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"Green Lodging Project Phase 1: Solid Waste Management, Waste Reduction, and Water Conservation"

-FINAL REPORT-

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Executive Summary

It has been documented that the Green Lodging Certification Program practices are generally effective in reducing multi-media waste streams and thus resulting into a cleaner environment, financial benefit, and positive publicity to the participating hotel businesses. Green Lodging practices are applied with respect to (a) water conservation, (b) solid waste management and waste reduction, (c) energy efficiency and (d) clean air practices.

This study is the first part of a two phase project. Both phases will be comprised of two parts: (1) critical literature review/data collection part, and (2) implementation part, where a hotel will be selected for application of Green Lodging practices and monitoring of its performance measures. The first phase will be focused on (a) water conservation and (b) solid waste management and waste reduction, while the second phase will include (a) energy efficiency and (b) clean air practices.

This report contains a critical literature review and data analysis regarding (a) water conservation and (b) solid waste reduction and management obtained from the lodging sector. Data are collected from a plethora of sources but the emphasis has been focused into the experiences from the State of Florida. However, nationwide and worldwide data were also included for comparison, and were found to be in agreement with the beneficial results identified through the Florida Green Lodging program.

Best management practices are also discussed in detail for each specific area of a hotel such as: main lobby/office, guest rooms/housekeeping, laundry, kitchen/restaurant/bar, conference areas/meeting rooms, grounds, and swimming pool/spa. The report also provides resources and information to disperse some common misconceptions of the hotel industry regarding: (a) perceived lack of information and resources about environmental options, (b) perceived lack of ability to research the environmental performance of hotels, and (c) perceived prohibitive cost issue. For the second part of the first phase of the project, two major hotels have been identified for participation in the Green Lodging program and subsequent assessment and monitoring.

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Introduction

The Florida Green Lodging Certification Program (FGLCP) is an effort by the Florida Department of Environmental Protection (FDEP) to encourage the tourist industry to conserve and protect Florida's natural resources. Under this program, hotels and motels have been able to help protect the environment, while saving money and generating positive publicity. The purpose of this study is to identify the factors that affect or influence the performance of environmental programs for FDEP Green Lodging Certification. With this information, more cost-effective measures can be identified and implemented. Florida is one of only a handful of states to implement a green lodging program. Others include California, which began its program in 2003, Vermont, which established its program in 1999, and Michigan and Wisconsin, which are conducted pilot phases.

According to the Travel Industry Association of America, business travel expenditures totaled $185 billion in 2000, with $37 billion spent on accommodations alone for 2.6 million rooms per day (CERES 2006). The lodging industry uses an estimated 180-250 billion gallons of water per year (Hemmila 1998; Abt Associates Inc. 2001), generates 0.6-2.8 million tons of solid waste annually (NCDENR 1998; Abt Associates Inc. 2001), and uses the fourth most electricity within the commercial sector. Nationwide, the lodging industry comprised over 51,000 facilities with over 3.1 million rooms in 1999 according to Patricia Griffin of the Green Hotels Association (quoted in Davies and Cahill 2000). According to the Florida Department of Business and Professional Regulation (www.myflorida.com/dbpr), as of March 2005 there were 398,322 hotel, motel and bed-and-breakfast rooms in Florida spread over 4,948 properties. Resort condos and dwellings add another 97,459 units from 10,177 properties. All together, they serve about 35-40 million guests annually, contributing over $14 billion to the local economy (VisitFlorida 2006). The lodging industry is responsible for generating 4% of the state's municipal solid waste per year, uses 625 million kWh of electricity, and consumes billions of gallons of water (Yon 2005).

Project Description

Candidates for Green Lodging Certification require information regarding performance measures for: 1) water conservation, 2) solid waste management and waste reduction, 3) energy efficiency, and 4) clean air practices. This study is proposed to be conducted in 2 phases, corresponding to the first two and the second two numbered performance areas described above, respectively. Once this information is made available, candidate facilities can target and implement specific measures that provide the maximum return on the investment in terms of reduced water and energy demands, pollution prevented, and indoor environments protected. Results will provide a clear understanding of currently available practices and their environmental and economic benefits as well as future conservation initiatives needed to maximize the impact of the Green Lodging Certification Program.

The study will be conducted in phases corresponding to the two sets of target areas described above. The scope of work for Phase 1 (solid waste management/waste reduction and water

conservation) is described below. In this project, Phase 1 is divided into two years. Year one is scheduled to end on June 9, 2006, and Year two work for implementation of Phase 1 will begin immediately following. Phase 2 will be similarly structured but will focus on energy efficiency and clean air practices.

An objective of this research is to review the cost and effectiveness of existing waste minimization and water conservation technologies and strategies implemented by utilities/municipalities or other Green Lodging programs in other states. This review will include the following:

- Costs for traditional waste management/minimization strategies;
- Costs associated with newer waste best management practices;
- Water usage values for traditional fixture type or appliance;
- Water usage values for newer low-flow fixture type or appliance;
- Cost savings expected from implementation of best management practices in the waste sector;
- Water savings expected from implementation of common water conservation technologies and measures that may be implemented as a result of this study.
- Legal, policy and social barriers to implementation of conservation measures, including staff training requirements;

Water Conservation

The United States Department of Environmental Protection (EPA) has estimated water use for the lodging sector using data from a survey of 408 hotels distributed all over the U.S. (Redlin and deRoos 1990). According to the EPA estimates, water use in the recreation sectors averages around 3 gallons per dollar of sales for lodging, around 0.5 gallons per dollar for restaurants, and 0.12 gallons per dollar sales in the retail sector. Indirect requirements total up to 0.9 gallons per dollar of sales for lodging, 1.8 gallons per dollar of sales for restaurants, and 0.7 gallons per dollar for retail (Creason 2000). Restaurant and retail sector estimates were published in Mays (1996). Using this data, the U.S. Department of Energy (DOE) Federal Energy Management Program estimates water usage at hotels using: 40-60 gpcd per hotel guest and 8-13 gpcd per employee (CH2M Hill 2002).

Several published data sets refer to the hotel industry through the SIC code. Sub-industries under SIC code 70 include hotels, motels, rooming and boarding houses, recreational vehicle parks, camp sites, and a variety of other types of lodging establishments. Because the literature focuses primarily on water use in hotels, motels, and bed and breakfasts (SIC codes 701 and 704), the analysis of the lodging sector is typically limited to these three types of establishments, referred to collectively as hotels. In data obtained from the Greater Vancouver, British Columbia (Canada) Regional District (GVBCRDPPD 1997) survey of 5000 industrial and commercial sector customers, the hotel/motel/tourist category (SIC code 7011) averaged 14,340 gallons per day per connection, which generated an annual demand of 5.2 million gallons per connection (n = 232) or 1.2 billion gallons per year. Combined national and international statistics cited in Vickers (2001), show that average water use for hotels with two persons per room is on the order of 60 gpcd plus 230 gallons per employee per day additional. In 2000, the American

Water Works Association Research Foundation (AWWARF) performed a study of billing records from five California and Arizona water providers to determine commercial water use by sector (Dziegielewski et al. 2000). The study found that conservation measures could potentially save 15-50% in water use with payback periods on the order of 2.5 years for most improvements. They also found that non-potable water sources, such as reclaimed water, could be substituted for drinking water in some common applications such as irrigation and cooling systems.

In Seattle, WA, the lodging sector, representing less than 1% of all commercial accounts, consumed approximately 5% of the total commercial water in utility service area (O'Neill & Siegelbaum and The RICE Group 2002). A telephone survey of 40% of the hotels with over 75 rooms (25% of the total lodging sector in the City of Seattle) found that a majority of the hotels had installed some combination of water conserving measures in the last five years, including 31% that had adopted the towel-linen reuse program, and 90% had installed faucet aerators or restrictors and low flow showerheads, while only 50% stated they had installed low flow toilets. Air-cooled ice machines were used in 60% of the surveyed hotels, but only 5% had efficient commercial dishwashers. In this study, two hotels were selected for more detailed water use audits. The Westin, an older hotel with in-house laundry and a banquet/restaurant facilities but with no site irrigation, consumed approximately 212 gpd per room during the month of August study period. The West Coast Grand, a newer facility with low flow toilet fixtures, banquet and restaurant facilities, but no in-house laundry consumed 129 gpd per room.

Redlin and deRoos (1990) found that hotels use an average of 209 gallons of water each day for each occupied room. Stipanuk and Roffman (1996) estimated that water use per room was 144 gallons per day. Cornell University's School of Hotel Administration (Enz and Siguaw 1999) conducted a study that determined that the average hotel guest room uses 52,500 gallons of water per year (144 gpd). Hotel water usage ranges from 101 gallons per available room per day in hotels with less than 75 rooms, to 208 gallons per room per day in hotels with 500 or more rooms. Additionally, limited service or economy class hotels reported a median use of 94 gpd while resorts, casinos, and conference centers reported a median of 254 gpd. Using the mean usage characteristics, this amount averages out to 154 gallons per guest room per day, or 56,210 gallons of water per room per year.

For comparison, a South Florida residential neighborhood typically has daily demands on the order of 70-380 gpcd, and these values include irrigation, car washing, and multiple fixtures. It is important to recognize that the 100-150 gpcd national average represents residents living in metered conditions, and who are responsible for paying monthly water bills. Residents of hotels and motels are not responsible for paying monthly water bills, a situation that often leads to water use in excess of the national average. To illustrate this point, studies of communities that have converted from unmetered to metered conditions in public housing units have shown decreases in water consumption between 16% and 50% (CH2M Hill 2002). Thus, the lodging industry has plenty of room for improvement, with the potential to reduce water consumption by at least half.

With respect to Florida-specific data, in the mid-1990s, hotels and motels in Southwest Florida used about 22,000 gallons per day on average according to a SWFWMD report (1997). More recently, the average hotel resident in Tampa, FL in 2003 was found to use 114 gpd per room, with values as high as 380 gpd also recorded (White 2004). This adds up to 1.2 billion gallons of water per year for the City of Tampa alone. From estimates of average water use

characteristics, Florida hotels consume as much as 63 million gallons per day of water (using 154 gpd per room), which totals up to 23 billion gallons of water per year.

Florida has nearly 85.8 million visitors each year (VisitFlorida 2006), and according to the Travel Industry Association of America, 54 million adult American travelers are inclined to book travel with companies that strive to protect and preserve the local environment of their destination (Moore 2005). The economy of Florida is heavily driven by the tourism and service industries, which are dependent upon plentiful supplies of clean water. In Florida, the supply of fresh water is a precious commodity and one of the State's most complicated environmental challenges. In Florida, the majority of the drinking water comes from ground water sources that are replenished by rainfall and aquifer recharge programs. On average, Florida communities must receive at least 53 inches of water per year to avoid drought conditions (Hinton et al. 2004), and avoid mandatory water conservation measures that impact both businesses and individuals.

Taken as a whole, the entire lodging industry has been estimated to use 154 billion gallons per year (Stipanuk and Ninemeier 1996), and it is estimated that by 2010, water use will climb to approximately 475 gallons per day for each room in high luxury facilities (Alexander 2002). In a study completed on tourism in Palawan, Philippines, it was estimated that in the early stages of tourism development in Busuanga West, the amount of water required for a single upscale hotel room would be 396 gallons per day; enough water to support 14 locals at their current standard of living (Alexander 2002). In another example, the Houston-based Green Hotels Association observed water use in a San Antonio La Quinta Inn for a one-month period, the hotel showed a more moderate average of 110 gallons of water being used per guest per billing period (Gerston 2002). Clearly, measured water use at lodging facilities is site-specific and varies considerably. For the most part, care should be exercised when making projections of water use and potential savings from conservation based on assumptions that are not from empirical measurements, even if estimates are the only data available.

Water Use

Potable water is used at lodging facilities for drinking, cleaning, bathing, recreation, irrigation, fire safety systems, cooling, and sanitary purposes.

From sub-metering data (Redlin and deRoss 1990), the following information was compiled:

- **On-Site Laundry Service**: Using data from 12 hotels, ranging in size from 251 rooms to 2033 rooms (with a median of 643 rooms), laundry water accounted for 5-30% of total water use, with a median of 14%. Efficiency ranged from 1.0-5.9 gallons of water per pound of laundry, with a median of 2.4. Daily pounds of laundry per guest room ranged from 6-19 pounds, with a median of 10.
- **Kitchens**: Using data from 10 hotels, kitchen water usage ranged from 0.05-25% of overall water use, with a median of 6%. Gallons per meal ranged from 2.4-15.8, with a median of 12.
- **Irrigation**: Using data from 13 hotels, usage accounted for 1-44% of total water use, with a median of 14%.
- **Cooling Towers**: Using data from 17 hotels, cooling towers consumed 1-21% of total water use, with a median of 9%.

- **Swimming Pools**: Using data from 16 hotels, swimming pools consumed between 0.01-13.1% of total water use, with a median of 0.16%.

In most estimates of water usage and potential water conservation savings, the Redlin and deRoss (1990) study is used to predict the water usage characteristics. However, this study was conducted over 15 years ago, and much has changed in the way of available conservation technologies and mandated plumbing fixtures. For example, many of the respondents to this survey considered 4-5 gpf toilets to be "water conserving devices," compared to previous 7.0 gpf standard models, while today we have available the 1.6 gpf version.

Water usage is highly dependent upon the size and type of the hotel. It is also affected by the target market. For instance, larger hotels often offer amenities that use large quantities of water, such as swimming pools and extensive landscaping. Furthermore, large hotels are more likely to have a central chiller, which is an important consumer of water (Redlin and deRoos 1990). A study conducted in Pinellas County subdivided the lodging facilities into five categories by number of rooms, and found that the larger the hotel, the more water was wasted (see Figure 1).

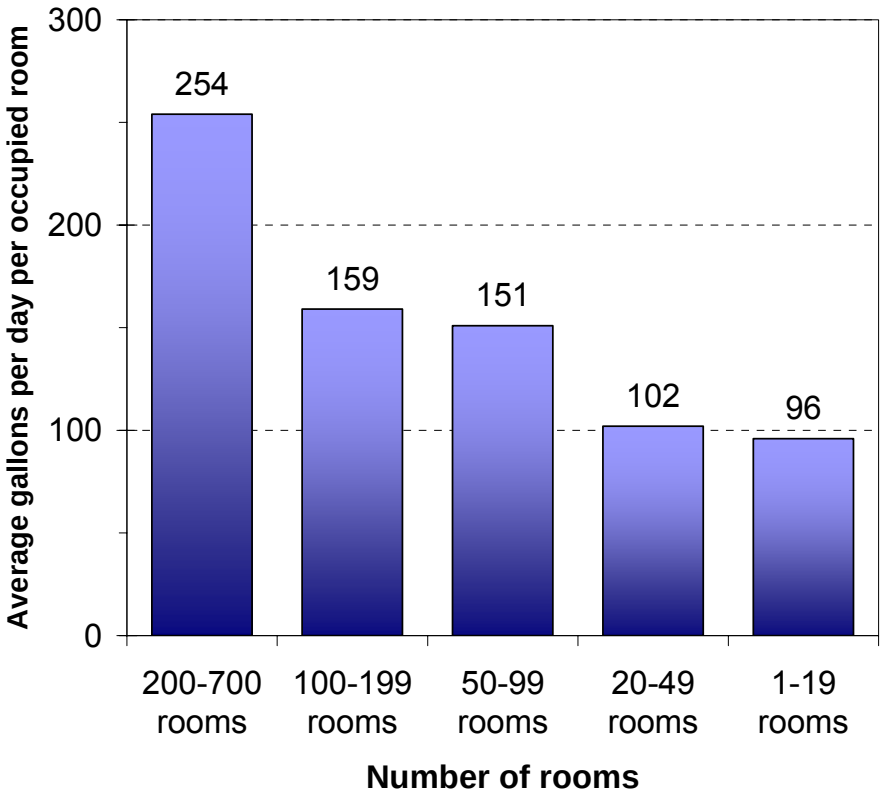

Figure 1. Summary of average water usage by hotel size in Pinellas County with an average occupancy rate of 73% (West 2006).

