

Retrofitting



the Suburban Home Landscape



for Sustainability



Rachel Jacobson

Retrofitting the Suburban Home Landscape for Sustainability

by Rachel Jacobson

A Senior Project Presented June 12, 2009
to the Faculty of the Landscape Architecture Program
University of California, Davis

in Partial Fulfillment of the Requirement
for the Degree of Bachelor of Science of Landscape Architecture

Accepted and Approved by:

Stephen Wheeler
UC Davis Landscape Architecture Faculty
Committee Member

David de la Peña
UC Davis Landscape Architecture Lecturer
Committee Member

Jenifer Segar
Committee Member

Mark Francis
UC Davis Landscape Architecture Faculty
Senior Project Advisor



Abstract

A survey of a suburban neighborhood in Davis, California highlights the design flaws of the suburban front yard. A compilation of actions suggests changes, along with a discussion of their costs and benefits. These include planting shade trees, reducing or eliminating lawn, using native/drought-tolerant/climate-adaptive/edible plants, using mulch, reducing impermeable surface, directing runoff into retention and filtration areas, and designing appropriately. A neighborhood tree plan and adjoining double-yard redesign illustrate the benefits of these retrofits. The potential effects of the changes if applied to the whole neighborhood are explored, along with some potential obstacles to implementation.



Dedication

To Mother Earth.

To those who want to save her.

To those who want to learn how to do their part.



Stuart M. Jacobson

Sandhill cranes at the Merced National Wildlife Refuge.

Acknowledgements

Many thanks to the members of my committee, Stephen Wheeler, David de la Peña, and Jenifer Segar, for their guidance through this process. Thank you for taking time out of your busy schedules to meet with me, to suggest books and ideas, and most of all to ask the questions that allowed me to discover what I wanted to do.


I am grateful to Mark Francis for small, well-timed shoves to get my work done.

Without Katie Gross, I would still have a mess instead of a planting plan.

My friends and family take such good care of me. Thank you, each of you.

Table of Contents

Title Page	i
Abstract	iii
Dedication	v
Acknowledgements	vi
List of Illustrations, Figures, Plans, and Photos	vii
Preface	ix
Definitions	xi
Introduction	1
Methods	p
Results	p
Analysis and Findings	p
Implications for Future Work	p
References	p
Appendix	p



List of Illustrations, Figures, Plans, and Photographs

Text
Text

Preface

The purpose of this project is to explore ways the landscape of the suburban home can be retrofitted to be more sustainable, including reduction of its carbon footprint and therefore its contribution to climate change, reduction of water use and runoff, inclusion of native/climate-adaptive/edible plantings, reduction of the urban heat island effect, and reductions in maintenance costs and waste.



Figure 1: Tract housing in a Cincinnati suburb.

There is much work being done at the regional and city scale, in commercial landscapes, and in the public realm to aim for sustainability. However, there is little that addresses the landscape of the suburban home. It is difficult to regulate things that are already built and privately held, and the number of properties and homeowners is daunting

to reach. This study is intended to create products accessible to city governments and homeowners in California, to persuade people to do their part to save the earth for their own benefit. This is not a comprehensive how-to guide or cookbook for a sustainable landscape. Rather, it suggests philosophies and approaches for the landscape that have a multitude of benefits, and enumerates some of those benefits. Also covered are some of the costs and requirements associated with those approaches. This study is not exact or scientifically rigorous. The data analysis does not include statistical significance analysis. The impact findings are based on approximate numbers, averages, and estimates, not precise measurements. Numerous studies and programs are finding that retrofits like these save money and the earth.

Sustainability and suburban sprawl as we know them are mutually exclusive. Efforts to make existing sprawl more sustainable by converting it to higher density, more appropriately-planned spaces with good transit systems are only feasible in abandoned or unsuccessful developments. Thus, this project addresses the need for more of a narrow scope, short-to-medium term strategy to combat the immediate problem of climate change in existing, successful suburban sprawl areas. While it is tempting to pursue solutions that would permit the perpetuation of the sprawled suburban lifestyle sustainably, that is an oxymoron, and cannot be done, so this project will not attempt to do it. Hopefully, this project will serve as a step toward increased awareness that will allow future generations to embrace denser, more responsible development.



Definitions

Text

Text

Definitions

Text

Text

Definitions

Text

Text

Definitions

Text

Text

Introduction

A study looking at individual homes in a neighborhood in Davis, California was conducted to identify the flaws of the typical suburban home landscape in terms of sustainability.



Figure 3: Davis is near Sacramento, in California's Central Valley.

The neighborhood chosen is located in the Mace Ranch development in East Davis.



Figure 4: Mace Ranch is on the eastern edge of Davis.

Mace Ranch, built within the last twenty years, is a ‘normal’ suburban development. Therefore, it is an established area, but has not undergone so many changes that it deviates from certain patterns. Wide streets with plenty of parking, large lots, and big houses characterize the neighborhoods. Expanses of lawn with trees plopped in and simple foundation plantings constitute most of the plant life. Eligio Lane is exemplary of such design. This out-of-the-way street is a loop off of a residential, local access-only street, and is like a circle, with very low traffic volume.



Figure 5: Eligio Lane, in the center of the image, is a loop off of a quiet residential street.

A survey of eleven houses on one block face yielded data on hardscape and plant materials. While these attributes may seem mundane, they represent decades of conventions based on small-minded, selfish principles founded in conspicuous consumption. Only front yards, the parts visible from the public domain, were surveyed.

The results of the survey were analyzed to find how each suburban homeowner can more responsibly use the land adjacent to his or her home and the shared land of the streetscape in the form of suggestions for retrofits: appropriate native plantings, shade trees, edible landscaping, reduced water use, and water retention and infiltration strategies. Benefits and costs were identified and are included for

Introduction

each retrofit.

This study seeks to advocate and demonstrate options in the landscape and their advantages. Use of native, drought-tolerant plantings will create habitat for birds and insects, reduce water use, and aid adaptation to changing climate conditions. Planting of shade trees will reduce the urban heat island effect, creating more livable outdoor spaces. Edible landscaping is a responsible and worthwhile use of landscape space, even in the front yard. Water retention and filtering will help protect water quality. Costs and benefits are explored further in the *Results* section.

One homeowner re-landscaping his or her yard may seem unremarkable, but it can provide serious rewards to that homeowner. One block face claiming their street and homes with shade trees and replacing their lawns with gardens yields greater returns for all. This study emphasizes some of these. At a town or city scale, the impact could be incredible.

