Memorandum

To:	Water Supply Advisory Committee and Toby Goddard, Santa Cruz Water Department
From:	Carolyn Wagner, Karen Raucher, and Bob Raucher, Stratus Consulting Inc.
Date:	6/2/2015
Subject:	Clarification of Conservation Program C Recommended

In this memorandum, we provide additional explanatory information about the measures and modeling approach used by Maddaus Water Management (MWM) to estimate the savings and costs associated with Program C Recommended (CRec). The purpose of this memorandum is to provide additional insights into Program CRec, and to provide transparency and clarity with regards to MWM's model, including inputs and assumptions, model specification, derivation of model outputs, and interpretation of outputs.[1]

1. Overview and Background

In 2013 and 2014, the Santa Cruz Water Department (SCWD) focused on the role of demand management by developing the Water Conservation Master Plan (recently recognized as a national model). The planning objective was to select a program that would maximize water savings based on total annual volume of water saved, with a secondary objective of selecting the more cost effective measures. The Water Conservation Plan was developed with the support of analysis conducted by MWM, using its Least Cost Planning Decision Support System Model (DSS Model). The DSS Model evaluates conservation programs based on cost effectiveness. MWM and SCWD developed and evaluated four programs: A, B, C, and D, each comprised of unique sets of conservation measures [e.g., rebates for ultra-high efficiency toilets (UHETs)]. After careful review of each set of measures, the SCWD identified Program C as providing the community with the largest set of benefits given costs. Program C was shared with the community for public comment in March 2014. After incorporating public comments, several measures within Program C were optimized and the program was renamed "Program C Recommended." The city concluded: "C recommended (CRec) was determined to be the best option for a long-range conservation plan for the City at this time" (Maddaus and Maddaus, 2014, p. 2).

1. This memorandum was developed by Stratus Consulting with support and insights provided by MWM and Toby Goddard at SCWD. Stratus Consulting is not an expert on the DSS Model and we do not have direct access to the inner workings of the MWM proprietary DSS Model. Appropriate caveats should be noted. We greatly appreciate the time and effort provided by Toby Goddard, Lisa Maddaus, and Bill Maddaus in giving us relevant information and insights.

The extensive work conducted by the SCWD in developing the Water Conservation Master Plan, where 50 measures were assembled into 4 potential conservation programs, provides a strong foundation of information that can be used by the Water Supply Advisory Committee (WSAC) in understanding the role of demand management in developing a long-term water supply plan; however, the process was extensive and the modeling work complex. This memorandum is designed to provide insight into how the DSS Model operates and why the results are not always intuitively clear.

The DSS Model

The DSS Model is a nationally recognized tool used to identify the cost-effectiveness of conservation programs. The model estimates program-level savings and costs using inputs and assumptions that are based on historical data and adjusted to city-specific parameters. Additional details about the assumptions and inputs are provided in the next section.

An issue with understanding the results of the DSS Model runs for the demand management consolidated alternatives is the relationship between Program A, which the city is already implementing, and Program C, because Program C builds upon Program A the costs and savings are not independent (as they are for other Alts). Stratus Consulting netted out the costs and savings associated with Program A and plumbing codes for our comparison with other consolidated alternatives, and those adjustments are reflected in the information provided for CRec as it is portrayed as a consolidated alternative. The information included in the remainder of this memorandum is inclusive of both Program A and plumbing codes; and thus, it is not possible to compare the information provided directly with other consolidated conservation programs.

1.1 Assumptions and Inputs

General assumptions within the DSS calculations include:

