AIR FORCE
WATER CONSERVATION GUIDEBOOK

PREPARED FOR

AIR FORCE CIVIL ENGINEER SUPPORT AGENCY

PREPARED BY

CH2MHILL

MAY 2002

Contents

Contents, Continued

Section **Page**

Contents, Continued

Acronyms and Abbreviations

AFCEEAir Force Center for Environmental Excellence

AFCESA	Air Force Civil Engineer Support Agency
AFEPPM	Air Force Energy Program Procedural Memorandum
BAT	Best Available Technology
BGD	Billion Gallons Per Day
BMP	Best Management Practice
CEMIRT	Civil Engineer Maintenance, Inspection, and Repair Team
CONUS	Continental United States
DOE	Department of Energy
ECIP	Energy Conservation Investment Program
EMCS	Energy Management Control Systems
ESCO	Energy Services Company
ESPC	Energy Savings Performance Contract
ET	Evapotranspiration
ETL	Engineering Technical Letter
FEMP	Federal Energy Management Program
FOA	Field Operating Agency
GPCD	Gallons Per Capita Per Day
GPCY	Gallons Per Capita Per Year
GPF	Gallons Per Flush
GPM	Gallons Per Minute
GPY	Gallons Per Year
ICI	Industrial, Commercial, and Institutional
IDIQ	Indefinite Delivery Indefinite Quantity
Kgal	Thousand Gallons
LCCA	Life Cycle Cost Analysis
MFH	Military Family Housing
MILCON	Military Construction Program

Acronyms and Abbreviations, Continued

NFESC	Naval Facilities Engineering Services Center
OCONUS	Outside Continental United States
O&M	Operations and Maintenance
OSD	Office of the Secretary of Defense
PACES	Parametric Cost Engineering System
RCO	Regional Contract Office
RESPC	Regional Energy Savings Performance Contracts
RWP	Recurring Work Program
SF	Square Foot
SIR	Savings to Investment Ratio
TO	Technical Order
TSF	Total Square Footage
UESC	Utility Energy Services Contracts
UFC	Unified Facilities Criteria
UPC	Uniform Plumbing Code
USGS	U.S. Geological Survey

Preface

This water conservation guide was developed under the auspices of HQ Air Force Civil Engineer Support Agency (HQ AFCESA). It is intended to assist base-level personnel in complying with Executive Order 13123 requirements for federal facilities to reduce potable water usage through the implementation of life cycle, cost effective water efficiency programs. These programs require each installation to:

- Develop an installation-specific water management plan; and
- Implement at least four separate water efficiency Best Management Practices (BMPs) that have been established by the DOE Federal Energy Management Program (FEMP).

Should you have questions regarding this guidance or any other issue associated with the potable water system at your base, you may direct them to your MAJCOM, or to:

Mr. Michael Clawson
Water Systems Engineer
HQ AFCESA/CESC
Tyndall AFB, Florida 32403
(850) 283-6363
DSN 523-6362
e-mail: michael.clawson@tyndall.af.mil

The mission of the Air Force Civil Engineer Support Agency (AFCESA) is to provide the best tools, practices, and professional support to maximize Air Force civil engineering capabilities in base and contingency operations. AFCESA is a field operating agency (FOA) of the Air Staff that consists of four directorates:

- Operations Support
- Technical Support
- Contingency Support
- Civil Engineer Maintenance, Inspection, and Repair Team (CEMIRT)

Collectively, these four directorates provide products and services in seven major product areas:

- Readiness
- Training
- Vehicles and Equipment
- Management Practices
- Automation Support
- Technical Support
- Research, Development, and Acquisition

For more information on the role, mission, and work of HQ AFCESA you may visit the agency's website at http://www.afcesa.af.mil.

Acknowledgements

Contractor support for development of this guide was provided to HQ AFCESA by CH2M HILL. CH2M HILL was ably supported in this effort by AFCESA staff (Mr. Michael Clawson ; Tyndall Air Force Base (AFB) staff (Mr. Nelson Mora); Tampa Bay Water Authority personnel (Mr. Dave Bracciano); and Southwest Florida Water Management District personnel (Mr. Anthony Andrade). CH2M HILL gratefully acknowledges their assistance in the completion of this effort.

We would also like to acknowledge the following individuals who took the time to review and provide comments on one or more drafts of the Guidebook.

Mr. John Kain (AFCESA/CESM, Tyndall AFB)
Mr. Pradip Badheka (EM-WP, Robins AFB)
SMSgt Peter Wixted (USAFE/CEVQ, Ramstein AFB)
Capt Scott Mattes (HQ USAF/ILEVQ, Pentagon)
Ms Stephanie Tanner (NREL, U.S. Department of Energy)
Ms Karen Kivela (AFCEE/EQT, Brooks AFB)
TSgt Michael Murphy (50 CES/ CEOFHU, Schriever AFB)
Mr. Timothy Adams, (AFCESA/ CESM- TRW, Tyndall AFB)
Mr. Dana Voight (AFCESA/CES -TRW, Tyndall AFB)
Mr. Nelson Mora (325 CES/CEO, Tyndall AFB)
Capt. Robert Cottrell (HQ AFCESA/CES-ULT)
Mr. Jim Snook (HQ AFCESA/CESC)
Mr. Jayant Shah (HQ USAF/ILEV, Pentagon)

The mention of specific products and/or trade names should not be construed as endorsement by the United States Air Force, HQ Air Force Civil Engineer Support Agency, or any other organization involved in the preparation of this guidebook.

Executive Summary

The purpose of this guidebook is to assist Air Force installations in meeting the new water conservation requirements of Executive Order 13123, *Greening the Government Through Efficient Energy Management.* The executive order requires the Air Force and all other federal agencies to reduce use of potable water through the implementation of life cycle, cost effective water efficiency programs.

Subsequent implementation guidance from the U.S. Department of Energy (DOE) Federal Energy Management Program (FEMP) established a federal water efficiency goal. The goal stipulates that each federal agency must develop a water management plan and implement at least four DOE FEMP Best Management Practices (BMPs). These stipulations apply to every Air Force installation (whether CONUS or OCONUS), though small Geographically Separated Units (GSUs) can be covered under the water management plan of the main base.

Technical aspects of water conservation are not included in the scope of this guidebook. Those issues are documented in Military Handbook 1165 (dated 7 April 1997). Similarly, previously existing water conservation requirements (i.e., Air Force Energy Program Procedural Memorandum 96-2, and other Air Force, federal, state, or local requirements) are not addressed. Instead, the guidebook focuses on providing detailed and practical instructions for developing the required water management plan; evaluating the ten FEMP established BMPs; and securing funding for required retrofit or replacement options associated with the BMPs.

Use of the procedures and strategies defined in this guidebook are optional, however, compliance with the executive order and the DOE-issued goal is mandatory for all Air Force installations. Compliance is to be reported annually through the chain of command using the form that is included in Appendix D of this guidebook.

CHAPTER 1

Why Conserve Water?

Water plays a key role in practically every aspect of human life. A plentiful and sustainable water supply is critical to our nation's economic, social, and physical health. In most areas of the United States water has historically been inexpensive and in abundant supply. For this reason, water conservation has never achieved a high level of priority for government, industry, commercial, or residential users. In recent years, however, given the increasing demand placed upon our nation's water resources, it has become apparent that the availability of fresh, potable water can no longer be taken for granted. Implementing water conservation initiatives is critical to the economic and sociological success of our civilization. In essence, we must conserve water because:

- Water is a limited natural resource with finite availability
- Water is a resource necessary to sustain human life
- The increasing cost of this resource will significantly impact economies and budgets

The Air Force recognizes the implication of these factors to its successful operation and that quality-of-life for future generations depends in large measure upon the proper stewardship of today's water resources.

1.1 Air Force Water Use

With installations worldwide, the U.S. Air Force is a major water user. In FY00, the baseline year for reporting water consumption, the Air Force used more than 52 billion gallons of potable water at a cost of more than $75 million. Given new regulations governing drinking water sources, treatment and distribution, and disposal of wastewater, the cost of water will increase in the future. Since 1990, water and sewer costs in some of America's major cities have increased by as much as 100 to 400 percent.

The Air Force has not been immune to these cost increases. Though the cost of water and sewer services is as low as $0.15 per-thousand-gallons (Kgal) at one installation, many other bases paid in excess of $4.00 per-thousand-gallons (Kgal) in FY00. One Outside Continental U.S. (OCONUS) installation reported a cost of more than $14.00 per Kgal.

As demand for water increases and regulatory requirements proliferate, the long-term forecast points to continually escalating water and sewer costs. For this reason, the Air Force is taking practical steps today to reduce potable water consumption.

1.2 Executive Order 13123

Recognizing that tremendous water conservation potential exists through federal conservation efforts, Executive Order 13123 was signed on 3 June 1999. This executive order, *Greening the Government Through Efficient Energy Management,* requires the federal government to determine a baseline for water consumption and establish water conservation goals for all federal agencies.

1.3 Executive Order Implications

The U.S. Department of Energy (DOE) was tasked with leading the effort to determine the federal water use baseline and developing the water conservation goals. The DOE formed an interagency working group comprised of representatives from each federal agency and military service to assist in this effort.

On 12 January 2000, the Secretary of Energy issued the first set of guidance documents for Executive Order 13123. This guidance established FY00 as the baseline year for measuring federal potable water usage. Because potable water is the most necessary water resource, it was decided non-potable water use would be excluded from the federal baseline. This decision will hopefully encourage federal agencies to consider switching to non-potable water sources, when appropriate and cost-effective, for uses that include irrigation, cooling, industrial processes, and similar activities.

1.4 Water Conservation Goals

On 31 July 2000 the DOE issued a second set of guidance documents, known as the *Guidance to Establish Water Efficiency Improvement for Federal Agencies* (see Appendix A). This guidance document establishes a federal water conservation goal requiring each Air Force installation (as well as every other federal agency) to develop a water management plan and to implement at least four water efficiency Best Management Practices (BMPs).

Each BMP consists of: (1) Operations and Maintenance (O&M) Options; and, (2) Retrofit and Replacement Options. The O&M options focus on optimizing existing equipment and fixtures to minimize water use. The Retrofit and Replacement options focus on modifying or replacing outdated fixtures and equipment. The BMPs established by the DOE FEMP address the following areas:

- BMP #1—Public Information and Education Programs
- BMP #2—Distribution System Audits, Leak Detection, and Repair
- BMP #3—Water Efficient Landscaping
- BMP #4—Toilets and Urinals
- BMP #5—Faucets and Showerheads
- BMP #6—Boiler/Steam Systems
- BMP #7—Single-Pass Cooling Systems
- BMP #8—Cooling Tower Management
- BMP #9—Miscellaneous High Water-Using Processes
- BMP #10—Water Reuse and Recycling

All Air Force installations must develop water management plans by 2005. Plans must be incorporated into existing operation or facility plans. Though not mandated, the suggested location for the water management plan is as a component of the installation's energy conservation plan. Compliance with the goal further requires the following percentage of bases to implement at least four BMPs by the dates shown.

- 5% of bases by 2002
- 15% of bases by 2004
- 30% of bases by 2006
- 50% of bases by 2008
- 80% of bases by 2010

The DOE goals do not require federal agencies to reduce water consumption by a set percentage. This was a conscious decision, made to prevent installations that have already implemented aggressive water conservation programs from being unfairly penalized. Instead, the goal will allow these installations to receive full credit for past water conservation initiatives. In addition, there are bases located in areas of the country that enjoy unusually low potable water rates. Due to the low rates these bases could find it difficult to realize enough savings to offset the cost of water conservation measures. The Department of Energy has reserved the option to review the progress of federal agencies in 2005. At that time the department could possibly revise the water efficiency improvement goals. Such a revision could result in a more onerous requirement, so it is important that the Air Force and all other federal agencies diligently pursue compliance with the goal as presently stated.

1.5 Funding for Water Conservation Projects

Obtaining funding for implementation of water conservation measures has historically been a difficult task for Air Force installations. Chapter Four of this guidebook specifically addresses the major avenues available for funding water conservation measures (WCMs).

One of these funding avenues is Energy Savings Performance Contracts (ESPCs). These contracts, with private sector companies known as *Energy Services Companies* (ESCOs), were created to provide an economical method to finance energy and water audits and conservation measures.

Under the program, such projects do not compete for funding with other base construction requirements. Instead, ESCOs incur all up-front costs for retrofit or replacement efforts in return for a predetermined share of future savings. This allows installations to implement water conservation measures without any initial capital investment, and even without future payment if the measures fail to produce the necessary savings.

Executive Order 13123 specifically encourages the use of ESPCs whenever practical for financing water and energy conservation measures. Indeed, one of the major purposes of this guidebook is to stimulate use of this funding strategy by defining a process for identification of WCMs that are candidates for implementation using an ESPC.

1.6 Benefits of Water Conservation

The legal and legislative requirements aside, water conservation makes good sense for the Air Force. Prudent use of potable water ensures this vital resource will be available for future generations. And as previously mentioned, a program for effective water conservation can help insulate the Air Force from constantly rising water and sewer costs.

Reducing water consumption can also lead to reductions in the energy costs for treating, heating, cooling, and pumping water. Reduced energy use translates into fewer emissions from power plants, an outcome that enhances the Air Force commitment to pollution prevention. Another environmental benefit resulting from water conservation is the reduced demand for chlorine and other chemicals used to treat potable water and wastewater. By conserving water the Air Force will also demonstrate to the public its willingness to serve as a responsive community partner in environmental stewardship activities.

Personnel responsible for plan development should be mindful that water conservation measures need not be severe or result in cutbacks in operations or service levels. In fact, water conservation should be pursued in a manner that does not degrade military readiness, safety, mission effectiveness, or quality of life for Air Force personnel or dependents.

CHAPTER 2

Water Management Plans

Issued in 1999, Executive Order 13123 (*Greening the Government Through Efficient Energy Management)* mandates an aggressive policy for reducing potable water consumption at federal facilities. Subsequent implementation guidance from the DOE (refer to Appendix A, *Guidance to Establish Water Efficiency Improvement Goals for Federal Agencies)* sets a requirement for each federal agency to "reduce potable water usage by implementing life cycle, cost effective water efficiency programs that include a water management plan, and not less than four FEMP Water Efficiency Improvement Best Management Practices (BMPs)."

This guidebook is written to assist Air Force personnel in complying with the new water conservation requirements of Executive Order 13123. This chapter provides a step-by-step approach for developing the installation-specific water management plan. Subsequent chapters include procedures for investigating the FEMP BMPs and for obtaining funding to implement retrofit/replacement options.

2.1 Required Components for Water Management Plans

At a minimum, each water management plan must comply with the following requirements, and contain the following information.

1. Utility information including:

- contact information for all water and wastewater utilities;
- current rate schedules and alternative schedules appropriate for your usage or facility type (you'll want to make sure you are paying the best rate);
- copies of water/sewer bills for the past two years (this will help identify inaccuracies and determine that you are using the appropriate rate structure);
- information on financial or technical assistance available from the utilities to help with facility water planning and implementing water efficiency programs (sometimes energy utilities offer assistance on water efficiency); and
- contact information for the agency or office that pays water/sewer bills; and production information (if the facility produces its water and/or treats its own wastewater).

2. Facility information:
    - While the FEMP guidance requires a walk through audit of all facilities to identify water usage and conservation opportunities, this guidebook offers a modified and more practical approach. Because of the number of facilities on a typical Air Force installation, a walk-through audit would be impractical from a time and manpower perspective. Instead of a walk-through audit, the procedure outlined in this chapter will allow Air Force personnel to develop a credible and defensible estimate of water

use by facility category without performing a walk-through audit. The Air Force has coordinated this change in procedure with FEMP. Installations that elect to perform a more detailed water use audit may consult MIL HDBK 1165 for specific instructions.

3. Emergency response information (water emergency and/or drought contingency plans):
   - plans must be developed (or incorporated) describing how installations will meet minimum water needs in an emergency, or reduce water consumption in a drought or water shortage (do this in conjunction with your local water supplier).
4. Comprehensive planning information including:
   - plan for informing staff, contractors, and the public of the priority your installation places on water and energy efficiency;
   - actions the base will take to ensure that personnel take water supply, wastewater, storm water issues, and water efficiency BMPs into account at the earliest stages of planning and design for renovation and new construction.
5. Inclusion of appropriate Operations and Maintenance (O&M) options into facility operating plans and procedure manuals. (This requirement applies only to the O&M options associated with BMPs that are selected for implementation. Options for BMPs that are not selected for implementation need not be included in facility operating plans and procedure manuals.)

2.2 Water Conservation Plan Development: A Step-By-Step Approach

The remainder of this chapter describes a six-step approach (see Figure 2-1) for developing a water conservation plan that complies with the executive order and DOE requirements. By following these steps, Air Force personnel will be able to develop a water management plan that complies with the federal requirements and identifies the most effective BMPs for implementation at the installation. For convenience, Appendix B consists of a sample water management plan that demonstrates use of the procedures defined in this guidebook.

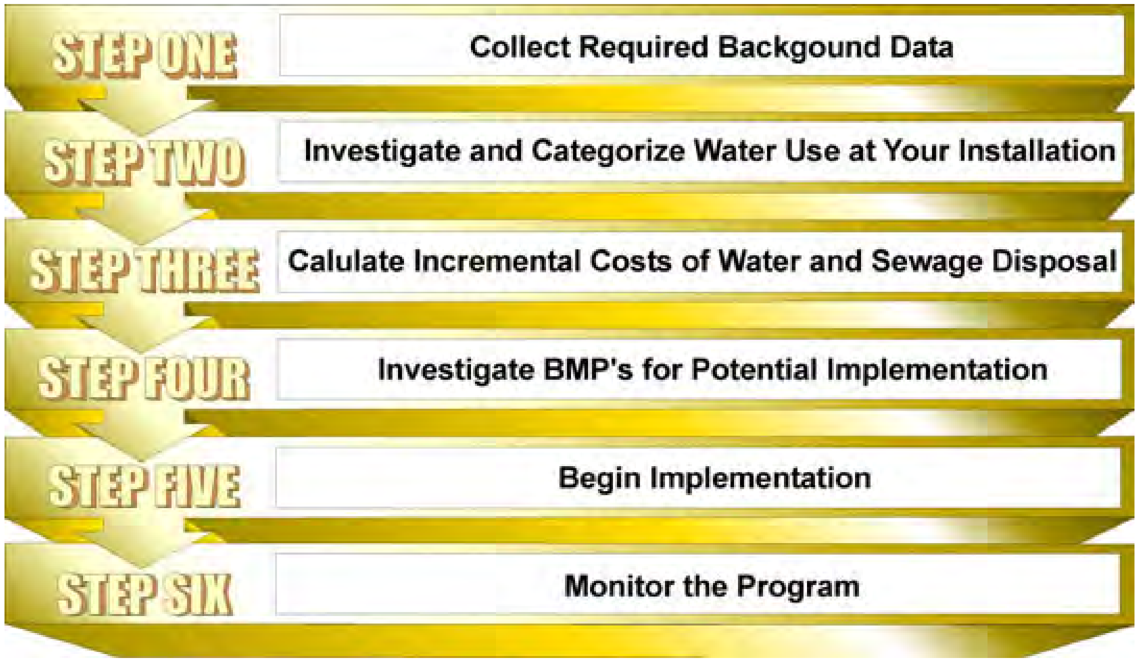
While implementing these steps is not complex, the process does require careful planning and participation from different levels of personnel. Personnel selected to lead development of the plan should possess a thorough understanding of the base, its facilities, the utility infrastructure, and water related policies and practices.

2.2.1 Step 1: Collect Required Background Data

The first step in the process involves collecting background and supporting data and documentation. This component of the water management plan involves data collection that provides support to the overall planning process. The background data required includes the following.

Utility Information. The required information, as discussed in Section 2.1, can be gathered through contact with the office at your base that has responsibility for paying water bills, and by contacting representatives of your local water utility.

FIGURE 2.1
Six-Step Approach to Water Conservation Plan Development



Water Emergency and/or Drought Contingency Plans. These plans are already developed for each base and should be included by reference in your water management plan. The emergency and/or drought contingency plans can be obtained by contacting your base energy manager.

Additional Information Requirements. There are additional requirements for the water management plan to include "appropriate O&M recommendations from the FEMP BMPs into facility operating plans and procedure manuals" and to undertake comprehensive planning efforts to "inform staff, contractors, and the public of the priority your agency of facility places on water and energy efficiency." Incorporating the water management plan into the installation's existing energy conservation plan can largely satisfy these requirements. Consult your base energy manager for information on how to accomplish this effort.

2.2.2 Step 2: Investigate and Categorize Water Use at the Installation

Though the DOE goal recommends a facility walk-though audit to identify how, where, and how much water is used at an installation, two factors make this recommendation impractical for the Air Force. First, given the number of facilities on a typical base, a walk-through audit would require a commitment of time and manpower that exceeds available resources. Secondly, because Air Force bases typically employ only a few secondary meters it is doubtful that the information gained from a facility walk-through audit would be of much real value.

In an effort to satisfy the intent of this requirement, the Air Force has selected a process for developing a credible and defensible estimate for water use by facility category. To the maximum extent possible, this process is designed to function in the mode of a "desk-top survey" that will minimize the time and effort required to understand water use at your installation and allow you to quickly produce a compliant water management plan.

Identify Water Use Categories for Installation Facilities

For the purpos of this process, it is sufficient to estimate water use according to the following broad categories. The categories include:

- Category 1 — Housing
- Category 2 — Commercial
- Category 3 — Irrigation
- Category 4 — Leaks, losses, and unaccounted for water
- Category 5 — Industrial

By getting a reasonable idea of the water used in each category, you will be able to identify the BMPs with the most water savings potential. For instance, if you determine that a large percentage of water is used in the irrigation category it may indicate a need to specifically investigate the applicability of BMP #3 (Landscape Irrigation), and/or BMP #10 (Water Reuse and Recycling). Similarly, heavy use in the housing and/or commercial categories could indicate BMPs #4 and #5 (Toilets/Urinals and Faucets/Showerheads, respectively) may be beneficial measures for reducing domestic water use. Conversely, low use in the leaks, losses, and unaccounted for water category (perhaps, <10%) may limit the need to further investigate BMP #2 (Distribution System Audits, Leak Detection, and Repair).

If a base is completely metered, determining water use by facility is a simple task. However, bases are rarely completely metered. The following paragraphs provide methods for estimating the usage by category. Because these are estimates, the actual usage of each category will be different from the estimate. Sometimes the difference may be significant. Because they are estimates, the total estimated usage for all categories may be more or less than the actual base usage. The purpose of the estimates is to help focus on areas where the highest potential for savings will occur.

Estimate Water Use By Category

If available, use data (i.e., billing records) that accurately reflects water use in the target categories. In the absence of such data, use the following methods to arrive at credible and defensible estimate for water use in each category.

Category 1—Housing. This category represents an estimate of water use in both Military Family Housing (MFH) and Unaccompanied Personnel Housing (dormitories, BOQs, BEQs).

Actual billing records should be available for this category; otherwise water use can be estimated by multiplying the number of residents in base housing by the national average of 101.0 gallons-per-capita-per-day (gpcd). The base housing office can provide you with the number of personnel who live in base housing facilities. Once you have multiplied the number of residents by 101.0 gpcd, the product is then multiplied by 365 (days) to arrive at the gallons-per-year (GPY) estimate for this category.

It is important to recognize that the 101.0 gpcd national average represents residents living in metered conditions, and who are responsible for paying monthly water bills. Residents of

Air Force housing units 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%. For this reason, if your estimate of water use in this category appears to be low you may consider using a figure that is higher than the 101.0 gpcd national average.

Category 2—Commercial. This category includes such facilities as administrative buildings, dining halls, hospitals, schools, etc. In the absence of actual figures you may use the Federal Water Use Indices included in Appendix C of this guide to estimate commercial water use. The indices consist of benchmarks for estimating water use for a variety of facility types.

Category 3—Irrigation. In the absence of secondary meters for irrigation systems, you may use at least two methods for estimating the irrigation water demand at your base.

Method One

The Federal Water Use Indices (see Appendix C) estimate that 1,571 gpd of landscape irrigation water is required per acre of turf areas, and 785 gpd per acre per non-turf areas. If you have a mixture of turf and non-turf areas under irrigation you should use the higher turf rate estimate.

If the base golf course is unmetered and uses potable water be sure to include it in your calculations. Golf courses have significant landscape irrigation water requirements. If the golf course is metered you should list the actual use figures separate from the general base irrigation estimate in order to prevent double-counting in this category.

Exclude any acreage that uses non-potable water for irrigation (i.e., surface water, non-potable wells, reclaimed wastewater) from your calculations since non-potable water usage is not a factor in the federal goals.

Note that irrigation water use varies greatly by geographic location. The Federal Water Use Indices are most accurate for non-arid areas. In arid or semi-arid regions you should consult your local water utility for region-specific irrigation water estimates.

Method Two

Another method for calculating water use in the irrigation category involves comparing monthly billing records. Colder temperatures in the winter months (December, January, and February) and dormant vegetation largely eliminate the need for irrigation water during this time of year. All other factors being equal, a large part of the difference in water use between the winter months and the rest of the year can be attributed to irrigation use.

To use this method, calculate the average of the total monthly water use for December, January, and February. Then, multiply this average by 12 and subtract the product from the total water use figure. The remainder is the estimated irrigation use at your installation.

Category 4—Leaks, Losses and Unaccounted for Water. Generally speaking, the older the distribution system the more water that will be lost due to leaks. A system that limits losses to less than 10 percent is considered a very tight system. Most Air Force systems will lose more than 10 percent, and some of the oldest may lose up to 50 percent of the total water produced or purchased.

To develop an estimate of water use in this category you may elect to monitor water and wastewater system flows and compare the volume of water entering the system to the volume of wastewater exiting the system. Bases equipped with Energy Management Control Systems (EMCS) can easily obtain this data when necessary points on the water and wastewater system are monitored. Other bases may need to manually measure system flows at their lowest points, typically between 0100 and 0300.

