SURVEY OF LEED WATER EFFICIENCY CREDITS AND STRATEGIES IN THE SOUTHEASTERN UNITED STATES

by

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Abstract

Sustainable building design is growing in popularity partly due to the success of the Leadership in Energy and Environmental Design (LEED) Rating System. LEED is becoming more common in the southeastern United States; however, much of the currently available literature focuses on LEED buildings in the western United States. At the same time water conservation is becoming an important objective as freshwater sources decline and water costs rise. LEED encourages building owners to incorporate water efficiency into buildings by offering five credits under the category "water efficiency." The purpose of this study is to assist future LEED project managers in the southeast, to identify the appropriate water efficiency credits to seek, and to determine the most efficient strategies by which to achieve them; as well as to provide a real-building example of how such strategies reduce water consumption and costs.

A survey was created and distributed to all certified and registered LEED projects in EPA Region 4 (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee) via e-mail contact. The results were compiled and analyzed using descriptive statistics and the following statistical tests (using the Statistical Package for the Social Sciences – SPSS) where appropriate: paired t-test with Bonferroni adjustment, crosstabs, and analyses of variance. The survey response rate was only 16%, but noteworthy information was obtained. Water Efficiency Credits 1.1-Water Efficient Landscaping (requiring a 50% reduction in potable water use for irrigation) and 3.1-Water Use Reduction (requiring a 20% reduction in potable water use) were the most commonly achieved/sought credits. High efficiency plumbing fixtures were used by nearly every project surveyed. The survey results also revealed with

statistical significance (p-values < 0.001) that financial benefit is the most important reason project managers decide to use particular water efficiency strategies.

The University of South Carolina's West Quad was used as a LEED project case study to provide a real-building example of how water efficiency strategies can save water and money. West Quad incorporated five of the eight water efficiency strategies and received two water efficiency credits. West Quad's water usage data confirmed that its water systems are operating as designed, which in-turn is providing a financial benefit of $3,959.28 per academic school year. Perhaps the most interesting aspect about West Quad is the low-flow plumbing fixtures used to make it more water efficient actually cost $4,204.30 *less* than traditional ones.

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Section 1. Introduction

"Interest in sustainable building design is not new but has grown in popularity in recent years due in large part to the success of the Leadership in Energy and Environmental Design (LEED) green building rating system" (Allen 2004). LEED buildings impose a smaller footprint on the environment in comparison to traditionally constructed buildings and are proving to be cost effective. Presently, states in the western United States are ahead in terms of LEED buildings. In fact, several case studies have been conducted and published regarding LEED projects in western states such as California, Oregon, and Washington. Unfortunately, published literature pertaining to LEED projects in southeastern states, e.g., Florida, Georgia, North Carolina, and South Carolina, is limited.

In the past, much of the focus in sustainable building design has been to control and reduce energy operating costs in buildings; but recently, controlling and reducing water costs have become an important objective. This shift can be attributed to a reduction in freshwater sources and the subsequent increase in water costs (Allen 2004). The LEED Rating System (See Section 2) encourages building owners to incorporate water efficiency into their buildings by offering five credits under the category "water efficiency." Even though water is generally not considered as scarce in the southeast as in the west, water is a finite natural resource whose supply will not remain static and is susceptible to depletion. Therefore, opportunities to conserve water should not be overlooked, especially when constructing a LEED building. Therefore, this study focuses on the water efficiency category of the LEED Rating System.

The purpose of this study is to assist future LEED project managers in the southeast, to identify the appropriate water efficiency credits to seek, and to determine the most efficient strategies by which to achieve them; as well as to provide a real-building example of how such strategies reduce water consumption and costs. Data to assess the appropriate water efficiency credits and strategies were obtained by creating and distributing a survey to all the certified and registered LEED projects in EPA Region 4 (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee) via the contact e-mail address available on the United States Green Building Council's (USGBC) web page (www.usgbc.org). The survey asked which of the five credits under the water efficiency category were (are being) sought, which credits were achieved, the strategies used to achieve the credits, and the rationale/reasons for selecting the strategies. The compiled survey results will help LEED project managers in the southeast narrow their focus to the appropriate water efficiency credits and strategies for their region.

The University of South Carolina's (USC) West Quadrangle (West Quad) (www.housing.sc.edu/westquad.asp) was used as a LEED project case study to provide a real-world example of how water efficiency strategies can save water and money. Demonstrating such strategies do indeed work and provide benefits, both environmental and financial, is essential.

The remainder of this thesis is structured as follows. Section 2 will provide a brief history of sustainable building design and an explanation of the LEED Rating System, its growth, and cost effectiveness. It will also include the reason for focusing on the southeast. Section 3 explains the water efficiency credits and strategies, and Section 4 presents the research questions addressed. The creation of the survey instrument is described in Section 5, as well as the approach to the case study. Section 6 contains the results of the survey, while Section 7 is a discussion of those results. The University of South Carolina’s West Quad case study is presented in Section 8, and the conclusions of the entire thesis are presented in Section 9.

Section 2. Background

2.1 History of Sustainable Building Design

The idea of sustainable building design has strengthened in the last decade, but its roots can be traced back to the nineteenth century. Sustainable building design, synonymous with green building, is defined by the Office of the Federal Environmental Executive as "the practice of 1) increasing the efficiency with which buildings and their sites use energy, water, and materials, and 2) reducing building impacts on human health and the environment, through better siting, design, construction, operation, maintenance, and removal – the complete building life cycle" (Cassidy 2003). According to David Gissen, curator of architecture and design at the National Building Museum in Washington, D.C., London's Crystal Palace and Milan's Galleria Vittorio Emanuele II, both constructed in the nineteenth century, employed passive systems, such as roof ventilators and underground air-cooling chambers, to moderate indoor air temperature. In 1932, the Rockefeller Center utilized both operable windows and sky gardens. About this time, commercial buildings began to incorporate retractable awnings and window shades to block the sun (Cassidy 2003).

In the 1970s, the environmental movement inspired individuals within the building community to explore methods of energy conservation in buildings through the use of triple-glazed windows, photovoltaics, and area climate-control mechanisms.

In the 1980s and early 90s further efforts were made to green the construction industry. During this time, the American Institute of Architects (AIA) published the *Environmental Resource Guide*, which described building products based on life cycle analysis. In 1993, President Bill Clinton announced his "Greening of the White House" initiative to make the White House "a model for efficiency and waste reduction" (Cassidy 2003). The success of this project sparked numerous Federal greening projects, including those of the U.S. Navy and the U.S. General Services Administration (GSA). The USGBC was also formed during this time and began the creation of the Leadership in Energy and Environmental Design (LEED) green building rating system (Cassidy 2003).

2.2 Leadership in Energy and Environmental Design (LEED)

The USGBC created the LEED green building rating system in 1993 and implemented it in 1999. It is a "voluntary, consensus-based national standard for developing high-performance, sustainable buildings" (USGBC 2005a). LEED includes four levels of certification for buildings, which are based on the total number of points achieved – certified (26 to 32 points), silver (33 to 38 points), gold (39 to 51 points), and platinum (52 or more points). Points can be achieved in the following areas: sustainable site development, water efficiency, energy efficiency and atmosphere, material and resource selection, indoor environmental quality, and innovation and design process. Points are awarded for meeting the requirements specified in a credit, and each area has a different number of credits. A credit addresses a specific issue within the broader area, i.e., Water Efficiency Credit 3.1-Water Use Reduction is one credit within the water efficiency area. Each credit summarizes the measure's intent and requirements and includes supportive information to help interpret, implement, and document performance.

Currently, there are LEED standards for new commercial construction and major renovation projects (LEED-NC), existing building operations (LEED-EB), commercial interiors projects (LEED-CI), and core and shell projects (LEED-CS). A standard for homes (LEED-H) is in pilot phase, and a neighborhood development (LEED-ND) standard is under development (USGBC 2005a). This study involves the LEED-NC and LEED-EB standards because they have exactly the same water efficiency credits and are currently in use. The LEED-NC standard has three versions: LEED-NC v.2.0, LEED-NC v.2.1 and LEED-NC v.2.2. Version 2.2 is the newest version having been released in November of 2005.

"LEED was created to:

- Define 'green building' by establishing a common standard of measurement
- Promote integrated, whole-building design practices
- Recognize environmental leadership in the building industry
- Stimulate green competition
- Raise consumer awareness of green building benefits
- Transform the building market" (USGBC 2005a).

When a company or organization has decided to pursue LEED certification for a project, the project is first registered on the USGBC website. After registering, project team members have access to an online version of the LEED Reference Guide and LEED Letter Templates both of which are critical to the certification process. As the project nears completion, the project team submits an application for certification to the USGBC. Once received, the USGBC reviews the application, requests any additional information needed to verify compliance, and selects up to six points for audit. Following the final review of the application and additionally submitted information, the USGBC awards the project its appropriate certification. Only then is the project referred to as “certified.”

2.3 Growth of LEED

The LEED green building rating system has transformed the building and design industries in the United States. It began with a small group of pilot projects, and there are now more the 1,600 projects registered with the USGBC (USGBC 2005c). LEED certification is becoming a requirement for government and corporate organizations such as the U.S. GSA, U.S. Navy, Ford Motor Company, Sprint, Steelcase, PNC Financial Services, and Toyota (Cassidy 2003). Cities and entire states are requiring LEED certification for city and state owned buildings, e.g., Chicago, Illinois; Phoenix, Arizona; Portland, Oregon; Seattle, Washington; Kansas City, Missouri; Nevada; and California (USGBC 2006). Colleges and universities are making LEED their standard for new construction as well (Cassidy 2003, USGBC 2006).

The growth of LEED is largely due to the realization that buildings designed with sustainability in mind reduce the built environment’s substantial impacts on our natural environment, economy, health, and productivity (USGBC 2003a). Buildings in the United States annually consume more than 30% of our total energy and 60% of our electricity. Five billion gallons of potable water are used each day to flush toilets in the United States. Buildings are also a significant source of solid waste and pollution (sulfur dioxide, nitrous oxide, and carbon dioxide emissions) (USGBC 2003b).

Buildings designed to LEED specifications are on average 30% more energy efficient than conventional buildings and reduce peak energy demand up to 40%.

According to one study, the total 20-year net present value of financial energy benefits for green U.S. commercial buildings is $6.09 per square foot (Kats et al. 2003). The federal government has constructed numerous buildings according to sustainable design guidelines. From 1985 to 2003, the federal government realized a 23% per square foot decrease in building-related energy costs, which translates to $1.4 billion (USGBC 2003a).

LEED buildings have vastly improved indoor air quality when compared to conventional buildings. Such improvements reduce incidents of sick building syndrome and other ailments, such as asthma, reduce absenteeism, and increase productivity. The "White Paper on Sustainability" reports the research of one of the most distinguished scholars of indoor environmental quality as follows:

> "William J. Fisk, PhD, of the Indoor Environmental Department at Lawrence Berkeley National Laboratory, has projected the estimated potential annual savings and productivity gains from improved indoor air quality at $6-14 billion from reduced respiratory disease, $1-4 billion from reduced allergies and asthma, $10-30 billion from reduced SBS[sick-building syndrome]-related illness, and $20-160 billion from direct improvements in worker performance that are unrelated to health" (Cassidy 2003).

The LEED Silver PNC Firstside Center building in Pittsburgh, Pennsylvania provides an example of the benefits created by improved indoor air quality. The company's senior vice president, Gary Jay Saulson, describes the benefits as follows: "People want to work here, even to the point of seeking employment just to work in our building. Absenteeism has decreased, productivity has increased, recruitment is better and turnover less" (Kats 2004). Voluntary terminations have decreased in two business units, by 83% and 53%, since moving into the new Firstside facility (Kats 2004).

Providing natural daylight has been shown to increase productivity among students and workers. Students in North Carolina schools with natural daylight consistently score higher on tests than students in schools with conventional lighting fixtures (USGBC 2003b). A study conducted by the Heschong Mahone Group entitled "Daylighting in Schools" analyzed the test scores of 21,000 students in Seattle, Washington; Orange County, California; and Fort Collins, Colorado. "In Orange County, students with the most daylighting in their classrooms progressed 20% faster on math tests and 26% faster on reading tests in one year than those with the least daylighting. For Seattle and Fort Collins, daylighting was found to improve test scores by 7% to 18%" (Cassidy 2003).

The Center for Building Performance at Carnegie Mellon University has reviewed over 1,000 studies relating technical characteristics (lighting and ventilation) of areas in buildings to tenant responses (productivity). These studies reveal that sustainable building design aspects involving lighting, ventilation, and thermal control correlate to increases in tenant/worker well-being and productivity. Average workforce productivity gains were 7.1% with lighting control, 1.8% with ventilation control, and 1.2% with thermal control (Kats 2004).

2.4 LEED is Cost-Effective

One of the first questions in regards to sustainable design and LEED certification is often: How much will it cost? A study conducted by Davis Langdon, an international construction and property consulting company, revealed "the cost per square foot for buildings seeking LEED certification falls into the existing range of costs for buildings of similar program type" (Matthiessen and Morris 2004). Therefore, it concluded, "that many projects can achieve sustainable design within their initial budget or with very small supplemental funding" (Matthiessen and Morris 2004). However, the decision to construct a LEED building must be made early in the process and considered at every step in the process (Matthiessen and Morris 2004).

Another study, "The Costs and Financial Benefits of Green Buildings," principally authored by Greg Kats, also demonstrates that sustainable design is cost-effective (Kats et al. 2003). Initially, green buildings were thought to have costs, ranging from 10% to 15%, above conventional buildings. However, Kats' study of 33 LEED registered projects found that the actual average cost premium was less than 2%. The cost premiums ranged from 7.5% for a silver-rated building to zero for several certified and silver-rated buildings (Kats et al. 2003).

Building green produces financial benefits such as "lower energy, waste disposal, and water costs, lower environmental and emissions costs, lower operations and maintenance costs, and savings from increased productivity and health" (Kats et al. 2003). Benefits from energy, waste, and water savings are fairly predictable because they are relatively easy to measure and monitor, while productivity and health benefits are less predictable because they are more difficult to accurately access. When life cycle savings are incorporated, the financial benefits of green buildings become more prominent. Kats' study found that "an upfront investment of less than 2% of construction costs yields life cycle savings of over ten times the initial investment" (Kats et al. 2003).

A study conducted by the Urban Environmental Institute in Seattle, Washington, also supports the idea that LEED buildings can be constructed with little or no additional cost. Often times, any additional cost is paid back within a short time, ranging from 5 to

20 years. The payback is due to the financial benefits realized from sustainable practices, which reduce energy and water demands resulting in lower energy and water bills. It is also possible to construct a LEED building under a traditional construction budget. Recreational Equipment, Inc. (REI)'s Denver Flagship building, for example, was constructed for 1.5% under the traditional construction budget (Urban Environmental Institute 2002).

The Urban Environmental Institute's study stresses the need to establish performance goals at the beginning of the process and to make careful, informed decisions. An option to consider is "sustainable cost transfer," which is employed within a fixed budget and eliminates certain elements and transfers the funds to elements with a higher environmental benefit. As stated in the study, "Green can be Gold." A building's value can be increased by incorporating appropriate sustainable strategies (Urban Environmental Institute 2002). An example of sustainable cost transfer would be eliminating a standard element such as garbage disposals in order to install solar light shelves, which filter out harmful UV radiation while allowing natural sunlight into a facility.

In 2004, the U.S. GSA commissioned a study to estimate the costs associated with building "green" federal facilities using the LEED-NC v.2.1 green building rating system. The study focused on the GSA's two most common project types – new courthouses and office building modernizations. For each project type, six scenarios were considered: a low- and high- cost facility for three certification levels (certified, silver, and gold). Cost premiums ranged from -0.03% to 8.1% for new courthouses and from 1.4% to 8.2% for office building modernizations (Table 1).

New Courthouse					
Certified		**Silver**		**Gold**	
Low Cost	**High Cost**	**Low Cost**	**High Cost**	**Low Cost**	**High Cost**
-0.4%	1.0%	-0.03%	4.4%	1.4%	8.1%
Office Building Modernization					
Certified		**Silver**		**Gold**	
Low Cost	**High Cost**	**Low Cost**	**High Cost**	**Low Cost**	**High Cost**
1.4%	2.1%	3.1%	4.2%	8.2%	7.8%

Table 1: GSA cost premiums in percentage change from traditional cost (Steven Winter Associations, Inc. 2004)

These construction cost estimates are reflective of GSA FY04 and a location of Washington, DC (Steven Winter Associates, Inc. 2004).

