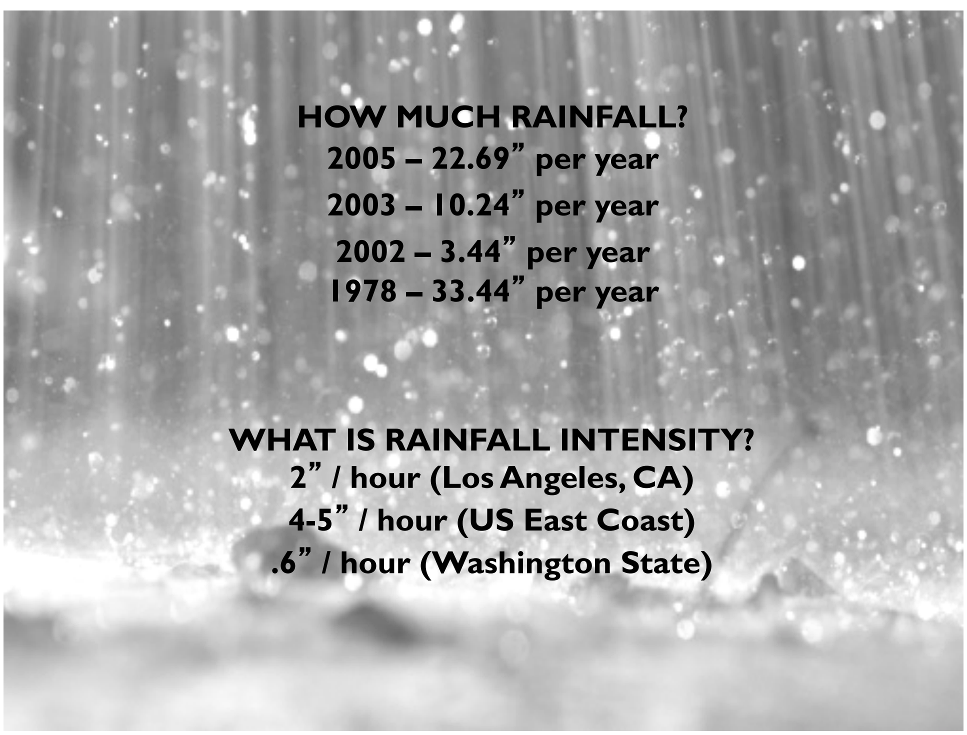
Catchment Area = Watersheds of Roof

How Much Water Falls On/Runs Off the Landscape?

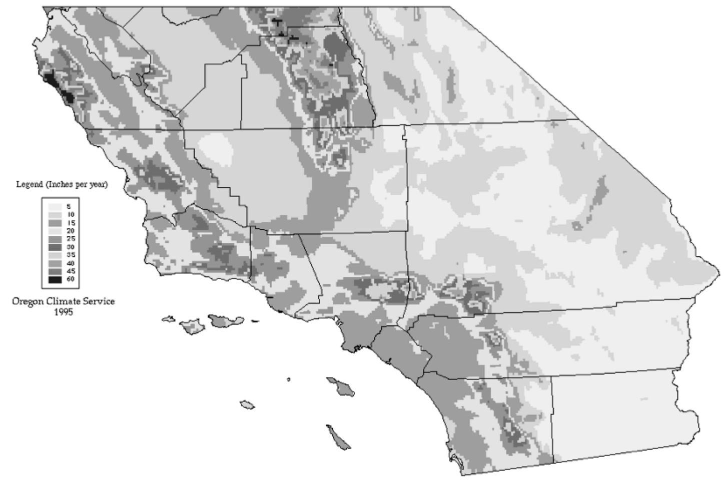
1. How Big? - How large is the catchment area?
2. Where Are We? - Where is the landscaped area located? What time of year does it rain? What is rainfall intensity? How much rainfall is in this area?
3. What's There? - What kind of surface is in the area?

Determine Average Rainfall for the site.





Annual Rainfall Varies Widely Across A Region



Annual Average Precipitation (Inches),
Southern California

Period: 1961-1990

Source: http://www.wrcc.dri.edu/precip.html - Western Region Climate Center

How Much Water Falls On/Runs Off the Landscape?

