Stormwater Infiltration Demo Info Sheet

DRAFT—December 7th 2015 art@oasisdesign.net

Your comments & corrections welcome; lots of new ground covered here

Optimizing one element in isolation pessimizes the entire system
—Natural Capitalism

Background

The perfect storm of crises we face is largely from the collateral damage of addressing problems in isolation. The way out of this mess is to seek a dynamic, integrated solution that optimizes for all the relevant factors at once. Doing this requires new brain wiring and tools for systems thinking.

And…our new climate requires redesigning our infrastructure. Extreme drought and flood events are becoming more frequent and intense as the climate changes. Warmer air holds more water, so more of our rainfall comes as "water bombs"—extreme rain events. The most extreme rain event in Santa Barbara flood control history occurred in December 2014. In the midst of the worst drought in recorded history, we got 1.2" in 15 minutes. Based on historical records, this should only happen every 400 years. The assumption that present—let alone future—rainfall can be predicted from the past record is no longer valid.

To achieve groundwater recharge, infiltration must exceed evapotranspiration. With warmer soil and air temperatures, more rainfall events will wet the surface of the soil sponge only to have it all evaporate and transpire away. To get below the root zone you need a lot of rain. And, if that rain comes down fast, most will just run off. We often engineer with runoff coefficient as a static assumption, but rainfall intensity is the main driver of the runoff coefficient, and it is anything but static. To get recharge, rainfall has to thread a needle: enough to get below the root zone, concentrated enough in time not to just evaporate, but not so concentrated that it runs off. The percentage of rain that threads this needle and makes it into the groundwater is small. And (I haven't really heard people talking about this) it seems like this percentage would be shrinking dramatically due to climate disruption.

Thus, we face a situation where:

1) In order to maintain our existing level of flood damage we need to make every storm drain in the county bigger…or increase water retention in the landscape

2) In order to maintain historical rates of groundwater recharge, infiltration rates must increase to offset higher runoff and evaportranspiration rates.

General Solutions

Much as greywater is the best residential systems thinking gateway[1], **stormwater is the best government agency systems thinking gateway.**

The old, isolated silos model: flood control dumps stormwater in creeks, these dump to the ocean; EH posts swimming advisories; Water Resources buys state water.

In contrast, integrated, optimized stormwater management might look something like this:

- **Flood control** — adds infiltration infrastructure to shave peaks off higher "water bomb" storm loading so the existing conveyance system is not overloaded
- **Water resources** — supports infiltration on public and private land as foundational component of sustainable water supply upstream of the meter
- **Water conservation**—support offsets to potable water use downstream of the meter due to improved on site topsoil storage, and use of rain and stormwater. (Quantity of rain on the average SB lot = quantity of metered water! Doesn't seem like it as most of it runs off with little beneficial use)
- **Planning**—ensure that land use takes into account areas where infiltration is geologically unsafe and areas where it should be maximized
- **Parks, Creeks**—promote infiltration on their land, educate through signage and events
- **Schools** —educate kids so they can catch their parents up to evolving ways of doing things, utilize large, flat play fields as stormwater spreading basins, landscaping for rooftop rainwater infiltration (La Cumbre Junior High, for example, has a 24" storm drain that looks like it flood their acres of flat turf for irrigation/ infiltration)
- **Waste management** —route green waste, tree chips, compost to where it will do the most to increase infiltration in the soil sponge and reduce climate impacts
- **APCD** —supports reduction of pollution from landfilling greenwaste, greenhouse gas reduction
- **Government regulators**—regulate chemicals and products that threaten groundwater quality
- **State Water Regulators**—support local efforts with funding and best practices information
- **Higher education**—research and codify best practices for local conditions
- **Landscapers, landscape architects, homeowners**—re-landscape the County for contextually optimum stormwater management; shedding, storage or infiltration. Improve soil tilth (the soil sponge within SB city limits holds about as much water as Gibralter reservoir…and, instead of being subject to siltation, it's capacity can be increased with good management)
- **Agriculture**—manages storage in the soil sponge for reduced water use, and does seasonal recharge where soil and geological conditions are appropriate

The first step to breaking down the silo walls and collaborating is to meet and talk with

