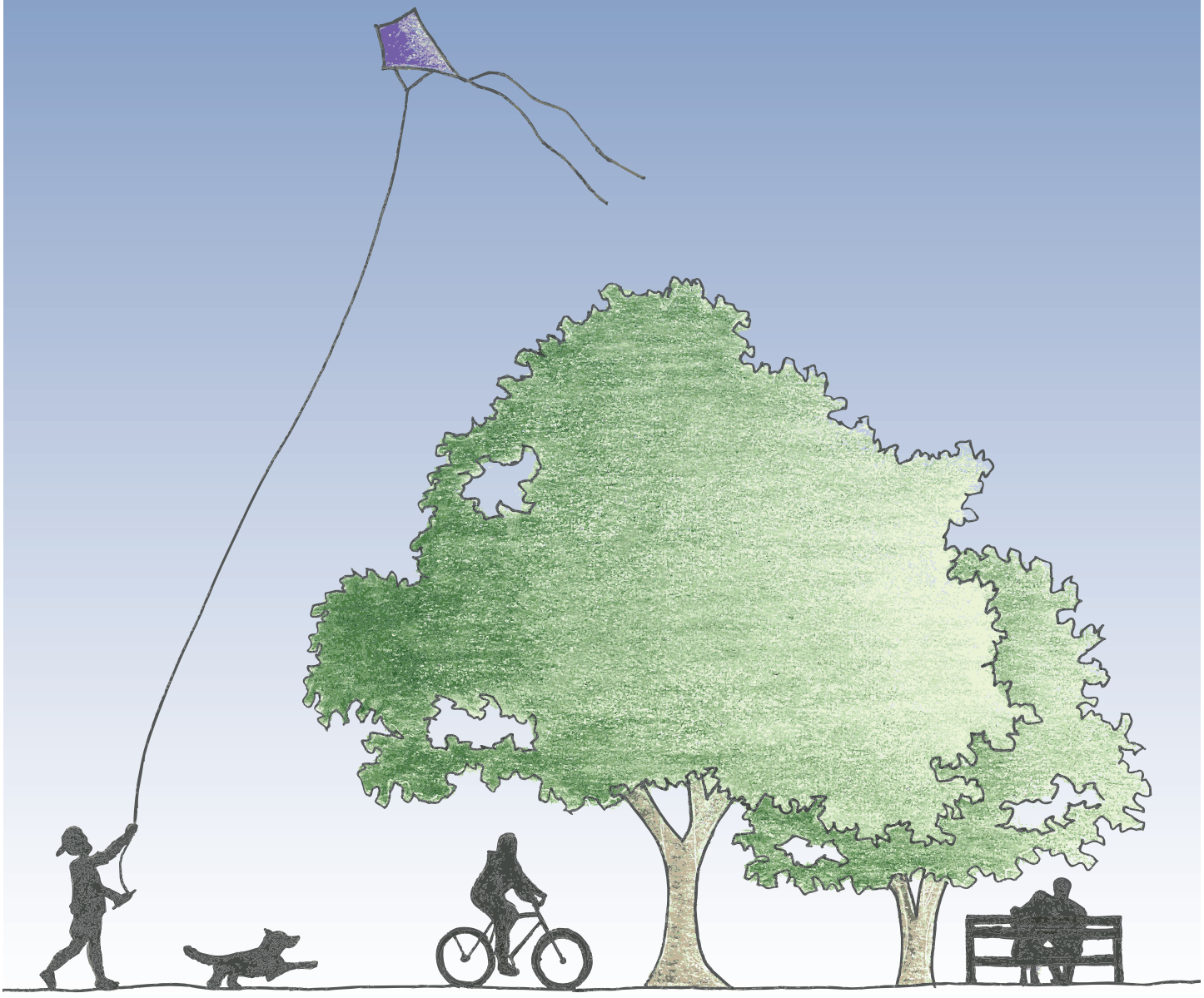
Evaluation of LEED and Sustainable Sites in Tercero Phase III

Senior Project Presented by Eryanne Edgerley

June 15, 2012



Evaluation of LEED and Sustainable Sites in Tercero Phase III

2012 Senior Project by Eryanne Edgerley

Presented to the Faculty of the Landscape Architecture Program at the University of California, Davis in Partial Fulfillment of the Requirement for the Degree of Bachelor of Science in Landscape Architecture.

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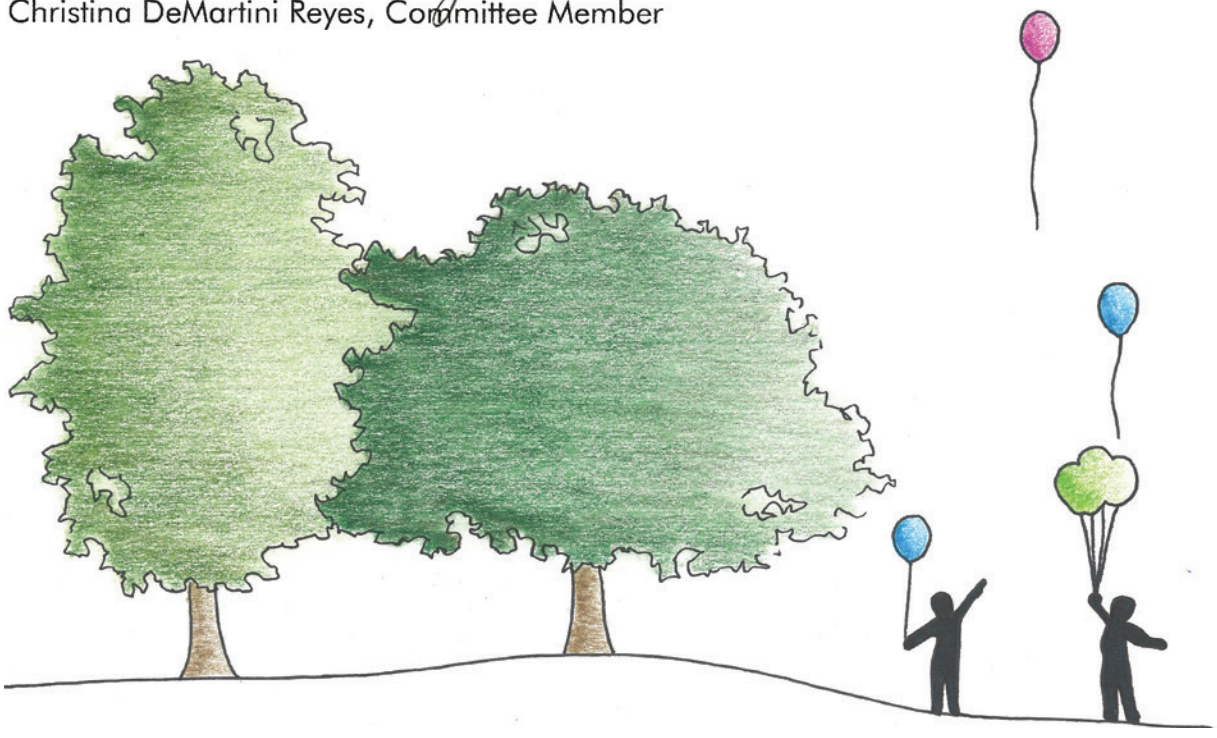

Abstract

Implementing sustainable design practices into building and site construction is an essential component in conserving the health of the planet. Without green building technologies and methods of quantifying the sustainability of projects, construction would continue without minimizing impacts to the important resources that human life depends on. The Leadership in Energy and Environmental Design (LEED) rating system has been used widely in the United States to motivate designers to create more efficient building designs, but has done little to address site issues and landscapes. The Sustainable Sites Initiative (SITES) program is designed to fill this gap left by LEED, and serves as a rating system that will quantify the sustainability of any site, even those without buildings.

These two unique rating systems will be used throughout this project in conjunction in order to provide the most complete analysis of a case study: the Tercero Phase III residence hall complex located on the UC Davis campus. The site design will be analyzed using the two rating systems, and the results will be used to determine what actions can be taken to improve the sustainability of the proposed design. A new site design is created to further enhance sustainability features of the site and lessen the impacts that the project will pose on the environment.

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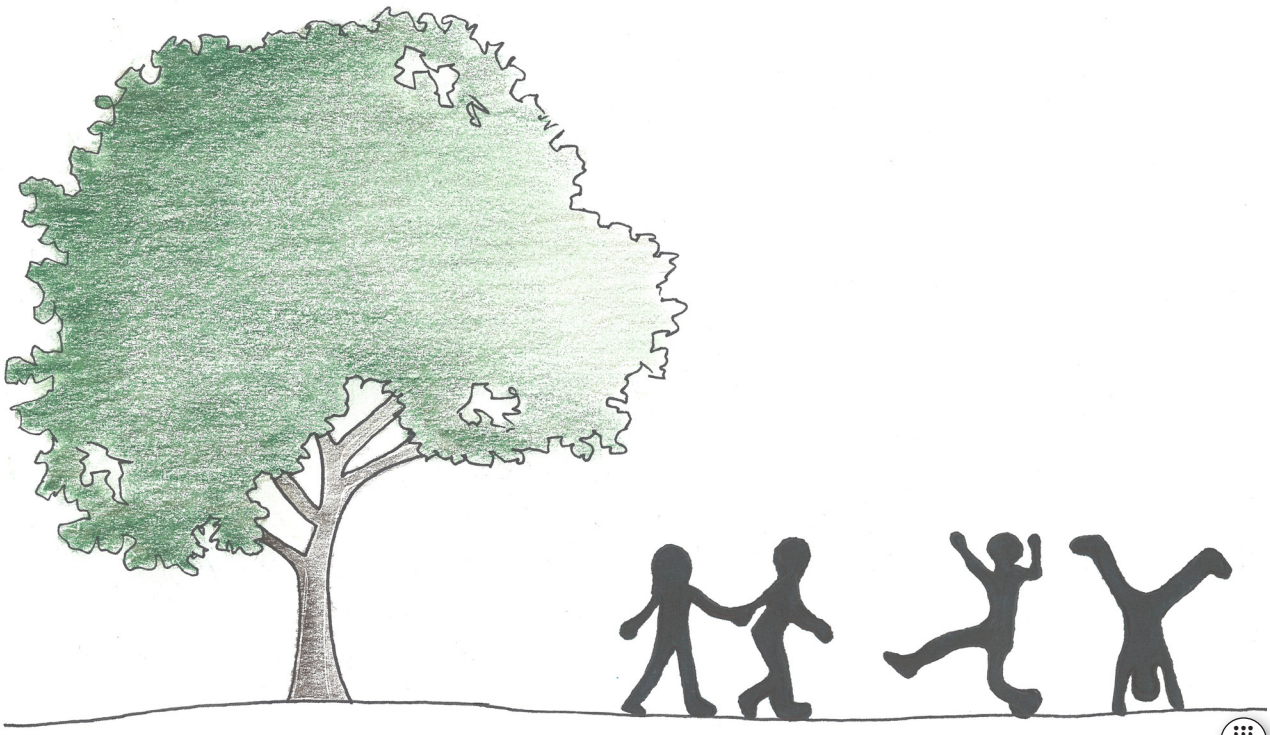

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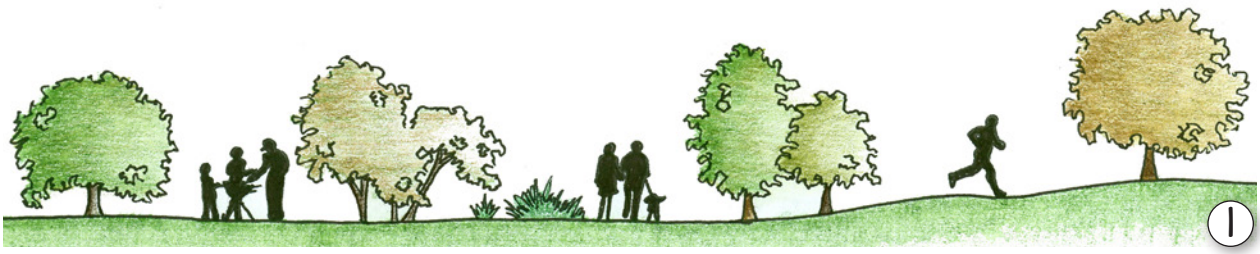
Introduction

It is almost impossible not to hear about sustainability and "green" design in today's society. People have become increasingly concerned over the health of our planet and the future of the limited resources we share (Glavinich, 2008). Sustainability is defined as being able to "meet the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland Commission, 1987). Since the United States is currently responsible for a significant portion of the world's greenhouse gases, and also uses a large amount of the total world energy supply, we have become very involved in the green building movement. This movement involves a whole new way of thinking about design, construction and operation that will result in a permanent shift of more sustainable and lower impact built environments. "Green buildings" are those that are designed, built and operated in a way that is resource efficient, and beneficial to the health of both humans and the environment (Taylor, 2011). With the use of sustainable building and landscape practices that meet certain criteria regarding the use of energy, water and other resources, the damage humans have caused on the environment can be reduced and perhaps even improved (USGBC, 2011).