1. How Big? - How large is the site area?
2. Where Are We? - Where is the landscaped area located? How much rainfall is in this area?
3. What's There? - What kind of surface is in the area?

Describe how IMPERMEABLE the surfaces are by describing the percentage of rainfall that will runoff that particular surface.

This percentage of PERMEABILITY is called a Runoff Coefficient or Rainfall Adjustment Factor

The rainfall running off each Catchment Area surface will be adjusted by a Runoff Coefficient or Rainfall Adjustment Factor.

Values of Runoff Coefficient (C) for Rational Formula

Land Use	C	Land Use	C
Business: Downtown areas Neighborhood areas	0.70 - 0.95 0.50 - 0.70	***Lawns:*** Sandy soil, flat, 2% Sandy soil, avg., 2-7% Sandy soil, steep, 7% Heavy soil, flat, 2% Heavy soil, avg., 2-7% Heavy soil, steep, 7%	 0.05 - 0.10 0.10 - 0.15 0.15 - 0.20 0.13 - 0.17 0.18 - 0.22 0.25 - 0.35
Residential: Single-family areas Multi units, detached Munti units, attached Suburban	0.30 - 0.50 0.40 - 0.60 0.60 - 0.75 0.25 - 0.40	***Agricultural land:*** *Bare packed soil* *Smooth *Rough *Cultivated rows* *Heavy soil, no crop *Heavy soil, with crop *Sandy soil, no crop *Sandy soil, with crop *Pasture* *Heavy soil *Sandy soil Woodlands	 0.30 - 0.60 0.20 - 0.50 0.30 - 0.60 0.20 - 0.50 0.20 - 0.40 0.10 - 0.25 0.15 - 0.45 0.05 - 0.25 0.05 - 0.25
Industrial: Light areas Heavy areas	0.50 - 0.80 0.60 - 0.90	*Streets:* Asphaltic Concrete Brick	 0.70 - 0.95 0.80 - 0.95 0.70 - 0.85
Parks, cemeteries	0.10 - 0.25	Unimproved areas	0.10 - 0.30
Playgrounds	0.20 - 0.35	Drives and walks	0.75 - 0.85
Railroad yard areas	0.20 - 0.40	Roofs	0.75 - 0.95

***Note:** The designer must use judgement to select the appropriate "C" value within the range. Generally, larger areas with permeable soils, flat slopes and dense vegetation should have the lowest "C" values. Smaller areas with dense soils, moderate to steep slopes, and sparse vegetation should assigned the highest "C" values.

How Much Water Falls On/Runs Off the Landscape?

1. How Big? - How large is the catchment area?
2. Where Are We? - Where is the landscaped area located? How much rainfall is in this area?
3. What's There? - What kind of surface is in the area?

Catchment Area in Sq. Ft. x Rainfall Inches x Runoff Coefficient x 0.62 =
Total Rainwater Running Off in Gallons

Rainwater Is a Real Resource for the Landscape

600 gallons of rainwater are generated for every 1 inch of rain on a 1,000 square foot surface.

Your "typical" residential property roof generates
600 – 1,200 gallons of water for every inch of rain,
or 6,000 to 12,000 gallons
over a typical season.

Catchment Area in Sq. Ft. x Rainfall Inches x 0.62 =
Total Rainwater in Gallons

1,000 Sq. Ft. x 1 inch x 0.62 = 620 Gallons


Total Rainfall Harvestable From Each Surface
FLAT COMPOSITE ROOF
RESIDENCE 40'W X 80'L
FLAT STEEL ROOF
GARAGE
40'W x 20'L
LANDSCAPED LAWN AREA
50'W x 85'L
GRAVEL
DRIVEWAY
50'W x 10'L
SIDEWALK 5'W x 100'L

Exercise #10
Calculate Amount of Rainfall From Each Impermeable Surface

Catchment Area	Sq. Ft.	x First Flush “	x Runoff Coefficient	x .62	= First Flush Gallons	x Annual Rainfall “	= Total Annual Gallons
				TOTAL		TOTAL	

Exercise #11
Calculate Runoff Available To Be Harvested From Each Hard Surface In This Landscape Scenario And Size BMPs For Capture

INSTRUCTIONS & DATA:

Use the Sq. Footage and Surface information on the first page Image for calculating the runoff that will be generated by each surface. Assume all runoff generated is harvestable.

