# [RE]GENERATIONS

## GREEN INFRASTRUCTURE FOR A VIBRANT FUTURE

*University of California, Berkeley* *Team Registration # : M1*

Abstract:

University campuses provide the perfect setting to develop innovative solutions that benefit future generations. We are challenging the traditional stormwater paradigm, which relies on gray infrastructure and rigid landscape modifications to control the hydrologic system; instead, our design collaborates with the creek and topography to strategically locate green infrastructure. Though most of the technical interventions will be placed in the campus core, non-technical interventions such as community outreach and stakeholder engagement will facilitate the diffusion of strategies to other parts of the city, leading to the restoration of off-campus watershed areas. [RE]Generations seeks to preserve the campus character while enhancing the economic, ecological, and cultural synergy between the university, the city, and the ecosystem. Under our proposal, the campus will become a model for sustainable and innovative growth.

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## I. INTRO

The University of California, Berkeley (UCB) campus is an iconic and historic landmark of the San Francisco Bay Area. As an open and public university in a diverse urban area, it is used, enjoyed and visited by many people. But our region is rapidly changing as soaring property values, gentrification, and displacement drive housing density upward and threaten vulnerable communities. Regional impacts on the environment include land use shifts, drought, wildfire, and the potential for worsening storms and rising seas. Together, these factors are straining the Bay Area's ecosystems and infrastructure. In the process of creating this master plan, we recognized the importance of addressing the fundamental creative tension between maintaining critical campus functions and facilitating change in anticipation of future challenges.

## II. CONTEXT

### B. PRESENT

The San Francisco Bay Estuary is the terminus of a macro-watershed originating on the western slopes of the Sierra Nevada mountains, hundreds of miles to the east of campus. An extensive inland delta complex conveys waters from the San Joaquin and Sacramento rivers through the Bay and out the Golden Gate. Local subwatersheds feeding directly to the Bay, including UCB's Strawberry Creek, face degradation typical of urban creek systems including pollution, erosion, sediment starvation and extensive channelization.

From its headwaters at Grizzly Peak to its outlet into tidal marsh at the Berkeley Marina outfall, Strawberry Creek travels five miles through four distinct land use types. In the upper watershed, the creek tumbles through mostly undeveloped wildlands. Immediately upstream of campus, the south fork of the creek is shunted into culverts under the football stadium, marking the creek's transition from a relatively natural to an urbanized watershed. Once on campus, the creek is mostly open channel, with one main culvert on the north fork. Channels are incised and many areas have concrete check dams, weirs, and reinforced banks. Below campus, the creek flows into a culvert which carries it under the City of Berkeley. The creek resurfaces once at Strawberry Creek Park, then disappears under the city until it reaches its ultimate destination: San Francisco Bay. Decades of in-stream restoration efforts on campus have successfully restored habitat for many native plant species, fish, and macro-invertebrates. Besides ecological habitat, Strawberry Creek also provides social, educational, and community value. The creek is featured in the curriculum of numerous UC Berkeley courses and is a popular destination for local community members and neighboring school field trips.

### C. FUTURE

Managing water is becoming increasingly important in the 21st century as we adapt to changes in the hydrologic cycle. Rising temperatures are driving sea level rise and are linked to shifts in weather patterns. California has faced more than its share of water woes in recent years; a long drought was followed by an unusually wet winter last year. Heavy rains nearly caused the state's largest dam to fail, and built up a vegetation fuel cache that has contributed to the worst wildfire season in our state's history. Farmers are scrambling to reach deeper for groundwater as we contemplate multi-billion-dollar infrastructure to shunt more water to Southern California. In the Bay Area, wastewater treatment plants and municipal water suppliers are bracing for an additional 2 million residents by 2040, even as rising seas challenge their infrastructure.

In addition, reduced infiltration and evapotranspiration in our urban areas has resulted in increased surface flows, erosion, and flooding. Pollutants from urban landscapes, such as metals, nutrients, sediment and bacteria are often conveyed directly to water bodies and degrade valuable ecological habitat.

The Bay Area is particularly vulnerable to these threats, as much of its densest development, vital infrastructure, and transportation system is located along the coast. The historic approach to flood control and stormwater infrastructure puts us at risk not only because it is inflexible and undersized, but also because much of this infrastructure is nearing the end of its service life.