Although green building is completely voluntary, it has become the standard method of construction in the United States. This is not only due to the concerns over the environment and energy usage, but also because of the improving technologies and monetary incentives that surround green building (Haselbach, 2010). With the cost of energy on the rise, and increasing public concern over the health of the environment, there is a growing movement to replace current forms of design, construction and maintenance of buildings with more sustainable practices. Humans have begun to realize that resources will not last forever, and it is important to protect the environment in order to protect valuable resources for future generations.



The environment provides humans with a range of ecosystem services including climate regulation, clean air, soil, water, habitat, food, cultural and aesthetic value, flood mitigation and many more (Evans, 2012). It is important to protect the environment so that these services will be provided far into the future, and the quality of human life will not be diminished in the years to come.

Sustainable Design Technologies

New technologies and methods of sustainable design are being introduced daily, shining light onto the future health of the planet. Some of these design technologies include green roofs and vertical landscaping, like those shown in figure 1, which are used to minimize the amount of solar radiation being absorbed by structures, therefore reducing cooling costs. These gardens can also serve as insulation in the winter and minimize the costs caused by building heating as well.

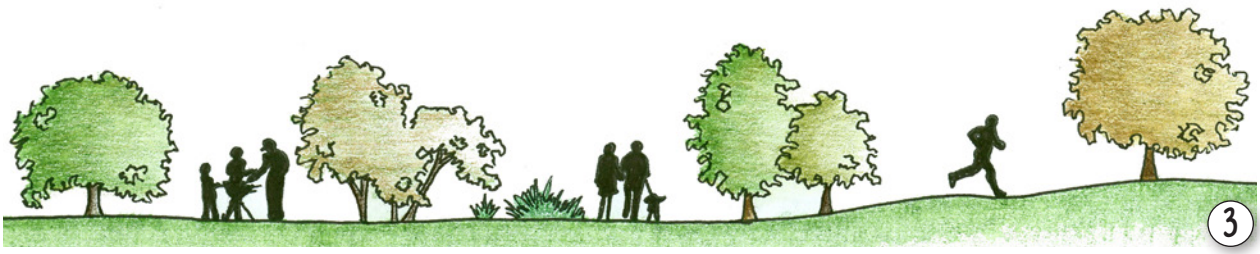
Water utilized in the interior of buildings as well in landscape irrigation and maintenance creates a large opportunity for improving current design standards, as well as saving a fair amount of money. Water efficient fixtures including shower heads and flush toilets should be installed in buildings to minimize the amount of water used.

Figure 1: Examples of Green Roofs and Vertical Landscaping

Landscape irrigation consumes a significant portion of many commercial buildings' water uses, and therefore it provides a big opportunity for water conservation. When designing landscapes it is important to install appropriate plantings as well as efficient irrigation systems. Native species or low water use plants should be used as much as possible, as these plants need little water once established on the site. The use of turf on the site should also be minimized, as very broad areas filled with turf will require a large amount of water, especially during summer heat. A technology called "xeriscaping" is a landscape strategy shown in figure 2 that uses only drought-tolerant or native species along with other landscape elements that do not use water such as rocks and bark. This concept of xeriscaping has become popular in recent years due to the minimal amount of water that these landscapes use once plants are established. Designs that use low water plant species may also be able to incorporate temporary irrigation systems that are removed after one year, significantly reducing the amount of water used on site (USGBC, 2011).

Figure 2: Example of Xeriscaping in the Landscape

Landscape irrigation and water runoff introduces the need for proper stormwater management systems. Stormwater can be controlled on a site by using dry ponds, rain gardens, bioswales or another similar method of capturing water to ensure that all runoff is treated and maintained within the site.



Other technologies and methods for designing a sustainable site include: designing pedestrian friendly streets that will encourage alternatives to vehicular transport, orienting buildings appropriately on sites to take full advantage of natural heating, cooling and lighting, minimize use of hardscaped surfaces to reduce runoff rates, design lighting to be reduced or turned off when not needed, and use efficient maintenance techniques throughout the life of the project (Haselbach, 2010). Methods such as these and many more are already in use on sites today and are helping to change the state of the environment. Through current research and developments in technology, these methods will be improved for the future, and the concepts of sustainability will continually be changing and expanding.

Why Go Green

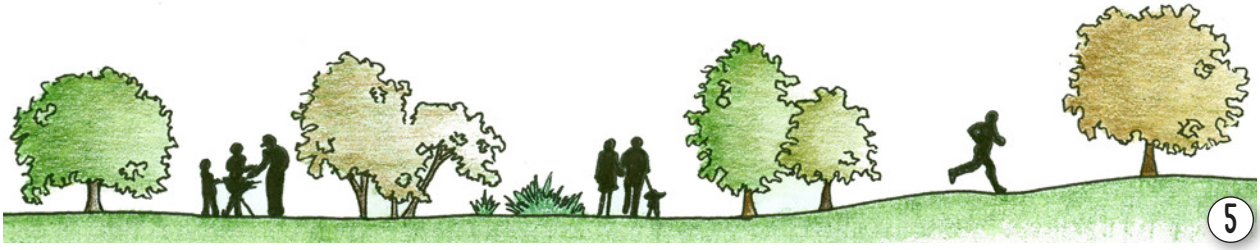
With so many options and incentives for designing sustainably, many building owners have made the choice towards environmentally conscious designs. Owners are making an effort to design sustainably in order to reduce energy used and resources taken up, saving them money in the long run. In some cases, owners require that their buildings be designed and built in an environmentally conscious way because they think it will lead to a competitive advantage. Many owners believe that by using sustainable practices in their buildings they will look good in the eyes of the public and they will have an advantage over other owners because people may prefer to live and work in a place that is good for the environment (Haselbach, 2010).

Another incentive for building owners to build green is they may receive financial contributions by state and federal agencies as well as positive recognition (Gevorkian, 2008). Before any of this can be achieved, however, methods of quantifying sustainability and determining whether or not a building should be considered "green" needed to be developed.

Rating Systems

Evaluation systems have been implemented to not only quantify the sustainability of projects, but also to help guide the design and construction of various sites. The goal of these rating systems is to ensure that the project being developed will minimize impacts to the environment, use energy and resources conservatively and provide a comfortable and effective space for users long into the buildings' life. In most cases, sustainable design and the use of a ratings system is completely voluntary, and rating systems are generally performed by a third party (Kibert, 2005). The majority of rating systems are point based, and the number of points earned by the project in a variety of categories will determine its' certification level. A higher certification level means that the building is more sustainable and could receive a higher level of recognition or monetary incentives. Ratings systems are updated fairly frequently in order to reflect the expanding market for green buildings, as well as the constant development of new technologies, beliefs and practices associated with sustainable design (Haselbach, 2010).

There are two rating systems utilized throughout this project to analyze a case study on the UC Davis campus called "Tercero Phase III." These two systems are the Leadership in Energy and Environmental Design System and the Sustainable Sites Initiative. Although these will be the only systems described in detail during this report, there are a variety of other rating systems available for use worldwide. In the United States, another notable system is the Green Building Initiative's "Green Globes" program. Rating systems can be used internationally, but as solutions and practices for sustainable buildings are not likely to be the same in all parts of the world, many other countries have developed their own rating systems (Vallero & Brasier, 2008). The United Kingdom's most popular rating system is the "Building Research Establishment Environmental Assessment Method



(BREEAM), Japan has the Comprehensive Assessment System for Building Environmental Efficiency (CASBEE) and Australia uses a system called "Green Star" (Kibert, 2005).

LEED

The Leadership in Energy and Environmental Design (LEED) rating system is the most widely used system in the United States, and has been recognized as a measure of sustainability worldwide (Haselbach, 2010). The system was originally developed by the United States Green Building Council (USGBC) in 1998, and the ongoing mission of the council is to "transform the way buildings and communities are designed, built and operated, enabling an environmentally and socially responsible, healthy and prosperous environment that improves the quality of life" (Taylor, 2011).

Figure 3: LEED Logo

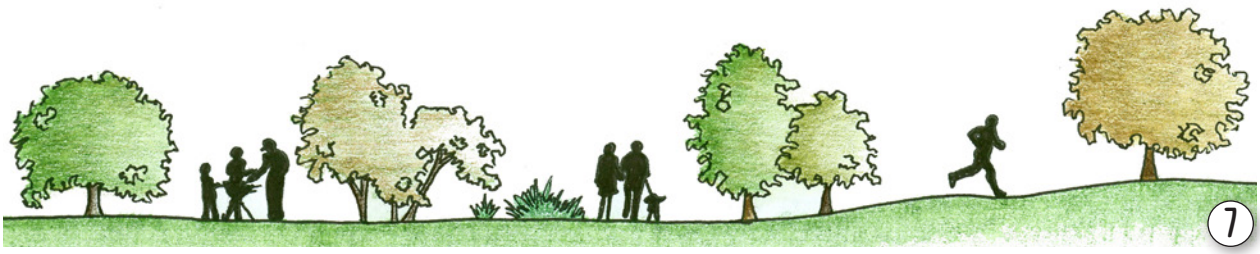
Throughout the past 20 years, the LEED system has successfully promoted environmentally friendly and sustainable buildings, and since the implementation of the program, the number of buildings applying for LEED certification has doubled each year (Haselbach, 2010).

The LEED system has several different categories, and the type of project being constructed will determine which category should be used. These different categories include criteria for Existing Buildings (EB), Commercial Interiors (CI), Homes (H), New Construction

(NC) and Neighborhood Development (ND). Once the category under which the project will be certified is chosen, the certification process can begin.

