Schoolyard Greening in the Los Angeles Unified School District:

Exploring Opportunities, Limitations, and Best Management Practices

UCLA Los Angeles Waterkeeper Team

Karen Cederholm, Jesus Delgado, Mikayla James, Timothy Li,

Gregorio Palomera, Prada Pothong, Sophia Stewart, Martha Vilchis

Advised by Alvar Escriva-Bou

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List of Abbreviations

BMP	Best Management Practice
CALFIRE	California Department of Forestry and Fire Protection
CEQA	California Environmental Quality Act
CGP	Construction General Permit
CTCA	California Tort Claims Act
EPA	Environmental Protection Agency
GIS	Geographic Information System
JUA	Joint Use Agreement
LADBS	Los Angeles Department of Building and Safety
LARWQCB	Los Angeles Water Quality Control Board
LAUSD	Los Angeles Unified School District
MS4	Municipal Separate Stormwater Sewer System
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
OEHS	Office of Environmental Health and Safety
O&M	Operations and Maintenance
OUSD	Oakland Unified School District
PAH	Polycyclic Aromatic Hydrocarbons
PM	Particulate Matter
PUSD	Pasadena Unified School District
RWQCB	Regional Water Quality Control Board
SCM	Stormwater Capture Mechanism
SWPPP	Stormwater Pollution Prevention Plan
SWRCB	Storm Water Resources Control Board
TPL	Trust for Public Land

Executive Summary

Schools within the Los Angeles (LA) region are largely composed of impervious surfaces with very little greenspace. With growing concerns over the health impacts of climate change – including heat injuries, poor air quality, and water pollution – school campuses have the unique potential to mitigate these impacts. In 2022, the Los Angeles Unified School District (LAUSD) Board of Education approved the Green Schools for All resolution, to increase greenspaces at all of its campuses to 30% of the schoolyard by 2035 (FSD Community Relations, 2023). At the time, 84% of campuses did not meet the standard. Implementing green schoolyards within LAUSD would serve the dual purpose of providing students with enjoyable environments, and improving water quality, and watershed health. However, to implement this greening of schoolyard, first potential liability claims related to greening infrastructure must be addressed and prime locations for greening must be identified.

Given this opportunity, LA Waterkeeper tasked our University of California, Los Angeles Institute of Environment and Sustainability Practicum Team with identifying LAUSD schools that would benefit the most from increased greening and stormwater capture. We also investigated the common obstacles that prevent these projects from taking place and provided a set of recommendations to facilitate the implementation and maintenance of these long-term endeavors.

To identify campuses that would be the most ideal candidates for greening, we conducted a spatial analysis using publicly available geologic, environmental, and census data to determine a school's overall fitness. Taking into consideration LA Waterkeeper and LAUSD's interests, four indicators were incorporated into the analysis: social vulnerability, park equity, heat island effect, and stormwater capture. We found that the majority of highly-ranked campuses for greening were located in East and South LA, in neighborhoods such as Historic South-Central, Huntington Park, and Florence. If greening projects on the top twenty high priority campuses were to be greened, it would cost around $25.2 million. They would accrue approximately $144 million in monetary benefits, as well as additional annual ecosystem benefits such as sequestering 11 million pounds of CO_2 and capturing 16 million gallons of stormwater.

Additionally, a review of the governing environmental laws and potential liabilities associated with schoolyard projects found that despite LAUSD's concerns, the total risk of such projects would be minimal and could be reduced by emphasizing strong internal and external communication channels. Similarly, funding opportunities and institutional partnerships in the form of joint use agreements (JUAs) would be more plausible through the formation of strong relationships with other businesses and organizations and increased community input. Successful implementation of JUAs at the top twenty schools identified in our spatial analysis would increase park access to approximately 130,000 more LA residents.

Lastly, interviews conducted with schoolyard greening experts and investigations of successful projects informed a list of twelve recommendations intended to assist LA Waterkeeper in moving forward with projects in the schools identified through our spatial analysis. The

recommendations detail how to best facilitate school greening projects with LAUSD, particularly navigating their planning, design, maintenance, JUAs, and funding. The experts' advice is summarized in the list below:

1. Prioritizing community goals and involvement
2. Forming partnerships with other businesses, organizations, and nonprofits
3. Utilizing variable designs in the schoolyards
4. Ensuring lasting projects through long-term funding and maintenance plans

Moving forward, the LAUSD-specific recommendations and policies explored in this report will need to be tailored to each school or community where a project is proposed. LA Waterkeeper and its partners will need to conduct further research to apply projects to individual schools' specific goals, willing allies, and available funding. This report provides valuable recommendations and advice compiled from the experience and labor of a variety of experts, organizations, and community members involved in schoolyard greening and stormwater capture. The next step is action – taking this knowledge and applying it to grant applications and groundwork within specific communities.

Introduction

Los Angeles' land use in urban centers, coupled with the stressors of high temperatures and extreme weather events exacerbated by climate change, could potentially create barriers to LA's climate resilience. The high levels of impermeable surfaces such as cement and asphalt in urban settings cause the environment to retain much more heat than in rural ones (Vahami & Ban-Weiss, 2016). This is known as the urban heat island effect, which puts inhabitants, particularly children (Antoniadis et al., 2020; Di Cicco et al., 2020), at risk of overheating and other temperature-related health concerns. The design of urban areas also disrupts watershed hydrology. Impervious surfaces are unable to absorb precipitation, which results in minimized groundwater recharge and increased stormwater runoff (Shuster et al., 2005). This increases flood risk, in addition to water resource stress and water quality concerns as harmful pollutants that accumulate on the ground are directly transported to nearby rivers and streams.

LAUSD owns 6,368 acres of land, making it one of the largest landowners in the greater LA area (LAUSD, 2023a). Many of the schools in the region have a high percentage of concrete and asphalt, which has led to increased stormwater runoff, greater urban heat island effect, and poor distribution of greenspace (FSD Community Relations, 2023). As the second largest school district in the country (LAUSD, 2023b), LAUSD has a significant opportunity to protect its students by addressing these health and equity concerns through schoolyard greening. Schoolyard greening is the process of converting a schoolyard into a space with more natural features including native greenery, outdoor learning spaces, and water filtration mechanisms. Schoolyard greening within LAUSD would have the capability to address the aforementioned issues while providing habitat for wildlife and increasing greenspace access for underserved communities (Connop et al., 2016). This would have a significant impact on LA residents as a whole, where approximately 37% of the current population citywide does not have access to a greenspace within walking distance (Trust for Public Land, 2024b).

Objectives

Our team, directed by LA Waterkeeper, addressed these issues by conducting a research and analysis report guided by three research questions:

1. What is the current state of greening infrastructure and stormwater capture on LAUSD campuses?
2. What are the site-specific socio-economic and physical indicators that would identify LAUSD campuses with the greatest need for and ability to maximize the benefits of schoolyard greening?
3. What obstacles would our client face when proceeding forward with new school greening projects and while planning for their long-term maintenance?

The goals of our project were to identify the best schools within LAUSD jurisdiction for greening projects and provide LA Waterkeeper with a list of recommendations that may be leveraged by them and related coalition partners to advance future greening projects in LA.

Approach

Our approach consisted of three essential components: a target list of priority schools, a policy and liability review, and a list of recommendations gathered from professionals in the field for moving forward with implementing projects at the target schools (Figure 1).

First, our team of GIS specialists compiled and analyzed data from open-source geospatial databases to analyze our chosen indicators of social vulnerability, park equity, urban heat island effects, and stormwater capture capacity using ArcGIS Pro. This culminated in a composite index that identified schools that would maximize the benefits of schoolyard greening for the students and communities served by LAUSD.

The secondary component of the report is a review of the regulations and liabilities associated with greening schoolyards. This research identifies and guides LAUSD on complying with the permits and environmental laws associated with the greening process. It also addresses potential human health risks in the implementation of greening and strategies for their mitigation, as well as potential funding avenues and opportunities to form JUAs.

Lastly, our team reviewed schools that successfully implemented greening projects to gather a greater understanding of their successes and challenges. This included conducting interviews with leaders at schools that have undergone greening transformations, non-profit organizations, and environmental professionals. Using this information, we produced a comprehensive list of recommendations categorized by planning, design, maintenance, JUAs, and funding. These can then be utilized to assist in the implementation of future greening projects.

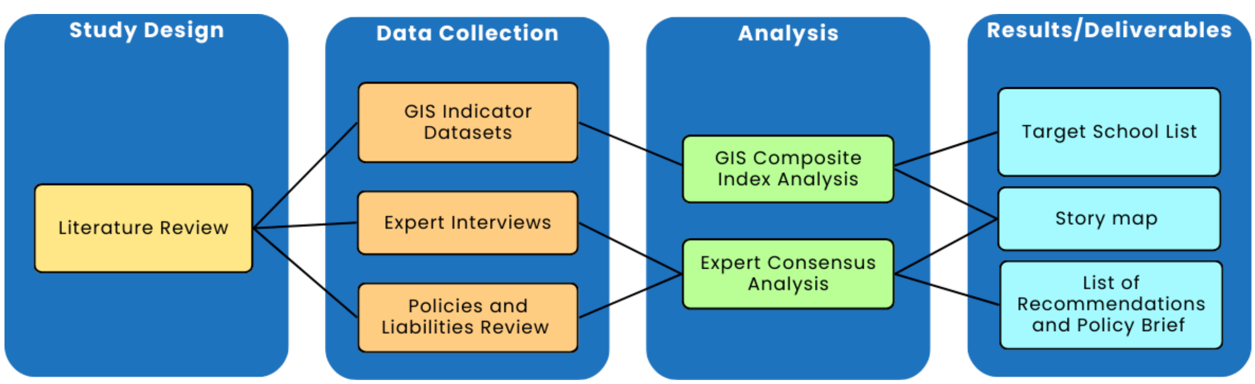

Figure 1. Flow chart of report structure

Spatial Analysis of School Prioritization for Greening

Introduction

To help with the process of selecting LAUSD schools for greening projects, we conducted a spatial analysis of campuses using a composite index tool to evaluate their potential for maximizing the benefits of greening. A composite index combines multiple variables into one single output under defined conditions to address a research question (ESRI, 2023). We utilized ArcGIS Pro's composite index tool to answer the question: "What schools would we recommend LA Waterkeeper prioritize for greening that would maximize social, environmental, and economic benefits for LAUSD and the LA community?". The index was calculated using four variables that we identified as important in informing greening decisions: social vulnerability, park equity, urban heat island effect, and stormwater capture capacity. LA Waterkeeper's interest in researching stormwater capture and addressing environmental justice issues motivated the selection of these indicators. The stormwater capture indicator highlighted schools that would maximize stormwater capture, while park equity, urban heat island effect, and social vulnerability emphasized the underserved communities in LA that suffer from lack of greenspace.

Although a composite index is vulnerable to the oversimplification of site-specific characteristics through a final composite score, the tool provided an accessible process to identify campuses of interest out of the almost 1,000 schools that make up LAUSD (Figure 2). The composite index will help inform LAUSD decisions on school greening in the future. Our data will also be made available for future use in greening research.

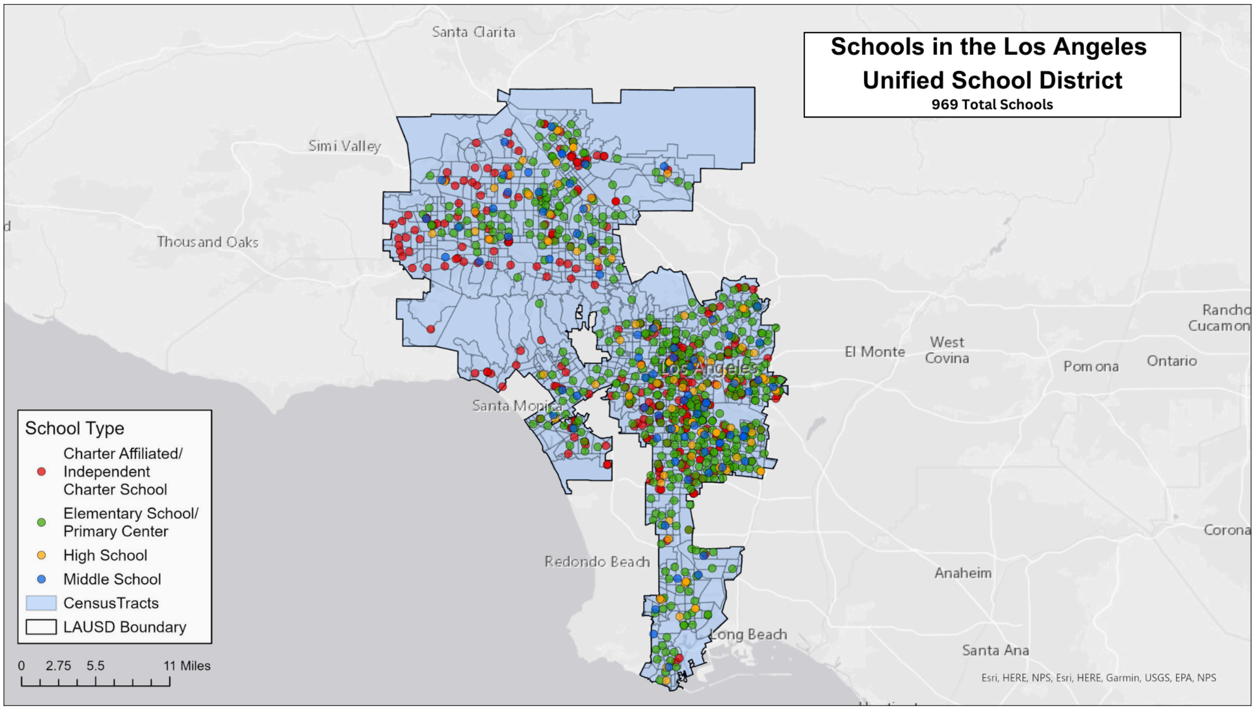

Figure 2. Map of Schools in LAUSD

Methods

To create a list of schools through the composite index, school site points were utilized as the spatial unit. There were 969 schools, including charter, elementary, middle, and high schools, in the dataset from Los Angeles Geohub (2016). Once the spatial unit was established, the data for the four sub-indices were extracted to the given spatial unit via spatial join. Calculating the composite index itself then required three major steps: pre-processing, calculation, and post-processing. Pre-processing prepared the data before calculation, scaling to ensure the given data was similar in unit and range so that they were compatible for calculation. We pre-processed our data by assigning a rating for each variable on a 0 to 100 scale, wherein a rating of 100 indicated extreme amenability for greening and 0 indicated incompatibility (See Appendix A for detailed methods on each variable).

Next, we used an additive mean method to combine variables. This method allowed for very high rankings in certain variables to compensate for low rankings in others, to ensure that schools were not unfairly penalized. For example, a school would not be completely eliminated from consideration for greening if it ranked lower in stormwater capture capacity, but extremely high in all other metrics. Additionally, at this stage, weighting could be manipulated in the calculation step to prioritize one variable over others. However, to produce our final list of schools, we calculated the final index with equal weighting, so that each sub-index was equally considered.

Finally, post-processing was conducted by condensing the entries of schools with the same address. Certain schools in our original dataset were considered separate under LAUSD delineations but shared the same campus, which resulted in those particular campuses being counted multiple times in our final index. These repeat entries had the potential to negatively influence the rank of other campuses and may have skewed the results of the final target school list. Thus, an important last step in producing the final list of target schools was to combine repeat campuses into one entry using their identical addresses (See Appendix A for a detailed post-processing method).

We will now discuss each sub-index – social vulnerability, park equity, urban heat island effects, and stormwater capture capacity – in more detail, as well as their limitations.

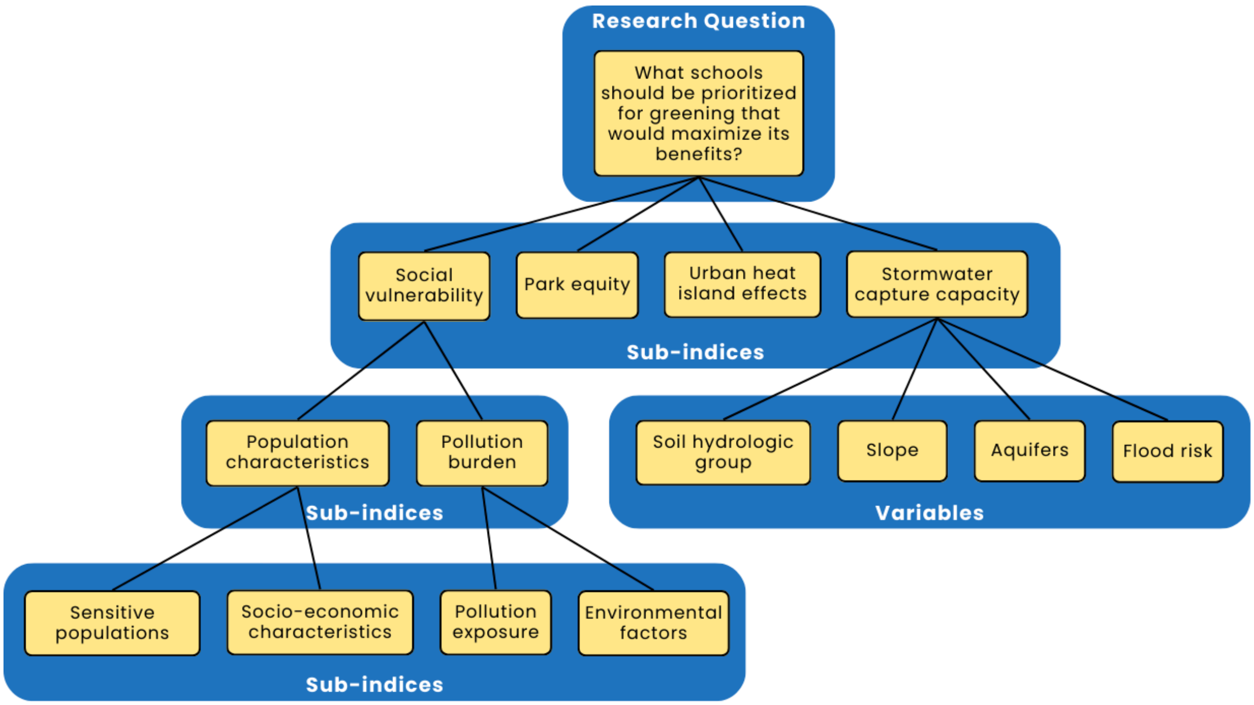

Figure 3. Flow chart of the Composite Index

<u>Social Vulnerability Sub-index</u>

The City of LA has a long history of social, economic, and pollution disparities. Historical redlining, among other issues, has isolated low-income communities and communities of color, disincentivizing investment into those areas and resulting in poor housing and degraded environmental conditions (Lane et al., 2022). To investigate these disparities, we used a social vulnerability sub-index composed of the population's social and economic indicators, such as poverty and public health, and pollution burden, such as air pollutant concentrations. The sub-index allowed analysis of the socio-economic characteristics of communities surrounding each school, as well as the pollution burden they face. Combined into the social vulnerability sub-index, both the socio-economic characteristics and pollution burden indicators aided in the identification of communities within LAUSD that are particularly vulnerable to hazards and thus would benefit from the social and environmental benefits associated with greenspaces.

Population Characteristics

This sub-indicator was composed of census data on sensitive populations as well as socio-economic characteristics. The sensitive population data included emergency room visits for asthma, cardiovascular disease, and low birth weight in infants per 10,000 visits, as well as children under 10 years of age and elders over 65 years. These conditions were selected to represent sensitive populations because exposure to hazards such as extreme heat or air pollutants can cause or exacerbate health issues, particularly in children and elders.

Socio-economic factors were also taken into account because they impact people's ability to live in areas unburdened by pollution. Focusing particularly on sensitive populations, children who come from a lower socio-economic status may experience higher levels of exposure to air pollution and face negative health impacts as a result, which can have a detrimental effect on academic performance (Mathiarasan & Hüls, 2021). The socio-economic factors considered were educational attainment, housing-burdened low-income households, linguistic isolation, poverty, and unemployment.

Pollution Burden

The pollution burden indicator took into account pollution exposure, as well as environmental factors. Pollution exposure data was incorporated for ozone and PM 2.5 concentrations, diesel PM emissions, contaminants in drinking water, children's risk of exposure to lead from housing, use of pesticides, toxic releases from facilities, and traffic impact. Because these particular pollutants directly affect the health of sensitive populations living in underserved communities, it was important to evaluate their presence within LAUSD communities.

Environmental factors included clean-up sites, groundwater threats, hazardous waste, impaired water bodies, and solid waste sites and facilities and are defined as "adverse environmental conditions caused by pollutants" (August et al., 2021). While these factors still have an impact on the health of the communities exposed to them, more weight was given to pollution exposure because these environmental factors may have a delayed impact on communities while environmental exposure was more direct in accounting for health impacts (August et al., 2021).

Limitations

The main limitation of this sub-index was that the data utilized in this index was from 2019. Therefore, a variety of these socio-economic and pollution burden numbers may be underrepresented, especially considering changes brought about by the COVID-19 pandemic (Barua & Nath, 2021; C-CHANGE, 2020).

<u>Park Equity Sub-index</u>

In LA County, approximately 37% of residents do not have access to a local park or greenspace within a half-mile, or a ten-minute walk, of their home (Trust for Public Land, 2024b). To address this inequity faced by underserved communities, the park equity sub-index identified the population within LAUSD boundaries who would benefit the most from schoolyard greening by analyzing the increase in the number of residents that would be served by each school in a potential case of greening.

