Options planning framework: alternatives for WA Water Supply

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Contents

Boxes, charts, figures and tables

1 Introduction

This note provides an illustration of the analysis that might be undertaken using an options approach to new source planning for the IWSS. To give it a specific focus, we examine the current situation of the IWSS. In particular, we consider strategies that might, assessed in an options setting, have greater appeal relative to the second desalination plant proposal that would emerge using more traditional planning methods. The same logic is equally applicable to strategies to take pressure off the Gnangara mound, if there is a concern that the short-term operating regime risks high cost irreversible damage to its associated ecosystems; or to SW Yarragadee as an alternative large supply scheme with substantial and irreversible up-front costs. Of course, the same logic also carries forward to the next requirement for system augmentation for security purposes – although construction of the second desalination plant appears set to defer the timing of that need by many years.

We have prepared this as an illustrative briefing paper – in the available time we have not been able to test all the ideas and costings thoroughly with the system experts and the conclusions as to specific initiatives should not be interpreted as in any sense definitive. We believe, however, that they are illustrative of important principles, with implications for water planning strategy in WA.

The analysis draws on Water Corporation's assessments of the post 1997, post 2000 and post 1975 climate change scenarios to illustrate the implications of climate change uncertainty, and the potential benefits from managing the response to that uncertainty adaptively.

The following section provides a brief description of the schemes that were considered by Water Corporation in its IWSS Source Development Plan (published in 2005), updated by information since made available from the Department of Water and Water Corporation. It includes a description of the flexibility of each scheme, how schemes might interact, and how well schemes might be used as a readiness option, incorporated into an *adaptive supply-demand portfolio response strategy*.

Section 3 then uses this information to construct alternative portfolios of schemes that maintain the supply-demand balance out to 2017/18. Importantly, each portfolio is required to be capable of being adapted to maintain the supply-demand balance under alternative climate conditions – in particular the "low flow" post 1997 and post 2000 climate change scenarios. We also consider an alternative scenario under which inflows revert to 30 year averages (post 1975 inflows) in the near future. The underpinning and characteristics of these climate scenarios are discussed in our paper on Frameworks for Centralised Procurement.

It is not known which of these scenarios will apply in future. Indeed, these are only three plausible scenarios from a spectrum of possibilities – though the post 2000 scenario is being widely viewed as a reasonable basis for worst case scenario planning. As highlighted in our earlier Discussion Paper, where there is the possibility of increased inflows, schemes which have not yet been committed irreversibly might then be deferred for many years and/or be avoided altogether. It can be worth paying a 'premium' on the cost of up-front initiatives in order to buy such flexibility and insurance against the risks of over-investment or large investment of a form that later proves to have been less than ideal.

Therefore portfolios which enable greater flexibility, and the avoidance of early commitment to large schemes, are particularly valuable – provided they continue to deliver adequate security. As we have argued in our other papers to this Inquiry – especially in the Discussion Paper on Procurement Issues – such flexibility can be sufficiently valuable to justify considering augmentation and DM measures with relatively high *nominal unit costs,* with the extra flexibility possibly allowing them to be highly competitive elements in an overall portfolio response to the supply concerns. Effectively, nominal unit costs can overstate *effective costs* for planning purposes. In particular, they can be highly misleading where there is poor alignment between the time a project is built and the time when the *full capacity* of the new project is likely to be needed.

To demonstrate this and how this type of reasoning could lead to a quite different strategy from that which emerges from current and recent planning methods, the paper develops two alternative portfolios, each of which is capable of being adapted in the light of actual inflows. One uses a series of smaller schemes to meet immediate demand requirements, and hence defer commitment to one or more of the high up-front augmentation options, including the second desalination plant, or, possibly, continuation of an aggressive operating regime for the Gnangara mound.

An alternative portfolio assumes that accelerated demand management plays a similar role. In practice, a blending of the most attractive elements of these two could well prove even more cost competitive within an options-setting – relative to proactive commitment to a large scheme that may prove not to have been needed.

2 Description of schemes

2.1 Harvey Water trading stage 1

Description

Water made available by the piping of irrigation systems is then available for transfer to the IWSS. Water Corporation has achieved 10 GL per annum, with the scheme expected to yield a total of some 12 GL pa when complete. The yields is dependent on the climate assumption, however, and could be as low as 6 GL pa under the post 2000 inflow scenario.

The piping of irrigation channels is expected to cost $134m spread over four years. In addition there are costs associated with transferring the water into the IWSS.

Contribution to portfolio

The transfer system required for this scheme is common to a number of other scheme options, including stage 2 water trading, South West Yarragadee groundwater, Wellington dam and the second desalination plant.

The phased increase in supply from Harvey Water trading is well matched to the annual growth in demand. Therefore it has attraction as a means of meeting growth water needs without creating significant over-capacity.