Before using this method you should ensure that water tanks are either full or valved off, otherwise some of the system flow will be going to fill the tanks after the peak usage period that comes between 1700 and 2200. If this is not possible, you should measure tank levels and calculate the change in water volume inside the tank (see the example below). Note that close coordination with the fire department should occur prior to valving off any water tanks to conduct this test.

After taking the measurements, compare the water flow to the wastewater flow. The difference between the measurements can be attributed to leaks, losses, and other unaccounted for water.

Example for Category 4—Leaks, Losses and Unaccounted for Water

Assume the following conditions and note that the numbers used in this example may equate to what you might find at a small guard or reserve base.

- Two-hour test period between 0100 and 0300
- One aboveground storage tank
- Metered wastewater flows
- Annual total base water use: 4,593 Kgal
- Initial water meter reading: 32,406.2 Kgal
- Final water meter reading: 32,410.0 Kgal
- Difference: 3.8 Kgal
- Initial wastewater meter reading:1,59301.0 Kgal
- Final wastewater meter reading: 1,59303.1 Kgal
- Difference: 2.1 Kgal
- Initial water tank level: 38.2 feet
- Final water tank level: 38.6 feet
- Diameter of tank: 24.0 feet (at water level)

Change in volume of the water tank is calculated as:

$(24\text{-feet})^2$ X 3.1415/4 X (38.6 – 38.2) = 181 cubic feet

181 cubic feet X 7.5 gal/cubic foot = 1,357 gallons = 1.36 (round to 1.4) Kgal

Leaks, losses and unaccounted for water is calculated as:

3.8 Kgal (water purchased) – 2.1 Kgal (wastewater flow) – 1.4 Kgal (storage tank increase) =0.3 Kgal (over two hour test period), or 0.15 Kgal per hour

Estimated total leaks, losses, and unaccounted water annually is calculated as:

0.15 Kgal/hr X 24 hrs/day X 365 days/year = 1,314 Kgal/yr = 28% of total water use

Note that in this example, leaks of only 150 gallons-per-hour (2.5 gpm) equate to 28% of total base water use.

You are encouraged to exercise discretion and common sense in interpreting results from this analysis because other factors can make it difficult to get an accurate estimate of system losses. You should consider:

- Meter accuracy, particularly with low flow rates that may be below the level of what can be accurately measured by the meter. In this instance, discrepancies can be significant.
- Water used for irrigation, or in the operation of heat/steam plants may appear to be leak related if not properly accounted for in your investigation.
- System infiltration may mask the true difference between system flows, particularly in rainy weather or in an area with a high water table.

A base that can limit losses in this category to 10-20 percent is doing a very good job of maintaining the water distribution system. Leak losses significantly higher may indicate the need for a distribution system audit and leak detection survey. See BMP #2 in Chapter 3 of this guide for more information.

Category 5—Industrial. Estimate the water use in this category by a process of elimination. Simply total the water use estimates in Categories 1 through 4 and subtract the figure from the total annual water use. For the purposes of this plan, the remainder can be shown as the total water use in the industrial category.

Reporting Findings

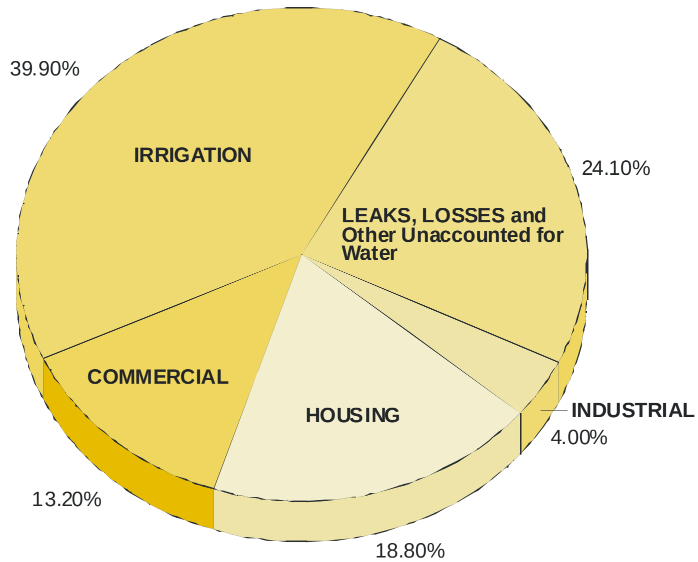
It may be useful to graphically depict the results of your investigation in a pie chart as shown in Figure 2-2. The percentages shown are purely for display purposes and do not represent Air Force or industrial averages.

2.2.3 Step 3: Calculating the Incremental Cost of Water and Sewage Disposal

Before assessing the economic viability of implementing a BMP, you must calculate the true cost of the water to be saved. This is called the *incremental* cost of water, and it can vary significantly from the average cost of water, or the cost of water that is charged to reimbursable customers.

Calculating the incremental cost of water requires the use of both past utility bills, appropriate rate schedules, and O&M costs for water/wastewater treatment and production. (If actual O&M costs are not readily available it is permissible to use estimated costs.)

FIGURE 2-2
Example Pie Chart



Calculations can be performed in several ways, depending on how your installation produces and/or purchases water. Following are example calculations based upon typical water production/purchase scenarios.

Example 1—Water is purchased from a single source at a flat rate

The base purchases water from a local municipality at a flat rate of $1.50/Kgal. In this example the average cost of water would be $1.50/Kgal, and the incremental cost of water would also be $1.50/Kgal.

Example 2—Water is purchased from a single source on a declining, sliding scale

The base purchases water from a local municipality, only this time the rate structure calls for the following sliding, declining scale:

0-1 million gallons per month at $2.00/Kgal
1 million – 5 million gallons per month at $1.50/Kgal
5 million – 10 million gallons per month at $1.25/Kgal
Over 10 million gallons per month at $1.00/Kgal

For a base using eight million gallons per month, the total monthly cost of water would be:

1 million gallons x ($2.00 divided by 1000) =	$ 2,000
4 million gallons x ($1.50 divided by 1000) =	$ 6,000
3 million gallons x ($1.25 divided by 1000) =	$ 3,750
Total Monthly Cost	**$11,750**

Given these parameters, the average cost of water per Kgal is calculated as:

($11,750 divided by 8 million gallons) x (1 million gallons divided by 1000) = $1.4687/Kgal

Further assume that you can implement a combination of BMPs that you estimate will reduce water use by 20%, or 1.6 million (1600 Kgal) per month. (Note: this is only an estimate for purposes of providing an example. The actual water savings potential of BMPs will vary by installation).

In this example, the dollar savings associated with the 1600 Kgal water savings will not equal the previously calculated average water cost of $1.46/Kgal. This is because the new monthly water usage figure will now be 6.4 million gallons (6,400 Kgal), meaning the water saved will be in the 5-10 million-gallon cost band This yields an incremental water cost of $1.25/Kgal which is less than the average cost of $1.46/Kgal.

In this example the incorrect calculation of the incremental cost of water overstated the value of the estimated water savings. This becomes evident when you recalculate water costs based on the new usage of 6,400 Kgal per month.

1 million gallons x ($2.00 divided by 1000) =	$ 2,000
4 million gallons x ($1.50 divided by 1000) =	$ 6,000
1.4 million gallons x ($1.25 divided by 1000) =	$ 1,750
Total Monthly Cost	**$ 9,750**

Given these new parameters, the average cost of water per Kgal is calculated as:

($9,750 divided by 6.4 million gallons) x (1 million gallons divided by 1000) = $1.52/Kgal

Notice in this example that the total cost of water decreased (from $11,750 to $9,750 per month)while the average cost of water increased (from $1.46/Kgal to $1.52/Kgal)This is because the water saved in this example is billed at the lower rate of the declining, sliding scale. The lesson taught in this example is to always calculate the dollar savings based on the *incremental* cost of water.

Example 3—Water is produced at an on-base plant

In this example assume the base produces all its water using wells and an on-base treatment facility. The plant has a capacity of 500,000 gallons (500 Kgal) per day, with the average use of 350,000 (350 Kgal) per day. This equates to approximately 127.8 million gallons per year (350 Kgal x 365 days per year).

For example purposes, assume the following production costs:

Treatment Facility and Well O&M	$100,000 per year
Treatment Plant Labor	$250,000 per year
Pumping Costs (350 Kgal/day)	$ 12,000 per year
Chemical Costs (350Kgal/day)	$ 24,000 per year
Total Annual Cost	**$386,000 per year**

The average water cost in this example is:

($386,000 divided by 127.8 million gallons) x (1 million divided by 1000) = $3.02/Kgal average water cost

Again, assume implementing a series of water conservation measures will reduce water use by 20 percent. This translates into savings of 25.6 million gallons per year, a new annual usage of 102.2 million gallons per year, and an average daily use of approximately 280,000 gallons.

Note that because the water treatment plant has significant fixed costs, your dollar savings will be less than the 20 percent water savings. The fixed costs (O&M, labor costs, etc.) for the plant will not be significantly reduced, in fact it is possible you may see no savings in these areas from your water conservation measure(s). There will, however, be pumping and chemical cost savings that can be estimated in proportion to water production.

The recalculation of the cost of water production based on the new numbers is:

Treatment Facility and Well O&M	$100,000 per year
Treatment Plant Labor	$250,000 per year
Pumping Costs (280 Kgal/day)	$ 9,600 per year
Chemical Costs (280Kgal/day)	$ 19,200 per year
Total Cost	**$378,800 per year**

In this example, even with a reduction in water use of 20 percent per year, annual production costs decreased by only $7,200, or about 2 percent. As the calculation shows, the result is an incremental cost of $0.28/Kgal, instead of $3.02/Kgal.

($7,200 DIVIDED BY 25.6 MILLION GALLONS PER YEAR) X (1 MILLION GALLONS DIVIDED BY 1000 KGAL) = $0.28/KGAL INCREMENTAL WATER COST

Given these low production and treatment costs it could be difficult to justify implementation of a BMP retrofit/replacement option based on cost savings. However, installations with low incremental water costs may still reach their goal of implementing at least four BMPs because credit for BMP implementation is based on employing applicable O&M options and the <u>cost effective</u> retrofit/replacement options. Consequently, if retrofit/replacement options are deemed to be uneconomical, credit for a BMP can still be gained through implementation of the O&M options.

Example 4—Water produced at an on-base plant and supplemented by off-base purchases

This hybrid situation is usually found when wells are permitted at withdrawal rates that are lower than peak demand requirements. The water produced on-base is supplemented by off-base purchases to meet the peak demand requirement. If your installation falls into this category you should try and determine the elements responsible for the spikes in peak demand. Many times, peak summer demand is driven by irrigation water requirements, a fact that makes investigation of irrigation-related water conservation measures a distinct possibility. But if you find that peaks are seasonal you must remember that savings from associated water conservation measures will also be seasonal.

Calculating the incremental cost of water in this situation will involve a combination of the techniques discussed in Example 3 (on-base production), and depending upon your rate scale for the supplemental water, Example 1 or 2 (off-base purchases).

Example 5—Purchasing water from a single source on an increasing, sliding scale

In an attempt to encourage conservation, some utilities have adopted rate scales that increase with the number of gallons used. Utility districts with limited water resources are more likely to use this type of rate scale.

The increasing, sliding rate scale is rarely seen at military installations but could be encountered if your base maintains satellite locations. For example purposes, assume the following rate scale:

0-10 Kgal/month at $2.00 per Kgal
10–20 Kgal/month at $2.50 per Kgal
20-50 Kgal/month at $2.75 per Kgal
Over 50 Kgal/month at $3.00 per Kgal

If a satellite location uses 22 Kgal/month, the total water cost per month is:

10 Kgal x $2.00/Kgal	=	$20.00
10 Kgal x $2.50/Kgal	=	$25.00
2 Kgal x $2.75/Kgal	=	$ 5.50
Total Monthly Cost		**$50.50**

The average cost of water is:

$50.50 Kgal divided by 22 Kgal = $2.30/Kgal

An assumed 20% water savings will be in the $2.75/Kgal cost band. This means the incremental cost of water you should use in calculating savings is $2.75/Kgal.

Example 6—Average and Incremental Sewage Costs

Sewage disposal costs can vary in the same fashion as water costs. When including sewage disposal costs in the savings calculations, be sure to use the incremental sewage cost and not the average cost. The incremental sewage cost is calculated in the same manner as the incremental water costs.

Sewage costs should only be included for BMPs that involve a device where water is discharged into the sewer system (i.e., showers, toilets, urinals). Sewer costs should not be included when the water does not end up being discharged into the sewer system (i.e., irrigation, leaks/losses, etc.).

2.2.4 Step 4: Investigate BMPs for Potential Implementation

Now that you have a credible estimate of your installation's water requirement, and an understanding of exactly how much that water costs, you can begin to explore and evaluate the implementation of applicable BMPs.

In general each BMP has two components for implementation: (1) O&M options; and, (2) Retrofit and Replacement options. The O&M options represent activities required to optimize effectiveness of the existing equipment, fixtures and systems. The retrofit and replacement options focus on initiatives that require capital investment to change equipment, fixtures, or processes to reduce water use.

The goal stipulates that before a BMP can be considered implemented both of the following criteria must be met:

- Applicable O&M options have been put into practice, and retrofit/replacement options have been reviewed within the last two years and those appropriate for implementation have been identified. (The easiest way to implement the O&M options is to add them to the RWP (reoccurring work program) schedule.) There is often no simple pay-back calculation that can be performed for the O&M options.
- Applicable cost-effective retrofit/replacement options have been implemented.

The goal at this phase in developing the water management plan is to rapidly assess which of the BMPs will be most beneficial and applicable to the installation. Some BMPs will be ruled out by the analysis while others will be deemed worthy of further study. Either way, you will be able to concentrate on those BMPs that offer the greatest economic pay-back potential.

The use of ESPCs can simplify the work required in evaluating the savings potential of a BMP retrofit/replacement option. A Phase I report performed by an ESCO can serve as a cost analysis of a BMP, and thereby relieve base personnel of this responsibility. This is yet another reason that Executive Order 13123 and this guidebook emphasize the aggressive use of ESPCs in meeting water conservation requirements. See chapter four of this guidebook for an explanation of the ESPC process and other available funding strategies.

Calculating Simple Pay-Back Periods

Identifying the most cost-effective BMPs requires calculation of their simple pay-back periods. This is the number of years required for the initial investment costs associated with implementing a BMP to be offset by the cumulative annual water, sewer, energy, and O&M cost savings. Before a large water conservation measure is implemented it will be subjected to a more rigorous life cycle cost analysis (LCCA), but at this phase in your planning a simple pay-back calculation will be sufficient to provide an indication of the cost-effectiveness of implementing a BMP.

The simple pay-back period can be calculated by dividing estimated implementation costs by the anticipated annual water savings (in dollars). For example, if your investigation determines that replacing 300 of the older 3.5 gpf toilets with new 1.6 gpf fixtures will save $40,000 annually at a cost of $88,500, the formula for calculating the simple pay-back period is:

> $88,500 (implementation cost) / $40,000 (annual savings) = 2.21 years (simple pay-back period).

BMPs with pay-back periods of 10 years or less should be strongly considered for implementation. If your analysis reveals there are not four BMPs with pay-back periods of less than 10 years you should consider implementing the four most cost-effective BMPs, or those with the easiest to implement O&M changes.

Financing Alternatives

After determining the most cost-effective BMPs you can begin investigating sources for financing their implementation. The federal guidance stipulates that applicable and cost effective retrofit and replacement options be implemented before a base can receive credit for implementing a BMP. This will require bases to invest in capital improvements to meet their water conservation goal.

Chapter four provides specific guidance on various funding avenues that may be applicable for implementing BMPs at your installation.

2.2.5 Step 5: Begin Implementation

For the four most feasible BMPs you should develop an implementation plan and work schedule. Should you determine that using an Energy Savings Performance Contract (ESPC) is the appropriate financing alternative, the plan may be as simple as referring the retrofit/replacement option to the Energy Savings Contractor (ESCO) for further study and potential implementation.

When developing the implementation schedule bear in mind that it is advisable to build in sufficient latitude. In this manner, a delay encountered in implementing one BMP won't throw the entire schedule off balance. If implementation of one BMP is expected to take 18 months, consider planning only the first six months in detail. Developing a sense of progress during this period will help you better plan subsequent phases. This strategy will also help insure that your plan is as realistic as possible and that it reflects actual progress compared to the initial plan.

2.2.6 Step 6: Monitor the Program

One of the requirements for getting credit for implementing a BMP is reviewing retrofit/replacement options every two years to insure the best BMPs are identified and implemented. Consequently, your plan must include a provision to re-calculate the cost-effectiveness of BMP retrofit/replacement options biennially (once every two years).

This requirement need not be onerous, because it is likely the only factors with a significant impact on economics will be changes in water and sewage disposal costs and/or reduction in the cost of water saving technologies. For example, when ultra-low flush toilets were first introduced the cost per unit was up to $300. Today the same units can be purchased for $100 or less.

Your base can remain in compliance by re-calculating BMP cost effectiveness every two years using updated implementation, water/sewer, energy, and O&M costs. In the event that cost changes render a previously uneconomical BMP to be cost-effective, then action must be taken to implement the BMP. If BMPs remain uneconomical no further action is required.

Monitoring should also include provisions to measure results. You should develop procedures to accomplish a systematic review of water/sewer bills to monitor decreases in consumption and charges.

After verifying that conservation measures are producing positive results it will be beneficial to share the findings. Base personnel should know how much water their efforts are saving. Talk with representatives of your public affairs office about the successes of the water conservation program. Communication of the results may help encourage other groups within the community to develop similar programs.

CHAPTER 3

Best Management Practices

In addition to developing the installation-specific water management plan described in Chapter 2, Air Force bases must also implement at least four BMPs. The FEMP's complete list of BMPs (along with all O&M and retrofit/replacement options) is included in Appendix A.

In general, each BMP includes O&M and retrofit/replacement options that must be considered for implementation. The O&M options focus on optimizing existing equipment and fixtures to minimize water use. The retrofit/replacement options require the investment of capital dollars to change the equipment, fixture, or process to reduce water use. Chapter 4 provides information on how to fund cost-effective retrofit/replacement options.

Not every O&M or retrofit/replacement option on the FEMP list is applicable to Air Force applications. Rather than re-stating the FEMP guidance for each BMP this chapter focuses on those options that are most applicable to Air Force installations. Tips are provided to assist you in evaluating each BMP. Sample calculations and cost information are also provided to help calculate simple pay-back periods.

The FEMP BMPs are:

- BMP #1—Public Information and Education Programs
- BMP #2—Distribution Systems Audits, Leak Detection, and Repair
- BMP #3—Water Efficient Landscaping
- BMP #4—Toilets and Urinals
- BMP #5—Faucets and Showerheads
- BMP #6—Boiler/Steam Systems
- BMP #7—Single-Pass Cooling Equipment
- BMP #8—Cooling Tower Management
- BMP #9—Miscellaneous High Water-Using Processes
- BMP #10—Water Reuse and Recycling

To receive credit for implementing a BMP an installation must meet all of the following criteria.

- Applicable O&M options have been put into practice
- Retrofit and replacement options appropriate for implementation have been identified
- Applicable cost-effective retrofit/replacement options have been implemented
- Remaining retrofit and replacement options have been reviewed within the last two years

3.1 BMP #1—Public Information and Education Programs

For the majority of installations, this BMP will be one of the easiest and most cost-effective to implement. At minimal cost, a public information and education program providing a strong foundation for all water conservation efforts can be implemented. In addition, these programs enhance public opinion by emphasizing the priority given to environmental stewardship on base.

The FEMP advises the following internal and external options be employed to implement this BMP.

3.1.1 Internal Options

- Enlist the cooperation of the public affairs staff at your installation to develop/publicize all public information and education programs. Public affairs personnel can be a vital resource in helping develop the programs and communicating them to the public.
- Coordinate the efforts with the existing Energy Awareness Program at your base.
- Establish a user-friendly hot line or other feedback system to report leaks or wastes of water. Respond to inquiries quickly to encourage continued participation.
- Place instructional signage near any new or retrofitted water using equipment to explain the technology and how to use it.
- Investigate methods to conduct regular training and workshops for maintenance personnel to keep them updated on operational changes and maintenance procedures.

3.1.2 External Options

- Work with local utilities to develop comprehensive programs and share your success with others. Many water providers have public information and education programs you can use to help develop your own program.
- Create displays in high traffic areas to communicate the results of your water conservation program.
- Develop websites, brochures, and other materials for distribution to employees and the public to describe your program, its goals, and successes.

3.1.3 Air Force Implementation Measures

To develop the Water Conservation Policy or Base Instruction and to receive credit for implementing this BMP at your installation you must establish a program that includes the following activities.

- Publish quarterly articles in the base newspaper that promote water conservation. Many base newspapers already carry regular articles focused on energy conservation, so it might be effective to incorporate the water conservation message into the energy conservation feature articles. Check with your base energy manager and/or the base public affairs flight for information on publishing the needed water conservation public awareness information.

- Develop or obtain water conservation factsheets and provide them to the housing office with a plan for distributing them to base housing residents when they move in.
- Establish and publicize a telephone hotline number for base personnel to report leaks or other water waste. This is typically done through the Civil Engineer service call desk, or the Housing Maintenance service call desk.

Additional measures that you may incorporate include:

- Coordination with the base cable television provider to telecast water conservation videos on the base information channel.
- Post water conservation posters at high-traffic areas throughout the base.
- Develop a water conservation module for the installation's Internet website.
- Look for ways to publicize water conservation issues in conjunction with existing basewide events that feature an environmental or conservation theme (i.e., *Earth Day* celebrations).

3.1.4 Support Resources

State water management districts and local water utilities frequently have their own public education and information programs that you may be able to use at your base. Federal, state, and municipal governments, along with some private sector organizations, frequently develop promotional resources to support conservation programs. Often available at little or no-cost, these items include generic brochures, buttons, posters, refrigerator magnets, videos, and other promotional materials. These local agencies should be your first source for an effective, low cost public education program**.**

There are many commercially available water conservation public education programs. One example of a commercially available campaign is entitled *Water – Use It Wisely.* This comprehensive public information program promotes water conservation. Instead of generic promotional tools, the developers of this program customize videos, brochures, posters, and other promotional items to fit the needs of the customer. This customization feature increases the cost for this alternative as opposed to other generic programs, like those available from the American Water Works Association (AWWA) and others.

3.2 BMP #2—Distribution System Audits, Leak Detection, and Repair

Even small leaks can result in large water losses over time. Consider that a one-inch-diameter hole can leak more than 180 gpm at 60 psi. Over the course of a year this would result in a loss of 94,608 Kgal, or $245,981 at an installation with an incremental water cost of $2.60per Kgal. Leak detection survey methods can locate underground leaks so they can be fixed. An average leak detection survey and repair program can result in a 25 to 50 percent recovery of water being lost due to leaks.

To initially evaluate this BMP refer to the water use estimate you developed for this category (see Chapter 2). If the estimate is 10 percent or less of total water use, you should disregard any further evaluation of this BMP. Otherwise you should consider the applicability of the following O&M and retrofit replacement options.

3.2.1 Operations and Maintenance Options

- Perform a full-scale audit and leak detection survey using a methodology consistent with that described in the American Water Works Association's *Water Audit and Leak Detection Guidebook* (*Manual of Supply Practices*, AWWA Number M36).

3.2.2 Retrofit/Replacement Options

- Repair leaks or replace pipes when leaks are found.

3.2.3 Estimating Program Costs

Distribution system audits and leak detection programs require specialized expertise, trained personnel, and specialized equipment. These programs are seldom performed by in-house personnel, instead there are a number of local, regional, and national firms that specialize in providing the needed services.

The Engineering Flight, MAJCOM water conservation POC, or HQ AFCESA are your base best source of information on the options available to you for securing contractor support. Contractors base their price for these services on the number of miles per system main. Costs will vary by geographic region and market conditions, but the typical cost range at the time of this writing (FY02) is between $100 and $200 per mile of water main. To reduce costs and focus on major leaks, the leak detection surveys are often limited to lines 2" in diameter or larger.

Calculating the Simple Pay-Back Period

To calculate the simple pay-back period of a distribution system audit and leak detection/repair program:

1. Estimate the potential annual water savings by multiplying the annual estimate of leaks, losses, and unaccounted for water by 25 percent.
2. Multiply the product (from Step 1) by the incremental water cost at your installation. If wastewater disposal costs at your installation are based on water use, be sure to use the incremental water *and sewer* costs. This yields an estimate of the cost of water that can be saved by locating and repairing leaks.
3. Estimate the cost of the program by multiplying the total miles of water main by an average cost of $150 per mile.
4. Divide the cost of the program (Step 3) by the projected dollar savings associated with the BMP (Step 2). The result is the simple pay-back period or the number of years required for water cost savings to off-set the cost of the system audit and leak detection and repair program. If the simple pay-back period is less than ten years the BMP is considered cost effective, and should be further investigated for potential implementation.

Note that the estimated cost for repairing leaks is not considered when calculating the simple pay-back period. Instead, these are considered normal O&M costs associated with utility operations.

It is critical that leaks be repaired quickly (within a few days or weeks) after being identified by the leak survey. Failure to do so will make the leaks harder, if not impossible to locate, due to fading of survey markings on pavements, vegetation, and soil. In addition, the sense of urgency to repair leaks often fades after the survey.

3.2.4 Additional Assistance

HQ AFCESA can support performance of distribution system audits and leak detection surveys through existing Indefinite Delivery Indefinite Quantity (IDIQ) Architect-Engineer (A-E) contracts. The cost for these services varies according to the size of the installation and other site-specific conditions. For more information, contact Mr. Michael Clawson, PE at (850) 283-6362 (DSN 523).