Limitations

Population density estimates were used to calculate the number of residents greening would impact and were calculated with the assumption that the population within each census tract was distributed evenly throughout. For the park access analysis on current parks, a half-mile buffer was used to estimate residential access, rather than a network analysis of each current park's service area, due to limitations with the tool's ability to analyze polygons. Finally, the acreage of current parks was not taken into account when analyzing accessibility. Small areas of greenspace were thus counted as parks, which meant that the communities around them were analyzed as having access to a park, although the small size of the park may still pose an obstacle to significant community usage.

Urban Heat Island Effect Sub-index

The urban heat island effect remains a significant issue for urbanized cities such as Los Angeles, where concrete and asphalt surfaces can reach temperatures as high as 142°F on hot days (Gonez, 2022). This phenomenon occurs due to the high levels of impermeable surfaces like cement and asphalt in cities which cause the environment to retain much more heat than typical ambient temperatures (Vahami & Ban-Weiss, 2016). The presence of heat islands in urban centers has harmful effects on vulnerable populations, such as children, the elderly, and those with respiratory illnesses. Children are especially susceptible to heat-related morbidity, as higher daily temperature has been correlated with a higher number of temperature-related hospital visits for children (Di Cicco et al., 2020). Furthermore, these negative health effects will be exacerbated as the frequency of extreme heat events will continue to increase due to climate change. With a majority of LAUSD schools lacking abundant greenspaces on their campuses, students may feel a heightened heat island effect at schools. The urban heat island effects sub-index addressed this by identifying regions of LAUSD particularly impacted by high temperatures. Introducing school greening in these impacted zones would alleviate the impact of heat islands in schools and improve the health of students and their communities.

Limitations

The heat island data was generalized on the tract level and then attributed to each school. 67 schools were excluded from a lack of data from the California Environmental Protection Agency (EPA). These values were replaced with the mean value from the data to prevent a drastic effect on the composite index due to zero values acting as outliers. These values matched the trend of temperature data in the area. The schools with replaced values were noted in the data table (See Appendix B).

Stormwater Capture Capacity Sub-index

Stormwater runoff consists of water that flows off of impervious surfaces, such as paved roads, accumulates harmful contaminants and pollutants, and deposits these pollutants in water bodies. This can pose significant adverse health effects both for exposed residents and ecosystems (EPA, 2024d). Pollutants that accumulate in stormwater runoff include bacteria and pathogens, nutrients, oil, sediment, heavy metals, pesticides, and trash (Stein et al., 2007). Stormwater capture, such as bioretention gardens, infiltration basins, and rainwater harvesting, can decrease stormwater runoff and prevent such pollution from reaching waterways. Additionally, stormwater infiltration contributes to groundwater recharge, which helps support a stable water supply. These beneficial impacts of stormwater capture make evaluating the stormwater capture capacity of sites important for public health and environmental protection.

To evaluate LAUSD school sites on their stormwater capture capacity, we developed a sub-index based on four variables: soil hydrologic group, slope, aquifer availability, and flood risk. The following sections discuss the importance of each variable in the context of stormwater capture.

Soil hydrologic group

The infiltration rate of stormwater into surrounding soils greatly impacts the efficacy of stormwater capture systems. Areas characterized by soils with high infiltration rates would maximize the volume of stormwater that can be captured and infiltrated into the ground. While soil could be amended to further increase infiltration, it is recommended that the site's in-situ soil infiltration rate at full saturation should be used to estimate infiltration (Minnesota Pollution Control Agency, 2023).

Soil hydrologic group is a soil categorization method that categorizes soils based on their infiltration rate and runoff potential when thoroughly wet. Group A soils are most amenable to stormwater capture, as such soils have a high infiltration rate and low runoff potential when fully saturated. Group B soils have moderate infiltration rates and moderately low runoff potential, while Group C soils have slow infiltration rates and moderately high runoff potential. Group D soils are the least effective soils for stormwater capture due to their qualities of slow infiltration and high runoff (Langner et al., 2021). These soil hydrologic group ratings were used in the sub-index to estimate a school campus' infiltration capabilities.

Slope

To maximize the stormwater capture capacity of best management practices (BMP) and green infrastructure, capture tools should be constructed on shallow slopes. Shallow slopes allow for slower movement of stormwater run-off, increasing infiltration rate and volume, and potential retention times. Additionally, for vegetated capture tools, such as rain gardens or vegetated filter strips, rapid flow rates can be overwhelming and result in soil washout, drastically decreasing its efficacy. BMPs are recommended to be built on slopes that are 5%-6% or less (EPA, 2014b).

Research shows that the slope maximums to maximize the cost-effectiveness of green infrastructure is 6% for bioretention planters and rain gardens, 5-6% for vegetated swales or bioswales, 5% for permeable pavements, and 5% for vegetated filter strips (EPA, 2014a). Within the stormwater capture capacity sub-index, schools with slopes less than 6% were more highly ranked.

Aquifers

Unconfined aquifers refer to aquifers that are exposed to atmospheric conditions through overlying porous materials that allow direct infiltration from overlying soils. Confined aquifers refer to aquifers that are confined both above and below by impermeable materials and cannot be recharged by direct vertical infiltration. Recharge occurs more easily and overall is less expensive in the case of unconfined aquifers, largely because confined aquifers often require deep injection wells for direct recharge or can only naturally recharge through small unconfined areas (Jakeman et al., 2016). Therefore, when analyzing a site's capacity for stormwater capture, areas over unconfined aquifers are preferable for maximizing infiltration.

Flood risk

Urban environments are characterized by high percentages of impervious surfaces such as asphalt and concrete, soil compaction, and a lack of vegetation or vegetation modification. These factors reduce the volume of water that can be infiltrated into the ground, facilitating high volumes of stormwater runoff and increased flood risk (Ercolani et al., 2018). While causing infrastructure damage and disruptions in transportation, flooding can also increase the risks of adverse health outcomes such as gastrointestinal disease and chronic disease as well as negative psychological outcomes such as PTSD, depression, and anxiety (Zhong et al., 2018). Therefore, accounting for flood risk is integral when considering site suitability for stormwater capture and schools with higher campus flood risk were more highly ranked in the sub-index.

Limitations

The original flood layer included 52 entries with null values due to a lack of parcels over the target schools, which were substituted by summarizing the mean of the flood depth values within a 650-foot buffer around the 52 sites. In the hydrologic soil group layer, 616 of the 969 school campuses had no hydrologic soil group rating assigned due to their location in the Web Soil Survey map in areas with a high composition of "Urban land," meaning the majority of its soils are sealed. To avoid the exclusion of these sites from the stormwater sub-index due to null values, each school was manually assigned a soil hydrologic group rating based on other soil series that have been found in the areas of focus. The respective substituted values are noted in the data table in the fields "Soil_Not_Null" and "Flood_Not_Null" (See Appendix B for data table).

Results of Spatial Analysis

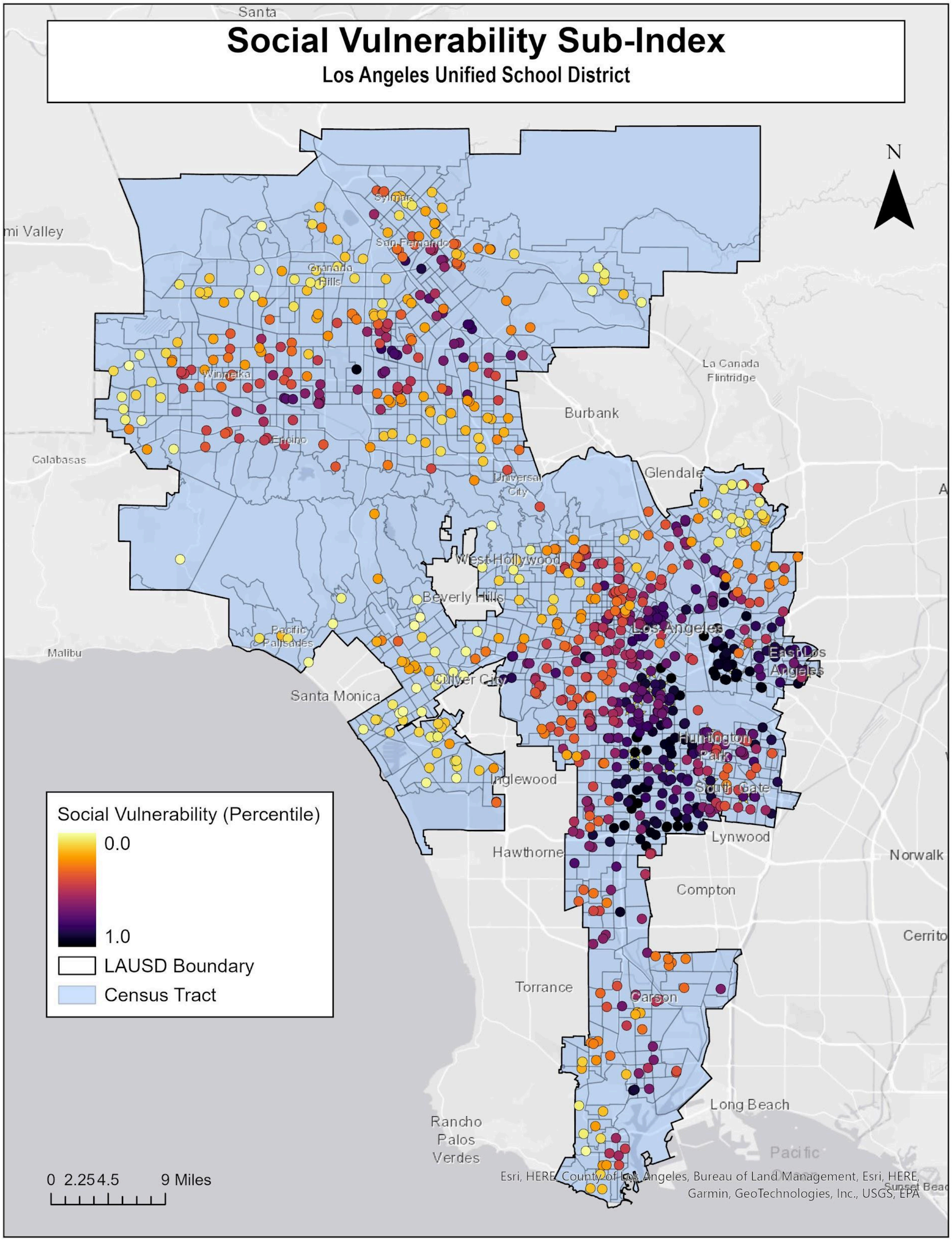

Figure 4. Map of the social vulnerability sub-index

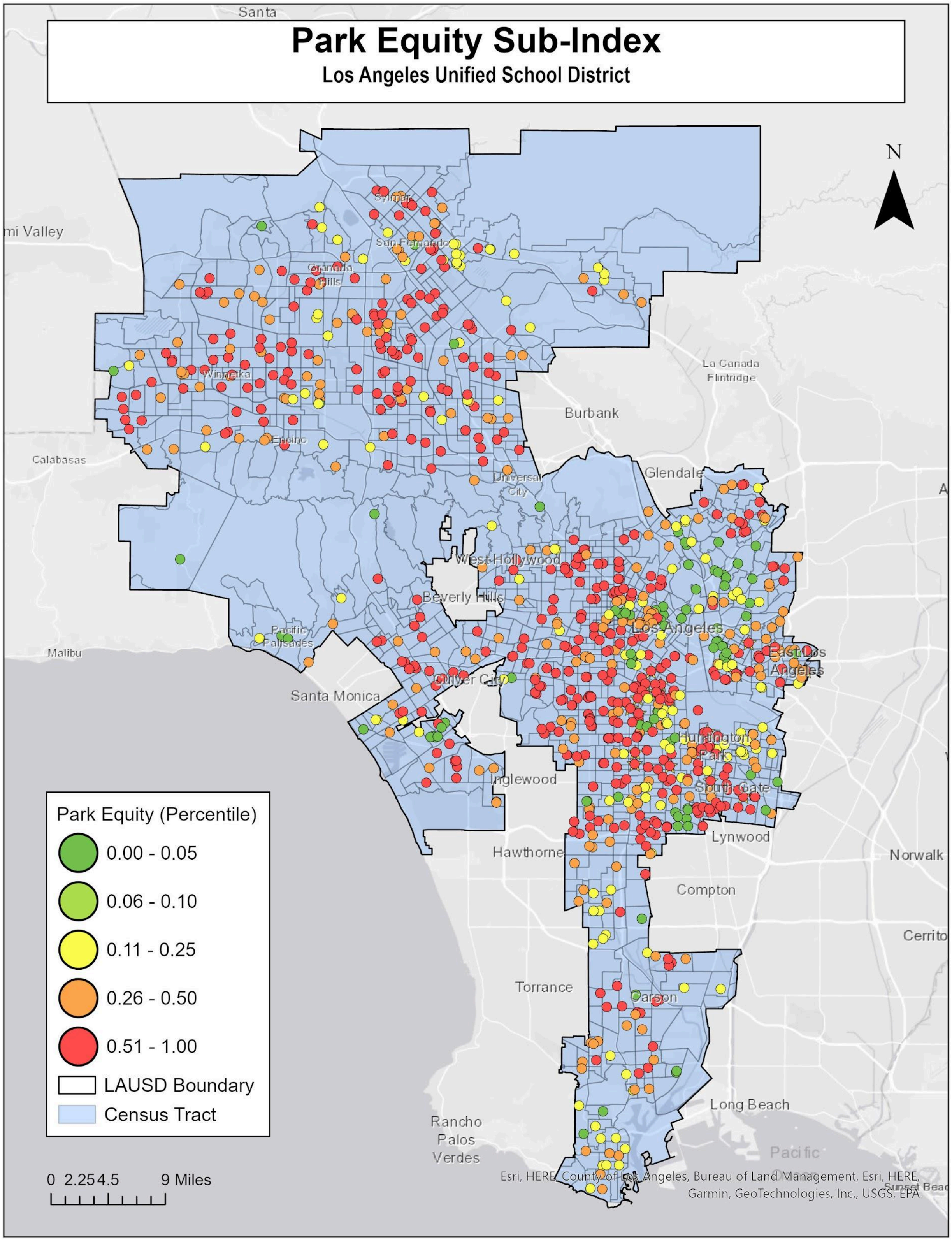

Figure 5. Map of park equity sub-index

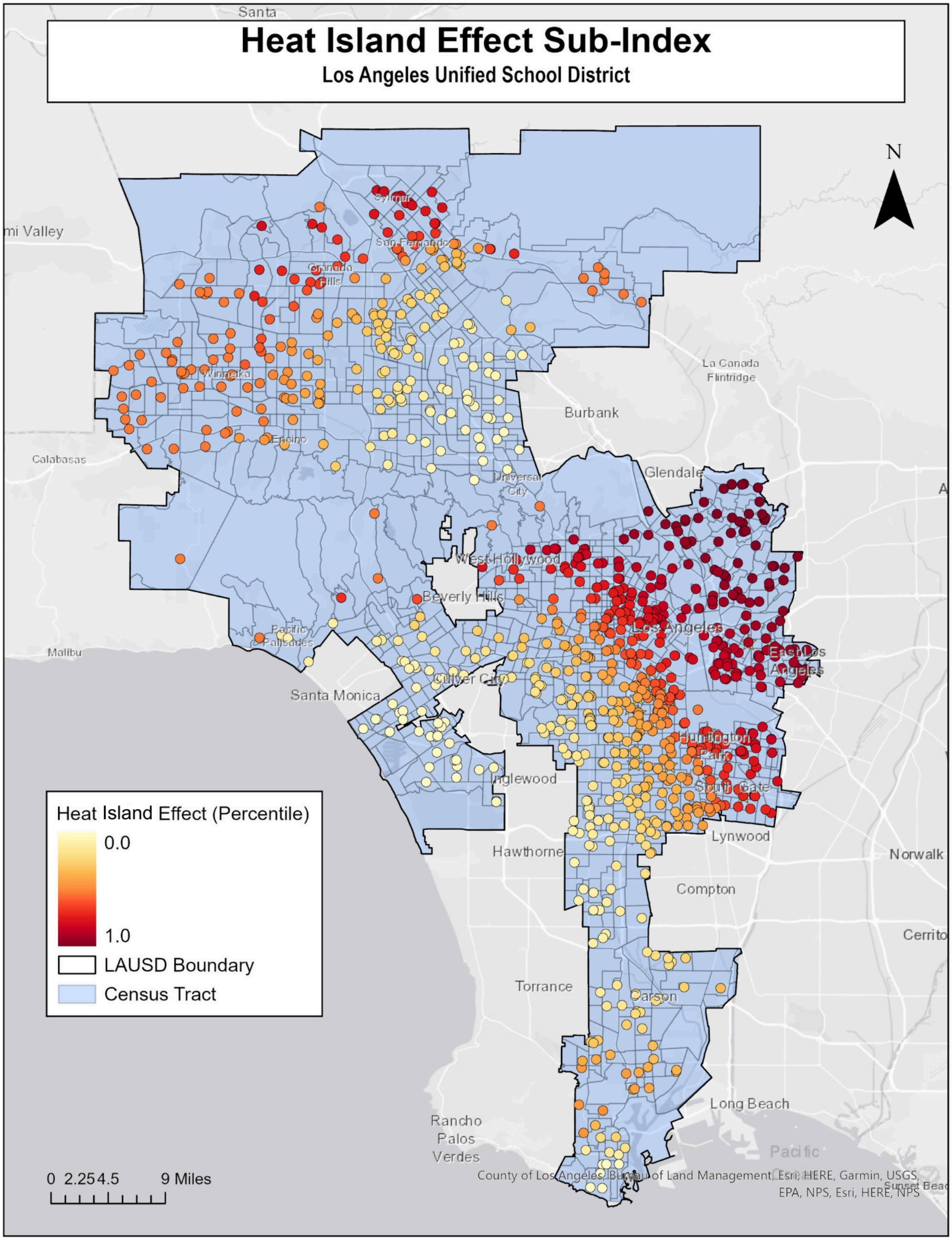

Figure 6. Map of urban heat island effect sub-index

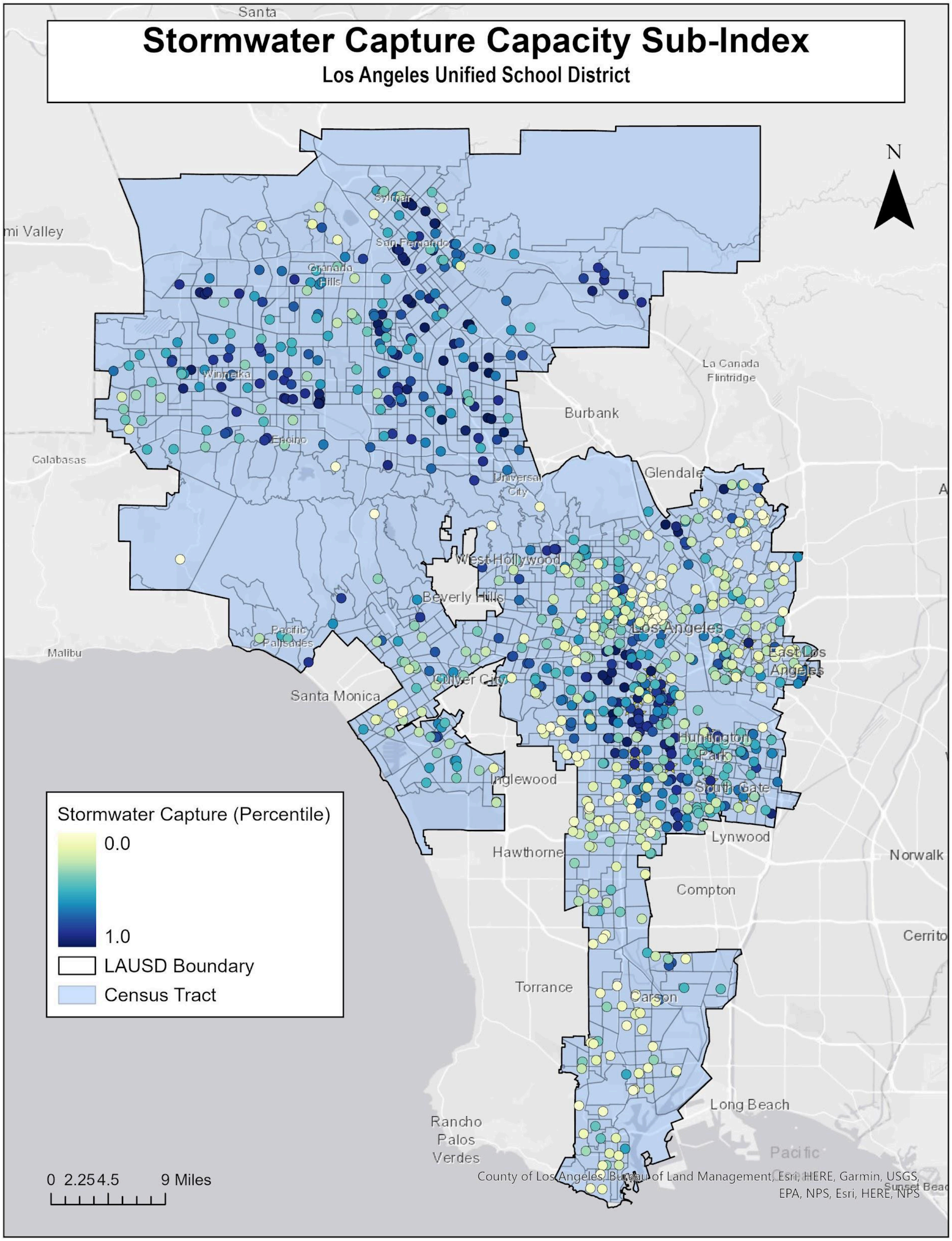

Figure 7. Map of stormwater capture capacity sub-index

For the social vulnerability sub-index (Figure 4), communities in East and South Los Angeles appear to be more highly vulnerable and make up most of the school neighborhoods within the top 90th percentile of vulnerable communities. While park inequity (Figure 5) is more varied across LAUSD, there is a high concentration of park-poor neighborhoods in Central and South Los Angeles, for example, around the South Gate and Exposition Park areas. Within the top 90th percentile, there are also clusters of park-poor areas near Winnetka and Reseda in the San Fernando Valley. In the heat island sub-index (Figure 6), the trend of heat islands matches expected basic temperature trends that rise as they leave the coast. The most severe heat island values were found in East Los Angeles, in areas such as Highland Park, Eagle Rock, and Lincoln Heights. For the resulting stormwater sub-index (Figure 7), the top 90th percentile results are concentrated in the San Fernando Valley and South Los Angeles, near areas such as Pacoima and Exposition Park, largely due to their rankings in hydrologic soil group A, favorable low slopes, and location over unconfined aquifers.