**D. LOCAL CONTEXT**

The Eastern San Francisco Bay Area has a Mediterranean climate with dry summers and wet winters. Average temperatures range from 43-56°F in the winter, and from 55-72°F in the summer. Average annual precipitation is only 25 inches, although these levels rise significantly during El Nino years.

Situated at the base of the East Bay hills, the UC Berkeley Campus is generally separated into two areas: north campus and south campus. A handful of green infrastructure (GI) facilities, including bioretention cells, green roofs, permeable pavers, and rigid soil cell systems are already in place and serve to treat and detain flows draining to Strawberry Creek. However, the majority of roads, parking lots, roofs, and lawns remain unaddressed. Impervious surfaces comprise approximately 61 percent of the campus area, with plantings and lawn accounting for 26 percent. The remaining 12 percent is composed of creek channel, existing stormwater facilities, and other landscape elements.

Soils on campus are classified as “urban soils” by the National Resource Conservation Service (NRCS). Interviews with campus sustainability and environmental staff revealed that the majority of soils are hydrologic soil group C: sandy clay loam with moderately high runoff potential (NRCS, 2007). Hydrologic soil group C are typically not suitable for most stormwater infiltration facilities, though some infiltration is possible if facilities are designed with elevated underdrains and storage reservoirs. The steep slopes in the Strawberry Creek watershed range from 2 to 25 percent and rapidly direct streamflow and rainfall through the campus from northeast to southwest.

## III. APPROACH

### A. OUR CHALLENGES

Like many urban creeks, Strawberry Creek’s hydrologic regime has been heavily modified due to its contributing area being converted from natural wildlands to impervious features. This has resulted in a threefold decrease in lag time to peak streamflow on campus, channel erosion, and channel incision. Today, the peak flow of Strawberry Creek is typically in the range of 100-200 cubic feet per second (cfs), with the highest historic flow in 1962, during the Columbus Day

Storm.

Eucalyptus, oak, and redwood trees line the banks of Strawberry Creek. Many of these are diseased or aging and pose a threat to pedestrians in a heavy storm event. In addition, multiple hazards, including kitchen and research outflows, trash areas, leaky pipes, and loose sediment, appear to concentrate along the creek corridor and near storm drains. Recent restoration efforts replanted native vegetation along the creek and reinforced banks with fiber mats; though nascent, these riparian habitats will aid in stormwater mitigation and detention.

It is clear that urbanization of the watershed has done more than simply pave the landscape; it has extensively modified the processes by which rainfall enters the creek. In addition to in-stream restoration efforts, it is essential to restore watershed hydrologic functions in order to fully address the impacts of urbanization on Strawberry Creek.

An exorbitant amount of funding goes towards water and sewer activities each year. In 2010, over $3 million was spent on water and sewer management (Zhang, 2010). The campus uses 614 million gallons of potable water per year, 8% of which is used for irrigation. Changing climate has been observed in the region in the form of heat waves (fall 2017), intense rainfall (spring 2017), and long term droughts (2011-2015).

## B.GOALS/OBJECTIVES

Factors and events that are difficult to accurately forecast will inevitably arise as the campus and the region evolves — as will the values, priorities and demands of local citizens. Therefore, our master plan, [Re]Generations, articulates a vision involving innovative and novel interventions on campus. The methodology is adaptable, allowing for evaluation and modification over time. Our proposal is grounded in three core principles, a set of central strategies, and a 'tactical toolkit' of interventions.

Principle 1. Understanding campus as a critical hydrologic and ecological link.
Principle 2. Promoting the campus as a community resource.
Principle 3. Embracing campus creeks as opportunities for innovation and education.

