HADLEY AND PETER ARNOLD

Pivot: Reconceiving Water Scarcity as Design Opportunity

Mapping a more absorbent landscape

Thirty million people in the American West depend on snowmelt to grow food, slake their thirst, and run their towns, cities, and industries. Twenty-two million of them live in Southern California. As in many parts of the world, western water supplies are over-allocated and populations are growing. Increasing variability in precipitation—the primary impact of climate change on the hydrologic cycle—exacerbates the stress: longer droughts, less snowpack, and earlier snowmelt are already observable. Current climate models estimate that 70 percent of western snowpack will be gone by 2100.

Water scarcity presents a profound challenge and opportunity for designers of the built environment. The questions reach beyond, where do we get more water? And how do we make do with less? Or even how do we build margins of water security into our cities or restore damaged ecoystems in our source ranges and valleys? These are critical questions engaging vast fields of engineers, economists, environmentalists, and policymakers. But the answers do not all lie in policy or technology. For designers, the questions are physical, spatial, qualitative, and experiential—fully vested in the

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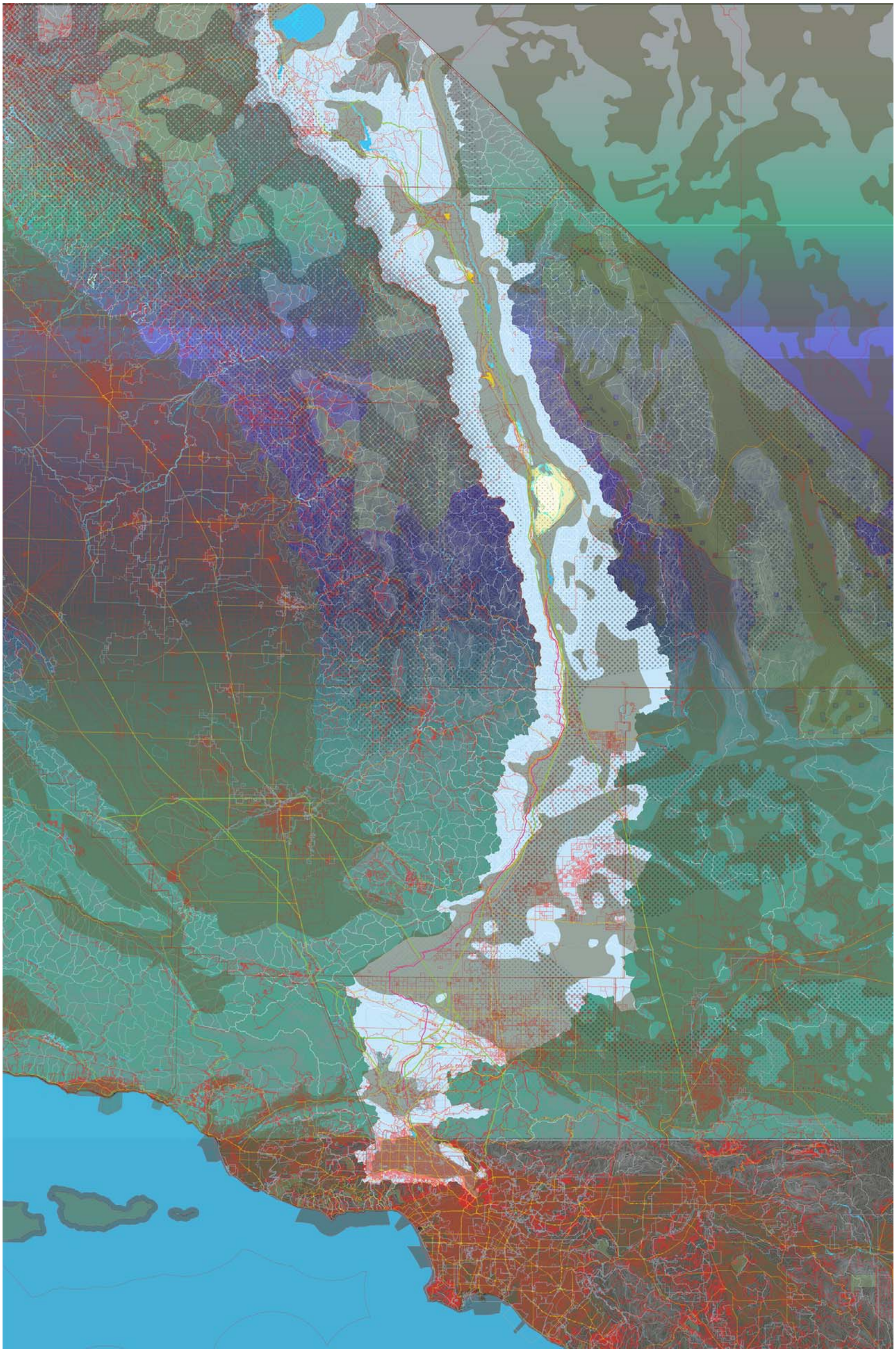