2.5 LEED in the Southeast

In general, LEED has not grown as fast in the southeastern United States as it has in the western states. In fact, when one researches LEED projects, the majority of the case studies and information involves projects in the western United States, particularly in California, Oregon, and Washington (Matthiessen and Morris 2004, Kats 2003, Urban Environmental Institute 2002). As of May 23, 2005, there were more LEED *certified* buildings in western states (81 projects) than southeastern states (30 projects) (USGBC 2005b). Western states include Arizona, California, Nevada, Oregon, and Washington; southeastern states include those in EPA Region 4 — Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee.

Information and research regarding LEED certified buildings in the southeast is limited; however, interest in LEED buildings is growing quickly. As of May 23, 2005, there were 138 projects *registered* in the southeast region (USGBC 2005c). The substantial number of registered projects illustrates the need and desire for information and research pertaining to LEED buildings constructed in the southeast. Although some aspects of LEED buildings are the same throughout the United States, climate and terrain differences between the west and southeast mean that some aspects of these regions' construction projects are inherently different. The regions exhibit marked differences in water efficiency and conservation aspects.

The next section focuses on the five water efficiency credits, including an explanation of each water efficiency credit, the strategies used to achieve them, the reasons for seeking them, and a brief discussion on future water costs.

Section 3. Water Efficiency Credits

The LEED-NC and LEED-EB Rating Systems include five water efficiency credits. As mentioned in Section 2.2, a credit addresses a specific issue within the broader area and summarizes the measure's intent and requirements. The first two credits pertain to water efficient landscaping and are intended to "limit or eliminate the use of potable water for landscape irrigation" (USGBC 2003b, USGBC 2004). The first one, Credit 1.1, requires a 50% reduction in potable water consumption for irrigation compared to conventional methods. To achieve this credit the use of high efficiency irrigation technology, captured rain, or recycled site water is suggested. Credit 1.2 requires a 100% reduction in potable water consumption for irrigation or that no permanent irrigation system be installed (USGBC 2003b, USGBC 2004).

Credit 2.0 pertains to innovative wastewater technologies and is intended to "reduce the generation of wastewater and potable water demand, while increasing the local aquifer recharge" (USGBC 2003b, USGBC 2004). The credit is earned by reducing "the use of municipally provided potable water for building sewage conveyance by a minimum of 50%" or treating "100% of wastewater on site to tertiary standards" (USGBC 2003b, USGBC 2004).

The final two credits involve water use reduction. Their intent is to "maximize water efficiency within buildings to reduce the burden on municipal water supply and wastewater systems" (USGBC 2003b, USGBC 2004). Credit 3.1 requires reducing potable water use by 20% after meeting the Energy Policy Act of 1992 (EPAct) fixture performance requirements (Table 2).

Fixture Type	Flow Requirement*
Toilets	1.6 GPF
Urinals	1.0 GPF
Showerheads	2.5 GPM
Faucets	2.5 GPM
Replacement Aerators	2.5 GPM
Metering Faucets	0.25 gal/CY

Table 2: EPAct fixture flow requirements

* GPF = gallons per flush, GPM = gallons per minute, gal/CY = gallons per cubic yard

The EPAct addresses numerous environmental concerns pertaining to the construction and operation of commercial, institutional, and residential facilities. One of those concerns is water use, which prompted the government to include flow requirements on plumbing fixtures. Credit 3.2 requires reducing potable water use by 30% after meeting the EPAct (USGBC 2003b, USGBC 2004).

Table 3 provides the formal name of each water efficiency credit and summarizes their requirements.

Water Efficiency Credit	Requirement
Water Efficient Landscaping 1.1	50% reduction in potable water use for irrigation
Water Efficient Landscaping 1.2	100% reduction in potable water use for irrigation **or** no permanent irrigation system
Innovative Wastewater Technologies 2.0	Reduce building sewage conveyance by a minimum of 50% **or** treat 100% of wastewater on site to tertiary standards
Water Use Reduction 3.1	20% reduction in potable water use
Water Use Reduction 3.2	30% reduction in potable water use

Table 3: Water efficiency credits and requirements (USGBC 2003b)

3.1 Water Efficiency Strategies

A number of strategies can be employed to achieve water efficiency credits. Table 4 provides a list of the strategies, along with the credits to which they can be applied. Note that some strategies can be used for more than one credit.

Water Efficiency Strategy	Applicable Credit(s)
Dry Plumbing Fixtures	2.0, 3.1, 3.2
Graywater Collection & Usage	1.1, 1.2, 2.0, 3.1, 3.2
High Efficiency Irrigation Systems	1.1, 1.2
High Efficiency Plumbing Fixtures	2.0, 3.1, 3.2
Occupant Sensors & Timers	2.0, 3.1, 3.2
On-site Wastewater Treatment	1.1, 1.2, 2.0
Rainwater Collection & Usage	1.1, 1.2, 3.1, 3.2
Xeriscaping	1.1, 1.2

Table 4: Water efficiency strategies (USGBC 2003b)

The majority of the strategies are self-explanatory. Xeriscaping, or dry landscaping, is a method of landscape design that makes water conservation the primary objective. It incorporates sound horticultural practices and uses plant species that are adapted to the local climate conditions. Graywater is wastewater from lavatory sinks, showers, and bathtubs as well as washing machines and sinks not used for disposal of hazardous or toxic ingredients or wastes from food preparation. The graywater is collected, stored on the site, and commonly used for irrigation purposes (USGBC 2003b). See Appendix A for a brief description of each strategy.

3.2 Reasons for Seeking Water Efficiency Credits

The reduction in freshwater sources and the increase in water costs have caused more building owners to consider water conservation methods. Initially, energy conservation was the primary focus (Allen 2004). According to a survey conducted by Plumbing and Mechanical (PM) and Environmental Design and Construction (ED&C) magazines, the majority of readers believe water conservation will be more important to customers in the future. The ED&C survey found that 34% of readers indicated a "seldom but growing" amount of times either they or their commercial/institutional clients included water conserving products to qualify for LEED points vs. the 19% that indicated "never." The PM survey found that 37% of readers said "never" to the same question vs. 16% that said "seldom but growing" (Smith 2004). Both cases demonstrate the need to educate clients about the reasons to seek LEED water efficiency credits and the options available to achieve them.

Water is a finite natural resource whose supply will not remain constant as demonstrated during South Carolina's five-year drought from June 1998 to August 2002; therefore, opportunities to conserve water should not be ignored. During the drought, the average precipitation was 10% to 30% below normal, stream flows reached historic lows, saltwater intrusion threatened coastal areas, and ground water levels in shallow and deep aquifers reached record lows. The effects were statewide and alerted water resource managers to the realization that western states were not the only states that could run out of water (Badr, Wachob, and Gellici 2004).

South Carolina's drought experience should serve as an example to others and encourage them to take advantage of opportunities to conserve water. Achieving LEED water efficiency credits will conserve water, which in-turn will provide economic benefits. Even if one does not believe there is a *need* to conserve water, the fact that water conservation has economic benefits should provide the necessary incentive to adopt and use water conservation methods.

A study conducted by the EPA entitled, "Cases in Water Conservation: How Efficiency Programs Help Water Utilities Save Water and Avoid Costs," highlights the successes of seventeen U.S. cities' water conservation programs. Cary, North Carolina, instituted a conservation program consisting of the following eight elements:

- "public education,
- landscape and irrigation codes,
- toilet flapper rebates,
- residential audits,
- conservation rate structure,
- new homes points programs,
- landscape water budget, and
- a water reclamation facility" (US EPA 2002).

The program reduced the city's operating costs and allowed Cary to delay two water plant expansions. The projected 10-year savings from the program are 1 mgd (million gallons per day) and 2 mgd by 2019 (US EPA 2002).

Tampa, Florida, included high efficiency plumbing retrofits, irrigation restrictions, landscaping measures, public education, and an increasing-block rate structure. Emphasis was put on efficient landscaping and irrigation. The landscape program reduced water use by 25% and an initial plumbing retrofit program reduced water use by 15%. Using less water reduced consumers' water costs and the city's operating costs (US EPA 2002). While these examples are based upon cities rather than individual building projects, they do demonstrate that water conservation provides economic benefits.

The U.S. GSA study commissioned in 2004 included a review of initial costs for individual LEED credits and found that most water efficiency (WE) credits are cost-effective to incorporate. WE Credits 1.1 and 1.2 were identified as having no cost premium and possibly creating savings. WE Credit 2.0 was identified as a credit that would not be pursued. WE Credit 3.1 is considered a GSA mandate and has no extra cost, and WE Credit 3.2 was identified as having a moderate cost premium (Steven

Winter Associates, Inc. 2004). Keep in mind that this review does not take into consideration any savings that would result from using less water once a building is in operation.

LEED buildings that have incorporated water efficiency credits can be 50% to 100% more efficient in terms of landscape water use and 20% to nearly 60% more efficient in terms of potable water use (USGBC 2003b). Once water efficiency strategies are incorporated into a LEED building, they will continue to save water and reduce water costs for the life of the building. Kats' calculated an example based on a 100,000 square foot LEED building in California, which is 30% more efficient for potable water use and 50% more efficient for irrigation water use. The total water savings at a 20-year net present value were $51,271 (Kats 2003). A Department of Energy study found that installing waterless urinals would save $590 per urinal because they require less piping than conventional urinals and would provide an annual cost savings of $330 (Cassidy 2003).

3.3 Future Water Costs

Although no definitive figure has been determined, past and current trends indicate that the cost of water will likely increase in the future. Numerous factors will affect the future cost of water. Some of them are discussed in the following paragraphs.

3.3.1 Treatment Costs. One factor is increasing treatment costs. Treatment costs will likely increase if and when the source water used is of lower quality than it is currently. Technological advances will alleviate some of this increase, but the technological advances will have to be financed and are expected to be expensive at first. As more is learned about pollutants and their effects on humans and the environment, it may be necessary to adjust the current drinking water regulations, which will also increase treatment costs. Again, technology will be helpful in this process, but it is initially expensive.

3.3.2 Operation and Maintenance Costs. In general, operation and maintenance costs are increasing and will likely continue to do so. This affects many aspects of society including water systems. As systems become older, more maintenance will be required. This factor will be compounded by the fact that the federal government is offering less assistance to public utilities for major repairs and expansion projects.

3.3.3 Expansion Costs. The need to expand water systems will also push water prices upward in the future. This will be a dominant factor in South Carolina as the state's population continues to grow, especially in coastal municipalities. Expansion costs will be high without federal assistance and will probably be paid for by increasing water and sewer rates. However, conserving water now will free up capacity for the growing customer base and likely delay the need for expansion. Raising customers' water and sewer rates will likely finance the water system operators' increasing costs. Therefore, investing in water efficiency strategies will save consumers money both now and in the future.

3.3.4 Estimated Future Water Cost. Although the exact future cost of water is unknown and will vary from city to city and state to state, past increases experienced by the University of South Carolina (USC) provide a good illustration of what the future might bring in Columbia, South Carolina. According to USC's Energy Services department, the cost to the University of 1,000 gallons of water in FY93/94 was $2.84. This increased to $4.17 in FY03/04 – a 47% increase over ten years (these prices include sewer charges). If the same rate of increase continues for the next ten years, the cost of 1,000 gallons of water in FY13/14 will be $6.13. Taking action to conserve water will provide financial benefits now and even more so in the future.

To summarize, LEED is increasing in popularity in the southeast, but there is limited region specific information available. The water efficiency category of LEED is not often a high priority for LEED project managers. However, water is a finite resource, and conserving it is becoming more important as freshwater sources decline and water costs increase.

LEED project managers in the southeast need to be addressing water efficiency issues in their projects, but they need help identifying the credits and strategies appropriate to their region. It is important for LEED project managers to know why certain strategies are used, which is normally determined by ranking the importance of a series of factors. When a water efficiency strategy is incorporated, the discussion in this section and discussions with experienced LEED project managers suggest that one or more of the following factors may play a role in the decision:

- Educational demonstration
- Public relations/marketing
- Financial benefits
- Building code
- Incentives provided
- Water concerns and/or shortages
- Owner demand
- Other regulatory requirements

Similarly, when a water efficiency strategy is *not* incorporated, one or more of the following factors may play a role in the decision:

- Cost constraints
- Time constraints
- Space constraints
- Regulatory restrictions
- Owner disapproval
- Lack of understanding

It is also essential for LEED project planners to know if water efficiency strategies save money and water as intended, which demonstrates the need for data from operating LEED buildings.

Section 4. Research Questions

From the previous sections it is apparent that there is limited information dealing specifically with LEED buildings in the southeast. Since water conservation is becoming a greater concern due to declining resources and rising costs, the water efficiency category of LEED should *not* be overlooked. In addition, the use of LEED in the southeast is increasing, which indicates the need for region specific information. Project managers need to know which water efficiency credits are appropriate to this region and which strategies are most effective in achieving them. Another essential component is data and information from operating LEED buildings in the southeast.

As mentioned in Section 1, the purpose of this thesis is to assist future LEED project managers in the southeast with identifying the appropriate water efficiency credits to seek, to determine the most efficient strategies by which to achieve them, and to provide a real-building example of how such strategies reduce water consumption and costs. To achieve these objectives, it was necessary to address the following questions:

1. What water efficiency credits were achieved/sought by certified and registered LEED projects in EPA Region 4?
2. What strategies were employed to achieve the credits?
3. What factors were considered when choosing strategies?
4. Do the strategies save money and water?
5. Are the appropriate credits and strategies utilized at West Quad?
6. Are water and money being saved at West Quad?

The answers to these six questions will help LEED project managers in the southeast (EPA Region 4) address the water efficiency category. The information in this study gives them an idea of what water efficiency credits to seek, strategies to employ, and why certain strategies are chosen instead of others. The study also provides the answer to a very important question, "will these strategies save money?" The key component of this study is its specificity to the southeast region. The case study on the University of South Carolina's West Quad provides real data from a functioning LEED building to demonstrate that these strategies can save money.

Section 5. Methodology

This section explains the methods that were employed to answer the research questions. The first four questions in Section 4 were addressed by administering a survey to all the managers of certified *and* registered LEED projects in EPA Region 4. EPA Region 4 was selected to provide consistency within the sample population in terms of climate and general terrain. The fifth and sixth questions were addressed by conducting a case study of the University of South Carolina (USC)'s West Quad. The facility was selected because it is a functioning LEED building in the southeast, and the building and data were accessible.

5.1 Survey Instrument

The survey focused on the LEED-NC and LEED-EB standards because they have exactly the same water efficiency credits and are currently being used by LEED project managers. The survey included questions regarding which water efficiency credits were (are being) achieved (sought), the strategies used to achieve the credits, and the factors considered when choosing the strategies. See Appendix B for the specific questions.

The strategies included in the survey were those mentioned in the water efficiency category of the LEED-NC v.2.1 Reference Guide. The lists of incorporated and not-incorporated factors were developed by reading LEED and green building literature, observing the decision-making process in LEED project planning meetings, and discussing LEED and the water efficiency category with numerous LEED project managers, LEED project owners, and contractors and engineers who have worked on LEED projects.

The survey also included questions pertaining to the project's type, function, size, and certification level. The survey was constructed with the assistance of Dr. Floyd J. Fowler, Jr's texts on social research methods (1995, 2002) and the thesis committee. Two volunteer members of the South Carolina Chapter of the USGBC reviewed the survey, provided feedback, and offered further suggestions. The survey was put into a web-based format (http://www.environ.sc.edu/leed/) with the assistance of Mr. Jeff Wallace, the Information Resources Coordinator for the School of the Environment at the University of South Carolina. When respondents submitted the survey, their responses were electronically directed to an Access database.

The e-mail address for each LEED project manager within EPA Region 4 was obtained from the USGBC's website (USGBC 2005c). An e-mail was then sent to each of the 213 managers explaining the project and asking for their assistance by going to the provided web link and filling out the survey.

Potential respondents were initially given two weeks to submit the survey. Those who did not respond were sent an additional e-mail. Follow-up phone calls were made, and project information was re-sent upon request. Some individuals chose to print the survey, fill it out, and fax it. Toward the end of the survey period, which lasted ten weeks, ten project managers were selected and sent the project information and survey via standard mail. These ten were selected because they had shown interest in completing the survey but had not done so, or the phone number provided was no longer valid. One of the selected ten returned a completed survey via fax.

