Guidelines

06--2012

Reducing Common Interior Domestic & Commercial Water Uses

Background/Rationale: Domestic water use includes water used for drinking, bathing/hygiene, laundry, and general cleaning. For the purposes of this guideline, commercial (office building/hotel/restaurant/institution) uses in these areas are included but water used for industrial janitorial and outdoor landscape is addressed in separate guidelines (see Guidelines #7 and #8, respectively). Domestic water use typically involves a variety of different types of fixtures, installed and/or updated at different points in time and for different tasks. In addition, leaks often go unnoticed and/or unaddressed. As a result, there is often an unnecessary and expensive amount of domestic water use, an increasingly valuable global resource, but also an unnecessary and expensive amount of energy used (electricity or natural gas) if the water is heated. Any person/business seeking to make operations more sustainable should take steps to fully understand the domestic water needs and implement strategies to make the use more resource efficient. Optimizing water use and reducing energy consumption will, in turn, indirectly help reduce greenhouse gas emissions and any adverse environmental impact associated with excess emissions.

Some improvements may be relatively simple and inexpensive to implement, while others may be more complex and require assistance from experienced professionals. The material contained in these guidelines is intended for use by persons who have a basic level of technical training/competence and familiarity with source reduction concepts and strategies.

Step 1: Assess the Current Situation/Define the Scope of the Situation

1.1. Collect and analyze information about current operations, including but not limited to:

- identify key/relevant sources of information (see Appendix 1, examples 1-3):
  - the environmental cause champion,
  - maintenance and/or facility supervisor(s),
  - purchasing or accounts payable personnel,
  - key suppliers/vendors,
  - business representative at local water utility
  - municipal building code or plumbing inspectors
  - local health department sanitarian
- collect pertinent documents and information (see Appendix 1, all examples):
  - policies/procedures related to water use:
    - formal/informal guidelines/expectations regarding use
  - formal/informal guidelines/expectations for routine fixture maintenance
  - maintenance records, equipment specifications
  - utility bills identifying billing rates and water/energy usage
- keep track of, document and distinguish between key assumptions, known or reported values, and information which is calculated (see Appendix 1, examples 2 and 3)
- identify number/location/type of fixtures in question (see Appendix 1, all examples):

    - develop map using existing blueprints or new diagram to represent system being analyzed so that everyone involved understands the scope and details of what is being analyzed
    - may require expert consultation for some aspects (e.g. how waterless urinals fit with local plumbing regulations/standards or the gallons per flush for tankless toilets)
- conduct use analysis (see Appendix 1, all examples):
    - identify number of uses per day/week/year per fixture
    - identify the temperature of the water being used
    - identify routine and special uses through interviews, direct observation or using testing equipment:
        - per area/unit
        - identify current and optimal water use requirements taking into account industry standards, employee preferences, and tasks involved
    - identify unnecessary uses by direct observation or interviews with key personnel
    - identify maintenance schedule:
        - identify tasks performed, frequency
        - identify reports, documentation related to maintenance
- calculate amount/cost of water for entire facility and amount/cost associated with domestic water use to compare the impact on the overall water use at the facility (see Appendix 1, example 1):
    - calculate full water costs, i.e. water supplied + water disposed (sewer)
    - verify utility rates per gallon from evaluation of the water bills
    - estimate the annual gallons used/calculate cost for water by area/unit
    - measure volume of water lost to identified leaks/drips
    - consider preparing full water balance map of facility to categorize domestic uses
    - tag and possibly photograph areas needing adjustment (leaks/replacement), and plot on diagram or map of facility
    - prioritize fixtures for adjustment—fixing largest water users first
- calculate amount/cost of electricity for entire facility and amount/cost associated with hot water use to compare the impact on the overall water use at the facility (see Appendix 1, example 3):
    - verify utility rate per kWh from evaluation of the electric bills
    - estimate the annual gallons used/calculate cost for heating water by area/unit
- calculate life cycle impact on greenhouse gas emissions from the water use reductions (see Appendix 3 for examples)

1.2. Conduct necessary research and calculations using the following useful material:

The following references are used to help calculate water waste and to identify potential strategies for improving efficiency of domestic water use and the water/energy nexus related to hot water use:

1. WaterSense, an EPA Partnership Program with suggestions/resources for water conservation, available online at http://www.epa.gov/watersense/pubs/indoor.html
2. American Water Works Association Water Wiser Drip Calculator available online at http://www.awwa.org/Resources/Waterwiser.cfm?navItemNumber=1561&showLogin=N
3. *Water Efficiency Manual for Commercial, Industrial and Institutional Facilities*, N.C. Department of Environment and Natural Resources, Division of Pollution Prevention and Environmental Assistance/Division of Water Resources, May 2009, available online at: http://infohouse.p2ric.org/ref/01/00692.pdf

4. *Watergy: A Water and Energy Conservation Model for Federal Facilities*, Sharon deMonsabert and Barry L. Liner, 1996, available online at: http://www.mendeley.com/research/watergy-a-water-and-energy-conservation-model-for-federal-facilities/

The following reference is used to calculate life cycle impact on greenhouse gas emissions:

1. U.S. EPA' Pollution Prevention (P2) Greenhouse Gas (GHG) Calculator, available online through the National Pollution Prevention Roundtable at: http://www.p2.org/category/general-resources/p2-data-calculators/

Step 2: Identify Feasible P2 Opportunities

2.1. In general:

- research a full range of possible operational improvements/modifications/suggestions relevant for the situation at hand (several commonly applicable suggestions are listed below)
- be specific about the "unit" for application, i.e. which fixtures to modify
- keep track of, document and distinguish between key assumptions, known or reported values, and information which is calculated (see examples throughout appendices)
- include a thorough cost analysis: use a chart to compare current to proposed costs and calculate payback period
- include relevant vendor information (the vendor information included in these guidelines is for example only)
- identify how to monitor/measure impact for each suggestion if implemented, e.g. compare water bills, monitor use & satisfaction with fixture features

2.2. Selected strategies to consider, including techniques and calculations to perform:

- detect and repair leaks (see Appendix 2, Example 1)
- reduce use of hot water: (see Appendix 2, Example 2)
  - clothes washing
- install low flow/efficient water fixtures and appliances:
  - modify sink faucets: (see Appendix 2, Example 3.a.)
    - faucet aerators
    - low-flow faucets
  - modify toilets and urinals: (see Appendix 2, Example 3.b.)
    - install dual flush toilets and low-flow urinals
    - install toilet diverters
  - install low-flow showerheads (see Appendix 2, Example 3.c.)
- install waterless urinals (see Appendix 2, Example 4)
- calculate life cycle impact on greenhouse gas emissions compared to current processes
  - see Appendix 3 for examples

Step 3: Identify Barriers to and Benefits of Implementation for Each Opportunity

After analyzing the fixtures and practices and identifying feasible opportunities for realizing savings, you will want to make as strong a business case as possible for making changes. Be proactive and identify key barriers to and benefits of implementing the opportunities you want to recommend. To help you do this, the P3 program offers the following information.

Based on experiences over the past 15 years, the P3 program has found that simple projects with thorough documentation and short pay back periods or projects with compelling cost and environmental savings have a high likelihood of being implemented. For example, suggestions for replacing faucet aerators with newer more water and energy efficient ones are often implemented. Companies are typically receptive to opportunities which reduce utility costs, especially if it doesn't inconvenience employees or interrupt work flow. Steps to reduce environmental impact often simultaneously have a positive impact on the satisfaction with the working environment.

On the other hand, suggestions which are high cost, with long payback periods, or which have complex implementation logistics, or are not adequately researched or quantified are typically not implemented. Suggestions for replacing multiple restroom fixtures with relatively costly alternatives may not be favorably considered, at least in the short run. Suggestions that require special variances from local plumbing codes (e.g., waterless urinals or reuse of condensate water) may also be implemented less frequently. Interestingly, some low cost, quick payback suggestions which involve changing employee behavior may not be implemented due to the common human tendency of resistance to change. For example, implementing a "report leaks" campaign may not be a strategic priority.

See Appendix 2 for examples of implemented P2 water conservation suggestions from the Nebraska intern program. These are annotated to make it clear what information is needed to perform these calculations for a different location and to explain why some suggestions were implemented and others were not.

Common Barriers:

Beliefs & Attitudes

- resistance to change—employees enjoy familiarity/convenience of full flush/ample flow fixtures in restrooms/kitchens/elsewhere
- skepticism—employees skeptical about time/inconvenience of operating reduced flow fixtures
- other/higher strategic priorities—the company may have other issues is sees as more important to address in the short run
- misinformation or lack of understanding about the costs of water and energy for hot water:
  - that small fixes can yield measurable results, e.g. the amount of water that is lost by even a small drip
  - how using unnecessary water/energy can affect the physical and political environment
  - lack of technical understanding that certain tasks require less water

Costs and Investments

- cost (time, effort and money) of implementing suggestions
  - capital investment-"up-front costs"
  - operating constraints: interrupting operations to implement changes
  - time/costs of retrofitting fixtures
- timeline for return on investment (ROI)—length of payback period
- perception of cheap and available water
- overall low cost of water relative to entire bottom line
  - the cost of disposal via the sanitary sewer usually doubles the cost of water

Technical Issues: What to Do and How

- lack of knowledge/skills re: what needs to be done/how to implement strategies
  - access to equipment for analyzing/adapting fixtures
  - access to plumber for modifications
- concern re: managing logistics and process changes, including down time

---

Common Direct and Indirect Benefits:

Cost Savings

- reduces costs and improves efficiency of operations by using less water to accomplish same tasks
- reduces costs and improves efficiency of operations by using less energy to heat water to accomplish tasks
- potential opportunity for grant $$/utility incentives to pay for projects

Environmental Impact

- reduces impact of water use on the environment:
  - reduces use of natural resources/raw materials to produce water/energy
  - reduces greenhouse gas emissions related to water/energy production
  - conserves/preserves/provides clean environment/quality of life for future generations