Yet, our suburbs are still predictable, irresponsible, and disappointing. Why has there not been change?

Part of the reason homeowners are not already doing these retrofits is because they cannot envision them - they lack examples to follow. This project aims to provide prototypes that respond specifically to Davis. Some cities prohibit installation of anything other than turf in the front yard; while this is not the case in Davis, it exemplifies the challenges facing designers and others who attempt to effect change. Social pressures coerce people into following an irresponsible 'ideal' landscape aesthetic, and many lack the creativity to escape it, unless they are given a different lead to follow. Changing these pressures and societal expectations is key to implementing widespread change.

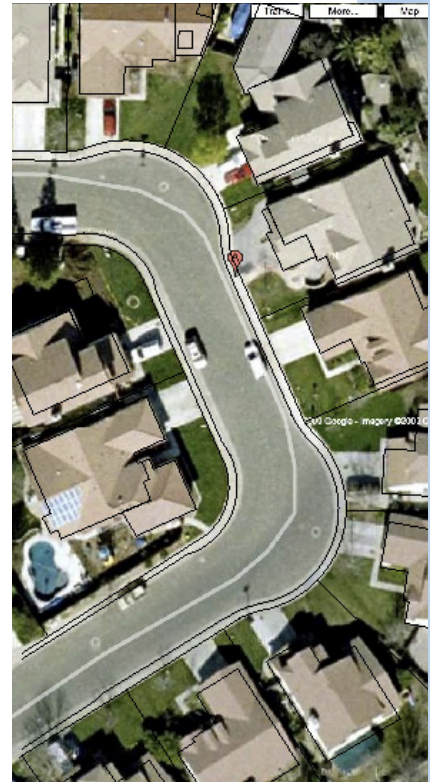


Figure 6: Eleven houses on one block face on Eligio Lane.



Methods

Identifying and evaluating actions that will contribute to a sustainable landscape was a critical step in defining the parameters of the study and the design goals for the study area. The *Results* section explores the services provided by each action, and the investments associated with each.

The survey methods are based on the methods used by Tyler Jones-Powell in his Landscape Architecture Senior Project in 2007 (Jones-Powell 2007), and have been adapted for specificity to landscape.

The on-site survey was conducted by one individual on three separate afternoons in May 2009 between the hours of 3:00 pm and 5:00 pm. These hours provide shade data during the hottest part of the day. Three different recording periods were necessary due to of the intensity of the afternoon sun. Aerial photograph approximations were performed off-site with the aid of site photographs after the on-site data had been recorded. Survey sheets can be found in the *Appendix*.

Each home included in the survey area was evaluated for:

- Hardscape: Driveway width*, length*, area*, % yard*, apparent use, materials, permeability, and drainage;
Other hardscape width*, length*, area*, % yard*, apparent use, materials, permeability, and drainage;
- Vegetation: Lawn/turf width*, length*, area*, % yard*, apparent use, materials, permeability, and drainage;
Plantings area*, % yard*, edible %, apparent use, placement, materials, and irrigation/drainage;
Tree species and diameter at breast height, water use/irrigation/drainage, placement, approximate % cover*, and edibility.

Categories with * were gathered off-site.

Measurements are not exact; they are intended to give approximate proportions of types of uses.

Percent cover is credited to the parcel on which the tree trunk is located, and only considers the area directly under the tree. The angle at which the shade is cast, in correlation with the height and shape of the tree, would result in a larger and longer shadow cast. Therefore, the numbers used are underestimates, and reflect the minimum amount of shade that a tree provides. Due to the nature of this component and this study, it is acceptable to err on the conservative side and to design a solution based on these low numbers.

Results

12 WAYS TO ACHIEVE A MORE SUSTAINABLE LANDSCAPE

Here are twelve actions, along with a discussion of each.

PLANT SHADE TREES

Shade trees alter the microclimate under and around them.

They not only provide shade, they actively cool and humidify their surroundings by evapotranspiration. This results in water savings from reduced irrigation needs, and money savings from reduced building cooling costs. Shaded surfaces contribute less to the Urban Heat Island Effect than unshaded ones. The shade also results in money savings, because materials (such as road paving) that are subjected to less UV radiation break down more slowly, and therefore last longer and need to be replaced or repaired less frequently. Trees cleanse the air by collecting particulate, such as that released in car exhaust, which results in improved air quality. By nature of their large size, long lives, and intimate interactions with soil, trees are critical agents in carbon sequestration. Trees change the character of an area by bringing tall structures and broad expanses of paving down to human scale. An example of this can be seen on Purdue Drive in North Davis. A direct comparison is available with the street one block to the north, Bucknell Drive.



Figure 7: Purdue Drive is on the right, Bucknell Drive is on the left. The Chinese pistache are in minimal tree wells in the street. Note the scale and friendliness of each photo.

If the right type of tree is chosen for a location, adding shade trees to a site can be a minimal investment of time and money that provides extensive benefits. Trees can cause a assortment of problems, such as root damage to paving and structures, leaf litter and limb dropping, pest problems like rats or insects, or shading out your vegetable garden. Most of these can be minimized by choosing a tree and location carefully and investing in occasional care, such as professional pruning. Some cities and utility companies will pay the purchase price for shade trees for their residents or customers: the energy savings from a good shade tree program can eliminate the need to construct a new power plant.

REDUCE OR ELIMINATE LAWN

Lawns are greedy and unnatural. Every species of grass used in turf is exotic. In California, lawns require frequent irrigation in the summer dry months, a season when water shortage can be a serious issue. Nothing in nature is of uniform height - competition for light and other resources drives strong plants taller and keeps less vigorous plants lower. The regular mowing required to keep a lawn neat and evenly mown is a waste of time and resources. Gasoline mowers have two-stroke engines which pollute worse than cars in terms of greenhouse gas emissions and air particulate pollution. The grass they are used on does little to ameliorate these conditions, unlike larger plants such as trees and shrubs. The frequent fertilizer applications required to keep a lawn green and vigorous pollute lakes, rivers, ground water, and the oceans by altering the nitrogen balance. To keep a lawn pest-free and a weed-free monoculture, chemical pesticides and herbicides are utilized. These pollute the immediate environment in which they were applied, they run off the site and pollute other places, they kill beneficial species as well as 'problem' ones, and these chemicals often do not even eradicate the plants and insects for which they were intended.