5.2 Statistical Methods for Survey Analysis

Formal statistical analysis was limited due to the nature of the survey and limited number of responses. The basic information regarding the projects surveyed was most useful when analyzed with basic descriptive statistics – the number and percentage of projects that fell under certain categories. This provides a broad picture and understanding of the survey group. Descriptive statistics were also used for analyzing the water efficiency credit and strategy information. The percentages revealed what credits and strategies are common for projects in the southeast region.

Analyzing the incorporated and not-incorporated factors was more involved. For each water efficiency strategy incorporated, respondents were asked to indicate the importance of each factor (in the list provided) in deciding to use the strategy. Similarly, for those strategies that were *not* incorporated, respondents were asked to indicate the importance of each factor (in the list provided) in deciding *not* to use the strategy. The following scale was used to rank the importance of each factor: 1 = not important; 2 = slightly important; 3 = moderately important; 4 = very important; 5 = extremely important. An average rating or level of importance was calculated for each factor.

A paired t-test analysis was conducted using the Statistical Package for the Social Sciences (SPSS) to determine if there were any differences among the factor averages. The Bonferroni adjustment was used to account for the multiple comparisons between the factors' averages. The p-values were multiplied by the total number of pairs in the analysis – for incorporated factors the multiplier was 28 and for not-incorporated factors the multiplier was 15. According to Dr. Roumen Vesselinov, Manager of the USC Statistical Consulting Lab, the Bonferroni adjustment is very conservative (per. com. 2005). Prior to the adjustment, the p-values reflected more of a statistical difference between the factor averages. This procedure was used for each water efficiency strategy. The same paired t-test analysis with Bonferroni adjustment was used to determine the *overall* importance of each factor. In this analysis, the multiplier for incorporated factors was 143, and 137 for not-incorporated factors.

To analyze the cost comparison data, the number and percentage of respondents that indicated each cost implication under each water efficiency strategy was determined. These values can help LEED project managers determine which strategies are likely to cost more, less, or about the same as compared to traditional methods. To determine if the estimated water savings information was related to the strategies chosen, a crosstabs analysis utilizing SPSS was conducted. A crosstabs analysis was also used to determine if there was any relationship between particular credits and/or strategies and the level of publicity/marketing benefits realized.

Respondents were asked to indicate the function of their project from a provided list. This information was analyzed by determining the number and percentage of surveyed projects that indicated a particular function was primary, secondary, or does not apply. An analysis of variance using SPSS was conducted to determine if a project's budget affected the number of credits achieved/sought. A SPSS crosstabs analysis was performed to determine if having prior LEED experience affected the certification level or number of credits achieved/sought.

5.2.1 Effect of Non-Response. When assessing the results of the survey, the effects of non-response should be considered. According to Fowler (2002), there is not an agreed-upon standard for minimum acceptable response rate. The Office of Management and Budget seeks a response rate in excess of 75%. Academic survey organizations in the U.S. are often able to achieve a response rate around 75%. Fowler states the effect of non-response on data is usually not known because there is not enough data indicating whether non-response is biased with respect to the survey's content (Fowler 2002). Dr. Robert Oldendick, Executive Director of the USC Institute for Public Service and Policy Research, referenced a response rate of 20% for surveys of this kind with a single request and a response rate closer to 33% with follow-up reminders (per. com. 2005).

5.3 Case Study Approach

The approach for the West Quad case study was to provide the answers to the West Quad survey that was completed by the Environmental Programs Manager for the University of South Carolina's Housing Department. Utilizing the factor data, information provided by the Environmental Programs Manager, and additional knowledge obtained by researching the strategies, a determination was made as to whether the strategies not incorporated at West Quad could have been incorporated and if these strategies should be incorporated in future USC LEED projects.

To determine if West Quad is performing as designed (saving water and money), the complex's water bills for the spring 2005 semester were reviewed. This time frame was selected to coincide with building occupancy and data availability. An average monthly water usage was calculated for West Quad and compared to the LEED Baseline average monthly water usage, which was calculated for LEED application purposes.

West Quad's average monthly water usage was also compared to that of USC's East Quad, which is another USC residence hall. East Quad was used as a benchmark because it is the most similar to West Quad in terms of structure, function, and occupancy; however, it was not designed and constructed as a green building. The primary difference, other than LEED designation, is that West Quad includes a café. This was accounted for by taking manual water meter readings at the café and subtracting its usage from the overall West Quad usage. The other main difference is that East Quad is smaller and houses 440 students while West Quad houses 500 students. This was accounted for by calculating the average monthly water usage per student for the two facilities.

The water savings were translated from volume to dollars by using USC's billed water rate of $3.12/cubic hundred feet (CCF). To further analyze the benefits of incorporating water efficiency strategies at West Quad, the cost of the low-flow plumbing fixtures at West Quad was compared to the cost of standard EPAct plumbing fixtures. The difference between the West Quad fixtures and the EPAct fixtures was utilized in a net present value calculation to estimate expected future savings.

Section 6. Results

This section provides the results of the survey separated into sections based on the content of the survey questions. With only 35 respondents, it was difficult to obtain robust, statistically significant results. Nevertheless the results do provide worthy information regarding which water efficiency credits to seek in the southeast and which strategies are commonly used. The results also indicate that certain factors are clearly guiding the decisions of project managers.

6.1 Survey Response Rate

At the end of the survey period, there were a variety of outcomes among the 213 requests sent (Table 5).

State(s)	SC	NC	GA	FL	Others: KY, TN, AL, MS	Totals/(%)
Total Projects	**32**	**38**	**67**	**43**	**33**	**213**
Surveys returned	*13*	*6*	*6*	*5*	*5*	*35 (16%)*
Spoke, no response *	5	8	11	7	7	38 (18%)
Message, no response †	6	11	28	14	14	73 (34%)
No LEED or project stalled ‡	5	2	2	3	2	14 (7%)
Commercial Interior Project, N/A	1	0	0	1	0	2 (1%)
Communication	**30**	**27**	**47**	**30**	**28**	**162 (76%)**
Missing e-mail or phone number	2	6	4	3	2	17 (8%)
Invalid e-mail or phone number	0	5	16	10	3	34 (16%)
No Communication	**2**	**11**	**20**	**13**	**5**	**51 (24%)**

Table 5: Survey outcomes

* The respondent was spoken to and said he/she would return the survey but did not do so; † The respondent was left a message (or messages in some cases) but did not follow-up on the message; ‡ The project did not pursue LEED certification or was stalled for some other reason such as budget constraints

There was communication with 76% of the potential respondents, and 16% of the 213 potential respondents returned surveys or 22% of the 162 respondents with which there was communication.

6.2 Characteristics of Surveyed Projects

Of the 35 surveys that were returned, 11 or 31.4% were for certified projects; and 24 or 68.6% were for registered projects. In the survey, respondents were asked to select a project type from a provided list. Figure 1 displays the frequency of each project type.

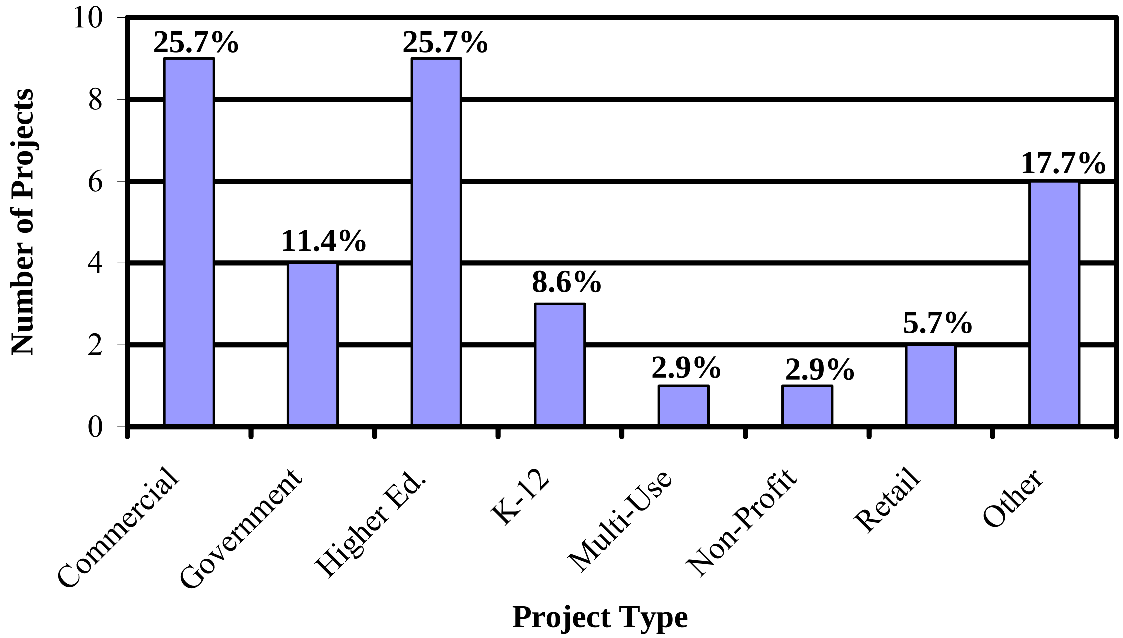

Figure 1: Frequency of project type

Most (51.4%) of the projects were classified as Commercial or Higher Education. Six projects (17.7%) were classified as “Other” with the following types specified: Restaurant, Day Care Center, Visitors’ Center, Medical Office, Recreational, and Residential. One project type, Laboratory, was not selected in any of the surveys.

Figure 2 displays the number of surveys returned per state.

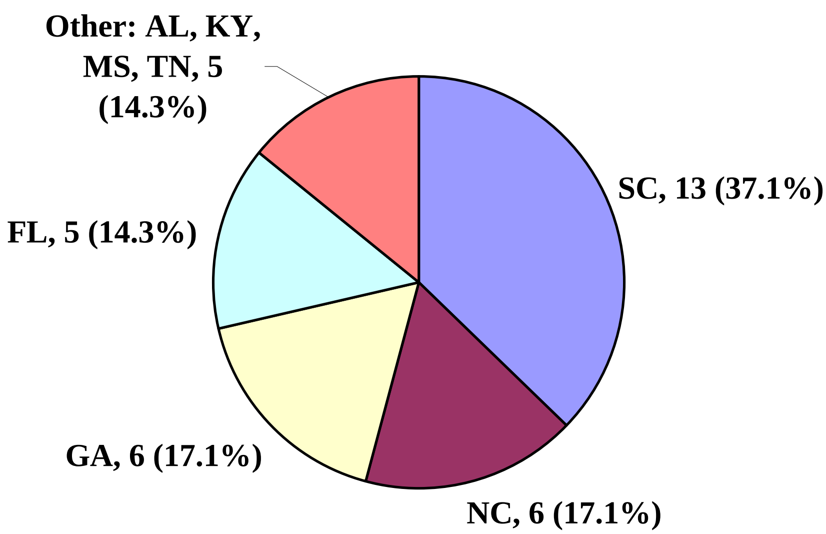

Figure 2: Number of surveys returned per state

South Carolina had the highest number (13, 37.1%) of returned surveys.

Not all of the projects surveyed were officially certified at the time the survey was completed; therefore, the actual *or* expected certification year was obtained (Figure 3).

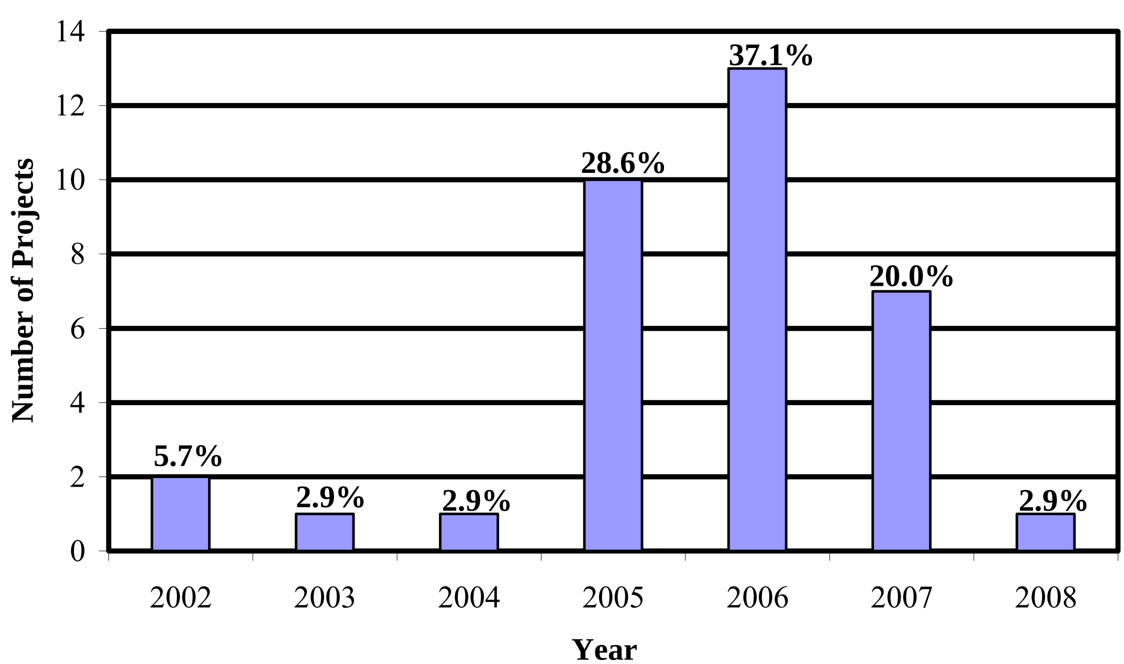

Figure 3: Project certification year

The majority (65.7%) of the projects received or are expecting certification in 2005 or 2006.

The average project size in gross square feet (GSF) was 103,000 GSF. However, the size of the projects ranged from less than 25,000 GSF to over 200,000 GSF (Figure 4).

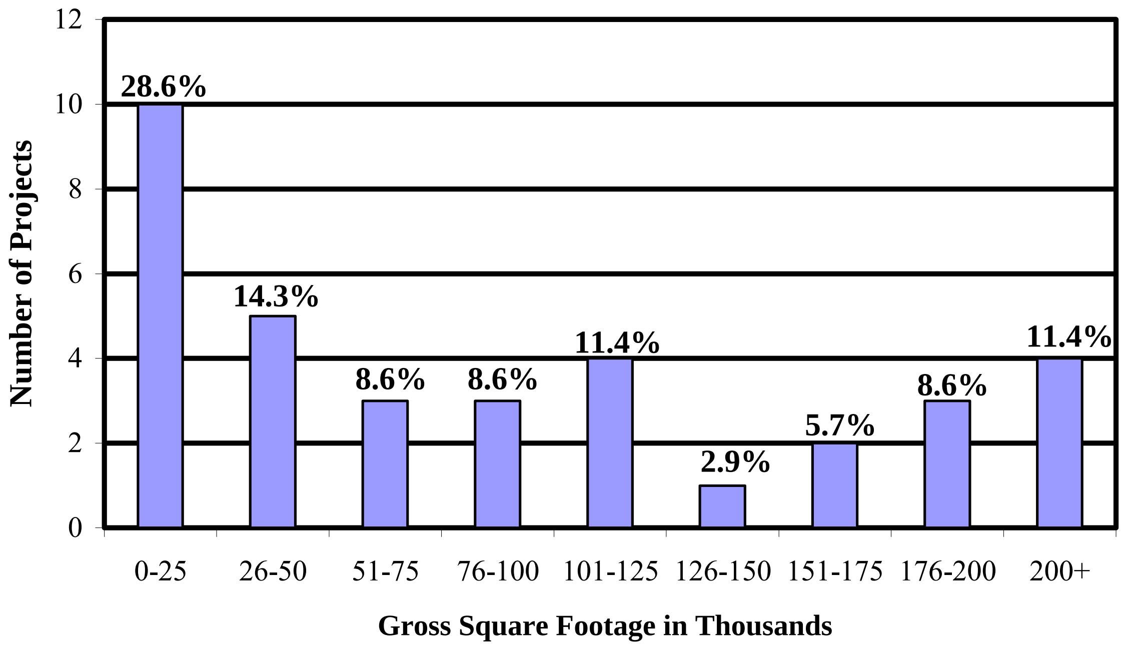

Figure 4: Distribution of project size

A greater percentage (60.0%) of the projects were less than or equal to 100,000 GSF.