The Naval Facilities Engineering Services Center (NFESC) also conducts water leak detection surveys for military installations . The NFESC has performed the services at Air Force, Navy, Army, Marine, and Coast Guard installations. Again, costs vary based upon site-specific conditions. For more information, contact the NFESC at (805) 982-6072 (DSN 551), or visit their website at http://www.energy.nfesc.navy.mil/energy.

3.3 BMP #3—Water Efficient Landscaping

The volume of water used for lawn and landscape irrigation in the United States is not well documented but is estimated to be significant. The U.S. Geological Survey (USGS) estimates 7.8 billion-gallons-per-day (bgd) is devoted to outdoor water use, primarily landscape irrigation. Landscape water use at most Air Force bases is similarly significant.

To evaluate this BMP for potential implementation, refer back to the estimate of irrigation water that you developed in Step 2 of your water management plan (see Chapter 2). If water use in the irrigation category at your installation is estimated to be 10 percent or less of total water use, you should consider implementing only the following O&M options.

3.3.1 Operations and Maintenance Options

- Verify that irrigation schedules are appropriate for climate, soil conditions, plant materials, grading, and season. Water only in the early morning to minimize losses to evaporation. Watering during these hours will not only this save water, but it will also reduce the opportunity for fungus growth to develop. Note that the general rule is to water deeply with less frequency.

- Monitor and inspect irrigation systems for effectiveness. These systems are considered high maintenance items by the Air Force, and limited resources sometimes prevent them from being maintained at the optimum level. Poorly maintained systems can waste large amounts of water and many systems end up being abandoned due to lack of maintenance. To facilitate maintenance it is advisable to have a maintenance contract on the system(s), or make certain inspection/testing/maintenance is included in the base's Recurring Work Program (RWP). Regardless of who is responsible for maintenance (contractor or in-house personnel) broken heads or other components that can waste water should be treated as urgent work requests.

- Establish a service call desk (see BMP #1) to receive reports of irrigation system problems. Once reported problems should be fixed promptly in order to both save water and encourage continued use of the service call desk.

If irrigation use is estimated to be greater than 10 percent of total water use you should implement the O&M options above, plus consider the following retrofit/replacement options.

3.3.2 Retrofit/Replacement Options

- Install rain sensors that shut off automatic irrigation systems in response to rainfall. This option can save an estimated five to 10 percent of irrigation water. Rain sensors cost between $15 and $45 each, with installation costs varying by geographic location and site-specific condition.
- Automatic in-ground irrigation systems at most Air Force installations utilize controllers. Properly programmed these controllers can save as must as 10 to 15 percent of the irrigation water demand. If new controllers are required they can cost $50 to $250 for small systems, and up to several thousand dollars for large or central controllers. Installation costs vary by geographic location and site-specific conditions.
- Conversion to a water-wise landscape that emphasizes the use of native turf and plants can result in savings of 20 to 50 percent. The cost of redesigning a landscape depends on many factors: fees for a landscape architect; size of the area redesigned; quantity and type of plants purchased and installed; labor charges; and any irrigation system retrofits/replacements that are required. Implementing this measure could involve significant costs and should be attempted only with expert consultation.

3.3.3 Additional Assistance

HQ Air Force Center for Environmental Excellence (AFCEE) has produced the *USAF Landscape Design Guide* to provide information on the irrigation system design process, and guidance on implementing cost effective and efficient irrigation systems. The guide is available at the AFCEE website, http://www.afcee.brooks.af.mil.

Additional assistance may be available from the following sources:

- Your local water utility.
- The state water management district that serves your region.
- The Irrigation Association (http://www.irrigation.org).
- American Society of Landscape Architects (http://www.asla.org).
- Xeriscape (http://www.xeriscape.org), for information on water-wise landscaping.
- The Natural Resource Conservation Service, with offices around the nation, the service is listed in most telephone books under the U.S. Department of Agriculture.

3.4 BMP #4—Toilets and Urinals

Americans flush about 4.8-billion-gallons of water down toilets and urinals every day. Studies show that water used to flush waste accounts for nearly one-third of a building's total water consumption. These consumption figures make the toilets and urinals at your installation a primary target of opportunity for reducing water consumption.

Many plumbing fixtures in use today were designed at a time when little concern was given to water conservation. Unless your facilities are new or have been recently renovated it is likely the toilets and urinals are using too much water.

Prior to 1994 typical toilets consumed 5 to 7-gallons-per-flush (gpf). Federal laws enacted on January 1, 1994 required that residential toilets use no more than 1.6 gpf, and in 1997 a similar limit was established for commercial toilets. Urinals were limited to 1.0 gpf by the 1997 requirements.

The 1.6 gpf toilets come in three basic categories: (1) flush valve; (2) pressure assisted; and, (3) gravity toilets. Generally, the flush valve and pressure-assisted toilets perform more effectively than gravity toilets because they use the water system pressure to assist in their operation. Design also plays a key role in operational effectiveness. Inexpensive models that lack proper bowl and water flow design may require occasional double-flushing.

Today's low flow toilets are far more effective than those available when the new laws first went into effect. The early models were sometimes only 3.5 gpf toilets equipped with 1.6 gpf tanks or flush valves that required frequent double flushing and often became clogged.

Additional information on water efficient toilets and urinals can be gained from MIL-HDBK 1165. The FEMP advises implementing the following O&M options (where applicable) can help conserve water used for flushing toilets and urinals.

3.4.1 Operation and Maintenance Options

- Fixing leaking toilets and urinals is extremely cost effective. A leaking flapper valve will waste 30 gpd, while a constantly running toilet or urinal can waste more than four gpm, which equals more than two-million-gallons of water annually. At an Air Force installation with a $4.10/Kgal combined water and sewer rate this amounts to more than $8,000 annually in additional water and sewer costs (refer to MIL HDBK 1165, Para 5.2.1.2, page 26). Establish a program to regularly check for leaking toilets and urinals and get them fixed promptly. In addition, establish a user-friendly process for consumers to report leaks. Finally, encourage cleaning and custodial crews to be a first line of defense for reporting leaks and other problems.
- When performing maintenance, replace worn out parts. Give particular attention to toilet diaphragms and the pin hole and rubber diaphragms in urinals. These parts should be promptly replaced when found to be functioning improperly.
- For flush valve toilets, consider adjusting the valve to reduce the water consumed per flush. It is recommended that the valve be adjusted to use as little water as possible without impeding waste removal or violating manufacturer recommendations.
- The following retrofit options should be investigated to determine their applicability for conserving water at your installation.

3.4.2 Retrofit Options

- A variety of toilet retrofit options (e.g., displacement dams) have been introduced to lower the water consumption rate of toilets. Unfortunately many of these options have short life spans, can hamper overall operation, and require frequent maintenance. Consequently, common retrofit options are generally not appropriate for federal facilities. Instead, toilet replacement should be pursued as the primary method for conserving water use in restroom facilities.
- If you have continuous flow urinals, install a timer to stop the flow of water when the building isn't scheduled for occupancy (e.g., after duty hours, on weekends). However,

it is often more cost effective to replace continuous flow urinals with the flush valve type.

- FEMP guidance suggests that infrared or ultrasonic sensors can be used to automatically activate flushing, and make it inconvenient for a user to double-flush a urinal. While this is true, preventing double-flushing has not been shown to result in significant water savings. Hence, the sensors represent more of a convenience measure than a water conservation measure, and with price tags of approximately $250 each they are generally regarded as cost prohibitive.

3.4.3 Replacement Options

- None of the O&M or retrofit options described will achieve the 1.6 gpf rate required of toilets manufactured after 1994, or the 1.0 gpf rate for urinals manufactured after 1997. The real value of O&M and retrofit measures is limited to making existing toilets and urinals operate more efficiently until they can be replaced.
- Waterless urinals are made with a urine repellent surface, and have no handles, sensors, or moving parts. Instead, a trap made of an immiscible liquid floating on top of a urine layer blocks sewer gases and urine odors from escaping into the restroom. Because these urinals use no water, they could be regarded as the ultimate in water conservation plumbing fixtures. However, waterless urinals may present problems in the areas of maintenance and cleaning. Waterless urinals made of fiberglass can be damaged with abrasive cleaners, and both the fiberglass and vitreous china models have traps that must be replaced several times per year. This requires development of a process, perhaps through a custodial contract or the Recurring Work Program (RWP) to ensure the proper maintenance is performed. Failure to replace the traps on schedule will cause odor and maintenance problems. However, the time it takes to replace these traps is often less than that required for typical flush-valve maintenance and repairs. For all these reasons, the use of waterless urinals must be carefully evaluated.

3.4.4 Estimating Potential Water/Wastewater Cost Savings

Average water use and savings by low-volume and high-volume toilets is shown for housing facilities in Table 3.1, and for industrial, commercial, and institutional (ICI) facilities in Table 3.2. (Note that the presence of urinals for use by men in ICI facilities results in different daily usage estimates for men and women in these facilities.)

Average water use and savings by low-volume and high-volume urinals (ICI facilities only) is shown in Table 3.3.

TABLE 3.1
Estimated Water Use/Savings by Low-Volume Toilets in Households

Year Manufactured or Installed	(A) Average Toilet Water-Use Rate (gpf)	(B) Estimated Water Use at 5.1 Uses per person/day (A x 5.1) (gpcd)	(C) Estimated Water Use Annually (B x 365 days) (gpy)	(D) Estimated Annual Water Savings with A 1.6 gpf Toilet (C-2,993 gpy) (gpcy)
1994-Present	1.6	8.2	2,993	--
1980-1994	4.0	20.4	7,446	4,453
1950s-1980	5.0	25.5	9,308	6,315
Pre 1950s	7.0	35.7	13,031	10,038

gpf = gallons per flush
gpcd = gallons per capita/per day
gpy = gallons per year
gpcy = gallons per capita/per year

Source: Amy Vickers & Associates

TABLE 3.2
Estimated Water Use/Savings by Low-Volume Toilets in ICI Facilities

Year Mfg. or Installed	(A) Average Toilet Water Use Rate (gpf)	(B) Daily Use Male/Female	(C) Daily Consumption Male/Female (AxB) (gpd)	(D) Annual Consumption (C x 260 days) Male/Female (gpy)	(E) Estimated Annual Water Savings (D-416/ D-1,248) Male/Female (gpy)
1994-Present	1.6	1.0/3.0	1.6/4.8	416/1,248	--
1980-1994	4.0	1.0/3.0	4.0/12.0	1,040/3,120	624/1,872
1950s-1980	5.0	1.0/3.0	5.0/15.0	1,300/3,900	884/2,652
Pre 1950s	7.0	1.0/3.0	7.0/21.0	1,820/5,460	1404/4,212

gpf = gallons per flush
gpcd = gallons per capita/per day
gpy = gallons per year
gpcy = gallons per capita/per year

Source: Amy Vickers & Associates

TABLE 3.3
Estimated Water Use/Savings by Low-Volume Urinals in ICI Facilities

Year Manufactured or Installed	(A) Average Urinal Water-Use Rat (gpf)	(B) Estimated Water Use at 2.0 uses per person/day (A x 2) (gpcd)	(C) Estimated Water Use Annually (B x 260 days) (gpy)	(D) Estimated Annual Water Savings With A 1.0 gpf Urinal (C – 520) (gpcy)
1994-Present	1.0	2.0	520	--
1980-1994	2.0	4.0	1040	520
Pre-1980s	5.0	10.0	2,600	2,080

gpf = gallons per flush
gpcd = gallons per capita/per day
gpy = gallons per year
gpcy = gallons per capita/per year

Source: Amy Vickers & Associates

Water and sewer cost savings associated with the installation of low-volume toilets can be calculated by multiplying the volume of water/wastewater reductions expected in housing and ICI facilities (refer to Tables 3.1 and 3.2 for toilets and Table 3.3 for urinals) by the incremental water and sewer rates at your installation (refer to Chapter 2).

To use this information you will need an estimate of the number of personnel living in housing facilities, and the number of military, DoD civilian, and contractor personnel who work in non-housing (ICI) facilities. The base housing and base contracting offices can provide you with this information. For the purpose of this investigation assume a male-to-female ratio of 1:1 in both housing and ICI facilities.

3.4.5 Estimating Number of Fixtures and Flush Volumes

Consult housing office records to determine the number of restrooms in housing facilities. Use the number of restrooms as an estimate of the number of toilet fixtures. Flush volumes for these fixtures can then be estimated by the date of construction or last renovation (see Table 3-1).

To estimate flush volumes for fixtures used in ICI facilities you will also need to determine the date of construction or last renovation and consult Table 3-1. To estimate the number of fixtures in ICI facilities you may use The *Uniform Plumbing Code* and/or the *Uniform Building Code.* The UPC specifies a fixture-to-personnel-ratio of 1:25 to be equally divided between males and females. As much as 50 percent of the fixtures in men's rooms may be urinals. For example, a facility with an occupancy of 1,000 personnel should have 40 fixtures consisting of 20 toilets in ladies' rooms, 10 men's room toilets, and 10 men's room urinals.

3.4.6 Estimating Energy Cost Savings

No direct energy savings are associated with installation of the most common types of low-volume toilets. Water and wastewater utilities reap indirect energy savings from the reduced volumes of water and wastewater pumped and processed for treatment and distribution. The savings need not be calculated for the purposes of your investigation.

3.4.7 Estimating Labor and Material Costs

Before calculating the simple pay-back period you need to estimate the cost of the anticipated replacement program. A construction cost estimating database such as *R.S. Means* can be consulted to develop an estimate of the typical costs associated with replacing a toilet or urinal At the time of this writing (FY02) the equipment and labor costs were:

- Toilets = $214 per fixture ($72 for fixture removal and set; $106 for materials cost for water closet installation; $36 for labor. Source: R.S. Means)
- Urinals = $133.50 per fixture ($97.50 for materials cost; $36 for labor. Source: R.S. Means)

3.4.8 Sample Calculation of Simple Pay-Back Period

The following sample calculation is based on the following assumptions.

- A toilet replacement for housing facilities with 1,028 units and 2,716 total residents (Source: Base Housing Office).
- All facilities constructed (or last renovated) between 1980 and 1994 (Source: Air Force Real Property Records).
- Number of fixtures, 2,262 (Source: Base Housing Office).

- Estimated flush volume of existing fixtures, 4.0 gpf (Source: Table 3.1).
- Estimated flush volume of new fixtures, 1.6 gpf (Source: Table 3.2).
- Incremental water and wastewater cost, $4.10 Kgal (Source: Utility billing information combined with the investigation in Chapter 2 of this guide).
- Estimated fixture replacement cost, $ 214 each (Source: R.S. Means Database).

Calculation

1. 5.1 (uses per day) x 2,716 (residents) x 4.0 gpf = 55,406 gpd current use rate.
2. 5.1 (uses per day) x 2,716 (residents) x 1.6 gpf = 22,162 gpd new use rate.
3. 55,406 gpd – 22,162 gpd= 33,244 gpd saved x 365 days = 12,134,060 gpy saved.
4. 12,134,060 gpy x ($4.10 Kgal/1000) = $49,750 per year in water/wastewater cost savings.
5. 2,262 fixtures x $214 (estimated replacement cost per fixture) = $484,068 total fixture replacement cost.
6. $ 484,068 (total fixture replacement cost) divided by $49,750 (annual savings) = 9.7 (years) simple pay-back period.

In this example the toilet retrofit program in housing facilities results in a simple pay-back period of 9.7 years. Similar rationale can be applied to estimate the cost-effectiveness of toilet and/or urinal replacements in ICI facilities. For the purpose of this investigation, the toilet replacement program would be deemed cost-effective and should be pursued for implementation.

3.5 BMP #5—Faucets and Showerheads

Tremendous amounts of water and energy can be wasted through use of non-water efficient faucets and showerheads. Even a brief five-minute shower can consume 15-35 gallons of water with a conventional showerhead with a flow rate of 3-7 gpm.

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 80 pounds per square inch, psi). Metered valve faucets manufactured after the same date are limited to 0.25 gallons per cycle.

Lavatory and kitchen faucets are found in both residential and ICI facilities. Showerheads are found in residential facilities (to include military family housing, dormitories, and temporary lodging facilities), though it is not uncommon to find a few shower facilities in administrative and industrial buildings. In addition, the base gymnasium will very likely be equipped with showers.

3.5.1 Operation and Maintenance Options

The FEMP advises implementing the following O&M options (where applicable) can help conserve water used in lavatories and showers.

- Fixing leaks is the most cost-effective manner to reduce water consumption for faucets and showerheads. Prior to spending any money on retrofit or replacement, ensure that that leaks are repaired.

- Establish a user-friendly method to report leaks and a process of fixing them quickly. Encourage cleaning and custodial crews to report problems.
- Test system pressure to make sure it is between 20 and 80 psi. If the pressure is too low, then low consuming devices will not function properly. If the pressure is above 80 psi, the faucets will deliver more water than their rated amount.
- Install expansion tanks and pressure reducing valves as appropriate. Reduce water heater settings to prevent temperature and pressure relief valves from discharging water.
- Lower the setting of the hot water temperature to achieve ancillary savings in electricity or natural gas used to heat water.
- Correctly adjust and maintain automatic sensors to ensure proper operation.
- With infrared or ultrasonic sensor faucets make sure that the flow controller connected to the sensor does not become clogged with impurities carried by the water.
- Post energy/water awareness information at point-of-use to encourage conservation.

3.5.2 Retrofit/Replacement Options

The following retrofit/replacement options should be investigated to determine their applicability for conserving water at your installation.

- Consider the use of flow restrictors on manual valve faucets. The restrictors limit the maximum flow rate to a range of 0.5 to 2.5 gpm through use of a washer-like disk installed in the faucet head.
- Replace manual valve faucets with newer models that achieve the 2.5 gpm standard.
- Equip faucets with aerators. Placed on top of the faucet head, aerators add air to the flow stream and increase the effectiveness of the flow to require less water. (Note: MIL HDBK 1165 suggests that aerators not be used in hospital facilities because of the potential for bacteria to be entrained in the air. The use of laminar flow devices is recommended in these facilities).
- Replace old showerheads that use 3-7 gpm with new models that achieve the 2.5 gpm rate. The newer model showerheads feature a narrower spray area and a greater mix of air than conventional showerheads. These features allow for a decrease in the overall water consumption while maintaining the feel of a full-volume shower.

3.5.3 Estimating Potential Water/Wastewater Cost Savings

Average water use and savings by low-volume and high-volume faucets is shown for housing facilities in Table 3.4. Average water use and savings by low-volume and high-volume showerheads is shown in Table 3.5.

TABLE 3.4
Estimated Water Use/Savings by Low-Volume Faucets in Households

Year Manufactured or Installed	(A) Average Faucet Flow Rate (gpm)	(B) Estimated Faucet Use Per Person (min/day)	(C) Estimated Water Use Annually (A x B x 365 days*) (gpy)	(D) Estimated Annual Water Savings with a 2.5 gpm Faucet (C-7,391 gpy) (gpcy)
1994-Present	2.5	8.1	7,391	--
1980-1994	2.7	8.1	8,130	739
Pre-1980	4.0	8.1	11,286	4,435

gpm = gallons per minute
gpy = gallons per year
gpcy = gallons per capita/per year

Source: Amy Vickers & Associates

TABLE 3.5
Estimated Water Use/Savings by Low-Volume Faucets in ICI Facilities

Year Manufactured or Installed	(A) Average Faucet Flow Rate (gpm)	(B) Estimated Faucet Use Per Person (min/day) (A x B)	(C) Estimated Water Use Annually (A x B x 260 days) (gpy)	(D) Estimated Annual Water Savings with a 2.5 gpm Faucet (C-650 gpy) (gpcy)
1994-Present	2.5	1.0	650	--
1980-1994	2.7	1.0	702	52
Pre-1980	4.0	1.0	1040	390

TABLE 3.6
Estimated Water Use/Savings by Low-Volume Showerheads in Households

Year Manufactured or Installed	(A) Average Showerhead Flow Rate (gpm)	(B) Estimated Shower Use Per Person* (min/day)	(C) Estimated Water Use Annually (A x B x 365 days) (gpy)	(D) Estimated Annual Water Savings With A 2.5 gpm Showerhead (C-4,863 gpy) (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

*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.

gpm = gallons per minute
gpy = gallons per year
gpcy = gallons per capita/per year

Source: Amy Vickers & Associates

AWWA's handbook *The Water Conservation Manager's Guide to Residential Retrofit* identifies the following formula for calculating potential water savings from faucet/showerhead retrofit/replacement for a targeted group:

$$(F_a - F_b) \times M \times C = D$$

> Where F_a = the average flow rate of existing fixtures at average psi, F_b = the average flow rate of retrofitted or replacement fixtures at average psi, M = the average number of minutes per use/per day, C = the total number of uses per person/year, and D = the potential number of gallons saved per year.

Water and sewer cost savings can be calculated by multiplying the incremental water and sewer cost (see Chapter 2) by the potential number of gallons saved per year (D).

To use this information you will need an estimate of the number of personnel living in housing facilities, and the number of military, DoD civilian, and contractor personnel who work in non-housing (ICI) facilities. The base housing and base contracting offices can provide you with this information.

3.5.4 Estimating Number of Fixtures and Flow Rates

To estimate the number of faucets/showerheads and their flow rates you will need to determine the date of construction or last renovation, and compare the date(s) to the information shown in Table 3.3 or 3.4. Construction/renovation dates are available from Air Force Real Property Records.

To estimate the number of fixtures and flow rates in ICI facilities you should consult the base personnel office to determine the number of military, civilian and contractor personnel working in ICI facilities. Next, refer to *Uniform Plumbing Code* and/or the *Uniform Building Code which* specifies a lavatory-faucet-to-personnel ratio of 1:40. Dividing the number of personnel by 40 will provide an estimate of the number of lavatory faucets in ICI facilities. For example, a facility with 1,000 occupants will have approximately 25 lavatory faucets (1,000/40 = 25 lavatory faucets).

3.5.5 Estimating Labor and Material Costs

You need to estimate the cost of the anticipated replacement program. In making the retrofit or replacement decision you should know that mechanical engineers, plumbers and construction contractors advise that showerhead replacement is usually more economical than a retrofit. Conversely, the same group of professionals reports that faucet retrofits, using inexpensive low-flow aerators, are typically more cost-effective than faucet replacements.

A construction cost estimating database such as R.S. Means can be consulted to develop an estimate of the typical costs associated with replacing or retrofitting a faucet or showerhead. At the time of this writing (FY02) the equipment and labor costs were:

- Faucet Retrofit w/ Aerator = $13
- Showerhead Replacement = $34

3.5.6 Sample Calculation of Simple Pay-Back Period

This sample calculation is based on the following assumptions.

- A showerhead replacement program for housing facilities with 1,028 units and 2,716 total residents (Source: Base Housing Office).
- All facilities constructed (or last renovated) between 1980 and 1994 (Source: Air Force Real Property Records).
- Number of showerheads, 2,262 (Source: Air Force Real Property Records).
- Estimated flow rate of existing showerheads, 4.0 gpm (Source: estimate from Table 3.4).
- Estimated flow rate of new showerheads, 2.5 gpm (Source: Table 3.4).
- Estimated number of showers per day/per person, 1.0 (Source: Table 3.4).
- Estimated duration of showers per day/per person, 5.3 minutes (Source: Table 3.4).
- Incremental water and wastewater cost, $4.10 Kgal (Source: Utility billing information combined with the investigation in Chapter 2 of this guide).
- Estimated fixture replacement cost, $34 each (Source: R.S. Means).

Calculation

1. 4.0 gpm (existing flow rate) – 2.5 gpm (flow rate of retrofitted showerheads) = 1.5 gpm.
2. 1.5 gpm X 5.3 (average number of minutes per day/person) = X 365 (showers per year/per person) = 2,902 (gpy saved/per person).
3. 2,901 (gpy saved/per person) X 2,716 (total persons) = 7,881,832 (total gpy saved).
4. 7,881,832 X ($4.10/1000) = $32,316 (cost of water saved annually).
5. 2,262 fixtures X $34 (estimated replacement cost per fixture) = $76,908 total fixture replacement cost.
6. $76,908 (total fixture replacement cost) divided by $32,316 (annual savings) = 2.4 (years) simple pay-back period.

In this example a showerhead replacement program in housing facilities results in a simple pay-back period of 2.4 years. Similar rationale can be applied to estimate the cost-effectiveness of faucet replacements.

For the purpose of this investigation, the showerhead replacement program would be deemed cost-effective and should be pursued for implementation.

3.5.7 Estimating Energy Cost Savings

Saving water used in lavatory/kitchen faucets and/or showerheads also results in energy savings involved in heating water. Statistics indicate that 60 percent of water used from a showerhead is heated, while 50 percent of water used from a lavatory/kitchen faucet is heated. It requires 0.2 kWh of electricity to heat one gallon of water, and 0.5 cf of natural gas to perform the same task. Kilowatt-hour charges for electricity and cubic-foot rates for natural gas can be determined by reviewing utility bills from the energy utility. Add the projected energy cost savings to the water/wastewater cost savings to enhance the simple pay-back period of a faucet/showerhead retrofit or replacement project.

3.6 BMP #6—Boiler and Steam Systems

Boilers and steam generators are used in large heating systems, in cooking, and in facilities where processed steam is required. Many of these systems use large quantities of water to make that lost to leaks and "blow-down." Water consumption rates vary for boiler and steam systems, and the cost of makeup water is usually small when compared to the cost of energy used by these systems. Still, significant savings can be achieved through decreased water consumption because the value of the water lost during system operation is enhanced by the value of the chemicals used to treat the water.

Often the energy and chemical costs greatly exceed the cost of water. For this reason, implementing water conservation measures with boiler and steam systems can be cost effective. When calculating potential savings it is important to account for the energy and chemical costs as well as the cost of water.

3.6.1 Operation and Maintenance Options

- O&M activities for boiler and steam systems are covered in MIL-HDBK-1149, Industrial Water Treatment. However, this MIL HDBK will soon be replaced by a Unified Facilities Criteria (UFC) document. This guidance mandates many of the O&M options for this BMP. (See Appendix A for a complete description of the O&M options associated with this BMP.) The proper operations and maintenance of boiler systems in accordance with this guidance can save significant amounts of water and reduce associated chemical & energy costs.

