CHAPTER 5 – WATER CONSERVATION

5.1 Introduction

This chapter presents a summary of opportunities for GWA to undertake to improve the efficient use of existing water resources through the implementation of urban water conservation. Water utilities worldwide are facing a water shortage for a variety of reasons, including (1) lack of availability of new water supplies for development; (2) inability or willingness to raise water rates to gain sufficient financial resources to maintain existing and continued expansion of water infrastructure thus forcing more efficiency from existing developed resources, or (3) climate change that is leading to unprecedented droughts or flood damage leading to emergency crises in lack of potable water supply.

Past views of water conservation thought it only applicable in times of drought as a way to ration customers when supplies were severely limited. Today, water conservation, or also known as water use efficiency, has progressed into everyday standard utility operations or "business as usual." Many utilities rely on water conservation as part of their integrated water resources portofolio of supplies and seek to maintain the water conservation needs in the forefront of utility staff and customer's minds. These programs also exist for utilities of varying size from a few thousand to over 100,000 connections in both water scarce and water rich watersheds. For example, over 330 water utilities in California servicing over 85% of the state's population of 36 million residents currently have embraced urban water conservation programs based on custom designed Best Management Practices (BMPs). These utilities have voluntarily committed to implement the 14 BMPs defined in the Memorandum of Understanding (MOU) Regarding Urban Water Conservation overseen by the California Urban Water Conservation Council (www.cuwcc.org). Another example is the commitment of the federal government to drive changes at existing and new facilities to conserve both water and energy through the various initiatives of the Federal Energy Management Program (http://www.eere.energy.gov/femp).

This chapter describes both a general background on water conservation program elements that may be feasible for GWA and overall recommendations for GWA if committed to embarking on the design of a water conservation program. Once sufficient data on GWA customer use along with other information related to feasibility has been gathered, this project will provide technical analysis tools to help develop a long-term, measurable water conservation BMP program.

5.2 General Background

There are various types of water conservation programs aimed at water demand reductions optimized to the more cost-efficient and attainable BMP implementation strategies. Over the past decades, key lessons learned from either voluntary or mandated utility water conservation agreements help planners and field staff to understand which BMPs may be most effective for GWA. Key reasons GWA may engage in water conservation include:

- Stewardship of the limited water resources on Guam and building the ethic of future water users
- Reduce high water losses (see Volume 2, Chapter 4 – Water Loss Control)
- Increased system pressure by reducing peak demands

- Business case analysis illustrating a comparison of which BMP implementation strategies are more cost efficient then developing new supplies to meet both current and future demands
- Customer service drivers to assist with reducing wasteful or excessive use by both commercial and residential customers.

Taking these drivers into consideration, an analysis of feasible BMPs is a means for water conservation decision makers to better design conservation program by providing information not previously available regarding the estimated water savings, costs and benefits of conservation programs.

The overall purpose of this chapter was originally intended to present the findings of a water conservation technical analysis, which, if information was available, would likely include a summary of the following:

- Past water conservation accomplishments and any resulting water savings of quantifiable BMPs.
- BMP modeling effort. The BMP modeling includes an analysis of the future costs and water savings of the quantifiable BMPs of two alternative water conservation plans.

5.3 Methodology for Estimating Water Savings

This section provides an explanation of the methodology used to estimate projected water savings based on quantifiable and non-quantifiable BMPs. These BMPs are listed and terminology and the general assumptions used for this analysis are defined.

5.3.1 Quantifiable and Non-Quantifiable BMPs

Using the CUWCC as a reference, some BMPs have water savings that are considered non-quantifiable by planners. A list of commonly used quantifiable and non-quantifiable BMPs is provided in Table 5-1. The BMPs are listed according to the CUWCC defined name and numbering system for the standardized program of BMPs for implemented by utilities in California. In the case of GWA, any number scheme and list of BMPs may be combined into a water conservation program. There is a lengthy list of over 100 BMPs that may be considered when screening for initial feasibility. A list of quantifiable BMPs could then be evaluated based on water savings assumptions and each BMP's projected activity as determined appropriate for GWA. The quantifiable BMPs are those for which water savings can be estimated. The non-quantifiable BMPs are those for which water savings cannot be accurately estimated.