Projects could have used one of the following versions of the LEED Rating System: NC 1.0, NC 2.0, NC 2.1, or EB 2.0. None of the projects surveyed used EB (existing building) 2.0, and one of the returned surveys was for a LEED-CS (core and shell) pilot project. The other versions had at least one project utilizing them (Figure 5).

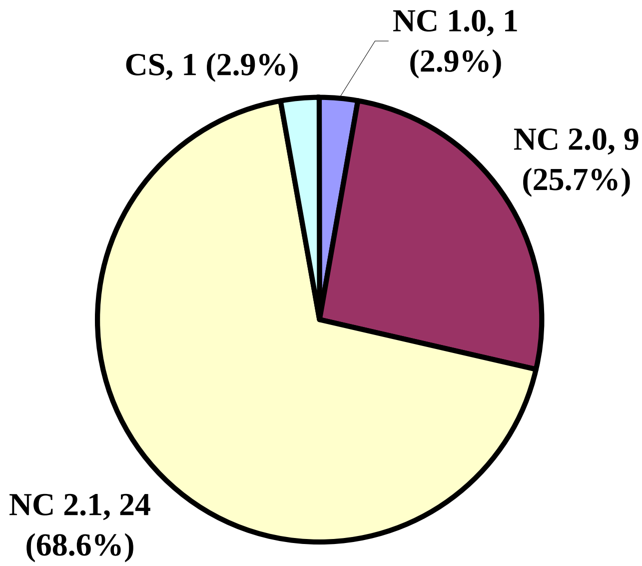

Figure 5: Number of projects that used each version

The version most frequently used was NC 2.1 with 24 projects (68.6%) utilizing it.

There are four primary certification levels: certified, silver, gold, and platinum. Each certification level was represented in the returned surveys (Figure 6).

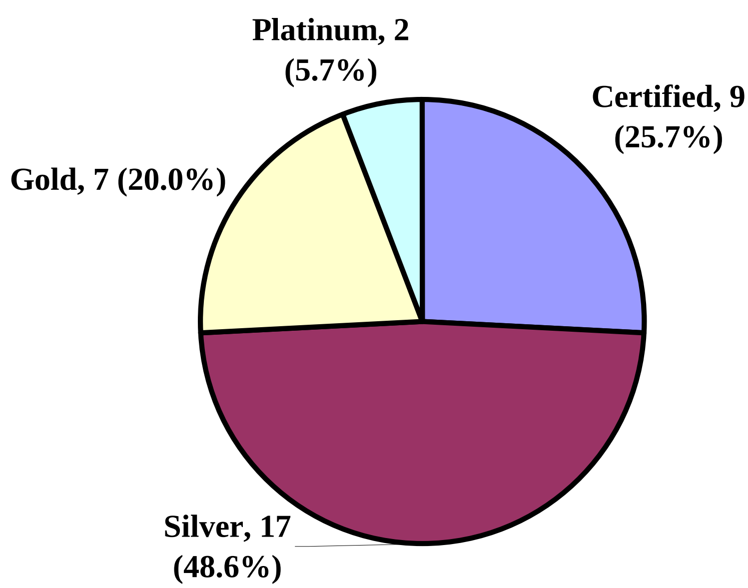

Figure 6: Certification level of projects

Most (48.6%) of the projects surveyed received or are expecting a silver certification for receiving 33 to 38 points in the LEED Rating System.

6.3 Water Efficiency Credits and Strategies

Of the 35 projects surveyed, all but one of them achieved/sought at least one of the five available water efficiency credits. Figure 7 displays how many projects achieved/sought each water efficiency credit.

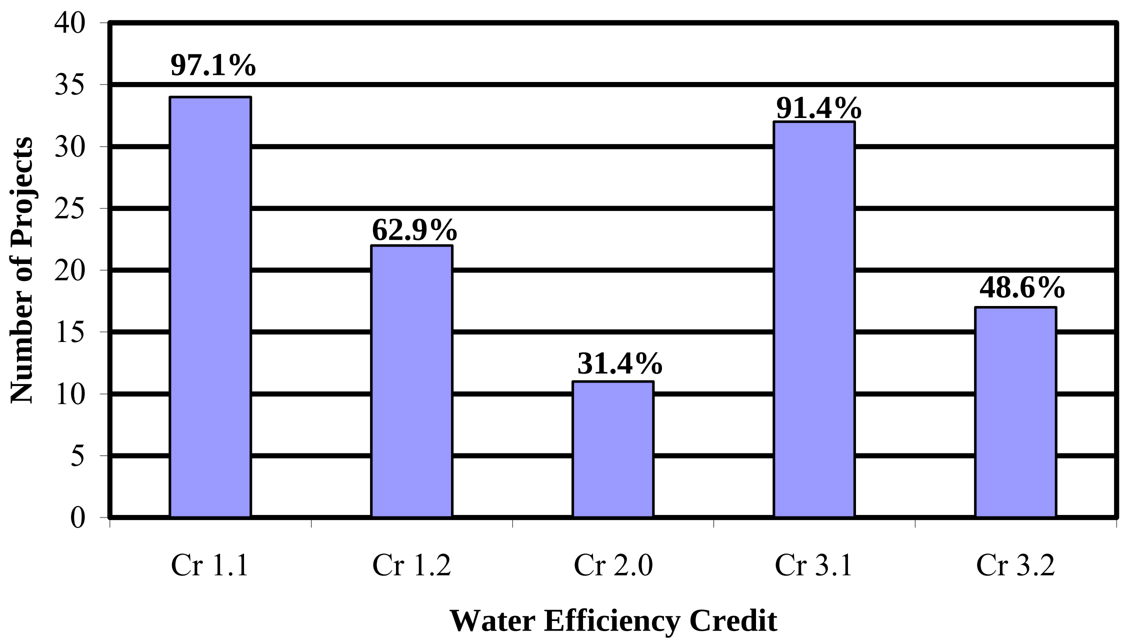

Figure 7: Frequency of water efficiency credits

Over 90% of the projects surveyed achieved/sought Cr 1.1-Water Efficient Landscaping (requiring 50% reduction in potable water use for irrigation) and Cr 3.1-Water Use Reduction (requiring 20% reduction in potable water use).

Figure 8 displays how many projects achieved/sought a particular quantity of water efficiency credits.

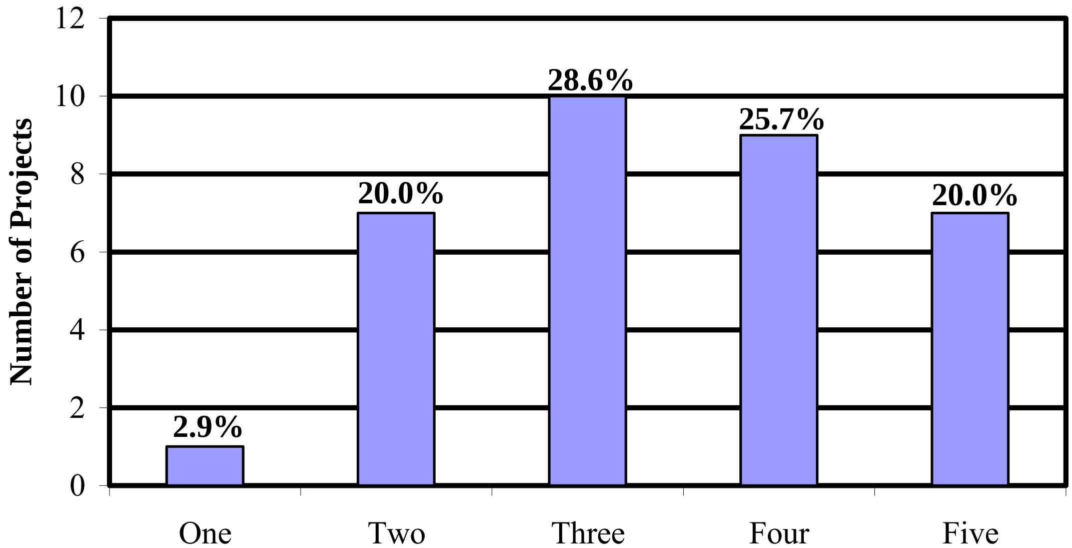

Figure 8: Number of projects per quantity of water efficiency credits

The majority (74.3%) of projects achieved/sought three or more water efficiency credits.

Survey respondents were asked whether they incorporated any of the following eight water efficiency strategies: dry plumbing fixtures, graywater collection and usage, high efficiency irrigation systems, high efficiency plumbing fixtures, occupant sensors and timers, on-site wastewater treatment, rainwater collection and usage, and xeriscaping. Table 6 displays the frequency of incorporated water efficiency strategies.

Water Efficiency Strategy	Projects that Incorporated (%)
Dry Plumbing Fixtures	12 (34.3%)
Graywater Collection & Usage	9 (25.7%)
High Efficiency Irrigation Systems	24 (68.6%)
High Efficiency Plumbing Fixtures	33 (94.3%)
Occupant Sensors & Timers	25 (71.4%)
On-site Wastewater Treatment	4 (11.4)
Rainwater Collection & Usage	16 (45.7)
Xeriscaping	19 (54.3)

Table 6: Frequency of incorporated water efficiency strategies

Most (94.3%) of the projects incorporated high efficiency plumbing fixtures, and many of them used occupant sensors and timers (71.4%) and high efficiency irrigation systems (68.6%). On-site wastewater treatment was incorporated in only 4 projects (11.4%).

6.4 Analysis of Incorporated and Not-Incorporated Factors

As described in Section 5.2, respondents were asked to indicate the importance of each incorporated factor (from the list provided) in deciding to use the strategy and the importance of each *not*-incorporated factor (in the list provided) in deciding *not* to use the strategy. The following scale was used to rank the importance of each factor: 1 = not important; 2 = slightly important; 3 = moderately important; 4 = very important; 5 = extremely important. An average rating or level of importance was calculated for each factor. Table 7 displays the average rating or level of importance of each factor for dry plumbing fixtures. The factors are in order from the highest average rating to the lowest average rating in both groups (incorporated and not-incorporated).

Dry Plumbing Fixtures	Average Rating
Incorporated Factors	
Financial Benefits	3.62
Educational Demonstration	3.54
Public Relations/Marketing	3.15
Owner Demand	2.85
Water Concerns +/or Shortages	2.46
Building Code	2.00
Incentives Provided	1.69
Other Regulatory Requirements	1.31
Not-Incorporated Factors	
Owner Disapproval	4.09
Lack of Understanding	2.43
Cost Constraints	2.17
Space Constraints	1.83
Regulatory Restrictions	1.74
Time Constraints	1.65

Table 7: Dry plumbing fixtures factor importance

As described in Section 5.2, a paired t-test analysis was conducted using SPSS followed by a Bonferroni adjustment to determine if there were any statistical differences among the factor averages. For dry plumbing fixtures-incorporated factors (Table 7), financial benefits (avg = 3.62) was statistically different (p-values ≤ 0.028) from building code, incentives provided, and other regulatory requirements. For not-incorporated factors, owner disapproval (avg = 4.09) was statistically different (p-values < 0.001) from all the other factors.

Graywater Collection & Usage	Average Rating
Incorporated Factors	
Educational Demonstration	3.56
Water Concerns +/or Shortages	3.00
Owner Demand	3.00
Financial Benefits	2.67
Public Relations/Marketing	2.56
Building Code	1.78
Other Regulatory Requirements	1.78
Incentives Provided	1.67
Not-Incorporated Factors	
Cost Constraints	3.73
Owner Disapproval	3.19
Time Constraints	2.19
Regulatory Restrictions	2.08
Lack of Understanding	2.04
Space Constraints	1.88

Table 8: Graywater collection & usage factor importance

For graywater collection and usage-incorporated factors (Table 8), educational demonstration (avg = 3.56) was statistically different (p-values < 0.001) from building code, incentives provided, and other regulatory requirements. For not-incorporated factors, cost constraints (avg = 3.73) was statistically different (p-values < 0.001) from *all* the other factors *except* owner disapproval.

High Efficiency Irrigation Systems	Average Rating
Incorporated Factors	
Financial Benefits	3.58
Owner Demand	3.04
Water Concerns +/or Shortages	2.75
Public Relations/Marketing	2.42
Educational Demonstration	2.33
Building Code	1.42
Incentives Provided	1.33
Other Regulatory Requirements	1.21
Not-Incorporated Factors	
Cost Constraints	1.82
Space Constraints	1.55
Time Constraints	1.36
Regulatory Restrictions	1.36
Owner Disapproval	1.27
Lack of Understanding	1.09

Table 9: High efficiency irrigation systems factor importance

For high efficiency irrigation systems-incorporated factors (Table 9), financial benefits (avg = 3.58) was statistically different (p-values < 0.018) from building code, incentives provided, and other regulatory requirements. For not-incorporated factors, there was no statistical difference (all p-values > 0.05) between the average ratings.

High Efficiency Plumbing Fixtures	Average Rating
Incorporated Factors	
Financial Benefits	3.64
Owner Demand	3.21
Public Relations/Marketing	2.79
Water Concerns +/or Shortages	2.61
Educational Demonstration	2.52
Building Code	2.06
Incentives Provided	1.52
Other Regulatory Requirements	1.24
Not-Incorporated Factors	
Cost Constraints	3.50
Time Constraints	3.00
Regulatory Restrictions	3.00
Owner Disapproval	3.00
Lack of Understanding	3.00
Space Constraints	2.00

Table 10: High efficiency plumbing fixtures factor importance

For high efficiency plumbing fixtures-incorporated factors (Table 10), financial benefits (avg = 3.64) was statistically different (p-values ≤ 0.028) from the other factors *except* owner demand and public relations/marketing. For not-incorporated factors, there was no statistical difference (all p-values > 0.05) between the average ratings.

Occupant Sensors & Timers	Average Rating
Incorporated Factors	
Financial Benefits	3.60
Owner Demand	2.96
Public Relations/Marketing	2.72
Educational Demonstration	2.68
Water Concerns +/or Shortages	1.96
Building Code	1.64
Incentives Provided	1.32
Other Regulatory Requirements	1.32
Not-Incorporated Factors	
Cost Constraints	2.67
Owner Disapproval	2.33
Time Constraints	2.11
Regulatory Restrictions	1.89
Space Constraints	1.67
Lack of Understanding	1.56

Table 11: Occupant sensors & timers factor importance

For occupant sensors and timers-incorporated factors (Table 11), financial benefits (avg = 3.60) was statistically different (p-values < 0.001) from the other factors *except* educational demonstration, public relations/marketing, and owner demand. For not-incorporated factors, there was no statistical difference (all p-values > 0.05) between the average ratings.

On-site Wastewater Treatment	Average Rating
Incorporated Factors	
Owner Demand	4.00
Educational Demonstration	3.75
Public Relations/Marketing	3.25
Water Concerns +/or Shortages	3.25
Financial Benefits	3.00
Building Code	2.25
Incentives Provided	2.00
Other Regulatory Requirements	1.50
Not-Incorporated Factors	
Cost Constraints	4.10
Owner Disapproval	3.39
Space Constraints	3.32
Time Constraints	2.71
Lack of Understanding	2.48
Regulatory Restrictions	2.45

Table 12: On-site wastewater treatment factor importance

For on-site wastewater treatment-incorporated factors (Table 12), owner demand (avg = 4.00) was *not* statistically different (all p-values > 0.05) from the other factors. For not-incorporated factors, cost constraints (avg = 4.10) was statistically different (p-values < 0.001) from the other factors *except* space constraints and owner disapproval.

Rainwater Collection & Usage	Average Rating
Incorporated Factors	
Financial Benefits	3.88
Owner Demand	3.44
Educational Demonstration	3.25
Public Relations/Marketing	3.25
Water Concerns +/or Shortages	3.13
Building Code	1.75
Incentives Provided	1.56
Other Regulatory Requirements	1.25
Not-Incorporated Factors	
Cost Constraints	4.00
Space Constraints	3.11
Owner Disapproval	2.63
Time Constraints	2.47
Lack of Understanding	2.05
Regulatory Restrictions	1.68

Table 13: Rainwater collection & usage factor importance

For rainwater collection and usage-incorporated factors (Table 13), financial benefits (avg = 3.88) was statistically different (p-values < 0.001) from building code, incentives provided, and other regulatory requirements. For not-incorporated factors, cost constraints (avg = 4.00) was statistically different (p-values ≤ 0.015) from *all* the other factors *except* space constraints.