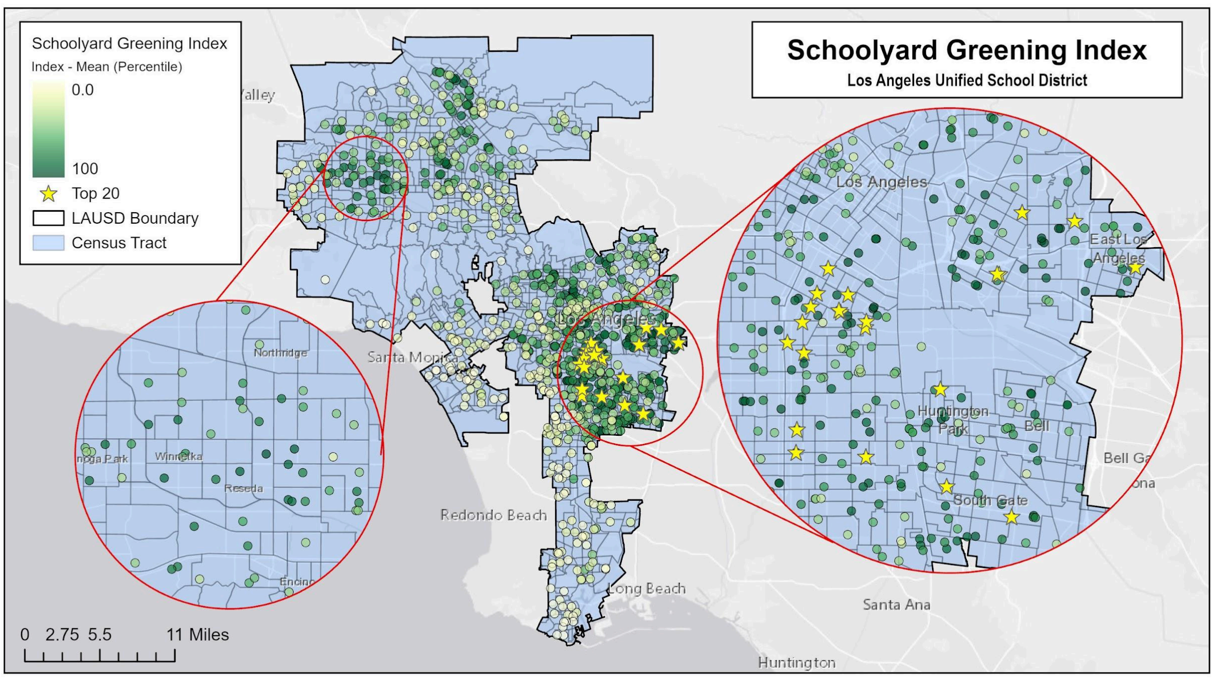

Figure 8. Map of the final composite index with the top twenty LAUSD campuses

After combining all the sub-indices into the final composite index, our results showed that the top 90th percentile of schools is concentrated in the South and Eastside regions of Los Angeles, with a few high-ranking campuses located in the San Fernando Valley region (Figure 8). The lowest-ranking schools were concentrated in the Westside and Harbor regions of Los Angeles. Of the top twenty schools identified as most in need of greening project implementation, six were located in Historic South-Central, three in Florence, two in Boyle Heights, two in East Los Angeles, two in Central-Alameda, two in South Gate, one in Koreatown, one in Huntington Park, and one in South Park. The school with the highest rank was the combined campus of Synergy Charter School and Quincy Jones Elementary School, with a composite score of 100, a social vulnerability score of 85.74, a park equity score of 96.18, an urban heat island score of 61.88, and a stormwater capture score of 84.81 (See Appendix C for the complete list of the top twenty schools).

Discussion of Spatial Analysis

By conducting a spatial analysis of LAUSD campuses based on social vulnerability factors, park equity in the surrounding community, urban heat island effects, and the capacity for stormwater capture, our team has produced a list of schools ranked based on their amenability to and maximization of the benefits of schoolyard greening. We have identified twenty schools from that list that are of particularly high priority for the implementation of greening projects due to their high ranking in all four sub-indices.

Altogether, these twenty highest-ranked schools amount to around 4,000,000 square feet of land, which, if greened, have the potential to make a large positive impact on the target schools, their students, and the communities around them. If LAUSD were to carry out projects that greened 60% of each campus, the total cost is estimated to be $25,200,000, with capital costs amounting to $24,000,000 at an average of $10 per square foot and operations and management costs amounting to $1,200,000 at an average of $0.50 per square foot (Green Values, n.d.). In regards to the benefits amassed by such a large-scale implementation of greening, around 130,000 Los Angeles residents would have new access to potential park space, 16,000,000 gallons of stormwater would be captured annually, and 11,700,000 annual tons of CO_2 would be sequestered from the atmosphere (Kats, 2006). LAUSD would also benefit monetarily, with an overall $21,600,000 saved in energy costs, $2,400,000 saved in emissions reductions, $2,400,000 in reduced water and wastewater spending, and an increase of $117,600,000 in revenue due to improved learning and test scores and decreased absenteeism over a twenty-year lifetime of the greenspaces (Kats, 2006; See Appendix D for calculations).

Schoolyard greening is a viable solution to the aforementioned issues of social vulnerability, park equity, urban heat island effects, and a lack of stormwater capture. Not only does the greening of schoolyards provide potential park spaces for their surrounding communities, but their emission reductions of CO_2, NOx, SO_2, and particulate matter and infiltration of pollutants accumulated in stormwater runoff can help reduce those communities' pollution burden (Kats, 2006). Greenspaces can also reduce temperatures in the surrounding area by as much as 33 to 39°F, combating the urban heat island effect and the high-temperature extremes that can harm the health of school children (Aram et al., 2019). Additionally, the infiltration capabilities of green schoolyards reduce stormwater runoff, which can greatly reduce the risk of local and regional flooding. Decreasing runoff volumes also prevents pollutants from being washed into waterways, improving water quality and preserving both Los Angeles' fragile ecosystems and the health of Los Angeles residents. In addition to improving water quality, the infiltration of stormwater also increases groundwater recharge and supports a more stable water supply for Los Angeles residents.

Given the potential benefits that are ancillary to schoolyard greening, we recommend that the top twenty schools identified in our composite index be prioritized immediately in school greening projects. However, we recognize that the index does not take into account every factor that differentiates a given school site's capacity for greening and that it may be vulnerable to oversimplification of factors that were analyzed by combining unique site information into a simplified aggregate score. To account for this, before site selection for greening projects, each campus must be individually reviewed through on-site observations, such as soil samples, to determine suitability.

To support the use of our index in future research, our data will be made available for researchers to calculate similar composite indices using different weights than were executed in this study (See Appendix B for data table access). A different weighting approach could be used to prioritize certain target issues over others, depending on the researchers' goal for the index. Additionally, future research may potentially further prioritize schools based on their area and percentage of impervious surface cover. Implementing greening on larger campuses could have a larger impact on stormwater volume reductions and groundwater recharge while converting campuses with a high percentage of impervious surfaces would maximize the ancillary benefits of greening.

Schoolyard greening improves air quality, pollution exposure, and access to parks, and reduces temperature and stormwater runoff volumes. Therefore, more greening projects should be implemented on school campuses. LA Waterkeeper and LAUSD can use our team's spatial analysis results to target schools for greening that would maximize greening benefits and aid in creating a better environment for all LA residents.

Promoting Safe and Feasible Greening Projects

Introduction

The regulations and liability review presents a comprehensive overview of the legal and financial landscape governing the district's school greening initiatives, while assessing the potential health risks associated with such projects. It was broken up into five major components including legal constraints, liability concerns, funding, JUAs, and best management practices.

This review made use of data from current scientific literature and databases that assessed the potential hazards regarding permitting, funding, and safety. For us to determine which laws and liabilities apply to the schoolyard greening of LAUSD campuses, we gathered information from governmental agencies, environmental authorities, and peer-reviewed journals. We also utilized information from LAUSD directly as they possess an extensive amount of past filings and reference guides all on LAUSD specifically. All gathered research was then compiled and synthesized to determine the process of getting approved for schoolyard greening projects. Ultimately, we analyzed our findings to create a collection of best management practices that could be leveraged to further improve the success of future greening projects.

Policy Review

Introduction

We identified several environmental regulations that must be considered to ensure the successful implementation of green schoolyards. The most noteworthy at the federal, state, and local levels are detailed below within this section. Box 1 on page 28 provides a general summary of each of the main regulatory hurdles.

Los Angeles Building Permit

LAUSD may find it necessary to procure a building permit from the Los Angeles Department of Building and Safety (LADBS). This permit is mandated for any construction, alteration, or repair work undertaken on private property within the jurisdiction of the City of LA.

To obtain a requisite building permit, an applicant must first formulate a comprehensive project outline and the draft of construction plans, which requires in-depth knowledge of zoning and property rights. Once completed, the finalized plans, along with a finished permit application, are forwarded to the LADBS. The duration of the review process varies, contingent upon the scale of the project undertaken by the contractor. Larger endeavors typically necessitate a lengthier assessment period. Certain projects may also need approval from additional departments depending on their scope and complexity. Upon successful review, LADBS approves the plans and issues a permit that can be obtained at the LADBS office. Once construction has begun, inspections are required. Following the final inspection, a Certificate of Occupancy is issued (City of Los Angeles Department of Building and Safety, 2024).

Contractors implementing a stormwater capture mechanism are mandated by LADBS to obtain a Plumbing permit. This permit is required for any installation or modification of drainage systems, waste and vent systems, fuel gas piping, potable water piping, rainwater piping, and lawn sprinkler systems (City of Los Angeles Department of Building and Safety, 2024). Detailed plans must be submitted and approved by LADBS. For LAUSD, these plans might encompass a drainage system, a rainwater piping system, or a lawn sprinkler system so that captured water can be repurposed and reused.

General Construction Permit

A necessary permit required in California is the Construction General Permit (CGP). The CGP permit facilitates coverage of stormwater discharges stemming from construction and land disturbance. The most recent iteration was ratified on January 18th, 2022, by the EPA, with subsequent updates occurring approximately every 4 to 6 years. While the permit is extensive, there are a few key points that must be accounted for to ensure compliance. Permit holders are obligated to develop a Stormwater Pollution Prevention Plan (SWPPP), which includes a delineated site map for equipment, construction boundaries, and discharge points. It also entails a rigorous monitoring system classified by the level of risk associated with pollutant discharge. Furthermore, it mandates exhaustive reporting and record-keeping to the Storm Water Resources Control Board (SWRCB) to guarantee compliance with the regulatory standards (EPA, 2022).

The threshold for pollutant discharge under the CGP is often measured by turbidity. The current benchmark is 50 Nephelometric Turbidity Units. Monitoring obligations include collecting at least one sample per day from each discharge point, comparing the average turbidity monitoring results, and reporting all weekly results no later than 30 days following each monitoring quarter (EPA, 2024b).

Depending on the nature of construction at various schools, LAUSD is likely required to obtain a CGP. The obligation arises in instances where there is a discharge of stormwater from construction activities or the site disturbs one or more acres of land. Given that LAUSD assumes the role of operator of the construction site and controls construction plans, they are responsible for applying for the permit. To initiate the process, LAUSD must submit a Notice of Intent (NOI) at least 14 days before commencing construction activities. The permit will be authorized 14 days after the EPA notifies their receival of the NOI unless notified that it has been delayed or denied (EPA, 2024a).

Porter-Cologne Act

The Porter-Cologne Act of 1969 is the principal legislation governing water quality regulations in California. It established the protocol for protecting water quality and delineated permissible uses of such water. Unlike the Clean Water Act, the Porter-Cologne protects both surface water and groundwater. This legislation designates the SWRCB as the statewide water quality authority and distributes authority to nine sub-boards, the Regional Water Quality Control Boards (RWQCB), throughout the state. The role of the SWRCB is to develop statewide water quality plans while the nine RWQCB are responsible for regional water quality plans, or basin plans. These plans must be approved by the SWRCB and the EPA and must include best management practices, plans for implementation, and water quality standards (CVWK Associate Director, 2020).

LAUSD falls within the Los Angeles Regional Water Quality Control Board (LARWQCB), which is tasked with protecting ground and surface water resources within the LA region, including coastal watersheds along the coast. To ensure the protection of local waterways, they follow a broad range of activities including monitoring and preparing National Pollutant Discharge Elimination System (NPDES) permits when needed, implementing local stormwater control efforts, and enforcing water quality laws in conjunction with public agencies in the region (California Water Boards, 2024a).

CEQA

The California Environmental Quality Act (CEQA) is a pivotal state statute that requires public agencies, including LAUSD, and local governments to evaluate the environmental ramifications of development projects and land disturbances to prevent negative environmental impacts. This legislation requires any new projects to undergo specific environmental review by the LAUSD Board of Education. Governed by CEQA state guidelines in the California Code of Regulations, Title 14, Section 15000 et seq., any LAUSD project must effectively adhere to all CEQA procedures. The CEQA officer who is responsible for overseeing environmental review functions, as authorized by Section 15025 of the CEQA guidelines, is the Office of Environmental Health and Safety (OEHS). OEHS is an LAUSD program utilized to provide support to ensure that health and safety concerns are met professionally. They are also responsible for responding to emergency calls, training employees, conducting safe school inspections, and delegating authority (LAUSD, n.d.a.; City of Newport Beach, 2024).

Clean Water Act and NPDES

In 1948, the Federal Water Pollution Control Act became the first major US law to address water pollution. In 1972, it was amended by the Clean Water Act. The Clean Water Act upheld existing requirements for water quality standards, established basic structures for regulating pollutant discharge, and gave authority to the EPA to implement stronger pollution control initiatives. It also provided funding for treatment facilities and formulated strategies to address nonpoint source pollution (University of California Agriculture and Natural Resources, 2003; EPA, 2023a).

Arguably the most significant aspect of the Clean Water Act was that it prohibits the discharge of pollutants through a single identifiable source into navigable waters of the United States (US) unless a NPDES permit is obtained. The NPDES permit contains limits on discharged substances, monitoring and reporting standards, and provisions to ensure the health of community members. The need for an NPDES permit hinges on the destination of the pollutants. If an entity discharges from a point source into US waters, a permit is required, but if the discharge of pollutants is into a municipal sanitary sewer system, no permit is necessary. The situation becomes more intricate when pollutants are discharged into a municipal storm sewer system because it depends on what pollutants are discharged. Regarding LAUSD, a NPDES permit titled the Municipal Separate Storm Sewer System Phase 2 permit is required (EPA, 2023b).

In California, the SWRCB and the nine RWQCB jointly monitor and issue permits to municipalities. Unlike some states where the EPA is the sole authority over permitting, California concurrently oversees the NPDES permit programs, state treatment programs, and general permit programs. Permittees are generally mandated to conduct regular sampling of their discharges and notify the SWRCB and RWQCB of such results. If they are not in compliance with NPDES regulations and fail to report it, then the SWRCB and RWQCB may send inspectors to the facilities. The EPA and state or regional water boards are protected under federal law to take action against those violating the permit requirements which could entail substantial financial penalties (California Water Boards, 2024c).

NPDES permits are effective for five years and can be renewed at least 180 days before their expiration. However, if the permit authority receives an application but does not reissue the permit before the expiration date, the permit may be continued until further notice. Every year, the NPDES permittees also adhere to a “Fee Schedule” guideline. Each public entity that owns and operates a stormwater conveyance system and is subject to an NPDES permit, such as LAUSD schools, must pay an annual fee according to the newly updated 2023-2024 schedule. For non-traditional Small Municipal Separate Storm Sewer Systems, such as LAUSD, the fee is based on the average daily population utilizing the entity's facilities, generally increasing as the population being served increases. Additionally, dischargers must pay an NPDES application fee of $200 to be granted a permit (23 C.C.R. §2200).

It is important to note that LAUSD schools fall under the NPDES general permit which is distinctively different from the NPDES individual permit. The individual permit reflects site-specific conditions of a single municipality based on the information given directly by the discharger. The general permit is written to cover multiple discharges – LAUSD school campuses for example – with similar operations and types of discharges. The most significant part of the application process for a general permit is the NOI, which informs the NPDES permitting authority – the California SWRCB in this case – of the discharger's intent to be covered under a general permit. This includes information on the planned discharge and mitigation efforts (EPA, 2023b).

MS4 Permit

The Municipal Storm Water Program was designed to develop permit requirements for reducing pollutant discharge into natural surfaces and groundwater. Initiated at the federal level in 1990, the Municipal Separate Storm Sewer System (MS4) program set baseline expectations for pollutant discharge while allowing states the autonomy to set their requirements to meet that federal standard. According to the EPA, an MS4 program can be defined as “a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains) owned or operated by a state" (EPA, 2000). Consequently, MS4 programs, which come in two different types of phases, are mandated to apply for NPDES permits.

LA operates under Phase 1 of the MS4 program and is overseen by the LA RWQCB and the SWRCB. LAUSD, on the other hand, is considered a small municipality and therefore falls under Phase 2.

Operators of MS4 Phase 2 municipalities are required to establish a comprehensive program that minimizes the discharge of pollutants to the "maximum extent practicable," safeguards water quality, and satisfies the water quality requirements of the Clean Water Act. This program encompasses six fundamental elements termed the "minimum control measures." Firstly, it necessitates the inclusion of public education and outreach. This includes distributing educational materials to inform students, teachers, and local community members about the impacts of stormwater pollution. The next fundamental element is active public participation and involvement as they create opportunities for community members to contribute to designing programs and implementing change. In regards to environmental impact, a systematic plan for the detection and elimination of illicit discharge is imperative to protect local waterways from the potential of hazardous pollution. Additionally, given that construction can lead to an increased potential of debris and pollutants, both construction site and post-construction site runoff control are required. This includes implementing an erosion control program as well as addressing the issues that arise as a result of uncontrolled discharges. The last minimum control measure is pollution prevention and good housekeeping, which requires a general plan aimed at reducing pollutant runoff from municipal operations (EPA, 2000).

Water Ownership

According to the California Water Code, the ownership of public water – encompassing rainwater and stormwater – is held by the State of California (California Water Boards, 2024b). Nonetheless, the SWRCB retains the authority to grant certain individuals and entities the right to beneficiary use of reasonable amounts of water, a concept commonly referred to as the usufructuary right to water. Under California Code section 10561.7, usufructuary rights concerning captured stormwater runoff from urban areas, such as public streets or sidewalks, are only provided by cities so long as it "augments existing water supplies" for the cities (California Code, WAT § 10561.7). However, the determination of what constitutes captured stormwater and whether it effectively "augments existing water supplies" is interpreted through the judicial precedent in the cases of *City of San Jose v. Monsanto Co.* and *County. of Los Angeles v. Monsanto Co.* (City of San Jose v. Monsanto Co., 2017; County of Los Angeles v. Monsanto Co., 2019). The previous cases determined that the City of LA may indeed assert property rights to stormwater that flows on public streets within its jurisdiction, but determining ownership of stormwater captured by project sites requires a more meticulous contextual analysis.

Assuming the City possesses property rights to stormwater on its streets and sidewalks, according to the City's pueblo rights, which entail the right to rainwater and stormwater that flows into the LA River, and California Code 10561.7, owners of project sites may still pursue the right to capture off-site stormwater, to the extent that the City allows it (California Code, WAT § 10561.7). The City Charter grants the Los Angeles Department of Water & Power (LADWP) Board of Water and Power Commissioners the discretion to manage the City's physical water supply and enforce all the necessary rules and regulations governing the operation and management of the water (Section 675(a) City Charter). It also gives them the power to control the distribution of water, reclaimed water, and surplus water owned by the City. Essentially, they are the governing body that can sell the water to the district and create contracts for the exchange. Section 673(b) of the City Charter states that the transfer of water from the City to another entity must be ratified by a supermajority vote of City voters. Section 673(c), on the other hand, states that the prohibitions in 673(b) do not apply "to the ordinary sale and distribution of water or reclaimed water to City inhabitants for their use." Because there is no definition of "reclaimed water" in the City Charter, it is not entirely certain whether stormwater is considered reclaimed water. However, the meaning of "ordinary sale and distribution" is also not defined – and thus does not explicitly exclude the sale of stormwater. Thus it can be interpreted to apply to the sale and distribution of stormwater, providing a mechanism for the City to sell stormwater to the owner of a project site and not be subject to 673(b) requirements.

