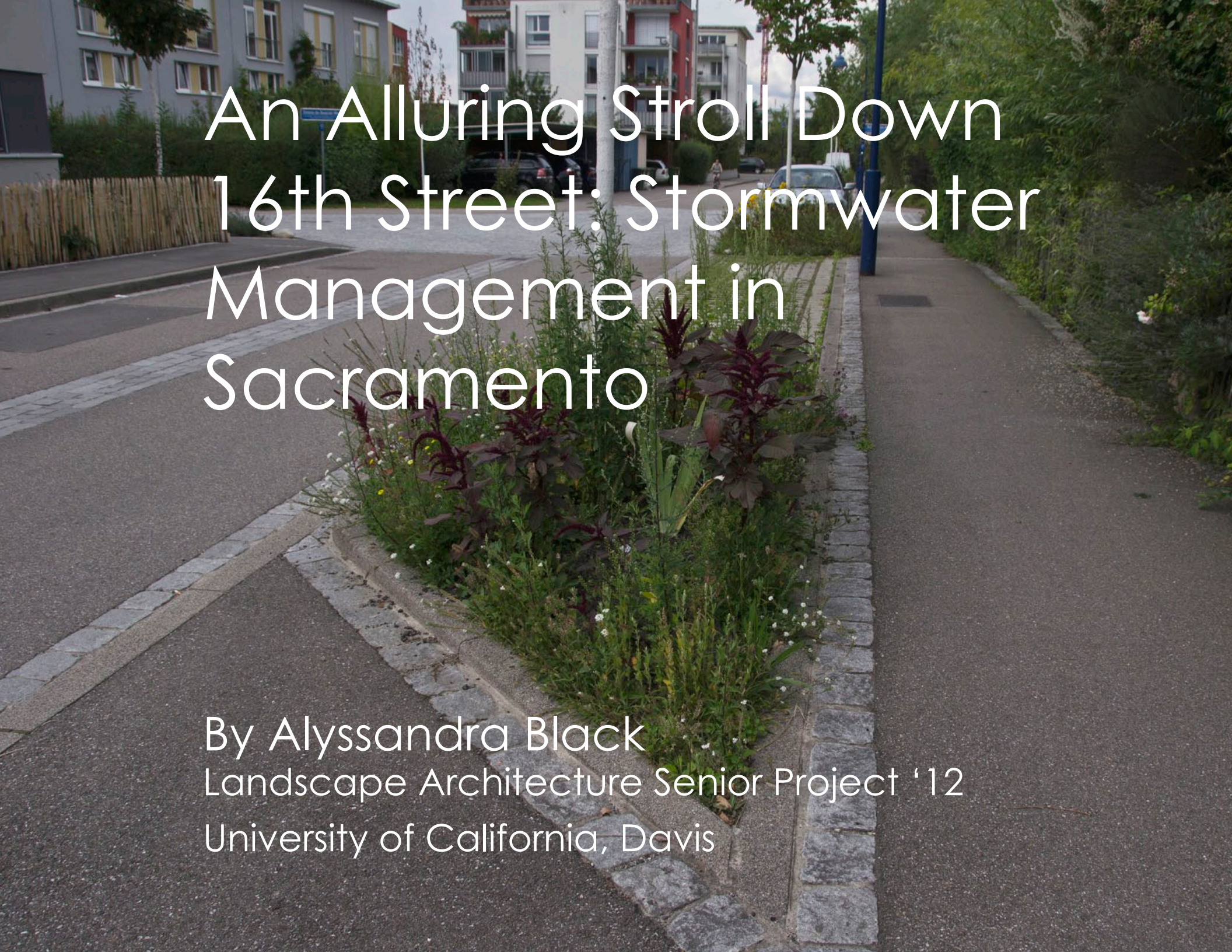

An Alluring Stroll Down 16th Street: Stormwater Management in Sacramento

By Alyssandra Black
Landscape Architecture Senior Project '12
University of California, Davis

An Alluring Stroll Down 16th Street: Stormwater Management in Sacramento

2012 Senior Project, Alyssandra Black

Presented to the faculty of the Landscape Architecture Program at the University of California, Davis in fulfillment of the requirements for the Bachelor's of Science in Landscape Architecture on June 15, 2012.

Accepted and Approved by:

Heath Schenker, Senior Project Faculty Advisor

Todd Leon, Committee Member

Byron McCulley, Committee Member

Kevin Perry, Committee Member

Abstract:

Most streetscape designs lack an integral component – namely, stormwater management. Sacramento has a history of working towards designing "complete streets." Its latest attempt involves utilizing creative stormwater management techniques to develop Green Streets – thoroughways which satisfy the transportation demands of the community in an aesthetically pleasing and environmentally conscientious way.

This project is the design of a Green Street on 16th Street in Sacramento. The concept plan, drawings, and designs in this paper will document my project - the stormwater facilities that I designed, the art pieces that I placed along the streetscape, and the signage intended to educate its pedestrians.

A successful streetscape transforms its user community. Integrating the needs of pedestrians with environmental considerations such as stormwater management and effective tree canopy is critical. But making the space livable and enjoyable in other ways is crucial as well; benches, tables, art pieces, and scenic views all contribute to the experience.

Acknowledgments:

I would like to thank a few people who have been influential to my completing this project.

First and foremost my committee members, Byron McCulley, Kevin Perry, Todd Leon for your help and support along the way. Especially Byron for meeting with me every week, pushing me to do my best and for helping me grow as a landscape architect. You have inspired me every day and I thank you for that.

My faculty advisor Claire Napawan for continually inspiring me and facilitating in my journey to find the perfect project for me.

My mother for her constant support, love and encouragement. Oh and for all the text messages saying, "You can do it!", "Sending love and hugs." They always brightened my day and kept me going.

My father for his unwavering support in me as well as the constant critiques and edits. I never would have gotten through all of this writing without you!

My friends, for the calls at night explaining in detail the curb cut dimensions, for staying up all night with me keeping me awake and last but not least helping me edit my writing. Gordon you da best! You will never know the impact you have had on me and how thankful I am.

Dedication:

To my pop pop who I love and miss. I will never forget all the moments I shared with you. Thank you for everything you taught me and I sure could have used your horticulture knowledge on my plant palette!

Preface:

In the summer of 2011, I studied and travelled throughout Europe. It was an amazing experience, and it sparked my interest in stormwater management. Walking around, I couldn't hel p but notice where the water was going – running off the buildings, across the sidewalk and into the street. Many cities and countries that I traveled to had developed creative ways to direct water into runnels or innovative stormwater catchment basins. This fascinated me, but it was not until I returned from Europe and took a studio on stormwater management that it became my passion. Since then, I have researched different stormwater management strategies and am now designing a Green Street. Interestingly enough, I found many of those strategies in case studies from the very cities which sparked my interest last summer. My incredible experience in this field over the past year has inspired me to continue my research and potentially pursue this topic in graduate school.

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List of Illustrations:

Images, photographs and sketches were created by the author unless otherwise noted.

Project Description:

Capital Area Development Authority (CADA) is the client for the 16th Street Streetscape Plan, "CADA is planning the development of medium to high density housing and commercial mixed-use at seven sites along 16th Street between Capitol Avenue and Q street" (Gothan, 2012). They contracted MIG, Inc. to complete the concept plan for the streetscape design in 2009 and the plan was completed in 2010. Since then CADA has applied for grants for the 1st phase— the green portion of the concept plan.

I was brought onto the project in January to complete the design development of the streetscape. Detailed in this document is the design development portion of the project as well as my research and site analysis. The document outlines a concept for the site, designs, plant palettes for the stormwater facilities, and a master plan of 16th Street from S Street to Capitol Ave.

Figure 1 Context Map

Objectives:

To create a streetscape that:

- Promotes pedestrian safety
- Improves pedestrian walk-ability
- Promotes environmental sustainability through improved stormwater management
- Creates a sense of continuity throughout the site
- Subtly educates visitors and users about water and stormwater management
- Incorporates art into the overall sense of place

Definitions:

A problem in this industry is the varying definitions for stormwater facilities. There are contrasting definitions and they muddle the concept and can lead to poor designs. To clarify what each type of stormwater facility is in this design, use the definitions below. Unless otherwise stated a planter will follow the definition as specified by Kevin Perry. Once defined in the design it will be called either an infiltration or flow through planter and it will follow the definition as specified by the City of Sacramento.

Swale: "Vegetated swales are shallow landscaped areas designed to capture, convey and potentially infiltrate stormwater runoff as it moves downstream" (Perry, 2011).

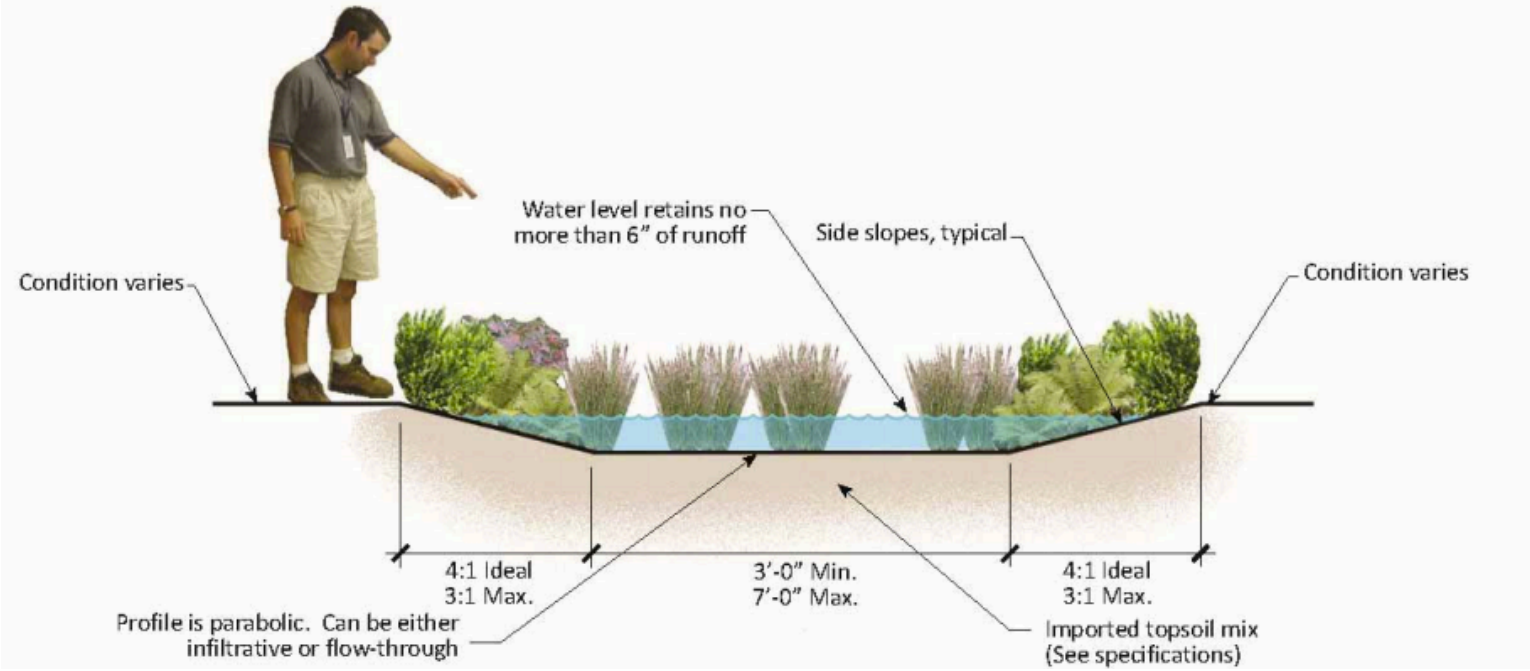


Figure 2

Infiltration and Flow-Through Planters: "Infiltration and flow-through planters are contained landscape areas designed to capture and retain stormwater runoff" (Perry, 2011).