3.6.2 Retrofit/Replacement Option

- Water cost savings alone will seldom justify the cost of retrofitting or replacing a boiler or steam generating system. Therefore, it is critical to incorporate any water saving boiler or steam system retrofits or replacements into the base energy program. Consult your base energy manager to identify any situations where this possibility may exist. Since the Air Force already has an aggressive energy conservation program, by incorporating these types of water saving initiatives into the energy program, additional funding resources may become available.

3.7 BMP #7—Single-Pass Cooling Equipment

Single-pass (or once-through) cooling systems circulate water once through a piece of equipment and then discharge the water. Single-pass cooling equipment includes items such as medical equipment (CAT scanners, x-ray machines), HVAC systems, hydraulic equipment, condensers, air compressors, welding machines, vacuum pumps and ice machines.

Since Air Force civil engineering maintenance and repair responsibilities are limited to real property items (e.g., HVAC systems for comfort cooling and computer rooms) the benefits of this BMP will likely be minimal. Zone Foremen and/or A/C shop technicians will be the best source of information for identifying the location and size of single-pass HVAC equipment at your base.

Information may also be available from the base backflow prevention plan. Equipment that uses potable water for cooling may require a backflow preventor, so the plan could help identify single-pass cooling equipment. Be advised that sometimes this list may not include equipment with integral backflow prevention. In addition, some equipment may have been overlooked when the plan was developed, or the plan may not be thoroughly up-to-date. Consult with your base backflow prevention program manager located in CE about updating the backflow prevention plan and incorporating any single-pass cooling equipment that may have been previously overlooked.

The FEMP advises that implementing the following O&M procedures, and/or retrofit/replacement options can help conserve water used in single-pass cooling equipment.

3.7.1 Operation and Maintenance Options

- Inventory cooling equipment to specifically identify all single-pass cooling systems.
- Ensure that procedures are in place to turn off the water supply when the single-pass cooling equipment is not in operation. Some equipment, both old and new, allows water to constantly run, even when the equipment is turned off.
- Check entering and leaving water temperatures and flow rates to ensure they are within manufacturers recommendations. For maximum water savings the flow rate should be near the minimum allowed by the manufacturer. This can produce significant water savings. Balancing valves are sometimes not installed, or they are not properly adjusted and left in the "wide open" position. Adjustment of a two-ton water-cooled air conditioning system from 7 gpm to 4 gpm will save more than 1.5 mgy, assuming the system is in 24-hour operation. Savings of this magnitude are worthwhile to pursue even if balancing valves have to be installed. Once the valves are properly set they should be marked (or fixed) in position to avoid future tampering.

3.7.2 Retrofit/Replacement Options

- Be advised that retrofit and/or replacement of the single-pass cooling features of medical equipment may be impossible due to impacts upon the performance of the equipment. Furthermore, medical equipment is not a real property item for which civil engineering has maintenance and repair responsibility.
- Modify equipment to operate on a closed loop that recirculates the water instead of discharging it.
- Find another use for single-pass effluent, such as boiler make-up supply or landscape irrigation. Secondary use of the 4 gpm flow from a two-ton air conditioning unit will produce a savings of more than $5,000 per year in avoided sewage costs.
- Be aware that some effluent may be contaminated (such as that coming from degreasers, hydraulic equipment, or cooling systems) and not fit for reuse. Contaminated effluent should never be used in boilers because the potential to hamper proper boiler operation.
- Replace once-through cooling systems with a multi-pass cooling tower or a closed loop system, or switch to a non-potable water source.
- Replace water-cooled equipment with air-cooled equipment, or the best available technology (BAT) for achieving energy and water efficiency.

3.8 BMP #8—Cooling Tower Management

Cooling towers help regulate a building's air temperature either by rejecting heat from air conditioning systems or by cooling hot equipment. Similar to boiler and steam systems (refer to BMP #6) cooling towers require vast quantities of make-up water to replace that lost to leaks, "blow-down," evaporation and carryover (water droplets or mist carried out of the tower by air flow.) The value of this water is enhanced by the cost of necessary energy and chemical treatment, hence significant savings may be possible through water conservation efforts.

3.8.1 Operation and Maintenance Options

- O&M activities for cooling towers are covered in MIL-HDBK-1149, Industrial Water Treatment. However, this MIL HDBK will soon be replaced by a Unified Facilities Criteria (UFC) document. This guidance mandates many of the O&M options for this BMP (see Appendix A for a complete description of the O&M options associated with this BMP). Operations and maintenance of cooling towers in accordance with this guidance can save significant amounts of water and reduce associated chemical and energy costs.

3.8.2 Retrofit/Replacement Options

- Water cost savings alone will seldom justify the cost of retrofitting or replacing a cooling tower. Therefore, it is critical to incorporate any water saving cooling tower retrofits or replacements into the base energy program. Consult your base energy manager to identify any situations where this possibility may exist. Since the Air Force already has an aggressive energy conservation program, by incorporating these water saving initiatives into the energy program, additional funding resources may become available.
- If your base has large central cooling plants there could be some benefit to investigating the reuse of cooling tower "blow-down" water. Reuse is limited to non-potable uses, and the disposal of "blow-down" water might be regulated. Those factors, combined with the fact that most bases employ small and/or isolated cooling towers, may limit the value of this option. If your installation has a source of reclaimed wastewater, it could prove cost effective to use this water as a source of make-up water instead of potable water. (See BMP #10 for more information on water reuse and recycling.)

3.9 BMP #9—Miscellaneous High Water-Using Processes

Examples of high water-using processes at Air Force installations may include depot activities, aircraft and ground vehicle washing systems, maintenance facilities, kitchen and food processing areas, cleaning/laundry services, laboratories, and hospitals.

FEMP guidance advises high water-using processes be identified and analyzed for potential water and energy efficiency improvements. However, at most Air Force installations water savings for these processes will be more effectively accomplished through implementation of other BMPs.

3.9.1 Operation and Maintenance Options

- If practical, consider metering or otherwise measuring the amount of water used in identified high water-using processes.

3.9.2 Retrofit/Replacement Options

- Get expert help to determine if water efficiency improvements are appropriate for specific processes. New system designs and improved materials can significantly reduce water and energy requirements, but they will also require significant capital investment. Retrofit and/or O&M options should be fully investigated before deciding to embark on a replacement project.

3.10 BMP #10—Water Reuse and Recycling

Some facilities or processes at your installation may have water uses that can be met by use of non-potable water. These applications should be identified during the review of water use practices at your installation. Use of non-potable water is generally most cost effective when considered and accommodated during the planning phase of a facility or system, therefore a process should be in place to evaluate non-potable water alternatives at the earliest phases of design.

There are three categories of water reuse, and the definitions and terminology may vary for each category. For the purpose of this guide the categories and definitions shown below should be used.

3.10.1 On-Site Water Recycling

On-site water recycling is sometimes referred to as on-site water *reuse*. The process relies on reusing water for the same purpose at the same location. The recycled water is usually filtered or treated in some manner to make it acceptable for its intended reuse. For instance, car washes that use recycled water are equipped to collect water, filter it, and then reuse it in the wash process for additional vehicles. In this application potable water is used only in the rinse process and/or to provide make-up water to replace losses.

Potential Air Force Applications

On-site water recycling applications include commercial washes and firefighter training. Before considering use of on-site recycled water in a process governed by a Technical Order (TO) you must first verify that the process is in compliance with the TO.

Typical treatment processes remove suspended solids, but leave dissolved solids (such as salts) in the recycled water. Salts can increase in concentration and present corrosion problems. While not particularly problematical for automobiles, busses, or golf carts, the increased concentration of salts could cause corrosion problems for aircraft wash racks or other systems that are governed by TOs. In such cases, check with the Item Manager.

3.10.2 Water Reuse

Sometimes referred to as *reclaimed water*, water reuse refers to the reuse of effluent from wastewater treatment plants following treatment to very high standards and approval for non-potable use. In some instances the treated water may even meet many drinking water standards, but due to public perception and regulations it is restricted to non-potable uses.

Reuse water is distributed in separate systems (i.e., *purple pipe systems)* to identify it as non-potable water. Figure 3.1 depicts overall guidelines for water reuse treatment and subsequent uses, but state laws and codes have specific requirements for compliance. For

Air Force purposes the state laws are further supplemented by the Uniform Plumbing Code (UPC), which was adopted by the Air Force in AFI 32-1066.

Potential Air Force Applications

ETL 99-1 should be consulted for specific information on water reuse at Air Force installations. These applications include:

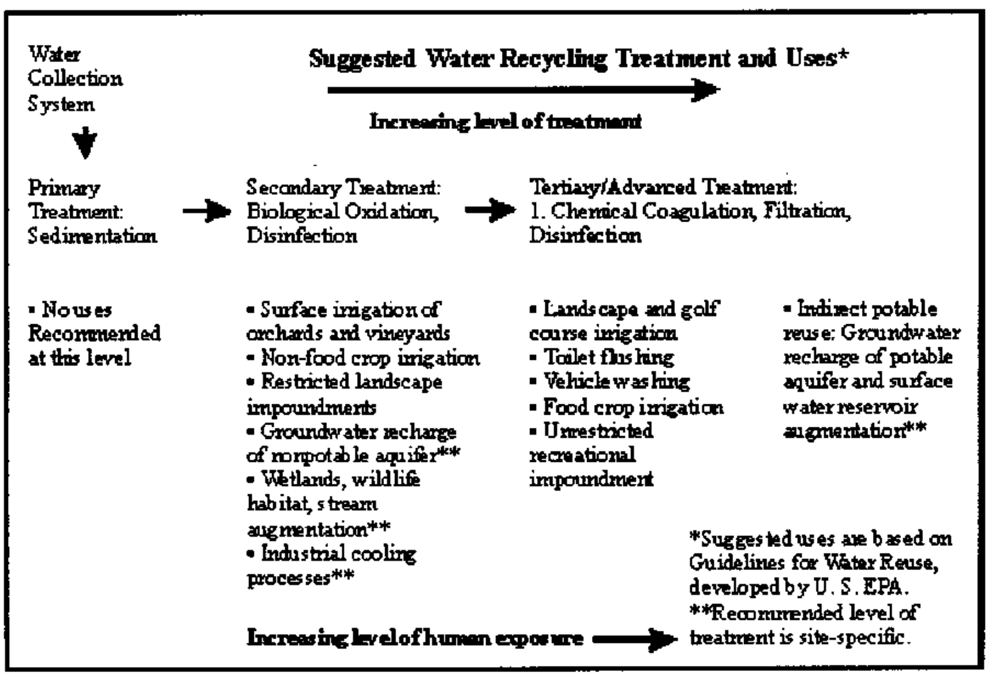
- Golf course irrigation
- Common area landscape irrigation
- Firefighter training pits
- Power plants
- Cooling towers

Before considering reuse for these or other applications several questions need to be answered.

- Is a reuse source available? If not, reuse is a moot point.

- How much is available? If reuse water is not available in sufficient quantity then reuse is not practical, but there may be opportunity to use reclaimed water as a supplemental source (i.e., a golf course could make use of groundwater and reclaimed water for irrigation purposes).

FIGURE 3.1
Overall Guidelines for Water Recycling Treatment and Subsequent Uses
While there are some exceptions, wastewater in the United States is generally required to be treated to the secondary level. Some uses are recommended at this level, but many common uses of reclaimed water such as landscape irrigation require further treatment.



- Is it on-site or from a municipal source? On-site reuse has more economic potential because it will not require purchase of reuse water from a municipal source. In addition, reuse water from an on-site source will (at a minimum) reduce the size of the transmission/distribution system necessary to deliver the water to where it is needed.
- Does it meet water quality requirements for its intended reuse? Assuming reuse water is available in sufficient quantities from a viable source it must also meet regulatory requirements for reuse. Supervisory personnel from the reuse water supplier should have this information. If not, the regulatory authority responsible for permitting the reuse source will be able to answer the question.

3.10.3 Gray Water

Gray water is collected from uses that include showers/baths and clothes washing, provided the water was not used to wash diapers or process food. It is reused for non-potable purposes such as landscape irrigation and toilet flushing.

Potential Air Force Applications

The UPC (refer to AFI 32-1066) restricts gray water systems to single-family residential properties, and then only for subsurface irrigation. Due to the potential for health concerns, gray water reuse is prohibited in commercial and industrial facilities. **For the same reason, gray water systems are generally prohibited for use at Air Force installations.**

3.10.4 Other Non-Potable Sources

In addition to the three categories defined above potential exists for use of water from other non-potable sources for certain uses (i.e., landscape irrigation, single pass cooling). Sources can include untreated surface water from a lake, stream, or pond; of water from a well that has not been treated to potable water standards.

Since the Air Force tracks only potable water use, a switch to a non-potable source for a high volume use could result in a significant reduction in potable water use. Use of water from non-potable sources may involve permitting and regulatory issues (including water rights) that must be carefully researched before being implemented.

Potential Air Force Applications

The same potential applications exist as for reuse water. Similarly, questions regarding availability, quantity, and proximity must also be addressed when considering use of a non-potable source.

3.10.5 Simple Pay-Back Period

Air Force installations should investigate all cooperative funding opportunities that may be available from the federal, state, and local government. In some instances grants are available that can enhance the economic potential for a reuse/recycling initiative.

Calculating the simple pay-back period involves dividing estimated implementation costs (i.e. design and construction of distribution or recycling systems) by the projected annual dollar savings.

Implementation costs/Annual dollar savings = Simple pay-back period in years

As with the other BMPs, reuse or recycling projects with a simple pay-back period of ten years or less are considered cost effective, and should be investigated further for potential implementation.

Estimating Implementation Costs

Implementation costs primarily consist of the design/construction of the required transmission and distribution system. Detailed cost data can be obtained from the Parametric Cost Engineering System (PACES), the Air Force Pricing Guide (Historical Cost Handbook), or R.S. Means. More information on PACES or the AF Pricing Guide can be obtained from the AFCESA Cost Engineering Website at http://www.afcesa.af.mil/Directorate/CES/Civil/CostEngr/CostEngr.htm.

Costs vary by geographic region and market conditions, but at the writing of this guide (FY02), rough-order-of-magnitude estimates were as follows.

Pipe Costs

For a precise estimate of pipe costs, you should refer to a cost estimating database such as PACES or R.S. Means. For a rough approximation of the costs, you can multiply the inside diameter of the pipe by $3.00, then multiply the product by the number of required feet. For example, a ten-inch reclaimed water main that is one-mile in length would cost $158,400 ($3.00 X 10-inch diameter X 5,280 feet = $158,400).

Tank Costs

For a precise estimate of storage tank costs, you should refer to a cost estimating database such as PACES or R.S. Means. As a "general rule-of-thumb" an at-grade storage tank costs aprpoximately $250,000 per million gallons of capacity. For example, a - one-half-million-gallon prestressed tank would cost approximately $125,000 ($250,000 X .5-million-gallons = $125,000).

For golf courses, ponds have proven a cost effective alternative to ground storage tanks for reclaimed water. The ponds provide an extra advantage in that they can double as water hazards.

Pump Costs

For a precise estimate of pump costs, you should refer to a cost estimating database such as PACES or R.S. Means. As a "general rule-of-thumb" you may assume $200,000 for every million-gallons-per-day of flow. For example, a 500,000-gpd average with a one-mgd peak capacity would cost approximately $ 100,000 (.5 mgd average flow rate X $200,000 = $100,000).

Sample Scenario. Billing records indicate the golf course at Anywhere AFB, USA uses 240,000 Kgal of potable water annually for irrigation purposes. With an incremental water cost of $2.60 per Kgal, golf course irrigation water costs the installation $624,000 every year. Treated effluent from a wastewater treatment plant is available two miles away at a cost of .20 cents per Kgal, or $48,000 annually.

Getting the water to the golf course will require 10,560 feet of 10-inch pipe, which will cost approximately $316,800. This estimate uses the previously mentioned rule of thumb that calls for multiplying $3.00 times the inside diameter of the pipe (10-inches), and multiplying the product by the number of feet ($3.00 X 10-inches X 10,560 feet = $316,800).

A one million-gallon at grade storage tank will cost approximately $250,000. This cost is estimated using the previously mentioned rule of thumb that an at grade storage tank will cost approximately $250,000 for every one-million-gallons of capacity ($250,000 X 1 = $250,000).

A one-mgd average flow pump will cost approximately $200,000. The cost is estimated using the previously mentioned rule of thumb calculation of $200,000 per one-mgd of flow ($200,000 X 1 = $200,000).

Adding the pipeline, tank and pump costs results in an estimated capital investment of $766,800. The dollar savings of using treated effluent instead of potable water is calculated by subtracting the annual cost of the treated effluent from the annual potable water costs ($624,000 annual potable water costs - $48,000 annual treated effluent costs = $576,000 annual savings).

Calculate the simple payback period in this fashion:

$766,800 (capital costs) / $576,000 annual savings =
1.33 (years simple payback period).

For the purpose of this investigation, this hypothetical golf course irrigation water reuse project would be deemed cost effective and should be pursued for implementation.

3.10.6 Additional Information

Water reuse, recycling and use of non-potable sources can save water and help limit or avoid disposal costs. Refer to the following sources for further information to assist your evaluation of this BMP.

- Southwest Florida Water Management District, *Reclaimed Water Guide* (http://www.swfwmd.state.fl.us/).
- U.S. Environmental Protection Agency Manual, *Guidelines for Water Reuse* (http://www.usepa.gov).
- American Water Works Association, *Backflow Prevention and Cross-Connection Manual*, (http://www.awwa.org).
- Water Environment Federation, *Water Reuse Guide* (http://www.wef.org).

You may also refer to the AFCEE website at http://www.afcee.af.brooks.mil.

CHAPTER 4

Financial Resources

Prior to credit being established for implementing a BMP, the language in the *Guidance to Establish Federal Water Efficiency Improvement Goal for Federal Agencies* (refer to Appendix A) requires identification and implementation of "applicable cost-effective retrofit and/or replacement options." Identification of the cost-effective retrofit/replacement options will be accomplished during development of the water management plan (refer to Chapter 2) and evaluation of the BMPs (refer to Chapter 3).

Actual implementation of BMPs will (in most instances) require funding. At present, the Air Force has no specific funding mechanism available for implementation of the cost-effective BMP retrofit/replacement options. However, there are six potential funding options that should be considered. These potential funding options are:

- Energy Savings Performance Contracts (ESPCs)
- Energy Conservation Investment Program (ECIP)
- Housing Funds
- Environmental Funds
- Operations and Maintenance (O&M) Funds
- Utility Energy Services Contracts (UESC)

Table 4.1 reflects the potential for these options to support BMP retrofit/replacement initiatives.

TABLE 4.1
Potential of Funding Options for Supporting BMP Implementation

BMP	ESPC	ECIP	Housing Funds	Environmental Funds	O&M Funds	UESC
#1-Public Information and Education Programs			X		X	X
#2-Distribution System Audits, Leak Detection and Repair	X	X	X		X	X
#3-Water Efficient Landscaping	X	X	X		X	X
#4-Toilets and Urinals	X	X	X		X	X
#5-Faucets and Showerheads	X	X	X		X	X
#6-Boiler and Steam Systems	X	X	X		X	X
#7-Single Pass Cooling Equipment	X	X	X		X	X
#8-Cooling Tower	X	X	X		X	X

TABLE 4.1
Potential of Funding Options for Supporting BMP Implementation

BMP	ESPC	ECIP	Housing Funds	Environmental Funds	O&M Funds	UESC
Management						
#9-Miscellaneous High Water- Using Processes	X	X	X	X	X	X
#10-Water Reuse/Recycling	X	X		X	X	X

4.1 Energy Savings Performance Contracts (ESPCs)

Energy Savings Performance Contracts (ESPCs) provide for the performance of services for the design, acquisition, financing, installation, testing, operation, and, where appropriate, maintenance and repair of an identified energy or water conservation measure. ESPCs provide that contractors (referred to as *Energy Services Companies* or ESCOs) incur the implementation costs of water and/or energy savings measures in return for a predetermined share of future savings that are realized from the measures.

Any of the BMP retrofit/replacement options could be considered as candidates for implementation through an ESPC. Consequently, the Air Force plans to rely upon ESPC contracts to secure the investment funds necessary to implement retrofit/replacement options.

Your initial economic analysis reflecting a simple pay-back period of 10 years or less is a starting point for considering use of an ESPC, but before a retrofit/replacement option is implemented the ESCO will perform a more thorough analysis. Figure 4.1 depicts the process of implementing an ESPC project.

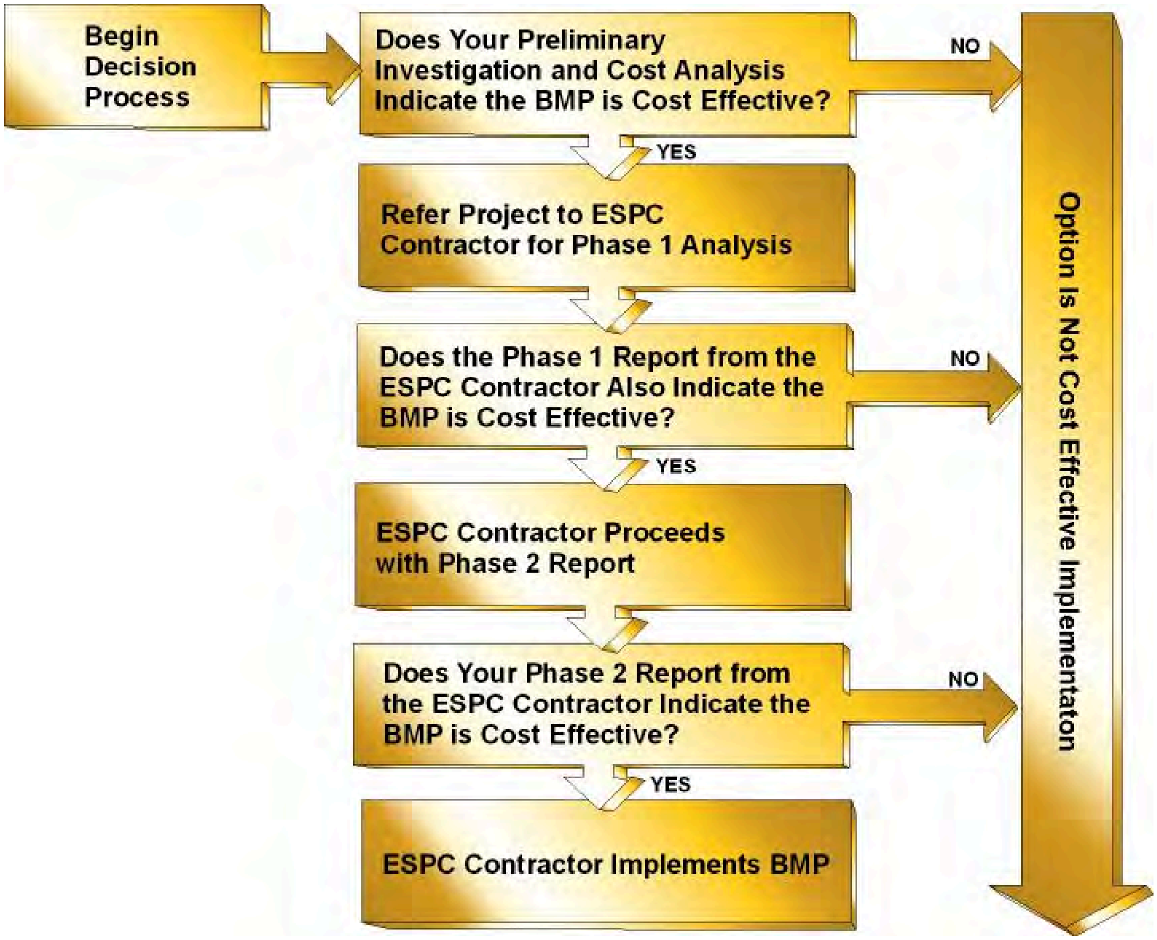
HQ AFCESA has already assisted six Regional Contracting Offices (RCOs) in the award of Regional ESPCs (RESPCs). These six IDIQ contracts provide Air Force installations in all 50 states and some OCONUS locations access to an Air Force RESPC. The AFCESA energy staff supports each RCO in managing these contracts and assumes much of the overhead work associated with administering the RESPCs.

The first step in considering use of an ESPC is contacting your base energy manager and/or base contracting office. They will be able to assist you in developing the necessary documentation for qualifying projects under ESPC.

For specific information on using ESPCs, the HQ AFCESA POC for the program is:

Mr. Quinn Hart
HQ AFCESA/CESM
139 Barnes Drive, Suite 1
Tyndall AFB, Florida 32403
DSN 523-6361
850-283-6361
e-mail: quinn.hart@tyndall.af.mil

FIGURE 4.1
Flow Chart for ESPC Implementation Process



4.2 Energy Conservation Investment Program (ECIP)

ECIP is a Military Construction Program (MILCON) intended primarily for accomplishing energy conservation retrofits of existing buildings. The program includes construction of new, high-efficiency energy systems and modernization of existing systems.

Though the program is funded by MILCON dollars, ECIP funds do not come from the same appropriations as typical MILCON, and there are additional eligibility requirements that include:

- The projects have a simple payback of 10 years or less.
- At least 20 percent of projected annual dollar savings come from reduced energy (BTU) savings (water projects are exempt from this provision).
- The projects have a savings-to-investment ratio (SIR) of at least 1.25. SIR is the savings generated over the entire performance period, or the life-cycle of the equipment or contract term, brought back to present value (PV) and divided by the capital investment of the project (SIR = Savings(PV) / Capital Investment).