First Flush = 1”
100 Year Storm Event = 4”
Average Annual Rainfall = 10”

QUESTIONS:

Calculate Square Footage of each Impermeable Surface.

Calculate First Flush Runoff in Gallons from each Impermeable Surface. (See Chart)

Calculate Total 100 Year Storm Event in Gallons.

Calculate Total Annual Avg. Runoff in Gallons.

Create a Living Soil Sponge – Passive Capture

Match Impermeable Surfaces with Permeable Areas

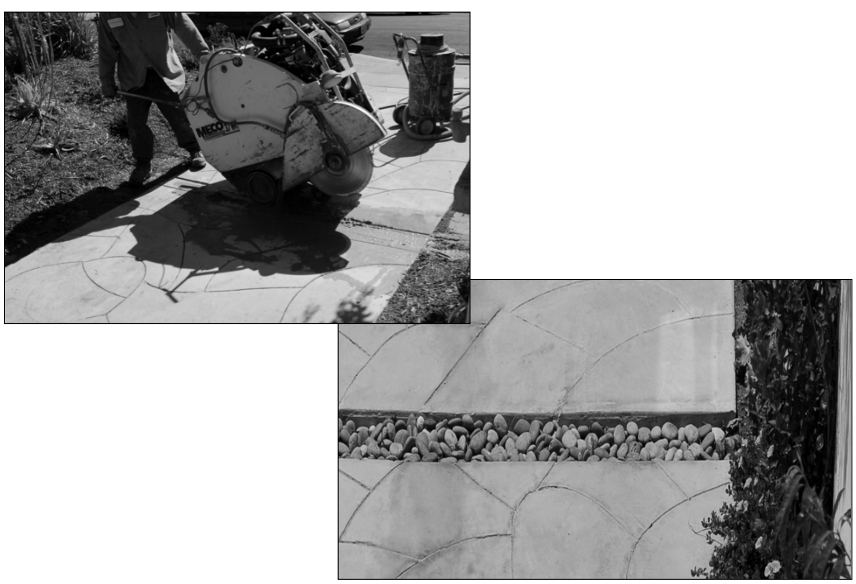
As we design the new landscape we seek to match the runoff generated from impermeable surfaces with **permeable areas** and low spots that might retain the rainwater on site.

SLOW IT!
Down from the Roof

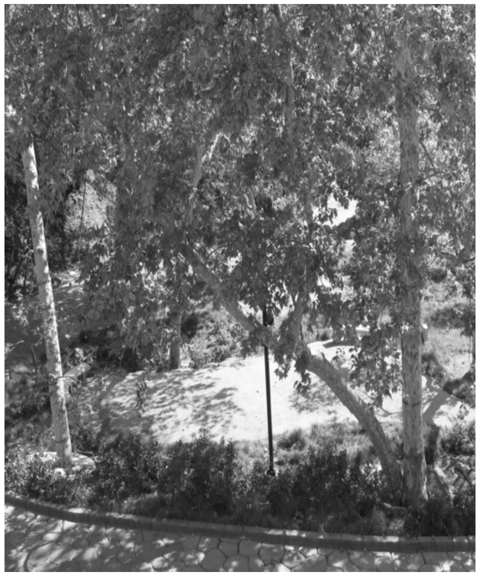
Replace downspouts with rain chains to slow it down when it hits the ground.

SPREAD IT! Think Permeable!

Cut Strips in Your Driveway to **SINK** the Rainwater



Plant More Trees to **SLOW** and **SINK**




Downspout Redirect

Replace downspouts with rain chains and contour site to keep water on property.

This allows soil to become fully hydrated when it rains.

Roof water has been redirected into landscape.

Garden now **SLOWS, SPREADS**, and **SINKS IT**!

It Doesn't Have to Be Complicated

A Simple Swale Will Suffice

Swales are low spots in the landscape. These usually are bordered by berms, or high points constructed from the soil removed to create the swale. Note the berm between the "dry creek bed" and the sidewalk, and between the swale and building. Plants that tolerate inundation can be placed in the swale, while dry-footed plants require placement on the berm.

A Good Runoff RULE OF GREEN THUMB

How Big Is the First Flush Container?