Mapping the Los Angeles Aqueduct. MAP COURTESY OF ARID LANDS INSTITUTE, CESIA LOPEZ AND ERIC LADOUCEUR.

knowledge that space and place matter. How do we craft cities and buildings that consciously and visibly mitigate, anticipate, and even celebrate, hydrologic variability? How would architectural systems, building codes, and zoning laws have to change? What shape would neighborhoods, architecture, and the urban experience take if design fully recognized and exploited the challenges of water scarcity?

Los Angeles provides the quintessential test-bed for answering some of these questions: a progressive, diverse, global city with an intense concentration of creative capital and widespread public recognition of urgent water challenges ahead. Drylands design innovation in Los Angeles has the potential to benefit not only the city's residents and ecosystems, but those of its broader watershed, a watershed created by epic engineering, stretching from the Sierra Nevada to the Rockies. Even if Los Angeles cannot wean itself entirely from water imports, can drylands design reduce dependence and lighten the city's impacts on the communities and ecosystems drained by the metropolis? Can design that exploits local urban water more effectively help Los Angeles and the Owens Valley renegotiate a shared water future?

At the Arid Lands Institute at Woodbury University, our goal is to catalyze drylands design leadership for public benefit, challenging design professionals and educators to marry exacting quantitative data with compelling design vision. With the support of the Metropolitan Water District of Southern California and the World Water Forum, we recently developed a high-resolution geospatial model to strategically identify and quantify the potential for improving stormwater capture within urban areas. Our modeling project, "Where is it? Let's reuse it," was designed as a riposte to William Mulholland's famously callous remark upon opening the spigot of the LA Aqueduct in 1913, "There it is. Take it." The research recognizes that maximizing recovery and reuse of rain and stormwater will be central to establishing a robust localized water portfolio for any drylands city seeking to buffer the effects of climate change.

Within the Metropolitan Water District's service area in Southern California, an estimated average of 1 million acre-feet of stormwater runs off from valley floors each year. Less than half is captured in spreading basins or other facilities for groundwater recharge: 520,000 acre-feet of unused stormwater is sent as discharge to the Pacific Ocean each year, enough to support 500,000 families at current usage rates with no conservation measures in place. [1] The Met, as the water district is also known, estimates that urban stormwater and recycled municipal supplies combined with increased efficiency could meet up to 82 percent of Los Angeles' water demand.[2] The challenge for us was to identify exactly where stormwater can be harvested and with what results.

Our Arid Lands Institute model focuses on one watershed within the larger Los Angeles basin: the Upper Los Angeles River Watershed Area, also known as the San Fernando Valley. The model builds on a foundational groundwater augmentation model developed by the US Department of Interior, Bureau of Reclamation, and Council for Watershed Health. But our model takes a finer-grain approach. We model the valley at the scale of rooftops, roads, curbs, parking lots, concrete, asphalt, and compacted earthen materials, and analyze three critical datasets and constraint layers. We model surface runoff as a function of precipitation rates and the permeability of different surfaces. Then we model soil types and conditions to understand how much water can move through the soil and where it is susceptible to liquefaction. Finally, we map the location of constraints on storing water in groundwater aquifers: groundwater contamination, the movement of plumes of contamination in the groundwater, where contaminated water is pumped out for treatment, and known underground chemical storage tanks that are leaking or could leak in the future. Putting the three layers together one on top of the other gives us an understanding of how water moves through the basin: where it comes from, where it's going, at what rate and volume. Soil types and conditions tell us where water can percolate into the ground. And the constraint layer tells us where it is not a good idea to add water to groundwater aquifers.