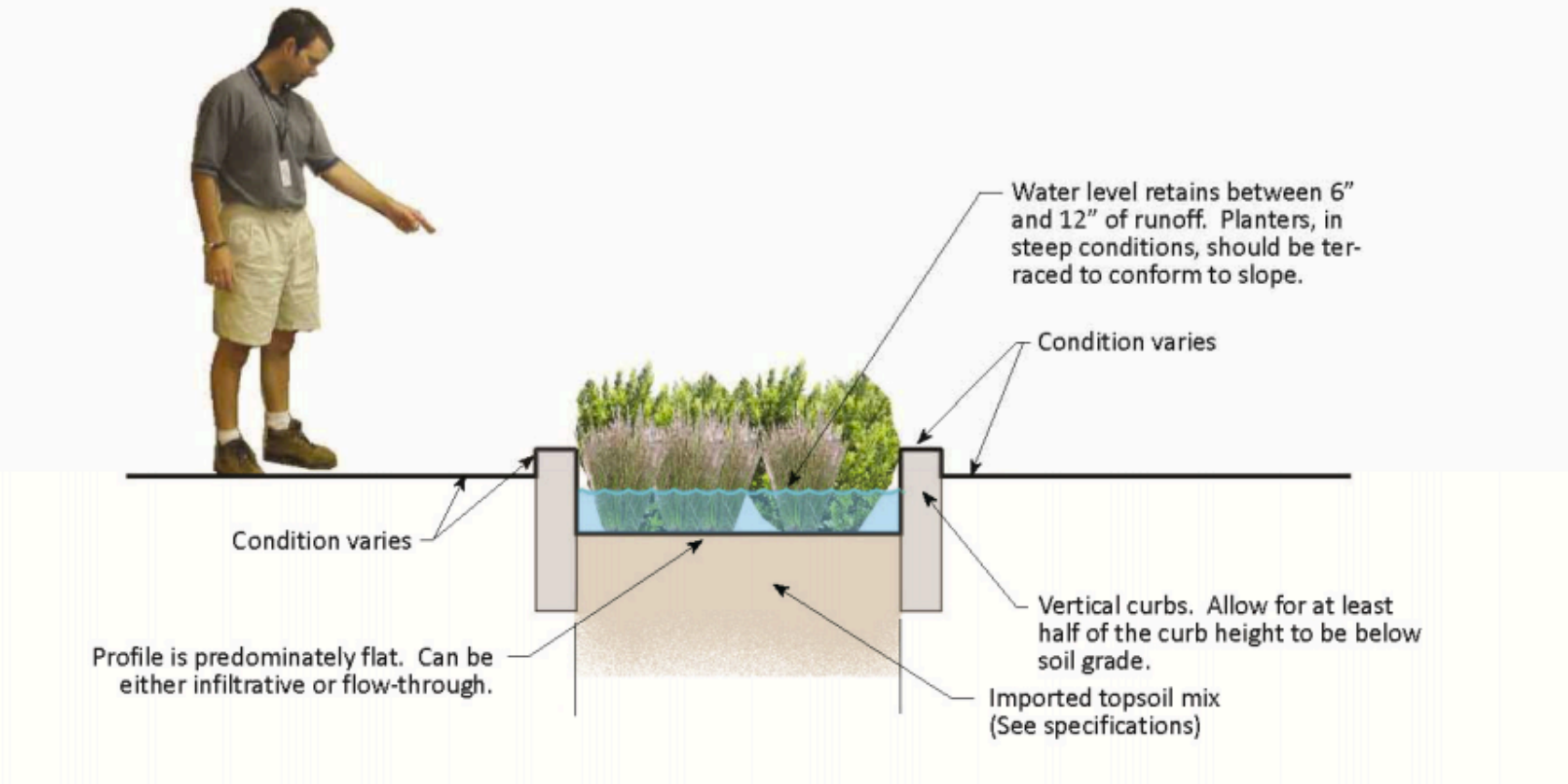


Figure 3

Rain Garden: "Rain gardens are shallow landscape areas that can collect, slow, filter and absorb large volumes of water, delaying discharge into the watershed system" (Perry, 2011).

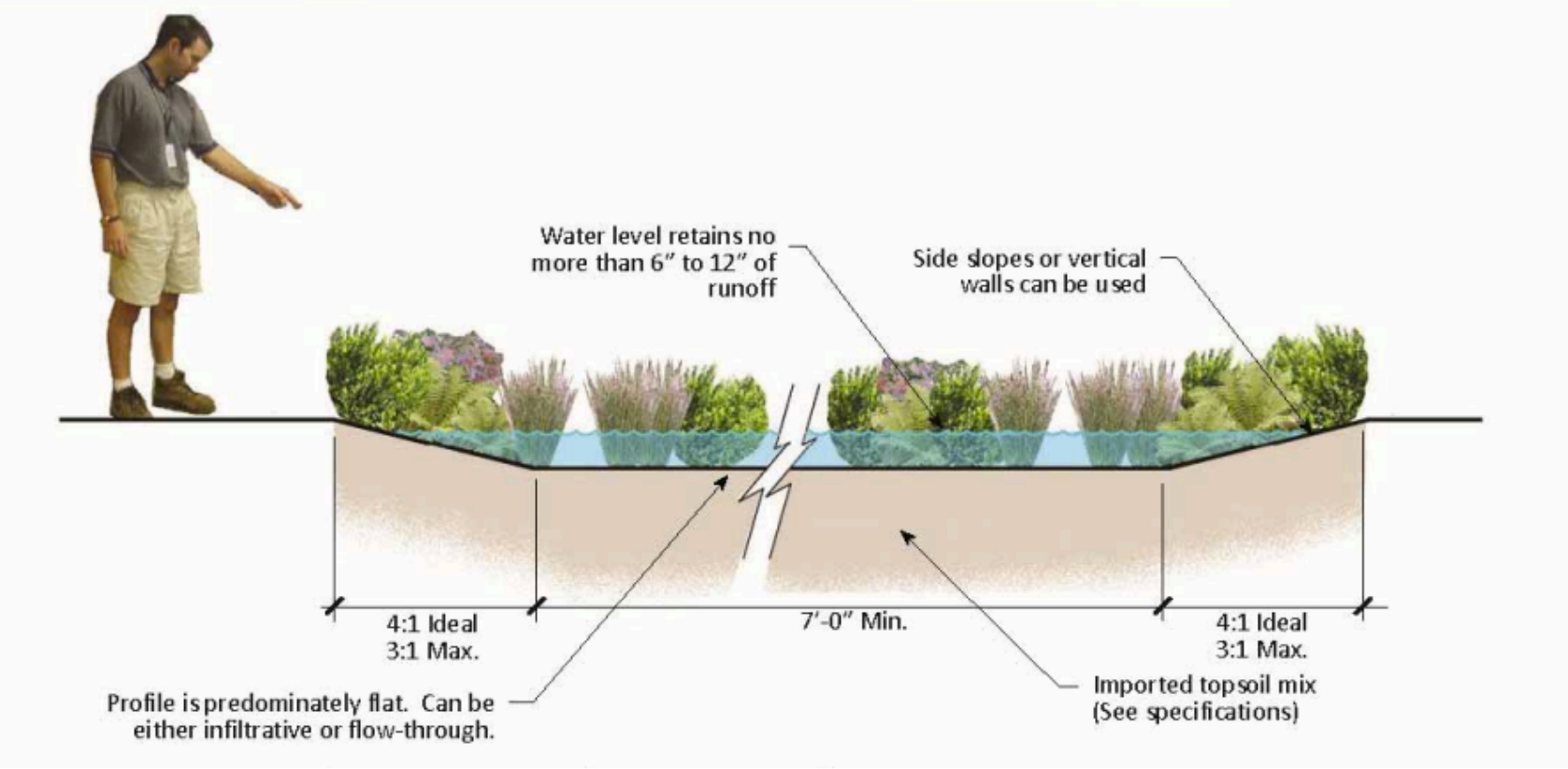


Figure 4

Stormwater Curb Extension: "Stormwater curb extensions are landscape areas within the parking zone of a street that capture stormwater and allow it to interact with plants and soil." (Perry, 2011) (insert section)

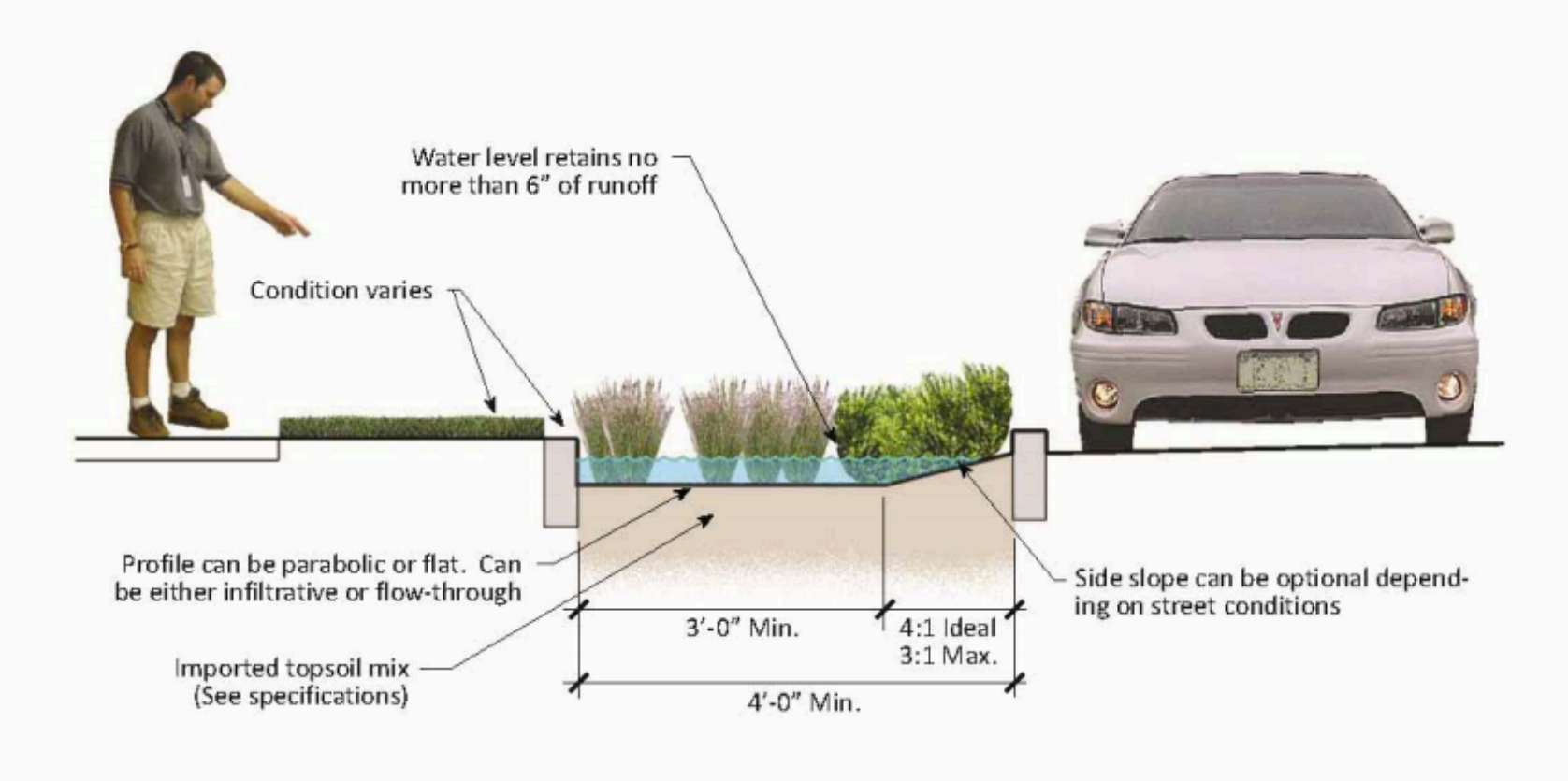


Figure 5

The City of Sacramento's definitions of stormwater planters and swales are:

Planter: "A stormwater planter is a low-lying vegetated planter that receives runoff from roof drains or adjoining paved areas. A shallow surcharge zone above the vegetated surface temporarily stores

stormwater (the water quality volume, WQV). The accumulated runoff gradually infiltrates into an underlying sand/peat bed and then into a gravel layer" (Sacramento, Grove, Galt, 2007).