Education

- educates employees and general public in efficiency and responsibility when information is posted about the change and why it was made

Company Image

- demonstrates social responsibility and best management practices
- positions company in good stead in community concerned about scarce water resources

Step 4: Make the Business Case for Change

4.1. Develop a written report for submission to decision makers.

- include a thorough assessment of the system, with process descriptions, flow charts and use/cost information.
- outline specific P2 Opportunities/Suggestions with the following information:
  - recommended action
  - brief summary of current operations
  - cost of implementing recommendation
    - include labor costs/savings in your economic analyses.
  - summary of benefits (acknowledge barriers but discuss how benefits outweigh):
    - potential cost savings ($)
    - water/electricity use reduction(s)
    - simple payback
    - indirect benefits: safety, risk/liability reduction, GHG reductions, etc.
- always identify how to monitor/measure impact for future analysis: e.g. install water meter, monitor employee satisfaction
- incentives to change: conclude the report with a summary of the benefits to be realized from implementing the recommendations made. Stress environmental stewardship. Call for action!
  - you may want to reference previous successes in similar businesses as a selling point
  - see Appendix 2 for example projects implemented and their results

---

4.2. Make an oral presentation to summarize your findings and call to action:

- focus on pertinent details of system assessment and P2 opportunities
- make it interesting yet include sufficient technical detail to be convincing and make the business case for change— include a picture of the product/change in action
- develop a final "impact" slide with table of metrics—call for action/change
- allow time for question/answer period

4.3. Advocate for change based on metrics/facts and environmental ethic:

- use informal interactions to establish trust in your abilities and to build a foundation for change
- use written report and formal presentation to communicate your findings and provide the formal information/rationale for implementing recommendations
- emphasize sustainability (triple bottom line) and preserving resources for future generations
  - water/energy conservation and the relationship to greenhouse gas emissions is particularly important for hot water applications
- use examples of implemented suggestions from past projects (see Appendix 2)

4.4. Report potential Greenhouse Gas (GHG) emission reductions as an important indirect benefit:

- include in written report and oral presentation
- include explanation of why GHG emissions are relevant/of concern to all businesses
- calculate potential carbon dioxide equivalent (CO2e) emission reductions for each recommendation
- include an appendix in written report documenting calculations (see Appendix 3 for details and example calculations for domestic/commercial indoor water use)
- see Appendix 4 for additional tips for making the business case for change.

Appendix 1
Example Assessments of Domestic/Commercial Water Use

Note: *Several examples of domestic/commercial water use assessments are included below. Each of these addresses one or more of the steps needed to accomplish a thorough assessment. In these examples, we have attempted to clarify for the reader what information is known or reported, what is logically assumed, and what has been calculated. This is embodied within the narrative for easy reference. In an actual report, these details would likely be in attached appendices so as not to interrupt the flow of the report.*

Example #1: Water Material Balance to Determine Total Domestic Water Use (adapted from report by Jon Kottich, 2010)

At this facility the amount of water used for restrooms, drinking fountains, breakroom and other domestic purposes is unknown. Analysis of the water bills was used to determine the amount of city water supplied to the facility. The water supplied to the facility is used for two purposes: domestic uses and outside irrigation. Analysis of the supply and sewerage bills was used to determine the amount of water used for outside irrigation since irrigation water was not used during winter months nor was discharged into the sanitary sewer system. The facility manager assisted in the estimation of water use by departments or restrooms/breakroom. **Figure 1** below shows the total amount of water supplied to the facility and where it is used during a full calendar year. Estimates of individual fixture use are included. A more comprehensive analysis with a portable flow meter available from the city water utility is recommended to verify these values.

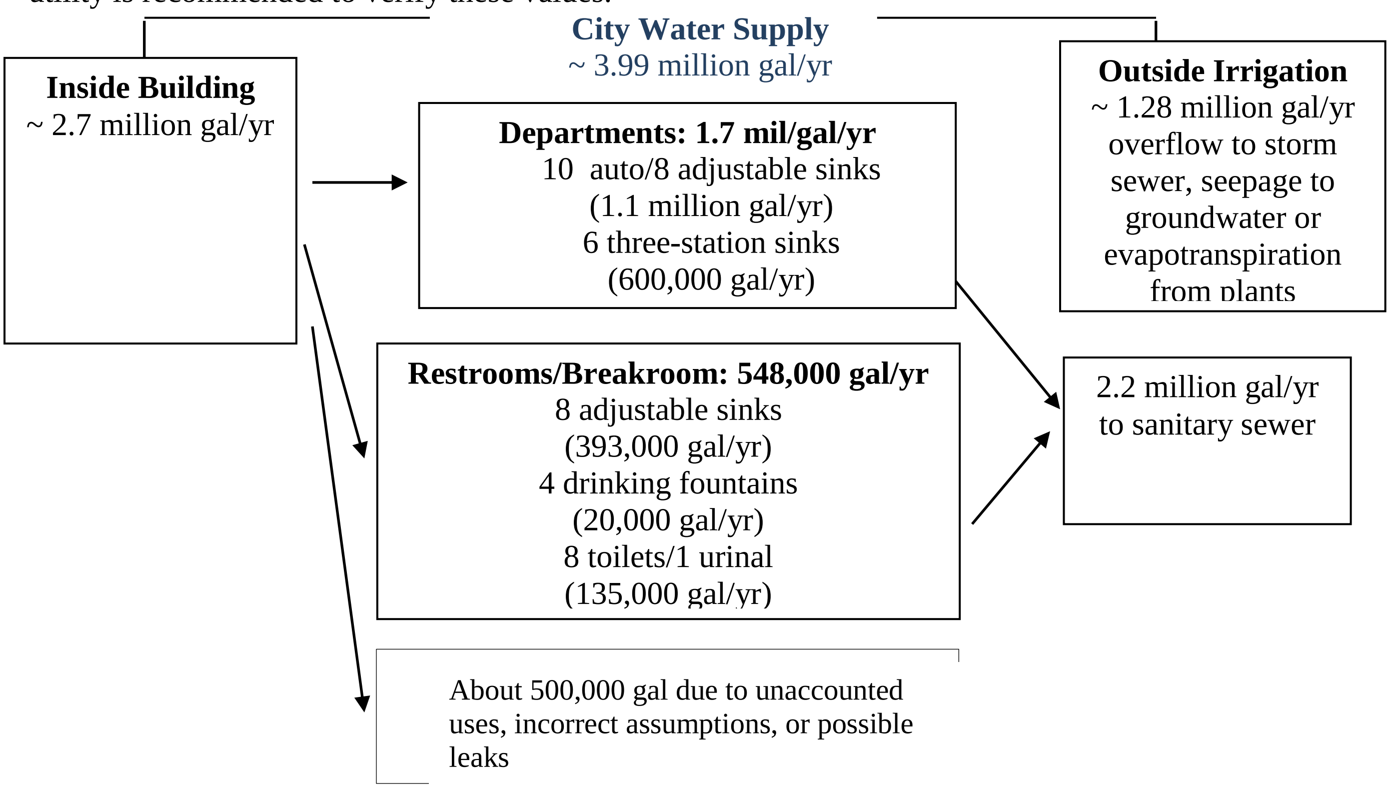


Figure 1. Facility Annual Water Use

Note: Similar calculations to those in Example 2 were used to determine the values in Figure 1.

Example #2: Usage Determination of Multiple Types of Fixtures for Cold Water Use (adapted from report by Jon Kottich, 2010)

The facility operates 364 days/year and uses water for a variety of purposes. The focus of this assessment is inside the building, where a complete inventory of the locations of various fixtures was conducted. There are over 30 sinks with faucets of multiple types, eight toilets, one urinal, and four drinking fountains in use. The following information was gathered in order to complete the analysis--some is based on information received from facility personnel, utility representatives or measurements taken; other is estimated:

- Each toilet is flushed an estimated 25 times a day at 1.6 gallons per flush (gpf)
- Urinals are flushed ~50 times a day at 1 gpf
- Automatic sinks are in use ~1.5 hours a day at an average of 2.2 gallons per minute (gpm)
- Adjustable sinks are in use ~1.5 hours a day at an average of 1.8 gpm
- Three-station sinks are in use ~2 hours a day at 2.2 gpm
- Drinking fountains are in use ~0.5 hour a day at 0.45 gpm
- All water supplied at cost of $1.22 per 748 gallon unit or $0.0016 gallon; disposed of at $0.0028 per gallon. Total used water cost is $0.0044 per gallon. (City of Lincoln Water Department data)

Based on these assumptions and the cost of water, the restrooms/breakroom use nearly 55,000 gallons of water per year and costs the facility $2400/year. Detailed calculations for amounts and costs follow.

