DEVELOPING AND IMPLEMENTING A WATER CONSERVATION PLAN

Guidance For Maryland Public Water Systems On Best Management Practices For Improving Water Conservation And Water Use Efficiency

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BACKGROUND

Drought conditions experienced in Maryland in both 1999 and 2002 impacted some water systems' ability to meet their customers' needs and prompted the State to consider measures that might improve water systems' water use efficiency. In January 2000, Executive Order 01.01.200.01 formed the Maryland Technical Advisory Committee on Water Supply Infrastructure. The Committee looked at water systems' capacity to meet demands during drought periods, high levels of unaccounted water as a result of leaking distribution systems, and the issue of inadequate funding for necessary water system improvements, and made recommendations to the Governor regarding community water system infrastructure deficiencies and needed improvements in Maryland. It was recommended at that time that the State focus water conservation efforts on water systems that serve more than 10,000 and have high per capita usage.

In 2002, the Maryland Legislature passed House Bill 693, the Maryland Water Conservation Act. This Act requires certain public water systems to submit information about their water conservation best management practices when applying for new or renewed water appropriation permits. The Act also requires the Maryland Department of the Environment (MDE) to issue guidance for public water systems on best management practices for improving water conservation and efficiency in water use, treatment, storage, and transmission. This document constitutes guidance as required under the Maryland Water Conservation Act.

The most effective way for a water system to improve its water use efficiency is to develop and implement a water conservation plan. A water conservation plan is a written document developed by a public drinking water system that evaluates current and projected water use, assesses infrastructure, operations, and management practices, and describes actions to be taken to reduce water losses, waste, or consumption and increase the efficiency with which water is used, treated, stored, and transmitted.

All water systems in Maryland are encouraged to develop water conservation plans. Current Maryland Department of the Environment (MDE) policies require that certain public water systems develop and submit to MDE's Water Supply Program written water conservation plans. These plans are required for water systems that serve a population of greater than 10,000 and produce more than 100 gallons of water per capita per day and for systems that are awarded financial assistance from the State for infrastructure improvements. MDE may also request a water system to submit a plan based upon sanitary survey findings, engineering studies, or other fact-finding events conducted as part of routine compliance activities. Water systems practicing an approved water conservation plan will not be penalized with a reduction of their current water appropriation permit limitations if they use less water.

In addition to regulatory or other requirements, there are many reasons for water utilities to develop and implement water conservation plans. Maryland's potable water sources are limited natural resources, and with the State's population continually increasing, this resource must be managed carefully. Developing a water conservation plan also helps to optimize existing facilities and may reduce or eliminate the need to undertake new drinking water and/or wastewater projects. In addition, water conservation leads to increased energy conservation and cost savings for utilities and their customers.

DEVELOPING A WATER CONSERVATION PLAN

Water conservation plans should address conservation on the supply side as well as on the demand side. Conservation plans for the supply side (i.e., leak detection and repairs, metering, etc.) may require additional financial resources, however there is some potential for reduction in operating costs and recovery of lost revenues. Conservation plans for the demand side (i.e. reductions in consumer usage) may result in lost revenues, however, a well-designed pricing program can offset potential losses in revenue. Other benefits associated with implementing a conservation plan (which include eliminating, downsizing, or postponing the need for capital projects, improving the utilization and extending the life of existing facilities, lowering variable operating costs, avoiding new source development costs, improving drought or emergency preparedness, educating customers about the value of water, improving reliability and margins of safe and dependable yields, and protecting and preserving environmental resources) may also help to balance losses in revenue.

Water conservation plans will vary based on many factors including the size of the water utility. Large water systems serving more than 10,000 persons will require a more complex and detailed water conservation plan than smaller water systems. The U.S. Environmental Protection Agency published Water Conservation Plan Guidelines in 1998. This helpful reference can be found at the following Internet address: http://www.epa.gov/owm;/water-efficiency/wecongid.htm. Hard copies of the document can be obtained by contacting the Water Resource Center by phone at 202-260-7786 or by email at center.water-resource@epa.gov and requesting EPA document: EPA-832-D-98-001.

MDE endorses a format similar to that recommended in EPA's Guidelines, which offers instruction on completing conservation plans of varying complexity: Basic, Intermediate, and Advanced. Maryland water systems should use either the Intermediate or Advanced Guidelines as a reference when writing their own conservation plans. The Advanced guidelines may be more appropriate for systems serving more than 10,000 persons, or for systems likely to experience water supply problems (i.e. where water production is close to capacity, where significant growth is expected, or where dry weather conditions result in water supply deficiencies.) Worksheets provided in Appendix A of this document were obtained from the Intermediate Guidelines. Developing a water conservation plan involves the following steps:

I. Establish the goals of the water conservation plan. The first step in developing a water conservation plan is for the utility to establish a list of conservation planning goals. Measurable goals, such as a water use reduction goal (in terms of percentage of baseline water usage), are useful for later evaluation of the conservation plan. Other common goals for water utilities include postponing or eliminating the need for capital projects or new source development, and improving drought preparedness. Utilities should consider involving their communities in the goal development and implementation process. In addition to helping to develop goals, participants can act as a focus group and serve as a gauge for the public's reaction to possible conservation measures.