For stormwater that falls directly on LAUSD property and is captured, California Water Code section 10561.7 would grant LAUSD superior rights to the water following capture. If LAUSD were to implement measures to divert stormwater from the public streets onto campuses for filtration and aquifer recharge, they would have to acquire the right to use the water from the City. The City would still technically own the captured stormwater and thus a contractual agreement between the City and the district would have to be made to relinquish recapture rights. The biggest concern regarding these contracts is that calculating the cost of stormwater, given its variability and unpredictability, is incredibly challenging.

Box 1. General Summary of Regulations

- **LADBS Building Permit, 1905:** This permit is mandated for any construction, alteration, or repair work undertaken on private property within the jurisdiction of the City of Los Angeles.

- **Porter Cologne, 1969:** The Porter Cologne Act of 1969 is the principle legislation governing water quality regulations in California. It establishes protocol for protecting water quality and delineates permissible uses of such water. This legislation also designates the SWRCB as the statewide water quality authority and distributed authority to nine sub-boards, the RWQCB throughout the state. The role of the SWRCB is to develop statewide water quality plans while the nine RWQCB are responsible for regional water quality plans.

- **CEQA, 1970:** CEQA is a pivotal state statute that requires public agencies, including LAUSD, and local governments to evaluate the environmental ramifications of development projects and land disturbances, with the aim of preventing negative impacts. This legislation requires any new projects to undergo specific environmental review by the LAUSD Board of Education.

- **Clean Water Act and NPDES Permit, 1972:** The Clean Water Act upheld existing requirements for water quality standards, established basic structures for regulating pollutant discharge, and gave authority to the EPA to implement stronger pollution control initiatives. It also prohibited the discharge of pollutants through a point source into navigable waters of the United States, unless a permit was obtained. The permit, known as the NPDES, contains limits on discharged substances, monitoring and reporting standards, and provisions to ensure the health of community members.

- **MS4 Permit, 1990:** The MS4 program set baseline expectations for pollutant discharge, while allowing states the autonomy to set their own requirements to meet that federal standard. Operators of MS4 Phase 2 municipalities, such as LAUSD, are required to establish a comprehensive program that minimizes the discharge of pollutants to the "maximum extent practicable," safeguards water quality, and satisfies the water quality requirements of the Clean Water Act.

- **California Code Section 10561.7, 2017:** The SWRCB retains the authority to grant certain individuals and entities the right to beneficiary use reasonable amounts of water, a concept commonly referred to as the usufructuary right to water. Under California Code section 10561.7, usufructuary rights concerning captured stormwater runoff are only provided by cities so long as it "augments existing water supplies" for the cities.

Liability Concerns

Introduction

Although there is an abundance of potential health concerns, we focused on three primary sources of risk including tree-related injuries, stormwater contaminant exposure, and soil contaminant exposure. The potential sources of risk are analyzed in detail below. Box 2 on page 36 provides a general summary of each source and Tort Law.

Tort Law and Negligence

Tort law is a subset of California law that handles civic breaches involving damages or harm committed by a party against another and typically involves resolution through monetary compensation. For LAUSD schools, the Los Angeles County Superior Court would oversee the trials (Judicial Council of California, 2024).

In 1963, California enacted the California Tort Claims Act (CTCA). Under the California Code of Civil Procedure, the CTCA allows people to file written claims against state establishments within six months of the alleged damage. Section 3333.2 establishes a $250,000 limit for the amount of monetary compensation of injuries (2 Cal. Civ. §§ 3333.2-3343.7). Furthermore, the CTCA acknowledges that the blame for injury could be divided between both parties, known as comparative negligence, which would reduce the amount of damages that can be obtained (EPA, 2024c; CaliforniaCourtRecords.us, 2024).

Tort law covers a myriad of different circumstances in California. They include negligence, willful application of stress or emotional discomfort, abuse, assault, infractions, and product liabilities. A significant concern for LAUSD after the implementation of schoolyard greening is that negligent liability claims may increase. Those pursuing a negligence claim against LAUSD must prove that there was harm done through failure to exercise a certain level of care. Injuries related to trees and new natural structures may be classified as not reaching a certain level of care if the supervision of the children is not up to relevant standards (CaliforniaCourtRecords.us, 2024).

Tort cases are filed on the prerogative of the plaintiff whereas criminal cases do not require the victim's consent to be prosecuted. The definition of harm is also defined by the community. Lastly, the conduct of the victim is significant in tort law whereas it is less significant in criminal cases (CaliforniaCourtRecords.us, 2024).

Before tort cases can be taken to court, however, a preliminary notice called a tort claim is required to notify the court of an injury or the detection of damage caused by a public entity. The general guidelines for filing a tort claim fall within general sections 910-913.2 of the California Government Code. It requires a written report and a $25 application fee which must be submitted to the Government Claims Program.There is about a 45-day wait period from the date of filing, resulting in approval or rejection (CaliforniaCourtRecords.us, 2024; Cal. Gov't Code §§ 910-913.2).

Introduction To Tree Related Injuries

During the Greening Schools and Climate Resilience Committee meeting on November 15th, 2023, members of the LAUSD community advocated for the planting of more trees to mitigate the severe heat effects while providing students with more space for outdoor learning and play. However, LAUSD had concerns regarding the possibility of liability claims and lawsuits as a result of injuries related to trees, like tree-climbing and tree failure. The basis for filing these lawsuits would be classified as negligence, as plaintiffs may claim that the teacher or supervisor was not meeting the standardized level of care which could have prevented the injury. Given this concern, we examined and cross-referenced multiple past studies to evaluate the apprehensions regarding the addition of more trees. The following studies provide a framework for understanding the possible risk of danger of tree failure-related injuries.

Tree Failure and Risky Play or Tree Climbing

One of the principal scenarios involving tree-related injuries is tree and branch failure. Trees may experience failure as the result of a variety of biomechanical and environmental factors. One study, authored by van Haaften et al., compiled over 160 analytic research papers and performed a meta-analysis that identified 15 primary causes for tree failure. They classified tree failure into 3 categories: stem, root, and branch failure, and drew a parallel between each potential cause and each type of failure. Across all 3 categories, wind was the predominant cause mentioned in 126 papers. It was reported that 407 wind-related tree failures caused deaths in the US from 1997-2007 (Schmidlin, 2009). Another significant conclusion from the study was that urban trees have a shorter lifespan than rural trees. The ecosystem dynamics of an urban tree such as experiencing harsher pollution, poorer soils, and limited root space serve as the leading causes of higher mortality rates (van Haaften et al., 2021; Schmidlin, 2009). Shorter lifespans then correspond to potential increased rates of tree failure, which can lead to heightened risks of injury.

The second principal scenario involving tree-related injuries is falling from a tree. Climbing trees is often considered risky play, characterized by more adventurous behavior that poses potential outcomes of injury. A study done by the University of Phoenix found that risky play served an important role in the well-being of children and that parents acknowledge the risks associated with tree climbing. In a 19-question online questionnaire, the researchers asked parents with children aged 3-13 about their perspectives on the potential benefits and risks of tree climbing and the impact it may have on child development. Over 70% of the parents found that tree climbing had a high impact on self-confidence, 60% agreed that it improved problem-solving skills, and around 67% noted that it greatly improved dexterity and physical strength. The parents were also asked why they allowed tree climbing to which 1,352 respondents answered “fun” while 1,317 also mentioned that it is “part of childhood.” The consensus was that the benefits generally outweighed the risk of tree climbing because it can profoundly impact a child's ability to grow physically and cognitively (Gull et al., 2018).

After establishing that both tree failure and tree climbing occur within these urban environments, we examined actual potential injury rates. The first study was from the Morristown Medical Center in New Jersey which analyzed trauma admissions from 2011-2015. They studied 11,677 total trauma admissions and found that 446 were related to injuries caused by trees. Of the 446, only about 4% were from falling from trees and about 3% were from trees falling, which is roughly 30 total individuals across 4 years. It is important to note that Morristown has an estimated 40-60% tree cover and these injuries occurred mostly after Hurricane Sandy. Another study done at the John Hunter Hospital in Newcastle, Australia took a retrospective review of all trauma admissions from January 2013 to June 2021. They found that only .26% (37 out of 13884) were attributed to trees and that the most common regions of injury were the chest at 47.6%, followed by head and neck at 42.8%. The study also noted that 52% of the injuries occurred with high-speed winds, but concluded that the likelihood of being injured by trees is extremely low. The last study looked at hospitalization rates over 6 years from 2012 to 2018 in the Midland region of New Zealand. Researchers found that 22.3% of the 8,697 pediatric hospitalizations came from playground and tree-related injuries. Of the 22.3%, about 225 were specific to trees, most of which were tree falls (Hakakian et al., 2018; Way & Balogh, 2022).

Playground Injury

Though tree-related injury concerns may arise, it is important to acknowledge that children are already at risk of injury when using playground equipment such as swings, monkey bars, or slides. According to a study done by the Directorate of Epidemiology in support of the U.S. Consumer Product Safety Commission, there were an estimated 205,850 playground equipment-related injuries treated in US hospital emergency rooms in 1999, the majority of which were children under the age of 15. Of these, only about 45% occurred directly in schools, while the majority occurred in spaces for public use. The most commonly reported injuries were fractures and 79% of these schoolyard injuries involved falls (Tinsworth, 2001). Another study that used data based on the United States Consumer Product Safety Commission’s National Electronic Injury Surveillance System found that only 72% of total playground equipment injuries were taken to the emergency room and reported, thus suggesting 200,000 greatly underestimates the true value of individuals experiencing these injuries (Mack et al., 1997). Because playground-related injuries already have high rates of occurrence, the addition of trees, which as discussed have lower frequencies in comparison, appears to pose minimal additional risk to children.

Additionally, similar to trees, playground equipment and experiencing play on such equipment has immense beneficial effects on children’s social and physical development. According to a field study thesis observing the Kurtulus Park of Ankara in Turkey, playgrounds often were the location where children had their first interactions with one another, which created a specialized atmosphere for them to become more skilled in social relationships and roles. They found that 51.4% of the children wanted to play with other children and that the type of equipment affected the way children interacted with one another. It was also established that the use of playground equipment, design of playground equipment, and risky play had profound effects on personal cognitive and emotional development (Metin, 2003).

Limitations

There were some limitations to these studies in terms of their direct connection to schoolyard greening liabilities. There was a general lack of sufficient studies regarding direct tree-related injuries on schoolyard grounds, which means that the majority of data collected had to be interpreted in the context of different environments. Many of these studies were taken from other countries which may have differentiating characteristics that affect tree failure and injury rates such as extreme weathering events and soil compositions. These studies looked at all ages as opposed to younger individuals and suggest that the majority of injuries occur working in the forest industry, rather than play-related climbing. In terms of the tree failure study directly, there was no commonly shared understanding, model, or function expressing the factors that explain tree failure, due to a low number of studies and sample sizes reported for each factor. Despite these limitations and the evident need for more research to be done, emphasizing the small possibility of tree-related injuries may assist LAUSD in identifying the likelihood of liability claims.

With these studies, it is important to keep in mind the methodological concerns regarding data collection and the accuracy of such data. A majority of the information comes from studies in the late 1990s and early 2000s in which playground safety standards were not as modernized as today. Thus, it is reasonable to expect the number of injuries to decrease as playgrounds become safer. However, the number of injuries that occurred on playground equipment may be underestimated as schools may have different thresholds for reporting injuries or may not have equal access to care.

Introduction to Stormwater Contaminant Exposure

LAUSD has the unique opportunity to incorporate stormwater capture mechanisms that are both good for the environment and human health. These mechanisms have the potential to reduce environmental risk in local areas, ease the burden on stormwater drainage systems, control local flood risk, and increase water supplies. Despite these benefits, the district has concerns regarding bringing contaminated stormwater onto campuses and the potential liabilities that may ensue as a result. Stormwater that travels along impervious surfaces often collects an abundance of harmful pollutants that pose a potential risk to students' health. LAUSD has the responsibility to protect its students and must exercise proper care to keep them safe and address potential harm. If a student were to become ill or injured as a result of coming into contact with collected stormwater, they may file a liability claim arguing that the school failed to properly address the risk of toxic pollutants. Given this concern, we examined and cross-referenced multiple past studies to evaluate apprehensions regarding stormwater contamination exposure.

Sources of Contamination

Harmful pollutants accumulated through stormwater collection can come from a variety of sources. According to a study done on the sources and loadings of urban stormwater pollutants attributed to urban catchment systems, there were five main catchment-borne pollutant sources. Firstly, the high use of vehicles led to the increase of combustion exhausts, leakages, and abrasion products. It similarly increased concentrations of CO, NOx, lead, and polycyclic aromatic hydrocarbons (PAHs) within the surrounding neighborhood. The second source of pollutants found in urban catchments was from construction sites. Particulate materials such as brick, cement, or asphalt debris of various grain sizes were often the result of such projects. The third significant source was the corrosion of local urban areas. Rates of corrosion depended on the availability of corrodible materials and maintenance and were often caused by acidic reactants and corroding gasses. This could release metals such as lead and iron into the local catchment system. The fourth source was animal waste as animal excrements can contain an abundance of nutrients that are contaminated with harmful bacteria. The final source was the direct result of human waste and anthropogenic consumption. The resulting pollutants from these sources were often flushed from the urban catchments and contribute to the overall pollution of the receiving water bodies (Brinkmann, 1985).

Most Common Contaminants

A chemical characterization study on the traditional and emerging contaminants in urban stormwater found a significant number of different pollutants that could potentially be harmful to the environment and human health. The study collected data from the US, Canada, New Zealand, and Australia to utilize the International Stormwater Best Management Practices database and the National Stormwater Quality Database to characterize and summarize the complexity of urban stormwater. They acknowledged the potential for finding nutrients such as nitrogen and phosphorus which could lead to eutrophication as well as the high probability of finding trace metals such as cadmium, copper, lead, and zinc which can come from brake dust, tire wear, and galvanized fencing. The study also points out the immense variety of anthropogenic compounds such as pesticides, hydrocarbons, and pharmaceutical chemicals. The results showed that there were important parameters for defining stormwater quality such as oil and grease levels, chemical oxygen demand, pH, and hardness. Within these parameters, they found that total suspended solids, which are a classifications of particulate matter, were the second highest observation. The metals found were primarily arsenic, antimony, beryllium, barium, cadmium, chromium, cobalt, copper, iron, lead, selenium, silver, and zinc, with iron being the clear dominating substance, though having the lowest toxicity. Past literature also showed that half of the 428 targeted chemicals in this study were detectable from 50 storm events at 21 sites across the US in which PAHs and pesticides made about 19% and 35% of the total detections respectively (Pamuru et al., 2022). This commonality indicates a potential risk for these contaminants to be present in stormwater on LAUSD campuses.

Further studies regarding anthropogenic chemicals and biological contaminants found that there were several new contaminants of emerging concern directly related to consumerism. A study by two researchers in the Department of Civil and Environmental Engineering at Washington State University identified per- and polyfluorinated alkyl substances, tire wear, personal care products, and fecal indicator bacteria as such contaminants. The per- and polyfluorinated alkyl substances were present in nonstick cookware, stain-resistant carpets, and coating for packages and were generally released during manufacturing. Tire wear was categorized as microplastics that contain a mixture of rubber tire tread and material from the road surface. They can become trapped in asphalt and continually leach chemicals. Personal care products were identified as a priority contaminant of emerging concern as they consist of substances such as ibuprofen that can be volatile. Lastly, fecal indicator bacteria can transport microbial contaminants like *Pseudomonas aeruginosa* and *Staphylococcus aureus* which pose significant health risks. Other studies have found traces of *Escherichia coli*, *Clostridium perfringens*, *Campylobacter*, *Salmonella*, *Giardia* cysts, and *Cryptosporidium oocysts* in residential catchments as well (Saifur & Gardner, 2021; Rodak et al., 2020).

Health Risk

Given the abundance of potentially harmful contaminants in collected stormwater, an analysis of the actual risk to human health is important. For metals, although they can be toxic in excess concentrations, causing acute and chronic diseases such as skin irritation and cancers, the chances of experiencing extreme effects may be exaggerated. A study evaluating the human health risks of six primary metals, zinc, cadmium, copper, lead, chromium, and nickel, found that when accounting for the bioavailability of such metals and their geochemical fractionation, the risk is significantly lower than assumed from a classical risk assessment. They identified three pathways for coming into contact with the stormwater, including ingestion of stormwater, incidental ingestion, and dermal contact, and considered the concentration of metals, exposure frequency, contact rate, exposure, and many more indicators to reach their conclusion. Another study examining the effects of heavy metals in stormwater found that the presence of a single heavy metal does not pose a significant risk, but the presence of multiple heavy metals could be potentially toxic. The largest contributors to that risk are chromium, manganese, and lead, although they were generally found in low concentrations (Jayarathne et al., 2020; Ma et al., 2016).

Climate Impact

The accumulation of pollutants in stormwater remains a significant concern but, with the continuing of climate change, the negative impacts of stormwater toxins will be exacerbated. The Intergovernmental Panel on Climate Change reported that estimated anthropogenic global warming since pre-industrial levels reached approximately 1.0 ℃ in 2017 and will reach 1.5 ℃ between 2030 and 2052. This warming is projected to lead to longer droughts and more extreme heat and precipitation events, although impacts vary geographically. Longer dry periods will allow an increased accumulation of particles and toxic pollutants on impervious surfaces. The high-intensity rainfall events that are then projected to follow will wash off an even larger amount of pollutants into receiving waters. Given Los Angeles's similar dry climate and abundance of impervious surfaces, this study is significant in understanding the future impacts climate change will bring in regards to increased stormwater runoff and any contaminants present in the runoff (Wijesiri et al., 2020).

Introduction to Soil Contaminant Exposure

The guidelines for toxic and hazardous conditions are set by state and local agencies such as the Department of Toxic Substances Control, the Department of Education, and the South Coach Air Quality Management District. LAUSD's Site Assessment Team, under OEHS, is responsible for reviewing and managing environmental project activities such as conducting environmental assessments, overseeing supplemental site investigations, developing remediation plans, and preparing removal action reports. It is also tasked with assisting the District Facilities Services Division and Maintenance operations associated with the management of hazardous soil, which is created by contaminant leakage from impervious surfaces (LAUSD, n.d.b). Given the abundance of asphalt used on LAUSD campuses, the potential for contaminant leakage and resulting contaminated soil is relatively high. When LAUSD takes on greening projects, a significant amount of soil will be unearthed as asphalt is removed. The district and other third parties assisting in these projects are required to test the soil because it could be harmful to the health of their students and staff. With this potential concern, it is important to examine the risk of exposure based on past literature and determine the defensibility of such apprehensions.

Health Risk

Asphalt and concrete generally harden and age due to chemical and physical influences such as UV radiation, traffic, and water. One study examined two fresh asphalt samples from a pavement company in Canada, one of which was a weathered low-traffic mix and the other was a high-traffic mix. They found that as these materials age, they release organic contaminants, such as PAHs, into air, water, and soil (Sadler et al. 1999; Birgisdottir et al. 2007; Sirin et al. 2018). These releases were primarily due to aggregates and binders found within asphalt which contain elevated concentrations of trace metals and metalloids. A considerable fraction of these metals and metalloids had the potential to leach into the environment over time from the <2 mm fraction of fresh asphalt concrete. The most significant metals were iron (8.34-40.0 g/kg), aluminum, and calcium, while other metals such as manganese (98.0-748 mg/kg), and phosphorus (202-522 mg/kg) were present as well. However, the study highlighted that the total amounts of elements released were relatively modest and it was only important to consider the contamination of soils underneath the paved roads due to increased weathering (Von Gunten et al., 2020).

Another important study on the contaminants in soil due to leaching took soil samples from a Former Brisbane City Council electric trolley bus depot, which had been surfaced with asphalt in 1951 and used exclusively for storage. The researchers collected soil samples by breaking the asphalt and sampling the immediate surface soil. They looked exclusively at PAHs, which present a health risk of carcinogenicity, and found contaminants that included Benz(a)anthracene, Benzo(b+k)fluoranthene, Benzo(a)pyrene, Indeno(1,2,3-cd)pyrene, and Dibenz(a,h)anthracene. The concentrations found at the site would exceed the current Australian investigation criteria and, given that the site had been idle for decades, the contamination was assumed to be the result of leaking. Despite these findings, they found the risk posed to public health was minimal and that human exposure would only be significant if the paving were removed. However, this risk can be alleviated by removing the layer of soil immediately below the asphalt surface (Sadler et al., 1999).

Box 2. General Summary of Liabilities

- **Tort Law:** Tort Law in California addresses civil breaches resulting in harm, typically leading to legal action for compensation overseen by the LA County Superior Court. The California Tort Claims Act allows individuals to take action against state entities for up to $250,000 for monetary compensation of injuries. For LAUSD, the implementation of more trees, stormwater capture, and soil contamination may increase the potential for tort liability claims.

