Submitted to
Water Efficiency & Conservation Network Workshop

Improving water demand management through end-use modelling

April 2016

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BUILDING A BETTER WORLD

Christine McCormack

Does bottling Canterbury water make economic sense?

ERIC CRAMPTON
Last updated 11:06, April 7 2016

Charging for water 'may be best option'

LOIS CAIRNS
Last updated 07:40, February 4 2015

Water meters are in place. Why
them?

In Christchurch, 6.2 cents in eve

Hanmer Springs runs out of water

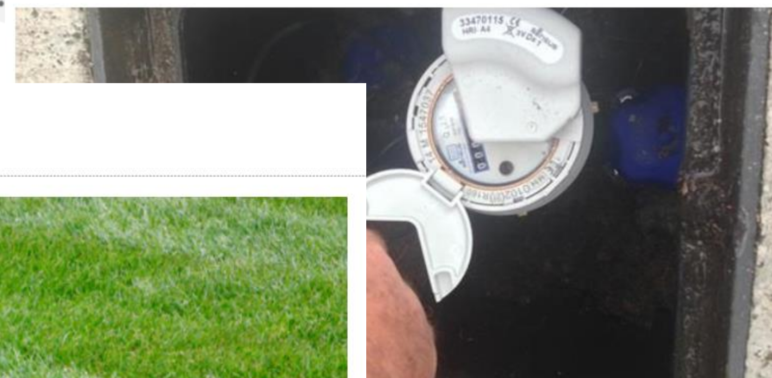
CHARLIE MITCHELL
Last updated 11:59, December 30 2015

Council can save $282m in water costs - report

By Sacha Harwood

12:44 PM Monday May 18, 2015

Add a comment



art of any water network shake up.

