Site Appropriate California Residential Landscaping

A Guide to Creating Beautiful Landscapes in a Low Water Climate

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A Senior Project
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For the Degree of
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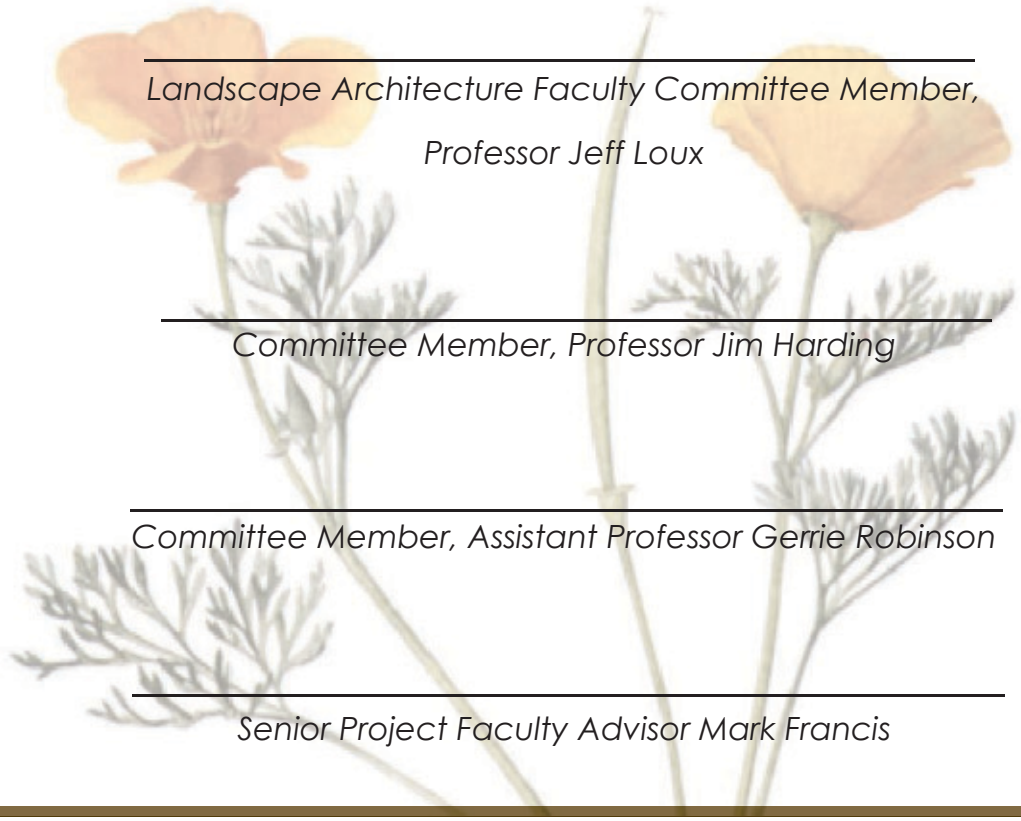
Accepted and Approved by:



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Abstract

Water levels in California have been an issue since the states settlement. With the growing population and constant threat of drought, individuals need to take it upon themselves to lower personal water uses. Because of the large push to retrofit interiors to be more water efficient, one of the few areas left to be modified for our climate is the landscape. Though state water resources continue to diminish, our personal landscapes are still cluttered with water loving plants, trees, and turf. It has said that landscape architects are suppose to analyze, plan, design, and watch over the natural and built environment. With this in mind, this project takes a holistic approach to California residential landscape design by capturing the attributes of a native and drought tolerant gardens with a wide variety of aesthetic appeal. This project provides a in look at the history and future of California water, native and drought tolerant design, ecology and wildlife, and safety for the rapidly growing population. The various aspects of residential design will then be analyzed and appropriately implemented into a design for a resident of Rocklin, California

Dedication

This

Project is

Dedicated to my:

Amazing, *Creative*,

Supportive, Silly, Logical, *Inspiring*, *Nurturing*,

CHARMING, CHARISMATIC, *Playful*,

Illogical, *Patient*, WHImSICAL, Crazy, Kind,

Beautiful **Intelligent**, *Loving*

Family.

I would not be half the person I am today without your love and support.

Acknowledgements

I began this project in the Winter of my Senior Year at Davis, but I feel like this is the accumulation of years of work. Throughout my college career, I have been interested in residential scale design, and how to make beautiful spaces with a low water need.

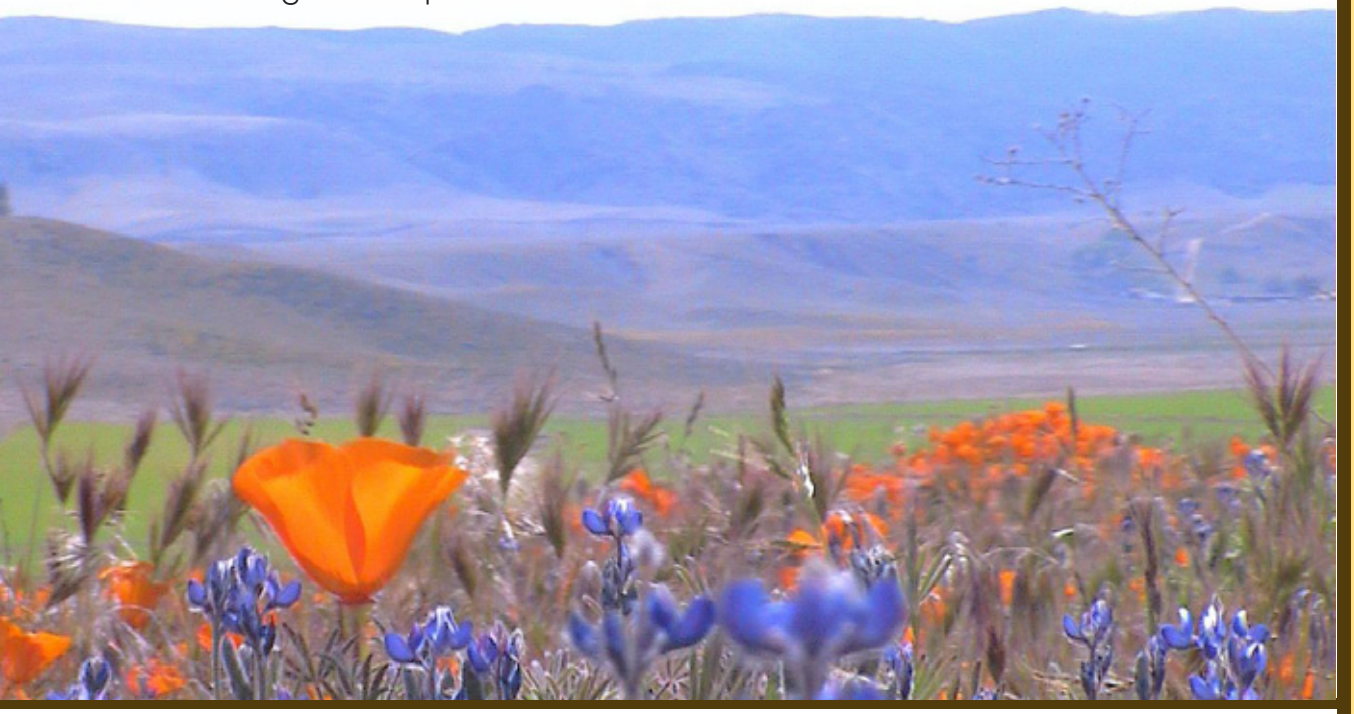
My inspiration first came from my parents who have been at the forefront of native design, even before it was trendy. Their forward thinking about residential design is what initially sparked my interest in landscapes, and has continued to inspire me today.

I would also like to acknowledge my committee members, Jim Harding, Gerrie Robinson, and Jeff Loux, who helped with every step of this project and supported me to make this the best project it could be.

I would also like to acknowledge my Professors who pushed me to develop a design style and strive to understand the extent to which landscape architecture can influence the world.

I would like to acknowledge my amazing brother who inspired and supported me through this project and through my life.

Finally I would like to thank Kathy and Dave Clemens for giving me the opportunity to learn using their space. It took a great amount of trust and I will never forget this experience



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Preface

Image P.1 Stereotypical Suburban Landscape

In the spring of 1994, my parents broke the cardinal rule of their homeowners association when they ripped out 6,000 square feet of highly manicured lawn to replace it with a zero-water native California landscape. People watched in horror as hundreds of native plants were brought into fill the once lush and green space. Our yard was not ugly, unkempt, or neglected, but when surrounded by plot after plot of highly manicured suburban lawn, our wood chips ground cover and xeriscape planting looked nothing short of dead.

Let me step back a few years to showcase what led my parents to make this unusual decision. Starting in 1987, large portions of the state of California experienced below average rainfall and snow pack. Droughts in California are relatively routine, so most people were inclined to ignore the situation and carry on with business as usual. This drought that started in 1987 continued for six years and by 1992 the damage was immeasurable. Agricultural crops were lost, old growth forests were dying, wildlife wetlands were gone, and reservoirs

had more mud than water as seen in the image P.2 to the right. It was estimated that millions of state dollars were lost in that short time, and that is before the environmental value was considered. The outlook was bleak until October 1992 when an exceptionally wet year finally came again and California was saved.

Image P.2 California Reservoir Drought

When a drought is followed by a year of floods that replenish the reservoirs, people quickly forget the devastation they experienced in the dry years and go swiftly back to their original routine of cleaning the driveway with a hose and over watering the lawn. My parents, being the forward thinkers they are, thought this was a ridiculous cycle and fought back by ripping out our lawn. Many individuals in the community tried to stop them, but after years of battling my parents were ultimately victorious and put in their native garden.

It took several years before my front yard stopped looking like a Charlie Brown Christmas tree, but eventually it grew into a surprisingly beautiful space. The oak trees grew into recognizable shapes, the flowers blossomed, and the native shrubs showed off their decorative side. Our neighbors have even started mimicking our landscape in subtle ways, mostly cutting out small chunks of lawn and replacing it with native plants, but every little bit helps. As each year passed, more and more people were inclined to make the difficult first step towards lower water landscapes especially in the dryer regions of California

These early years sparked my interest in native and drought tolerant residential landscaping. It seemed appropriate to me in an area that gets 12 inches of rain a year, a lawn that requires daily water is not intended for that space. Unfortunately, the image of a big house with a lush green lawn in front is the American ideal. In addition, many residents of California hail from other parts of the country or world where lush and green landscapes are totally natural and native. Tell these individuals that their landscape aesthetic is detrimental to the future of California, and you will be given blank looks. It is with these individuals in mind that I set out to design residential landscapes for California that can be lush, vibrant, and drought tolerant.

Chapter One:

Landscaping for a Region

Image 1.1 Fountain from the garden of Versailles, France

In the mid 1600's, a marvel of landscape architecture was erected that to this day amazes and astounds visitors from all over the world (Andr-Lablaude, 15). The Gardens at Versailles draw in hundreds of thousands of visitors each year to witness the vast achievement of landscape architecture, the beauty of the gardens, and the magnitude of the space. These formal gardens are historic, iconic, and completely impractical in the modern world.

In the roughly 2,000-acre space, there are 50 grand fountains, 620 water jets, and 36 kilometers of water pipes (Andr-Lablaude, 42). When the jets are running at half of their potential pressure, these fountains still use roughly 11 acre feet of water per day, and that is before any of the plants in the vast landscape are touched (Andr-Lablaude, 42). This may not sound like much initially, but

Image 1.2 Versailles Fountain

when compared with the statistic that 0.8 acre feet of water is enough to supply a family of four for a year, it starts to seem excessive. On most days in the garden, the fountains are not running to conserve water and energy.

Landscape architecture is a career that steadily evolves with the needs of the people. At the time of Versailles construction, the success and power of a landscape reflected the success and power of the landscapes owner. King Lois XIV was the self proclaimed Sun King (Andr-Lablaude, 27), and needed a landscape to reflect his great importance. For this reason, having water from several miles up stream relocated using horses and windmills to demonstrate his power was the ultimate sign of the King's dominance over a region, and, subsequently, a successful landscape. The landscape architects of today are hopefully much more focused on the long-term impact of the spaces they create to benefit both their clients and the greater surrounding environment.

The main issue facing landscape architects and the general population in California is the future resource availability of water for the state. The limitations on what can be implemented, altered, or constructed are more strict in California than almost any other place around the world, and this is affecting the residential sector greatly (Carle 19). These strict building guidelines encourage the creativity of California landscape architects to design spaces that have the same awe inducing impact that the Gardens at Versailles has on

millions, but with a drought tolerant and environmentally conscious outlook.

In California today, the term drought tolerant has become almost universally accepted as the gold standard of residential landscape design architecture. This term has been so embraced by landscape architects and designers, drought tolerant landscapes have even acquired their own aesthetic, many of which include sparse planting and rocks as featured elements much like image 1.3 to the left. Much in the same way that the English Cottage, Persian, Japanese, and many more gardens styles have intrinsic aesthetics value, now so does the drought tolerant landscape (Edinger, 65). But the term drought tolerant is much more versatile than many residential home owners may think, and can create spaces with far more interest that most give it credit for. With so much emphasis being placed on drought tolerant and low water landscapes today, California landscape architects are rising to the challenge and creating spaces that limit residential water consumption without limiting an individuals personal design aesthetic.

Image 1.3 Drought Tolerant Landscape

Since water is the hot topic in California's landscape architecture world, many other important aspects of California landscaping have been diminished. Although water is an essential part of California landscaping, in order to create the most sustainable design for a space a holistic approach to residential landscaping must be taken. Aspects of landscaping such as fire safety, site appropriate planting, ecology, stainability, and personal taste also have to be considered in order for the space to be considered truly successful for the client

and the environment.