ECIP projects compete DoD-wide for the limited dollars that are available each year in the program. Bases and MAJCOMs may submit projects at any time, or they may wait to submit until the Air Staff issues the annual call letter. The Air Staff prioritizes the candidate projects, primarily based on SIR, and forwards a suggested priority to the Office of the Secretary of Defense (OSD).

OSD includes a lump sum in the DoD budget for accomplishing all ECIP projects. After the budget is passed OSD then submits a list of projects to Congress that it intends to fund through the ECIP budget appropriation. After a 21-day notification period, OSD releases the ECIP funds to the respective services.

4.2.1 ECIP Procedures

Installation level personnel desiring to use ECIP to fund retrofit/replacement options must comply with the established procedures for the program. The procedures include roles and responsibilities not only for installation-level personnel, but also for Air Staff, HQ AFCESA, and MAJCOM representatives. The *Air Force Energy Program Procedural Memorandum (AFEPPM) 96-4*, dated 14 February 1996 (see Appendix E of this guide) details applicable procedures, roles and responsibilities.

4.2.2 Project Life-Cycle Cost Analysis (LCCA)

Each project submitted for consideration under ECIP must undergo a thorough LCCA. Similar to ESPC, the LCCA for ECIP projects requires a much greater level of detail than the preliminary economic analysis and simple pay-back period calculation that was performed during evaluation of the water conservation BMPs.

Your base energy manager or the Base Energy Steering Committee can provide information and guidance for developing the LCCA and additional requirements for using ECIP. For additional information on using the program to implement life-cycle cost effective water conservation retrofit/replacement options contact:

Mr. Quinn Hart
HQ AFCESA/CESM
139 Barnes Drive, Suite 1
Tyndall AFB, Florida 32403
DSN 523-6361
850-283-6361
e-mail: quinn.hart@tyndall.af.mil

4.3 Housing Funds

Water conservation initiatives related to base housing may be eligible for implementation using housing funds. Recent DoD and Air Force efforts to improve the quality-of-life for active duty personnel and dependents have resulted in more robust housing budgets. Consequently, implementing retrofit/replacement options through use of housing funds could be a viable strategy.

For more information on availability of funds, along with roles/responsibilities, and eligibility requirements, contact your MAJCOM.

4.4 Environmental Funds

Normally, environmental funds cannot be used for water conservation projects, unless special circumstances exist. This could be driven by Total Maximum Daily Load (TMDL) requirements, National Permit Discharge Elimination System (NPDES) restrictions, or other environmental requirements mandated by the regulatory agency. BMP retrofit/replacement options that are driven by environmental compliance requirements not associated with Operation & Maintenance (O&M) or infrastructure deficiencies may be eligible for implementation using environmental funds. It is critical to note that environmental funds can only be used for water conservation measures when the need for the project is driven by environmental regulations. In these cases, the primary focus of the project will be achieving compliance with environmental regulations. Any water savings that occur will be a supplemental benefit.

The regulations covering the use of environmental funds for projects are AFI 32-7001, Environmental Budgeting, AFI 32-7080 Pollution Prevention Program, and HQ USAF/ILE Memo "Environmental Quality (EQ)/Real Property Maintenance (RPM) Funding Eligibility Guidance for Non-reoccurring Infrastructure Projects," dated 31 Jan 2001 (See Appendix F).

An example of environmental funds being used to accomplish water conservation could occur if a base was required by a regulatory agency to divert some or all of the treated effluent of its wastewater plant away from the receiving water body. (This could be driven by Total Maximum Daily Load (TMDL) requirements, National Permit Discharge Elimination System (NPDES) restrictions, or other environmental requirement mandated by the regulatory agency.) If the diverted treated effluent is used to replace potable water for irrigation, water conservation would result. Because this is driven by a regulatory requirement, implementation costs for designing and constructing any needed reuse system(s) could potentially be eligible for environmental funding. In this instance the base would be implementing the project to comply with the environmental regulation(s), with water conservation being a supplemental benefit.

Installation-level personnel must coordinate all prospective environmental projects through the base civil engineer's environmental flight. For specific information on the potential to use environmental funding on projects to achieve supplemental water conservation benefits, contact your MAJCOM. The Air Staff POC for environmental funding of water projects is:

Mr. Jayant B. Shah
Water Program Manager
HQ USAF/ILEVQ
1260 Air Force Pentagon
Washington, D.C. 20330-1260
DSN 327-0120, Fax DSN 664-1812
Comm: 703- 607-0120
E-mail: jayant.shah@pentagon.af.mil

4.5 O&M Funds

O&M funding is the most flexible and widely used funding vehicle in the Air Force. However, the competition for O&M funds is stiff and conservation measures are often not given a high enough priority to compete successfully for the limited O&M dollars. The following procedures should be used to when seeking O&M funds.

4.5.1 O&M Funding for Water Projects

O&M-funded projects for real property are classified as maintenance, repair or unspecified minor military construction. It applies to all projects, including (but not limited to) those planned for accomplishment by organic forces. Organic forces include over-hires, temporary duty augmentees, troop labor, or contract support such as Simplified Acquisition of Base Engineer Requirements (SABER) contracts.

These funds are normally in the 3400 appropriation, or the 3740 for Air Force Reserve (AFRES), or the 3840 for Air National Guard (ANG). They may also include 3600 funds for Research, Development Test and Evaluation (RDTE), WCF or Defense SRM accounts when available for O&M functions. You should consult AFI 32-1031, Operations Management, for guidance on functions at the installation level.

4.5.2 O&M Funding Definitions

Two definitions apply to O&M funding. These definitions are sustainment and restoration and modernization (R&M).

Sustainment functions include annual maintenance and scheduled repair activities to maintain the inventory of real property assets through the expected service life. Further included are regularly scheduled adjustments and inspections, preventive maintenance tasks, and emergency response and service calls for minor repairs. Sustainment also includes major repair or replacement of facility components (usually accomplished by contract) that are expected to occur periodically throughout the life cycle of the facilities. Examples include regular roof replacement, refinishing of wall surfaces, repairing and replacement of heating and cooling systems, replacing tile and carpeting and similar work. Projects in the sustainment class of work should be assigned to EEIC 521 (Sustainment Maintenance) or EEIC 524 (Sustainment Repair).

Restoration and Modernization (R&M) may also be performed using O&M funds. Restoration includes repair and replacement work to restore facilities damaged by inadequate sustainment, excessive age, natural disaster, fire, accident, or other causes. Modernization includes alteration of facilities solely to implement new or higher standards (including regulatory changes), to accommodate new functions, or to replace building components that typically last more than 50 years (such as foundations and structural members). Projects in this category will be classified as repair and/or minor construction, and should be assigned to EEIC 522 (Repair) or EEIC 529 (Minor Construction O&M). For further information on O&M funding procedures consult AFI 32-1032, *Planning and Programming Appropriated Funded Maintenance, Repair, and Construction Projects.*

4.6 Utility Energy Services Contracts

Utility Energy Services Contracts (UESCs) can be used for implementation of water conservation projects. A UESC is a sole source agreement with the local utility executed under the authority of 10 USC 2865 and 10 USC 2866 for completion of energy and water conservation projects. A UESC is very similar to an ESPC agreement; however, the UESC statutes do not require (or exclude) guaranteed savings. Through accurate savings calculations and thorough measurement and verification (M&V) plans, UESCs have been shown to produce results consistent with ESPC and often for less money. The Air Force has executed numerous successful UESC projects, and advocates consideration of this installation/utility company partnership for implementing water conservation measures.

For more information on the program, you may contact:

Mr. Jim Snook, Utility Rates Management Team
HQ AFCESA/CESE
DSN 523-6295
Commercial 850-283-6295
Jim.Snook@tyndall.af.mil

APPENDIX A

Executive Order 13123

Guidance to Establish Water Efficiency Improvement Goal for Federal Agencies

This guidance document was issued by the Department of Energy on 10 May 2000 to implement the requirement for a water conservation goal mandated in EO 13123. A complete set of guidance documents for EO 13123 can be obtained from the DOE - FEMP website at http://www.eren.doe.gov/femp/resources/guidances.html.

May 10, 2000

Agencies shall reduce potable water usage by implementing life cycle cost-effective water efficiency programs that include a water management plan, in accordance with Attachment 1, and not less than 4 separate FEMP Water Efficiency Improvement Best Management Practices (BMP), listed in Attachment 2. BMPs can be considered implemented at a facility when all the following criteria are met:

Water Management Plans have been developed/revised and incorporated into existing facility planning processes and operating plans; and

Applicable Operations & Maintenance Options have been put into practice, and Retrofit/Replacement Options have been reviewed within the last 2 years and those appropriate for implementation have been identified; and

Applicable cost-effective Retrofit/Replacement Options have been implemented.

The schedule for implementation is as follows:

05% of facilities by 2002
15% of facilities by 2004
30% of facilities by 2006
50% of facilities by 2008
80% of facilities by 2010

The Department of Energy will review agencies' progress in 2005, and may revise the water efficiency improvement goal at that time. Agencies should also refer to the FEMP web site for information about reporting baseline water consumption and cost.

Attachment 1 - Facility Water Management Planning Guidelines

Background

A successful water management program starts with development of a comprehensive water management plan. This plan should provide clear information about how a facility uses its water, from the time it is piped onto the facility through its ultimate disposal.

Knowing how you currently use water and what it costs will enable you to make the most appropriate water management decisions. This plan should be included with existing facility operating plans.

Implementation

Develop or update facility water management plans to include at a minimum the following:

1) Operation and Maintenance (O&M) recommendations. Include appropriate O&M recommendations from the FEMP Best Management Practices in facility operating plans or procedure manuals.
2) Utility Information. Appropriate utility information should include the following:
    a) Contact information for all water and wastewater utilities.
    b) Current rate schedules and alternative schedules appropriate for your usage or facility type. You want to be sure you are paying the best rate.
    c) Copies of water/sewer bills for the past 2 years. This will help you identify inaccuracies and determine that you are using the appropriate rate structure.
    d) Information on financial or technical assistance available from the utilities to help with facility water planning and implementing water efficiency programs. Sometimes energy utilities offer assistance on water efficiency.
    e) Contact information for the agency or office that pays the water/sewer bills.
    f) Production information, if the facility produces its water and/or treats its own wastewater.
3) Facility information. At a minimum, perform a walk-through audit of the facilities to identify all major water using processes; location and accuracy of water measurement devices; main shut off-valves; verify operating schedules and occupancy of buildings. Because of reporting requirements in Executive Order 13123, facilities should include a description of actions necessary to improve the accuracy of their water usage data. This can include a metering (or other measurement) plan for the facility.
4) Emergency response information. Develop water emergency and/or drought contingency plans that will describe how your facility will meet minimum water needs in an emergency or reduce water consumption in a drought or other water shortage. This should be done in conjunction with your local water supplier.
5) Comprehensive Planning. Inform staff contractors and the public of the priority your agency or facility places on water and energy efficiency. Ensure that they take water supply, wastewater, storm water issues and water efficiency BMPs into account at the earliest stages of planning and design for renovation and new construction.

Attachment 2 - FEMP Water Efficiency Improvement Best Management Practices

Agencies shall implement a water management program that includes not less than four of the following best management practices:

BMP # 1 - Public Information and Education Programs
BMP # 2 - Distribution System Audits, Leak Detection & Repair
BMP # 3 - Water Efficient Landscape
BMP # 4 - Toilets and Urinals
BMP # 5 - Faucets and Showerheads
BMP # 6 - Boiler/Steam Systems
BMP # 7 - Single-Pass Cooling Systems
BMP # 8 - Cooling Tower Systems
BMP # 9 - Miscellaneous High Water-Using Processes
BMP #10 - Water Reuse and Recycling

BMP # 1 – Public Information and Education Programs

Background

Educating users is very important if water conservation technologies and methods are to be successful. Experience shows that it is not enough to install a retrofit or water saving technology in a facility. New operation procedures, retrofit or replacements are most effective when employees, contractors and the public know what the new technology or methods are and how to use them properly.

An additional benefit to water conservation is positive public opinion. If your facility is doing its part to save the community resources, let them know. Informing the public about your facilities commitment to reduce waste is good news. The news media is often interested in facilities that take a proactive stand on water conservation.

Internal Options

- Establish a user-friendly hot line or other systems to report leaks or other wastes of water and energy. Repair promptly to encourage continued participation.
- Keep employees informed about your commitment to water conservation, your ongoing conservation program and any program successes. Start a water column in your building or agency newsletter featuring how much water has been saved through the water management program. Send information via e-mail.
- Place sign and placards near new equipment so it is easy understand the new technology and how to use it properly.
- Start a suggestion and incentive system to recognize and encourage water saving in you facility. Consider distributing efficiency devices.
- Conduct regular training workshops for maintenance personnel to keep them up to date on operational changes and maintenance procedures.

External Options

- Work with local utilities to develop comprehensive programs and share your successes with other similar facilities.
- Invite members of the local news media to tour you facility and observe first hand the conservation program and successes achieved.
- Create displays presenting your water conservation results for posting in your lobby and other public reception areas.
- Develop web-sites, brochures and other materials for distribution to employees and the public describing your program, goals, and successes.

Other Information

Water Management: A Comprehensive Approach for Facility Managers, General Services Administration, http://www.gsa.gov/pbs/centers/energy/water.htm

Military Handbook 1165: Water Conservation, Naval Facilities Engineering Service Center; http://www.afcesa.af.mil/Directorate/ces/Civil/Water/Water.htm or http://energy.navy.mil/key-areas/WaterWeb.html

A Water Conservation Guide for Commercial, Institutional and Industrial Users, New Mexico Office of the State Engineer 1-800-water-nm.

BMP # 2 – Distribution System Audits, Leak Detection and Repair

Background

A distribution system audit, leak detection and repair program can help facilities reduce water losses and make better use of limited water resources. If you are located at the average, circa 1940's, military facility it is very likely that much more than 10% of your total water production and purchases are lost to system leaks. Regular surveys of distribution systems should always be conducted prior to obtaining additional supplies and can have substantial benefits including:

- ***Reduced water losses.*** Reducing water losses will help stretch the existing supplies to meet increasing demand. This could help defer the construction of new water facilities such as wells, reservoirs, or treatment plants.
- ***Reduced operating costs.*** Repairing leaks will save money by reducing power costs to deliver water, and reduce chemical to treat water.
- ***Increased knowledge of the distribution system***. As personnel become more familiar with the system including knowing the location of mains and valves, they are able to respond more quickly to emergencies such as main breaks.
- ***Reduce property damage.*** Repairing system leaks can prevent damage to property and safeguards public health and safety.

Operations and Maintenance

- Complete a prescreening system audit to determine the need for a full-scale system audit using one of the following methods. Every two years:

    1. Determine authorized uses
    2. Determine other system verifiable uses
    3. Determine total supply into the system
    4. Divide authorized uses plus other verifiable uses by total supply into the system. If this quantity is less than 0.9, a full-scale system audit and leak detection program is indicated.

    Or

- Once a system audit has been conducted, obtain and monitor minimum system flow. This is usually the flow rate at around 3 or 4 AM. Significant increases to this amount can be assumed to be leak-related and would indicate that a full-scale leak detection survey is necessary.
- When indicated, facilities shall complete full-scale water audits of their distribution systems using a methodology consistent with that described in the *American Water Works Association's "Water Audit and Leak Detection Guidebook,* Number M36."

Retrofit and Replacement Options

- Repair leaks or replace pipes when leaks are found.
- For specifics on this technology, consult with experts in the field. Your first resource should be your local or higher headquarters engineers, but do not overlook or rule out the benefits of input from experienced contractors or other Governmental agencies (DOD, CERL, DOE, FEMP, etc.)

Other Information

Water Audits and Leak Detection, American Water Works Association, Manual of Supply Practices. AWWA Number M36.

Preventing Water Loss in Water Distribution Systems: Money Saving Leak Detection Programs. US Army Corp of Engineers Construction Engineering Research Laboratory, Technical Report Number N-86/05

Military Handbook 1165: Water Conservation, Naval Facilities Engineering Service Center; http://www.afcesa.af.mil/Directorate/ces/Civil/Water/Water.htm or http://energy.navy.mil/key-areas/WaterWeb.html

BMP # 3 – Water Efficient Landscaping

Background

In most locations, traditional landscapes require supplemental water to thrive. For example, Kentucky bluegrass is native to regions that receive in excess of 40 inches per year of precipitation. To make up the difference between a plant's water requirement and the natural precipitation in your area, additional water must usually be added in the form of irrigation.

If your facility includes any irrigated landscape, then exterior water use should be an important part of your overall water conservation program. There are a number of good reasons to have a water efficient landscape:

1. Native and other "climate appropriate" landscape materials can reduce irrigation water use by more than 50%.
2. Reduced turf and other irrigated areas can significantly reduce time and money spent mowing, fertilizing, removing green wastes and maintaining landscapes.
3. Over-watering can cause more damage to plant materials than under-watering and can damage streets, curbs, other paving and building foundations.

Operation and Maintenance Options

- Periodically review all landscape service and maintenance agreements to incorporate high priority for water, chemicals and energy conservation. Consider incorporating a performance standard for water use and other parameters into contracts. Encourage landscape contractors to report and fix problems.

- Consider installing an irrigation meter to measure the amount of water applied to the landscape. Some water utilities offer an interruptible rate for the service or will provide a credit to the sewer charges.
- Verify that irrigation schedule is appropriate for climate, soil conditions, plant materials, grading, and season. Water only in the early morning to minimize evaporation. This will maximize the effectiveness of watering while minimizing the amount of water used and the opportunity for fungus growth. Generally, it is better to water deeply less frequently than to water lightly often.
- Recirculate water in decorative fountains, ponds and waterfalls and shut off when possible to reduce evaporation losses. Check water recirculation systems annually for leaks and other damage. Consider using non-potable water in these systems.
- Monitor irrigation systems for effectiveness. Make sure sprinkler heads are placed and adjusted so that they will water the landscape, not the pavement. Water plant roots, not trunks or leaves. Check for dirty or broken emitters. Verify that irrigation system pressure is within manufacturer specifications. Make sure replacement emitters match existing equipment.
- Alternate your turf mowing height between low and high levels. This encourages roots to grow deeply and helps make plants more able to go longer between watering. Keep the irrigated landscape weed free so that valuable water is consumed only by decorative landscape. Mulch also helps reduce weed growth.
- Make sure all handheld hoses have shut-off nozzles.
- Establish user-friendly method to report irrigation system problems and fix them immediately.

Retrofit Options

- Install an irrigation timer to appropriately schedule sprinkler use. Verify that emitters are appropriate to the plants being irrigated. Use low flow sprinkler heads instead of turf sprinklers in areas with plants, trees or shrubs.
- Use a soil tensiometer or other sensor to determine when the soil is dry and gauge the amount of water needed. If using a variety of automatic controls, make sure they have a manual override feature and that you use it. This way, if it rains, you can cancel your next watering. Rain sensors can also be installed to shut off automated irrigation systems when it is raining.
- Select climate appropriate turf, trees, shrubs and ground cover.
- Eliminate "strip grass" to the greatest extent possible. Small strips of grass, common in parking islands and between sidewalks and the roadway are hard to maintain and difficult to efficiently water, use bushes, mulch, colored tiles, instead.

Replacement Options

- Install irrigation systems that have controls or sensors

- Use a trickle or subsurface irrigation system that is installed underground and provides water directly to the roots, preventing water loss from evaporation and run-off.
- Use water from other systems such as once through cooling systems, cooling tower bleed off or other non-potable sources such as reclaimed water, or gray water, where environmentally appropriate.
- Replace or install entire landscape with climate appropriate, water-efficient materials and an efficient irrigation system.

Other Information

Water Management: A Comprehensive Approach for Facility Managers, General Services Administration, http://www.gsa.gov/pbs/centers/energy/water.htm

Military Handbook 1165: Water Conservation, Naval Facilities Engineering Service Center; http://www.afcesa.af.mil/Directorate/ces/Civil/Water/Water.htm or http://energy.navy.mil/key-areas/WaterWeb.html

Roadside Use of Native Plants; Federal Highway Administration; environment@fhwa.dot.gov

A Water Conservation Guide for Commercial, Institutional and Industrial Users, New Mexico Office of the State Engineer 1-800-water-nm

BMP # 4 – Toilets and Urinals

Background

The United States uses about 4.8 billion gallons of water every day to flush waste. Since toilets and urinals account for nearly one-third of building water consumption, the potential for savings in this area is significant. Unless your facility is relatively new or has been refurbished recently, chances are that your toilets and urinals are consuming too much water. Current Federal law requires that residential toilets manufactured after January 1, 1994 must use no more than 1.6 gallons per flush (gpf). Commercial toilets manufactured after January 1, 1997 must use no more than 1.6 gpf and urinals must use no more than 1 gpf.

Ultra-low-flush fixtures have been the topic of a great deal of discussion. When first introduced these fixtures were often judged to be inadequate. Unfortunately, the poor performance of early models continues to cast a cloud of doubt over the technology. However, ultra- low-flush toilets have come a long way. For instance, early modifications to flush valves to reduce the volume of water, without changing the bowls, led to many reports of clogging and double flushing. As a result, national standards have been established to match tanks and bowls, and accommodate varying water pressure. Most surveys conducted to measure consumer satisfaction with ultra-low flush toilets have shown an acceptance or satisfaction rate of more than 80%.

Operation and Maintenance Options

- Establish user-friendly method to report leaks and fix them immediately.

- When performing maintenance replace worn parts and adjust mechanisms to ensure that the water consumed per flush meets manufacturers' guidance.
- Encourage cleaning or custodial crews to report problems.

Retrofit Options

- Retrofits for tank style toilets, such as displacement dams or bags may hamper overall operation of the toilet and increase maintenance costs, as they often have a short life span and require frequent replacement or adjustment. Therefore, they may not be appropriate for many Federal facilities.
- For flush valve style toilets, infrared or ultrasonic sensors can be used to automatically activate flushing, making it unwieldy for users to flush twice. However, these devices need to be set properly to avoid multiple flushing.
- Also early closure or valve insert or replacement devices can reduce flush volumes from 0.6-2 gpf. However, they often require frequent replacement or adjustment. Therefore, they may not be appropriate for many Federal facilities.

Replacement Options

- Replace 3.5 to 7 gpf toilets, to maximize water savings, with valves and porcelain specifically designed to use 1.6 gpf. Site specific evaluation of existing waste lines, water pressure, distance, usage, settling, and types of users (employees, residents, occasional members of the public, high visitor populations, etc) is necessary to determine the appropriate models for a specific site. Where appropriate, recycle used parts (crushed vitreous china can be used for roadbed materials), to minimize land fill impacts.
- Replace urinals with models designed to use 1 gpf or install a waterless (no-flush) urinal.
- In remote areas, consider replacing water using toilets and urinals with alternative technologies such as composting or incinerator toilets.
- Consider non-potable water for toilet and urinal flushing.
- For specifics on this technology, consult with experts in the field. Your first resource should be your local or higher headquarters engineers, but do not overlook or rule out the benefits of input from experienced contractors or other Governmental agencies (DOE, FEMP, etc.)

Other Information

Water Management: A Comprehensive Approach for Facility Managers, General Services Administration, http://www.gsa.gov/pbs/centers/energy/water.htm

Military Handbook 1165: Water Conservation, Naval Facilities Engineering Service Center; http://www.afcesa.af.mil/Directorate/ces/Civil/Water/Water.htm or http://energy.navy.mil/key-areas/WaterWeb.html

A Water Conservation Guide for Commercial, Institutional and Industrial Users, New Mexico Office of the State Engineer 1-800-water-nm

BMP #5– Faucets and Showerheads

Background

Tremendous amounts of water and energy are wasted using non-water efficient faucets and showerheads. Federal guidelines mandate that all lavatory and kitchen faucets and aerators manufactured after January 1, 1994, must use no more than 2.2 gpm, showerheads must use no more than 2.5 gpm. If your facility still uses older faucets and showerheads, there is a significant opportunity to save both water and energy costs.

Operation and Maintenance Options

- Establish user-friendly method to report leaks and fix them immediately. Encourage cleaning or custodial crews to report problems.
- Test system pressure to make sure it is between 20 and 80 psi. If the pressure is to low, then low consuming devices won't work properly, if its too high they will consume more than their rated amount of water.
- Install expansion tanks, pressure reducing valves and reduce water heater settings, where appropriate, to prevent temperature and pressure relief valves from discharging water.
- Correctly adjust and maintain automatic sensors to ensure proper operation.
- Encourage users to take shorter showers.
- Post energy/water awareness information to encourage conservation from users.

Retrofit/Replacement Options

- Install showerheads that achieve the 2.5 gpm and aerator or laminar flow devices that achieve the 2.2 gpm requirement.
- Install temporary shut-off valves in faucets. These valves cut off the water flow during intermittent activities like scrubbing or dishwashing. The water can be reactivated at the previous temperature without the need to remix the hot and cold water.
- Install automatic shut-off valves. These can be operated by infrared or ultrasonic sensors, which detect the presence of someone's hands and will shut off water when the hands are removed. However, these devices need to be set properly to operate properly.

Other Information

Water Management: A Comprehensive Approach for Facility Managers, General Services Administration, http://www.gsa.gov/pbs/centers/energy/water.htm

Military Handbook 1165: Water Conservation, Naval Facilities Engineering Service Center; http://www.afcesa.af.mil/Directorate/ces/Civil/Water/Water.htm or http://energy.navy.mil/key-areas/WaterWeb.html

A Water Conservation Guide for Commercial, Institutional and Industrial Users, New Mexico Office of the State Engineer 1-800-water-nm

BMP # 6 – Boiler/Steam Systems

Background

Boiler and steam generators are commonly used in large heating systems, institutional kitchens or in facilities where large amounts of process steam are used. This equipment consumes varying amounts of water depending on the size of the system, the amount of steam used and the amount of condensate return.