The certification process involves several steps, and there are many forms that must be submitted to the USGBC. All required forms and a detailed description of the application and certification process can be found on the USGBC's website: http://www.usgbc.org. In brief, the first step of this process is to register the project with the USGBC. After the project is registered, an application for certification is submitted and all supporting documentation must be provided at this step to verify each prerequisite and credit claimed in the project. A project narrative that describes the site and its highlights, as well as an application fee is always required during this stage. Once this paperwork is submitted, the USGBC council will review the project and issue preliminary findings and request any additional information, if needed. Within 30 days of receiving the review, the project team must make a final submittal to the USGBC. This is then followed by the final review by the USGBC and they will award the appropriate certification level to the project (Haselbach, 2010).

The LEED system offers four levels of certification, based on the point values that the project receives. The lowest level of certification designates the project as certified, next is silver certification, then gold, and the highest level is platinum. The specific categories and point values required for each level of certification, as well as individual credits will be discussed in more detail later on in this report. There are some categories within LEED that require prerequisites, and these must be met before the project can earn any points in that category. Although prerequisites are mandatory, it is not required by LEED that all credits be addressed in the project (Haselbach, 2010).



The LEED system has been criticized since its implementation due to the lack of science involved in many of the components, but it has been a very successful program, promoting green building efforts due to its broad acceptance, the ease of use and relatively low costs (Haselbach, 2010).

SITES

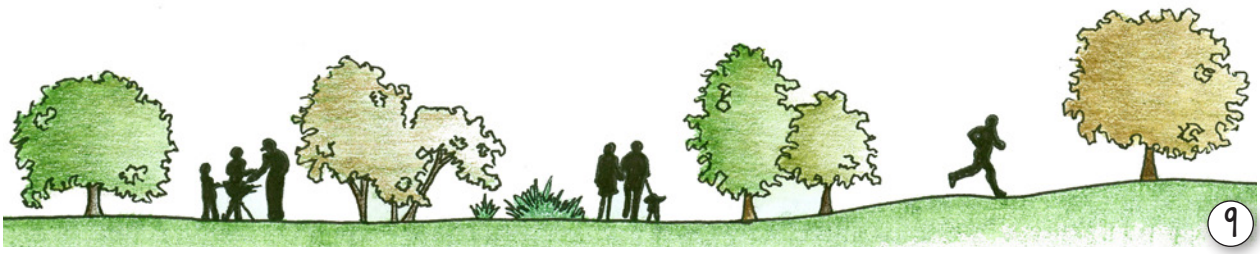
Although the green building standards developed by the USGBC have been very successful in reducing the environmental impact of buildings, they do not fully address the sustainability of landscapes and their associated components (Sustainable Sites Initiative, 2007). The Sustainable Sites Initiative (SITES) was designed in an effort to fill this gap left by LEED, and provide standards for site development that will work to reduce the environmental impact of landscapes. Developed by the American Society of Landscape Architects, the Lady Bird Johnson Wildflower Center at the University of Texas at Austin and the United States Botanic Garden, SITES has been nicknamed "LEED for Landscapes" and can be used to rate the sustainability of the design, construction and maintenance of landscapes. It is designed to work on all project scales and will apply the principles of sustainability to any site, even those without buildings (Schwartz, 2009). The most sustainable site is one that successfully integrates the built environment with the natural, and can balance the needs of humans and the environment in order to benefit each (Sustainable Sites Initiative, 2007).

Figure 4: SITES Logo

Like LEED, participation in the SITES program is completely voluntary. Projects applying for certification can range anywhere from residential to commercial landscapes, to

public parks, to medical and academic campuses, to buffer zones and more. The program is not currently widely known because it is still in the testing phase, and is only undergoing evaluation through the use of test sites and pilot programs. SITES will receive feedback from these pilot projects until summer 2012, and at that point the system will be finalized and available for public use in 2013 (Daigneau, 2010). Once released, the system will be used to evaluate site performance based on a 250 point scale, and will give projects an overall certification ranging from one to four stars. Points will be awarded based on credits that cover areas including site selection, material usage, soils, vegetation and construction and maintenance practices. Like LEED, there are also prerequisite categories that must be met before the site can achieve points, and not all the credits offered must be addressed by the project (Sustainable Sites Initiative, 2009). Individual credits and point scales will be addressed later in the report, but for a complete guide to the SITES program and certification process, visit their website at: http://www.sustainablesites.org. The goal for the Sustainable Sites Program, once released in 2013 will be to achieve for landscapes what LEED has already achieved for building design and construction.

The LEED rating system and the Sustainable Sites Initiative share the similarity that they both encourage new thinking and push efforts in sustainable design. Both SITES and LEED for Neighborhood Development (ND) will be used in this study to examine the Tercero Phase III residence hall design project located on the UC Davis campus. LEED ND focuses on site location and how people live and move around, where SITES focuses on the way that people maintain, protect and restore the resources within these sites (Sustainable Sites Initiative, 2007). Although the LEED system and SITES vary quite significantly, they are intended to be complimentary to each other, and by using the two systems together it will lead to a thorough evaluation of the overall sustainability of the Tercero Phase III site.



Introduction of the Site

The Tercero Phase III project is located on a 7.5 acre site on the south-west corner of the UC Davis campus. As seen in the basemap to the right (Figure 5), it is situated between Dairy Road, Bioletti Way and Tercero Hall Circle, directly across from the Tercero Dining Commons. The 12 original buildings shown on the map, completed in 1967, were known by most students as the lettered buildings, but were known officially as Thille and Pierce Halls. The buildings were each three stories tall and housed a total of 800 first-year students. All of the buildings had to be removed and replaced due to seismic safety concerns (The Regents of the University of California, 2011). Figures 6 and 7 below show the original buildings, and figures 8, 9 on the following page show the demolition of the site, set to be competed at the end of summer 2012.

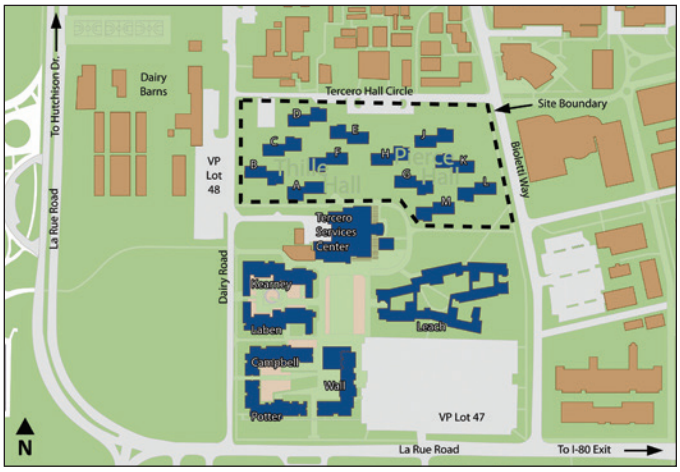


Figure 5: Basemap of Site Location

Figure 6: Photograph of Original Buildings

Figure 7: Photograph of Original Buildings

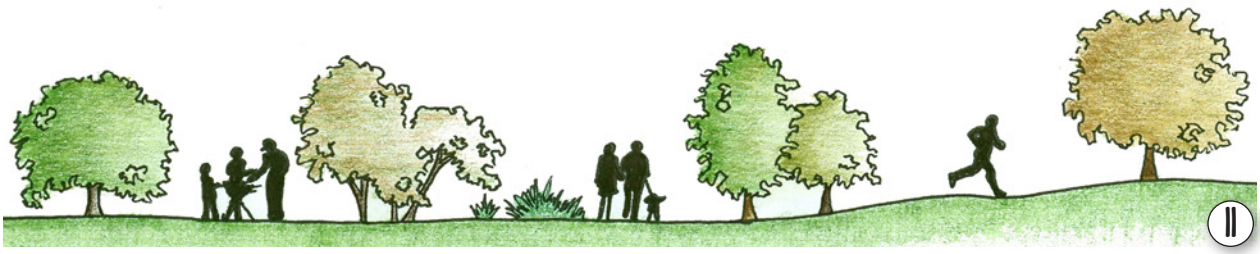
Figure 8: Photograph of Site Demolition

Figure 9: Photograph of Site Demolition

The new design, proposed by Sundt Construction, Inc. will include seven residence buildings, each four stories tall, housing a total of 1,200 freshman students. There are also two smaller buildings in the design which will serve as an auditorium, lecture halls and classroom space. A complete plan of the site design can be seen in figure 10 on the next page.

The design proposes to minimize the use of turf, with one central quad in the middle of the design. The site also features low-water landscaping as well as small bioswales located around the buildings to capture storm water runoff from pavement and building roofs. Images 11 and 12 on page 13 are project renderings created by Sundt, which show some of the features of the site, and how it will look to users upon completion.

The project is seeking a rating of gold using the LEED criteria for new construction (NC), and is hoping to reach platinum after analysis of operational implications and life-cycle cost analysis (The Regents of the University of California, 2011). Construction on the project will begin in the summer of 2012, with an estimated completion date of June 2014.



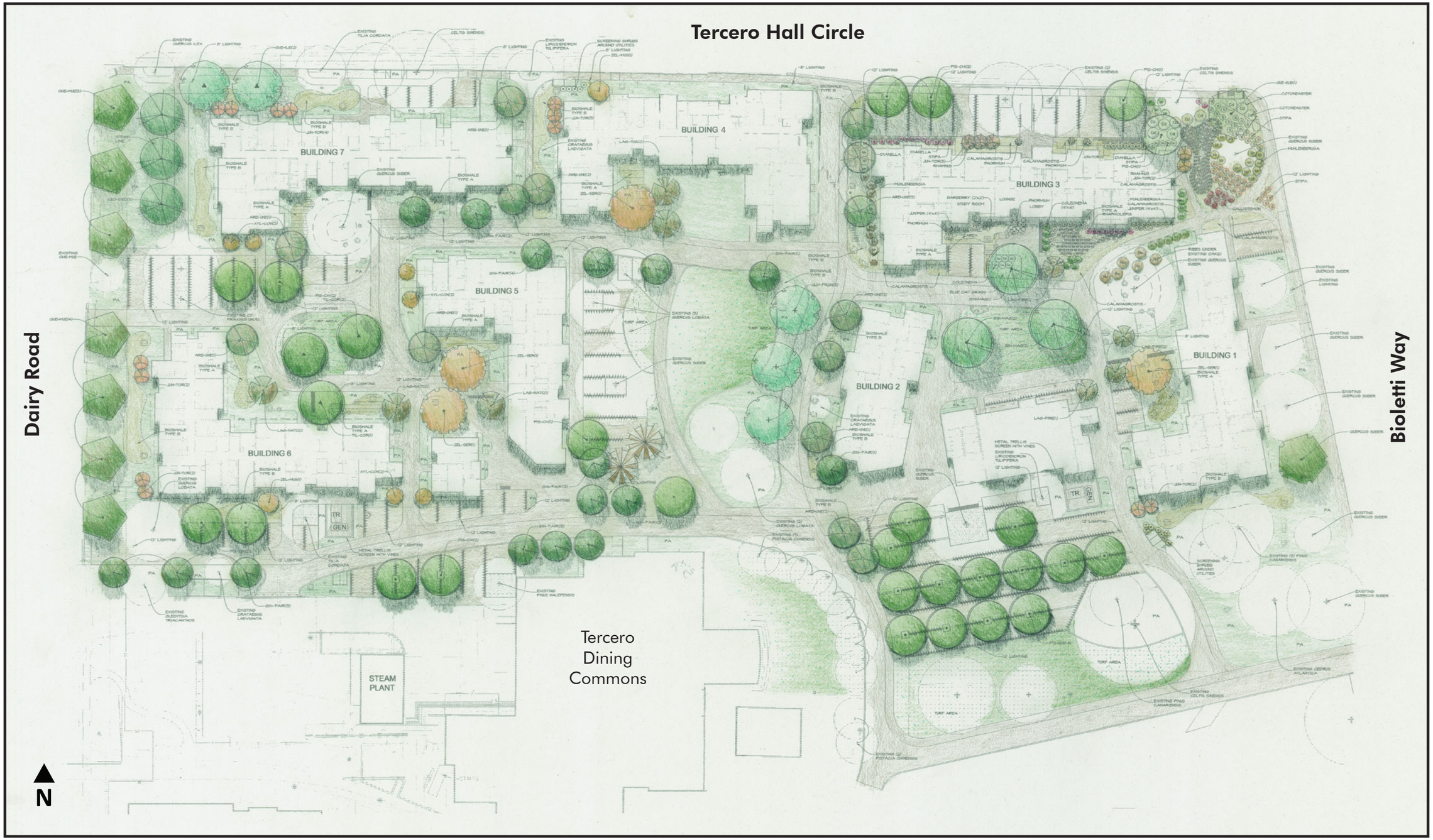


Figure 10: Design Proposed by Sundt Construction, Inc.

