

## ABSTRACT

### Integrating Non Revenue Water Management With Customer Water Conservation Programs

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**Topic:** Management Benefits from Reducing Water Losses

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**Abstract:** Considerable progress has been made in modelling customer-side demand management programs. Detailed models also exist to evaluate the costs and benefits of non-revenue water reductions. But to date there has been no integration of the two topics; there has been no clear or comprehensive guidance for utility managers to assess where to place utility investments, particularly between customer-side demand management programs and utility-side physical loss reduction programs.

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This paper and platform presentation will describe a spreadsheet-based model developed in 2009 by the Alliance for Water Efficiency specifically for use in water utility integrated resource planning and customer-side demand management analysis. It was primarily designed to project water savings from conservation programs and to calculate conservation program costs, benefits, and ratepayer impacts. In addition to providing water managers with a standardized methodology for water savings and benefit-cost accounting, the model includes a library of pre-defined, fully parameterized conservation activities from which users can construct conservation program planning scenarios. Users can also define their own conservation activities to use with the model or customize the model's pre-defined activities to better suit their local circumstances.

Water Loss Management as a program activity is included on a benchmark basis as described below.

## **Introduction**

The Alliance for Water Efficiency is a non-governmental organization serving the United States and Canada, the two countries in the world with the highest per capita water consumption and thus in desperate need of sound water efficiency programs. Founded in 2007, the Alliance is dedicated to promoting water efficient products and practices, fostering water efficiency research, and assisting water utilities and communities in the implementation of water efficiency programs. A detailed web site of water efficiency information (including information on non-revenue management) has been built and is openly accessible at [www.allianceforwaterefficiency.org](http://www.allianceforwaterefficiency.org). To date over 290 individual organizations have joined the organization and are participating in Alliance activities.

Shortly after its founding, the Alliance determined that there was a need for a systematic, transparent, comprehensive, yet user-friendly model to evaluate water conservation and efficiency options. Although numerous excellent models already exist, most are proprietary. Others are free but difficult to use. Nearly all the existing models have hidden source code, so that the user cannot easily amend the calculations and parameters to customize the model for their own purposes. Finally, most models do not have incorporated into the model algorithms the latest information on product savings and product codes.

The project got underway in early 2008 with seed funding provided by the Home Depot Foundation. A year was spent building the detailed background calculations of the model and constructing the user interface. Four water utilities in the United States provided beta testing and the opportunity to verify the savings calculations against their own savings experiences. Three additional utilities in the country of Jordan tested the model and customized it for their purposes. Changes were made based on the early feedback received, and the model is now already in Version 1.2.

Released in July, 2009 with a detailed User Guide, the model is called a “Water Conservation Tracking Tool” because of its usefulness in also tracking the savings of programs chosen and undertaken. The Tool is available free of charge to members of the Alliance for Water Efficiency. A utility can obtain it and use it freely with an annual membership of merely one cent US per customer service connection. Small utilities of less than 50,000 customer connections are thus able to get the Tool for \$500 or less. Consultants are also able to freely use the Tool for their clients, provided that the consultant is a member and the utility system is also a member.

## **Tool Description**

The Water Conservation Tracking Tool is an Excel-based spreadsheet model for evaluating the water savings, costs, and benefits of urban water conservation programs. In addition to providing users a standardized methodology for water savings and benefit-cost accounting, the tool includes a library of pre-defined, fully parameterized conservation activities from which users can construct conservation programs. Water managers can use the tool in a variety of ways to aid their water resource planning and operations. For example:

- The tool can be used to quickly compare alternative conservation measures in terms of their water savings potential, impact on system costs, and potential benefits to utility customers.
- The tool can be used to develop long-range conservation plans. It can be used to construct conservation portfolios containing up to 50 separate conservation program activities.
- The tool can be used as an accounting system for tracking the implementation, water time savings, costs, and benefits of actual conservation activities over time.