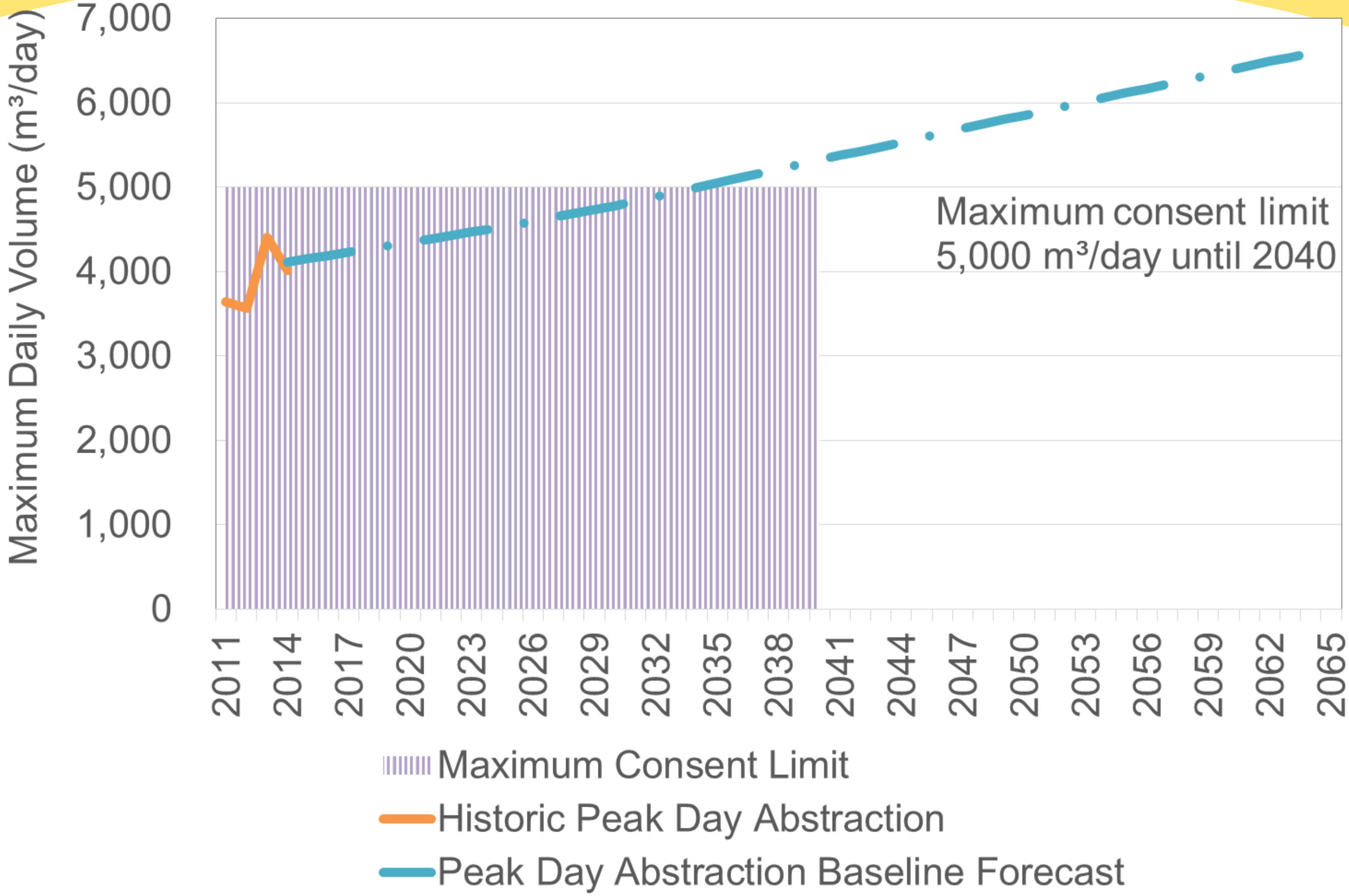
Water restrictions for Waikato

Thursday, 07 January 2016

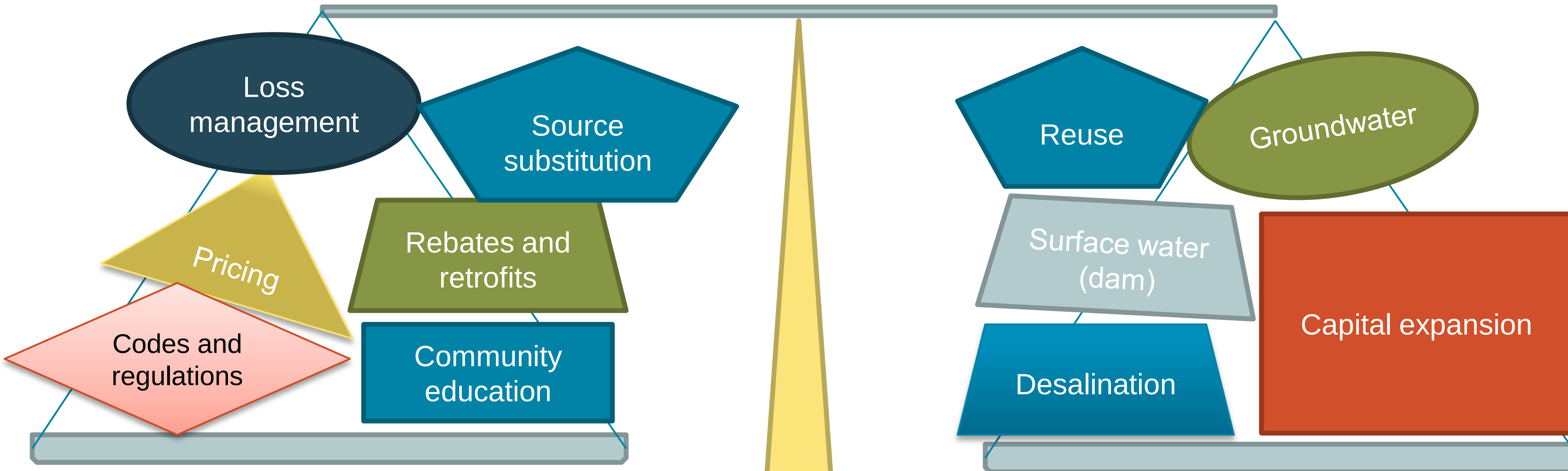
Overview

- The balancing act of supply and demand
- New Zealand guidance
- Types of water demand forecasts
- What is end-use modelling?
- Benefits of end-use modelling
- Types of data required
- Example outputs from end-use modelling
- Conclusions

Will there be enough water?