Our model suggests that around 92,000 acre-feet of stormwater runoff could be harvested in the San Fernando

Can design help Los Angeles and the Owens Valley renegotiate a shared water future?

San Fernando Valley Basin:

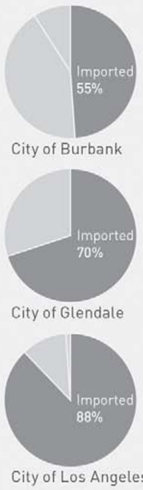
The San Fernando Valley basin (approximately 200 sq miles) lies within the Upper Los Angeles River Watershed. Cities within the focus area depend largely on imported water supplies:

City of Burbank:
49% imported sources, 51% local sources

City of Glendale:
70% imported sources, 30% local sources

City of Los Angeles:
88% imported sources, 12% local sources

The City of San Fernando is the only exception, where imported supplies are used to supplement groundwater resources.

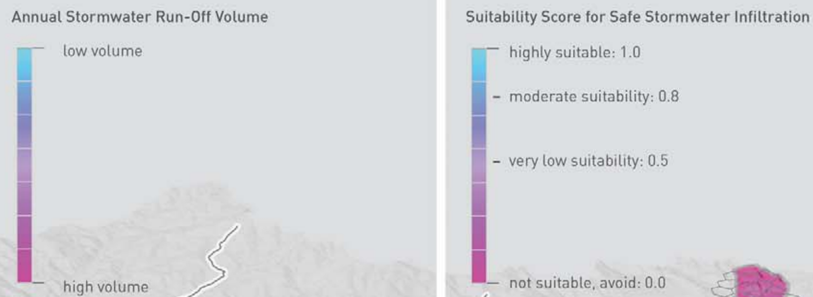


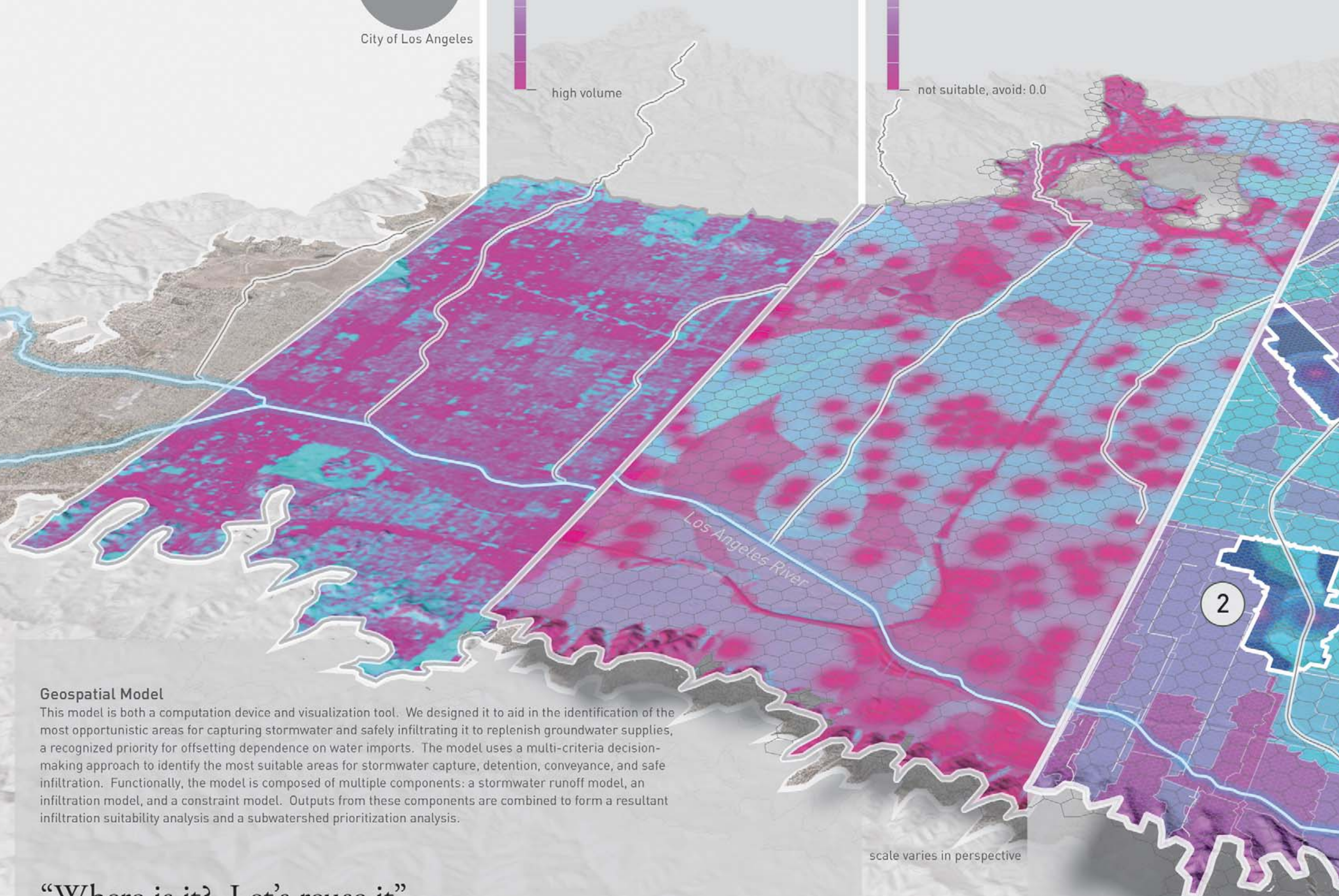
Surface Run-Off Model:

Computes annual urban stormwater runoff derived from 30-year annual precipitation data coupled with impacts of ground surface impermeability within the San Fernando basin.

Resultant Analysis:

Combines infiltration model (assessing the soil types and conditions for infiltrating stormwater) with a constraint model (assessing risks associated with both surface and subsurface chemical contamination) to describe the suitability for safely infiltrating stormwater runoff within the San Fernando Valley basin, and pinpoints appropriate strategies for resource recovery within the basin. Three case studies are identified (at right).





Geospatial Model

This model is both a computation device and visualization tool. We designed it to aid in the identification of the most opportunistic areas for capturing stormwater and safely infiltrating it to replenish groundwater supplies, a recognized priority for offsetting dependence on water imports. The model uses a multi-criteria decision-making approach to identify the most suitable areas for stormwater capture, detention, conveyance, and safe infiltration. Functionally, the model is composed of multiple components: a stormwater runoff model, an infiltration model, and a constraint model. Outputs from these components are combined to form a resultant infiltration suitability analysis and a subwatershed prioritization analysis.

"Where is it? Let's reuse it"

A Fine-Scaled Geospatial Modeling Tool for Strategically Reassessing Urban Stormwater Resources

Developed by: Arid Lands Institute at Woodbury University
Peter Arnold, Ethan Dingwell and Karim Snoussi

