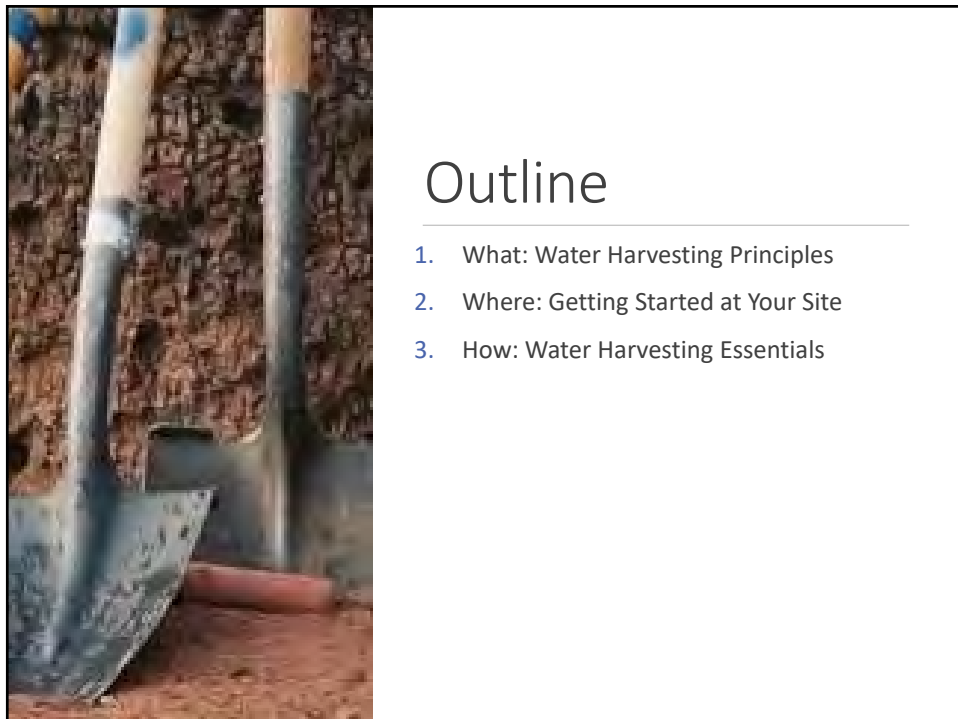
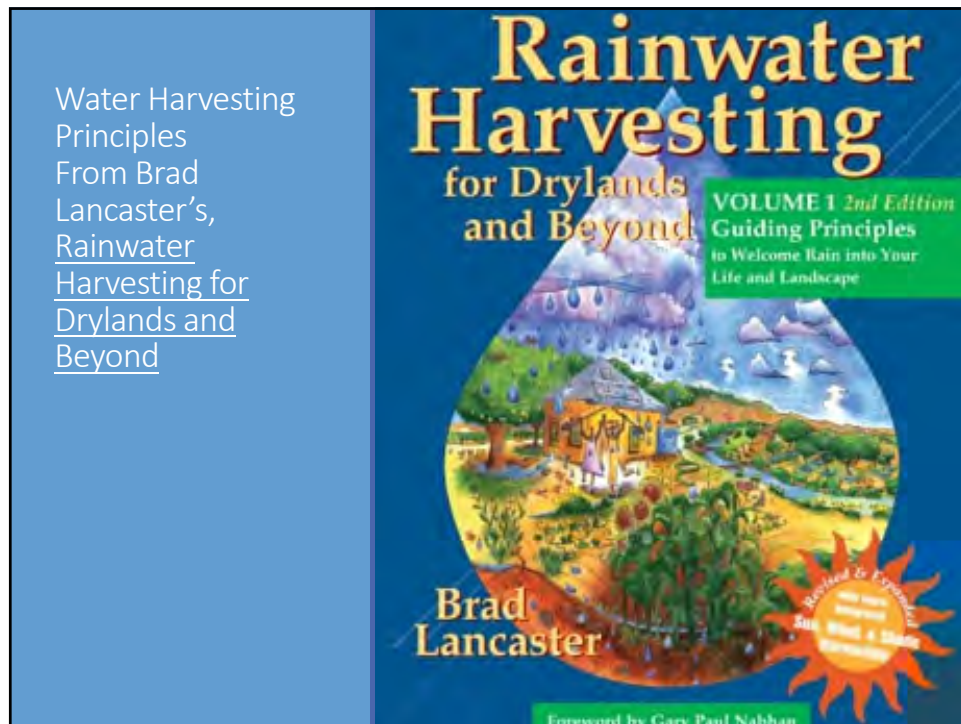