By 2100, we propose a campus that serves as the link between urban development, ecological habitat, and sustainable growth through stormwater interventions that treat pollutants with filtration and plant uptake, in-channel interventions, and peak flow reduction. Guided by our three principles, we developed the following objectives:

- Convert all impervious surfaces to be self-

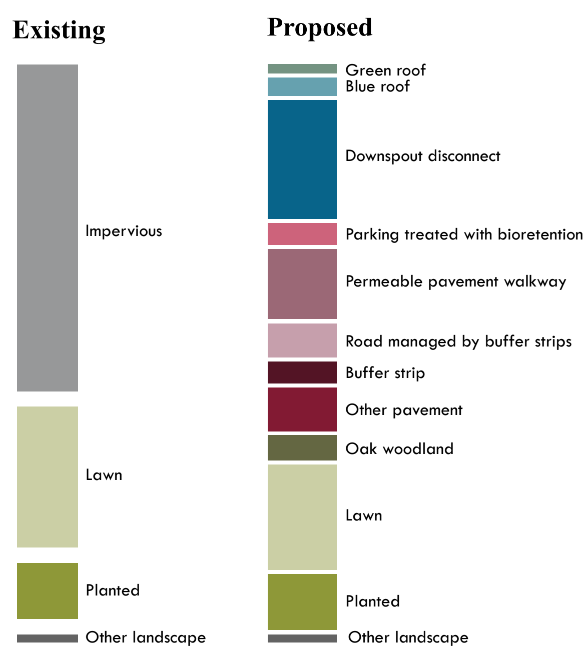



**Figure 1. Existing and proposed landcover**

mitigating or otherwise managed by green infrastructure, such that any runoff from campus draining to Strawberry Creek and SF Bay is treated.
- Expand the floodplain and daylight Strawberry Creek across campus.
- Remove all invasive plant species (e.g., algerian ivy) along the creek channel and replant with native vegetation and oak trees
- Design all new buildings with green roofs or rainwater collection/blue roofs, and disconnect downspouts on existing buildings to route rainwater to bioretention or rain gardens
- Incorporate creek restoration and stormwater management strategies into a comprehensive living laboratory educational program
- Use stormwater green infrastructure and creek habitats on campus as a means of catalyzing connectivity between the campus, watershed, and City of Berkeley via interpretive signage, trails, and parks.
- Form partnerships with local organizations to encourage engagement and foster educational opportunities in the Strawberry Creek watershed.

## C. PROCESS

We began our process by gathering data, reviewing documents, conducting interviews, and spending time in the field. We then began an iterative design process. In conjunction, we used the EPA's Stormwater Management Model (SWMM) to assess the impact of proposed interventions on Strawberry Creek under both existing and future climate conditions.

*Literature Review*
We began with a literature review of the existing plans and hydrology reports prepared for and by UC Berkeley to highlight which locations on campus are slated for change under the existing planning framework. These locations present an opportunity to intervene with innovative and sustainable stormwater practices. The literature review also allowed us to identify areas of hydrologic concern on campus that flood frequently or are more likely to be contaminated by vehicle or point-source pollution. While the downstream-most culvert at Oxford Street has the capacity to manage the 25-year storm, other locations on campus are overwhelmed in smaller storm events: The VLSB bend, West Circle culvert, and Cross Campus culvert capacities are exceeded by a 2-3 year storm event.

From the review, we also gleaned important information about which specific buildings are likely to be removed or renovated, areas protected for historic preservation, and the general priorities of campus planners.

*Geospatial Survey*
We gathered data from the following sources to perform a geospatial analysis (Figure 2).
- Hydrologic soil groups (source: NRCS)
- Parking lots and roads (source: UCB Dept of Environment, Health, and Safety (EH&S))
- Pollution hotspots (source: UCB EH&S)
- Slope (source: USGS)
- Percent Impervious area (source: NLCD)
- Topographic Wetness Index (TWI) (calculated)

- Historic channel alignment (source: UCB EH&S)
- Curve numbers (source: UCB EH&S

Using the geospatial analysis, we identified problematic water quality and water quantity hotspots for immediate intervention. These areas were determined by overlaying pollutant hot spots, pollution generating pavement areas, and calculating the topographic wetness index of the watershed. The TWI is a dimensionless index that relates slope to contributing area, and indicates areas in the landscape that are more prone to saturation. These "wet areas" may be targeted for conveyance and ponding areas for bioretention swales. The TWI map also revealed a remnant fork of Strawberry Creek, which converges under the largest open field on campus and lies adjacent to a storm drain that is prone to backing up and flooding during heavy rainfall.

