This presentation premiered at WaterSmart Innovations

watersmartinnovations.com



Yes, Virginia: Demand-controlled pumps* do make a difference

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Chair, Technical Advisory Committee The Cochise Water Project www.thecochisewaterproject.com "below average is smart" Managing Partner Real*i*ty LLC <u>www.reality-llc.com</u> *"good plumbing design keeps on giving"*

*DCP = demand-controlled pump which satisfies EPA/WaterSense Version 1.2 new home inspection pump definition.

An achievable goal



Energy

Study basics

Do DCPs make sense?

- How much wasted hot water?
 "Water down the drain while waiting for hot water"
- Homeowners collected
 Real wasted water <u>and</u> time data
- 4 daily hot water demands assumed

The data

Collection

- 38 individual homes
- Kitchen sink and master bath fixture
- Behavioral and real; not from data loggers

Evaluation

- 3 demands at kitchen sink; 1 demand in master bath
- Median and average deviation
- The home only
- Cradle-to-grave including "invisible water and energy"

Study outputs

- The "long bullet" effect
- Savings with DCP
- Thirsty, State; USA
- Cradle-to-grave
 - Impact of water-energy nexus

Plumbing systems encountered



Plumbing systems encountered (continued)



Take-a-Away #1

Variability lives

Long Bullet	Volume Out of Pipe Before Hot: 1.1-1.5 to 1		
Hot	Cold		
Flow Rate: 1-3 GPM	Distance: 5-10 Feet		

Λ

- "Long bullet" effect
- What percentage of water is wasted while going from warm to hot as compared to cold to hot?
- % = (warm to hot ÷ cold to hot)*100

Schematic source: Potential Best Management Practices Year 3 Report; Koeller & Company; January 2007. Chapter 7, Residential Hot Water Distribution; Figure 2. Delivery Phase Schematics (not to scale). (Chapter 7 prepared by Gary Klein, Affiliated International Management.)





Kitchen sinks only Sample = 38

^ Schematic source: Potential Best Management Practices Year 3 Report; Koeller & Company; January 2007. Chapter 7, Residential Hot Water Distribution; Figure 2. Delivery Phase Schematics (not to scale). (Chapter 7 prepared by Gary Klein, Affiliated International Management.)





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Time from ambient to hot; seconds

Schematic source: Potential Best Management Practices Year 3 Report; Koeller & Company; January 2007.
Chapter 7, Residential Hot Water Distribution; Figure 2. Delivery Phase Schematics (not to scale). (Chapter 7 prepared by Gary Klein, Affiliated International Management.)
** Avedev = 1 average deviation of the sample.

Cold to warm to hot flow without DCP

Long Bullet	Volume Out of Pipe Before Hot: 1.1-1.5 to 1
Hot	Cold
Flow Rate: 1-3 GPM	Distance: 5-10 Feet

Cold to warm to hot flow with DCP

Plug Flow	Volume Out of Pipe Before Hot: 1.01-1.1 to 1
Hot	Cold
Flow Rate: More than 5 GPM	Distance: Less than 1 Foot

With DCP, long bullet virtually disappears!

^ Schematic source: Potential Best Management Practices Year 3 Report; Koeller & Company; January 2007. Chapter 7, Residential Hot Water Distribution; Figure 2. Delivery Phase Schematics (not to scale). (Chapter 7 prepared by Gary Klein, Affiliated International Management.)

Take-a-Away #2

A pump trumps a 1/3

Per demand, average wasted water and time waiting for hot water without DCP; cups, seconds



Per demand, average wasted water and time waiting for hot water with DCP; cups, seconds



Percent reduction with DCP

(wasted water and time while waiting for hot water)



The Median Homes

In-home only; with and without DCP; annualized waste



The Median Homes

In-home only; with and without DCP; annualized waste



Take-a-Away #3

A pump is convenience + + +



The 4 Median Homes

(Annual waste and costs; cradle-to-grave)

w/o DCP

Water heater

EL

NG

EL NG

w/DCP

The 4 Median Homes

(Annual waste and costs; cradle-to-grave)

	w/o DCP		<u>w/ D</u>	DCP	
Water heater	EL	NG	EL	NG	
<u>Waste</u>					
Water; gals	2433	2433	379	379	
Energy; kWh, the	erm 5 482	24.0	75	3.7	
<u>Cost;</u> \$	2~~~				
Water	17.03	17.03	2.65	2.65	
Energy	48.16	24.04	7.50	3.57	
"Invisible"	M				
Water; gals	\$ 990 \$	34	155	5	
Energy; kWh	13	13	2	2	

4 Median Homes Cradle-to-grave

Annual wasted water, energy, & money*

	Without DCP	With DCP	<u>Savings</u>
EL: water; gals	3,423	534	2,889
water & energy; \$	48.16	7.50	40.66
NG: water; gals	2,467	534	1,933
water & energy; \$	24.04	3.74	20.30