II. Conduct a water system audit. Completing an initial water system audit is an integral part of developing a water conservation plan because it will serve as a baseline measure of water use. Subsequent annual audits can track progress towards meeting established goals. Most water systems already have the basic information necessary to complete a water audit. MDE guidance instructions for

completing a Water System Audit and a template for reporting results can be found in Appendix A-1 and A-2 or at the following web address:
http://www.mde.state.md.us/Programs/WaterPrograms/Water_Conservation/Water_Auditing/index.asp

A water system audit collects data on accounted and unaccounted water. Unaccounted water includes water that is metered but not billed and water that is not metered. Unmetered water consists of authorized uses (fire protection, flushing mains, etc.), as well as unauthorized uses (losses due to accounting errors, thefts, inaccurate meters, and leaks). Utilities should strive to minimize the quantity of unmetered, unauthorized water use. A water system audit should also provide information about the quantity and type of population served, geographic considerations, number of total connections and metered connections, and the average and peak demands. EPA's worksheet "Water Accounting and Loss Control" is available in Appendix B-1.

A discussion summarizing conditions that might affect the water system and conservation planning should also be provided. Issues such as anticipated population growth, large quantities of unaccounted water, and major planned improvements should be included in this discussion.

III. Prepare a demand forecast. A demand forecast estimates water use requirements into the future. Demand forecasts can range from a simple projection based on population growth to complex models that contain several variables. The size of the utility will dictate the complexity of the projection. It is suggested that forecasts be prepared for 5, 10, and 20 years into the future. If a water system has prepared a demand forecast within the past two years, calculating a new demand forecast is probably not necessary. It is also recommended that forecasts be made for each water end user group (residential, commercial, etc.) as opposed to the water system as a whole, unless the water system serves a population of fewer than 10,000. The forecast should take into account any known, planned, or measurable changes that will have an effect on demand, with the exception of additional conservation measures considered in this plan. Uncertainties in the demand forecast should be highlighted and discussed. EPA has published a "Preliminary Water Demand Forecast" that can be used as a guide to calculating a water demand forecast. A copy of this publication is included as Appendix B-2.

When the growth in projected demand is large, it may be useful to prepare an estimate of supply costs necessary to meet increased demand. In some cases increased demand will require improvements or additions to the water system. Anticipated supply costs are needed to compare the costs of supply-side and demand-side conservation measures. Appendix B-3 contains a worksheet from EPA's guidance designed to help calculate the costs of any improvements and/or additions.

IV. Identify and select potential water conservation measures. MDE has categorized water conservation measures into Required Elements and Recommended Elements. Required elements should be included for all water utilities, while the recommended elements may be evaluated for inclusion as appropriate. An integral part of evaluating these various conservation measures is a cost analysis. For each conservation measure the utility should estimate implementation costs and projected water savings. A cost analysis worksheet entitled, "Analysis of Each Conservation Measure or Group of Measures" from EPA's guidance is included in Appendix B-4.

A. Required Elements. These elements should be included in all water conservation plans for Maryland public water systems.

1. Metering. Plans should describe the metering method(s) used, and establish protocols for maintaining meter accuracy, conducting calibration and repair, and replacing old or inaccurate meters. Inaccurate meters often result in lost revenue for the utility.

Recommendations:

- Evaluate installation of new metering if none exists.
- Develop and schedule a plan to test, calibrate, repair, and replace meters as necessary
- Evaluate and replace older meters as necessary.
- Ensure that meters are appropriately sized. If a meter is too large for a customer, it will typically under-register water use, resulting in lower revenues.

2. Water Accounting and Loss Control. A well-designed loss-prevention program should target both real and apparent losses. Real losses are physical losses including leaks, bursts, and overflows. Apparent losses are non-physical losses that include meter inaccuracies and unauthorized consumption, such as theft or illegal use.

Recommendations:

- Inspect, clean, or perform other maintenance (such as corrosion control) on pipes to prevent leaks from occurring.
- Manage pressure to reduce volume and frequency of water loss.
- Control water level to reduce storage overflow.
- Implement improvements in metering and billing.
- Locate illegal or unregistered connections.
- Regularly employ leak detection equipment to detect leaks along water distribution mains, valves, services, and meters.
- Use remote sensors and telemetry technologies for ongoing monitoring of leak detection at source, transmission, and distribution facilities. This technology can promptly alert operators to leaks, changes in pressure, and problems with equipment.
- Repair leaks when detected. The cost of lost water can be measured in terms of operating costs associated with supplying, treating and delivering the water. Water lost to leakage produces no revenues for the utility. Although repairing leaks may be costly, cost savings will usually pay for the repairs over time.

3. Pricing. Water conservation will prove to be most cost effective when rate structures are modified to encourage customers to conserve water. There are several pricing strategies that can encourage water conservation.

Recommendations:

- Repeal volume discounts to eliminate any disincentive for conservation.
- Charge a higher unit price as use rises (i.e. increasing block rates).
- Implement higher rates during seasons when water use is higher.
- Charge excess use fees where appropriate for high-use consumers.

4. Information and Education Program. A good information and education program can be very effective in reducing consumer demand.

Recommendations:

- Provide understandable and informative water bills to customers. The water bill should contain consumer usage in terms of gallons per day. When customers are aware of their daily water use, they are more likely to conserve.
- Provide educational information through water bill inserts or other means. For water systems where residential water use is greater than 100 gallons per capita per day, this should occur at least once a year.
- Additional recommendations for public education are described in Appendix C.

B. Recommended Elements

1. Develop outreach for specific users. Utilities typically serve three types of customers: residential, municipal, and industrial/commercial customers. Each of the outreach efforts described below is geared to one or more user types, which are identified in parenthesis.

Recommendations:

- **Conduct Water Use Audits for Consumers** (*Residential, Industrial/Commercial, and Municipal*). Water use audits can provide water systems and their customers with information about how water is used and help identify potential conservation strategies. Audits can be particularly effective when targeted towards large volume users, or other selective end use customers (e.g., single family homes with large yards, parks or other large landscapes, etc.).

