Eco-Urbanism in the Age of Climate Change
Adaptive Strategies for Sacramento's Midtown

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Abstract

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This thesis seeks to examine the intersection of urbanization and climate change and asks how design can play a part in developing sustainable, healthy, vibrant, and adaptive cities. More specifically, it asks "How do we design for growing urban landscapes that are threatened by climate change?" The city of Sacramento, California is a relevant study site for this topic as it is currently experiencing a new era of growth and development while concurrently being threatened by intensifying weather extremes.

The project focuses on the adaptive reuse of a freight railroad track that cuts through the Midtown neighborhood of Sacramento, and proposes re-imagining this space as a pedestrian-focused promenade layered on top of and integrated with functional urban stormwater infrastructure. The project also examines the existing spatial hierarchies of the city's right-of-way adjacent to the project site and suggests strategies for reallocating space to prioritize interactions, activities, and designs that make for better urban life in addition to overlaying a network of climate adaptive strategies. A survey of relevant literature and precedent projects serves as the theoretical grounding for the design framework and proposed implementations.

Ultimately, the goal of this project is to create a scalable set of strategies that address the thesis question and adhere to the tenets of the framework, and apply them to the study site as a neighborhood-scale pilot. Strategies for scaling the project up to a regional scale and down to an individual scale are examined with the intent to use this project as a catalyst for lasting positive change on the region, its inhabitants, and other urban environments both local and far afield.

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1. INTRODUCTION

Human beings have been a force of environmental change since we first began modifying our surroundings. With the advent of agriculture we began to alter the earth, with trade we crossed continents and oceans, introducing plants and animals to new lands. More recently with the industrial revolution we began a seemingly unstoppable and potentially devastating trend of altering the very atmosphere of the planet. This trend can be encapsulated in one word: urbanization.

Urbanization describes the phenomena of populations shifting from rural to urban living patterns. While urbanization has occurred at different rates in different parts of the world, humanity is trending on the whole towards an urbanized state. In the early 1800s, it is estimated that about 2% of the global population lived in urban areas.[1] This is in large part because cities were some of the unhealthiest places to live; pollution from industrialization, overcrowding, and poor sanitation led to higher rates of disease and death than in rural areas. In fact, city populations were maintained in large part by a consistent stream of incoming inhabitants who had previously resided in rural areas, replenishing the ranks of those unfortunate city dwellers who had succumbed to the myriad fatal threats present in urban environments.[2] Since that time, the global urban population has ballooned from 2% to over 50% and this trend is not expected to stop any time soon. Improved urban fertility rates and continued migration from rural to urban areas factor into projections of disproportionately high population growth taking place in urban regions.[3] By the year 2050 the global population is projected to reach nearly 10 billion people and two-thirds of that number will reside in cities. Because of this, the management of urban areas is "one of the most important development challenges of the 21st century" according to John Wilmoth, director of the UN Department of Economic and Social Affairs Population Division.[5]

Urban planners and those who manage the infrastructural systems of a city often look to the past for guidance. When available, historical data on temperature, flood levels, storm cycles, etc., can help to inform planning decisions in an effort mitigate the damage of future weather events. Statisticians might call this reference to historical levels stationarity, defined as a time series whose statistical properties are constant over time.[6] However,

the unexpected weather extremes of recent decades has led some to declare that stationarity is dead.[7] Historical levels are being surpassed at an increasing rate, and the design and management of the built environment is being complicated by something largely of human creation but entirely out of human control: climate change.

Caused in large part by industrialization and the urbanization that followed, climate change has altered historic weather patterns in unprecedented ways. Melting polar ice due to global warming is causing the sea level to rise, threatening coastal cities. Though projections vary greatly based on the model used - NASA reports possible sea level rise from anywhere between .2 and 2 meters by the year 2100 - even the low end of this spectrum could result in the 100-year flood events of today occurring as frequently as multiple times per year.[8] Beyond sea level rise, climate change is pushing weather events even farther into the extremes. An EPA report on observed changes in the following five categories helps to illustrate what this could look like going forward:

- Temperature: Average global temperatures are rising, with each of the top ten warmest years on record occurring since 1998.[9] In addition, extreme temperature conditions have become more common; summer highs are coming more frequently and heatwaves are lasting for longer, and summer night lows are rising as well, indicating less cooling off at night. This is particularly noticeable in urban areas where the heat-island effect can result in temperatures as high as 22 degrees Fahrenheit above surrounding areas[10]. In addition, unusually low winter temperatures have become less frequent.
- Precipitation: While total annual precipitation has increased globally, shifting weather patterns have caused certain areas to experience less precipitation, and even increased the frequency of droughts. Precipitation, when it does come, is more and more frequently being delivered in intense focused events rather than over extended periods of weather. Overall, storm activity is becoming more intense and more frequent.
- Flooding: Tied in large part to precipitation, flood-prone areas are experiencing a higher frequency of flood events. In coastal locations, the threat of flooding

may be coming from both rivers and the coast, a phenomena known as the "coastal squeeze".[11]

The Question

Cities are clearly the future of human population, and managing these urban areas is critical to the long-tern health and sustainability of both the built and unbuilt environment. However, climate change is causing extreme weather events to occur with greater frequency and intensity, and many existing urban infrastructure systems are not equipped to deal with these new extremes. As landscape architects who often work with a sensitivity to sustainability/ecological concerns and on anthropocentric/urban sites, how can we think about urban design so that it accounts for the population growth of our cities and the need to adapt to a changing climate? How do we design for growing urban landscapes that are threatened by climate change?

Site Introduction

Sacramento is the fastest-growing major city in California, and one of the quickest-growing urban areas in the country. Public and private entities are rushing to fill the demand for housing while urban planners try to cope with the growing pains of development. Simply put, Sacramento is evolving, and these conditions represent an enormous opportunity for the city to guide its growth in a environmentally sustainable and socially vibrant way. Sacramento leadership is relatively progressive when it comes to embracing these principles, as evidenced by written city goals that include making Sacramento the walking and biking capital and America's farm-to-fork capital, to name a few. However, Sacramento is also challenged by its susceptibility to climate change; in recent years the region has been exposed to extreme droughts followed immediately by record-breaking rains. The city's location at the confluence of the Sacramento and American rivers makes it the second most flood-prone city in the United States.[12] For these reasons, in addition to my personal familiarity with the city having lived there for several years, I have chosen Sacramento as the subject of this thesis.

Further analysis detailed in chapter 3 led to the selection of the Midtown neighborhood for the study

area. Large mixed-use and smaller-scale development projects are changing the historical single-family/low-rise residential fabric of the neighborhood, and increasing property values will push density in this area higher than ever before. With this increased density comes increased demand for public realm spaces, making Midtown a prime candidate for new development. Increased density will also put more of a strain on infrastructure such as roads, water supply/water management, and the aging combined sewer system, making this already at-risk region even more sensitive to climate extremes. The proposals posited in this thesis culminate in the final selection and development of a project site situated along a freight railroad track right-of-way that bisects Midtown, a linear park I call the Sacramento Lowline.

The project site is currently owned and used by the Union Pacific Railroad (UPRR) company for freight transportation between its major Sacramento hub and Stockton, the second largest inland shipping port on the west coast and an important shipping route, to the south.[13] However, the UPRR owns and operates a parallel rail route to Stockton that passes around Midtown. This thesis suggests that by diverting all rail traffic to the parallel track, the railroad right of way that cuts through Midtown could be repurposed as a social space. There are a number of factors that make this proposal viable. First, the concept of adaptively reusing railroad infrastructure has been successfully pioneered by projects such as New York's Highline and the Atlanta Beltline. Second, the location of the proposed park and its proximity to existing public amenities would make it an potent piece of connective tissue in the city. Furthermore, there is pre-existing interest in moving the railroad outside of midtown. Passing trains are loud and cause traffic congestion as well as impeding the movement of pedestrians and cyclists. In 2016 a stalled train during the morning rush hour stranded commuters and had some citizens calling for the track to be rerouted.[14] Finally, the location of the proposed Lowline park is such that it would intercept over half of the surface water within the combined sewer shed that services Midtown and downtown, reducing the strain on the system during extreme storm events and mitigating flooding in the geographical and cultural center of the city.

New York Highline

Adaptive reuse of an elevated rail track in Manhattan. Designer James Corner/Field Operations preserved characteristics of the old railway while transitioning its use. The linear park is now a popular destination and the success of the project is often pointed to by officials considering similar projects in their own locations.

Atlanta Beltline

This rails to trails project is one of the largest transportation and economic redevelopment efforts of its kind. Located in Atlanta, Georgia, the 22-mile loop connects 45 neighborhoods along a multi-use network of trails, arboretums, and streetcars, and integrates affordable housing, public art, and historic preservation.

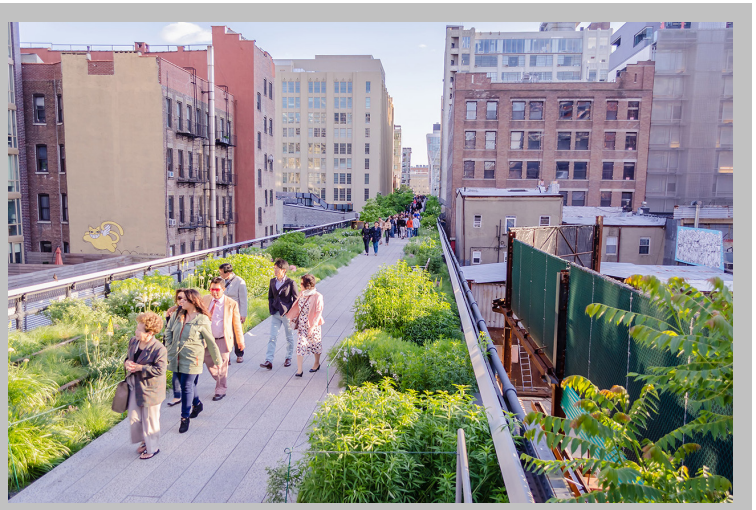

Figure 1.1
[Top] New York Highline
Figure 1.2
[Bottom] Atlanta Beltline

Looking Ahead

Sacramento is not unique in being faced with the tandem challenges of urban growth and climate change. Cities across the globe are feeling the pressures of an increasing population, the demand for adequate housing, the strain on aging infrastructure, and the needs of a dynamic citizenry. They are also feeling the threat of rising sea levels, powerful storms, extreme droughts, and the new reality of changing climate norms. While no two places will be exactly alike in their approach to dealing with these issues, it is my hope that the methods applied in this thesis offer a lens through which the complexity of the challenges facing urban areas can be brought into focus. The concept of multifunctionality as it applies to green infrastructure, strengthened by a foundation rooted in local or regional ecology, is an adaptable framework that is applicable beyond the scale and scope of this thesis project.

Figures

1.1 New York Highline. Image source: Shutterstock via https://www.timeout.com/newyork/blog/a-food-walking-tour-of-the-high-line-072616
1.2 Atlanta Beltline. Image source: http://network.thehighline.org/projects/atlanta-beltline/

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2. LITERATURE REVIEW

Theoretical Grounding

The design recommendations in this thesis have been influenced by and distilled from a body of literature that represent some of the leading principles and philosophies of landscape architecture today. The goal of this literature review is to underscore relevant theory within the field in an effort to be better prepared to address the complexities of the site. The final design proposal was influenced by a synthesis of these works, focusing namely on the interconnected concepts green infrastructure, ecological urbanism, ecological aesthetics, and multifuntionality in the right of way.

Green Infrastructure

It is nearly impossible to imagine a city without public infrastructure. Whether we are consciously aware of them or not, we rely on infrastructure systems every day to deliver drinking water and energy, to remove waste, or to allow for functional and safe mobility. Since its inception, the fundamental goal of public infrastructure has been to directly improve human well-being. Earlier philosophies regarding the human relationship to nature believed that it was a human right to have dominion over nature, to tame it, or to perfect the imperfections seen in nature. Evidence of this view can be seen in the early development of cities, where the environments in which people occupied were greatly modified for the benefit of human activity but often at the detriment of the environment. Public infrastructure was overlaid on the landscape with a blunt instrument, and the landscape was made to conform to needs of these systems. More recently, however, a vision nature has emerged with city being one end of the spectrum of nature, wilderness being the other. This idea, first introduced by Ann Spirn, conceptualizes the city as a garden tended by humans where nature's form is different from its wild counterparts in the wilderness but not intrinsically separate from it.[1] Derived in part from advancements in ecological science, new philosophical and ethical frameworks have repositioned humans relationship with nature from one of "control over" to one of "embedded within".

These philosophical changes have infiltrated public infrastructure, which has been reimagined and broadened to include factors that indirectly impact human well-being in addition to those that impact it directly. For example,

whereas in the past a waste removal system might be successful if it simply moved waste out of the city to a landfill, today the question of "then what?" is asked. "Is that waste disposed of properly? Is it leaking toxic effluent into the environment? Will that toxicity damage the environment? Will damaging the environment effect human health?" Based on a deeper understanding of systems-based complexities, linear models are being replaced by models that aim to have more holistic considerations, and a more complex understanding of the interconnectedness of human action, environmental well-being, and ecological systems.

Norwegian philosopher Arne Naess contributed to this paradigm shift with the concept of deep ecology. Coined by Naess in 1973, deep ecology promotes the inherent value of all human and non-human life, regardless of any utility in support of human needs.[2] Taken a step further, deep ecology asserts that all life, human included, is reliant on an infinitely complex web of nested ecological systems. This philosophy asserts that long-term human well-being and sustainability is reliant on services provided by ecological systems, rather than any sort of control over the environment or an ability to subdue nature. From a design standpoint, this framework points to ecological systems as guides for how to achieve adaptive, regenerative, and sustainable systems in the built environment, an idea that is being furthered philosophically by the concept of ecological urbanism and more concretely by the practice of green infrastructure.

Green infrastructure takes a multifunctional approach by broadly examining the stacked uses and combined benefits possible in built environment infrastructure when designed through the lens of ecological services. Green infrastructure typically signifies a natural systems approach in which the forms and processes in nature are applied to an urban context.[3] In relation to climate change, green infrastructure aims to implement design strategies that mitigate the harmful effects human activities have had on the climate while simultaneously adapting human landscapes to be able to withstand the volatility of changing climate norms. Nancy Rottle, director of the Green Futures Research and Design Lab, identifies five systems critical to urban green infrastructure: social, biological, hydrologic, circulatory, and metabolic.[4]

- Social System: Places in the public realm that allow for social interaction and bring "comfort, delight, connection, and health to urban dwellers" such as places to eat, drink, meet, express, debate, or reflect.[5] The strength of this system is crucial to the sustainability of cities because it allows for people's needs to be satisfied in a relatively compact area, thereby reducing the ecological footprint of individuals as compared to less dense suburban landscapes.
- Biological System: Places that support biodiversity. Urban landscapes are often disruptive to plant and animal species, unbalancing the fragile equilibrium of ecosystems that deliver services beneficial to both human and nonhuman life. Increasing biodiversity in cities can not only support these ecosystems but can also improve human contact with nature, providing significant benefits to health and education for example.[6] Biological systems can take on a number of different forms and scales, from small scale plantings to interconnected arboretums.
- Hydrologic System: According to Rottle, the hydrologic system "encompasses water as a resource as well as the health of aquatic environments. Five «waters» can be considered for these purposes: clean water source for drinking; stormwater, or rain water that falls on urban surfaces; greywater, which is water that has been used for functions such as washing and is easily recycled for other uses; black water, or sewage; and aquatic environments."[7] The green infrastructure approach to the hydrologic system considers closed-loop systems for the research waters, limiting costly inputs or damaging outputs, while simultaneously improving or enhancing environmental health of aquatic environments. Also known as green stormwater infrastructure (GSI), this system is one of the most important when considering climate effects on cities, both for instances of drought or excessive precipitation. In comparison to typical stormwater systems which are designed to convey water away from the build environment as quickly and efficiently as possible, GSI reduces the amount of stormwater that enters these systems by treating the water at its source, all while delivering environmental, social, and economic benefits.[8]
- Circulatory System: Networks and facilities that

promote the use of active transportation. Walking and biking is not only beneficial to human health, but also reduces automobile-related emissions that are damaging to the environment. In addition, these slower modes of transportation also allow for lingering in public space and increase the chance of random encounters, improving social connections.

- Metabolic System. Elements that produce green energy, such as wind and solar for power or gardens that produce food, with minimal negative environmental impacts.[9] Typically these elements are small-scale and provide energy resources to local users, with any surplus being distributed to the grid.

It is important to note that these systems all share some degree of overlap; in fact, this is what makes green infrastructure such a potent framework for designing urban landscapes. Instead of a standard street with traffic lanes and narrow sidewalks, that same ROW space approached through the multifunctional lens of green infrastructure might include bike lanes (circulatory), a planted strip that intercepts stormwater (biological, hydrologic), solar cells over an adjacent parking lot (metabolic), and pedestrian amenities such as benches (social).