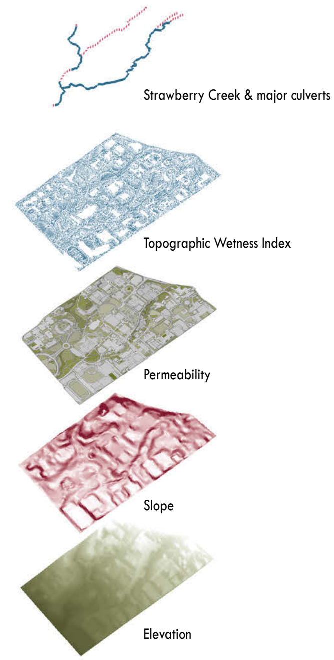


**Figure 2. Geospatial Analysis**

**IV. PROPOSAL**

**A. CONCEPT**

Our concept proposal stems from a desire to improve the functionality of our campus, reveal more of the hydrologic cycle, and to further incorporate the community into the thought process behind our design and management decisions. In order to meet these goals, we developed an approach that would consider the flow of water before it reaches campus, as it passes through campus, and its movement under the city of Berkeley and into the San Francisco Bay. We believe that understanding the entirety of the watershed is important in developing a framework which will provide a greater understanding of the potential problems and constraints associated with the hydrologic cycle. In order to address some of these concerns, we propose an in-stream floodplain expansion intervention, with the hope that by both widening the creek channel stormwater would slow and flood the appropriate areas. A floodplain expansion would be useful also in allowing the creek to meander naturally, taking its "espace de liberte". Finally, we propose daylighting more of the creek, not only to improve its ability to provide ecological functions, but also in order to create more areas for outdoor classrooms and therefore environmental education.

**B. TACTICS**

Our proposal mitigates 86 percent of impervious surfaces on campus by managing all parking lots with bioretention, managing all roads with filter/buffer strips, replacing walkways with permeable pavement, converting roofs to green roofs, and employing rainwater collection and disconnected downspouts. Remaining impervious surfaces include surfaces such as dumpster pads and nitrogen tank areas, which are likely unsuitable for green infrastructure. Existing invasive plant species in the creek's riparian zone will be removed and replaced with native Coast Live Oak (*Quercus agrifolia*) trees.

Table 1. Tactical Toolkit, Surface Types, Functions, and Suitability

| Tactic | Surface Type | Function | Suitability Considerations |
|---|---|---|---|
| Permeable pavement | Walkway, sidewalk, pathways | Infiltration through porous surface to underlying soils, attenuating peak flows and removing pollutants. | Underdrained to improve drainage in low permeability soils. Good for flat ground, but can be installed on slopes up to 5-12%. |
| Filter strip/ buffer | Roads | Remove sediment and pollutants from runoff through filtration, deposition, infiltration, or plant uptake. | Buffer should be planted cross-slope or on contour downhill from source of sediment, at a 15 foot width along the length of the road. Maximum of 5% slope along leading edge of strip. |
| Bioretention swales or cells | Parking lots | Capture, treat, infiltrate stormwater to filter pollutants via pollutant uptake with native vegetation and engineered soils. Attenuates peak flows and removes pollutants. | Vegetated depression, less than 2 feet deep of bioretention soil media and underdrain. Best placed adjacent to parking lots, buildings, and at the base of steep slopes. Maximum recommended drainage management area per cell is 0.25 acres. |
| Regenerative stormwater conveyance | In-stream, steep | Convey, treat, and detain runoff through shallow pools, riffle weir grade controls, and native vegetation. Facilitate restoration of eroded channels. | Good for drainage features with slopes of 10% or less, but adaptable for steeper slopes. Prioritize native riparian vegetation with fibrous roots and create retaining rock walls to stabilize slopes. |
| Creek daylighting | In-stream, culverted | Relieve pinch points in the creek caused by undersized culverts, increase infiltration and storage, reduce runoff velocities, improve water quality, serve as outdoor lab. | Any creek channel that is culverted or piped can be daylit where surrounding area allows for seasonal inundation. |
| Floodplain expansion | In-stream, flat | Allow natural ponding at confluence and store excess water during heavy rainfall for slower infiltration. Reduce pressure on drains and culverts. | Grasses and vegetation must withstand short-term inundation. Redesign walkways and open spaces as floodable development that maintains accessibility. |