This document will provide a thorough yet concise resource for Landscape Architects, Designers, and homeowners to reference when designing California residential landscapes. The various chapters will highlight how best to construct a landscape that can fit specific requirements such as landscaping for fire safety, landscaping for ecology, and landscaping for water harvesting. In the final chapter, a design will be presented that applies these specific factors to a small residential landscape design for a homeowner in Rocklin, California.

Chapter Two:

Water and the State of California

Image 2.1 California Aqueduct

Water is an issue in the forefront of many Californian's minds today, however the issue of water in California dates back to the time of settlement in the state. Considering that it takes roughly 8 gallons of water to grow one tomato, and 616 gallons to make just a single hamburger patty, a farming state with a water issue should be an issue that is seriously addressed (Carle, 8). The food consumed by the average Californian on any given day represents an investment of 4,500 gallons of water according to the California Farm Bureau, and that is before personal use and landscapes are even considered (Carle, 8). In the densely populated state of California where in a good year it rains sporadically for six months, water shortages are a very real and threatening possibility that should be on Californians minds as they go through their daily

routine (Carle, 10). Citizens of California are now some of the most water conscious individuals in the world, but many residential landscapes are still water loving environments. Californians need to alter their residential landscape water needs before the states water goes dry.

From 1987 to 1992 a drought challenged the very existence of citizens of California (Roos, 3). Before this time droughts had occurred in California, many of them quite serious, but it was the combination of the growing population and the longevity of this drought that altered the way California's lived from day to day (Roos, 3). Rationing of water occurred early on, grey water reuse started soon after. Built landscapes were destroyed, and even native vegetation and forests were struggling and dying off. After this extended drought finally ended, many individuals started looking at California's use of water in a different way. It was during this time that California residents started looking towards their personal water use in the home and landscape as a way to conserve water for the benefit of the state.

California's water issues are not a new problem. In fact, the history of California can largely be told through the struggle for water for drinking and irrigation (Johnson, Loux, 1). Past the mere shortage in supply for the growing population, one if the biggest problems that has been facing California's water supply since the beginning is the staggeringly uneven distribution of rainfall (National Atlas, 2008). Most of the rainwater falls in the northern half of the state, and most of the people live in the southern half of the state (National Atlas, 2008). This is shown graphically on the maps on the next page. Large channels, aqueducts, and dams have been constructed to try and move water to meet needs of the people, instead of having the people move to meet the water. Though this is inefficient and illogical, it is so deeply ingrained into the history of California that will likely never change.

Water in California has been allocated in many different ways, however

it has always been available to homeowners with little or no struggle (Carle, 84). With a constant water source, many homeowners associations enforced strict regulations for the landscapes, which historically would restrict any kind of landscape design past the use of other than lawns and lush shrubs (Thompson, 2009). The idea of an expansive lawn leading to the entry to the home was an idea brought to America from England, where the design is much more conducive to the native climate. Most of California can be categorized as an arid desert, where lawn is anything but natural.

Water is a pressing issue in California today, especially considering the expected growth of the population. Current data is showing that the area in California that will receive the greatest influx of people will be in the south eastern region of the state (DOF, 2009). Before a new development is build in the state, developers first have to first prove enough water is present to meet the needs of the homes without hindering use or future use to the existing area. The map on the next page shows the south east to be an area of the state that overwhelmingly receives less than 10 inches of rain per year, and most of the water for that area is brought in from the north. Because of the low levels of rainfall in this region, the area is classified as a desert (Lancaster, 53).

In order for this new growth to occur, the areas of old growth will have to reduce and conserve the amount of water used. This is where retrofitting landscapes and home appliances plays a large role. In previous generations, it was many agreed that native or drought tolerant landscapes for a residents was messy or unkempt, simply because it differed so greatly from the traditional suburban landscape. This idea has impeded the forward movement of drought tolerant landscape design, and is still and issue that Californian's are struggling with today.

Landscape Architects, designers, and home gardeners around the world take into consideration how to make spaces that benefit their region while

incorporating their personal design preferences. Californians have to go the extra mile to insure that their spaces are low water yielding to insure their future in the state. If California residents do not step up and reduce their personal water intake for their landscape, California's population will not be able to flourish.

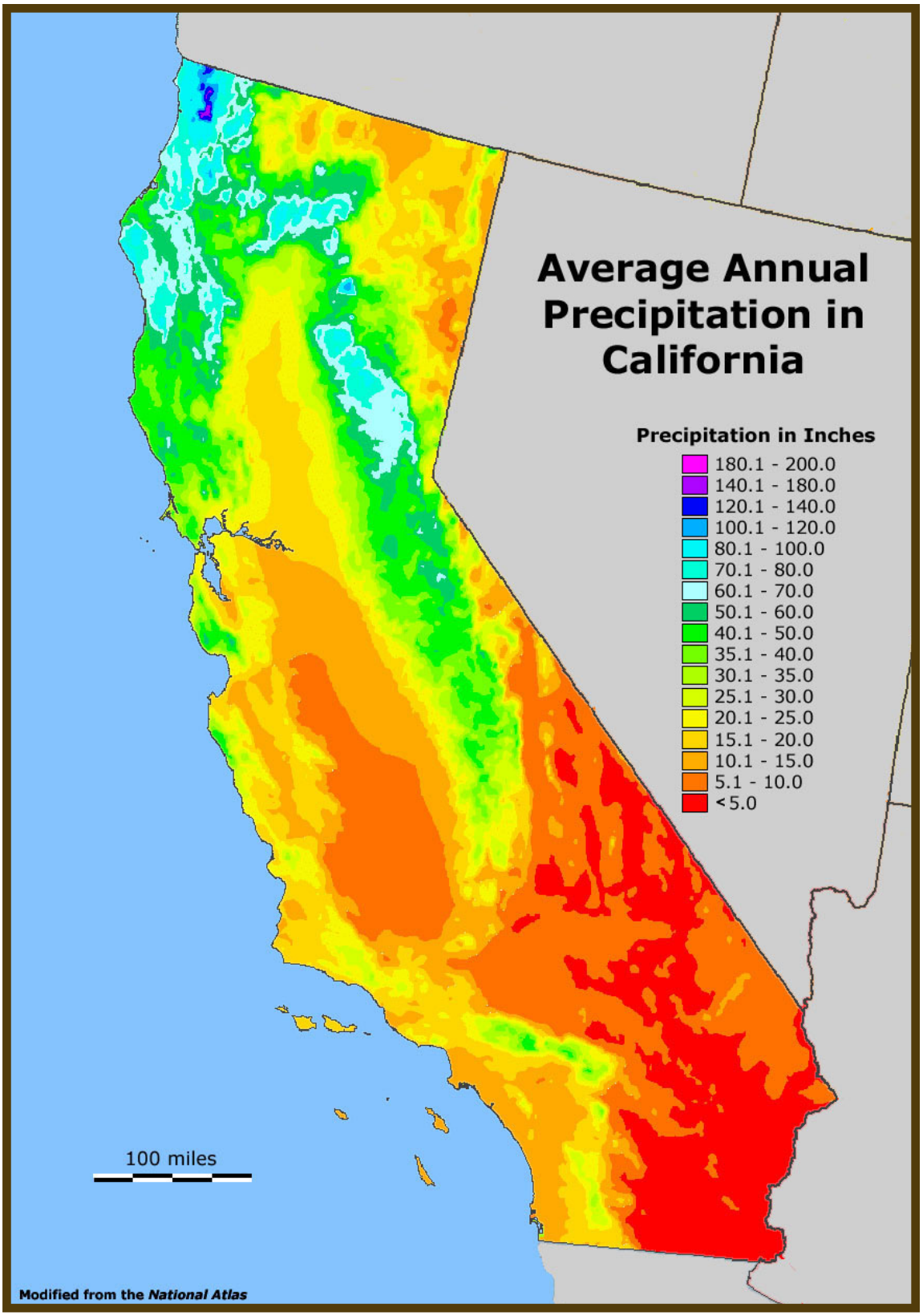


Image 2.2 California Precipitation Map

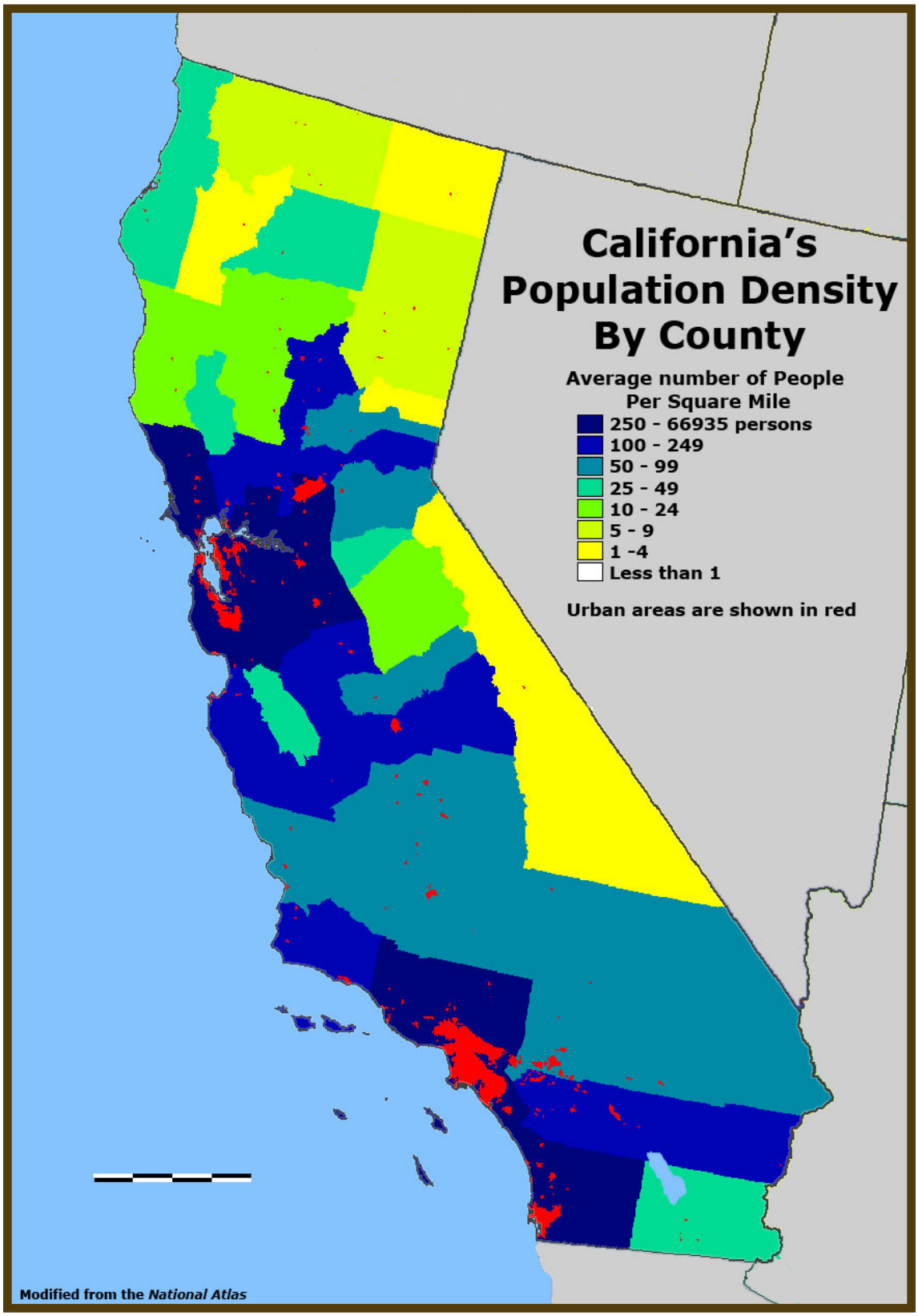


Image 2.3 California population map

Chapter Three:

Fire Resistant Landscaping

Image 3.1 Fire near Los Angeles, California, Fall, 2007

Each year, thousands of new residents flock to California for the beautiful coastlines, pristine foothills, and scenic mountain views. As residents of California eventually learn, living in the Golden State means living with wildfire. Much of California's native plants and landscapes depend on routine fires to thrive (Kent, 19). Some of the native plants like Manzanata have seed casings will only split open under the heat of fire. Other natives can only survive if the dead brush is cleared and other plants are not allowed to become overgrown (Kent, 11). Unfortunately, these necessary wildfires can be detrimental to California residents who are forced to collect their valuables and flee from their homes each time a wildfire creeps towards their property.

Since fires are a natural part of life for many in California, residents need to be educated on proper percussion to insure that their property remains safe. Increasing the chances that a home will be safe in a fire is less random that it may appear. For a personal residence, the best way to protect valuables from a wildfire is with a strong fire resistant roof (Kent, 29). The second most important is the landscaping leading up to the home. In the most recent batch of fires in California, fire fighters focused their property saving efforts on personal homes that followed a few simple design rules.

Image 3.2 Residence saved by smart landscaping

Many residential homes in California sit on varied topography, home location can drastically increase danger from wildfire. Locating a structure on a ridge at the top of a "fire chimney" can create fire drafts that will make some homes extremely difficult to protect (Kent, 44). A "fire chimney" is any steep area with seasonal drainage, causing low thick vegetation (Kent, 44). With California's long dry season, the vegetation dries out. If started, a fire will travel rapidly up the chimneys. Often home

Image 3.3 Fire Chimney, Santa Barbara, California

location may have been decided years prior to your ownership. Only landscape maintenance can reduce fire danger to these homes (Kent, 21).

Of the various fire factors, landscaping is one of the most easily altered fire safe components. In more urban situations, choice of plant materials can greatly alter fire potential, and in rural areas, management of existing native vegetation can greatly reduce fire danger. In either case, maintenance to remove dead branches, to mow dried grass, and to remove pine needles and leaves is crucial. Irrigation will generally reduce flammability of plant matter, but in many areas of California soaking a landscape in preparation for fire season would not be practical or economically feasible (Kent, 36). The plant selection should instead be adapted to the elevation, soils, soil depth, soil moisture and shade found on the site.