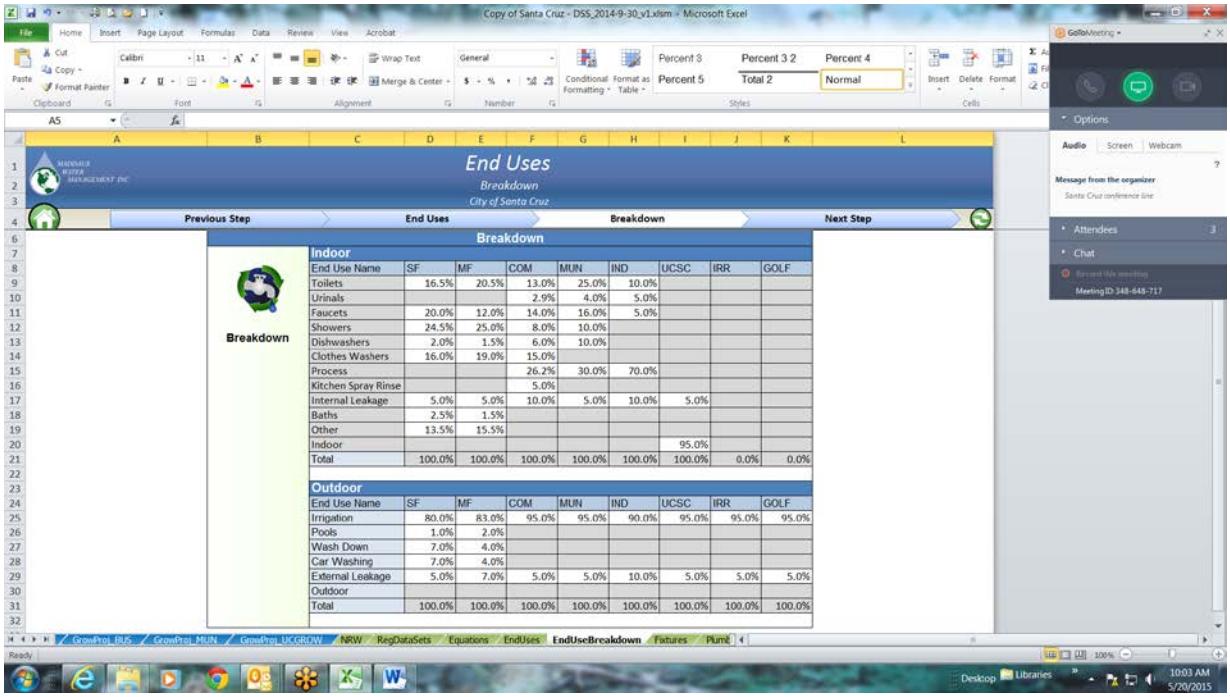
- The timeframe includes years 2014–2040.
- The demand forecast used in the DSS Model was estimated by MWM based on input from SCWD. MWM reran the DSS Model to produce updated savings and cost estimates taking into account the revised interim demand forecast developed by David Mitchell (Mitchell, 2015). Additionally, the model adjusts forecasted demand to account for the impact of future plumbing codes.

- Present value (PV) calculations include:
  - Costs are discounted at 2.25%
  - Savings are not discounted
  - PV costs per unit of water saved [PV$/million gallons (mg)] are calculated using utility cost only (does not include costs to customers).
- Water savings calculations are based on end-use water allocation assumptions (see the example calculation below). These data are based on national averages that, where possible, are scaled to be more accurate to Santa Cruz. For example, Figure 1 provides a screenshot of the end-use breakdowns that are included as inputs to the DSS Model.
- The model calculates savings using percentages. As such, as plumbing codes and other measures reduce "baseline" water usage (i.e., the amount of water to which the percent savings is applied), the amount of estimated savings also decreases. The model is intended to evaluate the programs rather than the individual measures, and thus use of the individual measure-level savings output is cautioned.
- Administrative costs are estimated as a percentage of the cost of each measure, and are included in the cost outputs. (Note that for our assessment of CRec as a consolidated alternative, we have separated out administrative costs from each measure, and instead consider administrative costs at the program-wide level).

In addition to these general assumptions, each measure has specific assumptions and inputs (for example, see Section 2 for inputs specific to the UHETs measure). One particularly uncertain and driving assumption is the percent of accounts targeted. We present this assumption for each measure in Table 1. While these inputs are uncertain, they are based on best professional judgment informed over years of conservation work by MWM and SCWD.

Table 1 presents the measures included in Programs A and CRec, a description of Program A and CRec, the types and percent of accounts targeted, and the outputs (e.g., water savings and PV cost per water saved).

Figures 2 and 3 provide the water savings and cost per unit of savings for each measure, respectively, as derived from the DSS Model runs for Santa Cruz.