Flow-Through Planter: "It has an impermeable bottom liner and an under drain pipe to collect the treated water and discharge it to the municipal storm drain"(Sacramento, Grove, Galt, 2007).

Infiltration Planter: "Planters without an impermeable bottom liner (infiltration planters) will also require an under drain when the underlying soils are less permeable than the planter's sand/peat layer" (Sacramento, Grove, Galt).

Vegetated Swale: "A vegetated swale is a wide, shallow, open channel planted with dense, sod-forming vegetation and designed to accept runoff from adjacent surfaces. As the runoff slows and travels through the vegetation and over the soil surface, pollutants are removed by a variety of physical and chemical mechanisms, including sedimentation, filtration, adsorption, precipitation, and microbial degradation and conversion" (Sacramento, Grove, Galt).

Research:

Complete Streets is a growing concept across the nation. Different entities, government programs, and designers have different definitions of complete streets but all of them are used to, "serve everyone- pedestrians, bicyclists, transit, riders and drivers- and they take into account the needs of people with disabilities, older people and children" (McCann, Rynne, & Association, 2010).

Historically the street has been centered around the automobile. Now designers are starting to think about all modes of transit from bicyclists and pedestrians to bus and light rail as well as the non-transportation aspects of the streetscape. Many countries around the world have been designing streets for centuries to incorporate natural aspects such as stormwater, habitats and vegetation. Now as a society we are moving towards designing all of our streets for multi-use. "Economically, complete streets can help revitalize communities, and they can give families the option to lower transportation costs by using transit, walking or bicycling rather than driving to reach their destinations" (Transportation, 2012). This concept thinks about the issue of the entire matrix of the city, the walk-ability, bike-ability, the proximity of amenities, and land uses. It tries to incorporate everything to create a complete street that then can be incorporated into a network of complete streets.

In Sacramento complete streets have become a principle in the city codes. It started with the Barden, et al v. City of Sacramento et al court case, which required ADA compliant sidewalks and curb ramps

along all public streets, " in 1999, Joan Barden and seven other Sacramento residents with mobility and vision impairments brought a suit against the city and its director of public works for failing to add sidewalks and ramps when the city performed street overlays" (McCann & Rynne, Complete Streets: Best Policy and Implementation Practices , 2010).

The US courts ruled in favor of Barden and this set the precedents of installing sidewalks and curb ramps. After this lawsuit Mayor Heather Fargo became a major champion for improving the safety and access of the city's streets. City engineer Jesse Gothan drafted the new street section of the street standard for the city, the new section required "sidewalks to be separated by landscaped strips for all street types and dedicated bike lanes for collector and arterial roads" (McCann & Rynne, Complete Streets: Best Policy and Implementation Practices , 2010). This is a good start to incorporating complete streets into the framework of the city but it lacks a very important element of the complete street, stormwater management. This is a good start but it lacks the important element of stormwater management. Requiring a landscape strip to separate the sidewalk and travel lanes should designate that landscape strip as a stormwater facility. Having a landscape strip without a designation of what type of vegetation or function can lead to an over amount of lawn and the amount of irrigation needed for this lawn can be a problem especially in a city like Sacramento. This strip of vegetation can be hard to irrigate and leads to a significant amount of water runoff.

An example of a pedestrian improvement to a sidewalk that could have also incorporated stormwater management is Sixth Avenue in Seattle, Washington. The below are before and after images of

Figure 6-7
Before and After images of Sixth Avenue in Seattle.

the Sixth Avenue project, they had to regrade the street to complete this project. Adding curb cuts and a stormwater facility instead of the curb and lawn area would not be significantly more expensive. It also would have lowered the amount of water that runs off the street into the storm drain which is something Seattle has to consider concerning its heavy levels of rainfall. Instead of just looking at the pedestrian portion of the street it would be beneficial and more cost affective to incorporate stormwater management.

Portland has several examples of complete streets that incorporate stormwater facilities like the SW 12th Avenue Green Street. The images on the following page illustrate the project. The SW 12th Avenue and Montgomery St is a great example of how the project encompasses the whole street. The project manages street runoff while maintaining pedestrian circulation with a pedestrian egress zone and pedestrian crossings. The important aspect of this project is the disconnection of stormwater runoff from a storm sewer that drains directly into the Willamette River and manages it on site in the stormwater planters. This project is an example of an infiltration planter stormwater facility.

Green Street: "streets designed with landscape areas that capture, filter and allow for infiltration of stormwater runoff"(City of Portland, 2007). The incorporation of this definition into the complete streets concept leads to the term of green infrastructure. There are two different types of infrastructure in cities, gray and green. Gray infrastructure is the current system, it is a combined sewer and stormwater system that takes water and channels it directly into the drains and then to a body of water. Green infrastructure uses natural ways to handle stormwater to alleviate the system overall.

Many communities are facing old and deteriorating infrastructure including their water, rainwater, and sewage infrastructure and need to renovate. Currently it costs about $3-4 billion dollars to renovate the gray infrastructure while around $1-2 billion to put in green infrastructure. A study is being done in Philadelphia because they are putting in new infrastructure and teaming up with the EPA to come up with the plan of action. Cost benefits of green infrastructure outweigh the cost of retrofitting the old because around $1 trillion will be spent specifically on water infrastructure from now until 2035. (ASLA Presentation)

Figure 8-10
SW 12th Avenue and Montgomery St. in Portland, Oregon. Stormwater planters with pedestrian egress zone.

Green Infrastructure is a key component in the battle against urbanization and it aids in the creation of livable communities. Throughout the last decade we have lost a significant amount of natural landscapes to urbanization. (Insert an aerial photo in the past and present to show the changes.) The incorporation of the concept of green infrastructure into the definition of complete streets will enhance the overall design and create the model of an actual complete street.

Nearly all biological diversity dies when impervious surfaces make up 25% or more of the site. A one acre single home is made up of about 12% impervious surfaces while a shopping center or road is made up of 90% impervious surfaces. Adding green infrastructure can lower the amount of impervious surfaces with different paving materials like permeable pavers, stormwater planters, and vegetation. If the amount of impervious surfaces is lowered we can improve the level of biological diversity in our water, and filter it before it flows into the main body of water. Currently legislation is being discussed that will benefit the green infrastructure movement financially.

Congress is discussing passing HR 2030 S.1115 Green Infrastructure for Clean Water Act, which is headed by Representative Donna Edwards (D-MD) and Senator Tom Udall (D-NM). Another piece of legislation that is benefitting green infrastructure is the Transportation Reauthorization Bill. Current Green Streets and stormwater management projects are using funding from this federal bill. This bill is under its 9th extension in congress and going to be revised in the next few months. It is important for people to understand that all of these problems are connected and if we actively think about how to incorporate

these concepts into the same legislation and funding we can create holistic designs that will affect the city on a larger scale.

Benefits of these legislations are:

- "Provides grants to communities to help create green infrastructure projects.
- Creates Centers of Excellence around the country to provide technical assistance to local governments and research on green infrastructure best practices.
- Establishes a green infrastructure program within the Environmental Protection Agency's Office of Water to help promote and integrate green infrastructure into projects around the country." (asla.org)

Sacramento has been moving towards improving their streetscapes in their policy as well as their projects. Last year the 1st Green Street was built on Dixieanne Avenue in Sacramento. The images on the following page is of the Green Street on Dixieanne Avenue. There are many aspects of the street that could be improved to make it a successful Green Street. The fatal flaw of this Green Street is the fact that the curb cuts were not constructed as designed and they are too small. This leads to them being clogged and not able to function as a path for water to get into the stormwater facility. This also adds a significant amount of maintenance cost to continually cleaning these curb cuts. Overall the street is a good design and it ended up providing designers in the Sacramento region with positive and negative aspects of a Green Street design.

The Dixieanne Green Street was the 1st Green Street in Sacramento and since it does not function as a Green Street the next Green Street designed in Sacramento has high expectations attached with it. 16th Street is trying to become the next Green Street, which is why there is a lot of scrutiny in the design. The proximity to the capitol is a positive factor to the project. The project is the design of 16th street in Sacramento. The landscape architecture firm MIG, Inc completed the concept plan in 2011. In January of 2012 I took on the design development. The last phase of the project is to do the construction documents, which will be completed in the summer of 2012.

Figure 11
Dixieanne Avenue, Sacramento, CA
This image shows the curb cuts without a drop in grade for the vegetation.

Figure 12
Dixieanne Avenue stormwater facility with curb cut/ trench drain. The image illustrates the size of the curb cut and shows how it is too small to allow a large flow of water. The construction of the curb cut is not how it was originally deisgned and causes maintenance problems because it is costantly clogged.

Site Analysis:

After meeting with CADA in January I completed a review of the literature and analyzed the concept plan completed by MIG, Inc. I expanded the plans to include a detailed plan with four different types of stormwater facilities.

The first step in the design process is to perform site analysis. Most of the successful projects I analyzed used site specific elements. This occurs in stages, the first part of which is a simple walkthrough. Second is to look at the spaces; guage barriers, distances between amenities, and anything else relevant to the "feel of the site". After completing this, take photos and sketch preliminary design ideas. Identifying the distance allotted for each user and comparing that to the distance needed can help narrow down the design details in the later design process. Analyzing the feel of the space can help determine if a pedestrian or a cyclist will feel comfortable or scared. For instance, the block from O St. to P St. has an awkward spot on the sidewalk that makes pedestrians feel cramped and potentially frightened. The sidewalk meanders through trees and around a walled-off patio before dropping an entire foot on pavement to the curb and parking. Transferring the

Figure 13 O St. & P St. Patio with meandering sidewalk.

seating to be in between the trees will create a direct path for pedestrians without needing to remove the trees.

Overall there is a lot of space to accommodate pedestrians and stormwater facilities. The sidewalk is approximately seven feet, and there is another seven feet of concrete which can easily be retrofitted into a stormwater planter, swale or rain garden. The images on the following page highlight spaces identified for stormwater facilities while performing site analysis. The images below those are preliminary sketches of the different types of stormwater facilities.