- **Offer fixture retrofits and replacements** (*Residential, Industrial/Commercial, and Municipal*). Retrofitting involves making an improvement to an existing fixture, as opposed to replacing an existing fixture. Retrofit programs usually target plumbing fixtures and can be made available to customers free or at cost. Retrofit kits can be distributed directly, through community organizations, in conjunction with water audits, or to other targeted customer groups.
- **Offer rebates and incentives** (*Residential, Industrial/Commercial*). Options include having utilities install water-efficient fixtures by providing them at no cost, giving rebates for consumer purchased fixtures, or arranging for suppliers to provide fixtures at a reduced price.
- **Promote water reuse and recycling** (*Industrial/Commercial*). Some industries can reduce water demand by reusing water in the manufacturing process. In some cases, using gray water or treated wastewater for nonpotable water uses may be appropriate. Reuse and recycling can also be encouraged for large-volume irrigation applications. Water reuse applications must meet applicable State and federal wastewater disposal regulations.
- **Encourage landscape efficiency** (*Municipal, Industrial/Commercial*). Utilities can promote water conservation principles into the planning, development, and management of new landscape projects such as public parks, building grounds, and golf courses. Existing projects can also be renovated to incorporate water-conserving practices. Water utilities can also work with commercial and industrial customers to plan and renovate their landscapes.

2. Pressure Management. Reducing excessive pressures in the distribution system can save water by reducing stresses that could result in leakage, decreasing quantities of water that are currently leaking, and reducing the amount of flow through fixtures.

Recommendations:

- Assess the need for pressure management in residential areas with pressures greater than 80 pounds per square inch.
- Install pressure reducing valves in street mains and in buildings where appropriate.

3. Water-Use Regulations. Water utilities may wish to consider having regulations in place that manage water use during normal times as well as during times of drought or other water supply emergencies.

Recommendations:

- Institute restrictions or bans on certain non-essential water uses.
- Develop standards for new developments with respect to landscaping, drainage, and irrigation practices.
- Develop a fine or penalty system for frequent misuse of water during drought emergencies.

V. Develop and present implementation strategy.

The water utility should develop a schedule and timetable for implementing the water conservation strategies. Implementation actions should include a timetable for securing budgetary resources, hiring staff, procurement of materials, acquisition of any necessary permits, and activity milestones.

REFERENCES

Maryland Statewide Water Conservation Advisory Committee. Final Report. November 2000.

Maryland Technical Advisory Committee of Water Supply Infrastructure. Final Report. November 2000.

Thornton, Julian. 2002. Water Loss Control Manual. McGraw Hill. New York, New York. 645 p.

U.S. Environmental Protection Agency. Water Conservation Plan Guidelines. EPA-832-D-98-001. August 6, 1998.

APPENDIX A-1

MDE Water Audit Guidance

INTRODUCTION

What is a water audit?

A water audit determines the amount of water lost from a distribution system (due to leakage, storage overflow, meter malfunctions, and theft) and the cost of this loss to the utility. Water audits balance the amount produced with the amount billed and account for the remaining water (loss). Comprehensive audits can give the utility a detailed profile of the distribution system and water users, allowing easier management of resources and improved reliability. It is an important step towards water conservation and, linked with a leak detection plan, can save the utility a significant amount of money and time.

Elements of the audit include

- Record of the amount of water produced
- Record of the amount delivered to metered users
- Record of the amount delivered to unmetered users
- Record of amount of water loss (balance of water, including leaks)
- Measures to address water loss (leaks and other unaccounted water)

What is Water Loss?

There are two types of loss: real and apparent losses. Real loss includes water lost through leakage of distribution systems, service connections, and storage tanks (including overflow). Apparent loss includes meter and record inaccuracies and unauthorized water uses such as theft and unauthorized connections. Authorized unmetered uses can be considered a special type of lost water, and they can also represent lost revenue so should be estimated carefully.

What are the benefits of a water audit?

Benefits of an audit include improved knowledge and documentation of the distribution system including problem and risk areas. By providing a better understanding of what is happening to the water after it leaves the treatment plant, the audit can be a valuable tool to manage resources.

According to the American Water Works Association, water audit programs lead to reduced water losses, financial improvement, increased knowledge of the distribution system, more efficient use of existing supplies, increased safety for public health and property, improved public relations, reduced legal liability, and reduced disruption to customers.

How do I perform a water audit?

This document includes a model water audit worksheet and instructions based on one developed by the Texas Water Development Board. This worksheet is simple, but it is sufficient to account for water usage and quantify lost water. A water audit can be completed in one day if meter-reading records are easily available and significant adjustments to the records are not necessary. The audit should use existing records to the extent possible to produce the most accurate results.

Audits are completed by calculating the difference between the amount of water produced and the amount sold (metered sales) then addressing the difference. Metered sales are compiled and remaining difference between produced water is lost. An audit records the amount of water produced, amount delivered to metered users, amount delivered to unmetered users, and water loss, along with likely causes for the unaccounted water. Then the results are analyzed and estimates are made for recoverable leakage.

Corrective measures should be evaluated and any needed distribution system improvements should be described. Cost benefit analyses should be performed and an effective course of action implemented.

Once the efficiency of the water system is evaluated, the system should take necessary steps to reduce the amount of recoverable water loss. Effective water audits usually result in leak detection programs, which identify and correct problems in the distribution system. A leak detection programs is an effective way to minimize leakage and to fix small leaks before they become major problems. A comprehensive follow up audit might be necessary to determine the accuracy of meters, track unmetered use, and locate and repair leaks.

Recommended Strategy

A preliminary audit should be undertaken to determine the amount of water loss, then followed up with congruous measures as determined by the findings of the audit. If water loss is significant, a more detailed study should be undertaken. If a detailed study shows water loss is significant, measures should be taken to reduce the loss.