Developed for: The Metropolitan Water District of Southern California's World Water Forum:
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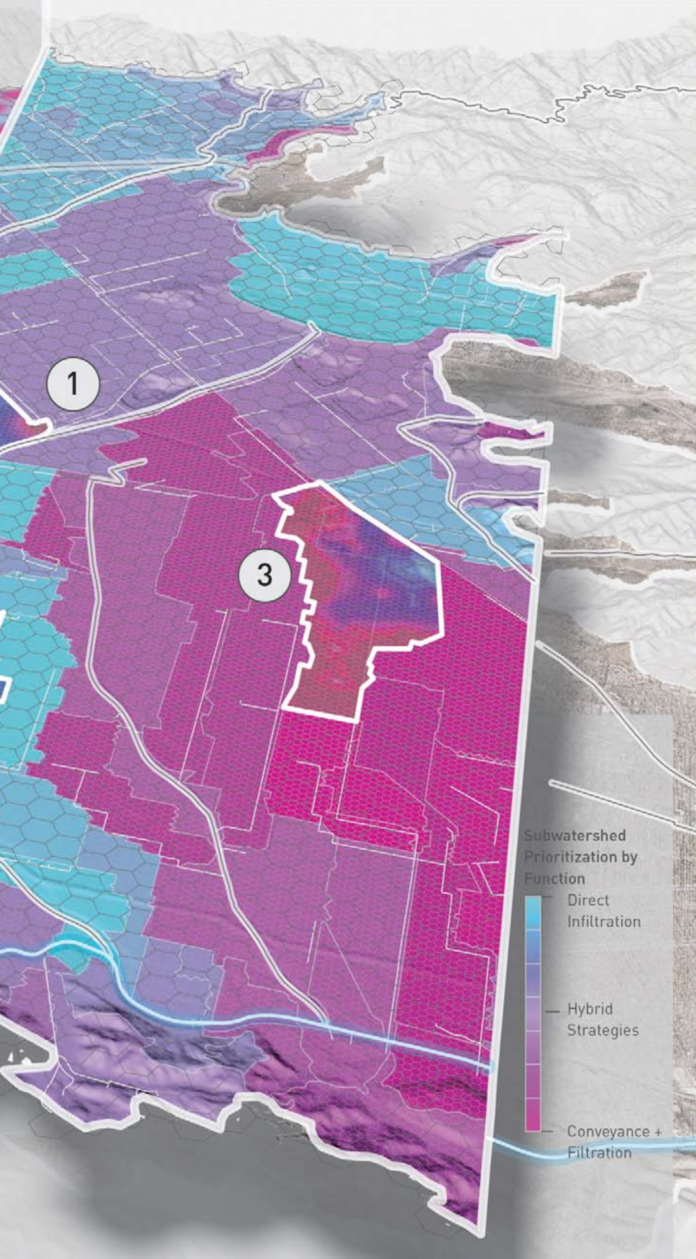
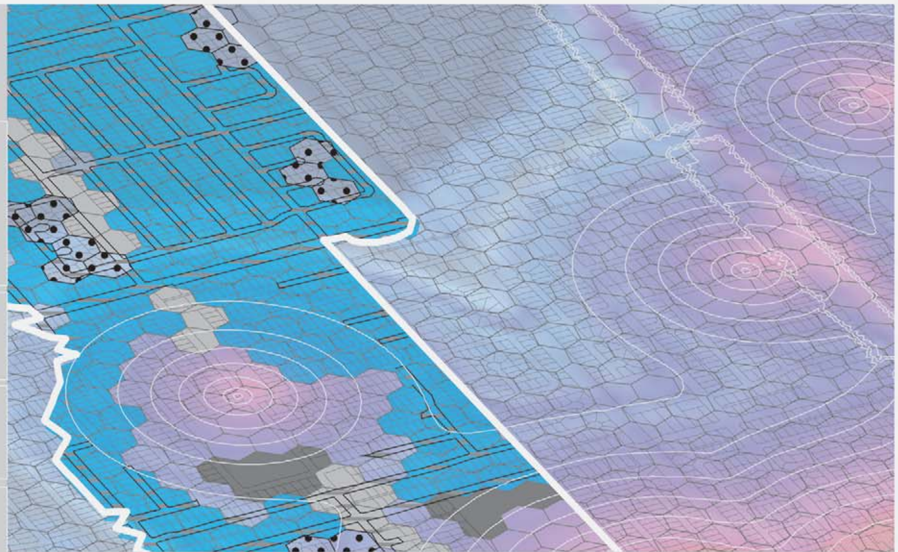
Subwatershed Prioritization:

How best to comprehensively manage stormwater runoff within the basin? The subwatershed prioritization ranks each of the subwatersheds according to their hydrologic function and suggests a subwatershed-scale approach to managing stormwater at the basin-scale.