End Uses
Breakdown
City of Santa Cruz

Previous Step | End Uses | Breakdown | Next Step

Breakdown

Indoor

End Use Name	SF	MF	COM	MUN	IND	UCSC	IRR	GOLF
Toilets	16.5%	20.5%	13.0%	25.0%	10.0%			
Urinals			2.9%	4.0%	5.0%			
Faucets	20.0%	12.0%	14.0%	16.0%	5.0%			
Showers	24.5%	25.0%	8.0%	10.0%				
Dishwashers	2.0%	1.5%	6.0%	10.0%				
Clothes Washers	16.0%	19.0%	15.0%					
Process			26.2%	30.0%	70.0%			
Kitchen Spray Rinse			5.0%					
Internal Leakage	5.0%	5.0%	10.0%	5.0%	10.0%	5.0%		
Baths	2.5%	1.5%						
Other	13.5%	15.5%						
Indoor						95.0%		
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	0.0%	0.0%

Outdoor

End Use Name	SF	MF	COM	MUN	IND	UCSC	IRR	GOLF
Irrigation	80.0%	83.0%	95.0%	95.0%	90.0%	95.0%	95.0%	95.0%
Pools	1.0%	2.0%						
Wash Down	7.0%	4.0%						
Car Washing	7.0%	4.0%						
External Leakage	5.0%	7.0%	5.0%	5.0%	10.0%	5.0%	5.0%	5.0%
Outdoor								
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Figure 1. Least-cost planning DSS Model screenshot of the end-use breakdowns.

Source: Toby Goddard, Administrative Services Manager, SCWD, personal communication, May 20, 2015.

2. Detailed Example of DSS Calculation

In this section, we present an example calculation of the saving and costs associated with the measure, "Res UHET Rebates," which provides a rebate or voucher for the installation of an UHET to residential (SF and MF) customers. This example calculation was developed by Toby Goddard at the SCWD (Toby Goddard, Administrative Services Manager, SCWD, personal communication, May 20, 2015), based on his access to a version of the DSS Model.

Table 2 presents the water savings calculation for 2014, and compares the calculated savings to the reported savings in the measure output screenshot. While the final calculated water savings are close (about 3% difference), they are not an exact match. We believe this small difference is due to plumbing code changes that reduce toilet end-use water consumption between 2010 and 2014, which are netted out in the DSS Model before the active program savings are calculated (Toby Goddard, Administrative Services Manager, SCWD, personal communication, May 20, 2015).

Table 1. Description of Program A and CRec measures (per DDS Model)

Name of measure	Included in revised Program CRec and Program A	Description of measure	Type of accounts targeted	Accounts targeted (%)	Average water savings (mgd)	Cost per unit volume ($/mg)
Reduce Water Loss	Optimized in CRec	Seek to maintain low nonrevenue water rates through controlling both apparent and real water losses.	All	N/A	0.10759	$1,803
Advanced Metering Infrastructure (AMI)	CRec only	Install or retrofit system with AMI meters and associated network capable of providing continuous consumption data to utility offices.	SF MF COM	3.00%	0.00764	$4,967
Water Rates	Optimized in CRec	Develop individualized monthly water budgets for all or a selected category of customers.	IRR	36.00%	0.016291	$178
General Public Information	Both programs	Comprehensive education and public awareness campaign that would evolve over the years and seek to drive participation in other conservation programs.	SF	50.00%	0.015917	$6,268
Public Information (Home Water Use Report)	CRec only	Detailed water billing reports for customers with neighborhood use comparisons and suggestions on customer-specific conservation actions.	SF	20.00%	0.02454	$1,795
Residential Leak Assistance	CRec only	May require that customer leaks be repaired, but either subsidize part of the repair and/or pay the cost with revolving funds that are paid back with water bills over time.	SF MF	0.50%	0.058182	$1,080
Residential SF Survey	Both programs	Outdoor water surveys for existing SF residential customers. Target those with high water use and provide a customized report to owner. May include giveaway of efficient shower heads, aerators, or toilet devices.	SF	1.50%	0.005116	$12,615
Plumbing Fixture Giveaway	Optimized in CRec; non-optimized in Program A	Utility would buy showerheads and faucet aerators in bulk and give them away at utility offices and/or community events.	SF	2.50%	0.052487	$182

Table 1. Description of Program A and CRec measures (per DDS Model) (cont.)