Ecological Urbanism

The term “EcoUrbanism" was first used in 1998 by architect and planner Miguel Ruano in his book of the same name. In the book, Ruano defines ecourbanism as "the development of multi dimensional sustainable human communities within harmonious and balanced built environments”.[10] The underpinning concept of combining ecology and urban design was further refined by Mohsen Mostafavi and Gareth Doherty in their 2010 book Ecological Urbanism, in which they frame the city as complex and intersecting networks of people, places, and processes.[11] The authors propose a systems-based approach for thinking about urban design, emphasizing the need for multi-scalar interventions and an awareness of multi-disciplinary environmental thought. In his introduction to Ecological Urbanism, Mostafavi writes: "Increased numbers of people and cities go hand in hand with a greater exploitation of the world’s limited resources. Every year, more cities are feeling the devastating impacts

of this situation. What are we to do? What means do we have as designers to address this challenging reality?"[12] Ecological urbanism attempts to answer these questions by proposing a new paradigm for urban design, one that synthesizes human needs, sustainable practices, and the function of cities.

One of the great challenges of ecological urbanism is maintaining a zoomed-out systems level view while simultaneously engaging with site and citizen at a personal, detail-oriented level. In Toward an Urban Ecology, Kate Orff tackles the difficulties of scale while taking the crucial next step of engaging with citizens by conceiving of urban ecology as "infrastructure systems overlaid on and connected with a unit of engaged citizenry."[13] Orff asks the poignant question of how to not just make landscapes but make change, and argues that expanding environmental awareness by "bringing together large-scale strategic planning practices and community-based participatory initiatives" can lead to both achievable solutions and a collective responsibility for implementation.[14] Orff also writes about the need to magnify, or in some cases revive, perceptions of regional landscape identity, which she suggests can be achieved by bringing elements of regional ecology into the forefront of the built environment. This proposition re-introduces the concept of aesthetics into ecologically functioning built landscapes, a component of design that, at least in this corner of the profession, has historically taken a back seat to function.

Ecological Aesthetics

Landscape architects often use design to address issues of sustainability, utilizing the forms found in ecosystems to create functional landscapes capable of performing ecological services. Despite advancements in design theory, engineering, and ecological sciences that have improved our understanding of how to design and construct functional landscapes, the challenge of changing people's ingrained behavior and generating a lasting sustainable ethic is still present. In her 2008 article Sustaining Beauty, landscape theorist Elizabeth Meyer postulates that landscape architecture can be an agent of change and help to shift people's behavior towards this sustainable ethic, but that there is a missing link preventing them from doing so.[15] That missing link — beauty — allows

one's individual experience of a designed landscape to "be a spatial practice of noticing, wandering and wondering in, and caring about the environment. The experience of landscape can be a mode of learning and inculcating values".[16] Rather than mimicking the forms found in nature, Meyer suggests urban landscapes should mimic the function of ecosystems but be aesthetically sensitive of and adaptive to urban form. This could help bridge the disconnect between perception of the landscape and its actual ecological health; human activity often impacts the ecosystem at a very high level, but individuals only ever experience landscapes at a human scale.

Aesthetics have always been a part of landscape architecture. Early practitioners of the profession recognized the power of physical beauty in the landscape, such as Frederick Law Olmsted who believed that a landscape's sensory qualities impact one's psychological state.[17] However, when speaking in terms of sustainability, earlier aesthetic philosophies posited that information about the functionality of a landscape was enough to influence preference. This philosophy put performance above all other factors, relegating discussion of aesthetics to the superfluous or negative.[17] Later studies called this thesis into question, however, finding that knowledge of the ecological value of a given site had little, if any, influence over preference.[18]

Joan Iverson Nassauer, another landscape theorist, observes that people tend to prefer some evidence of human care in urban landscapes.[19] Beauty can make ecologically performing landscapes recognizable and compelling. In cases where a functional landscape might naturally appear messy or wild, Nassauer suggests adapting an aesthetically acceptable public-facing edge to serve as a strategy to bridge the gap and "align the aesthetic experiences that people already value with the ecological health they do not yet know how to recognize."[20] Through this process of making something familiar and of creating emotional connection, designers can use beauty and form to create "new cultural expectations for ecological health."[21] Meyer argues that any discussion about sustainability in the landscape must include aesthetics, in addition to the more typically discussed principles of social equity, ecological function, and economic viability, because beauty "is a necessary component of fostering a sustainable community, and […] is

a key component in developing an environmental ethic"[22]. Attention to aesthetic experience helps make a cognitive connection between behavior and the impacts of those behaviors, restructuring one's priorities and values. In the parlance of contemporary scholarship, beauty performs. This is not to say that aesthetics are static; Meyer goes on to propose that perceptions can change, and perhaps even be informed by what is known to be ecologically healthy. In this sense, beauty and attraction to a particular landscape - and therefore its value - can be aligned with ecological performance if the audience is so inclined.

Multi-functionality in the Right-of-Way

After World War II when personal automobiles became more prevalent, many communities in the United States began to design their roads to facilitate the fast and easy movement of cars. In turn, the convenience of getting around by car encouraged the development of more auto-centric roads, often at the detriment of pedestrian and cyclist amenities. This created a feedback loop in which automobiles became the central focus of transportation infrastructure and land use policy. The result of this process is that many streets in American cities today have very poor conditions for pedestrians or any other mode of transportation besides cars. However, a movement known as complete streets is beginning to shift the focus of the right-of-way (ROW) from cars back to people.

In 1971, the first program resembling complete streets policy began in the stare of Oregon; state bill OSR 366.514 known colloquially as the "Bike Bill" required that new or rebuilt roads accommodate bicycles and pedestrians, in addition to stipulating additional funding for pedestrian and bicycle facilities in the public ROW [23]. The term "complete streets" would later arise in 2005 out of Smart Growth America, a nonprofit whose mandate is to establish economically prosperous, socially equitable, and environmentally sustainable communities in the United States. The term was quickly adopted by advocacy groups as way to describe a new approach to the ROW.[24] The theory behind complete streets is that the street should be made accessible for users of all kinds, including cyclists, pedestrians, transit riders, and drivers. Proponents of the movement believe that complete streets have a number of benefits over typical car-oriented streets, such as

improving safety due to slowed traffic, encouraging health through walking and biking, stimulating local economies by increasing foot traffic, creating a sense of place and improving social interaction, and improving adjacent property values.[25]

While increasing modal split and user diversity is a good start to ROW improvements, there is still more that can be done with streets. The ROW represents the vast majority of public open space in most cities, and the majority of the right of way is devoted to streets whose sole purpose is to serve automobiles. Is there more that can be accomplished in the ROW? In her book Living Streets, Leslie Bain and her co-authors take the idea of complete streets a step farther by articulating three ways to better utilize the space in the street. The first, as advised by the complete streets movement, has to do with expanding the concept of mobility to include multiple modes of travel. The second is place-making, which involves creating opportunities for people to gather and socialize and recognizing streets not just as a means to get to a place, but as places in and of themselves. The third is to support natural systems and embrace the ROW as an opportunity to reconnect with nature, both functionally and aesthetically.[26]

Design Framework

Sacramento is challenged by the effects of climate change; summers are seeing hotter, dryer conditions while winters are seeing more intense periods of rain. These increasingly extreme climate conditions, compounded with the city's location along the Sacramento and American rivers and its aging stormwater infrastructure, make managing Sacramento's growth a top concern. The principles outlined by green infrastructure, ecological urbanism, ecological aesthetics, and multifunctional streets offer a scaffold on which to structure solutions that would make Sacramento a functional, healthy, and sustainable city now and in the future. Based upon these principles, the following design framework has been established to address the need for multifunctional public space.

<u>Mobility</u>

Goals:

- Improve pedestrian infrastructure: Walkable cities are more social, more vibrant, and more interesting to

live in. Increasing pedestrian mobility by improving pedestrian infrastructure such as sidewalks leads to more people on the street, making for chance encounters, more traffic for local businesses, and increased social mixing. More walking also means less driving, which beneficially impacts climate change by reducing vehicle related emissions.

- Improve cycling infrastructure: Much like walking, cycling improves health and reduces environmental impacts related to driving. Cycling also allows for chance social encounters, though less so than walking. Still, cycling is incredibly important to sustainability in the urban landscape and requires an investment in infrastructure, particularly when it comes to street design, to encourage use and provide a safe environment for cyclists.

Proposals

- Re-evaluate the ROW network of Midtown with a greater emphasis on pedestrian and bicycle space. Establish a hierarchy of needs for vehicles and other modes, allowing primary driving streets to remain functional while secondary streets are partially or fully converted for pedestrian and cyclist use.
- Look for ways to connect existing cycling routes within the city, improving connectivity and encouraging cycling. Connect to existing regional parks and multi-use trail system, local points of interest such as neighborhood parks and the state capitol, and established restaurant/arts districts.
- Develop pedestrian-only spaces to improve the pedestrian experience in Midtown and increase access to open space.

<u>Ecology</u>

Goals

- Bring nature into the city: Whether in vast urban parks or small roadside planters, exposure to nature in urban landscapes improves human health while supporting biodiversity.
- Take inspiration from local and regional landscapes: Working within existing ecologies helps to support local biodiversity, and modeling systems after those found nearby can make for functional landscapes that are based on established ecological systems. Use

natural systems to enhance urban design instead of fighting against it.

Proposals

- As part of the street redesign effort, identify places to insert vegetation in the ROW.
- Look to the Sacramento River watershed for design inspiration, particularly when it comes to planting design.
- In reference to the Sacramento region's agricultural heritage and the dire state of some pollinator species such as bees, particular emphasis will be placed on designing pollinator-friendly landscapes.
- Improve and enhance the city's urban canopy by making space for more street trees.

Hydrology

Goals

- Prepare Sacramento for climate extremes: As climate change promises to bring more intense storms, the already flood-prone city must adapt how it manages this threat. On the other end of the spectrum, the city needs to improve its ability to store water for periods of drought, and reduce water usage during those periods.
- Improve stormwater infrastructure: Green stormwater infrastructure relies on a network of stormwater infrastructure components that work to slow stormwater down, allow it to infiltrate back into the ground thereby recharging the groundwater table, and even reduce water-bourn pollutants via filtration in specially planted catchment areas.

Proposals

- Reduce the amount of stormwater entering Midtown's combined sewer system by establishing a network of GSI in the ROW, including planted swales, permeable landscapes, and areas designed to flood when needed.
- Reduce the strain on Midtown's combined sewer system by intercepting water before it enters the sewer.
- Use drought-tolerant vegetation in the landscape to reduce irrigation needs during the dry season while still providing high-quality vegetated spaces.
- Clean surface water with vegetated roadside swales to remove pollutants.
- Capture and store water for use during times of drought.

Context and Engagement

Goals

- Become a cultural landmark and a place of learning: Invite the public to take ownership and engage with stewardship of the space and celebrate regional identity through design details.
- Increase awareness of environmental issues through landscape experience: People tend to value spaces they find aesthetically interesting or familiar, or when they form an emotional connection with a place.
- Create a vibrant social experience in Sacramento: Social spaces are beneficial for local businesses, can improve pedestrian safety when not allowing vehicles, and serve as important public forums for everything from celebrations to debate.

Proposals

- Create spaces for learning and participation, such as teaching gardens, community gardens, and educational events and experiences. Interactive signage will reinforce positive behavior via immediate feedback, such as water fountains that count how many disposable bottles were saved from entering a landfill due to reusable bottle fills, or bicycle counters that display the number of cyclists that have passed and translating that into how many tons of vehicular emissions were saved from entering the atmosphere.
- Create more social space for pedestrians in the ROW with improved social amenities, and create off-street social spaces within Sacramento's existing commercial nodes. Connect to existing social focal points to create a network for high-quality public spaces.

Together, the goals and proposals in this design framework represent a suite of tools to be applied to the project site introduced in chapter 4 as the Sacramento Lowline. While the categorical groupings of mobility, ecology, hydrology, and context and engagement makes it easier to understand individual proposals, it is crucial that the implementation of these proposals be structured across categories so as to be truly multifunctional.

Figure 2.1
Sacramento from above, looking northwest over the confluence of the American and Sacramento Rivers.

Figures

2.1 Sacramento from above. Source: Ron Reiring via Creative Commons.

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3. CONTEXT AND SITE ANALYSIS

A Brief Regional Grounding

The Sacramento River is the largest river and watershed system in California and the second largest in the nation by discharge volume to drain into the Pacific (after the Columbia River, which is 6 times larger).[1] The Sacramento River carries 31% of California's total surface water runoff and its 27,000–square mile basin drains the northern segment of California's central valley and the Sierra Nevada, the eastern slopes of the Coast Range, and the western slopes of the southern Cascades.[2] The Sacramento is highly managed for flood control and human use as it runs it course from its headwaters just south of Mount Shasta, through the fertile central valley floodplain, and into the delta before draining into the Pacific, with large volumes of water withdrawn for irrigation, industry and urban supplies.

The city of Sacramento is the capitol of California and is located within the low-laying central valley floodplain at the confluence of the Sacramento and American rivers. The city's history goes back to 1839 when John Sutter established Sutter's Fort at the confluence[3]. Sutter's intent was to establish an agricultural settlement, however when gold was discovered in the California foothills in 1848 the fledgling city quickly transformed into a trading and mining outpost, becoming a focal point of the California Gold Rush.[4] In 1849 John Sutter Jr. seized on the opportunity to capitalize on the Embarcadero, a wharf that his father had built, that was being used a major staging area for prospectors going east.[5] Sutter Jr. overlaid a grid of numbered and lettered streets and established the foundation for the modern city. Sacramento was officially chartered in February of 1850.[6]

The same waterfront location that catalyzed Sacramento's founding made it extremely vulnerable to flooding, and in January of 1850 after heavy rains caused the Sacramento and American rivers to crest simultaneously the city was devastated by flooding.[7] Sacramento's first system of levees and dams were constructed shortly after by Hardin Bigelow, whose efforts saved the city from a second flood in March of that same year and earned Bigelow the title of Sacramento's first mayor.[8] December

Figure 3.1
[Facing page] Sacramento River Watershed, Sacramento River, and the city of Sacramento within California.

Figure 3.2
View of Sacramento during the Great Inundation of January 1850. Lithograph by Geo. W. Casilear & Henry Bainbridge. Courtesy Bancroft Library,University of California at Berkeley.

1861 and January 1862 saw another bout of destructive floods, and city residents elected to build additional levees and raise the city by one story, an effort that was carried out from 1868 to 1873, resulting in many of the buildings' original first floors to be buried under ground.[9] The city still relies on its aging system of levees, dams, and weirs to prevent flooding, and is considered the second-most flood threatened urban area in the country after New Orleans, Louisiana.[10]

Railroads also played a defining role in Sacramento's early history. In 1862 President Abraham Lincoln signed the Pacific Railroad Act, kicking off the race to complete America's first transcontinental railroad.[11] Sacramento served as the western terminus for the the Central Pacific Railroad as it rushed to meet its rival from the east, the Union Pacific Railroad out of Omaha, Nebraska. As with the gold rush, the completion of the transcontinental railroad in 1869 brought thousands of people into Sacramento, reducing the overland journey from months to days.[12] The city remained a major hub for the Central Pacific, and later the Southern Pacific, until the 1990s. During much of this time, the railroad industry with its machine shops, lumber mills, and foundries was Sacramento's largest employer[13]. After a series of mergers and acquisitions the Union Pacific gained dominance in the 1990s and now owns all the major railroad lines through the city.[14] To this day Sacramento serves as a major junction between east-west and north-south routes, from Chicago to San Francisco and Seattle to San Diego.