Case Study: Hybrid Strategies

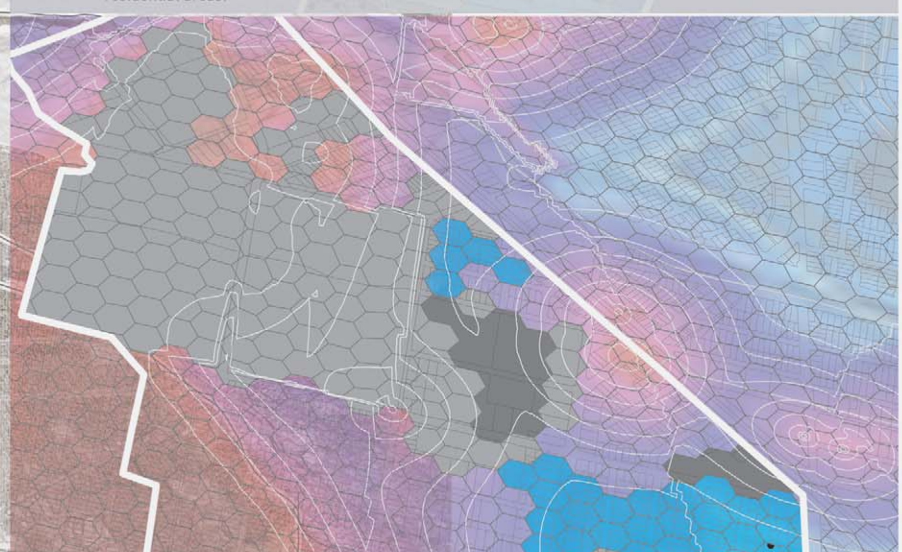
1

Within this subwatershed, stormwater strategies are mixed: direct infiltration where possible, and—in areas where groundwater contamination is known—a combination of on-site detention and conveyance to areas more suitable for infiltration.

Case Study: Direct Infiltration

2

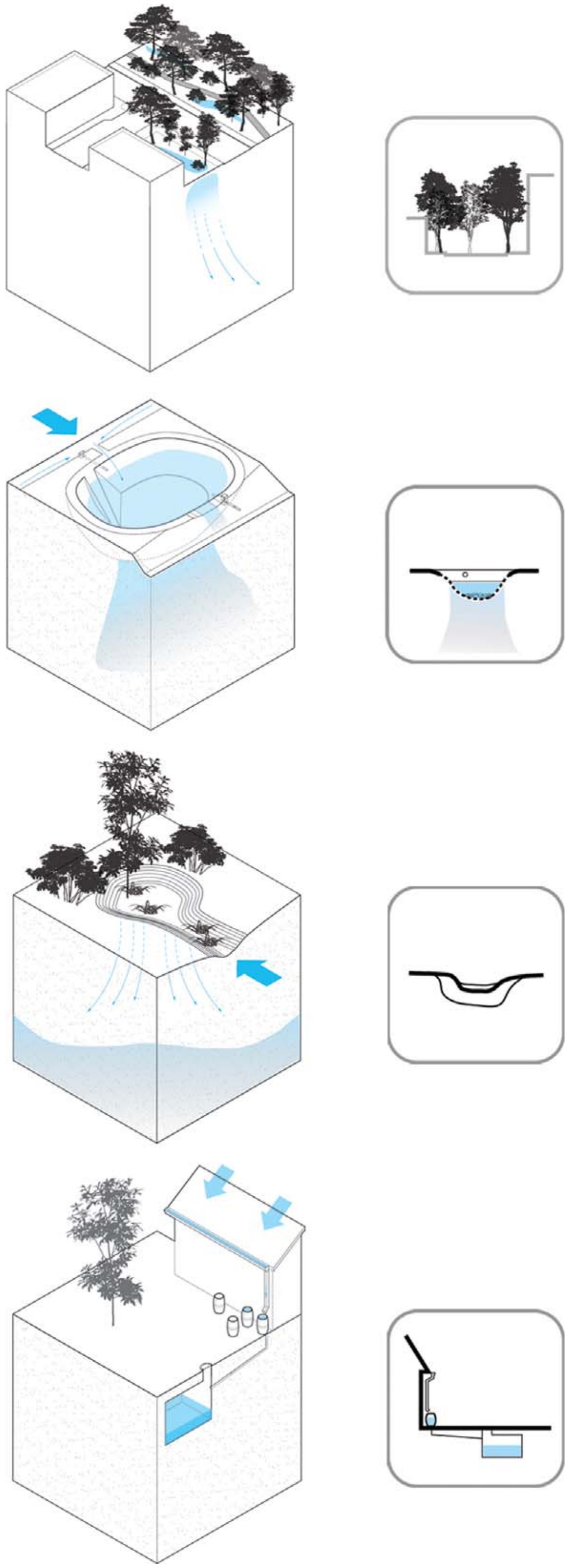
This subwatershed is well suited to maximum infiltration of stormwater and suggests a dense web of dry ponds and decentralized infiltration basins for public and municipal landuses. Water-smart streets with porous pavement, tree box filters, and curb extensions would be ideally suited here. On-site detention and direct use of stormwater through techniques such as rain gardens and cisterns would be appropriate for residential areas.