2.2 Second desalination plant

Description

A second desalination plant has been announced as the next major water source for Water Corporation. It is planned for continuous operation, in which case it will supply 45 GL pa. It is expected to come on-stream during 2011. Additional transfer capacity, over and beyond that installed for the Harvey Water trading scheme will be required. The integration costs will be much higher than those for the first desalination scheme, implying substantially higher capital costs and levelised costs of water production from the scheme. Capital cost is estimated at about $1b, assumed to be spread over 3 years.

Contribution to portfolio

The scheme creates significant new capacity and will remedy the currently assessed supply deficit. However the scheme will create significant capacity over and beyond that required to redress the demand/supply balance, which will take some 9 years of continued demand growth to become fully utilised, even under the most pessimistic of the scenarios.

Moreover, and as indicated above, there is a possibility that the current supply deficit and the post 1997 and post 2000 hydrology series are substantially the result of a prolonged drought on top of a longer term, but rather less severe, climate change trend and that the drought will end in the foreseeable future.

In that event, the capacity provided by the second desalination looks set to be surplus to requirements for much more than those 9 years.

Such 'lumpiness' is common and can be unavoidable if size economies are to be tapped. However, in an options setting, such lumpiness does detract substantially from flexibility and the resultant value of the option to the overall portfolio.

Desalination is truly climate independent, so it serves to diversify climate change risk. Adding a second desalination plant to Perth's supplies means that around 35% of Perth's water supplies will be fully rainfall independent, while many of the groundwater sources appear to offer a significant buffer against short-term hydrology variation.

2.3 South West Yarragadee

Description

South West Yarragadee is a significant groundwater source, that has been assessed as being capable of providing 45 GL pa in the short term. Investigations have been completed and approvals gained, so that the scheme could be instituted relatively quickly (in around two years). Construction of the borefield, associated treatment plant and interconnection with the IWSS is expected to cost $700m.

Contribution to portfolio

The cost of integrating the scheme into the IWSS is relatively expensive, however that transfer capacity would be able to be shared across future up-grades to the borefield and/or other schemes in the southern area.

The Yarragadee aquifer is estimated to have an annual recharge of 374 GL, indicating that substantial increases in abstraction could be possible in the future.

2.4 Other groundwater sources

Description

Water Corporation has identified three other prospective groundwater sources: Eglington, Yanchep and Gingin. Eglington would provide 15 to 17 GL pa, Yanchep would provide 9 to 11 GL pa and Gingin 20 to 30 GL pa.

There is uncertainty as to the sustainable yields from Eglington (which involves the Leederville aquifer) and Yanchep (which draws from the Gnangara Mound), with abstractions from both aquifers under review.

The IWSS source development plan estimated that Eglington would cost $58m[1] and that Yanchep would cost $36m. Eglington and Yanchep might also

[1] Converted to 2007 prices

require investment in a North West trunk main, which could involve a further $70m capital outlay.

Gingin is a larger groundwater scheme, expected to provide 20 to 30 GL pa. It would cost $472m, plus the cost of integration into the IWSS. However it is a physically complex scheme, and there is competition for the resource. Consequently there would probably be long delays in resolving the allocation issues.

Contribution to portfolio

Groundwater sources are rainfall dependent. However, there is typically a much longer lead time involved than with dams, and in many cases it is possible to extract above sustainable yields for a period without imposing irreparable damage on the catchment. (Particularly if any over-extraction is reversed within a reasonable period). As such, groundwater sources can provide considerable flexibility to a portfolio – in particular allowing short term deferral of commitment to major schemes. In the event that future inflows are restored to levels approaching the 30 year average, the large schemes that are regarded as essential on current planning parameters can be deferred for long periods, and possibly avoided altogether if less expensive but longer term options become feasible in the meantime.

The above schemes are small relative to the second desalination plant and SW Yarragadee – but, within an options setting, that very size and the scope for flexibly compiling a mix of sources over time, without the need to commit irreversibly up-front – could prove a substantial asset in supporting more cost effective risk management. It can also allow for better matching of the timing of costs to the timing of need for the water for supply purposes – with poor timing in this respect being one of the stronger arguments against 'lumpy' supply schemes.

2.5 Dam catchment management

Description

Currently Water Corporation is running a trial in the Wungong catchment which involves the non-commercial thinning of trees to improve inflows. The trial will take 12 years to complete, producing up to 4 GL pa during this period and will cost $20m. Once complete, Water Corporation expects to be able to roll out similar management practices across other catchments, to yield an additional 31 to 34 GL pa.

Contribution to portfolio

This scheme has a long lead time, and so cannot be used in the short term to meet demand growth/supply deficits. However it is a relatively inexpensive option that would be useful to include in the portfolio, provided excess capacity is not committed in the meantime. From an options perspective, a major up-front commitment to excess capacity would have the effect of substantially reducing the option value of the dam catchment management process.

2.6 Major aquifer recharge

Description

Treated wastewater can be used to supplement recharge to groundwater resources. Tertiary treated wastewater from Beenyup and Alkimos WWTPs could be used to recharge local aquifers and provide 25 GL to the IWSS. Water Corporation's source development plan estimated the cost to be $232m.