Operation and Maintenance Options

- Develop and implement a routine inspection and maintenance program on steam traps and steam lines.
- Maintain proper water treatment to prevent system corrosion and optimize cycles of concentration.
- Develop and implement routine inspection and maintenance program on condensate pumps.
- Use periodic quality assurance of boiler water treatment.
- Regularly clean and inspect boiler water and fire tubes. Reducing scale buildup will reduce the amount of blowdown necessary as well as improve the energy efficiency of the system.

Retrofit Options

- Install and maintain condensate return system. By recycling condensate for reuse, water supply, chemical use and operating costs for this equipment can be reduced by up to 70 percent. A condensate return system also helps lower energy costs as the condensate water is already hot and need less heating to produce steam than water from other make-up sources.
- Install an automatic blowdown system based on boiler water quality to better manage the treatment of boiler make-up water.
- Add an automatic chemical feed system controlled by makeup water flow.

Replacement Options

- Replacement options vary depending on the size of the facility and existing equipment. Consider performing an energy audit to reduce heating load and ensure that the system is sized appropriately. Reducing the size of the boiler system can reduce water requirements.
- Always purchase the most life cycle cost-effective boiler available for new installations or major renovations.

- Consider installing a small summer boiler, small distributed system or heat capture system for reheat or dehumidification requirements instead of running a large boiler at part load. Also consider alternative technologies such as heat pumps.
- For specifics on this technology, consult with experts in the field. Your first resource should be your local or higher headquarters engineers, but do not overlook or rule out the benefits of input from experienced contractors or other Governmental agencies (DOE, FEMP, etc.).

Other Information

Water Management: A Comprehensive Approach for Facility Managers, General Services Administration, http://www.gsa.gov/pbs/centers/energy/water.htm

Military Handbook 1165: Water Conservation, Naval Facilities Engineering Service Center; http://www.afcesa.af.mil/Directorate/ces/Civil/Water/Water.htm or

http://energy.navy.mil/key-areas/WaterWeb.html

A Water Conservation Guide for Commercial, Institutional and Industrial Users, New Mexico Office of the State Engineer 1-800-water-nm

BMP # 7 – Single-Pass Cooling Equipment

Background

Single-pass or once through cooling systems provide an opportunity for significant water savings. In these systems, water is circulated once through a piece of equipment and then disposed down the drain. To remove the same heat load, single-pass systems use 40 times more water than a cooling tower operated at 5 cycles of concentration. The types of equipment that typically use single-pass cooling are: CAT scanners, degreasers, hydraulic equipment, condensers, air compressors, welding machines, vacuum pumps, ice machines, x-ray equipment and air conditioners. Operation and Maintenance Options provide: Provide proper insulation on piping, chiller or storage tank.

- Inventory cooling equipment and identify all single-pass cooling systems.
- Check entering and leaving water temperatures and flow rates to ensure that they are within the manufacturer's recommendations. For maximum water savings, water flow rate should be near the minimum allowed by the manufacturer.
- Keep coil loops clean to maximize heat exchange with the refrigerated enclosure.

Retrofit Options

- Add an automatic control to shut off entire system during unoccupied night or weekend hours. This option should only be considered where shutdown would have no adverse impact on indoor air quality.
- Modify equipment to operate on a closed loop that recirculates the water instead of discharging it.

- Find another use for the single pass effluent, in boiler make-up supply or landscape irrigation and implement. Note some equipment effluent may be contaminated such as degreasers, hydraulic equipment. This effluent should not be used in boilers.

Replacement Options

- Replace the once through cooling systems with a multi-pass cooling tower or closed loop system.
- Replace water-cooled equipment with air-cooled equipment or best available energy /water efficient technology.
- For specifics on this technology, consult with experts in the field. Your first resource should be your local or higher headquarters engineers, but do not overlook or rule out the benefits of input from experienced contractors or other Governmental agencies (DOE, FEMP, etc.)

Other Information

Water Management: A Comprehensive Approach for Facility Managers, General Services Administration, http://www.gsa.gov/pbs/centers/energy/water.htm

Military Handbook 1165: Water Conservation, Naval Facilities Engineering Service Center; http://www.afcesa.af.mil/Directorate/ces/Civil/Water/Water.htm or http://energy.navy.mil/key-areas/WaterWeb.html

A Water Conservation Guide for Commercial, Institutional and Industrial Users, New Mexico Office of the State Engineer 1-800-water-nm

BMP # 8 Cooling Tower Management

Background

Cooling towers help regulate temperature by rejecting heat from air-conditioning systems or by cooling hot equipment. In doing so, they use significant amounts of water. The thermal efficiency, proper operation and longevity of the water cooling system all depend on the quality of water and its reuse potential.

In a cooling tower, water is lost through evaporation, bleed-off, and drift. To replace the lost water and maintain its cooling function, more make-up water must be added to the tower system. Sometimes water used for other equipment within a facility can be recycled and reused for cooling tower make-up with little or no pre-treatment, including the following:

- Water used in a once through cooling system
- Pretreated effluent from other processes, provided that any chemicals used are compatible with the cooling tower system.
- High-quality municipal wastewater effluent or recycled water (where available)

Operation & Maintenance Options

- Consider measuring the amount of water lost to evaporation. Some water utilities will provide a credit to the sewer charges for evaporative losses.
- Find out if conductivity is actually representative of your controlling parameter. Depending on your water supply, the equipment being cooled and the temperature differential across the tower, your parameter may be hardness, silica, total dissolved solids, algae or others. Once you determine the relationship between conductivity and your controlling parameter, set you blowdown valve to keep that parameter constant.
- Install conductivity and flow meters on make-up and bleed-off lines. Meters that display total water being used as well as current rate of flow are most useful. Check the ratio of conductivity of make-up water and the bleed off conductivity. Then check the ratio of bleed-off flow to make up flow. If both ratios are not about the same, check the tower for leaks or other unauthorized draw-off. Read conductivity and flow meters regularly to quickly identify problems. Keep a log of make-up, bleed-off consumption, dissolved solid concentration, evaporation, cooling load, and concentration ratio.
- Consider using acid treatment such as sulfuric or ascorbic acid, where appropriate. When added to recirculating water, acid can improve the efficiency of the water by controlling scale buildup created from mineral deposits. Acid treatment lowers the pH of the water, and is effective in converting a portion of the calcium bicarbonate, the primary cause of scale, into the more readily soluble forms. Make sure that workers are fully trained in the proper handling of acids. Also note that acid overdoses can severely damage a cooling system, so use a timer and add acid at points where the flow of water is well mixed and reasonably rapid. Also beware that lowering pH may mean you may have to add a corrosion inhibitor.
- Select your chemical treatment vendor with care. Tell vendors that water conservation is a high priority and ask them to estimate the quantities and costs of treatment chemicals, volumes of bleed-off water and the expected concentration ratio. Keep in mind that some vendors may be reluctant to improve water efficiency because it means the facility will purchase fewer chemicals. In some cases, saving on chemicals can outweigh the savings on water costs. Vendors should be selected based on "cost to treat 1000 gallons makeup water" and highest "recommended system water cycle of concentration."

Retrofit Options

- Install a sidestream filtration system that is composed of a rapid sand filter or high-efficiency cartridge filter to cleanse the water. These systems draw water from the sump, filter out sediment and return the filtered water to the tower, enabling the system to operate more efficiently with less water and chemicals. Sidestream filtration is particularly helpful if your system is subject to dusty atmospheric conditions. Sidestream filtration can turn a troublesome system into a more trouble-free system.
- Install covers to block sunlight penetration. Reducing the amount of sunlight on tower surfaces can significantly reduce biological growth such as algae.
- Consider alternative water treatment options such as ozonation or ionization, to reduce water and chemical usage. Be careful to consider life cycle cost impact of such systems.

- Install automated chemical feed systems on large cooling tower systems (over 100 ton). The automated feed system should control blowdown/bleed-off by conductivity and then add chemicals based on makeup water flow. These systems minimize water and chemical use while optimizing control against scale, corrosion and biological growth.

Replacement Options

- Get expert advice to help determine if a cooling tower replacement is appropriate. New cooling tower designs and improved materials can significantly reduce the water and energy requirements for cooling. However, since replacing a cooling tower involves significant capital costs, the facility manger should investigate every retrofit and O&M option available and compare their costs and benefits to a new tower. For specifics on this technology, consult with experts in the field. Your first resource should be your local or higher headquarters engineers, but do not overlook or rule out the benefits of input from experienced contractors or other Governmental agencies (DOE, FEMP, etc.)

Other Information

Water Management: A Comprehensive Approach for Facility Managers, General Services Administration, http://www.gsa.gov/pbs/centers/energy/water.htm

Military Handbook 1165: Water Conservation, Naval Facilities Engineering Service Center; http://www.afcesa.af.mil/Directorate/ces/Civil/Water/Water.htm or http://energy.navy.mil/key-areas/WaterWeb.html

A Water Conservation Guide for Commercial, Institutional and Industrial Users, New Mexico Office of the State Engineer 1-800-water-nm

BMP # 9 – Miscellaneous High Water-Using Processes

Background

Many other high water using processes are found at federal facilities, including kitchens and food processing, cleaning/laundry services, laboratories, fish hatcheries and other environmental uses, Treasury production, and so on. High water using processes should be identified and analyzed for potential water and energy efficiency improvements.

Operation and Maintenance, Retrofit, and Replacement Options

- Consider metering or otherwise measuring the amount of water used in high watering processes.

- Get expert advice to help determine if water efficiency improvements are appropriate. New system designs and improved materials can significantly reduce the water and energy requirements. However, since this may involve significant capital costs, the facility manger should investigate every retrofit or O&M option first. Your first resource should be your local or higher headquarters engineers, but do not overlook or rule out the benefits of input from experienced contractors or other Governmental agencies (DOE, FEMP, etc.)

New Facilities Construction and Major Renovations

- Efficient water use should be considered and implemented where appropriate in the design and construction of all new federal facilities.

Other Information

Water Management: A Comprehensive Approach for Facility Managers, General Services Administration, http://www.gsa.gov/pbs/centers/energy/water.htm

Military Handbook 1165: Water Conservation, Naval Facilities Engineering Service Center; http://www.afcesa.af.mil/Directorate/ces/Civil/Water/Water.htm or http://energy.navy.mil/key-areas/WaterWeb.html

A Water Conservation Guide for Commercial, Institutional and Industrial Users, New Mexico Office of the State Engineer 1-800-water-nm

BMP # 10 – Water Reuse and Recycling

Background

Many facilities may have water uses that can be met with non-potable water. Due to unclear terminology, several entirely different water reuse concepts are often confused. Some of these concepts and appropriate uses include:

- Filtered but otherwise ***untreated*** water, which can often be easily reused on-site for non-potable uses without being discharged to the wastewater system. Examples include using rinse water from laundries or car washes for the next wash process, or cooling tower condensate distributed for adjacent landscape irrigation.

- Wastewater that is ***treated*** to meet high standards at a wastewater treatment plant can then be ***redistributed*** for non-potable uses. Pursuant to health regulations established under the Clean Water Act and various States' regulations, this water is allowed for non-potable uses, including landscape irrigation, decorative water facilities, cooling towers and other industrial processes, fire sprinkler systems, and as flush water for toilets and urinals. Although treatment and distribution of this water can be expensive, it is usually cost-effective when compared to the costs to develop additional potable water supplies.

- Water from showers/baths and clothes washers (not used to wash diapers or process food), which can be used for landscape irrigation. Use of this water at Federal facilities is generally not recommended because of high capital costs and health and safety issues.

Operation and Maintenance, Retrofit, and Replacement Options

As described in other BMPs, potential non-potable water use should be identified while reviewing current water use practices. The use of non-potable water is generally most cost-effective when included in the design of new facilities.

For specifics, consult with experts in the field. Your first resource should be your local or higher headquarters engineers, but do not rule out the benefits of input from experienced contractors or other Governmental agencies (DOE, FEMP, etc.)

Other Information

*Water Management: A Comprehensive Approach for Facility Mana*gers, General Services Administration, http://www.gsa.gov/pbs/centers/energy/water.htm

Military Handbook 1165: Water Conservation, Naval Facilities Engineering Service Center; http://www.afcesa.af.mil/Directorate/ces/Civil/Water/Water.htm or http://energy.navy.mil/key-areas/WaterWeb.html

A Water Conservation Guide for Commercial, Institutional and Industrial Users, New Mexico Office of the State Engineer 1-800-water-nm

APPENDIX B

Summary Report for the Base Water Management Plan

S A M P L E

Anywhere AFB, USA

Background

Executive Order 13123, *Greening the Government Through Efficient Energy Management,* mandates an aggressive policy for reducing potable water consumption at federal facilities. Implementation guidance from the U.S. Department of Energy (DOE) set a requirement for each federal agency to "reduce potable water usage by implementing life cycle, cost effective water efficiency programs that include a water management plan, and not less than four Federal Energy Management Program (FEMP) Best Management Practices (BMPs). "

To comply with the executive order and implementation guidance, each Air Force base must develop an installation-specific water management plan by 2005. The plans must be incorporated into existing operation or facility plans. Compliance further requires the following percentage of Air Force bases to implement at least four BMPs by the dates shown.

- 5% of bases by 2002
- 15% of bases by 2004
- 30% of bases by 2006
- 50% of bases by 2008
- 80% of bases by 2010

Objective

The objective of this plan is to gain full compliance with Executive Order 13123 and associated DOE implementation guidance on behalf of Anywhere AFB, USA. To develop the plan installation personnel relied upon a process defined in the *Air Force Water Conservation Guidebook*, published by HQ Air Force Civil Engineer Support Agency (HQ AFCESA) in May 2002.

Methodology

Using the aforementioned process, Anywhere AFB has, as of September 30, 2002:

- Developed the installation-specific water management plan designated as Attachment 1 of this Summary Report;
- Incorporated this plan as a component of the Anywhere AFB energy conservation plan;

- Investigated the water savings potential and life-cycle cost effectiveness of the Operations and Maintenance (O&M) and retrofit/replacement options associated with the ten FEMP BMPs;
- Put into practice all applicable O&M options;
- Identified retrofit/replacement options appropriate for implementation (based upon calculation of the simple payback periods); and
- Established a schedule for implementation of applicable and cost-effective retrofit/replacement options.

Summary of BMP Investigation and Implementation Initiatives

Table 1 summarizes the BMP implementation initiatives at Anywhere AFB, USA. Details of the investigative activity are included in Section 4.0 of the water management plan (see Attachment 1).

In accordance with the goal, a BMP can be considered implemented when the "applicable operations and maintenance options have been put into practice, and retrofit/replacement options have been reviewed within the last two years and those appropriate for implementation have been identified; and the cost-effective retrofit/replacement options identified have been implemented."

TABLE 1
BMP Investigation and Implementation Initiatives

Best Management Practice	O&M Options Implemented	Are Retrofit and Replacement Options Cost Effective?	Have Retrofit and Replacement Options Been Implemented?	Is Credit Claimed for BMP Implementation?
#1 Public Information and Education Programs	Yes	N/A	N/A	Yes
#2 Distribution System Audits, Leak Detection, and Repair	Yes	Yes	No (Estimated Completion OCT 03)	No
#3 Water Efficient Landscaping	Yes	Unknown	No	No
#4 Toilets and Urinals	Yes	Yes	No (Estimated Completion OCT 03)	No
#5 Faucets and Showerheads	Yes	Yes	No (Estimated Completion OCT 03)	No
#6 Boiler/Steam Systems	Yes	No	No	Yes
#7 Single-Pass Cooling Equipment*	N/A	N/A	N/A	N/A
#8 Cooling Tower Management	Yes	No	No	Yes
#9 Misc. High Water-Using Processes	No	No	No	No
#10 Water Reuse and Recycling	N/A	No	No	No

*No Single-Pass Cooling Equipment was identified at Anywhere AFB, USA

Determination and Findings

Demonstrated by the investigation and implementation measures summarized above, Anywhere AFB is on a pathway to full compliance.

Thus far the installation has completed the installation-specific water management plan (Attachment 1), and implemented the following three BMPs:

- BMP #1 Public information and education programs (plan in place as of 30 SEP 02)
- BMP #6 Boiler and steam systems (O&M options in place as of 30 SEP 02)
- BMP #8 Cooling tower management (O&M options in place as of 30 SEP 02)

The potential for implementation of retrofit/replacement options for the following BMPs is currently under study by the ESCO

- BMP #4 Toilets and urinals
- BMP #5 Faucets and shower heads

Should the ESCO's analysis of these BMPs validate the preliminary findings of this plan, the ESCO estimates that retrofit/replacement options will be implemented by 1 OCT 03.

In addition, funds are currently being sought to implement the following BMP:

- BMP #2 Distribution system audits, leak detection, and repair

To maintain compliance, the installation will re-evaluate the applicability of BMP retrofit/replacement options within the next two years. Should the re-evaluation show the economics of any retrofit/replacement option has improved to the point that it warrants implementation, the water management plan will be amended and the retrofit/replacement option(s) will implemented.

Certification of Final Review and Submission

The undersigned certifies the attached installation-specific water management plan has been appropriately reviewed, and with their signature submits the plan in compliance with Executive Order 13123 and associated DOE implementation guidance.

Authorizing Signature (date),

____

John A. Smith, PE
Base Energy Manager
Anywhere AFB, USA

Attachment (1)

(1) Anywhere AFB, USA installation-specific water management plan dated September 30, 2002.

Attachment 1

Base Water Management Plan

Anywhere AFB, USA

This plan has been developed in compliance with Executive Order 13123 and associated DOE implementation guidance. To develop the plan, installation personnel used the process defined in the *Air Force Water Conservation Guidebook*, published by HQ AFCESA in May 2002.

The water management plan consists of the following sections:

- Required Background Data
- Investigation/Categorization of Water Use at Anywhere AFB, USA
- Calculation of Incremental Costs of Water and Sewage Disposal
- Investigation of DOE FEMP BMPs
- Implementation Plan
- Program Monitoring

1.0 Required Background Data

Development of this water management plan required collection of specific background data related to: (1) utility information; (2) water emergency and/or drought contingency plans; and, (3) additional information requirements. The following data components have been collected and are included by reference in the Anywhere AFB, USA water management plan.

1.1 Utility Information

The utility information collected included the following.

- Point of Contact (POC), telephone numbers, and addresses of all water and wastewater utilities that serve Anywhere AFB, USA.
- Current water and sewer rate schedules.
- Copies of water and sewer bills for the past two years, specifically FY 00 and FY 01.
- Information from water and wastewater utilities that details all financial and/or technical assistance available for planning or implementing water efficiency programs.
- POC(s), telephone number(s), and address for the Anywhere AFB office charged with the responsibility to pay water and sewer bills.
- Production information (deemed “not applicable” because Anywhere AFB neither produces potable water, nor treats its own wastewater).

1.2 Water Emergency and/or Drought Contingency Plans

The following water emergency and/or drought contingency plans are incorporated into the Anywhere AFB water management plan by reference.

- Anywhere AFB 702 Contingency Response Plan (developed by the 100th Civil Engineer Squadron and dated 1 OCT 94).
- Drought Contingency Plan (developed by the Anywhere Valley Utility District and dated 1 JAN 82).

1.3 Additional Information

To satisfy the additional information requirements of the executive order and the DOE implementation guidance, this water management plan has been incorporated into the existing energy management plan of Anywhere AFB, USA. As such, appropriate O&M recommendations from the FEMP BMPs will be suitably incorporated into facility operating plans and procedural manuals. In addition, inclusion of the water management plan in the base energy management plan will satisfy comprehensive planning requirements to "inform staff, contractors, and the public of the priority Anywhere AFB places on water and energy efficiency."

2.0 Investigation/Categorization of Water Use

Developers of this water management plan are cognizant of the DOE recommendation to conduct a "facility walk-through audit to identify how, where, and how much water is used." However, Anywhere AFB consists of more than 300 industrial, commercial, and institutional (ICI) facilities, and more than 1,000 additional military family housing (MFH) units.

Conducting the recommended walk-through audit would have exceeded the time and manpower resources available to develop the water management plan. It was also determined that the general lack of secondary meters at the installation would have significantly limited the potential of a walk-through audit to produce information of true value. Therefore, instead of a walk-through audit, developers of the plan opted to use the process defined in the *Air Force Water Conservation Guidebook* to develop a "credible and defensible estimate for water use by facility category." The following water use categories were designated for investigation:

- Category 1 – Housing Facilities
- Category 2 – Commercial Facilities
- Category 3 – Irrigation Water Use
- Category 4 – Leaks, Losses, and Unaccounted for Water
- Category 5 – Industrial Facilities

2.1 Category 1 – Housing Facilities

For the purpose of the plan this category includes both multi-family housing (i.e., dormitories and temporary lodging facilities), and MFH units.

Base housing staff estimate that approximately 2,600 military personnel and dependents live in the housing facilities at Anywhere AFB. The national average for water use is 101.0 gallons-per-capita-per-day (gpcd). Multiplying the number of military personnel and dependents by the average gpcd water use results in a daily consumption estimate of 262.6 Kgals (2,600 X 101/1000). This yields an annual estimate of water use in this category of approximately 95,849 Kgal (262.6 x 365), or 29.4 percent of total water use in the FY00 baseline.

2.2 Category 2 – Commercial Facilities

This category includes such facilities as administrative buildings, dining halls, hospitals, schools, etc. Due to a lack of secondary meters for these facilities, the annual water use was estimated using the DOE FEMP Federal Water Use Indices. Table 1 summarizes the analysis of commercial water use.

TABLE 1
Commercial Facilities Water Use Estimate Using Federal Water Use Indices

Facility	Unit	Typical Gallons/Unit/Day	Estimated Units at Anywhere AFB	Estimated GPD	Estimated GPY
Offices	Employee	15	13,164[1]	197,460	51,339,600[2]
Hospital	Beds	120	56	6,720	2,425,800[3]
School	Student	25	800	20,000	5,200,000[4]
Laundry (Self-service)	Machine	550	40	22,000	8,030,000[5]
Total					66,995,400

[1]Sum of 3,058 active duty personnel and 10,166 civilian and contractor personnel
[2]GPD x 260 annual duty days
[3]GPD x 365 annual duty days
[4]GPD x 260 annual duty days
[5]GPD x 365 annual duty days

The total GPY estimate of 66,995,400 GPY equals approximately 66,995 Kgals, which is approximately 20.6 percent of total water use identified in the FY00 baseline.

2.3 Category 3 – Irrigation Water Use

Water use in this category was estimated using the "Method Two" technique in the *Air Force Water Conservation Guidebook.* This method involves calculating the average monthly water use for the months of December, January and February. This average is multiplied by 12 months , and the product is then subtracted from the base's total annual water use figure. The remainder is the estimated irrigation water use.

Table 2 shows total water usage for FY00 at Anywhere AFB.

TABLE 2
Total Water Usage for FY00 at Anywhere AFB, USA

Month	FY00 Water Use (Kgal)
January	26,719
February	15,898
March	17,831
April	23,041
May	21,965
June	35,045

TABLE 2
Total Water Usage for FY00 at Anywhere AFB, USA

Month	FY00 Water Use (Kgal)
July	46,990
August	34,505
September	38,850
October	29,211
November	18,469
December	17,088
Annual Water Use (Kgal)	**325,614**

The average monthly water use for December, January and February is approximately 19,902 Kgals. This results in an annualized average of 238,824 Kgals (19,902 x 12). Subtracting the annualized average of 238,824 Kgals from the total annual water use of 325,614 Kgals results in an irrigation water use estimate of 86,790 Kgals, or approximately 26.6% of total water use as identified in FY00 baseline.

2.4 Category 4 – Leaks, Losses and Unaccounted for Water

Water use in this category was estimated according to the method outlined in the *Air Force Water Conservation Guidebook.* This method relies upon measuring water and wastewater system flows at their historically lowest points, in this case between 0100 and 0300.Using this method it was determined that approximately 14.3743 Kgals was unaccounted for during the two-hour test period. Over the period of one year this would equal a leaks, losses, and unaccounted for water volume of approximately 62,955 Kgals annually, or 19.37 percent of the total water purchased by the installation.

2.5 Category 5 - Industrial Facilities

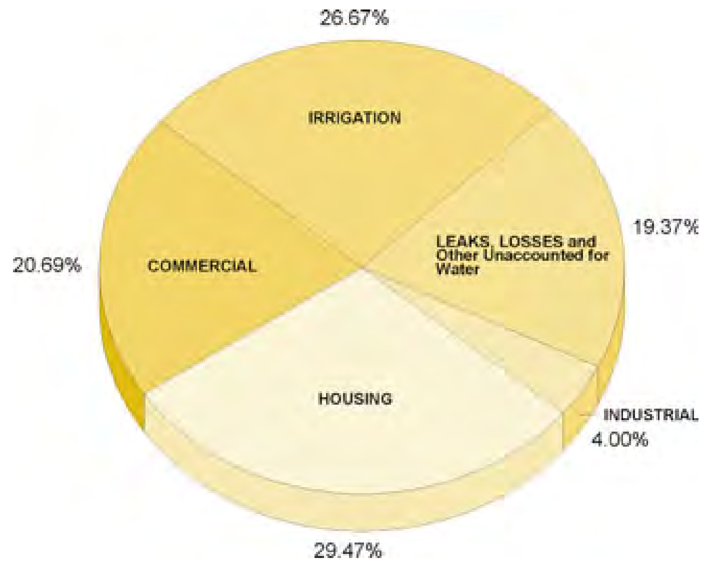
Water use in this category was estimated according to the *Air Force Water Conservation Guidebook*, which calls for subtracting the estimates from Categories 1-4 from the FY 00 baseline.

> Total Water Use (325,614 Kgal) – Housing Use (95,849 Kgal) – Commercial Use (66,995 Kgal) – Irrigation Use (86,790 Kgal) – Estimated Leaks, Losses and Unaccounted for Water (62,955 Kgal) = Estimated Industrial Use (13,025 Kgal)

The industrial water use estimate of 13,025 Kgals is approximately 4.0% of total water use at the installation as identified in the FY00 baseline.

2.6 Summary of Findings

The following figure graphically depicts the findings of water use survey at Anywhere AFB, USA.