Name of measure	Included in revised Program CRec and Program A	Description of measure	Type of accounts targeted	Accounts targeted (%)	Average water savings (mgd)	Cost per unit volume ($/mg)
Residential High Efficiency Toilet (HET) Rebates	Program A only	Provide a rebate or voucher for the installation of a HET.	SF MF	1.75%	0.022056	$2,079
Residential UHET Rebates	CRec only	Provide a rebate or voucher for the installation of an UHET.	SF MF	1.20%	0.036127	$4,294
High Efficiency Clothes Washer (HECW), Rebates A	Program A only	Provide a rebate for HECW to SF homes and in-unit condo/apartment complexes that do *not* have common laundry rooms.	SF MF	2.25%	0.064606	$993
HECW, Rebates B	Optimized in CRec	Provide a rebate for HECW to SF homes and in-unit condo/apartment complexes that do *not* have common laundry rooms.	SF MF	3.75%	0.096686	$2,097
HECW, New Development	Optimized in CRec	Require developers to install an HECW that meets certain water-efficiency standards.	SF MF COM	100.00%	0.026061	$812
Hot Water On Demand, New Development	CRec only	Work with developers and permitted remodels to equip new homes or buildings with efficient hot water on demand systems.	SF MF COM	100.00%	0.010568	$2,407
Toilet Retrofit Time of Sale (TOS)	Both programs	Work with the real estate industry to require a certificate of compliance that verifies a plumber has inspected the property and efficient fixtures were either already there or were installed at the TOS.	SF MF COM	0.85%	0.021117	$1,070
CII MF Common HECW	Optimized in CRec	Provide a $400 rebate for the installation of a high-efficiency commercial washer (HEW) in CII and MF common area laundry.	MF COM	35.00%	0.006112	$3,128

Table 1. Description of Program A and CRec measures (per DDS Model) (cont.)

Name of measure	Included in revised Program CRec and Program A	Description of measure	Type of accounts targeted	Accounts targeted (%)	Average water savings (mgd)	Cost per unit volume ($/mg)
CII Incentives	Both programs	After the free water-use survey has been completed at site, the utility will analyze the recommendations on the findings report that is provided and determine if the site qualifies for a financial incentive.	MF COM	0.50%	0.036742	$305
Pre-Rinse Noz Giveaway	CRec only	Provide free spray nozzles and possibly free installation for the rinse and clean operation in restaurants and other commercial kitchens.	COM	5.71%	0.025215	$241
CII Surveys	Both programs	Offer top water customers from each category a professional water survey to evaluate ways for the business to save water and money.	MF COM	0.50%	0.037584	$2,389
High Efficiency Urinals (HEU) Program	Optimized in CRec; non optimized in Program A	Provide a rebate or voucher for the installation of a HEU.	COM MUN IND	5.00%	0.004734	$5,792
Public Restroom Faucet Retrofit COM	MUN and COM in CRec; “Regular” in neither	Consider direct install program, rebates, or grants for the installation of high-efficiency sensor faucet fixtures in all or selected high-use commercial or institutional buildings.	COM MUN IND	2.50%	0.031747	$3,902
Public Restroom Faucet Retrofit MUN	MUN and COM in CREC; “Regular” in neither	Consider direct install program, rebates, or grants for the installation of high-efficiency sensor faucet fixtures in all or selected high-use commercial or institutional buildings.	COM MUN IND	2.50%	0.031747	$3,902
School Retrofit	CRec only	School retrofit program where school receives grant to replace fixtures and upgrade IRR systems.	MUN	1.00%	0.008923	$581

Table 1. Description of Program A and CRec measures (per DDS Model) (cont.)

Name of measure	Included in revised Program CRec and Program A	Description of measure	Type of accounts targeted	Accounts targeted (%)	Average water savings (mgd)	Cost per unit volume ($/mg)
Landscape Ordinance	Both programs	Include less IRR demand for new accounts due to more efficient landscape designs due to City Code.	MF COM MUN IND	100.00%	0.013626	$382
Residential SF Turf Removal A	Optimized in CRec; non-optimized in Program A	Provide a per square foot incentive to remove turf and replace with low water-use plants or permeable hardscape.	SF	0.20%	0.00279	$17,920
Residential MF CII Turf Removal A	Optimized in CRec; non-optimized in Program A	Provide a per square foot incentive to remove turf and replace with low water-use plants or hardscape.	MF COM	0.10%	0.001019	$24,534
Expand IRR Survey Water Budgets	CRec only	Outdoor water audits offered for existing large landscape customers.	IRR	2.20%	0.003293	$11,157
Sprinkler Nozzle Rebates	CRec only	Provide rebates to replace standard spray sprinkler nozzles with rotating nozzles that have lower application rates.	SF MF COM	0.50%	0.005583	$3,051
Gray Water Retrofit	CRec only	Provide a workshop to support a gray water challenge. Offer rebate to assist covering certain percentage of the cost to SF homeowners per year to install gray water systems.	SF	0.10%	0.000831	$8,206
Support Residential Rain Barrel	Both programs	Provide incentive for installation of rain barrels.	SF	2.00%	0.007404	$2,857