Design Alterations For Fire Safety

Below is a list of fire safe landscaping techniques that can be applied to any home landscape to aid in fire safety. This list has been adapted from information found in Douglas Kent's book *Firescaping: Creating Fire-resistant Landscapes, Gardens, And Properties In California's Diverse Environments.*

- Clear brush and dying foliage away from your home at least 100 feet in every direction to create a defensible space. Increase this number to 150 feet if your home is located on a hill.
- When establishing your landscape, keep trees furthest from your house, shrubs can be closer, and bedding plants and lawns are nearest the house.

- Assess your fire risk. Is your home on a hill? Are you near highly flammable native vegetation or drought-damaged ornamental plants? If your answer is yes, your fire risk is greater than average.
- Image 3.4 shows a map of California that colors various regions of California based on their fire threat. The darker the color, the greater the threat.
- Eliminate the "fire ladder." Fire needs fuel to burn. You can sap its strength by robbing it of the continuous sequence of vegetation that can carry flames from your landscape to your house.
- Group plants of similar height and water requirements to create a "landscape mosaic" that can slow the spread of fire and use water most efficiently.
- Space trees at least 10 feet apart, and keep branches trimmed at least 10 feet from your roof. For trees taller than 18 feet, prune lower branches within six feet of the ground. As shown in image 3.5 to the left.

Image 3.5 Fire Safe Planting Guide

- Install fire resistant, drought-tolerant plants that have a high moisture content. Use plants that do not accumulate dead leaves or twigs. Keep your landscape healthy and clean. On a regular basis, remove dead branches, leaves and pine needles from your yard. These can serve as added fuel to a fire.
- Recycle/compost plant materials. Participate in your community's

green waste recycling program. You can also compost plant litter and create a money-saving alternative to store-bought soil and mulch.

Image 3.4 California Fire Risk Map

Low Water Fire Resistant Plant List

Trees

Scientific Name	Common Name	Description
Calocedrus decurrens	Incense Cedar	Slow growing at first, however once established it can grow 2 feet each year. This stunning conifer is able to adapt to nearly any climate in California with no pruning required. 75-90 feet tall
Pinus lambertania	Sugar Pine	Slow growing in youth, then speeds up to rapidly reach 200 feet tall. Dark blue green needles with a flat top shape with age.
Quercus sp.	California Oak	Hundreds of species all native to the northern hemisphere. California oaks have adapted to the long dry season by tapping an extensive root system. Height and width vary greatly among species, but all could use a periodic pruning.
Umbellularia californica	California Laurel	In the wild this tree can grow to 100 feet tall, however in garden homes it usually grows about 1 foot a year to 25 feet tall. Yellow flowers are prominent in spring, followed by purple, olive like edible fruit. Tolerates many conditions, but grows best with regular water. Casts a heavy shadow unless thinned out.
Aesculus californica	California Buckeye	Grows 10-20 feet tall, and 30 feet wide. In spring, giant blooms of fragrant pale peach flowers. Plants often drop their leaves by July to revile silvery bark and gnarled branch shape.

Image 3.6 Aesculus californica

Image 3.7 Quercus lobata

Shrubs

Scientific Name	Common Name	Description
Arctostaphylos sp.	Manzanita	A stunning evergreen shrub with smooth and crooked reddish bark. Small pink and white flowers generally bloom late in winter or early in spring. Requires well drained soil, but can handle poor, rocky, or acidic soil conditions. Varies from a ground cover to a large shrub. Can be pruned into a small tree, however it is slow growing.
Arctostaphylos uva-ursi	Bearberry	A ground cover version of Manzanita that sprawls to 15 feet. Glossy green leaves turn purple and red in winter. Heavy mulching is encouraged between plants to suppress weeds.
Baccharis pilularis	Coyote Brush	Has remarkable adaptation to soil and climate. Creates a dense bright green mat of leathery evergreen leaves. Near the coast, requires no water. Inland conditions it looks best with monthly watering. Grows from 8-24 inches tall, spreading to 6 feet or more wide.
Dendromecon rigida	Bush Poppy	Showy displays of bright yellow 2 inch flowers. Depending on the variety, can be anywhere from 4 to 12 feet tall. Requires no irrigation and can handle full sun.
Heteromeles arbutifolia	Toyon	Grows in a dense shrub from 6-10 feet. Can be pruned to be a single or multi trunked tree. White flowers show in fall, followed by showy bright red pea sized berries in winter. Can be subject to fire blight, and looks best with moderate irrigation in dry areas.
Lupinus sp.	Bush Lupine	There are hundreds of varieties, many of which are native to the western U.S. Can be found in a variety of different conditions, but all need good drainage and most prefer slightly acidic conditions.
Rhamnus californica	Coffee Berry	This is used mostly as a background screening plant because of its ordinary foliage and unspectacular flowers. There are many varieties that alter in height and width.
Styrax officinalis	California Snowdrop	Provide a showy display of attractive white springtime flowers in hanging clusters. Deciduous tree or shrub needs well drained slightly alkaline soils, but does not have any issues with invasive roots
Rhus trilobata	Lemonadeberry	Brilliant yellow and red fall color in this deciduous shrub. Clumps to make a natural low hedge

Mimulus aurantiacus	Bush Monkey Flower	Woody perennial from 1-4 feet tall. Plant in full sun or light shade to flower several times throughout the year with showy flowers of yellow, orange or peach.

Vines, Herbs, and Grasses

Scientific Name	Common Name	Description
Achillea millefolium	Yarrow	Bloom from summer to early fall with bright yellow, peach, pink or red flat topped flowers on 3 foot stems. Provides a unique grey foliage for the landscape.
Allium sp.	Wild Onion	About 500 species native to the western US related to the edible onion. Have small round flowers that bloom in spring to summer in a variety of colors. Range in height from 8 inches to 5 feet tall. All enjoy well drained soils, with unique and delightful fragrances.
Brodiaea sp.	Brodiaea sp.	Bloom in spring and early summer, with a few grass like leaves. After flowering, plants die back to the ground.
Calochortus sp.	Mariposa Lilies	A bulb that demands long warm dry summers. Flower colors vary from yellow, purple, lavender, red, pink, to white.
Chlorogalum pomeridianum	Soaproot	
Clematis lasiantha	Foothill Clematis	A deciduous climbing vine with an attractive bloom that comes in a variety of shapes generally 6-8 inches wide. Flower color varies from pastels to crimson reds and oranges. Vines need some kind of structure to support their growth.
Epilobium (Zauschneria)	California Fuschia	Low sprawling flower from whites, to yellows, oranges, and reds. Tubular flowers attract hummingbirds, and grow in nearly every soil and climate condition. California Fuschia can spread easily by seed, and can get a bit woody after their first year of growth, but can be cut back at the end of each season to maintain their original lush grey green foliage.
Eschscholzia californica	California Poppy	One of the most easily grown flowers in California. Spreads to almost any area by wind and seed. Needs some sun to grow. Generally grown as an annual, but when grown as a perennial it becomes woody like the fuschia.
Festuca Californica	California Fescue	Grows in a loose clump of grey green, to silver white grasses. Generally 3 feet tall and 3 feet wide, but can be cut to maintain a smaller size. Can be used as a specimen plant or massed as a ground cover.
Solidago rugosa 'Fireworks'	Goldenrod	3 feet tall, 4-5 feet wide. Blooms with farrow streamers of yellow flowers from mid summer to fall.

Chapter Four:

Rain Harvesting in California

Rainwater harvesting is the process of catching rainwater and using it as close as possible to where it naturally falls (Lancaster, 1). In California and throughout the country, extensive storm water systems have been created to do just the opposite. In the average suburban community, rainwater falls on the roof of the house, is captured by the storm water gutters, funneled down to the street where it flows into the nearest storm drain. This is generally where people stop thinking about their storm water, unless the system backs up and causes flooding. But the water's journey is far from over. After the rain goes into the storm drain, it is carried to the nearest water body connected to the system. Though rivers and streams are where excess water generally ends up after running its course

Image 4.1 Point Source Storm Water Drain

through the natural landscape, it does not enter in the same quantity, with the same intensity, or from such specific locations as when entering through a point source entry like the storm drain shown in image 4.1 to the left (Lancaster, 12). This type of system can overwhelm the natural flow of water in a stream and create incised channels in otherwise healthy waterways.

An incised channel is a river which cuts its channel through the bed of the valley floor, as opposed to one flowing on a floodplain (Lancaster, 33). The channel formed by the process of repeated degradation of the same area. Incised channels can occur naturally, however they are generally an indication of accelerated and destructive erosion caused by humans alterations of natural systems (Lancaster, 33). Image 4.2 to the right is a severely incised channel that has been caused by generations of point source erosion and flooding.

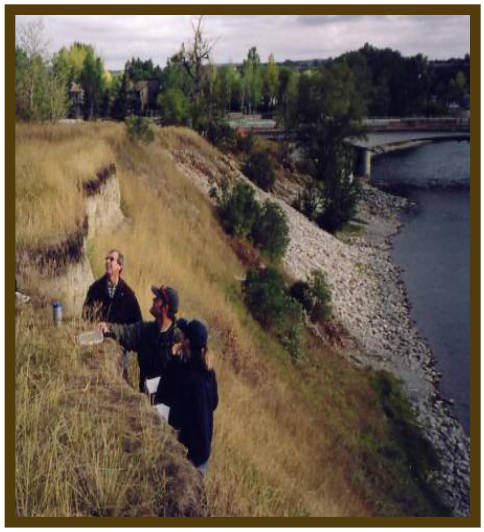


Image 4.2 Incised River Channel

As the population of California steadily grows, infrastructure is being placed to accommodate this growth, and as a result more concrete lined channels are built to divert storm water flows away from homes and towards

storm water channels. As storms move through the state, some homes only defence is the storm water drainage system, but as has been proved time and time again, these systems fail when they are overwhelmed. When these systems fail, water is pushed back into homes, sometimes causing millions of dollars in damage as in image 4.3 to the right. The simple solution is minimize our impact on system by capturing more water on site and preventing it from entering the storm water system (Lancaster, 12).

Image 4.3 Storm Drain Failure

Generally November is when rains really state in California, after 8 months or so of dry weather (River friendly landscaping, 28), These winter rains provide the bulk of California's water supply. Though the state tries to capture and retain as much of the winter rainfall for the coming year, large amounts of the states finite rainwater is lost as runoff. There are 2 reasons why California's winter rains, and especially the first heavy rains, have trouble making it into our reservoirs and water tables: First, California's prolonged dry season creates dry, compacted soils that struggle to absorb rainfall; and second, the state's increasing urbanization, and the hard surfaces that accompany urban sprawl, do a poor job of absorbing and holding onto rainwater (Lancaster, 19). As a result, the rainfall does not recharge the water table. Instead, the rainwater heads straight for the ocean (Lancaster, 19).

With California's increasing urbanization, runoff has become a major environmental problem. The Environmental Protection Agency ranks runoff among the top 3 threats to American watersheds (EPA, 2009). Runoff collects chemicals, heavy metals, and other pollutants, and delivers it to vulnerable aquatic ecosystems (EPA 2009). It also enters the watershed with incredible speed and force, literally scouring away sandbars, wetlands, and estuaries.

Hard surfaces, such as roofs, roads, driveways, parking lots (and even lawns) encourage rainwater to run quickly, and in large volumes, into storm drains and out to sea (River Friendly Landscaping, 28). Unlike meadows, marshes, or woodlands, whose soft surfaces soak up the rainwater and slow it down, these hard, man-made surfaces amplify the water's speed and force. Runoff also causes erosion, washing away valuable topsoil, and in some cases, runoff can trigger mud slides or landslides (EPA, 2009).

Rain Gardens

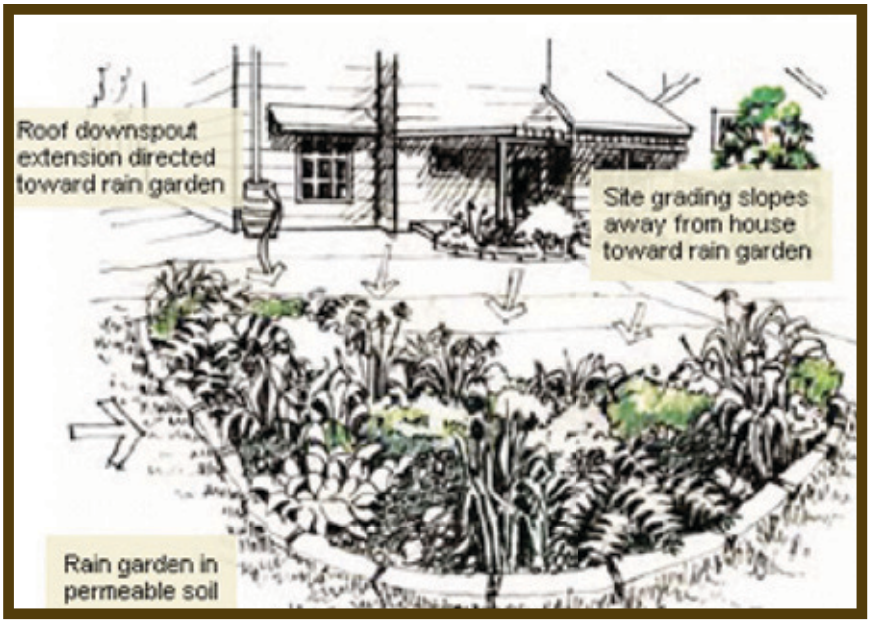


Image 4.4 Rain water draining away from the home

A Rain garden is one of the easiest alterations that can be made to a landscape to prevent urban runoff, and they are becoming increasingly popular in the personal landscape. A rain garden is a natural or dug shallow depression designed to capture and soak up storm water runoff from your roof or other impervious areas around your home like driveways, walkways, and even compacted lawn areas (Dunnett, 7). They can be used as a buffer to shoreline areas to capture runoff from the home landscape before it enters a lake, pond,

or river. The rain garden is planted with suitable trees, shrubs, flowers, and other plants allowing runoff to soak into the ground and protect water quality.