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1. Begin with Long and Thoughtful Observation
Water Harvesting Principles

4



2. Start at the Top

Water Harvesting Principles

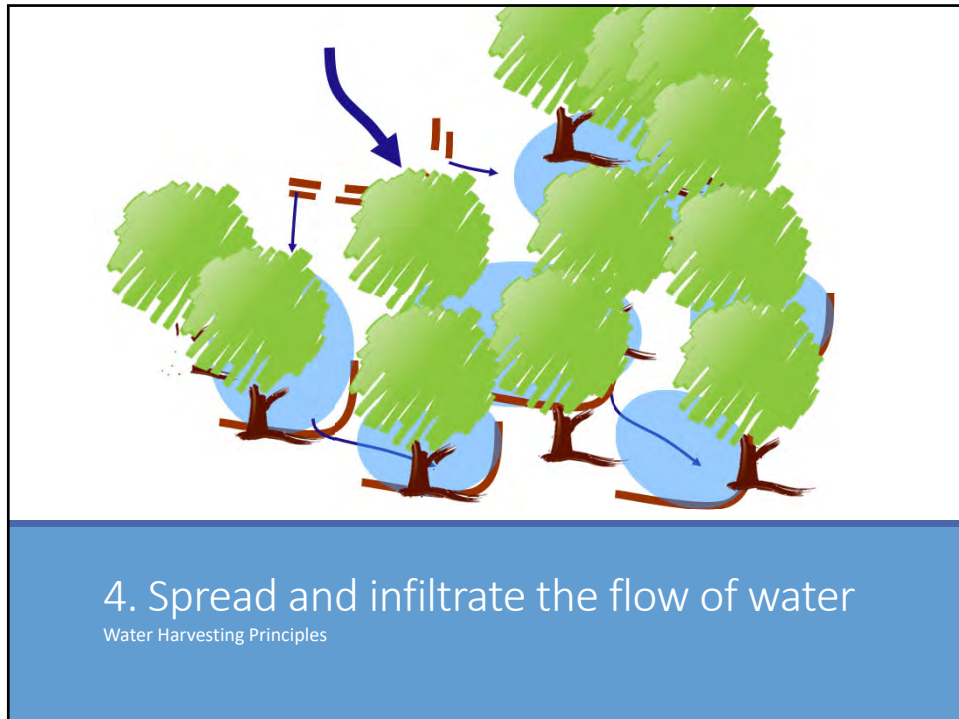
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3. Start small and simple

Water Harvesting Principles

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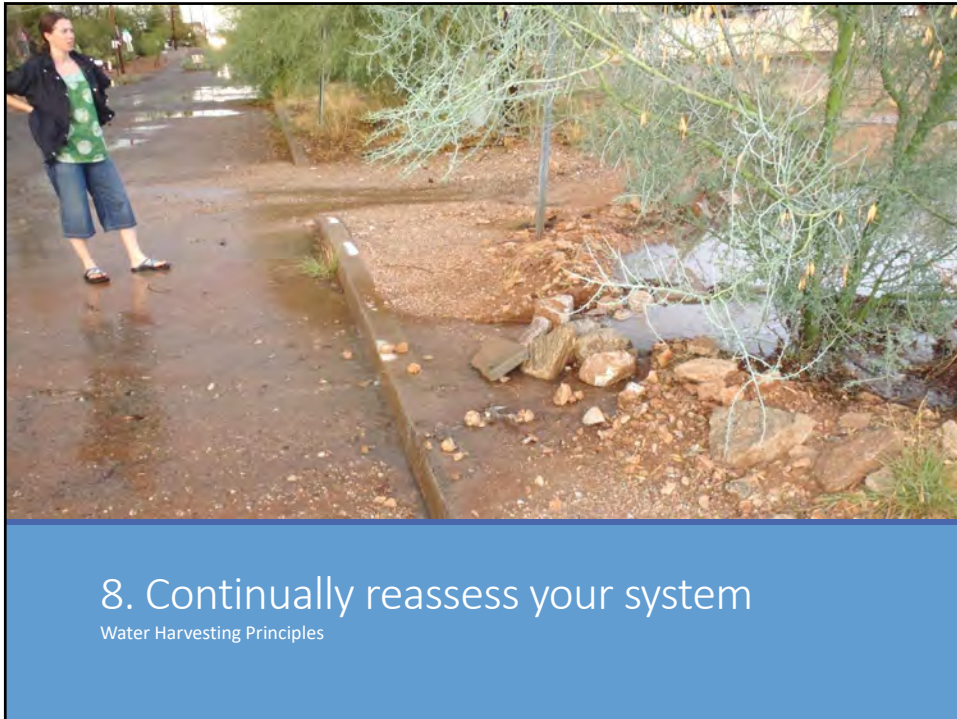
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8. Continually reassess your system