Table 1 has a summary of water usage statistics by category. The indicated values show that the guest rooms, laundry facilities, and the kitchens are areas where large potential savings are possible since they account for the largest fractions of water usage in hotels.

In a study in Seattle, WA, two hotels were analyzed for water use. The guest rooms accounted for 40-44% of the total usage; laundry (14%); kitchens (25-29%); cooling/heating (7-19%); and leaks and unaccounted for water (11-12%) (O'Neill & & Siegelbaum and The RICE Group 2002). Another factor that impacts the water usage characteristics of a lodging facility is if the property uses a cooling tower. Data adapted from West (2006) for the City of Tampa is illustrated in Figure 2. The impact of the cooling water tower is clearly shown, but the most significant usage category remains sanitation.

Table 1. Summary of water usage breakdown

Usage Sector	Percent of Total by Volume	Reference
Guest Rooms	51.0% 62.0% 38.4% 30.0% 24.0% 35.5% (includes 6.4% for sanitation)	MWD 2002 SWFWMD 1997 GVBCRDPPD 1997 City of San Jose 1992 Ploeser et al. 1992 Gerston 2002
Laundry	14.0% 8.0% 14.7% 20.0% 12.0% 16.2%	MWD 2002 SWFWMD 1997 GVBCRDPPD 1997 City of San Jose 1992 Ploeser et al. 1992 Gerston 2002
Cooling and heating	10.0% 7.0% 41.6% (includes misc.) 15.0% 21.0% (includes 7.0% once-through cooling water) 27.5% (includes 17.4% once-through cooling water)	MWD 2002 SWFWMD 1997 GVBCRDPPD 1997 City of San Jose 1992 Ploeser et al. 1992 Gerston 2002
Landscaping	10.0% 13.0% 3.3% 10.0% 22.0% 3.8%	MWD 2002 SWFWMD 1997 GVBCRDPPD 1997 City of San Jose 1992 Ploeser et al. 1992 Gerston 2002
Kitchen	10.0% 6.0% 8.9% 24.1% 12.0% 3.1%	MWD 2002 SWFWMD 1997 GVBCRDPPD 1997 City of San Jose 1992 Ploeser et al. 1992 Gerston 2002
Unaccounted for water	5.0% 4.0%	MWD 2002 SWFWMD 1997

	0.9% 6.0% (includes leaks) 13.9% (include 0.6% leaks)	City of San Jose 1992 Ploeser et al. 1992 Gerston 2002

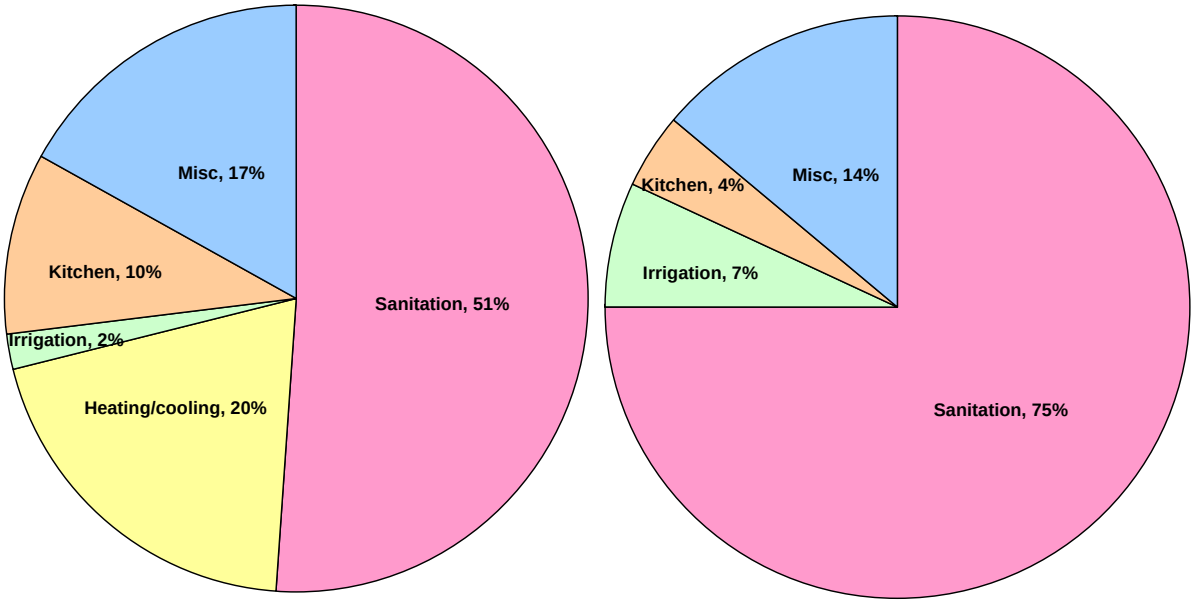

Figure 2. Tampa Water Department Audit of 27 hotels showing water use by category for hotels with cooling towers (left) and without cooling towers (right). Data adapted from West (2006).

Costs and Savings

From water use billing records, the total amount of water used per month can be determined. Using this value and the billing rates for the water service provider, the costs for water and sewer can be determined. Rate structures vary among municipalities and water purveyors, but generally consist of a fixed rate determined by meter size and a variable rate computed on a per gallon basis sliding scale. The sewer values are typically not metered and are determined by applying a factor or a sliding scale based on metered potable water usage. This data can be obtained from either the lodging facility or the water service provider. In South Florida, typical water and sewer rates for 25,000 gallons/month using a 1-inch meter were compared in Figure 3 using 2006 data. The average bill was $101.72/month at this usage, and the highest rate occurred in the City of Ft. Lauderdale ($148.70) and the lowest in Boca Raton ($44.37).

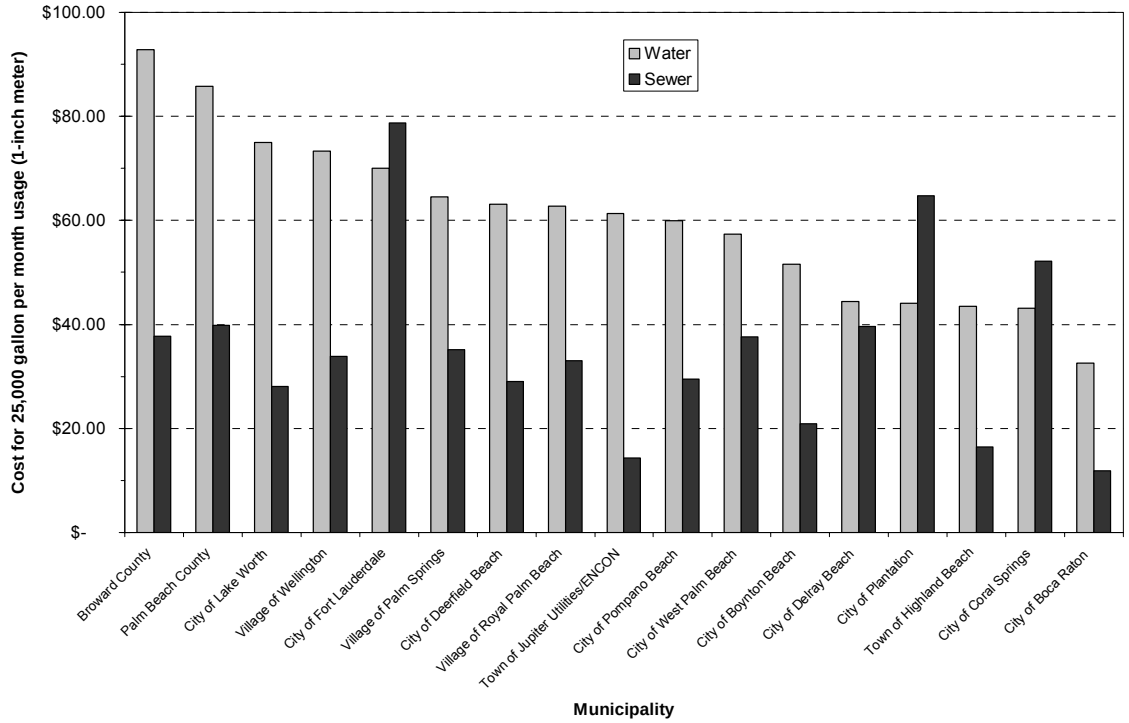

Figure 3. Comparison of water and sewer rates for a 25,000 gallon per month usage with a 1-inch meter. Adapted from Helfritch (2006).

In the mid-1990s, it was estimated that the average water and sewer cost for a 350-room hotel facility was on the order of $60,000 (or about $107,400 in 2006 dollars), and retrofitting programs realized up to 30% reductions, or savings of $18,000 (or 32,200 in 2006 dollars) annually (Ton et al. 1996). More recently, a Tampa hotel reduced its water use by 35% following a comprehensive evaluation. The retrofit program consisted of replacing toilets with new 1.6 gallon per flush models, installing lavatory aerators, and replacing showerheads with 2.0 gallon per minute models. The potential savings totaled 0.9 million gallons of water and $5,093 per year (White 2004). Another Southwest Florida hotel adjusted the conductivity of its cooling water up to a higher level that could still provide reliable service while wasting less water. The potential savings of this retrofit totaled 1.2 million gallons of water and $7,134 per year (White 2004).

Pinellas County Utilities conducted year-long water-use audits on 17 representative properties that ranged in size from 1-10 rooms to 700 rooms. A combined total of 16 million gallons of water was saved in one year after implementation. The total savings of the program was $128,000. If all the hotels and motels within Pinellas County fully participated, they would have saved over 71 million gallons of water and over $500,000 last year (White 2004).

In a study conducted by the Pacific Institute for Studies in Development, Environment, and Security (Gleick et al. 2003) two independent approaches for estimating water use in commercial sectors were used and findings were compared against other published estimates.

The first approach involved compiling, reviewing, comparing, and analyzing data gathered from various water users in California using several survey instruments. From these surveys, water-use coefficients (in gallons of water per employee per day) were calculated and combined with employment data. In the second approach, water-delivery records were obtained by sector, as reported by water purveyors. Water use in hotels was modeled using published estimates of restroom visits, showers, and faucet use by guests and employees, irrigated turf areas, cooling requirements, kitchen usage, and leaks. Estimates of water use per employee were converted to water use per occupied room per day and then compared to water use model predictions. Many of the end use data were derived from study of water use in the hotel industry (Redlin and deRoos 1990). Using the number of occupied hotel rooms (350,000 total rooms x 66% occupancy rate), and the total water used by the hotel sector in 2000 in this study (30,300 acre-ft), the researchers estimated that the daily water use per occupied room was on the order of 117 gallons using the survey data, and the results of the modeling data is summarized in Table 2, showing a usage value of 145 gpd per occupied room.

Table 2. Results of modeling water use in hotels. Adapted from Gleick et al. (2003).

	Typical Daily Use per Occupied Room		
	Rate/Unit	Number of Units	Water Use (gpd)
Indoor Use			
Showers [A]	2.2 gal/min	16.2 min/day	35.6
Faucets [B]	1.3 gal/min	0.4 min/day	0.5
Toilets [C]	3.0 gal/flush	4.0 flush/day	12.0
Laundry [D]	2.5 gal/lb	8.0 lb/day	20.0
Kitchen [E]	7.6 gal/meal	2.2 meal/day	17.0
Icemakers [F]	0.5 gal/meal	2.2 meal/day	1.1
Misc.	gal/day		25.0
Cooling [G]	5.6 gal/cdd	1.4 cdd/day	7.9
Outdoor Use			
Irrigation [H]	0.06 gpd/ft^2	432 ft^2/room	25.9
Pools			0.5
Total			145.5

[A]For showers, typical showerheads operate at two-thirds their rated flow, which is on the order of 2.75 or 3.0 gpm for most installed showerheads, so the water usage is typically 2.2 gpm (Vickers 2001). The average of 16.2 min/day per occupied room is developed in Brown and Caldwell (1990).

[B]For faucets, the average residential restroom faucet is typically rated at 2.0 gpm, but because faucets are rarely run at the maximum rate, use is estimated at 1.34 gpm (Vickers 2001). Three studies (cited in Gleick et al. 2003) related faucet use to urinal or toilet use and found that the average amount of gallons per use was 0.11 gpf (Knight et al. 1997). Using this value and an occupancy of two people per room, the value of 0.4 min/day is derived from 1.7 million flushes/day from 231,000 occupied rooms.

[C]For toilets, the average gallons per flush were developed from surveys conducted by Hazinski (2002), MWD (2002), and Hagler Bailly Services

(1997). The value of 4 flushes per day was cite in Brown and Caldwell (1990)
[D]For the laundry estimates, 89% of hotels surveyed had in-house laundry service, and the daily number of pounds per occupied room of laundry was obtained from the average of 12 hotels' response (Redlin and de Roos 1990)
[E]For the kitchen estimates, 76% of the hotels surveyed had in-house restaurants, and the average gallons per meal was obtained from the restaurant sector analysis (Redlin and de Roos 1990)
[F]For the icemaker estimates, 0.5 lb/meal was estimated from ASHRAE (1994), 1.0 gal/lb was estimated from Pike (1995)
[G]For the cooling estimates, nearly 50% of the hotels surveyed had central cooling, and the average annual cooling degree days in California was 1035. Cooling degrees per day (CCD) = 1035 x 50% ÷ 365 = 1.4 cdd/day. Value of 5.6 gallons of water per cooling degree day was obtained from Redlin and de Roos (1990)
[H]For the irrigation estimates, the total water usage for landscaping was estimated to be 5,509,615 gpd and the total landscaped area was estimated at 99,905,000 ft^2. The total landscaped area was divided by the total number of occupied rooms to give 432 ft^2/room (Gleick et al. 2003)

Using these detailed estimates, the study determined that the potential for water savings was on the order of 32%. In an independent study of a Marriot Hotel in Albuquerque, NM, an integrated water conservation program focusing on guest room fixture replacements, irrigation system and kitchens leak detection, ice machine upgrades, and laundry appliance replacement allowed the hotel to achieve a reduction in water consumption from 42.19 million gallons in 1994 to 26.8 million gallons in 1998, a savings of 36.5% (Schultz Communications 1999).

In terms of use category, the guest rooms represent the largest single use within the hotel, and through plumbing replacement programs for high efficiency fixtures, a savings of 31% can be achieved. The second largest single user is the laundry facility, but it represents the largest potential for savings through linen reuse programs and wash-water recycling programs, potentially saving up to 54-66% of water. In the kitchen, icemakers, dishwashers, and pre-rinse nozzles can be upgraded to achieve about 20% reduction in water waste. Finally, in terms of landscaping, water-efficient technologies including drip irrigation, automatic shut-off nozzles, water-sensing devices, and schedule optimization can expect to achieve about 50% reductions in water use. Another study by the California Department of Water Resources (1997) audited 741 commercial sites in six different state including Florida and estimated that the potential water savings for the hotel, accommodations, and hospitality sector (n = 342) was on the order of 17-23%. However, it is important to remember that these estimates were developed based on one single study of site-specific sub-metering conducted over 15 years ago. In addition, without adequate follow up data, it is difficult to judge how reliable specific projections may be.

Water Efficiency

Increasing water efficiency is an important opportunity to achieve cost savings as well as impact water conservation of precious potable water supplies. Many water-saving solutions are easily implemented and affordable. In addition to a decrease in water bills, indirect savings may also be realized by decreases in electricity costs, sewage bills, and decreased chemical costs.

Water conservation can be achieved through behavioral or operational changes, as well as new technologies. Some of these changes cost very little to implement but can have major impacts on water usage. Three important resources include WAVE, Energy Star®, and Water C.H.A.M.P.