Rain gardens can be slightly complex in California because of our long dry season, however they do allow gardeners to recreate the natural hydrological cycle on a small scale. These gardens, which are designed to help slow down runoff and sponge up rainwater, can also help improve local water quality, filter out pollutants, decrease erosion, and even help replenish the local water table (Dunnett, 16). A rain garden should improve the soil's ability to filter and absorb rainwater, so they should be put in areas with good or amended soil. If the property includes an area where water consistently pools during a rainstorm, consider channeling water away from these areas, using pipes or dry wash, towards your rain garden (Dunnett, 31). A "dry wash" (a seasonal creek that only runs during the rainy season) can also be used to direct rain water away from the house foundation (Dunnett, 31).

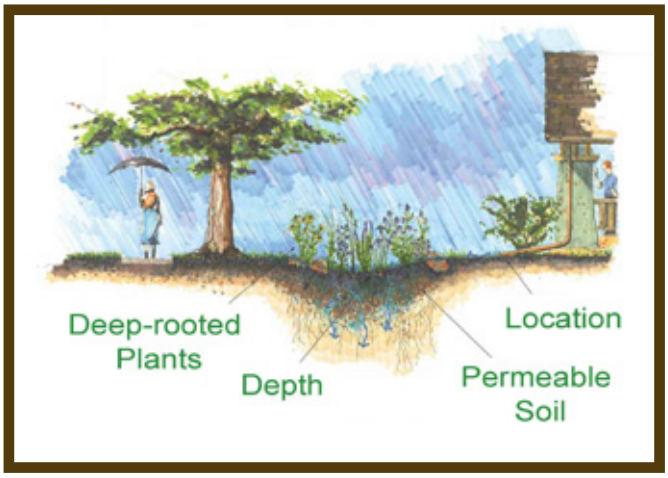


Image 4.5: Section of a Raingarden

Be sure to locate your rain garden at least 10 feet away from the foundation (Dunnett, 31). Gardeners with space limitations should consider installing a rain barrel or cistern to catch rainwater for landscape use. More will be discussed about these systems later. Additional features can be added to the rain garden including a water feature, like a permanent pond or a vernal pool. Water features attract and sustain wildlife, and provide valuable habitat for frogs, salamanders, and other aquatic creatures.

When designing a rain garden, consider using native plants, which

will provide food and shelter for local wildlife, and will also require less maintenance than exotics. Especially in California, native plants are adapted to handle both long dry seasons, as well as the wet seasons. This is not the case with plants that may be from Washington or Oregon, because the dry season in these states is not nearly as harsh. Strongly consider the natural ecosystem of the site, as well as your local micro climate before choosing the plants for a rain garden. Just as an example, the East Bay Hills sometimes struggle with their large variety of micro climates. Individuals living in the North Berkeley hills experience a wetter, cooler climate, where ferns, redwoods, and dogwoods thrive. However, individuals just a few miles north of Berkeley have a drier, sunnier environment, where the native plant community is best described as "coastal prairie" (Dunnett, 41). In this environment, the plants would include sedges (Carex spp.), Fescues, blue-eyed grass, Douglas iris, California checker mallows, mariposa lilies, and other meadow plants.

California Rain Garden Planting List

Trees and Shrubs

Scientific Name	Common Name	Description
Calycanthus occidentalis	Western Spicebush	Blooms with gorgeous pink to fuschia flowers. Enjoys shady places, but some sun won't hurt. This beautiful California shrub grows up to 8 feet tall.
Corylus cornuta	California Hazelnut	It bloom in the late winter, early spring and grows five to ten feet tall. Hazelnuts ripen in early fall and are rich in a variety of vitamins and minerals as well as anti-oxidants and fiber. Wildlife will enjoy these nuts year after year.
Myrica californica	Wax Myrtle	Can grow into a nice modest-sized shrub of two feet or all the way up to a medium-sized shrubby tree of twenty feet. Myrica californica is tolerant of sandy and clay soil and does well on sea-side locations.

Hysocarpus capitatus	Pacific Ninebark	Spreading shrub, growing three to eight feet tall, this shrub bears beautiful balls of white flowers that later release dried seeds. Ninebark prefers partial shade and can grow in sand or clay.
Salix lucida	Shining Willow	Grows to about 20 feet tall and it's yellow flowers bloom in early spring. It enjoys full sun, but make sure you give it plenty of space. It is often used to stabilize creek beds.
Ribes sanguineum	Red-Flowering Currant	Grows eight to ten feet tall and boasts brilliant red blooms in the early spring. This lovely shrub prefers the shade, but some sun won't hurt. Birds enjoy the fruit of this bush.
Rubus spectabilis	Salmonberry	This shrub produces raspberry like fruits, that are enjoyed by many species. Salmonberry grows three to ten feet.
Vaccinium ovatum	California Huckleberry	Huckleberry blooms in early spring with beautiful, pink, urn-shaped flowers and produces little blue berries
Washingtonia filifera	California Fan Palm	Grow 45 feet tall and prefers desert washes or palm oases. It also produces an edible nut.

Wildflowers, Grasses, Ferns, and Sedges

Scientific Name	Common Name	Description
Achillea millefolium	Common Yarrow	Bloom from summer to early fall with bright yellow, peach, pink or red flat topped flowers on 3 foot stems. Provides a unique grey foliage for the landscape.
Aquilegia formosa	Western Columbine	Yellow and orange flowers with red spurs. Plants are erect and range from 2 inches to 4 feet. Blooms early spring and summer.
Aralia californica	Elk Clover	A large deciduous shrub, can be pruned into a multi-stemed tree. Sends off suckers that can be invasive. Produces berry like fruit that can be enjoyed by birds. White flowers are showey in mid summer against the dark green foliage.
Carex nudata	California Black Flowering Sedge	Native to below the high water mark along perennial water courses. Forms a bright green, dense, arching mound with interesting black flowers in spring. Best in moist soils, full sun to light shade. 1 - 2 1/2 ft.. tall and wide. Winter deciduous. Beautiful in containers too. Deer resistant.
Carex barbarea	Santa Barbara Sedge	Rich green leaves 1 foot long. Forms a slowly spreading clump that is good for erosion control. Does not need water, however it will grow more aggressively with irrigation

Chondropetalum tectorum	Small Cape Rush	This is a beautiful, clumping, reed-like plant from South Africa that gets to be 4' tall. Along the length of the wiry green stems, brown bracts create bands that have quite an ornamental effect. At the tips of the stems clusters of small brown flowers appear. Found growing in marshes & seeps in South Africa, it can also take drought once established.
Darmera peltata	Umbrella Plant	Indian rhubarb has tall pink flower spikes in mid spring followed by 1-2 feet wide leaves atop tall stalks. Seen in the mountain stream beds of Northern California, it provides an almost tropical effect to the other wise woodland setting. Usually grown in the shade, it will nonetheless do well in full sun where the leaves turn a bright red in fall. The large rhizomes cling to rocks and dip their tails into the water, looking like green lobster tails. Very hard to find in nurseries.
Delphinium glaucum	Tower Delphinum	This wildflower is native to western North America from Arizona to Alaska. It grows in moist mountainous environments, such as riverbanks and meadows. This plant sprouts one to several tall, stout, pale green erect stems which may approach three meters in height.
Decentra formosa	Pacific Bleeding Heart	Generally found in moist wooded areas from California to British Columbia. The plant can approach half a 3 feet in height. The flower has four petals between one and two centimeters long in shades of purple to pink to nearly white.
Epipactis gigantean	Stream Orchid	Giant helleborine is a perennial Orchid that grows in wet or moist places. Stream Orchid will go dormant at the first sign of drought. Grows all over the West from Texas. to B.C. to S. Dakota, always in distinct locations, not uniform distribution. The orchid flowers are pale yellow-brown to yellow with purple veins.
Epilobium canum latifolium	California fuchsia	Unusual pink flowers selection. Takes regular garden care. Afternoon shade in hot inland areas. Likes water but can handle drought conditions. Flowers summer through fall. Can go under oaks.
Erigeron glaucus	Beach aster	A great butterfly plant and provides a cool blue spot of color in a coastal garden. A bit of nature for a sunny perennial garden in San Francisco or part-shade garden in Los Angeles. Mix with monkey flowers, Stachys, Iris douglasiana or Salvia spathacea. Out of its range Seaside daisy likes a little extra water and hates dust.
Eriogonum fasciculatum	California bickwheat	Very drought tolerant. Can be used in place of Roses because of the longer flowering period, and less water needed. Very important to butterflies as one of the pillars of their communities. Flowers, leaves and seeds are all used by butterflies and small birds. White flowers come on in late spring, gradually turn pink in summer, then rust colored in fall. The rusty flowers commonly stay on until the next spring.

Festuca mairei	Atlas fescue	A densely tufted, evergreen, perennial grass with glossy, pale gray-green, flat leaves, reaching 24 to 36 inches long. In early summer it bears spikelets of gray-green flowers. They are often used in landscaping, where wonderful effects can be achieved with just ornamental grasses, or when skillfully mixed with other appropriate plants. A good species to use on a slope for erosion control. Require good drainage and full sun.
Gaillardia spp	Blanketflowers	These plants form wiry, branched stems with lanceolate to linear basal leaves. The plant grows to 1 1/2 to 2 feet tall, with bright daisy-like single color and bi-color blooms in shades from buff to red to brown. The flowers bloom in the summer. There are more than two dozen known species of Gaillardia. They will grow under very harsh and dry conditions, forming mounds, 8 - 18 inches high, and will even bloom in sand along a seashore.
Juncus patens	California Gray Rush	Clumps of round, steely blue-grey leaves provide an upright, grassy effect. Fabulous accent plant for the sunny wet garden: combine with Spider Lilies and Sarracenia to create a bog with all-season interest. Grows well at water's edge or in a pond container. The insignificant brown flowers are not the strength of this distinctive plant — it's the blue foliage. 1-2' tall in moist-to-wet locations in full sun.
Lilium pardalinum	Leopard Lily	A native of damp areas in the coastal ranges of California. Typically it grows to about two meters high, the tallest and most vigorous plants can reach up to 2.5 meters. The flowers are Turk's-cap shaped, red-orange, with numerous brown spots, usually flowering in July. The bulbs are small, and many are usually clustered together on a rhizomatous stock.
Mimulus cardinalis	Scarlet Monkey Flower	A perennial to 3'. It likes sun to full shade It has 2" red tubular flowers most of the year. An aggressive seeder. It's serpentine tolerant and an important Hummingbird flower. The flowers are very showy and it is native in the mountains surrounding the deserts.
Mirabilis multiflora	Giant Four O'Clock	Perennial plants that die back to their roots each year. These plants form large clumps from multiple stems, are 1-3 feet tall and as broad or broader. The dark green leaves are opposite and are round to egg-shaped -- At times they appear heart-shaped -- With short petioles. The leaves and stems may be either smooth or have sticky hairs. The leaves vary from 3/4-7 inches long and are often pointed at the tip.
Muhlenbergia rigens	Deer Grass	Deer grass or meadow muhly, a robust, perennial bunchgrass, grows 3-4 ft... high, with narrow, 2 ft.. plumes rising above light-green blades. The plant resembles a small pampas grass.

Muhlenbergia capillaries	Purple Deer Grass	A knee high purple haze in the distance may not be an atmospheric event, but the effect created by the wispy, purplish flower heads in a dense stand of Gulf muhlygrass. This is a showy clump forming grass that can get to 3 ft.. tall and just as wide. The stems and leaves are wirelike and unbranched, originating from a dense basal clump. (Muhlygrass does not produce runners.) The purplish-red or pink inflorescence is a diffuse, silky panicle, 18 in long and 10 in wide, that stands above the wiry leaves. It appears in late summer, and persists for 6-8 weeks. The ripe seeds that follow give an attractive tan color to the wispy plumes.
Penstemon heterophyllus	Beard Tongue	A rather long lived perennial with hundreds of one inch violet flowers on three foot spikes in spring and summer. Likes full sun, is drought tolerant, needs good drainage. Has been alkali tolerant. An excellent dry land garden plant. If you trim the flower heads after the first flowering you can induce a second flowering. It is very stable in coastal, desert or mountain planting, if not over watered, fertilized or otherwise abused.
Polypodium californicum	California Coneflower	A creeping perennial fern that grows in moist rock crevices. Almost always associated with seeps in the coastal areas and in the middle Sierras. Usually in part-shade, sometimes in the fairly deep shade of bays (Umbellularia californica). It does occur in the shade of many of the oaks, particularly the live oaks. Soils can be heavy clay, gravel or just rock. Polypodiums just need wet feet in winter and early spring, as the ground dries out, so do they, gradually going dormant in mid-summer.
Salvia greggii	Cherry Sage	A soft, mounded shrub is 2-3 ft.. tall, with small, crisp, green leaves which are evergreen in warmer climates. Minty, aromatic flowers can be red, pink or white and are borne in ascending spikes. A minty-smelling shrub with many branches and few deep pink to reddish-lavender, bilaterally symmetrical flowers in each leafless raceme.
Salvia leucophylla	Purple Sage	A three to six foot evergreen shrub with flowers that are light purple in Summer. Has leaves that are whiteish grey. This sage occurs on dry slopes and needs sun, no water after established. Can be grown in any soil type, however prefers clay.