- **Tree Related Injuries:** There may be potential liability from tree-related injuries when incorporating more trees into LAUSD schoolyards for climate resilience and outdoor learning. Studies on tree failure and risky play like tree climbing indicate that, while such injuries are possible, they are relatively rare and the benefits greatly outweigh the potential risks. Additionally, the risk of injury is already present given abundant use of playground equipment. Despite limitations in the data, understanding the low probability of tree-related injuries may help LAUSD assess potential liability claims more accurately.

- **Stormwater Contamination:** LAUSD is considering incorporating stormwater capture systems for environmental and health benefits, but concerns over liabilities due to potential contamination exposure remain an obstacle. Studies show stormwater collects harmful pollutants from sources like vehicular traffic and construction, posing potential health risks. However, the actual risk to students may be lower than assumed when considering the bioavailability of contaminants.

- **Soil Contamination:** LAUSD's Site Assessment Team oversees environmental projects and manages hazardous soil, particularly during greening initiatives that involve asphalt removal, which can unearth contaminants. Studies show that although aged asphalt releases organic contaminants and trace metals into soil, the exposure risk is very low and proper mitigation efforts can be taken to decrease it further.

Funding

LAUSD Financial Situation

LAUSD has historically been underfunded and its current financial standing is not sustainable. According to the Department of Education, LAUSD was set to spend the entirety of its $24 billion, including its $1.8 billion in reserve, by 2021 (LAUSD, 2017a). That spending was allocated toward federal and state-required programs, raises for all employees, discretionary funds, and district-wide expenses (LAUSD, 2017b). As remaining funds decreased, LAUSD utilized the last of its major pandemic aid and approved an $18.8 billion budget for the 2023-2024 academic year (Blume, 2023). Currently, the plan has been officially adopted which includes raises for staff, smaller class sizes for students, $124 million for Black student success programs, and increased mental health workers. While these positive investments greatly benefit the students and faculty of LAUSD, the district's spending allocations leave little funds left to support other projects such as schoolyard greenings. The 2023-2024 LAUSD budget report stated that "L.A. Unified continues to have a structural deficit whereby in-year expenditures exceed in-year revenues. As revenues continue to decrease due to enrollment decline, expenditures have not been reduced proportionately" (LAUSD, 2023a). The transition out of the COVID emergency funds leaves Superintendent Alberto Carvalho with decisions to make regarding the employment of staff, educational programs, and greening projects.

While their future economic situation remains uncertain, the district has shown the capability to continue striving for improvements. Currently, LAUSD plans to rapidly increase the access students have to greenspace at school. The Green Schools For All initiative aims to create at least 30% greenspace in all of their schools by 2035. LAUSD estimates about 15 million square feet must be greened to meet this goal, costing about $4 billion total. 220 schools have a more immediate need for improved greenspace, which is estimated to cost $1.5 billion. As of August 2023, the LAUSD board approved the use of $78 million for the outdoor renovation and greening of 7 schools, in addition to $600,000 dedicated to five schools which are Sustainable Environment Enhancement Developments for Schools projects (LAUSD, 2023a).

Costs of Greening and Stormwater Capture Mechanism Implementation

Due to site-specific factors, different stormwater capture mechanisms have variable costs involved in operations and management. However, median cost estimates for stormwater projects are $590 per acre-foot for large projects (>6,500 acre-feet) and $1,500 per acre-foot for smaller projects (<1,500acre-feet) (Cooley & Phurisamban, 2016). In the Living Schoolyards for Oakland program, it was reported that, of the three of five schools that completed green renovations, costs typically were between $1-2 million. Average greenings from the Trust for Public Land (TPL) cost $2.6 million, not including maintenance costs (Trust for Public Land, 2022). Tree People School Greening Senior Project Manager, Michelle Bagnato, states that oftentimes $1 million is not enough for one school, with Tree People leaving the securing of maintenance funding to the schools. Although initial costs for school greenings may seem higher than the traditional asphalt installation, which is approximately $2.3 million per school, green schoolyards are more cost-effective over 20 years. Asphalt requires routine costly maintenance while a green school produces a net benefit of roughly $600,000 per year from higher student attendance and staff retention, better academic performance, and savings on energy costs (Ionescu, 2022). LAUSD estimates $12 to $15 million may be required to sustain future greenings from the Green Schoolyards for All initiative (LAUSD, 2024).

Sources of Funding for Green Initiatives

To secure funding for school greening, local, state, and private sources may be used. At a local level, general funds of a municipality provide services to communities including stormwater management and general obligation bonds. General obligation bonds are local voter-approved bonds to fund capital projects. An example of general obligation bonds in LA are the bonds from Proposition RR. As of October 2023, there was $5.975 billion left in unissued funds. $300,400,000 of this funding was intended for new construction and updating of school facilities, specifically to enhance and expand learning, wellness, and recreational opportunities and provide a more energy or water-efficient environment.

The Safe, Clean Water Program and Tax passed in LA in 2018 under Measure W which established a parcel tax of 2.5 cents per square foot of impermeable surface for private landowners. The program provides roughly $280 million annually to fund projects that improve water quality and public health and increase water capture. Safe, Clean Water Program funding is allocated across three areas: the Regional Program, the Municipal Program, and the District Program. The Regional Program receives 50% of funding, with the majority of that being spent on infrastructure projects and scientific studies across LA County. The Municipal Program receives 40% to be used on infrastructure, maintenance, and more. 10% of the Program's resources are reserved for the District Program, which covers administration, technical assistance, and countywide initiatives that benefit the county (Safe Clean Water Program, 2024). To receive funding from the Safe, Clean Water Program, schools first apply under the regional program with a feasibility study, which determines the viability of proposed projects and involves a detailed investigation and report. Bagnato from Tree People states that the funding from Measure W is reportedly difficult to access for school greening projects, many of which would otherwise fulfill the requirements of the grant. As stated by LAUSD, such bonds will be "generally limited to projects that provide wide public benefit and for which broad public support has been generated" (LAUSD, 2023a). To receive disbursement of these funds, raising public awareness of local green projects may be informally a part of the application process.

There are many grants funded by state agencies that may be used for school greening. The California Natural Resource Agency, for example, has $23.75 million in grant funding available under the Urban Greening Program. School greening and stormwater capture fulfill many of the grant's requirements – the reduction of greenhouse gasses and mitigation of extreme heat, air pollution, and water pollution utilizing natural systems for multi-benefits. Additional goals may be met through enhancing community greenspaces, in disadvantaged schools for higher grant consideration, and the use of existing public lands (California Natural Resources

Agency, 2024). For the Living Schoolyards Program in Oakland Unified School District (OUSD), the California Coastal Conservancy awarded $566,00 through a Coastal Conservancy Grant to TPL to design and implement a pilot green schoolyard project (California State Coastal Conservancy, 2017). Another agency that provides grants for urban greening projects is the California Department of Forestry and Fire Protection (CALFIRE). The Green Schoolyards Grant from CALFIRE is funded by the California General Fund and is separated into two categories: planning and implementation. A maximum of $200,000 per school campus may be awarded through the Planning Grant while the Implementation Grant has a maximum of $2.5 million per school campus. CALFIRE grants do require schools to match grants given with 25% of the project funding from sources outside of CALFIRE. TPL is one well-known organization that has received grants from CALFIRE to fund school greening. With three of five initial Living Schoolyards program schools completing their greening, TPL has acquired almost $7.8 million in CALFIRE Planning and Implementation Grants to complete their Oakland Living Schoolyards project (California Grants Portal, 2024). Applications for agency grants, such as the Coastal Conservancy Grants, are reviewed on a rolling basis while applications to CALFIRE grants, for example, have a specific deadline period. Thus, it is important for LAUSD to understand the different timelines when applying for various grants.

Obstacles to Funding

Currently, there is no dedicated funding for stormwater capture projects specifically, only general funds and private funding. Many avenues of funding are not given a carte blanche and cannot be applied to maintenance costs of projects, serving solely as funding for capital costs of a greening project. The maintenance of greening projects has been a key element in upholding long-lasting and successful greenings. Without the proper funding for operations and maintenance (O&M), green schoolyards may fall into disarray or not receive proper utilization by students and the public without the staff needed to upkeep and guide the use of the new spaces. Information surrounding funding can be confusing due to a lengthy or complicated application process, with many stipulations built into grants. Additionally, due to limited avenues of funding, the applications may be highly competitive or may require recipients to match parts of the award. Also, a common occurrence will be high-profile funding from propositions running out of money. For example, all Proposition 84 grant funds as well as the funds from the California budget to the Green Schoolyards Grant have all been awarded. Currently with the State of California budget for 2024-2025, reallocation of funds has caused delays in disbursements to programs. For example, the source of funding for the Urban Greening Program changed to the California General Fund to $23.75 million from the Greenhouse Gas Reduction Fund (GGRF) and was delayed to 2024-2025.

Joint Use Agreement

What is a JUA?

Conventionally, JUAs are agreements between two parties, public or private, where facilities, land, utilities, or other common elements are shared (CC&S and PHLP, 2008). JUAs are instrumental in facilitating an increase in urban greenspaces, as they allow for more multi-purpose land usage – for example, the opening of school grounds to the public as parks. These agreements can take place formally as contracts between school districts and other entities or informally in the form of leaving school grounds unlocked after school hours. Currently, this informal access to outdoor school recreation facilities (athletic fields, basketball courts, tennis courts, and playgrounds) is the most common type of joint use (Jones and Wendel, 2015). There are many precedents of successful implementations of JUAs in California schools. California legislature allows for school districts to enter agreements with another governmental entity, such as a local government or city, that include some or all of the territory of the district for the joint use of park and recreation facilities (Ed. Code, § 17551). Many schools have utilized the ability to enter into JUAs to serve communities by granting public access to school grounds outside of school hours or as a means to secure support and funding for renovations and school greenings.

How Has It Been Done Before?

Currently, an example of JUAs used to expand the greenspaces available to the public in LA exists in the form of four community school parks created under the agreement between the City of LA Department of Recreation and Parks (RAP) and LAUSD. In this agreement, LAUSD opens the schoolyards for access outside of school hours, and RAP shoulders the costs for programs, staffing, and maintenance (City of Los Angeles Department of Recreation and Parks, 2023). Other examples within LA County include the JUAs between the City of Pasadena and Pasadena Unified School District (PUSD), one of which is the usage of Madison School Park which was approved for joint use in 2016 during specified, non-school hours (PUSD, 2022). In this JUA, the city holds responsibility for security, park access, and cleanup of the park while it is in public use, while the PUSD covers ongoing field maintenance. Each party covers liability during their respective operating hours of the grounds. An example of a successful instance of leveraging a JUA to fund a project was the Agoura High School tennis court renovations. The circumstances leading to the renovation of the tennis court facilities are currently less commonly seen in joint use projects. In this case, the City of Agoura Hills had already set aside money for public recreation facilities and partnered with the school to prevent the need to construct more facilities in public parks. The JUA stipulates that the city takes on maintenance and other responsibilities, while the public can use some of the courts during school hours and the rest of the facility is completely open to the public after school hours (Changelab Solutions, 2010). A specific case of JUAs to facilitate school greening occurred in 2017 with the OUSD in partnership with the City of Oakland, TPL, and Green Schoolyards America to increase public access to the greenspaces created outside of school hours.

Risk of JUAs

There are some risks involved with opening up schoolyards for public use. Concerns over school safety may arise when schools are viewed as easily accessible or if clear boundaries are not constructed on school grounds (Derr & Rigolon, 2016). For example, some schools carefully keep the line of sight clear with no tall trees obstructing views to prevent the possibility of people hiding on school grounds. However, most parties are more concerned over legal liabilities. Responsibility for the maintenance of facilities and the well-being of people using the school grounds at varying hours under a JUA are of higher concern to most schools. With a clear-cut division of responsibility over potential liabilities and maintenance, many JUAs have not had issues over responsibility disputes. Typically, schools maintain their same responsibilities over grounds during designated school hours, and while grounds are in public use, the JUA partner is in charge of potential liability and maintenance needed from public access to the schools.

Final Thoughts on Regulations and Liabilities

Ensuring Compliance with Environmental Regulation

There is an abundance of environmental and legal restrictions that must be accounted for before greening projects can proceed, but there are measures LAUSD can take to facilitate this process. The following practices are suggestions we believe can minimize any hesitancy that may arise as a result of environmental regulation compliance. Generally, LAUSD should start the permitting process as early as possible and complete comprehensive research to understand the regulatory requirements that govern these projects. This review may support the preliminary research and guide further examinations of relevant federal, state, and local regulations. LAUSD should pursue the establishment of communication channels and strong relationships with regulatory agencies. These agencies will be able to clarify permitting restrictions and answer any necessary questions regarding the process. For the district, a faculty member or group as the main contact for the SWRCB and RWQCB would suffice as a liaison. This is important because LAUSD does not currently have a dedicated point of contact for this purpose.

While this communication with regulatory agencies is paramount, internal communication amongst the faculty, board members, and community is also necessary to decrease the likelihood of any problems occurring in the permitting process. Internal communication starts with engaging these groups in educational programs and training to not only increase awareness about these legal barriers but also encourage more individuals, most importantly faculty, to help with the connection between regulation agencies. If there are more administrative staff that are well equipped to understand the environmental standards, then there will be more individuals capable of writing accurate and precise permits. This can also allow for more internal auditing and allow LAUSD schools to implement an internal review process to increase the likelihood that these permits are approved and regulatory restrictions are met. LAUSD currently uses a set of crafted guidelines regarding necessary steps to remain in compliance with certain environmental regulations, but up-to-date versions are not readily accessible. For example, the current guidelines for managing pollutant discharge from construction were written in 2017, whereas updating these guidelines annually and making them easy to access would ensure that the district accounts for potential changes in regulations.

In terms of stormwater ownership, because the city and state legal proceedings are complex, LAUSD should opt for stormwater capture mechanisms that do not involve the harvesting or reuse of the water itself. The city may sell collected stormwater to the project sites, but implementing natural filtration practices and focusing on groundwater recharge may alleviate some of the stress involved with liabilities regarding stormwater ownership. For water that LAUSD does want from the city, the district must argue for contracts that include a provision that grants them full rights to use the acquired stormwater, store the stormwater, and reuse it following recharge of the aquifer.

Mitigating Health Risk and Liability Claims

The district can take multiple proactive measures to decrease the potential health risks associated with tree-related injuries and in turn, minimize tort liability claims. Given the stressed importance of large trees for shading and playing by community members, LAUSD must conduct regular inspections to look for signs of tree decay and structural damage and take immediate action to alleviate those issues. These inspections may involve hiring an outside contractor to make regulatory appearances, but given the district might not have the funds to do so, training maintenance staff to identify and solve these issues is paramount. Concurrently, LAUSD must maintain proper supervision of students outdoors at all times and school faculty should be trained with the proper safety procedures. However, these measures will not completely prevent injuries from occurring due to the nature of playground activities and risky play. Therefore, in the interest of minimizing the extent of potential injuries, more absorbent or loose-fitting surfacing around climbing apparatuses, trees, and play structures should be installed. Additionally, schools should have a comprehensive emergency response plan that includes proper contacts for local authorities in the most severe cases.

Similarly, while stormwater pollutant exposure presents a significant concern, proactive preventive measures can be implemented to greatly decrease the potential for negative health impacts. LAUSD should primarily opt for natural filters in the form of bioswales and rain gardens. Bioswales have a slight longitudinal slope that draws in the flow of water to be filtered by vegetation and percolate through the soil. Rain gardens, similarly, are depressed vegetative gardens used to collect runoff and filter contaminants while simultaneously recharging groundwater. An increase in green infrastructure will greatly increase the volume of absorbed stormwater and filtered pollutants, while also making campuses more aesthetically pleasing. LAUSD should also identify the most common and harmful types of pollutants that affect the area as they differ by location, which allows them to implement measures aimed directly at minimizing the source. This includes constant monitoring to assess how successfully implemented mitigation strategies are to determine if strategies need to change. Additionally, educational campaigns should be created to share information on pollutants and mitigation strategies with students, staff, and community members so that LAUSD can promote beneficial behaviors and overall reduce health risks.

Lastly, addressing the concerns surrounding soil contamination necessitates implementing comprehensive mitigation strategies that not only tackle existing problems but also prevent further issues from arising. The District Facilities Services Division and Maintenance operation is already directed to run soil sampling tests on unearthed soil, but consistent post-construction testing is necessary for continuing to protect community safety. This includes developing a maintenance and monitoring schedule to ensure that contaminated soils are dealt with swiftly using a multidisciplinary approach. A few strategies LAUSD may want to prioritize are bioremediation or soil washing. Bioremediation is the process of using biological systems to remove pollutants from soil and other environments. It is considered a safe practice because it does not produce any harmful byproducts. Soil washing is an ex-situ technology that removes contaminants through the physical separation and chemical leaching of the soil by a liquid, usually water. It can be done on-site and may be the cheaper option, making it a viable alternative to bioremediation. Complete removal is also an option but should not be prioritized because LAUSD would have to incur extensive transport costs.

Strategies for Securing Proper Funding

Acquiring proper funding remains a significant challenge, but can be achieved through relying heavily on grant opportunities and public-private partnerships, rather than using a majority of the LAUSD budget to pay for these greening projects. The district should consistently pursue annual grants from governmental agencies – with the most money available at the state and regional level – and non-profit organizations that are tailored towards greening initiatives. Successful projects using money from these grants will likely increase the chances of securing future funding from the same agency, thus providing more long-term success. To increase the likelihood of receiving a grant initially, the district needs to invest time into grant proposal writing and either train staff or engage a third party to assist in that process. Additionally, independent fundraising is a requisite for many state-sourced grants that require an average of 25% of the grant given to be matched by recipients. Schools may also issue bonds to fundraise or push for local measures to allocate further taxes to fund school greenings.

Similarly, collaboration with corporations and philanthropic groups can result in consistent funding as many such businesses take part in environmental initiatives as part of their social responsibility. Organizations like the Nike Foundation and the Chuck Lorre Foundation are key contributors to the work done by the TPL. It is also extremely important to encourage community engagement by emphasizing the benefits of greening, especially when advocating for funding initiatives in Measure W. Advocacy spreads awareness about the benefits of these projects which also inclines community members to vote certain bond measures forward. Such campaigns require trained staff who are willing to educate and mobilize voters. LAUSD can create a volunteer program or school campaign to get more people involved.

Increasing Joint Use Agreements on LAUSD Campuses

Incorporating JUAs often brings up apprehensions regarding the maintenance of school grounds and student safety. The liability concerns, however, can be overcome by a series of strategies aimed at protecting the district and providing a greenspace to the community. Before implementation starts, LAUSD must have a clear understanding of the potential partners they could collaborate with and involve community engagement on the kinds of opportunities community members want to see during non-school hours. This includes researching the local organizations, youth programs, and sports leagues who may benefit from the greenspace as well as holding community meetings and sending out surveys to gather input. Including the community in JUA discussions can also proactively address liability apprehensions as locals will be more aware of the rules in the agreement. Community engagement builds support for greening projects and can aid with raising funding and ensuring the space is properly used in the future. Making the broader community aware of the social and environmental benefits of greenspaces will increase public support for opening up schoolyards and ease liability concerns. Additionally, a greater breadth of grants and funding are available to projects that increase local greenspaces access for the surrounding community, which may incentivize LAUSD to create more JUAs in their schools.

Negotiating for these contracts, whether it be with third-party organizations or city governments, can also be a challenging process. The district should aim for the City to take responsibility for liability and maintenance issues during non-school hours as is typical in joint use situations involving cities and schools in California. This would ease concerns regarding schoolyard upkeep and ensure that LAUSD is not responsible for incidents that occur at these times. The district should not, however, be flexible with delineated boundaries for what is accessible to the public. LAUSD must protect its campuses from unwanted individuals, which can be achieved by ensuring that contract agreements include area limitations.

Expert Testimonies and Recommendations

Introduction

The following section presents a list of LAUSD-specific recommendations, compiled from expert interviews and studies of successful projects, to guide LA Waterkeeper in implementing successful greenspace and stormwater capture systems in the target schools previously identified in this report. Based on preliminary research, it was clear that greening endeavors brought forth by external organizations to LAUSD are time, energy, and capital-intensive. While there are general recommendations published online on how to start greening schools, we recognized that there was a need to investigate how LAUSD manages schoolyard transformations and what specific strategies have proven successful for past projects. The following list is not a step-by-step plan, but rather an emphasis on frequently mentioned points that our team drew parallels of across multiple interviews. We hope to ease the process for gaining approval and implementing change on school campuses for LA Waterkeeper and provide insight into the challenges that other organizations and agencies have faced.

Methods

Our research team met with key stakeholders and experts in the field of school greening and stormwater capture. We conducted semi-structured interviews following a list of general questions concerning the interviewee's knowledge and experience with JUAs, funding protocols for greening, and stormwater capture projects, with the addition of specific questions pertaining to the interviewee's area of expertise or experience. The list of questions is included in Appendix E.