Table 5-1 – Quantifiable and Non-Quantifiable BMPs

BMP	BMP Description	Quantifiable	Non-quantifiable
1	Interior and Exterior Water Audits and Incentive Programs for Single Family Residential, Multi Family Residential, and Institutional Customers	X	
2	Plumbing Retrofit of Existing Residential Accounts	X	
3	Distribution System Water Audits, Leak Detection, and Repair	For metered systems	For unmetered systems
4	Non-Residential and Residential Meter Retrofit	X	
5	Large Landscape Water Audits and Incentives for Commercial, Industrial, Institutional and Multi-Family Developments	X	
6	High Efficiency Washing Machine Rebate Program	X	

Table 5-1 – Quantifiable and Non-Quantifiable BMPs (continued)

BMP	BMP Description	Quantifiable	Non-quantifiable
7	Public Information		X
8	School Education		X
9	Commercial and Industrial (CI) Water Conservation	X	
11	Conservation Pricing for Metered Accounts		X
12	Water Conservation Coordinator		X
13	Water Waste Prohibition		X
14	Ultra-Low Flush Toilet Replacement Program for Residential and Non-Residential Customers	X	

5.3.2 Analysis Perspective

A benefit-cost analysis can be performed from several different perspectives. The perspective of this analysis is from the utility perspective. The utility benefit-cost analysis is based on the benefits and costs to the water provider. This perspective considers the program costs that will be directly borne by the utility. This enables the utility to compare various water supply options and the potential investments for saving water. The utility perspective does not count the benefits accrued or costs incurred outside of the utility.

5.3.3 Analysis Terminology and General Assumptions

Each component of the water savings analysis is described below. In addition, general water savings assumptions are provided. Industry experience-based "common" assumptions from the CUWCC MOU and the American Water Works Association (AWWA) are the basis for the water savings assumptions.

- *Incremental Water Savings* – Incremental water savings are the new water savings realized as a result of new interventions implemented during the corresponding year. Incremental water savings does not include water savings from interventions implemented in previous years.
- *Annual Water Savings* – Annual water savings is the total water savings of the BMP for each year. Annual water savings include the water savings being realized from previous years' interventions.
- *Intervention* – Each individual water conservation action the agency performs is called an intervention. For example, an individual action for one customer such as one meter installation or one water audit is considered an intervention.
- *Unit Water Savings* – A summary of BMP specific water savings assumptions is provided in Table 5-2. Water savings for each conservation measure are considered in terms of end-use water reductions. Each conservation measure evaluated in this analysis targets a particular water user group (single family residential, multi family residential, etc) and a particular water use within that user group (toilets, showerheads, etc). In some cases, a conservation measure targets multiple end uses. For example, residential water surveys often target indoor uses such as toilets, showerheads, and faucets, and outdoor water use.
- *Water Savings Life* – The average water savings life of an intervention is the duration of time during which the intervention will realize water savings. The life span of an intervention will vary by customer. However, for this analysis it is

assumed that water savings will be realized for the length of the assumed average life span.

To determine how much water is saved from implementing each conservation measure, water reductions are applied to the specific end use targeted by the BMP. Water savings in the form of a percent are multiplied by the appropriate water use. The percent reductions are only applied to the amount of water identified for the end use, not the entire category of use. The water use varies by utility and still needs to be further understood for uses on Guam by GWA customers before this analysis could proceed.

Table 5-2 – Water Savings Assumptions

BMP number	BMP Description	Affected Account Category [1]	Affected End Use(s)	% Reduction in Water Use	Water Savings Life (year)
1	Residential Water Audits	RSF	Internal	5% [2]	4 [2]
		RMF			
		RSF	External	10% [3]	
		RMF			
2	Plumbing Retrofit	RSF	Toilets	10.0% [4]	4 [2]
		RSF	Showers	21.0% [4]	
		RSF	Faucets	10.0% [4]	
		RMF	Toilets	10.0% [4]	
		RMF	Showers	21.0% [4]	
		RMF	Faucets	10.0% [4]	
4	Meter Retrofit	URSF	All	20.0% [3]	Permanent [8]
		URMF	All		
		UCOM	All		
		UIST	All		
		UIND	All		
		UMUN	All		
5	Large Landscape Water Audits	COM	Irrigation	15.0% [3]	4 [9]
		IND	Irrigation		
		INS	Irrigation		
		MUN	Irrigation		
		IRR	External		
		LND	External		
6	Clothes Washer Rebates	RSF	Laundry	34.0% [5]	Permanent [10]
		RMF			
9	Water Audits	COM	All	12% [2]	4 [9]
	Water Audits	IND	All	15% [2]	
	Water Audits	INS	All	12% [2]	
	Water Audits	MUN	All	12% [2]	
9	ULFT Rebates	COM	Toilets	Fixture Model [6]	Permanent [10]
		IND			
		INS			
		MUN			
14	ULFT Rebates	RSF	Toilets	Fixture Model [7]	Permanent [10]
14		RMF			