| Tactic | Surface Type | Function | Suitability Considerations |
|---|---|---|---|
| Cisterns or blue roofs | Building roof to remain | Collect and store rainwater for greywater use in building and irrigation. | Cistern must be contained and circulation pumps may be required to prevent bacteria and algae buildup. Plumbing systems required for storage of 5,000 gallons or more. |
| Downspout reroute to bioretention cell or vegetated area | Building roof to remain | Redirect stormwater to green infrastructure such as bioretention, rain garden, or vegetated areas instead of drains. | Redirects roof area to permeable vegetated area. Assumed that downspouts are directed to bioretention and rain garden cells. Cross section should be large enough to accommodate moderate velocity. |
| Green roof | Future building roof | Improve water quality by filtering rainwater through growing media. | Extensive roofs (2-12 cm depth) require minimal maintenance, ideal for native grasses. Intensive roofs (minimum 12 cm depth) ideal for education and showcase, but heavier. |

**C. BIG MOVES**

First, the UC Berkeley Campus is a well used and accessible place, and we wanted to maintain this circulation in our proposal. We maintained the historic cardinal axis, allowing students and visitors to continue to move through, and across the campus. This is important, especially considering that the main routes from Sproul Hall to Euclid Ave, and from Oxford to the Campanile Clock Tower receive high pedestrian volumes.

Second, we focused on both Strawberry Creek, and the remnant channel which had been lost to buildings and fill. We determined the creek was an ideal place to begin intervening as it is the most visible and prominent example of the hydrologic cycle on campus. The creek is also the current greatest environmental concern and should be prioritized for restoration.

Finally, we wanted to incorporate environmental education into our narrative, furthering the knowledge and understanding of visitors and students with respect to ecologic functionality and sustainability. We therefore focused on creating connections between departments and redesigned spaces which might be suitable as outdoor classrooms, as well as places to relax and contemplate the world.

These "Big Moves" will catalyze change in surrounding neighborhoods

**Figure 3. [Re]Generation"Big Moves"**

and watersheds in the Bay Area to daylight culverted creeks, increase permeability, storage, and infiltration throughout the landscape. To be successful, [Re]Generations will require support across the campus, watershed, and community.

**D. PHASING**

*2025: Identify and Treat*
The plan targets areas for immediate intervention, including pollution priority hot spots, overcapacity storm drains, and culvert pinch points, using strategies from the Tactical Toolkit to treat 25% of impervious surface runoff. The university will begin creating partnerships with community and city stakeholders to ensure their support of the construction and look for collaborative opportunities. Any feedback will be evaluated and incorporated into the plan as the administration sees fit.

*2050: Design and Plant*
Toolkit interventions will treat 75% of runoff, concentrating on areas with steeper slope and areas adjacent to roadways in the northeastern part of campus. Floodplain expansion will begin with the redesign of the Eucalyptus Grove. This project includes the removal of hazardous vegetation and restoration of Strawberry Creek using the regenerative stormwater conveyance tactic. Demolition of buildings nearest to the creek will allow floodplain expansion. All remaining buildings will have cisterns or downspouts installed.

*2075: Construct and Educate*
All impervious surfaces, pathways, and sidewalks will be replaced with toolkit interventions to treat 100% of surface runoff. Floodplain expansion will continue near Memorial Glade. Buildings identified in the Long Range Development Plan will be removed and construction will continue on new buildings, which will feature green roofs, blue roofs, or rainwater collection in addition to photovoltaic power generation. The creek and stormwater management system will become a living lab through educational installations, a formal monitoring program, and development of publicly available data archives.

*2100: Grow*
The UCB campus will act as an important intermediary between the upper watershed and the City of Berkeley. Only 50% of the original parking lots will remain. The last phase also focuses on promoting the new spaces and educational programming to engage the local community. The plan will be evaluated in relation to climatic conditions to inform the creation of a new development plan guided by the same process-oriented thinking.

The implementation process is iterative, collaborative, and evaluative. Each phase will be closely monitored to ensure the products are connected to one of the three guiding principles in the vision statement. Challenges will be addressed through a holistic lens that considers the economic, social, and ecological concerns of the campus and the Berkeley community to ensure sustainability of the plan in the long term.