Interviewees were selected based on their expertise and prior involvement in efforts related to greenspace implementation and management within LAUSD. We also reached out to individuals with extensive experience in designing and developing stormwater capture projects in schoolyards. Those that we connected with and interviewed included:

1. Claire Latane - Eagle Rock Elementary
    a. *Asst. Professor of Landscape Architecture, Studio MLA designer*
2. Amanda Millet - Eagle Rock Elementary
    a. *Parent and coalition member*
3. Elizabeth Zernik - Environmental Resources Management
    a. *Stormwater consultant*
4. Aditi Bhaskar - Colorado State University
    a. *Engineering Professor, watershed health and stormwater management effectiveness researcher*
5. Michelle Bagnato - TreePeople
    a. *School Greening Senior Project Manager*

6. Amanda Begley - TreePeople
    a. *Watershed Senior Program Manager*
7. Trust for Public Land
    a. *California Director*
8. Trust for Public Land
    a. *California Advisory Board Member*
9. Joel Alvarez - LA Department of Recreation and Parks
    a. *Senior Management Analyst*
10. Ryan Carpio - LA Department of Recreation and Parks
    a. *Director of External Affairs*
11. Edith de Guzman- Luskin Center of Innovation, UCLA
    a. *Former Director of Research at Tree People, Water Equity and Adaptation Policy Cooperative Extension Specialist*

In addition to semi-structured interviews, we investigated and reviewed successful school greening projects within LAUSD, such as Eagle Rock Elementary and Castellanos Elementary, Mary W. Jackson Elementary in Pasadena, and Oakland Unified School District in Northern California, to supplement our findings from interviews and provide further context of successful implementations and their strengths, obstacles, and solutions. For a complete list of those projects see Appendix F.

Information gathered from interviews and background research was then compiled into a single list of recommendations divided into five categories: planning, design, maintenance, joint use agreements, and funding.

Final Recommendations List

Planning

Implementing a schoolyard greening project requires first getting approval from both the school staff and community, along with LAUSD. Therefore, it is important to consider how potential plans are presented to these valued stakeholders to motivate them to pursue the project. Our recommendations include advice on how to garner support for, and generally set up, the project for success.

1. *Emphasize the multi-benefits of the greening project*

Though one of the leading goals of LA Waterkeeper is to maximize stormwater capture, green schoolyard design and installation provide additional benefits to students and the school community. These benefits include the mitigation of negative heat impacts, equitable access to greenspace, and enhanced student attention and social behavior in the classroom. Highlighting these improvements to LAUSD, the target school administration, and the surrounding communities will increase public approval and interest, and in turn, widen the range of funding opportunities. Multiple experts, including Edith de Guzman, Clare Latane, Amanda Begley, and Michelle Bagnato, encouraged leveraging multi-benefits during the grant application and approval process. Maximizing these benefits should also be incorporated into the project's design.

2. *Find a "champion" at each location*

Stormwater compliance expert Elizabeth Zernik and school greening expert Michelle Bagnato advised seeking out a teacher, administrator, or other staff member at each site to be a liaison for the school and contributor to the project's development, implementation, and future maintenance planning. These "champions" should have extensive knowledge or access to information about their school landscape and operations to serve as leading advocates and guides for the project. Their position in the school would also mean they would be on-site to keep up with the maintenance after the project's completion.

3. *Measure project progress and success*

Producing results that the school, district, and surrounding community can understand are key aspects to advancing a greening project and paving the way for more partnerships. These results should further the mission of LA Waterkeeper but also be aligned with the mission and vision of LAUSD. Michelle Bagnato shared that their organization measures success through reduced temperatures at and near their school projects. This metric is tied to LAUSD's goals through attendance rates. Extreme heat poses a health risk to young children and on days with high temperatures, parents may choose to keep kids at home where they will not be exposed to searing asphalt. By removing impervious surfaces, adding natural landscaping, and planting trees, TreePeople has demonstrated that their efforts to cool temperatures and mitigate the risk of heat injuries improve the average school attendance at their project sites.

<u>Design</u>

Although LA Waterkeeper may consult a design firm for green schoolyards within LAUSD, LA Waterkeeper will have the power to suggest important aspects of the design plans. The following recommendations integrate research around the physical and mental health of children, as well as practical concerns regarding upkeep and water capture.

1. *Create variable schoolyard components*

Design expert Claire Latane recommended that schoolyard designs maximize variety. This can be done by having multiple schoolyard components. For example, Eagle Rock's schoolyard includes a kickball field, a forested grassy area, and a native plant garden. Including a variety of nature-based features for children to explore based on their mood or emotional needs was shown in Latane's research to be beneficial to their health and behavior. Due to her findings that uninterrupted asphalt space leads to more disorderly conduct, Eagle Rock planted a row of trees in their old blacktop space to break up asphalt coverage. Based on the success of this project's design, we strongly encourage LA Waterkeeper to advocate for a similar strategy in future greening efforts to provide variable features that both engage students and address different environmental needs.

2. *Invite community members to the table*

Nearly every expert we consulted on schoolyard design and planning stressed the importance of considering student and community needs at this stage. Students, faculty, staff, and other community members impacted by the space must have a voice in what is to be included. This may involve directly consulting these stakeholders on what they want to be added, removed, or left alone. For example, after finalizing contracts for a schoolyard at Castellanos Elementary, TPL spent ten weeks workshopping potential designs with fourth-grade students at the school. At Eagle Rock Elementary, direct consultation with community members was paired with an observational study by Dr. Marci Raney on which current schoolyard components were used the most and the least. The most well-loved and well-used areas were kept intact in the new design, while unused areas were improved or redesigned. Co-developing plans involving community opinions makes the resulting project more valuable to the community. The final product will foster a sense of belonging and ownership for those involved.

3. *Utilize designs familiar to LAUSD Facilities*

Although specific stormwater retention and infiltration designs may have small differences in capacity or capture, installing designs that LAUSD Facilities are more familiar with is more important than efficiency. Ensuring that Stormwater Capture Mechanisms (SCMs) receive proper upkeep is crucial to their lasting functionality. By utilizing designs that have established maintenance plans and pre-existing history in LAUSD, the resulting benefits may be maintained for the greenspace's lifetime. Additionally, this practice could help minimize the difficulty of the facility staff's jobs, encouraging their cooperation with the project.

4. *Install site-specific Stormwater Capture Mechanisms based on hydrology*

LAUSD campuses have the incredible opportunity to incorporate SCMs that greatly decrease pollutant discharge into natural bodies of water and successfully recharge ground aquifers. However, given the size of LA County and the dispersion of LAUSD schools, the amount of stormwater differs from site to site. The California Director for TPL highlighted the importance of using site-specific designs for SCMs at these different campuses. Castellanos Elementary School, for example, used natural climate stormwater management mechanisms by diverting water away from storm drains and into bioswales to clean up pollutants. Another school, however, may be better suited for more elaborate collection techniques and reuse. The main goal, independent of which mechanisms are used, is to maximize stormwater capture and the environmental, education, and public health benefits.

<u>Maintenance</u>

Maintenance was identified by the majority of our interviewees as one of the main obstacles to the schoolyard greening process. Securing approval and forming an agreement with LAUSD Facilities can be difficult. Maintenance needs can be labor and knowledge-intensive, and require long-term planning and funds; correctly approaching this aspect is crucial.

1. *Outline a long-term maintenance plan*

Facilitating maintenance and long-term community investment in a school greening project, beyond implementation, is key. Elizabeth Zernik suggested forming a long-term maintenance plan that outlines how to care for schoolyard elements and includes training materials for those who will maintain them. For example, if a green schoolyard design includes a native plant garden, the manual should describe what each plant species is and how to properly manage it. If there is a comprehensive manual and training curriculum, community volunteers could even be responsible for the upkeep of a project. TPL's OUSD Living Schoolyards Guidelines document is an example of the level of detailed documentation for future upkeep that relevant stakeholders could reference.

<u>Joint use agreements (JUAs)</u>

JUAs are one avenue for maximizing the impact of school greening benefits. Though ideal in theory, liability concerns from LAUSD and environment-focused organizations can pose a barrier to opening campuses to the general public. Our recommendations for navigating this option focuses on methods that have helped the creation of successful JUAs in the past and in other jurisdictions.

1. *Leverage successful JUAs*

LAUSD has a short history of opening its schoolyards to the public. The California Director for TPL pointed out that the school district is not necessarily built to prioritize JUAs due to its bureaucratic structure. However, a change in district priorities can allow for increased JUA presence on LAUSD campuses. In the past, the City has taken on potential liability concerns that arise during non-school hours and would repair any damage that has occurred to the campus. Implemented designs could also strategically place park spaces closer to the street to separate community and campus spaces during joint use hours. The City of Irvine and San Diego have successfully implemented similar JUAs. Additionally, it is important to cater to the individual school administration when proposing a JUA. Ryan Carpio directs the Community School Parks Program which involves developing JUAs within LAUSD. He stressed that a large portion of what drives a successful partnership is the willingness of the school administration to make the change. At the end of the day you cannot open a campus to the public if the administrative staff on site is not willing. This unwillingness may stem from concern of vandalism or destruction of property, maintenance and staffing costs, or general disinterest. As mentioned previously, placing new greening features closer to the street can help to isolate any property damage. Lastly, to handle general disinterest, LA Waterkeeper must leverage past examples and their benefits. Highlighting just how valuable of a commodity these schools can be for residents of the region, as well as how JUAs can create more funding opportunities for the district, are jumping off points for establishing a connection and being one step closer to expanding the multi-benefits of school greening to the greater LA population.

2. *Collaborate with third-party organizations*

Navigating the complexities of JUAs can be time-consuming and difficult to navigate. Many schools in LAUSD require assurance that a JUA will bring more benefits than risks. Partnering with larger, well-known organizations that require greenspaces for their operations is a helpful strategy to convince school administrators that JUAs will bring overwhelming benefits to the campus and the public. Entities such as the American Youth Soccer Organization, or other youth sports programs, are organizations that our interviewees at the LA RAP and TreePeople mentioned as potential partners to approaching schools. Establishing connections with other interested parties can distribute the burden of addressing all liability concerns and seeking out staff to monitor and secure the schoolyard during after-school or weekend operational hours.

<u>Funding</u>

Undertaking a school transformation project is overwhelmingly dependent on whether the project has secured sufficient funding. While there are multiple grants and awards dedicated to improving the state of greening in the region, these can be competitive or limiting in their usage. Thus, approaching this aspect of any greening project will require a strong case and detailed research.

1. *Leverage community support*

To increase the likelihood of receiving funding through grants and donations, there needs to be a clear demand by the school and the surrounding community. Conducting outreach to local foundations, businesses, and community members can garner attention to the project and gain support for its implementation. Amanda Millet spoke on how the Eagle Rock Elementary grant coalition team used widespread community support in their successful campaign for attaining the Proposition 84 grant. Engaging in extensive community outreach also attracted the help of pro-bono services and aid in planning the project by local non-profit organizations. Demonstrating unilateral support and the community's desire for the project indicates to grant-holders that a project will be successful, deliver its benefits, and be upkept following its completion.

2. *Secure funding that includes maintenance after installation*

Due to the importance of establishing clear maintenance plans, it is also crucial to ensure that enough funding is secured during the development of any school greening project. This can be accomplished through fundraising and seeking grants. Many greening grants, however, may not factor in upkeep costs. Measure W (Safe Clean Water Program) is a newer stormwater funding measure designed to consider the need for funding beyond upfront costs. The grant includes maintenance costs as an approved expense. In regards to securing additional funds, Michelle Bagnato mentioned that when partnering with a school, TreePeople strongly encourages the "champion" to lead fundraising efforts to ensure that even after the completion of a green project, there are funds available for upkeep and maintenance staffing. The costs associated with maintenance will vary with each project. However, this information may be available to reference with the Complex Project Manager of the selected schools.

Discussion of Recommendations

Through interviews with reliable experts familiar with greening, stormwater capture, and park accessibility, our team synthesized actionable recommendations to inform LA Waterkeeper's goals to expand school greenings within LAUSD. Based on our analysis, we identified three groups of stakeholders to address and cater to when introducing a project: the individual school, LAUSD, and the neighboring community. Our recommendations apply specifically to often overlooked or difficult to manage aspects of greening project implementation in schools in order to increase understanding by stakeholders unfamiliar with the process and to ease common cost, injury, or labor concerns related to school greening projects.

As follows, community support is one of the most important factors in achieving success. This concept spans across multiple categories of our recommendations. Parents, local nonprofits, and other community organizations have shown to be key players in amassing the knowledge and resources needed for development efforts, as was the case for Eagle Rock Elementary. Completed projects displayed the importance of leveraging community support, prioritizing their needs and perspectives, and choosing designs that contain various components and multiple benefits.

Our recommendations can be applied to maximize benefits and implementation success at the school sites identified in the earlier "Spatial Analysis" section The interviews and case studies that informed our recommendations were mainly focused within LAUSD to better address the specific challenges most commonly encountered within the district's jurisdiction.

However, every campus has a different administrative staff, surrounding neighborhood, and subsurface composition. Due to this, our list is generalized to the entire district and may not apply to each school within LAUSD. Furthermore, there is currently no established set of guidelines for external organizations, such as LA Waterkeeper or their coalition partners, to collaborate with schools. Third-party entities must go through a trial-and-error process, which can create confusion and delay the process. Since there is a lack of transparency on behalf of LAUSD, there may be other obstacles that LA Waterkeeper will face that were not addressed in our list. Moving forward, LA Waterkeeper should advocate – alongside other organizations – for a clear path to greening with the district.

Conclusion

Schoolyard greening is a critical strategy for addressing the environmental and health burdens LAUSD schools face as a consequence of impervious surface coverage. Our report identified the optimal locations for greenspace and stormwater capture within the school district using a composite index that considered four factors relevant to schoolyard greening. Our analysis revealed that schools in East and South LA are most amenable to schoolyard greening, particularly in areas such as Historic South-Central, Florence, and Boyle Heights. If the twenty highest-rated schools from our list were to green 60% of their campuses, the cost to transform and maintain these schoolyards is estimated to be $25.2 million in total. However, the total benefits to LAUSD over a 20-year lifetime are projected to be valued at $144 million, which encompass dollars saved in energy spending, emission reduction, water expenses, and increased revenue. Though the upfront cost of greening is high and would require sufficient planning, the maximized social, economic, and environmental improvements and their fiscal estimates strongly outweigh it.

To support the target schools list we compiled, we organized a guide for complying with relevant regulations and navigating liabilities within schoolyard greening projects. This will help inform future projects on the administrative process and provide recommendations on how to best minimize potential liabilities associated with greening LAUSD schools.

Lastly, we interviewed key experts and formulated a list of recommendations based on vital steps and commonly stated obstacles to greenspace implementation in LAUSD schools. Experts with experience in this field emphasized comprehensive long-term planning, community-driven design, and sustained upkeep and funding plans in partnership with third-party organizations like TPL and TreePeople. Since each school will have different administrative staff and capacity for terrain alterations, our suggestions require tailoring toward site-specific designs and implementations. These recommendations highlight solutions to improve the current state of schoolyards and support the effectiveness and sustainability of greening projects for our target schools.

Our report aims to inform LA Waterkeeper about LAUSD schools that are potential candidates for greening and stormwater capture. It provides the foundation for successful transformation projects through expert-supported recommendations, data-driven geospatial analysis, and an exploration of the legal intricacies and risks associated with these endeavors. However, it is important to acknowledge that our report is broadly generalized and there will be cases for schools we identified that will require further assessment and research to best implement changes. Our aim with this report was to support school greenings and their mitigation of the negative health and environmental impacts that are a consequence of decades-long reliance on impervious surfaces. We hope our report will guide the fundamental steps to achieve the Green Schools for All initiative and LA Waterkeeper's goal for greening schools and increasing stormwater capture.

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Appendix

Appendix A

Specific Spatial Analysis Methods

Social Vulnerability

To create the Social Vulnerability sub-index for the Schoolyard Greening index, four sub-indexes were created using the Calculate Composite index tool in ArcGIS Pro, which were then combined into two sub-indexes, and were finally combined into the final Social Vulnerability sub-index.

Raw data was gathered from CalEnviroScreen 4.0. This data set is made up of census tracts that have population and environmental information associated with each census tract. The four sub-indexes that were first created were socio-economic characteristics, sensitive populations, pollution exposure, and environmental factors. The indicators that were selected for each sub-index are the following:

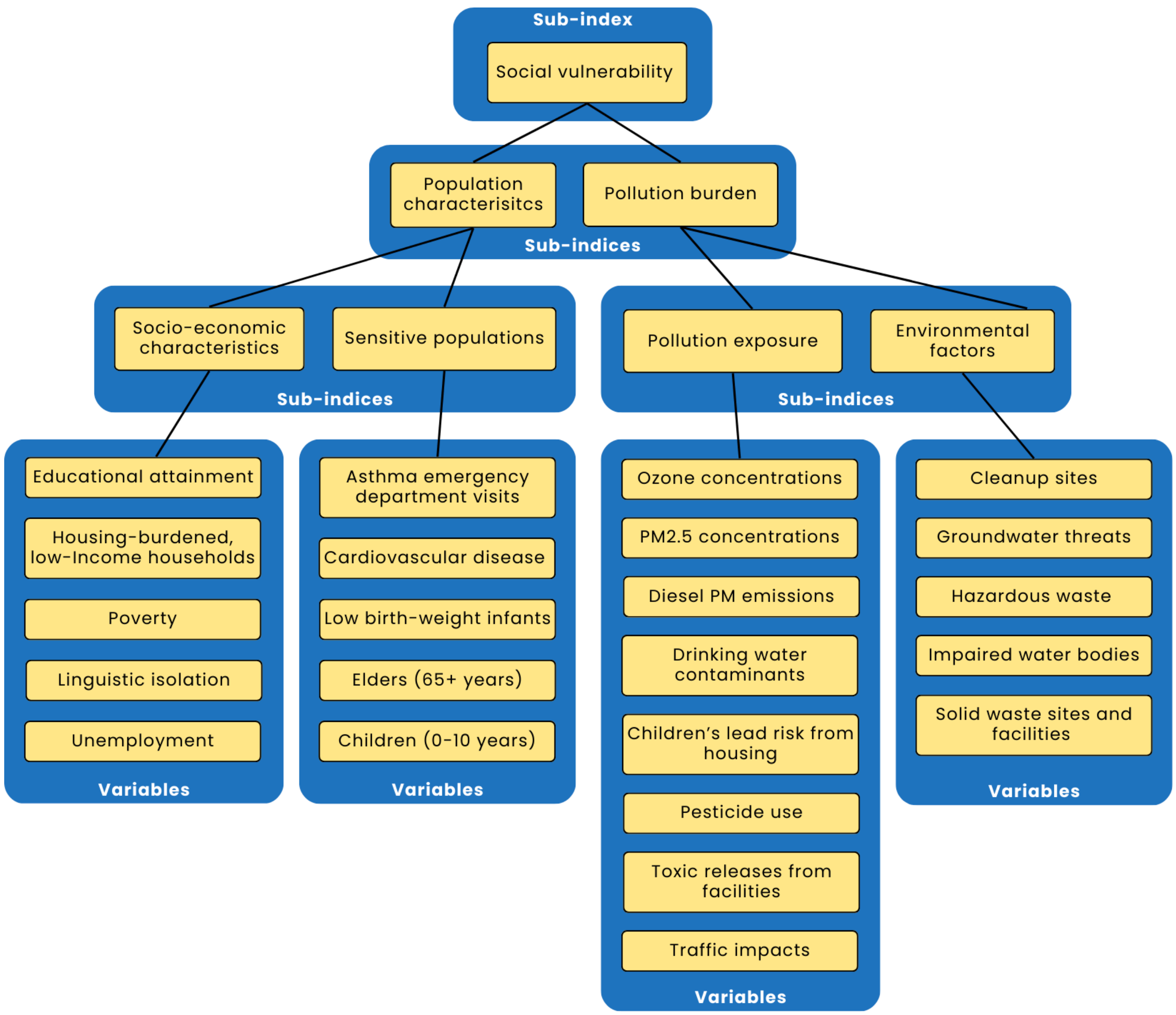

Figure 9. Flow chart of the Social Vulnerability sub-index

The original CalEnviroScreen data set was first clipped to the census tracts within the LAUSD boundary using the "Pairwise Clip" tool, with the LAUSD boundary layer used as the clip feature. From there, the "Standardize Field" tool was used to scale each variable using a minimum-maximum standardization method with the minimum value being set to 0 and the maximum value being set to 100. Then, the "Calculate Composite Index" tool was used to calculate each of the four initial sub-indices individually with a pre-processing method of percentiles and an additive mean method to combine scaled variables. There was no weight given to any of the indicators for this step in the analysis.

To create the next two sub-indexes, the method above was repeated with the "Calculate Composite Index" tool. The population characteristics sub-index was calculated using the "SOC_ECON_INPC" and "SENS_POP_INPC" fields, with a percentile pre-processing method and a mean method to combine scaled variables. The new index was appended to the original input table and no weights were added. The pollution burden sub-index was calculated using the "POL_EX_INPC" and "ENV_FACT_INPC" fields, with a percentile pre-processing method and a mean method to combine scaled variables. The new index was appended to the original input table and a weight of "2" was given to the "POLL_EX_INPC" field.

The final social vulnerability sub-index was calculated using the "Calculate Composite Index" tool, with the fields "POL_BUR_INPC" and "POP_CHAR_INPC" as the input variables. The percentile pre-processing method and mean method for combining scaled variables were applied and the new index was appended to the original input table. No additional weight was added to the indicators.

Finally, to attribute the calculated information to each LAUSD campus, a spatial join using the "Spatial Join" tool was performed between the final social vulnerability sub-index and the school point dataset (Los Angeles GeoHub, 2016b). The final output resulted in a shapefile of the schools that now had the score from the Social Vulnerability index attached to it.

Park Equity

Raw data on the LA population in 2019 for each census tract was obtained from CalEnviroScree. The census tract shapefile was clipped to include only the tracts that intersect with the LAUSD boundary, ensuring the population served by the LAUSD was accurately represented. To maintain precision, the entirety of each census tract intersecting with the LAUSD boundary was included. Shape areas were calculated using the "Calculate Geometry" tool in ArcGIS, converting all units to acres. Population density was subsequently determined by dividing the 2019 population by the census tract area, resulting in a population per acre metric.