1. RSF=residential single family, RMF=residential multi-family, URSF=unmetered single family, URMF=unmetered multi-family, UCOM=unmetered commercial, UIND=unmetered industrial, UINS=unmetered institutional, UMUN=unmetered municipal, COM=commercial, IND=industrial, INS=institutional, MUN=municipal, IRR=irrigation, LND=landscape
2. BMP Cost and Savings Study (CUWCC, 2005)
3. MOU (CUWCC, 2004)
4. A & N Technical Services report (2005)
5. A & N Technical Services report (2005, p2-13), derived from THELMA (1997) data.
6. CII ULFT Savings Study (CUWCC, 1997)
7. MOU Exhibit 6, Tables 1&2 (CUWCC, 2004)
8. Professional judgment – assuming the meter will not be removed once it is in place.
9. A & N Technical Services, 1999
10. Professional judgment that user will not replace an efficient machine with an inefficient one.

Permanent life measures are applied to conservation measures that involve the replacement of water use-equipment, such as a clothes washer or recommend specific equipment replacement, such as with a meter retrofit. For these measures, the measure life is assumed to be permanent because it is highly unlikely that when the equipment wears out, it would be replaced with an inefficient model.

Measures that rely on the behavioral change of a homeowner or water user to save water are assumed to have a finite life. For example, a water conservation measure that involves a homeowner setting an irrigation controller to reduce water use does not create permanent water savings because the house may be sold to another owner and there is no guarantee that the new homeowner will continue the same behavior. This is particularly true when the action requested is voluntary and there is no compliance monitoring. In these cases, a finite water savings life is assumed. A summary of the water savings life per type of intervention used in this analysis is provided in Table 5-3.

Table 5-3 – Summary of Intervention Life Span Assumptions

BMP	Intervention	Water savings life span, years	Reference
1	Single family survey Multi-family survey Institutional survey	4 4 4	C&S Study, page 2-44 (CUWCC, 2005)
2	Plumbing retrofits	4	C&S Study, page 2-44 (CUWCC, 2005)
4	Meter retrofit	Permanent	Permanent water savings is assumed
5	Large landscape audits	4	A & N Technical Services, 1999 (page 2-20)
6	Washing machine rebates	Permanent	Permanent - - - - - - - - - - - Professional judgment that user will not replace an efficient machine with an inefficient one, given pending state standards
9	Commercial/industrial audits	4	A & N Technical Services, 1999 (page 2-20)
14	Residential toilet rebates Commercial toilet rebates Industrial toilet rebates Institutional toilet rebates	Permanent Permanent Permanent Permanent	Permanent water savings is assumed

5.3.4 Benefit Cost Modeling Overview

The BMP modeling analysis can be performed using the Microsoft® Excel 2003 spreadsheet calculations. These spreadsheet models have been used elsewhere and have been proven effective in providing a planning evaluation framework for water demand management programs. The spreadsheet calculations perform a cost-effectiveness evaluation on each BMP using the data on market potential for each conservation measure and the assumptions for each conservation measure variable. The cost-effectiveness evaluation conducted using spreadsheet program projects on an annual basis the number of interventions, water savings, and the dollar values of the benefits and costs that would result from implementing the BMPs. The benefit cost model components consist of the following steps:

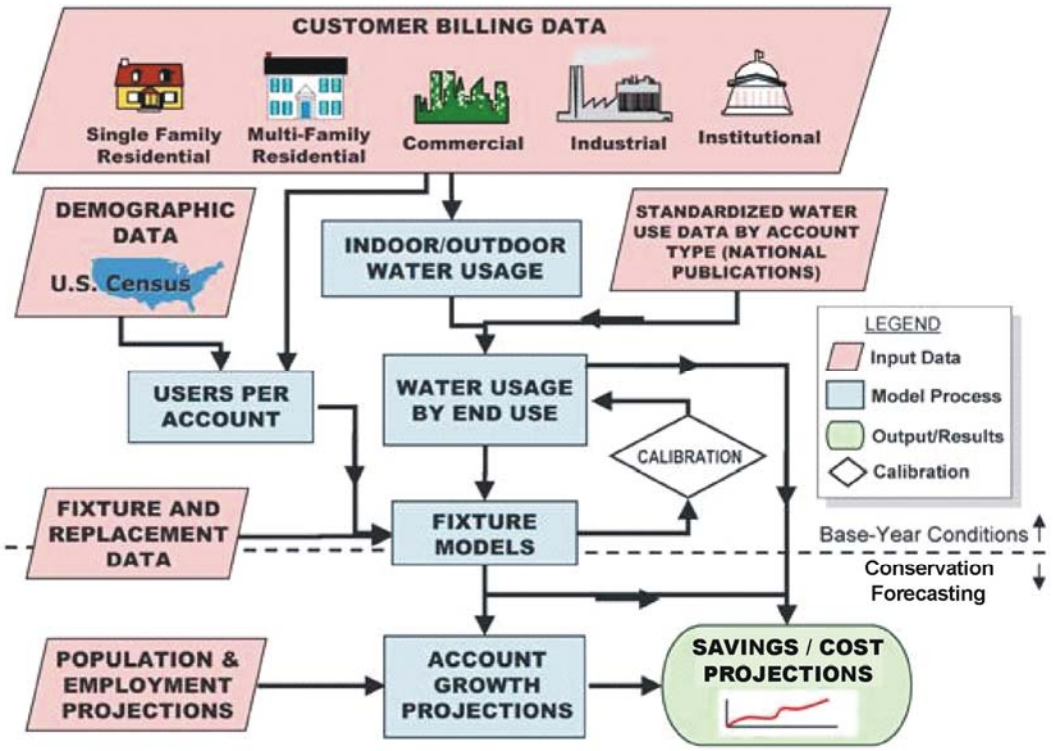
- Establish customer base-year water use conditions by customer-billing category and then by end use.
- Establish service area conditions for evaluation of conservation measures by creating a database of service area data relevant to the conservation measures to be evaluated.
- Use the service area data to perform a benefit and cost evaluation of each BMP.

5.3.5 Model Inputs and Data Analysis

Model inputs from data provided by GWA when it becomes available include the modeling analyses are the inputs associated with the annual and unit costs and water use characteristics. The analyses may be updated in the future if more accurate data becomes available.

The data collected from GWA includes water demand by customer category, number of customers in each customer category, system production, water loss, large landscape data, and BMP program cost data. Several analyses are performed to determine the base year conditions including analyses of service area characteristics, annual account water use, and indoor/outdoor water use. These analyses are described in the following sections. The base year for this analysis would be either 2004 or 2005 depending on data availability for the most recent full year of data.

Figure 5-1 – Benefit to Cost Modeling Process Flow Chart



5.3.6 GWA Customer Characteristics

To evaluate each BMP in GWA's three system service areas, it would be necessary to determine the potential "market" within which the conservation measures could be implemented. The applicable markets for each of the BMPs include factors such as number and types of toilets, number of large landscape areas (parks, schools, golf courses, cemeteries, etc), and number of unmetered accounts. In addition to the data collected, estimates would be made regarding water use for particular categories of use within the purveyor's service area such as the amount of water use per commercial or residential toilet, and the average amount of irrigable land per park, school, commercial site, etc.

An analysis of the service area demographics has already performed. The 2000 US Census data within the service area would be reconciled with year 2004 GWA customer billing data to determine the number of people per single family and multi family dwelling units. People per dwelling unit factors are used to determine the per capita water use. The 2004 base year demographic data was estimated based on the change from 2000 to 2004 in customer billing data. Table 5-4 provides the estimated 2004 population and people per single family and multi family household.

Table 5-4 – Demographic Inputs by GWA

System	2004 Residential population	People per dwelling unit	
		Single family	Multi family
South	To be completed in the Final Report		
Central			
North			
Total			
Average			

Note: 2004 residential population reflects the residential population within each system's service area represented in the residential customer categories (single family and multi-family). The residential population does not include the institutionalized population in the service area or residential population the may be included in other customer categories (i.e. GWA accounts for high density multi family customers in the commercial water use customer category. Population from these customers is not shown in this table.).

5.3.7 Annual Account Water Use

An analysis was performed to determine the water use characteristics of each customer category for each system. Typically, metered water use data is available for the non-residential customer categories and in some cases accurate data is also available for the residential customer categories. The water use characteristics for the metered customers could be developed based on a comparison of the number of customers in each category and the respective water sales. For agencies with unmetered residential customers, estimates are made for the residential unit water use. Table 5-5 contains the customers by customer category, consumption by customer category, and the average water use per account.

Table 5-5 – 2004 Customer and Water Use Characteristics by GWA

Account category	South		Central		North	
	Customers	gpd/account	Customers	gpd/account	Customers	gpd/account
Single Family Metered Unmetered	To be completed in the Final Report					
Multi-Family[1] Metered Unmetered						
Commercial Metered Unmetered						
Industrial						
Municipal						
Irrigation						
Total[2]						

Note: Customers are for each system service areas.

1. Multi-family customers are for complexes. Each multi-family customer contains multiple dwelling units.
2. Total customers may not include all customer categories. For example categories such as "construction" or customers such as industrial for the GWA are not included.