Catchment Area in Sq. Ft. x Rainfall Inches x 0.62 =
Total Rainwater in Gallons

1,000 sq. ft. x 1 inch (First Flush) x 0.62 = 620 Gallons

Total Rainwater in Gallons ÷ 7.48 Gallons/Cu.Ft. =
Cu. Ft. Needed For Container

620 gal. ÷ 7.48 gal./cu. ft.= 83 Cu. Ft.

TOTAL **Storage Space Needed For First Flush**

= **83 Cu. Ft. Per 1,000 Sq. Ft. Catchment Area**

Calculating Depth of a BMP

How deep is the BMP if 100 square feet are available for the swale?

Cubic Feet Capture ÷ Area Available in square feet

83 Cu. Ft. ÷ 100 sf = 0.83 feet
0.83 feet x 12"/ft = 9.96" (round up to 10")

Depth of swale needed to capture 83 cubic feet of rainwater in 100 square feet = 10 inches

Capture constraints: 15' setback from buildings; 3' setback from sidewalks, 10' setback from neighbors' properties and no runoff on to neighbors' property.

What is the Maximum Length and Maximum Width (and how much square footage) available for capture given the constraints outlined above?

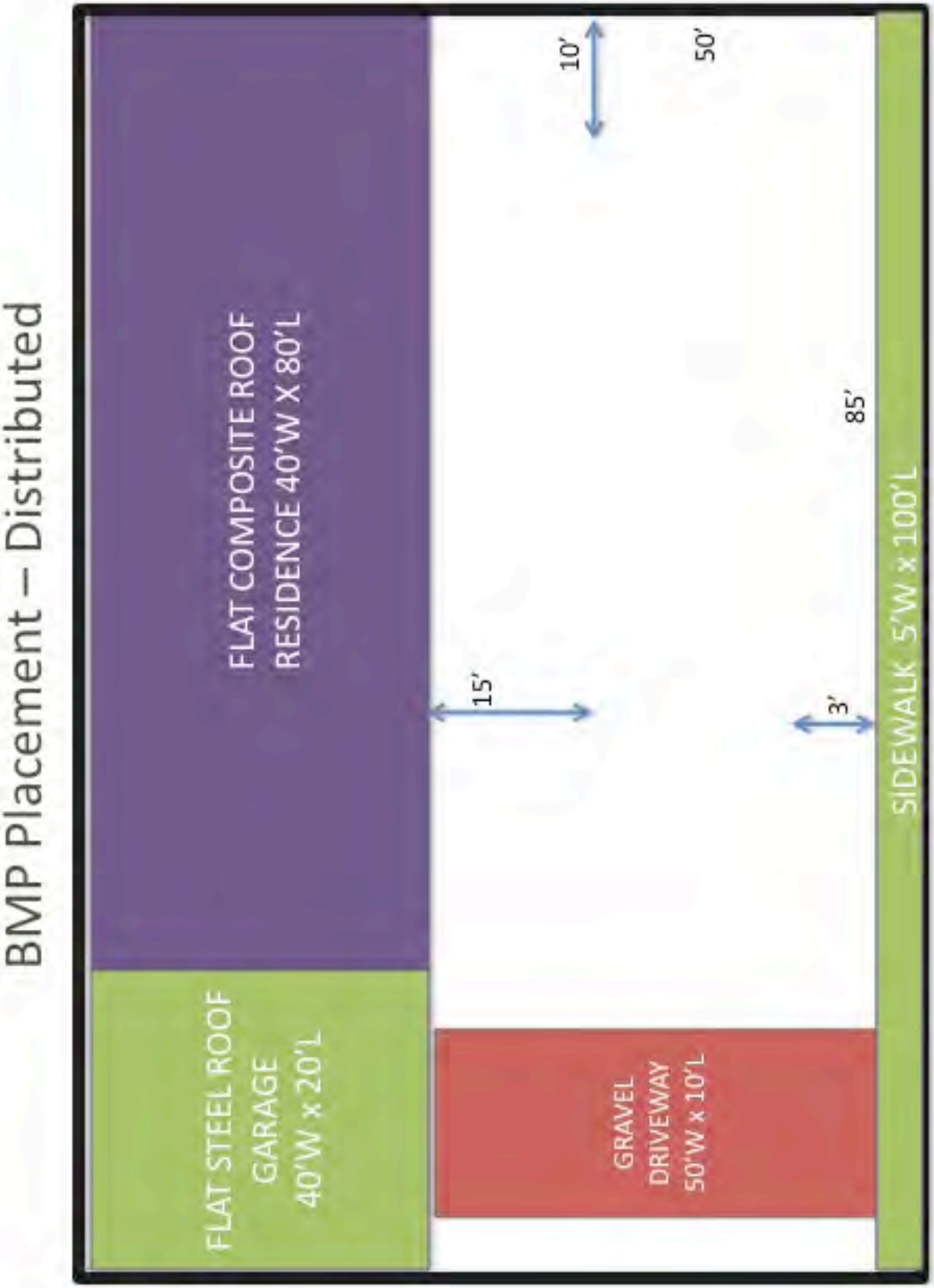
What is the Total Square Footage available for capture?