WAVE Program

The Water Alliances for Voluntary Efficiency (WAVE) program was developed by the U.S. Environmental Protection Agency to promote water efficiency. WAVE encourages businesses and individuals to reduce water consumption, while simultaneously increasing profits. WAVE has 40 hospitality partners, including Westin, Hyatt, Sheraton, Outrigger and La Quinta Inn. It is reported that WAVE partners have reduced their water consumption by 30% annually, and as a sector, the lodging industry could potentially save 32 billion gallons of water per year and over one trillion BTUs per year in energy consumption, saving $10 million per month in water bills alone (Hinton et al. 2004).

After becoming a WAVE partner and signing a letter of commitment agreeing to survey all facilities and install water-efficient equipment wherever possible, lodging facilities receive WAVE Saver, a software package that enables the survey and tracking of water use with ease and accuracy. Partners put forward an image of environmental stewardship, which can lead to increased revenues and higher occupancy rates.

Energy Star®

Appliances with the Energy Star® designation save water as well as energy. The initial cost of such appliances may be higher in some instances, but the life cycle costs are substantially lower. For example, Energy Star® qualified washers use 18-25 gallons of water per load, compared to the 40 gallons used by standard machines. They do this by extracting more water from clothes during the spin cycle. This reduces the drying time and saves energy and wear and tear on linens. Top-loading models look like conventional machines from the outside, but some use sensors to monitor incoming water temperature and some rinse clothes with repeated high-pressure spraying instead of soaking them in a full tub of water. Front-loading models are similar to machines used in laundromats. They use a horizontal or tumble-axis basket to lift and drop clothing into the water instead of rubbing clothes around a central agitator. Both top-loading and front-loading Energy Star® qualified clothes washers save water and energy. They also use faster spin speeds to extract more water from clothes, reducing drying time and energy use. An Energy Star® qualified dishwasher saves about $100 over its lifetime. The savings comes from using less hot water than conventional models. (Hinton et al. 2004)

Water C.H.A.M.P.

Water C.H.A.M.P. is the Water Conservation Hotel and Motel Program conducted by the Southwest Florida Water Management District (SWFWMD) in Pinellas County, southern Pasco County or Hillsborough County. The goal of this free program is to save water for Florida's future in ways that also save money. As part of the program, the SWFWMD helps partners conduct

water-use surveys to determine where water savings can occur. They also provide training materials for management staff to provide on-site water conservation workshops.

Solid Waste Management

Florida's tourism industry serves an estimated 85.8 million visitors annually (VisitFlorida 2006). A majority of these visitors are hotel guests during their stay. Wastes generated by these guests constitute a significant portion of Florida's commercial waste stream. In Florida, 15-20 million tons of garbage is disposed of in landfills annually (Wagner 1998) despite aggressive commercial and residential recycling programs. Reducing materials at their source, coupled with recovery, reuse, and recycling prevents pollution and reduces or eliminates treatment and disposal costs. Recycling program must be specifically designed to accommodate the hotel's operating procedures. Resource management efforts such as waste reduction, waste minimization, and recycling can represent an important potential savings in terms of solid waste management.

The amount of solid waste generated is dependent upon the size and type of the hotel, as well as the existence of waste management facilities. For example, in a survey conducted in New Hampshire in 2001, there are more than 600 lodging establishments with over 55,784 units bringing in over $364 million dollars in sales each year (NHDES 2001). A pilot study conducted in the mid-1990s by the Florida Department of Environmental Protection, the Central Florida Hotel and Motel Association, and the University of Florida found that the average rate of solid waste generation at hotels ranged from 132.7 pounds per room per month for a Comfort Inn to 220.3 pounds per room per month at an upscale Hilton in the Walt Disney World Village (Shanklin 1993). Another study reported similar values, with the addition that the numbers doubled on checkout days (Shanklin et al. 1991).

Waste Composition

Lodging establishments generate important volumes of solid waste. National estimates range from 0.5-28 pounds per unit per day, with an average of approximately 14 pounds per day per occupied room (NHDES 2001). Compositional analysis indicates that 50-65% of typical lodging waste can be diverted from disposal through recycling, reuse, or waste prevention. In practice, the percentage is typically about half this value at 25-35% (NHDES 2001). Food waste, cardboard, beverage containers, and newspaper typically represent over half of the lodging facilities' waste stream. If the lodging industry can take advantage of this opportunity, it could help delay construction of additional solid waste transfer stations, landfills, and incinerators.

A characterization of the waste stream of the Wyndham Anatole Hotel in Dallas, TX conducted by the Texas Natural Resource Conservation Commission showed three primary materials; paper (40%), food waste (30%) and yard waste (24%) (TNRCC 1998). Additional sources were consulted to determine a representative breakdown of materials in the hotel waste stream generated from the kitchen guest rooms, storage areas, and restaurants. The findings are summarized in Table 3 for results obtained in percent by volume and in Table 4 for percentage by weight.

Table 3. Summary of water usage breakdown, values shown are in percent by volume.

Component	Percent of Total by Volume	Reference
Paper	39.9% 37.0% (with 11.7% cardboard) 46.8% (with 22.5% newspaper; 5.7% mixed paper; 4.6% cardboard) 35.0% (with 20% cardboard; 10% newspaper; 5% mixed)	NYCDS 1992 Alexander 2002* SWIX 2000 Solana Recyclers, Inc. 1999
Food/organic	27.8% 46.0% 20.0% 18.0%	NYCDS 1992 Alexander 2002* SWIX 2000 Solana Recyclers, Inc. 1999
Glass	7.6% 5.6% 2.5% 1.0%	NYCDS 1992 Alexander 2002* SWIX 2000 Solana Recyclers, Inc. 1999
Plastic	7.1% 6.7% 10.2% 22.0% (with 14% polystyrene; 5% HDPE; 3% PET)	NYCDS 1992 Alexander 2002* SWIX 2000 Solana Recyclers, Inc. 1999
Metal	6.1% 4.5% 3.1% 4.0%	NYCDS 1992 Alexander 2002* SWIX 2000 Solana Recyclers, Inc. 1999
Yard waste	6.7% 3.5%	NYCDS 1992 SWIX 2000
Other	4.5% (with 0.2% hazardous waste) 13.9% 23.0% (with 6% linens)	NYCDS 1992 SWIX 2000 Solana Recyclers, Inc. 1999

*Alexander 2002 (reported a 1991-1993 study without citation)

If a lodging facility is going to commit to solid waste management, hotel staff and management must minimize waste generation. This can be accomplished through eco-purchasing and evaluating usage activities to come up with alternatives that generate less waste. Another technique can be recycling for materials that have market value as raw materials or composting depending on the availability of local processing and beneficial end uses. Regardless of how innovative the integrated solid waste management plan is, the remainder of the waste stream must be disposed of. Clearly, before implementing a waste reduction and recycling program, hotels should consider the costs and benefits. When landfill tipping and hauling fees are low, incentives for waste reduction and recycling may decrease. However, hotels should prepare for the contingency of increased tipping and hauling fees increase, and as a competitive advantage, consider promoting waste reduction and recycling. Tipping fees are often adjusted annually by each of Florida's 67 counties.

Table 4. Hotel solid waste composition as reported in the State of California integrated waste management audit 2000 (from NHDES 2001). Values listed are in percent by weight.

Category	% by weight	Category	% by weight
Paper		**Glass**	
Newspaper	12.7%	Clear glass	4.3%
Scrap paper	8.8%	Brown glass	3.5%
Corrugated cardboard	5.7%	Green glass	1.6%
Magazines/catalogs	2.8%	Composite glass	0.4%
Paper bags	0.7%	**Metal**	
White ledger paper	0.8%	Aluminum cans	0.5%
Color ledger paper	0.1%	Other ferrous	1.4%
Computer paper	0.6%	Non-ferrous	0.3%
Other Paper	4.8%	Tin/steel cans	0.7%
Food	28.0%	**Yard waste**	
Organics	2.8%	Leaves/grass	2.6%
Plastic		Prunings/trimmings	1.7%
Plastic packaging	4.9%	Rock, soil, fines	0.1%
Composite plastic	1.8%	**Other**	
Durable plastic	1.3%	Textiles	2.0%
HDPE	0.9%	Construction/Demolition	0.9%
PET	0.8%	Misc. (tires, concrete, etc.)	1.2%
Other plastic	0.5%		

Eco-purchasing

The most effective method for reducing waste is to prevent it in the first place. Eco-purchasing is an important component of a hotel's solid waste management program. The practice of eco-purchasing involves evaluating procedures and products based on durability, reusability, recyclability, and post-consumer recycled content, rather than merely on price and quality. It may require a policy change or merely how a product is packaged in order to get the best value. The life cycle cost of products should be considered during the purchasing decision process. Life cycle costs include factoring in not only the initial cost, but also repair and maintenance and disposal costs, realizing that both delivery and disposal incur a cost.

The average hotel purchases more products in one week than 100 families will typically purchase in one year (Ton 1996). So the opportunity is there to make an important impact on the waste stream. The first step is to develop a materials flow plan, which identifies materials, collection, container size and placement, recycling, reuse, and disposal using a “cradle to grave” or “cradle to cradle” approach. The next step is to keep owners, corporate management, and administration and staff informed about waste stream and recycling opportunities that will save time and money. Then, realistic goals and objectives should be established and specific areas for waste reduction should be targeted. Practical reduction programs must be periodically evaluated in relationship to the overall economic benefits and impacts to time and manpower usage. Establishing an accounting system that tracks monthly waste management costs can be

useful in this endeavor. Preparing a monthly report card for tracking waste disposal and reduction information will allow for performance measurement.

Some of the most common approaches to achieve eco-purchasing goals include the following:

- **Review buying habits and purchase only what is needed**. Overstocked inventory may exceed expiration dates and may need to be disposed of without even being used. Charting the shelf life of items and purchasing only when the item is needed will reduce spoilage.
- **Purchase from vendors committed to reducing packaging**. Examples of easily minimized packaging include: eliminating the non-recyclable, foil-embossed box "gift packaging" of liquor during the holiday season, packing produce and fish in recyclable cardboard or wooden boxes instead of in single-use polystyrene containers, and collecting and reusing shipping pallets instead of disposing of them. The receiving department at the Fontainbleau Hilton Resort and Towers in Miami Beach, FL collects polystyrene packing peanuts from incoming shipments and uses them in the mailroom or drops them off at a local mail service center (Winter and Azimi 1996). Buying in bulk in conjunction with refillable or recyclable containers will also minimize packaging waste.
- **Combine supply orders from various departments**. Eliminate packaging waste from multiple smaller orders. Also, hotels that make purchases on a decentralized basis cannot benefit from bulk purchasing discounts.
- **Maximize usage**. Rent seldom used items or equipment, rather than buying them. Repair items rather than purchasing new ones. By replacing worn parts, refinishing surfaces, repairing scratches, dents, and holes, and reupholstering cushions, the useful life of furniture, fixtures, and equipment can be extended.
- **Purchase materials of higher quality that will last longer without replacement**. For instance, sheets with a high thread count for longer wear or reusable containers instead of disposable paper or polystyrene cups.
- **Purchase products with reduced hazardous or toxic material content**. For example, cleaning supplies are available that are vegetable-based (biodegradable) and non-toxic. Non-chlorine bleaching agents, phosphate-free soaps, and VOC-free paints can also reduce pollution (DeFranco and Weatherspoon 1996). Disposable batteries should be replaced with rechargeable batteries in pagers, walkie-talkies, radios, calculators and flashlights. This reduces the amount of lead acid batteries in landfills (lead is the leading toxic substance in landfills). A comprehensive list of opportunities to reduce items with toxic content is found in Table II-1 in Winter and Azimi (1996).
- **Purchase products with recycled content**. Everyone should be encouraged to buy recycled products manufactured with post-consumer materials whenever possible. Common items include: letterhead, stationery, tissues, toilet paper, paper towels, computer paper, office supplies, playground equipment, picnic/park benches, and re-refined oils (Wagner 1998). This practice helps to keep the market strong for recycled materials.

Recycling

Recycling is the process by which materials, otherwise destined for disposal, are collected and reused as raw materials for new products (Wagner 1998). Recycling prevents potentially useful materials from being disposed of in landfills or combusted in an incinerator, thus saving energy and natural resources. Waste reduction through recycling programs also offers two financial opportunities: (1) avoidance of disposal fees and (2) generation of revenues from the sale of recycled materials.

Probably one of the most important barriers to recycling programs is perceived costs. First of all, disposal costs at a landfill or incinerator, usually $50-$100 per ton of waste (not including transportation charges), are typically higher than processing fees for recyclables at material recovery facilities (MRFs). South Florida tipping fees range from $28/ton for garbage to $40/ton for construction and demolition waste. In addition, hauling costs typically range from $1-2 per mile per ton of material, so there is a distinct advantage for haulers that can access a local facility for recycling (NHDES 2001). Recycling allows a hauler to avoid some or all of the disposal charge (tipping fees), and if the hauler uses a local MRF, all cardboard, glass, plastics, and aluminum can be recycled locally with little or no processing fee.

So for the hauler and the solid waste authority, recycling is clearly economical. However, many factors influence the cost effectiveness of recycling, such as the efficiency of collection and source separation, the cost of transportation, and the market value of materials. Thus the impetus remains with the lodging facility to take advantage of this cost savings as well, and for the most part they are. Large properties can generate as much as 8 tons of waste per day, and up to 60% of this material may be recyclable (Hinton et al. 2004). Many hotels and motels in Florida already have some sort of recycling, reduction, reuse program established. Florida's hotel/motel industry has been a nationwide leader in resource management, actively participating since the early 1980s.

One problem is identifying which materials are recyclable and which are the most valuable. In designing a hotel recycling program, consider the following list of commonly recycled materials:

- Aluminum cans
- Antifreeze
- Appliances
- Batteries
- Building materials
- Cardboard
- Carpet
- Cell phones
- Cooking grease
- Computers
- Fluorescent bulbs
- Food waste
- Freon
- Furniture
- Glass jars
- Landscape waste
- Magazines
- Motor oil
- Newspapers
- Office supplies
- Paint
- Plastic bottles
- Plastic buckets
- Radios
- Scrap metal
- Steel containers
- Telephone books
- Televisions
- Wood

It is important to design an effective system to get the materials from the point of generation to the location in which they will be collected by the hauler. There are a wide variety of systems

and containers that have been designed for this purpose. In order to maximize the benefit, care must be taken to recover those materials that are most valuable. A study by the Southern Waste Information Exchange (SWIX 2000) found that the materials most often recycled in Florida hotels are as shown in Figure 4.

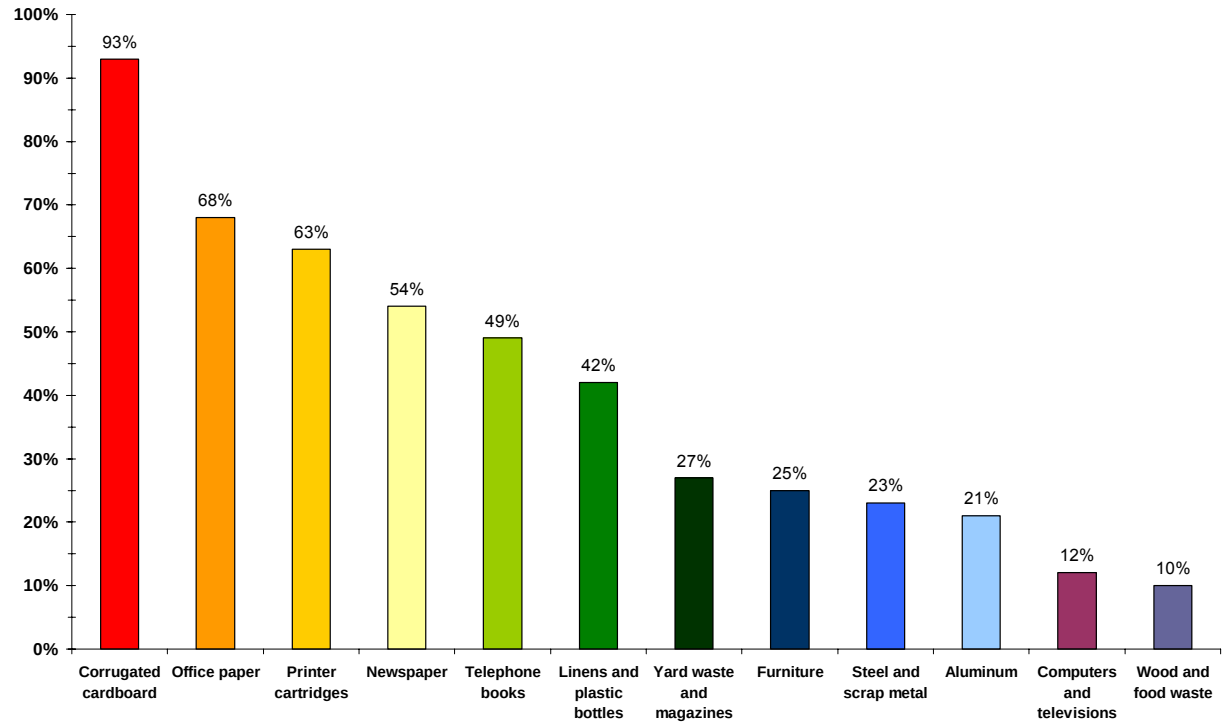

Figure 4. Breakdown of recycled materials from Florida hotels, adapted from (SWIX 2000).