PLANNING THE WATER AUDIT

Considerations

Water audits can be designed by reviewing the system records and staff expertise and using these resources to develop and complete effective worksheets. Distribution system characteristics vary, so each utility will have different challenges in performing the water audit. Each system will need to decide how it can perform the audit accurately with the least cost. A worksheet should be developed, and a study period set.

Set Study Period

A study period should be set to allow an evaluation of the complete water system. One year is recommended because it includes all seasons and gives enough time to eliminate the effect of meter reading lag. Shorter periods might not give a complete picture of the water system, and longer periods can be difficult to manage.

Develop a worksheet

MDE has attached a spreadsheet that utilities are encouraged to use; however, utilities may develop their own worksheet. The worksheet, similar to an accounting spreadsheet, should make the computations clear and simple and allow the utility to balance water produced with water used. As well as balancing water in and out of the distribution system, the worksheet should list and account for various water usages.

Water is the commodity and assets (gallons water produced) will be balanced with liabilities (gallons sold) to determine the loss of commodity. If the worksheet is properly designed, a preliminary audit should be able to be completed in a day if using existing meter reading data.

Worksheets can vary in detail and will determine how well the distribution system is described. A more detailed worksheet will provide better understanding of the water usage and could be a useful tool for the water utility.

CONDUCTING THE AUDIT

Compile water production and sales data

Once the study period has been set and a worksheet has been developed, the audit can be conducted. A set of model forms and instructions are included that can be used if the utility does not choose to develop one. Records should be compiled and meters should be checked so accurate totals are recorded.

Once totals are computed, the worksheet should then be filled in, and water delivered should be balanced with water used. Unmetered uses should be documented along with the methods to quantify them. An attempt to account for water loss should be made. Based on the findings of the audit, options should be developed to reduce water loss.

Make adjustments as necessary

When making adjustments to metered amounts, document the adjustments and how they were calculated. All records should reflect any adjustments and should be verifiable. If adjustments are made for significant amounts of water then the system should make changes to eliminate need of adjustments in the future. Adjustments could be known production meter inaccuracy, or the difference between finished reservoir storage at the beginning and end of the study period. One difficulty might be in adjusting existing records to fit the study period. When meter-reading periods overlap, some adjustments will be necessary to represent the study period. Some flow records might have to be pro-rated so that all flow measurements reflect the same period. This should be done carefully to insure the accuracy of the audit.

Comprehensive Audits (optional)

In addition to the above, a more thorough or comprehensive audit would include the following:

- Develop an inventory of meters
- Check accuracy of meters
- Analyze water loss and methods to reduce the loss

Compile a list of different types, sizes, and age of meters in the distribution system. This will help estimate the accuracy of the meters on a system wide scale. This can compliment the water usage information and show usage patterns in the distribution system. It also will help any meter replacement program and cross-connection control program.

It will be important to verify records and check meter accuracy, as these will affect the accuracy of the audit. Meters should be inventoried so they can be tested for accuracy and checked for proper size and type. If meters measure in units other than gallons, the units must be converted to allow compilation. Records should be checked carefully to make sure that units are correct, all measurements are included, measurements represents the same time period, and that calculations are correct.

Possible corrective measures include leak detection programs, meter replacement or installation programs, and conservation programs. Factors to be considered include: where the losses occur, how much loss is in each problem area, what possible solutions exist, cost of the solutions, and time to make the solutions.

FOLLOW UP

Plan for reducing water losses

If the unaccounted or unmeasured water loss is greater than 10 percent, we are requesting that you prepare a plan within three months outlining steps that you intend to take for further identifying and reducing water losses. Steps that you may choose include initiating or expanding a leak detection and repair program or

eliminating unmetered accounts. Cost benefit analyses should be conducted to choose the right option. If future annual audits continue to show unmeasured water greater than 10%, the plan for reducing water losses should be updated and re-submitted.

Benefits of recovering leakage

Benefits the utility should consider are the lost commodity, risk of allowing leaks, and the liability of not addressing leaks. Lost commodity is easy to quantify, as it should be the bottom line of the audit worksheet. Risks include letting small problems continue that might cause major outages and emergency repairs. Liabilities of leakage, or inaction, include capacity waste, water theft (or dead meters), road or foundation collapse, and flooded basements. Leaks also pose a serious cross connection threat, as leaks can be a direct conduit into the distribution system whenever pressure fluctuates.

Cost of recovering leakage

Costs include the personnel and the equipment required to make improvements. Repair costs should not be included because these need to be done eventually.

Long-term goals

Long-term follow up should include updating the audit, reducing loss and checking meters. After the first audit, areas where data is lacking should be identified and addressed. Subsequent audits should provide greater accuracy and reduction of water losses.

More Information

Sources of information on Water Audits include:

AWWA manual M36 *Water Audits and Leak Detection*

International Water Association *Losses from Water Supply Systems: Standard Terminology and Recommended Performance Measures*

APPENDIX A-2

Water Audit Instructions and Worksheet

Note: Units should be reported in millions of gallons for larger systems. For small water systems, reporting in thousands of gallons may be more appropriate.

Line 1 – Total Water Supply to Distribution System

This is the total volume of all water supplied to the system as measured by the master meter(s) and interconnects with other sources of supply. If water is purchased from an interconnected system, please include detailed quantities in the spreadsheet.

Line 2 – Adjustments to Water Delivery

Adjustments may be an increase or a decrease in storage capacity from the beginning to the end of the study period, or adjustments for known broken, or inaccurate master meters.

Line 3 – Net Water Produced

This is the net adjusted water produced and/or measured through the master meters, from plants and interconnections, after adjustments.