Xeriscaping	Average Rating
Incorporated Factors	
Financial Benefits	3.05
Educational Demonstration	3.00
Owner Demand	2.89
Water Concerns +/or Shortages	2.79
Public Relations/Marketing	2.63
Incentives Provided	1.68
Building Code	1.63
Other Regulatory Requirements	1.37
Not-Incorporated Factors	
Owner Disapproval	3.00
Lack of Understanding	2.19
Cost Constraints	1.75
Time Constraints	1.69
Regulatory Restrictions	1.63
Space Constraints	1.44

Table 14: Xeriscaping factor importance

For xeriscaping-incorporated factors (Table 14), financial benefits (avg = 3.05) was statistically different (p-values ≤ 0.028) from building code, incentives provided, and other regulatory requirements. For not-incorporated factors, owner disapproval (avg = 3.00) was statistically different (p-values ≤ 0.015) from space constraints and regulatory restrictions.

To summarize the previous eight tables, Table 15 displays the overall average rating/importance for each factor when deciding what strategies to incorporate and not to incorporate.

Overall Factors	Average Rating
Incorporated Factors	
Financial Benefits	3.55
Owner Demand	3.10
Educational Demonstration	2.85
Public Relations/Marketing	2.78
Water Concerns +/or Shortages	2.63
Building Code	1.77
Incentives Provided	1.52
Other Regulatory Requirements	1.31
Not-Incorporated Factors	
Cost Constraints	3.13
Owner Disapproval	3.07
Space Constraints	2.28
Time Constraints	2.14
Lack of Understanding	2.13
Regulatory Restrictions	1.94

Table 15: Overall factor importance

Financial benefits is clearly the most important factor when deciding to incorporate strategies. The financial benefits average (3.55) was statistically different (p-values < 0.001) from *all* the other factors. On the other hand, cost constraints is the factor most often considered when deciding *not* to incorporate strategies. The cost constraints average (3.13) was statistically different (p-values < 0.001) from *all* the other factors *except* owner disapproval (avg = 3.07) implying that owner disapproval is also an important factor to consider.

As Table 14 shows, the incorporated factor given the least consideration is other regulatory requirements (avg = 1.31). The non-incorporated factor with the least importance is regulatory restrictions (avg = 1.94). This illustrates that regulations are not playing a big role in decisions regarding LEED water efficiency strategies.

6.5 Cost Comparison

For each incorporated strategy, respondents were asked to compare the cost of its implementation versus the cost of implementing traditional methods. They were given the following choices:

- Cost was more than 10% greater than traditional methods
- Cost was 1-10% greater than traditional methods
- Cost was within 1% of traditional methods
- Cost was 1-10% less than traditional methods
- Cost was more than 10% less than traditional methods
- Not applicable

Table 16a displays the cost implications of four of the strategies providing the number of responses (and percentage) for each available choice.

Dry Plumbing Fixtures Cost Implications	Number of Responses (%)
More than 10% greater than traditional methods	1 (2.9)
1-10% greater than traditional methods	4 (11.4)
Within 1% of traditional methods	5 (14.3)
1-10% less than traditional methods	2 (5.7)
More than 10% less than traditional methods	0
Not applicable	23 (65.7)
Graywater Collection & Usage Cost Implications	**Number of Responses (%)**
More than 10% greater than traditional methods	5 (14.3)
1-10% greater than traditional methods	4 (11.4)
Within 1% of traditional methods	0
1-10% less than traditional methods	0
More than 10% less than traditional methods	0
Not applicable	26 (74.3)
High Efficiency Irrigation Systems Cost Implications	**Number of Responses (%)**
More than 10% greater than traditional methods	1 (2.9)
1-10% greater than traditional methods	11 (31.4)
Within 1% of traditional methods	10 (28.6)
1-10% less than traditional methods	0
More than 10% less than traditional methods	1 (2.9)
Not applicable	12 (34.3)
High Efficiency Plumbing Fixtures Cost Implications	**Number of Responses (%)**
More than 10% greater than traditional methods	2 (5.7)
1-10% greater than traditional methods	14 (40.0)
Within 1% of traditional methods	16 (45.7)
1-10% less than traditional methods	1 (2.9)
More than 10% less than traditional methods	0
Not applicable	2 (5.7)

Table 16a: Strategy cost implications

Because only those that used each strategy reported a cost implication, the sample sizes for each strategy were relatively small and were not appropriate for formal statistics. However, knowing the number of responses (and percentage) for each available choice for the strategies is useful. Table 16b displays the cost implications of the other four strategies.

Occupant Sensors & Timers Cost Implications	Number of Responses (%)
More than 10% greater than traditional methods	5 (14.3)
1-10% greater than traditional methods	9 (25.7)
Within 1% of traditional methods	12 (34.3)
1-10% less than traditional methods	0
More than 10% less than traditional methods	0
Not applicable	9 (25.7)
On-site Wastewater Cost Implications	**Number of Responses (%)**
More than 10% greater than traditional methods	1 (2.9)
1-10% greater than traditional methods	4 (11.4)
Within 1% of traditional methods	0
1-10% less than traditional methods	0
More than 10% less than traditional methods	0
Not applicable	30 (85.7)
Rainwater Collection & Usage Cost Implications	**Number of Responses (%)**
More than 10% greater than traditional methods	7 (20.0)
1-10% greater than traditional methods	9 (25.7)
Within 1% of traditional methods	0
1-10% less than traditional methods	0
More than 10% less than traditional methods	0
Not applicable	19 (54.3)
Xeriscaping Cost Implications	**Number of Responses (%)**
More than 10% greater than traditional methods	0
1-10% greater than traditional methods	1 (2.9)
Within 1% of traditional methods	15 (42.9)
1-10% less than traditional methods	1 (2.9)
More than 10% less than traditional methods	2 (5.7)
Not applicable	16 (45.7)

Table 16b: Strategy cost implications

6.6 Estimated Water Savings

To determine if the estimated water savings information was related to the strategies chosen, a crosstabs analysis utilizing SPSS was conducted. A statistical relationship was not detected (all p-values > 0.05); however, there is information worth noting.

For irrigation water savings:

- Of those utilizing graywater collection and usage, 88.9% (8 out of 9) of them estimated saving over 50% for irrigation water
- Out of the 24 projects using high efficiency irrigation systems, 19 (79.2%) of them estimated saving over 50% for irrigation water
- Four projects are utilizing on-site wastewater treatment and each one of them estimated saving over 50% for irrigation water
- Of those utilizing rainwater collection and usage, 87.5% (14 out of 16) of them estimated saving over 50% for irrigation water
- Out of the 19 projects using xeriscaping, 15 of them (78.9%) estimated saving over 50% for irrigation water

For potable water savings:

- Of the 12 projects that estimated saving 21% to 30% for potable water –
  - 11 (91.7%) of them did *not* use dry plumbing fixtures
  - 12 (100.0%) of them utilized high efficiency plumbing fixtures
- Of the 13 projects that estimated saving *over* 30% for potable water –
  - 9 (69.2%) did *not* use graywater collection and usage
  - 10 (76.9%) of them utilized occupant sensors and timers
  - 12 (92.3%) of them utilized high efficiency plumbing fixtures.
- Of the 12 projects that used dry plumbing fixtures, 8 (66.7%) of them estimated saving *over* 30% for potable water
- The majority of projects, 22 out of 31 or 71.0%, that estimated saving 21% or better for potable water did *not* use on-site wastewater treatment

Only 5 individuals completed question 12 regarding billed water rate for potable water and only 2 provided a billed irrigation water rate. Most indicated they did not know the water rate or the building was not billed directly. The majority of respondents did not know the project's estimated baseline yearly water usage (question 13); only 15 individuals provided information for potable usage and 2 for irrigation usage. Due to the lack of information provided for questions 12 and 13, formal statistical analysis was not appropriate for these questions.

6.7 Additional Information

Public relations/marketing efforts, such as newspaper and magazine articles and local news channel coverage, have been made for 23 or 65.7% of the surveyed projects.

A SPSS crosstabs analysis was conducted to determine if there was any relationship between particular credits and/or strategies and the level of publicity/marketing benefits realized. No statistical relationships were detected (all p-values > 0.05).

Table 17 provides a summary of the primary and secondary functions of the 35 project surveys received.

Function of Project	**Primary**	**Secondary**	**Does Not Apply**
Housing (Higher Ed)	4 (11.4%)	0	31 (88.6%)
Classroom(s)	9 (25.7%)	9 (25.7%)	17 (48.6%)
Retail	1 (2.9%)	9 (25.7%)	25 (71.4%)
Laboratory	3 (8.6%)	2 (5.7%)	30 (85.7%)
Food Service	3 (8.6%)	4 (11.4%)	28 (80.0%)
Office(s)	16 (45.7%)	13 (37.1%)	6 (17.1%)
Research	3 (8.6%)	3 (8.6%)	29 (82.9%)
Manufacturing	1 (2.9%)	0	34 (97.1%)
Meeting/Conference	3 (8.6%)	16 (45.7%)	16 (45.7%)
Multi-Family Housing (Private)	0	0	35 (100.0%)
Other	7 (20.0%)	0	28 (80.0%)

Table 17: Project functions: quantity and percentage

The following functions were specified as primary under "Other": camp dormitory; court rooms; gym, swimming pool, fitness center, etc.; library; medical office; restaurant; and visitors' center.

Out of the 35 projects, 23 reported an overall budget. An analysis of variance using SPSS was conducted to determine if a project's budget affected the number of credits achieved/sought. No effect was found (all p-values > 0.05). The budget information was simplified into twelve distinct categories and a crosstabs analysis conducted to see if a relationship would be present between budget and the number of credits achieved/sought. Again, no effect was found (all p-values > 0.05).

Of the 35 surveyed projects, 18 or 51.4% had teams with prior LEED experience. A SPSS crosstabs analysis was performed to determine if having prior LEED experience affected the certification level or number of credits achieved/sought. No effect was found (all p-values > 0.05) with either certification level or number of credits.

Few survey respondents provided comments (see Appendix C).

Section 7. Discussion

This section will provide probable explanations for the results obtained from the survey and the implications of these results.

7.1 Survey Response Rate and Validity

The response rate was only 16%; however, this is likely due to many factors, including:

- Respondents' job work load
- On-line survey submission problems
- Length of survey
- Lack of interest in survey subject.

Some respondents replied to the survey request by saying they did not have time to complete the survey because they were too busy and had deadlines to meet. This is likely the primary reason for individuals not responding, but other factors also contributed.

The survey was put on the web to make it less cumbersome; however, some individuals received an error message – "data could not be saved to database field" – when they tried to submit the survey. A few individuals took the time to fax in their surveys, but others were not willing to do so. The source of this error message was likely an error in the database created to receive the survey data; however, despite lengthy efforts, it could not be identified. At least five individuals encountered this problem and chose *not* to fax in their surveys, but the total number of surveys not received due to this problem is unknown. This could have been avoided by having the survey submitted to an e-mail address rather than a database.

The length of the survey might have deterred people from responding. It is six pages long in PDF format; however, some of that length is due to question format (i.e., question #9). Efforts were made to streamline the survey without losing the potential for obtaining valuable information and to make it easy to complete by putting it on-line. Lack of interest in the survey might have kept some from responding. These issues might have best been avoided by going through the survey questions while on the phone with respondents.

7.2 Characteristics of Surveyed Projects

The fact that there were more registered projects in the returned surveys is not surprising. Once a project is officially certified, those listed as contacts for the project may have little involvement with the project and not know to whom to forward the survey request. Registered projects are currently underway; therefore, the listed contact person is likely to be more involved with the project.

Commercial and Higher Education projects were predominant among the returned surveys. Commercial facilities are likely choosing LEED because of its many previously mentioned benefits. As previously stated, some colleges and universities around the United States are requiring LEED for new construction (Cassidy 2003, USGBC 2006). Responding to the survey might have also been seen as a publicity opportunity for Commercial and Higher Education projects.

It was expected that South Carolina would be the state with the greatest number of returned surveys because of connections to the University of South Carolina and the USGBC-SC Chapter. Receiving surveys for projects that received or are expecting certification in 2005 or 2006 makes sense because these are projects that are more recent and fresh in the minds of those responding. The fact that a greater percentage of projects were 100,000 GSF (gross square feet) or smaller might have more to do with the survey respondents than the actual projects. Individuals working on smaller projects may be more involved with them and willing to take the time to complete a survey.

LEED-NC 2.1 was the most frequently used version most likely because it was the most current and updated version at the time the survey was distributed. Many of the projects received or expected silver certification. Silver certification tends to be the target for many projects because it can be achieved with a small additional effort beyond basic certification.

7.3 Water Efficiency Credits and Strategies

Credits 1.1-Water Efficient Landscaping and 3.1-Water Use Reduction were achieved/sought by over 90% of the projects indicating that these two credits are likely easier to obtain than the others and should be considered by LEED project managers in the southeast. Water Efficiency Credit 1.2 (Water Efficient Landscaping, requiring a 100% reduction in potable water use for irrigation or no permanent irrigation system) and Water Efficiency Credit 3.2 (Water Use Reduction, requiring a 30% reduction in potable water use) are achievable in the southeast as indicated by Figure 7 but may require more planning and careful design selection than Credits 1.1 and 3.1.

The survey results also indicate that many projects achieved/sought three or more water efficiency credits, which reflects the additive nature of the credit structure. If a project achieves Credit 1.1 requiring a 50% reduction in potable water consumption for irrigation, it will be half-way to achieving Credit 1.2 (in addition to Credit 1.1) requiring a 100% reduction in potable water consumption for irrigation or no permanent irrigation system. Likewise, if a project achieves Credit 3.1 by reducing potable water use 20% beyond the EPAct of 1992; it will be well on its way to achieving Credit 3.2 (in addition to Credit 3.1) requiring a 30% reduction.

From the survey results, the three water efficiency strategies incorporated the most from the eight provided were:

- High efficiency plumbing fixtures, 94.3%
- Occupant sensors and timers, 71.4%
- High efficiency irrigation systems, 68.6%

These three strategies are also quite effective at saving water. Of the 13 projects that estimated saving *over* 30% for potable water, 12 utilized high efficiency plumbing fixtures and 10 utilized occupant sensors and timers. Twenty-four projects used high efficiency irrigation systems, and 19 of them estimated saving *over* 50% for irrigation water. Therefore, these three strategies should be strongly considered by LEED projects in the southeast to assist in achieving water efficiency credits.

7.4 Analysis of Incorporated and Not-Incorporated Factors

The results of the rated importance of each factor in incorporating or not incorporating each water efficiency strategy were limited in strength because the total number of returned surveys was not large. To compound this, the number of rankings contributing to each strategy's factor average ratings was even smaller than the overall number of returned surveys (i.e., dry plumbing fixtures were incorporated by 12 projects so the average rating for 'incorporated factors' is based upon 12 ratings, while the average rating for 'not-incorporated factors' is based upon 23 ratings). The strength of this analysis was also limited because there were multiple comparisons to be made requiring a Bonferroni adjustment. However, because this adjustment is very conservative, statistical differences detected after the adjustment are indeed noteworthy.

From the results presented, there are differences worth further attention and discussion. Owner disapproval was overwhelmingly the most important factor for not incorporating dry plumbing fixtures. This result is not a surprise and reflects the attitudes that have been encountered in various discussions regarding the use of dry plumbing fixtures. Project managers who would like to utilize dry plumbing fixtures should make a strong effort to educate the project owner about dry plumbing fixtures – the pros *and* cons. As suggested by USC's Environmental Programs Manager for Housing, a project manager might also suggest installing one dry plumbing fixture (i.e., a waterless urinal) in a currently occupied building to see how it works and is received by the building occupants. However, if such a trial is going to be conducted, it is important to educate the building occupants and custodial staff about the fixture and proper maintenance.

Cost constraints and owner disapproval were the primary factors for not-incorporating graywater collection and usage. Again, this result is not a surprise. Graywater collection systems do tend to add cost to a project because they require an additional set of pipes. Owners tend to disapprove of graywater collection systems because they are not part of traditional construction methods and may not be accepted by building occupants. Some also fear such systems will cause public health issues if the separation system fails. Costs constraints are difficult to avoid; however, owner disapproval can be addressed by providing the owner with examples of graywater collection and usage systems that are currently working and educating them on the process.