Figure 11: Site Rendering of Proposed Design

Figure 12: Site Rendering of Proposed Design

LEED Evaluation of the Site

Although in actuality the Tercero Phase III site will be evaluated using LEED NC (for new construction), for the purpose of this project the site will be analyzed using LEED criteria for Neighborhood Development (ND). This is because LEED ND is most comparable to the criteria for SITES, and will give readers a clearer understanding of the differences between the LEED and SITES ratings systems.

LEED ND has five separate credit categories that are included in the system, and each will be briefly described below. The first is the "Smart Location and Linkage" category, which is intended to encourage the builder to consider the location of the site, discourage sprawl, transportation alternatives and the preservation of sensitive land. Next, "Neighborhood Pattern and Design" credits emphasize the design of vibrant communities that are mixed-use, walk-able and good for the environment. "Green Infrastructure and Buildings" is included to encourage design and construction methods to use best practices that will reduce energy and water use, use sustainable materials and re-use existing as well as historic structures. Credits are given in "Innovation and Design Process" when the

LEED® FOR NEIGHBORHOOD DEVELOPMENT

110 TOTAL POINTS POSSIBLE

SMART LOCATION & LINKAGE — 27 POSSIBLE POINTS

PREREQ 1	Smart Location	REQ
PREREQ 2	Imperiled Species and Ecological Communities	REQ
PREREQ 3	Wetland and Water Body Conservation	REQ
PREREQ 4	Agricultural Land Conservation	REQ
PREREQ 5	Floodplain Avoidance	REQ
CREDIT 1	Preferred Locations	●●●●●●●●●●
CREDIT 2	Brownfield Redevelopment	●●
CREDIT 3	Locations w/ Reduced Automobile Dependence	●●●●●●●●
CREDIT 4	Bicycle Network and Storage	●
CREDIT 5	Housing and Jobs Proximity	●●●
CREDIT 6	Steep Slope Protection	●
CREDIT 7	Site Design for Habitat / Wetland & Water Body Conservation	●
CREDIT 8	Restoration of Habitat/Wetlands and Water Bodies	●
CREDIT 9	Long-Term Cnsrvtn. Mgmt. of Habitat/Wetlands & Water Bodies	●

NEIGHBORHOOD PATTERN & DESIGN — 44 POSSIBLE POINTS

PREREQ 1	Walkable Streets	REQ
PREREQ 2	Compact Development	REQ
PREREQ 3	Connected and Open Community	REQ
CREDIT 1	Walkable Streets	●●●●●●●●●●●●
CREDIT 2	Compact Development	●●●●●●●
CREDIT 3	Mixed-Use Neighborhood Centers	●●●●
CREDIT 4	Mixed-Income Diverse Communities	●●●●●●●
CREDIT 5	Reduced Parking Footprint	●
CREDIT 6	Street Network	●●
CREDIT 7	Transit Facilities	●
CREDIT 8	Transportation Demand Management	●●
CREDIT 9	Access to Civic and Public Spaces	●
CREDIT 10	Access to Recreation Facilities	●
CREDIT 11	Visitability and Universal Design	●
CREDIT 12	Community Outreach and Involvement	●●
CREDIT 13	Local Food Production	●
CREDIT 14	Tree-Lined and Shaded Streets	●●
CREDIT 15	Neighborhood Schools	●

GREEN INFRASTRUCTURE & BUILDINGS — 29 POSSIBLE POINTS

PREREQ 1	Certified Green Building	REQ
PREREQ 2	Minimum Building Energy Efficiency	REQ
PREREQ 3	Minimum Building Water Efficiency	REQ
PREREQ 4	Construction Activity Pollution Prevention	REQ
CREDIT 1	Certified Green Buildings	●●●●●●
CREDIT 2	Building Energy Efficiency	●●●
CREDIT 3	Building Water Efficiency	●
CREDIT 4	Water-Efficient Landscaping	●
CREDIT 5	Existing Building Use	●
CREDIT 6	Historic Resource Preservation and Adaptive Reuse	●
CREDIT 7	Minimized Site Disturbance in Design and Construction	●
CREDIT 8	Stormwater Management	●●●●
CREDIT 9	Heat Island Reduction	●
CREDIT 10	Solar Orientation	●
CREDIT 11	On-Site Renewable Energy Sources	●●●
CREDIT 12	District Heating and Cooling	●●
CREDIT 13	Infrastructure Energy Efficiency	●
CREDIT 14	Wastewater Management	●●
CREDIT 15	Recycled Content in Infrastructure	●
CREDIT 16	Solid Waste Management Infrastructure	●
CREDIT 17	Light Pollution Reduction	●

INNOVATION & DESIGN PROCESS — 6 POSSIBLE POINTS

CREDIT 1	Innovation and Exemplary Performance	●●●●●
CREDIT 2	LEED Accredited Professional	●

REGIONAL PRIORITY CREDIT — 4 POSSIBLE POINTS

CREDIT 1	Regional Priority	●●●●

40–49 POINTS: CERTIFIED 50–59 POINTS: SILVER 60–79 POINTS: GOLD 80+ POINTS: PLATINUM

FOR MORE INFORMATION SEE THE *LEED REFERENCE GUIDE FOR GREEN NEIGHBORHOOD DEVELOPMENT*

The LEED-ND Rating System was created by the Congress for the New Urbanism, Natural Resources Defense Council, and the U.S. Green Building Council.

LEED for Neighborhood Development offers designations for many types of projects and phases of development. Projects may constitute whole, multiple, or portions of neighborhoods, and may be single- or mixed-use. A three-stage certification model corresponds to the phases of the development process:

Stage 1 – Conditionally Approved Plan: Projects that have not completed the entitlements, or public review, process can earn this designation, envisioned to help gain support from the local government and the community.

Stage 2 – Pre-Certified Plan: Fully-entitled projects or projects under construction may earn this designation, which can help secure financing, expedite permitting, or attract tenants.

Stage 3 – Certified Neighborhood Development: Constructed projects can certify that the final built project meets all attempted prerequisites and credits.

Figure 13: LEED ND Credit Chart

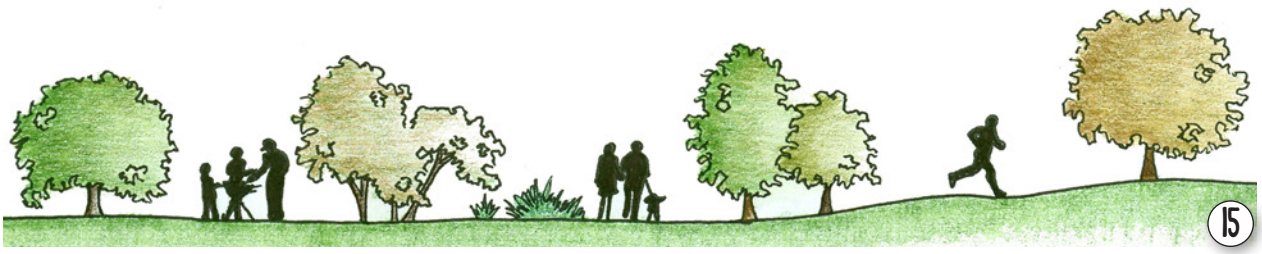
project utilizes an innovative technology that extends beyond the existing credits that are in the rating system. An additional point is also given in this category for having a LEED accredited professional involved in the team. Lastly, "Regional Priority" credits are used to encourage projects to earn credits of significance to the project's local environment (USGBC, 2011).

A chart for LEED ND can be seen in figure 13 on the previous page, which details each of these categories and the subsequent credits that can be earned in each. There are a total of 12 prerequisite credits that must be fulfilled before the project can gain any points in the category. The LEED ND ratings system includes a total of 110 possible points that can be achieved from 51 different credits. If 40-49 points are achieved the project will be recognized as a LEED certified project. With 50-59 points, it will be recognized with a silver certification, 60-79 points will achieve gold and with over 80 points the project will reach the highest LEED certification, platinum.

The Tercero Phase III project was evaluated based on these credits and the results can be seen in figure 14 on page 16. The project received an overall score of 78 points, giving it a certification of gold.

SITES Evaluation

The Sustainable Sites Initiative is broken down into nine separate categories to evaluate a project. The first, "Site Selection" is used to choose site locations that will preserve existing resources or repair already damaged ecosystems. The next is "Pre-Design Assessment and Planning", intended to persuade designers and contractors to plan for a sustainable project from the very beginning stages. The next category includes site design



LEED ND Evaluation for Tercero Phase III

Certified: 40-49 points, **Silver:** 50-59 points, **Gold:** 60-79 points, **Platinum:** 80+ points

Total Possible Points 110

Yes	No			
18	**9**	**Smart Location and Linkage**	**Possible Points**	**27**
Y		Prereq 1	Smart Location	Req.
Y		Prereq 2	Imperiled Species and Ecological Communities	Req.
Y		Prereq 3	Wetland and Water Body Conservation	Req.
Y		Prereq 4	Agricultural Land Conservation	Req.
Y		Prereq 5	Floodplain Avoidance	Req.
6	4	Credit 1	Preferred Locations	10
	2	Credit 2	Brownfield Redevelopment	2
7		Credit 3	Locations with Reduced Automobile Dependence	7
1		Credit 4	Bicycle Network and Storage	1
2	1	Credit 5	Housing and Jobs Proximity	3
1		Credit 6	Steep Slope Protection	1
1		Credit 7	Site Design for Habitat or Wetland+Water Body Conservation	1
	1	Credit 8	Restoration of Habitat or Wetlands and Water Bodies	1
	1	Credit 9	Long-Term Conservation Management of Habitat or Wetlands and Water Bodies	1

34	**9**	**Neighborhood Pattern and Design**	**Possible Points**	**43**
Y		Prereq 1	Walkable Streets	Req.
Y		Prereq 2	Compact Development	Req.
Y		Prereq 3	Connected and Open Community	Req.
10	2	Credit 1	Walkable Streets	12
6		Credit 2	Compact Development	6
4		Credit 3	Mixed-Use Neighborhood Centers	4
	7	Credit 4	Mixed-Income Diverse Communities	7
1		Credit 5	Reduced Parking Footprint	1
2		Credit 6	Street Network	2
1		Credit 7	Transit Facilities	1
2		Credit 8	Transportation Demand Management	2
1		Credit 9	Access to Civic and Public Spaces	1
1		Credit 10	Access to Recreation Facilities	1
1		Credit 11	Visibility and Universal Design	1
1		Credit 12	Community Outreach and Involvement	1
1		Credit 13	Local Food Production	1
2		Credit 14	Tree-Lined and Shaded Streets	2
1		Credit 15	Neighborhood Schools	1