COM: commercial; CII: commercial, industrial, and institutional; IND: industrial; IRR: irrigation; MF: multi-family; mgd: millions of gallons per day; MUN: municipal; SF: single-family.

Source: MWM, Undated.

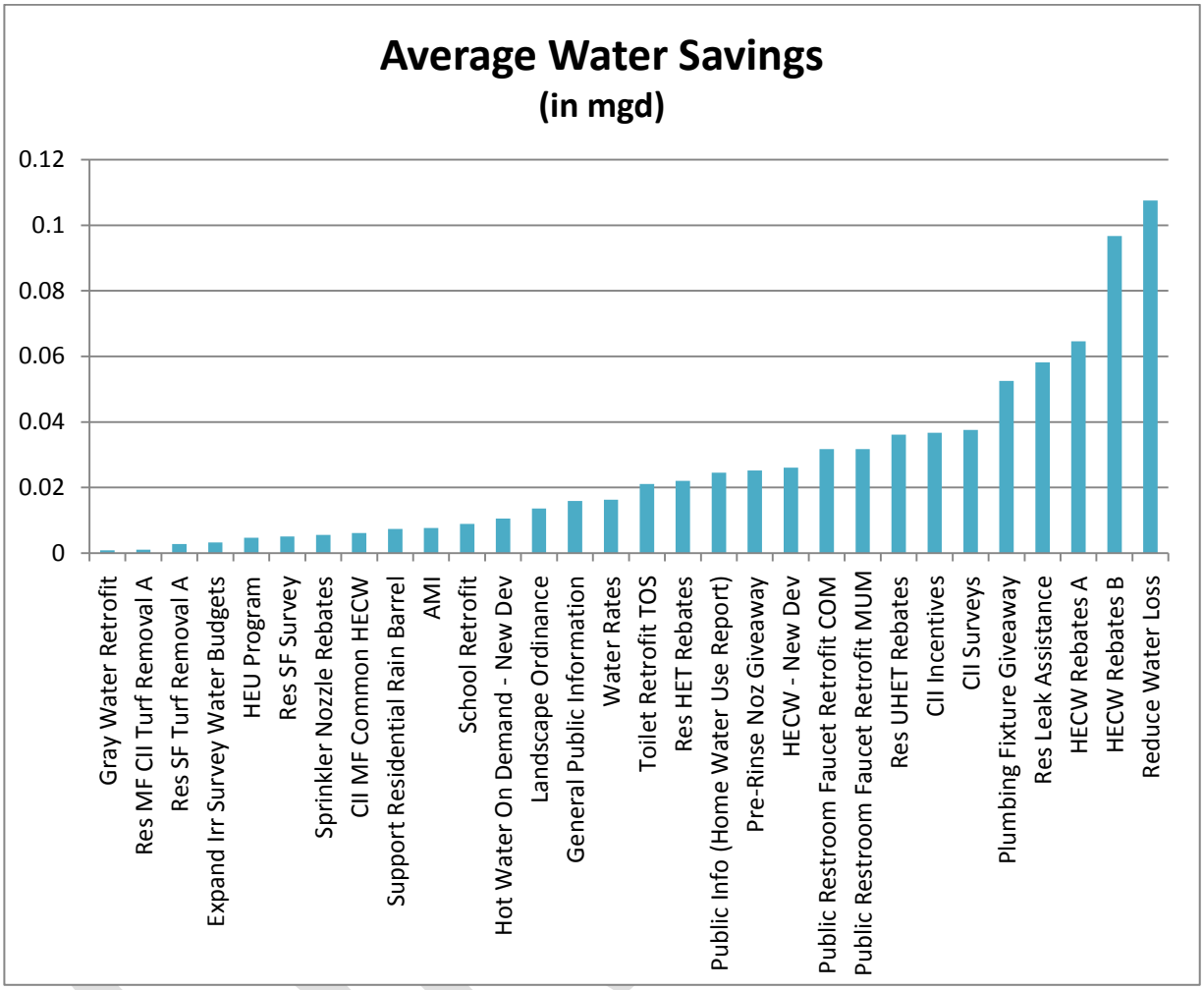


Figure 2. Average water savings for each CRec measure.