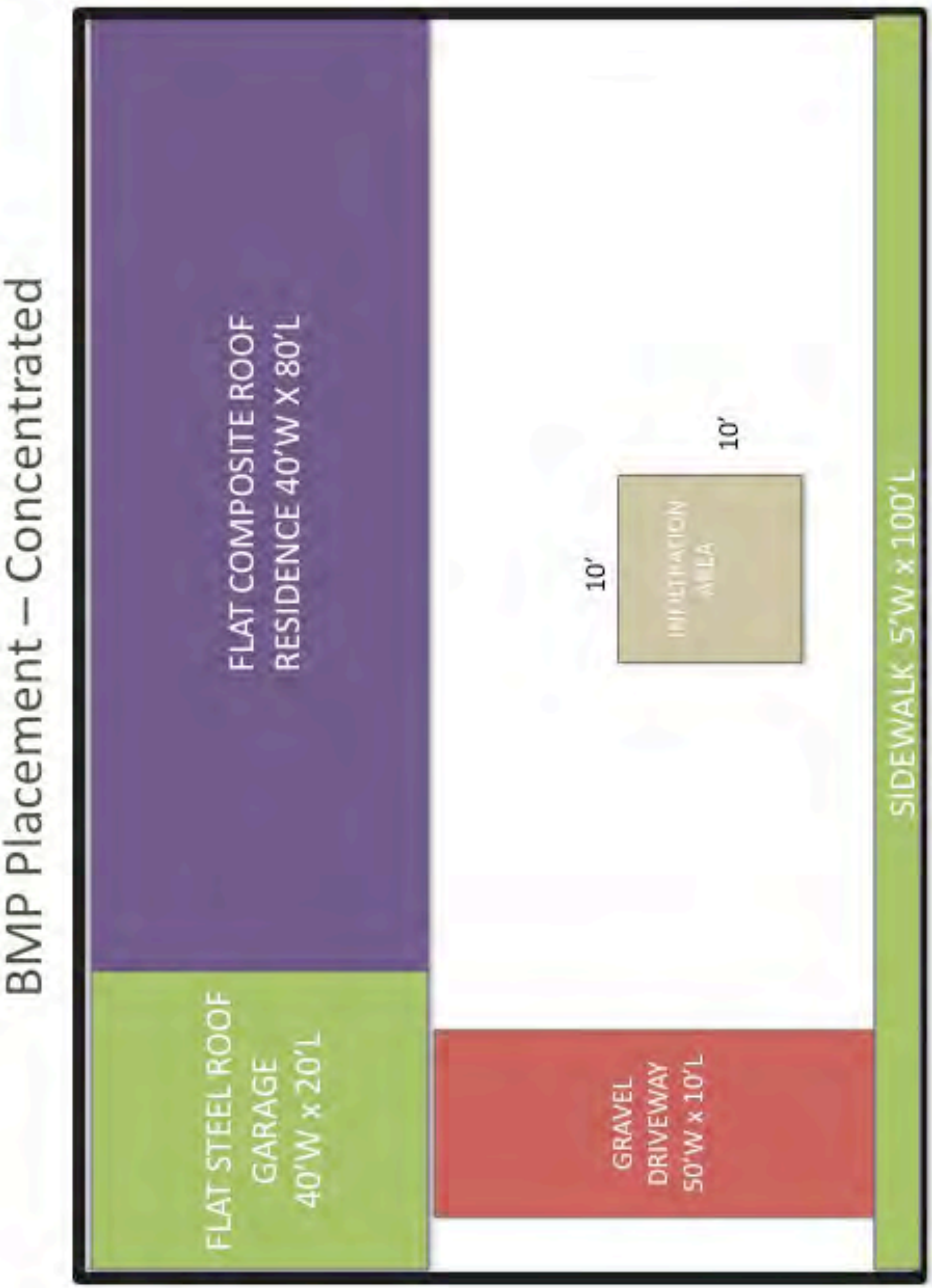
What is the Minimum Depth required of the BMP to capture First Flush if the entire BMP square footage is available for use?