Reducing or eliminating lawn reduces or eliminates many of these issues. Replacing it with a perennial landscape reduces inputs of time, chemicals, and water. Installing edible landscaping may not reduce inputs, but generates returns, which saves resources elsewhere.

Turfgrass has its place. It is an excellent surface for many types of recreation. However, most Americans only ever interact with their lawns to tend to them. For

Results



Figure 8: This house has reduced the front lawn to a small patch by the front door

those whose children play on the lawn, perhaps it is a worthwhile investment for ten or twenty years. Even so, the lawn area should be reduced to only the area that is actually used. Also, it is generally not advisable to spray harmful chemicals on a child's play surface, so a more organic approach is in order if lawn is to be included. Eventually, it should be re-evaluated and possibly removed.

USE NATIVE PLANTS

Native plants provide habitat for native animal species, which can save species from extinction. They support ecosystem services (see *Definitions* section) including pollination, pest and disease regulation, and various cultural services. If adapted to an arid climate, native plants are generally drought-tolerant and low water use, which allows water conservation and other water-related savings. Native plants can be hard to find in nurseries, and may be difficult to establish when first planted in the landscape. As the use of native plants becomes more common, so does their availability and solutions for their challenges.



USE DROUGHT-TOLERANT AND CLIMATE-ADAPTIVE PLANTS

California has annual summer droughts. In years when there is too little rain, or the dry season is too long, plants and people become stressed by water shortage. Expending precious gallons on a landscape is inappropriate and irresponsible. With climate change, summer temperatures are rising, the dry season is unpredictable, and the intensity of rain events actually leaves less water than one would expect in reserves because flooding and runoff occur, instead of retention and infiltration.



Use of a drought-tolerant planting palette consisting of plants that require little to no irrigation once established helps reduce water needs at peak demand times. A climate-adaptive plant palette considers the direction of climate change and focuses on species that thrive in Davis's climate, as well as one or two Sunset zones hotter and drier. Water is precious, and may someday cost what it is worth. A wise homeowner will work to establish a low-water landscape before it is mandated.

USE EDIBLE PLANTS

Edible plants include annual and perennial fruits and vegetables, herbs, and fruiting vines and trees. An edible landscape can be a lot of work, depending on the products desired and the plants chosen. An entirely annual composition will require seasonal sowing and near-constant harvest. Certain species



Results



require extra care for a successful crop. There are many perennial options - plants that are ornamental most of the year and bear fruit occasionally - that can easily be integrated into a landscape. Edible plants are less frequently drought-tolerant as compared to many native plants, but unlike lawn, you get tangible, pluckable rewards for the resources you put into an edible landscape. Less money is spent at the grocery store on something that was shipped there from afar, and you reduce your carbon footprint when you reduce demand for impactful goods. A vegetable garden need not be relegated to the backyard. Locate it where it

will get the full sun most edibles need. For some, the front yard is the only place they will remember to water and tend to their plants. What is more gratifying and enjoyable than watching the fruits of your labor develop on the vine?

USE MULCH

Around all of these wonderful native, drought-tolerant, climate-adaptive, and/or edible plantings you are now planning to install, use mulch. Mulch is a mundane material, easy to overlook or forget. However, mulch is the best thing for just about any landscape. It can be plain or decorative, organic or inorganic. No matter the type, mulch insulates the soil from the desiccating rays of the sun. Plant roots are subjected to less heat stress, as well as less drought stress, because mulch keeps water from evaporating out of the soil. Organic mulches slowly decompose and must be replenished from time to time. In the process, they improve the soil structure, which increases the nutrient- and water-holding capacities of the soil, which makes them more hospitable plant habitats and makes plants prosper. Mulch is inexpensive and invaluable to any landscape. Don't skip the mulch!



IRRIGATE APPROPRIATELY, MAINTAIN CONSCIENTIOUSLY

Appropriate irrigation is an easy way to reduce regular water consumption. most plants prosper with regular but not frequent deep watering. Berms are difficult to water if not planted according to the rates of drainage at various elevations on them. Drip irrigation is the most efficient system. Using



existing spray systems, leftover from lawn, on a new landscape until it is established is a way to recycle infrastructure. once the new, drought-tolerant plants are established, the sprinkler system exists as a backup. Every so often, check the irrigation of plants that do require watering to make sure it is only watering what it is supposed to, not paths or driveways, and not overwatering, causing wasteful runoff.

Find out how much water your landscape needs, and then water just for that. Don't guess. Books like the Sunset Western Garden Book can answer most questions about plant care. Water at a time of day (or night!) when evaporation will be minimal.

REDUCE IMPERMEABLE SURFACE

Impermeable areas allow no water to penetrate back into the soil beneath them. That includes roofs, roads, driveways, and parking lots. This water has to go somewhere else. Cities are built to whisk water from a house's gutter to the nearest water body, which can overwhelm natural systems. When water flows over and through impermeable surfaces like concrete and pipes, none of it percolates back into the ground water supply to recharge aquifers.

Dense development, while seeming full of impermeable surface, is actually the best approach. A taller building houses more people within one building footprint, and only one road has to be built to get there, which adds up to less impermeable surface per capita.

Results



Impermeable surfaces also tend to be heat-absorptive surfaces, so to combat the urban heat island effect, surfaces that cannot be reduced or greened should at least be shaded.

In the suburbs, there is often an excess of driveway and street surface. Roads are built to a far higher travel capacity than they will ever see. Vastly reducing paved surfaces by converting them to tree planters removes

impermeable area and provides shade to remaining portions.

USE PERMEABLE PAVING

The parts of roads and driveways that cannot be eliminated can be replaced with permeable paving. Permeable paving can be many materials: bricks set in sand, or concrete mixed without the small aggregate - as long as it allows water to flow through.



DIRECT RUNOFF FROM IMPERMEABLE SURFACES INTO RETENTION AND FILTRATION AREAS

Roofs that cannot be greened and roads and driveways that cannot be reduced or replaced with permeable surfaces should be designed or retrofitted so that their runoff is directed into retention and filtration areas. Retention areas hold water, in depressions in the earth like swales or basins, or in man-made collection containers. In swales and basins, the water percolates into the ground. From collection containers, water may be used in the home or landscape, for things like toilet flushing or irrigation. Filtration areas, such as bioswales, cause water to pass through plantings. The plants inhibit and absorb chemicals, minerals, and

particulate from the water, and also slow its flow. The water that does not percolate leaves the site cleaner than it otherwise would have after washing over roads and roofs.