There were not overwhelming statistical differences among the factors for high efficiency irrigation systems, high efficiency plumbing fixtures, and occupant sensors and timers. In fact, there were no statistical differences among the not-incorporated factors for these strategies. This is likely due to there being a small number of projects that did not use these three strategies.

For on-site wastewater treatment, even though owner demand appeared to be the most significant factor (avg rating = 4.00) for choosing to incorporate it, it was not statistically different from the other factors (not even other regulatory requirements – avg rating = 1.50) after the Bonferroni adjustment. This lack of statistical difference is most likely because there were only four projects that chose to incorporate on-site wastewater treatment. This result suggests that when a project does decide to incorporate on-site wastewater treatment, it is likely because the owner requires it and is committed.

There were not any overwhelming statistical differences among the factors for rainwater collection and usage and xeriscaping. Financial benefits was the incorporated factor with the greatest importance rating for each strategy; however, its average importance rating could not be distinguished from the average rating for educational demonstration, public relations/marketing, water concerns and/or shortages, and owner demand.

Even though there was not a significant statistical difference among the factors for each individual strategy, there were statistical differences among the factors when looked at collectively across all eight strategies. The rating for financial benefits was statistically significant from the other factors. It was overwhelmingly the most important factor for choosing to incorporate water efficiency strategies. This result supports incorporating water efficiency strategies and shows that doing so is expected to have financial benefits. This should encourage future LEED project managers in the southeast to incorporate water efficiency strategies in their projects and help them make the case for doing so to the project owner.

In contrast to the primary factor causing water efficiency strategies to be incorporated (financial benefits), the primary factor causing water efficiency strategies *not* to be incorporated was cost constraints. Cost constraints are not an issue with some strategies such as dry plumbing fixtures and xeriscaping; however, they do play a large role in deciding against other strategies such as graywater collection and usage and on-site wastewater treatment. Cost constraints are not the only factor contributing to decisions not to incorporate water efficiency strategies; owner disapproval also had a high overall importance rating and could not be distinguished from that for cost constraints. Owner disapproval plays a very strong role for certain strategies such as dry plumbing fixtures.

However, contrary to cost constraints, owner disapproval can be addressed by educating the owner about the particular strategy in question. This approach may not be effective in every situation, but is well worth the effort especially when the strategy in question is relatively benign, e.g., dry plumbing fixtures. Cost constraints may be more difficult to deal with when budgets cannot be adjusted. One option around this is to apply for outside funding such as grants, which may or may not be appropriate for every project.

7.5 Cost Comparison

As previously stated, formal statistics were not appropriate for the data collected on this topic. However, there are some trends worth mentioning. Of those that chose to incorporate graywater collection and usage, on-site wastewater treatment, and rainwater collection and usage, the cost associated with each strategy was estimated as 1% to 10% greater than traditional methods or more than 10% greater than traditional methods. This coincides with the higher average importance rating given to cost constraints for these three strategies. Most of those that chose to incorporate xeriscaping estimated the cost to be within 1% of traditional methods, which provides support for using this strategy.

7.6 Estimated Water Savings

The results of this topic were not statistically significant, but they do provide insight and useful information for future LEED project managers in the southeast. In order to save over 50% for irrigation water one or more of the following strategies should be incorporated:

- Graywater collection and usage
- High efficiency irrigation systems
- On-site wastewater treatment
- Rainwater collection and usage
- Xeriscaping.

To save 21% to 30% for potable water, it is necessary to use high efficiency plumbing fixtures but not essential to use dry plumbing fixtures. All LEED projects should incorporate high efficiency plumbing fixtures and at least consider the use of dry plumbing fixtures. To save *over* 30% for potable water, again high efficiency plumbing fixtures are essential, occupant sensors and timers are highly recommended, and dry plumbing fixtures should be strongly considered. However, graywater collection and usage and on-site wastewater treatment are not necessary to save 21% or better for potable water but will help reduce irrigation water usage.

Questions 12 and 13 regarding billed water rates and estimated baseline yearly water usage provided very little useful information because they were not completed by the majority of respondents. This is most likely related to the fact that many of the returned surveys were for registered projects. Many registered projects are not finished and have not completed the LEED application process; therefore, water rates and baseline usage may not be known.

7.7 Additional Information

Even though no statistical relationships were detected between public relations/marketing efforts and particular credits and/or strategies, 23 projects did make the effort and 18 (78.3%) of them reported some or extreme benefits. LEED project managers and/or LEED project owners should make the effort to publicize a LEED project because benefits are often seen by those that make the effort. These benefits could range from positive press such as newspaper or magazine articles to increased business (for companies) or recruitment (for colleges and universities).

The budget information was not entirely useful for drawing relationships between the number of credits achieved/sought primarily because there are too many factors that contribute to a project's budget, and these factors are often unique to each LEED project. Grants may be awarded to boost the budget of some projects. A project team may be extremely dedicated to achieving certain goals and willing to work beyond the norm to accomplish them in the allotted budget. Some projects may have unlimited budgets but not see water efficiency credits as a priority and, therefore, not strive for them. Project size and location can also influence a project's budget and not always affect the number of water efficiency credits a project can obtain.

Prior LEED experience did not affect the certification level or number of credits achieved/sought. However, it is highly recommended for at least one member of the team to have LEED experience as indicated by LEED Innovation and Design Credit 2.0 – LEED Accredited Professional (USGBC 2003b). It will make the process, from beginning to end, go much smoother. The individual with LEED experience should be brought in during the design phase and included in decision-making throughout. This will be of great value especially for gathering documentation in preparation for the certification process. Ideally, the documentation process should begin in the beginning with specification requirements and continue throughout the length of the project so that there is not a big rush or unexpected problems towards the end of construction when it is time to submit the certification application.

Seven survey respondents provided comments (Appendix C). Most of the comments provide support for sustainable design and LEED projects. One comment indicates the importance of educating decision makers about LEED and involving those with LEED experience in the process. Perhaps the most unexpected comment was one regarding Kentucky and its 'code officials' not allowing waterless urinals. This again illustrates the importance of educating decision makers (e.g., code officials) about the benefits of water efficiency strategies such as waterless urinals. Waterless urinals in particular have been greatly improved since they were first introduced into the market. Perhaps a trial installation of just a few waterless urinals should be tried in an effort to dispel the current thoughts on them.

7.8 Summary

Even though the survey response rate was not as high as one would have liked, it did provide useful information. Water Efficiency Credit 1.1 (Water Efficient Landscaping, requiring a 50% reduction in potable water use for irrigation) and 3.1 (Water Use Reduction, requiring a 20% reduction in potable water use) were the most commonly achieved/sought credits, which suggest they should be considered by LEED project managers throughout the southeast. Admittedly, they may not be appropriate for *every* LEED project in the region, but the majority of the respondents in this survey achieved/sought them. High efficiency plumbing fixtures were used by nearly every surveyed project indicating this strategy should be strongly considered by LEED project managers in the southeast. Occupant sensors and timers and high efficiency irrigation systems were also frequently used by the surveyed projects and should be given consideration.

The overall analysis of factors affecting incorporation clearly revealed with statistical significance that financial benefits was the most important factor for choosing to incorporate water efficiency strategies. However, cost constraints and owner disapproval were the two most important factors for choosing *not* to incorporate water efficiency strategies. The survey data revealed that three water efficiency strategies tend to cost more than traditional methods: graywater collection and usage, on-site wastewater treatment, and rainwater collection and usage. Xeriscaping was identified by most of those that incorporated it as costing within 1% of traditional methods. The estimated water savings information indicated that high efficiency plumbing fixtures need to be incorporated to save over 20% for potable water. However, graywater collection and usage and on-site wastewater treatment are not necessary to save over 20% for potable water but will help reduce irrigation water usage.

Section 8. Case Study

The University of South Carolina's (USC) West Quad was used as a LEED project case study to address the fifth and sixth research questions stated in Section 4, which ask whether the appropriate credits and strategies were utilized at West Quad and if water and money are being saved at West Quad. The purpose of the case study is to further support the use of water efficiency strategies by providing a real-building example of how they can save water and money. Information for this case study was obtained from the completed survey as well as discussions with USC personnel involved with the project.

8.1 University of South Carolina, West Quadrangle

West Quad was completed in August of 2004 and houses 500 students. The Living-Learning Center for Sustainable Futures is an essential component of the complex, and "[I]ts mission is to promote increased awareness and sustainability through fostering the development, demonstration, investigation, and evaluation of sustainable policies, practices, and technologies" (USC, University Housing 2004). West Quad received silver certification under LEED-NC v.2.0 in August of 2005. It is among the first LEED certified college/university residence halls in the country and the world's largest at 177,315 gross square feet (USC, University Housing 2004).

8.2 Water Efficiency Credit and Strategy Analysis

The West Quad survey was completed by the Environmental Programs Manager for USC Housing. Two water efficiency credits were achieved: Water Efficient Landscaping Credit 1.1 and Water Use Reduction Credit 3.1. Table 18 provides a summary of the strategies incorporated to achieve these credits and their cost implications.

Water Efficiency Strategy	Incorporated	Cost Implication
Dry Plumbing Fixtures	Yes	Within 1% of traditional methods
Graywater Collection & Usage	No	Not Applicable
High Efficiency Irrigation Systems	Yes	1-10% less than traditional methods
High Efficiency Plumbing Fixtures	Yes	1-10% less than traditional methods
Occupant Sensors & Timers	Yes	Within 1% of traditional methods
On-site Wastewater Treatment	No	Not Applicable
Rainwater Collection & Usage	No	Not Applicable
Xeriscaping	Yes	Within 1% of traditional methods

Table 18: West Quad strategies and cost implications

Graywater collection and usage, on-site wastewater treatment, and rainwater collection and usage were not incorporated at West Quad. Of these three strategies, rainwater collection and usage would have been the most likely to include in West Quad but was not incorporated primarily due to cost constraints, owner disapproval, and lack of understanding. However, after the fact, it was discovered that a rainwater collection system could have been included without exceeding the budget. If this had been known at the time of the decision, a greater effort would have been made to combat the owner disapproval and lack of understanding so the strategy could have been included.

If a rainwater collection and usage system would have been installed at West Quad, rainwater collection would have amounted to 116,285 gallons during the month of July based upon the LEED-NC v.2.1 Reference Guide's suggested calculation (using average historical rainfall data for July and 95% collection efficiency). The LEED calculation uses July because this is typically the month with the most evaporation effects; and therefore, the greatest irrigation demands. According to West Quad's LEED application, the drip irrigation system requires 169,200 gallons during the month of July. Therefore, a rainwater collection and usage system would not have eliminated the need for an irrigation system at West Quad. However, it would have conserved water resources, reduced the irrigation water bill, and served as an example for other projects both on and off campus.

Graywater collection and usage was not incorporated at West Quad for the same primary reasons as rainwater collection and usage: cost constraints, owner disapproval, and lack of understanding. However, incorporating graywater collection and usage would have been a more difficult task. Graywater systems require a separate piping system which adds considerable cost, and there is currently not a graywater system installed or operating in the state of South Carolina.

At this time, the South Carolina Department of Health and Environmental Control (SC DHEC) does not differentiate graywater from blackwater in its regulations (see Appendix A for definitions). Therefore, if a graywater system had been installed at West Quad, the graywater would have had to be treated as blackwater before it could be discharged to the land for irrigation purposes. A land discharge of this kind would have required a separate permit from DHEC. Until DHEC regulations differentiate graywater from blackwater, separating graywater in a building to be used for irrigation purposes will not have enough benefits to overcome the additional costs and requirements for it to be widely used.

Graywater could have also been separated and collected in the buildings at West Quad and used to flush the toilets. The primary concern with this approach was the added cost for the additional piping. However, if a graywater system to flush toilets had been installed, West Quad would be using less potable water and have lower water bills. Depending upon the amount of graywater collected and used, an additional water efficiency credit could have been achieved, such as Water Efficiency Credit 2.0-Innovative Wastewater Technologies or Water Efficiency Credit 3.2-Water Use Reduction 30%.

On-site wastewater treatment is the least likely of the three strategies not incorporated at West Quad to be implemented in future USC projects. The primary reasons for not incorporating it in West Quad were owner disapproval, lack of understanding, and costs constraints. On-site wastewater systems are generally complex, maintenance intensive, costly, require additional permits, and are considered a public health concern if not properly managed. These issues are likely why only four of the surveyed projects incorporated on-site wastewater treatment.

8.3 Water and Money Savings

As Table 18 indicates, the water efficiency strategies incorporated into West Quad did not cost more than 1% of traditional methods. The strategies were used to reduce water consumption, which in turn saves money on water bills; however, is West Quad performing as designed?

To determine if West Quad is performing as designed – saving water and money, the complex's water bills for the spring 2005 semester were reviewed. This time frame was selected to coincide with building occupancy and data availability. Table 19 displays water usage for West Quad compared to East Quad (averages from spring 2005 water bills) and the West Quad LEED Baseline, which is the expected water usage with standard plumbing fixtures, used for the LEED application.

Facility	Avg. Monthly Water Usage (CCF)
West Quad	558
East Quad	699
West Quad-LEED Baseline	444

Table 19: Water usage in hundreds of cubic feet (CCF)

East Quad, another USC residence hall, was used as a comparison because it is the most similar to West Quad in terms of structure, function, and occupancy but was not designed and constructed as a green building. The primary difference, other than LEED designation, is that West Quad includes a café and East Quad does not. This was accounted for by taking manual water meter readings at the café and subtracting the usage from the overall West Quad usage. The other main difference is that East Quad is smaller and houses 440 students while West Quad houses 500 students. This was accounted for by calculating the monthly water usage per student for the two facilities: West Quad 1.12 CCF/student and East Quad 1.59 CCF/student.

The average monthly water usage at West Quad is 20.2% less than that at East Quad, which translates to a $439.92 monthly savings (using $3.12/CCF for water cost). The monthly water usage *per student* at West Quad is 29.6% less than that at East Quad. West Quad was designed to be at least 20% more efficient than a building that just meets the 1992 Energy Policy Act (EPAct) plumbing fixture standards such as East Quad.

If one compares the West Quad average monthly water usage to the West Quad LEED baseline, West Quad does not appear to be performing as designed. The West Quad usage is 20% *more* than the LEED baseline. This discrepancy is present because the LEED baseline calculation was designed for commercial buildings having only restrooms. West Quad has showers and washing machines, which increase its usage. This demonstrates the importance of verifying the performance of a LEED building to a similar structure and not just the LEED baseline value.

It also shows that process loads such as washing machines and manufacturing processes are essential to the overall efficiency of a building. The LEED Rating System does not include process loads. However, project managers should take these into consideration because they have the potential to greatly affect the overall efficiency of the building. Even though improving the efficiency of process loads will not earn additional LEED credits, it will reduce usage, which will in-turn reduce operating costs.

The design feature that resulted in the greater than 20% water efficiency, beyond EPAct standards, was low-flow plumbing fixtures. Low-flow fixtures can cost more than fixtures that just meet EPAct requirements; however, the low-flow fixtures installed at West Quad (WQ) cost $4,204.30 *less* than fixtures just meeting EPAct requirements (Table 20).

Fixture	Quantity	WQ Price	WQ Subtotals	EPAct Price	EPAct Subtotals
Toilet	260	$145.20	$37,752.00	$145.20	$37,752.00
Bath Sink	258	$91.00	$23,478.00	$86.85	$22,407.30
Kitchen Sink	250	$89.25	$22,312.50	$92.50	$23,125.00
Shower	250	$120.45	$30,112.50	$138.30	$34,575.00
Grand Totals			$113,655.00		$117,859.30

Table 20: Fixture quantities and prices

This unexpected difference in price is due to the lower price of the shower fixtures used in West Quad. Fixture prices were determined using the West Quad project manual to determine the fixture manufacturer and model number. Then the manufacturers' websites and customer support help lines were consulted to determine the prices of the fixtures used in West Quad and similar fixtures that just meet EPAct flow requirements.

Money and water are definitely being saved at West Quad as a result of the water efficiency strategies being used. The 20.2% reduction in water use results in a yearly savings of $3,959.28. (The yearly savings values were calculated based on a 9-month academic school year to coincide with West Quad's occupancy.) The overall lower cost of the plumbing fixtures at West Quad enhances the savings. Taking these two factors into consideration the ten-year net present value is $34,776.81 with a 5% discount rate applied. Even if the water efficiency strategies had cost $10,000 more than traditional methods, the ten-year net present value taking the $3,959.28 water savings into consideration would be $20,572.51 with a 5% discount rate applied.

