Does demand management work over the long term? What are the critical success factors?

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EXECUTIVE SUMMARY
This paper identifies some of the key issues in planning, developing, implementing and evaluating demand management (DM) programs to ensure water efficiency is maximised and savings are achieved and maintained in the long-term. The paper draws on the experience of the Institute for Sustainable Futures (the Institute) and key staff who have worked closely with many water planners and DM managers across Australia since the early 1990s.

Unfortunately, even with such a long history of DM in Australia and all the DM targets set around the country there is limited evidence of real long-term commitment to DM such as adequate budgeting and staff resources. This factor, combined with limited examples of thorough review and evaluation of programs, to enable ongoing improvement, is resulting in a growing tendency for water planners to believe that 'DM has already been done' and for DM opportunities to be overlooked for more expensive potable source substitution, reuse and major supply options.

A large menu of DM options is available to us, which if tapped into can provide significant long-term savings. It is essential that we explore this potential now before we lock ourselves into more expensive and resource intensive options. It is also essential that water planners and where necessary government agencies fully commit to their DM targets and objectives by aligning their strategic visions and associated plans, budgets, action plans, modelling and evaluation tools and staff resources.

Having worked with many water planners since the early 1990s the Institute has identified some of the key factors that can assist water planners to tap into and maintain water savings. These factors can be considered within an integrated resource planning (IRP) framework that facilitates adaptive management. This IRP framework is the subject of a manual that will be released by the Water Services Association of Australia in 2006/07, as an update and extension of the previous WSAA manual on DM (White, 1998). Some of these key factors, which are identified in the manual and summarised here include:

- overall planning and commitment to DM by water planners;
- water planners becoming water service providers;
- considering water conservation potential of a specific region by disaggregating demand into sectors and end uses to clarify how water is used and might be saved;
- the use of both structural and behavioural changes when designing DM options as well as combining measures (what to change) and instruments (how to change them);
- control and influence issues and how water planners need to develop a broad spectrum of options that show other stakeholders the importance of their involvement;
- careful implementation planning, development of a DM team and the importance of pilots/phasing of programs prior to full implementation to fine tune program design; and

- the need for ongoing review and evaluation of implemented programs including the use of best practice statistical analysis methods to facilitate ongoing improvement, maximise savings and reduce costs.

This paper will be of interest to a broad spectrum of practitioners beginning or currently involved in the development of water planning options and implementation and evaluation of DM programs.

BACKGROUND

The implementation of water efficiency/DM programs in Australia has been around since the late 1980s. Whilst examples such as Kalgoorlie-Boulder in Western Australia show that comprehensive DM programs have been implemented since the mid 1990s (White, 1998), in many locations DM programs have been limited to user pays pricing and education programs with a few showerhead rebates thrown in for good measure. Only in a few locations have well considered comprehensive programs been adopted that begin to take advantage of the full water conservation potential available or utilise ongoing adaptive management processes that enable programs to be modified to increase their effectiveness over time.

Only more recently have water planners and government agencies begun to take DM seriously and as a worthy contender in the portfolio of options required to provide water services into the future. For example, by 2005 Sydney Water Corporation (SWC) had invested over $80 M in DM programs and achieved an estimated saving of 35,000 ML/a. The level of investment by a number of agencies and the expected savings to achieve the required target (a 35% reduction in per capita demand by 2011 based on 1991 levels) will increase further. With the recent Review of the Metropolitan Water Plan (White et al, 2006) and release of the 2006 Metropolitan Water Plan for Sydney, water efficiency programs will be required to provide a significant contribution as shown in Figure 1.

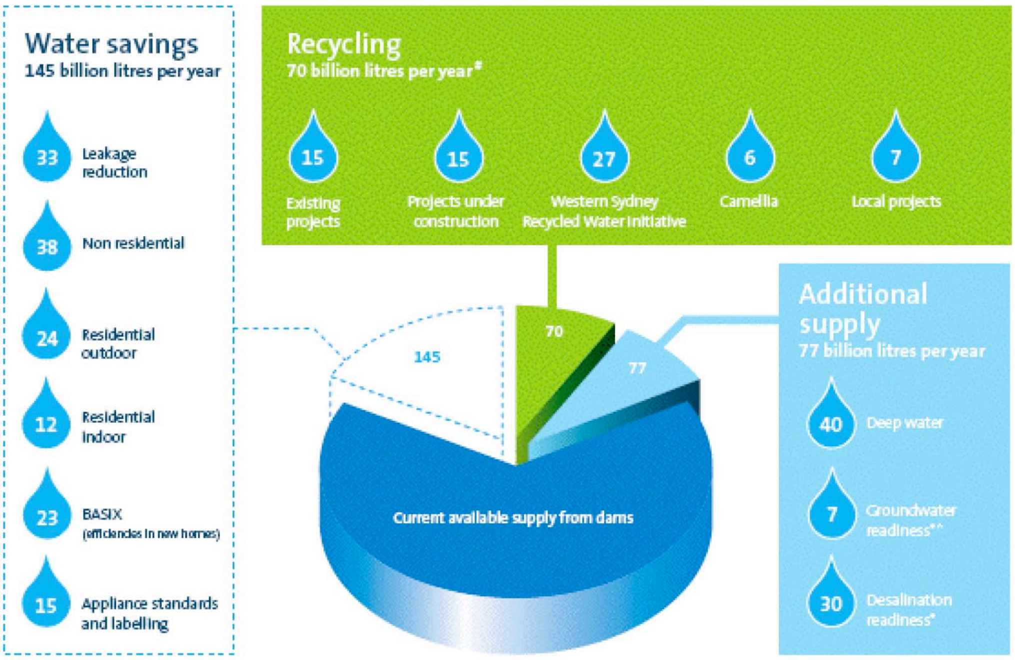

Figure 1 – 2006 Metropolitan Water Plan for Sydney (NSW Government, 2006)[1]