Contribution to portfolio

Recycled water is another source that is largely climate independent. It tends to be less energy intensive than desalination and hence is less expensive in financial terms compared at least to continuous operation desalination. This advantage could diminish dramatically relative to desalination that has been planned for intermittent operation (such as has been proposed for Sydney.

Recycling can also contribute to water quality objectives through wastewater and nutrient management, providing external benefits that could help to offset the cost of the scheme.

Aquifer recharge can significantly lower portfolio costs (inclusive of user as well as supplier costs) than other forms of recycling, by avoiding the need for third-pipe systems. As identified by the Department of Water, it also has the potential to provide significant volumes of water. For all of these reasons, aquifer recharge has the potential to be a very cost-effective source of new supplies in future.

2.7 Wellington dam

Description

Two possible schemes have been proposed for Wellington dam. The first is a pumpback scheme, which would yield an additional 12 to 15 GL. It would involve microfiltration to deal with the salinity of the water, and would cost around $93m. However technical issues still need to be resolved before this becomes a viable option. An alternative option would be to desalinate the water. This would be considerably more expensive – though the relatively low salinity levels would imply much lower energy needs than for sea water.

Contribution to portfolio

Both of these options provide only limited diversification from climate risk, since they involve a surface water source. The uncertainty and delay in resolving the uncertainties detract from its immediate application. However, a package of such possibilities for the future could have high option value – where there are good prospects for some of these proving up – as part of a strategy based around progressive roll-out of smaller schemes.

2.8 Small schemes

There are a number of small schemes that have been explored by the Department of Water as means of reducing the current pressure on Gnangara Mound. The most promising of these schemes are Harris Dam, Jandakot groundwater, Neerabup, Collie and Logue Brook.

Harris dam

Available water allocations in the Harris dam could be transferred to Stirling Dam, and then into the IWSS. Around 10 GL would be available in total, probably spread over two years. The scheme would involve no new infrastructure, making it a very inexpensive option. The timing of the availability of the water is constrained by work currently being undertaken on Stirling dam – however this should be completed soon.

Jandakot groundwater

Jandakot is another small scheme that can be instituted relatively quickly. It involves sinking a new bore in an existing borefield. As a consequence, all other infrastructure, including the transfer system, is already in place. The bore could provide 2 GL pa in 2008/9, growing to 5 GL pa in 2011/12. However any water extracted is likely to be regarded as a substitute for water currently taken from the more sensitive central area of Gnangara Mound. The cost of the bore would be around $9m but could be more depending on treatment requirements.

Neerabup groundwater

Neerabup involves sinking two bores in an existing borefield. The scheme would also require a treatment plant upgrade, making a total cost of around $60m. The bores could start producing around 3 GL pa in 2008/9, increasing to 13 GL pa by 2011/12. Again the extraction is likely to be viewed as substituting for water currently taken from the central areas of the Gnangara. However the lower level of environmental risk is likely to allow some increase in total draw above conservative low-flow assumptions.

Collie

Water from de-watering by mining companies could be released to Water Corporation and transferred into the Harris dam. 5 to 6 GL would be available for at least 5 years (but with no guarantee of long term availability). Expected capital costs are $35m to $45m to construct a 10 km pipeline. Additional water may become available subsequently.

Logue Brook

This scheme involves the piping of irrigation supplies from Logue Brook dam. It involves 10 km of pipelining. The resultant water efficiencies would provide 5 GL of water pa. Currently Logue Brook dam is used for recreational purposes, and the Government has recently announced that some $13m will be spent to develop an alternative public recreation area at Lake Kepwari. Total cost is expected to be $16m.

Contribution to portfolio

These are examples of small, but relatively easily instituted, schemes. Taken in conjunction, they could provide sufficient volumes to enable deferral of commitment to a large and expensive source in the short term. A key point is that, in an options portfolio setting, small schemes can be very attractive – whereas supply planning under more traditional paradigms tends to focus on larger schemes with (possibly) better project economics. It is the distinction between project and portfolio economics, emphasised by the options approach, that really adds to the potential value of these prospects.

Of course, while the Department of Water has been considering these schemes as possible substitutes for an aggressive operating regime for Gnangara Mound, they could also serve as substitutes (or 'deferers') for other large schemes involving high up-front costs. Logically, they would be considered as alternatives to the least cost effective elements assessed from a portfolio perspective.

2.9 Accelerated demand management

Drawing on the experience of other jurisdictions, we allow for the option of undertaking accelerated demand management activities. The types of programs that could be used include:

- An enhanced residential retrofit program, involving intensive shower retrofit program
- Accelerated toilet rebate program
- Accelerated clothes washer rebate program, and
- Enhanced non residential program.