After analyzing the facilities, space, demographics, and user activity, it is important to envision the sense of place. If the site lacks this to begin with, which is true of many sites along 16th street, it is important to write down everything that is going on in the site. I walked the site multiple times, took photos, wrote notes and sketched to try and identify what the place should be in the context of its surroundings. Afterwards I then searched for images to convey my preliminary ideas of site amenities. There is a business called Hot Italian along 16th Street whos customers are generally bicyclists which lead to the idea of creating seating to incorporate bicycles, see figure to the right. Throughout the site I thought of ideas of

Figure 14 Creative site amenities, proposed location outside of Hot Italian.

Figure 15-17
The images on the left are photos with identified spaces to retrofit into stormwater facilities.

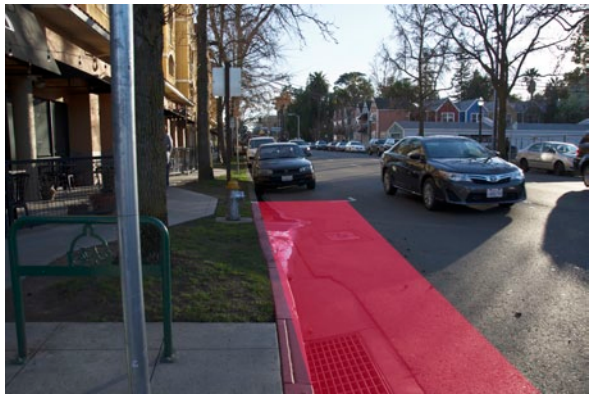


Figure 18-20
The images on the right are sketches of preliminary designs of stormwater facilities.

incorporating art into the site amenities to help facilitate in the creating of a "sense of place". These are integrated into the final design along with locations of art pieces.

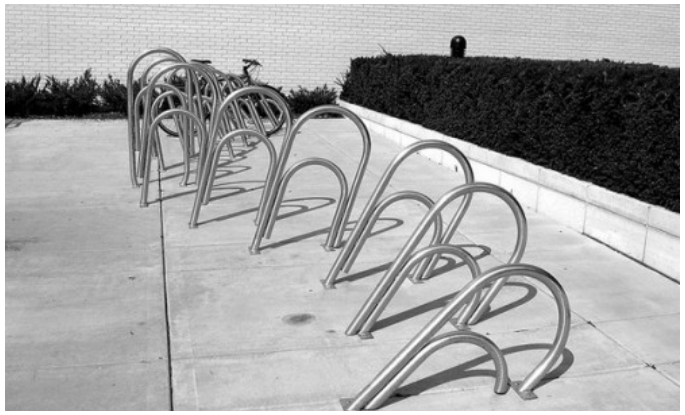


Figure 21 Creative site amenities, potential bicycle parking.

To continue the discussion of art for the site I talked with Shelley Willis from the Sacramento Metropolitan Public Arts Commission. We settled on a theme of "Natural vs. Built" and discussed using art to communicate to users the balance between natural aspects – stormwater, runoff and vegetation – and their interaction to the built – the road, hardscape, sidewalk, and buildings. Ms. Willis is currently working with CADA to select the artists for the central arch across from Fremont Park, as well those for the art pieces throughout the site.

Figure 22 Arch between P St. and Q St. Community survey showed the residents want an iconic symbol to showcase there community around 16th Street.

To successfully design stormwater facilities, the flow of water and the locations of the drains need to be identified. The drains currently on 16th street are constantly clogged, see images on the following page, and do not function as drains. One concern of the design is the cost of maintenance for the green street

and that there is a low budget dedicated to the maintenance of the street. The success of the stormwater facilities is the functionality of the curb cuts and flow of water.

Figure 23 - 25 These images are the current conditions of 16th Street. It is hard to identify where the drains are located because they are covered with sediment. The stormwater facilties with help with the amount of sediment but there still will need to be some maintenance to clear curb cuts.

The design of curb cuts needs to be based on the current drainage/ grading of the site. Each facility has a different type of curb cut and in the design of this project is a new type of curb cut that will hopefully guide the water directly into the facility. The reason for this new design is during heavy rainfall the water passes by the curb cut and never enters the facility, the water needs a more distinct path to follow. The images on the following page show different curb cuts along with a sketch of the new curb cut design. The dimensions of the curb cuts should be a minimum of 18" wide. This is for water flow as well as for maintenance.

Figure 27 Curb cut in a curb extension. To make it most effective there needs to be a drop in grade to keep the water in the facility. 6" is the typical amount of grade change needed

Figure 26 This is a traditional curb cut. It is wide enough to facilitate a significant amount of water and can easily be cleaned if debris collects.

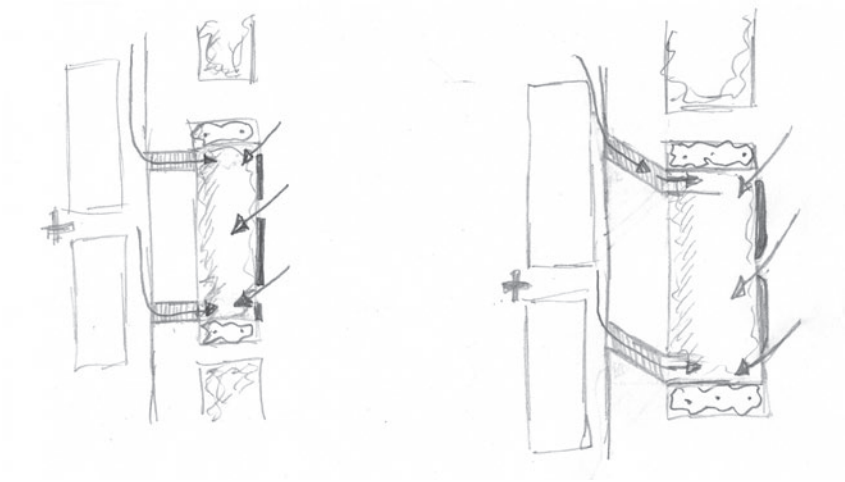


Figure 28 Sketch illustrating the new design of the curb cuts. The image on the left is the traditional design of curb cuts which are at right angles. The image on the right is my proposed design of curb cuts with angles to help guide the water to the stormwater facility.

Design Phase:

There are two different design options for the facilities; one is illustrated in the water diagrams and the other in the plan and section images. These images are on the following pages. The purpose of having a curb is so people with disabilities or sensory impairments will know where the edge of the sidewalk is. Although some projects use a six inch buffer instead of a curb to create a sheet-flow water condition to help guide the water into the facility, we were unable to use this strategy as it violates municipal policy.

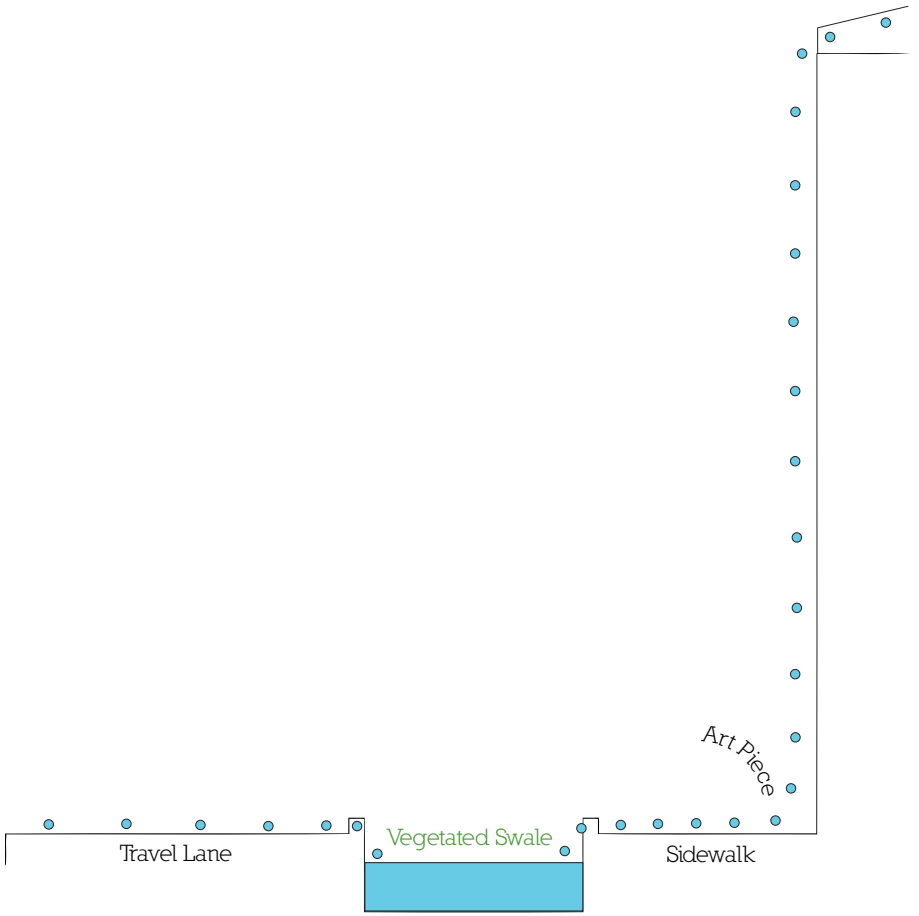


Figure 29 This water diagram illustrates the flow of water into a vegetated swale without side slopes. The art piece is a creative way to guide the water from the downspout of the building into the stormwater facility. There are curb cuts from the road and the sidewalk to allow water to flow into the facility.

Figure 30 This water diagram illustrates the flow of water into a vegetated swale with side slopes. The design of the curb cuts can be a 6" traditional curb which is illustrated here or vegetation can be used to create the "curb".