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[1] Involves the most connections and context sensitivity: tune together fixture flow rates, user habits, plant selection and location, site rainwater and stormwater management, management of green waste—all for the site soil and slope conditions and context.

each other, which is why we invited you to our house today. That, and to see our Stormwater Infiltration demo:

A specific best practice

One way to increase recharge in the system we're sharing today is to **take concentrated stormwater, slow, spread and sink it into the soil sponge in small, shallow distributed mulch basins.**

As far as I know this has not been studied to the degree more industrial means of enhanced recharge have been. Yet, it appears that large numbers of these basins could make a significant contribution: Rough estimate for the city of SB: 3000 afy….better estimates are an objective of our work.

The soil needs to be porous enough for this excess water to sink in quickly (we have that here), and the geology needs to be stable enough that the slope isn't likely to fail (our neighborhood has very unsafe slopes in places, our site is relatively flat and indications are that infiltrated water goes deep into the bedrock fissures below rather than spreading laterally). Then, the concentration of rainfall needs to be enough such that the amount of water far exceeds evaporation and transpiration—we have major run-on potential; up to 3 acres of catchment.

Then this water needs to be conveyed to soil with a surface shape that **holds the concentrated water so it doesn't just run off.** And, the soil needs to be mulched to increase tilth. Note the difference in infiltration between the raw mineral soil on the NE basin and the twenty years mulched soil around the tangerine…it's on the order of 10x. Parts of our land have 50x better infiltration than when we moved in.

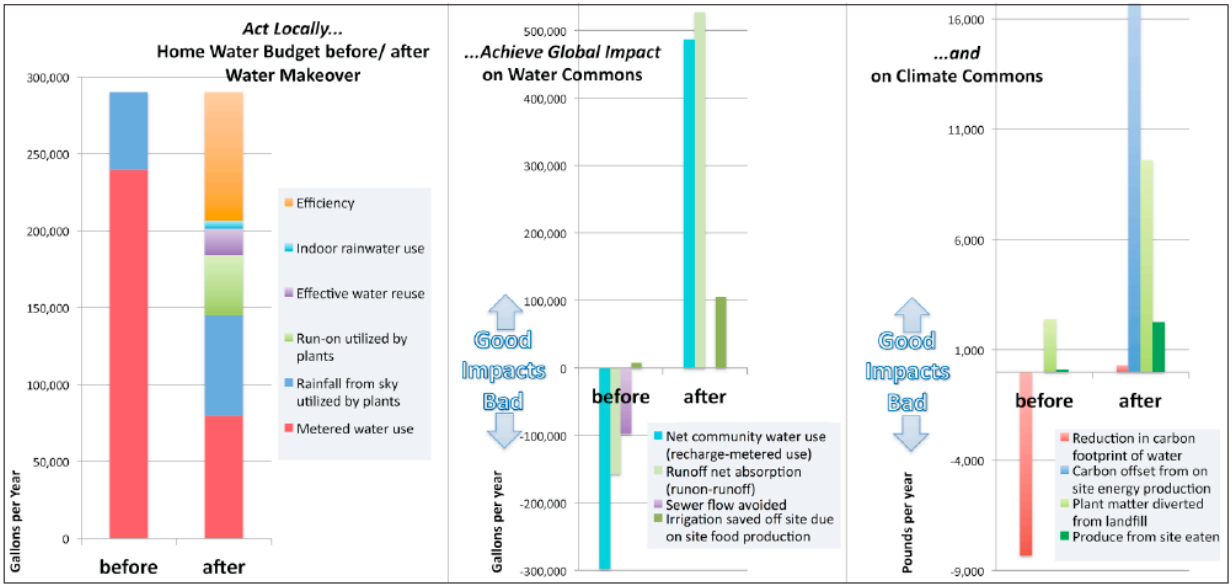
How does this simple, passive system perform?

A typical project that conforms with modern LID requirements might absorb an inch of site rainfall in an hour; beyond this the runoff coefficient might be 70%.

The site you are seeing today has absorbed nearly 100% of two different 100 year events; 6 inches in six hours, and later the same year, two inches in 48 minutes… and this was **before** the giant upgrade in capacity we just completed.