Water Harvesting Principles

11

WHERE?

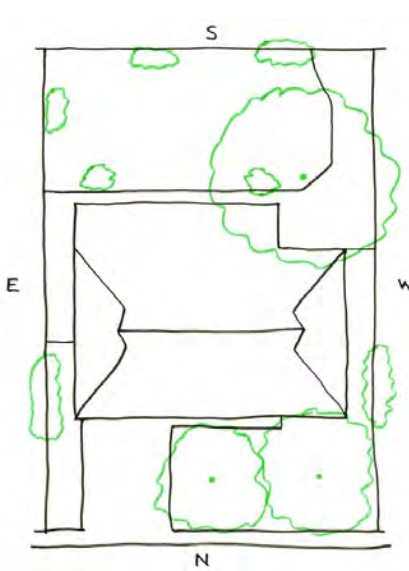
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1. Begin with Long and Thoughtful Observation

Water Harvesting Principles

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DRAW YOUR SITE

- Property lines
- House
- Other permanent structures (storage sheds, pool, driveway, sidewalks, etc.)
- Existing trees and shrubs
- Mark direction - North, South, East, West

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SECTORS / FACTORS

Sectors deal with the wild energies...from outside our system and pass through it.

Intro to Permaculture pg. 14

- Sun
- Water
- Wind
- Fire
- Wildlife
- Pollution
- View
- Utilities
- Community

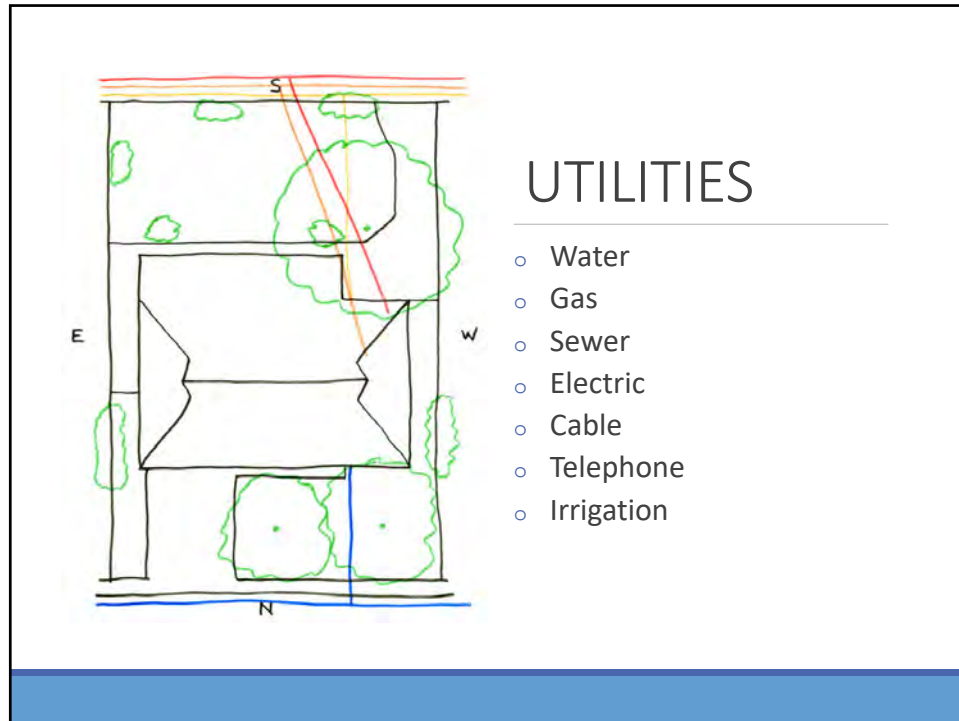
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UTILITIES