78 Total Project Score = Gold Certification

Yes	No			
23	**6**	**Green Infrastructure and Buildings**	**Possible Points**	**29**
		Prereq 1	Certified Green Building	Req.
		Prereq 2	Minimum Building Energy Efficiency	Req.
		Prereq 3	Minimum Building Water Efficiency	Req.
		Prereq 4	Construction Activity Pollution Prevention	Req.
5		Credit 1	Certified Green Buildings	5
2		Credit 2	Building Energy Efficiency	2
1		Credit 3	Building Water Efficiency	1
1		Credit 4	Water-Efficient Landscaping	1
1		Credit 5	Existing Building Use	1
	1	Credit 6	Historic Resource Prevention and Adaptive Reuse	1
1		Credit 7	Minimized Site Disturbance in Design and Construction	1
2	2	Credit 8	Stormwater Management	4
1		Credit 9	Heat Island Reduction	1
1		Credit 10	Solar Orientation	1
	3	Credit 11	On-Site Renewable Energy Sources	3
2		Credit 12	District Heating and Cooling	2
1		Credit 13	Infrastructure Energy Efficiency	1
2		Credit 14	Wastewater Management	2
1		Credit 15	Recycled Content in Infrastructure	1
1		Credit 16	Solid Waste Management Infrastructure	1
1		Credit 17	Light Pollution Reduction	1

3	**3**	**Innovation and Design Process**	**Possible Points**	**6**
1		Credit 1.1	Innovation in Design: Green Building Education	1
1		Credit 1.2	Innovation in Design: Green Cleaning	1
	1	Credit 1.3	Innovation in Design	1
	1	Credit 1.4	Innovation in Design	1
	1	Credit 1.5	Innovation in Design	1
1		Credit 2	LEED Accredited Professional	1

0	**4**	**Regional Priority Credit**	**Possible Points**	**4**
	1	Credit 1.1	Regional Priority Credit	1
	1	Credit 1.2	Regional Priority Credit	1
	1	Credit 1.3	Regional Priority Credit	1
	1	Credit 1.4	Regional Priority Credit	1

Figure 14: Evaluation of Tercero Phase III Design Using LEED ND

Sustainable Sites Initiative Evaluation for Tercero Phase III

Points **One Star:** 100 points, **Two Stars:** 125 points, **Three Stars:** 150 points, **Four Stars:** 200 points

Total Possible Points 250

Points			
	1. Site Selection:		**Possible Points 21**
16	Select locations to preserve existing resources and repair damaged systems		
Y	Prereq 1.1	Limit development of soils designated as prime farmland, unique farmland, and farmland of statewide importance	Req.
Y	Prereq 1.2	Protect floodplain functions	Req.
Y	Prereq 1.3	Preserve wetlands	Req.
Y	Prereq 1.4	Preserve threatened or endangered species and their habitats	Req.
5	Credit 1.5	Select brownfields or greyfields for redevelopment	5-10
6	Credit 1.6	Select sites within existing communities	6
5	Credit 1.7	Select sites that encourage non-motorized transportation and use of public transit	5
	2. Pre-Design Assessment and Planning:		**Possible Points 4**
4	Plan for sustainability from the onset of the project		
Y	Prereq 2.1	Conduct a pre-design site assessment and explore opportunities for site sustainability	Req.
Y	Prereq 2.2	Use an integrated site development process	Req.
4	Credit 2.3	Engage users and other stakeholders in site design	4
	3. Site Design—Water		**Possible Points 44**
14	Protect and restore processes and systems associated with a site's hydrology		
Y	Prereq 3.1	Reduce potable water use for irrigation by 50% from baseline	Req.
0	Credit 3.2	Reduce potable water use for irrigation by 75% or more from baseline	2-5
0	Credit 3.3	Protect and restore riparian, wetland, and shoreline buffers	3-8
0	Credit 3.4	Rehabilitate lost streams, wetlands, and shorelines	2-5
7	Credit 3.5	Manage stormwater on site	5-10
5	Credit 3.6	Protect and enhance on-site water resources and receiving water quality	3-9
1	Credit 3.7	Design rainwater/stormwater features to provide a landscape amenity	1-3
1	Credit 3.8	Maintain water features to conserve water and other resources	1-4
	4. Site Design—Soil and Vegetation		**Possible Points 51**
28	Protect and restore processes and systems associated with a site's soil and vegetation		
Y	Prereq 4.1	Control and manage known invasive plants found on site	Req.
Y	Prereq 4.2	Use appropriate, non-invasive plants	Req.
Y	Prereq 4.3	Create a soil management plan	Req.
6	Credit 4.4	Minimize soil disturbance in design and construction	6
5	Credit 4.5	Preserve all vegetation designated as special status	5
3	Credit 4.6	Preserve or restore appropriate plant biomass on site	3-8
1	Credit 4.7	Use native plants	1-4
0	Credit 4.8	Preserve plant communities native to the ecoregion	2-6
0	Credit 4.9	Restore plant communities native to the ecoregion	1-5
2	Credit 4.10	Use vegetation to minimize building heating requirements	2-4
3	Credit 4.11	Use vegetation to minimize building cooling requirements	2-5
5	Credit 4.12	Reduce urban heat island effects	3-5
3	Credit 4.13	Reduce the risk of catastrophic wildfire	3
	5. Site Design—Materials Selection		**Possible Points 36**
32	Reuse/recycle existing materials and support sustainable production practices		
	Prereq 5.1	Eliminate the use of wood from threatened tree species	Req.
1	Credit 5.2	Maintain on-site structures, hardscape, and landscape amenities	1-4
2	Credit 5.3	Design for deconstruction and disassembly	1-3
4	Credit 5.4	Reuse salvaged materials and plants	4
4	Credit 5.5	Use recycled content materials	2-4
4	Credit 5.6	Use certified wood	1-4
6	Credit 5.7	Use regional materials	2-6
2	Credit 5.8	Use adhesives, sealants, paints, coatings w/reduced VOC em.	2
3	Credit 5.9	Support sustainable practices in plant production	3
6	Credit 5.10	Support sustainable practices in materials manufacturing	3-6
	6. Site Design—Human Health and Well-Being		**Possible Points 32**
25	Build strong communities and a sense of stewardship		
2	Credit 6.1	Promote equitable site development	1-3
3	Credit 6.2	Promote equitable site use	1-4
4	Credit 6.3	Promote sustainability awareness and education	2-4
0	Credit 6.4	Protect and maintain unique cultural and historical places	2-4
3	Credit 6.5	Provide for optimum site accessibility, safety and wayfinding	3
4	Credit 6.6	Provide opportunities for outdoor physical activity	4-5
4	Credit 6.7	Provide views of vegetation & quiet outdoor spaces	3-4
3	Credit 6.8	Provide outdoor spaces for social interaction	3
2	Credit 6.9	Reduce light pollution	2
	7. Construction		**Possible Points 21**
14	Minimize effects of construction-related activities		
Y	Prereq 7.1	Control and retain construction pollutants	Req.
Y	Prereq 7.2	Restore soils disturbed during construction	Req.
5	Credit 7.3	Restore soils disturbed by previous development	2-8
3	Credit 7.4	Divert construction and demolition materials from disposal	3-5
5	Credit 7.5	Reuse or recycle vegetation, rocks, soil generated during cons.	3-5
1	Credit 7.6	Minimize generation of GHG emissions and exposure to air pollutants during construction	1
	8. Operations and Maintenance		**Possible Points 23**
16	Maintain the site for long-term sustainability		
Y	Prereq 8.1	Plan for sustainable site maintenance	Req.
Y	Prereq 8.2	Provide for storage and collection of recyclables	Req.
4	Credit 8.3	Recycle organic matter generated during site operations & main.	2-6
0	Credit 8.4	Reduce outdoor energy consump. for all exteriors and landscape	1-4
3	Credit 8.5	Use renewable sources for landscape electricity needs	2-3
2	Credit 8.6	Minimize exposure to environmental tobacco smoke	1-2
3	Credit 8.7	Minimize generation of GHG and exposure to pollutants	1-4
4	Credit 8.8	Reduce emissions and promote the use of fuel-efficient vehicles	4
	9. Monitoring and Innovation		**Possible Points 18**
10	Reward exceptional performance and improve knowledge on sustainability		
10	Credit 9.1	Monitor performance of sustainable design practices	10
0	Credit 9.2	Innovation in site design	8
159	**Total Project Score = Three stars**		

Figure 15: Evaluation of Tercero Phase III Using SITES

issues regarding water. These credits are intended to protect and restore systems associated with water usage on the site. The next category deals with design issues surrounding the soil and vegetation on the site. The "Human Health and Well-Being" category is intended to help build strong sites with a sense of community, and improve the health of the users. The "Construction" category is used to minimize the effects of the project construction and the "Operations and Maintenance" category uses the credits to ensure that the project will continue to perform sustainably long after completion. The last category is "Monitoring and Innovation", used to reward designs that are viewed as exceptional and even improve concepts and knowledge of sustainability (Evans, 2012).

Included in these nine categories mentioned above is a set of 15 prerequisites that also must be achieved before the project can earn points in the category. With a total of 51 credits, projects can earn a maximum of 250 points on the SITES scale. A project that reaches 100 total points will earn a one star rating, 125 points will get two stars, 150 points is three stars, and a rating of at least 200 points will earn a four star rating.

The Tercero Phase III project was evaluated on this four star scale, and the resulting points given for each credit can be seen in figure 15 on page 17. The project earned 159 points total, giving it a three star rating.

Positive Design Aspects

There were several areas in the evaluations where the project gained maximum points and showed exceptional environmentally conscious design strategies. The first is that the new site design incorporates many of the trees that already exist on the site. The plan in figure 16 on the following page indicates all existing trees to be saved, which accounts

Figure 16: Site Plan Showing Existing Trees to be Saved

for approximately 33% of all trees in the new design as seen in the pie chart in figure 17. The three brown trees shown on the plan are trees that were cited to be incorporated into the new design, but were unfortunately killed during the demolition process. Although only a small percentage of the species used in the design were California natives, the majority of the plants selected were appropriate for the site and require minimal water usage. A graph showing all of the different species of trees on the site and the number planted can be seen in figure 18 below.