Rain Catchment in California

Rainwater harvesting is the storage of rain in receptacles placed above or below the ground in barrels similar to the one in image 4.6 on the next page (Lancaster, 34). Though rain harvesting has been in practice for centuries, the practice has been resurrected to counter drought conditions and address the need to conserve water in cities throughout the United States.

Image 4.6 Rainwater Catchment System

In California, rain water catchment is becoming more common, however, it is mostly successful in areas that have enough rain to support the added system. Many areas of California, especially in the Southern half of the state, only 15 inches of rain a year (DOF, 2009). This is a significant amount of rain, however it is not necessarily logical to catch this rain, then hold onto it for months until it is needed in the dry season. Water catchment is especially successful in areas that receive small amounts of water throughout the year, but areas like the Bay Area in California that receive around 30 inches of rain are also quite good (Lancaster, 80). Below is a chart showing how much water can be caught with the California Rain Conservation System, a 50 gallon storage tank.

Roof Sq. Footage	Inches of Rain	Collectable Gallons
1,000	30”	18,690
1,500	30”	28,035
2,000	30”	37,380
3,000	30”	56,070
6,000	30”	112,140

If rainwater harvesting barrels and collection tanks are widely distributed and used in conjunction with other water-sensitive development practices such as low impact development and conservation design, a substantial fraction of runoff can be removed from the drainage system (Lancaster, 32). This, in turn, potentially would reduce sewer overflow events and reduce bacterial and

other pollutant concentrations in receiving water bodies. The used of harvested rainwater for outdoor uses such as watering lawns and gardens could reduce domestic potable water consumption by 10 to 30 percent, a substantial number in a dry year (Lancaster, 18). The use of roofs for rainwater collection is not a new technique, but is becoming more common as people's awareness of potable water limitations and costs increase. Just as with any system, there are many possible opportunities and constraints for individuals looking to add rainwater catchment to their home. Some of the benefits and issues are as follows.

Roofs are an ideal location for rainwater harvesting for three main reasons. First, gravity can be used to collect runoff thus eliminating the need for electricity for pumps. Second, when compared to toilet and other household wastewater, water collected from roofs could be relatively clean. In Fact, using captured rain water to water plants is actually better for the plant than using regular municipal water. Rain water in most regions is extremely low in dissolved minerals such as salt and boron that are present in high quantities in conventional irrigation systems (Lancaster, 91). Plants are extremely sensitive, and these minerals can cause burning on the foliage as can be seen in image 4.7 on the following page. Davis is one of the notable exceptions to this. There are so many cows in Davis that the pH of the rain water is extremely basic, and can do far more damage to plants than other minerals. Finally, third, a second and separate plumbing system would not be required. Other side benefits of using reclaimed water include cost savings to the consumer via reduction in municipal water consumption and increased efficiency for the drinking water authority in that less water must be treated, especially during hot, dry days when

Image 4.7 Salt Damaged Leaves

overall water use is likely to be higher.

While roofing seems like an obvious choice for rainwater harvesting, there are some drawbacks in using this resource. Laboratory studies of roofing materials purchased at a local big-box hardware store demonstrated the potential for pollutant leaching into the environment (EPA, 2009). A large reservoir of nutrients and metals existed in these materials, and, if the environmental conditions were favorable, some of this reservoir potentially could be released into the runoff. Some common high level contaminants include: pH, nitrate, phosphorus, and heavy metals all of which could be detrimental to humans and to the landscape.

One of the final arguments that can be made against the use of catchment basins and any kind of rain harvesting devices is the idea that water traditionally goes into storm drains has a greater purpose for those 'downstream.' Parts of Colorado have made it illegal to capture water for personal use in the home, landscape, or otherwise (Castle, 2009). The thinking is that the water that falls on a residents property will eventually end up in a stream, river, or reservoir, the rights of which are sold to another (Castle, 2009). So an individual capturing water off his or her own roof is effectively stealing from the individual who would get that water from the stream, river, or reservoir.

Rain water harvesting in California is quickly gaining popularity, especially with the threat of drought and unsteady supply of water. There is great potential for rain water harvesting, however it still has several years to go before it is a viable option for a majority of individuals in the state.

Chapter Five:

Residential Landscaping and Ecology

Image 5.1 Butterfly Pollination

Ecology is a field that is ever growing in importance in the realm of Landscape Architecture. Ecology is the study of the relationships and interactions between living organisms and their natural or developed environment (Turner, ix). This field really began to flourish in the 1970's when people began to notice that their actions had an impact on the natural environment. Because of the strong diversity of regions in the state, California has a very complex ecology (Turner, 14). On the residential scale taking the specific ecology of the site into consideration when constructing a landscape can benefit the site itself, as well as the greater region and state.

The proper assessment of the ecology of a site can lead to the success

or faultier of the landscape. One extremely important part of this ecology is the health of the soil mycorrhizal grid (the symbiotic relationship between plant roots and fungi) (Turner 52). The nature of the relationship between native plants and the mycorrhizal fungi which attach to them is symbiotic, meaning that it benefits both sides (Turner, 52. The fungi, which do not photosynthesize and so cannot make their own food, receive carbohydrates that the plants produce. The fungi in turn help break down matter in the soil into usable nutrients that the plants need and, being better suited than plants' roots to absorbing these nutrients, subsequently "share" them with their partner plants. Thus, mycorrhizae are especially beneficial for the plant partner in nutrient-poor soils, like those which occur frequently in California.

Understanding specifics about the soil of the site can lead to the success or failure of a plant (Turner, 59). Many plants native to California are unable to grow in water logged or compacted soils. Unfortunately, due to the nature of home construction today, extreme soil compaction generally occurs in the landscape. Before adding plants (trees in particular), be sure to take the time to break up the soil and provide plenty of space for roots to grow and spread comfortably.

Residential Wildlife Ecology

Moving away from the soil, animals provide a key ingredient in California ecology. Pollinators facilitate reproduction in 90 percent of the world's flowering plants, and on average, one in every three bites of food humans take is the direct result of an animal pollinator (Shepherd, xxi). Throughout the world, habitat loss is the leading cause of species endangerment and extinction. In California, large portions of the land has been cleared due to agricultural and urbanization pressures, leaving

marginal and fragmented habitats for animals (Turner, 32). Consequently, backyards play an increasingly important role in wildlife conservation. The negative effects of habitat loss on birds, bees, butterflies, and other wildlife species can be diminished by creating a favorable landscape. Providing wildlife-friendly habitat in urban and suburban areas is especially important for migrating birds and butterflies. These groups of animals also are least likely to cause nuisance or damage problems.

Creating a habitat for animals in a home landscape is not as complicated as it sounds. In fact many residential landscapes already contain the items needed for many insects and animals to thrive. A wildlife-friendly landscape is composed of four essential items (Shepherd, 24):

1) Food year round
2) A clean source of water
3) Protective cover or shelter
4) A suitable place to raise young.

To provide the most beneficial habitat for birds, bees, and butterflies, native trees and shrubs should be emphasized. Native plants are adapted to local conditions and, therefore require less maintenance (especially irrigation and fertilization). Native plants also provide the best quality resources because wildlife species are adapted to use native plants (Shepherd, 27). In California especially, it can be very difficult to plant with natives, simply because of the diversity of the region. Because a plant is native to a region of California by no means insures its success in California as a whole.

Exotic plants can threaten other plant and animal species. The California Invasive Plant Inventory is a document that categorizes non-native invasive plants that threaten the state based on an assessment of the ecological impacts of each plant. California is home to 4,200 native plant species, and is recognized internationally as a "biodiversity hotspot." Approximately 1,800 non-native plants also grow in the wild in the state (Turner,

24). A small number of these, approximately 200, are the ones that this Inventory considers invasive and should be avoided in landscaping (Turner, 25).

Before you start landscaping your yard, plan ahead. Map your backyard and determine what environmental conditions you have. This includes but is not limited to factors such as soil conditions, sun intensity, and micro climates. To provide optimal habitat for a diverse array of species in your backyard, choose a variety of trees and shrubs of varying heights to mimic natural structure. Plant a few different species of canopy trees, along with fruiting shrubs of various shapes and sizes. Choose plants that provide habitat or resources at different times of the year. For example, conifer trees provide cover and warmth during the winter, whereas fruiting trees provide seasonal food resources (Shepherd, 42). When choosing fruiting shrubs, select species that produce fruits at different times of the year to ensure that food is available throughout the season. In addition, many of the fruiting shrubs display large fragrant flowers that add to the attractiveness needed for any landscape.

Picking the Right Plant for Wildlife

Just as humans sensory system is geared towards a particular food preference, various pollinators have the foods that they prefer as well. This list is intended to aid designers. Landscape architects, and home owners to use to attract or detract particular forms of wildlife. Some of the preferred shapes, colors, and other attributes are given to help pick the perfect plant for the preferred pollinators. Here is a list of those attributes, all gathered from information provided by Pollinator Conservation Handbook: A Guide to Understanding, Protecting, and Providing Habitat for Native Pollinator Insects. All of these insects live in California, and are vital to the pollination of California plants.

Plants Pollinated By Ants: Ants visit inconspicuous, low-growing flowers positioned close to the stem. Examples of ant-pollinated plants in North America include Small's stonecrop (Diamorpha smallii), alpine nailwort (Paronychia pulvinata), and Cascade knotweed (Polygonum cascadense).

Image 5.2 Bee Pollination

Plants Pollinated By Bees: Bees are attracted to bright white, yellow, blue, or violet flowers, or those that reflect ultraviolet light. Ultraviolet patterns called "nectar guides" may be present. The flower's shape is often tubular with moderate to abundant nectar at the base of the tube. Pollen is often limited. Small, short-tongued bees prefer clusters of tiny flowers such as marigold, daisy, aromatic herbs, phlox, and butterfly weed. Bee-pollinated flowers smell fresh, mild, or minty.

Image 5.3 Beetle Pollination

Plants Pollinated By Beetles: Beetles tend to pollinate flowers that are dull white, yellow or green with an odor that is often unpleasant to humans, perhaps strongly fruity or fetid. The flowers are large and flat or bowl-like, with sexual organs exposed and pollen ample and easily accessed. Nectar may be absent. The flowers may be solitary or in clusters of smaller flowers. Examples of beetle-pollinated flowers include: magnolia, aster, sunflower, rose, butterfly weed, pond lilies, goldenrods, and Spirea.

Plants Pollinated By Butterflies: Butterflies feed from bright red, orange,

yellow, pink, blue, or purple flowers that are often large and showy with a faint fresh odor. Pollen is often limited. The flower often features a funnel shape or narrow tube with nectar at the base, as well as a landing platform. Examples of butterfly-pollinated plants include: zinnia, calendula, butterfly weed, yarrow, goldenrod, Spirea, milkweeds, honeysuckle, and daisy. Butterflies also require foods in addition to nectar, such as animal droppings or rotting fruit. Butterflies also need plants in which to lay eggs and provide food for larvae (caterpillars). These may not be the most typical or desirable of garden plants; in fact, some are plants that you might otherwise consider "weeds." And of course the leaves will be damaged by caterpillar foraging. Good plants for larvae include milkweed, aster, lupine, thistle, fennel, violets, hollyhock, and black-eyed susans.

Image 5.4 Fly Pollination

Plants Pollinated By Flies: Flies visit pale and dull green, white, or cream flowers, and sometimes dark brown or purple; sometimes the flowers are flecked with translucent patches. Preferred flower shapes include simple bowl shapes, funnel-like shapes, or complex shapes. The most noticeable aspect of fly-pollinated flowers is often their odor, which may be similar to the smell of decaying protein (e.g., carrion or rotting meat). Nectar is usually absent and pollen is limited.

Plants Pollinated By Moths: Moths visit pale and dull flowers - Often white, pink, purple, or red - that open in late afternoon or at night, at which time they typically emit a strong and sweet odor. The flowers, often described as large and showy, are tubular with deeply hidden, abundant nectar and limited pollen. Flowers may form clusters that provide a landing platform. Examples

of moth-pollinated plants include evening primrose, morning glory, tobacco, yucca, and gardenia.

Plants Pollinated By Birds: Birds often pollinate scarlet, orange, red, or white tubular flowers with perch support and the petals curved out of the way. Bird-pollinated flowers are typically large and showy with abundant nectar and usually lacking in a noticeable scent. Unlike other birds, hummingbirds do not require perch support because they hover while feeding on nectar. Examples of hummingbird-pollinated plants include honeysuckle, sage, fuchsia, jewelweed, fireweed, cardinal flower, bee balm, nasturtium, century plant, columbine, and red salvia.