A Growing City

On May 1st, 2017, the California Department of Finance released its annual state population report showing that Sacramento had the largest percentage gain in population (1.4%, or 6,900 people) out of the ten largest cities in the sate.[15] Sacramento area counties also saw significant gains, indicating a trend of growth in the capitol region. It is hard to pin down exactly why Sacramento and its surroundings are growing at such a rate; while some of that growth is almost certainly related to California's general statewide growth, some of it may be attributed to people fleeing the high cost of living in the San Francisco Bay Area to settle in the more affordable central valley. This growth is not expected to slow down any time soon-

Sacramento County is projected to grow from around 1.5 million people today to over 2 million by 2050, according to the UC Davis Center for Regional Change.[16]

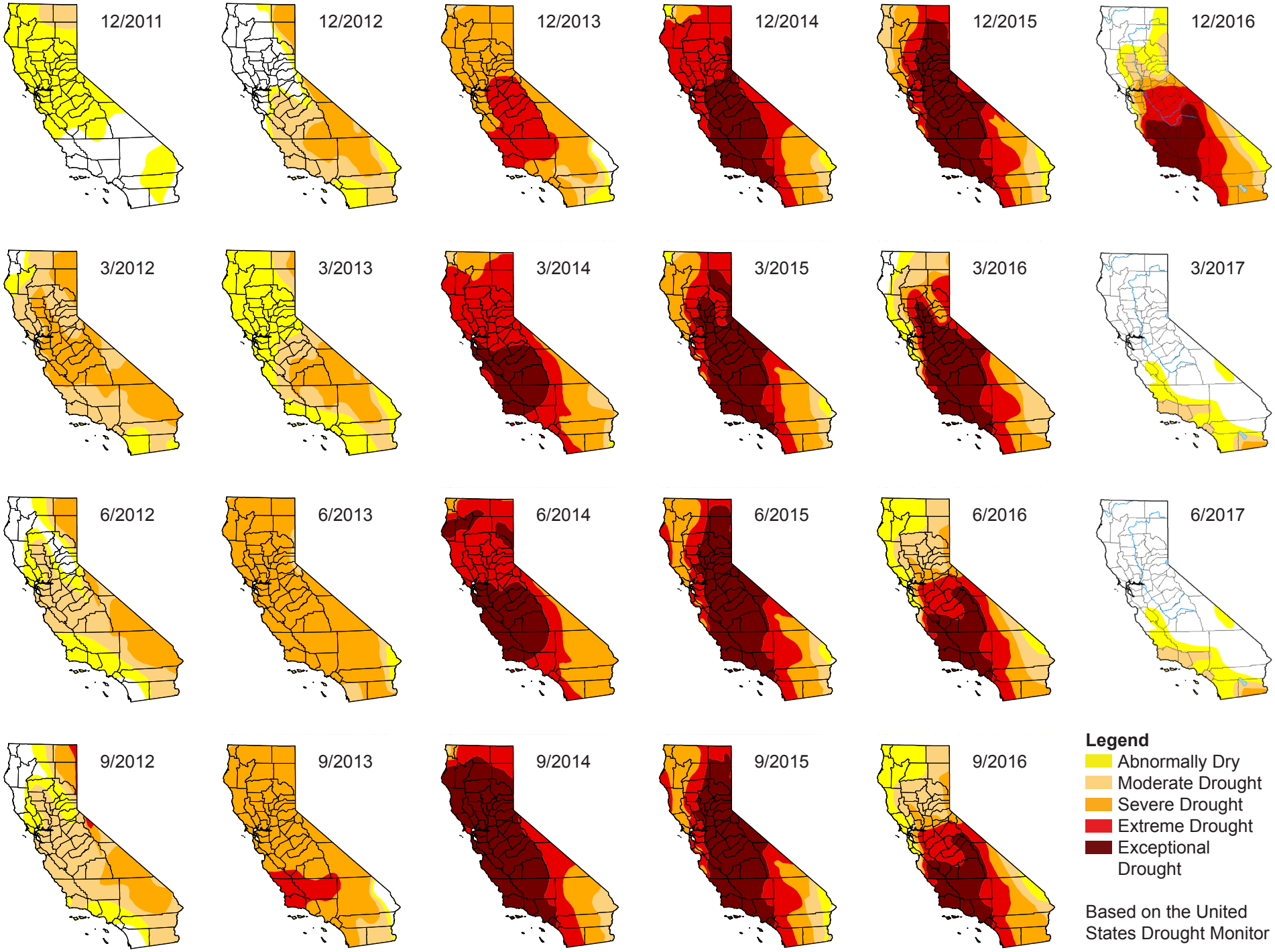
One of the challenges of this population increase is a shortage of housing. In addition to continued development in its suburbs, Sacramento is seeing increasing commercial and residential development in the downtown core, an area that has historically been dominated by offices and government buildings. How the city will adapt to this new downtown density remains to be seen. The new Sacramento Kings arena, Golden 1 Center, has been a catalyst for development in the area, with new retail, restaurants, entertainment, and lodging either planned or under construction as of this writing.[17] The Golden 1 Center plaza adds 3 acres of publicly accessible open space (though privately owned by the Sacramento Kings) around the stadium, but it is unknown how much more open space will be developed for pedestrian use as the city's core continues to grow.[18]

Climate Change in the Capitol Region

Sacramento has historically enjoyed a comfortable Mediterranean climate, which is characterized by mild winters, dry summers, low humidity, and ample sunshine. However, climate scientists expect to see more variability in typical weather patterns with global warming and climate change. In the capitol region, this is likely to mean longer droughts, more intense storms when they do come, and less snowpack in the mountains. This is troubling news on its own, but combined with the increased demand for resources like water due to the region's growing population, resource management becomes one of the most critical issues facing the region. In fact, even though California water agencies are on track to meet a state-mandated reduction in consumption (20% by 2020), it is projected that these savings won't be enough to keep up with population growth by 2030.[19]

Events of the last few years have exposed just how susceptible to climate change Sacramento really is.

Figure 3.3
[Facing page] California drought maps.


12/2011
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6/2013
6/2014
6/2015
6/2016
6/2017
9/2012
9/2013
9/2014
9/2015
9/2016
Legend
Abnormally Dry
Moderate Drought
Severe Drought
Extreme Drought
Exceptional Drought
Based on the United States Drought Monitor

During California's historic drought, officially lasting from December 2011 to April 2017, Sacramento was at "extreme" to "exceptional" levels - the two most severe - from November 2013 to May 2016 according to data from the U.S. Drought Monitor.[20] While water shortages and mandated rationing had little to no effect on statewide commerce, the lack of water put extreme stress on Sacramento's urban canopy. Before the drought, Sacramento had an estimated 1.7 million trees within the city limits.[21] While post-drought tree numbers are not yet known, it is estimated that many trees, already weakened by the drought, fell victim to the storms that shortly followed. The loss of urban tree canopy is a big deal for Sacramento, as this expansive network of growing shade structures plays a huge role in keeping temperatures down, slowing stormwater runoff, and reducing soil erosion.[22] In addition, lost trees are a resource that cannot be replaced overnight; the Sacramento Tree Foundation estimates that it will take several decades to regrow the urban canopy and regain lost benefits, and during that time global warming may lead to even hotter temperatures in the city.[23]

Dovetailing with the end of California's historic drought in 2015, the 2016-2017 rainfall season ranked as Sacramento's fourth wettest season since such record keeping began 140 years ago.[24] The heavy rainfall exposed weaknesses in regional infrastructure, with the Oroville dam crisis receiving national media coverage. Less publicized but no less damaging were the effects of heavy rains on area combined sewer systems. While the city relies on an aging system of levees, floodgates, and pumps to protect it from the rivers flooding, surface water due to precipitation is still a major concern. From the start of January to the end of February more than 1 million gallons of wastewater spilled into the capitol region due to sewer lines and treatment facility backlogs.[25] According to reports from the State Water Resources Control Board, most of the contamination spilled into waterways.[26] As climate change continues to push weather events farther into the extremes, it is possible that similar or even more powerful storms will threaten the region.

Figure 3.4
[Facing page] Flooding in Discovery Park at the confluence of the American and Sacramento rivers, January 12th, 2017.

Oroville Dam Crisis

On February 11th, 2017 unusually heavy rains required the Oroville Dam, located about 75 miles north of Sacramento in Butte county, to use its emergency spillway for the first time in the dam's 56-year history[27]. Existing damage was exacerbated by released water which caused erosion at the base of the spillway, leading to its eventual failure. State authorities feared that the torrent of water might cause enough erosion to weaken the actual dam, the nation's tallest at 770 feet, and issued mandatory evacuation orders due to the risk of flooding[28]. While dam failure was averted by easing rains, the spillway was severely damaged and nearly one million cubic yards of debris was later removed from its base.[29] The Oroville Dam crisis served as a stark wake-up call to the condition of California's - and the nation's - aging water infrastructure.

Figure 3.5
Water escaping from a break in the Oroville Dam's emergency spillway.

Site Analysis

Before selecting a site for intervention and developing a program for the project design, a regional and city-scale analysis was conducted to help develop a better understanding of the local context. This larger-scale analysis helped inform and address regional issues and bring forward relevant ecologies, which were then translated for an urban locus. The findings of the analysis influenced the selection of Sacramento's Midtown neighborhood as the most impactful location for this work, due to its nature as the cultural, commercial, and economic hub for the city, due to the imminent development and subsequent population increase of the area, and due to its susceptibility to flooding and pre-existing combined sewer system. These findings are explained in greater detail and mapped in the following pages.

After conducting city-scale analysis and selecting the project area, a zoomed-in land use analysis influenced the selection of the site itself. This land use analysis helped to identify distinctive character zones within the site and areas of opportunity for specific context-driven programming. At this scale, it was also possible to explore how the site, currently a freight-rail corridor, could be leveraged to create or strengthen connections to other important locations in Sacramento, such as the Capitol Mall to the west, the American River Parkway trail system to the north, and proposed off-street trails to the south and east.

Finally, the site analysis conclusion identifies the extent of this proposed project, introduced as the Sacramento Lowline in chapter four, and lays the groundwork for the project's design ethic and goals.

Emblematic Landscapes

The design of the Sacramento Lowline is inspired by landscapes and ecologies present in the Sacramento River watershed. As the river runs south from its headwaters on the slopes of Mount Shasta, it passes through rocky foothills, fertile valleys, and flooded marshlands. These three ecologies were translated into thematic typologies which informed aesthetic and programmatic elements of the site design. For the sake of this project, the zones are named Upper River, Valley, and Sacramento-San Joaquin Delta. This map shows the approximate location of each zone and its location within the Sacramento River watershed and the city of Sacramento. These ecological zones are explored in greater depth in chapter 4, and applied to each of the project zones: the American River Parkway Trailhead, The Stroll, and the Delta Park, respectively.

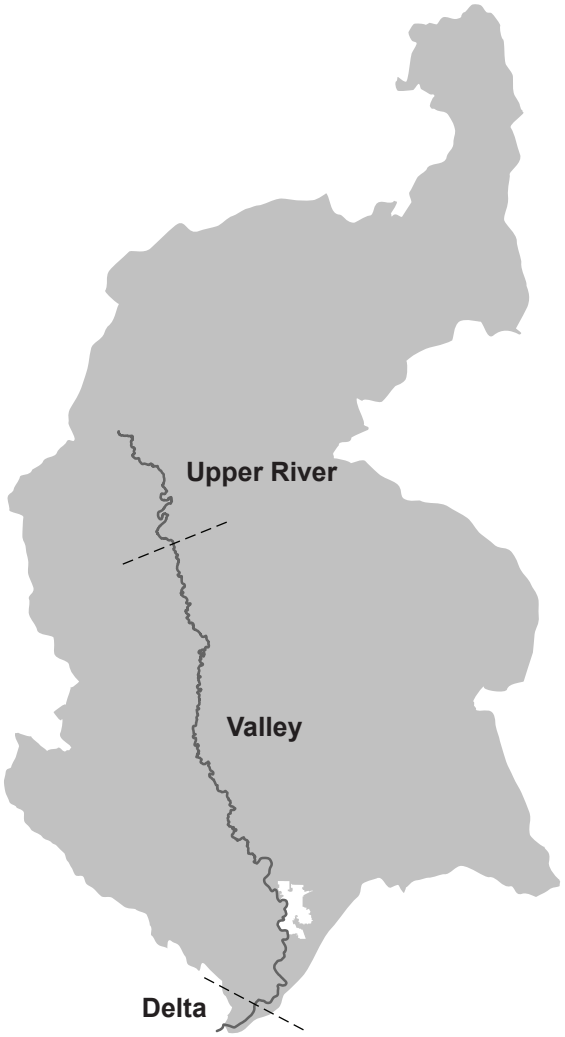
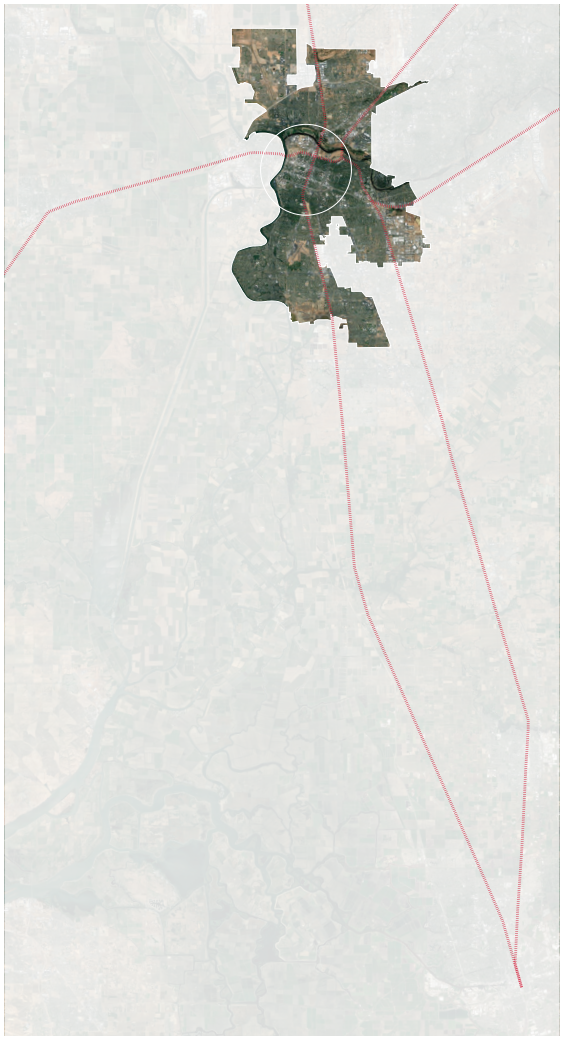


Figure 3.6
Sacramento River ecologies



Union Pacific Railroad Tracks

Sacramento is a major hub of the Union Pacific Railroad company. After a series of mergers and acquisitions the Union Pacific gained dominance in the 1990s and now owns all the major railroad lines through the city. To this day Sacramento serves as a major junction between east-west and north-south routes, from Chicago to San Francisco and Seattle to San Diego.

One of the main routes is from Sacramento to the city of Stockton, California's largest inland port and a major shipping hub, to the south. Two roughly parallel tracks service this route, one cutting directly through Midtown and the other turning east through less developed parts of the city before turning south towards Stockton. This project presupposes a hypothetical future in which the city has acquired the western track segment for conversion into a linear park, diverting all rail traffic to the eastern track.

Figure 3.7
Railroad map

Population Density by Census Block

The 2015 census measured the population of Sacramento at 485,199 people, and the same data was used to produce this map. Interestingly, the city center is a lower density compared to areas to the north, east, and south. This is due in part to the downtown area being one of the oldest parts of the city, with most of the residential buildings in the area consisting of single or subdivided homes on big lots or multifamily buildings under four stories. Another reason is that the downtown area is mainly occupied by commercial buildings, such as office and retail, or governmental/ institutional buildings. Population density is certain to increase in the near future as the city pushes its agenda of bringing more commercial and residential development to the core (see figure 3.7). While this imminent population increase may help to revitalize the downtown core, it may also bring complications such as increased congestion and higher demand for public amenities such as parks and open space.

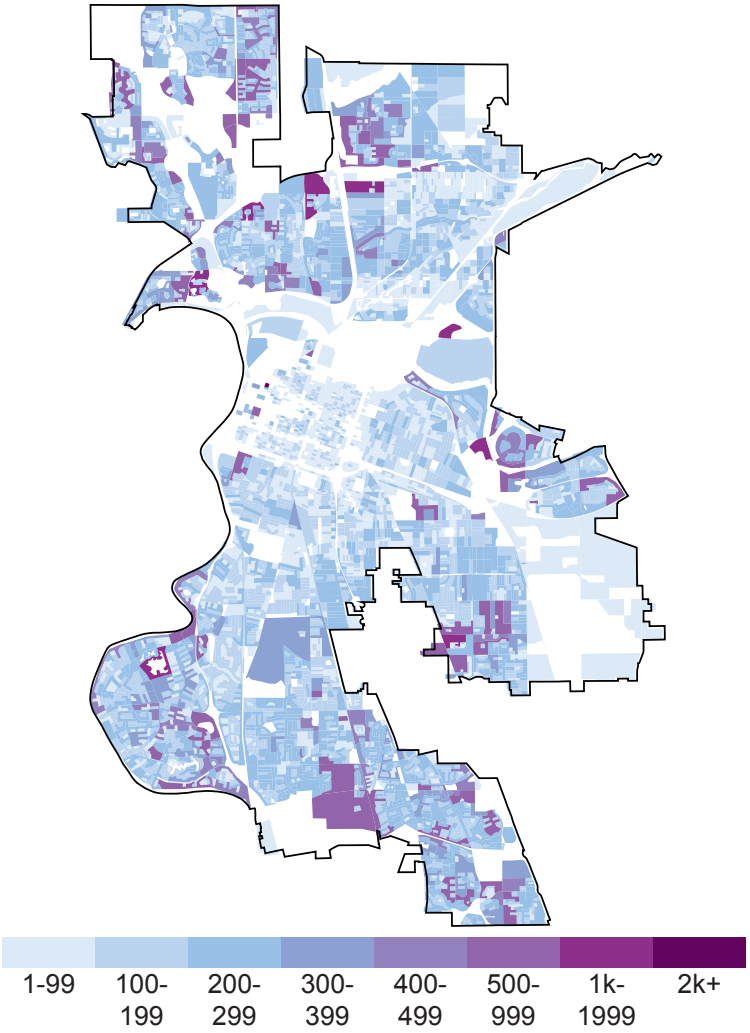


Figure 3.8
Population density by census block.