[1] http://www.waterforlife.nsw.gov.au/p/wfl2006.pdf [accessed 15 June 2006]

The investigations in Sydney have assisted in unveiling the true potential of the combination of DM, potable source substitution, reuse and low cost supply options which are expected to achieve reductions in demand of about 145,000 ML/a and provide over 50,000 ML/a of reuse potential. Although the expenditure will increase to over $500 M, the investment in DM is less than half the unit cost of the alternative large-scale desalination plant supply option.

THE NEED FOR PLANNING AND COMMITMENT

This level of planning and commitment to relying and investing in DM is not universal in Australia. Unfortunately, there is often a tendency for DM targets to be chosen arbitrarily and with little assessment of what can be achieved in a specific region or how much a specific target may cost the community as a whole. Also, whilst there may now be a plethora of DM targets around Australia, many options are often chosen on an ad hoc basis, are poorly designed and implemented, are rarely evaluated for effectiveness and/or there is a lack of adequate resources provided in terms of funding and trained staff.

As such, water planners are at risk of not achieving their DM targets and skipping over the full conservation potential of DM and moving to more expensive potable source substitution and reuse as well as major supply options such as desalination. It is imperative that we learn to tap into the full potential of DM programs more effectively now before the perception that '*demand management has already been done'* or '*doesn't achieve the savings expected'* becomes mainstream. When designed, implemented and evaluated well as part of an ongoing adaptive management process, DM programs are amongst the cheapest, least resource intensive, long lasting and beneficial options to society and the environment that can be chosen by any regional water planner.

A key factor is that water planners must now see themselves as **water service providers** and not just sellers of a commodity, 'water'. Water service providers need to recognise that a kilolitre saved is equivalent to a kilolitre provided and that in fact water saved provides significant benefits in terms of deferring capital expenditure and reducing water and wastewater operating and treatment costs, energy costs (for both the water service provider and customer) and greenhouse gases. Recognising and actually calculating not only the whole of society costs but also benefits to various stakeholders assists in determining how to share the cost and benefits to the community and enables justification for price path through where there is a risk the water service provider may incur lost revenue.

The first step to tapping into and uncovering the benefits of DM is for the water service providers and/or government agencies to commit to a transparent decision making process that facilitates effective water planning for a specific area. Committing to such a process involves inclusion of appropriate stakeholders in the decision-making process ranging from various departments in a water utility to numerous government agencies in more complex water planning areas and where possible community representatives. Committing to such a process also involves aligning strategic visions and associated plans, appropriate levels of analysis, action plans, planning and review tools as well as resources in terms of adequate short and long-term budgets and trained staff. By involving stakeholders in such a transparent process and aligning the various elements identified there is less of a risk of disconnect between what is required, what is planned, what the community consider appropriate and what actually happens.

THE AUSTRALIAN INTEGRATED RESOURCE PLANNING FRAMEWORK

From the Institute's experience of working with water service providers since the early 1990s we have developed a framework that helps them plan, act, review and improve their approach to water service provision using a consistent and transparent decision-making process. At the foundation of this process lies the internationally recognised best practice approach of integrated resource planning (IRP) (White and Howe, 1998). The process/framework (shown in Figure 2) helps water service providers agree from the outset on the overall planning process they intend to use and to commit to that process. Within the process water service providers forecast water demand more accurately by disaggregating demand into sectors and end uses, which assists them to understand how water is being used. By forecasting demand in this way they can then determine where water might be best saved or supplied through demand-side and supply-side options. Once the appropriate response to achieve a DM target (or fill a supply-demand balance gap) has been determined through economic analysis and sustainability assessment, they can then plan and implement their preferred response. Following implementation they are then expected to monitor and evaluate their savings so that they can determine how effective the response was and where improvements can be made.

This ongoing adaptive management process assists water service providers to ensure that they adequately consider the potential of DM in their region, thoroughly assess the cost effectiveness of such options against supply-side options, allocate sufficient resources, carefully plan and implement DM programs and then review the implemented programs to maximise ongoing effectiveness.

This process and elements within it, is now being used by many water service providers across the country and has been adopted by the Water Services Association of Australia (WSAA) as a best practice approach that will aim to provide consistency in water planning across Australia. To facilitate this WSAA has released a series of tools and resources and will shortly release a Manual on the process to assist water service providers to undertake the process in their own specific region and at the pace and level appropriate to them.

Using the Manual 'steps' as a guide, other key factors that need to be considered to ensure DM is effective in the longer term are summarised in the following sections. For further details refer to the WSAA Manual.