Source: MWM, Undated.

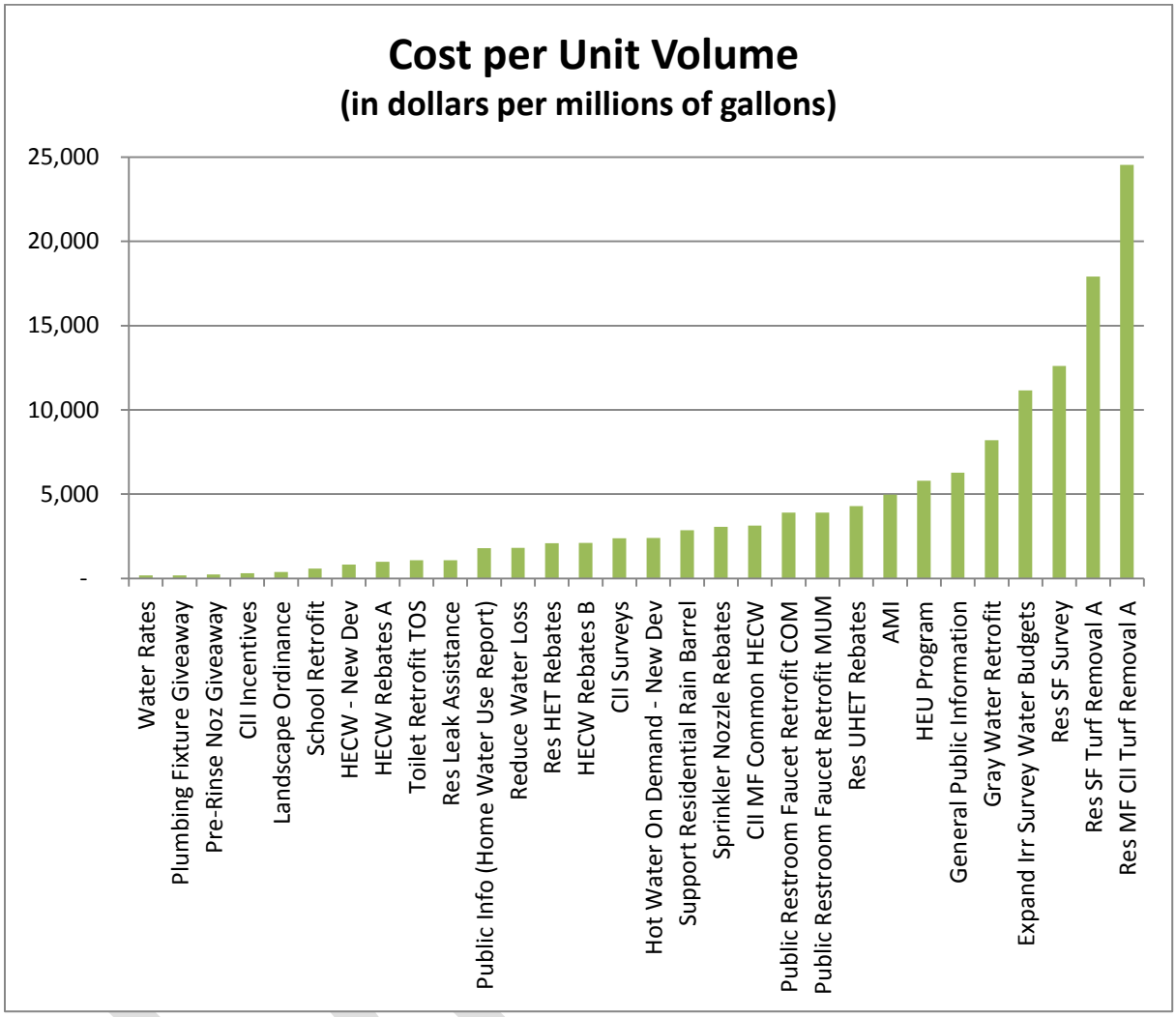


Figure 3. Cost per unit volume for each CRec measure.

Source: MWM, Undated.