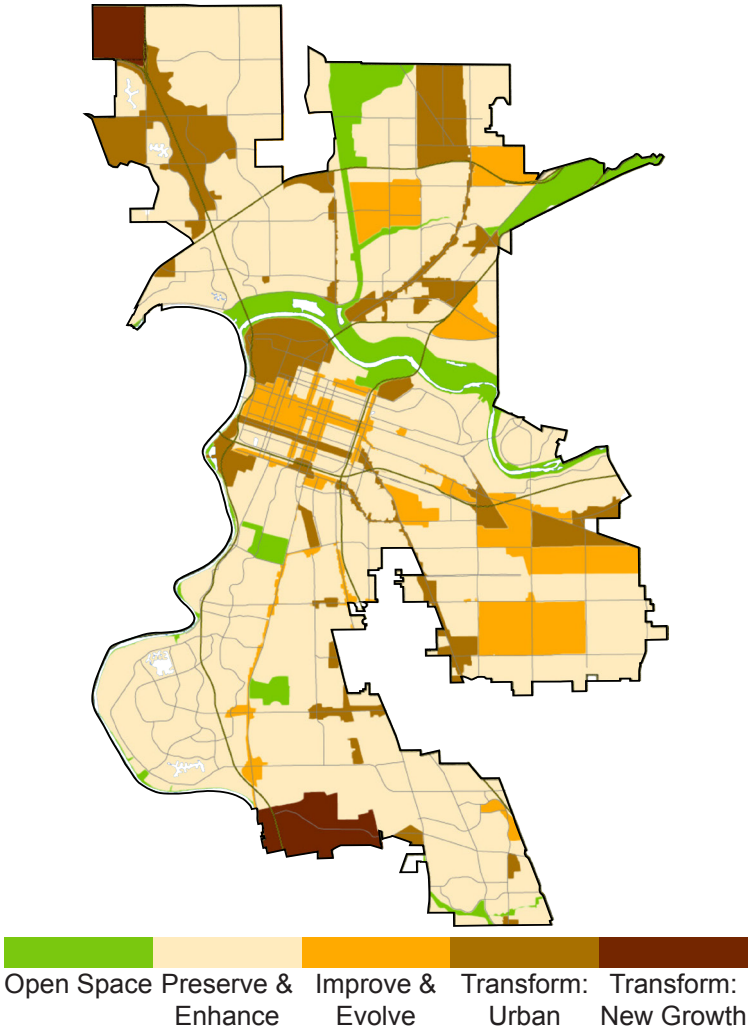


Figure 3.9
Land use plan.

Land Use Plan

The 2035 Sacramento Land Use and Urban Design plan emphasizes infill development while maintaining a mix of uses and creating spaces that "facilitate and enrich the life of the community".[30] The midtown neighborhood is Sacramento's primary zone for pedestrian-focused activities such as restaurants, bars, shops, and small businesses, and the city's land use plan identifies this neighborhood as an area to improve and evolve or to transform into a more urban typology.

Also of note are the small "Transform: Urban" nodes to the south of the central city located adjacent to one of Sacramento's lightrail lines and (see figure 3.10) and a proposed off-street trail (see figure 3.11). The Lowline Park proposed in this thesis will merge with this corridor, creating a connection between these proposed areas of growth and facilitating pedestrian mobility between the central city and the neighborhoods outside it.

Pedestrian Demand

The 2006 Pedestrian Master Plan defines pedestrian demand as "…the extent to which people want to walk to a particular place and is influenced by land use and development types including mixes and intensities of activities, the presence of public spaces and parks, and the availability of transit facilities."[31] Demand was measured by rating criteria including:

- Demographics – indicators describing groups that have a greater likelihood of walking, including seniors, youth, low income, and those without cars.
- Proximities – indicators of nearness to key walking destinations (located within 1 mile of walking distance).
- Pedestrian environment – indicators that have been empirically shown to correlate with the choice to walk, including population density, employment density, and mixed land uses.
- Policy areas – presence of special areas having greater importance for pedestrians due to City policies.

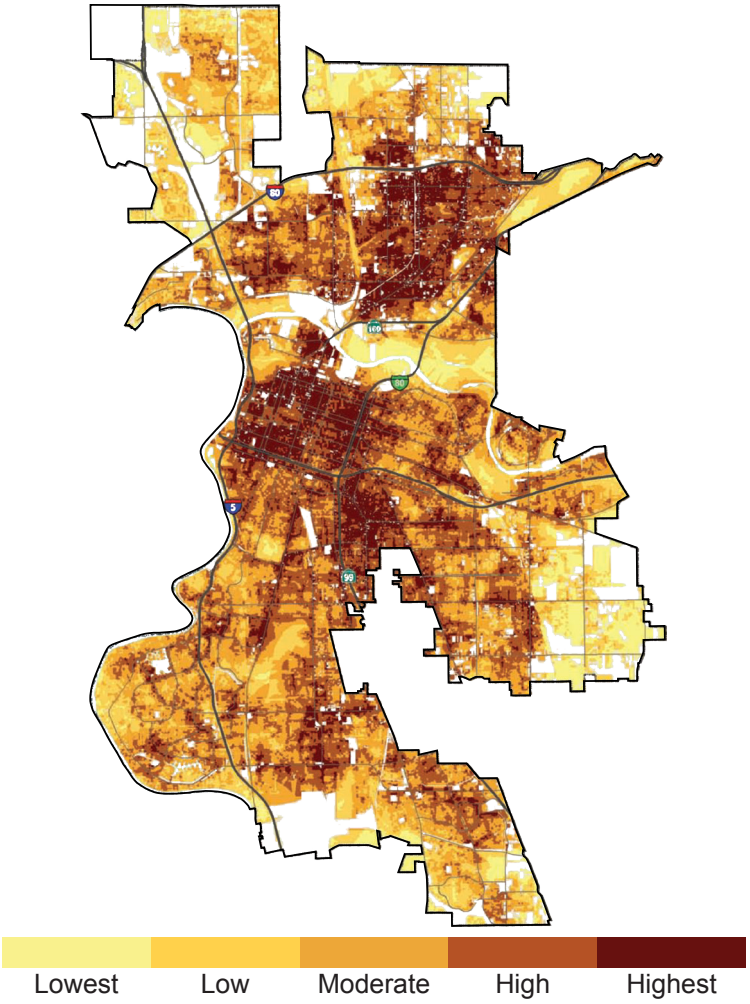


Figure 3.10
Pedestrian Demand

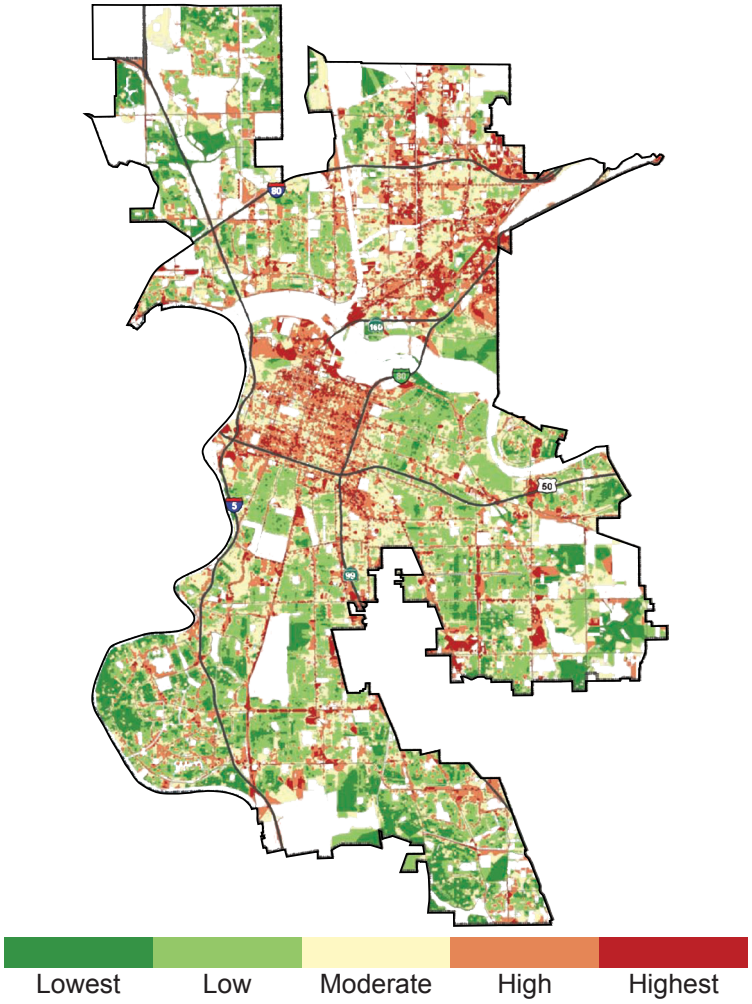


Figure 3.11
Pedestrian Improvement Need

Pedestrian Improvement Need

The 2006 Pedestrian Master Plan defines pedestrian need as a composite of pedestrian demand (see figure 3.8) and walkability, referring to "…the ease, comfort, and safety of walking and is influenced by connectivity, accessibility, the sense of safety (real and perceived), and the quality of the pedestrian environment"[32]. These scores were generated by assigning each street segment a walking potential rating and an infrastructure deficiency rating based on a set of indicators. The synthesis of these ratings gives the overall improvement score, which can be understood with the generic equation of: Demand + Walkability = Improvement Need. With this metric, improvement projects can be targeted to areas with high pedestrian demand but low walkability.

Transit

Sacramento has a relatively limited public transit network, consisting of several streetcar routes and a number of bus routes. Shown here in orange, the streetcar can be seen crossing in the middle of the city's downtown core before extending out to the north, south, and east.

The bus network offers more complete coverage of the central city, but limited service into neighborhoods outside of the center.

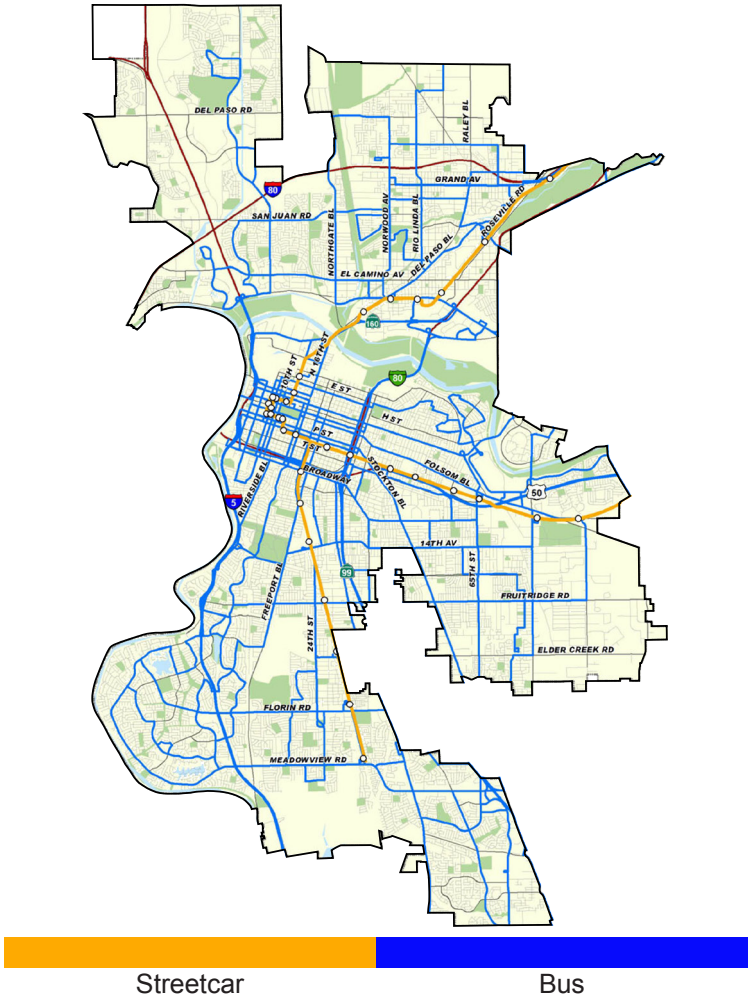


Figure 3.12
Transit map

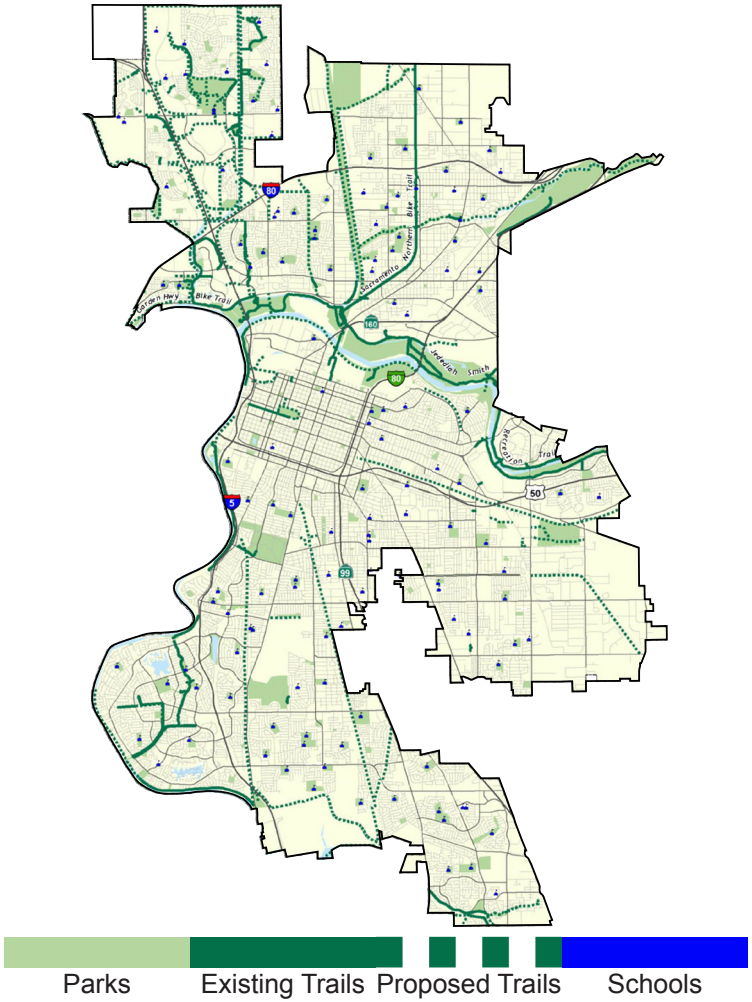


Figure 3.13
Off-street trails map

Off-Street Trails

One of Sacramento's characteristic features is its flat topography, which makes for excellent biking. The City and County of Sacramento have created a joint Bikeway Master Plan, composed of a network of existing and proposed off-street multi-use trails. This plan integrates with on-street bikeways to create an expansive network of cycling routes, supported in part by the city's 2035 Master Plan goals concerning livability and the climate action plan which commit the city to increasing its bicycle mode share to 7% by 2020.[33]

One of the region's largest and most used trail systems is the American River Parkway, which flanks the American River along the north side of the central city. While accessible from on-street bicycle lanes there are no off-street connections to this trail network into Midtown, nor are there any other off-street cycling paths through the center of the city. Additional infrastructure in this area would help to bridge the gap in service.

Elevation

The average elevation of Sacramento is about 30 feet, or 9 meters above sea level. Its lowest point is a neighborhood called the "pocket", located to the south west within a bend in the Sacramento River. The topography gradually slopes upwards to the east. Some of the city is located below the level of the Sacramento River.