3.0 Calculation of Incremental Costs of Water and Sewage Disposal

Incremental water and sewage disposal costs were calculated in accordance with "Example 1" in the *Air Force Water Conservation Guidebook.*

Potable water service for Anywhere AFB, USA is purchased from the Anywhere Valley Utility District at a flat rate of $2.60 per Kgal. The utility district also provides sewer service at a rate of $1.50 per Kgal, with billing based on 100 percent of water use. This results in an incremental cost of water and sewage disposal of $4.10 per Kgal ($2.60 + $1.50 = $4.10).

Officials at the Anywhere Valley Utility District anticipate the cost of water and wastewater will continue to rise for the foreseeable future. The rates have increased approximately 86 percent since FY 96.

4.0 Investigation of DOE FEMP BMPs

For the purpose of developing this water management plan the investigation of water conservation measures was limited to ten BMPs that were specially designated by the DOE FEMP. Those ten BMPs are:

- BMP #1—Public Information and Education Programs
- BMP #2—Distribution System Audits, Leak Detection, and Repair
- BMP #3—Water Efficient Landscaping
- BMP #4—Toilets and Urinals
- BMP #5—Faucets and Showerheads
- BMP #6—Boiler/Steam Systems
- BMP #7—Single-Pass Cooling Systems
- BMP #8—Cooling Tower Management
- BMP #9—Miscellaneous High Water-Using Processes
- BMP #10—Water Reuse and Recycling

The goal for water management plan developers was to rapidly assess which of the BMPs has potential for implementation at Anywhere AFB. Where applicable, the simple pay-back periods were calculated using the following formula:

Estimated Implementation Costs/Annual Savings = Simple pay-back period

BMPs with a simple pay-back period of ten years or less were judged to be cost effective, and were thus identified for implementation. The remainder of this section summarizes the BMP analysis.

4.1 Analysis of BMP #1 - Public Information and Education Programs

The benefits and cost-effectiveness associated with this BMP were readily obvious and required practically no analysis to justify implementation. Utility districts implementing Public Information and Education programs report average annual savings between 10 and 15 percent of total water use.

A public information and education program can provide a strong foundation for all water conservation efforts at Anywhere AFB. Implementation can largely be achieved through currently established public information vehicles at little or no cost.

To implement this BMP and receive proper credit, developers of this water management plan have:

- Worked with the base public affairs flight to publish quarterly articles in the base newspaper that promote water conservation.
- Developed water conservation factsheets and provided them to the base housing office for distribution to new residents at move-in.
- Publicized the telephone numbers for the Civil Engineer and Housing Maintenance service call desks, with instructions for personnel to report leaks or other water waste. Publication avenues include the base newspaper, cable television information channel, the previously mentioned factsheets, and the installation website.
- Worked with the base public affairs flight to develop a water conservation module for the Anywhere AFB website (http://www.anywhere.af.mil).

4.2 Analysis of BMP #2 - Distribution System Audits, Leak Detection and Repair

The annual estimate of water lost due to leaks is 62,955 Kgal, or 19.3 percent of the total annual water purchase of Anywhere AFB. With an incremental cost of water and sewer of $4.10 per Kgal, a loss of this amount costs the installation approximately $258,116 annually.

On average, a leak detection survey and repair program could result in a savings of between 25 and 50 percent of estimated losses. This would translate into an annual savings of between $64,529 and $129,058 for Anywhere AFB. The estimated cost for a leak detection survey ranges from $100 to $200 per mile of main, and with Anywhere AFB having 400-miles of water main the estimated total cost to the installation would be between $40-thousand and $80-thousand.

Assuming a mid-range savings of $96,793.50 (37.5% of estimated system losses), and a mid-range cost of $60-thousand ($150 per mile of main), the simple pay-back period would be calculated as:

$60,000/$96,793.50 = 0.61 years

Savings at the lower end of the ranges would be calculated as:

$80,000/$64,529 = 1.23 years

According to the *Air Force Water Conservation Guidebook,* BMPs with a simple pay-back of less than ten years should be deemed cost effective for implementation. Even with the assumption of the least attractive simple pay-back period (1.23 years) BMP #2 is judged cost effective for implementation at Anywhere AFB.

Note that the cost of repairing leaks identified by the survey are not counted as implementation costs, but rather as routine O&M costs associated with base utility operations.

Since leak detection surveys are not funded under ESPC another funding avenue will be required to conduct the survey. Leak detection surveys have historically been found to be cost-effective at Air Force installations, but funding obstacles make the surveys difficult to execute. Hence, a strategy must be developed for Anywhere AFB to budget or otherwise request funds for performing the survey if the installation is to receive credit for implementing this BMP.

4.3 Analysis of BMP #3 - Water Efficient Landscaping

The landscape irrigation requirement for Anywhere AFB is estimated to be 26.6% of the total water demand for the installation. The *Air Force Water Conservation Guidebook* advises installations with an irrigation requirement in excess of 10% to implement the following O&M options.

- Verify that irrigation schedules are appropriate for climate, soil conditions, plant materials, grading, and season. Water only in the early morning to minimize losses to evaporation. Watering during these hours will not only this save water, but it will also reduce the opportunity for fungus growth to develop. Note that the general rule is to water deeply with less frequency.
- Monitor and inspect irrigation systems for effectiveness. These systems are considered high maintenance items by the Air Force, and limited resources sometimes prevent them from being maintained at the optimum level. Poorly maintained systems can waste large amounts of water and many systems end up being abandoned due to lack of maintenance. To facilitate maintenance it is advisable to have a maintenance contract on the system(s), or make certain inspection/testing/maintenance is included in the base's Recurring Work Program (RWP). Regardless of who is responsible for maintenance (contractor or in-house personnel) broken heads or other components that can waste water should be treated as urgent work requests.
- Establish a service call desk (see BMP #1) to receive reports of irrigation system problems. Once reported problems should be fixed promptly in order to both save water and encourage continued use of the service call desk.

The developers of this water management plan will take appropriate steps to implement these O&M options. At this time however, investigation of retrofit/replacement options was not conducted. Costs and savings were judged to be difficult to quantify, and since the installation can meet its goal without implementing this BMP, plan developers elected to focus their limited time and resources in other areas of the analysis.

4.4 Analysis of BMP #4 - Toilets and Urinals

A series of MFH whole house renovation projects since 1994 has replaced older, inefficient toilets with 1.6 gpf ultra-low-flush toilets. The same cannot be said for the majority of toilets and urinals in service in Industrial, Commercial and Institutional (ICI) facilities. The average age of ICI facilities (i.e. non-MFH facilities) on the installation is 36-years. This means the average facility was commissioned in 1966, a time when toilets and urinals typically consumed 5.0 gpf.

Though multiple facilities have been renovated at various times since the 1966 baseline, plan developers elected to assume that the average toilet and urinal in service in an ICI facility consumes 5.0 gpf.

It was noted that none of the FEMP recommended O&M or retrofit measures is capable of achieving the 1.6 gpf rate required of toilets manufactured after 1994, or the 1.0 gpf rate of urinals manufactured after 1997. For this reason, plan developers elected to target the toilets and urinals in ICI facilities for replacement with modern and efficient fixtures.

4.4.1 Estimating Number of Fixtures and Projected Savings

A total of 13,164 active duty military, civilian and contractor personnel work each day in ICI facilities at Anywhere AFB. Assuming a 1:1 ratio of males-to-females there are 6,582 males and 6,582 females who work in ICI facilities over 260 annual duty days.

The UPC specifies a fixture ratio of 1:25, to be divided equally between males and females. Additionally, up to 50% of the fixtures in men's rooms maybe urinals. Using these figures it is estimated there are approximately 527 toilets and/or urinals in use in ICI facilities (13,164/25 = 526.56). A total of 263 are toilets located in ladies' rooms (527/2 = 263.5); a total of 132 (264/2 = 132) are toilets located in men's rooms; and the remaining 132 (264/2 = 132) are urinals located in men's rooms.

According to table 3.2 in the *Air Force Water Conservation Guidebook*, replacing a 5.0 gpf toilet in a ladies room with a 1.6 gpf fixture will save 2,652 gpy/person. Replacing all the 5.0 gpf toilets will save 17,455,464 gpy (6,582 females x 2,652 gpy), or approximately 17,455 Kgals.

Replacing a 5.0 gpf toilet in a men's room with a 1.6 gpf fixture will save 884 gpy. Replacing all the 5.0 gpf toilets will save 5,818,488 gpy (6,582 males x 884 gpy), or approximately 5,818 Kgals. Replacing a 5.0 gpf urinal in a men's room with a 1.0 gpf fixture will save 2,080 gpy . Replacing all the 5.0 gpf urinals will save 13,690560 gpy (6,582 x 2,080 gpy), or 13,691 Kgals.

Thus, replacing all the 5.0 gpf toilet and urinal fixtures in ICI facilities will save approximately 39,964 Kgals. At a rate of $4.10 per Kgal, this will save the installation approximately $151,552 annually in water and sewer costs.

According to R.S. Means, the labor and equipment cost for replacement is $214 per toilet and $133.50 per urinal. Replacing 395 toilets will cost approximately $84,530 , and replacing

132 urinals will cost an additional $17,622 . This produces a total estimated implementation cost of $102,152 .

The simple pay-back period of toilet and urinal replacement in ICI facilities is calculated as:

$102,152/$151,552 = 0.674 years

According to the *Air Force Water Conservation Guidebook,* BMPs with a simple pay-back of less than ten years should be deemed cost effective for implementation. Hence it is recommended that toilet and urinal replacements in ICI facilities be pursued because the simple pay-back period is a little more than eight months.

As a result of these findings the ESCO is conducting a Phase 1 study to determine the actual cost effectiveness of the measure. If the ESCO concurs with our preliminary findings the replacements will be made under the ESPC. If the ESCO determines the replacements are not cost effective the project will be canceled and reevaluated in two years. Once the retrofits are completed, or the project is deemed not cost-effective, the BMP will be considered implemented.

4.5 Analysis of BMP #5 - Faucets and Showerheads

A series of MFH plumbing retrofits/replacements since 1994 has replaced older, inefficient faucets and showerheads with new units that consume 2.5 gpm. A similar retrofit program has not been initiated for ICI facilities. The average age of ICI facilities (i.e. non-MFH facilities) on the installation is 36-years. This means the average facility was commissioned in 1966, a time when the average faucet flowrate was 4.0 gpm, and the typical showerhead flowrate was 7.0 gpm.

Seeing the potential for significant and cost-effective savings, plan developers elected to target the lavatory faucets in ICI facilities for retrofit with aerators that reduce the flowrate to 2.5 gpm. Because of the relatively small number of showerheads in use in ICI facilities (i.e. base gymnasium), it was decided to exclude showerheads from the retrofit program at this time.

4.4.1 Estimating Number of Fixtures and Projected Savings

A total of 13,164 active duty military, civilian and contractor personnel work each day in ICI facilities at Anywhere AFB.

The UPC specifies a lavatory faucet ratio of 1:40, meaning there are approximately 329 faucets in ICI facilities (13,164/40 = 329). According to table 3.5 in the *Air Force Water Conservation Guidebook*, retrofitting a 4.0 gpm faucet in an ICI facility with an aerator that restricts flow to 2.5 gpm will result in a savings of 390 gpcy.

At Anywhere AFB this translates into a savings of 5,133,960 gpy (13,164 personnel x 390 gpcy = 5,133,960), or approximately 5,134 Kgals. With an incremental water and sewer cost of $4.10 per Kgal, this results in an annual monetary savings of approximately $21,049 ($4.10 x 5,134 = $21,049.40).

According to R.S. Means, the labor and equipment cost for retrofitting a faucet with an aerator is $13 per unit. Retrofitting 329 units will cost approximately $4,277.

The simple pay-back period of toilet and urinal replacement in ICI facilities is calculated as:

$4,277/$21,049. = .20 years

In addition to the water savings there are also energy savings associated with consuming less hot water from lavatory faucets. Statistics indicate that 50 percent of the water used from a lavatory faucet is hot water. Adding energy savings will only enhance the pay-back period of this BMP.

According to the *Air Force Water Conservation Guidebook,* BMPs with a simple pay-back of less than ten years should be deemed cost effective for implementation. Hence, plan developers recommend that faucet retrofits in ICI facilities be pursued.

The ESCO is conducting a Phase 1 study to determine the actual cost-effectiveness of the measure. If the ESCO concurs with our preliminary findings the retrofits will be made under the ESPC. If the ESCO determines the retrofits are not cost-effective the project will be canceled and reevaluated in two years. Once the retrofits are completed, or the project is deemed not cost-effective, the BMP will be considered implemented.

4.6 Analysis of BMP #6 - Boiler and Steam Systems

O&M activities for boiler and steam systems are governed by UFC 3-240-03, the replacement guidance for MIL-HDBK 1149, *Industrial Water Treatment.* Anywhere AFB complies with UFC 3-240-03 in the operation and maintenance of boiler and steam systems, and has therefore implemented O&M options for this BMP.

Retrofit/replacement options for this BMP were judged to be non-cost effective based upon the high capital cost of replacing a boiler or steam system, and the inability of water savings to produce a sufficient pay-back.

Based upon the implementation of O&M options, and the unfavorable economics of retrofit/replacement options, Anywhere AFB claims credit for implementing this BMP.

4.7 Analysis of BMP #7 - Single-Pass Cooling Equipment

A conference with the installation’s senior A/C shop technician, Mr. Dave Lennox, revealed no single-pass cooling equipment is in use at Anywhere AFB. The single-pass cooling system serving the base credit union was the last such system in operation on the installation. The system was replaced in FY 98 under an Energy Savings Performance Contract (ESPC) based upon the potential for energy savings.

While the installation may be able to make a case for having implemented this BMP, plan developers advise the BMP be shown as “Non-Applicable” in the installation’s water management plan. Anywhere AFB will meet the BMP implementation goal with or without credit for this BMP.

4.8 Analysis of BMP #8 - Cooling Tower Management

Similar to BMP #6 (Boiler and Steam Systems), Anywhere AFB complies with UFC 3-240-03 in the operation and maintenance of cooling towers.

Retrofit/replacement options for this BMP were judged to be non-cost effective based upon the high capital cost of replacing a cooling tower, and the inability of water savings to produce a sufficient pay-back. Based upon the implementation of O&M options, and the unfavorable economics of retrofit/replacement options, Anywhere AFB claims credit for implementing this BMP.

4.9 Analysis of BMP #9 - Miscellaneous High Water-Using Processes

Examples of high water-using processes in use at Anywhere AFB include aircraft and ground vehicle washing systems, aircraft maintenance facilities, kitchens and food processing areas, cleaning/laundry services, laboratories, and the base hospital. FEMP guidance advises high water-using processes be identified and analyzed for potential water efficiency improvements, however the *Air Force Water Conservation Guidebook* states "water savings for these processes will be more effectively accomplished through implementation of other BMPs."

In agreement with that sentiment, plan developers elected to forego further investigation of this BMP and instead focus the limited time and personnel resources on analyzing other BMPs. The installation can meet its goal without implementing this BMP.

4.10 Analysis of BMP #10 - Water Reuse and Recycling

The investigation of this BMP did reveal the potential for on-site water recycling in vehicle wash systems. Water reuse, also known as reclaimed water was deemed non-applicable due to lack of a reuse water source. Use of gray water was not investigated due to restrictions delineated in the Uniform Plumbing Code and AFI 32-1066.

Non-potable water (untreated surface water from Lake Anywhere) is currently used for irrigation purposes at the base golf course. Additional applications for replacing use of potable water with non-potable water were not readily identified.

Plan developers advise that credit not be sought for implementation of this BMP. The installation will meet its implementation goal without seeking credit for the previously implemented measure to use non-potable water from Lake Anywhere for irrigation purposes at the installation golf course.

5.0 Implementation Plan

Table 3 summarizes the analysis of all the BMPs, and lists action items for implementation of O&M and/or retrofit and replacement measures.

TABLE 3
Summary of BMP Analysis and Action Items for Implementation

Best Management Practice	Implement O&M Options?	Retrofit and Replacement Options Cost Effective?	Selected for Implementation?	Claim Credit for BMP Implementation?	Action Items Necessary to Claim Credit
#1 Public Information and Education Programs	Yes	N/A	Yes	Yes	No further action required
#2 Distribution System Audits, Leak Detection, and Repair	Yes	Yes (0.61-1.23 years)	Yes	No	Request funds for survey
#3 Water Efficient Landscaping	Yes	Unknown	No	No	N/A

TABLE 3
Summary of BMP Analysis and Action Items for Implementation

Best Management Practice	Implement O&M Options?	Retrofit and Replacement Options Cost Effective?	Selected for Implementation?	Claim Credit for BMP Implementation?	Action Items Necessary to Claim Credit
#4 Toilets and Urinals	Yes	Yes (0.67 years)	Yes	No	Refer to ESCO for in-depth analysis and possible implementation
#5 Faucets and Showerheads	Yes	Yes (0.2 years)	Yes	No	Refer to ESCO for in-depth analysis and possible implementation
#6 Boiler/Steam Systems	Yes	No	Yes	Yes	No further action required
#7 Single-Pass Cooling Equipment*	N/A	N/A	N/A	N/A	No further action required
#8 Cooling Tower Management	Yes	No	Yes	Yes	No further action required
#9 Misc. High Water-Using Processes	No	No	No	No	No further action required
#10 Water Reuse and Recycling	N/A	No	No	No	No further action required

*No single-pass cooling equipment was identified at Anywhere AFB, USA

5.1 Funding for Implementation

Table 4 summarizes the options that will be used to provide funding for implementation of cost-effective BMPs. In addition to the BMPs shown, the following BMPs will require practically no funding to establish credit for meeting the installation goal:

- BMP #1 Public information and education programs
- BMP #6 Boiler/steam systems
- BMP #8 Cooling tower management

TABLE 4
Potential of Funding Options to Support BMP Implementation

BMP	ESPC	ECIP	Housing Funds	O&M Funds
#2-Distribution System Audits, Leak Detection and Repair			X	X
#4-Toilets and Urinals	X			
#5-Faucets and Showerheads	X			

6.0 Program Monitoring

To maintain compliance with the executive order and DOE FEMP implementation guidance the cost effectiveness of retrofit/replacement options must be re-evaluated within the next two years. The deadline for this re-evaluation is established as September 30, 2004. At that time the following BMP retrofit/replacement options will be re-evaluated to determine if economics have changed in such a manner as to make them favorable for implementation.

- BMP #3 Water efficient landscaping
- BMP #6 Boiler and steam systems
- BMP #8 Cooling tower management
- BMP #9 Miscellaneous high water-using processes
- BMP #10 Water reuse and recycling

Plan developers will also undertake responsibility for monitoring results of water conservation BMPs that are implemented at Anywhere AFB. This will be accomplished by measuring water use for the 12-month period following final implementation of cost-effective BMPs, and comparing the new water use to the FY00 baseline. Both the number of Kgals saved and the cost of water savings will be measured. The results of this monitoring program will be added as an appendix to this water management plan.

7.0 Conclusion

The six BMPs identified for implementation (or potential implementation based upon results of the ESCOs phase two analysis) present extremely attractive opportunities for water conservation at Anywhere AFB, USA. Indeed, during the first year alone there is nearly a two -dollar savings in water costs for every dollar invested in BMP implementation.

Table 5 reflects the water and dollar savings potential associated with implementation of the six selected BMPs.

TABLE 5
Water Savings Potential of Selected BMPs

BMP	Estimated Savings (Kgal)	Estimated Dollar Savings	Estimated Implementation Costs	Simple Pay-Back Period
#1 Public Information and Education Programs	32,561 (10%of Total Use)	133,500	Minimal	Immediate
#2Distribution System Audits, Leak Detection and Repair	15,739 (25%of Leak Losses)	64,530	80,000	1.24 years
#4 Toilets and Urinals	39,964	151,552	102,152	0.67 years
#5 Faucets and Showerheads	4,277	21,049	4,277	.20 years
#6 Boiler and Steam Systems (O&M only)	Undetermined	Undetermined	Minimal	Undetermined
#8 Cooling Tower Management	Undetermined	Undetermined	Minimal	Undetermined

TABLE 5
Water Savings Potential of Selected BMPs

BMP	Estimated Savings (Kgal)	Estimated Dollar Savings	Estimated Implementation Costs	Simple Pay-Back Period
(O&M only)				
Total	**92,541**	**370,631**	**186,429**	**0.50 years**
	(28.4% of FY00 baseline)			

APPENDIX C

Federal Water Use Indices

The U.S. Department of Energy Federal Energy Management Program provided these indices as a guide for agencies. Agencies should be aware that they are rough estimates of water usage at different types of sites. Your site may vary considerably. The indices should only be used to assist in determining baseline data when no other information is available about a site's water usage.

Federal Water Use Indices			
		Gallons/unit/per day*	
User	**Unit**	**Range**	**Typical**
Commercial Airport	Passenger	4-5	3
Apartment house	Person	100-200	100
Boarding house	Person	25-50	40
Hotel	Guest Employee	40-60 8-13	50 10
Lodging house and tourist home	Guest	30-50	40
Motel	Guest	25-40	35
Motel with kitchen	Guest	25-60	40
Laundry (self-service)	Machine	400-650	550
Office	Employee	8-20	15
Public Lavatory	User	3-6	5
Restaurant (including toilet) Conventional Short-order	 Customer Customer	 8-10 3-8	 9 8
Shopping Center	Parking Space Employee	1-3 8-13	2 10
Open Space Non-turf Turf	 Acre Acre		 785 1571
Recreational Apartment, resort	Person	50-70	60
Bowling alley	Alley	150-250	200

Federal Water Use Indices			
		Gallons/unit/per day*	
User	**Unit**	**Range**	**Typical**
Camp Pioneer type with toilet and bath Day, with meals Day, without meals	 Person Person Person Person	 15-30 35-50 10-20 8-18	 25 45 15 13
Trailer	Trailer	75-150	125
Campground	Person	20-40	30
Country club	Members Employee	80-125 10-15	100 15
Dormitory (bunk house)	Person	20-45	35
Fairground	Visitor	1-2	3
Picnic park with flush toilets	Visitor	5-10	6
Swimming pool and beach	Customer Employee	5-15 8-15	10 10
Visitor center	Visitor	4-8	5
Institutional Assembly hall	 Seat	 2-4	 3
Hospital medical	Bed Employee	80-150 5-15	120 10
Prison	Inmate Employee	80-150 5-15	120 90
Rest home	Resident Employee	5-120 5-15	90 10
School day with cafeteria, gym and showers with cafeteria only without cafe & gym	 Student Student Student	 15-30 10-20 5-15	 25 15 10
School, boarding	Student	50-100	75

Source: American Water Works Association 1996.

APPENDIX D

Annual Report Format

Base Name & State:	
MAJCOM	
Date	
Reporting Period Fiscal Year (FY)	
Total Potable Water Usage (Million Gallons per Year – MGY)	
Potable Water Cost – Do not include disposal sewage costs ($)	
Total Non-Potable Water Usage -including reclaimed water (MGY)	
Non-Potable Water Cost ($)	
Does the Base have a water management plan (WMP) that meets ALL the criteria of the DOE guidance? (Yes/No) The plan must contain: Facility Information, Utility Information, Emergency Response Information, Comprehensive Planning (including plan for implementing at least 4 of the BMPs)	
If the base does not have a WMP meeting all the DOE-FEMP criteria, when will the base have a plan in place (Month – Year)	
Has the base fully implemented at least 4 of the DOE-FEMP Best Management Practices (BMPs) (Yes/No)	
List all BMPs that have been fully implemented (i.e. BMP1, BMP 3, BMP10, etc.)	

List all water conservation projects initiated, under way, or completed in previous FY reporting period

Project Description	**Status ***	**Estimated Project Cost ($)**	**Estimate Annual $ Savings**	**Est Annual Potable Water Savings (MGY)**	**Payback Period (Yr)**	**How is project Funded (ESPC, MFH, ECIP, O&M, Env, etc)**

- Status (P – In planning, D- Under Design, C – Under Construction, COMP – Completed)

Example of Filled out form

Base Name & State:	Anywhere AFB, FL
MAJCOM	USAFE
Date	12 Nov 02
Reporting Period Fiscal Year (FY)	FY 02
Total Potable Water Usage (Million Gallons per Year – MGY)	132.23 Million Gallons
Potable Water Cost - Do not include disposal sewage costs ($)	$198,245
Total Non-Potable Water Usage -including reclaimed water (MGY)	18.34 Million Gallons
Non-Potable Water Cost ($)	$12,2435
Does the Base have a water management plan (WMP) that meets ALL the criteria of the DOE guidance? (Yes/No) The plan must contain: Facility Information, Utility Information, Emergency Response Information, Comprehensive Planning (including plan for implementing at least 4 of the BMPs)	No
If the base does not have a WMP meeting all the DOE-FEMP criteria, when will the base have a plan in place (Month – Year)	Jan 2003
Has the base fully implemented at least 4 of the DOE-FEMP Best Management Practices (BMPs) (Yes/No)	No
List all BMPs that have been fully implemented (i.e. BMP1, BMP 3, BMP10, etc.)	BMP 1 & 4

List all water conservation projects initiated, under way, or completed in previous FY reporting period

Project Description	**Status ***	**Estimated Project Cost ($)**	**Estimate Annual $ Savings**	**Est Annual Potable Water Savings (MGY)**	**Payback Period (Yr)**	**How is project Funded (ESPC, MFH, ECIP, O&M, Env, etc)**
Replace MFH toilets	Comp	$130,000	$24,000	0.45	3.12	MFH
Replace toilets Admin Bldgs	C	$250,000	$49,000	1.12	5.11	ESPC

- Status (P – In planning, D- Under Design, C – Under Construction, COMP – Completed)

APPENDIX E

Air Force Energy Program Procedural Memorandum 96-2

AIR FORCE ENERGY PROGRAM
PROCEDURAL MEMORANDUM (AFEPPM) 96-2
1 June, 1996

AIR FORCE ENERGY OFFICE

AIR FORCE WATER MANAGEMENT PROGRAM

This memorandum is the implementation plan for the Air Force philosophy, organizational relationships, responsibilities, funding strategies, and procedures for implementing and managing water conservation programs at Air Force installations.