Next, the point dataset on LAUSD campuses was obtained from the LosAngeles GeoHub and a service area buffer was created around each school to represent a ½ mile walking distance using the "Network Analysis" tool, which considers walkable paths. This buffer was clipped using the "Pairwise Clip" tool to calculate the population within the area covered by each census tract buffer. A park acres dataset was utilized from LA County's Countywide Parks and Open

Space (*Countywide Parks and Open Space (Public - Hosted)*, n.d.) GIS dataset found on the LA County Geohub and clipped to include only park acres intersecting with the LAUSD boundary. To create a comparable service area buffer around parks, a 0.6 km buffer was used instead of 0.8 km (½ mile) due to the inability to account for walkable paths. This buffer aimed to approximate a ½ mile walking distance, aligning with the service area around schools.

Next, the "Erase" tool in ArcGIS was used to remove intersecting areas of park and school buffers, prioritizing populations without park access. Then the "Pairwise Intersect" tool was used to divide each service area into the intersected census tracts. This ensured that each polygon contained the population density data of the census tract it intersected. The area of each polygon was then calculated using the "Calculate Geometry" tool, and this area was multiplied by the population density to determine the population in each polygon.

To estimate the total population benefiting from schoolyard greening in LAUSD-served communities, the ArcGIS Dissolve tool was used to sum the population density of each service area. The population data was standardized using the ArcGIS "Standardize Field" tool, with the minimum was set to 0 and the maximum to 100, where 0 represents the smallest population and 100 represents the largest.

Urban Island Heat Effects

Raw data for the San Fernando Valley and Southern California regions, representing the greater LA county area was obtained from CalEPA. These KMZ files were first clipped to our LAUSD boundary focus area and then spatially joined to our census tracts under LAUSD using the "Clip" and "Spatial Join" tools. The LAUSD schools point layer from Los Angeles Geohub was then spatially joined to our census tracts with heat island data to attribute a heat island rating to each school. To address missing values (67 schools) that were located in areas not represented by the CalEPA heat island data, the mean of the heat island values was obtained using the "Summary Statistics" tool and replaced null values using the tool "Calculate field." The following code block was used to perform this task:

```
def reclass(uhiiint):
    if uhiiint is None:
        return 5077
    else:
        return uhiiint
```

"Calculate field" was also utilized to note which schools had values replaced with the calculated data in the following code block:

```
def reclass(uhiiintfinal):
    if uhiiintfinal == 5077:
        return 0
    else: return 1
```

Finally, the “Standardize Field” tool was used to apply a rank of 0 to 100 to each school with a minimum-maximum standardization method using 0 as the minimum and 100 as the maximum.

Stormwater Capture Capacity

Soil hydrologic group

Raw data was obtained for the West San Fernando Valley Area, Santa Monica Mountains National Recreation Area, Southeastern Los Angeles County, and Angeles National Forest Area via the USDA Web Soil Survey (USDA, 2023a,b,c,d). The shapefiles for each region were merged in ArcGIS Pro using the “Merge” tool and the output was clipped to the LAUSD boundary using the “Clip” tool. Tabular data for the soil hydrologic group ratings was imported and joined to the shapefile base using the “Map unit symbol” and “MUSYM” fields. To attribute a specific rating to each school campus, a spatial join was performed between the soil data and the LAUSD school point dataset from the LA GeoHub (2016b). For schools that were missing soil data, the “Map unit name” field was used to identify soil series present in the area. Soil series information from the USDA and the National Cooperative Soil Survey on the saturated hydraulic conductivity and runoff volume was then used to manually input a soil hydrologic group rating for null-rated schools based on the given definitions of soil hydrologic groups (USDA, n.d.). A new field was added where values that were manipulated were reclassified as 0 and values that were not manipulated were reclassified as 1 using the “Calculate field” tool. Finally, soil hydrologic group ratings were reclassified using ArcGIS Pro’s “Calculate field” tool on a 0-100 scale, wherein 100 denotes soils that are best for stormwater infiltration, using the code block:

```
def reclass(Rating):
  if Rating == "A":
    return 100
  elif Rating == "B":
    return 75
  elif Rating == "C":
    return 50
  elif Rating == "D":
    return 25
  else:
    return 0
```

Slope

Slope data was analyzed using NOAA’s digital elevation model (DEM) (2023). The DEM was filtered to the SoCal_1as DEM, then clipped using the LAUSD boundary polygon. To calculate the slope, first the raster was edited using the “Split” function to divide it into 6 separate raster files to meet the measurement conventions required to successfully calculate the slope. The “Calculate slope” tool in ArcGIS Pro was used to calculate the slope of all six rasters, using a degree scaling and a Z factor of 1. From there, the rasters were combined into a singular output using ArcGIS Pro’s “Mosaic to new raster” tool. To reduce the processing time required, we then used the “Aggregate” tool with a cell factor of 10 and a mean aggregation technique and reduced the resolution of the raster. The resulting raster was converted into a polygon with the “Raster to Polygon” tool. Finally, the polygon output was spatially joined to the LAUSD school points dataset (LA Geohub, 2016b) to attribute slope data to each campus, and the resulting slope field was reclassed using the following Python command block to attribute a 0-100 ranking:

```
def reclass(gridcode):
  if gridcode >= 0 and gridcode <= 6:
    return 100
  elif gridcode >6 and gridcode <=10:
    return 75
  elif gridcode >10 and gridcode <=15:
    return 50
  else:
    return 25
```

Aquifers

Aquifer data was utilized from the “Confined and Unconfined Aquifers” dataset made available from the LA River Master Plan. The aquifer data polygon was spatially joined with the LAUSD school points dataset using the ArcGIS “Spatial Join” tool. From there, each school was assigned a ranking based on the presence of an unconfined or confined aquifer or lack thereof using the Python code block:

```
def reclass(Unconfined):
  if Unconfined==1:
    return 100
  elif Unconfined==0:
    return 75
  else:
    return 50
```

Flood Risk

Flood risk data for LA County was adapted from Schubert et al. (2022). The dataset defines 100-year flood risk by flood depth for Los Angeles County parcels. First, a parcel dataset from the County of Los Angeles’ Internal Services Department Enterprise GIS Section (2024) was imported and clipped to the LAUSD boundary polygon. Then, Schubert et al.’s (2022) flood risk data were joined to the parcel layer using the “Parcel ID” fields. From there, the “C100yrMEAN” data column, which indicated composite mean 100yr flood depth in meters, was spatially joined with the school points dataset to attribute flood risk to each LAUSD campus using the "Spatial Join" tool. There were 52 school campuses with null values due to issues with parcel matching. Therefore, to complete the dataset, those schools were isolated in a separate map layer and a 650-foot buffer was applied to each school using the "Buffer" tool. Then the mean flood risk of the parcels within the buffer was calculated using ArcGIS Pro's "Summarize within" tool to estimate the flood risk of the target schools. A new field was added where values that were manipulated were reclassified as 0 and values that were not manipulated were reclassified as 1 using the "Calculate Field" tool. The resulting flood risk values were then manually input into the final flood depth attribute table. To achieve a ranking of 0 to 100 based on flood risk, the "Standardize Field" tool was utilized with a minimum-maximum standardization method using 0 as the minimum and 100 as the maximum, where a ranking of 100 indicated high flood risk and a ranking of 0 indicated the lowest flood risk. Finally, to ensure robustness to extreme values or outliers, the percentile was calculated on Google Sheets after the table was exported as a comma separated value file. The pseudocode formula used was as follows:

=PERCENTRANK(Range of Data, Highest Value,Number of Desired Significant Figures)

The actual code appeared as:

=PERCENTRANK($AC$2:$AC$969,AC2,10)

where column AC indicates the respective row value.

Stormwater capture capacity sub-index

The stormwater capture capacity sub-index was calculated using the "Calculate Composite Index" tool on ArcGIS Pro, using the raw values of the final "Manual Soil Infiltration Rank," "Slope Rank," "Aquifer Rank," and "Flood Risk Rank" fields as the method to scale input variables, with an additive mean method to combine scaled variables.

Final Composite Index

To calculate the final composite index, the data for the social vulnerability, park equity, urban heat island effects, and stormwater capture capacity sub-indices were joined together using the "Spatial Join" tool. Then, the "Calculate Composite Index" tool was run using the "uhiiintfinal_MIN_MAX," "SUM_PopDenAc_MIN_MAX," "SV_INPC," and "SW_INPC" fields as the input variables. A percentile pre-processing method was used to apply percentiles to the park equity and urban heat island data to minimize the effect of extreme outliers, while a mean method was used to combine scaled variables. Equal weighting was used to calculate the final composite index, wherein each school was given a percentile score where 100 indicated high need or capacity for greening and 0 indicated a low need for greening.

Post-Processing

To combine repeat school campuses into one entry, the “Export Table” tool in ArcGIS Pro was used to export the final composite index as a comma separated value (.csv) file. This new .csv was then opened in Excel. A new integer column was added to the right of the address column, with its purpose being a counter for each unique address that was associated with the school. First, the schools were re-organized from A-Z based on their address and then the first row had the counter set to 1. The second row under the counter column had the following pseudocode formula added:

=IF(Address in row 3 = Address in row 2, True: Counter = Counter value of 2, False: Counter = Counter value of row 2 + 1)

The actual code appeared as:

=IF(C3=C2, D2, D2 +1

where column C indicates addresses and column D indicates the counter.

This was applied to all of the rows and resulted in the schools that had the same address being given the same counter value. Then, to combine the name of the schools that share the same address into one column, a new string column titled “School(s)” was created. The first row of this column had its value set to the name of the school of this row. Then the following pseudocode formula was used:

=IF(Counter in row 3 = Counter in row 2, True: CONCATENATE(Set cell value to school name in row 2, “, ”, School name in row 3), False: Set cell value to school name in this row only)

The actual code appeared as:

=IF(E3=E2, CONCATENATE(F2, ", ", F3),F3)

where column E indicated the counter and column F indicated the school name.

In this new column, each school that shared the same address was appended to each other and the school names were combined into the last row with the shared address.

After this step, there were many rows that had the “School(s)” column incomplete, as only the last row of the shared address had all of the schools appended to each other. The rows with the repeated addresses and incomplete schools were then manually deleted. This resulted in a finalized dataset with unique addresses for each point, but still maintained the name of all the schools associated with each address. This file was exported as a .csv file and imported back into ArcGIS Pro. It was then joined to the final composite index feature layer in ArcGIS Pro using the “Join Field” tool, with the “Input” field being “MPD_ NAME” and “Join” field also being “MPD_ NAME” since this is unique and would provide a one to one join. Because there were 870 addresses in the post-processed .csv, but 969 addresses in the composite index, there were rows that had a “Null” value for the “School(s)” field. This meant that these were addresses that had multiple schools associated with them and, since the school name had already been appended to other schools that shared the same address, these rows were then deleted.

Appendix B

Data Table for Final Composite Index

https://drive.google.com/file/d/1n58oFQOfJfJk-0Dauub6zq77ztrif1wA/view?usp=sharing

Field Name	Description
Asthma	Emergency room visits for asthma per 10,000 visits (2015-2017 average);census tract
Cardiovas	Emergency room visits for asthma per 10,000 visits (2015-2017 average)
LowBirtWt	Percent low birth weight in infants (2009 -2015 avg)
Child_10	Percent of children under 10 years of age in census tract
Elderly65	Percent of elders over 65 years of age in census tract
POP_SEN_INPC	Sensitive population sub-index score (percentile)
Educatn	Educational attainment - Percent of 25+ year olds with less than high school education (2015-2019)
HousBurd	Housing-burdened low-income households - percent of households that are low-income and burdened by housing costs (2015-2017)
Ling_Isol	Percentage of households that are limited in English-speaking
Poverty	Population living two times below the federal poverty level as percentage (2015-2019)
Unempl	Percentage of population over 16 and eligible for the workforce
SOC_ECON_INPC	Socio-economic population characteristics sub-index score (percentile)
Ozone	Daily maximum of 8-hour ozone ppm concentration from May-October (average 2017-2019)
PM2_5	Annual mean concentration of PM2.5 (2015-2017)
DieselPM	Distributions of diesel PM emissions for both on-road and

	off-road sources (2016)
DrinkWat	Index of drinking water contaminants (2011-2019)
Lead	Children's lead risk from housing - children from low-income communities who are at risk of lead exposure because of older housing
Pesticide	Tota pounds of selected 132 active pesticide ingredients per square mile (average 2017-2019)
Tox_Rel	Modeled chemical releases from facility emissions in California and Mexico to air using toxicity-weighted concentrations (average 2017-2019, average 2014-2016)
Traffic	Traffic impacts - traffic volumes summed adjusted by road segment length (vehicle-km / hr) by total road length (km) within 150 meters of the census tract (average 2017)
POL_EX_INPX	Pollution Exposure sub-index score (percentile)
Cleanup	Sum of weighted cleanup sites in census tract (2021)
GWThreat	Sum of scores (weighted) for each site with groundwater threat in census tract
HazWaste	Sum of permitted hazardous (weighted) waste facilities and generators per census tract (2021, 2018, 2018-2020)
ImpWatBod	Impaired water bodies per census tract (2018)
SolWaste	Sum of solid waste sites and facilities (weighted), (2021)
POL_FACT_INPC	Environmental Factors sub-index score (percentile)
POP_CHAR_INPC	Population Characteristics sub-index score (percentile)
POL_BUR_INPC	Pollution Burden sub-index score (percentile)
SV_INPC	Social Vulnerability sub-index score (percentile)
SUM_PopDenAc	Number of residents impacted by school greening
SUM_PopDenAc_MIN_MAX	Number of residents impacted by school greening, standardized from 0 to 100 on a minimum-maximum scale

uhiiint	Raw data for heat island values from the CalEPA heat island maps attached to census tracts
uhiiintfinal	Heat island values of schools with missing values added in
uhiiintfinal_MIN_MAX	Heat island values standardized to a 0 to 100 minimum-maximum scale
uhii_not_null	Notation of whether a school had raw data or added data with 0 referring to schools with added data and 1 referring to schools with raw data values
C100yrMEAN	Composite mean 100 year flood depth in meters with summarized means assigned to schools with previously null values
Aquifer	Raw data for unconfined aquifers (classed as 1), confined aquifers (classed as 0), and no aquifers (classed as Null)
Slope	Raw data for the degree of slope on each campus
Soil_Hyd_Rating	Data on soil hydrologic group ratings with manual ratings assigned to schools with previously null values
Slope_Rank	Slope data for each campus ranked from 0 to 100
Soil_Rank	Soil hydrologic data for each campus ranked from 0 to 100
Soil_Not_Null	Notation of whether a school had raw data or added data with 0 referring to schools with added data and 1 referring to schools with raw data values
Aquifer_Rank	Aquifer data for each campus ranked from 0 to 100
Flood_Rank_INPC	Composite mean 100 year flood depth in meters with summarized means assigned to schools with previously null values (percentile)
Flood_Not_Null	Notation of whether a school had raw data or added data with 0 referring to schools with added data and 1 referring to schools with raw data values
SW_INPC	Stormwater capture capacity sub-index score (percentile)
SUM_PopDenAc_MIN_MAX_INPC	Park equity sub-index score (percentile)

uhiiintfinal_MIN_MAX_INPC	Urban heat island effects sub-index score (percentile)
Final_Score_INPC	Final composite index score (percentile)

Appendix C

Composite Index Results for Top 20 Ranked Schools

School name	Composite index score	Social vulnerability score	Park equity score	Urban heat island score	Stormwater capture score
Synergy Charter School, Quincy Jones Elementary School	99.896694	85.7438	96.1777	61.8802	84.814
Los Angeles Leadership Academy Charter	99.793388	89.9793	77.2727	67.2521	91.5289
Engineering & Technology, Engineering And Technology Academy, East Los Angeles Renaissance Academy, and Social Justice Leadership Academy Magnet at Esteban Torres High School	99.380165	88.4298	59.9174	91.219	75.8264
Maple Primary Center	99.27686	71.0744	97.7273	45.5579	99.8967
Wallis Annenberg High School, Accelerated Charter, Accelerated Elementary School	98.966942	76.8595	99.7934	41.1157	96.1777
75th Street Elementary School	98.863636	94.4215	92.0455	33.1612	88.9463
Early College Academy - LA Trade Tech College, Nava College Preparatory Academy, Thomas Jefferson High School, Student Empowerment Academy	98.347107	83.8843	69.3182	63.0165	90.0826
South Gate Middle School	98.347107	75.9298	91.1157	72.7273	66.5289

Liberty Boulevard Elementary School	98.243802	87.9132	65.2893	62.9132	89.3595
Dolores Huerta Elementary School	98.140496	91.1157	91.0124	52.5826	69.6281
Lorena Street Elementary School, Extera Public School 2	97.933884	95.3512	80.062	85.8471	39.7727
Malabar Street Elementary School	97.830579	40.7025	76.0331	89.7727	94.2149
Santee Education Complex	97.727273	70.8678	66.6322	65.5992	97.5207
Mary McLeod Bethune Middle School	97.520661	99.2769	75.9298	33.5744	88.3264
Pacific Boulevard Elementary School	97.520661	75.4132	66.9421	71.3843	83.3678
4th Street Elementary School	97.417355	77.2727	53.4091	91.8388	74.2769
West Vernon Avenue Elementary School	97.31405	76.8595	97.8306	41.1157	80.8884
Parmelee Avenue Elementary School	97.210744	84.6074	81.6116	42.562	87.5
Central Region Early Education Center No. 2	97.107438	77.2727	51.5496	91.8388	74.2769
Alliance College-Ready Academy High School #5	97.004132	73.2438	81.7149	44.8347	92.2521

Appendix D

Calculations for Estimated Costs and Benefits of Greening

Costs

The estimated construction costs for schoolyard greening projects were calculated from The Green Values Stormwater Management Calculator Methods, where the construction costs for green roofs ($11.98/Ft^2), rain gardens ($6.07/Ft^2), planter boxes ($9.46/Ft^2), amended soil ($0.29/Ft^2), bioswales ($17.58/Ft^2), vegetation filter strips ($0.59/Ft^2), native vegetation ($0.19/Ft^2), parking lot and roadside swales ($36.93/Ft^2), and permeable pavement ($8.68/Ft^2) were averaged. The average of all nine BMPs was calculated to be $10.20/Ft^2, rounded down to $10/Ft^2 for simplicity.

The estimated O&M costs for schoolyard greening projects were also calculated from The Green Values Stormwater Management Calculator Methods, where the maintenance cost for green roofs ($0.75/Ft^2), rain gardens ($0.41/Ft^2), planter boxes ($1.18/Ft^2), amended soil ($0.0/Ft^2), bioswales ($0.26/Ft^2), vegetation filter strips ($0.04/Ft^2), native vegetation ($0.05/Ft^2), parking lot and roadside swales ($1.83/Ft^2), and permeable pavement ($0.02/Ft^2) were averaged. The average maintenance costs for all nine BMPs were calculated to be $0.50/Ft^2.

To calculate the capital and O&M costs, it was assumed that 60% of the total area of the top twenty schools would be greened. Therefore the total costs would be:

(4,000,000 Ft^2)(0.60)($10/Ft^2 + $0.50/Ft^2) = $25,200,000

Benefits

The estimated benefits values were utilized from *Greening America's Schools: Costs and Benefits* (Kats, 2006). They estimate the monetary benefits of greening as energy costs saved ($9/Ft^2), costs of emissions saved ($1/Ft^2), water and wastewater costs avoided ($1/Ft^2), and increased earnings due to higher test scores and decreased absenteeism ($49/Ft^2) over an average twenty-year lifetime. Assuming that 60% of the top 20 schools are greened, the monetary benefits would be:

(4,000,000 Ft^2)(0.60)($9/Ft^2) = $21,600,000 in energy savings
(4,000,000 Ft^2)(0.60)($1/Ft^2) = $2,400,0000 in emissions reductions
(4,000,000 Ft^2)(0.60)($1/Ft^2) = $2,400,000 in water and wastewater savings
(4,000,000 Ft^2)(0.60)($49/Ft^2) = $117,600,000 in increased earnings

The estimated non-monetary benefits for decreased emissions tons were estimated from *Greening America's Schools: Costs and Benefits* (Kats, 2006). They estimate that a green school reduces emissions of CO_2 by 585,000 pounds annually. Using that estimation, twenty schools would reduce CO_2 emissions by 11,700,000 pounds annually. The estimated non-monetary benefits of decreased stormwater volume were calculated using the equation:

Amount of stormwater capture = (Square footage of school)(Percentage of campus greenspace)*(Amount of stormwater captured per square foot of BMP)(Average inches of rainfall)(Efficiency of BMP)*

The square footage of schools used was 4,000,000 Ft^2, with 60% of campuses as greenspace. The amount of stormwater captured per square foot of BMP is estimated to be 0.650 gallons/Ft^2 per inch of rainfall. The average inches of rainfall was estimated to be the average for Los Angeles, around 14 inches, and the average efficiency of the BMP was estimated to be 75%). Thus, the estimated stormwater capture is:

(4,000,000 Ft^2)(0.60)(0.650 gallons/inch Ft^2)(14 inches)(0.75) = 16,380,000 gallons/year (rounded down to 16,000,000 for simplicity).