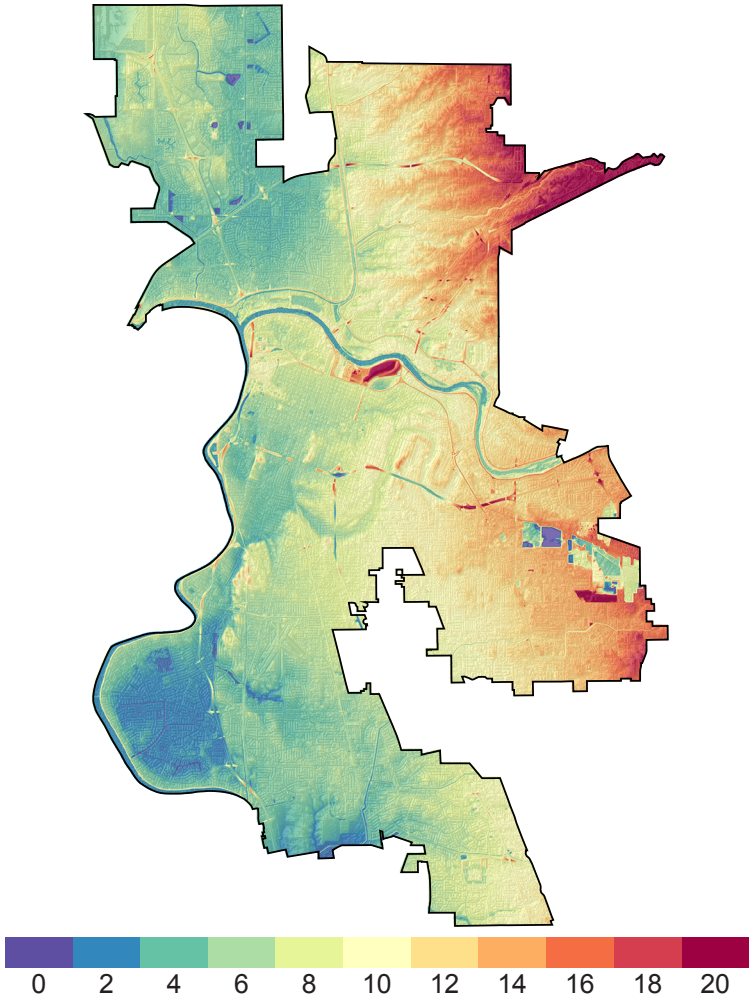
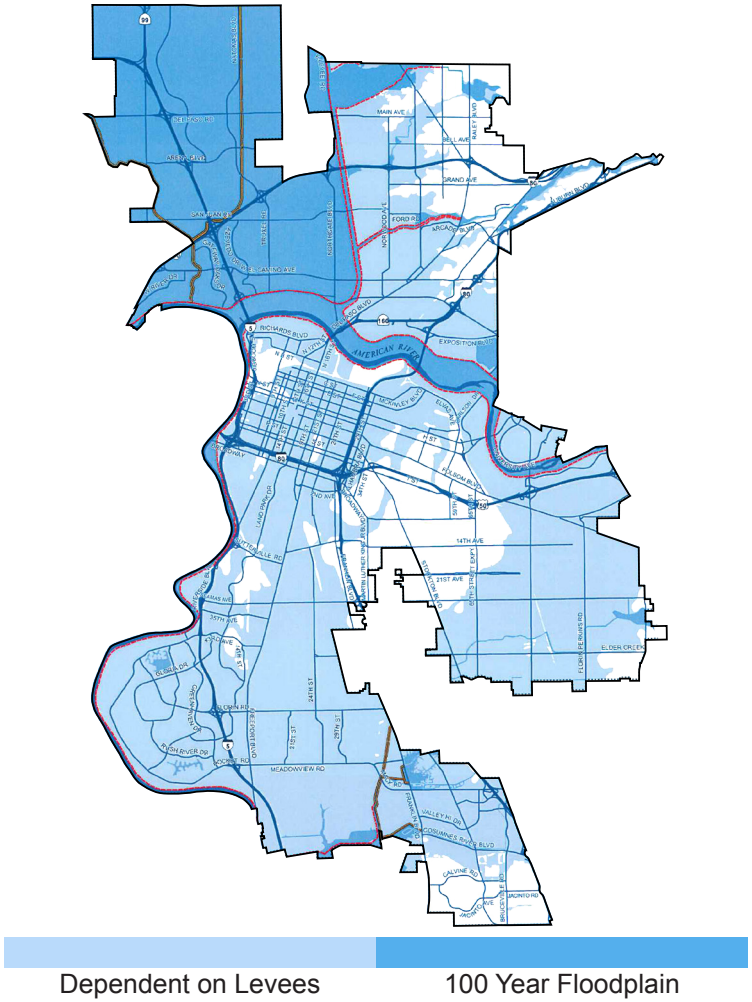


Figure 3.14
Elevation in meters



Areas Dependent on Levees

Sacramento's location in California's central valley floodplain at the confluence of the American and Sacramento Rivers makes it extremely susceptible to flooding. Nearly all of the land within city limits is reliant on the levees to prevent flooding. The city relies on an aging system of levees, dams, and weirs to prevent flooding, and is considered the second-most flood threatened urban area in the country after New Orleans, Louisiana.

Historic 100-year flood event levels are projected to cause flooding in the areas to the north of downtown. However, changing climate conditions have cast doubt on the validity of these older models, as more intense storm conditions are now delivering 100-year events more frequently than in the past. Without extreme flood-prevention measures, it is likely that Sacramento will come under threat more and more frequently in the future.

Figure 3.15
Areas dependent on levees

Combined Sewer System Shed

About one third of Sacramento's sewer system is part of a combined sewer system, meaning that storm drains overflow into the sewer when they get overloaded with water. In instances of normal precipitation this does not cause any problems, as the two systems remain separated and sewage is delivered to treatment plants. However, in extreme rain events when the storm drains flood the sewer system, this mixed effluent floods into nearby waterways. This was the case in 2017 when from the start of January to the end of February more than 1 million gallons of wastewater spilled into the capitol region.[34]

Capturing, slowing, and reusing stormwater are strategies that can help reduce the amount of water entering the system during storm events, taking pressure off of strained systems and reducing the likelihood of overflows. This is the goal of the Lowline, which will capture about half of the combined sewer system shed surface water flowing downhill from the east.

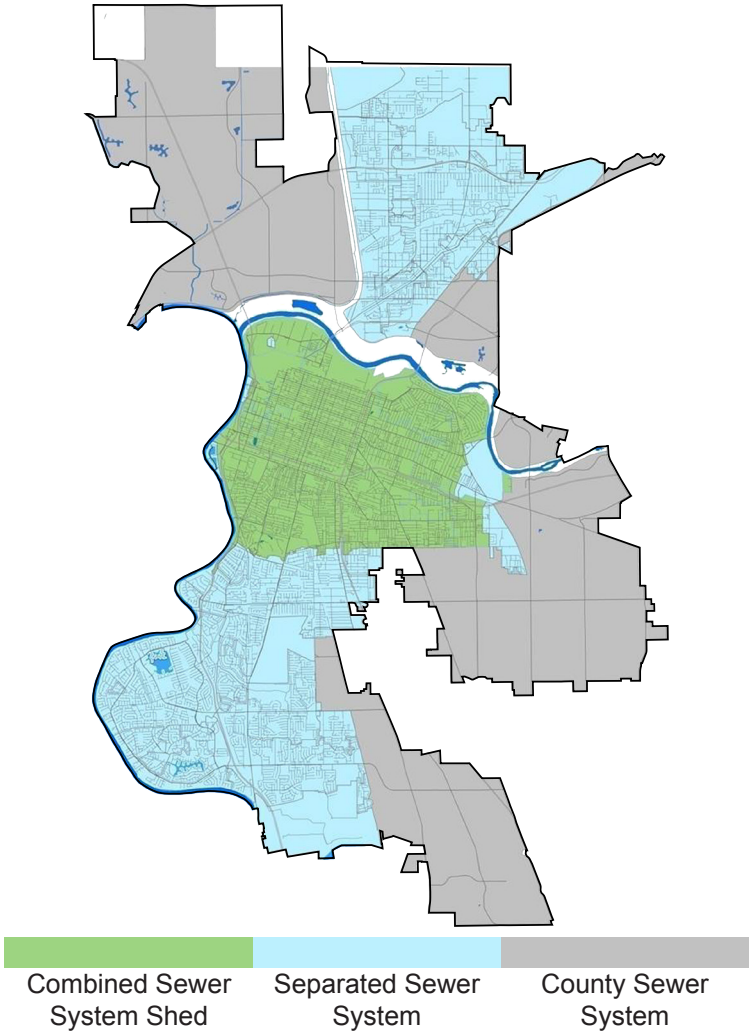


Figure 3.16
Combined sewer system shed map

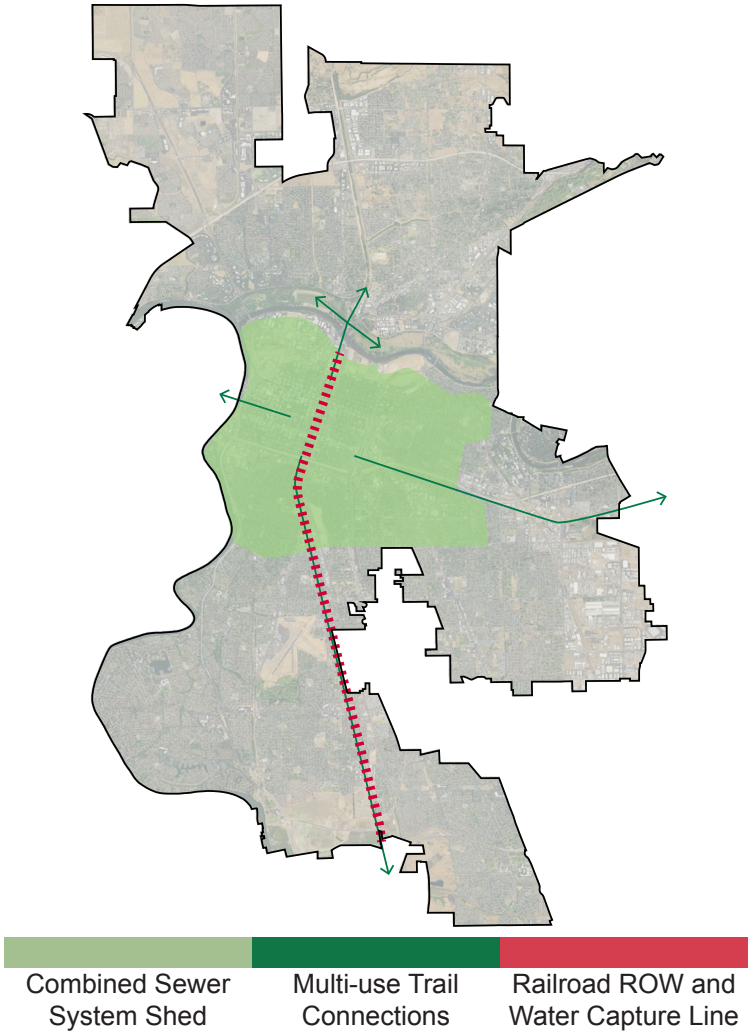


Figure 3.17
Analysis summary map

City-Scale Analysis Summary

Based on the analysis thus far, the following elements were identified and considered during the final site selection:

- New trail connections to areas of increased development.
- Improve downtown/midtown core, create vibrant pedestrian space based on demand and need.
- Capture water to reduce strain on combined sewer shed.

A freight railroad track that cuts through midtown follows the proposed connection line of the project. This design suggests that a portion of the railroad ROW be acquired by the city and transitioned into a linear park for pedestrian use (see figure 3.16).

Land Use Analysis

A zoomed-in neighborhood land use analysis reveals the makeup of the urban fabric. Midtown is composed of several sub-neighborhoods bisected by two major commercial corridors running east-west, and one running north-south. Using these areas as rough guidelines, the project was divided into three distinct zones which will be sensitive to the existing urban fabric as well as future opportunities to strengthen or grow.

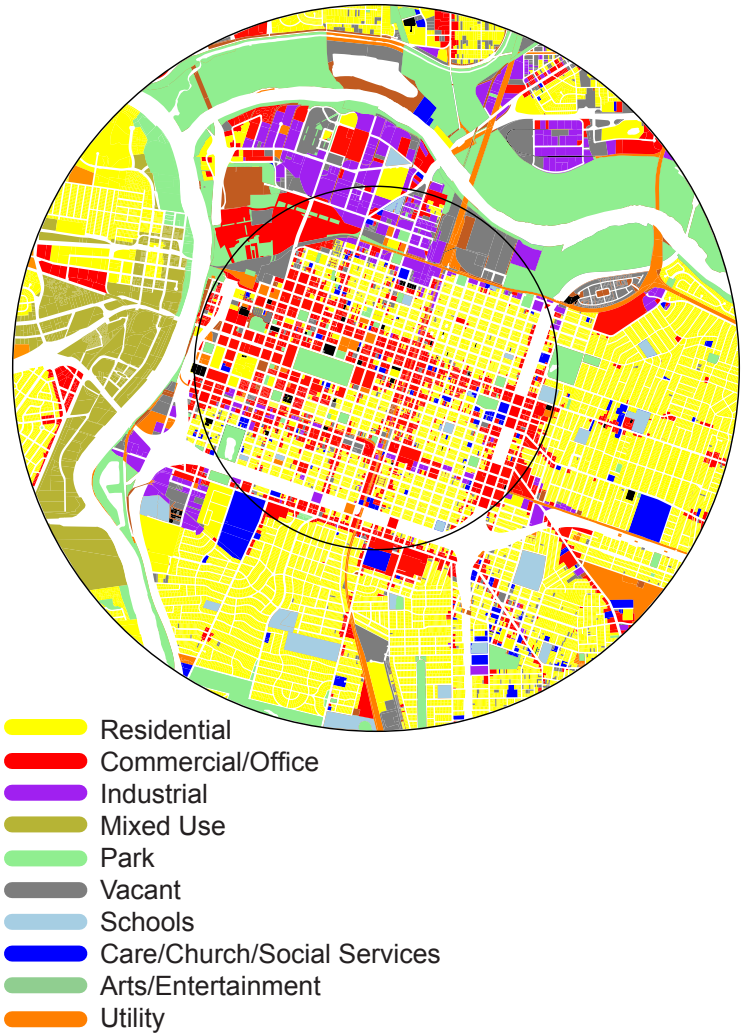
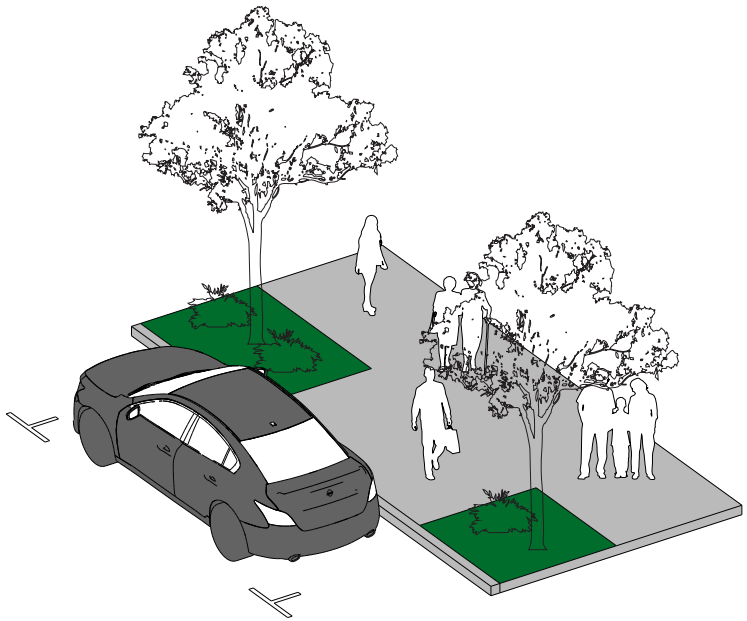


Figure 3.18
Land use analysis



Typical Street

The typical Midtown Sacramento street is composed of 2-3 lanes of traffic in one or both directions, an unmarked bike lane, a row of parking, and a sidewalk with occasional tree pits. An analysis of the Midtown street network reveals that vehicles are awarded the majority of space in the ROW (see figures 3.20-3.21). However, the street hierarchy map (figure 3.23) illustrates that not all streets are equally important to vehicular mobility. Therefore, it is possible to re-think space allocation in the street network and redistribute space in the ROW depending on a given street's vehicular need versus its potential to improve pedestrian, bicycle, ecological, or hydrological infrastructure. Street design ideas are detailed further in chapter 4.

Figure 3.19
Typical street

Pedestrian Space

Looking closer within the site, it is easy to see how limited pedestrian space, consisting of parks/plazas and space within the right of way (ie sidewalks), is in comparison to vehicular space. A spacial analysis based on GIS data showed that pedestrian spaces in the public realm account for only seven percent of the total land area shown here, and only 18% of all public lands.

From this map it is also possible to see that there is a gap in parks towards the eastern half and southeastern third of Midtown. The Lowline Park will introduce a new park space in this underserved area.

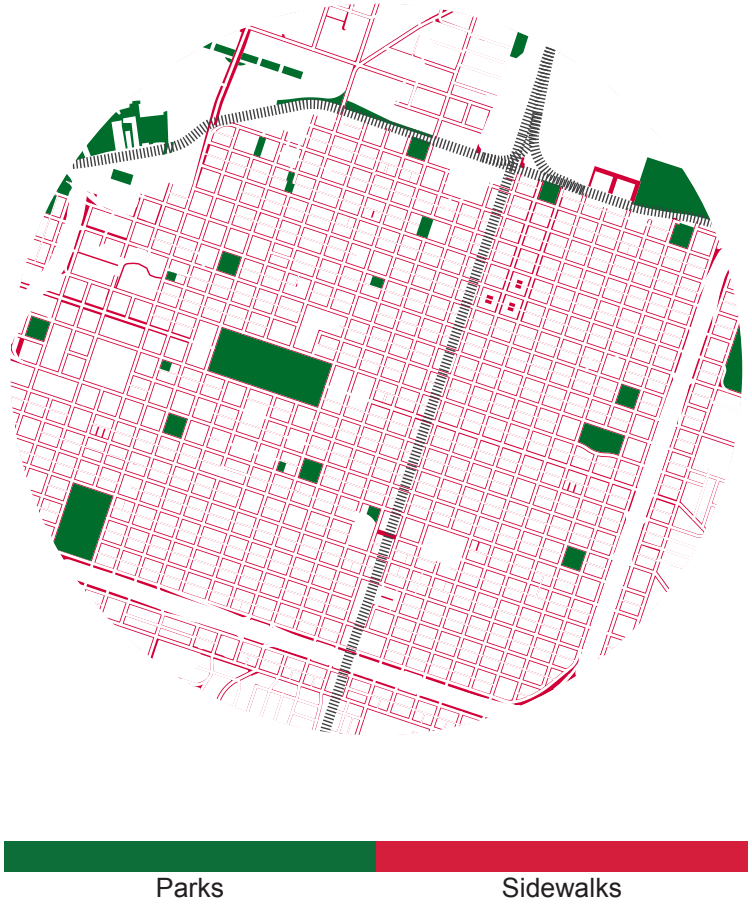


Figure 3.20
Pedestrian space analysis map

Vehicular Space

Vehicular space accounts for the vast majority of the public realm, accounting for 82% of all public lands. When including private parking lots, vehicle space accounts for over a third of the total land area shown here at 36%. In addition, vehicular space (including shared bicycle lanes) accounts for 94% of the ROW, leaving pedestrians with only six percent of this valuable public resource.