It was the Alliance’s intention to provide a tool that utilities could adapt to a wide variety of user situations, regardless of geographic location, water system size, or extent of previous conservation program experience. To meet this objective, the tool provides a generic framework for characterizing water system demands and costs, and for specifying the attributes of water conservation activities. This generic framework utilizes several key assumptions and simplifications, all of which are fully explained in a detailed User Guide.

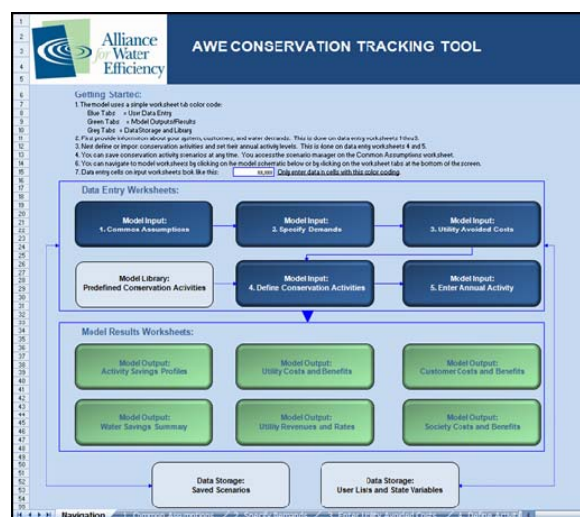


Figure 1: User Navigation Sheet

### Features of the Tracking Tool

The following is a listing of some of the key features of the Water Conservation Tracking Tool:

Multiple Analysis Perspectives – The tool evaluates conservation program costs and benefits from three perspectives: (1) the utility’s; (2) the program participant’s; and (3) society’s. Each perspective provides insight into a key aspect of conservation program planning and evaluation.

Class	Activity Name	Unit Cost (\$/AF)	Cost	Cost
37	Residential Surveys, SF	\$ 820	\$ 385,395	\$ 25,696
38	Residential HE Toilets, SF	\$ 762	\$ 1,642,142	\$ 106,658
39	CI HE Toilet	\$ 764	\$ 4,097,411	\$ 273,190
40	Residential Irrigation Controller, SF	\$ 762	\$ 2,967,651	\$ 199,865
41	Large Land Irrigation Controller	\$ 189	\$ 440,840	\$ 29,305
42	<b>Subtotal Conservation Activities</b>	<b>\$ 687</b>	<b>\$ 9,686,442</b>	<b>\$ 637,832</b>
43	<b>Total With Overhead &amp; Public Information</b>	<b>\$ 687</b>	<b>\$ 9,686,442</b>	<b>\$ 637,832</b>

Class	Activity Name	Unit Benefit (\$/AF)	PV Benefit	Avoided Supply	Avoided Wastewater	Capacity Benefit
93	Residential Surveys, SF	\$ 600	\$ 281,013	\$ 235,370	\$ 10,347	\$ 35,297
94	Residential HE Toilets, SF	\$ 665	\$ 2,880,261	\$ 2,282,200	\$ 241,010	\$ 357,051
95	CI HE Toilet	\$ 685	\$ 3,674,130	\$ 2,911,233	\$ 367,438	\$ 455,464
96	Residential Irrigation Controller, SF	\$ 575	\$ 2,264,287	\$ 1,897,607	\$ -	\$ 366,680
97	Large Land Irrigation Controller	\$ 567	\$ 1,321,437	\$ 1,124,780	\$ -	\$ 199,656
98	<b>Total</b>	<b>\$ 629</b>	<b>\$ 8,448,189</b>	<b>\$ 668,784</b>	<b>\$ 1,614,190</b>	