USE SWALES AND BIOSWALES

Swales and bioswales are low points in the landscape (like ditches) that are designed to collect and direct water. In flat places like the Central Valley, it should be easy to design site grading so surface runoff is collected on-site, and only flows out into gutters and storm drains when it is at capacity. Water from impermeable surfaces, like roofs and driveways, can also be directed to swales or bioswales. See #10 for the retention and filtration advantages of swales.



DESIGN APPROPRIATELY

A design that works with the natural conditions of the site, responds to user needs, and does not require constant maintenance to keep it functional is on its way to being a successful, sustainable design. Plants that are too large for the space they are allotted and require constant trimming or pruning constitute a poor design choice, as do plants that require frequent watering or fertilizing.

A good, sustainable design saves time, money, and water today and the health of the planet into the future.

		1610 Eligio Ln	1604 Eligio Ln	1550 Eligio Ln	
Address		1610 Eligio Ln	1604 Eligio Ln	1550 Eligio Ln	
Date Surveyed		5/14/09	5/14/09	5/14/09	
Time Surveyed		3:10 PM	3:20 PM	3:30 PM	
Total Yard Area		1955 sf	1910 sf	2125 sf	
Hardscape	Driveway	Width	16'	16'	
		Length	22'	22'	
		Area	352 sf	384 sf	
		% Yard	18%	20%	
		Materials	Concrete	Concrete	
	Drainage Notes	Slopes to street	Slopes to street		
	Other Hardscape	Type	Path to front door, path around house	Path to front door, path around house	Path to front door, path around house
		Materials	Concrete, concrete	Concrete, DG	Concrete, large gravel
		Area (Total)	64 sf	90 sf	96 sf
		% Yard	3%	5%	5%
Irrigation/Drainage Notes					
Vegetation	Lawn Area	Area	1355 sf	1048 sf	1380 sf
		% Yard	69%	55%	65%
		Materials	Turf grass	Turf grass	Turf grass
	Irrigation/Drainage Notes	Drains S and W, not too steeply. Low pt is on E side of palm tree	Drains to street, E then S	Drains to street, E & S	
	Plantings	Approximate Area	195 sf	382 sf	255 sf
		% Yard	10%	20%	12%
		Edible? (%)	0	0	0
		Placement	Around entry and across front of house, both sides of garage	Around foundation and along walk	Along foundation, along N edge of driveway
		Irrigation/Drainage Notes	Mulch under roses, slopes with lawn	Slopes with lawn	Strip along driveway drains to street, slopes with lawn
	Trees	Species and DBHs	Liriodendron tulipifera (3"), Platanus x. acerifolia (10-12"), Washingtonia sp. (15' high)	Betula pedula (1@5-6", 1@4-5")	Lagerstroemia indica (1-2"), Pistacia chinensis (4")
Placement		All in lawn	At foundation, near door and at outside corner	In lawn	
Approximate % Cover		21%	7.50%	4%	
	Edible?	no	no	no	