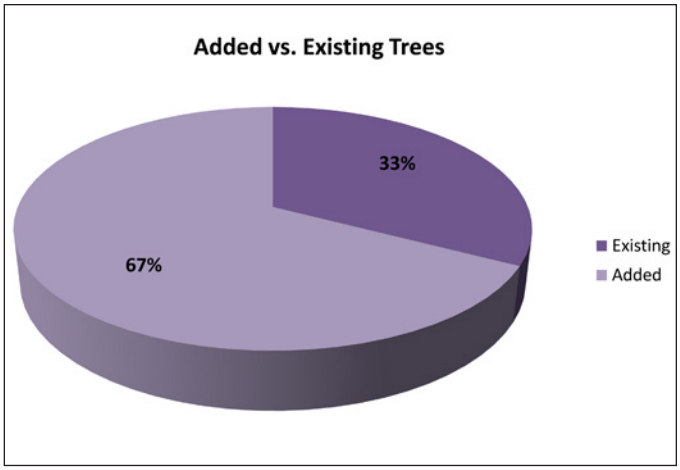


Figure 17: Chart Showing Percentage of Existing Trees Saved

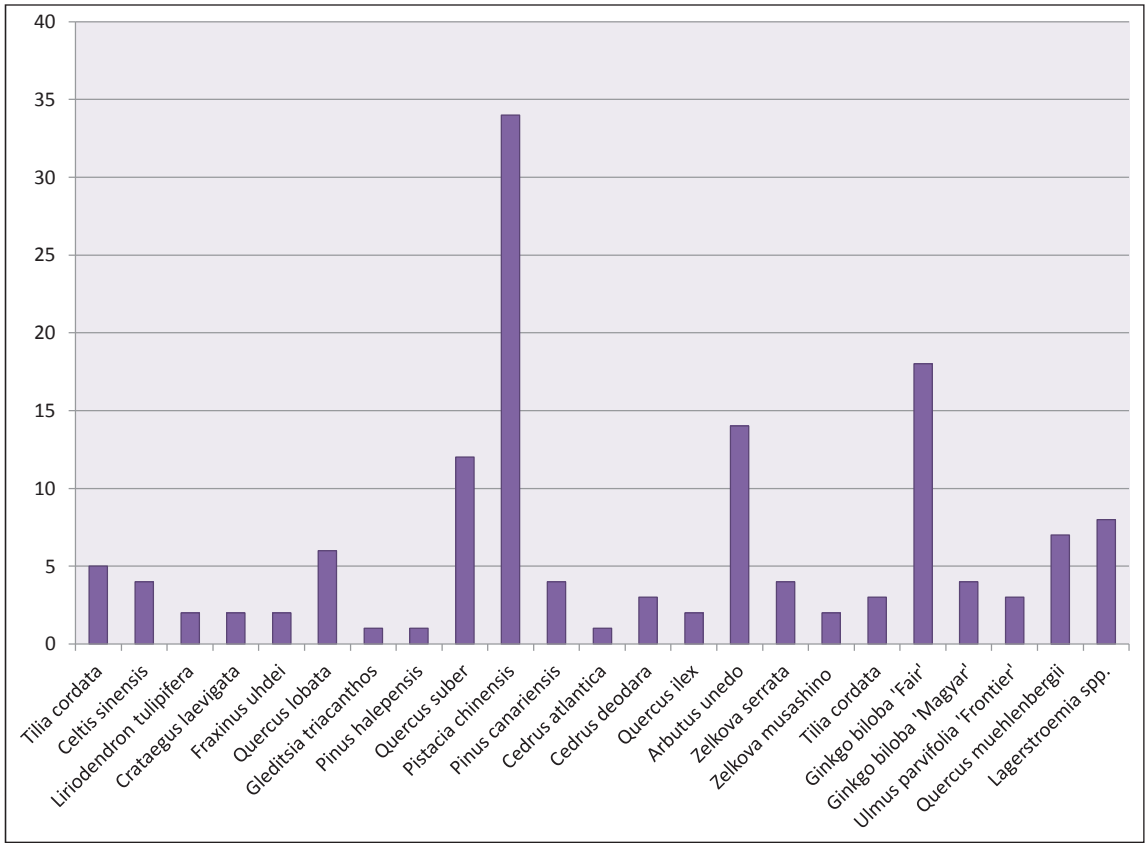
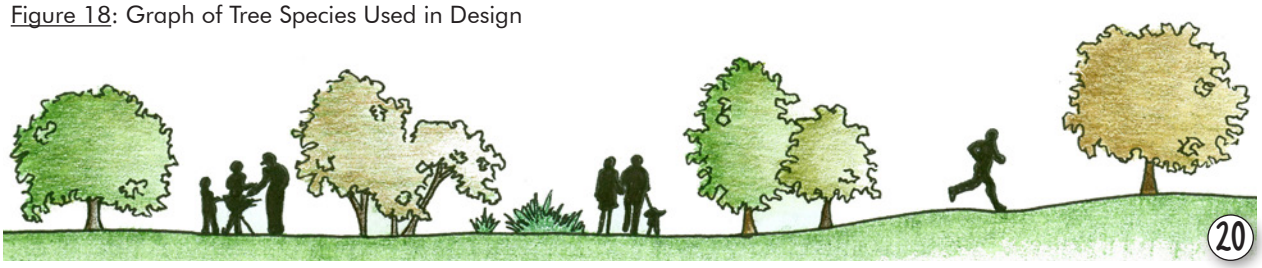


Figure 18: Graph of Tree Species Used in Design



The new design also proposes to increase the total density of the site. The old project housed 800 students, and the new will house a total of 1,200 students. Even though the density will be increased by 400 people, there is no additional parking added on site. There are even two small parking lots on the original site that have been removed in the new design, reducing parking even further. By providing fewer parking spaces in the area it will hopefully discourage users from driving automobiles and persuade them to use alternative modes of transport. The site is designed to be extremely walkable and also very bike friendly. Bike paths and walking paths weave through the entire site, and a total of 1,500 bike racks, like those seen in figure 19, will be provided for storage. Biking and walking have been designed to be a great alternative to driving a vehicle through the site.

Figure 19: Bike Parking Implemented in New Design

Figure 20: Permeable Pavement Used in Bike Parking Areas

The proposed design does a good job of reducing the amount of hardscape. Permeable pavement is used where possible to limit the amount of runoff, and to allow the water to soak through to the ground instead. As seen in figure 20, bike parking areas will be created with

permeable pavement, and strips of permeable pavement will be used to break up other large areas of concrete. Additional examples of permeable pavement can be seen in figures 21 and 22 directly below.

Figure 21: Example of Permeable Pavement

Figure 22: Another Example of Permeable Pavement

Bioswales, like the one seen in figure 23, have been designed around the site to capture the stormwater runoff from the pavement and also from the roofs of the buildings. The bioswales will minimize the amount of water that runs into the storm drain and keep the majority of the water within the site. The bioswales have been planted with grasses which function to filter the water before it leaches through the soil. All of the above mentioned are sustainable design efforts that are being implemented on the exterior of the building, but there are many more things that are going on in the interior.

Figure 23: Bioswales Designed to Capture Stormwater Runoff From Pavement and Roofs

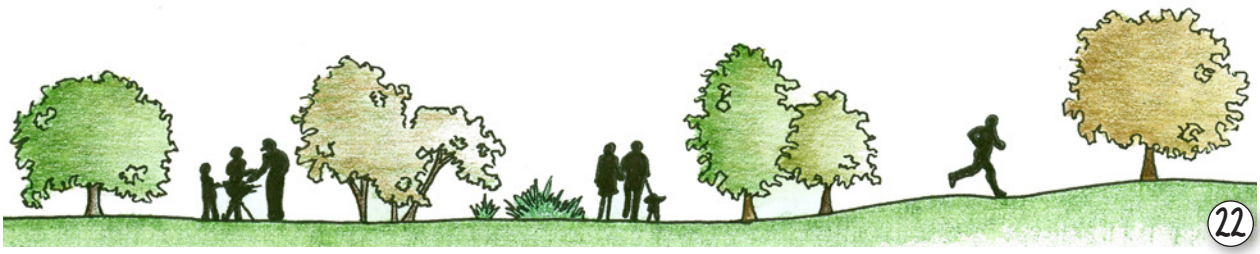


Figure 24: Displays in Residence Buildings to Educate Students on Sustainability

Figure 25: Recycling Labels Used in Residence Halls

Student housing will run several programs within the new residence hall buildings to educate the residents about sustainability and promote their green buildings. RA's and other students are trained by student housing to teach residents about sustainability. These individuals run tours of the buildings, create printed materials and also educational displays like the one seen in figure 24 to educate the residents of the building.

The students also participate in competitions, such a "Recyclemania" where all of the student housing residence buildings compete to see who can recycle the most over a period of time. This program is not only fun for the students, but it encourages them to recycle while providing educational opportunities. Student housing also encourages students to recycle through their recycling program. They have created labels, seen in figure 25, which are placed on bins around the halls to educate students about what items can be recycled and where.

Lastly, all new students living in residence hall buildings are given a special reusable water bottle to encourage them to recycle. This bottle can be used in the dining hall, or can be refilled at special bottle filling stations installed in the residence hall buildings. As seen

in figure 26, bottle filling stations provide filtered water and some provide a counter that indicates how many plastic bottles the residents are saving by using reusable bottles, providing encouragement for students to re-use their bottles.

Figure 26: Bottle Filling Stations Used in Residence Halls

Re-Design of Tercero Phase III to Enhance Sustainability Efforts

After reviewing the proposed plan by Sundt, Inc. and their design build team for the Tercero Phase III site, there are several ways that the site could improve their scores on the LEED and SITES evaluations. A few suggestions include, choosing vegetation types carefully to minimize irrigation, taking advantage of natural cooling capabilities of vegetation, finding ways of managing stormwater entirely on the site and using a source other than freshwater to supply water to the landscape and buildings. The remainder of this report will look at a few design options that are proposed for Tercero Phase III in order to improve the sustainability of the site. The intent behind the re-design is to take advantage of current sustainable technologies and use them to make the most sustainable site possible. The completed plan for the re-design of the site can be seen in figure 38 on page 37.

Re-Designing Access and Pathways

An essential component of the Tercero Phase III site is access and mobility, due to the large amount of people living in the space. It is very important to have efficient pathways that lead people directly where they want to go. If not, people will make their own paths and this could lead to compacted soils, trampling and even death of groundcovers.

The re-design includes direct pathways to buildings, classrooms and the dining commons to encourage users to stay on the designated walks and eliminate trampling and other damage to vegetation.

Pathways are placed around the footprint of each building to separate planted areas from the base of the structure. It is important to provide a space between the building and vegetation for several reasons. First, the pathway will provide a buffer area for maintenance crews. If crews need to come and wash windows, for example, the waste water will not fall directly on the plants and potentially harm them. The maintenance workers will also not need to trample plants in order to access certain areas. Another reason for pathways around the buildings is for students that may want to go knock on friends' windows, or get someone's attention if they forgot their keys. Creating a space for students to do these things will eliminate trampling of plants and reduce compaction of soils.

Pathways running through the site were also connected to main pathways that lead to other areas of campus to allow the site to be easily accessed. All pathways are designed to be mixed use, as they are extra wide to allow bikers and pedestrians to use the same path safely. Proper lighting will also be installed along all paths so they can be used at any time and users will feel safe. It is very important to promote accessibility within the site and provide users with convenient walkways in order to encourage alternative modes of transportation like walking and biking.

Re-Designing the Landscape

All of the vegetation proposed by Sundt, Inc. and their design build team was removed, except for all existing trees on the site. Keeping as many existing trees as possible

is very important because these trees are already fully grown and provide many extra benefits on the site that young trees do not. If a site is fully planted with new trees it will take years, even decades for them to provide the shading and cooling capabilities of fully grown trees. Therefore, it is more sustainable and efficient to keep the existing trees.

Natural Temperature Control

New trees are placed on the site to maximize their natural cooling capabilities, therefore reducing energy usage. Shade trees have been placed around the west and northwest walls of buildings to shade them from afternoon sun, as diagrammed in figure 27. Shade from trees placed in these locations will fall directly on the buildings, reducing interior temperatures by up to 20° F and potentially reducing air conditioning needs by 50% (Build it Smart, 2012). This results in a great reduction of energy use and also saves a considerable amount of money. Many deciduous trees have been placed near buildings because they lose their leaves in the winter, therefore allowing sunlight to enter during these months and still provide natural heating. Evergreen trees placed in these areas would block the sun during winter, and building heating costs would be greater.