Interior Water Use Calculations

Known Values:

City water costs: $1.22 \frac{\$}{unit} \div 748 \frac{gallons}{unit} = \$0.0016\ per\ gallon\ water$

$$\$.0016\ \frac{gal\ supplied}{water} + \$.0028\ \frac{gallon\ disposed}{water} = \$.\mathbf{0044}\ \frac{\mathbf{gallon}}{\mathbf{water}}$$

Calculations:

Automatic sinks: $10\ sinks * 2.2\ gpm * 60\ \frac{mins}{hour} * 1.5\ \frac{hours}{day} * 364\ \frac{days}{year} = \mathbf{720,720}\ \frac{\mathbf{gal}}{\mathbf{yr}}$

Adjustable sinks: $16\ sinks * 1.5\ gpm * 60 \frac{mins}{hour} * 1.5 \frac{hours}{day} * 364 \frac{days}{year} = \mathbf{786,240} \frac{\mathbf{gal}}{\mathbf{yr}}$

Side dept. adjustable sinks: $\frac{8}{16} * 786240 \frac{gal}{yr} = \mathbf{393,120} \frac{\mathbf{gal}}{\mathbf{yr}}$

Restroom/Breakroom sinks: $\frac{8}{16} * 786240 \frac{gal}{yr} = \mathbf{393,120} \frac{\mathbf{gal}}{\mathbf{yr}}$

Toilets/Urinal: $8\ toilets * 1.6\ gpf * 25 \frac{flushes}{day} * 364 \frac{days}{year} + 1\ urinal * 1.0\ gpf * 50 \frac{flushes}{day} * 364 \frac{days}{year} = \mathbf{134,680} \frac{\mathbf{gal}}{\mathbf{yr}}$

Drinking fountain: $4\ fountains * 0.45\ gpm * 60 \frac{mins}{hour} * 0.5 \frac{hours}{day} * 364 \frac{days}{year} = \mathbf{19,656} \frac{\mathbf{gal}}{\mathbf{yr}}$

3-Station sinks: $6\ sinks * 2.2\ gpm * 60 \frac{mins}{hour} * 2 \frac{hours}{day} * 364 \frac{days}{year} = \mathbf{576,576} \frac{\mathbf{gal}}{\mathbf{yr}}$

Department total: $720720\frac{gal}{yr} + 393120\frac{gal}{yr} + 576576\frac{gal}{yr} = \mathbf{1,690,416}\frac{\mathbf{gal}}{\mathbf{yr}}$

$$1.7\,mil\frac{gal}{yr} X\,\$.0044\,gal = \$\mathbf{7,500/yr}$$

Restroom/Breakroom total: $393120\frac{gal}{yr} + 134680\frac{gal}{yr} + 19656\frac{gal}{yr} = \mathbf{547,456}\frac{\mathbf{gal}}{\mathbf{yr}}$

$$548{,}000\frac{gal}{yr} X\,\$.0044\,gal = \$\mathbf{2,400/yr}$$

Example #3: **Assessment of Energy and Water at Sink Faucets for Cold & Hot Water Use** (adapted from report by Jon Kottich, 2010)

A hotel in Lincoln, NE received technical assistance from a P3 intern in 2010. One of the issues researched was reducing water use in guest room restroom sink faucets. (Note: this analysis could be expanded to other fixtures using hot water, such as shower heads, kitchenette sinks, etc.) To track and measure the waste streams (water and natural gas energy for heating water), a simple flow chart was created as shown below in **Figure 1.** To construct this flow chart, the following information was gathered from facility management and a review of billing records:

- The hotel has 109 guest rooms, with a 75% occupancy rate (according to management)
- Each guest room has one restroom sink faucet
- When occupied, each restroom sink is in use for ~15 minutes a day, using water at the rate of 1.8 gallons per minute (gpm)
- Water supplied costs $0.0016 per gallon; water disposal costs $0.0028 per gallon; therefore total water cost is $0.0044 per gallon
- One half of the water used is heated
- 1 therm = 100,000 BTU at Nebraska cost of $0.60 per therm

Calculations for the water and natural gas energy use indicate that over 805,000 gallons of water and 3054 therms of natural gas per year are used in the sinks at a cost of $5,400/year. Calculations are shown below.

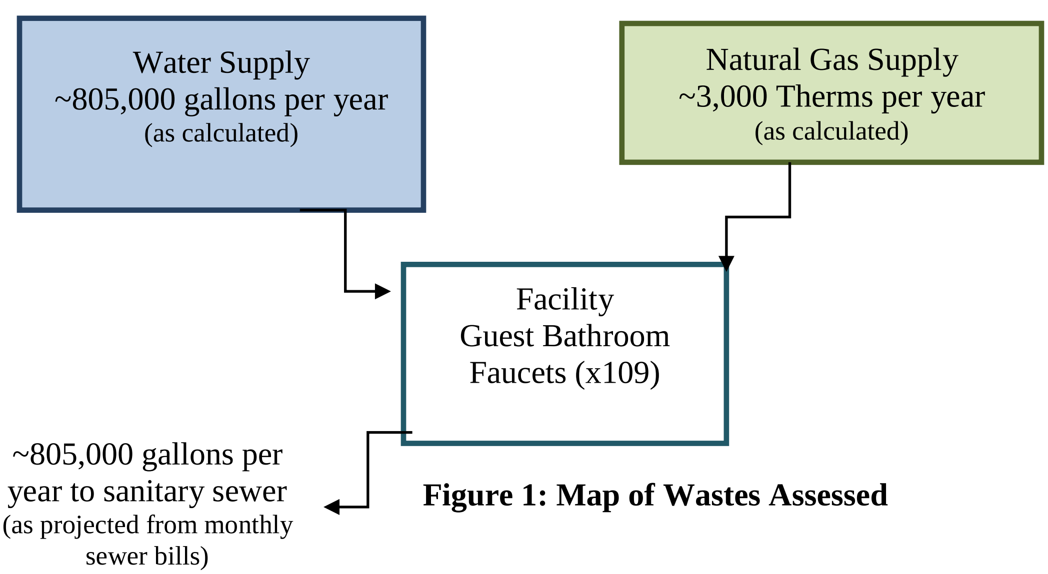


Figure 1: Map of Wastes Assessed

Water and Energy Use Calculations

Known Values and Assumptions

--Density of water is 8.33 lb/gal

--Temperature change as given by the EPA Greenhouse Gas Emissions Calculator is (120-55) °F

--Standard efficiency coefficient of natural gas is 1.4

--1 BTU/lb*F

--1 therm = 100,000 BTU at Nebraska cost of $0.60 per therm

--Half of water used is heated

Calculations:

$$75\%\ occupancy * 109\ bathroom\ sinks * 1.8\ gpm * 15\frac{min}{day} * 365\frac{day}{yr} = \mathbf{805,646}\frac{\boldsymbol{gal}}{\boldsymbol{yr}}$$

$$805{,}646\frac{gal}{yr} * \frac{1}{2}heated * 8.33\frac{lb}{gal} * \quad 120F - 55F \quad * 1\frac{BTU}{lb*F} * 1.4 \div 10^5\frac{BTU}{therm} = \mathbf{3054}\frac{\boldsymbol{therms}}{\boldsymbol{yr}}$$

Water Cost: $805{,}646\frac{gal}{yr} * \$0.0044\ per\ gallon = \$3545\ per\ year$

Gas Cost: $3054\frac{therms}{yr} * \$0.60\ per\ therm = \$1832\ per\ year$

⇨ **$5,400 per year**

Example #4: Assessment of Water Waste Due to Drips and Leaks (adapted from report by Andrew Anderson, 2009)

Leaky faucets and showerheads can contribute to substantial water loss over extended periods of time if left unrepaired. Four fixtures were observed to have continuous drip leaks while assessing the facility. Using an online calculator that translates drips per minute into annual water usage, an estimated 15,768 gallons could be lost annually from these four observed fixtures (see calculations below). This doesn't include the fixtures not observed to be dripping or future drips, which would waste even more water.

Not included in this analysis was a hard-to-measure continuous leak from the wall observed at the base of a showerhead in one of the upper story dressing rooms, which contributes even more wasted water to the sewer. This leaky water not only costs money (both for using municipal water and the sewer charges), but affects the image of the facilities by employees, venue artists, and event goers.

Calculations for Dripping Fixtures

Using the drip calculator from the American Water Works Association website:
www.awwa.org/awwa/waterwiser/dripcalc.cfm

Fixture 1: $\frac{14drips}{10\sec} \times \frac{60\sec}{1\min} = 84\frac{drips}{\min}$

Fixture 3: $\frac{11drips}{10\sec} \times \frac{60\sec}{1\min} = 66\frac{drips}{\min}$

Fixture 2: $\frac{15drips}{10\sec} \times \frac{60\sec}{1\min} = 90\frac{drips}{\min}$

Fixture 4: $\frac{5drips}{5\sec} \times \frac{60\sec}{1\min} = 60\frac{drips}{\min}$

TOTAL = 300 drips/minute

Yearly waste for 300 drips/min = 15,768 gallons/year

$$15,768\ gal\ X\ \frac{1unit}{748gal} = \frac{21.1units}{year}$$

$$21.1units\ X\ \frac{\$1.65 + \$1.62}{unit} = \sim\$70\ per\ year$$

After evaluation of the water and sewer bills it was determined that a unit of water used costs $1.65, while a unit of water sent to the sewer costs $1.62. The public water utility uses a unit of water which is 748 gallons for calculation purposes. The calculation indicated the cost of the drips is approximately $70/year.

Appendix 2

Example P2 Opportunities for Reducing Domestic/Commercial Water Use

Note: *Several examples of opportunities for reducing domestic water use are included below (see separate Guideline # 007 for Janitorial Water Use). Each of the examples below addresses a different way to improve practices and achieve direct and/or indirect savings and each uses different techniques for encouraging implementation. In these examples, calculations are embodied within the narrative for easy reference, although in an actual report, these would likely be in appendices at the end so as not to interrupt the flow of the report.*

Example #1: Detect and repair leaks (adapted from report by Michael McKinney, 2009)

It was observed that water continuously leaked from the nozzle connected to the flex hose for washing.. The hose appeared to be mounted to the wall properly, but was leaking from within the nozzle at a rate of 250 drops per minute. Using the water waste calculator available online at www.awwa.org/awwa/waterwiser/dripcalc.cfm , it is estimated that the dripping nozzle wastes approximately 13,000 gal/year water.

Assuming that the cost of a unit (750 gallons) of water in Lincoln, NE is \$3.84, the cost for 13,000 gallons water/year is approximately \$70:

$$\frac{13{,}000\ gal}{yr} \times \frac{\$3.84}{750\ gal} = \frac{\$66.56}{yr}$$

A replacement nozzle costs approximately \$26. The payback period for replacing the nozzle is 4.5 months (\$26/\$70 x 12 months = **4.5 months**).

Implementation Status: Not yet reassessed to determine impact.