Results

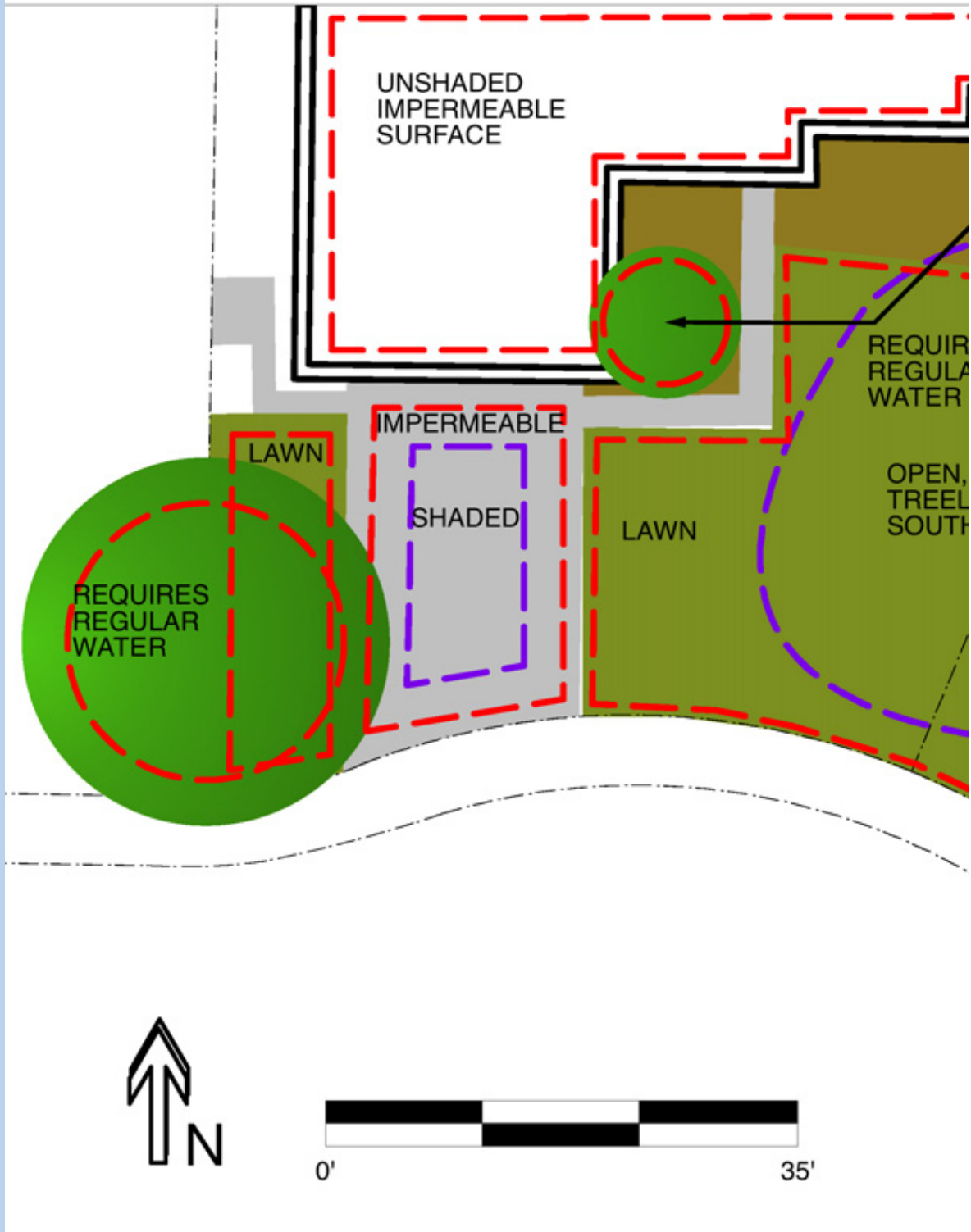
Results

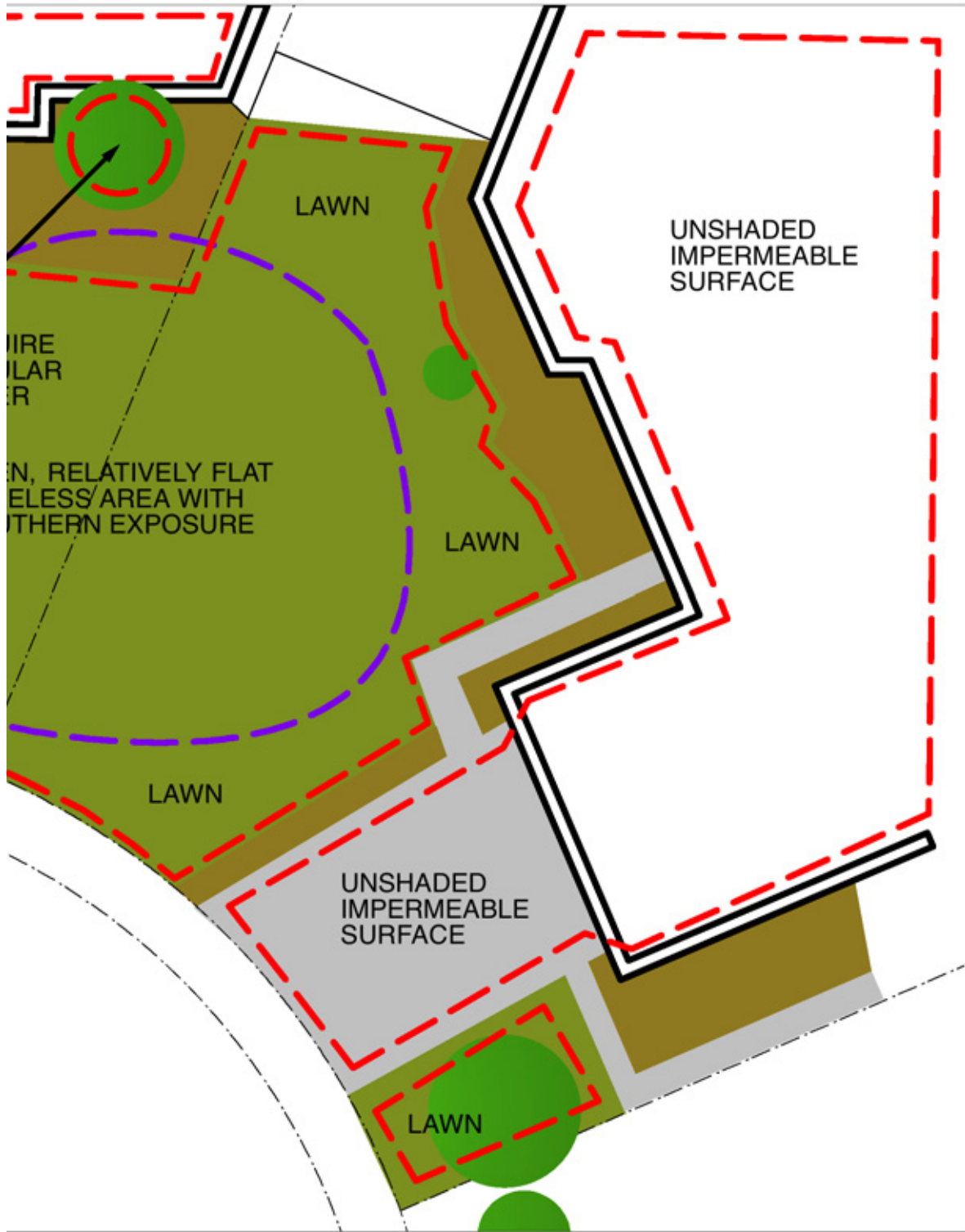
Results

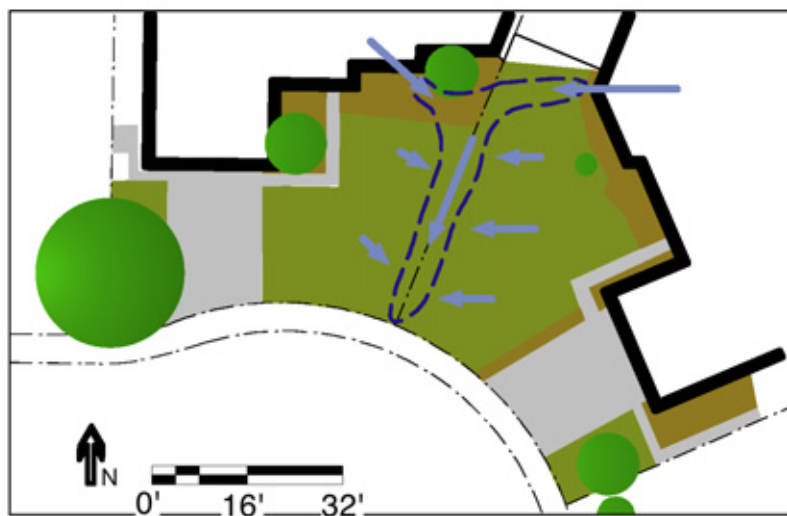
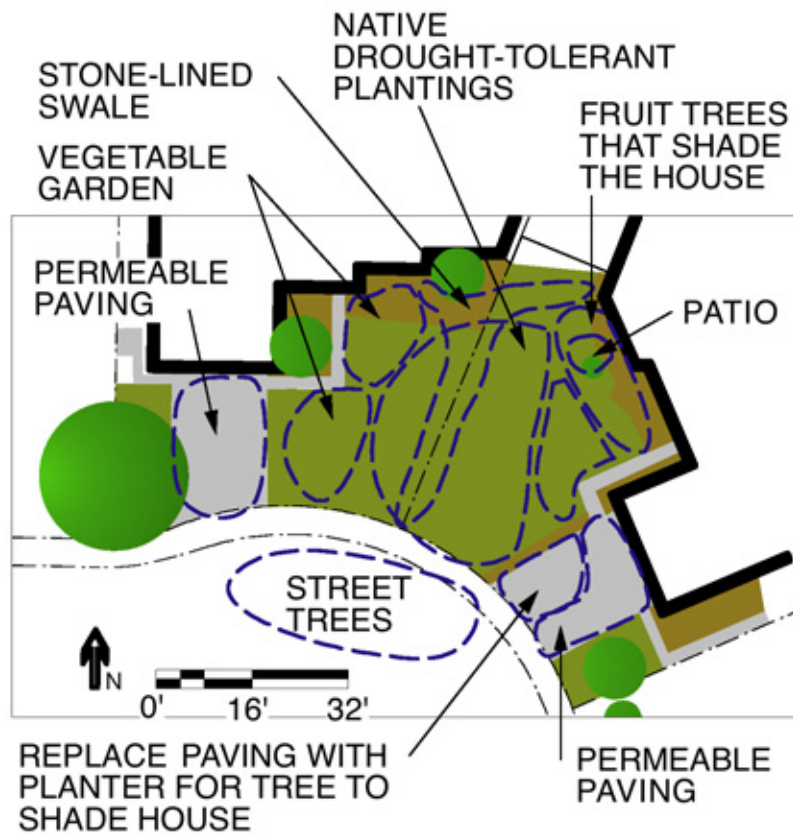
Text