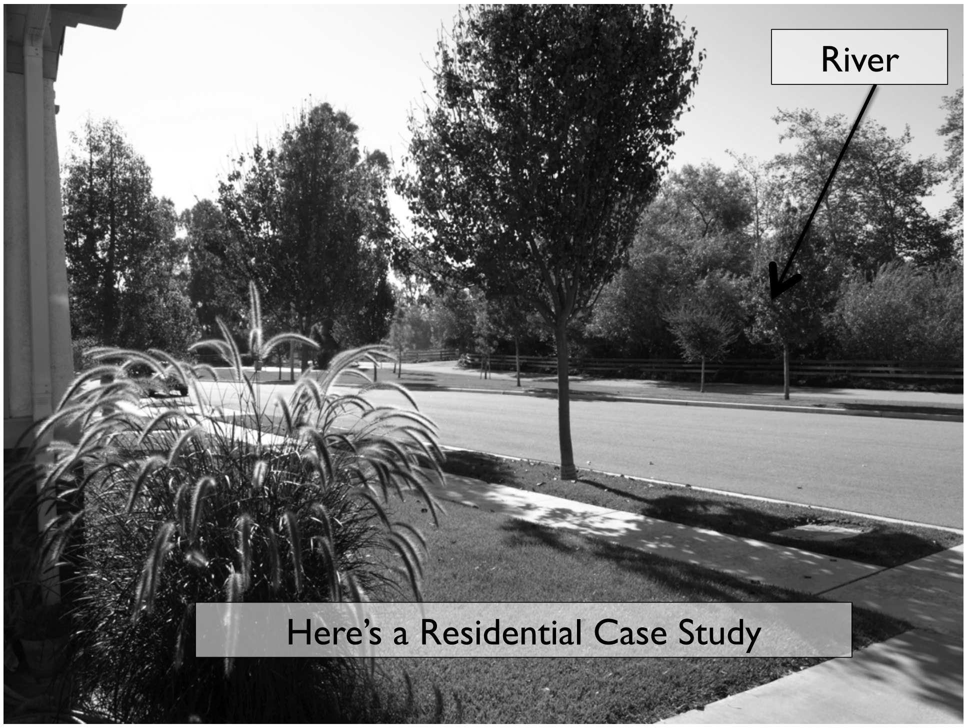
What is the Minimum Depth required of the BMP to capture A 100 Year Storm Event if the entire BMP square footage is available for use?

What is the Minimum Depth required of the BMP to capture First Flush if only 100 sq. ft. is available for use?

What is the Minimum Depth required of the BMP to capture Annual Average Precipitation if only 100 sq. ft. is available for use?


BMP Placement – Distributed
FLAT COMPOSITE ROOF
RESIDENCE 40'W X 80'L
FLAT STEEL ROOF
GARAGE
40'W x 20'L
GRAVEL
DRIVEWAY
50'W x 10'L
SIDEWALK 5'W x 100'L
10'
50'
85'
15'
3'


BMP Placement – Concentrated
FLAT COMPOSITE ROOF
RESIDENCE 40'W X 80'L
FLAT STEEL ROOF
GARAGE
40'W x 20'L
GRAVEL
DRIVEWAY
50'W x 10'L
10'
10'
INFILTRATION
AREA
SIDEWALK 5'W x 100'L


River
Here's a Residential Case Study


When We Showed up to Do a HOW…
The Homeowner Had Already Started Sheet Mulching

With a Little Professional Coaching He Developed a Design

Creating Contours and Low Spots to SPREAD and SINK IT

Boosting Soil Biology to Create a Healthy Sponge

But the Proof of the Sponge Is in the Rain It Holds

December – 4" or 1,600 gallons

The Proof of the Sponge Is in the Rain It Holds
February – 3.5" or 1,450 gallons

Native Plants Love the Sponge Garden
April – Needs 0 gallons irrigation


August: A Little Hand Watering Only


TWO YEARS LATER:
NO SIGNIFICANT IRRIGATION!