- White = Proposed Excavation
- Pink = Temporary Survey Markings
- Red = Electric Power Lines, Cables, Conduit and Lighting Cables
- Yellow = Gas, Oil, Steam, Petroleum or Gaseous Materials
- Orange = Communication, Alarm or Signal Lines, Cables or Conduit
- Blue = Potable Water
- Purple = Reclaimed Water, Irrigation and Slurry Lines
- Green = Sewer and Drain Lines

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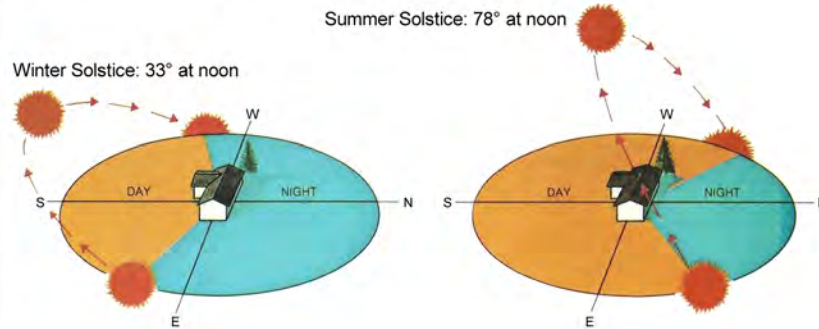
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SEASONAL SUN ANGLES