Example #2: Reduce use of hot water (adapted from report by Michael McKinney, 2009)

Clothes washing does not require hot water. It is recommended that the company either **no longer use hot water for clothes washing** or at least **reduce hot water heater temperature.**

1. No longer heat water used for washing:
According to staff, there are two hot water washes per day, six days per week, that take about 15-20 minutes each. The hot water heater runs at 110 kW. The cost of electricity id \$0.05/kWh. Discontinuing use of hot water for washing will result in saving **20,000 kWh of energy and \$1000 annually**. Detailed calculations regarding savings are shown below:

Hours used per year

$$\frac{(15+20)min}{2} \times \frac{2\ washes}{day} \times \frac{6\ days}{wk} \times \frac{1\ hr}{60\ min} \times \frac{52\ wk}{yr} = 182\ hrs/yr$$

Electricity used per year

$$\frac{182\ hrs}{yr} \times 110\ kW = 20{,}020\ kWh/yr$$

Annual Savings

$$\frac{20{,}000\ kWh}{yr} \times \frac{\$0.05}{kWh} = \frac{\$1000}{yr}$$

Initial costs to discontinue using hot water for clothes washes are negligible, so the payback period is immediate.

2. Reduce the temperature of hot water:
The hot water used for clothes washing is 200F. Lowering this temperature to 80F would reduce the amount of energy that is currently being used to heat the water.

According to the Department of Energy (DOE), there is generally 4% savings for every 10 degrees a thermostat is lowered. By this estimate, lowering the thermostat from 200F to 80F would result in a savings of **$320 and 9,600 kWh annually**. Calculations are shown below:

$$\frac{4\%}{10F} \times \ 200 - 120\ F = 32\%\ savings$$

$$\frac{\$1000}{yr} \times 32\% = \frac{\$320}{yr}$$

Initial costs to reduce water temperature are negligible, so the payback period is immediate.

Implementation Status: Not yet reassessed to determine impact.

Area #3: Switch to low-flow/efficient water fixtures and appliances (faucets, shower heads, toilets, urinals, spray nozzles, laundry, dishwashers, etc.)

Example #3a: Modify sink faucets (adapted from reports by Jon Kottich, 2010)

1. Install low-flow aerators: Restroom sinks do not need a high flow rate to perform tasks such as washings hands or filling a drink container. The current faucet flow rate of 1.8 gallons per minute (gpm) can be reduced to as low as 0.5 gpm using low-flow aerators. Aerators are inexpensive, will reduce water use, and can also save natural gas energy used by reducing the amount of hot water used. Reducing water and energy use also reduces greenhouse gas (GHG) emissions. Potential savings calculations and product information are detailed following **Table 1** below, which summarizes the benefits of installing faucet aerators.

Table 1: Benefits of Faucet Aerators

	Current Faucets	New Aerators
Initial Cost, $	-	130
Water Use, gal/yr	806,000	224,000
Natural Gas Use, therms/yr	3,050	850
Operating Cost, $/yr	5,400	1,500
Natural Gas Savings, therms/yr	-	**2,000 +**
Water Savings, gal/yr	-	**580,000 +**
Cost Savings, $/yr	-	**3,800 +**
Payback Period	-	**56 days**

Faucet Aerator Calculations

Known Values

--Density of water is 8.33 lb/gal

--Temperature change as given by the EPA Greenhouse Gas Emissions Calculator is (120-55) °F

--Standard efficiency coefficient of natural gas is 1.4

--1 BTU/lb*F

--1 therm = 100,000 BTU at Nebraska cost of $0.60 per therm

--Half of water used is heated

--Aerators have an initial cost of $1.15/per aerator

--Installation time for aerators = 15 minutes per aerator at $17 per hour labor cost

Current Faucets:

$$75\%\ occupancy * 109\ bathroom\ sinks * 1.8\ gpm * 15\frac{min}{day} * 365\frac{day}{yr} = \mathbf{806,000\frac{gal}{yr}}$$

$$806{,}000\frac{gal}{yr} * \frac{1}{2}heated * 8.33\frac{lb}{gal} * \ \ 120F - 55F \ \ * 1\frac{BTU}{lb * F} * 1.4\ \div 10^5\frac{BTU}{therm} = \mathbf{3050\frac{therms}{yr}}$$

Water Cost: $806{,}000\frac{gal}{yr} * \$0.0044\ per\ gallon = \$3545\ per\ year$

Gas Cost: $3050\frac{therms}{yr} * \$0.60\ per\ therm = \$1832\ per\ year$

→ **$5,400 per year**

Proposed Aerators:

$$75\%\ occupancy * 109\ bathroom\ sinks * 0.5\ gpm * 15\frac{min}{day} * 365\frac{day}{yr} = \mathbf{224,000}\frac{\mathbf{gal}}{\mathbf{yr}}$$

$$224{,}000\frac{gal}{yr} * \frac{1}{2} heated * 8.33\frac{lb}{gal} * \ \ 120F - 55F \ \ * 1\frac{BTU}{lb * F} * 1.4 \div 10^5\frac{BTU}{therm} = \mathbf{850}\frac{\mathbf{therms}}{\mathbf{yr}}$$

Water Cost: $224{,}000\frac{gal}{yr} * \$0.0044\ per\ gallon = \$984.68\ per\ year$

Gas Cost: $850\frac{therms}{yr} * \$0.60\ per\ therm = \$509\ per\ year$

⇨ **$1,500 per year**

Savings:

Gas: $3050\frac{therms}{yr} - 850\frac{therms}{yr} = \mathbf{2,206}\frac{\mathbf{therms}}{\mathbf{yr}}$

Water: $806{,}000\frac{gal}{yr} - 223{,}791\frac{gal}{yr} = \mathbf{581,855}\frac{\mathbf{gal}}{\mathbf{yr}}$

Cost: $\$5400\ per\ year - \$1500\ per\ year = \$\mathbf{3,900}\ \mathbf{per\ year}$

Payback Period: $\frac{\$1.15\ upfront\ cost + 0.25\ hrs\ labor * 17\frac{\$}{hr} \ * 109\ bathroom\ sinks}{\$5400 - \$1500} = 0.15155\ years$

$$0.15155\ years * 365\frac{days}{yr} = \sim\mathbf{56\ days}$$

Implementation Status: **Not yet reassessed to determine impact.**

Low-Flow Faucet Aerators Vendor Information

This is one of numerous faucet aerators available. This site also sells a 1.0 gpm aerator. It can be viewed at http://www.greensuites.com/Environmentally-Friendly-Hotel-Supplies/Sink-Aerators;jsessionid=fJm2Mj0YCc0RWyypdWK2jBrsvLYWzC1CfThr2DNBtdBWvLmnpnQ7HlC8n8BGGQmNLryvQdqRHS45LCdm7LhlZm8Bb1dCbYXLFGPPQbjXSsv8RqQhpJMK0rftqpcLy0ng!-92290712

Other sources include:

- www.grainger.com
- www.eartheasy.com
- www.mcmaster.com

2. Install low-flow faucets: While hand washing is important to personal health and to the maintenance of a safe and healthy work/living environment, improper lavatory use is a common source of preventable water waste. Fortunately, there are some ways to minimize water flow without sacrificing water pressure or health standards. Installing low-flow faucets is one good alternative, which would save **over 217,000 gallons/year water and over $660/year.** Potential water and cost savings from installing 15 new low-flow faucets in place of traditional faucets in restrooms are displayed below in Table 2 below. This option has a payback period of 2.5 years. Detailed calculations follow same methods as shown previously.

Table 2: Water Use & Cost Analysis of Low Flow Faucets

Faucet Type	Initial Cost ($ per faucet)	Operating Cost, $/yr	Water Use, gal/yr	Water Savings, gal/yr	Cost Savings, $/yr
Current Faucets	-	$1,584	517,500	-	-
Low-flow Faucets	$109	$918	300,000	217,500	$666

Note: Similar calculations to those in Example 3a were used to determine the values in Table 2.

Implementation Status: Not yet reassessed to determine impact.

Home | Sign In | Your Account | Register   0 Items in your Order | Contact Us | Help

GRAINGER. FOR THE ONES WHO GET IT DONE

Catalog 401   Find a Branch   Search   Search

Products | Resources | Services | Worldwide | Repair Parts | About Us | Today's Features | Site Features

MOEN Lavatory Faucet, 1 Handle, Lever, Chrome NEW!

Plumbing > Tub/Faucets > Faucets

Lavatory Faucet, Single Handle, Handle Type Lever, Material of Construction Brass, Faucet Finish Chrome, Spout 4 3/8 In., Spout Standard, Number of Holes 3, Deck Mounting, Mounting Centers 4 In., Connection 1/2 In IPS In., Flow Rate 1.5 GPM, Replacement Cartridge 2P318, Drain Type None, Outlet Type Aerated, ADA Compliant, Standards WaterSense (R) CSA B125, ASME A112.18.1, ANSI/NSF 61/9, ICC A117.1, California Proposition 65, ADA, AB1953 Compliant

Grainger Item #	4NEJ7
Price (ea.)	**$100.50**
Brand	MOEN
Mfr. Model #	CAL4605
Ship Qty.	1
Sell Qty. (Will-Call)	1
Ship Weight (lbs.)	2.5
Usually Ships**	Today
Catalog Page No.	3667
Country of Origin (Country of Origin is subject to change.)	USA

Enlarge Image

See Notes & Restrictions for important safety information.

Qty.

Add to Order   Add to Personal List

Price shown may not reflect your price. Sign in or register.

Tech Specs | Additional Information | Compliance & Restrictions | MSDS | Required Accessories | Optional Accessories | Alternate Products | Repair Parts

Item	Lavatory Faucet
Type	Single Handle
Handle Type	Lever
Material of Construction	Brass
Faucet Finish	Chrome
Spout (In.)	4-3/8
Spout	Standard
Number of Holes	3
Mounting	Deck
Mounting Centers (In.)	4
Connection (In.)	1/2" IPS
Flow Rate (GPM)	1.5
Replacement Cartridge	2P318

http://www.grainger.com/Grainger/items/4NEJ7?Pid=search

Example #3b: Modify toilets and urinals (adapted from reports by Josh Gardner, 2009 and Jon Kottich, 2010)

1. Install High Efficiency Flushometers to Reduce Water Use. Installing dual flush toilet kits and 0.5 gallon/flush urinal kits to retrofit current fixtures will reduce gallons per flush by over 50 percent in some areas of the facility, which has a large mix of toilet fixtures. There are older toilets flushing at 3.5 gallons per flush and newer toilets operating at 1.6 gallon per flush. Most of the urinals flush at 1.0 gallon, which is the consensus standard.