Gather Rainfall from the High Point of Your Watershed and Store It for a Dry Day

Start Designing for Capture and Use


Capture What You Can,
Spread & Soak the Rest

PASSIVE RAINWATER CAPTURE

Purpose:
1. Demonstrate how simple it is to redirect water from a downspout and hold it on the landscape.
2. Calculate the necessary land forming for capturing the first flush (1") of rainfall off a hard surface.

Preparation:
Find a site with gutters and downspouts and at least 50 sq. ft. of space in which to redirect the water from the downspout.
If the actual building of a rain garden is not feasible on the property, then get permission to use marking paint to lay out a future rain garden. All calculations, etc. are the same.

- Bunyip!!!
- Tri-C Premium Humate
- Paper rolls (3'x150')
- Scissors or box cutters
- Mulch – 4-6" depth
- Flags
- Measuring tape
- Hoses
- Picks
- Hand mattocks
- Shovels: flat and pointed
- Steel rakes
- Wheel barrows

Activity Cue: Field Work/ How to size a Rain Catchment BMP

1. Measure the size of the roof area contributing to the downspout
2. Draw a site map of the roof, downspout and target rain garden area.
3. Walk through the Simple Rain Garden math section of the book.
4. Identify area and calculate size for overflow.
5. Use bunyip to determine existing grade and grade of new garden area or swale.
6. Students pair up to practice using Bunyip to determine fall and depth for excavation of Capture Area.
7. Split students into three groups for site prep and grading: A) Trenching along hardscape, B)Excavating Basin, and C) Grubbing grass.
8. Team A begins digging trench 10" – 12" wide and at least 10" – 12" deep along all hardscape surfaces and any interfaces with other planter beds.
9. Team B begins excavating the basin area.

Continued

PASSIVE RAINWATER CAPTURE

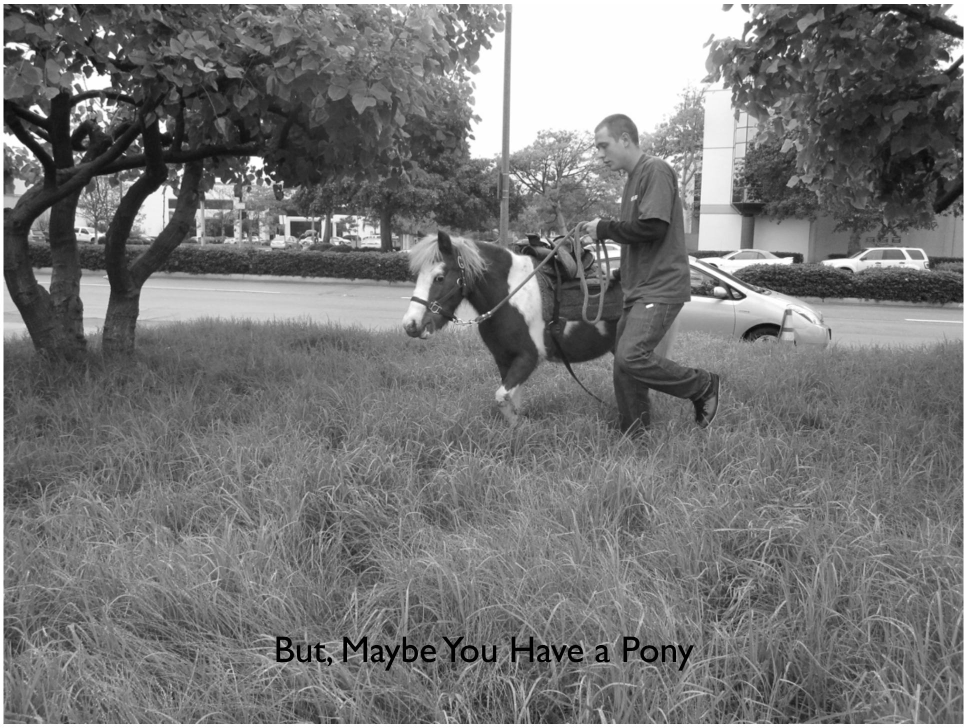
10. Team C walks the site and identifies any areas that need additional grubbing and weeding. Grubbed grass and weeds are to go to the dumpster with as little soil as possible.
11. As basin is excavated, students check levels with Bunyip.
12. Split students into five groups to begin sheet mulching: A) Humic Acid, B) Hose Wranglers, C) Mulch into wheelbarrows, D) Paper Rolling and Cutting, and E) Mulch out of wheelbarrows and raked on to site.
13. Review Sheet Mulching process and demonstrate a small area.
14. Lightly water whole area.
15. Spread humic acid, casting as evenly as possible over entire area.
16. Roll out paper starting at trench. Two people minimum are needed: one to roll and one to cut. Try to complete 2 rows before mulching.
17. Make sure there is at least 6" of overlap between the rows of paper.
18. Water the paper to make it stick to the soil (think paper mache). Watch out for stepping on the paper or it will rip!
19. If there is a rip, repair it with a patch that covers adjacent paper at least 6" on all sides.
20. Cover paper with 4" – 6" of fresh tree trimming mulch.
21. Water mulch constantly to get complete saturation to the soil.
22. Clean up.