WATER CONSERVATION POTENTIAL AND STRUCTURAL AND BEHAVIOURAL CHANGES

As part of Steps 2 and 3 of the IRP process (within demand forecasting and identifying and designing options) a water service provider needs to understand demand in their area in more detail through disaggregating demand into sectors (residential, non residential and non revenue water) and also end uses (toilets, showers, washing machines etc.). By disaggregating demand in this way a water service provider has a greater ability to determine how efficient the stock of appliances are in a specific region and where there is potential to maximise **water conservation potential** by converting inefficient appliances to efficient ones. This can be considered for the residential sectors (single and multi residential households) by, for example, considering conversion of all non-efficient showerheads to AAA rated showerheads (flow rate of less than 9 L/minute). In many regions 80% of showerheads are non efficient, providing significant water conservation potential just for this one end use. Typical measured savings for such conversion are approximately 15 kL/household/annum, dependent on several factors such as water pressure and occupancy ratio (Turner et al, 2005a). Similar potential exists for other end uses such as washing machines.

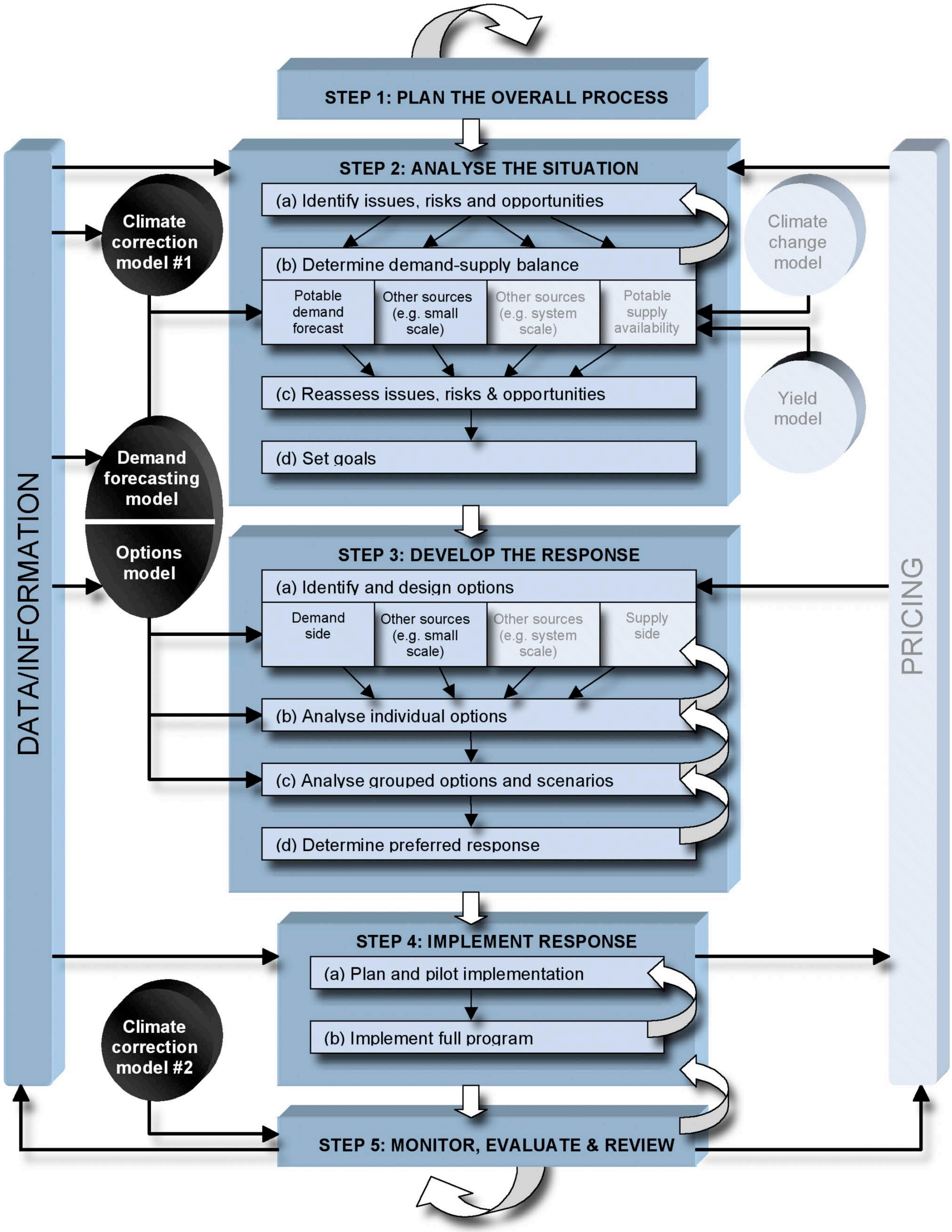

Figure 2 – The Australian Integrated Resource Planning Framework (Turner et al, 2005b)

Many other residential indoor and outdoor end uses can be considered in the same way as can the non residential sector (commercial, industrial, institutional) and associated sub sectors (hotels, office blocks, schools). Conservation potential can also be considered for non revenue water in terms of how the managed system relates to the International Water Association (IWA) and WSAA infrastructure leakage index (ILI). In this benchmark, unavoidable annual real losses (UARL) and current annual real losses (CARL) are identified, which enables strategies to reduce UARL and CARL through pressure management and leakage detection programs to be considered.