The potential of this upgrade was invisible to me until I developed a protoype of water wizard software that quantitively tracks budgets for all rain, stormwater, runoff, run-on, fixture-by-fixture, and plant-by-plant water use, efficiency, storage, water reuse, sewage flow, and recharge for a property. And translates all these factors into a list of suggested water actions ranked for your particular context.

This may be the best systems thinking aid I've ever used. With the full scope of the water budget illuminated, it was clear that in our particular context stormwater is significant for us personally, and the contribution of infiltrating stormwater run-on for water and climate commons benefits is bigger than every other action we could take combined:

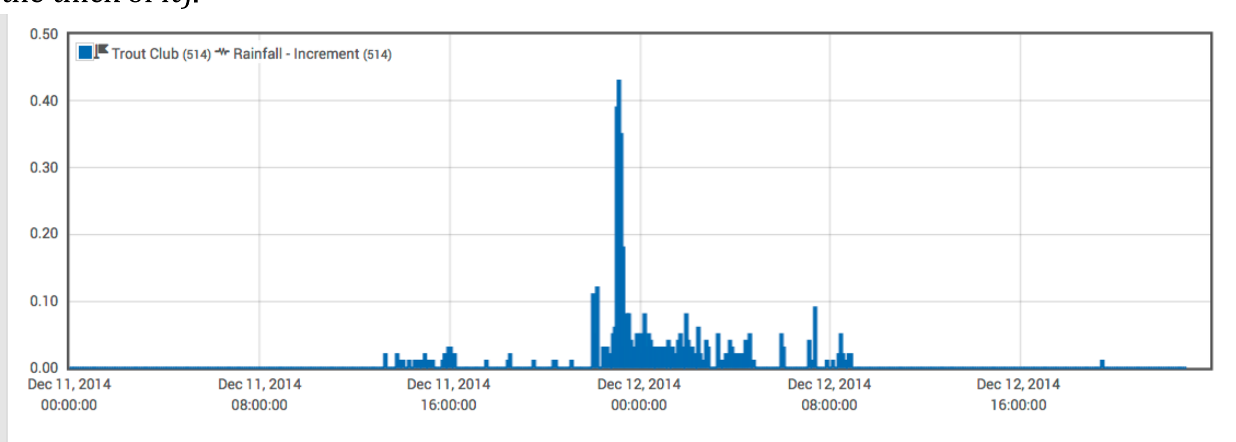


Residential water budget graphs, before and after water makeover.

So…we upgraded our system to go from the 30,000 gpy personal water benefit to the 500,000 gpy water commons benefit (200,000 to 1,000,000 gallons this winter depending on the outcome of Godzilla vs The Blob).

On paper, the system we're sharing today should be able to absorb 100% of the rainfall from a repeat of these two 100 year rain events….*from an area six times as large as the property, as well as the property itself (!)*

Additionally, *it might be able to capture 100% of a repeat of the 400 year rain bomb from a 10x area.* This is estimated to deliver 3500 gpm for 15 minutes. (The image of this rain bomb flow at 2 am was never far from mind…I feel very lucky to have been there right in the thick of it).