Line 4 – Gallons of Metered Water Sold

This lists the total amount of water that is sold through meters in the system. This includes residential, commercial, industrial, institutional, and other metered sales such as standpipes for water haulers. It is important to evaluate when the meters are read so that the readings can be adjusted to reflect the time it takes to actually read the meters. To assure that the production/purchase records are comparable to the customers' meter readings, consumption during the meter-reading period must be adjusted to match the production/purchase period.

Line 5 – Billed Unmetered Sales

These are sales to customers that are not metered. They include connections that are not metered and any bulk sales (e.g. through hydrants). These amounts should be detailed in the spreadsheet.

Line 6 – Unbilled Authorized Consumption

Provided on the chart is a general listing of potential uses that are frequently not metered, however, if these facilities are metered they should be included in Line 4. You may use this list or make your own estimates of unmetered users and accounts. Please include detail amounts with documentation in the spreadsheet.

Line 7 – Apparent Water Losses

These consist of unauthorized consumption and meter inaccuracies. Meter inaccuracy includes production meters and customer meters. These amounts should be documented in the spreadsheet.

Line 8 – Real Water Losses

These losses are generally those that cannot be metered. They primarily include leaks and tank overflow. Any water that has not been documented in other categories should be listed as lost and included in one of the three categories.

Line 9 – Net Lost or Unmeasured Water

Net lost or unmeasured water is determined by subtracting the sum of Lines 4, 5, and 6 from Line 3 (3 – (4+5+6)). This should be the same value as the sum of Lines 7 and 8 (7+8).

Line 10 – Percentage of Lost or Unmeasured Water

The percentage of lost or unmeasured water is calculated by dividing Line 9 by Line 3.

WATER AUDIT WORKSHEET FOR TREATED WATER*

(units should be reported in millions of gallons)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
WATER DELIVERED													
1. Total Water Supply to Distribution System													
2. Adjustments to Water Delivery													
3. Net Water Produced													
WATER USED													
4. Gallons of Metered Water Sold													
Residential													
Commercial													
Industrial													
Institutional													
Other													
Total													
5. Billed Unmetered Sales													
6. Unbilled Authorized Consumption													
Water Main Flushing													
Sewer/Storm Drain Flushing													
Parks/Playgrounds/Swimming Pools													
Golf Courses													
Cemeteries													
Road Medians													
Schools													
Training/Fire Fighting													
Construction													
Storage Tank Drainage													
Sewer Plant Uses													
Total													
7. Apparent Water Losses													
Water Meter Malfunction													
Theft													
Other													
Total													
8. Real Water Losses													
Leaks													
Storage Overflow													
Other													
Total													
9. Net Lost or Unmeasured Water													
10. Percentage of Lost or Unmeasured Water													

Source: Adapted from the Texas Water Development Board

* Worksheet is also available as an Excel spreadsheet

APPENDIX A-3

ANNUAL WATER AUDIT SUMMARY

SYSTEM INFORMATION

SYSTEM NAME: _____

SYSTEM ID: _____

WATER AUDIT INFORMATION

A. Total Water Produced Annually (Line 3*): _____

B. Total Lost or Unmeasured Water (Line 3* minus the sum of Line 4*, Line 5*, and Line 6*) or (Line 7* plus Line 8*): _____

C. Percentage of Water Lost or Unmeasured to Total Water Produced (Line 9* divided by Line 3*): _____
Note: If greater than 10 percent, a plan should be prepared outlining steps to identify and reduce water system losses.

WATER AUDITOR

Name of person completing this report: _____

Signature: _____ Date: _____

Phone Number: _____ E-mail Address: _____

Please mail this summary page, the worksheet, and any other supporting documents that you may want to submit to:

Maryland Department of the Environment
Water Supply Program
1800 Washington Boulevard, Ste. 450
Baltimore, Maryland 21230

For questions, please call (410) 537-3706

* Line numbers refer to table in Appendix A-2

APPENDIX B-1

Worksheet A-2: Water Accounting and Loss Control

Line	Item	Volume (gallons)		% of Amount in Line 1
1	**Total Source Withdrawals and Purchases**			100%
2	*Adjustments to source water supply [a]*			
2A	Adjustment for source meter error (+ or -)			
2B	Adjustment for change in reservoir or tank storage (+ or -)			
2C	Adjustment for transmission line losses (-) [a]			
2D	Adjustments for other source contributions or losses (+ or -) [a]			
3	Total adjustments to source water (add lines 2A through 2D))			
4	**Adjusted Source Water (subtract line 3 from line 1)**			%
5	*Metered Water Sales*			
5A	Metered residential sales			
5B	Metered commercial sales			
5C	Metered industrial sales			
5D	Metered public sales			
5E	Other metered sales			
6	Total metered sales (add lines 5A through 5D)			

7	Adjustment for meter reading lag time (+ or -)			
8	Adjustment for meter errors (+ or -) [a]			
9	Adjusted total meter sales (add lines 6 through 8)			
10	**Nonaccount Water (subtract line 9 from line 4)**			%
11	*Metered and accounted-for but not billed*			
11A	Public-use water metered but not billed			
11B	Other water metered but not billed			
12	*Authorized unmetered water: operation and maintenance*			
12A	Main flushing			
12B	Process water at treatment plant			
12C	Water quality and other testing			
13	*Authorized unmetered water: public use*			
13A	Storm drain flushing			
13B	Sewer cleaning			
13C	Street cleaning			
13D	Landscaping in large public areas			
13E	Firefighting, training, and related maintenance			
14	*Other authorized unmetered use*			

14A	Swimming pools			
14B	Construction sites			
14C	Other unmetered uses			
15	Total authorized unmetered water (add lines 11A through 14C)			
16	**Total Unauthorized Losses (subtract line 15 from line 10)**			%
17	*Identifiable water losses and leaks*			
17A	Accounting procedure errors [a]			
17B	Malfunctioning distribution system controls			
17C	Illegal connections and theft			
17D	Meter inaccuracy			
17E	Unavoidable water leaks			
17F	Avoidable water leaks			
18	Total identifiable water losses and leaks (add lines 17A through 17F)			
19	**Unaccounted-For Water (subtract line 18 from line 16)**			%

[a] Methodology subject to industry and regulatory standards.