Class	Activity Name	NPV (\$)	B/C Ratio
146	Residential Surveys, SF	\$ (104,382)	0.73
147	Residential HE Toilets, SF	\$ (236,112)	1.75
148	CI HE Toilet	\$ (423,272)	0.90
149	Residential Irrigation Controller, SF	\$ (730,264)	0.76
150	Large Land Irrigation Controller	\$ (885,997)	3.00
151	<b>Subtotal Conservation Activities</b>	<b>\$ (854,691)</b>	<b>1.09</b>
152	<b>Total With Overhead &amp; Public Information</b>	<b>\$ (854,691)</b>	<b>1.09</b>

Figure 2: Utility Costs and Benefits

**Flexible Modeling of Water Savings** – Water savings for an activity can be modeled as having a fixed life or as persisting indefinitely. A conservation activity’s savings profile can include a decay process or it can be modeled as constant. Savings from conservation activities that interact with existing plumbing/energy codes that exist in the US and Canada, such as toilet, showerhead, and clothes washer replacement and/or rebate programs, can be disaggregated into program-related and code-related savings components.

**Conservation Activity Library** – The tool includes a library of pre-defined, fully parameterized conservation activities that users can import into the model. At their option, users can use these activities as they are or customize them to better match their service area conditions and program characteristics.

Figure 3: Conservation Activity Menu

**Water Savings Disaggregation** – The tool disaggregates water savings three different ways: (1) by water user classification; (2) between system peak and off-peak periods; and (3) between program-related and code-related water savings. The tool has built-in capability to estimate service area water savings due to national toilet, showerhead, clothes washer, and dishwasher water efficiency code requirements.

Demand Forecasting – The tool can modify a baseline water demand forecast to account for both program-related and code-related water savings over time. The tool can also generate a simple baseline demand forecast if the user does not have one.

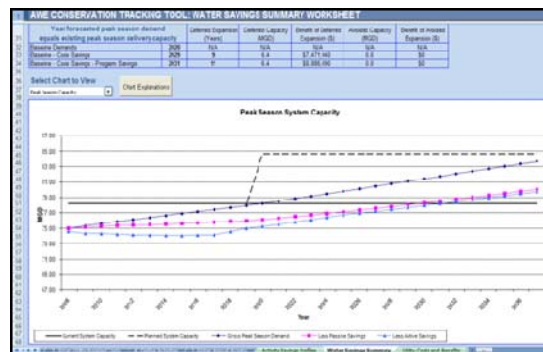


Figure 4: Water Savings Summary

Avoided Cost Analysis – Users have the option to use their own forecasts of system avoidable costs or they can use the tool’s avoided cost calculator to estimate avoidable system operating and capital costs due to conservation water savings.

Minimal Data Requirements – Every effort has been made to minimize the tool’s data requirement so that users are not overburdened with data collection and input tasks. This was a key priority for the Alliance in building the model.

Data Entry Assistance – The tool includes custom data entry forms and dialogs to help users define or edit conservation activities, import conservation activities from the tool’s library, and save and retrieve scenarios. Data input cells are color coded to make them easy to spot. A brief message explaining why the tool needs the requested information appears whenever a data entry cell is activated.

Charting & Reporting Capability – The tool includes dynamic charts and tables that automatically adjust to user settings and conservation program specifications. Charts are embedded within worksheets, but also can be displayed in their own windows with a click of a button (this feature is not available if using Excel 2007). Charts and reports can be easily copied into other documents for report generation.

Scenario Management – Users can easily save scenarios and retrieve them for later use. This makes it easy to see how different program mixes or assumptions about water savings or program costs impact the overall results.

Open Source – Users can examine the tool’s internal logic. Users can customize or extend the capabilities of the tool to meet their specific planning needs. Visual basic code used by the tool is extensively commented within the model and in the User Guide to make it easy to follow.