Having identified the conservation potential in terms of stock of appliances and their technology flow rates/usage (e.g. AAA rated showerhead of < 9 L/min and 5A or 4 star washing machines of <51.5 L/load for a standard 5 kg capacity washing machine) the water service provider also needs to consider the behaviour patterns of the community. For example, current average shower duration and washing machine loads per week. They also need to determine whether there is conservation potential available for the community to change these behaviour patterns (e.g. reduce shower duration from 7 to 5 minutes and washing loads from 5 part loads to only 3 full loads per week through awareness campaigns).

Figure 3 illustrates some of the typical options available in the residential sector and the combination of **structural/technical and behavioural changes** that can be used to tap into the conservation potential available.

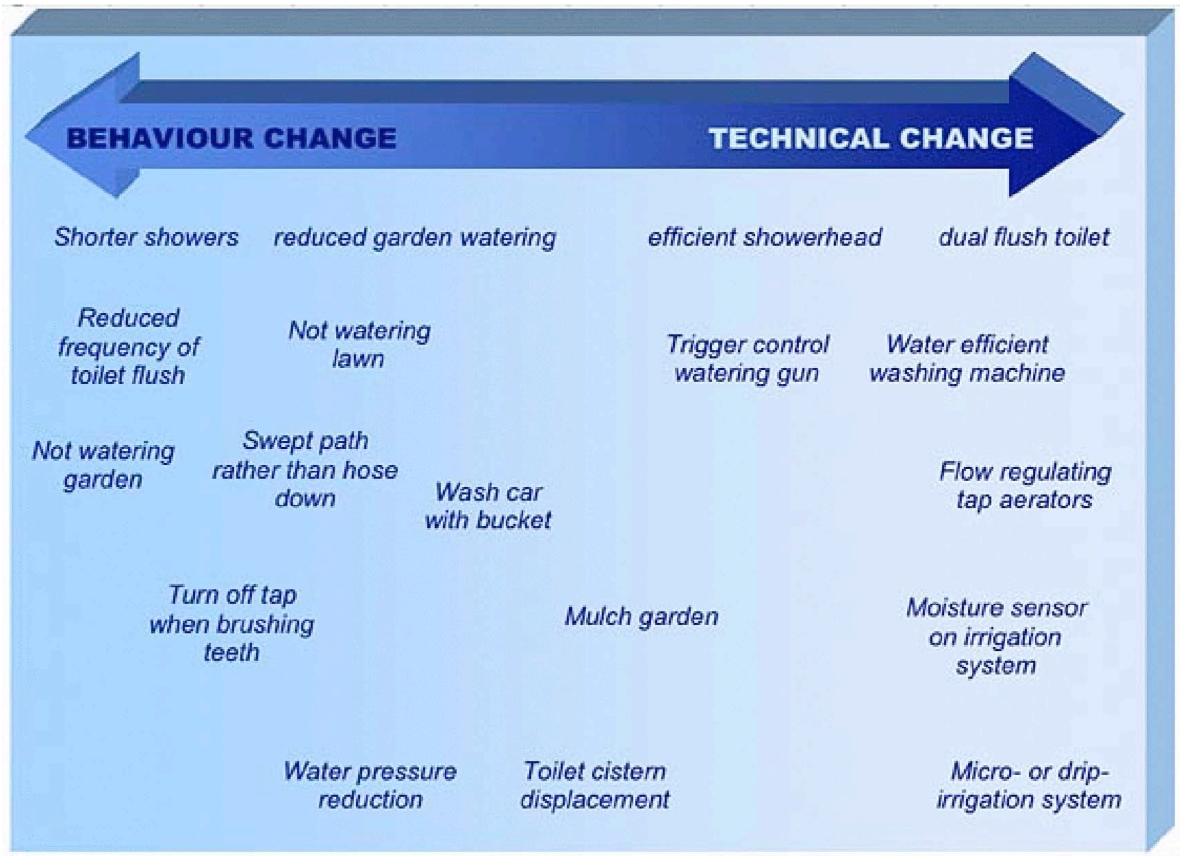

Figure 3 – Structural/technical and behavioural changes (White et al, 2003)

MEASURES & INSTRUMENTS

As part of developing the response in Step 3 and having identified the structural and behavioural conservation potential available, the water service provider needs to consider the combination of **measures and instruments** that can be used to form individual DM programs and tap into the conservation potential. Measures are what to do (e.g. conversion of inefficient showers and toilets to efficient AAA rated showerheads and 4.5/3L dual flush toilets) and instruments are how to do it (i.e. using economic, regulatory and/or communicative instruments). For example, in cities where only 25% of households might have AAA rated showerheads, how can the remaining 75% of households be converted to AAA rated showerheads with the potential of saving on average 15 kL/household/a for a single residential household? Tapping into the conservation potential can be done in several ways.

For example, in many locations including Perth, the Gold Coast and Canberra, showerhead rebates have been offered where households can obtain a AAA rated showerhead from a number of sources at a reduced cost (an economic incentive instrument). However, in Sydney a low cost residential retrofit has been offered since 2000 in which over 300,000 households have participated to date. On average savings of 21 kL/household/a (Turner et al 2005a) for single residential households have been obtained for the program as a whole (i.e. some participants may have had all measures replaced and some may have had none). This retrofit style of program uses both economic incentive instruments and educative/communicative instruments and generally involves a qualified plumber coming to the household and installing a AAA rated showerhead, tap flow regulators, offering to fix leaks and provide educational material and advice. The plumber might also offer a toilet displacement device, a cistern weight or a voucher for a reduced cost toilet retrofit (e.g. minimising the risk of free riders on a complementary toilet retrofit program).