Source: http://www.epa.gov/OW-OWM.html/water-efficiency/wave0319/ws-a2.htm

Worksheet 4-4: Preliminary Water Demand Forecast [a]

Line	Item	Current year	5-year forecast	10-year forecast	20-year forecast
A	**RESIDENTIAL DEMAND**				
1	Current annual water residential sales (total gallons)				
2	Current population served [b]				
3	Residential sales per capita (line 1 divided by line 2) [b]				
4	Projected population [b]				
5	Projected annual residential water demand (line 3 multiplied by line 4)				
B	**NONRESIDENTIAL DEMAND [C]**				
6	Current annual water nonresidential sales (total gallons)				
7	Current number of employees or jobs [c]				
8	Water use per employee or job (line 6 divided by line 7)				
9	Projected number of employees or jobs				
10	Projected annual nonresidential water demand (line 8 multiplied by line 9)				
C	**NONACCOUNT WATER (WATER NOT SOLD TO CUSTOMERS)**				
11	Current and forecast amount [d]				
D	**WATER SYSTEM TOTAL DEMAND**				
12	Current total annual water demand (add lines 1, 6, and 11)				
13	Projected total annual water demand (add lines 5, 10, and 11)				
14	Adjustments to forecast (+ or -)				
15	Current (line 12) and adjusted total annual water demand forecast (add lines 13 and 14) [e]				
16	Current and projected annual supply capacity [f]				
17	Difference between total use and total supply capacity (+ or -) (subtract line 12 from line 15)				
E	**AVERAGE-DAY AND MAXIMUM-DAY DEMAND**				
18	Average-day demand (line 15 divided by 365)				
19	Current maximum-day demand				
20	Maximum-day to average-day demand ratio (line 20 divided by line 19)				
21	Projected maximum-day demand (line 18 multiplied by line 20 for all forecast years)				
22	Adjustment to maximum-day demand forecast [e]				
23	Current (line 19) and adjusted maximum-day demand forecast (add lines 21 and 22)				
24	Daily supply capacity (divide line 16 by 365)				
25	Ratio of maximum-day demand to daily supply capacity (divide line 23 by line 24)				

APPENDIX B-2

[a] Separate forecasts should be prepared for large-volume users.
[b] Planners can chose to use service connections or households instead of population and per-connection water use instead of per-capita water use.
[c] Explanatory variables other than employees or jobs can be used as appropriate. The forecast should be disaggregated by sector of water use to the greatest extent possible (for example, commercial and industrial water use and nonaccount water) and a qualitative sensitivity analysis ("what if") should be performed for each sector's forecast.
[d] Please provide an explanation of the forecast of nonaccount water, including all relevant assumptions.
[e] Please provide an explanation of adjustments to your forecasts, including all relevant assumptions.
[f] Supply capacity should take into account available supplies (permits), treatment capacity, and distribution system capacity and reflect the practical total supply capacity of the system, including purchased water.

Source: http://www.epa.gov/OW-OWM.html/water-efficiency/wave0319/ws-44.htm

Worksheet 4-6: Cost of Supply-Side Facilities

		Facilities for meeting average-day demand	Facilities for meeting maximum-day demand [a]			Water purchases needed to meet demand [b]	Estimate of simple incremental supply cost ($/gallon)
Line	Item	Source of supply	Water treatment facilities	Treated water storage	Major transmis-sion lines		
A	**SUPPLY CAPACITY IN ANNUAL GALLONS [c]**						
1	Current installed capacity or water purchases						
2	Planned improvements and additions						
3	Planned retirements						
4	Future installed capacity or purchases (line 1 plus line 2 less line 3)						
B	**COST OF PLANNED IMPROVEMENTS AND ADDITIONS**						
5	Approximate total cost of planned improvements and additions identified in line 2 (including financing costs)						
6	Expected life of new facilities (years)						
7	Estimated annual capital costs (line 5 divided by line 6)						
8	Estimated annual operating costs [d]						
9	Estimated total annual costs (line 7 plus line 8) [e]						
10	Per unit cost of new facilities (line 9 divided by line 2)						
11	Simple incremental supply cost (add all entries from line 10)						

[a] Additional facilities or capital equipment can be included as appropriate.
[b] The plan should indicate whether purchases are needed to meet average-day or maximum-day demand or both.
[c] Planners should select a reasonable planning horizon for supply facilities and use the same time frame for all facilities.
[d] Annual variable operating cost (including energy, chemicals, and water purchases).
[e] This calculation of simplified value does not include a discount rate, an escalation rate, or an adjustment for inflation. This analysis also can be extended to include the incremental cost of wastewater collection and treatment.