1. **Applicability.** This implementation plan applies to all Air activities and installations. They must perform the indicated actions as part of their planning for water management, as part of their Energy Program, and to meet Executive Order 12902 and the Energy Policy Act of 1992 (EPACT 92.)

2. **Background.** On 8 March 1994, President Clinton issued Executive Order 12902 on energy efficiency and water conservation. The mandate is an aggressive policy aimed at reducing energy and water use by federal facilities. All federal agencies must adhere to the provisions stated within the order, which augment criteria already directed by EPACT 92.

2.1. **The Goals of EPACT 92 and EO 12902 Impacting upon the Water Program Management.**

2.1.1. Cost Effectiveness. All conservation projects must be deemed cost-effective. Cost-effective implies a pay back period of less than 10 years. Projects required to comply with local constraints on water use will be considered individually and may be exempted from this requirement. The term applies to both energy conservation and water management (EPACT 92, Sec. 152 and EO 12902, Sec. 103).

2.1.2. Water and Energy Prioritization Surveys. All Federal Agencies must conduct a water and energy prioritization survey of the facilities it manages by 7 September 1995. The prioritization surveys will determine which facilities receive a comprehensive facility audit first. By 8 March 1995 (under EPACT 92, Sec. 152 and EO 12902, Sec 303), based on preliminary recommendations from the prioritization survey, all Federal Agencies must accomplish audits on 10% of its facilities followed by an additional 10% each year thereafter

2.1.2.1. Within 180 days following each comprehensive facility audit, all Federal Agencies must begin to implement program and funding recommendations derived from the audit.

2.1.3. Annual Reporting. All Federal Agencies must report annually to the Department of Energy (DOE) and the Office of Management and Budget (OMB) on its progress toward meeting established goals and deadlines as stated in the order.

3. **Responsibilities.**

3.1. **HQ USAF/CEO/CEC.**

OPR: HQ USAF/LGSP (Major Marsha Davis)

3.1.1. Provides overall Program policy.

3.1.2. Rank candidate ECIP & FEMP projects (with assistance from HQ AFCESA) before submission to OASD and subsequent review by Congress.

3.1.3. Provide HQ USAF/LGS with consolidated Air Force inputs for annual reports to Congress.

3.2. **HQ AFCESA.**

3.2.1. Provide assistance for program implementation.

3.2.2. Assist MAJCOMs and installations in identifying metrics to be used in conducting prioritization surveys.

3.2.3. Provide assistance in conducting comprehensive facility audits, tracking audit recommendations, and developing effective cost-saving projects with a discounted pay back period of less than 10 years.

3.2.4. Validate water conservation projects.

3.2.5. Consolidate MAJCOM report inputs for submission to AF/CEO for the annual report to Congress.

3.3. **MAJCOMs.**

3.3.1. Include water management planning within the responsibilities of the Energy Management Steering Group. Commands are responsible for developing their own programs

3.3.2. Review and update their plan to accomplish prioritization surveys and comprehensive audits annually.

3.3.3. Establish a monitoring program for implementing the recommendations of the comprehensive facility audits..

3.3.4. Submit ECIP and FEMP project submissions to HQ AFCESA as directed by call letters.

3.3.5. Evaluate overall success of base water programs and nominate the most successful units for water conservation awards.

3.3.6. Report status of prioritization surveys, comprehensive audits, and project programming/execution when requested.

3. 4. **Installations.**

3.4.1. Establish a water management program to include the following:

3.4.1.1. Develop a water management plan including contingency planning for mission support

3.4.1.2. Develop water conservation investment improvement projects

3.4.1.3. Monitor base water usage and all related costs
3.4.1.4. Establish an aggressive water conservation program

3.4.1.5. Foster an awards and recognition program

3.1.4.6. Report status of prioritization surveys, comprehensive audits, and project programming/execution when requested

4. **AIR FORCE WATER MANAGEMENT PROGRAM.**

4.1. **Program Objective.** The objective is to reduce water use without degrading military readiness, safety, mission effectiveness, or quality of life. Execution of policy on water management includes identifying and programming water conservation projects, and promoting water conservation awareness programs throughout the Air Force. The water conservation program is integrated within the energy management program at each installation.

4.2. **Facility Data Collection.** Developing a successful water management program depends in large part on the quality and quantity of pertinent data gathered for each facility. The program focuses its efforts on three main areas: Performing prioritization surveys, performing comprehensive facility audits according to initial prioritization survey results, and promoting effective project management.

4.3. **Prioritization Surveys.** Determine the potential costs and benefits of accomplishing water management projects. Recommend prioritization surveys include the following information:

4.3.1. A leak detection survey, if not accomplished within the previous five years.

4.3.2. The type, size, water/energy use, and performance of all water-related systems and their interaction with their surrounding facility.

4.3.3. A summary of appropriate water conservation maintenance and operating procedures currently implemented at the facility.

4.3.4. Recommendations for the acquisition and installation of water conservation measures including economic analysis and programming documents.

4.4.5. A strategy detailing the implementation of recommendations.

4.4. **The Renewable and Energy Efficiency Planning (REEP) Program Installation Report.** Accomplished by the US Army Construction Engineering Research Laboratory (CERL) for DoD), this report will serve as a ball park determinant of water usage and project cost for the prioritization survey. The REEP program analyzed 83 Energy Conservation Opportunities (ECO) at 239 DOD installations. Calculations are partitioned into separate rows so analysis can be conducted exclusively on water or energy issues, or both simultaneously. The REEP contains a financial savings summary that shows a particular

ECO's total investment, total net discount savings, annual savings, simple pay back in years, savings-to-investment ratio (SIR), adjusted internal rate of return (AIRR), and societal savings. The societal savings figure can be used by MAJCOMs to rank bases for accomplishment of audits.

4.5. **Purpose of Water Program Audit.** The main purpose of an audit is to detect inefficient water systems, determine how much water and money is lost through leakage or waste, and determine a feasible method to implement conservation recommendations. Bases that have performed comprehensive audits within the last 3 years may consider the information acquired from those audits as current. Bases that require an audit are encouraged to seek out suppliers that will provide free audits. Air Force Facility managers may acquire a list from GSA, (202) 501-1763, of all utilities that offer no-cost water conservation audits and demand-side management services and incentives.

4.5.1. The American Water Works Association's (AWWA) "M36" manual and Enviro-Management & Research, Inc's. (EMR), "Water Management: A Comprehensive Approach For Facility Managers" are good references for audit implementation. For a copy of the M36 Manual call Pacific Northwest Laboratory (DOE) at (509) 372-4368, or the American Water Works Association at (303) 794-7711. For a copy of the EMR manual call 703-875-2800.

4.5.2. The Rocky Mountain Institute’s "Water-Efficient Technologies" manual is a good reference for determining
which water-efficient equipment may be appropriate for a particular facility. The manual contains a list of water-conserving products and their respective manufacturers. For a copy call 303-927-3851.

4.6. **Installation Water Resources Analysis and Planning System (IWRAPS).** IWRAPS could serve as a useful water conservation forecasting tool. The IWRAPS models are designed to calculate the winter and summer water requirements for military installations. The IWRAPS software can also:

4.6.1. Prepare water supply sustainability plans.

4.6.2. Compare water reduction measures for implemented water conservation programs.

4.6.3. Assess cost effectiveness of selected conservation measures.

4.6.4. The primary point of contact for IWRAPS information is HQ AFCESA/CESC, DSN 523-6338.

4.7. **Funding Sources.** In addition to funds available under the Energy Conservation Investment Program (ECIP) and Federal Energy Management Program (FEMP), the Air Force will seek and use Demand Side Management (DSM) and Energy Savings Performance Contracting (ESPC) to accomplish projects identified by the audits. Efforts should focus on the most cost-effective alternatives. Economic evaluation of water projects will include the following:

4.7.1. The cost of energy saved due to reduced water usage.

4.7.2. The direct cost of water

4.7.3. The cost of heating hot water saved.

4.7.4. O&M costs of wells, pumps, treatment facilities, etc.

4.7.5. Reduced sewer costs.

4.7.6. O&M savings realized by new processes, equipment (retrofit), or other implementations.

4.7.7. Availability of grant funding to improve economic analysis of programs.

4.8. **Economic Analysis Tools.** The National Institute of Standards and Technology's (NIST) life-cycle cost analysis software, Building Life Cycle Cost (BLCC) 4.2-95 and Handbook NBS 135 are on the National Institute of Building Sciences' (NIBS) Construction Criteria Base (CCB). The US Army's Construction Engineering Laboratory's Life Cycle Cost In Design (LCCID) is also on the CCB. These software packages allows the user to make a variety of economic calculations for energy and/or water conservation projects and are recognized by DOD for FEMP and ECIP projects. The software allows for seasonal variances, price escalation rates, and annual usage indices. The software also assists in the calculation of simple pay back, net savings, adjusted internal rate of return (AIRR), and savings-to-investment ratios (SIR). NIBS updates the CCB quarterly and distributes it to all Air Force MAJCOMs and bases. Air Force energy managers may obtain more information on the CCB from HQ AFCESA/CES, 139 Barnes Dr, Suite 1, Tyndall AFB FL 32403-5319.

4.8.1. Typically the projects with the most economical pay backs include the following:

4.8.1.1. Plumbing retrofit (shower heads, toilets, etc.)

4.8.1.2. Leak detection and repair

4.8.1.3. Xeriscaping, waste water reuse, and other cost-effective landscaping techniques

4.8.1.4. Projects funded in whole or in part with grant money

4.8.1.5. Modifications to cooling towers, boilers and processes equipment

4.9. **Program Implementation.** The implementation and execution of a water conservation plan depends largely on the level of commitment by those involved in the implementation. Before a conservation program is implemented, notify the occupants of the facility of the program and its procedures. For example, distributing a letter to all occupants expressing support for and explaining the new program is a good start. The letter explains why changes are being made, what differences the changes will make and why water management projects are necessary.

4.9.1. Post notices near water equipment to notify correct usage and inform visitors of water conservation initiatives at that facility. Other program support methods might include setting up a hot line for questions or reporting detected leaks, distributing flyers to increase awareness, or setting up a bulletin board to track program progress and recognize exceptional efforts by individuals.

4.9.2. Monitor the program and keep close ties with the facility users to determine what is working and what is not. Monitor consumption rates to determine the effectiveness of the program. It is also very important to share program monitoring results with facility occupants to increase program awareness.

4.10. **Technical Assistance.**

4.10.1. To assist in the implementation of conservation programs, EPACT 92 and Executive Order 12902 directs DOE to provide the following:

4.10.1.1. Guidance explaining the relationship between water use and energy consumption as well as the energy savings achieved through water conservation efforts (still in process)

4.10.1.2. A guide outlining innovative funding options (still in process)

4.10.1.3. An annual newsletter consisting of sample contracts, case studies, guidance, and success stories (not available as yet)

4.10.1.4. Viable technologies available through the national energy laboratories (still in process)

4.10.1.5. Training to assist in the identification of cost-effective procedures (call FEMP for a seminar schedule at 1-800-566-2877)

4.10.1.6. A list of qualified water contractors nation-wide for inclusion on a Federal schedule

4.10.1.7. A model provision on water conservation to be included in new leasing contracts

4.10.2. To assist in the implementation of conservation programs, EPACT 92 and Executive Order 12902 directs GSA to provide the following:

4.10.2.1. A list of utilities that will perform no cost audits for water conservation and/or offer special services/incentives such as demand-side management (still in process)

4.10.2.2. Techniques and methods that will facilitate the procurement process. (still in process)

Attachment 1

GLOSSARY

Adjusted internal rate of return (AIRR) provides a measure of return on investment of a selected project relative to other potential investments that can be made.

Annual Savings refers to the expected yearly savings (in dollars) for implementing a particular project.

Comprehensive facility audit refers to an examination of a building or facility that provides sufficiently detailed information to allow an agency to enter into water savings performance contracts or to invite inspection and bids by private upgrade specialists for direct agency funded energy or water efficiency investments (EO 12902 Sec. 102).

Demand-side management refers to utility sponsored programs that promote water conservation to fulfill demand instead of increasing the supply of water to meet demand (supply side) (EO 12902 Sec. 104).

Federal building refers to any individual building structure, or part thereof, including the associated energy or water-consuming support systems, that is constructed, renovated, or purchased in whole or in part for use by the Federal Government and that consumes energy or water. Also included under this term shall be any building leased in whole or in part by the Federal Government where the term of the lease exceeds 5 years and the lease does not prohibit implementation of the provision in question (EO 12902, Sec. 107).

Federal facility, for Air Force purposes, refers to an *entire* base as a whole.

Gain sharing refers to incentive systems that allocate some portion of savings resulting in productivity to the workers who produce those gains (EO 12902, Sec. 110).

Industrial facilities refers to any fixed equipment, building, or complex used for the production of goods that uses large amounts of capital equipment in connection with, or as part of, any process or system, and within which the majority of energy use is not devoted to the heating, cooling, lighting, ventilation, or to service the hot water load requirements of the building (EO 12902, Sec. 111).

Life-cycle cost refers to the cost incurred over the life of a system.

Prioritization survey refers to a rapid assessment that will be used by an agency to identify those facilities with the potential projects so they can be ranked based on the degree of cost effectiveness and to schedule comprehensive facility audits prior to project implementation (EO 12902, Sec. 113).

Renewable energy sources refers to, but is not limited to, agricultural and urban waste, geothermal energy, solar energy, and wind energy (EO 12902, Sec. 115).

Savings-to-investment ratio (SIR) refers to the total net discount savings divided by the total investment.

Energy Savings Performance Contracting refers to a contract under which the contractor incurs the cost of implementing water savings measures (including, but not limited to, performing the audit, designing the project, acquiring and installing equipment, training personnel, and operating and maintaining the equipment) and in exchange for providing these services, the contractor gains a share of any energy cost savings directly resulting from implementation of such measures during the time of the contract (EO 12902, Sec. 114).

Simple pay back refers to the amount of time required for the savings of a proposed project to cover (pay back) the initial investment cost. Total investment divided by annual savings.

Total Investment refers to the total amount of money required to initiate a proposed project.

Total Net Discount Savings refers to the sum of all discounted energy savings plus the sum of all non energy discounted savings.

Water savings performance contracts refers to contracts that provide for the performance of services for the audit, design, acquisition, installation, testing, operation, and maintenance/repair of an identified water conservation measure or series of measures at one or more locations (EO 12902, Sec. 105).

Xeriscaping refers to the strategic selection, placement, and maintenance of plants/soil/irrigation techniques and equipment that optimize water use.

APPENDIX F

Environmental Funding Memorandum

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS UNITED STATES AIR FORCE
WASHINGTON DC

MEMORANDUM FOR ALMAJCOM/CE 31 JAN 2001
HQ USAFA/CE

FROM: HQ USAF/ILE
1260 Air Force Pentagon
Washington DC 20330-1260

SUBJECT: Environmental Quality (EQ)/Real Property Maintenance (RPM) Funding Eligibility Guidance for Non-recurring Infrastructure Projects

The purpose of this memo is to provide guidance to major commands on programming EQ-eligible non-recurring infrastructure projects to achieve and maintain environmental compliance. Continued success of the environmental program depends on our ability to maintain credibility with the Air Force Corporate Structure by advocating for only valid environmental requirements as opposed to RPM requirements.

A lack of RPM investment has contributed to deterioration in the condition and structure of some of our water, wastewater, and other infrastructure. Although installations are exerting heroic efforts in maintaining compliance by performing emergency repairs and other work-arounds, continued lack of RPM investment is potentially exposing these installations to noncompliance with environmental laws and regulations. This has created an increase in EQ funding requests for infrastructure repair, replacement, and upgrade projects. To maintain a credible environmental program under current fiscal constraints, MAJCOMs and installations should only program environmental projects that are Level-1 *and* meet EQ funding eligibility criteria.

The following EQ and RPM funding guidance for non-recurring infrastructure projects is provided for Air Force-wide implementation to achieve compliance with new and existing federal, state and local environmental laws and regulations, Final Governing Standards (FGS) and the Overseas Environmental Baseline Guidance (OEBGD):

a. **EQ Funding Eligibility.** Primarily, EQ funding is to be used for the cost of *initial* construction, modification, or upgrade of a facility, system or component(s) to comply with *new* environmental laws or regulations. Once constructed, these systems should be maintained and repaired/replaced with non-environmental funds even if the need to perform Operation and Maintenance (O&M) is cited by an environmental law, regulation, or a permit. If an installation has been found as non-compliant with an *existing* environmental regulation in writing by, 1) a regulatory authority, or 2) a Major Finding in an Environmental Compliance Assessment and Management Program (ECAMP) report and validated by a MAJCOM, then -- after consideration of the seriousness of the situation by ILEVQ -- an infrastructure project to correct the noncompliant portion of a system *may be* eligible for EQ funding. As part of a request for EQ funding support for non-compliant systems, MAJCOMs shall ensure an engineering evaluation for the non-compliant portion of the system has been performed to document specifically what portion(s) or component(s) of the system are non-compliant, and why the EQ project scope and programmed amount are necessary to correct the non-compliant situation.

b. **RPM and Military Construction (MILCON) Funding Eligibility.** RPM or MILCON funding should be used for operation, maintenance, repair or repair-by-replacement of real property in accordance with AFI 32-1032 *Planning and Programming Appropriated Funded Maintenance, Repair, and Construction Projects.* RPM funds should be used to maintain infrastructure in such condition that it may be used effectively for its designated purpose in accordance with current standards or codes regarding accessibility, health, safety, or environmental compliance. It is important that MAJCOMs and installations plan, program, and budget for RPM activities to properly maintain infrastructure systems and minimize out of compliance situations due to inadequate maintenance or repair.

We have included a table of commonly identified non-recurring infrastructure projects (Atch 1) with our determination as to their EQ funding eligibility. The table is not all-inclusive, but contains *general* examples as a guide, whereas your specific situation(s) may be different. This guidance supercedes any current policy or guidance on EQ funding eligibility for non-recurring infrastructure projects and will be included in the next update of AFI 32-7001 *Environmental Budgeting*. MAJCOMs shall implement this guidance effective immediately. This is an AF/ILEO, AF/ILEC, and AFLSA/JACE coordinated memo. If you or your staff have any questions, please contact, Mr. Mike McGhee, HQ USAF/ILEVQ, DSN 327-0125, e-mail: michael.mcghee@pentagon.af.mil.

EARNEST O ROBBINS II
Major General, USAF
The Civil Engineer
DCS/Installations & Logistics

Attachment:
EQ Eligible/Ineligible Projects

cc:
SAF/MIQ/FMB/MII
HQ USAF/ILEO/ILEC/ILEP
HQ AFCEE/CC/CCR/A/D/S
HQ AFCESA/CC/CESC
HQ AFMOA/SGZE
AFLSA/JACE
AFIT/CE

EQ FUNDING ELIGIBLITY OR NON-ELIGIBILITY FOR NON-RECURRING INFRASTRUCTURE PROJECTS

Note: This table is meant to supplement the accompanying guidance memorandum and offers general examples.

ELIGIBLE	INELIGIBLE*
WATER	
Construction of new; or upgrading/modifying/replacing existing water and wastewater treatment plant, process or system component in order to comply with *new environmental laws/regulations*, FGS or OEBGD	Upgrading/modifying/replacing existing water and wastewater treatment plants, processes or system component(s) for any reason other than to comply with a new environmental law or regulation
Modifying/repairing/replacing existing sewer systems to correct Infiltration/Inflow (I/I) causing violation of permitted flow limits, bypasses or overflow of untreated wastewater, or where sewer systems routinely exceed EPA standards for I/I. Eligibility is limited to the non-compliant portion of the system only.	Routine Operation and Maintenance (O&M) and repair/replacement of water and wastewater treatment plant(s), oil/water separators, lift stations, water and wastewater lines, storm drain systems, water storage tanks, back-flow prevention devices, valves, dead end lines, lagoons, septic tanks, retention basins, etc....to effectively sustain their designated purpose.
Initial survey and modifying/repairing existing sewer systems *to eliminate cross connections*	Repair/replacement of deteriorated, broken or collapsed sewer systems, joints or sections.
Implementation of cost-effective Pollution Prevention (P2) and Best Management Practices (BMPs) to meet storm water National Pollutant Discharge Elimination System (NPDES) permit requirements. Construction of structural solutions as a BMP are eligible only after documenting ineffectiveness of non-structural BMPs or P2 actions.	Construction of storm water retention ponds, unless mandated by State or local regulation; FGS, OEBGD, etc. Construction of a deicing runoff capture system, unless there is documentation of a reasonable effort to reduce deicing runoff through implementation of storm water BMPs and P2 practices.
Construction of connection to sanitary sewer; or treatment and disposal of wastewater from existing wash rack.	Construction of new wash rack.
Construction of new secondary containment structures for AF- owned non-DESC fuel storage tanks required by Spill Prevention Control and Countermeasures (SPCC) Plans developed in accordance with 40 CFR Sec. 112.7	Maintenance and repair of existing secondary containment structures; Construction of secondary containment for tanks inside a building; Construction/repair/replacement of Aqueous Film-Forming Foam/Aircraft Fire Fighting Foam (AFFF) storage/retention pond(s)
Replacement of existing lead or copper lines/valves/fittings as required by the "lead and copper rule" of the Safe Drinking *Water Act (SDWA)*. Replacement of piping/joints constructed of asbestos-containing material causing any release of asbestos into Drinking Water (DW) system.	Replacement of lead or copper lines/valves/fittings due only to detection of lead or copper that does not exceed SDWA action levels in otherwise-compliant DW samples. Replacement of asbestos pipe/joints where there has been no detection of asbestos in DW samples.
Repair/replacement/upgrade of non-compliant portion of DW distribution system to meet Total Coliform Rule which has inadequate chlorination protection caused by infrastructure deficiencies and confirmed by opportunity assessment	Repair/replacement/upgrade of DW system infrastructure due solely to low chlorine residual levels
Initial survey *and installation of back-flow prevention devices* in DW system	Inspection, repair, replacement, or testing of existing back-flow prevention devices
Providing for alternate source of drinking water if State regulation mandates the requirement.	Water conservation projects driven by EO 13123 or other non-environmental regulations
AIR	
Construction/installation of air emission controls for boilers, paint booths, etc. in response to a new environmental requirement or newly-issued air permit.	Repair/replacement of existing air emission control devices or air pollutant-emitting infrastructure
TANKS	
Removal/replacement/upgrade necessary to comply with Underground Storage Tank (UST) regulations for previously unidentified UST	Repair/replace/upgrade *of existing USTs in-compliance with UST regulations.* Repair/replacement of cathodic protection systems.
RCRA	
Initial construction of hazardous waste accumulation point(s) and Treatment Storage and Disposal (TSD) facilities	Maintenance, repair and replacement of TSD facility

*** Exception to Ineligibility: If an installation has been notified as non-compliant with an *existing* environmental regulation by: 1) a regulatory authority; or 2) a Major *Finding in an Environmental Compliance Assessment and Management Program (ECAMP) report; then* -- after consideration of the *seriousness of the situation* -- an infrastructure project to correct the non-compliant portion of a system *may be* eligible for EQ funding.**

Shah, JLI/VQ/607-0120

This page intentionally left blank.

APPENDIX G

USAF Water Conservation Points of Contact

Air Force Water Conservation POC
Mr. Michael X. Clawson
HQ AFCESA/CESC
139 Barnes Drive, Suite 1
Tyndall AFB, FL 32303
DSN 523-6362
(850)283-6362
Michael.Clawson@tyndall.af.mil

HQ AETC Water Conservation POC
Mr. Fred Waterman
HQ AETC/CEOE
266 F Street West
Randolph AFB, TX 78150-4321
DSN 487-2594
(210) 652-2594
fred.waterman@randolph.af.mil

HQ PACAF Water Conservation POC
Mr. Michael Nii
HQ PACAF/CECI
25 E Street, Suite D-306
Hickam AFB, HI 96853-5412
DSN (315) 449-8083
Commercial (808) 449-8083
michael.nii@hickam.af.mil

HQ AMC Water Conservation POC
MSgt Hector M. Gonzalez
HQ AMC/CEOI
507 Symington Dr.
Scott AFB IL, 62225-5022
DSN 779-0687
Com. (618) 229-0687
hector.gonzalez@scott.af.mil

HQ AFRC Water Conservation POC
J E Dennard
HQ AFRC/CEOM
255 Richard Ray Blvd
Robins AFB GA 31098-1637
DSN 497-1036
(478) 327-1036
je.dennard@afrc.af.mil

HQ ACC Water Conservation POC
Mr. Mark H. Turner
ACC/CEOI
129 Andrews Street, Suite 102
Langley AFB, VA 23665-2769
DSN: 574-2876
(757) 764-2876
markturner.2@langley.af.mil

HQ AFMC Water Conservation POCs
Mr. Ralph Butler./ Ms April Lewis
HQ AFMC/CEOM / HQ AFMC/CEVQ
4375 Chidlaw Rd. Ste 6
WPAFB, OH 45433-5747
DSN 787-6589 / DSN 787-8269
(937) 257-6589 / (937) 257-6589
Ralph.Butler@wpafb.af.mil /
April.Lewis@wpafb.af.mil

HQ USAFE Water Conservation POC
Bernie Kruse
USAFE/CECE
Unit 3050 Box 10
APO AE 09094-5010
DSN 480-6207
bernie.kruse@ramstein.af.mil

HQ ANG Water Conservation POC
Dennis F. Ballog
ANG/CEP
3500 Fetchet Av.
Andrews AFB, MD 20762
DSN 278-8429
(301)836-8429
BallogD@ang.af.mil