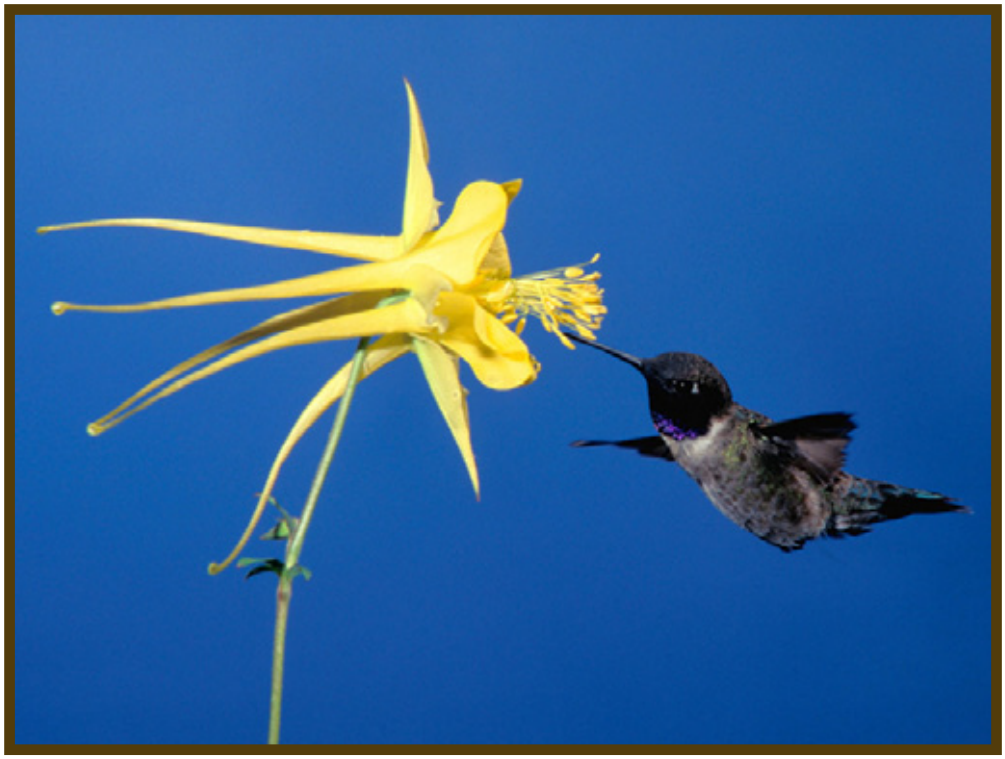


Image 5.5 Bird Pollination

Chapter Six:

Beautiful, Low Water, Sustainable Design

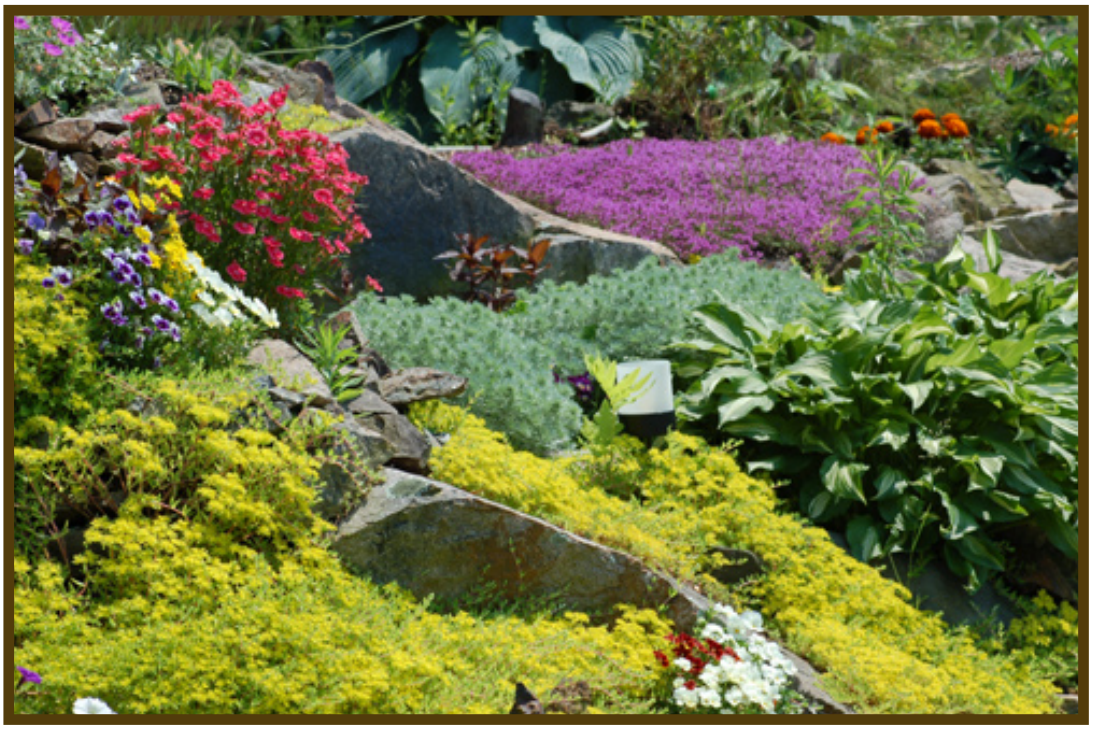


Image 6.1 Colorful drought tolerant rock garden, Santa Ynez, California

Throughout the state, rules and regulations have been put forth to help residents conserve water in their home landscapes and lower their personal water use. Though these rules and regulations have yet to be strictly enforced, their presence alone is encouraging many individuals to make the initial jump towards a more sustainable lifestyle. Lowering personal landscape water uses helps to reduce water needs for individuals, allowing more water to be retained in reservoirs, help sustain the natural wildlife, and support the ever-growing population.

The initial steps to creating a beautiful, sustainable, and low water landscape may take a little more thought than a landscape consisting of lawn

alone, however the end result will be far more interesting and spectacular. Creating interest year round that caters to an individuals aesthetic. The realm of drought tolerant or low water plants is extensive, and can fit the tastes of almost any individual. Since lawn has the same look and style all year, it creates a static landscape with little interest. Lawns are not terrible, and I would argue that it serve a very important purpose in our society, and even in our homes. The issue with lawns arises when they are over used, over watered, and are mistakenly identified as a low maintenance. With the most common varieties of lawn, regular watering, regular fertilizing, and regular mowing is required simply to keep them looking green (Ondra, 14). This creates added green waste to the environment, added fertilizers and pesticides and nutrients that can enter the water ways, and added water that the state does not have (Ondra, 15).

Image 6.2 Low Water Lawn

There are many types of grasses, indistinguishable from lawn, that will lower water needs, lower the use of fertilizers, and lower maintenance requirements. A mix of on the market today contains a combination of Sheep Fescue, Chewings Fescue, Hard Fescue, Creeping Red Fescue, and Perennial Ryegrass (Ondra, 42). This combination show in the image to the left is almost indistinguishable from traditional lawn, but has half the water requirements (Ondra, 42). Also, unlike many lawn grass seed mixtures, these Fescues require nitrogen fertilizer only in extreme situations. This particular fescue mix has a very slow growth rate, if

maintained as a lawn, mowing requirements will be almost non existent (Ondra, 42).

Between pets, children, and recreation spaces, grass will probably never completely leave the realm of residential landscape design, so these small alterations that can make the space more sustainable become very important. The remainder of this chapter will focus on alterations that can be made to a landscape to increase the stainability of the design, lower water needs, and create an aesthetic that appeals to home owners of varying tastes.

One of the most important parts of planting a low maintenance, low water garden is choosing the correct plants for the space. Unfortunately, this may take some trial and error, because not every plant grows where the label says it should. Take care when picking out plants, and make sure to check that they can grow and thrive in the provided space. The image to the right is a far to common site in residential and commercial landscaping. In an effort to keep large shade trees small, their are cut back to stumps every year so they can sprout controlled new growth for the spring. On top of having this awkward interim period for most of the winter and spring, this type of pruning can expose the tree to disease, and cause a gnarled growth at the top of the cut point. This type of pruning also creates large amounts of green waste every season.

Image 6.3 Poor Tree Choice and Pruning

Sustainable in the Landscape

Sustainable design is a catch phrase that has been taking over every realm life, and the landscape is no different. People are now striving to reestablish their property as a totally sustainable system. For the means of this document, sustainable design will be classified as the intention to "eliminate negative environmental impact completely through skillful, sensitive design," as stated in the Philosophy of Sustainable Design by McLennan, J. F.

To eliminate the negative impact on the environment for something small like a residential home may sound simple, however it is far more complicated that it may initially seem. Many aspects of residential design that we embrace as standard can have a negative impact on the environment. Extreme care has to be taken to insure that a landscape is as sustainable as possible to benefit future generations.

Starting small, create a compost pile to dispose of organic household and yard material (McLennan, 2004). As these materials break down, they create nutrient rich soil that can be recycled into the landscape. If there is green waste on the property that cannot be put into the composing such as tree limbs or grass clippings that take too long to break down, use a green waste system, but be aware. Not every green waste program composts the waste, in fact most of the waste is taken to a landfill. Instead use plants that stay the appropriate size for the landscape. This will require less overall maintenance and prevent added material in the local landfill.

Although pesticides and herbicides are becoming less harmful, it can still cause pollution if they end up in the local water system. Though pesticides can kill insects that can hurt your landscape, they can also harm beneficial insects like those discussed in the ecology chapter. If pesticides

and herbicides must be used, use them sparingly to insure they do not enter into the greater ecosystem (McLennan, 2004).

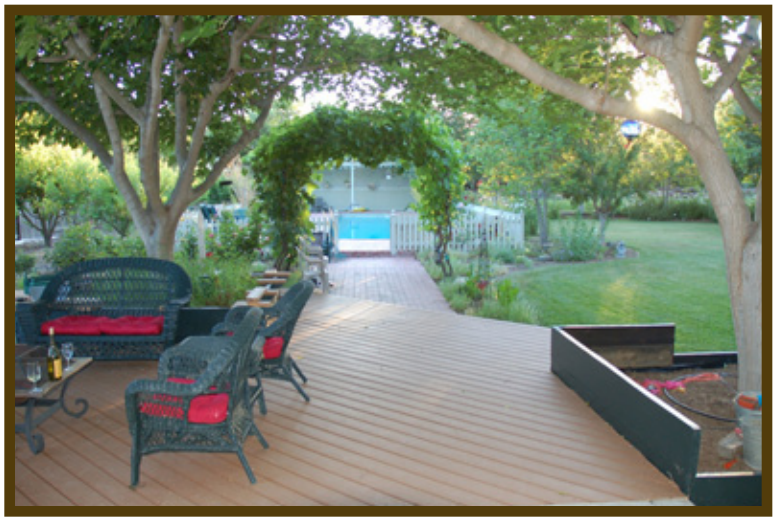


Image 6.4 Example of a WoodTrex Deck

There are many alternatives on the market now that take the place of natural resources such as wood. Instead of using highly refined materials like pressure treated wood for a deck, use recycled Wood Treks. The look is basically the same, but instead of being made of wood, it is made of recycled plastic. On top of having a longer life expectancy than actual wood, it also never has to be varnished or refinished, reducing the amount of materials used on site.

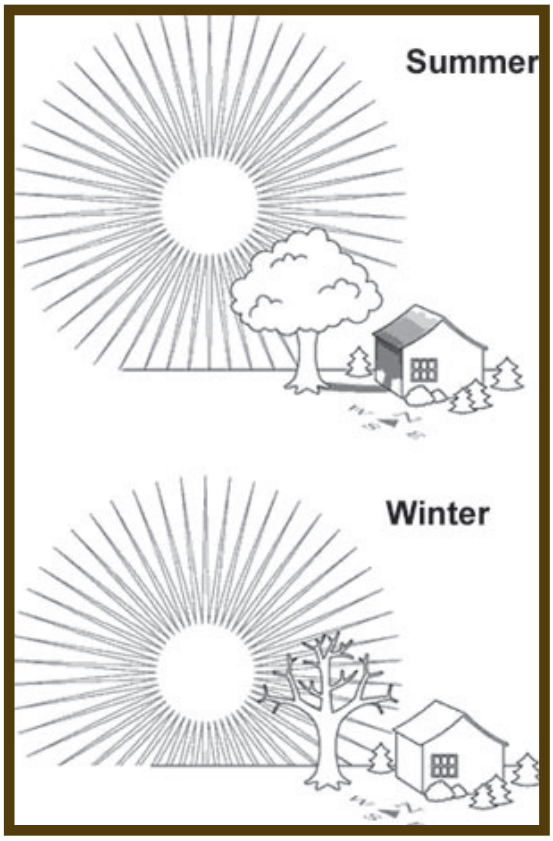


Image 6.5 Energy Efficient Planting

Small design implements can make a huge difference for energy costs. Carefully positioned trees can save up to 25% of a household s energy consumption for heating and cooling (McLennan, 2004). Computer models devised by the U.S. Department of Energy predict that the proper placement of only three trees will save an average household between $100 and $250 in energy costs annually. On

average, a well-designed landscape provides enough energy savings to return your initial investment in less than 8 years. Shading and evapotranspiration (the process by which a plant actively moves and releases water vapor) from trees can reduce surrounding air temperatures as much as 9 degrees F (5 degrees C). Because cool air settles near the ground, air temperatures directly under trees can be as much as 25 degrees F (14 degrees C) cooler than air temperatures above nearby blacktop. Studies by the Lawrence Berkeley Laboratory found summer daytime air temperatures to be 3 degrees F to 6 degrees F (2 degrees C to 3 degrees C) cooler in tree- shaded neighborhoods than in treeless areas. Utilizing the on site benefits of the space is one of the most important factors if sustainable design. Utilizing naturally occurring benefits such as solar and wind energy, reusable materials, mature vegetation, aesthetically pleasing views, and on site water and loamy soils can greatly increase the stainability of any space.

The additional care and effort put into making the landscape the best suited for the location will ultimately benefit the aesthetic of the landscape. When plants and materials are used in their intended way, they have a longer life span and are overall more healthy than if they are used in areas where they do not naturally belong. Appropriate landscaping will take additional thought and care initially, however the overall benefits of the space will far outweigh the additional time spent creating the space.

Chapter Seven:

The Final Design

This research was put into practical use with the design of a residential home in Rocklin, California. The Clemens live in a fairly traditional suburban home, that overlooks a hilly landscape of native grasses and oaks. Their neighborhood consists of traditional suburban landscape designs, with lawn and lush planting in the front yard of the property. Kathy and Dave Clemens are very environmentally conscious, and wanted to lower their personal water use. The idea for this space was to retrofit their existing landscape to make it more sustainable and drought tolerant, while still maintaining the feeling of a lush and flourishing space.

Kathy and Dave are originally from the North West, and have a personal design aesthetic to match that location. Lush redwoods, lawn, and water loving flowers filled their yard. They knew that they would not be able to keep this same landscape and lower their water requirements, but they loved the feeling of the space and wanted to maintain the greenery. The trees remained the same, however because they are already fairly well established, the water needs are not substantial. They also provide a good shade canopy for the low water plants that cannot handle the hot rocklin summer sun.