Hotels also produce large volumes of construction and demolition (C&D) waste materials, especially during renovations. These materials are often recyclable. In particular, clean rubble, concrete, plastics, ferrous metals, drywall, light fixtures and ballasts, doors, bathroom fixtures, and wood can all be recovered. Hotels and motels have a variety of options for reducing and recycling C&D waste. Green building techniques may be used in renovation and construction of a hotel. For example, a contractor can reduce wood waste by taking time to measure wood accurately before cutting or donating excess wood material to a local reuse building organization. Untreated wood waste can be collected for composting or mulched and used on site.

Another option for C&D waste is to consider donating some of the more useable items, such as old or unwanted furniture, light fixtures, bathroom fixtures, linens, uniforms, equipment, doors, drapes, and appliances to a charity, nonprofit organization, or thrift store or make them available to employees. Carpet companies may also recycle old carpets and pads, especially if you plan to purchase replacements from them.

One growing opportunity for recycling is referred to as E-Waste, which is generated from obsolete electronic equipment. The rate of introduction of new technologies is making E-waste one of the fastest growing waste streams (Hinton et al. 2004). Most electronic equipment in use today will likely be replace within 3-5 years. Some of the items that fall into this category are communications (telephones, cellular phones, wireless networks and routers), computers, keyboards, monitors, calculators, television sets, VCRs, DVD players, tape recording machines, cameras, video cameras, two-way radios, fax machines, copiers, and printers. The following describes opportunities and methods for reducing E-waste.

- Electronics are potentially recyclable but contain lead, which can be harmful to the environment if disposed of improperly. All motels and hotels will likely have 1-2 television sets in each guest room. There are additional televisions in lobbies, guest and employee lounges, laundry rooms, bars, restaurants and in-house gyms. Leasing televisions and communications (phone, cable, and internet) services places the burden on the leasing company to recycle these items at the end of their useful life (3-5 years). Keep in mind that coastal hotels may have to replace their electronic equipment more often because the salty air tends to corrode the internal components at a faster rate (Hinton et al. 2004).
- Recycle or donate used electronics. Some lodging properties have a system to sell back items to their own employees or local residents. Others try to donate to local charities. Some outlets have recycling opportunities for cellular phones. Many counties and cities also have electronic recycling days for their communities.
- Develop a disposal plan for batteries. Florida law prohibits the disposal of lead-acid and nickel-cadmium rechargeable batteries into the regular solid waste stream (403.708(13)(a) and 403.7192(3), F.S.). The local household hazardous waste program will typically accept all types of batteries from residents and businesses.

Staff training is one of the most important keys to making a successful recycling program. Just as with water conservation measures, monitoring and quality control will ensure that it all works smoothly. Solicit feedback from staff and administrative personnel. This will help to find out what is working and more importantly what is not working, resulting in higher participation. Some hotels use a newsletter to disseminate information and success stories out to the employees. These newsletters often include information on any new efforts to reduce waste, as well as amounts recycled, amounts diverted, and cost savings. They may also reward employees who have provided useful input or saved the most money.

Many hotels have implemented recycling programs, which include collection in the guest room as well as containers in the pool areas, main lobby, meeting rooms, and other common areas. In New Hampshire, a 40-room inn generating 36 tons of waste annually was able to recycle 23 tons of waste. The revenue received from just the sale of newspaper was on the order of $47 per ton, while the cost avoided by diverting the newspaper from the landfill was on the order of $100 per ton ($62 per ton tipping fee and $38 per ton fuel surcharge), for a total savings of $147 per ton (NHDES 2001). In total, the recycling program saved up to $3,000 annually when 65% of the material was recycled.

Recycling saved a 2,033-room Hyatt Regency Chicago Hotel over $100,000 a year through reduced solid waste handling fees. The monthly bill was reduced from $12,000 to $2,000 in just

one year (1991). Each housekeeper separates aluminum, glass, plastics, papers, and cardboard from garbage when cleaning rooms or working with recyclables in the kitchen, lobby, and other areas. The hotel now makes around $20,000 a year selling their recyclables (WDNR 2001). In 1990, the Chicago Hilton, a 1,543-room, 2-million-square foot convention center hotel, collected 50,000 pounds of corrugated cardboard, paper, glass, and aluminum each month. The hotel currently collects 14,000 pounds of cardboard each month and has collected more than 42 tons in 6 months (CDPHE 2002). All cardboard from restaurants, guest rooms, exhibit floors, banquet halls, and offices is collected by the housekeeping and facility department, separated, and loaded into a baler that crushes the cardboard in preparation for off-site recycling. During the same year, Canadian Pacific Hotels began a program to reduce the amount of waste sent to landfills by 50% through guest room recycling and eco-purchasing policies to achieve source reduction. The first hotel to begin the guest room recycling program collected 12,120 bottles and 57,600 cans from 70 rooms in just one year (Canadian Pacific Hotels and Resorts 1990).

The Westin San Francisco Airport Hotel implemented their recycling program in 1994. The hotel practices such waste-reducing steps as purchasing recycled content products, providing environmental education to their employees, donating their excess food to local food banks, and recycling paper, aluminum, and plastics. In fact, the hotel received an award from the Waste Reduction Awards Program in 2000 for its waste reducing efforts and is a member of the Recycled Paper Coalition and the Sustainable San Mateo County Business Council. Annually, 22 tons of materials are recycled for a savings of $6,000 (Alexander 2002).

According to the Vermont Bureau of Environmental Protection, out of 48 participating “Green Hotel” properties, 35 had towel reuse programs (1758 rooms), 24 changed to more environmentally-friendly purchasing programs, 35 offered recycling programs, and 11 had composting facilities. This resulted in 895,320 gallons of water saved, 1317 gallons of bleach saved, 11,192 lbs. of detergent saved, 21,488 KWh saved, and 124,020 lbs. of recycled waste diverted (Burger 2005).

In a study sponsored by USEPA Region IX, a luxury hotel with 416 rooms with over 106,000 room-nights occupied per year was surveyed. The hotel recycled corrugated cardboard, mixed paper, glass, and yard waste. The monthly onsite collection costs were: $109 per pull (35 yd^3 compactor), $41/ton standard tipping fee, and an average of 6 tons per pull. With an average of four pulls per month, the bill was typically on the order of $1,420 (Solana Recyclers, Inc. 1999). Cardboard represented 20% of the waste stream by volume, so by diverting the cardboard for recycling, the hotel saved $1,310 per year and diverted 8 tons of waste. Recycling paper from rooms and offices also saved the hotel an additional $1,770 per year and diverted 24.5 tons of waste. The program cost an initial capital outlay of $2,500, which was paid back in less than 2 years.

Closer to home, a large Florida hotel (over 400 rooms) recycled 81 tons over a six month period and pocketed more than $3,000 in revenue, and a small hotel (less than 100 rooms) recycled 3158 lbs. over a six month period, netting $470 in revenues and reducing the number of solid waste pick-ups to just twice per week (Moore 2002). The Palm Plaza Oceanfront Resort and Beachside Motel in Daytona, FL saved $529 per month through its recycling programs and reduction in the number of waste pulls (Moore 2002).

Typical equipment used for recycling includes roll-off containers, dumpsters, and portable 90-gallon carts. Roll-offs may be covered or compartmentalized for sorting. The larger the

container, the less often it needs to be hauled or emptied. The portable carts are convenient for small facilities and also for larger hotels for collecting and storing one or two types of recyclables and transporting them to a central storage area.

Bulky items like cardboard boxes and plastic bottles can take up valuable space in recycling containers, forcing more frequent pick-ups. One way to limit the number of recycling pulls is to use a compactor or a baler. Typically, a 35-yard^3 compactor rental can range from $150-350 per month, on top of which a hauling and disposal fee will be assessed for each pull. Compactors require three-phase power or a converter, both of which can be expensive to install, however. For a roll-off, the rental fee will cost approximately $75, plus hauling and disposal (NHDES 2001). Baling increases the value of recycled materials from $20-40 per ton. A commercial bale is usually 5'x2'x3' and may weigh 600-1,800 pounds. However, baling requires additional equipment, like a forklift, large bins to hold loose materials, storage for bales, as well as additional staff training. If baling is not an option, merely breaking down (flattening by hand) corrugated cardboard boxes allows six times more cardboard to be placed in a dumpster than placing the intact boxes in the dumpster. Finally, another option to reduce pick-up frequency is to consider sharing recycling (and associated costs) with neighboring facilities.

Composting

Some hotels have started to really consider composting the organic portion of their waste stream. Composting is a process, which begins whenever moist organic materials are placed together. The organics naturally begin to decompose and with the proper moisture, temperature, and microbiological conditions, within about one month, the system can produce a mature compost. Keeping the materials covered (to reduce odors and aerate the compost) and routinely turning while adding additional moisture (to control the temperature in the reaction) can accelerate this microbiological process. The final product, called compost, can be used as mulch in landscaped areas or in the restaurant chef's herb garden. The local Cooperative Extension Service can provide useful guidelines for setting up and maintaining a successful composting program.

The optimal size for a small compost pile is about 3-ft x 4-ft (Wagner 1998). There are several composting bins commercially available. However, a simple enclosure can be constructed by securing the ends of a twelve foot length of 2"x4"x36" chicken wire fencing and covering with a tarp or plywood board (Wagner 1998). Alternatively, old trash cans with lids can be modified by cutting one-inch air holes spaced four inches apart all around the can. In-vessell composting containers should be placed in a well-ventilated area to minimize odors and maximize air flow. Compostable materials include chopped yard waste, kitchen scraps, discarded paper napkins or paper towels (Wagner 1998).

Largest contributors to waste stream are office paper and food/organics. By using a large spinning composter up to 85 pounds of compost can be produced in 30 days. The cost for such a composter is about $136.

Areas that should be included for the composting program are office areas, food and beverage outlets, guest rooms, swimming pool and spa, convention/meeting rooms, housekeeping/laundry, landscaping, maintenance and purchasing.

Best Management Practices

Specific Areas

To make identification of best management practices less complex, measures will be subdivided into specific areas of the hotel. These are: main lobby/office, conference/meeting rooms, guest rooms/housekeeping, laundry facilities, kitchen/restaurant/bar, grounds: landscaping/parking lot/recreational areas, swimming pool/spa, mechanical systems/operations & maintenance

Main Lobby/Office

-Water-

The combined cost of water and wastewater services is typically on the order of $5-6 per thousand gallons. If the cost of energy to heat and pump water is factored in, the cost can be as high as $9 per thousand gallons. As discussed earlier, for South Florida, water and sewer rates vary between a low of $1.77 (Boca Raton) to a high value of $5.95 (Ft. Lauderdale) per thousand gallons (Helfritch 2006). Depending on the size of the hotel and its water usage, a small percentage savings can potentially translate to significant annual savings in the utility bill. Within the lobby of the hotel, several areas for improvements have been identified and are discussed in more detail below.

- **Water-conserving icemakers.** Standard icemakers use water to remove heat. However, newer systems employ an air-cooled instead of a water-cooled unit. Air-cooled machines use air rather than water as the heat sink, saving from $50-100 per month (Gerston 2002) and about 1.5 million gallons of water annually (CDPHE 2002). In single-pass (or once-through) cooling systems, water is circulated once through a piece of equipment and then disposed of down the drain. If the machine has two lines going to the floor drain, then it is a water-cooled system, which can use 800 gallons per day just for cooling the coils and 125-300 gallons per 100 lb ice (NCDENR 1999). This is ten times more water than air-cooled systems. The newer air-cooled units pay for themselves within a short time by eliminating the cooling water for the coils, valued at about $120-$170 per month. For instance, ice machines with water-cooled condensers employing once-through cooling water use about 149 gallons of cooling water per hundred pounds of ice, and since medium-use machines produce almost 400 pounds of ice daily, for a daily total of almost 60,000 gallons of water per day, according to Rick Fischer of Manitowoc Equipment Works (cited in Gerston 2002), there is considerable opportunity to achieve water savings. To improve the efficiency of single-pass cooling equipment:

1. Add an automatic control to shut off the system during low usage times. A solenoid valve cuts off once-through cooling water when the compressor is not running. Installing a $200 solenoid valve on a 400-pound ice machine would render an immediate payback and a water savings of 1.9 million gallons per year (Gerston 2002).
2. Modify to operate on a closed loop that re-circulates water instead of discharging it.
3. Find an alternate use for the once-through effluent, either in boiler make-up supply or for landscape irrigation.

- **Water efficient urinals.** Replace urinals with models that use 1 gpf (gallon per flush) or replace with a waterless urinal.
- **Install timed shutoff valves.** In public restrooms, install shutoff valves in the faucets. These valves cut off water flow after a short period of time.

Another major opportunity to achieve water savings involves the cooling and heating systems of the lodging facility. Cooling towers use significant amounts of water to operate air conditioning and refrigeration systems. Although cooling towers use 90-95% less water than single-pass cooling systems (Vickers 2001), they are still likely to be a large water user in the overall scheme of a lodging facility. Cooling towers lose water by evaporation, blowdown, or drift and other losses. Thus the system must be replenished by consuming make-up water. In quantitative terms, evaporative losses consume 1-3% of the circulated water. Actually increasing the evaporative effect, increases the cooling effect, but mist eliminator systems can limit the amount of water lost to the air stream. Evaporation typically occurs at 1% of the recirculating flow for every 10°F temperature drop, depending on amount of cooling and ambient weather conditions. This amounts to 2.4 gpm per 100 tons of cooling (Vickers 2001). Evaporated water leaves behind suspended solids that concentrate in the recirculating water flow. This high TSS/TDS water can damage the process piping through scaling, biofouling, and corrosion. Thus this water must be drained off and replaced with make-up water. The amount of bleed-off and make-up water is expressed as the concentration ratio or cycles of concentration. This value, which ranges from 1.0 to 12, indicates the number of times the water is passed through before it is discharged. The water quality (TDS) of the recirculating water can be checked for conductivity, and discharge is then triggered when a preset value is reached. For example, a 120-ton cooling tower in Boston, MA generated excessive bleed-off because make-up water was added at a constant 4.0 gpm instead of as-needed. Installation of a conductivity controller unit reduced the flow of make-up water by 75% and $14,400 per year, reducing the annual water demand by 1.6 million gallons at a cost of $3500 (Vickers 2001). In most cooling tower systems, the cost of water is typically not as significant as the cost of the energy, but substantial reductions in water consumption are possible with the modifications described herein.