Many new trees have also been placed to provide shade for walkways, bike parking spaces and other areas of pavement. This will allow a more comfortable space for pedestrians in the summer and will also reduce heat to pavement, therefore reducing the urban heat island effect of the entire site (Build it Smart, 2012).

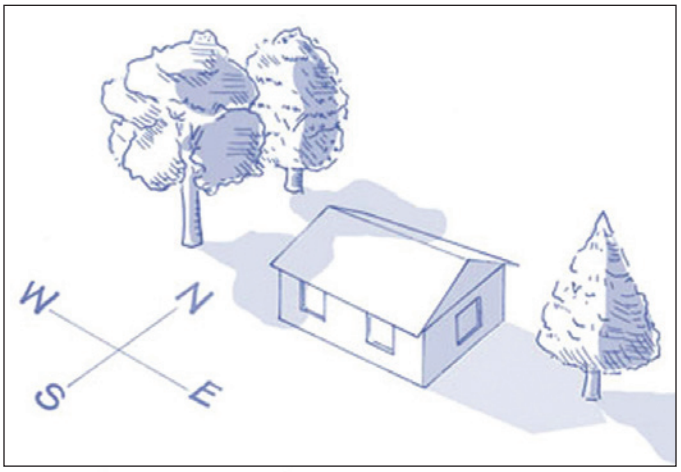


Figure 27: Placement of Trees on Site for Natural Cooling

Valley-Wise Gardening

With the exception of some of the existing trees on the site, the new design will be landscaped using a technique called "valley-wise" gardening. This technique incorporates only those plants that are well adapted to the Central Valley of California and regions with similar conditions. Since these plants are well adapted to the area they will thrive under the conditions and will also require less water and fewer chemicals to grow (Gale, 2007). These plants will also be able to live longer in our climate and will require less frequent replacement, saving a great deal of time and money. The plants chosen in a valley-wise landscape also provide valuable food and shelter for butterflies and birds, leading to an overall healthier ecosystem.

Valley-wise garden plants might be more hardy and well adapted to the climate, but this does not mean that they are boring and dull. The Ruth Risdon Storer garden located in the Arboretum at UC Davis is a great example of a beautiful garden that uses only valley-wise plantings. As pictured in figure 29, this garden has a lot of color and a wide variety of plants that attract many wildlife species including birds, butterflies and squirrels. This example proves that an environmentally conscious garden can save money and also be very enjoyable at the same time.

Plants for the re-design of Tercero Phase III were site were chosen based on their ability to be drought tolerant, disease resistant, low maintenance and ability to provide habitat and food for local species. Also, since this site is very heavily trafficked, several plants were chosen based on their ability to recover after being trampled, or their ability to

deter people from walking on them. All plants selected fall under the title of being "valley-wise" species, and a list of suggested plants can be viewed in figure 28 below.

	Scientific Name	Common Name
Hardy Groundcovers	*Opuntia compressa*	Eastern prickly-pear
(to resist trampling)	*Erigeron karvinskianus*	Santa Barbara Daisy
	Heuchera 'Rosada'	Rosada coral bells
	Echeveria 'Imbricata'	Hens and chicks
	Rosa 'Jaccasp'	Miniature groundcover rose
	Genista lydia	Lydian broom
	Aloe x *spinosissima*	Spider aloe
	Yucca pallida	Pale-leaf yucca
	Agave pelona	Bald agave
	Kniphofia thomsonii	Alpine poker plant
Groundcovers	*Tulbaghia violaceae* 'Silver Lace'	Striped society garlic
	Heuchera 'Lillian's Pink'	Lillian's pink coral bells
	Helictotrichon sempervirens	Blue oat grass
	Nepeta x *faassenii*	Hybrid catmint
	Scabiosa 'Butterfly Blue'	Butterfly blue pincushion flower
	Ceratostigma plumbaginoides	Dwarf plumbago
	Aurinia saxatilis	Basket-of-gold
Shrubs	*Digitalis* x *mertonensis*	Strawberry foxglove
	Tulbaghia violaceae 'John Rider'	Society garlic
	Ribes malvaceum 'Montara Rose'	Montara rose chaparral currant
	Salvia x *jamensis*	Hybrid autumn sage
	Salvia greggii 'Dark Dancer'	Dark raspberry autumn sage
	Hunnemannia fumariifolia	Mexican tulip poppy
	Ceratostigma willmottianum	Chinese plumbago
	Glaucium flavum	Horned poppy
Trees	*Cornus mas*	Cornelian cherry
	Teucrium x *lucidrys*	Wall germander
	Koelreuteria bipinnata	Chinese flame tree
	Lagerstroemia sp.	Crape myrtle
	Malus	Crabapple
	Cotinus 'Grace'	Grace hybrid smoke tree

Figure 28: Landscape Re-Design Suggested Plant List

Figure 29: Ruth Risdon Storer "Valley-Wise" Garden

Figure 30: Mulches Used in Planter Areas

Aside from the chosen vegetation, mulches are used in many planter areas on the site for their aesthetic and environmental benefits. It is not possible to completely eliminate the possibility that people will walk through planter areas, but by placing mulch in planters like those in figure 30, instead of covering the entire area with groundcover, it is more likely that a person will walk around the plants and just step on the mulch. This will hopefully avoid trampling and damage to the plants. Mulches are also considered to be a very sustainable addition to the landscape due to their ability to reduce moisture loss, compaction, insulate plant roots and eliminate weeds and in consequence lowering herbicide use (Gale, 2007).

Temporary Irrigation

Valley-wise gardens reduce the amount of irrigation on the site dramatically, and once established, irrigation in some areas of the site can be completely eliminated. Many species planted in a valley-wise garden need no irrigation in the winter, and only need a deep watering once every few weeks in the dry season (Gale, 2007). Due to these low watering requirements, a technique called zoning will be used to place species with similar watering requirements in the same area. Zones that require very little watering can make use of a temporary irrigation system. By using temporary irrigation systems like

the one seen in figure 31, the site will gain more points on both LEED and SITES because the irrigation will be completely removed after the plants are established. Establishment usually takes about a year, and after this point the plants will only need additional watering in the dry season, which can be done by hand with a garden hose.

Figure 31: Temporary Irrigation System

There are a few planter areas located on the design labeled "TI" and these will use temporary irrigation systems. The planters are all in an area of the site which can be fenced off temporarily, which must be done while the temporary irrigation system is in place to avoid tripping hazards and tampering with the system.

Central Quad

Although the use of turf in a landscape is not a sustainable practice, it is vital for this particular site. Since the site is on a college campus, and inhabited by a large number of students, it is very important to provide a space for them to socialize, relax, tan, play sports, games or just hang out. As seen on other parts of the campus, such as the main quad and the rec pool, a grassy area is very popular with students and it provides

Figure 32: Central Quad for Student Recreation

the perfect hang out spot. Figure 32 shows a large lawn area in front of the Segundo residence halls that is well used by students on a daily basis.

The re-design of Tercero Phase III includes a large central quad, as well as two smaller quads centered between clusters of buildings. These quads serve as meeting places for students as they are the center focus between buildings and where walking paths meet. They are intended to be a great place for students to run into their friends or sit and relax to watch people go by.

Since the site is heavily trafficked, placing large lawns in the area could pose many problems. Students may take shortcuts and walk directly across the lawn instead of walking around. Too much traffic on the turf can cause major compaction and wear, damaging the grass significantly. These damages will cost a lot of money to reverse and could kill the lawn if proper care is not taken. In an attempt to eliminate these issues and deter students from walking through the lawn, two of the grassy areas are slightly mounded. People are far less likely to walk over a mound of grass, because it would require extra effort, and therefore they are more likely to just walk around it.

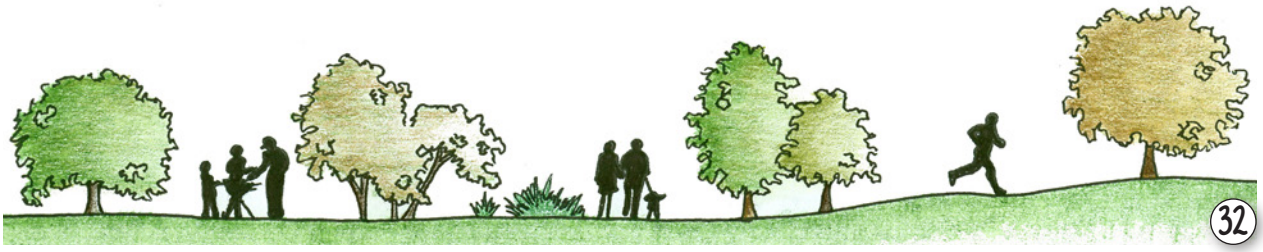
The central quad is placed near existing trees in order to make use of the shade that these trees will provide soon after the site is ready for use. New trees will also be planted around the quad to provide additional shade once the trees reach maturity. Providing both sun and shade on the lawn area is important so that it will attract a wide variety of users. Some may want to tan on a sunny day, while others may want to take a nap in the shade. Therefore, the area has been designed to please all users and provide opportunities for a wide variety of activities.

Resident Community Gardens

Figure 33: Existing Resident Community Garden in Segundo

To further promote concepts of sustainability to residents of the Tercero area, a community vegetable garden has been incorporated into the new design. Figure 33 shows a resident garden that currently exists in the Segundo Residence hall area, providing residents with an opportunity to get their hands dirty learning about edible plants, while providing leadership and community involvement skills. The gardens are primarily run by students, with the help of Sodexo and UC Davis Student Housing. The garden is open to all students living on campus, but you must participate in an orientation workshop and obtain a 'Gardener Card' before any student is allowed to work in the garden. The garden grows a variety of vegetables including beets, kale, lettuce, spinach and cabbage, and is used by students during all months of the year. Although students are not allowed to sell the plants, or use them for cooking in the dining commons, they are able to consume whatever they grow (Sodexo, 2012).

The Segundo garden has been very successful over the past year, educating students about where their food comes from and giving them a chance to connect with nature. A student garden much like the one designed in Segundo, is proposed for students in Tercero Phase III. The incorporation of a small community garden will not only give the site additional points on the SITES scale, it will also provide a more diverse living community and offer students more ways to become involved.



Rainwater Harvesting

Since the turf and the majority of the plants on the site will still have the need for some sort of irrigation system, the redesigned site proposes a more efficient way to irrigate. Through the use of rainwater harvesting, water can be collected and stored on site and then used for such purposes as irrigation. If enough rainwater is collected the system could also be used in the interior of the building to flush toilets or other uses.

A rainwater harvesting system will greatly reduce the amount of freshwater used, saving precious resources and also a significant amount of money over time. A total of four water tanks are on the site, which will provide enough space to meet the water needs of the site during the dry season. The tanks seen in figure 34 are used by the Robert Mondavi Institute for Wine & Food Sciences on the UC Davis Campus. Tanks designed for Tercero Phase III will be similar to these except not as large. The institute that uses these tanks hopes to be completely eliminated from the campus water line in the near future and rely solely on rainwater, thus the storage capacity of the tanks must be very large (Bailey, 2010). It would be very hard to accomplish a similar task with Tercero Phase III due to the large amount of residents and usage of the site, so tanks will be reserved mainly for irrigation purposes.