Table 1 **Indicative accelerated demand management savings**

	Number of hh pa	Saving kL per hh	Savings per year
		kL/hh/annum	GL
Enhanced residential retrofit program	70,000	21	1.5
Accelerated toilet rebate	14,000	24	0.3
Accelerated clothes washer rebate	70,000	24	1.7
Enhanced non residential program			2.0
Total			5.4

Indicative levels of savings achievable from the programs are given in Table 1. These figures are based on (unpublished) investigations of demand management options in other major urban jurisdictions and as such provide only a broad indication of the possible costs and savings achievable in Perth. We have not had time to probe in detail the current status of DM programs in WA. In a traditional planning context, these sorts of scheme would often be seen as tiny with relatively little strategic value.

Contribution to portfolio

Evidence from other jurisdictions suggests that the total cost of the program in terms of incentive payments or other mechanisms could be between $50m to $100m pa. Taking a conservative assumption of $100m pa implies a levelised *supplier/agency* cost of the order of $1.20/kL saved. However, typically such schemes will also entail a significant user cost, in bringing forward and raising the net cost of equipment replacement etc. In a traditional planning paradigm, this leads to a 'cut off' in the cost effective rate of roll-out of such programs, where the costs are rising about alternative supply projects. Under an options paradigm, that cut-off point can be expected to be much higher (possibly 2 to 3 times higher) for two main reasons:

- The small scale of these contributions which again can offer scope (possibly in concert with small supply-side measures) to better match the timing of costs to the timing of need for the savings; and
- The flexibility, inherent in the mechanism, to rapidly ramp down, ramp up or cease the schemes in the event of a change in the level and urgency of supply threat.

2.10 Caveats

Note that a range of other options exist. These tend to be less well defined, in terms of capacity and cost and so have not been detailed above. Some of these sources may have the potential to provide useful future sources – such as industrial re-use. However, in the absence of plausible yields and costings, we have not been able to include them in the consideration of possible scheme portfolios.

It is also important to recognise that all of the yields and costs are subject to considerable uncertainty.

Table 2 **Summary of major supply options 1**

Scheme	Harvey water trade 1	Desal plant 2	South West Yarragadee	Harris dam	Jandakot GW
Volume pa	12 to 18 GL, climate affected	45 GL	45 GL	Around 10 GL over 2 years in total	5 GL by 2011/12
Lead time yrs	Spread across 4 years	3 years	2 years	Short, but constrained by work on Stirling dam	2 years
Capital cost $m	$144m, plus $63m for transfer system	$640m for plant, plus $315m to interconnect to IWSS	$700m	Minimal	$9m, plus possible additional treatment costs
Operating cost pa $/kL	$0.13/kL incl transfer	$0.48/kL incl transfer	$0.36/kL	Assume $0.25/kL	Assume $0.20/kL
Levelised cost $/kL	$1.00 to $2.70 depending on climate scenario and transfer costs	$1.94/kL	$1.44/kL	$0.30/kL	$0.32/kL
Description	Full piping of Harvey and Waroona Irrigation districts.	Desalination plant constructed at Binningup	Construction of borefield and treatment plant at Jarrahwood	Transfer of water from Harris dam to Stirling dam. Transfer mains already exist.	Construction of a bore in an existing borefield. Transfer system already in place.
Variants	Stage 2 would release 16 GL for a further $272m for piping collie ID. Not clear if additional transfer costs.				
Readiness option	No	Yes			No
Flexibility/interactions	No	Transfer system common to Harvey Water trades, SW Yarragadee and other southern sources. Potential to increase up to 100 GL	Aquifer has estimated annual recharge of at least 374 GL.	Constrained by work being done on Stirling dam, which should be completed this year.	Could provide 2 GL pa starting in 2008/9, growing to 5 GL pa.
Issues			Extraction for the IWSS is unpopular in the South West. Environmentalists have also raised concerns.	While retained in Harris dam lowers the water quality risks to the Great Southern Towns Scheme.	Dependent on drilling results, testing for water quality. Substitutes for water from central Gnangara.

Table 3 **Summary of major supply options 2**

Scheme	Dam catchment management	Eglington GW	Yanchep GW	Gingin GW	Major aquifer recharge
Volume pa	2 to 4 GL pa during trial, 31 to 34 GL when rolled out	15 to 17 GL	9 to 11 GL	20 to 30 GL	25 to 35 GL
Lead time yrs	12 years for Wungong trial to be completed	Long, planning permissions	Long	Long, to resolve allocation issues	Preparatory work for a 4 year trial begun
Capital cost $m	WG trial to cost $20m	$58m, with $70m for NW trunk main	$36m, with $70m for NW trunk main	$472m, plus cost of integration	$232m
Operating cost $/kL	?	$0.25/kL	$0.25/kL	$0.30/kL	Assume $0.45/kL
Levelised cost $/kL	$0.33/kL for trial	$0.82/kL	$0.99/kL	$1.79/kL	$1.18/kL
Description	Non commercially thinning of trees to improve inflows. Following Wungong trial can be rolled out to other ctachments	New groundwater scheme, which includes bores into Leederville aquifer.	New groundwater scheme	New groundwater scheme	Recycled water used to recharge a major aquifer north of Perth
Variants					
Drought response	No	No	No	No	Yes
Flexibility/interactions	Utilises existing infrastructure more effectively	NW trunk main would serve both Eglington and Yanchep	NW trunk main would serve both Eglington and Yanchep		In the long term, could supply 70-100 GL pa, from Perth's major wastewater treatment plants.
Issues	Long lead time for trial to be completed	Sustainable yield uncertain, as abstraction of Leedervill aquifer is under review. Social issues as located in an urban area	Uncertain yield, due to groundwater reviews. Abstracts from Gnangara Mound which is under stress.	Physically complex scheme. Competition for the resource.	Indirect potable re-use is politically sensitive.