- **Monitor boilers and cooling towers to insure optimal efficiency.** Boilers and steam generators use large quantities of water to make up for amounts lost to leaks and blowdown. Typically, cooling tower water use is minimized in January and maximized in July (West 2006). Reductions in the amount of make-up water are typically achieved by increasing the concentration ratio. For instance, adjusting the concentration ratio from 1.5 to 9 will result in 63% savings in water use (Vickers 2001). An equation was developed to predict the amount

of water saved by altering the concentration ratio from the initial level (CR_o) to a new higher level (CR_n) (Kobrick and Wilson 1993) :

$$\% \text{ conserved} = \frac{(CR_n - CR_o)}{CR_o(CR_n - 1)} \times 100\%$$

- **Use a blowdown meter.** In a cooling tower, water is lost through the evaporative cooling process. To replace lost water and maintain cooling function, make-up water must be added. A meter can track the amount of water that is actually discharged as it goes to the cooling tower. Since 90% is lost to evaporation, the facility will only pay for the blowdown water that was discharged not the total amount of make-up water. In this manner, installing make-up and blowdown meters for cooling towers will likely lead to substantial savings in utility bills (CH2M Hill 2002), even if water usage remains the same.
- **Preventative maintenance plan.** Proper maintenance and monitoring of operations can greatly improve boiler/cooling tower efficiency. For instance, a routine inspection and maintenance program for steam traps, steam lines, and condensate pumps can reduce water losses from 15-30% down to just 5% or less (Vickers 2001). Every two weeks, a flue gas analysis on the boiler to test fuel to air ratio settings should be conducted to adjust air to fuel ratio to optimize efficiency. Another cost incurred is related to the chemical agents required to treat the water used in these systems. This can also be an opportunity for reduction in water consumption through the use of more concentrated chemicals, for example.

-Waste-

In terms of solid waste management, the main lobby and the office sections of the property can participate by focusing on waste reduction strategies and recycling. To successfully reduce waste disposal from these areas, an audit should be conducted to determine the types and volumes of waste generated in order to target specific products or materials that contribute the greatest volume and/or weight to the waste stream or which create the most signification disposal problems. In addition, the main lobby/office is a great place to introduce employees, guests, and visitors to the waste reduction policies of the lodging property by posting highly visible signs and placards in these high-traffic areas. Some specific ways to reduce waste include:

- Purchase refillable or recycled toner cartridges.
- Use a computer-based filing system to replace paper files.
- Use reusable mugs for coffee.
- Place recycling containers at or behind the front desk or other public areas to collect paper waste.
- Purchase stationary, computer and other paper products composed of at least 20% post-consumer recycled content paper fiber.

According to the National Office Paper Recycling Program, one office worker generates about 1.5 pounds of recyclable paper waste per day (USEPA 1990). Removing office waste paper

from the waste stream can reduce the amount of waste going to the landfill and reduce tipping and hauling fees. As stated earlier, about 50-60% of a typical hotel's waste stream is recyclable. Instituting a recycling program is a cost-effective way to reduce waste and save money. Recyclables should be collected near the point of generation, such as desks, copy machines, fax machines, printers, etc. The following are opportunities for reducing waste from the office:

- **Office paper.** Items that can be recycled include: copier/fax paper, file folders, self-adhesive notes, and corrugated cardboard boxes. Envelopes should be reused for internal routing. Scrap paper that is clean on one side can be easily used for messages, notes, or draft printing. All collected items for off-site recycling should be stored in a covered dry place, free from moisture (Hinton et al. 2004). Finally, unused files should be archived or converted to electronic storage, and unneeded documents should be purged. Participate in *Clean Your Files Week* or *Clear Out the Clutter Week* celebrated the third week of April.

- **Fax machines, printers, and copiers.** Use self-adhesive notes or hotel fax stamps on the first page of faxes instead of a separate cover sheet. Choose re-manufactured toner cartridges and participate in toner cartridge return programs for refilling/rebuilding. Use double-sided (duplex) photocopies and printing, and use soy-based and other nontoxic inks. Eliminate unnecessary copying and convert to electronic whenever possible. Centrally post memos or route them instead of making multiple copies. Proof-read documents on the computer before printing, and store documents electronically instead of creating hard copies. Use internal email and voicemail. Format draft reports and other files, so that more words will fit on a page by reducing the fonts and margins.

- **Newspapers, magazines, and promotional literature.** Return unread newspapers to the vendor. Newspapers may be donated to pet stores, animal shelters, fish markets, mail and moving companies, detail shops for window cleaning, and retail stores for packing material. Provide complementary newspapers only when requested. Cancel duplicate subscriptions and share journals, magazines, newspapers, phonebooks, rather than receiving multiple copies. Reduce the amount of junk mail you receive. Donate unwanted books and magazines to libraries, schools, nursing homes, abuse shelters, and child care centers. In Tampa, more than 322 tons of school supplies valued at $2 million was donated over the last 3 years (Brown 2006). Mailing lists current should be kept current and marketing material should be printed in reasonable quantities. Use email listserv marketing announcements and internet links to a web page instead of direct mail.

- **Containers.** Administrative personnel and staff should switch from disposable to reusable mugs and containers. Everyone should also be encouraged to recycle aluminum cans, plastic, and glass bottles.

- **Adopt an eco-purchasing program.** Purchase paper products that use post-consumer recycled content. Buy products that have minimal or recycled packaging.

- **Life cycle costing.** This technique evaluates the total costs associated with a product over its useful lifetime. Products are paid for when you purchase them and again when you dispose of them. Life cycle costing should be considered when making purchasing decisions for: disposable napkins, cups, and serving ware; paper towels, individually packaged condiments or amenity items, batteries, and laser toner cartridges, etc.

Guest Rooms/Housekeeping

-Water-

Water for toilets, sinks, and showers used by guests and by housekeeping staff for cleaning accounts for nearly half of a hotel's water use (EPA and Purdue University 1997). Guest rooms offer some inexpensive ways to conserve water. They are one of the most visible areas for conservation practices insuring that the hotel is getting the most promotional "bang for the buck." Regardless of the fixture type, water savings can be achieved by maintaining optimal system pressure between 20-80 psi. Water efficient faucets and showerheads will not operate efficiently if the pressure is outside of this range. If the pressure is too low, low consuming devices will not work properly. If the pressure is too high, fixtures will consume considerably more than their rated amount of water.

In the 1990s, the Saunders Hotel Group began a project focused on reducing water consumption at three hotels: Boston Park Plaza Hotel and Towers (977 rooms), Copley Square Hotel (152 rooms), and Lenox Hotel (222 rooms). They installed showerheads that reduced water flow from 5.0 to 2.5 gpm and installed faucet aerators in bathrooms that reduced flow from 3.0 to about 1.6 gpm. In addition, they retrofitted most of the guest room toilets from 6-7 gpf to 1.5 gpf. The discarded toilets were pulverized by a Boston-area gravel company, and the crushed pieces were used as road bedding. Before the toilets were sent to the gravel company, the metal components were removed and recycled. Water cost savings from this project were used to buy tools for the maintenance department (CDPHE 2002).

In the following sections, details of water conservation practices for plumbing fixtures are presented. The successful linen reuse program is discussed in further detail in the laundry section.

Toilets

- **Check for leaks in the toilets.** Toilets account for 50% of the water used in a bathroom setting (Vickers 2001). To check for leaks, any colored cleaning agents must be removed first. Then the toilet must be flushed to clear the water in the bowl. Next, one leak-detecting dye tablet (or five drops of food coloring) must be dropped into the tank, and if colored water appears in the toilet bowl without additional flushing after 15 minutes, there is a leak. Even a small leak can cause 40 or more additional gallons of water to go down the drain per day, even in a room that is not occupied (Vickers 2001). Just one leaky toilet can waste 16,000-18,000 gallons per year (WDNR 2001). Housekeeping staff must be properly trained and vigilant to report leaks in a timely fashion.

    1. **Replace toilet handles.** Replace any toilet handle that sticks in the flushing position. This causes a running toilet that can waste hundreds of gallons of water per hour.

    2. **Install variable-buoyancy flappers.** Variable-buoyancy flappers and flap actuators that ride on the overflow tube are another opportunity for increasing the efficiency of existing toilets. These devices force the flapper to close before all the water rushes from the tank and into the bowl. At the same time, they maintain the same force of

the water. If a variable-buoyancy flapper is put on a toilet that uses 5 gallons and is set at 2 gallons, all 5 gallons are still moving downward once flushing starts, but the flap will close while 2 gallons still remain in the tank, saving 3 gallons of water waste. However, a study by La Quinta Inn in San Antonio found that early-closure flappers were not acceptable for guest rooms from a public perception and maintenance perspective (Gerston 2002).

- **Replace toilets with low-flow toilets.** Toilets purchased after 1994 should be low-flow and use less than 1.6 gallons per flush. Most units have a stamp or sticker indicating the gallons per flush rating. Depending on the year the unit was manufactured or installed, the gallons per flush can be estimated according to the data presented in Table 5. For instance, replacing all pre-1950 toilets with modern 1.6 gpf units, should save an expected 10,000 gallons per guest per year at the same occupancy rate. Put another way, if 100 guests used 1.6 gpf toilets (in place of 3.5 gpf), the estimated annual savings would be on the order of $5,800. La Quinta Inn documented that replacing all public area toilets with ultra-low flush toilets showed a payback period of 2.1 years and an annual water savings of 180,000 gallons per year (Gerston 2002).

Table 5. Estimated annual water use savings for toilet flushing for fixtures of different eras (Vickers 2001).

Year Manufactured	Average Toilet Water Use Rate (gpf)	Daily Use at 5.1 flushes per person per day (gpcd)	Annual Estimated Water Use (gpcy)	Potential Annual Water Use Savings (gpcy)
1994-Present	1.6	8.2	2,993	--
1977-1994	3.5-4.0	20.4	7,446	4,453
1950-1977	5.0-7.0	25.5	9,308	6,315
Pre-1950	7.0	35.7	13,031	10,038

- **Typical costs:**
  - Urinals = $133.50 per fixture ($97.50 for materials cost; $36 for labor. (unadjusted CH2M Hill 2002 estimates)
  - Toilets = $200-$450 per fixture ($70-$150 for fixture removal and set; $100-$200 for materials cost for water closet installation; $30-$100 for labor) (adjusted CH2M Hill 2002 estimates)

  Costs below do not reflect installation charges:
  - Gravity Tank = $75 to $225 (Hinton et al. 2004)
  - Flushometer (valve) = $50 to $125 (Hinton et al. 2004)
  - Flushometer (pressure-assisted) = $150 to $650 (Hinton et al. 2004)
  - Compressed Air = $500 to $950 (Hinton et al. 2004)
- **Use displacement bags.** If old-style toilets (pre-1977) are installed, replacement is not the only option. Modifications, such as displacement bags or dams, can be made to lower the

amount of water used. A displacement bag can save about one gallon per flush (Gerston 2002). Displacement bags are filled with water and take up volume in the tank. These are available from most hardware, plumbing and home stores. For example, the Phoenician Resort in Arizona installed toilet dams in 605 guest rooms. They made their own low-cost dams by reusing plastic tubs and other used food containers (i.e. half-gallon milk jugs filled with water). Water usage was reduced by 500,000 gallons of water per year since the dams were installed.

- **Sensors.** The THC Rotorua Hotel in New Zealand used urinals that flushed automatically every nine minutes. Each flush used 2.6 gallons of water. This added up to 416 gallons per day per fixture, regardless of whether the urinals had been used or not. The hotel decided to install detectors to allow flushing to only occur at a specified time after use. This program reduced water consumption to only 16 gallons per day, a reduction in water use of 96%.

Faucets

Federal guidelines mandate that all lavatory and kitchen faucets and replacement aerators manufactured after January 1, 1994 use no more than 2.5 gpm measured at normal water pressure (typically 20-80 psi). Metered valve faucets manufactured after the same date are limited to 0.25 gallons per cycle. According to the Plumbing Code, commercial lavatory faucet-to-personnel ratios of 1:40 are typically used to estimate the number of fixtures required. For example, a facility with 1,000 occupants will have approximately 25 lavatory faucets (1,000/40 = 25 lavatory faucets). This factor is often used to estimate potential savings of water conservation programs. Options for water savings in this category include fixture replacement, leak detection, and installation of aerators. Expected savings from different types of fixtures are summarized in Table 6.

- **Check for leaky faucets.** A leaky faucet that drips one drop of water every second for a year wastes 2,700 gallons of water (Hinton et al. 2004). If hot water is leaking, there are additional energy costs. A visual inspection of all sinks on a monthly basis must be part of the preventative maintenance plan. Replacing a worn washer or gasket usually solves the problem.
- **Install aerators.** Water usage in faucets can also be reduced by using aerators. First, the amount of water flowing from each faucet must be checked. If the faucet is open to full force and a container is filled for 10 seconds, the amount of water in the container multiplied by 6 will be equal to the amount of water per minute of flow. In the bathroom a 1.5-2.0 gpm aerator will provide enough water for shaving, hand washing, and personal hygiene.

Table 6. Estimated annual water use savings for faucet fixtures of different eras (Vickers 2001).

Year Manufactured	Average Faucet Water Use Rate (gpm)	Estimated Daily Faucet Use per Person[A] (min/day)	Annual Estimated Water Use[B] (gpcy)	Potential Annual Water Use Savings[C] (gpcy)
1994-Present	2.5	(1.0) 8.1	(650) 7,391	--
1980-1994	2.7	(1.0) 8.1	(702) 8,130	(52) 739

Pre-1980	4.0	(1.0) 8.1	(1040) 11,286	(390) 4,435

[A]1.0 min/day is estimated for industrial, commercial, and institutional faucet use (Vickers 2001).
[B]Value in parenthesis is estimated for industrial, commercial, and institutional faucet use based on 260 days use per year or 71% occupancy (Vickers 2001).
[C]Estimated based on replacement with 2.5 gpm. The value in parenthesis is derived from the lower 1.0 min/day usage rate for industrial, commercial, and institutional facilities (Vickers 2001).

- **Typical costs:**
  - Faucet retrofit with aerator = $13-$79 (CH2M Hill 2002)
  - Aerator adapters = $3
  - Replacement washer/gaskets = $1

Showerheads

Substantial amounts of water and energy can be wasted through use of inefficient faucets and showerheads. For instance, a brief five-minute shower can consume 15-35 gallons of water with a conventional showerhead with a flow rate of 3-7 gpm. To be certain, showerheads are found in all the residential facilities (guest rooms) of a hotel, although it is not uncommon to find a few shower facilities in the maintenance or administrative areas of the lodging facility. Expected savings from different types of showerheads are summarized in Table 7.

- **Install low-flow showerheads.** Showers and baths account for about 30% of the water use in a typical bathroom (Vickers 2001). Replacing showerheads that use 3.0 gpm or more with more modern units that use 2.5 gpm or less can make a significant difference in the amount of water used per room. The payback period can be on the order of 3-4 years depending on the extent of the project (Alexander 2002). Replacing showerheads will not only save water, but also the cost of heating water. In a recent case study, La Quinta Inn installed low-flow shower heads and aerating faucets in each guestroom, resulting in a savings of $1.50 per room per month. As a case study, the THC Rotorua Hotel in New Zealand installed low-flow shower heads at a cost of $3,060 for the entire property. The annual savings from water conservation alone came to $5,244, with a payback of only seven months.

Table 7. Estimated annual water use savings for showerhead fixtures of different eras (Vickers 2001).

Year Manufactured	Average Water Use Rate (gpm)	Estimated Daily Shower Use per Person[A] (min/day)	Annual Estimated Water Use[B] (gpcy)	Potential Annual Water Use Savings (gpcy)
1994-Present	2.5	5.3	4,863	--
1980-1994	3.0	5.3	5,803	940
Pre-1980	7.0	5.3	13,541	8,678

[A]The average residential indoor water-use rate for showering has been reported to be 8.2 minutes per shower; however, on a daily basis, a total of 11.6 gallons per capita is used for showering at an average flow rate of 2.2 gpm, or 5.3 minutes per capita per day for showering (Vickers 2001).
[B]Values have not been adjusted for industrial, commercial, and institutional shower use or occupancy rate (Vickers 2001).