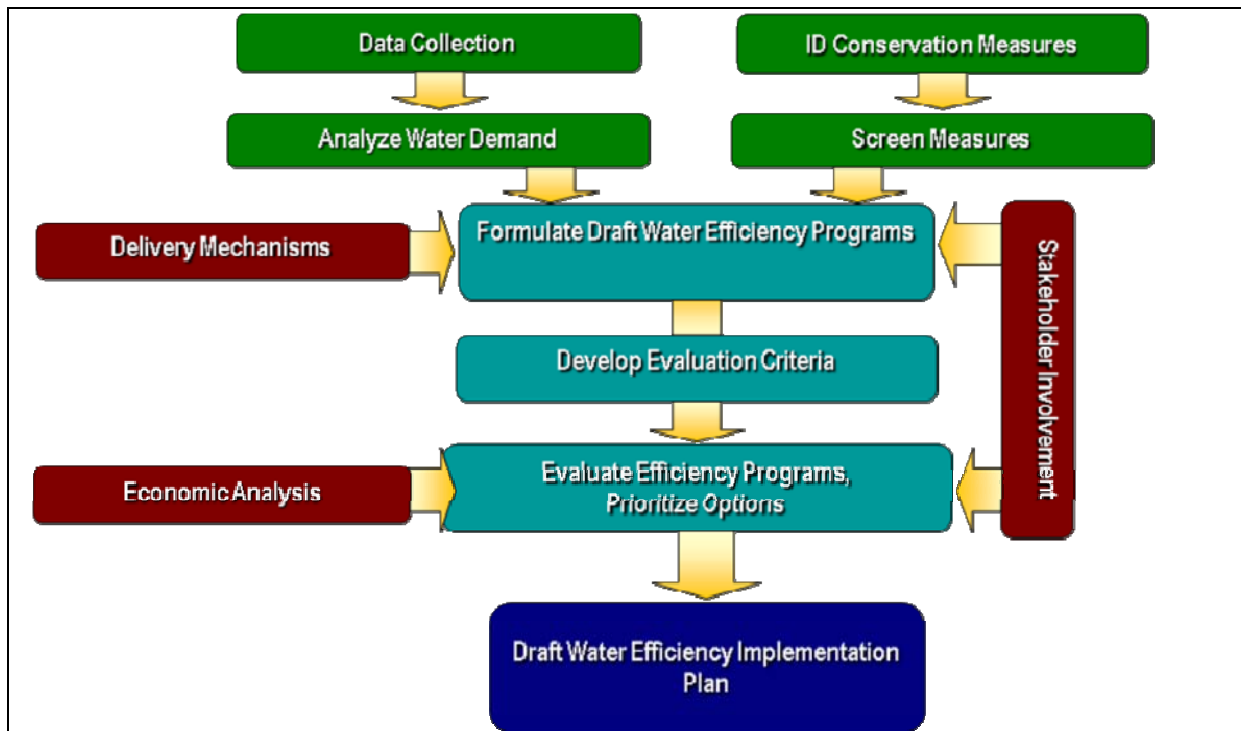


Figure 5: Conservation Planning Process

Source: A&N Technical Services, Inc.; AWWARF Project 2935: Water Efficiency Programs for Integrated Water Management

### Non Revenue Water Calculations

Figure 5 shows the steps of the planning process for water conservation that the model automates. Non-Revenue Water Management is currently integrated into this demand side model by benchmarking physical water loss savings and costs against similar savings and costs of conservation programs. The goal is an integration of both approaches, so that utility managers can assign financial resources to appropriate program strategies in both areas.

Figure 6 shows how the model depicts savings from demand side conservation programs against a 20% reduction in physical losses and a 40% reduction in physical losses, assumptions developed based on review of available literature and compilation of field experience. By comparing the savings profiles shown in Figure 6, a utility manager can assess the total savings projected to a utility from the various demand side conservation activities versus water loss management and where utility financial resources are best applied in what time period.

The costs for water loss management are assessed based on an analysis done by Julian Thornton and Reinhard Sturm and presented at WaterLoss 2007 in Bucharest. In their paper, the costs of water loss reduction from seven different US utilities were documented, with a maximum cost of \$658 per acre-foot of water saved and a minimum of \$318 per acre-foot of water saved. These two bounds were incorporated into the model as benchmark

cost values for water conservation programs, as shown in Figure 6. In this simple manner, a utility manager can correctly assess where an investment is best placed.

