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| TOC | Change History | Preface | Chp1 | Chp2 | Chp3 | Chp4 | Chp5 | Chp6 | Chp7 | Chp8 | Chp9 | Chp10 | AppdxA | AppdxB | AppdxC | AppdxD | AppdxE | AppdxF | AppdxG | AppdxH | AppdxI | AppdxJ | AppdxK | AppdxL | AppdxM | AppdxN | AppdxO | AppdxP | AppdxQ | AppdxR | AppdxS | AppdxT | AppdxU | AppdxV | AppdxW | AppdxX | AppdxY | ALL |

APPENDIX V. DOE Guidance on Facility Water Management Plans and Water Efficiency Improvement Best Management Practices (BMP)

Recommended Elements of a Facility Water Management Plan

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, including:

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 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 Order13123, 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.

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 see first-hand the conservation program and successes you have 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.

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 percent 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

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 (e.g., DOD, CERL, DOE, and FEMP).

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:

Native and other "climate appropriate" landscape materials can reduce irrigation water use by more than 50 percent.

Reduced turf and other irrigated areas can significantly reduce time and money spent mowing, fertilizing, removing green wastes and maintaining landscapes.

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 nonpotable 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 nonpotable 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.

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 percent.

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 to 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 (e.g., employees, residents, occasional members of the public, and high visitor populations) 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 nonpotable 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 (e.g., DOE and FEMP).

BMP #5- Faucets and Showerheads Background

Tremendous amounts of water and energy are wasted using water-inefficient 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.

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 blow down 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 (e.g., DOE and FEMP).

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 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 multipass 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 (e.g., DOE and FEMP).

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 pretreatment, 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 blow down 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 side-stream 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. Side-stream filtration is particularly helpful if your system is subject to dusty atmospheric conditions. Side-stream 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 blow down/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 (e.g., DOE and FEMP).

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 (e.g., DOE and FEMP). 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.

BMP # 10 - Water Reuse and Recycling Background

Many facilities may have water uses that can be met with nonpotable 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 onsite for nonpotable 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 nonpotable uses. Pursuant to health regulations established under the Clean Water Act and various States' regulations, this water is allowed for nonpotable 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 nonpotable water use should be identified while reviewing current water use practices. The use of nonpotable 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 (e.g., DOE and FEMP).

Water Management References

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Roadside Use of Native Plants; Federal Highway Administration; http://www.fhwa.dot.gov/environment/veg_mgt.htm or environment@fhwa.dot.gov

A Water Conservation Guide for Commercial, Institutional and Industrial Users, New Mexico Office of the

State Engineer; (800)WATER-NM

| TOC | Change History | Preface | Chp1 | Chp2 | Chp3 | Chp4 | Chp5 | Chp6 | Chp7 | Chp8 | Chp9 | Chp10 | AppdxA | AppdxB | AppdxC | AppdxD | AppdxE | AppdxF | AppdxG | AppdxH | AppdxI | AppdxJ | AppdxK | AppdxL | AppdxM | AppdxN | AppdxO | AppdxP | AppdxQ | AppdxR | AppdxS | AppdxT | AppdxU | AppdxV | AppdxW | AppdxX | AppdxY | ALL |

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