Retrofit kits can be installed on the existing fixtures without replacing the entire bowl. A cost analysis is provided in Table 1; calculations for replacement high efficiency fixture kits follow.

Table 1. Relevant Information for Installation of High Efficiency Toilets

Fixture	Qty.	Purchase Cost	Installation Cost	Water Saved (gal/yr)	Annual Savings	Payback (Yrs)
3.5 GPF Toilet	7	$ 1,200	$ 400	62,600	$ 150	11
1.6 GPF Toilet	8	$ 1,300	$ 400	19,600	$ 50	34
All Urinals	10	$ 1,900	$ 500	48,700	$ 110	22
TOTAL	**25**	**$ 4,400**	**$ 1,300**	**130,900**	**$ 310**	**18**

Calculations for High Efficiency Toilets/Urinals

Assumptions:

--Men use the urinal 66% vs. the toilet 33% of the time

--Usage based on fixture location and number of employees in proximity

--Total water use for toilets and urinals is 1150 gallons/day or 285,000 gallons/year

--Cost of high efficiency equipment is $166.25/toilet and $189.60/urinal

--Installation takes 2 hours/fixture at a rate of $27/hour

Initial Investment

--15 Toilets * $166.25/Toilet = $2,500

--10 Urinals * $189.60/Urinal = $1,900

TOTAL = $4,400

Installation Cost

--$27/hour * 2 hours/fixture * 25 fixtures = $1,300

Annual Savings

--(3.5 – (0.33*1.6 + 0.66*1.1)) gal/flush * 27,900 flushes/year * 7.48 ft3/gal * ($0.82 + $0.92)/100 ft3 = $150

--(1.6 – (0.33*1.6 + 0.66*1.1)) gal/flush * 15,500 flushes/year * 7.48 ft3/gal * ($0.82 + $0.92)/100 ft3 = $50

--(1.5 –0.5) gal/flush * 5,400 flushes/year * 7.48 ft3/gal * ($0.82 + $0.92)/100 ft3 = $10

--(1.0 –0.5) gal/flush * 86,700 flushes/year * 7.48 ft3/gal * ($0.82 + $0.92)/100 ft3 = $100

TOTAL = $310

Payback Period

--$5,700 / ($310/Year) = 18 Years

Dual flush valves when flushed up are a high efficiency toilet removing liquid waste at 0.8-1.0 gallons per flush. When the valve is flushed down, it becomes a normal toilet flushing solid waste at 1.6 gallons per flush. Product information and a sample memo are included below to educate employees on how the new dual flush toilets work.

Because the payback period is long, this suggestion could be an on-going project. The main idea is to remember to install high efficient equipment when replacing or purchasing new toilet and urinal equipment. As shown in Table 1, this will save **$310 annually** while saving about **131,000 gallons water,** of an increasingly scarce natural resource.

Implementation Status: Implementation in process. Because of the long payback period it is an on-going project that could take years to complete. They do believe that this is an investment that is well worth making.

Key Barriers/Benefits: The situation was thoroughly analyzed and the solutions well researched and disclosures fully made about the long-term nature of this project. Installing low flow toilets and urinals will be economical when a replacement is required.

Vendor Information for High Efficiency Toilets/Urinal

Sloan Uppercut WES-111 Flushometer
Information about Sloan Valve Co. (Memo found here)
http://www.sloanvalve.com/index_4822_ENU_HTML.htm

Vendors:
- Drillspot.com - $166.25 with free shipping
  - http://www.drillspot.com/products/341532/Sloan_WES111_Dual_Flush_Valve
- Grainger - $190
  - http://www.grainger.com/Grainger/wwg/productIndex.shtml?operator=prodIndexRefinementSearch&originalValue=flushometer&L1=Flushometers

Zurn Aquavantage Z6000AV Dual Flush
Information about Zurn Inc.
http://www.zurn.com/pages/catalog.asp?ProductGroupID=6&OperationID=2#p67

Vendors:
- Faucet Direct - $157.28 with free shipping
  - http://www.faucetdirect.com/index.cfm/page/product:display/productid/z6000av%2Dws1%2Ddf/manufacturer/zurn/finish/chrome&source=bec_866590

TOTO TMU1LN12-CP 0.5 GPF Urinal Flushometer
Information about TOTO
http://admin.totousa.com/Product%20Downloads/SS-00097,%20TMU1LN,%20V.01.pdf

Vendors:
- Faucet Direct - $189.60
  - http://www.faucetdirect.com/index.cfm/page/product:display/productid/tmu1ln%2D12/manufacturer/toto/finish/chrome%20plated&source=shz_932336

Company XYZ

Memo

To: [Click **here** and type name]

From: [Click **here** and type name]

CC: [Click **here** and type name]

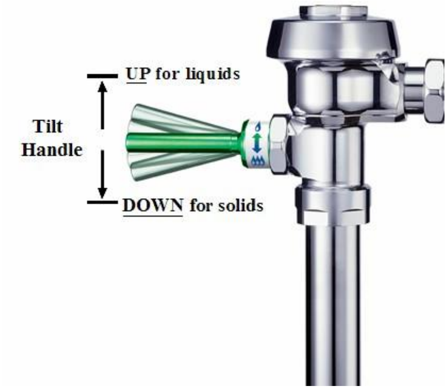
Date: 9/18/20129/17/2012

Re: New Water Conserving Fixtures in Restroom

This facility recently installed new water conserving fixtures in the restrooms to help save water. By installing these new water saving devices we have demonstrated our commitment to helping conserve the world's most precious resource.

How They Work

The new toilets have a Dual-Flush feature which can save up to a 1/2 a gallon of water per flush. Depending on the need, you can either tilt the handle UP for a reduced flush – this is for times when you are only flushing liquid and light paper waste. Or, you can tilt the handle Down for a full flush – this is for solid waste. There are signs within the bathroom area which reinforce the proper operation of the product.



These new Dual-Flush toilets can save a tremendous amount of water, but only if we use them properly. You will notice the new handles on the valves are Green; the handles are coated with specially formulated antimicrobial coating to protect against germs. We hope you will join us in our efforts to save our most precious resource.

Thank you

2. Install toilet diverter on guest room toilets. A toilet diverter is a small device which is installed behind the toilet to divert some of the water which is used to fill the bowl, to fill the tank. It is an inexpensive product which can help reduce up to half a gallon of water per flush. An analysis of the savings derived from use of this product is shown in **Table 1,** assuming that:

- All toilets are retrofitted with an installation time of 15 minutes at $17 per hour
- The product costs $0.75
- A 0.4 gallon reduction occurs each flush
- An average of 2 guests stay in each room, resulting in approximately 5 flushes per day
- There are 109 rooms with an occupancy rate of 75% at the facility
- Cost of water is $0.0044/gallon

Table 1: Analysis of Toilet Diverter

Diverter?	No	Yes
Initial Cost, $	-	82
Water Use, gal/yr	238,710	179,033
Operating Cost, $/yr	1,050	788
Water Savings, gal/yr	-	**~60,000**
Cost Savings, $/yr	-	**250 +**
Payback period	-	**2 years**

Toilet Diverter Calculations

Current Situation

$$75\ \%\ occupancy * 109\ rooms * 1.6\frac{gal}{flush} * 5\frac{flushes}{day} * 365\frac{days}{yr} = \mathbf{238,710}\frac{\mathbf{gal}}{\mathbf{yr}}$$

Cost: $238710\frac{gal}{yr} * \$0.0044\ per\ gallon = \$\mathbf{1,050\ per\ year}$

Proposed Situation (with diverter)

$$75\%\ occupancy * 109\ rooms * 1.2\frac{gal}{flush} * 5\frac{flushes}{day} * 365\frac{days}{yr} = \mathbf{179,033}\frac{\mathbf{gal}}{\mathbf{yr}}$$