As with the residential retrofit programs, whenever changing a measure, such as a washing machine, at least two instruments are recommended to maximise effectiveness of that program (e.g. an economic incentive and communication/education). This will assist in providing both structural and behavioural changes (e.g. a more efficient washing machine and the participant realising that they can save both water and energy if they wait to use a full load when washing clothes).

In cases where there is no immediate need to achieve a specific DM target and the marginal cost of water is fairly low then regulation can be used to change the conservation potential. For example, in the case of toilets only 6/3 and now 4.5/3 L dual flush toilets are available on the market and in the near future appliances such as washing machines will be regulated by minimum water efficiency performance standards so that only efficient models will be available in the market. Only where there is an immediate need to achieve a DM target, defer a supply option, where there is a local wastewater constraint or the marginal cost of water is over approximately 1.00 $/kL should retrofitting of more expensive and regulatory controlled measures such as toilets really be considered.

Whenever estimating savings of individual programs, measured savings should be used wherever possible. In many cases measured savings from a similar program in another location may need to be used if measured savings in the specific region being assessed are not available. Care should always be taken in assuming theoretical savings, as these are likely to result in an overestimation of water savings potential.

CONTROL & INFLUENCE

When developing DM options in step 3, the water service provider should not constrain themselves to their sphere of control (i.e. the water system or retrofitting/rebates) but should also expand the options to their sphere of influence. By clearly identifying how different instruments in combination with measures can affect the conservation potential and cost of each option, a clear argument can be made to government, regulators and other stakeholders to play their part. For example, although some may question regulatory schemes such as BASIX in NSW[2], the use of appropriate regulation to ensure that each new and renovated household must achieve a specified level of water efficiency, can only be seen as a positive step in achieving and locking in conservation potential. Similarly with water efficiency labelling and the move towards minimum water efficiency performance standards for appliances such as showerheads, washing machines and evaporative air conditioners (at a Commonwealth government level), again can only be seen as positive. These regulatory instruments are key to achieving and locking in the savings of water conservation potential and are critical to maintaining the savings of retrofits/rebates as appliances are gradually replaced in the longer term. If only water efficient appliances can be bought in the near future then there will be minimal risk that the savings cannot be maintained unless participants water using behaviour practices increase significantly.

Figure 4 shows a typical range of DM options available and the cost comparisons for DM options using both regulation and retrofitting/rebates. These are also compared to options that include potable source substitution and reuse (i.e. the NCERS, North Canberra Effluent Reuse Scheme).