- **Typical costs:**
    - Showerhead replacement = $34 (CH2M Hill 2002)

-Waste-

A typical guest room generates 1-2 pounds of waste on a non-checkout day and twice that amount on a checkout day (NCDENR 1998). However, recycling can be a challenge because it depends on guest participation and appropriate separation of waste at the source. Other opportunities for waste reduction in guest rooms, such as use of recycled-content "personal" paper products (i.e. toilet paper, tissues) and use of environmentally preferable cleaning products, can be accomplished without relying on guest participation. Some hotels are reluctant to pursue environmental projects because they are concerned about how the projects will be accepted by their guests. However, according to the Green Hotels Association®, 70-90% of hotel guests participate in linen and towel programs (Ton 1996).

Significant amounts of waste are collected from a guest room each day. Paper products (45%), food waste (40%) including glass and plastic bottles and packaging, and bathroom waste (5%) are the most common items (Hinton et al. 2004). More specific items that can be potentially recycled effectively from guest rooms include the following:

- Newspaper and magazines
- Aluminum cans (soft drinks, beer)
- Plastic bottles and containers (soft drinks, water bottles, toiletries containers)
- Glass bottles (soft drinks, juice, beer, liquor)
- Clothing and shoes
- Office paper

The most effective approach is for the housekeeping staff to collect and sort recyclables as the room is being cleaned. Recycled waste from guest rooms can be collected using bags or containers on the side of housekeeping carts and then stored in a larger bin on each floor station.

The following are specific opportunities to reduce waste from guest rooms:

- **Newspaper recycling**. Ask guests at check-in if they would like a complimentary newspaper in their rooms. Alternatively, complimentary newspapers can be placed in a central location (i.e. near an elevator, breakfast area, or the front counter) for pick up.
- **Discarded or leftover materials**. Donate discarded clothing or leftover bottles of shampoo, lotions, bar soap, and half rolls of toilet paper to charities, homeless and abuse shelters, and churches. Eliminate, or offer by request only, under-used amenities such as shower caps, shoeshine cloths, sewing kits, lotions, and mouthwash. Reuse items if the seal is not broken.

Mattresses may also be donated or sold to employees. Recycle phone books seasonally, and donate bibles to religious organizations or prisons.

- **Designate a recycling receptacle in the guest room.** This can increase efficiency of collection and increase participation of housekeeping staff by reducing the time needed to sort waste.
- **Place recycling bins in vending areas.** Make bins visible for guests to recycle newspaper, cans, bottles, etc. Always include a garbage can nearby to minimize cross contamination of recyclables with common garbage.
- **Limit replaceable items in the guest rooms.** Use refillable dispensers instead of small bottles. Use glasses and mugs instead of disposables. Eliminate plastic liners in ice buckets and paper doilies. Eliminate printed information placed in rooms. For example, list television stations on a sticker on the remote control or provide a laminated copy for continuous use instead of a TV Guide booklet. Reduce the size of individual packaged items, such as bar soaps and shampoo. Place half-used toilet paper rolls from guest bathrooms in employee restrooms rather than throwing them away.

Laundry

-Water-

A linen reuse program that launders bed linens and towels every third day of a guest's stay, unless requested otherwise by the guest, can save lodging facilities up to 30% on water usage and up to $1.00-1.50 per night, per occupied room, on laundry expenses (Hinton et al. 2004). The American Hotel and Motel Association, which represents over 12,000 lodging facilities in the United States, enacted the “Good Earthkeeping” campaign for reusing guest linens and towels, and this program has been enormously successful. Thus an average-sized hotel of 150 rooms can save about $300,000 per year in only 65% of the guests participate in linen reuse (Vickers 2001).

To establish a linen reuse program, the guests must be informed and given the opportunity to “buy in” to the program. Informational cards should be made available in the guestrooms and bathrooms stating the linen reuse policy. By choosing not to replace bath towels and linen daily, 13.5 gallons of water can be saved per day per guest (PDEP 2000) or up to $6.50 per day (Bujak and Goren 2005). A large San Diego luxury hotel with 400 rooms and over 106,000 room-nights occupied per year saved $118,930 per year with their linen reuse program (Solana Recyclers, Inc. 1999). According to the Texas Water Resources Institute (Gerston 2002), institutional washing machines use about 2.5 gallons per pound of linen laundered. Depending on type of lodging and other factors, such as proximity to the beach, linen use is estimated at 8-12 pounds per day per double occupancy room. Most hotels that have a linen reuse policy only change sheets every three days unless the guest requests that the sheets be changed or the housekeepers notice that the sheets need changing. Towels that are hanging on the racks should not be changed; only bathroom towels that are on the floor should be replaced.

Another option is to replace obsolete appliances with Energy Star® units, which save water as well as energy. The initial cost is typically higher, but the life cycle costs are substantially lower. For example, full-sized Energy Star® washers use 18-25 gallons of water per load, compared to the 40 gallons used by standard machines. They do this by extracting more water from the load

during the spin cycle. This reduces the drying time and saves energy as well as delaying deterioration of linens. Newer top-loading models look like conventional machines from the outside, but use less water and less energy. Many have sensors to monitor incoming water temperature closely. They also rinse clothes with repeated high-pressure spraying instead of soaking them in a full tub of water. Front-loading models are similar to machines used in laundromats. They use a horizontal or tumble-axis basket to lift and drop clothing into the water instead of rubbing clothes around a central agitator. Both top-loading and front-loading Energy Star® qualified washers save water and energy. They also use faster spin speeds to extract more water from clothes, reducing drying time and energy use. An Energy Star® qualified dishwasher saves about $100 over its lifetime (Hinton et al. 2004). Most of the savings comes from using less hot water than conventional models.

Large conventional washer-extractor machines use fresh water for each wash and rinse cycle without internal recycling. The capacity of these units range from 25-400 dry pounds per load, requiring 2.5-3.5 gallons of water per pound of laundry. Coin operated machines (16-pound) are slightly larger than residential units (14-pound) and use 35-50 gallons of water per load (Vickers 2001).

The benefits of linen and towel reuse programs can be quantified by the amount of laundry reduction, amount of labor time on room cleanup reduction, water savings, electricity savings, amount of detergent reduced, and amount of sheet/towel replacement reduced. For example, at 80% occupancy, a Southwest Florida hotel with 100 rooms saved 87,272 gallons of water, 581 gallons of detergent, and $26,718 in energy costs, water bills, detergents, labor, and sheet/towel replacement (White 2004).

A Doubletree Hotel in Portland, OR, installed a $200,000 laundry water recovery system consisting of a pumped closed-loop, three-phase microfiltration and recycling system. The older system heated water to 150°F and then discharged it after one use. The new system recycles the warm water through a screen and a microfiltration unit and returned to the washers for another use. In total, this system saves $40,000 per year in water, sewer, and electric bills, paying back the initial costs in less than 5 years (Vickers 2001).

Additional water saving options for laundry facilities include: washing loads at full capacity, adjusting water levels for short loads, investigating the recycling of gray water for irrigation purposes, reporting leaks and responding promptly, and replacing washers with front loading systems (Defranco and Weatherspoon 1996). For example, washing only full loads provides immediate payback with no upfront costs.

-Waste-

Always separate waste from recyclables in the housekeeping cart or at the source of generation. The following are opportunities and methods for reducing your waste stream:

- **Recycle old linens and towels**. Donate old linens and towels to charities or other facilities that may use them (homeless shelter, humane societies, veterinarian offices, school, car washes etc). They may also be used for “back of the house” operations, such as rags for maintenance shops, housekeeping and kitchen. Recycle sheets and stained tablecloths into placemats for room service trays, napkins and kitchen aprons. Sheets may also be made

into pillow cases, bedspreads into hot pads and urn covers for kitchen use. Purchase sheets with higher thread count for longer wear. Extend the life of draperies by rotating their exposure to the sun. Return laundered garments and dry cleaning to guests in reusable bags or baskets rather than plastic or paper.

- **Reduce chemicals**. Laundry and cleaning chemicals should be biodegradable and as least toxic as possible. When possible, use environmentally friendly cleaning agents (MSDS Health Hazard Rating of 1 or less). Minimize the use of bleaches, chemical pesticides, and other detergents and chemicals. For an environmentally friendly alternative to floor wax, use 1 cup of white vinegar mixed with 2 gallons of water to mop linoleum or no-wax floors. Choose refillable pump spray applicators instead of aerosols. Use products in correct concentration and "as recommended." This saves on the amount of product needed. Train staff in the proper storage, use, and safe disposal of any essential hazardous substances to avoid risks to both staff and the environment.
- **Minimize hazardous waste inventory**. Through experience or careful tracking, the exact amount of cleaning chemicals necessary can be determined precisely. Also some vendors are willing to ship products right when you need them. Just-in-time inventory methods can reduce the need to store chemicals and other hazardous products.
- **Choose reusable vacuum cleaner bags**. Along the same note, garbage can liners do not have to be replaced every time they are emptied, and of course they can be made of recycled content just like vacuum cleaner bags.
- **Recycle or donate other housekeeping products**.
    1. **Corrugated boxes**. Break down corrugated boxes and store dry before taking them to recycling compactor. Separate plastic from boxes before breaking down to control contamination. Throw contaminated items in garbage.
    2. **Tissues**. Replace tissue box only when dispensers are near empty. Use roll type hand towels rather than c-fold paper towels. In guest rooms leave new tissue rolls or boxes for guest to replace as needed.
    3. **Clothing hangers**. Donate excess hangers to local dry cleaner or guest laundry service. The Ritz-Carlton in Naples, FL started collecting hangers for reuse in their on-site dry-cleaning facility and saved the costs of purchasing an estimated 7,000 hangers annually (Strickland 2005).
    4. **Plastic containers**. Ask your vendor to take back empty plastic containers. If they are unable, clean them out and reuse them or give them to employees.

Kitchen/Restaurant/Bar

-Water-

There are many ways to reduce water usage in the kitchen and food service areas of a hotel. For instance, a typical 125-seat restaurant serving 225 meals per day uses about 200,000 gallons of water per year (Hinton et al. 2004). Traditionally, saving water has not been a major concern of commercial food establishments. Case histories have shown that water efficiency

programs are cost-effective, and most initial costs are retrieved within a two-year period (NCDENR 1999). For example, in 2000 the Sheraton Seattle Hotel & Towers replaced four kitchen Rotoclone® exhaust fans and conventional kitchen exhausts with variable speed drives. The Rotoclone® fans use water to clean the exhausted air. This change alone saved 43,000 gallons per day with an estimated annual savings of over $80,000 in water and sewer charges (Siegelbaum 2005). Other plumbing fixtures of interest for potential water conservation in kitchens are dishwashers, garbage disposals, faucets (nozzle-type), and ice machines (discussed earlier). Improved technologies have eliminated many water issues associated with kitchen equipment, as more rigid standards have been created to limit excessive water use. Water audits of commercial facilities have shown that 60% of identified water savings comes from simply installing faucet aerators in all kitchen sink outlets (NCDENR 1999). The following water conservation opportunities exist in the kitchen area:

- **Dishwasher options**. All dishwashing machines employ wash, rinse, and sanitizing cycles. There are four main types of dishwashing machines: undercounter, door, conveyor, and flight. Requirements for machine size can be calculated by estimating the amount of traffic that will be served in the food service area. Commercial dishwashers use approximately 1.0-1.5 gpm, while conventional rack washers use 9-12 gallons per cycle. Newer units use only 0.75-2.5 gallons per rack (NCDENR 1999). Undercounter washers use the most water, and conveyor types use the least amount of water. Energy efficient, low flow conveyor washers can reduce water consumption by 43% (NCDENR 1999). An Energy Star® dishwasher saves about $100 over its lifetime, mostly from using less hot water than conventional models. Energy guidelines and water consumption levels for dishwashers are continuing to tighten, and manufacturers are offering more water-saving models. Using an appropriately sized, water efficient model will save a significant amount of water. Other important water saving measures with dishwashers include:

    1. Hand wash or scrape without using water prior to loading dishes.
    2. Presoak items in basins of water instead of using running water.
    3. Run dishwashers only when full.
    4. Recycle final rinse water for washing.
    5. Install electric eye sensors to allow water flow only when dishes are present. In Boston, MA, a dishware-sensing gate saved an estimated 225,000 gallons per year ($2700), and at a cost of only $1200, this measure paid for itself in only 3 months (Vickers 2001).
    6. Install door switches for convenient on/off access.
    7. Use steam doors to prevent water loss due to evaporation.
    8. Install low-temperature machines that rely on chemical sanitizing over high water temperature.
    9. Reuse gray water. Gray water is rinse water that is not contaminated with chemicals. This can be used to water plants and supplement city water for irrigation. Water from steam tables and used ice are excellent candidates for reuse.

- **Kitchen faucets**. Faucets can waste large amounts of water, as they are one of the most heavily used water sources in the kitchen. One way to save water is to install pedal-

operated faucet controllers to ensure that valves are closed when not in use. Commercial kitchen low-volume, automatic shut-off nozzles typically cost $20-$80. By installing a foot-actuated faucet, one food service facility in North Carolina reduced its monthly water usage by 3,700 gallons; an annual savings of nearly $700 (NCDENR 1999). Another way is to install infrared or ultrasonic sensors that activate water flow. Commonly, rubber gaskets wear out and deform because of the high volume of hot water use. By installing a brass gasket and an automatic shutoff nozzle, a facility could save as much as 21,000 gallons of water per year (NCDENR 1999). Merely replacing spray nozzles with the newer 1.6 gpm models (versus the older 3-4 gpm nozzles) can save 50,000 gallons of water per year and nearly 2000 kWh of electricity per year (White 2004), while saving $50-$70 per month, on a typical 3 hour/day usage pattern (West 2006).

- **Garbage disposals**. These devices use 3-8 gpm or more if operating in conjunction with a food scrapping trough. For instance, at 5 gpm (8 hours/day, 6 days/week), they can use 745,000 gallons of water per year. It is recommended that the use of garbage disposal systems be minimized or eliminated from kitchen operations. Many facilities use strainers or traps that employ a mesh screen to collect food waste for proper waste treatment. These systems can operate at 2 gpm or less (Vickers 2001). Another option is to install strainers in sinks, leaving the food matter in the sink for disposal in trash receptacles or composting units. Food debris should be swept into trash cans. Kitchen staff should not use the water hose as a broom to wash everything on the floor into the drain to clean. Besides being a large consumer of water waste, this practice leads to grease, food debris, detergents, and other chemicals entering the wastewater collection system. If the debris does not get washed down the drain, it may be swept out onto the asphalt behind the kitchen, where it may ultimately find its way to the storm drain and into our creeks, lakes, and aquifers. Dry cleanup as the first pass cleaning is recommended. Dry cleanup involves using a rubber scraper, squeegee, or absorbent to capture a large portion of the food material or grease to keep it from going down the drain. Do not remove drain screens that keep paper, plastic, or utensils from accidentally going down the drain.

- **Thawing practices**. Running water should not be used to thaw frozen foods or melt ice. Frozen items should be thawed out in the refrigerator overnight, unless the local Department of Health code requires otherwise. If the code requires running water no less than 70°F, then perhaps the flow rate can be reduced or multiple thawing areas can be consolidated into one to use the minimum amount of water necessary.

- **Fats, oils and grease**. Residual fats, oils, and grease (FOG) are by-products from the kitchen. They enter the plumbing system from washing dishes, pots and pans, cleaning the floor, and sanitizing equipment. Sanitary sewer systems are not designed or equipped to handle the grease that accumulates on the interior of the collection system, leading to overflows or sewage backups.

    1. **Recycle oil and grease**. FOG is a commodity and should be treated as a resource. Some rendering facilities offer services free of charge or may offer a rebate. If rendering barrels are stored outside, be sure that the lid is secured. Uncovered or partially covered barrels allow storm water to enter causing oils contamination onto the ground and possibly into storm drains.