8.4 Recommendations

Reviewing past LEED projects, such as West Quad, is a good way for future USC LEED project managers to learn and provides valuable information for other project managers in the southeast, particularly South Carolina. The West Quad case study supports the use of water efficiency strategies and illustrates that they can be incorporated in LEED projects in the southeast without adding significant additional costs. The data for West Quad shows that these water efficiency strategies not only save water but also money.

West Quad achieved two of the five water efficiency credits and incorporated five of the eight water efficiency strategies. The cost of all the strategies incorporated was either within 1% of traditional methods or 1% to 10% less than traditional methods; therefore, USC projects should incorporate these strategies in the future.

Rainwater collection and usage was not utilized at West Quad; however, it should be considered for inclusion in future USC projects. The additional cost is not extreme, ranging from $5,000 to $15,000 depending upon the project size, and should be included in future project budgets to take advantage of the wet climate and reduce the University's irrigation water bill. Owner disapproval and lack of understanding are no longer as prominent as they were when West Quad was designed and constructed because further efforts have been made to educate decision makers on the benefits of rainwater systems.

West Quad did not incorporate graywater collection and usage. This strategy will be a challenge to include in future USC projects. The most likely usage of such a system will be for flushing toilets rather than site irrigation. However, either system would have to treat the graywater as blackwater under the current DHEC regulations. If the regulations are adjusted to differentiate the two, graywater systems will be more appealing.

If one entity in South Carolina moves forward with a proposed graywater collection and usage system and it is approved, the barrier will be broken and more systems will likely follow. Graywater systems have the potential to save a substantial amount of water regardless of how the collected water is used, and the savings from lower water bills would in time pay for the additional piping costs. If properly designed, a graywater system could also add an additional water efficiency credit to a LEED project.

On-site wastewater treatment was also not incorporated at West Quad and is not a suggested strategy for USC projects at this time, unless a particular location and project presents an ideal opportunity for such a system to serve as an educational tool for the campus community and others. The additional costs associated with on-site wastewater systems are usually unavoidable. These systems are generally very complex and maintenance intensive and often require additional permits. If on-site wastewater systems are not properly managed they could pose a public health concern.

Future USC LEED projects should be able to achieve three, if not four, water efficiency credits: the two that West Quad achieved – Water Efficient Landscaping Credit 1.1 and Water Use Reduction Credit 3.1 – and possibly Credit 1.2 and/or Credit 3.2. Credit 1.2, awarded if no potable water is used for irrigation or no permanent irrigation system is installed, could be achieved by using a rainwater collection system for irrigation needs. Credit 3.2, awarded if potable water use is reduced by 30%, could be achieved by using a graywater collection system for flushing toilets. This credit could be achieved in buildings with public bathrooms by using waterless urinals in the men's restrooms. West Quad used a waterless urinal in one location, but if more waterless urinals are installed where low flow urinals or toilets would be in men's restrooms in future projects, enough water could be saved to earn this credit.

Credit 2.0 – Innovative Wastewater Technologies is the credit least likely to be included in USC projects. A graywater system to flush toilets would help earn this credit and may be a possibility for some future USC projects; but depending on the size and usage of the building, a graywater system may not completely earn this credit. This credit could be achieved with on-site wastewater treatment; however, this strategy is not suggested for USC projects as previously explained.

If for no other reason, water efficiency strategies should be incorporated into USC LEED projects to save money. West Quad is saving the University money by using less water than a traditional residence hall and will continue to do so in the future, especially as the price of water increases.

Section 9. Conclusion

Based on the research conducted for this thesis, it is clear that LEED water efficiency credits are worth pursuing and can be effective in the southeast, saving both water and money. This conclusion is heavily based on surveys of 35 LEED projects in the southeastern United States. The basic characteristics of the surveyed projects are as follows:

- 24 projects were registered and 11 were certified
- 51.4% of the projects were classified as Commercial or Higher Education facilities
- 13 of the projects were located in South Carolina
- 68.6% of the projects used LEED-NC v.2.1 since it was the most current and updated version at the time the survey was distributed
- 17 of the projects received/expected silver certification

As for water efficiency credits and strategies, the surveyed projects also provided useful information. Water Efficiency Credit 1.1 (Water Efficient Landscaping, requiring a 50% reduction in potable water use for irrigation) and 3.1 (Water Use Reduction, requiring a 20% reduction in potable water use) were achieved/sought by over 90% of the projects indicating that these two credits are likely easier to obtain than the others and should be considered by LEED project managers throughout the southeast. Water Efficiency Credit 1.2 (Water Efficient Landscaping, requiring a 100% reduction in potable water use for irrigation or no permanent irrigation system) and Water Efficiency

Credit 3.2 (Water Use Reduction, requiring a 30% reduction in potable water use) are achievable in the southeast as indicated by Figure 7 but may require more planning and careful design selection than Credits 1.1 and 3.1. The majority (74.3%) of the projects achieved/sought three or more water efficiency credits, which reflects the additive nature of the credit structure.

There are eight primary water efficiency strategies to choose from to assist in achieving LEED water efficiency credits. The survey results indicate that three water efficiency strategies were incorporated more often than the others:

- High efficiency plumbing fixtures (94.3%)
- Occupant sensors and timers (71.4%)
- High efficiency irrigation systems (68.6%)

These three strategies are also quite effective at saving water. Of the 13 projects that estimated saving *over* 30% for potable water, 12 utilized high efficiency plumbing fixtures and 10 utilized occupant sensors and timers. Twenty-four projects used high efficiency irrigation systems, and 19 of them estimated saving *over* 50% for irrigation water. Therefore, these three strategies should be strongly considered by LEED projects in the southeast to assist in achieving water efficiency credits.

Several factors are considered when deciding which water efficiency strategies should be incorporated to achieve water efficiency credits. To determine which factors are driving decisions, a series of potential factors were first analyzed by each water efficiency strategy. Owner disapproval was overwhelmingly the most important factor (avg = 4.09, p-values < 0.001) for *not* incorporating dry plumbing fixtures. Cost constraints (avg = 3.73) and owner disapproval (avg = 3.19) were the primary factors (p-values < 0.001) for *not* incorporating graywater collection and usage.

For on-site wastewater treatment, even though owner demand appeared to be the most significant factor (avg = 4.00) for choosing to incorporate it, it was not statistically different from the other factors. This lack of statistical difference is most likely because there were only four projects in the sample that chose to incorporate on-site wastewater treatment. Financial benefits was ranked the most important factor for incorporating six of the eight water efficiency strategies:

- Dry plumbing fixtures
- High efficiency irrigation systems
- High efficiency plumbing fixtures
- Occupant sensors and timers
- Rainwater collection and usage
- Xeriscaping

The two strategies that did not have financial benefits ranked as the most important factor were graywater collection and usage and on-site wastewater treatment. This is likely because these two strategies tend to cost more to incorporate than the other strategies; therefore, the savings from using less water take longer to recover the investment costs.

The factors were also analyzed collectively across all eight water efficiency strategies. The factor financial benefits was statistically significant (p-values < 0.001) from *all* the other factors and was the most important factor for choosing to incorporate water efficiency strategies. This result should encourage the use of water efficiency strategies in LEED projects in the southeast.

In contrast to the primary factor causing water efficiency strategies to be incorporated (financial benefits), the primary factor causing water efficiency strategies *not* to be incorporated was cost constraints. Cost constraints were not the only factor contributing to decisions *not* to incorporate water efficiency strategies; owner disapproval also had a high overall importance rating and could not be distinguished statistically from that for cost constraints. Cost constraints and owner disapproval do not appear to be issues with all water efficiency strategies but do play a large role with some strategies (e.g., costs constraints affect whether graywater collection and usage is used and owner disapproval affects whether dry plumbing fixtures are incorporated).

The results of the cost comparison data revealed that the more costly strategies in the survey group were graywater collection and usage, on-site wastewater treatment, and rainwater collection and usage. The cost associated with each of these strategies was estimated as 1% to 10% greater than traditional methods or more than 10% greater than traditional methods. The cost comparison data also revealed that most (18 out of 19) of those that chose to incorporate xeriscaping estimated the cost to be within 1% of traditional methods or less than traditional methods, which supports the use of this strategy.

According to the surveyed projects' estimated water savings, one or more of the following strategies should be incorporated to save *over* 50% for irrigation water:

- Graywater collection and usage
- High efficiency irrigation systems
- On-site wastewater treatment
- Rainwater collection and usage
- Xeriscaping

To save 21% to 30% for potable water, the survey results show it is necessary to use high efficiency plumbing fixtures; but it is not essential to use dry plumbing fixtures. To save *over* 30% for potable water, again high efficiency plumbing fixtures are essential, occupant sensors and timers are highly recommended, and dry plumbing fixtures should be strongly considered.

Even though no statistical relationships were detected between public relations/ marketing efforts and particular credits and/or strategies, 23 projects did make the effort and 18 of them reported some or extreme benefits. The budget information was not entirely useful for drawing relationships between the numbers of credits achieved/sought primarily because there are too many factors that contribute to a project's budget, and these factors are unique to each LEED project. Prior LEED experience did not affect the certification level or number of credits achieved/sought; however, 18 of the projects had teams with prior LEED experience.

The detailed case study of the University of South Carolina's (USC) West Quad project provided further support for the use of water efficiency strategies by including real data on a functioning LEED building. West Quad achieved two water efficiency credits: Water Efficient Landscaping Credit 1.1 (requiring a 50% reduction in potable water use for irrigation) and Water Use Reduction Credit 3.1 (requiring a 20% reduction in potable water use). Five of the eight water efficiency strategies were incorporated into West Quad:

- Dry plumbing fixtures
- High efficiency irrigation systems
- High efficiency plumbing fixtures
- Occupant sensors and timers
- Xeriscaping

All of the strategies incorporated had costs either within 1% of traditional methods or 1% to 10% less than traditional methods.

Of the three strategies not included (graywater collection and usage, on-site wastewater treatment, and rainwater collection and usage), rainwater collection and usage is the most likely to be incorporated into future USC LEED projects. The additional cost associated with rainwater collection and usage is not extreme, ranging from $5,000 to $15,000 depending upon the project size. Owner disapproval and lack of understanding are no longer as prominent as they were when West Quad was designed and constructed because further efforts have been made to educate decision makers on the benefits of rainwater systems.

Graywater collection and usage will be a challenge to include in future USC LEED projects. Graywater systems require an additional set of piping, which is an added cost, and graywater must be treated as blackwater under the current SC Department of Health and Environmental Control regulations. If the regulations change, graywater systems will be more appealing. On-site wastewater treatment is the least likely strategy to be included in future USC LEED projects because the systems are complex, maintenance-intensive, costly, require additional permits, and are considered a public health concern if not properly managed.

Spring 2005 water bills confirmed that West Quad's water systems are operating as designed. The average monthly water usage at West Quad is 20.2% less than its benchmark East Quad, which was used because it is the residence hall most similar to West Quad in terms of structure, function, and occupancy but was not designed and constructed as a green building. The monthly water usage *per student* at West Quad is 29.6% less than that at East Quad. The water savings at West Quad translate to a financial benefit of $3,959.28 per academic school year. The design feature that resulted in the greater than 20% water efficiency was low-flow plumbing fixtures, which actually cost $4,204.30 *less* than traditional ones. Therefore, the water efficiency strategies incorporated at West Quad not only cost less money to incorporate but are also saving money in water usage every academic year.

This study provides support for a base of southeast specific literature regarding LEED buildings. Admittedly, the study included only a fraction of the LEED projects in the southeast and focused on only one LEED category and one detailed study of a functioning LEED building. Nevertheless, the reported results appear to be somewhat robust. To garner support for and to continue the growth of LEED in the southeast, more region specific studies need to be conducted.

Future related studies might involve more varied or a larger number of projects or analyze all of the LEED categories for one or more buildings. It is important to discuss the benefits of LEED buildings and the specific steps a project manager might take to succeed. At this juncture, however, it is probably more important to gather more tangible data that provide further evidence for the claim that LEED buildings function more efficiently and provide financial benefits. There is likely to be a number of highly successful LEED projects in the southeast, but more hard data is needed to provide specific proof and to further the growth of LEED in the region.

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Appendix A
Explanation of LEED Water Efficiency Strategies

* The following definitions and explanations are from the USGBC's *LEED Reference Guide for New Construction and Major Renovations (LEED-NC) Version 2.1* May 2003.

Dry plumbing fixtures – Plumbing fixtures that do not require water to operate such as waterless urinals and composting toilets. Waterless urinals have an advanced hydraulic design and a buoyant fluid instead of water to maintain sanitary conditions. Composting toilets combine human waste and organic material to produce a nearly odorless end product, which can be used as a soil fertilizer.

Graywater collection and usage – Wastewater from lavatory sinks, showers, and bathtubs as well as washing machines and sinks not used for disposal of hazardous or toxic ingredients or wastes from food preparation. The graywater is stored in cisterns on the site and used for irrigation purposes. (Graywater is not to be confused with "blackwater," which is wastewater from toilets and kitchen sinks that often contain organic materials.)

High efficiency irrigation systems – Irrigation systems, which deliver up to 95% of the water supplied, compared to conventional irrigation systems that may by only 60% efficient. They include sprinkler irrigation enhanced by moisture sensors, clock timers, and weather database controllers as well as micro (or drip)-irrigation. With micro (or drip)-irrigation, water drips to the soil from perforated tubes or emitters. Sensors, timers, and weather database controllers can also enhance drip irrigation systems.

High efficiency plumbing fixtures – Plumbing fixtures with flow rates that exceed the Energy Policy Act of 1992 requirements.

Occupant sensors and timers – These can be utilized on toilets and faucets to control when the fixtures operate and/or how long they operate.

On-site wastewater treatment – A process that uses localized treatment systems to transport, store, treat, and dispose of wastewater generated on the project site. The products of these systems include potable water, non-potable water, and nutrients. The nutrients can be used to enhance soil quality on the site. The system can be a created wetland where plants and microbes naturally remove water contaminants. Another option is an aquaculture system in which wastewater contaminants become food for fish and plants (a 'living machine').

Rainwater collection and usage – Rainwater is collected from roofs and stored in cisterns on site, which can be used for potable or irrigation purposes depending on its quality. Rainwater can be filtered through graded screens and paper filters if needed prior to use.

Xeriscaping – A method of landscape design also called "dry landscaping" that places water conservation as the primary objective. It incorporates sound horticultural practices and native plant species that are adapted to the local climate conditions.

Appendix B
University of South Carolina
Survey of LEED Certified and Registered Projects

Purpose: To gather data pertaining to water efficiency credits achieved by LEED certified and registered projects in EPA Region 4. The information provided will be compiled and incorporated into a master's thesis, which will provide assistance to future LEED project planners. Individual project information will remain confidential. The compiled survey information will be shared with survey respondents. *If you have worked on or are working on more than one project, **please complete one survey for each project**.* If there are any questions please contact Elaine Durr at edurr@environ.sc.edu or 803-777-9911.