Cost: $179033\frac{gal}{yr} * \$0.0044\ per\ gallon = \$\mathbf{788\ per\ year}$

Savings

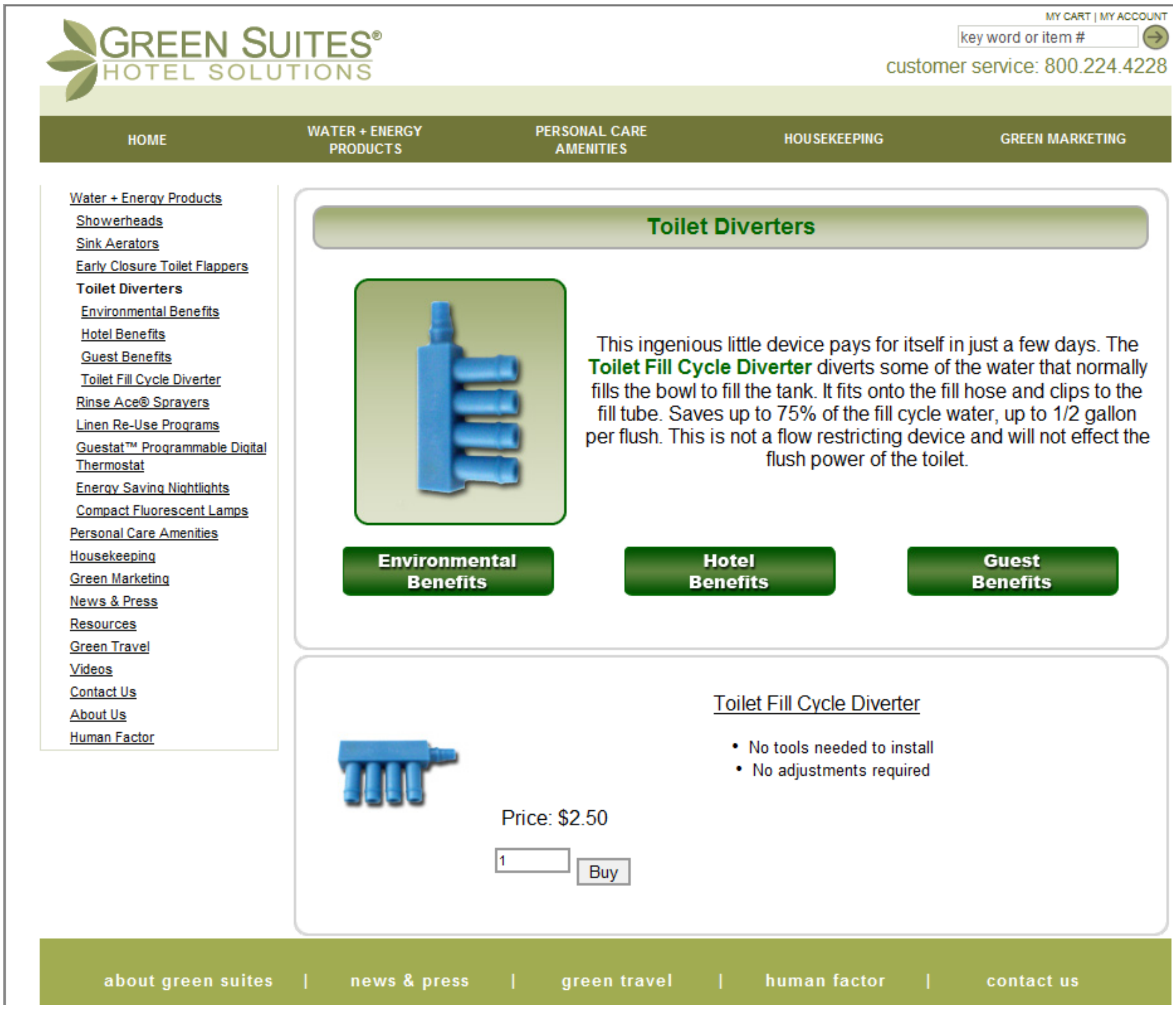
Water: $238710\frac{gal}{yr} - 179033\frac{gal}{yr} = \mathbf{59,677}\frac{\mathbf{gal}}{\mathbf{yr}}$

Cost: $\$1050\ per\ year - \$788\ per\ year = \$\mathbf{262\ per\ year}$

Payback: $\frac{\$0.75\ initial\ cost + 0.25\ hrs\ labor * \$17\ per\ hour\ \ * 109\ rooms}{(\$1050 - \$788)} = \mathbf{2.08\ years}$

Implementation Status: **Not yet reassessed to determine impact.**

Toilet Diverter Vendor Information



Other diverters do exist. This particular one used in the calculations is located at:
http://www.greensuites.com/Environmentally-Friendly-Hotel-Supplies/Toilet-Diverters;jsessionid=GLF3Mm1DW1Js9LzhLnh2Djsvht5301kK9k0d3gnycsXHMcNXyhycY2vcpXTzJrKhTT966G4955CPcX3tRJ8Jn1l5fGTJXYWJvL1cBhKCkcD9nT78XdsCkfDTh0q2GLfJ!1505400622

A few alternatives, at as low of a cost as $0.75, may be found at:
http://www.conservationmart.com/p-320-niagara-toilet-fill-cycle-diverter-n3139.aspx
http://www.energyfederation.org/consumer/default.php/cPath/3499_1062
http://www.usalandlord.com/tankeeclipper.html

Example #3c: **Replace existing shower heads with low-flow models** (adapted from report by Jon Kottich, 2010)

The shower heads in each guest room use 2.0 gpm and should be replaced with new ones with flows as low as 1.5 gpm. These fixtures are somewhat expensive, but they will result in water, natural gas and monetary savings, because all of the water used is heated. The payback period for the project is approximately **1 year.** The possible savings for implementing this modification are shown in the calculations that follow.

Shower Head Calculations

Known Values & Assumptions

--Density of water is 8.33 lb/gal
--Temperature change as given by the EPA Greenhouse Gas Emissions Calculator is (120-55) °F
--Standard efficiency coefficient of natural gas is 1.4
--1 BTU/lb*F
--1 therm = 100,000 BTU at Nebraska cost of $0.60 per therm
--All of the water is heated
--New shower heads use 1.5 gpm at an initial cost of $14.99/each
--All shower heads are replaced with an installation time of 30 minutes at $17 per hour

Current Shower heads

$$75\%\ occupancy * 109\ shower\ heads * 2\frac{showers}{day} * 2.0\ gpm * 10\frac{min}{day} * 365\frac{day}{yr} = \mathbf{1,193,550}\frac{\mathbf{gal}}{\mathbf{yr}}$$

$$1{,}193{,}550\frac{gal}{yr} * 8.33\frac{lb}{gal} * \ 120F - 55F \ * 1\frac{BTU}{lb*F} * 1.4 \div 10^5\frac{BTU}{therm} = \mathbf{9,047}\frac{\mathbf{therms}}{\mathbf{yr}}$$

Water Cost: $1{,}193{,}550\frac{gal}{yr} * \$0.0044\ per\ gallon = \$5250\ per\ year$

Gas Cost: $9047\frac{therms}{yr} * \$0.60\ per\ therm = \$5428\ per\ year$

$10,680 per year

Proposed Shower heads

$$75\%\ occupancy * 109\ shower\ heads * 2\frac{showers}{day} * 1.5\ gpm * 10\frac{min}{day} * 365\frac{day}{yr} = \mathbf{895,163}\frac{\mathbf{gal}}{\mathbf{yr}}$$

$$895{,}163\frac{gal}{yr} * 8.33\frac{lb}{gal} * \ 120F - 55F \ * 1\frac{BTU}{lb*F} * 1.4 \div 10^5\frac{BTU}{therm} = \mathbf{6,786}\frac{\mathbf{therms}}{\mathbf{yr}}$$

Water Cost: $895{,}163\frac{gal}{yr} * \$0.0044\ per\ gallon = \$3939\ per\ year$

Gas Cost: $6{,}786\frac{therms}{yr} * \$0.60\ per\ therm = \$4072\ per\ year$

$8,010 per year

Savings

Gas: $9047\frac{therms}{yr} - 6786\frac{therms}{yr} = \mathbf{2261}\frac{\mathbf{therms}}{\mathbf{yr}}$

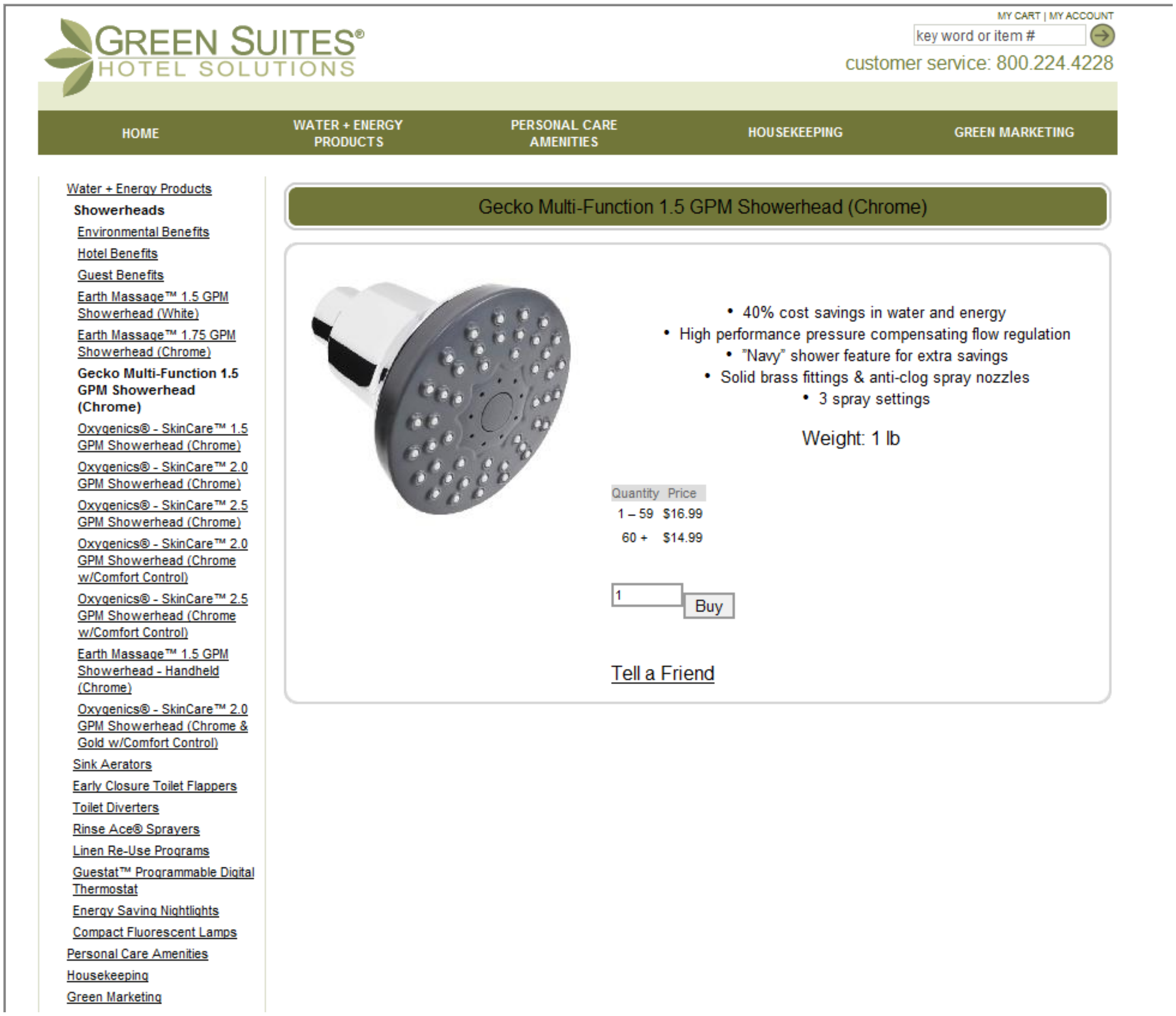
Water: $1{,}193{,}550\frac{gal}{yr} - 895{,}163\frac{gal}{yr} = \mathbf{298,387}\frac{\mathbf{gal}}{\mathbf{yr}}$