    2. **Grease traps**. Traps or interceptors must be properly sized, installed, and maintained in order to work efficiently. Units that are too close to the discharge or are not big enough to allow coalescing of the grease and oils will not work efficiently. All

grease-bearing drains should discharge to a grease trap. Be aware that the local wastewater treatment plant may have additional requirements for interceptors and grease management.

3. **Preventative maintenance**. Set up a schedule to periodically service all equipment to eliminate grease blockages. Grease or oil should not be hot-flushed, which leads to liquefied grease entering the main sewer system and escaping the grease traps. Pump out schedules should be established to avoid overflows, downstream blockage, and excessive oil and grease buildup ending up in the drain. Small hoods can be hand-cleaned with spray detergent and wiped down, but professional contractors have specialized equipment that can be more cost effective when dealing with large hood filters.

4. **Change fryer grease regularly**. Fryer grease should be skimmed and filtered daily; however, the grease should only be changed out when necessary. Build-up of carbon deposits on the bottom of the fryer act as an insulator that forces the fryer to heat longer, which causes the oil to break down sooner. Food grade paper rather than water sprays can be used to soak up oil and grease under fryer baskets.

- **Spills.** Preventing spills will reduce the amount of waste from food preparation and serving areas that require employee cleanup. Kitty litter or vermiculite can be substituted for water to absorb liquid spills, as long as the spill is not a hazardous material.

-Waste-

Another aspect of a solid waste reduction program is dealing with food waste, which can frequently be a large portion of the waste produced in hotels and lodging facilities (Alexander 2002). Over-preparation, table scraps, cooking losses, and packaging failures can lead to accumulation of food waste. At least one hotel waste audit cited in Hinton et al. (2004) showed that the majority of waste in a lodging facility is not produced in the guest rooms, but rather in the food service sector. Therefore, the kitchen areas are prime candidates for solid waste reduction strategies.

- **Food Waste**. Banquet scraps are edible leftovers from client functions. Guest plate and food preparation scraps, which typically include unusable portions of fruits and vegetables, cooking losses, spoiled leftovers, packaged failures and spillage, are considered non-edible. Waste oils and grease are leftover from cooking. Food waste is easily amenable to reduction, recovery, and reuse programs. Some recommendations are detailed below. Composting is another alternative to consider.

    1. **Create a food waste reduction policy for scraps**. Banquet scraps may still have a beneficial use. Too much food prepared or leftovers that have a short shelf life may have secondary usage, such as grilled chicken breast to chicken casserole or chicken soup. This can also be donated to a local food bank or food donor (i.e. Second Harvest) or used in the employee cafeteria. Offer half-sized portions to patrons in the restaurant. To help decide what items should be at half-size, perform a survey with service staff to record the amounts left uneaten. Establish a contact with food banks so procedures are in place. All food must be kept at the proper temperature to be reused and monitored for spoilage.

2. **Develop a plan for food scraps**. All plate scraps are non-edible and should be separated into a collection bin labeled "food waste only." Solid food preparation scraps can be dumped into the same bin. This bin can be used for composting. Scrap food can be saved for farmers (pig, cattle, and poultry). However, coffee grounds/salty foods are harmful to livestock and should be composted.

3. **Consider donating food waste to local farmers**. Farmers who collect food waste can be found by placing an ad in a local newspaper or visiting a farmers market. The farmer must have a permit to accept waste and must cook meat products prior to feeding it to the animals. The storage area for food waste and composting should be inaccessible to pests, covered and in a cool place.

4. **Contact local wastewater treatment plant to find out about local rendering facilities that accept oils/grease**.

- **Other Waste Reduction Practices**. Glass makes up an important component of the material that is recyclable from the kitchen areas along with tin/steel cans, plastic bottles, containers, and corrugated cardboard. During a 2001 study of a hotel's waste stream, 96% of the tin/steel cans were being recycled, which was the highest recycling rate of any other material at the hotel. Approximately 74% of green glass containers, 70% of corrugated paper, 69% of HDPE containers, 63% of brown glass containers, 41.5% of plastic buckets, and 39.5% of clear glass containers were recycled. The recycling rate for aluminum cans was almost 20%, and PET containers were recycled at a rate of 13% (NHDES 2001). Many of these items can be found in the kitchen areas and represent opportunities for recycling. Some additional recommended practices that should be considered are:

  1. **Buy less food.** Us just-in-time inventory and use first-in, first-out distribution to keep items fresh. Order food in bulk and closer to the time needed. Many food distributors are able to deliver within a short period of time to reduce storage and spoilage. Track the amount of different types of food that are consumed and purchased. Redesign the restaurant menu to improve secondary use of edible food (i.e. sliced fruit to fruit salad, chicken to chicken salad or soup). Reassess portion sizes to reduce wastage, and purchase locally grown produce, which may last longer and be less expensive due to lower transportation cost. The Totem Pole Restaurant at the Thunderbird Hotel in Bloomington, MN began a food waste reduction program by having the head chef monitor the food inventory, the amount of food per meal, the percent of waste per meal, and type of food commonly disposed in the recycling containers. This resulted in modification of the food preparation practices that achieved a 20% reduction in food waste, resulting in a net savings of $325 (Alexander 2002).

  2. **Avoid centrally locating items in the restaurant.** Co-locating several items in one part of the restaurant or takeout areas tends to generate more usage and waste. Keep condiments on tables in containers or make patrons ask for items and quantity needed.

  3. **Avoid over-packaging and limit use of disposable items**. For room service or take-out orders, use silverware, porcelain dishware, aluminum foil, glass cups, and reusable stainless steel plate covers instead of Styrofoam containers, paper cups, cellophane wrapping, and plastic utensils. Offer condiments, napkins, and straws upon request only. In the restaurant, use bulk straws instead of individually wrapped. There will be less paper waste. Use fountains to dispense soda. Replace cocktail

napkins with permanent coasters at dinning room tables and bars. Eliminate paper placemats, and switch from paper to cloth dinning napkins and tablecloths. Ask vendors to take back empty plastic containers. If they are unable, clean them out and reuse them in other hotel operations, such as in maintenance and housekeeping or simply give them to employees. Recycle plastic six, four and nine-pack rings. Replace individual condiment packets with bulk dispensers.

4. **Limit kitchen staff waste**. Use rubber mats around sinks and dishwashers to reduce glass breakage. Rubber mats will cushion surfaces that tend to cause breakage. Install a magnet on food waste containers to recover flatware that was accidentally thrown away. Use longer lasting spun glass pads for scrubbing pots and pans instead of steel wool. Use washable hats and aprons instead of disposable ones.

Conference Areas/Meeting Rooms

-Water-

Opportunities for reductions in water use for the conference areas and meeting rooms are similar to the main lobby/office section (i.e. low-flow fixtures in the restrooms, etc.). An additional method to reduce water waste in convention areas is by not pre-filling water glasses at banquet tables. For instance, during a three-day seminar with served lunches for 2,200 attendees, up to 520 gallons of water can be saved (Convention Industry Council 2004). Ice water should only be provided to guests when requested, and water glasses should not be filled close to the end of the session or meal. Over-serving water can also be an annoying interference if it occurs frequently. Another consideration should be to reuse steam table water or ice bath water for initial floor rinsing (check with the local health department first) (Sigelbaum 2005).

-Waste-

Depending on the size of meeting rooms, this is one area that could provide a highly visible way for hotels to recycle. Participants usually generate paper products in the form of meeting/exhibitor handouts and newspapers. Refreshment breaks generate a considerable amount of waste material in the form of plastic bottles, glass bottles, aluminum cans, and paper cups. The following are opportunities and methods for reducing waste in the conference areas:

- **Switch to glass cups, saucers, and cloth napkins.** Provide reusable drinking glasses and coffee cups because reducing waste at the source is preferable to recycling.
- **Provide recycling bins that are clearly marked and place bins in well-traveled areas and always include one for garbage as well.** Monitor collection bins and empty often or at least daily. Use pictogram labels showing what items to place in which bin. Consider various languages if you have many foreign guests. Some programs even have a different color bin for each type of recyclable.
- **Recycle materials used in convention/meeting rooms.** Consider recycling newspaper, aluminum cans, plastic bottles, glass bottles, and office paper. Recycle leftover pallets or charge exhibitors extra for disposal. Breakdown and recycle corrugated boxes. Use a garbage compactor or baler to reduce volume. Contact a recycling company to pickup

collected office paper and corrugated boxes. Use reusable cloth drapes or skirts on display booths rather than the single-use varieties. Reuse pens, pencils, and name tag holders. Provide notepads with limited sheets in conference areas and guest rooms. For example, the Hotel Macklowe in New York replaced 50-page notepads for conferences with 20-page notepads and saved $2,100 annually (Winter and Azami 1996).

- **Publicize recycling efforts.** Publicize your collection efforts in the convention area with reader boards, in-house menu television, and inside meeting planner kits. Include recycling information in vendor packet so venders know their recycling responsibilities. Offer incentives such as reduced disposal fees to convention exhibitors who minimize leftovers and take back excess materials.

Grounds

-Water-

The volume of water used for lawn and landscape irrigation in hotels is not well documented. Extrapolating typical irrigation demands in Florida residential areas to hotels would likely lead to gross exaggeration. Outdoor water use in South Florida can be on the order of 30-50% of the total demand. However, estimates from studies in Tampa and Pinellas County, show that on a per capita (guest) basis, the percentage is extremely low, on the order of 2-7% (West 2006). Landscaping use is likely to be variable, depending highly on the area, plant types, climate, rainfall, water costs, maintenance practices (i.e. frequency of sidewalk cleaning), and the number of golf courses, swimming pools, and fountains. There are many available water-saving landscape options designed to promote water conservation:

- **Xeriscaping.** This term, coined by the Denver Water Company to promote water conservation, refers to the art of minimizing water usage for irrigation by proper planning and design, soil analysis, selecting appropriate plants (drought-tolerant or native species), selecting practical turf areas, operating efficient irrigation schedules and systems, use of moisture-retaining mulches, and appropriate maintenance programs. Water-Wise is a water use efficiency program developed by the USEPA to promote conservation efforts like xeriscaping. More information on this program can be obtained by visiting www.epa.gov.
- **Florida Yards and Neighborhoods Program**. This program was developed by the University of Florida Institute of Food and Agricultural Sciences Extension (IFAS Extension) to promote conservation of water, reduce storm water runoff, decrease non-point source pollution, enhance wildlife habitat, and create beautiful landscapes (http://hort.ufl.edu/fyn/object.htm). In order to promote Florida-Friendly Landscaping, several measures are recommended:

    1. **Efficient watering**. The most straightforward method of minimizing water consumption is to carefully design a landscape that receives sufficient amounts rainfall to thrive, while requiring minimal amounts of supplemental irrigation water. For instance, a lawn in full sun will require more frequent irrigation than a plant bed of drought-tolerant shrubs and groundcovers under a canopy of shade. However, even an ideal landscape can be over-irrigated. Therefore, care must be exercised in irrigation scheduling. If watering is necessary, grounds should not be watered during

the daylight hours to reduce evaporative losses; soaker hoses should be used in place of sprinklers; hose connections should be checked for leaks; trees and flower beds should be mulched; and sidewalks, driveways, and parking lots should be swept instead of hosed down (Defranco and Weatherspoon 1996).

2. **Plant selection**. Careful planning and site evaluation are necessary because Florida is a diverse state with multiple climatic zones, soil types, temperature ranges, and precipitation patterns. It is not uncommon for widely different conditions to exist within the same property. Local codes often dictate which species may be planted in certain municipalities. Therefore, the appropriate agencies should be consulted when developing a landscaping plan. Whenever possible, it is recommended to select drought resistant plants that require less water. Many of these will likely be native plants, which tend to thrive only on rainfall. Remove invasive exotic plants and replace with appropriate natives or other non-invasive exotics. Native and other "climate appropriate" landscape materials can reduce irrigation water use by more than 50%. An additional benefit to using native plants is that they tend to attract wildlife.

3. **Fertilize appropriately**. Fertilize in moderation and only during the growing season. Use fertilizers that contain slow-release, water insoluble forms of nitrogen, or use organic compost (possibly from in-house food waste recycling). Many trees and landscape plants demand little or no fertilizer once they are established. When over-applied, fertilizers aggravate insect and disease problems and create excessive growth issues, increasing the frequency of mowing or pruning. Excess fertilizers can run off into waterways or leach into the aquifer, polluting the source of drinking water.

4. **Mulching**. Mulching flower beds, shrub beds and trees can have several benefits. It helps the soil absorb water, allows water to better penetrate plants root systems, reduces soil erosion and unwanted weed growth, and moderates large changes in temperature. As the mulch decomposes, the organic content of the soil is increased. Mulch also increases the attractiveness of areas. A 2-to-3-inch layer of organic mulch over the roots of trees and shrubs and in plant beds is sufficient (Hinton et al. 2004). Self-mulching areas can be created under trees, so that leaves can stay where they fall. In a Florida Yard, grass clippings, leaves, and yard trimmings are turned into mulch to return valuable nutrients to the soil. By-products or alternative mulches such as pine bark, eucalyptus and melaleuca, or recycled mulches may be available from your community, after a hurricane cleanup for example. This opportunity should be taken advantage of by consulting the local solid waste management authorities. Often mulch can be made available free of charge.

5. **Replace mowed landscaping with ground cover**. Plan the landscape with minimal use of turf grass. Only plant grass that requires watering and mowing where it is necessary for guest satisfaction. Replace grass with ground cover that requires less maintenance and less water. Try to eliminate small areas of grass, such as parking islands and areas between sidewalks and roadways. These are hard to maintain, require a lot of watering and may be replaced with mulch without losing any of the decorative appeal.

- **Employ the most efficient irrigation methods**. Sprinklers should be used for lawns, bubblers for trees, drip irrigation for gardens and shrubs, and soaker hoses for flower beds and ground covers. Wherever possible, trickle, drip, or soaker hose irrigation systems

should be used because they consume less water than sprinklers. If sprinklers are used, select slow releasing heads, close to the ground, in contrast to those that release a mist, which tends to evaporate more easily. Place sprinklers at the top of sloped areas so that the water that runs off ends up irrigating the entire slope. Heads should be aligned with the areas that they are intended to water. Always check when irrigation systems are operating to insure they are not watering sidewalks and driveways.

1. **Leaks**. If water drips or leaks from sprinklers after being turned off, the sprinkler should be replaced or repaired. Hoses and lines should be routinely checked for punctures and repaired or spliced. When using a hand hose to water new plantings, a nozzle to control the amount of water consumed is recommended. Just as with indoor leaks, outside leaks can increase the water bill substantially. A leaky faucet that drips one drop of water every second for a year wastes 2,700 gallons of water (Hinton et al. 2004). A visual inspection of all hoses, faucets and sprinklers should be done on a monthly basis.

2. **Irrigation times**. The best time to irrigate is during the early morning or early evening hours when temperatures and wind velocities are at their lowest. Water evaporates quickly during the daylight hours, and during windy conditions, water may not reach targeted areas or may fall onto paved areas. Often, municipalities or water management districts have specified local regulations for watering times. Standard restrictions include no irrigation between the hours of 10 a.m. to 4 p.m. There may be additional restrictions, particularly during drought conditions. Irrigation is not necessary during a rainfall event; therefore, any new irrigation system is required by law (Chapter 373.62, Florida Statutes) to have a rain shut-off device or sensor that will override the system.

3. **Metering**. Irrigation systems also can be metered and set to deliver a specified amount of water.