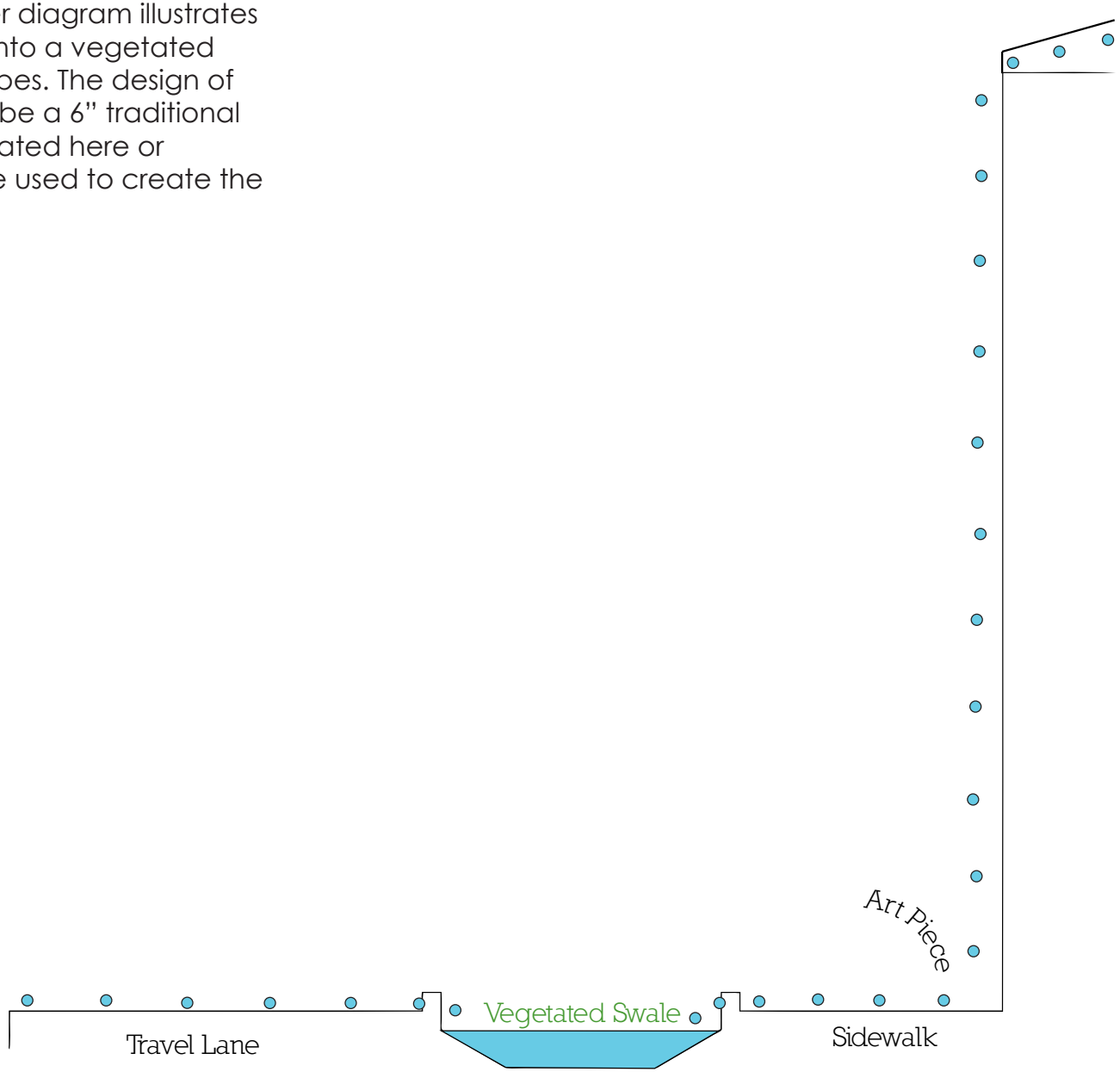


Figure 31 This is a plan and section of a vegetated swale. It shows the relationship of users to the stormwater facility as well as shows the curb design where there is a 6" drop before the larger drop in grade of the facility. The vegetation is used as the "curb" barrier for those who need the curb to differentiate the end of the sidewalk.

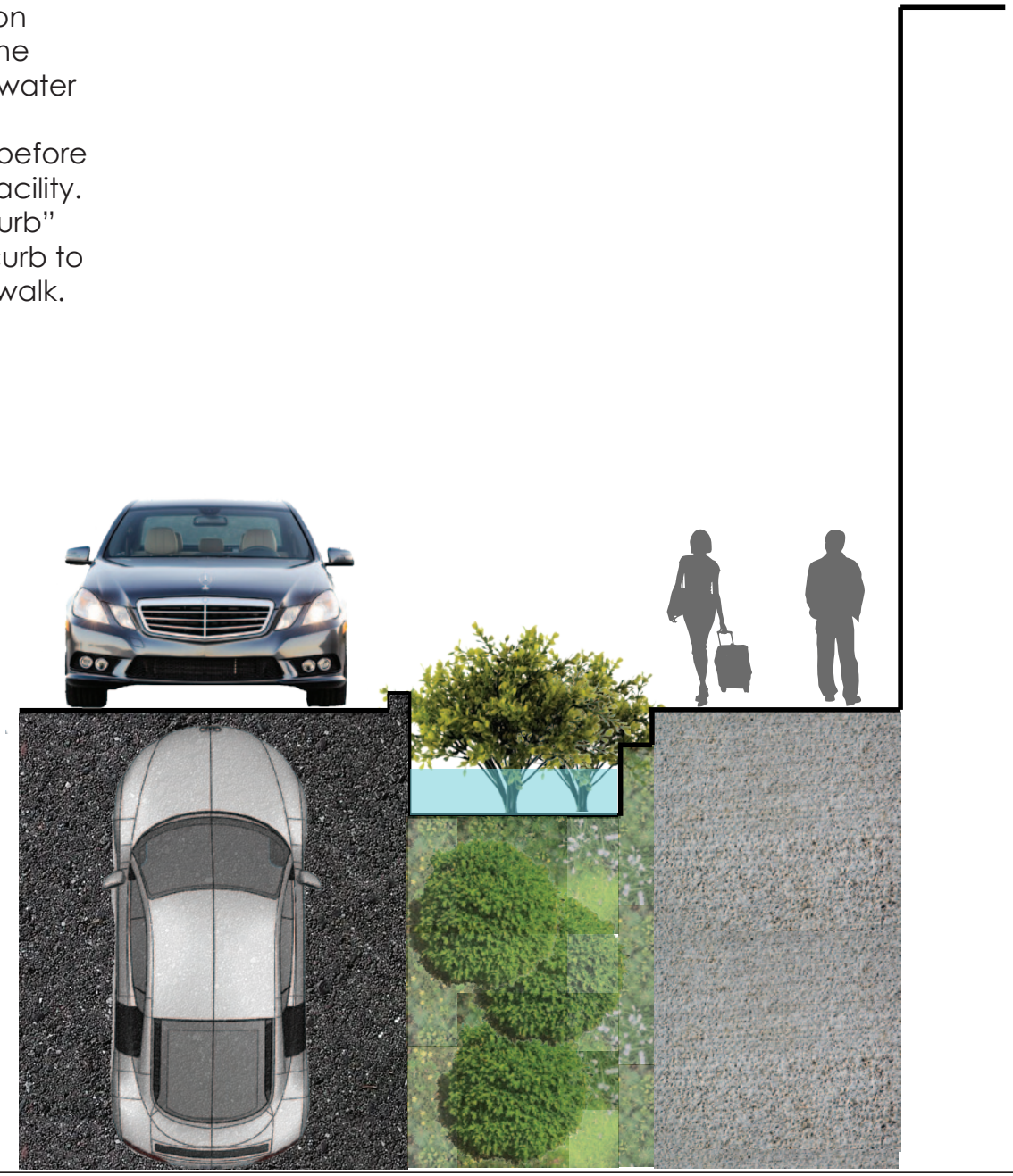


Figure 32 This water diagram illustrates the flow of water into a planter with a pedestrian egress. There is a pedestrian egress zone for people getting out of their cars. This will make it easy for them to get around the planter as well as help keep the planter from being walked through. The flow of water from the travel lane and parking will be through curb cuts in the pedestrian egress zone. There will be a grate covering these curb cuts for pedestrians to walk over. The grates will be easily removable to allow for cleaning.

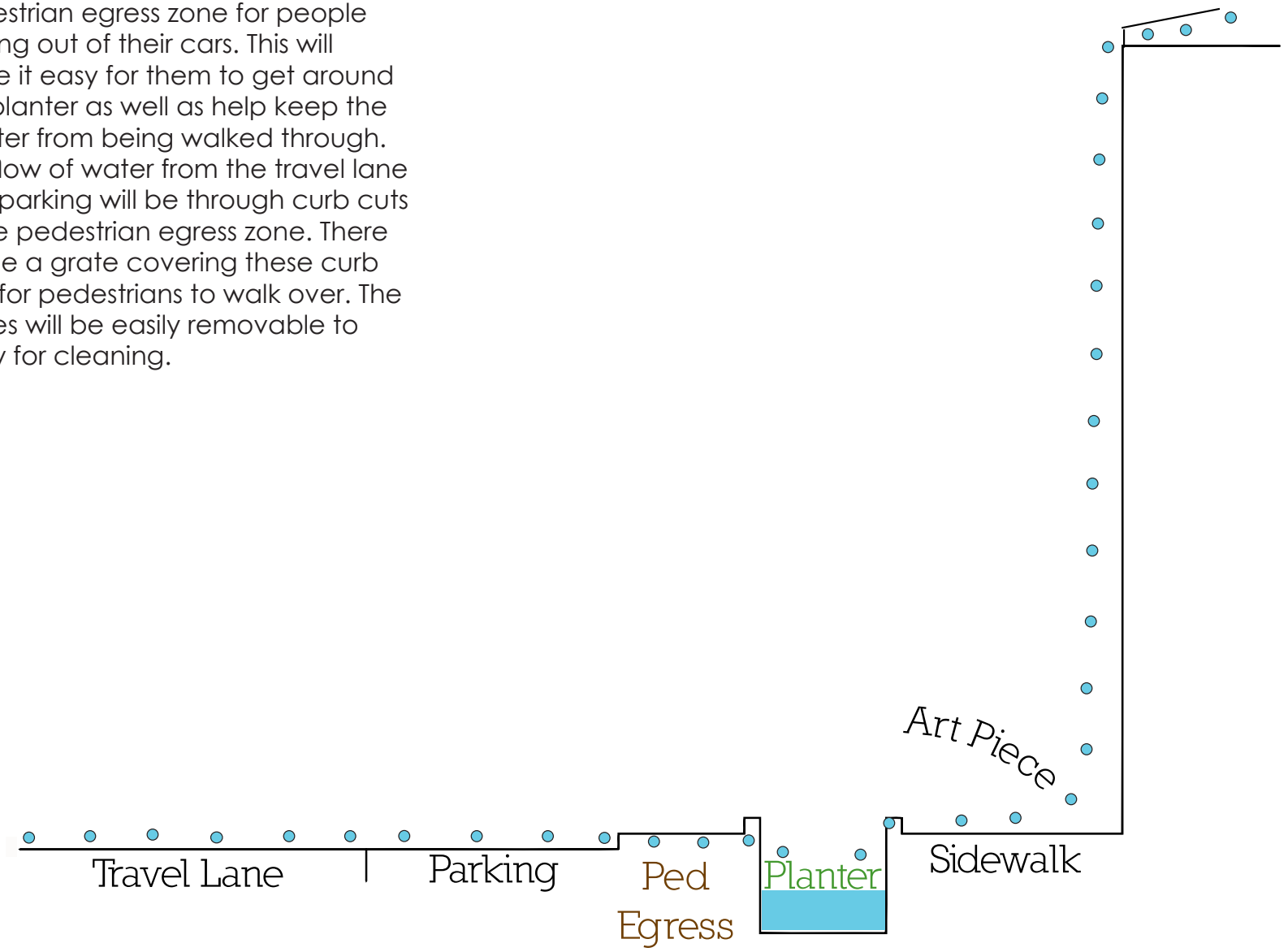


Figure 33 This is a plan and section of a planter with a pedestrian egress. It shows the relationship of the pedestrians to the planter. In this graphic the pedestrian path is illustrated as being wood, it can be a number of materials depending if the planter is continuous with vegetation underneath the path or if the planters are connected with a pipe.