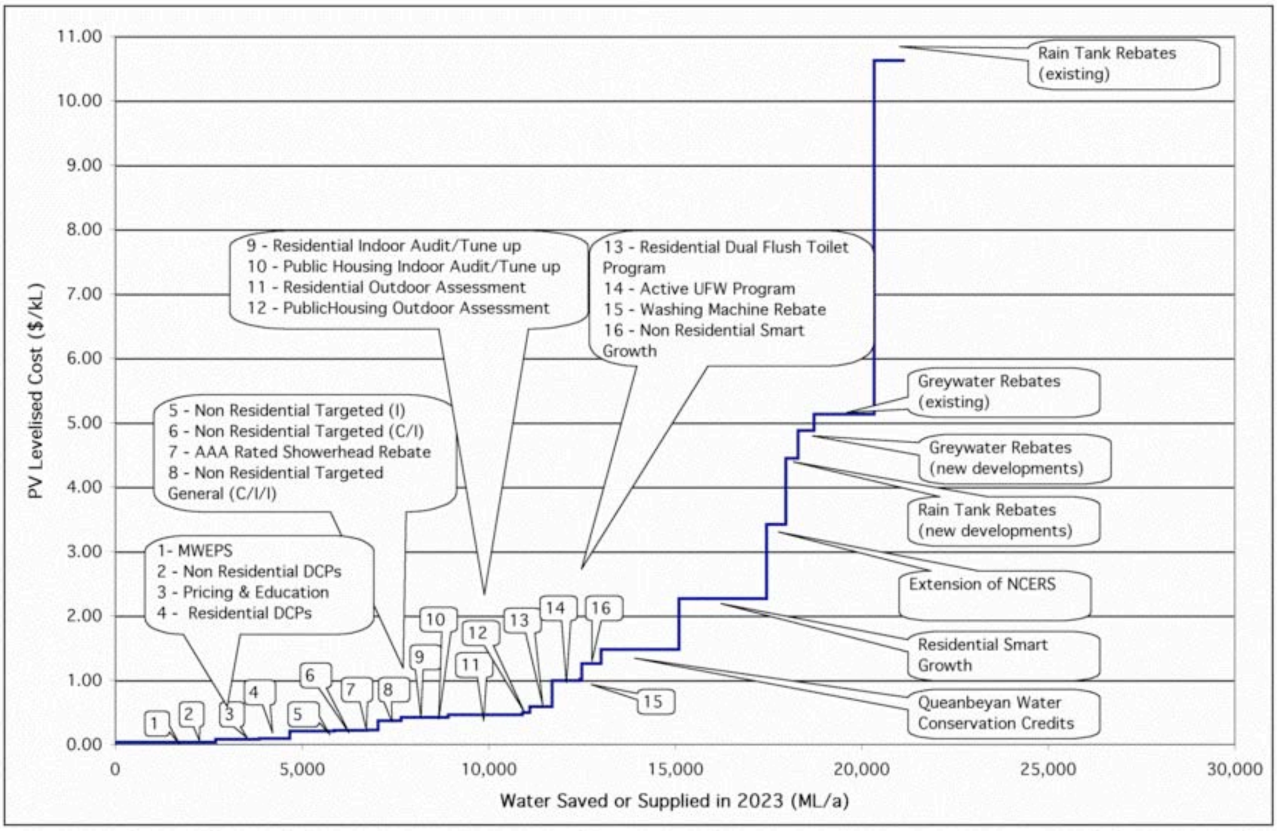

Figure 4 – Typical range and cost comparison of options (Turner and White, 2003c)

[2] See http://www.basix.nsw.gov.au/ [accessed 15 June 2006]

TEAM SKILLS AND IMPLEMENTATION PLANNING

Under step 4, as with any major water planning investment, the team undertaking the task of planning, managing and implementing the project must have the necessary skills. In DM these skills are diverse involving technical engineering knowledge, expertise in setting up and managing contracts, managing and auditing contractors, experience in advertising and marketing, public and trade ally liaison, education and training etc. Recognition that a well trained team with adequate financial and staff resources is required, is essential to the success of the program.

The use of piloting or phasing of programs before full-scale implementation can be extremely useful for the team to learn what is required in their specific region. Such pilots have been used for residential retrofit programs in Sydney and Canberra. For example, for retrofits, plumbers are likely to need training to ensure they believe in the benefits of the program and give a consistent message to participants. Contracts will need to specify high quality appliances to minimise the risk of dissatisfied customers and plumbers using substandard equipment that customers will remove. The team will need to determine what advertising and marketing material is required to gain the participation rate they require and what educational material is needed to modify the participants behaviour as well as the appliances in their home. Hence pilots can be used to iron out some of these issues and knowledge gaps. They can also be used to gather information on the stock of appliances in households (if randomly selected), which can subsequently be used to inform demand forecasting models. Canberra used such a pilot in 2004/05 for their residential retrofit program (Turner et al, 2005c).

Careful planning in terms of timing and choosing programs that complement each other are also essential. Care needs to be taken in locations such as Canberra where both showerhead rebates and retrofits are offered at the same time and in other locations where showerhead rebates may have already been offered and now retrofits are offered. In such circumstances there is a risk that when the plumber visits a house for a retrofit that the participant may have already taken part in the showerhead rebate and converted their showerheads. This reduces the potential savings and increases the unit cost of the retrofit program due to ‘cream skimming’ associated with the showerhead rebate program. To minimise the risk of this it is advisable to offer showerhead rebates to a specific target group. For example, they could be offered to only multi residential households built post mid 1990s (i.e. their toilets are already likely to be dual flush and thus already have a lower conservation potential). In all cases participants need to be carefully logged in a database so that they are restricted from participating in programs that have the potential for cream skimming and to enable evaluation at a later date.

As with any major investment in water planning an action plan is required to assist in the implementation phase. An implementation plan that clearly identifies the planning objective, the budget required, the individual DM programs to be implemented, the scheduling, the team, roles and responsibilities of stakeholders, awareness campaigns, pilots, data gaps that need to be filled and monitoring and evaluation scheduling etc. is essential.

EVALUATION AND MONITORING

Finally, as part of step 5, ongoing evaluation and monitoring of both the individual programs and their contribution to the overall objectives of achieving a DM target (or filling a supply-demand balance gap), are key. Without such monitoring and evaluation there is a significant risk that: savings estimates for a particular region may be overestimated if inappropriately assumed to be similar to another area; that savings actually achieved are significantly less than their potential due to a poorly designed/implemented program; and decay in the savings of a program may occur.

From an overall program perspective climate correction models can be used to track demand taking into consideration the effects of climate variables. This can reveal how DM programs are contributing to an overall DM target (Turner et al, 2003). Evaluation of individual program savings also need to be undertaken, carefully, by using best practice statistical methods such as those used for the Sydney Water Every Drop Counts Residential Retrofit Program. This program, which has now been implemented on over 300,000 households in Sydney, has been found to save 21 kL/household/annum using best practice statistical analysis methods (Turner et al, 2005a). In such analysis the **relative savings** of a participant versus their matched control (matched for example on either geographical proximity or better still the mean and variance of their monthly or annual demand) is estimated using t-tests and anova to find the mean within a 95% confidence interval. This can assist in identifying the savings of a specific program and elements within that program (e.g. modification of showers only versus a combination of showers/taps/toilets/leaks). By assessing the relative savings of participants versus their matched control before and after implementation the savings attributable to that specific intervention can be identified. By finding the relative savings, other factors such as climate that might affect demand will have been taken into consideration. Merely considering the demand of a participant before and after implementation of a program in isolation (without a control) will not take these factors into consideration and may provide very misleading results. Figures 5 and 6 show the findings of best practice statistical analysis methods.