What are the urban water options?



Demand Side

- ↓ Energy use
- ↓ Infrastructure footprint
- ↓ Flow diversion
- ↑ Water quality

Supply Side

- ↑ Energy use
- ↑ Infrastructure footprint
- ↑ Flow diversion
- ↓ Water quality

New Zealand guidance - OAG

Office of the Auditor General 2010 report: "Planning to meet the forecast demand for drinking water" (follow up OAG reports for Watercare)

1. Use accurate and up-to-date information.
2. Verify the reliability of forecasts.
3. Improve the efficiency of drinking water supplies.
4. Participate in an independent benchmarking programme.
5. Prepare comprehensive demand management plans.
6. Carry out rigorous evaluations of the costs and benefits of options.
7. Define targets for performance measures and demonstrate progress.
8. Integrate sustainable development strategies into demand management plans.

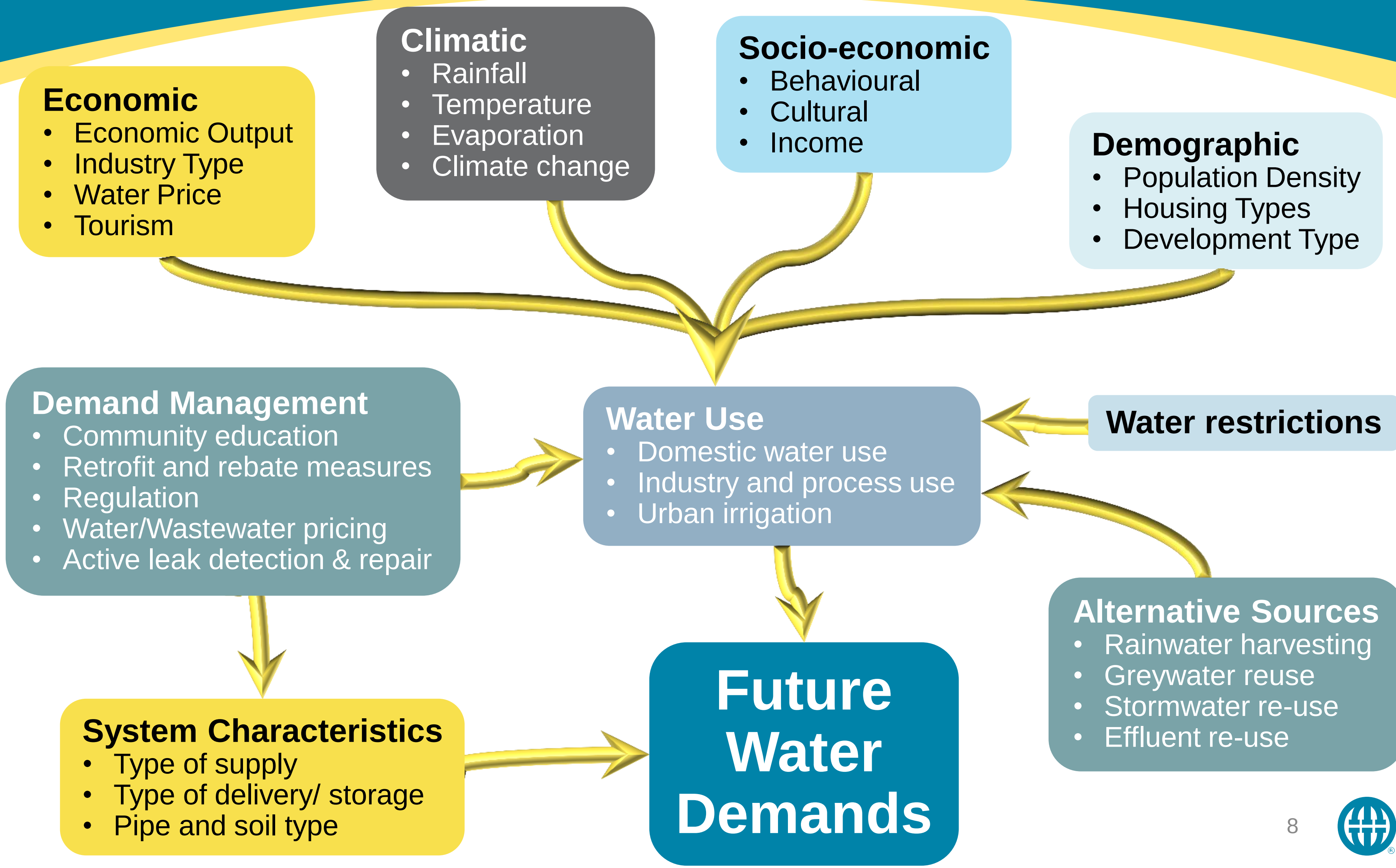
New Zealand guidance - OAG

The OAG report also outlined their expectations for effective demand forecasting methodologies :

- Use relevant information and show an understanding of the main factors that influence demand.
- State assumptions about factors that might affect future water demand.
- Identify and document risks associated with the forecasts.
- Appropriate to the size of the community being supplied.

- A key finding : demand forecasts are considered more reliable when prepared for separate classifications of use and sectors.

What are the Demand Drivers?



Types of water demand forecasts

Three primary methods

1. Total demand in litres per capita per day
2. Sector-based demands
3. End-use demands

What is end-use modelling?

- "Bottom-up" forecasting approach