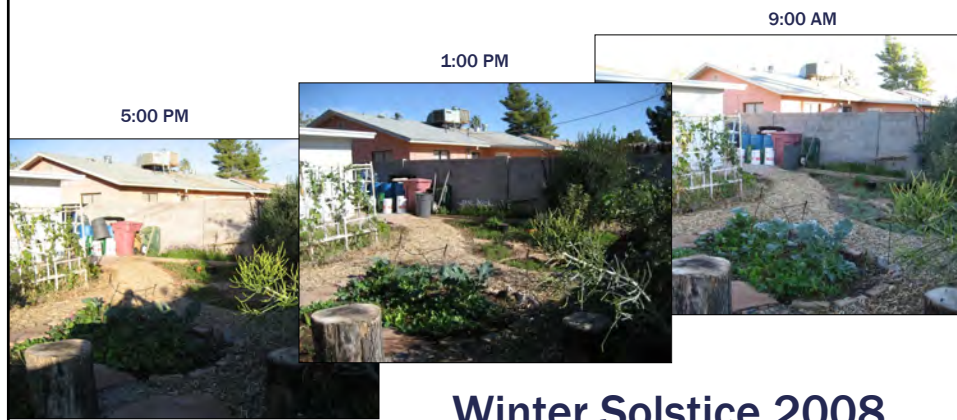
Seasonal Sun Angles - Phoenix, AZ



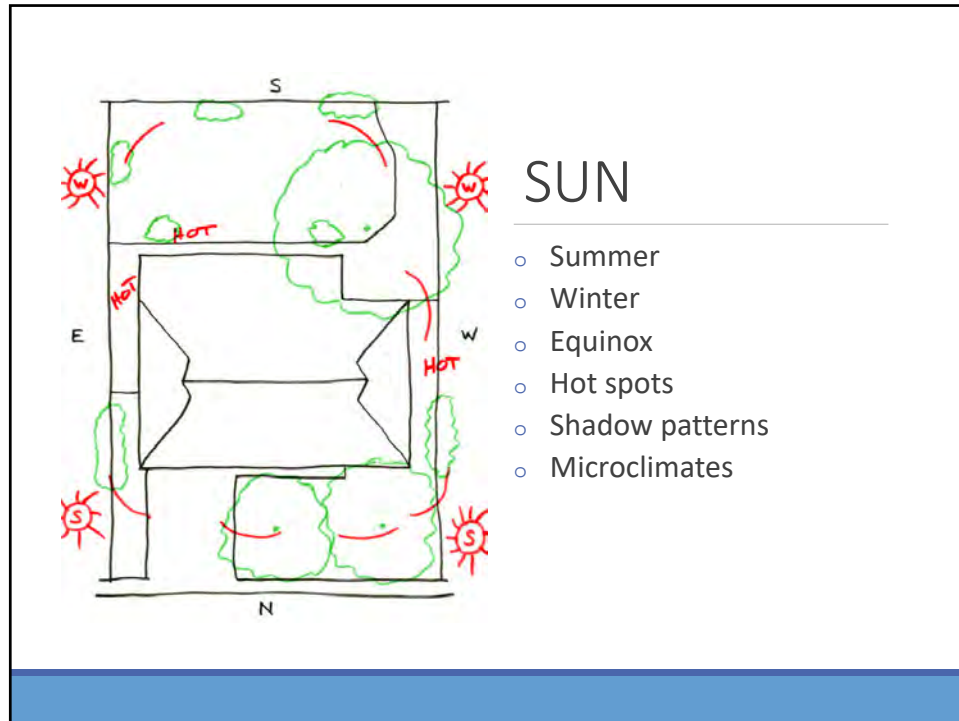
NOAA Solar Calculator
<http://www.esrl.noaa.gov/gmd/grad/solcalc/>

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SEASONAL SHADE PATTERNS



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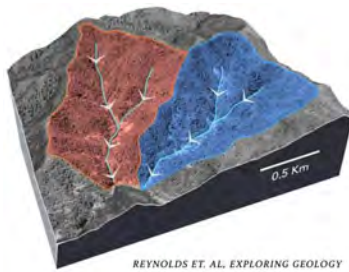
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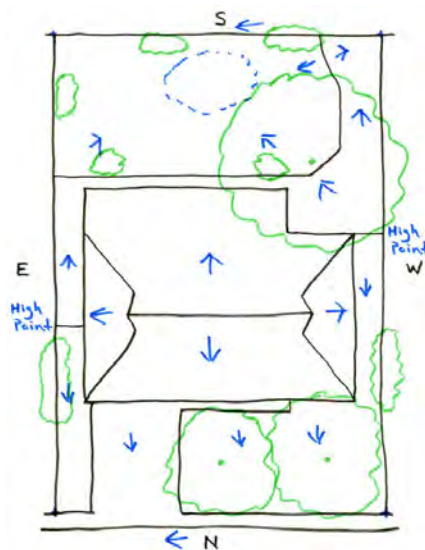
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Watersheds

Watershed: a watershed is the land area that drains water to a particular stream, river or lake. An area that drains to a common point.