Text

Analysis and Findings

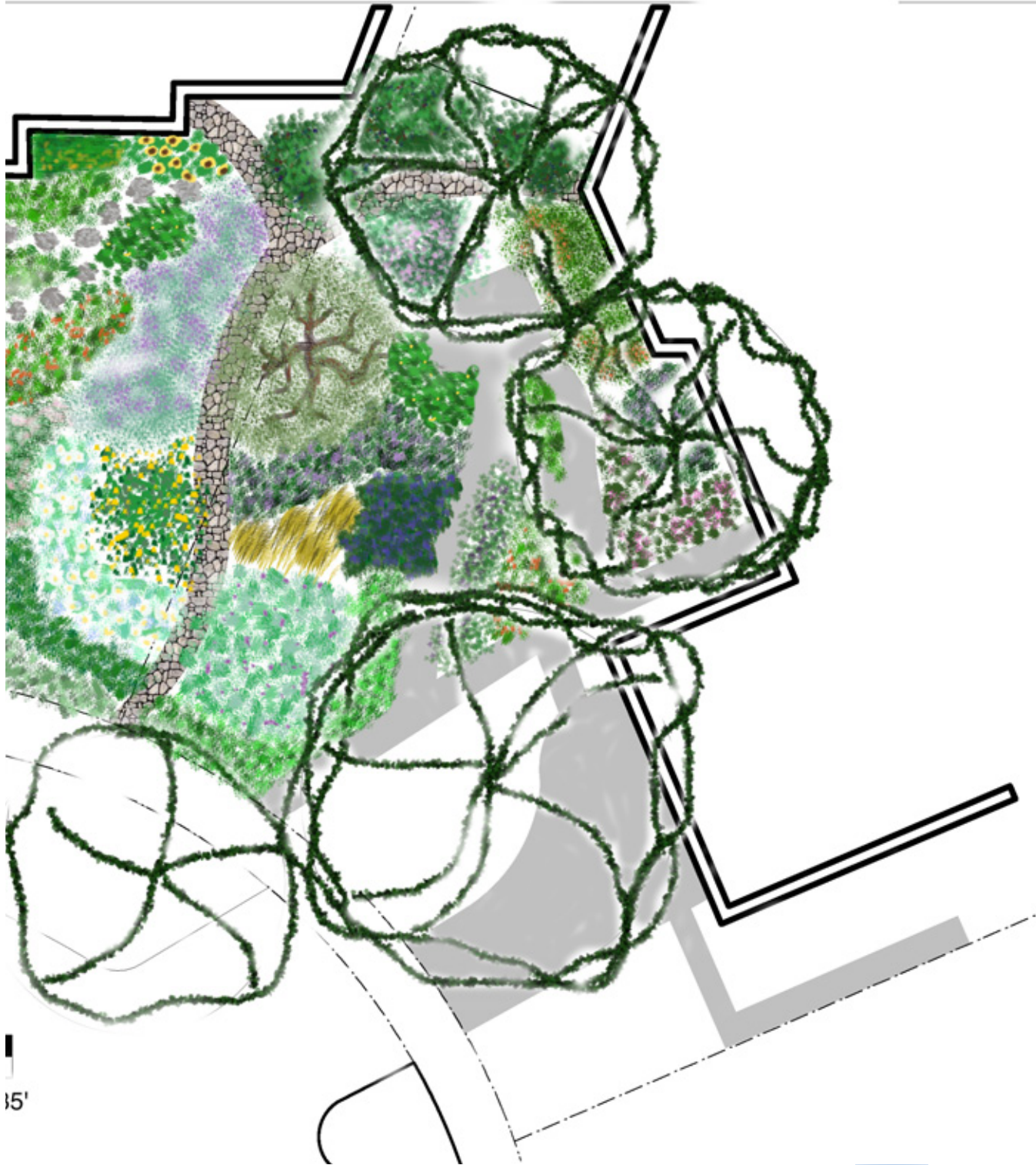




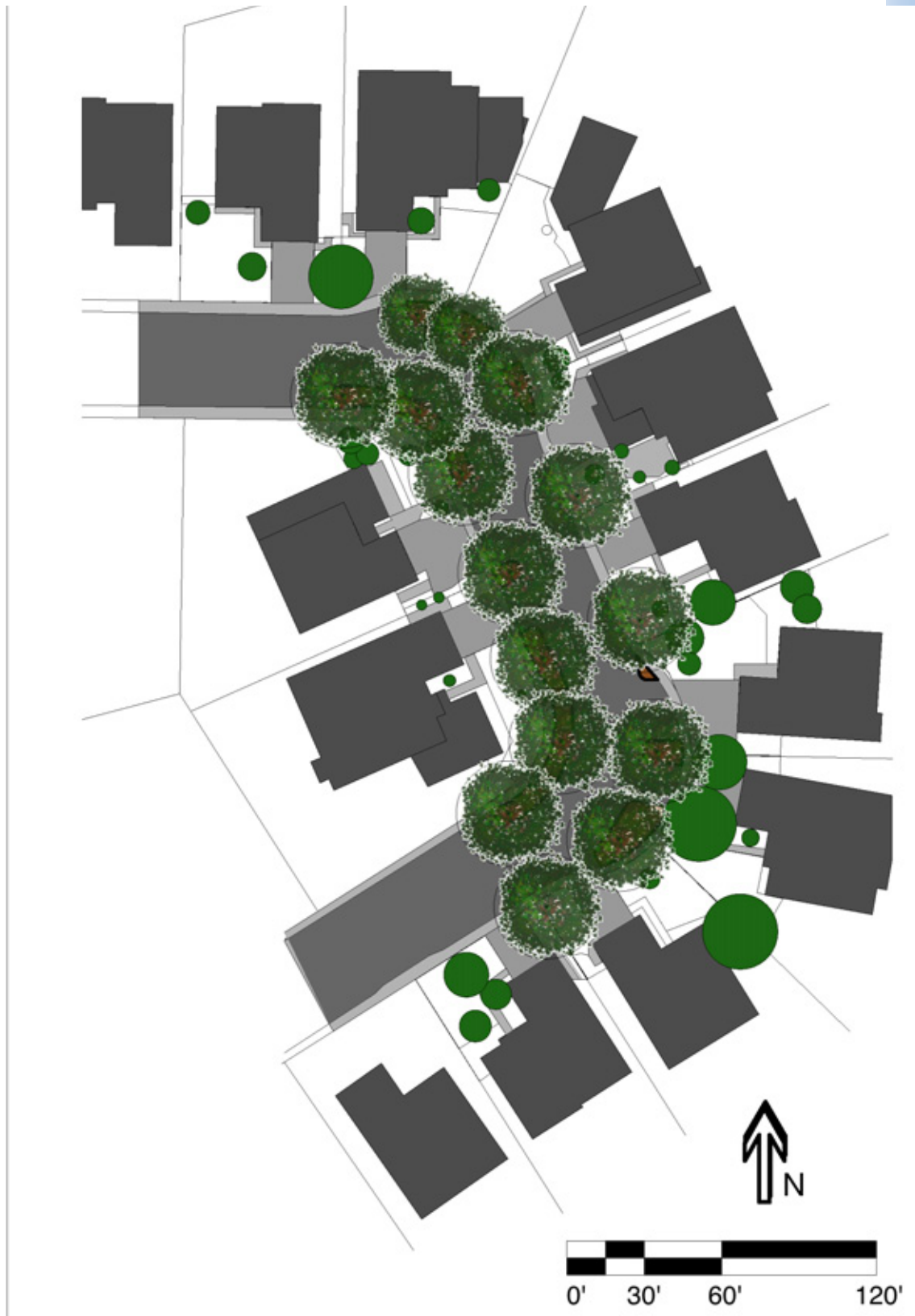


Analysis and Findings