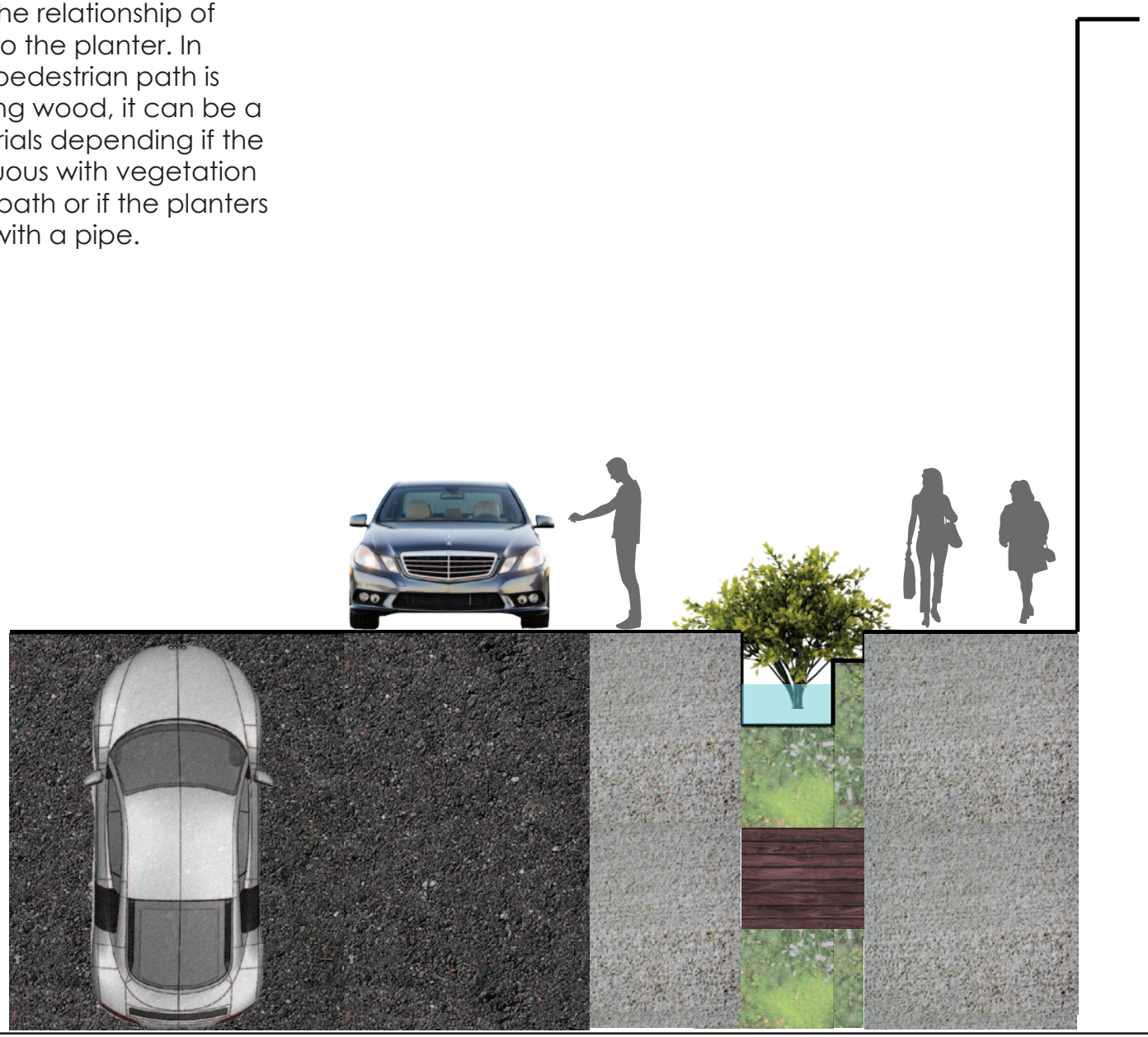


Figure 34 This water diagram illustrates the flow of water into a rain garden. The dimensions of the rain garden basin can vary depending on the specific site of the facility.

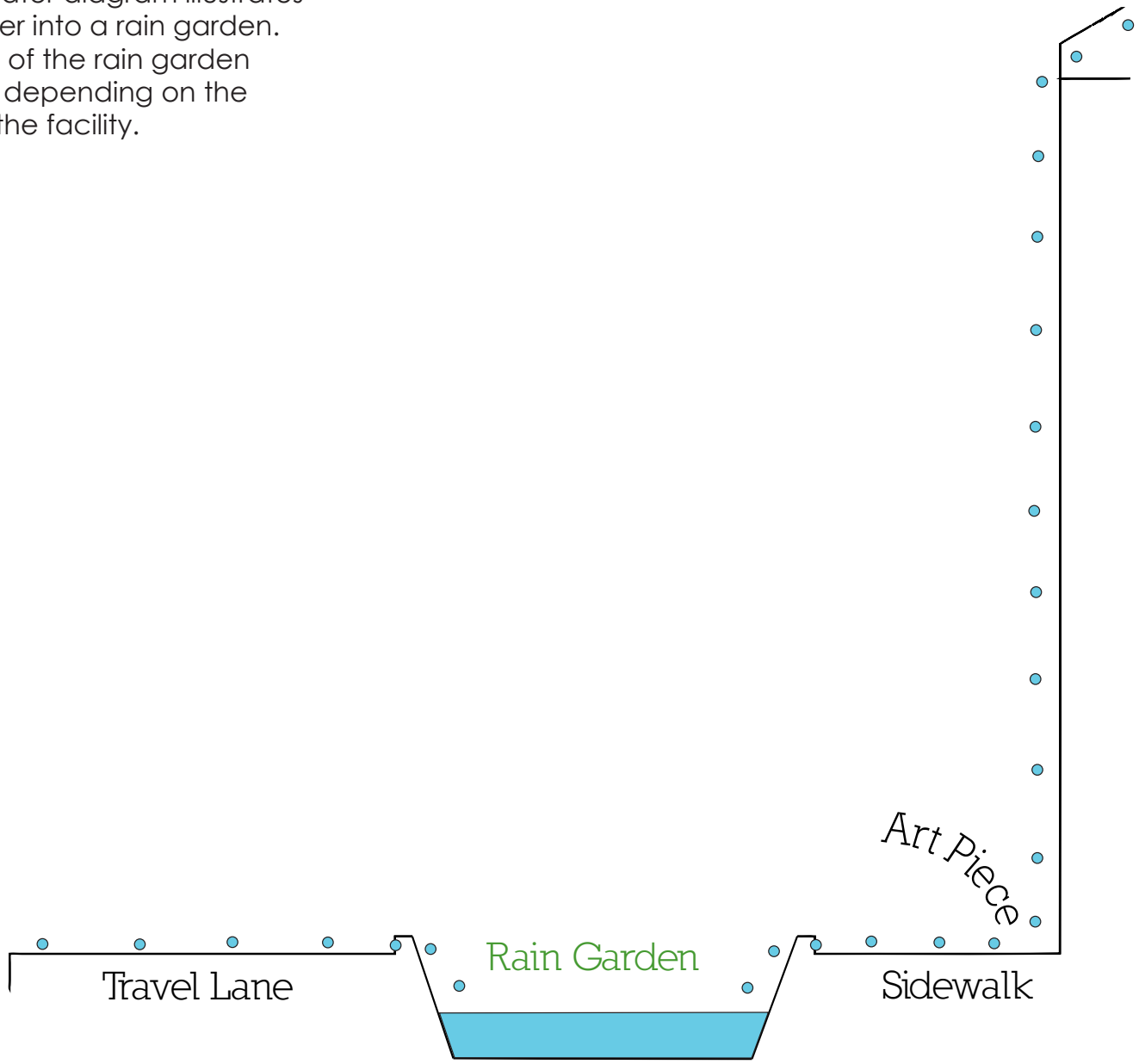
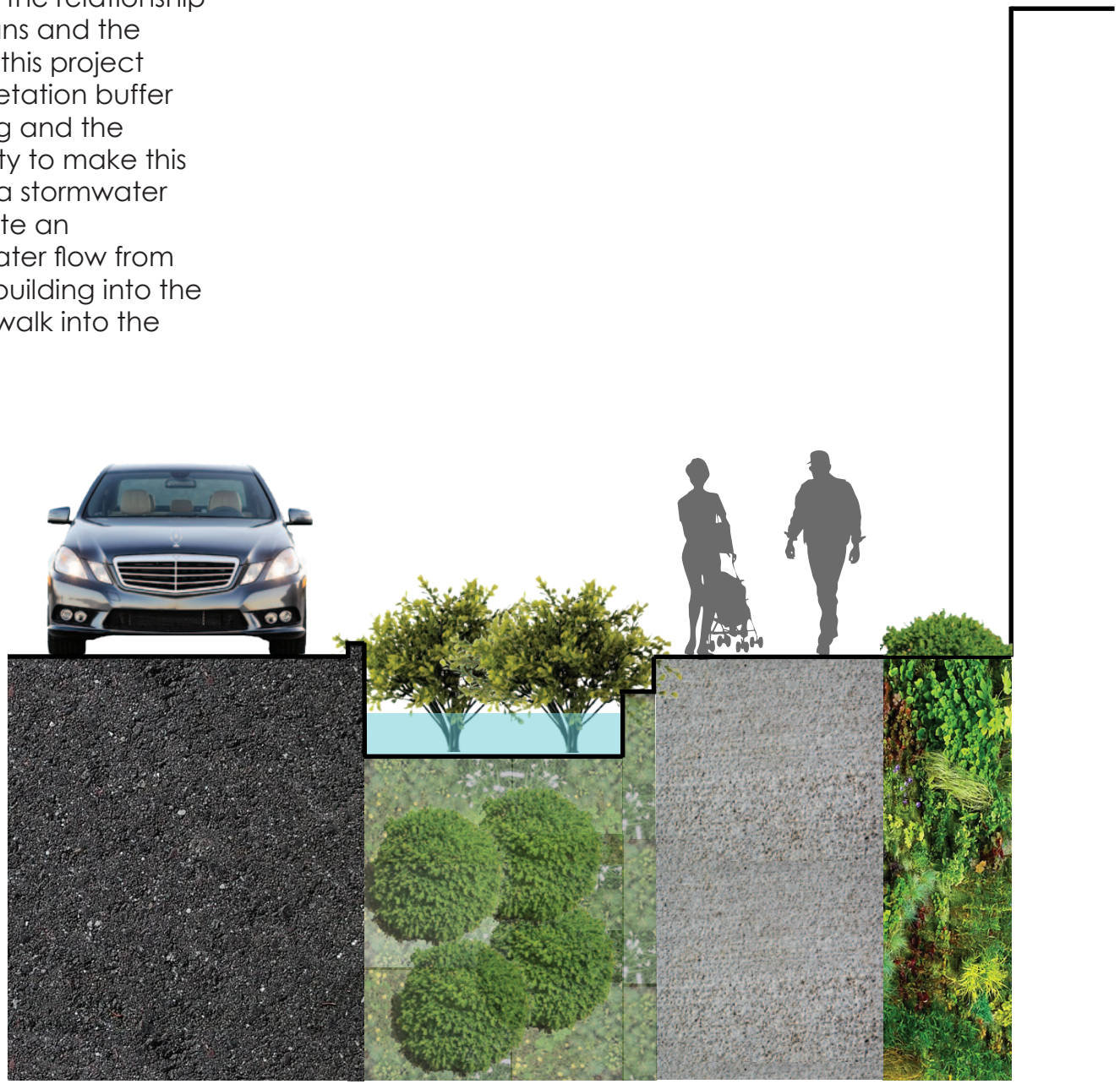


Figure 35 This a plan and section of a rain garden. This shows the relationship between the pedestrians and the stormwater facility. For this project there typically is a vegetation buffer in between the building and the sidewalk. It is a possibility to make this vegetation buffer into a stormwater facility which can create an interesting design of water flow from the downspout of the building into the facility, across the sidewalk into the rain garden.



After walking the site I created an opportunity and constraints map, shown on the following page. I identified the different locations for stormwater facilities as well as where they could be expanded to incorporate parking lots or a part of perpendicular streetscape. The idea of the design bleeding into the other parts of the site reinforces the Natural vs Built theme. Additionally, the incorporation of the stormwater facilities could become a second phase for the project, which would minimize impervious surfaces and decrease the amount of water for each facility to handle. The graphic on the following page is a stormwater allocation plan of all the stormwater facilities along the site.