5.3.8 Indoor/Outdoor Water Use

Another analysis that should be performed is the determination of the indoor and outdoor water use for each customer category. When monthly water use data is available by customer category, it is assumed that 90 percent of the lowest month of water use is indoor water use. In systems that are not completely metered, the indoor and outdoor water use percentages are assumed based on typical regional indoor/outdoor percentages or indoor/outdoor percentages for systems with similar customer bases.

5.3.9 Annual Market Penetration/Implementation Requirements

The annual market penetration identifies how many fixtures, rebates, surveys etc the purveyor would have to offer annually to reach the implementation requirement for that BMP. The implementation goals are still to be determined.

5.3.10 Water Conservation Program Costs Inputs

The cost of implementing each BMP would be an input into the analysis. GWA and the consultant team would need to work together to determine GWA's costs to perform each BMP according to their unique water demand reduction strategies. Two cost components are input for each BMP: annual fixed costs and intervention unit costs. The annual fixed costs are annual program costs that do not vary significantly with the number of interventions implemented annually. These include marketing and administrative costs. Intervention unit costs are the costs to perform each intervention. These may include the cost of staffing the implementation of the measures, and the costs of purchasing and maintaining the equipment necessary to the implement the BMP.

The time-value of money is considered in this analysis. The value of all future costs and benefits are discounted to 2004. The benefit-cost calculates the "real" interest rate, by adjusting the current nominal interest rate (assumed to be 6.1 percent) by the rate of inflation (assumed to be 3 percent). Cash flows discounted in this manner are referred to as "Present Value" sums. The higher the discount rate, the lower the present value of future expenditures.

5.4 Recommended Next Steps

This section describes the overall next steps for the design of a water conservation program for GWA based on a BMP analysis. It should be noted that the water savings estimated in a BMP analysis will not occur unless the required activities and interventions are performed. This analysis estimates water savings for BMP activities would be starting in 2007. The BMPs are typically modeled based on the definition of the BMPs per GWA defined goals.

This analysis requires further data collection on the part of GWA and the consultant team. These overall data collection activities will include categorizing the BMPs into purveyor controlled and customer and/or outside agency dependant categories and recognizing the need for data organization and screening for applicability to GWA and its customers. Estimates of the level of effort including program staffing needs and associated costs for each participating agency can also be provided.

5.4.1 Purveyor Controlled and Customer and/or Outside Agency Dependant

The water conservation BMPs can be grouped into two categories:

- *Purveyor controlled BMPs* - BMPs whose level of implementation is directly controlled by the purveyors
- *Customer and/or outside agency dependant BMPs* – BMPs whose level of implementation is dependant upon customer participation or participation of an agency outside of the water agency. The agency must rely on the customer's and/or outside agency's willingness to participate in the BMP.

Table 5-6 provides a list of the BMPs separated into the two control categories. Based on the other utility experience with program implementation since the start of implementation of their water conservation plans, it has been observed that relatively high goals (e.g., greater than 2% of the customer category accounts) for these customer and/or outside agency dependent BMPs can be difficult to achieve. This is because GWA must rely on customers to volunteer their participation in the program. Customers would need to be surveyed or more experience with GWA customers to better understand their willingness to participate in water conservation BMPs.

Table 5-6 – Purveyor Controlled versus Customer and/or Outside Agency Dependant BMPs

BMP	BMP Description
	Purveyor controlled
3	Distribution System Water Audits, Leak Detection, and Repair
4	Non-Residential and Residential Meter Retrofit
7[1]	Public Information
8[2]	School Education
11	Conservation Pricing for Metered Accounts
12	Water Conservation Coordinator
13	Water Waste Prohibition
	Customer and/or outside agency dependant
1	Interior and Exterior Water Audits and Incentive Programs for Single Family Residential, Multi Family Residential, and Institutional Customers
2	Plumbing Retrofit of Existing Residential Accounts
5	Large Landscape Water Audits and Incentives for Commercial, Industrial, Institutional and Multi-Family Developments
9	Commercial and Industrial (CI) Water Conservation
14	High Efficiency Flush Toilet Replacement Program for Non-Residential Customers

Note: BMPs are numbered according to Water Forum numbering system unless noted otherwise.
1. Level of implementation is partly dependant upon participation of other community organizations.
2. Level of implementation is partly dependant upon school district participation.

It is important that the recording and monitoring of all program elements including implementation numbers, costs, and pre and post water consumption, is tracked. In addition, it is useful that conservation staff be able to query a database for customer information within each customer category.

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