Field Work and Calculations: 140 minutes
Q&A: 10 minutes

BUILD HABITAT AND COMMUNITY

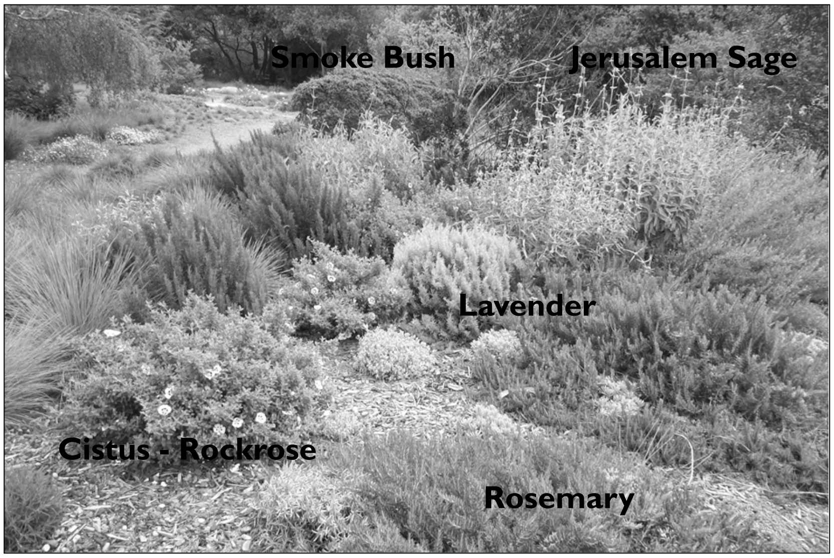
Introducing:

- Planting For Pollinators
- Considerations For Turf Removal
- Cutting Curbs


But, Maybe You Have a Pony


Or Have Already Minimized Your Lawn Area

And Replaced It with Mediterranean Plants That Thrive in Southern California...



Remember That Local Natives Feed the Native Locals


So Try
Natives,
Even with
an Edible
Garden


What Do We See Happening Here
Too Narrow for Spray
Too Narrow for Turf

Try Changing Out Parkway Concrete or Turf for Groundcover

Or Change Both Garden and Parkway


Sheet Mulch and Add a Curb Cut


Install a Drip Irrigation System

Invite Friends for Planting Day

Resist the Urge to Overplant


Start with Small Plants and
Watch Them Grow


Plants Will Grow!

Every Garden Needs Continued Maintenance to Remain Healthy

There Are No Zero Maintenance Gardens!

Become a Part of G3

1. Complete the Exam with score of 75% or better.
2. Sign up for G3 Blog, Facebook & Twitter.
3. Watch the G3 Calendar for information about events in your area.
4. Become an active volunteer in your neighborhood.
5. Attend a G3 Communications Workshop to become a G3 Qualified Trainer.
6. Attend G3 Intensive Seminar and become G3 Certified Professional to qualify for greater design, consulting, education, and activism collaboration.
7. Use your skills to build your Green Career.

Watershed Wise
Landscape Program

green gardens group

Seminars

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