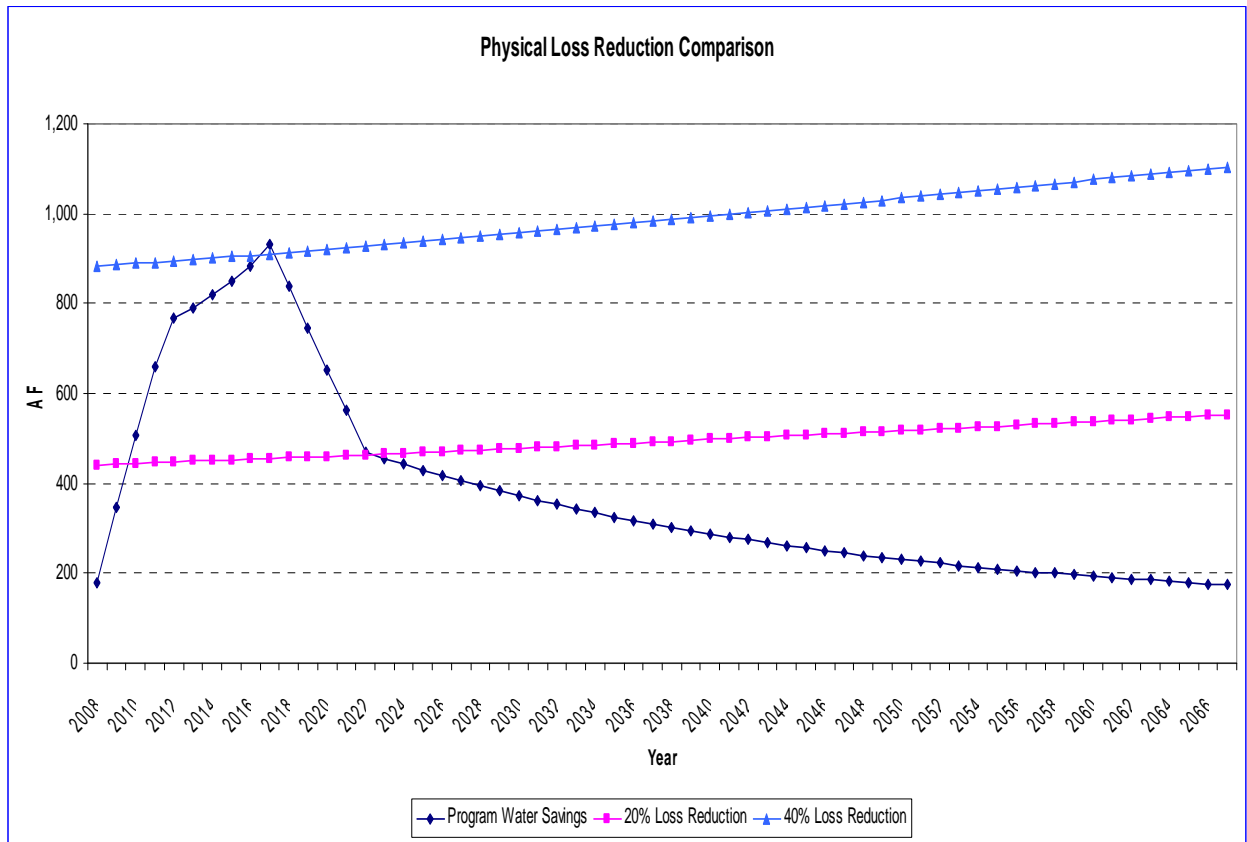


Figure 6: Physical Loss Reduction Comparison with Conservation Programs

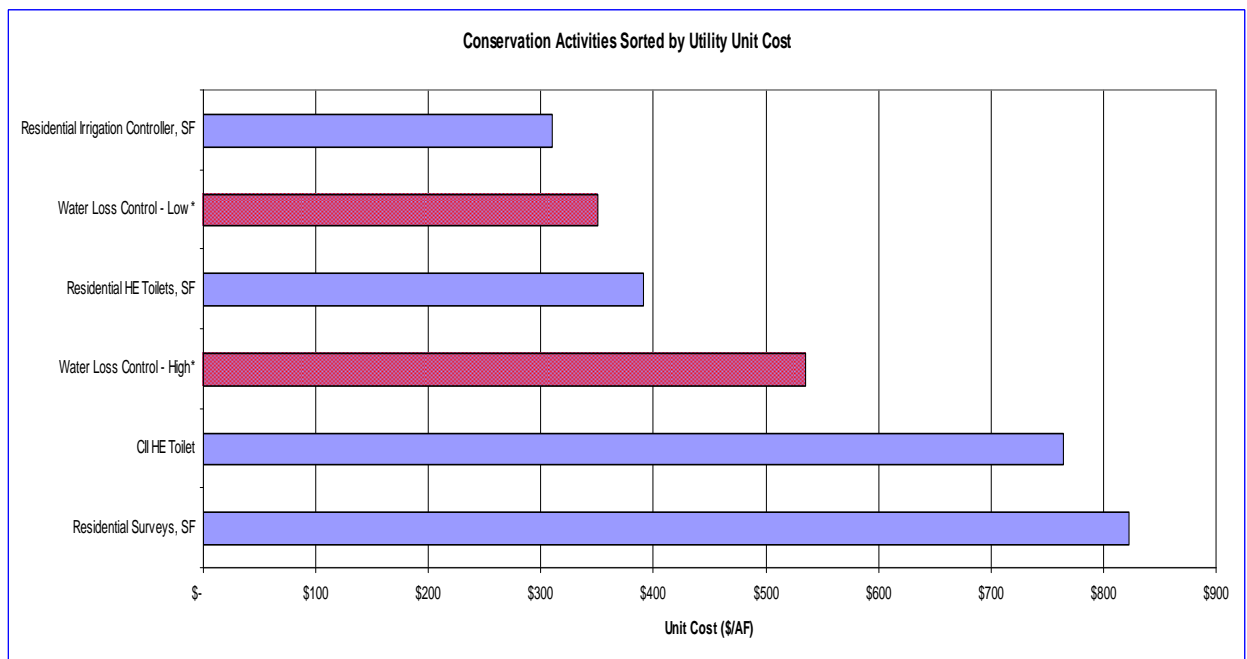


Figure 7: Conservation Activities Benchmarked against Water Loss Control

However, this approach is only a first rudimentary first step in a combined analysis of water conservation and water loss management programs. Currently underway is a more detailed and robust modeling of specific water loss management strategies that will be incorporated into the model, based on actual utility water loss and network characteristics. Thus, these specific water loss management activities will be better compared and analyzed alongside the same level of detail for customer water conservation programs. Rather than just appearing as benchmark values, non-revenue water management will be a scripted activity in its own right.

The progress of this more detailed modeling will be presented at the conference.

### **Uses of the Tool and Plans for the Future**

The Water Conservation Tracking Tool can be used to plan detailed cost-effective conservation programs, by ranking those program measures that yield the most benefit for the least cost. Because it uses the same data as planners use for integrated resources planning, the conservation activities modeled with the tool can be included as water resource portfolio options in a water utility's long-range system plan.

Future versions of the Tool will add more customer-side conservation activities into the model's Resource Library. As new technologies are piloted and savings results and costs documented, they will be included. Non-revenue water management is a complex activity that must be included in this type of modeled financial analysis so that the utility manager can compare the true costs and benefits of economic water loss control against the same parameters for demand-side management programs. Additional functions such as calculating greenhouse gas emission reductions from conservation savings and water loss management will also be added for those utilities that have complete data on their water supply's embedded energy.