The concept plan maps out what type each stormwater facility will be and identifies locations where art pieces would benefit the "sense of place". The next step was to identify where the utilities are located, what type of soil exists currently and user constraints such as turning radii for trucks. Analysis of these conditions led me to select a flow through planter with an under drain. The soil is mainly clay, which means infiltration will be difficult to achieve – so an under drain allows the planter to use a shallower bed. Another reason for the planters being flow-through is that the utilities run along the bottom of the curb, so a barrier is necessary to protect them from water. The section on the following page illustrates exactly where the utilities are going to be in relation to the main drain, the under drain and the pedestrian crossings.

Opportunities and Constraints Diagram

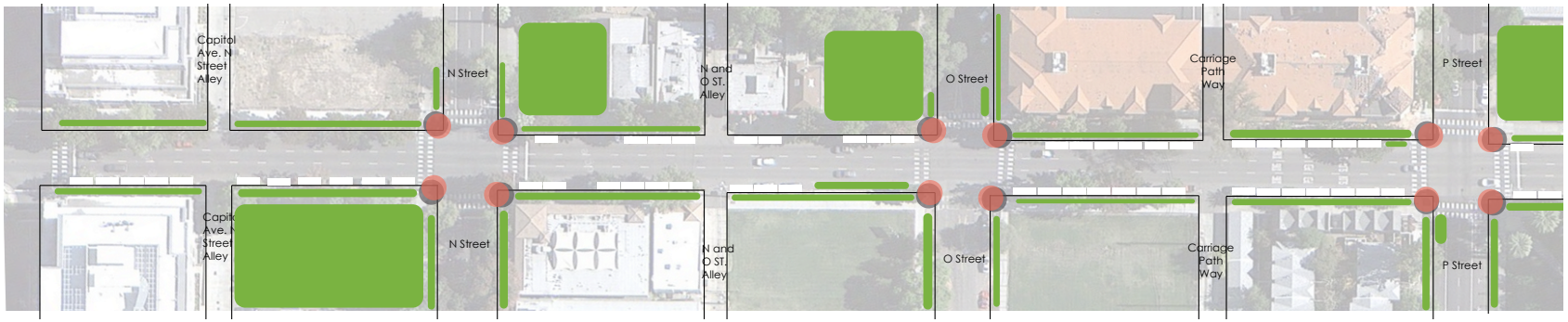
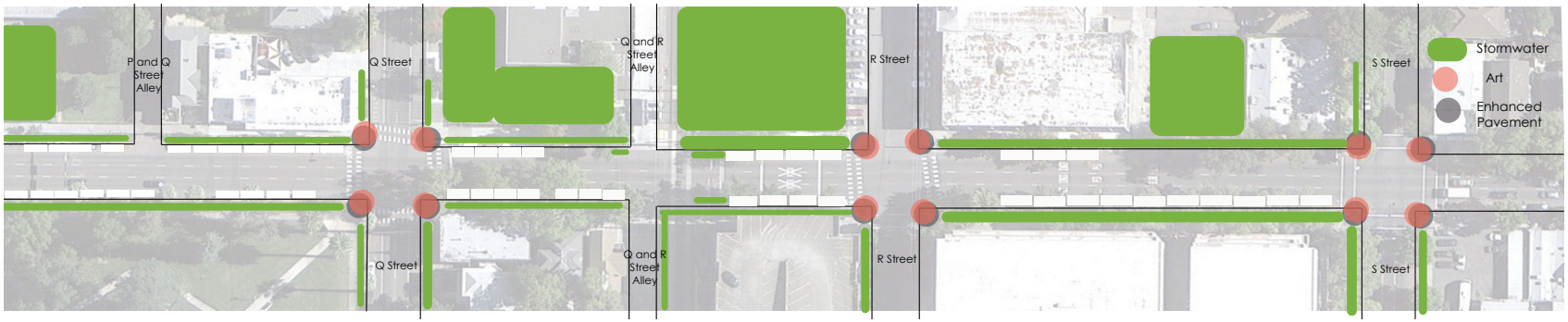


Figure 36


P and Q Street Alley
Q Street
Q and R Street Alley
R Street
S Street
Stormwater
Art
Enhanced Pavement
Q Street
Q and R Street Alley
R Street
S Street

Stormwater Allocation Plan

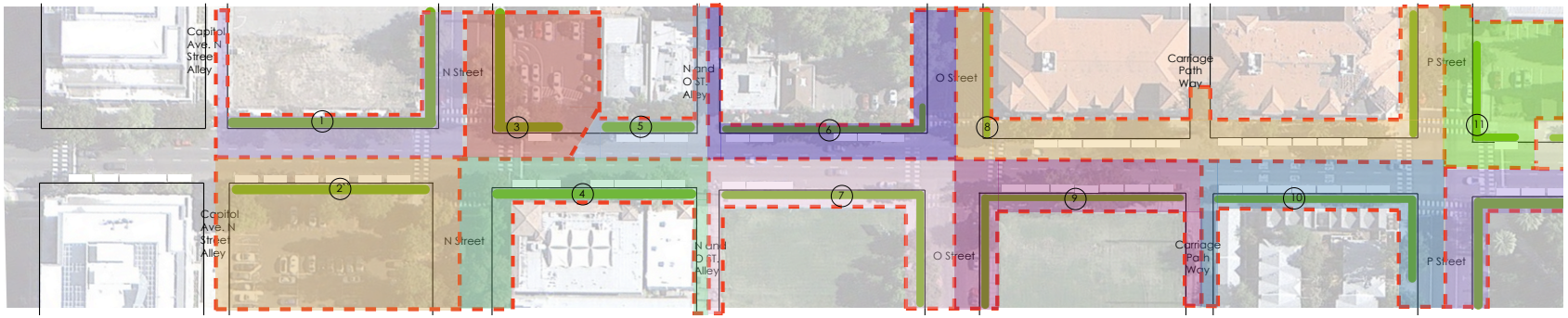
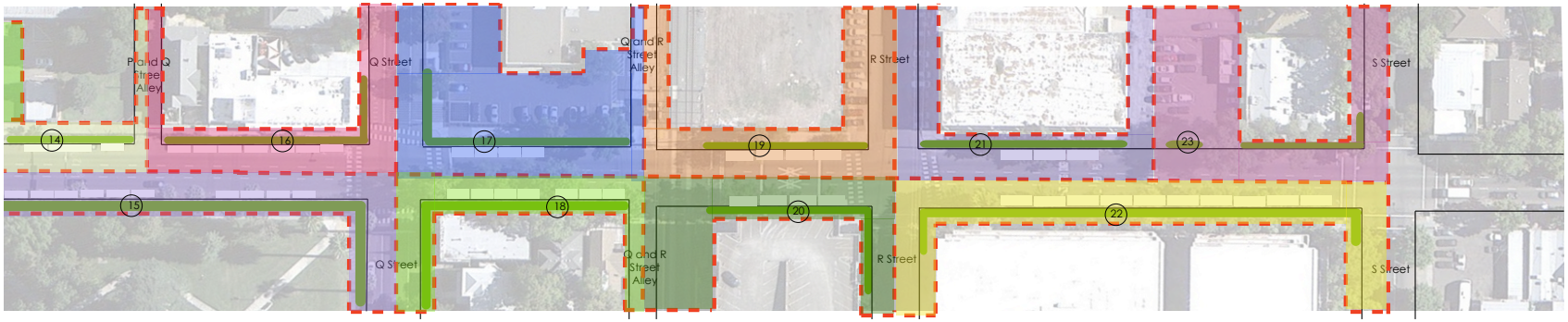


Figure 37


P and Q Street Alley
Q Street
Q and R Street Alley
R Street
S Street
14
15
16
17
18
19
20
21
22
23
Q Street
Q and R Street Alley
R Street
S Street

Concept Plan

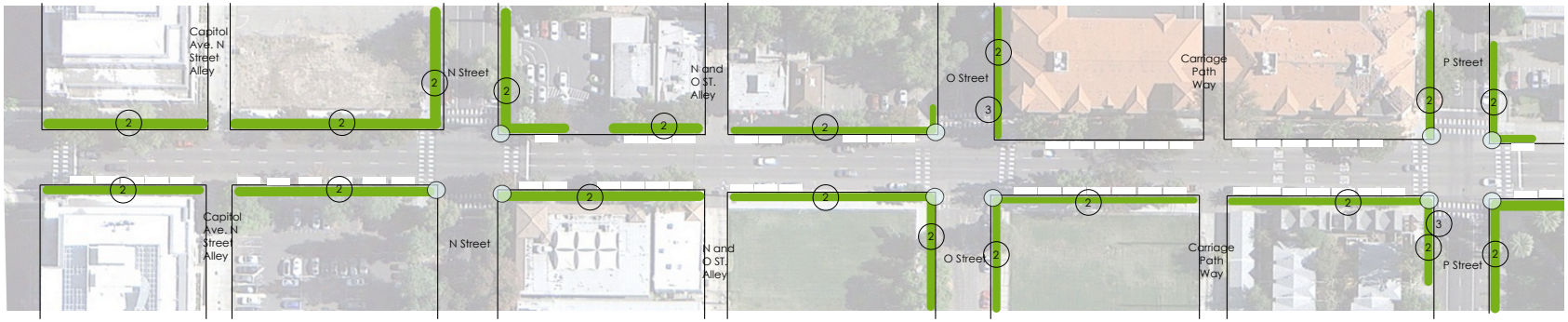
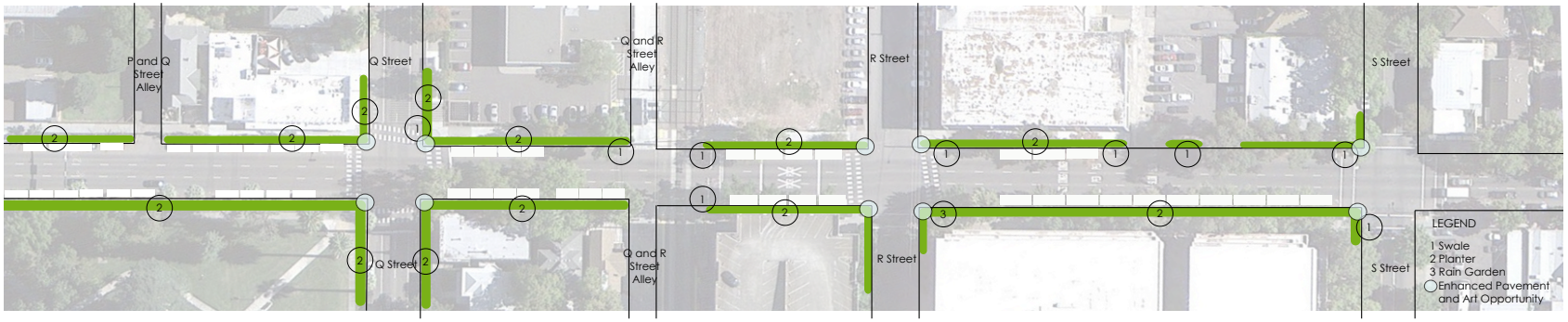


Figure 38


P and Q Street Alley
Q Street
Q and R Street Alley
R Street
S Street
Q Street
Q and R Street Alley
R Street
S Street
LEGEND
1 Swale
2 Planter
3 Rain Garden
Enhanced Pavement and Art Opportunity

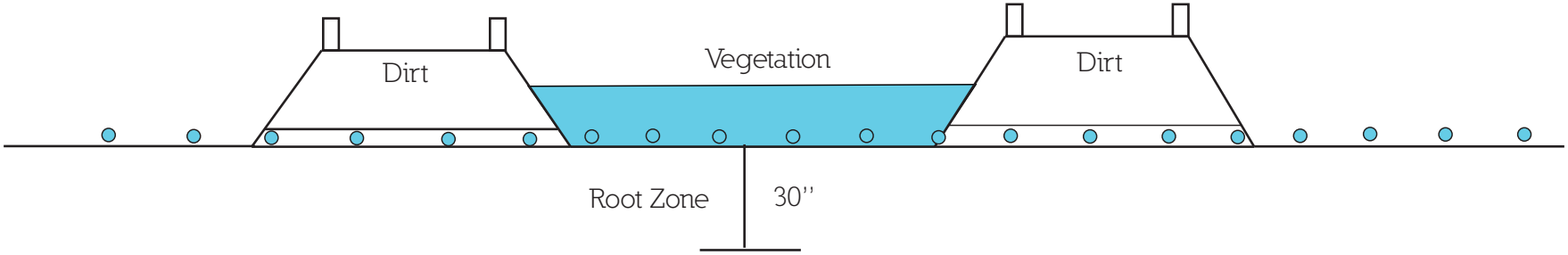


Figure 39 This graphic illustrates the flow of water vertically through the planter. In this design there are pipes that connect the planters together. The water flows into the planter via curb cuts and then flows through pipes underneath the pedestrian egress zones. There are several options for the pedestrian egress zones construction. It can be solid concrete, have a concrete exterior with dirt in the middle or a continuous flow of vegetation. The planter depth can be a few feet because the root zone only needs to be about 30" deep. The roots of many street trees need more horizontal space then vertical space to grow which leads to a deisgn with longer planters.