* assumes 4 daily demands only

Thirsty – 1,000 median homes Cradle-to-grave

Annual wasted water, energy, & money*

	Without DCP	With DCP	<u>Savings</u>
ing Contractor			
EL: water; gals	3,423,000	534,000	2,889,000
water & energy; \$	48,160	7,500	40,660
NG: water; gals	2,467,000	534,000	1,933,000
water & energy; \$	24,040	3,740	20,300

* assumes 4 daily demands only

Thirsty: the median homes x 1000

(cradle-to-grave annual wasted water and costs)



Annual cost of wasted water and energy; K \$

Thirsty: the median homes x 1000

(cradle-to-grave annual wasted water and costs)



Annual cost of wasted water and energy; K \$

Take-a-Away #4

Collaborate & cooperate

- Water agencies
- Energy providers
- Municipalities

Summary

- Data collection:
 - Design smart
 - Homeowner: important, appreciate, inform
 - Carrots and sticks
- Installed DCP is key!
 - Virtually eliminates long bullet
 - Hot water loss trimmed by a factor of 6!
 - Huge impact on water-energy nexus, cradle to grave
- Variability of outcomes
 - Fact of life

Thanks for attending!

• Questions?

Backup: assumptions and calculations

- Some presentation slides repeated here for ease of understanding
- Assumptions regarding water, electricity, natural gas, et al; most are easily scalable
- Calculations to back up presentation materials

Thirsty, State; USA

Cradle-to-grave: wasted water, energy and money

- <u>xxxx</u> median homes
- Water, energy, infrastructure:
 - Water & sewer rate: \$7/K gals
 - Electricity = \$0.10/kWh
 - Natural gas = \$1.00/therm
 - All water heaters are high efficiency
 - Average year-round ground temperature = 53°F
 - 4 daily hot water demands; 3 kitchen & 1 master bath
 - Electricity: 2 gallons of consumptive water per 1 kWh produced
 - 5 kWh for 1K gals water moved from watershed to sewage treatment
- Adjust the rates for your community

The 4 Median Homes

(Annual waste and costs; within the homes)

	w/o DCP		w/ DCP	
Water heater	EL	NG	EL	NG
<u>Waste</u>			NA	
Water; gals	2433	> 2433	379	379
Energy; kWh, therm	482	> 24.0	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	3.7
Cost; \$	- VV -			
Water	17.03	17.03	2.65	2.65
Energy	48.16	24.04	7.50	3.74

EL = electric water heater; NG = natural gas water heater

The 4 Median Homes

(Annual waste and costs; cradle-to-grave)

w/o DC		DCP	<u>w/</u>	DCP
Water heater	EL	NG	EL	NG
Waste				
Water; gals	2433	2433	379	379
Energy; kWh, the	rm 482	24.0	275 2	3.7
Cost; \$	your		Zur	
Water	17.03	17.03	2.65	2.65
Energy	48 16	24.04	7.50	3.74
" <u>Invisible</u> " 🛩				

The kWh required <u>and</u> its associated <u>consumptive water</u> needed when producing electricity for the <u>wasted hot water in the home</u> from the watershed to and through the home and finally to sewage disposal treatment.

"Invisible water and energy"

(the calculations)

1 kWh produced consumes 2 gallons of water

1 therm of natural gas consumes 1.3 gallons

1 acre-foot (AF) ≈ 326,000 gallons

1 AF of water drawn from watershed has a \$30 energy cost.

1 AF of water treated effluent has a \$140 energy cost.

The Median Home annual wasted water, gals 2,433 To DCP; 379 w/ DCP

Invisible kWh and water required for pumping and treating the wasted water:

w/o DCP: (2433/326K)*(\$170/\$/kWh) = 13 kWh = 26 gals

w/DCP: (379/326K)*(\$170/\$/kWh) = 2 kWh = 4 gals

Invisible kWh and water required to originally heat the water wasted:

w/o DCP: EL = 482 kWh = 964 gals; NG = 24.0 therms = 31 gals

w/ DCP: EL = 75 kWh = 150 gals; NG = 3.7 therms = 5 gals

Total invisible kWh and water associated with the annual wasted water: w/o DCP: EL = 26 + 964 990 gals, 13 kWh; NG = 26 + 31 = 57 gals, 13 kWh w/ DCP: EL = 5 + 150 = 155 gals, 2 kWh; NG = 4 + 5 = 9 gals, 2 kWh

The 4 Median Homes

(Annual waste and costs; cradle-to-grave)

	w/o DCP		w/ DC	<u>P</u>
Water heater	EL	NG	EL	NG
Waste				
Water; gals	2433	2433	379	379
Energy; kWh, ther	m 482	24.0	\$ 75 \$	3.7
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Water	17.03	17.03	2.65	2.65
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"Invisible"	M		M	
Water; gals	5990 5	34	\$155 }	5
Energy; kWh	13	13	5~2~	2

4 Median Homes Cradle-to-grave

Annual wasted water, energy, & money*

		Without DCP	With DCP	<u>Savings</u>
EL:	water; gals	3,423	534	2,894
	water & energy; \$	48.16	7.50	40.66
NG	: water; gals	2,467	534	1,933
	water & energy; \$	24.04	3.74	20.30

* assumes 4 daily demands only; 3 kitchen & 1 master bath