- Water demands are forecast on the basis of the type of end use in each **customer sector**
  - Example **Residential**: toilets, showers, baths, taps, dishwashers, washing machines, leakage, irrigation, etc
- Depends on having reliable estimates of water consumed by typical customers and "end use" monitoring studies
- Each end-use is translated into aggregate demand by multiplying an individual end-use demand by frequency of usage, projected demographic growth and functions that reflect changes in the efficiency of the technology and mix of stock over time.

Benefits of end-use modelling approach

- Evaluation of benefits and costs from three perspectives: utility, customers and community (utility plus customers)
- Allows evaluation of single measures or programmes of measures
- Prevents double-up of calculated savings that may occur with a simpler cost benefit model (e.g. sector only)
- Takes into account market penetration over time for efficient fixtures and appliances
- Can also assess impact on average wastewater flows and wastewater avoided costs

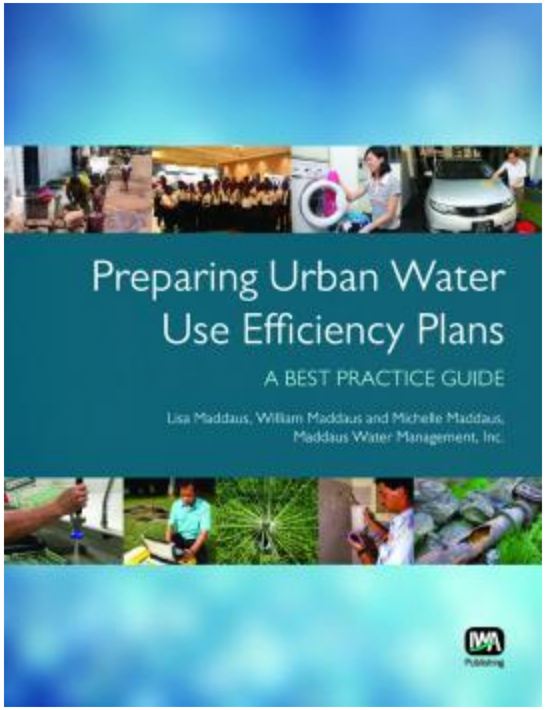
History of the DSS end-use tool

Demand Side Management **Decision Support System tool:**

- First Fixture/Stock Models – Bangkok 1995
- First Formal DSS Model – Christchurch 1996
- QLD DNR – first version of current model – 1999
- New South Wales, Australia (now Office of Water) preferred end use modelling tool since 2002
- Officially endorsed by California Urban Water Conservation Council (CUWCC) – January 2005
- Simplified version developed for New South Wales demand management studies 2006

Where has end-use modelling been used?