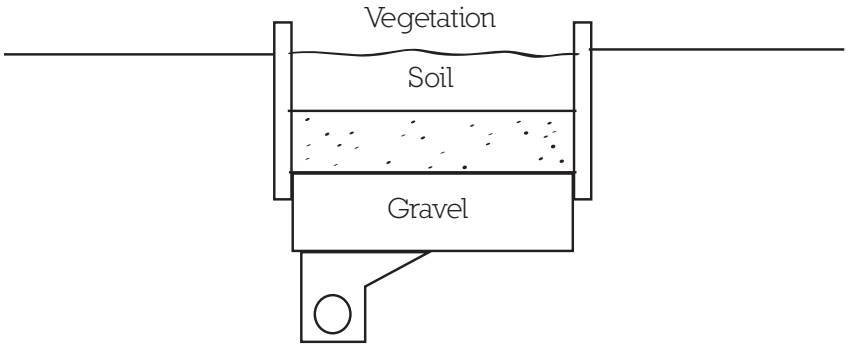


Figure 40 This diagram illustrates the below grade aspects of the stormwater facilities. Most of the facilities in this design require an underdrain due to utilities and the lack of infiltration due to clay soil. After deciding if there needs to be an underdrain then there need to be citing of the location in realtion to the electrical utilities and the irrigation. Preferably the electrical utilities and irrigation will be on opposite sides of the planter.

Final Design:

Once the type of facility has been decided upon, the distances between pedestrian crossings and curb cuts need to be detailed. For this design, curb cuts are typically about twenty feet apart and planters are about twenty-two feet long before a pedestrian crossing. Additionally, planters are connected with pipes to ensure an even flow of water between each planter. The final plan on the following page details this design, as well as the pedestrian crossings, pipes, curb cuts, and water flow from several angles. All of these drawings are suppose to show typical design details. The plan view shows a typical intersection. For each corner in the intersection there are three options for corner design: plain concrete, enhanced pavement, art or vegetation. Some corners can utilize multiple options, depending on the aesthetic, functional, and environmental fit with the surrounding area.

The final component in the site is the art opportunities. The theme of Natural vs. Built suggests direct interaction. A few ideas are to have large insects emerging out of the facilities, or to create pieces that bridge the gap between the buildings and the stormwater facility. The most functional idea so far to incorporate art into stormwater facilities is to have etchings in the pavement which guide the water from downspouts across the sidewalk into the facilities – perhaps etched in the form

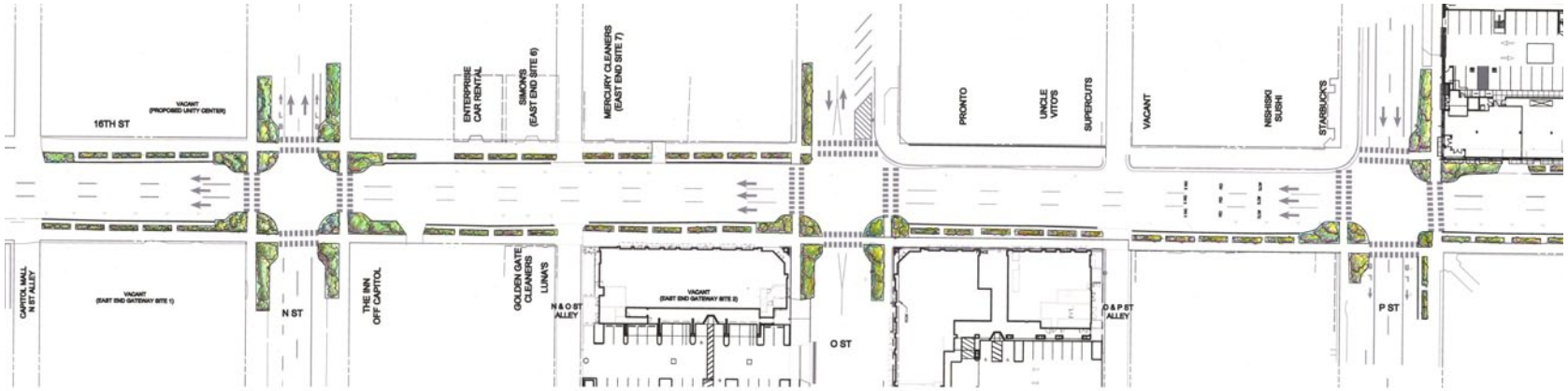
Figure 41 An image of a design which incorporated the river into the new development in a creative and artistic way.

of a river to depict the natural flow of water. CADA will be working with the Sacramento Metropolitan Arts Commission to hire artists to design installations based on the Natural vs. Built theme.

On the following page is my final plan. The design incorporates techniques from the various case studies and research mentioned above. The decisions regarding curb cuts and the dimensions of the facilities are based mostly on the research and projects of Kevin Perry. The final design for the curb cuts is guided primarily by the need for more successful water flow in and around the stormwater facilities. The use of multiple types of stormwater facility is based on my site analysis and the need for continuity to create a coherent "sense of place". The plan shows the location of art pieces and site amenities that will later be designed by the selected artist(s).

The design incorporates every component of a functional Green Street. Implementing these stormwater facilities will decrease the amount of impervious surfaces, which will improve the biological diversity in the water, filter the local water supply, and decrease the toxins in the water before it reaches a larger body. The goal is ultimately threefold: use pre-existing policies and analysis of user needs to produce safe and functional conditions for pedestrians and vehicles alike; use art installations and educational pieces to create a continuous aesthetic throughout the site and develop an enjoyable user experience; finally, use smart stormwater and runoff management to create an environmentally sustainable streetscape and promote the completion of even more Green Streets in the Capitol.

Final Plan


16TH ST
VACANT (PROPOSED UNITY CENTER)
ENTERPRISE CAR RENTAL
SIMONS (EAST END SITE 6)
MERCURY CLEANERS (EAST END SITE 7)
PRONTO
UNCLE VITO'S
SUPERCUTS
VACANT
NISHIKI SUSHI
STARBUCKS
CAPITOL MALL N ST ALLEY
VACANT (EAST END GATEWAY SITE 1)
N ST
THE INN OFF CAPITOL
GOLDEN GATE CLEANERS
LUNA'S
N & O ST ALLEY
VACANT (EAST END GATEWAY SITE 2)
O ST
O & P ST ALLEY
P ST

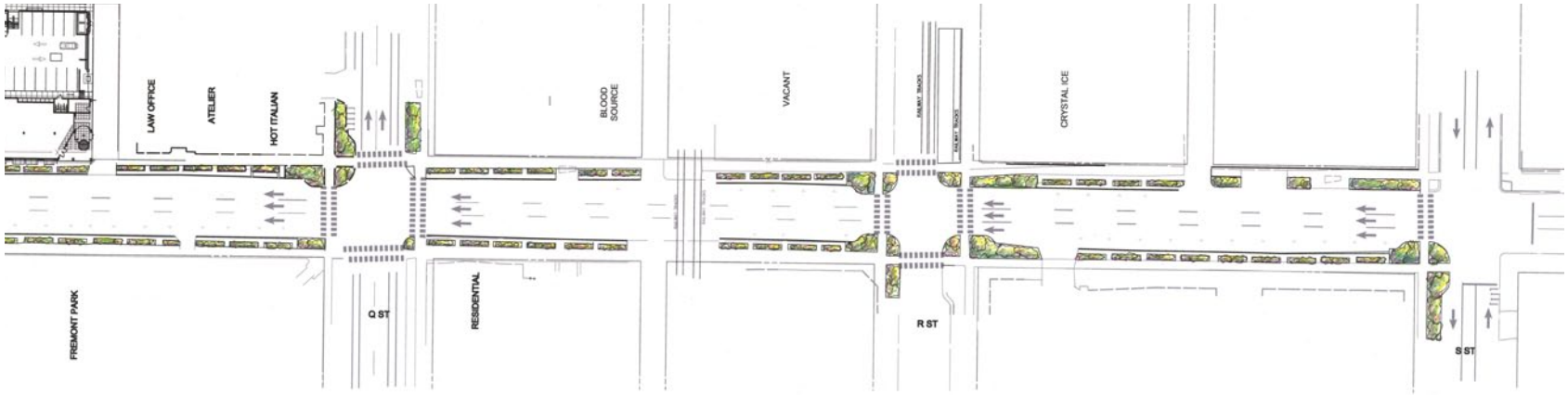

LAW OFFICE
ATELIER
HOT ITALIAN
BLOOD SOURCE
VACANT
CRYSTAL ICE
FREMONT PARK
Q ST
RESIDENTIAL
R ST
S ST

Figure 43 The detailed plan illustrates the curb cuts in the curb extensions and the planter. This is a typical intersection with curb cuts at the corners to facilitate the flow of water into the stormwater facilities. The "bulb-out" portion has 3 options for its design; vegetation that can intake stormwater, enhanced pavement or the incorporation of an art piece.

Glossary:

Swale: "Vegetated swales are shallow landscaped areas designed to capture, convey and potentially infiltrate stormwater runoff as it moves downstream." (Perry, 2011)

Infiltration and Flow-Through Planters: "Infiltration and flow-through planters are contained landscape areas designed to capture and retain stormwater runoff." (Perry, 2011)

Rain Garden: "Rain gardens are shallow landscape areas that can collect, slow, filter and absorb large volumes of water, delaying discharge into the watershed system." (Perry, 2011)

Stormwater Curb Extension: "Stormwater curb extensions are landscape areas within the parking zone of a street that capture stormwater and allow it to interact with plants and soil." (Perry, 2011)

Flow-Through Planter: "It has an impermeable bottom liner and an under drain pipe to collect the treated water and discharge it to the municipal storm drain."

Infiltration Planter: "Planters without an impermeable bottom liner (infiltration planters) will also require an under drain when the underlying soils are less permeable than the planter's sand/peat layer." (Sacramento, Grove, Galt).

Complete Street: "serve everyone- pedestrians, bicyclists, transit, riders and drivers- and they take into account the needs of people with disabilities, older people and children." (McCann, Rynne, & Association, 2010)

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Thank you!