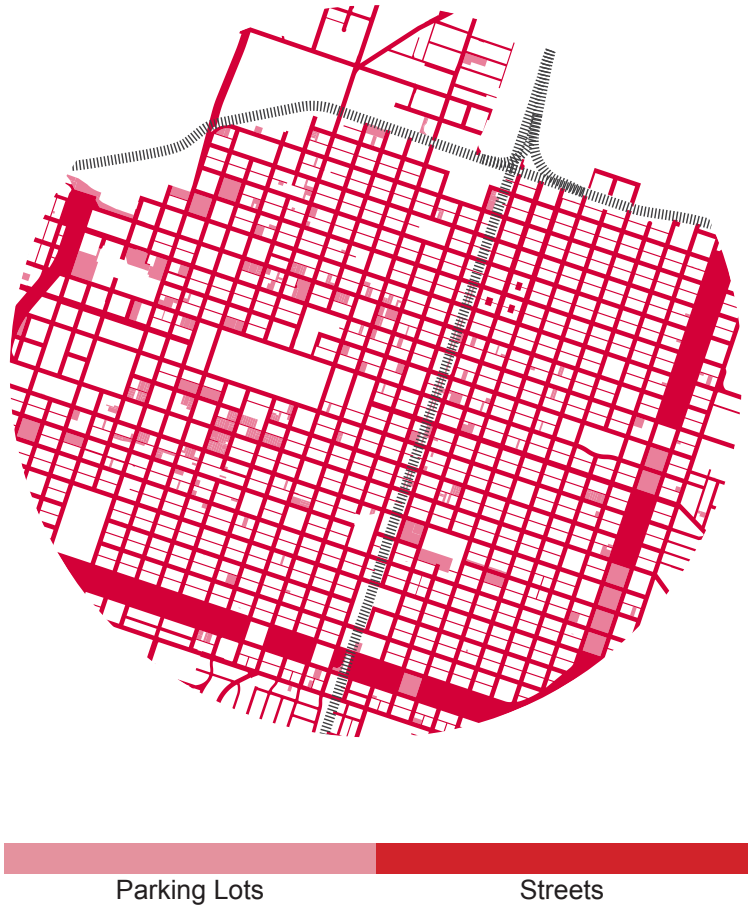


Figure 3.21
Vehicular space map

Street Hierarchy

Sacramento's street network has been divided by the city into four main categories: arterials, collectors, local streets, and alleys, listed from highest to lowest vehicular importance. Maintaining a functional street network is of course essential, however it is possible not to impeded vehicular traffic while simultaneously redistributing space in the ROW to other uses, such as pedestrians, cyclists, and hydrological/ecological infrastructure. This map illustrates the street hierarchy in Midtown, and figure 3.23 gives examples of these street types. Figures 4.2-4.19 give examples of how to reconfigure space in the ROW based on these street types.

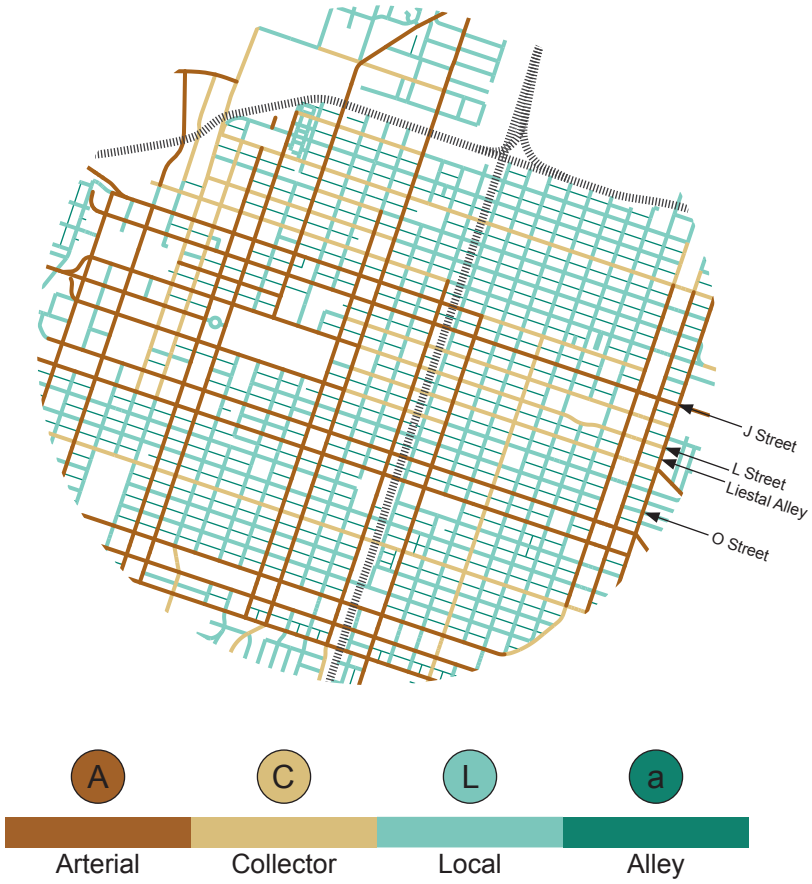


Figure 3.22
Street hierarchy map
Figure 3.23
[Facing page] Street typologies

Arterial: Maintain vehicle focus

Collector: Lane reductions, increase ped and cycle space

Local: Ped and cyclist focus, increase green/blue space

Alley: Close to vehicle traffic where feasible, focus on ped

Figures

3.22 Street hierarchy map

3.23 Street typologies. Images from Google Maps.

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4. SACRAMENTO LOWLINE

New York has its Highline, a linear park perched atop the old elevated train tracks in Manhattan. Sacramento lacks an elevated train, but the ground-level freight railroad track that bisects midtown makes for a prime location for a linear park, transforming an older piece of industrial infrastructure into a powerful public amenity. I call the new park proposed in this thesis the Sacramento Lowline, and it will serve as a new green spine for the city.

More than just planted urban space, the Lowline is programmed to serve the city in an infrastructural capacity with an eye towards the challenges that Sacramento will face in the future, namely: climate extremes such as flooding and drought, and the need to inject more green space into the rapidly urbanizing environment. The Lowline will achieve this agenda by integrating stormwater capture and storage within the design of the park, in addition to a series of adaptations to the right-of-way. Together these spaces will become a vibrant social amenity in Sacramento that brings nature into the city in a new and unique way.

The design of the Lowline is inspired by the regional ecology and geography of the Sacramento River, which passes through several evocative landscapes as it runs towards the Pacific. For the purposes of this project, these emblematic landscapes been distilled into three zones:

- Upper River
- Valley
- Sacramento-San Joaquin Delta

The Sacramento Lowline takes inspiration from these ecologies as it flows slightly downhill from its northern connection to the American River Parkway to the southern edge of Midtown. Just like the watershed that gives it its name, the Lowline park passes through three zones established by the context and site analysis detailed in chapter three. Those three zones have been named:

- American River Parkway Trailhead
- The Stroll
- Delta Park

Together, the three emblematic landscapes and three zones of the Lowline can be understood as three matched pairs with the built work pulling inspiration from its grander

regional counterpart. The close relationship of the project design to the regional landscape ecology and forms will make this project uniquely Sacramento, enhancing understanding and pride of local residents and visitors alike.

In addition to the green spine of the park itself, a suite of street redesigns radiating out from the Lowline will tie together the hydrological and bicycle networks while increasing and improving space for pedestrians and vegetation. These street proposals (figures 4.8-4.25) will be located based on the street hierarchy analysis in chapter 3 (figures 3.22-3.23) so that a functional vehicular network is maintained on arterials while shifting the ROW space allocation away from cars on less traffic-important streets.

While the three zones and street improvement proposals are all located within Midtown, it is important to note that future extensions of the park would expand out from this primary core. To the north, connections to the well-established American River Trail network enable active recreation along the American River. To the south, the proposed trail extension through some of Sacramento's established areas of more intense development ties the southern half of the city into midtown with an off-street bicycle friendly path. To the east and west, existing shared roads strengthen bicycle routes through the city of today and offer future pedestrian-only street closures for the Sacramento of the future.

Figure 4.1
[Facing page] Sacramento Lowline map.


Trailhead
The Stroll
Delta
Parks
Sacramento Lowline Parcels
Future Lowline Extension

Upper River // American River Parkway Trailhead

The upper Sacramento River is characterized by rocky canyons and woodland chaparral. As it descends the foothills south of Mount Shasta, the river has a narrower flow than in the valley floor. Key Habitat Types include woodland chaparral, blue oak woodland, and annual grasses.

In the Lowline, this ecology inspired the American River Parkway Trailhead portion of the park. It serves as the gateway to the American River Parkway and the miles of multi-use trails and river frontage it contains. Programming in this space is focused on outdoor recreation and education, such as a nature center. This area will feature vegetation commonly seen in upper river landscapes, such as oaks, buckeyes, and sages. Like the river as it winds through the foothills, the Lowline will weave its way through the narrow railroad right-of-way as it snakes towards the American River trail.

In addition to being a popular recreation area, the Parkway is also frequented by the local homeless population, many of whom use bicycles and the trails to move themselves and their belongings around the region. The homeless camps have been the source of litter and numerous destructive fires in this area. A neighborhood bicycle kitchen proposed as part of the new Lowline infrastructure will provide services to the community, with part of the program including trading volunteer hours in exchange for bicycle-related goods and services. Volunteer activities could include fire safety classes, trail cleanup, and bicycle maintenance assistance.

Figure 4.2
[Facing page] Rending of upper river landscape.
Figure 4.3
[Following pages] Rending of American River Parkway Trailhead.

AMERICAN RIVER PARKWAY TRAILHEAD


BIKE

Valley // The Stroll

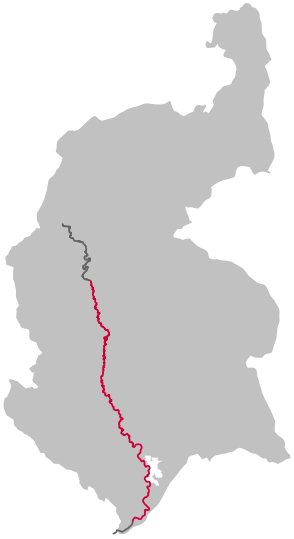
As the Sacramento River flows through the California central valley, the topography flattens out into a broad and fertile floodplain. This region is characterized by expansive meadows, fertile farmland, and riparian corridors along waterbodies. Here the river naturally widens and slows, though not much - if any - of the river is allowed to follow its own path in this region, as it is managed extensively for agriculture and to prevent flooding. Dominant habitat types in this region are grasslands, seasonal flooded wetlands, riparian corridors, and agricultural fields.

The Lowline translates this slowing, meandering river into the pedestrian-focused hub of the site: the stroll. Modeled after pedestrian streets such as Copenhagen's famous Strøget, the stroll is geared towards urban activities and businesses that enhance public life, such as shops, restaurants, and bars, and places of work. Business will capitalize on the new pedestrian space behind them in the old railroad ROW and turn to face the Lowline as well as the street.

In addition, the stroll is inspired by the Sacramento Valley's prolific agricultural heritage and will incorporate elements inspired by local food production into the landscape design, such as edible plant gardens, teaching gardens, and community gardening space. Sacramento has a goal to become the farm-to-fork capital of America, and this area will be the physical manifestation of that goal.

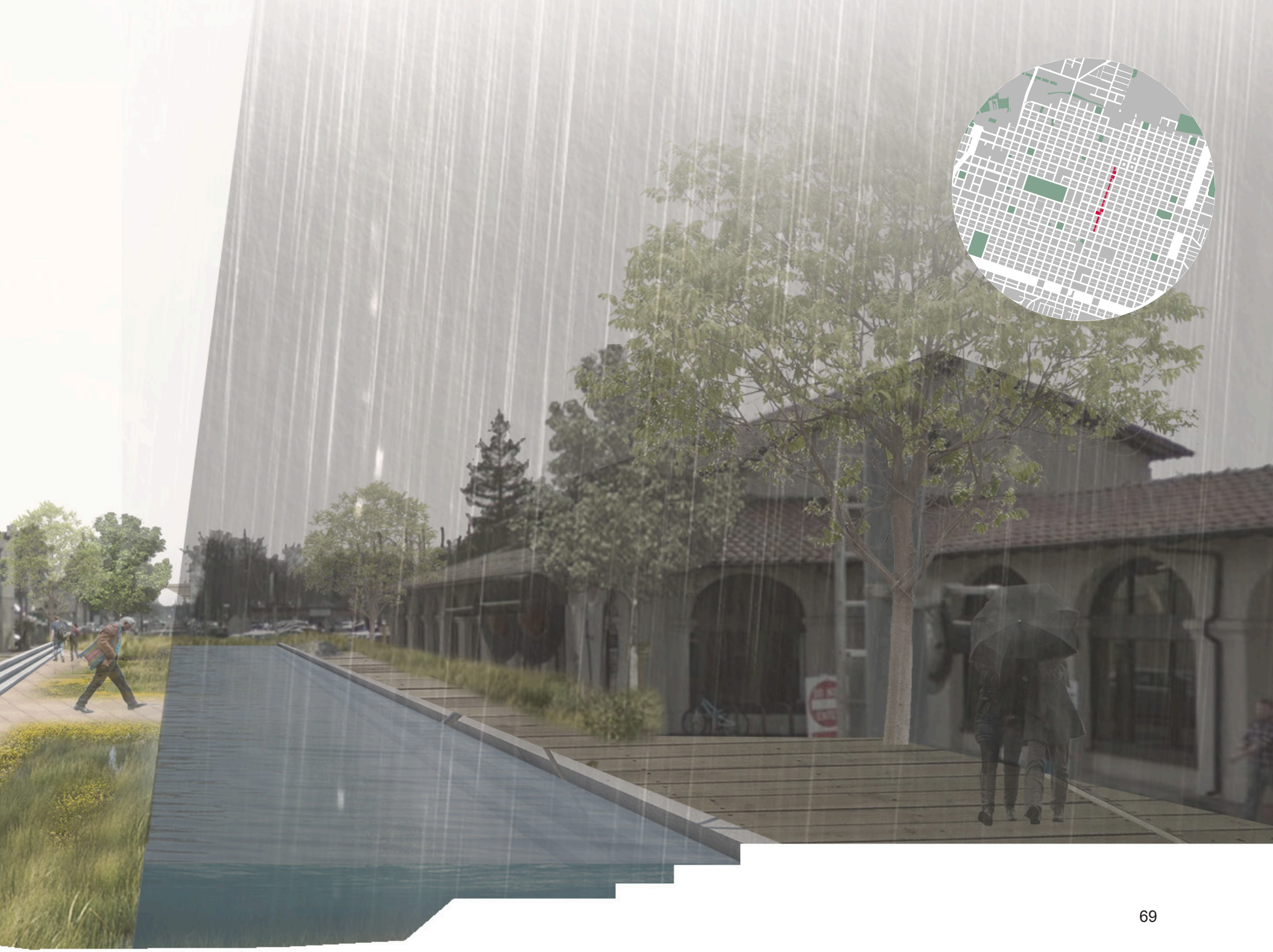
Finally, the stroll will accomplish the Lowline's stormwater capture goals by incorporating floodable spaces into the public realm landscape. In periods of extreme rain, this area will capture surface water before it overwhelms the sewer system, storing water and releasing it slowly into the ground or capturing it for irrigation use at a later point.

Figure 4.4
[Facing page] Rending of valley landscape.
Figure 4.5
[Following pages] Rending of The Stroll.



SACRAMENTO LOWLINE


MARRS
midtown art retail restaurant



Sacramento-San Joaquin Delta // Delta Park

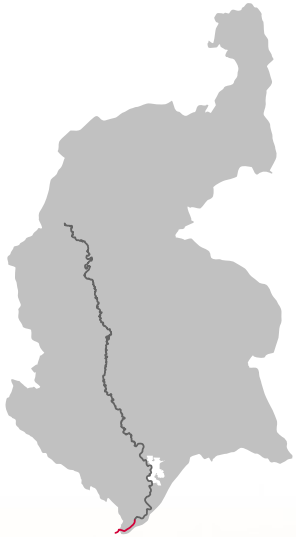
The Sacramento River joins the San Joaquin River just south of Sacramento before flowing out to sea. This area is characterized by seasonal flooding through grassy marshlands. The river has a highly braided pattern as it cuts through the lowlands, with the primary habitats being wetland marshes and riparian areas.