Appendix E

List of General Questions Utilized in Expert Interviews

1. How did you fund your projects? Was the process difficult? Do you have any suggestions for our project?
2. What were the steps of implementation/development for your project?
3. What external organizations were involved in your project?
4. For organizations that have worked with LAUSD:
    a. What was your experience like working with LAUSD? How did you navigate or overcome their concerns for liability and funding?
5. In the development stage of school greening, how do you go about addressing soil type and found contaminants when implementing stormwater capture tools?
    a. What contractors did you use to build/design these systems around those constraints?
6. Do any of your organizations' projects include JUAs? If so, what are some of the obstacles when doing so?
    a. What are aspects of JUAs that the general public doesn't think about that your organization has to consider and extensively work through?
7. How much stormwater runoff or pollution mitigation has your project(s) achieved?
    a. Do you have figures, numbers, or any publications that we can read to learn more about the successes of your assisted schools?
8. How do you choose which schools to work on?
    a. Do schools reach out to you or vice versa?
    b. Do you have a list of schools you have worked with?
9. What do you know about water ownership around stormwater capture in schools?
10. Most commonly upheld Best Management Practices?
    a. What designs did you put in and why?
11. How long do projects take from development to completed construction?

Appendix F

List of Successful Schools Studied to Inform Greening Recommendations

Project/School	Partner organization(s)
Castellanos Elementary School (LAUSD)	Trust for Public Land
Eagle Rock Elementary (LAUSD) *Interviewed involved parents and designer*	LA Beautification Team
Mary W Jackson Elementary (Pasadena School District)	Amigos de los Rios
Oakland Unified School District	Trust for Public Land

Appendix G

Reports of Case Studies from Appendix F (above 4 schools)

Castellanos Elementary School – Trust for Public Land

TPL is a nonprofit organization whose mission is to create parks and protect public land to ensure equitable access to the outdoors for all generations. It was founded in 1972 and has already protected over 4 million acres of land, created 5,420 outdoor spaces, and secured $94.4 billion in public funding. The organization is driven by four major commitments, the first being equity. The current distribution of park access is far from equal as disparities fall along social and economic lines, but TPL is motivated by the opportunity to reduce the equity gap. Their second commitment is to improve health by building quality parks that encourage physical, mental, and environmental health. The third commitment is to create more resilient environments to mitigate the negative effects of climate change through increasing tree cover and capturing stormwater. The final commitment is to strengthen the local communities by providing social opportunities and preserving rich cultural heritage (Trust for Public Land, n.d.).

The TPL does significant work on schoolyards, along with indigenous lands, hiking trails, and local parks. In regards to their work in LAUSD, TPL recently began its most significant schoolyard initiative titled the “28x28 Green Schoolyard Initiative.” They joined LAUSD and other local nonprofits with a goal to transform 28 asphalt playgrounds into superior greenspaces for students and local communities by the 2028 LA Olympics. An estimated 260,000 people will have newly acquired park access within a 10-minute walk from their homes, which is a significant stride in the direction towards equitable park access (Trust for Public Land, 2024).

In January of 2024, the first of these 28 schools were completed at the Castellanos Elementary School and our team was able to speak with the California Director for TPL and a California Advisory Board member about the process. The schoolyard renovation began right before the pandemic started, which consequently slowed the process immensely. The first step was to acquire proper funding to support the project. Both interviewees note that funding was obtained through federal grants and state funding as well as other private foundations such as the Nike Foundation and the Chuck Lorre Foundation. None of it came directly from the district. The next step was entering a contractual agreement with the district which required gathering all the necessary permitting documents. After finalizing the contracts, they spent about 10 weeks engaging the students in the potential design ideas. It was Ms. Garcia’s 4th-grade class that spent significant time learning about the environmental and sustainability benefits that could be incorporated as well as sharing their thoughts about what they wanted in their schoolyard. The designs were then approved by the district and the California state architect before construction officially began. The result of the project was 26 new native trees and over 500 native shrubs, as well as a new play structure and shaded outdoor classroom. TPL also had to change a fire lane that went through campus because all LAUSD campuses are required to have fire truck access. It took about one year to complete after construction started and is now readily available for the children to enjoy.

In addition to learning about the Castellanos Elementary School Project, the overall process of working with LAUSD and the complications that may arise during these greening projects was expanded on through our interviews.

Construction often comes with many complications, one of which is addressing potential contaminants that might appear when digging up soil to implement stormwater capture tools. The TPL staff stated that soil testing in areas they plan to disturb is required if asphalt is removed. If the results come back clean, the project can proceed, but if contaminants are found, mitigation efforts must be made depending on the levels of contamination. The most common contaminants found are lead paint and asbestos in the areas closer to buildings. Currently, TPL has not found any instances of contaminated soil, but if it were to appear, they must follow the Department of Health and Department of Toxin and Substance Control guidelines to ensure the soil is safe.

An important part of these projects is the implementation of stormwater capture mechanisms, which involves the process of creating these mechanisms and how they are utilized. The main takeaways were that they are site and hydrology-dependent. The main goal is to maximize the environmental, education, and public health benefits which means that TPL will maximize the potential of stormwater capture mechanisms that each site allows. Some mechanisms will be more significant such as capturing and reusing water for irrigation while other mechanisms allow for managing pollutants, but infiltration is prioritized anytime it is feasible. An important aspect to consider when constructing these projects, though, is that any capital improvements at a school site over $100,000 require a state review for ADA compliances. While it may be required by the district to fix all ADA issues even if they do not have a connection to the project, negotiation over unrelated compliances can occur.

Given that these projects occur on LAUSD campuses, we discussed how building a strong relationship with LAUSD generally works for non-profits and other third-party organizations and what the district's main apprehensions are with supporting greening projects. LAUSD has historically not partnered with non-profits and are not acclimated to building relationships with third-party organizations, making the process more difficult. The TPL staff mentioned that it was important to remember that LAUSD is a large bureaucracy and therefore, the district does not make it easy for nonprofits to help with “one-stop shopping.” For example, for a greening project to occur, there must be agreements between the permit and design team, the real estate team, and the operations and maintenance team, which may be complex for outside organizations to navigate and demonstrates how the district is not designed to receive outside help. Currently, LAUSD treats third-party organizations as private contracts and requires these organizations to pay the district to review any plans, rather than acknowledge the support they are receiving. Under the current bureaucracy, a systematic policy change is required to facilitate the work that third-party organizations carry out for LAUSD’s school greenings.

As a part of increasing park access to local communities, LAUSD has the opportunity to implement JUAs, but the TPL staff noted that there are some challenges concerning getting them approved. They stated that, while the challenges are not complicated themselves, they continue to persist because of the state of third-party relationships with LAUSD. The district does not prioritize this work because it does not align with their mission, which means that a complete shift in how the district thinks about these issues and the way these schools are designed, developed, and built is necessary. For LAUSD, they feel that JUAs are an exception, not a fundamental aspect of their responsibility to the community. At the same time, the concerns surrounding JUAs are not unsolvable, as any labor and liability issue can be negotiated in a contract between the City and LAUSD. For example, there are currently labor contentions wherein the City has offered to clean up the schools on the weekends, but LAUSD custodians view this negatively as a reduction in their job responsibilities. However, LAUSD staff would need to be paid double time for working during non-school hours and the district lacks the funds to do so. The solution, therefore, is to change contracts and negotiate proper terms to ensure the students and local communities have access to greenspace.

Eagle Rock Elementary – LA Beautification Team

Eagle Rock Elementary is an elementary school and magnet center located within The Los Angeles Unified School District (LAUSD). In 2016, the school completed construction on a green schoolyard that included a kickball field, a line of trees to function as bioswales and provide shade, and native plants, making it one of the first within LAUSD to implement such changes. We interviewed Claire Latane, Assistant Professor of Landscape Architecture at Cal Poly San Luis Obispo and part of the Studio MLA design team in charge of the project, and Amanda Millet, former parent, and member of the grant proposal team for Eagle Rock's Proposition 84 grant.

The Path to Greening

When Claire began teaching at Cal Poly in 2009, she decided to use Eagle Rock for her class' design studio project. At the end of the year, the class presented design concepts they had drawn up for a new green schoolyard at a PTA meeting.

Employees within LAUSD who identified Eagle Rock Elementary as a good candidate for the Proposition 84 grant joined with a parent task force and then began preparing a grant proposal. Three architects, two of them experienced in sustainable design, and a community outreach member, Amanda Millett, were also involved. With one month to prepare the proposal, the team went to work creating a design proposal, planning logistics, and forming community partnerships and alliances. Demonstrating community support and alliances was an integral part of the proposal. The goal of this initiative was to assure the State of California, who provided funding, that the project had unilateral support, and would be used, maintained into the future, and truly improve and add value to the community. Millett secured letters of support from county and state representatives and leaders. Additionally, she received offers for pro-bono services and plans for programming at the new facilities from arts and environmental education non-profit organizations. Partnerships and supporters included city council people, the City of LA, and

Occidental College. Hollywood Beautification Team, or HBT (now LA Beautification Team), signed on as the non-profit partner. The Audubon Center at Debs and the Theodore Payne Society for Native Plants were two organizations that offered to provide curriculum and help with the planting and design of the native plant garden.

HBT submitted the final proposal to the State in March of 2011. Within a few months of submission, the State showed interest in Eagle Rock. At the time, the State was prioritizing LA intercity schools, areas with a need for greenspace, and low-income brackets. Criteria that made Eagle Rock an ideal candidate for the funds are stated in a chronology drawn up by Millett listing "Title 1 school, High need for recreation and park space in the neighborhood, High percentage of children who stay in after-school care, High population density, Strong parent population to support and maintain long term greening projects, Strong Community Support". The State completed a site visit and interviews, before officially awarding the project a $349,000 grant in May of 2012.

Obstacles to Approval

Although LAUSD Facilities was originally supportive of the project, with the Chief Facilities of the time, Kelly Schmader, writing a letter of support, the next head of facilities became an obstacle to carrying out the project. In the months and years following state approval of the grant, Eagle Rock stakeholders repeatedly requested LAUSD and Facilities to sign-off on the project, only to be met with pushback. Millett's chronology details "stalling tactics" and "moving goal posts". Facilities members stated a need for greatly decreased project scope and cutting plans outlined in the proposal. Additional tactics included refusing to meet or respond to requests for communication or documents. Other actors within LAUSD were similarly difficult to work with.

Al Grazioli objected strongly to the community access component of the project, a component of the approved proposal. His objections, labeled as obstruction and deception in the document, included claims of lack of staff or requirements of only limited access, such as monthly community classes. Although similar access agreements had been established at other schools within the district, opposition to a community garden at Eagle Rock became a major sticking point with the district.

Amanda Millett explained the struggle to secure a Memorandum of Understanding for LAUSD as being largely related to a lack of knowledge or experience with green infrastructure. LAUSD and facilities were concerned about taking on risk and financial burden. Although the awarded grant offered funding for the construction of a schoolyard, these costs would not cover maintenance in the future.

In the end, LAUSD would not budge on community access. To at last secure approval, the Eagle Rock project advisor and PTA president Bevin Ashenmiller, compromised by omitting the community access portion of the project, as well as securing outside funding for future maintenance. Of the 5-6 year process of securing funding, Latane and Millett concur that maintenance concerns, and LAUSD Facilities in particular, were the greatest obstacle to the project.

Eagle Rock's solution to maintenance concerns was agreeing to allocate Eagle Rock Elementary Foundation and PTA funds to make a three to five-year maintenance contract with a local landscaping organization.

A more general solution to the issue has been addressed in recent greening grants. Measure W is a newer stormwater funding measure designed to consider the need for funding beyond upfront costs. The grant includes maintenance costs as an approved expense.

Furthermore, with schools like Eagle Rock having paved the way, LAUSD and maintenance now have experience and increased confidence with approving greening projects. The Board has been gaining momentum concerning creating green schoolyards. The 2019 Unified Teachers LA strike called for updated green infrastructure and outdoor spaces for schools. Then, the 2020 pandemic demonstrated the importance of public schools, and going outside, both for health and learning.

Claire Latane is one of the founding members of the LA Living Schoolyards Coalition. The group's goal is to break down barriers to greening in LA. Structural and systematic obstacles exist to greening, beyond LAUSD-specific concerns. In 1978, California voters passed Proposition 13, a property tax bill designed to cut property taxes for seniors and decrease their financial burden. However, up until the bill's passage, two-thirds of education funding in the state came from property taxes. By decreasing property tax returns, school funding experienced damaging cuts. Since then many aspects of public education in California have gone without the funds to receive updates or improvements. Even with available funding for projects, change takes time. LAUSD is the second largest school district in the nation and is based on 100 years of an industrial education model. Changing direction from this model to a student-based model is hard, even if most people are on board.

Claire is part of a movement to make that transition more efficient and more navigable. The Coalition is requesting that LAUSD provide community members with a clear and easy-to-understand path to greening, which would fulfill the Facilities team's needs. This document would acknowledge that many of the large successful projects carried out thus-far have been largely community-run. These community resources—knowledge, time, expertise—can make the process extremely inequitable. Therefore a document that clears up bureaucratic confusion and steps would hopefully aid in making the process more accessible to all.

Design

Claire Latane, who also participated in the Eagle Rock project as a designer with Studio MLA, and went on to write a book detailing recommendations for effective green schoolyard design, shared her best practices with us. Claire's book, *Schools that Heal*, focused on three general best practices.

The first is to create spaces that increase one's sense of belonging. This may mean physical belonging, through designs that work well for play, or it may be creating a deeper sense of belonging by involving others in the process to show that their existence and ideas belong. Latane stressed the importance of engaging the community in all steps of the process. Teachers, parents, staff, and students should be consulted to best understand and incorporate their goals and needs into the project. One way students were involved in creating a design that best fit their needs at Eagle Rock was through observation of their play. As soon as the grant was approved, Dr. Marci Raney began studying how students used the old play yard. The most well-loved and well-used areas were kept intact in the new design, while unused areas were improved or redesigned. For example, kickball was a very popular activity and therefore, one kickball field stayed asphalt, while the other was made grass-based. Additionally, the shape of the grass field was decided with the help of the school's principal, Stephanie Leech.

Secondly, Latane recommends creating nature-filled spaces. Whether this means adding plants and greenery through a green schoolyard or even just providing views of trees through open windows, or nature-based decor, in classrooms, incorporating nature into learning spaces is helpful to children's learning and attention. Latane referenced Rachel and Steven Kaplan's *Attention Restoration Theory*, which posits that nature sounds draw a listener or viewer's restful attention. This type of attention calms and restores one's focus, rather than depleting or distracting an observer. This effect makes green designs a great tool and aid for teachers. Eagle Rock's design incorporated nature in several ways. For example, the aforementioned grass kickball field was attached to a larger grass area to form a park-like, forested space where children could play within the tree cover.

Lastly, Latane advocates for designs that inspire awe. Designs should facilitate creativity and a feeling of wonder in students and teachers. Latane stresses the importance of variety in schoolyard design – the more the better. Having a variety of options for children to explore and participate in based on their mood or emotional needs is shown in Latane's research to be beneficial to their health.

Eagle Rock's design incorporates all three of these practices. A row of trees going from North to West through the campus provides multiple benefits. First, the trees break up asphalt coverage. Latane states that uninterrupted asphalt space leads to more disorderly conduct. Having more sectioned, varied components within a schoolyard addresses this issue as well as it allows for student and environmental needs to be met in a variety of ways. The trees also provide the benefit of shade – cooling buildings and the ground beneath them. The trees are visible from classroom windows, to assist in creating a nature-filled space. Importantly to LA Waterkeeper's goals, the trees also intercept and absorb stormwater runoff.

Measuring Success

Since the implementation of its new green schoolyard, Eagle Rock has seen improvements in student behavior and well-being. In 2021, Dr. Raney, who also observed student schoolyard use before design, published a study based on Eagle Rock. She found that the new schoolyard was correlated with an increase in positive social behavior. Students increased their physical activity levels by 20-30 minutes per week, especially female students. Additionally, the increased time students spent in small groups in the new space corresponded with a decrease in bullying.

Though Claire Latane did not have official measures of stormwater capture or runoff diversion post-implementation, she estimated that the project removed about 23,000-25,000 square feet of asphalt.

As one of the first schools to implement a green schoolyard, Eagle Rock Elementary's journey to receive a grant, get it approved, and see results in student health and behavior was a long and difficult one. Parent involvement and dedication to the project, as well as the support of local nonprofits and community organizations, were critical to amassing the knowledge and resources needed for the success of the project. Now that school greening is a better-known, and better-established practice in LAUSD, the process is likely to be smoother. However, lessons we can take from Eagle Rock's process are to strongly leverage community support, consult and involve school staff and students in the design process, and choose designs that contain variety, multiple benefits, and prioritize nature-based spaces.

Mary W Jackson Elementary – Amigos de los Rios

Jackson Elementary is one of several schools within the Los Angeles Basin to have their campus transformed in partnership with Amigos de Los Rios, a non-profit organization with a mission to provide equitable access to nature by creating the "Emerald Necklace" which connects the surrounding mountains to the Pacific Ocean through parks (Amigos de los Rios, 2024). Located in Altadena, California, Earth Economics estimates that only 32% of residents live within half a mile of a park and experience at least a week of excess heat days as of 2023, raising concern for the health and safety of the residents, especially young children (Earth Economics, 2023). As a result of this, Amigos de los Rios led the development of the Jackson Elementary Watershed Discovery Campus project in 2021 to deliver social, economic, and environmental benefits to the students and faculty at this school (Earth Economics, 2023).

Prior to this project, the school's campus resembled many schools in LA County: mostly paved over with a small grass field (Earth Economics, 2023). Through this partnership between Amigos de los Rios, Jackson Elementary, and the PUSD, the project replaced 22,000 square feet of asphalt and concrete with permeable pavement and natural features, including native grass and shrubs. The use of native plants created habitats suitable for the San Gabriel Mountain region that the campus is located within. Additionally, 15% of the schoolyard now includes bioretention areas to capture and filter stormwater, and 84 trees were planted, which is projected to cover 70% of the schoolyard with the canopy at full maturity (Earth Economics, 2023).

This project was made possible through funding from several sources leveraged over six years (Earth Economics, 2023). These sources include the California Natural Resources Agency's Urban Greening Grant Program, the Disney Foundation's Water Conservation Program, California ReLeaf, LA County's Safe Clean Water Program, CALFIRE, One Tree Planted, and Lowes (Earth Economics, 2023).

After the completion of the schoolyard renovation, Amigos de los Rios partnered with Earth Economics, a non-profit organization that quantifies the benefits of nature, to measure the success and economic returns of the schoolyard's features (Earth Economics, 2023). As of 2023, this greening project is estimated to provide approximately $400,000 in annual benefits in a range of categories such as heat mitigation, stormwater retention, and generating economic activity and jobs in Altadena (Earth Economics, 2023). Earth Economics breaks down this figure into a benefit-cost ratio of 1:3.60, where for every dollar invested in this project, there is a return of $3.60 in monetizable benefits socially, economically, and environmentally (Earth Economics, 2023).

The schoolyard currently is not open for public use by surrounding residents, however, Amigos de los Rios and Earth Economics recognize the health benefits this could bring. In a scenario analysis conducted by the latter organization, opening the Jackson Elementary playground to 45 more people per month would yield more physical activity benefits than the cost of operating and maintaining (O&M) the schoolyard. The O&M is estimated to be over $62,000 (Earth Economics, 2023).

Oakland Unified School District – Trust for Public Land

Beginning in 2017, the TPL began working with the OUSD, the City of Oakland, and Green Schoolyards America to begin a school greening program as part of the Living Schoolyards Project. After analyzing schools in the district based on several factors including park equity, levels of environmental stress, and readiness for greening, TPL selected 4 pilot schools at which to begin developing projects. These schools were Melrose Leadership Academy, César E. Chávez Education Center, Markham Elementary School, and Bridges Academy at Melrose. All 4 schools have since been completed.

The project was partially funded by Measure Y, the School Repairs Bond, which included funding for school infrastructure updates, including $200 million for asphalt conversion to greenspaces.

A document detailing the guidelines for OUSD Living Schoolyards, produced by TPL, details the design principles that governed the projects. The first, to create spaces that support learning, encourages the inclusion of an outdoor classroom, a gathering space or commons, “break-out spaces” for smaller group activities, and areas with a specifically designed learning outcome, for example, a native plant garden. Additionally learning curriculum and outcomes should be built around the space. Next, TPL advocates considering child development in schoolyard design. The yard should be tailored to the age of students, and what developmental needs their age will require from an outdoor space. Thirdly, the guidelines include equity considerations. This was a piece of site selection, as well as the schoolyard’s designation as a community park during non-school hours.

The guidelines also include optimizing environmental resilience. This encompasses selecting trees that will be climate change resilient, utilizing permeable concrete or pavement, and including stormwater capture. The stormwater component of the design is also required by construction codes governing school spaces. Practices proposed by TPL around stormwater include keeping collected stormwater with potentially hazardous substances away from child-accessible areas and installing stormwater BMP capture modes at optimized locations for maximum capture.

The guidelines for greening also encourage the use and consideration of existing school and community access. This means considering existing draining patterns in the schoolyard and involving community members and the skills and knowledge individuals or local organizations may be able to contribute. Lastly, it is important to consider maintenance. This is a way to ensure a lasting project. During the design process, those who will be doing the maintenance – in this case, the school staff and OUSD facilities members – should be consulted on what is realistic and feasible. Training and materials costs for maintenance must be worked into the planned budget.