Cost: $\$10680\ per\ year - \$8010\ per\ year = \$\mathbf{2,670}\ \mathbf{per\ year}$

Payback Period: $\frac{\$14.99\ upfront\ cost + 0.5\ hrs\ labor * 17\frac{\$}{hr}\ * 109\ shower\ heads}{\$106810 - \$8010} = 0.96\ years \sim \mathbf{1}\ \mathbf{year}$

Implementation Status: **Not yet reassessed to determine impact.**

Shower Head Vendor Information



This is one of numerous shower heads available. This site also sells a 1.75 gpm shower head. It can be viewed at http://www.greensuites.com/Environmentally-Friendly-Hotel-Supplies/Showerheads . Other sites to find low flow shower heads are:

www.grainger.com
www.eartheasy.com
www.showerheadstore.com
www.mcmaster.com

Example #4: Install waterless urinals (adapted from report by Kara Scheel, 2011)

Product Information: Waterless urinals are designed to reduce the amount of water used in a facility. They look fairly similar to regular urinals. Urine travels down the drain, through a replaceable strainer to catch debris, and then through the sealant liquid. The sealant liquid is designed to be less dense than urine, therefore the urine passes through the sealant, allowing it to seal off odor and allowing the urine to flow down the drain line. The sealant liquid provides an airtight barrier between the drain pipe and restroom, preventing odors from leaving the drain. Odor in urinals comes from the chemical reaction that occurs when water and urine mix, generating the familiar ammonia smell. In waterless urinals, urine runs down the drain and is trapped under sealant liquid. Therefore waterless urinals should be odor free as long as the proper cleaning procedures are used. Manufactures recommend that urinals be cleaned daily with a cleaning solution. Other maintenance requires changing sealant liquid according to manufactures recommendations as well as periodically replacing a strainer to keep urinals odor free. Problems with odor in waterless urinals arise from other liquids being poured down waterless urinal drains, interfering with the sealant liquid and the incorrect type of drain pipe being used. To avoid such problems, the company is advised to inform employees of problems occurring when liquids besides urine are disposed of in waterless urinals. Another problem that can lead to odor is the incorrect type of drain pipe being used in the fixture. Manufactures recommend not using copper drainage pipes because copper will corrode and cause problems. Because building codes vary from location to location and waterless urinals are a relatively new technology, the installation and use of this kind of urinal should be confirmed through the local regulatory authority.

Install Waterless Urinals throughout the Facility

By using the new building as a trial, the company can determine whether it is suitable to install waterless urinals throughout the facility. Replacing all urinals in the new building would lead to an annual savings of **250,000 gallons of water and approximately $1,300.** Urinals in the older building are original to the building and use 1.5 gallons per flush causing the building to use a total of approximately 350,000 gallons of water a year. This translates to approximately $1,800 spent on these urinals annually. By installing waterless urinal throughout both buildings, the company could save a total of approximately **600,000 gallons** of water annually. This translates to a total cost savings of approximately **$3100 annually**. Not only would the company save on the amount of water used, maintenance of urinals would decrease due to elimination of leaks and other problems associated with water.

Installing waterless urinals would also reduce the amount of time and resources spent on repairs and maintenance. Because waterless urinals are not connected to a water supply, there is no maintenance or replacements required on flush valves, water supply plumbing, handles, or sensors. Most current wall mounts can be used for new waterless urinals so installation should be easy. Because the company employs a full time plumber, the cost of installation is assumed to be negligible. Table 1 below summarizes the annual savings and payback periods associated with installing waterless urinals in each location. Detailed calculations follow.

Table 1. Summary of Annual Savings and Payback Periods

Location	Water Saved (gal/yr)	Annual Savings	Payback Period: years
Entire New Building	250,000	$1,300	1.5
Entire Old Building	350,000	$1,800	2.0
Entire Facility	**~600,000**	**~$3,100**	**1.5**

Annual Water Cost & Savings Calculations

Known Values:

--Cost of water in Lincoln: $3.84/unit (obtained from water utility Website)

--750 gallons per unit

--Quotes for equipment and installation were obtained from Falcon Waterfree Technologies

Calculations:

Old Building: $350{,}000\ gallons * \frac{1\ unit}{750\ gallons} * \frac{\$3.84}{unit} = \$1{,}792\ per\ year$

New Building: $250{,}000\ gallons * \frac{1\ unit}{750\ gallons} * \frac{\$3.84}{unit} = \$1{,}280\ per\ year$

Total Cost: ~$3,100 per year

Replacing all 9 urinals in new building:

--~250,000 gallons saved annually $250{,}000\ gallons * \frac{1\ unit}{750\ gallons} * \frac{\$3.84}{unit} = \$1{,}280\ saved\ per\ year$

Replacing all 14 urinals in old building:

--~350,000 gallons saved annually $350{,}000\ gallons * \frac{1\ unit}{750\ gallons} * \frac{\$3.84}{unit} = \$1{,}792\ saved\ per\ year$

Payback Period

Replacing all (9) urinals in new building:

--250,000 gallons of water saved -- $1,280 annual savings

--Urinal Cost:

--Falcon: Cost per Unit - $244 $\frac{\$2{,}196}{\$1{,}280/yr} = \sim 1.5\ year\ payback$

Replacing urinals (14) in old building:

--350,000 gallons of water saved -- $1,792 annual savings

--Urinal Cost:

--Falcon: Cost per Unit - $244 $\frac{\$3{,}416}{\$1{,}792/yr} = \sim 2\ year\ payback$

Replacing all (23) urinals:

--600,000 gallons water saved -- $3,072

--Urinal Cost:

--Falcon: Cost per Unit - $244 $\frac{\$5{,}612}{\$3{,}072/yr} = \sim 1.5\ year\ payback$

Note: Some jurisdictions have limitations on the use of waterless urinals as part of their plumbing codes.

Implementation Status: Not yet reassessed to determine impact.

Appendix 3
Greenhouse Gas Reductions Explanation and Calculations

Relevance of Greenhouse Gas Emission Estimates

This issue is an increasingly important one for business decision makers as it relates to regulations, stakeholder interests and day-to-day business operations and energy use. There are several important dimensions of analysis for any pollution prevention opportunity. One is certainly direct environmental impact (e.g. reductions in solid or hazardous waste, water use, air pollution, or energy use). Another important dimension is cost. Yet another is the intangible (not quantifiable) impact, such as reduced liability, increased worker safety/satisfaction, or improved corporate image. A final important dimension is indirectly estimating the impact on greenhouse gas (GHG) emissions that can be achieved by implementing any given pollution prevention opportunity.

GHGs include a number of different gases such as carbon dioxide, methane, nitrous oxide, ozone, chlorofluorocarbons and water vapor. These gases contribute to the "greenhouse effect" in the Earth's atmosphere. While GHGs make the planet warm enough to be habitable, an excessive amount of these gases is believed to be building up in the atmosphere and causing the average global temperature to rise, leading to climate change and instability. A significant spike in GHG concentrations in the atmosphere has occurred since the industrial revolution, pointing to the man-made nature of this change. This is why a new emphasis, and discussion of possible regulations, has been placed on reducing GHG emissions in all parts of our society, including government, business and industry.

The most widely recognized unit for measuring GHG emissions is carbon dioxide equivalent (CO2e). Each of the GHGs has a different capacity to heat the earth's atmosphere, called its global warming potential (GWP). Carbon dioxide (CO2) has a GWP of 1, so in order to standardize reporting, when GHG emissions are calculated, they are reported as equivalent to a given volume of CO2.

Array of Calculation Tools

Reductions in GHG emissions can be estimated using a variety of calculation tools and computer models. The direct environmental/cost benefits estimated or realized are used as quantified input for these calculations, therefore the resulting GHG emission reduction estimates are considered indirect benefits. Some commonly used tools are listed below:

--Nationally recognized conversion factors from the U.S. Department of Energy and the American Water Works Association: these are used to estimate GHG emissions for electricity, natural gas, and water use. For example, a national average estimate of kilowatt-hours (kWh) of electricity used can be converted to GHG emissions using a factor of 1.404 pounds CO2 e per kWh.

--EPA's WAste Reduction Model (WARM): this tool is used to determine GHG emissions related to solid waste. This online calculator uses a life-cycle approach to determine the change in GHG emissions caused by alternative end-of-life waste management decisions or disposal methods for a number of different kinds of wastes. For example, using the weight of a solid waste diverted from a landfill and recycled, an approximate reduction in GHG can be calculated. WARM is periodically updated and new material types are added by the EPA as new information from climate change research becomes available.

--Economic Input Output Life Cycle Assessment (EIO-LCA): this model used to estimate GHG reductions has been developed by researchers at Carnegie Mellon University. This model provides a useful approximation of GHG reductions through the full life-cycle production of a material or chemical, based on the cost savings from reductions in use. For example, if a business reduces its lubricating oil purchases by $50,000, the EIO-LCA estimates the GHG emissions to produce that oil through the mining, extracting, refining, packaging and delivery (to list a few) steps in the process of getting that oil to the end user.

--Recycled Content (ReCon) Tool: EPA created the ReCon Tool to help companies and individuals estimate life-cycle greenhouse gas (GHG) emissions and energy impacts from purchasing and/or manufacturing materials with varying degrees of post-consumer recycled content.