Table 4 **Summary of major supply options 3**

Scheme	Wellington dam	Neerabup GW	Collie	Logue Brook
Volume pa	12 to 15 GL	13 GL by 2011/12	5-6 GL, available for at least 5 years	5 GL, climate dependent
Lead time yrs	8 years	Short	Short	Available 2009/10
Capital cost $m	$93m	$60m	$20 to $40m	$16m
Operating cost $/kL	$0.38/kL	Assume $0.20/kL	Assume $0.25/kL	Assume $0.25/kL
Levelised cost $/kL	$0.87/kL	$1.28/kL if water extracted for 7 years	$1.94/kL if water supplied only for 5 years	$0.47 to $0.69/kL depending on climate
Description	Installation of pump back and microfiltration system to deal with saline water	2 new bores installed in an existing borefield. Requires a treatment plant upgrade.	Water released by mining operations could be transferred into the Harris dam. Requires a 10km pipeline to be built.	Piping of irrigation supplies. Requires a 10km pipeline. Creation of alternative recreation site at Lake Kepwari.
Variants	An alternative approach would be to install a desalination plant at the dam			
Diversification of climate risk	No	No	Yes	
Flexibility/interactions			Takes advantage of transfer infrastructure used by Harris dam option.	
Issues	Would impact on irrigation allocations and recreational use. Adequacy of microfiltration requires investigation.	Substitutes for water from central areas of Gnangara Mound. Allows some increase in take above conservative levels due to lower environmental risk.	Water may not be available over the longer term.	Social costs involved, as the dam would become unavailable for recreational uses.

3 Alternative portfolios

The following portfolios have been designed to ensure that the probability of a total sprinkler ban remains below 3%. Water Corporation's sprinkler ban model has been used to model the inflows and additional schemes required to maintain a 3% or less probability under each of the three climate scenarios incorporated in the model (a post 1975 inflow scenario, a post 1997 inflow scenario and a post 2000 inflow scenario).

3.1 Water Corporation post 1997 climate scenario

Under Water Corporation's post 1997 climate scenario, ground water abstractions are assumed to decline throughout the forthcoming period, reaching 124 GL pa by 2012/13 and 111 GL by 2017/18. Surface water is assumed to yield around 140 GL pa.

We have assumed that Water Corporation undertakes as planned the schemes that have been announced, namely continuation of Harvey Water trading, introduction of transfers from Logue Brook dam and commissioning the second desalination plant (which delivers 20 GL in 2011/12 and 50 GL pa thereafter[2]). Together these are sufficient to meet the sprinkler ban criteria (assuming post 1997 inflows).

Figure 1 compares demand (given by the black line) with the stack of supply options needed to meet the sprinkler ban criteria.

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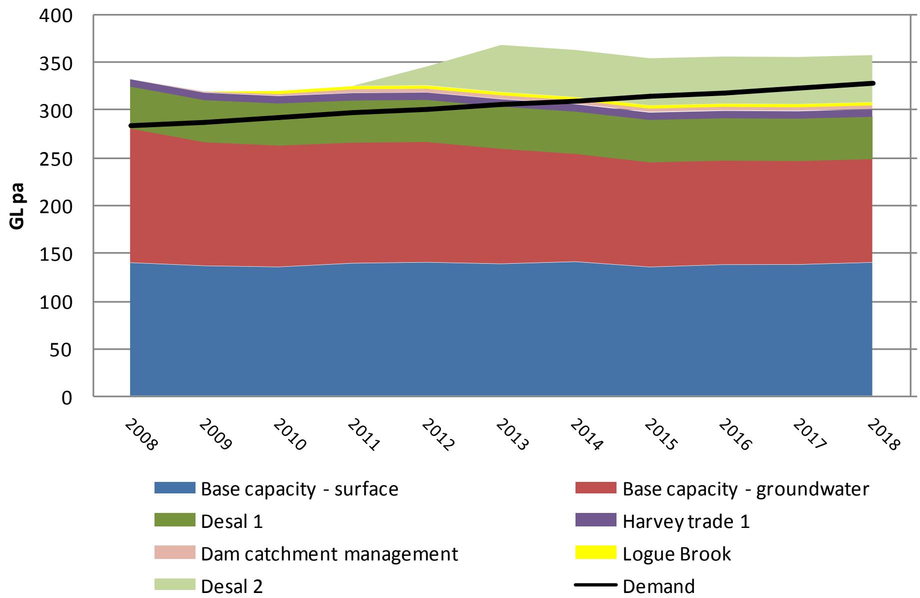
2 While not all of the volumes from the desalination plant are needed to restore the demand/supply balance, we assume that the plant is run to capacity in order to restore groundwater levels.