## E. PARTNERSHIPS

*Campus Partnerships*

UC Berkeley has 40 registered environmental and sustainability focused student organizations, some of which could assist with encouraging student engagement and hosting student programming around the new developments. The plan requires that faculty in the fields of landscape architecture, city planning, engineering, geology, and life sciences integrate these principles into their curricula to continue innovating new technologies and solutions to stormwater management.

*Community Partnerships*

The campus can partner with Berkeley Public Schools, the Boys and Girls Club, YMCA, and YWCA to engage elementary to high school students in learning about resilient landscapes, stormwater management, and ecological restoration. The non-profit Berkeley Youth Alternatives is a youth and family service center that provides mental health and academic support, health education, mentoring, and job training. Their facility is located near Strawberry Creek Park in West Berkeley, the only other daylit portion of the creek. The campus should also partner with Friends of Strawberry Creek, a group that plans, prioritizes, and makes decisions on issues related to the creek.

*Public Outreach*

Representatives from the Berkeley City Council will be involved throughout the process to catalyze the inclusion of Toolkit interventions in other areas around the city. The plan will be publicized at various events and town meetings to educate the community about the changes on campus and initiate a conversation about how they can get involved. Public works, utilities, and waste collection staff will receive training on green infrastructure maintenance and best management practices to ensure continued performance.

# V. PERFORMANCE

## A. METHODS

One of the ultimate goals of the Master Plan is to restore ecological habitat and stream flows in Strawberry Creek, so it was essential to model the watershed as a whole. To assess performance and quantify benefits of the proposed interventions, we developed a stormwater model of the campus and upper watershed using the EPA's Stormwater Management Model (SWMM). We used the SWMM model to understand existing conditions, proposed conditions, and climate change effects.

*Model Development*

Using ArcHydro in ArcGIS, we divided the Strawberry Creek watershed into 64 subcatchments, which had an average area of about 17 acres. There are a total of 8 subcatchments that comprise the central campus area and 14 that intersect with campus; the remainder comprise the upper Strawberry Creek watershed (Figure 4). We aggregated and averaged the impervious surface cover and curve number by subcatchment using the National Land Cover Database impervious surface raster and the curve numbers from UC Berkeley EH&S. The downstream-most point of the model represents flow in the Oxford Street culvert where Strawberry Creek leaves campus and flows under the City of Berkeley.

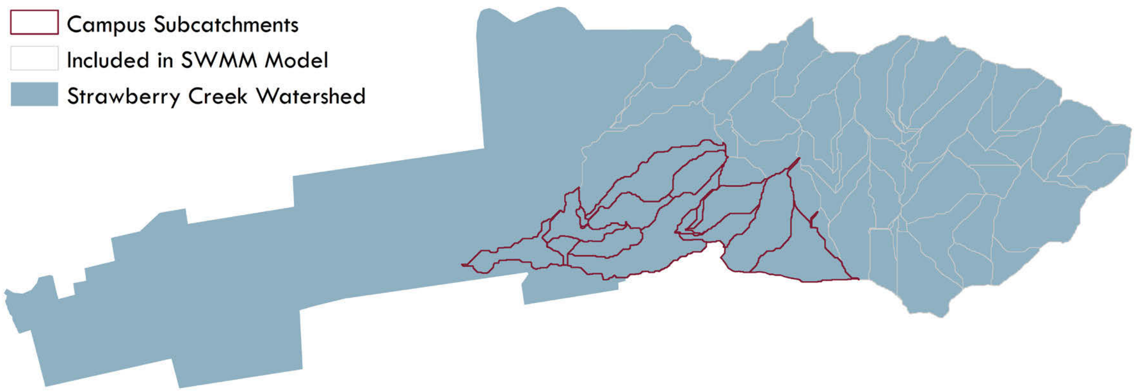



**Figure 4. Strawberry Creek watershed and SWMM Subcatchments**

A portion of the benefits associated with our proposal are not captured in the SWMM model, as runoff from the northern- and southern-most areas does not flow to the Oxford Street culvert, but rather flows to Strawberry Creek further downstream.