Table 2. Example calculation for water savings in 2014 residential UHET measure

Step	Step description	Input	SF	MF
Step 1	**Determine number of targeted accounts**			
1.1	Use number of accounts in 2010	2010 accounts[a]	18,862	2,726
1.2	Scale up number of accounts in 2010 by population to starting year, 2014	2014 population[b]	49,209	35,536
		2010 population[b]	48,493	34,378
		SF account scalar	1.014765018	1.033684333
		2014 accounts	**19,140.50**	**2,817.82**
1.3	Apply % of accounts targeted/year to determine number of targeted accounts in starting year	% accounts targeted	1.2%	1.2%
		Accounts targeted, 2014	**230**	**34**
Step 2	**Determine targeted end use in gallons/account/day**			
2.1	Find average account use in gallons per account per day	Gallons/account/day[a]	199.49	742.42
2.2	Multiple by percent of indoor use	% indoor use	76.7%	88.4%
		Gallons/account/day used indoors	**153.01**	**656.30**
2.3	Multiple indoor use by percent of end use, i.e., toilets, to get the gallons per account per day	% indoor use toilets	16.5%	20.5%
		Gallons/account/day used for toilets	**25.25**	**134.54**
Step 3	**Apply estimated savings to targeted accounts and target end use**			
		Accounts targeted, 2014	230	34
3.1	Multiply targeted accounts from 1.3 by end use	Gallons/account/day	25.25	134.54
		Gallons/day for toilet use, accounts targeted	5,798.8	4,549.4
3.2	Multiply by the percent saving per account	% savings[a]	37.5%	37.5%
		Savings, gallons/day	2,174.53	1,706.01

Table 2. Example calculation for water savings in 2014 residential UHET measure (cont.)

Step	Step description	Input	SF	MF
3.3	Divide by 1,000,000 to determine savings in mgd	Million factor	1,000,000	1,000,000
		2014 savings, mgd	**0.002174534**	**0.001706012**
		Total 2014 savings (SF + MF), calculated here (mgd)	**0.00388**	
		Total 2014 savings, reported from DSS Model (mgd)[c]	0.00376 (97% of above)	

a. Toby Goddard, Administrative Services Manager, SCWD, personal communication, May 20, 2015.
b. MWM, Undated.
c. Difference is due to plumbing code changes reducing toilet end use between 2010 and 2014, which is subtracted in the model before the active program savings.

Table 3 presents the cost calculation for 2014, and compares our calculated savings to the DSS Model-reported savings in the measure output screenshot. The resulting cost estimates are virtually identical (within $3, or 0.001%); they are not an exact match, probably due to rounding (Toby Goddard, Administrative Services Manager, SCWD, personal communication, May 20, 2015).

Table 3. Example calculation for water costs in 2014: Residential UHET measure

Step	Step description	Input	SF	MF	Total (SF + MF)
Step 4	**Determine customer and utility costs per account**				
4.1	Utility costs = utility costs per fixture multiplied by the number of fixtures and the markup percentage for administration	Fixture costs/account[a]	$445.50	$810.00	
4.2	Customer costs = customer cost per fixture multiplied by the number of fixtures	Fixture costs/account[a]	$330.00	$600.00	
Step 5	**Multiply costs per account by target end number of accounts for:**				
5.1	Utility	Accounts targeted, 2014	$102,325.10	$27,389.24	**$129,714.35**
5.2	Customer	Accounts targeted, 2014	$75,796.37	$20,288.33	**$96,084.70**
5.3	Total (UHET total costs for 2014) calculated here				**$225,799.05**
	Total costs reported				**$225,802**

a. MWM, Undated.

3. Conclusions

As our example demonstrates that while the DSS Model has some "black box" characteristics in its current form, initial-year savings and cost calculations are reproducible once one has the right input values and understands the steps in the calculation process. Results for future years are more difficult to reproduce due to the fact that water savings are calculated as percent decreases, and the initial (baseline) amount of water to which the present savings are applied is reduced over time due to the impact of plumbing codes and other measures. Additionally, during our review of CRec, we realized that many of the questions concerning water savings and their associated costs stem from the lack of information on the inputs. It is our hope that this memorandum provides some level of clarity on how these inputs are used, and offers a level of transparency in how the model derives its results. We recognize that the inputs themselves may be of interest and encourage readers to contact us with additional questions.

References

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