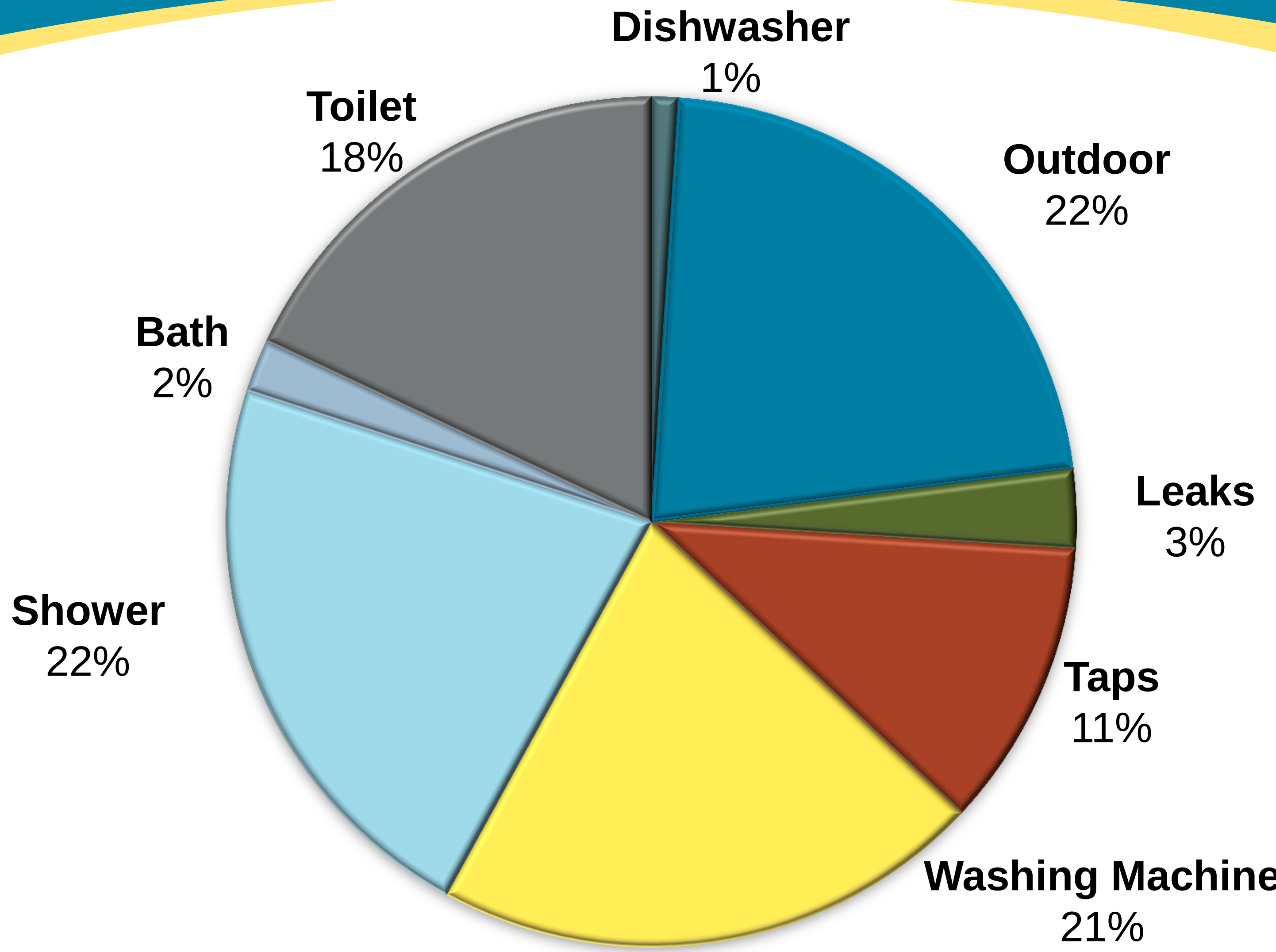
- New South Wales, Australia e.g. Centroc Region
- Queensland, Australia
- Christchurch, New Zealand
- Canada, e.g. Region of Waterloo
- Throughout the United States



What types of data do you need?