*Calibration and Land Use*

We calibrated the model using known streamflow and precipitation data for water year 2011. The streamflow was calculated using the Strawberry Creek rating curve and creek stage measurements. To estimate existing pollutant loadings and expected performance of the GI interventions, we assigned a pollutant load to each subcatchment based on the National Stormwater Quality BMP Database (Pitt et al., 2004) pollutant loads for residential and open space land uses. Specifically, we included pollutant loads from TSS, metals (zinc, copper), and nutrients (phosphorus and nitrate), pollutants typical of residential and similar land uses.

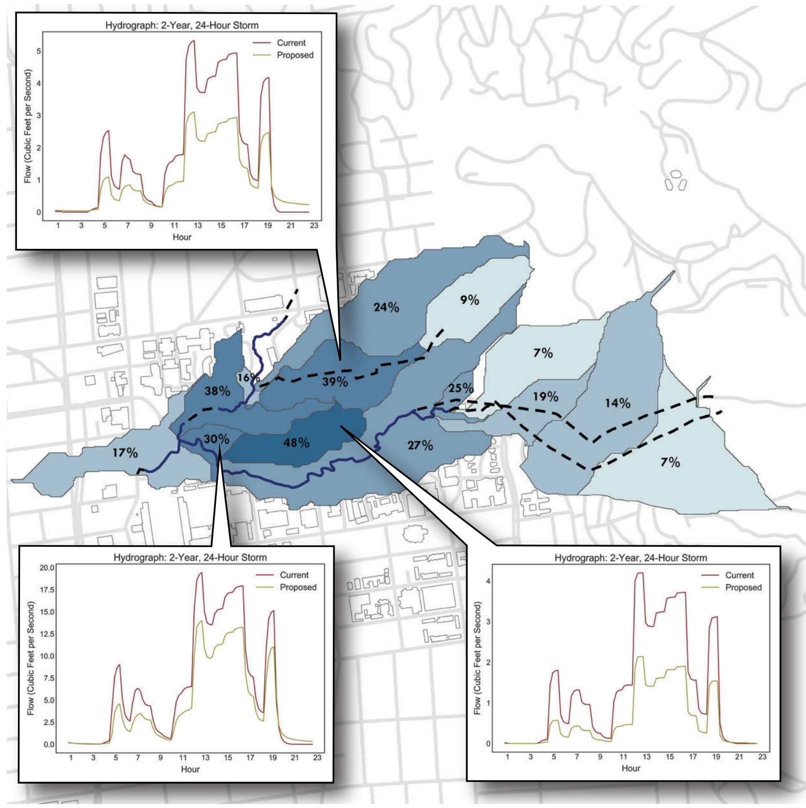
*Design Storm and Precipitation*

San Francisco Public Utilities requires runoff from projects with 50 percent or less existing impervious area not to exceed the stormwater runoff rate and volume of pre-development conditions for the 1- and 2-year 24-hour design storm. Green infrastructure and low impact development facilities are typically most effective for the smaller, more frequent storm events. For these reasons, we chose the 2-year 24-hour storm as our design storm, which corresponds to 2 inches of rainfall in the 24 hour period (calculated using a precipitation return interval relationship that was developed using precipitation data from 1895 to 2011).

We ran the model using precipitation data from 2016 (considered an "average" precipitation year, with 29 inches of rainfall total) and identified a representative 2-year storm from March 5, 2016, which resulted in roughly 2 inches over a 24 hour period. We analyzed the 2-year, 24-hour peak flow and annual pollutant load reduction at the campus-scale and watershed-scale to assess the performance of proposed GI interventions.

*Climate Change*

To assess the impact of the proposed GI interventions in future climate change conditions, we used the SWMM-Climate Adjustment Tool (SWMM-CAT). SWMM-CAT applies a location-specific adjustment factor to each month of rainfall data for the near-term and far-term IPCC climate change scenarios. The user can specify a hot/dry, warm/wet, or median change scenario, allowing for different iterations of the model using these correction factors. Because our plan extends to the year 2100, we modeled the far-term IPCC climate change scenario, and evaluated the range of hot/dry, warm/wet, and median conditions.




## B. RESULTS

*Campus Scale*
The proposed stormwater interventions reduce runoff in all 14 campus subcatchments, with peak runoff reduction ranging from 6.5% to 48% (average reduction of 23%) (Figure 5). These benefits also extend to pollutant removal; pollutant loads in all campus subcatchment are reduced under our proposal. Total pollutant load reduction across campus is shown in Figure 6.