For this space, I cut back the amount of the grass in the yard, but kept enough so their two small dogs would have a space to run around. I chose plants that had foliage with year round interest so the landscape never looks dry or baron. I also staggered the blooming period of many of the plants so there would be year round color in flowers and not just foliage. The year round blooms

also create year round interest for native butterflies and birds which they were interested in attracting to their landscape

Kathy loves purple, so I chose a cool color palate for the space that focused on purples, blues, and dark greens. This also contributed to a softer and more lush feeling like the landscapes of the north west, instead of a lush tropical feeling that wormer colors would create. The existing lawn on the site was removed and replaced with one that used less water, and required less maintenance. Lawn was still desired for this space, however, because the couple has two small dogs that need a space to play.

The Clemens Residence

4318 Sandhurst Way
Rocklin, Ca 95677

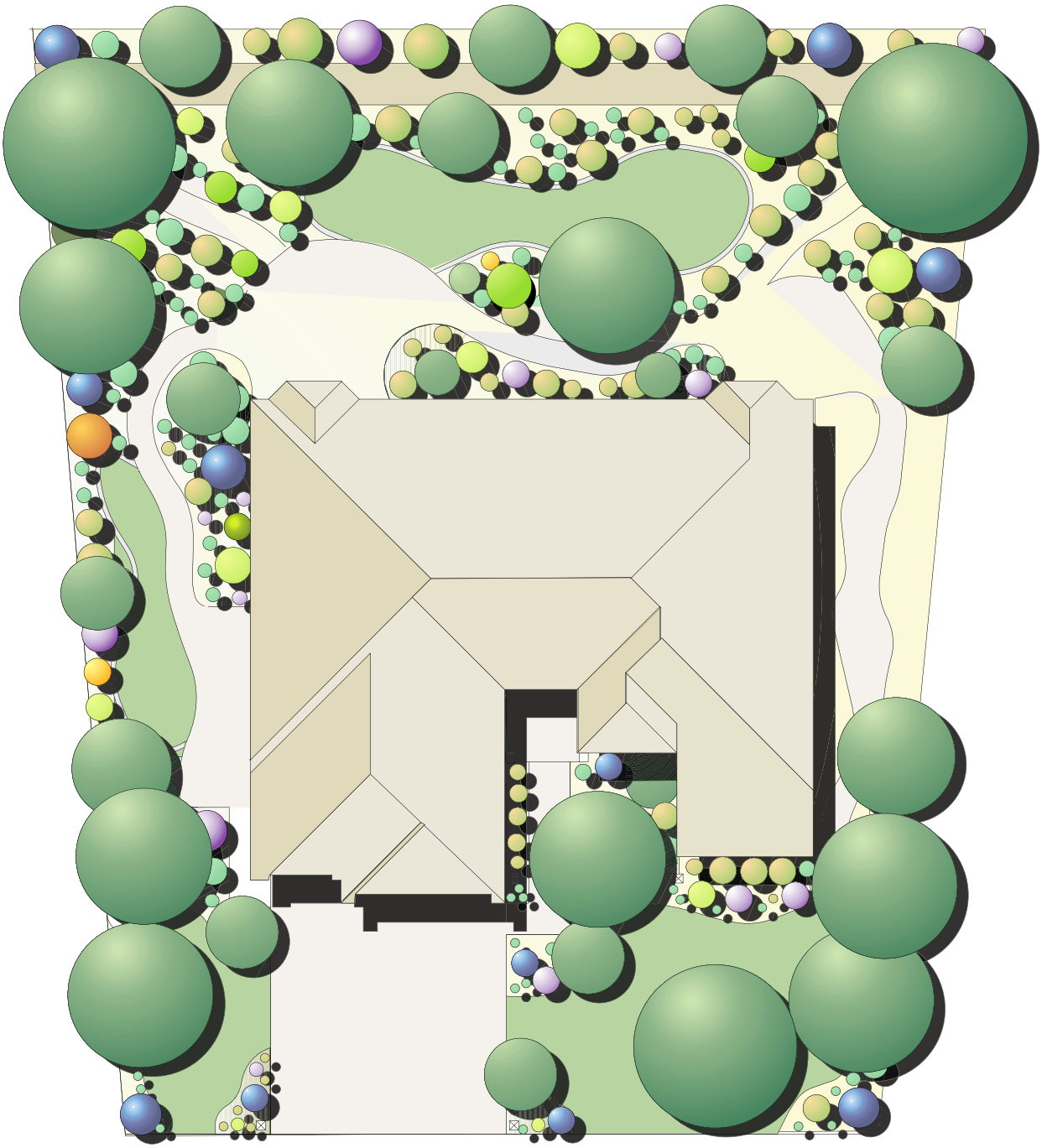


Image7.1 Illustrative Plan for the Clemens Property

Opportunities and Constraints Map

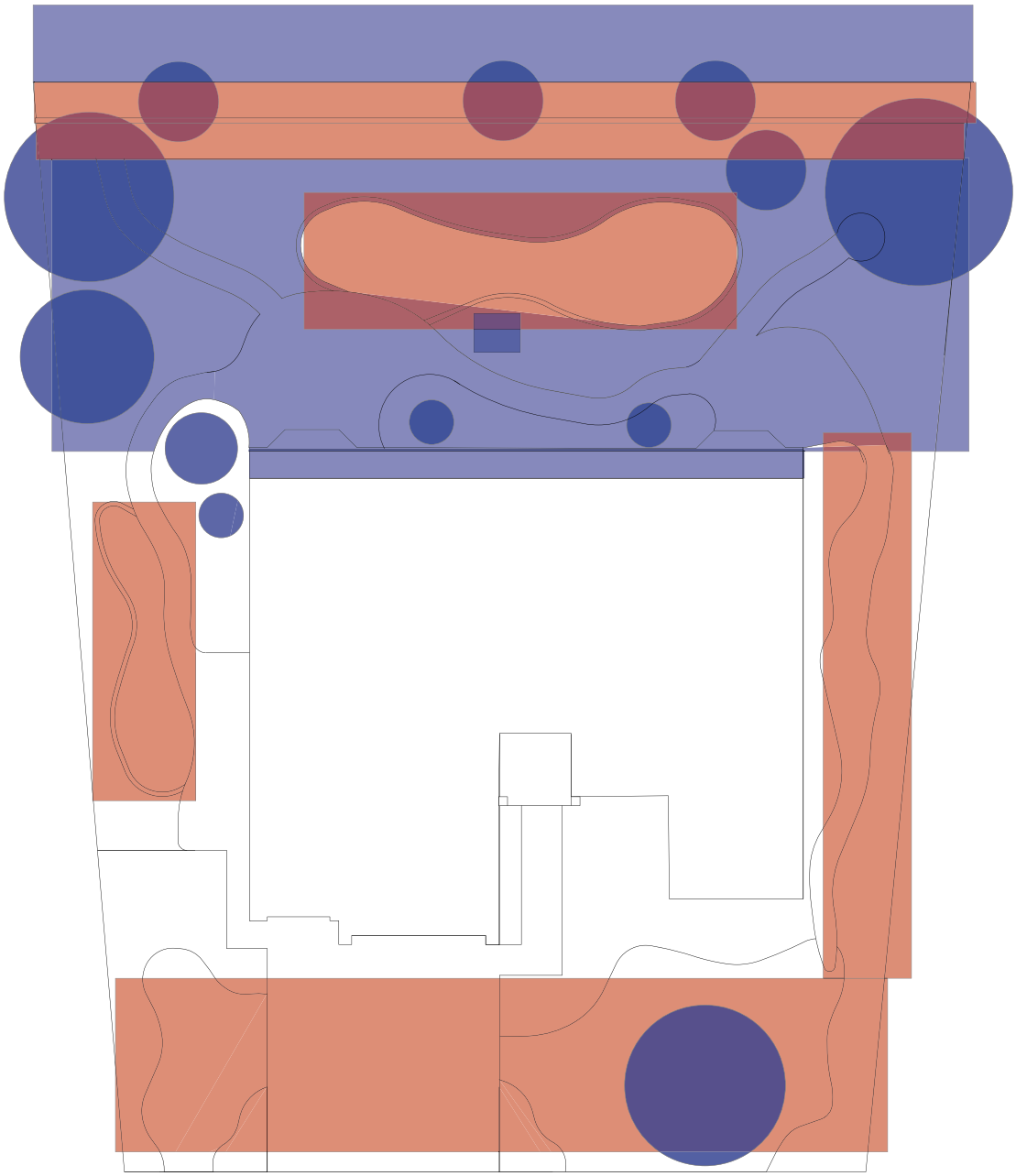


Image7.2 Opportunities and Constraints Map for the Clemens Property

Opportunities and Constraints Chart

Opportunities	Constraints
Large trees provide shade and screening	Drainage area in the back of the property
Views out to the surrounding oak savannah	Very little space between the drainage area and the back fence
Views form the out house to the garden	Unable to alter the front or side of the property
Lots of area for planting in both sun and shade	Still need to maintain lawn area for dogs
Trees are already established so they take less water than young trees.	Owners want concrete mowing strip
Home owners are open to drought tolerant landscape	Dogs kick up mulch and chew on drip irrigation heads
Fountain needs very little water by creates a lush feeling in the landscape	Common drainage makes it difficult to do rain garden or rain catchment on site
Not at great rusk for fire	Hardscape is already established

Clemens Property Planting Plan

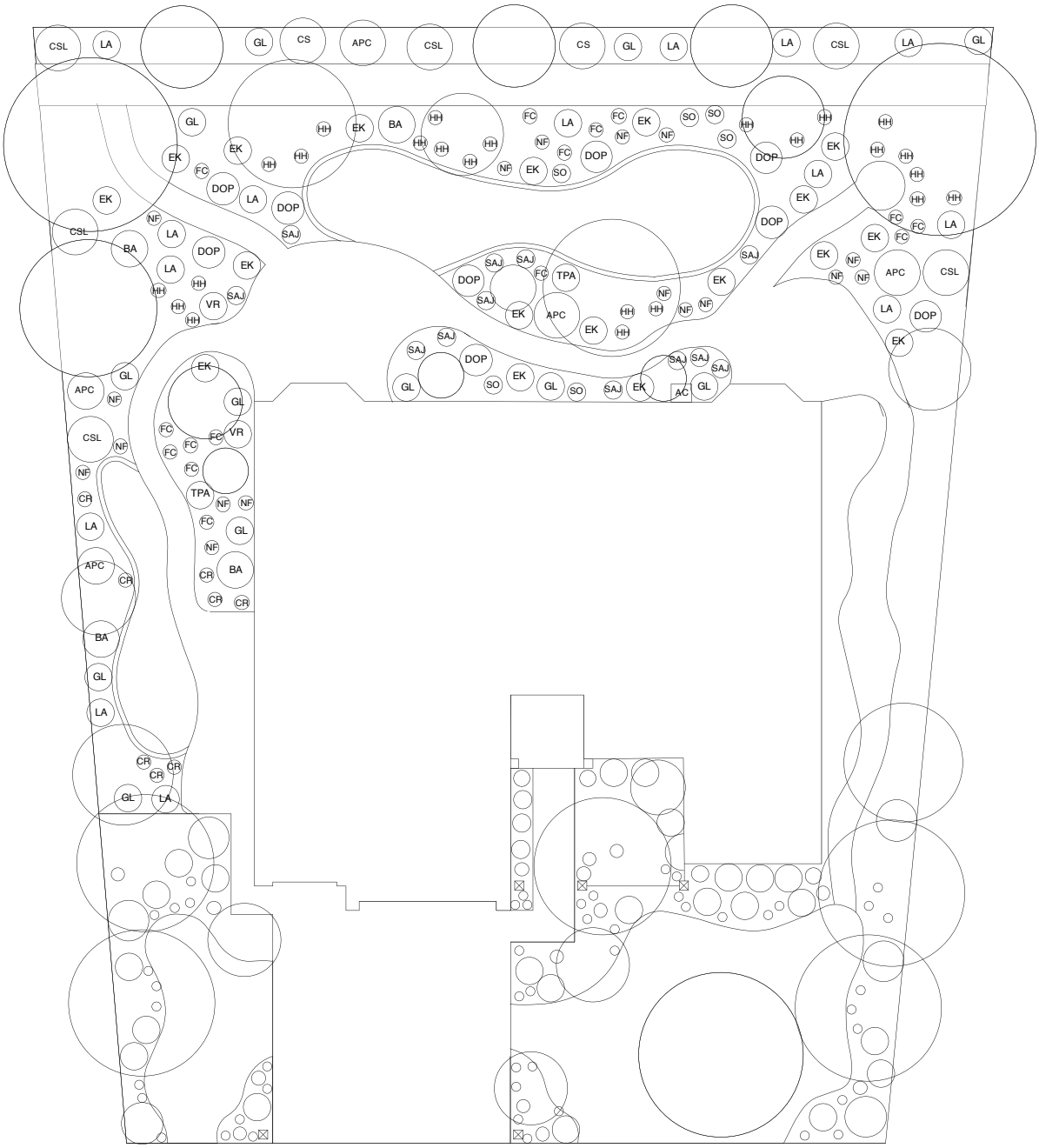
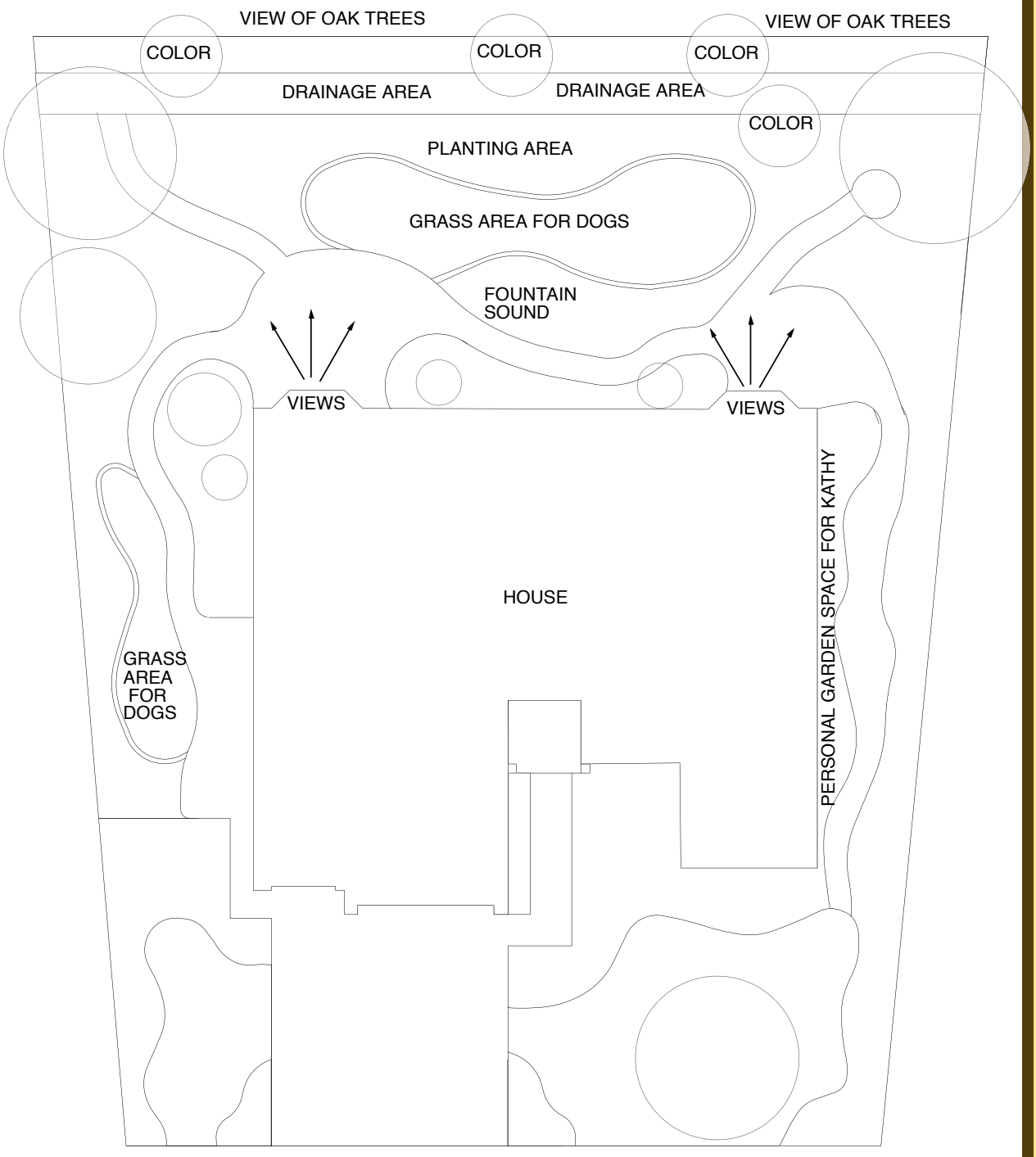