- By customer sector: end-use % assumptions (including % indoor versus outdoor)
- Assumptions for efficient fixtures and appliances – stock models
- Avoided costs including operating
- Usual forecasting information; forecasts for accounts by customer sector and household occupancy (population), current water loss %, average and peak day, volume used and accounts for each sector…

Relies on end-use assumptions



Available end-use information

- BRANZ Auckland study 2008 on residential use, the Auckland Water Use Study
- BRANZ non-residential water use studies since 2007
- Lee’s proposed Residential Water Use Project
- Yarra Valley, Australia (comparable for indoor water use)
- Others?

End Use Modelling - DSM DSS

Baseline Forecasts

- Demographic Forecasts
- End Use Breakdown
- Hot Water Use
- End Use Forecasts

Avoided Costs Module

- Operational Costs
- Energy Use
- Capital Works Schedule

Conservation Impact Modules

- Water Pricing
- Fixture Modelling/Retrofit Program
- General Conservation Measure
- Water Loss Reduction
- II Reduction

Measure Evaluation Sheets

Stand-alone measure summary

Measure Interaction

Program Evaluation Sheets

Bundled measures evaluation

Types of forecasts from an end-use model

- The baseline water demand includes no water demand management measures
- The Business As Usual forecast includes status quo:
  - E.g. National Mandatory Water Efficiency Labelling Scheme (WELS)
  - Existing commitments by water utility e.g. education
- Scenarios that combine different combinations of demand management measures

Evaluate available tools : benefit-cost analysis

Encouragement tools e.g. rebates on water efficient devices

Economic tools including pricing

Enforcement tools e.g. Building Code, Bylaw

Education tools including awareness and social marketing

Engineering e.g. leakage reduction

Examples of benefit-cost calculations

- **E**xpected water reduction from a measure (%) = **R**eduction expected (fraction) x **M**arket **P**enetration of measure (% at end of programme)

$$E = R \times MP$$

- **R**eduction expected = annual **S**avings from the measure / **W**ater use without measure in place (both in L/p/d)