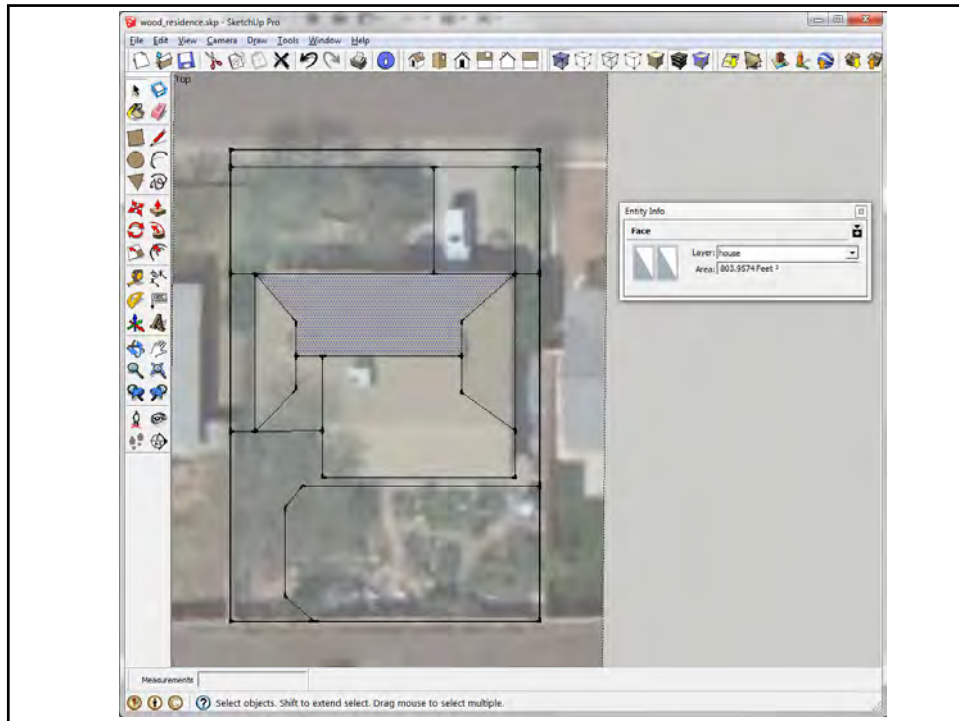
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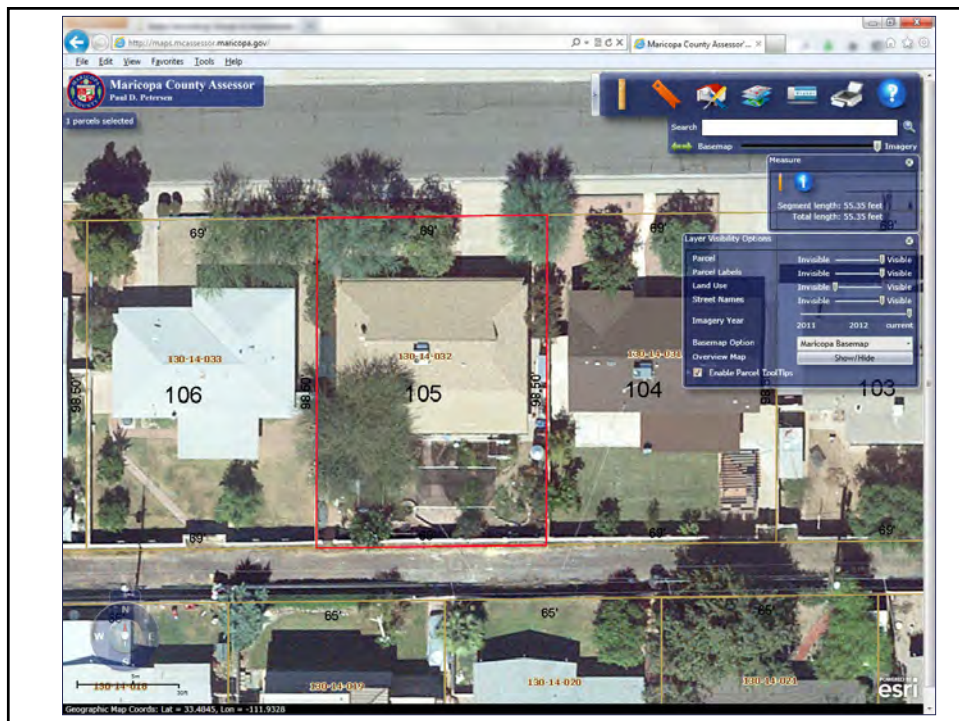
WATER

- Watersheds, subwatersheds
- Water movement
- Slope, topography
- Hose Bibs
- Annual rain fall
- Determine square feet
- Multiply square feet by .623 to convert into gallons for a 1" rain

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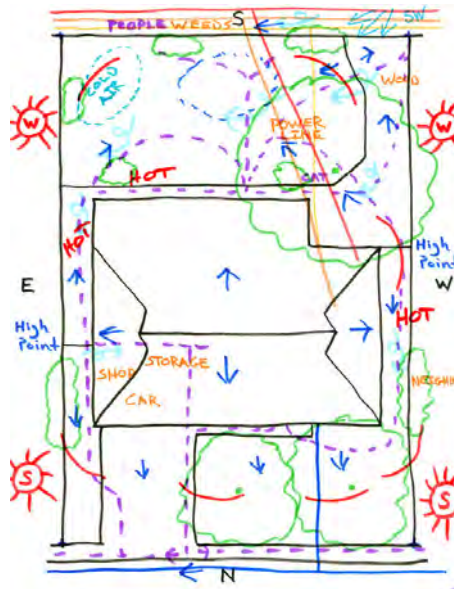
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SECTORS / FACTORS

Sectors deal with the wild energies...from outside our system and pass through it.