Figure 34: Rainwater Harvesting Collection System

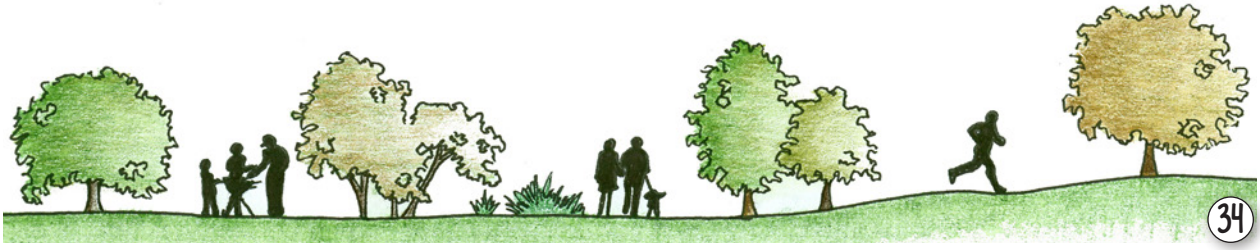
Green Roofs and Natural Lighting

Green roofs are a very important component of the new design, due to the overwhelming number of environmental benefits they provide. Not only will they beautify the site but they will aid in stormwater management, reducing the urban heat island effect, improving air quality and reducing energy costs. Green roofs like those in figure 35 will be placed on three of the seven residence hall buildings on the site, and will also provide small patio areas for student use.

Figure 35: Green Roofs Proposed for Residence Buildings

These gardens will serve to retain and filter rainwater that lands on the roof and reduce the amount of water entering bioswales and storm drains. They will also serve a significant role in cooling the building interiors during the summer as they will be covering rooftops, which are some of the hottest surfaces in the environment. The plants will also serve to capture additional pollutants in the air, decreasing the amount of CO_2 (Green roofs for healthy cities, 2012). Green roofs will be placed in the re-design of Tercero Phase III because they serve many important environmental functions and will result in saving a large amount of money.

Figure 36: Skylights Provide Natural Lighting, Reducing Costs



In addition to having green roofs on building tops, skylights will be installed to take advantage of natural lighting. Skylights like those in figure 36 will be placed on the buildings and used to direct sunlight into building interiors. These skylights are currently being used on campus and work just as well, if not better than traditional light bulbs. Unlike traditional lighting however, the skylights use the benefits of the sun to light interiors and will therefore save a significant amount of money in energy costs.

Educational Signage

Lastly, with so many site improvements and efforts toward sustainability incorporated into the design, it is important to educate and inform all users and visitors of the site. Signage will be placed in the design, providing a visual look at the sustainable design aspects and what effect they have in the conservation of precious resources. By educating users they will feel more connected to the site, and may feel more respect for it, giving them a reason to make a greater effort as individuals to preserve resources. Not only will the signage serve a purpose for those living within the site, but it gives an opportunity for visitors of the site to learn about the sustainability aspects and gain a greater appreciation for their surroundings. Signs, such as those seen in figure 37 were introduced into the UC Davis arboretum to teach visitors about sustainable gardening practices. Interactive signs, similar to these will be placed in Tercero Phase III so users can have a greater understanding and appreciation for the community they live in.

Figure 37: Signage Used to Educate Users of Site Features

Key of Proposed Design Improvements

1. Landscape incorporates valley-wise gardening, which uses low water and low maintenance plantings and also mulches to reduce water and pesticide use
2. Planting areas with temporary irrigation save water and reduce costs
3. Placement of trees around buildings takes advantage of natural cooling capabilities
4. Bioswales capture stormwater from surfaces and roofs, keeping water on-site and reducing the amount running into stormdrains
5. Rainwater harvesting system is used to capture rainwater from building roofs to use for landscape irrigation
6. Building tops have been converted to green roofs and use skylights to provide natural lighting
7. Rooftop patios provide students with secluded study spaces
8. Solar panels placed on building roofs create renewable, clean energy
9. Grassy quads create areas for student activities and recreation
10. A community garden promotes concepts of sustainability and allows residents to get involved and gain valuable life skills
11. Educational signage provides users with information on sustainable aspects of the site

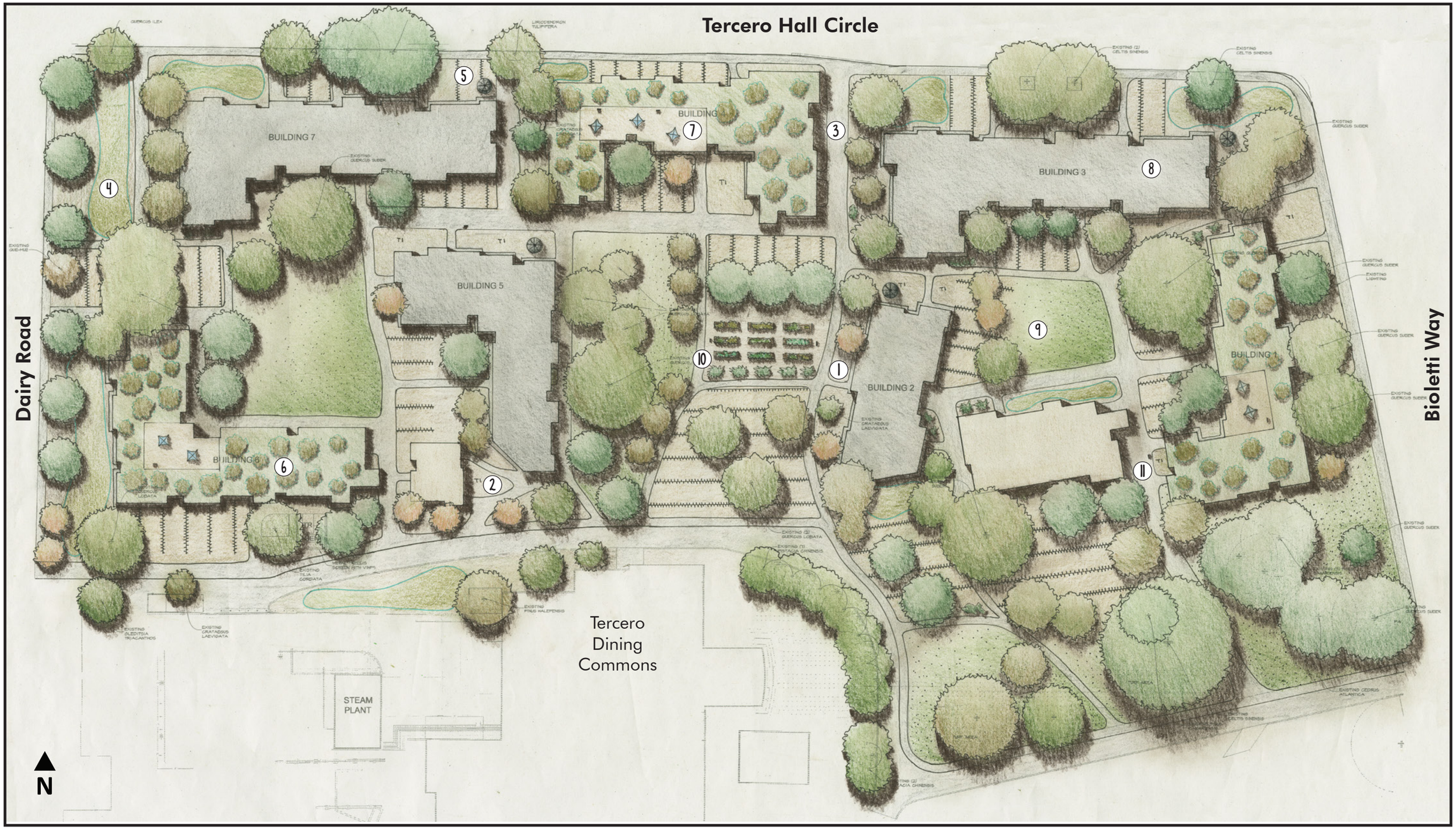
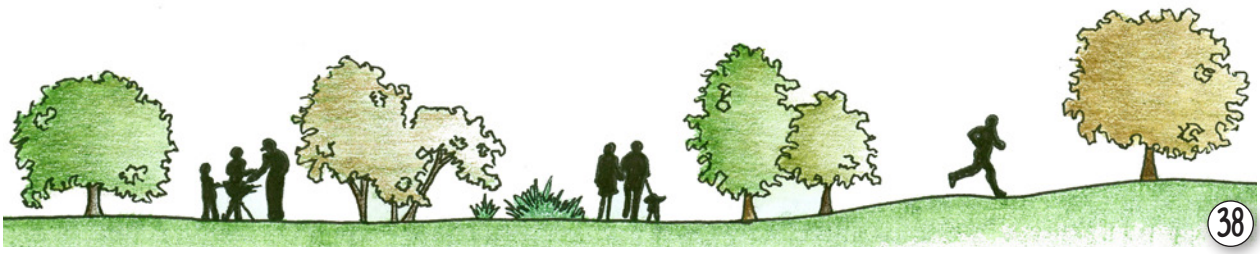


Figure 38: Final Design Plan Improving Sustainability Efforts of the Site

Conclusion

This project was the result of an interest in sustainable landscapes and methods of design to lower the impact that projects cause on the environment. What started as a research project to learn more about the Leadership in Energy and Environmental Design (LEED) rating system for buildings quickly grew into much more, and even progressed into the re-design of an entire site. While researching aspects of LEED and talking with professionals, another system was brought up: the Sustainable Sites Initiative (SITES), which is used to quantify the sustainability of landscapes. The LEED and SITES systems were each used throughout this project to evaluate the sustainability of the proposed Tercero Phase III site on the UC Davis campus.

After an analysis was done on the site to discover how sustainable the proposed design really was, it became clear that much more could be done to reduce impacts to the environment. Although this site was designed with a budget in mind, there are many sustainable design opportunities that will actually benefit the design and save a great deal of money over time. These design opportunities were examined for their sustainable aspects and the site was re-designed in an attempt to increase the sustainability and provide a site that will benefit the environment instead of damaging precious resources. Overall, this project provided a great amount of learning opportunities and the resulting site design provides many additional benefits than the original, including fewer impacts to the environment.



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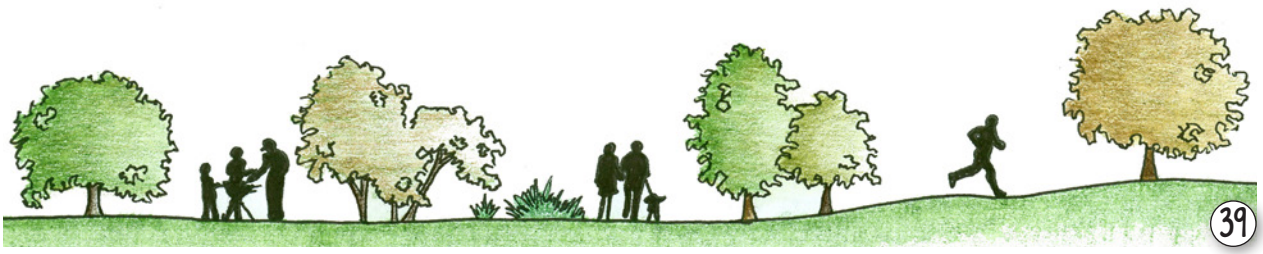

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