Image7.3 Planting Plan for the Clemens Property

Planting List:

Abbreviation	Scientific Name	Common Name	Number in Plan	Container Size	Description
LA	Lavandula angustifolia	English Lavender	12	4” Pots	Blooms from spring to fall. Flowers with aromatic stems
VR	Verbena rigida	Moss Verbena	2	4” Pots	Small purple upright flowers
HH	Heuchera hybrida	Hybrid Heuchera	21	4” Pots	Dark foliage
EK	Erigeron karvinskianus	Santa Barbara Daisy	18	6 Pack	Nearly year round blooms
BA	Baptisia australis	Blue False Indigo	4	1 Gallon Container	Large deep blue flowers
SO	Salvia officinalis purpurea	Garden Sage	5	4” Pots	Purple foliage
CSL	Ceanothus ‘Sky Lark’	Wild Lilac	6	5 Gallon Container	Shiny green foliage
SA	Sedum ‘Autumn Joy’	Sedum Autum Joy	8	4” Pots	Bright autumn color, interesting foliage
GL	Gaura lindheimeri ‘Pink Fountain’	Pink Fountain Gaura	11	1 Gallon Container	Upright pink flowers
NF	Nepta x faassenii	Catmint	18	4” Pots	Silver foliage
APC	Artemisia ‘Power Castle’	Power Castle Sagebrush	4	1 Gallon Container	Silver foliage and pink flowers
TPA	Thyme praecox arcticus	Creeping Thyme	As Desired	6 Pack	Low sturdy ground cover. Purple flowers may attract bees
CR	Coreopsis rosa	Coreopsis Rose	8	4” Pot	Low water rose
CS	Cistus salvifolius	Sageleaf Rockrose	2	1 Gallon Container	Very low water needs
DOP	Pittosporum Dwarf Orange	Dwarf Orange Pittosporum	9	1 Gallon Container	Small mounds of light green leaves
FC	Festuca Californica	California Fescue	13	4” Pots	Brightly colored grass
AB	Amaryllis Belladonna	Naked Lady	As Desired	Bulbs	Bloom early in summer, and dies down for winter and fall

Site Analysis



The site analysis for a property shows the various positive and negative sights, sounds, smells, touches, and tastes of a site. For this site, the views are the main part of the site to take into consideration. The back portion of the house is filled with windows, and beyond the property is beautiful

Image7.4 Site Analysis for the Clemens Property

Original Site Water Calculations:

The Calculation used here was created for the County of Riverside in Southern California in December, 2006. This calculation was created after the county found that they were using upwards of 150 percent of the water requirements of other counties in the area, and their water supply was quickly diminishing. The county created ordinance 859 to help reduce water uses by 20 percent. This is done by calculating the MAWA, or the maximum annual water allowance.

Maximum Annual Water Allowance: MAWA

INPUT the total square footage of the landscape = 5675 Square Feet
INPUT the historic Evapotranspiration for the area = 57
MAWA = 213 ccf/yr

Hydrozone 1: Lawn Area

INPUT Plant Factor = 0.8
INPUT square footage of hydrozone = 1,500 Square Feet
INPUT hydrozone irrigation efficiency = 0.6
EAWU = 94 gal / yr

Hydrozone 2: Trees

INPUT Plant Factor = 0.5
INPUT square footage of hydrozone = 1,600 Square Feet
INPUT hydrozone irrigation efficiency = 0.9
EAWU = 42 gal / yr

Hydrozone 3: hard scape

INPUT Plant Factor = 0.1
INPUT square footage of hydrozone = 765 Square Feet
INPUT hydrozone irrigation efficiency = 1
EAWU = 4 gal / yr

Hydrozone 4: planting

INPUT Plant Factor = 0.5
INPUT square footage of hydrozone = 1,810 Square Feet
INPUT hydrozone irrigation efficiency = 0.9
EAWU = 48 gal / yr

SubTotal EAWU = 188 gal / yr
Input Irrigation System Operation Factor 0.85
Total EAWU = 221

EAWU < MAWA = -7 cu ft / yr
(this number must be positive)

Revised Site Water Calculations

Maximum Annual Water Allowance: MAWA

INPUT the total square footage of the landscape = 5675 Square Feet
INPUT the historic Evapotranspiration for the area = 57
MAWA = 213 ccf/yr

Hydrozone 1: Lawn Area

INPUT Plant Factor = 0.5
INPUT square footage of hydrozone = 750 Square Feet
INPUT hydrozone irrigation efficiency = 0.6
EAWU = 30 gal / yr

Hydrozone 2: Trees

INPUT Plant Factor = 0.5
INPUT square footage of hydrozone = 1,600 Square Feet
INPUT hydrozone irrigation efficiency = 0.9
EAWU = 42 gal / yr

Hydrozone 3: hard scape

INPUT Plant Factor = 0.1
INPUT square footage of hydrozone = 765 Square Feet
INPUT hydrozone irrigation efficiency = 1
EAWU = 4 gal / yr

Hydrozone 4: planting

INPUT Plant Factor = 0.3
INPUT square footage of hydrozone = 2,560 Square Feet
INPUT hydrozone irrigation efficiency = 0.9
EAWU = 40 gal / yr

SubTotal EAWU = 116 gal / yr
Input Irrigation System Operation Factor 0.85
Total EAWU = 136

EAWU < MAWA = 78 cu ft / yr
(this number must be positive)

Calculation Interpretation

Before the redesign, the Clemens backyard landscape was using roughly 188 gallons of water per year. After the redesign, the landscape only used 116 gallons of water per year. Though this may not sound like a significant difference, it is about a forty percent savings. If everyone retrofitted their landscape in this way, it would represent a significant savings for California's water.

Glossary:

Acre Foot: The volume of water that would cover 1 acre to a depth of 1 foot; 43,560 cubic feet or 1233.5 cubic meters

Aqueduct: A pipe or channel designed to transport water from a remote source, usually by gravity.

California Aqueduct: A 444 mile long aqueduct in the California that carries water from Northern California to Southern California. A typical section has a concrete-lined channel 40 feet wide at the base and an average water depth of about 30 feet.

Compost: A mixture that consists largely of decayed organic matter and is used for fertilizing and conditioning land. Also aids in the mineralization of green waste.

Cistern: A receptacle for holding water or other liquid, especially a tank for catching and storing rainwater.

Desert: A landscape or region that receives very little precipitation. There are areas with an average annual precipitation of less than 10 inches per year, or as areas where more water is lost by evapotranspiration than falls as precipitation.

Drought Tolerant: Refers to the degree to which a plant is adapted to arid or drought conditions. Desiccation tolerance is an extreme degree of drought tolerance. Plants naturally adapted to dry conditions are called xerophytes.

Dry Wash: A seasonal creek that only runs during the rainy season much like a dry creek bed

Ecology: the study of the relationships and interactions between living organisms and their natural or developed environment.

Green Waste: Biodegradable waste that can be comprised of garden or park waste , such as grass or flower cuttings and hedge trimmings.

Home Owners Association: A legal entity created by a real estate developer for the purpose of developing, managing and selling a development of homes.

Incised Channel: A river which cuts its channel through the bed of the valley floor, as opposed to one flowing on a floodplain; its channel formed by the process of degradation.

Mulch: A protective covering, usually of organic matter such as leaves, straw, bark, or peat, placed around plants to prevent the evaporation of moisture, the freezing of roots, and the growth of weeds. Mulch comes in a variety

of shapes, sizes, and colors to match any landscape.

Mycorrhizal Grid: the symbiotic relationship between plant roots and fungi.

Native Landscape: In this document, I will use Native landscape in reference to the low water alternative to lawn. Although native is in the title, it is possible that not all the plants will be native to California, however they will all be adapted to the low water California Climate.

Native Plant: One that develops, occurs naturally, or has existed for many years in an area. These can be trees, flowers, grasses or any other plants. Some of them may have adapted to a very limited range. They may have adjusted to living in unusual environments or under very harsh climates or exceptional soil conditions.

Point Source Pollution: A single identifiable localized source of air, water, thermal, noise or light pollution.

Pollination: The process by which plant pollen is transferred from the male reproductive organs to the female reproductive organs to form seeds. In flowering plants, pollen is transferred from the anther to the stigma, often by the wind or by insects. In cone-bearing plants, male cones release pollen that is usually borne by the wind to the ovules of female cones.

Rain Gardens: This is a garden that is designed to hold the water that falls on a property on site to be used for the landscape. This includes a series of swales and planting to prevent the water from percolating off into storm drains.

Renewable: Relating to a natural resource, such as solar energy, water, or wood, that is never used up or that can be replaced by new growth. Resources that are dependent on regrowth can sometimes be depleted beyond the point of renewability, as when the deforestation of land leads to desertification or when a commercially valuable species is harvested to extinction. Pollution can also make a renewable resource such as water unusable in a particular location.

Retrofitting Landscape: conserve water in an existing landscape by reducing irrigated turfgrass areas, especially on steep slopes, south and west exposures and narrow parking strips.

Suburban: commonly defined as smaller residential communities lying immediately outside a city. In the United States, suburbs have a prevalence of usually detached[1] single-family homes.[2] Some suburbs have a degree of political autonomy, and most have lower population density than inner city neighborhoods.

Swale: A swale is a low area on the land designed to slow and capture runoff by spreading it across a gradient in the landscape, and allowing it to seep into the soil.

Symbiotic Relationship: A relationship between two entities which is mutually beneficial for the participants of the relationship. Thus there is a positive-sum gain from cooperation. This is a term commonly used in biology to explain the relationship between two entities that need each other to survive and prosper.

Water Conservation: Water conservation revers to the effort to reduce water use. The goals of water conservation include
1. Stainability: Insure water exists for future generations of humans, wildlife, and the environment.
2. **Energy Conservation**: reduce the needs of energy in pumping, transporting and treating water in locations. These processes are extremely energy intensive and can be easily reduced by conservation.
3. Habitat Conservation: Less water for human use means more water for wildlife and reduces the need for additional infrastructure such as dams

Water Harvesting: the gathering, or accumulating and storing, of rainwater.Traditionally, rainwater harvesting has been practiced in areas where water exists in plenty, and has provided drinking water, domestic water, water for livestock, water for small / Little irrigation and a way to increase ground water levels.

WoodTrex: Trex is the leading brand of alternative decking, railing, fencing, and trim products designed to maximize your outdoor living experience. Trex composite products are made of a unique combination of wood and plastic fibers. Trex gets its plastic and wood fibers from reclaimed or recycled resources. Including sawdust and used pallets from woodworking operations, and recycled plastic grocery bags from all over the country. Our resources are closely screened for high quality standards before they go near a Trex plant.

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