$$R = S/W$$

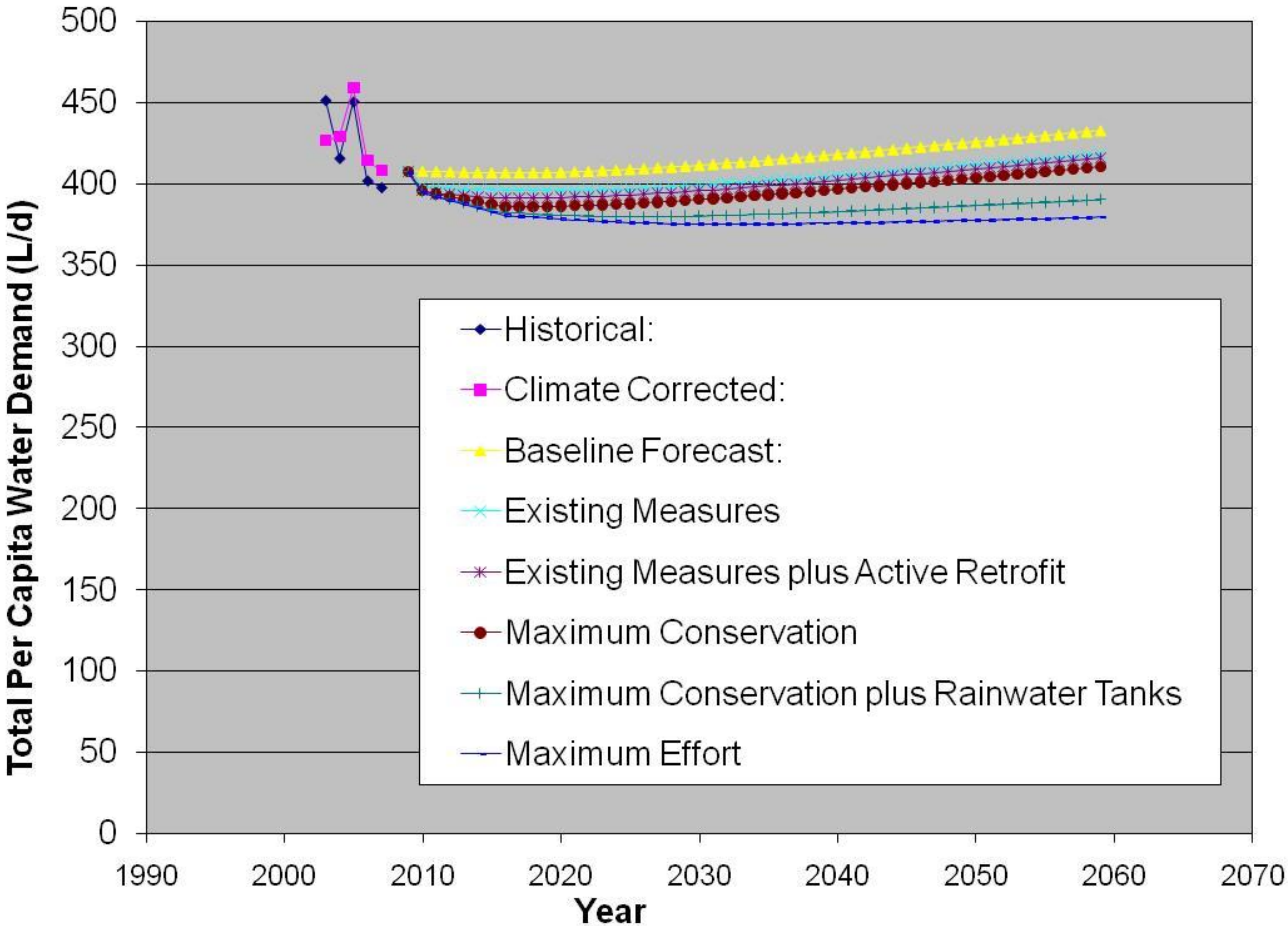
- **E**xpected **W**ater **S**avings from the measure = R x MP x **B**aseline annual water use for the targeted group