Figure 1 **WC's scheme planning under post 1997 climate scenario**



The present value of the future costs of the supply schemes (ie excluding the first desalination plant but including the operating costs of Harvey Water trading) as at 2006/7 amounts to $1.11bn in 2006/7 prices[3] [4].

As the figure makes clear, when planning on a definite continuation of the post 1997 climate scenario, the need for supply augmentation from 2011/12 is modest relative to the scale of the second desalination plant. The planning only brings in the large increment because of the lumpiness of these schemes. The need, under this low inflow scenario, is for at most 5GL/annum rather than 50GL as a block. This in itself challenges the economics of these augmentations to the portfolio where more incremental (even if higher nominal unit cost) opportunities exist – because of the implied poor timing of costs relative to need, even assuming the worst case scenario.

In addition, the impact of climate change is uncertain, with a distinct possibility that some of the current low inflows are in fact attributable to a prolonged (10 year) drought. Should the drought end and inflows revert to the levels seen under the 30 year climate scenario, then Water Corporation would be limited in its ability to adapt the capital program. With a reversion to a wide range of conditions drier than the last 30-years, but not as deep drought-like as the past 8 years, the likelihood of 'regretting' a large pre-emptive investment in capacity

[3] Using a 6.5% real discount rate

[4] The present value of future costs would be similar ($1.7bn) even if the desalination plant's operation were to be phased up in line with demand, rather than being operated flat out from when it is commissioned.

– where a more incremental and adaptive strategy could have been used – seems high. This possibility is explored further in Section 3.3 below.

3.2 Water Corporation post 2000 climate scenario

Under the 'worst case scenario', inflows are assumed to continue the pattern of post 2000 inflows. Surface water inflows are low, averaging 107 GL pa. Higher abstractions from existing groundwater resources would compensate to some extent, with Water Corporation modelling suggesting these would average around 126 GL pa from 2012/13. Yields from Harvey Water trading and Logue Brook would also be lowered.

We assume that the second desalination plant can be brought forward by one year. In addition, a combination of a one-off transfer from Harris dam and the introduction of the Collie transfer (both in 2009/10) would be required to keep the probability of total sprinkler below 3%[5]. The 5 GL pa from Collie is assumed to continue for 6 years, providing sufficient supply capacity until the second desalination plant comes on-stream in 2010/11.

Figure 2 **WC's scheme planning under post 2000 climate scenario**

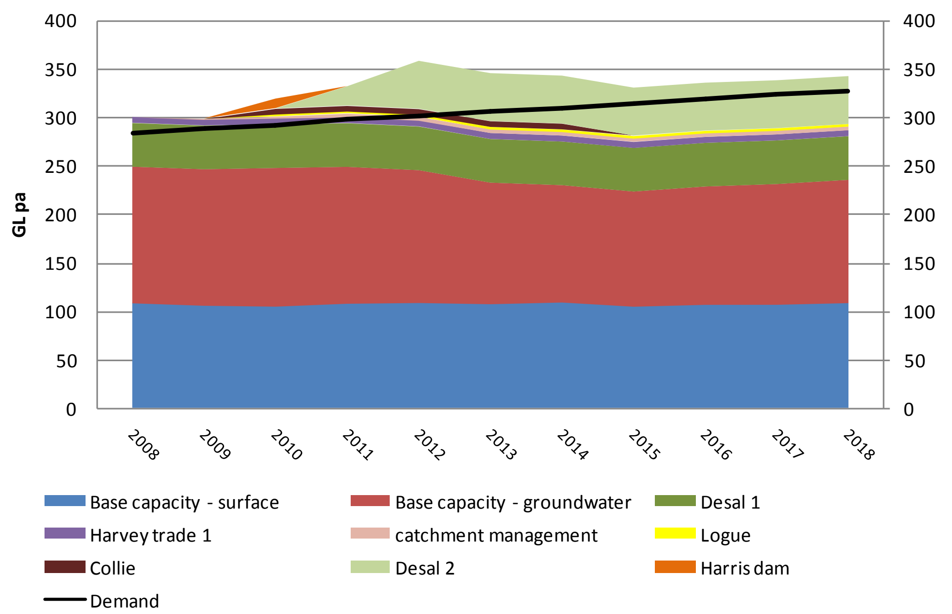


Figure 2 shows the scheme stack required to meet the constraint on total sprinkler bans compared to the demand forecast.