The bioretention cells account for approximately 85% and permeable pavement surfaces account for approximately 13% of the total avoided runoff; vegetated strips and green roofs provide minimal hydrologic benefits. While the flow reduction performance of green roofs and vegetated strips are lower, these interventions still provide important stormwater quality treatment functions.

*Watershed Scale*
While the runoff reduction and pollutant removal results on campus are dramatic, the impact of these changes to Strawberry Creek streamflow and pollutant loads are relatively small. Our proposed plan achieves a 15 cfs peak flow reduction in Strawberry Creek: only a 6% reduction from existing conditions. This relatively small change highlights the need for green infrastructure and stormwater management across the watershed—not just on campus.

Our proposed plan reduces peak 2-year storm flows for each climate change scenario: hot/dry,

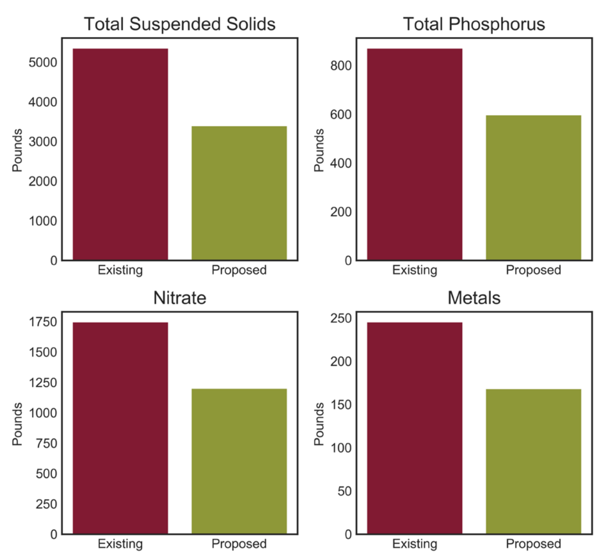



**Figure 6. Campus pollutant load reduction**

warm/wet, and the median projection. There is a 6-7 percent reduction in peak flows during the design storm under all climate projections tested (Table 2).

Table 2. Oxford Street Culvert Design Storm Peak Flows

| | Existing (cfs) | Proposed (cfs) | Peak Flow Reduction (cfs, (%)) |
|---|---|---|---|
| Current Climate | 257 | 242 | 15 (6%) |
| Hot/Dry Scenario | 242 | 225 | 16 (7%) |
| Warm/Wet Scenario | 301 | 283 | 18 (6%) |
| Median Scenario | 240 | 224 | 16 (7%) |

*Other Benefits*

The proposed interventions will have benefits that expand beyond just hydrologic. Each mature Quercus agrifolia sequesters 186 pounds of carbon and intercepts 4,158 gallons of rainfall per year (iTree, 2017; SFEI, 2017). The cisterns and blue roofs will capture 3.5 million gallons of rainwater annually: enough to irrigate 50,000 square feet of vegetated area on campus for one year. Proposed instream interventions were not modeled in the SWMM model, but would provide valuable in-stream habitat for native fish species by improving water quality, increasing dissolved oxygen content, and cooling baseflow temperatures.

## VI. CONCLUSION

Our process included bringing together an interdisciplinary team to review existing campus master plans, study green infrastructure precedents, and model campus hydrology using SWMM. Using the knowledge gained from our explorations, we identified the ideal locations for locating green infrastructure. Our stormwater master plan unites these distributed features into a coherent vision for the campus.

Our plan, [RE]Generations, employs a wide range of tactics to restores critical hydrologic functions of the landscape while retaining the distinct cultural and social aspects of the campus. Distinct features of the campus landscape such as Strawberry Creek and the main pedestrian corridors will be reinvigorated and serve not only to treat and detain stormwater, but to improve the campus environment. By implementing a model, we were able to assess our plan's performance, and confirm that it would accomplish our goals. Beyond improving campus water quality and reducing peak flows, our master plan will address the desire of connecting the local community to the watershed. We believe that these goals are already important, but will become even more so in the lives of the next generations.

## VII. ACKNOWLEDGEMENTS

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