4. **Avoid ponding**. Irrigate thoroughly, slowly, and less often. Reduction of irrigation time and application of other appropriate measures can equal a potential savings of 4.5 million gallons of water and $8,833 each year (White 2004). Lawns should be watered so that the soil is moist to a depth of 4-6 inches (Hinton et al. 2004). It is preferable to irrigate thoroughly (so water reaches the root systems) once each week than to water lightly each day. Watering lightly can damage the lawn because only the surface, rather than the roots, may be reached. Watering should be done slowly to avoid runoff. Sandy soil absorbs water quickly but does not retain moisture. Adding mulch will help correct these problems. On the other hand, over-irrigation can also result in problems such as excess water runoff carrying fertilizers and pollutants into our waterways. It can also result in diseases, such as fungus, and in the excessive growth of weeds and pests. Too much water promotes weak growth, which increases the frequency of pruning and mowing as well as likelihood of damage resulting from storms. Less frequent watering encourages deeper root development and healthier turf. Using chemicals to compensate for the results of over-irrigation exacerbates the problem by increasing stormwater runoff pollution.

5. **Use automatic shut-off nozzles**. If watering manually with a hose, the flow should b e controlled with an automatic shut-off nozzle. This prevents the water from accidentally being left running.

- **Reduce stormwater runoff.** To remove debris from sidewalks and driveways, sweep or use a blower instead of a hose to wash these areas. Sprinklers should not be watering the driveways or sidewalks. Keeping rainfall and irrigation water on the pervious areas, and out of the storm drains, reduces pollution. Additional ways to reduce runoff include: directing downspouts onto lawns or landscaped beds, using cisterns to collect rain water for irrigation, and using pervious materials such as gravel or mulch for driveways and paths.
- **Use recycled water**. For example, instead of using the lodging facility personnel and water supply, use a commercial car wash that recycles water to wash vehicles. Another potential application to reduce water waste involves the use of reclaimed water or reuse water, which is highly treated wastewater. If available from the local wastewater treatment facility and allowed by local regulations, reclaimed water can be used for watering lawns, shrubs, and flower beds.

-Waste-

For landscaping, lodging facilities should minimize the use of herbicides, fungicides, fertilizers and CCA-treated wood that contains copper, chromium, and arsenic. By the same token, they should endeavor to maximize the use of recycled landscaping material as mulch for groundcover and compost for fertilizer. The following are opportunities to improve the solid waste management of the grounds:

- **Composting**. Composting is a process, which generates a humus-like material via a controlled biological decomposition reaction of organic material in the presence of air. It is an excellent source of organic material and nutrients for rebuilding and enriching soil. A little bit of paper, as well as food waste and mulched landscaping yard waste, are all good candidates for composting materials. Fairmont Hotels & Resorts is exploring ways to divert up to 50% of its current waste stream through industrial composting. Consider prior to enacting: storage, composting area, and who will work the area (grounds or kitchen staff).
- **Practice waste-reducing maintenance**. Maintenance should repair items such as furniture and appliances or donate to charity rather than send to disposal. Scrap metal should be collected and taken to a local scrap dealer. Rent equipment that is used only occasionally. Aerosol spray cans, paint cans and batteries are all recyclable. Procure battery chargers and use rechargeable batteries for power tools. Purchase and use solar-powered items such as flashlights, outdoor lighting, and pool heaters.
- **Determine landscape waste disposal method**. Even if the facility lacks the proper space or decides that composting is not a viable option, landscape debris should be handled in a responsible manner. Find out what your groundskeeping staff does with cuttings and switch to using composted products. Many municipal sanitary landfills mulch landscape waste and do not add them to the landfill. These materials can then be used on the property at little or no cost.
- **Landscaping**. Use xeriscaping or native plants for ground cover. If restocking planted areas, return plastic pots to nurseries, and offer live plants slated for replacement to employees or local charities like Adopt-a-Tree.
- **Consider alternative fueled vehicles**. Alternative Fueled Vehicles (AFVs) operate without gasoline and instead run on methanol, ethanol, compressed natural gas, liquefied petroleum

gas, electricity, and others. Some AFVs can run on a mixture of conventional and alternative fuels. These hybrid vehicles are more practical unless you have easy access to an alternate fuel supply.

- **Pallets**. For pallet control, require vendors to remove pallets in the contract. Contact a local pallet vendor about repairing, reusing, or recycling excess wooden shipping pallets.

Swimming Pool/Spa

-Water-

Water use in swimming pools and spa facilities varies depending on size, design, climate, and water quality and treatment requirements. Pools are often drained and refilled more often than truly necessary. This frequency should be limited to only when absolutely essential. However, water must be added routinely to replenish losses due to evaporation, splashing, leaks, and filter backwashing. One way to reduce such losses is to invest in an insulated pool cover. About 95% of pool water lost to evaporation can be saved by using a pool cover (CDWR 1998). An average uncovered outdoor pool loses up to 1 inch of water per week during the summer months due to evaporation (Vickers 2001). In addition, lowering the pool water level will help to reduce the amount of water lost to splashing. If fountains, waterfalls, or other features are used, replace them with water features that use recycled water, and theses water features should be turned off during drought conditions.

- **Use a water-saving swimming pool filter.** Replace pool filters with newer water-saving pool filter.
- **Reduce backwashing.** A single backwash with a traditional filter uses 180-250 gallons of water. This water can be saved by cleaning filters by dismantling and rinsing rather than backwashing.
- **Backwash in non-sensitive areas.** If backwashing is absolutely necessary, monitor the frequency and duration carefully to optimize water use and efficiency. The backwash water that is generated can be recycled in areas, where appropriate (i.e. lawns, shrubs, etc.).

-Waste-

These areas provide additional opportunities for recycling, reduction and reuse.

- **Repair or donate pool furniture.** No need to buy new if repairs can be made or donate unusable items to charity.
- **Recycle or donate old or stained towels.** Donate old or stained towels to charities or other facilities that may use them (humane societies, veterinarian offices, school car washes). They may also be reused on-site (i.e. rags for maintenance shops, housekeeping, and kitchen).
- **Control chemical use.** Cleaning chemicals should be biodegradable and as least toxic as possible to get the job done. Choose pump sprays instead of aerosols. Use products in

correct concentration and "as recommended." This saves the amount of product needed. The supplier may be able to provide the strength necessary for cleaning. Over-chlorination is not necessary and there are non-chlorine based sanitizing agents available now. Check into alternatives for chlorine to minimize the use of a hazardous substance. Copper/silver ionization is a proven technology used to sanitize water for several different applications.

- **Minimize hazardous waste by inventory.** Know what you have in inventory and what you need to get the job done. Just-in-time inventory methods can reduce the need to store chemicals and other products. Find vendors who are willing to ship a product when you need it. Also make sure that all stored materials are date stamped when they arrive and that the older product is always used first.
- **Use waste reduction strategies in spa.** In the shower areas, use leftover amenity soaps and shampoos from the guest rooms, if the seal has not been broken. Or, use bulk soap and shampoo dispensers. Air-conditioning should be used year round to control humidity.

Barriers

Legal, policy and social barriers to implementation of conservation measures

As has been commented in many of the earlier sections, some green lodging practices simply cannot be implemented due to local health codes and legal restrictions. Beyond this limitation, there are three major obstacles that typically frustrate lodging managers from communicating their preference for environmentally responsible hotel services:

1. A perceived lack of information and resources about environmental options.
2. A lack of ability to research the environmental performance of hotels.
3. A perceived prohibitive cost issue.

Let us tackle each of these barriers one by one. With regards to the lack of information issue, sadly there is some truth to this perception. While institutional purchasers are inclined to favor green hotel services, they need improved access to environmental information in order to include such considerations in their purchasing decisions. The available information must be put in a form that can be easily implemented by an average hotel manager. Fortunately great strides have been made in this area. For instance, the USEPA has a pair of comprehensive websites with excellent information regarding environmental standards related to purchasing and procurement.

1. EPA Procurement: http://www.epa.gov/epaoswer/non-hw/procure/index.htm
2. EPA Buy Recycled http://www.epa.gov/epaoswer/non-hw/muncpl/buyrec.htm

However, during the course of the literature review found herein, it can be seen that many of the green practices outlined in this report were proposed 10-20 years ago. Many of those recommendations have payback periods on the order of months or even generate income on the order of tens of thousands of dollars per year, and yet so many have not been put into practice.

The second perception refers to a lack of performance measures. Again, during the course of the literature review for this document, the authors have come across literally hundreds of success stories and case studies detailing the environmental performance and economic benefits of green lodging practices. What is missing is to put these success stories in the context of non-participating hotels is to express the results into the language or business jargon of the decision-makers. This concept must be explored further using interdisciplinary means. At first glance, it may involve computing a rate of return on investment, a cash-flow diagram, or some other method.

The third perception is the prohibitive cost issue. Although a number of incentives are in place such as environmental product labeling and green hotel certification, the vast majority of hotel operations have not embraced the green lodging movement. At the corporate scale, the industry lacks a clearly articulated motivator to make significant changes. This is complicated by the fact that most brand name hotels have a complex management scheme involving the property ownership group, the operations management company, and the corporate flag. Since decisions are not made at the local level and require months of study for standardization and training and communication prior to adoption, implementation of green principles is a slow moving process. Certainly, the current environmental guidelines available to the industry do not provide sufficient information or are themselves too complex and not practical enough for the average hotel manager to implement. However, the cost issue, which has been shown to rarely be a driving force acting against implementation, can be a real problem because the management group annual budget may require ratification from the ownership group and the flag. Thus capital expenditures required to establish some green lodging practices may be difficult to secure for larger corporate hotels. Because it “takes money, to make money,” the prohibitive cost issue is often used as an excuse. At the smaller level, those hotels that are owned and operated by the same group or person tend to follow the leader of the larger hotels to attract a more diverse customer base, which is accustomed to policies and operations of big chain hotels, and to stay competitive in the market.

The perceived cost issue leads us to the “bang for the buck” issue. The question of which improvement should the hotel implement with limited resources is easily answered by which measure saves the most money, right? Well the answer is often not so straightforward. Take the following statement for example: the Hyatt Regency Coconut Point Resort and Spa reduced its water consumption by 28% and reduced its waste by 2.8%. This makes it appear that the water conservation efforts saved 10 times more, but after closer inspection, we can determine that the solid waste disposal costs were 20 times more on an annual basis, so we can conclude that the waste reduction efforts saved the most money. This example illustrates the communication issue that well-intentioned green lodging proponents have, and highlights the divide between the wealth of data in support of green measures and the conflicting message to decision-makers.

With respect to solid waste management issues, the recent trends of recycling programs provide an important lesson. According to the American Hotel and Motel Association (AHMA), between 1996 and 1998 the percentage of AHMA members offering recycling services dropped from 59% to only 46%. Larger, luxury hotels continue to offer recycling services, while economy lodging properties are less and less likely to offer such a service. However, waste prevention measures such as towel/linens programs, soap dispensers, and hand dryers are being used

more now than in the past. Reasons may include poor pricing for recycled materials, labor shortages, or lack of competitive recycling services (NHDES2001).

Educating guests about recycling through guest cards, media boards, and in-house television is a great public relations tool that is received favorably by guests. Many guests are familiar with recycling from home or work and are glad to continue the process when in a hotel. However, hotels often hesitate to establish programs in solid waste management because of the coordination and cooperation needed among management, employees, and guests. Nevertheless, the very real cost benefit remains an incentive. (Alexander 2002)

Typical fallacies about recycling can be seen in the lodging industry literature. For example, "Recycling programs can often save money, but if the time required to separate the waste is too great, or the procedure too impractical, frustrations and increased time-pressure on employees could negate any dollar savings" (Florida Hotel & Motel Journal, June 1999). Here is another quote from the same journal: "Waste representatives often fail to encourage their clients to recycle because recycling waste is less expensive to dispose of than commingled solid waste (regular garbage)" (Florida Hotel & Motel Journal, June 1999). This is the difficult environment in which the green lodging movement must overcome.

With regards to water conservation, we will focus on equipment versus behavioral measures. In Seattle, WA, a pilot program investigated water conservation opportunities related both to replacement or significant upgrades to existing equipment, and "behavioral measures" related to equipment maintenance and to employee/guest education. Many commercial water conservation studies have focused exclusively on equipment measures. However, without adequate employee education and establishment of regular maintenance schedules, water savings projected for equipment replacements may not be achieved, leading to distrust in other projected green lodging savings estimates (O'Neill & Siegelbaum and The RICE Group 2002). It is far more likely that a one-time event like replacing all showerheads with low-flow fixtures for example will be undertaken, rather than routine leak monitoring, which is a long-term maintenance issue. A likely reason for this is that the purchase and installation can be done at the management level and contractor level, respectively, but the routine monitoring is typically accomplished by the housekeeping or maintenance staff, which has little incentive. In addition, new shiny faucets, drench-style showerheads, and fancy toilets give the perception of luxury, but luxury is not always compatible with water conservation.

Many water conservation opportunities provide opportunities for energy savings at the same time. For example, two hotels in the west coast of Florida were audited, and the potential water savings equaled approximately one-third of the current water consumption. For the older Westin Hotel, close to 90% of the projected savings were from "equipment measures" primarily related to upgrades in restrooms, ice machines and laundry equipment. For the West Coast Grand Hotel, a converted office building, close to 90% were for "behavioral" measures, primarily related to maintenance and operation of heating and cooling equipment. What is needed is a commitment to do both in order to achieve the most savings success.

However, determining success is based on more than the water saved in any given year. Rather, success might be measured by whether those changes are part of a long-term strategy that is integral to the hotel's philosophy and practice, versus the "flash in the pan" result of an environmental champion whose departure will impair long-term environmental improvement. (O'Neill & Siegelbaum and The RICE Group 2002).

Partners

- EcoSMART Technologies, Inc.
- Niagara Conservation Corporation
- SP Newsprint Co.
- ICI Paints
- Pineapple Hospitality Inc.
- Zinsser Company Inc.
- ProTeam Inc.
- Rejuvinair Inc.
- SOMS Indoor Air Quality, LLC

Candidate Hotels

According to scope of work, quantifiable improvement will be related to the number of guest rooms occupied within the lodging property. For purposes of comparison, candidate hotels will be sub-divided into four classes of establishments:

1. Hotel and convention center multipurpose facility (800 + rooms)
2. Large chain hotel (300 – 500 rooms)
3. Motel (< 100 rooms)
4. Bed and Breakfast

In addition, the occupancy rate of a hotel varies as a function of seasonal and economic factors. To facilitate comparisons, control hotels will be used with similar occupancy rates and will be monitored over the same study period. For example, with a national chain hotel, a candidate hotel will be selected for project implementation and a similar sized hotel from the same chain, if possible, in a nearby location will be selected as the control. Monitoring will also focus on the 12-month period prior to implementing any changes as well as the immediate 6 month – 2 year period following implementation.

A pair of candidate hotels have been preliminarily identified and are described below.

- The Four Seasons (Miami, FL) is located at 1435 Brickell Avenue, Miami, Florida 33131, just one block from Biscayne Bay, in the business district of downtown Miami. The facility is a 70-story tower of luxurious guest rooms and suites with views of the city and bay. The hotel has 221 spacious guest rooms including 182 standard sized rooms of 500 ft^2, 15 executive suites (750 ft^2), and 24 luxury suites (>1000 ft^2). Amenities include: fitness facilities, pools, spa, business services, high-speed wireless internet, one restaurant and two lounges, as well as a variety of other high-end services for guests. The hotel also has over 20,000 ft^2 of conference, boardroom, classroom, and banquet hall space.

- The Four Seasons Resort Palm Beach (West Palm Beach) is located 2800 South Ocean Boulevard, Palm Beach, Florida, 33480. The facility offers 210 guest rooms, including 13 suites, featuring private, furnished balconies with views of the ocean or the Resort's landscaped gardens and pool area. The standard guest rooms (196) are of varying sizes

(546, 439, 393 ft^2) and the suites vary from 685 to 1370 ft^2. Amenities include: fitness facilities, pools, spa, business services, high-speed wireless internet, two restaurants and one lounge, as well as a variety of other high-end services for guests. The hotel also has over 34,000 ft^2 of conference, boardroom, classroom, and banquet hall space.

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