Again, however, this scenario assumes a continuation of recent past experience of low inflows that is not certain. Climate change research suggests that in fact

5 Probability reaches 3.1% in 2009/10.

the post 1997 inflow scenario is the most likely outcome, with the post 1975 inflow situation (or at least some improvement over the last eight years) remaining a possibility.

3.3 Water Corporation post 1975 climate scenario

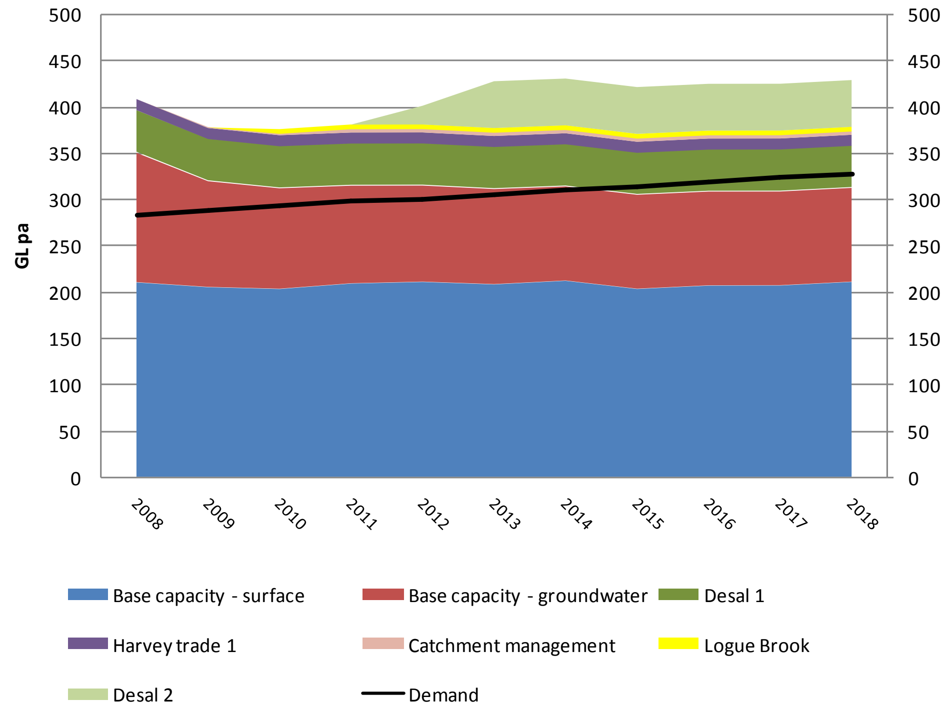
To understand the ability of the Water Corporation portfolio to respond to an improved inflow scenario, we assume that inflows follow the post 1975 patterns from 2007/8 but that it takes a year for confidence in the inflows to be restored. Water Corporation will have commenced construction on Desalination Plant 2 (assumed to come on stream in 2011/12) and Logue Brook would similarly be committed. Water Corporation would be able to defer the planned investment in Harris dam and Collie. We assume also that Water Corporation would delay operation of the second desalination plant until it was needed (and would at that point generate only the required volume of water).

Figure 3 shows the stack of schemes required to meet the demand supply balance under the revised climate change scenario. Under this 'realisation' of future hydrology, it seems likely that, in retrospect, the second desalination plant will have been committed much too early when assessed within this options framework – if it can buy time to defer the planned early irreversible investments. Moreover the capacity provided by the first desalination plant would not be fully utilised by demand until well after 20017/18. (For consistency we assume that in this scenario the first desalination plant nonetheless continues to operate at full capacity in order to restore aquifer levels[6].)

Water Corporation has argued to us that the water will be need eventually, and can be held in storage. In our opinion, this misses the point that the capital costs incurred in the next couple of years to meet demand that does not emerge for many years will prove very expensive because of the opportunity cost of funds. Examples showing that the effect can be very large were provided in our Discussion Paper.

6 An alternative assumption would be to assume that the Perth desalination plant is operated at 50% of capacity, as this would be sufficient to adhere to the sprinkler ban constraint.

Figure 3 **Revised WC scheme planning under post 1975 pattern**



3.4 Smaller schemes to avoid early commitment under post 1997 inflows

A real options/adaptive planning approach would try to minimise the up-front commitment that has been to be made prior to understanding what future inflows are likely be – subject to the requirement to sustain adequate system security.