The southern end of the Lowline is adjacent to a development area known as the R Street Corridor, which is characterized by converted warehouse spaces, artist lofts, and music venues. This creative culture combines with the local delta ecology to inspire the Delta Park, the largest contiguous space along the Lowline. The Delta Park will change seasonally just as the real delta does, providing a large gathering space in the dry season and a detention basin during the wet season.

Dry season programming will include outdoor events such as concerts and festivals, tapping into the creative energy of R Street to feature local artists as well as drawing in traveling talent. Wet season programming will include wetland education, migratory bird sanctuary, and wildlife viewing platforms. This area serves as the terminus for the Lowline's water collection network, and will be able to flood with all the water collected by the Lowline and street collection infrastructure in periods of extreme precipitation. This water, which would otherwise flood the combined sewer system that serves Midtown, will be held and slowly infiltrate back into the soil.

While this area is the end of Lowline Park as designed in this project, a multiuse path proposed by the city will extend the off-street pedestrian and cycle connections south of the Lowline and into other parts of Sacramento.

Figure 4.6
[Facing page] Rending of delta landscape.
Figure 4.7
[Following pages] Rending of Delta Park.



SACRAMENTO LOWLINE

DELTA PARK


INTERDIT
V Cᵀᵉ M²RIS
AUX 2 ROUES
ACCÈS INTERDIT
SAUF AUX LIVRAISONS
ET RIVERAINS
DU LUNDI AU VENDREDI
DE 8H00 À 10H00
ET LES DIMANCHES
ET JOURS FÉRIES
DE 19H00 À 23H00

Something New in the Right-of-Way

The site of the proposed Lowline Park is currently crossed 30 times; 16 times by streets and 14 times by alleys. While this frequency of street crossings is reflective of the typical city block makeup in Sacramento, it would be disruptive to the flow of the linear park and go against one of the design goals of increasing high quality, connected off-street space. That said, several important traffic routes cross the Lowline site that must be maintained for a functional traffic network. Therefore, this thesis uses the analysis of the street hierarchy (see figures 3.22 and 3.23) to strategically propose changes to the Lowline cross-streets that preserves important vehicle space while enhancing social space where possible. A combination of temporary and permanent ROW alterations address the need for multifunctionality by combining strategies for increasing urban nature, expanding pedestrian and bicycle space, and integrating green stromwater infrastructure. A toolbox of these strategies can be found on the following pages. The strategies can be implemented where appropriate, following the guidelines and intent for each of the four street types: arterials, collectors, local streets, and alleys.

A Arterials: These are the most important streets to vehicular traffic, and must be maintained with that focus for the street network to functional for drivers. In Midtown, this means maintaining three lanes of one-way traffic and not introducing re-designs that impede on the street.

C Collectors: These streets are secondary to arterials, and feed arterials with two lanes of traffic in one or both directions. Collectors still have a vehicular focus, but can be altered in areas to enhance other uses. One effective way to do this is with temporary installations or programming base on time of day. Lowline crossings could use paving patterns or raised tables to demarcate shared space.

L Local: These streets are the least important in terms of traffic flow, and therefore offer the most opportunity for restructuring. This thesis proposes closing local streets where they cross the Lowline as much as possible, and reusing that space as short extensions to the park.

a Alleys: Like local streets, the alleys should be converted for pedestrian-only use, except for specific times of day for deliveries.

Planted Curb Bulb

Increases distance between pedestrians and moving traffic. Planted area allows for more vegetation and can be integrated with stormwater collection.

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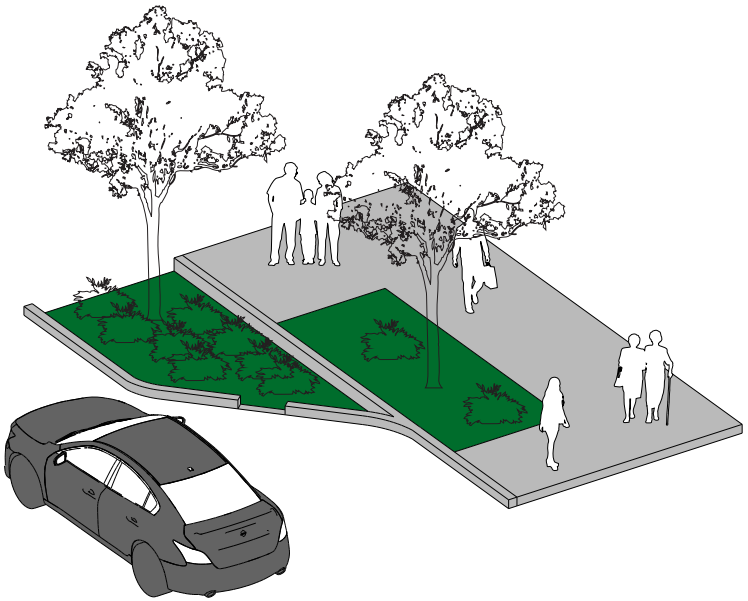

Figure 4.8
Planted curb bulb

Temporary Curb Bulb

Replaces parking spaces with configurable, non-permanent activities such as seating, bike parking, or public art. Increases pedestrian space.

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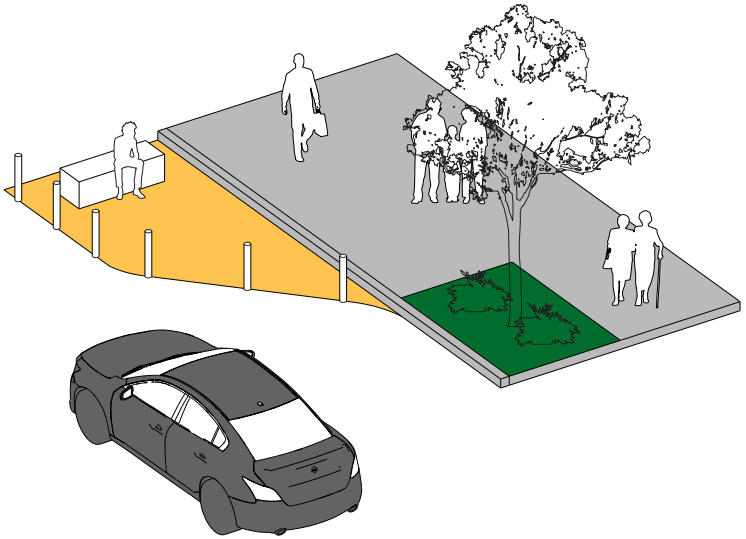

Figure 4.9
Temporary curb bulb

Temporary Sidewalk Extension

Removes parking spaces in favor of pedestrian space. Can be programmed based on time of day, such as car space during rush hour and ped space during weekends.

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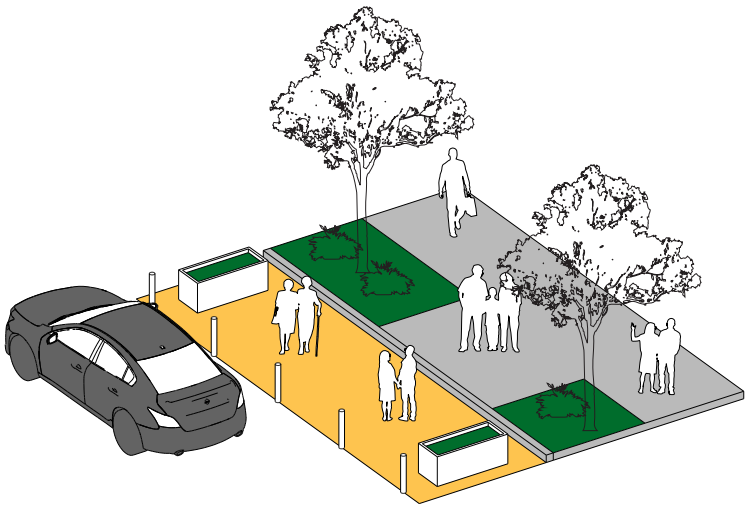

Figure 4.10
Temporary sidewalk extension

Sidewalk Extension

Creates more pedestrian space for sidewalk activities.

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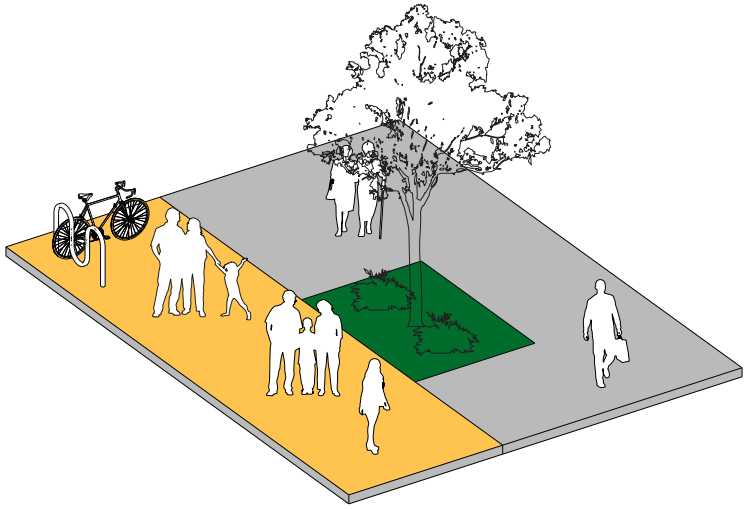

Figure 4.11
Sidewalk extension

Pocket Park

Removes parking spaces to create more permanent pedestrian-activated street space for cafe seating, planters, etc.

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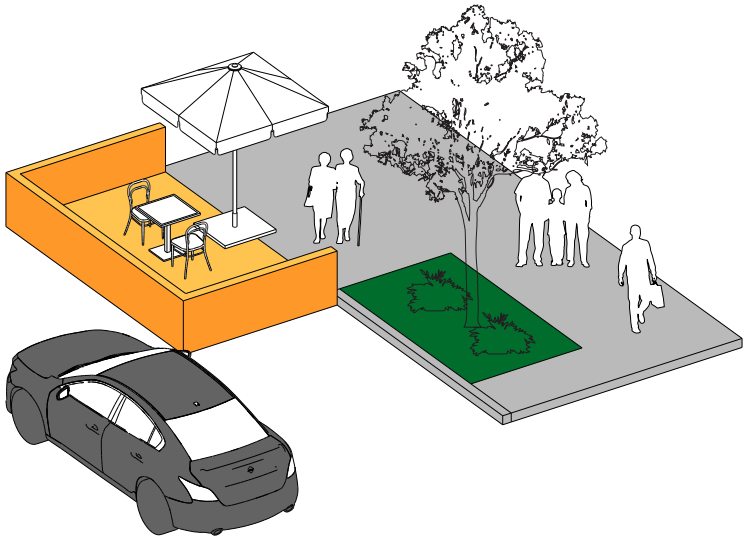

Figure 4.12
Pocket park

Raised Table

Prioritizes pedestrians when crossing streets and forces drivers to slow down.

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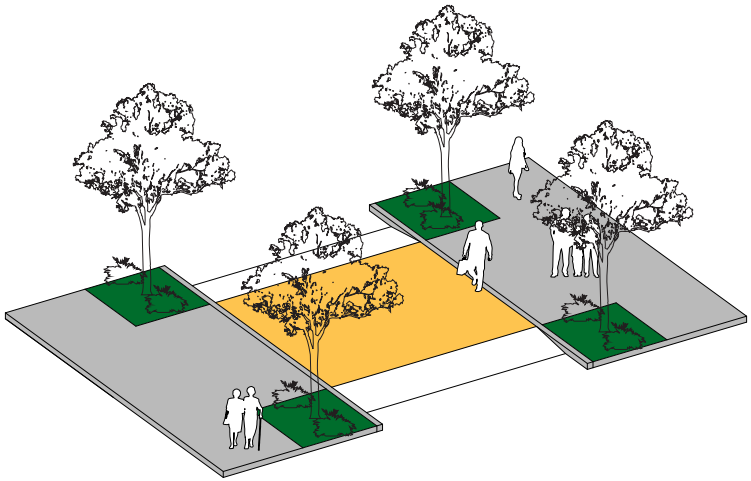

Figure 4.13
Raised table

Shared Street

Helps give agency to pedestrians and creates an awareness of other street users for drivers.

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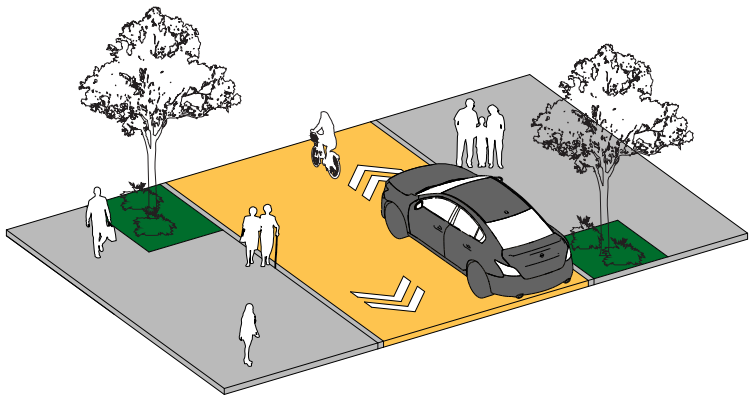

Figure 4.14
Shared street

Temporary / Permanent Road Closure

Turns underutilized street space into public open space.

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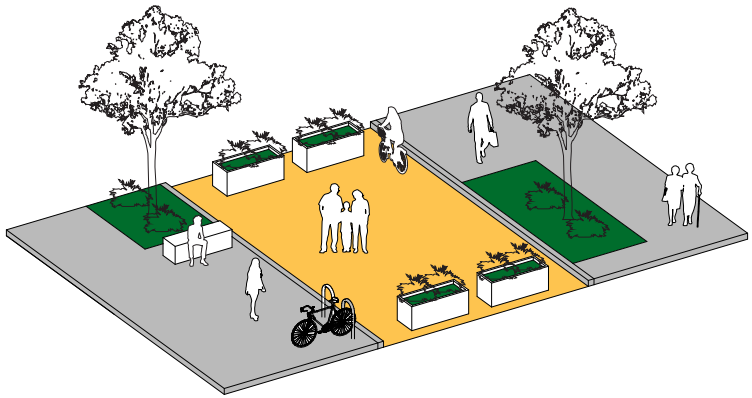

Figure 4.15
Temporary/Permanent road closure

Shared Bike Lane

Typically identified by painted street markings, bikes share the street space with cars.

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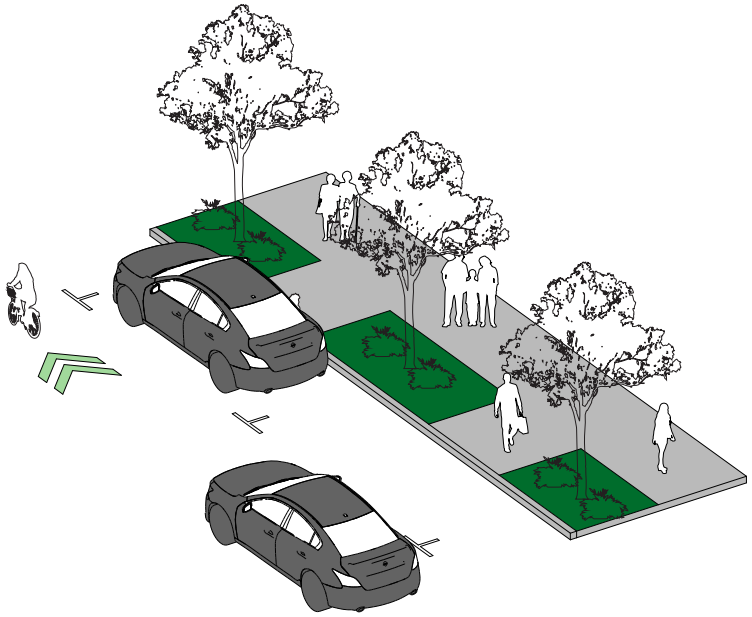

Figure 4.16
Shared bike lane

Painted Shoulder Lane

Bike lane is between moving traffic and parked cars. This gives designated space to cyclists but is still not as protected as totally separated cycle lanes.

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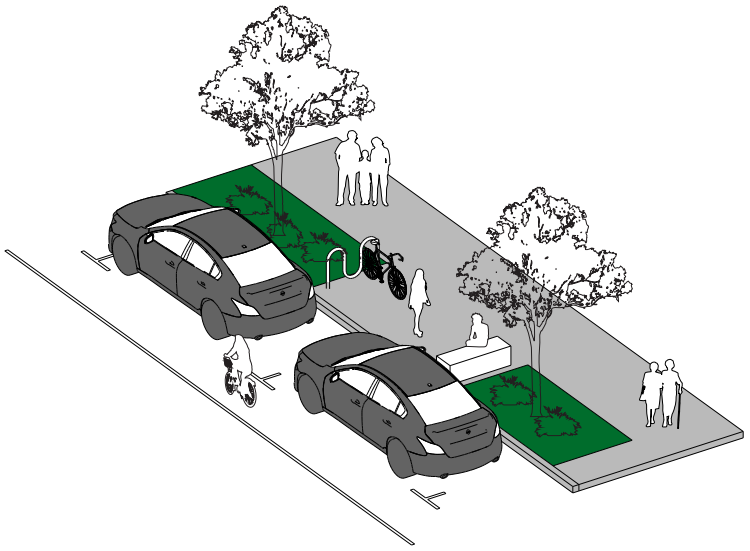

Figure 4.17
Painted shoulder lane

Protected Separated Lane

Creates a wider distance from moving traffic for safer cycling.