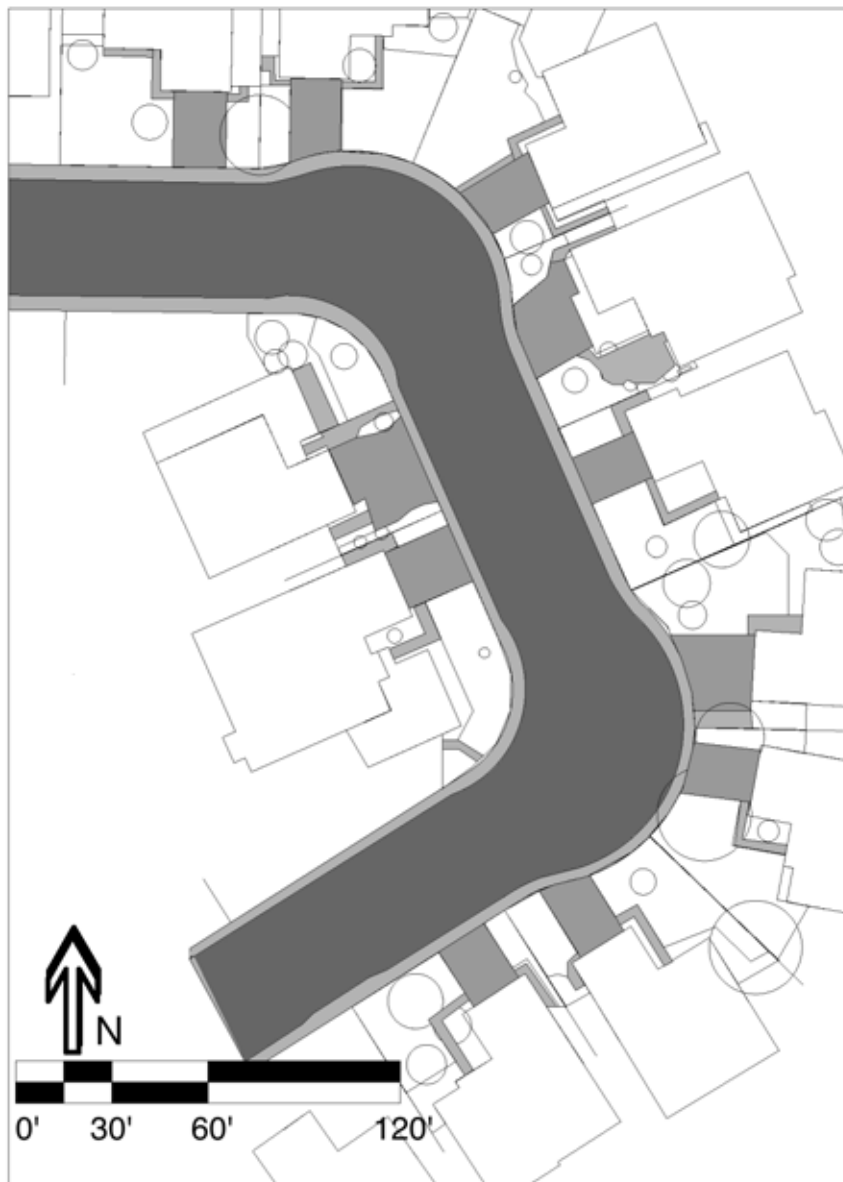


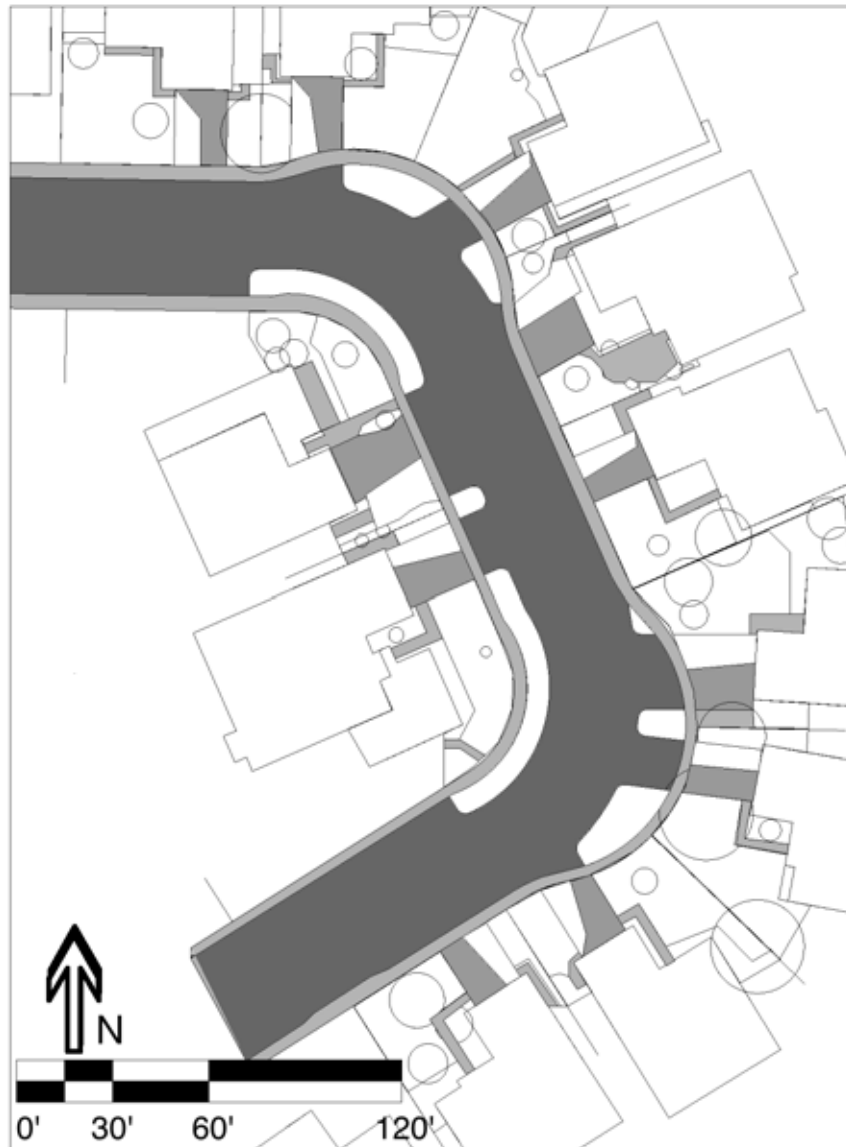




Analysis and Findings

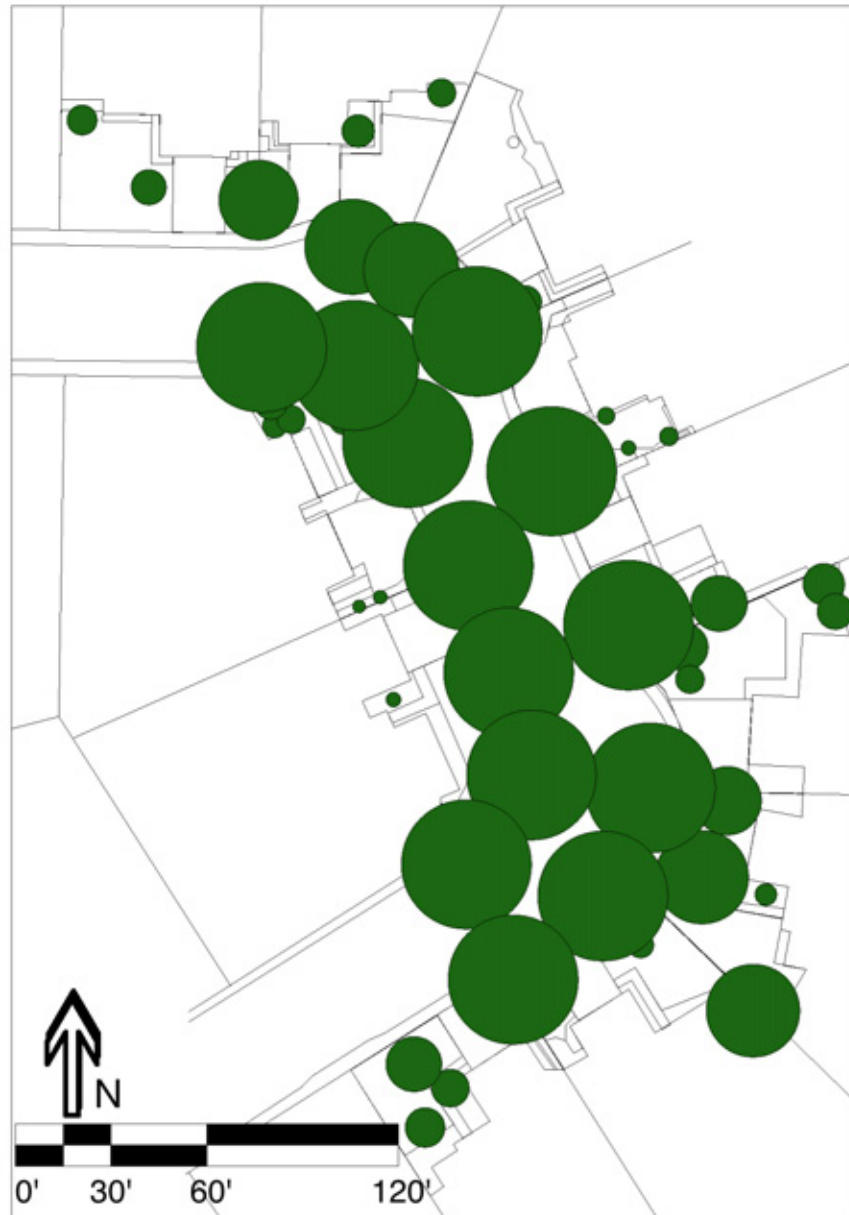








Implications for Future Work



Implications for Future Work

Text

Text

References

Text
Text



Appendix

Appendix

Appendix

Appendix