Intro to Permaculture pg. 14

- Sun
- Water
- Wind
- Fire
- Wildlife
- Pollution
- View
- Utilities
- Community



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HOW?

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Water Harvesting (Passive) Earthworks

Created features formed from soil, rock, or plant material

Use gravity to distribute rain runoff

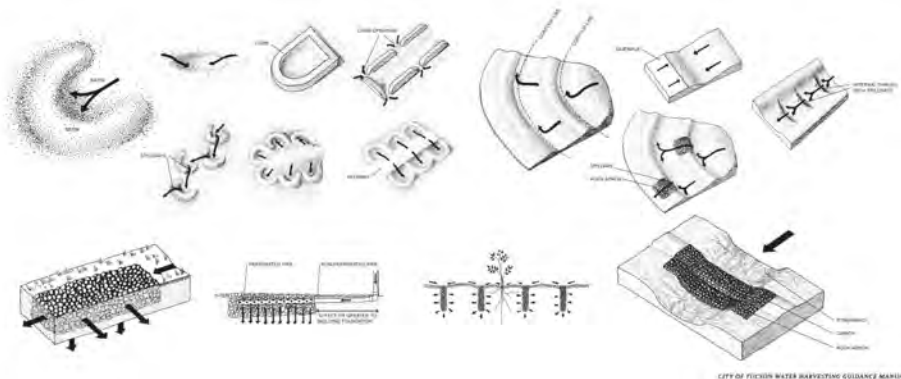
- SLOW
- SPREAD
- SINK

Cheapest storage option for large amounts of rainwater



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Earthworks Slow it, Spread it, Sink it!



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Convey: Swales



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Infiltration: Basins



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Raised: Berms



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Infiltration: French Drains

> 10ft from structure

Water source needs to be free of
sediment & particulates

Use angular, uniform sized rock
(~40% porosity)

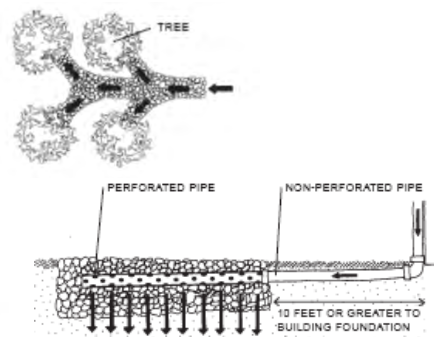
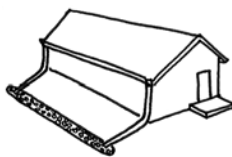


Figure Sources: City of Tucson Water
Harvesting Guidance Manual and
Watershed Management Group
Earthworks Handout

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Sizing Earthwork Capacity

1. Stormwater retention
(Design storm event: 25yr, 50yr, 100yr) – Flood control (Lancaster, Vol 2, pg 136)
 - Calculate open capacity of feature
 - Size to meet estimated stormwater runoff
 - Ensure water will percolate in 12 to 24hrs
2. Percolation Rate Method
Greywater Systems (Ludwig, A., pg 13)
 - Surface area needed to infiltrate peak water volume
 - Based on percolation rate and discharge volume
3. Plant Needs
Irrigation/Dryland farming (Lancaster, Vol 2, pg 80)
 - Sized to capture sufficient runoff from catchment area to irrigate specific plant(s)

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Sizing for Stormwater Retention



cfp.arizona.edu

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Sizing Earthwork Capacity

Runoff Coefficients for the Southwest United States

Surface	Runoff Range	Notes
Roof	0.80 – 0.95	Metal: 0.95, Concrete/asphalt: 0.90, Built up tar/gravel: 0.85 – 0.80
Paving	0.90 – .95	Older irregular surfaces may be lower than 0.90.
Bare Soil	0.20 – 0.75	A best guess based on characteristics of soil and experience. Unprotected soil surfaces tend to surface seal easily unless high levels of organic material or a high content of sand is present.
Soil with Vegetation	0.10 – 0.60	Leaf litter, basal area, and roots all help increase infiltration rates and can also absorb water.
Grass/Lawn	0.05 – 0.35	A high density of leaf area and root densities help reduce runoff. If soil underneath is compacted runoff rates can be higher.
Gravel	0.20 – 0.75	Use the coefficient of the ground below the gravel

*Chart adapted from 1) Lancaster, Brad, 2006, Rainwater Harvesting for Drylands, Vol.1 Rainsource Press and 2) Waterfall, Patricia, 2006, Harvesting Rainwater for Landscape Use 2nd Ed. Pima County Cooperative Extension.