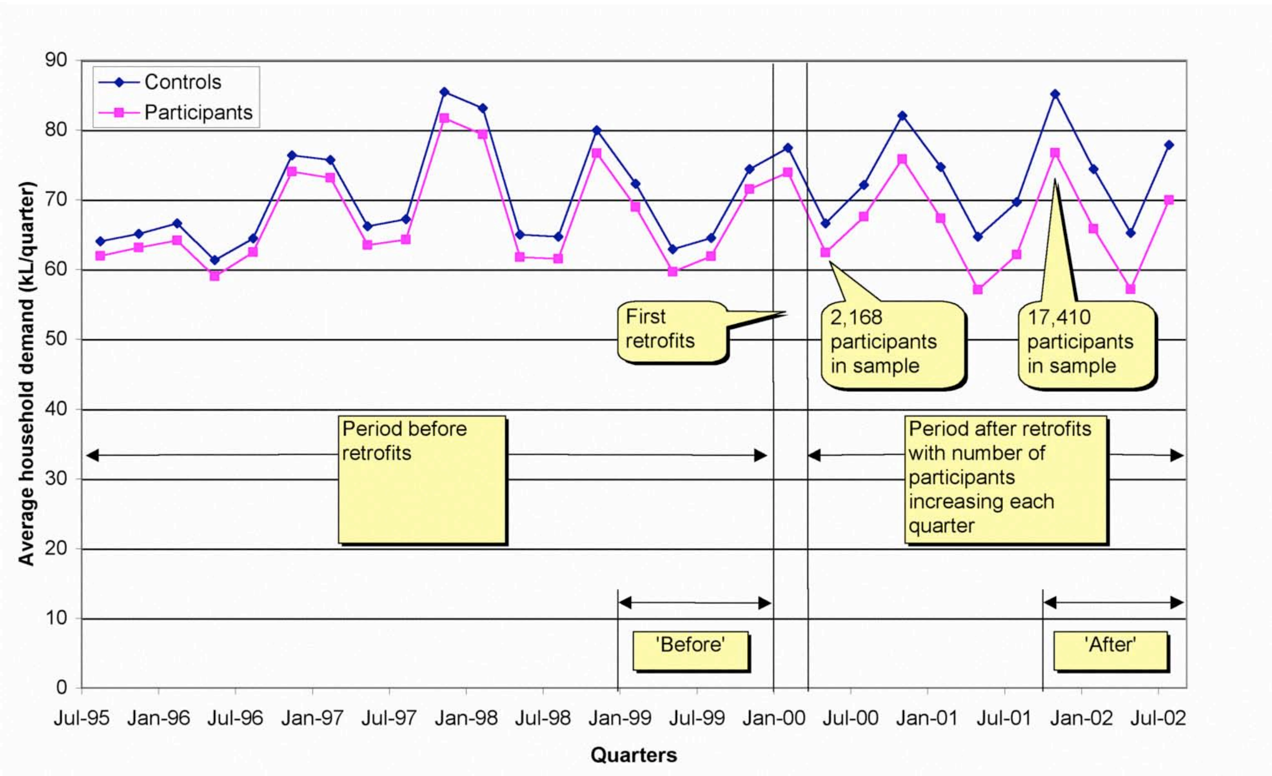

Figure 5 – Comparison of average demand per household for participants relative to controls before and after retrofits in Sydney (Turner et al, 2005a)