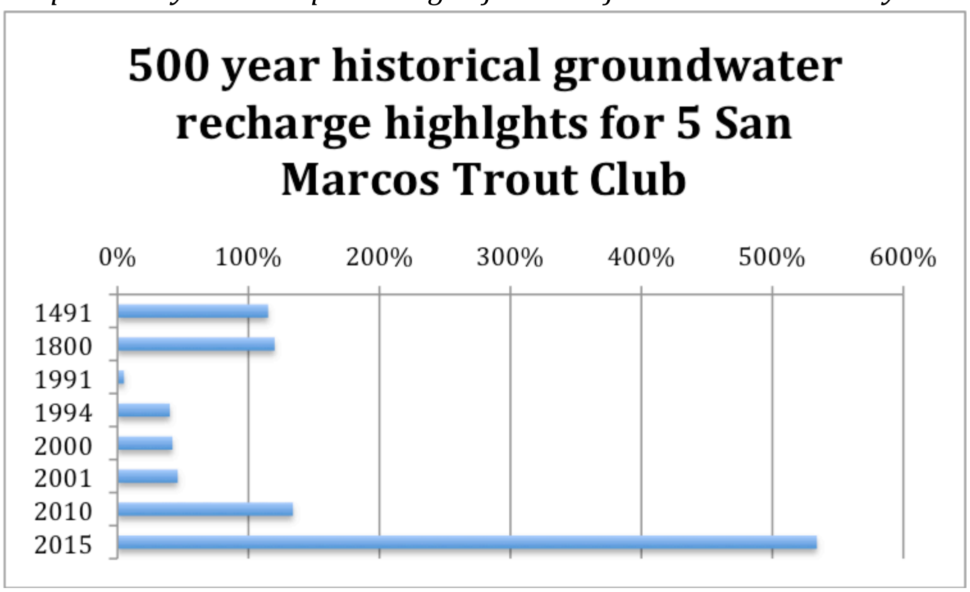
*Graph of a rain bomb; 0.4" of rain for each of three consecutive **five-minute** periods. The county had just calibrated the rain gauge. Wish I had a way of downloading a picture of the flow from my mind…*

How will the system be affected by the chaos of incoming gravel and mud flows, falling branches and trees, UPS truck sized boulders falling into the road, etc.? Perhaps in a few months we will know.

- The inlet capacity is 3500 gpm.
- The infiltration capacity of the 4000 ft2 of infiltration area is in the neighborhood of 600 gpm ..continuous.
- There is about 12,000 gallons of above ground surge capacity in the basins (4000 ft2 4" deep).
- There is approximately 100,000 gallons of storage in the top four feet of sandy topsoil

The French drains for our downstairs can serve as sampling points for vadose zone water quality and quantity: almost no water comes through this drain line, which is 8 ft below the surface just 20-50 feet from a major infiltration zone, which suggests that the water quickly finds fissures in the bedrock and goes deep.

A rough estimate of the amount of recharge on this 14,000 ft2 of land at significant points in the past 500 years as a percentage of the rainfall that lands directly on the site.



- **1491:** burned annually to facilitate acorn harvest, large oaks, native bunch grasses?
- **1800:** Annual burning stopped by European settlers; lots of organic matter/ fuel accumulation
- **1992:** last year before we purchased the property. Leaves raked up, whole yard is bare earth, much of it compacted. 4000 ft2 has super hard, impervious soil where soil profile was inverted for leachfield replacement.
- **1994:** We planted 160 trees, mulched everything to 4" depth, re-contoured land with basins and swales.
- **2000:** We restored the soil profile; topsoil back to the top, subsoil under
- **2001:** Run on capture with temporary 1" tube
- **2010:** Run on capture with two 2" hard plumbed pipes
- **2015:** Run on capture with 60 in2 flume, 5 curb cuts, more water retaining terraces

If you want to support this work…

- Talk with your colleagues in other departments and agencies
- Support the County Water Agency to bring all the water entities together in common cause on stormwater.
- Read Brad Lancaster's books (Rainwater Harvesting for Drylands vol 1 and 2) and try these practices out at your own home, and in your work (if you buy them from us it will help us pay our water bill…we used 15% of 60 days allotment in 10 minutes today)
- Join the statewide collaboration I'm promoting to 1) fill data gaps needed to engineer small scale infiltration and 2) accurately estimate water supply contribution potential 3) codify best practices and create educational materials for engineers, landscapers and homeowners (I am currently negotiating a contract with SB City and EBMUD to do some of this needed work… the state is also interested in funding it. One reason this class of tools is underutilized is that it lacks a corporate champion; there's no patent on basin shaped dirt, no mulch manufactures association to lobby for standards that mandated use. Public agency support for these public domain technologies is needed to fill this vacuum.
- Email Frances Spivy-Weber at the SWRCB ***before Dec 15th*** and ask that:
  1) the state eliminate the inflexible requirement for 50% local matching, at least for projects that have uniform statewide benefit,
  2) encourage the SWRCB to consider supporting the collaboration for filling data and best practice information gaps described above,
  3) investigate the potential benefits for development and statewide deployment of the Water Wizard software I mention above