Case Study: Conveyance and Filtration

3

Due to highly contaminated groundwater and the risk that extensive stormwater infiltration may mobilize subsurface contaminants, opportunities for direct infiltration on this subwatershed are quite limited. Strategies to control, detain, and convey stormwater off the existing urban fabric to areas more suitable for direct infiltration are favored. A network of urban forests would aid in remediating brownfields, breaking up impervious surfaces, filtering particulate matter, and decreasing heat loads.



Strategies for Capturing and Infiltrating Urban Stormwater, top to bottom: Urban Forests, Infiltration Basins, Dry Ponds, On-Site Detention. Source: U.S. Environmental Protection Agency.

IMAGES COURTESY OF ARID LANDS INSTITUTE, ETHAN DINGWELL AND KARIM SNOUSSI.

Neighborhood by neighborhood, street by street, lot by lot, the model tells us where effort and investment are best targeted.

Valley, enough to sustain almost 100,000 households at current usage rates. That number has a certain poignancy in the larger context of California's contested water systems: it is nearly identical to the amount of water that the Los Angeles Department of Water and Power is currently required to use to keep harmful dust from blowing off of Owens Lake, desiccated in part by LA's thirst.

More importantly, the model can guide our efforts to capture local water in precisely identified zones by applying particular landscape design strategies. Neighborhood by neighborhood, street by street, lot by lot, the model tells us where effort and investment are best targeted for specific hydrologic functions using low-impact best management practices such as vegetated swales to slow and direct the movement of stormwater runoff, detention basins to store water, and urban forests to absorb water. Notably, the model clearly tells us that "infiltrate everywhere" is not an advisable strategy. Some parts of the valley are appropriate for capturing and storing water. Others will work well for moving water from one place to another. Some areas could filter water. Others could be used to allow the water to percolate into the groundwater aquifers in the valley. And others—particularly where groundwater is contaminated—should be avoided until they are cleaned up.

Data-rich modeling has the potential to inspire compelling, high-performance, cost-effective design strategies for transforming the city. As Los Angeles embarks on a comprehensive redrafting of its 1946 zoning laws, our model offers new planning elements and parameters for twenty-first-century drylands urbanism. In partnership with collaborators in the public, private, and academic sectors, the Arid Lands Institute is inviting multidisciplinary design teams to take up these findings and envision a new climate-adapted LA. The challenge could yield new ways of organizing metropolitan landscapes, and the infrastructure, architecture, and agriculture that support them—not just in LA but around the world. Los Angeles could lead the way in creating localized models for living with water scarcity. To do so will require design intelligence rooted in science and design vision as a catalyst for the public imagination. **B**

Notes

1. Metropolitan Water District of Southern California Blue Ribbon Committee, *Developing New Water Options for Southern California*, 8 April 2011, 126.
2. Metropolitan Water District of Southern California, *Final Report of the Blue Ribbon Committee*, 12 April 2011.