$$EWS = R \times MP \times B$$

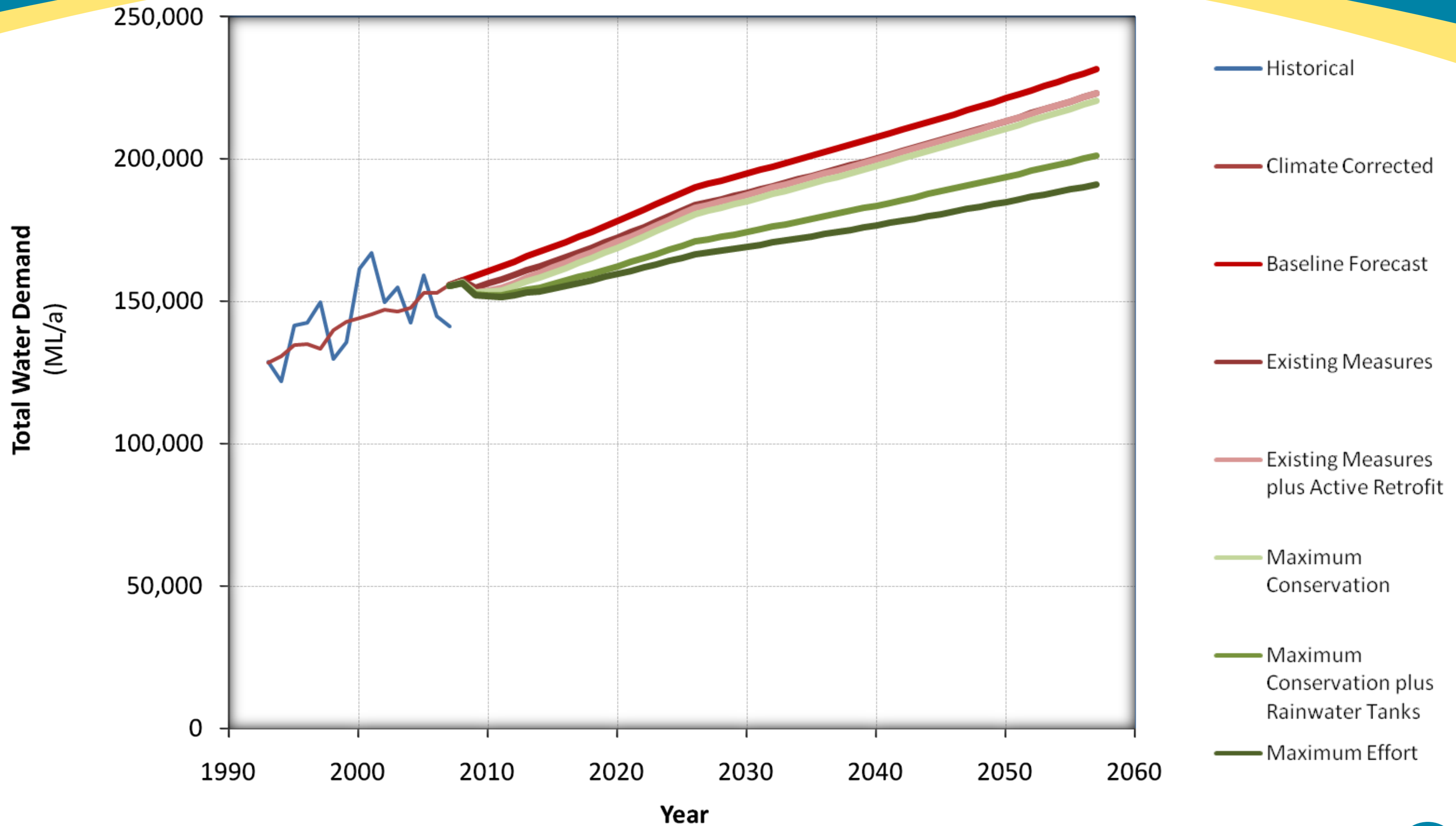
Example output from DSS end-use model

Measure Name	Water Utility Benefit Cost Ratio:	Total Community Benefit Cost Ratio:	Average Water Savings (ML/a)
Conservation Pricing	21.9	21.9	10
Residential Washing Machine Rebate	7.6	0.6	6.2
Non-Residential Water Audits	7.5	4.5	5.9
Permanent Low Level Restrictions on Water Use	5.8	5.8	12.9
Community Education with Savewater Alliance	5.2	8.2	5.4
National Mandatory Water Efficiency Labelling Scheme (WELS)	2.6	1.0	4.2
Community Education with Waterwise	2.0	3.2	5.4
BASIX - Fixture Efficiency with Rainwater Use	1.8	1.2	9.1
Residential Shower Retrofit	1.3	5.9	0.6
System Water Loss Management	1.2	1.2	28.7
Rainwater Tank Rebates for all existing Residential Development	0.5	0.1	1.9

Example forecast from DSS end-use model (per capita)



Example forecast from DSS end-use model (total demand)



Conclusions

- OAG expect local government to prepare accurate demand forecasts appropriate to size of community and considers demand forecasts are considered more reliable when prepared for separate classifications of use and sectors.
- End-use modelling
  - is assumption driven but allows the evaluation of programmes of measures without double-up of savings
  - evaluates benefits and costs from three perspectives: utility, customers and community
  - takes into account market penetration over time for efficient fixtures and appliances

Thank you

Any questions?

Discussion:

- Could end-use modelling be useful in the NZ context for benefit-cost analysis and forecasting?