Source: http://www.epa.gov/OW-OWM.html/water-efficiency/wave0319/ws-46.htm

Worksheet 4-9: Analysis of Each Conservation Measure or Group of Measures

Describe conservation measure:

_____

Typical water savings from the measure: _____ per _____

Number of planned installations: _____

Anticipated life span for the measure: _____ years

The measure is designed to reduce:

- ☐ Average-day demand
- ☐ Maximum-day demand
- ☐ Both average-day and maximum-day demand

Line	Item	Amount	Amount
A	**COST OF THE CONSERVATION MEASURE [a]**	**Per unit [b]**	**Total cost of the measure**
1	Materials	$	$
2	Labor		
3	Rebates or other payments		
4	Marketing and advertising		
5	Administration		
6	Consulting or contracting		
7	Other		
8	Total program costs for the life of the measure (add lines 1 through 7) [c]		$
B	**ESTIMATED SAVINGS**		
9	Number of units to be installed [d]		
10	Estimated annual water savings per unit in gallons [e]		
11	Total estimated annual savings for the measure in gallons (multiply line 9 by line 10)		
12	Expected life span for the measure in years		
13	Total life span estimated savings for the measure in gallons (multiply line 11 by line 12)		
C	**ANALYSIS OF COST EFFECTIVENESS**		**Amount**
14	Cost of water saved by the measure (line 8 divided by line 13)		/gallon
15	Simple incremental cost of water supply [f]		/gallon
16	Cost comparison (line 15 less line 14)		/gallon
D	**NET BENEFIT OF CONSERVATION**		**Amount**
17	Estimated value of water saved by the measure based on incremental supply cost (line 13 multiplied by line 15)		$
18	Net value of water saved by each measure (line 17 less line 8)		$

[a] This analysis is used to aid the comparison and selection of measures. Planners will estimate actual effects of conservation on planned capital facilities in Section 8. A separate analysis should be performed for each conservation measure, but measures can be combined if

they jointly produce water savings. .
[b] Examples of a unit are a toilet, a retrofit kit, and an audit. A unit estimate may not be appropriate for each measure, in which case total program water savings and costs for the measure can be used. .
[c] Include all recurring operation and maintenance costs over the life of the measure..
[d] Units can be individual product units (such as toilets) or groups of products (such as household retrofits), as long as the analysis is consistent. Leave blank if unit values do not apply..
[e] For example, water savings per retrofit. See Appendix B for benchmarks and sample calculations. Leave blank if unit values do not apply.
[f] From Worksheet 4-6, line 11.

Source: http://www.epa.gov/OW-OWM.html/water-efficiency/wave0319/ws-49.htm

APPENDIX C

PUBLIC EDUCATION

There is a wide array of options available for water utilities to educate water consumers about the benefits of conservation. EPA has published a document entitled "Cases in Water Conservation: How Efficiency Programs Help Water Utilities Save Water and Avoid Costs", which is available on EPA's website at http://www.epa.gov/ow/yearofcleanwater/docs/utilityconservation.pdf or by calling the EPA Hotline at 800-426-4791. This publication provides details regarding successful water conservation programs for 17 utilities throughout North America. Almost all of these water conservation programs include a successful public education component. Some of the most frequently used public education initiatives are described below.

Bill information and/or Flyers

Include information in customer invoices is a quick and easy way to convey messages to all water customers. Providing historical water usage to customers, with water usage expressed in gallons per day can also help consumers to become more mindful of their water usage. Another option is to include water conservation tips with the bill. Flyers can also be used convey water conservation messages; however, including information with bills is usually more cost effective.

Website development

Utilities that currently have websites can develop a web page devoted to water conservation. Conservation tips and information regarding other conservation efforts the utility is promoting can be posted on the web page.

School Programs

Water utilities or municipal water districts can work with local schools or environmental education centers to organize a water conservation program geared towards children. Options could include developing educational information for distribution in schools or having staff members available to make presentations to students. For example, staff members with the Town of Cary in North Carolina are available by appointment to teach lessons on water conservation and related topics to students (elementary and middle school) and to arrange tours of water and wastewater treatment plants. Schools and teachers can choose one of ten different lesson plans, all of which address different water topics.

Community Education Programs

Utilities can also offer education opportunities for members of the community. For example, Gilbert, Arizona runs a homeowners education program. Cary, North Carolina offers workshops that teach water efficient landscaping and gardening techniques.

Water Audits

Several utilities throughout the country have offered free water audits to their residential customers. Most of these audits are performed in response to customer requests. During the water audit, a utility representative analyzes water use and suggests appropriate conservation measures. The utility representative may also inspect a property for leaks and/or install water-saving fixtures, such as low-flow showerheads or faucet aerators. To a lesser extent utilities have also offered free water audits to commercial users and large irrigation users.

Retrofits, Replacements, and Rebates

Utilities can sponsor water fixture retrofit or replacement programs. Distribution of water saving fixtures can occur in a variety of ways including distributing and installing fixtures during water audits or including the fixtures in free or low-cost water conservation kits. Water conservation kits can be provided to customers upon request or can be distributed at public events. The Houston Department of Public Works and Engineering had success distributing conservation kits, with water saving fixtures, to over 10,000 fifth graders as part of an education program in the elementary schools.

Rebate programs are not used as frequently as retrofit and replacement programs, however several cities have had success with rebate programs. Seattle, Washington sponsored a program called WashWise where citizens that purchased a water-efficient washing machine received a mail-in cash rebate. Over the past two decades, many utilities have offered rebates for replacing old toilets with new, water-efficient toilets.

Landscape Efficiency Programs

On average, throughout the country, outdoor water use accounts for about 40 percent of all residential water use. Teaching citizens about outdoor water conservation can have a positive impact on water conservation. Tampa, Florida distributes rain sensors for irrigation systems on a limited, as requested basis and they also conduct sensible sprinkling evaluations for a limited number of households each year. There are several utilities that have developed daily watering guides. Phoenix, Arizona publishes a Lawn Watering Guide in the weather section of the daily newspaper each day and several utilities in California have watering indexes that are updated weekly posted on their websites.

APPENDIX D

CASE STUDIES

CARY, NORTH CAROLINA

The population in the Town of Cary, North Carolina increased dramatically in the 1990s, placing a strain on the Town's water system. Cary began to plan an expansion of its water treatment facilities. In 1996, the Town adopted a water conservation program as part of its integrated resource management plan. The goal of the program is to reduce the Town's average per capita water use 20 percent by the year 2015.