1. **Indicate ("X") whether the project is certified or registered.**
   Certified ( ) Registered ( )

2. **Project type as certified (registered) with USGBC: (indicate with an "X" next to the type)**
   Higher Education ( ) Commercial ( ) Multi-Use ( )
   K-12 ( ) Government ( ) Laboratory ( )
   Retail ( ) Non-Profit/NGO ( )
   Other (please specify)

3. **Project Name and location:**

4. **When (month and year) was (is) the project (expected to be) certified by the USGBC?**

5. **What is the (expected) gross square footage of the project not including parking or outdoor facilities?**

6. **Indicate ("X") which version of the LEED Rating System you used (are using):**
   1.0 ( ) NC 2.0 ( ) NC 2.1 ( ) EB 2.0 ( )

7. **Indicate ("X") which certification level you achieved (expect to achieve):**
   Bronze ( ) Certified ( ) Silver ( )
   Gold ( ) Platinum ( )

8. **Indicate ("X") which water efficiency credits were achieved (are being sought): Check all that apply.**
   Water Efficient Landscaping: 1.1 ( ) 1.2 ( )
   Innovative Wastewater Technologies: 2.0 ( )
   Water Use Reduction: 3.1 ( ) 3.2 ( )

9. **LEED certified projects can incorporate a number of strategies to achieve water efficiency, including dry plumbing fixtures; graywater collection and usage; high efficiency irrigation systems; high efficiency plumbing fixtures; occupant sensors and timers; on-site wastewater treatment; rainwater collection and usage; and xeriscaping. In the following section, please indicate whether each of the strategies was (is being) incorporated or not incorporated in the project. For those strategies that were (are being) incorporated, please indicate ("X") the importance of each of the factors listed in deciding to use the strategy (left column). Similarly, for those strategies that were <u>not</u> (are not being) incorporated, indicate ("X") the importance of each factor in deciding <u>not</u> to use the strategy (right column).**
   In rating these items, use the following scale: 1 = not important; 2 = slightly important; 3 = moderately important; 4 = very important; 5 = extremely important

Dry Plumbing Fixtures **Yes ( )** **No ( )**

Incorporated

Factors	**Not Imp. 1**	**2**	**Mod Imp. 3**	**4**	**Ext. Imp. 5**
Educational Demonstration	( )	( )	( )	( )	( )
Public Relations/Marketing	( )	( )	( )	( )	( )
Financial Benefits	( )	( )	( )	( )	( )
Building Code	( )	( )	( )	( )	( )
Incentives Provided	( )	( )	( )	( )	( )
Water Concerns +/or Shortages	( )	( )	( )	( )	( )
Owner Demand	( )	( )	( )	( )	( )
Other Regulatory Requirements	( )	( )	( )	( )	( )
Other (specify)	( )	( )	( )	( )	( )

Not-Incorporated

Factors	**Not Imp. 1**	**2**	**Mod Imp. 3**	**4**	**Ext. Imp. 5**
Cost Constraints	( )	( )	( )	( )	( )
Time Constraints	( )	( )	( )	( )	( )
Space Constraints	( )	( )	( )	( )	( )
Regulatory Restrictions	( )	( )	( )	( )	( )
Owner Disapproval	( )	( )	( )	( )	( )
Lack of Understanding	( )	( )	( )	( )	( )
Other (specify)	( )	( )	( )	( )	( )

Graywater Collection & Usage **Yes ( )** **No ( )**

Incorporated

Factors	**Not Imp. 1**	**2**	**Mod Imp. 3**	**4**	**Ext. Imp. 5**
Educational Demonstration	( )	( )	( )	( )	( )
Public Relations/Marketing	( )	( )	( )	( )	( )
Financial Benefits	( )	( )	( )	( )	( )
Building Code	( )	( )	( )	( )	( )
Incentives Provided	( )	( )	( )	( )	( )
Water Concerns +/or Shortages	( )	( )	( )	( )	( )
Owner Demand	( )	( )	( )	( )	( )
Other Regulatory Requirements	( )	( )	( )	( )	( )
Other (specify)	( )	( )	( )	( )	( )

Not-Incorporated

Factors	**Not Imp. 1**	**2**	**Mod Imp. 3**	**4**	**Ext. Imp. 5**
Cost Constraints	( )	( )	( )	( )	( )
Time Constraints	( )	( )	( )	( )	( )
Space Constraints	( )	( )	( )	( )	( )
Regulatory Restrictions	( )	( )	( )	( )	( )
Owner Disapproval	( )	( )	( )	( )	( )
Lack of Understanding	( )	( )	( )	( )	( )
Other (specify)	( )	( )	( )	( )	( )

High Efficiency Irrigation Systems **Yes ( )** **No ( )**

Incorporated

Factors	**Not Imp. 1**	**2**	**Mod Imp. 3**	**4**	**Ext. Imp. 5**
Educational Demonstration	( )	( )	( )	( )	( )
Public Relations/Marketing	( )	( )	( )	( )	( )
Financial Benefits	( )	( )	( )	( )	( )
Building Code	( )	( )	( )	( )	( )
Incentives Provided	( )	( )	( )	( )	( )
Water Concerns +/or Shortages	( )	( )	( )	( )	( )
Owner Demand	( )	( )	( )	( )	( )
Other Regulatory Requirements	( )	( )	( )	( )	( )
Other (specify)	( )	( )	( )	( )	( )

Not-Incorporated

Factors	**Not Imp. 1**	**2**	**Mod Imp. 3**	**4**	**Ext. Imp. 5**
Cost Constraints	( )	( )	( )	( )	( )
Time Constraints	( )	( )	( )	( )	( )
Space Constraints	( )	( )	( )	( )	( )
Regulatory Restrictions	( )	( )	( )	( )	( )
Owner Disapproval	( )	( )	( )	( )	( )
Lack of Understanding	( )	( )	( )	( )	( )
Other (specify)	( )	( )	( )	( )	( )

High Efficiency Plumbing Fixtures **Yes ( )** **No ( )**

Incorporated

Factors	**Not Imp. 1**	**2**	**Mod Imp. 3**	**4**	**Ext. Imp. 5**
Educational Demonstration	( )	( )	( )	( )	( )
Public Relations/Marketing	( )	( )	( )	( )	( )
Financial Benefits	( )	( )	( )	( )	( )
Building Code	( )	( )	( )	( )	( )
Incentives Provided	( )	( )	( )	( )	( )
Water Concerns +/or Shortages	( )	( )	( )	( )	( )
Owner Demand	( )	( )	( )	( )	( )
Other Regulatory Requirements	( )	( )	( )	( )	( )
Other (specify)	( )	( )	( )	( )	( )

Not-Incorporated

Factors	**Not Imp. 1**	**2**	**Mod Imp. 3**	**4**	**Ext. Imp. 5**
Cost Constraints	( )	( )	( )	( )	( )
Time Constraints	( )	( )	( )	( )	( )
Space Constraints	( )	( )	( )	( )	( )
Regulatory Restrictions	( )	( )	( )	( )	( )
Owner Disapproval	( )	( )	( )	( )	( )
Lack of Understanding	( )	( )	( )	( )	( )
Other (specify)	( )	( )	( )	( )	( )

Occupant Sensors & Timers **Yes ( )** **No ( )**

Incorporated

Factors	**Not Imp. 1**	**2**	**Mod Imp. 3**	**4**	**Ext. Imp. 5**
Educational Demonstration	( )	( )	( )	( )	( )
Public Relations/Marketing	( )	( )	( )	( )	( )
Financial Benefits	( )	( )	( )	( )	( )
Building Code	( )	( )	( )	( )	( )
Incentives Provided	( )	( )	( )	( )	( )
Water Concerns +/or Shortages	( )	( )	( )	( )	( )
Owner Demand	( )	( )	( )	( )	( )
Other Regulatory Requirements	( )	( )	( )	( )	( )
Other (specify)	( )	( )	( )	( )	( )

Not-Incorporated

Factors	**Not Imp. 1**	**2**	**Mod Imp. 3**	**4**	**Ext. Imp. 5**
Cost Constraints	( )	( )	( )	( )	( )
Time Constraints	( )	( )	( )	( )	( )
Space Constraints	( )	( )	( )	( )	( )
Regulatory Restrictions	( )	( )	( )	( )	( )
Owner Disapproval	( )	( )	( )	( )	( )
Lack of Understanding	( )	( )	( )	( )	( )
Other (specify)	( )	( )	( )	( )	( )

On-site Wastewater Treatment **Yes ( )** **No ( )**

Incorporated

Factors	**Not Imp. 1**	**2**	**Mod Imp. 3**	**4**	**Ext. Imp. 5**
Educational Demonstration	( )	( )	( )	( )	( )
Public Relations/Marketing	( )	( )	( )	( )	( )
Financial Benefits	( )	( )	( )	( )	( )
Building Code	( )	( )	( )	( )	( )
Incentives Provided	( )	( )	( )	( )	( )
Water Concerns +/or Shortages	( )	( )	( )	( )	( )
Owner Demand	( )	( )	( )	( )	( )
Other Regulatory Requirements	( )	( )	( )	( )	( )
Other (specify)	( )	( )	( )	( )	( )

Not-Incorporated

Factors	**Not Imp. 1**	**2**	**Mod Imp. 3**	**4**	**Ext. Imp. 5**
Cost Constraints	( )	( )	( )	( )	( )
Time Constraints	( )	( )	( )	( )	( )
Space Constraints	( )	( )	( )	( )	( )
Regulatory Restrictions	( )	( )	( )	( )	( )
Owner Disapproval	( )	( )	( )	( )	( )
Lack of Understanding	( )	( )	( )	( )	( )
Other (specify)	( )	( )	( )	( )	( )

Rainwater Collection & Usage **Yes ( )** **No ( )**

Incorporated Factors	Not Imp. 1	2	Mod Imp. 3	4	Ext. Imp. 5
Educational Demonstration	( )	( )	( )	( )	( )
Public Relations/Marketing	( )	( )	( )	( )	( )
Financial Benefits	( )	( )	( )	( )	( )
Building Code	( )	( )	( )	( )	( )
Incentives Provided	( )	( )	( )	( )	( )
Water Concerns +/or Shortages	( )	( )	( )	( )	( )
Owner Demand	( )	( )	( )	( )	( )
Other Regulatory Requirements	( )	( )	( )	( )	( )
Other (specify)	( )	( )	( )	( )	( )

Not-Incorporated Factors	Not Imp. 1	2	Mod Imp. 3	4	Ext. Imp. 5
Cost Constraints	( )	( )	( )	( )	( )
Time Constraints	( )	( )	( )	( )	( )
Space Constraints	( )	( )	( )	( )	( )
Regulatory Restrictions	( )	( )	( )	( )	( )
Owner Disapproval	( )	( )	( )	( )	( )
Lack of Understanding	( )	( )	( )	( )	( )
Other (specify)	( )	( )	( )	( )	( )

Xeriscaping **Yes ( )** **No ( )**

Incorporated Factors	Not Imp. 1	2	Mod Imp. 3	4	Ext. Imp. 5
Educational Demonstration	( )	( )	( )	( )	( )
Public Relations/Marketing	( )	( )	( )	( )	( )
Financial Benefits	( )	( )	( )	( )	( )
Building Code	( )	( )	( )	( )	( )
Incentives Provided	( )	( )	( )	( )	( )
Water Concerns +/or Shortages	( )	( )	( )	( )	( )
Owner Demand	( )	( )	( )	( )	( )
Other Regulatory Requirements	( )	( )	( )	( )	( )
Other (specify)	( )	( )	( )	( )	( )

Not-Incorporated Factors	Not Imp. 1	2	Mod Imp. 3	4	Ext. Imp. 5
Cost Constraints	( )	( )	( )	( )	( )
Time Constraints	( )	( )	( )	( )	( )
Space Constraints	( )	( )	( )	( )	( )
Regulatory Restrictions	( )	( )	( )	( )	( )
Owner Disapproval	( )	( )	( )	( )	( )
Lack of Understanding	( )	( )	( )	( )	( )
Other (specify)	( )	( )	( )	( )	( )

10. **For each strategy incorporated, please compare the cost of implementing it relative to the cost of implementing traditional methods. Select “not applicable” if the strategy was not incorporated. Indicate your selection with an “X”.**

Dry Plumbing Fixtures
( ) Cost was more than 10% greater than traditional methods
( ) Cost was 1 - 10% greater than traditional methods
( ) Cost was within 1% of traditional methods
( ) Cost was 1 - 10% less than traditional methods
( ) Cost was more than 10% less than traditional methods
( ) Not applicable

Graywater Collection & Usage
( ) Cost was more than 10% greater than traditional methods
( ) Cost was 1 - 10% greater than traditional methods
( ) Cost was within 1% of traditional methods
( ) Cost was 1 - 10% less than traditional methods
( ) Cost was more than 10% less than traditional methods
( ) Not applicable

High Efficiency Irrigation Systems
( ) Cost was more than 10% greater than traditional methods
( ) Cost was 1 - 10% greater than traditional methods
( ) Cost was within 1% of traditional methods
( ) Cost was 1 - 10% less than traditional methods
( ) Cost was more than 10% less than traditional methods
( ) Not applicable

High Efficiency Plumbing Fixtures
( ) Cost was more than 10% greater than traditional methods
( ) Cost was 1 - 10% greater than traditional methods
( ) Cost was within 1% of traditional methods
( ) Cost was 1 - 10% less than traditional methods
( ) Cost was more than 10% less than traditional methods
( ) Not applicable

Occupant Sensors & Timers
( ) Cost was more than 10% greater than traditional methods
( ) Cost was 1 - 10% greater than traditional methods
( ) Cost was within 1% of traditional methods
( ) Cost was 1 - 10% less than traditional methods
( ) Cost was more than 10% less than traditional methods
( ) Not applicable

On-site Wastewater Treatment
( ) Cost was more than 10% greater than traditional methods
( ) Cost was 1 - 10% greater than traditional methods
( ) Cost was within 1% of traditional methods
( ) Cost was 1 - 10% less than traditional methods
( ) Cost was more than 10% less than traditional methods
( ) Not applicable

Rainwater Collection & Usage
( ) Cost was more than 10% greater than traditional methods
( ) Cost was 1 - 10% greater than traditional methods
( ) Cost was within 1% of traditional methods
( ) Cost was 1 - 10% less than traditional methods
( ) Cost was more than 10% less than traditional methods
( ) Not applicable

Xeriscaping
( ) Cost was more than 10% greater than traditional methods
( ) Cost was 1 - 10% greater than traditional methods
( ) Cost was within 1% of traditional methods
( ) Cost was 1 - 10% less than traditional methods
( ) Cost was more than 10% less than traditional methods
( ) Not applicable

11. **Indicate ("X") the estimated percentage of water that is being (will be) saved by incorporating the various strategies:**
    Irrigation Water Savings:
    0-10% ( ) 11-20% ( ) 21-30% ( ) 31-40% ( ) 41-50% ( )
    51-60% ( ) 61-70% ( ) 71-80% ( ) 81-90% ( ) 91-100% ( )
    Potable Indoor Water Savings:
    0-10% ( ) 11-20% ( ) 21-30% ( ) 31-40% ( ) 41-50% ( )
    51-60% ( ) 61-70% ( ) 71-80% ( ) 81-90% ( ) 91-100% ( )

12. **What is the billed water rate for the project? If the irrigation water rate is different than the potable water rate, provide both. Please include the units; for example $3.17 per CCF.**
    Potable water rate: **Irrigation water rate:**

13. **What is the project's estimated baseline yearly water usage? Please include the units.**
    Potable water usage: **Irrigation water usage:**

14. **Have public relations/marketing efforts been made regarding the strategies employed?**
    Yes ( ) **No** ( )
    If so, indicate ("X") the publicity/marketing benefits realized (expected) as a result of incorporating the various strategies:
    None ( ) Only a little ( ) Some ( ) A great deal ( ) Extreme ( )

15. **Indicate the use of the LEED project: (1 = primary; 2 = secondary; X = doesn't apply) Indicate all that apply.**
    Housing (Higher Ed.) ( ) Classroom(s) ( ) Retail ( )
    Laboratory ( ) Food Service ( ) Office(s) ( )
    Research ( ) Manufacturing ( ) Meeting/Conference ( )
    Multi-Family Housing (Private) ( ) Other (please specify)

16. **What was (is) the overall budget for the project?**

17. **Did (Does) the organization responsible for this project have prior LEED certification experience? Yes** ( ) **No** ( )
    If so, provide the number of previous LEED projects.

18. **Please provide any individual comments you feel would help in understanding how decisions about the strategies employed in LEED projects are made.**

Would you like the compiled survey information? ( ) Yes ( ) No
If so, please provide the appropriate e-mail address below.

Please provide the following information for the individual responsible for completing this survey. If provided, <u>all</u> personal information will remain confidential.

Name:
Title:
Phone:
E-mail:

Please <u>save and return</u> this survey October 28, 2005 via e-mail to edurr@environ.sc.edu or fax to (803) 777-5715.

Thank you for completing this survey; your time is greatly appreciated!

Appendix C
Survey Comments

The identity of those that provided comments is confidential.

[A]rbitrary and capricious unless decision makers are educated and involved with LEED design team members.

LEED has value to publicly accountable organizations as a seal-of-approval, if life-cycle cost savings can be documented.

Since this was a renovation project many of the site water conservation issues were not feasible to pursue.

Long term benefits.

Kentucky code officials did not allow waterless urinals.

I have another YMCA designed by the same architects and same engineer. They are using the same strategies.

Most of [our] buildings employ sustainable design though not all seek LEED certification for a number of reasons.