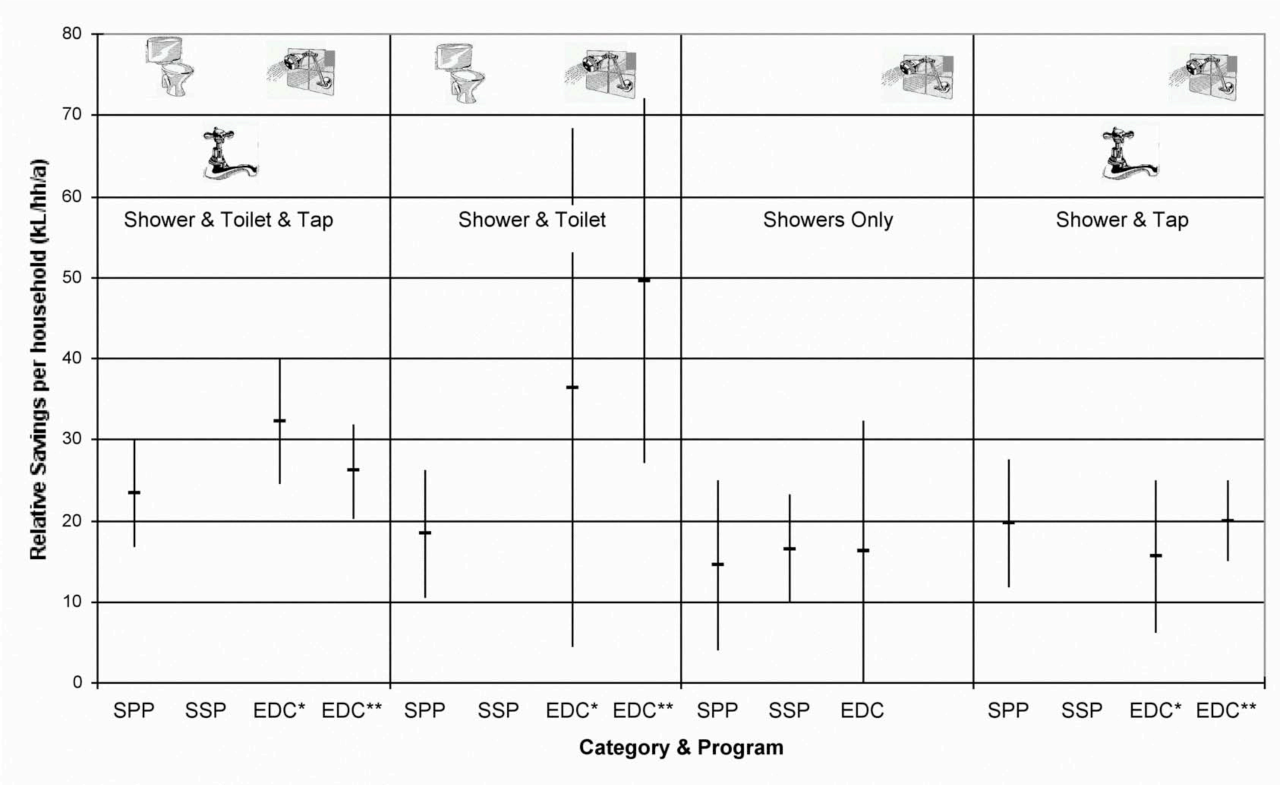

Figure 6 – Comparison of Sydney retrofit program with other evaluations (Turner et al, 2005a)

Note the various programs listed are the Shellharbour Pilot Program (SPP), Smart Showerhead Program (SSP), Every Drop Counts (EDC).

Similar methods can be used for the non residential sector, although other factors such as key performance indicators may need to be considered to take account of changes in production levels on a particular site that might affect baseline demand.

Unfortunately only limited evaluation of savings of residential, non residential and non revenue water programs have been undertaken in Australia using best practice statistical analysis methods. Current research being undertaken by the Institute, for Sydney Water Corporation and Gold Coast Water, will assist in adding to this limited body of knowledge and streamlining the methodologies used so that water service providers can undertake evaluation of individual programs more easily.

Other issues that need to be evaluated on a per program basis include: costs, participation/uptake rates and customer satisfaction etc. It is important to keep an eye on these as they can have serious implications to the long-term potential savings of a program. For example, if in a particular area poor quality AAA rated showerheads are being installed and customers are dissatisfied, this voice of discontent can spread relatively easily through media opportunities which may ultimately put a cap on uptake of the program and its potential to achieve an expected portion of an overall DM target. Similarly, in a showerhead rebate program and the recent Sydney DIY kit where shower and tap flow regulators are offered as a kit for installation by the participant, there is a risk that the showerheads and DIY kits might not be installed. Hence it is important to audit participants and evaluate savings to check that participation translates to actual water savings. This form of detailed monitoring and evaluation is critical if poor performing programs are to be improved and where programs are performing well, for the success factors to be captured.

CONCLUSIONS

DM programs have and can continue to provide a significant contribution to water planning both now and in the future. However, water service providers need to take into consideration a number of key issues and undertake a transparent and adaptive management decision-making process such as the WSAA IRP process. This is needed if we are to tap into the full conservation potential of each region and minimise the risk of skipping over DM options in preference for more expensive and resource intensive potable source substitution, reuse and supply options. It is key that we reflect on what we have achieved from DM to date and where and how we might improve programs to achieve the long-term savings we need.

REFERENCES

NSW Government (2006) '2006 Metropolitan Water Plan', report by the Metropolitan Water Directorate for the NSW Cabinet Office, NSW Government.

Turner, A., Campbell, S., White., (2003) 'Alice Springs Water Efficiency Study Stages I & II – Final Report – Volume I', report prepared by the Institute for Sustainable Futures for Power and Water and the Department of Infrastructure Planning and Environment, NT.

Turner, A., White, S., Beatty, K. & Gregory, A., (2005a) 'Results of the Largest Residential Demand Management Program in Australia', *International Conference on the Efficient Use and Management of Urban Water*, Santiago, Chile, 15-17 March 2005.

Turner, A., White, S., Snelling, C., (2005b) 'End Use and Demand Management Training – A Training Package for the Water Industry (Revision 1)', report and training materials prepared by the Institute for Sustainable Futures for the Water Services Association of Australia.

Turner, A., White, S. & Bickford, G. (2005c) 'The Canberra Least Cost Planning Case Study', *International Conference on the Efficient Use and Management of Urban Water*, Santiago, Chile, 15-17 March 2005.

White, S. (ed) (1998) 'Wise Water Management: a Demand Management Manual for Water Authorities', Water Services Association of Australia, Sydney. ISBN 1 875298 87 8.

White, S., Robinson, J., Cordell, D., Jha, M., Milne, G., (2003) 'Urban Water Demand Forecasting and Demand Management: Research Needs Review and Recommendations – Occasional Paper No.9' report prepared by the Institute for Sustainable Futures for the Water Services Association of Australia.

White, S. & Howe, C. (1998), 'Water efficiency and reuse: a least cost planning approach', *Proceedings of the 6th NSW Recycled Water Seminar,* November.

White, S., Campbell, D. Giurco, D, Snelling, C., Kazaglis, A. and Fane, S. (2006) 'Review of the Metropolitan Water Plan: Final Report', report prepared by the Institute for Sustainable Futures (with ACIL Tasman) for the Metropolitan Water Directorate, NSW Cabinet Office.