--Pollution Prevention (P2) Greenhouse Gas (GHG) Calculator: designed by U.S. EPA in conjunction with a panel of professionals from the P2 community with state and local governments, business facilities, grantees, and project managers in mind. The tool was reviewed in national webinars and conferences reaching over 600 participants and reworked to be more robust and user friendly. The tool is available in an Excel format and finalized as of **November 2011**. U.S. EPA will periodically update the tool as new information and data sources become available. It is designed to help calculate GHG emissions reductions in metric tons of carbon dioxide equivalent (MTCO2e) from electricity conservation, green energy, fuel and chemical substitutions, water conservation, and improved materials and process management in the chemical manufacturing sector.

Selecting the Most Appropriate Tool(s):

When using one of these models to estimate GHG emission reductions for a client, always provide an explanation of which model was used, why it is most relevant for the issue at hand, what assumptions were applied, and the importance of reducing GHG emissions as a business and global sustainability strategy.

A summary sentence stating the amount of GHG reduction should be included with each recommendation, e.g. "Using more water efficient faucets will save 580,000 gallons/water/year and reduce GHG emissions by over 12 $MTCO_2e$/year. A detailed appendix should be developed which shows how the GHG emission reductions were calculated. An example of an Appendix documenting such follows.

Example Appendix of Greenhouse Gas Calculations

Opportunity 1 – New faucet aerators

GHG calculated Using EPA's P2 GHG Calculator

Savings:

--581,855 gallon reduction in water use per year

--2,206 therm reduction in natural gas usage per year

--$3,883.76 in savings

Assumptions:

--GHG Conversion based on Nebraska conversion factor

--11.728 lb CO_2E per therm based on the EPA GHG Calculator

--0.03516 $MTCO_2E$ per 1,000 gallons of hot water based on EPA GHG Calculator

--0.003149 $MTCO_2E$ per 1,000 gallons of cold water based on EPA GHG Calculator

--1 $MTCO_2E$ (Metric Ton of Carbon Dioxide Equivalent) is equal to 2204.6 lb

Calculations:

$$Gas: \quad 2206\ therms * 11.728 \frac{lb\ CO_2E}{therm} * 1 \frac{MTCO_2E}{2204.6\ lb} = 11.735\ MTCO_2E$$

$$Water: \quad 581855\ gallons * 0.003149 \frac{MTCO_2E}{1{,}000\ gal} = 0.831\ MTCO_2E$$

⇨ **12.566 $MTCO_2E$**

Sources:

Natural gas

--The Climate Registry, "General Reporting Protocol" 2008. (http://www.theclimateregistry.org/downloads/GRP.pdf)
--IPCC Second Assessment Report, 1995, Chapter 2, Table 2.14, Page 212. (http://www.ipcc.ch/ipccreports/ar4-wg1.htm)

Water

--U.S. EPA, Clean Energy. "eGRID 2007 Version 1.1." February 2009. Downloadable ZIP file: eGRID20071_1year05_aggregation.xls, tab NRL05 and US05.
--US EPA, Downloadable Document: "Unit Conversions, Emissions Factors, and Other Reference Data, 2004." Table I, Page 1.
--Water and Sustainability: U.S. Electricity Consumption for Water Supply & Treatment—The Next Half Century, EPRI, Palo Alto, CA: 2000. 1006787.
--EPA's WaterSense Calculator (http://www.epa.gov/WaterSense/calculator/WaterSenseCalculator.xls)

Opportunity 2 – Waterless Urinals

GHG calculated Using EPA's P2 GHG Calculator

Assumptions:

- Using Nebraska Averages
- Conversion Factor: 3,300 kWh/1,000,000 gal. water used

Calculations:

- Input: 170,000 gal; Output: 0.535 $MTCO_2e$ (after implementing changes)
- Input: 600,000 gal; Output: 1.889 $MTCO_2e$ (existing condition; before changes)
- **Difference (Total reduction in GHG emissions): 1.354 $MTCO_2e$**

Sources:

- U.S. EPA, Clean Energy. "eGRID 2007 Version 1.1." February 2009. Dowloadable ZIP file: eGRID20071_1year05_aggregation.xls, tab NRL05 and US05.
- US EPA, Downloadable Document: "Unit Conversions, Emissions Factors, and Other Reference Data, 2004." Table I, Page 1.
- Water and Sustainability: U.S. Electricity Consumption for Water Supply & Treatment—The Next Half Century, EPRI, Palo Alto, CA: 2000. 1006787.

Tips for Making the Business Case for Change

Tip # 1: Writing an Executive Summary
An executive summary is a brief overview of a report designed to give readers a quick preview of its contents. Its purpose is to consolidate the principal points of a document in one place. After reading the summary, your audience should understand the main points you are making and your evidence for those points without having to read every part of your report in full. It is called an executive summary because the audience is usually someone who makes funding, personnel, or policy decisions and needs information quickly and efficiently in order to make decisions and respond appropriately.

Guidelines:
An executive summary should communicate independently of the report. It should stand on its own as a complete document.

It should explain why you wrote the report, emphasize your conclusions or recommendations, and include only the essential or most significant information to support those conclusions.

Use subtitles, bullets, tables, selective bolding or other types of organizational structure to add clarity to your summary

It should be concise—about 10% of the length of the full report.

It should be organized according to the sequence of information presented in the full report. Don't introduce any new information that is not in your report.

To help with organizing the executive summary, after you have written the full report, find key words; words that enumerate (first, next, finally); words that express causation (therefore, consequently); words that signal essentials (basically, central, leading, principal, major); and contrast (however, similarly, less likely).

Read the completed summary with fresh eyes. Check spelling, grammar, punctuation, details, and content. Ask someone else to read it.

Tip #2: Technical Writing Tips:

Use these tips as a **checklist** as you prepare your report.

- **Proof reading.** Write your report, let it sit, then proof read it for grammar, jargon, clarity, multiple meanings, and technical correctness before submittal. Re-read the report from the recipient's point of view. Reading the report aloud may help.
- **Figures and tables.** Refer to each figure and table in the text prior to inserting it. Always place the figure or table in the report soon after you have referred to it. Include a title and number for all figures and tables, capitalizing the title when referring to a specific table or figure, e.g., "All of the wastes generated by the shop are listed in Table 1
- **Transitions.** Provide brief transition sentences between sections of the report and before a bulleted list to explain what the list consists of and how it is organized.
- **Parallel construction.** Use parallel construction in all numbered or bulleted lists. For example, all items should be a complete sentence or none should be; or all items might begin with an active verb, e.g., "use," "change," "remove" or a noun, like this list.
- **Format.** A general format/outline has been suggested, although this may need to be modified to address a client's requests. Generally you should:
  - Move from generalities to specifics, in each section and across the report as a whole.
  - Use page numbers.
  - Keep section headings with the narrative that follows at page breaks.
  - Rarely split a table across two pages.
- **Abbreviations.** On first use, spell the term out completely, followed by the abbreviation in parentheses. For example, "Volatile Organic Compounds (VOCs) are another waste that could be minimized." Subsequently, just the abbreviation is sufficient unless it is used at the beginning of a sentence. Never start a sentence with an abbreviation or a numeral.
- **Professional tone.**
  - Avoid slang, informal terminology (inexpensive vs. cheap), or imprecise (there, that, it) language.
  - Be careful how you word suggestions. Avoid making recommendations outside of your area and level of expertise in source reduction and waste minimization.
  - Use tact and be positive in your conclusions. Remember a reader likes to be complimented, but can see through phoniness.
  - Be careful to confirm your information if you state it as a fact; or cite your source, e.g., "According to Mr. Jones, Plant Engineer, . ." or state that the information is a potential based on xyz assumptions.
- **Common errors.**
  - i.e. vs. e.g.: i.e. means "that is" or "in other words," and e.g. means "for example."
  - compliment vs. complement: a compliment is a nice comment, and a complement is a part of a whole
  - how many vs. how much: how many can be counted, and how much is uncountable, e.g., how many bottles of water vs. how much water.
  - policies vs. procedures vs. practices: policies are formal written positions or statements about some issue; procedures are written directives aimed at accomplishing a task or complying with a policy; practices are typically informal steps people take, which may or may not follow written policies and procedures

Tip #3: General Recommendations

General recommendations are made to help a company establish the culture and infrastructure needed to establish and sustain a commitment to source reduction and sustainability. Examples of commonly made general recommendations include:

1. A pollution prevention policy statement should be generated and periodically updated by management to formally reflect management's commitment to incorporating pollution prevention in the company's operations. Some examples of formal policy statements follow:

> *This company is committed to continued excellence, leadership, and stewardship in protecting the environment. Environmental policy is a primary management responsibility, as well as the responsibility of every employee.*
>
> *The corporate objective is to reduce waste and achieve minimal adverse impact on the air, water, and land through excellence in environmental control.*
>
> *Minimizing or eliminating the generation of hazardous waste is a prime consideration in process design and plant operations and is viewed by management as having a priority as high as safety, yield, and loss prevention.*

2. To further implement the corporate pollution prevention policy, one or more "cause champions" should be selected to lead the pollution prevention program and overcome the resistance present when changes are made to existing operations. These "cause champions" may include a project manager, an environmental coordinator, or anyone else dedicated to implementing the pollution prevention ideal and company policy. These individuals must be given authority by management to carry out the policy.

3. Input from employees should be considered, encouraged, and valued. Since the employees must deal with the waste, they may have insight into how a specific pollution prevention opportunity may be implemented. Many companies offer incentives to employees who suggest innovations to minimize or reduce waste generation.

4. Goals should be established to help implement and track the progress of the corporate pollution prevention policy. Specific, quantitative goals should be set that are acceptable to those willing to work to achieve them, flexible to changing requirements, and achievable with a practical level of effort. To document the progress of the pollution prevention goals, a waste accounting system should be used.