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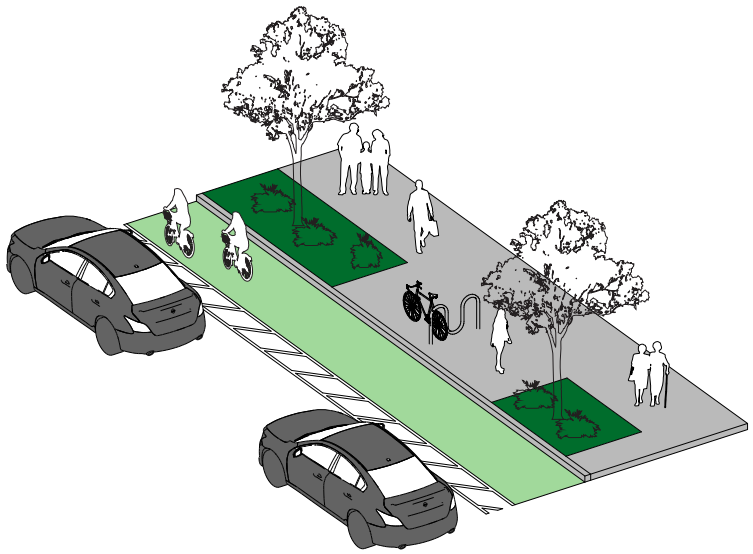

Figure 4.18
Protected separated lane.

Raised Cycle Track

Popular in Copenhagen, the raised cycle track offers better safety for pedestrians and cyclists by creating a vertical separation between the street, the cycle lane, and the sidewalk.

Present on street types: A C L a

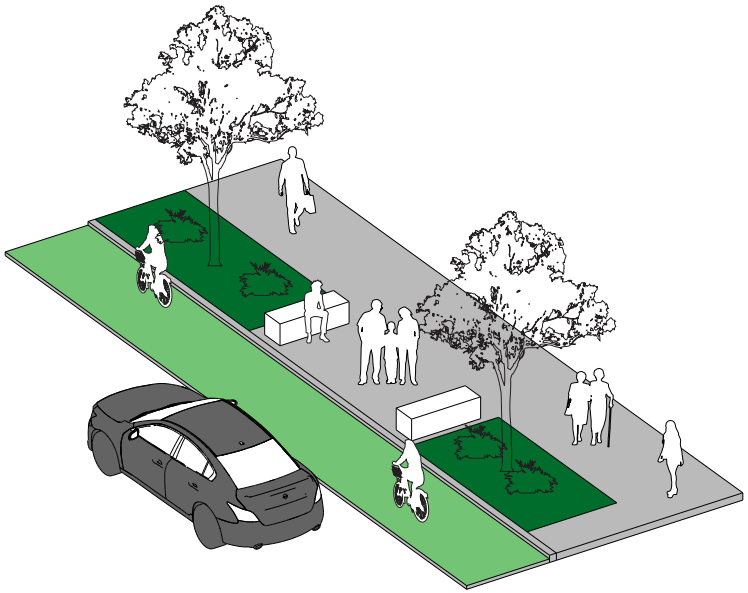

Figure 4.19
Raised cycle track

Temporarily Protected Cycle Track

Movable barriers designate space for cyclists. This is a good way to test a street redesign before committing to more permanent methods.

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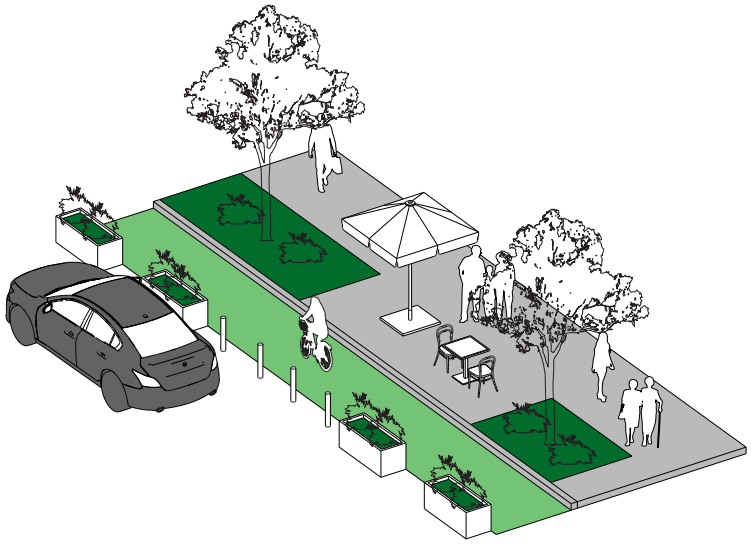

Figure 4.20
Temporarily protected cycle track

Permanently Protected Cycle Track

A planted median separates cyclists and pedestrians from moving traffic. The planted areas can also be incorporated into stormwater infrastructure.

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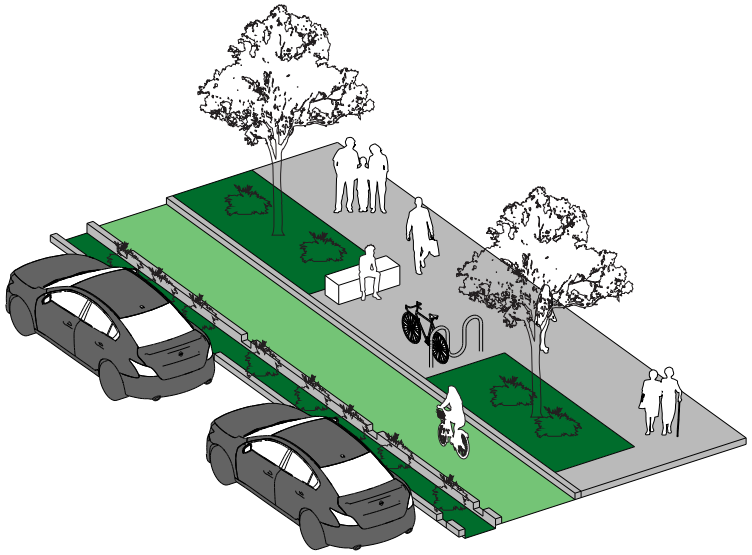

Figure 4.21
Permanently protected cycle track

Infiltration And Flow-Through Planters

Captures and filters surface water, can buffer bike and pedestrian space. Vegetation in the planter can filter out roadway contaminants carried by surface water.

Present on street types: A C L a

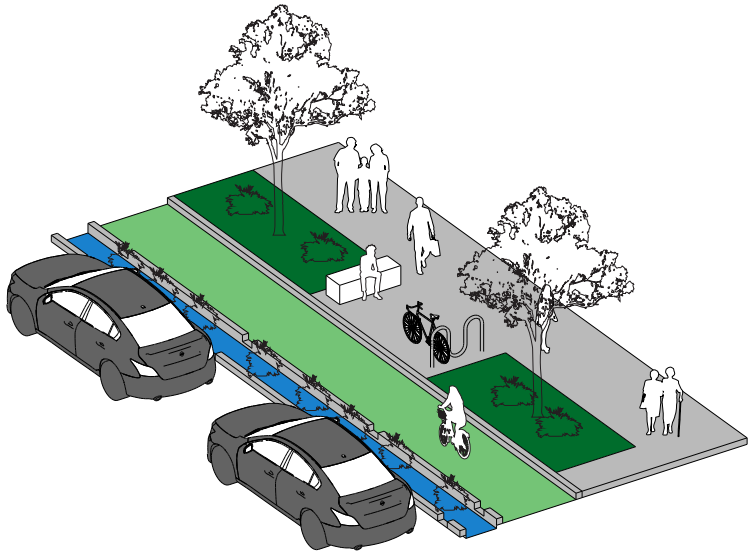

Figure 4.22
Infiltration and flow-through planters

Curb Bulb Rain Garden

Captures street water and buffers sidewalk. Can be incorporated into sidewalk planters to collect sidewalk water as well.

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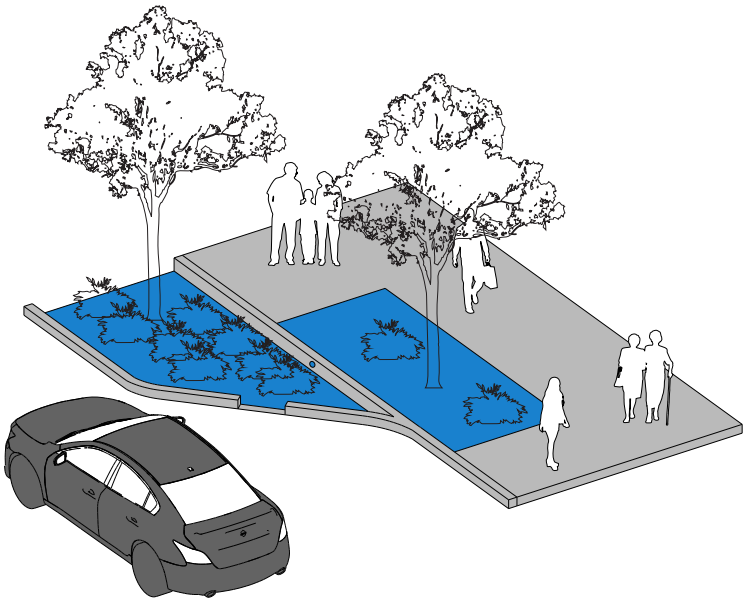

Figure 4.23
Curb bulb rain garden

Permeable Hardscape

Mitigates runoff , allows for infiltration, and restores groundwater. This is beneficial to reducing the amount of water that sheets off of traditional impermeable hardscapes and ends up in stormwater systems

Present on street types: A C L a

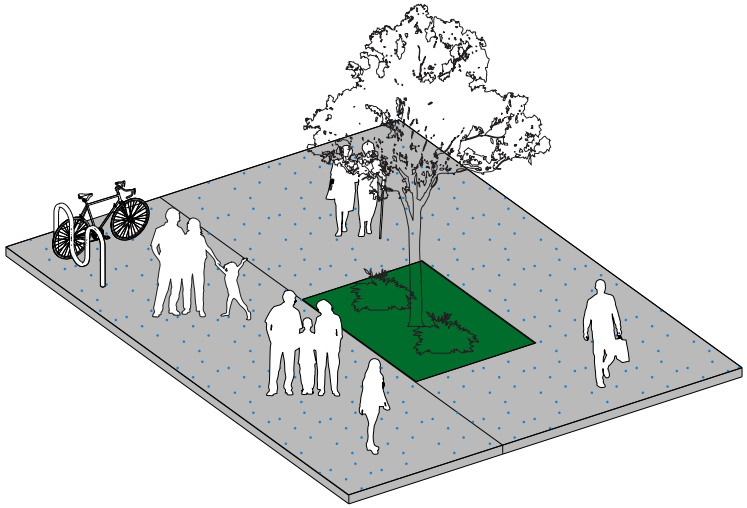

Figure 4.24
Permeable hardscape

Stormwater Storage

Water is stored for irrigation during times of drought, or to alleviate the effects of extreme rain events by reducing pressure on the sewer system. Storage areas can be below grade, or incorporated into landscape features at grade.

Present on street types: A C L a

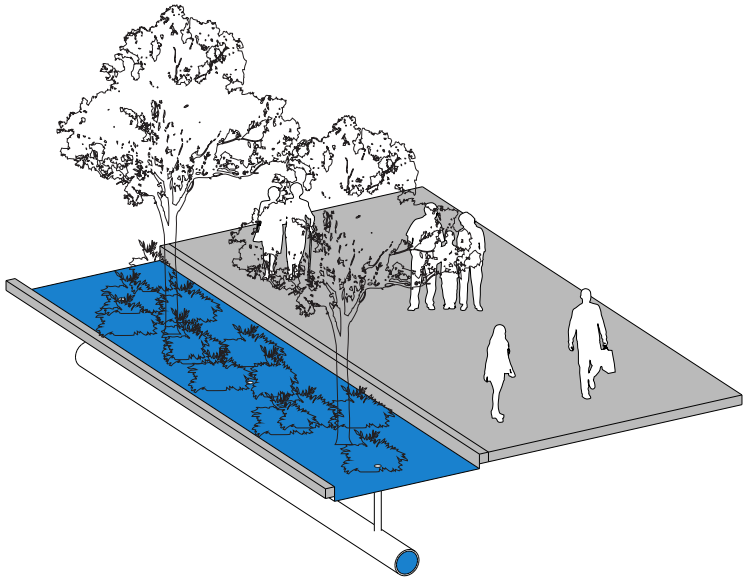

Figure 4.25
Stormwater storage

Figures

5. CONCLUSIONS

The Sacramento Lowline proposed in this thesis is a multiuse, multifunctional space that aims to provide social, ecological, economic, and hydrological performance to the rapidly growing Midtown neighborhood. The three sections of the park are inspired by three ecological regions found in the Sacramento River Watershed, and each section treats the narrow railroad ROW slightly differently in response to the surrounding neighborhood context. Overall, the park is a piece of connective tissue, a green spine that joins the city together within a vibrant pedestrian space. In addition, Midtown streets were analyzed for possible reallocation of right-of-way space, taking away vehicular space where possible and transferring it to pedestrians, cyclists, and green/blue infrastructure. Together, this network of streets and park work together to address the threats that climate change promises to bring to the Sacramento region, in particular the need to intercept surface water from entering and overloading the area's combined sewer system, all while establishing a prominent new green space for the city.

I envision this project as a catalyst for bigger change within Sacramento; the water collection ideas proposed here to alleviate the combined sewer shed in Midtown could, and should, be expanded to all corners of the city, and geared towards water collection for drought as well as flood prevention. My next steps would be to calculate figures for water capture and use, and design specific systems for a closed-loop water cycle.

Another area of interest in this thesis that I would like to explore further is the power of citizen engagement. I see this as a means to scale the ideas in this project both up to the city/regional level (policy) and down to the individual level (behavior). I think there is great potential in participatory landscapes, or activities that occur therein, and it would be interesting to develop a list of strategies for involving citizens in the design, maintenance, and use of the park. Finally, the principles of green infrastructure and ecological urbanism are fascinating to me, and the potential to design functional and beautiful projects, based off the teachings of natural systems, is endless. If I had to choose one word to describe my design ethic in relation to this project, it would be multifunctionality, as it is the layering of systems that makes for truly resilient landscapes.

The goal of this thesis was to apply design as a tool

to address the issues facing Sacramento, but also with an eye towards making the design philosophy applicable to other locations. This is not to say that the proposals put forth for the Lowline should be copied verbatim to other locations, but rather that the method of looking to local or regional contexts should be used to inform and inspire an appropriate response in each unique environment. The multifuntional layering of social, ecological, and hydrological systems forms the core of the approach, and sensitivity to local context makes these systems come together in a way that is unique and meaningful.

In this project I focused mostly on the neighborhood scale, however it would be interesting to examine these ideas at a larger city-scale or even within a regional context in order to understand how the design might influence farther-reaching policy, and how that policy might then influence new projects. In the end, it may be that the policy goals - to integrate green stormwater infrastructure, to improve social spaces, to integrate urban nature, etc. - would be the most transferable ideas to other places. If every city were to approach projects through a framework similar to this one, perhaps our urban spaces could be transformed into vibrant, sustainable, and integrated cities.

I firmly believe that cities will play a crucial role in humanity's future. As an environmentalist and one who absolutely loves the great outdoors, this may seem like a contradiction. After all, it is to the wilderness I go when I need to escape the pressures of every day responsibilities, to recharge and level my head. That said, my studies in graduate school, undergrad, and experiences traveling at home and abroad have underscored the notion that there really is no place on this planet that we as a species have not influenced. I cherish those places that have been preserved in a state that might most closely resemble something wild, and in order to keep those places as they are for generations to come, we must look back towards the urban environment. The era of human domination over nature is - cognitively, at least - coming to a close, and I say good riddance and welcome a future that turns towards ecology as a guide.

It has never been a more exciting time to be a designer. The number of tools available, the extent of shared knowledge and access to truly groundbreaking research means that potential solutions to truly important

problems could lay just around the bend. Urban areas, that mass - or mess, depending on who you ask - of human ecology represent an enormous opportunity to educate, engage, change behavior for the betterment of all life, human and non-human alike, on this planet. This project operates under the assumption that climate change will bring previously unheard of levels of catastrophe. At the risk of sounding pessimistic, I do believe that we will have to learn to look beyond our individual frames and seek solutions bigger than ourselves and our limited time. Sadly that is not a lesson that will come easy, but there are no quick-fixes for puzzles as complex as human development. That said, theoretical projects like the Sacramento Lowline, and the real-world examples that it was inspired by, are the first steps of many. Every step in the right direction counts.

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