Potential Harvested Rainwater Volume (gallons)

Catchment area (ft²) x rainfall depth (in) x 0.623 (conversion) x Runoff Coef. = Volume (gallons)

Calculating Basin Volume (gallons)

- Quick Estimate: Average Surface Area (ft²) x Average depth (ft) x 7.48 (gal/ft³) = Volume (gallons)
- More Accurate Ballpark: Depth (ft) x [(L1 x W1) + (L2 x W2)] / 2 x 7.48 (gal/ft³) = Volume (gallons)
- Most Accurate: CAD or GIS based delineation and calculation

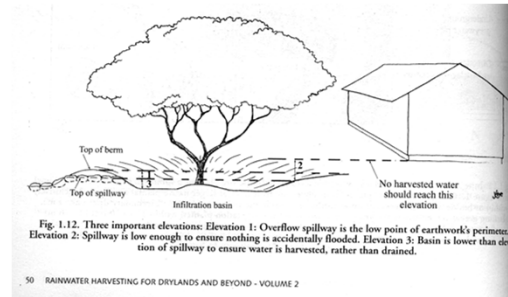
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Locating Earthworks

Consider:

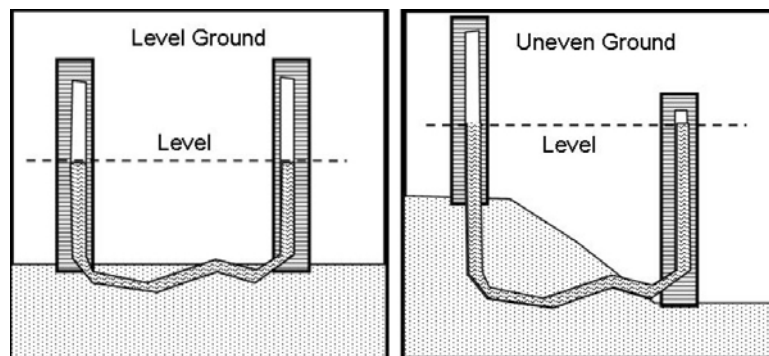
- Utility Lines: ~ 2-10ft distance
(Call a Utility Locating Service!)
- Structural Foundations: ~10ft distance
- Pathways: raise and use to manage runoff (i.e. berm)
- Right-of-ways (ROW): lookup local restrictions

Remember the 3 Elevations:



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Water Level (Bunyip)



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Toolbox – Passive Features



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Vegetation: Native / Adapted



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CAUTION!!

Flooding

- Slowing Runoff -> backing up surface flow upstream

Ponding -> standing water risks

Mosquitos -> minimize ponding time

Structural and Utilities -> protect infrastructure

Soil Saturation/Loading -> slope instability/failure

Walkability/Bikeability -> Always promote alternative transportation activities

General Safety -> vertical drops (<18"); excavation and sediment control; traffic visibility; plant types, etc...

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Maintenance

Observe:

- During and after rainfall events
- Seasonally

Check:

- Overflow – Appropriately sized and placed
- Percolation – Duration of standing water
- Capacity – Loss, undersized, ...
- Stability – Rocks are secured; soil surface stable
- Plant Productivity – Sufficient water, placement, ...
- Mulch Material – Need to add more?

Adjust & Improve:

- Design – capacity, aesthetics, water routing, ...
- Plants – species, placement, ...
- Soil Improvements – drainage, nutrients, ...

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Questions?

Watershed Management Group
www.watershedmg.org
Office: 520.396.3266

Ryan Wood Design
ryan@ryanwooddesign.com
Cell: 602.618.6650

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Thank You!!!



Phoenix Green Living Co-op Project 10/12/2013

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