In 2000 the Town of Cary adopted a Water Conservation and Peak Demand Management Plan. This plan aims to reduce peak water use over the short term until the water treatment plant expansion has been completed. To reduce peak water use the Town constructed two reclaimed water systems at its wastewater treatment plants. The reclaimed water receives at least advanced secondary treatment, meets water quality requirements as defined by the North Carolina rules and is reused for irrigation and cooling after it flows out of a water reclamation facility.

This plan also addresses long-term conservation efforts. The following conservation measures are part of the long-term conservation program:

- **Public Education Program.** Efforts include a "Block Leader Program" and a summer "Beat the Peak Program".
- **Toilet Flapper Rebate Program.** The Town provides a financial incentive for customers to replace existing flappers with early closure models.
- **Water Waste Ordinance.** Regulations prohibit wasteful outdoor watering that falls on impervious surfaces.
- **Rain Sensor Ordinance.** Regulations require all existing and new customers with irrigation systems to install a rain sensor that measures rainfall and overrides the irrigation timer if it is raining or soils already contain sufficient moisture.
- **Residential Audits.** Residential customers are offered an onsite audit to assess water use, recommend appropriate conservation measures, and provide low-flow plumbing supplies.
- **Conservation Rate Structure.** An increasing block rate structure consists of four rate tiers.
- **New Homes Points Program.** The City approves development projects based on a point scale, giving extra points for developments using selected water-efficient measures.
- **Landscape Water Budget.** Large irrigation users are provided with monthly water budgets that identify the appropriate water needs

To date the conservation plan has been successful and the City of Cary has been able to delay the two water plant expansions. According to estimates, water conservation efforts will reduce per capita water use by 20 percent by the year 2015.

GALLITZIN, PENNSYLVANIA

Gallitzin is a small city, with a population of 2,000 residents, located in western Pennsylvania. During the early 1990s, the Gallitzin Water Authority (GWA) was experiencing water losses of over 70 percent. In addition to high water loss, problems with the water system included recurring leaks, high operational costs, and complaints of low pressure. In response to these problems, GWA instituted a comprehensive leak detection and corrosion control program in 1994.

As part of the leak detection program, GWA developed accurate water production and distribution records using seven days of data collected from meters at the plant and pump station. Next, they created a system map to locate leakage. GWA identified 95 percent of the leaks in-house using a leak detector and employed an outside contractor to identify the remaining five percent.

In 1998, four years after the initiation of the leak detection program, water use decreased by almost 60 percent and water loss dropped from 70 percent to nine percent. This resulted in cost savings for the GWA, including $5,000 on annual chemical costs and $20,000 on annual power costs. Other benefits to the water system included extending the life expectancy of equipment, reducing purchased water costs during droughts, reducing overtime costs, and improving customer satisfaction.

MASSACHUSETTS WATER RESOURCES AUTHORITY

The Massachusetts Water Resources Authority (MWRA) provides water to a population of 2.2 million people located in 46 cities, towns, and municipal water districts. From 1969 to 1988, MWRA exceeded the safe yield for water withdrawals by about 10 percent annually and began exploring ways to their supply capacity. One option was to divert the Connecticut River, at a cost of 120 million dollars in capital costs plus three million dollars in annual costs, to increase supply. Another option was to build a new water treatment facility with a maximum capacity of 500 million gallons per day (mgd). MWRA decided to implement a water conservation plan initially and to complete the other plans as necessary.

MWRA's water conservation plan had several aspects that are described below:

- **Leak Detection Program.** The Authority implemented a program to detect and repair leaks.
- **Retrofit Program.** 730,000 homes were retrofitted with low-flow plumbing devices.
- **Business Outreach.** The Authority developed a water management program for businesses and institutions.
- **Public Education Program.** The Authority developed and conducted extensive public and school education programs.
- **Regulatory Changes.** The state plumbing code was modified to require new toilets to use less than 1.6 gpm.

- **Meter Upgrades.** Metering systems were improved in an effort to track and analyze water usage.
- **Conservation Rate Structure.** The Authority instituted water and sewer rates that encouraged water conservation in the community.

MWRA's conservation program was successful. Average daily demand decreased almost 24 percent, from 336 mgd to 256 mgd. This decrease in daily demand resulted in the capacity of the new water treatment facility being reduced by 20 percent and a 20-year deferral in diverting the Connecticut River for additional supply.

NEW YORK CITY, NEW YORK

Since the mid-1970s, New York City's (NYC) water facilities were exceeding safe yields, and by 1990 three of the city's wastewater treatment plants were also exceeding permitted flows. Water and sewer rates were skyrocketing and the City faced the need for major water infrastructure projects. In 1992, NYC conducted a cost analysis of supply alternatives and found conservation to be the most economical option.

NYC's conservation plan had four main elements that are described below:

- **Education program.** The City conducted door-to-door water efficiency surveys to 220,000 homeowners. Citizens were provided with educational information, free water saving fixtures, and a free leak inspection. The City also provides Home Water Saving Kits free of charge upon request and offers water conservation classes to building managers.
- **Metering.** The City installed meters at unmetered properties. Water savings from meter installation equal about 200 mgd.
- **Leak Detection.** The City uses computerized sonar leak detection and advanced flow monitoring programs to help detect leaks. Water savings from the leak detection program equate to about 40 mgd.
- **High Efficiency Toilet Program.** The City replaced over 1.3 million toilets with high efficiency toilets that use 1.6 gallons of water per flush. This program saves about 75 mgd.

Overall the per capita use in NYC dropped from 195 gallons per day (gpd) in 1991 to 167 gpd (about 14 percent) in 1998. Customers also saved between 20 and 40 percent in total water and wastewater bills.

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