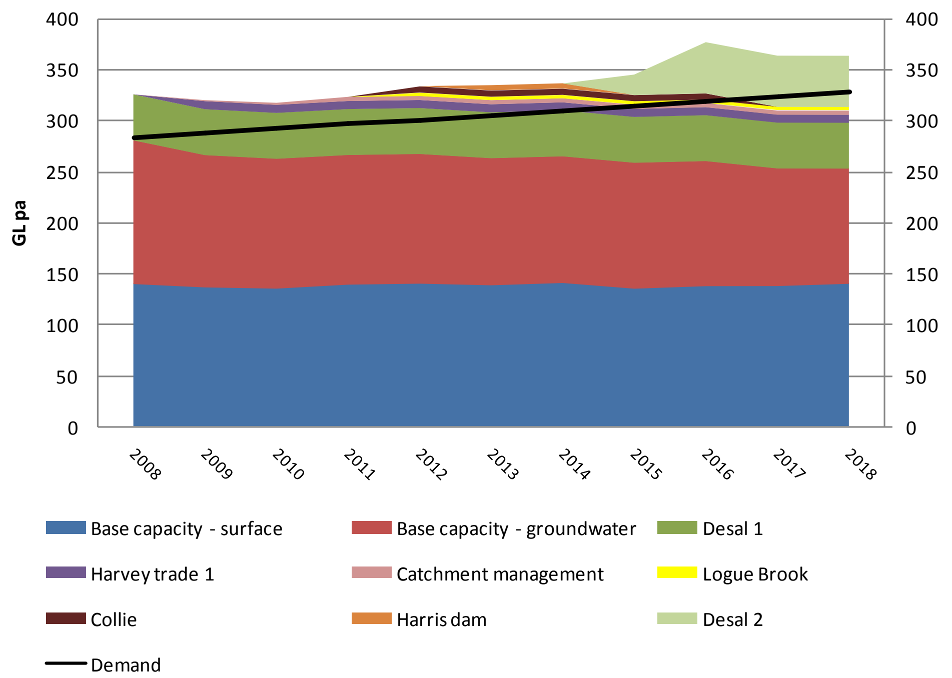
Figure 4 shows the stack of schemes required to balance demand and supply if a number of smaller schemes (identified by the Department of Water) are utilised in advance of the first new major scheme. These smaller schemes involve:

- a transfer of water from Harris dam to Stirling dam and hence into the IWSS, 10 GL available over two years
- Transfer of water from Collie to Harris dam over a 5 year period.

These are in addition to the smaller schemes already incorporated in the Water Corporation planning scenarios, namely Harvey Water Trading, the catchment management trial and the use of Logue Brook entitlements through piping of the irrigation district.

The transfer from Harris dam makes use of existing infrastructure, and hence is very inexpensive. It is assumed to provide a one-off transfer of 5 GL pa in each of 2013/14 and 2014/15. The Collie transfer requires a 10km pipeline and provides 5 GL pa for six years from 2011/12. In all cases the extent of capital commitment is relatively small.

Figure 4 **AT scheme planning under post 1997 climate scenario**



The implementation of these smaller and/or temporary sources allows the deferral of the large, expensive scheme, so that capital expenditure on the second desalination plant is deferred beyond the immediate planning horizon – when there will be more information as to the likely pattern of future inflows.

As a result of this deferral, the present value cost of this portfolio of schemes is lower than the base Water Corporation portfolio, at $967 million.

3.5 Smaller scheme portfolio under post 2000 scenario

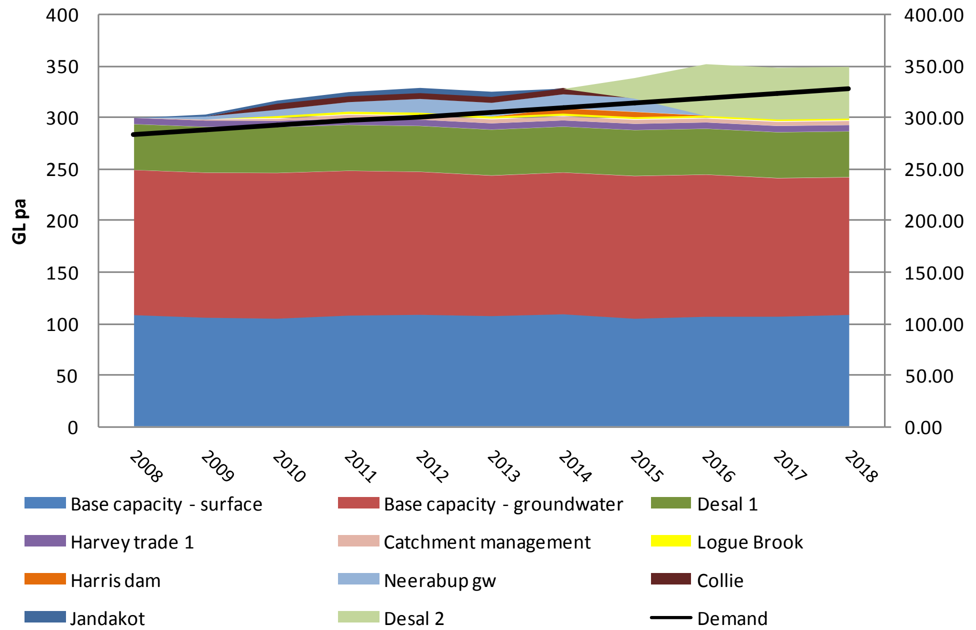
Should inflows follow the post 2000 inflow pattern, the portfolio could be ramped up by temporarily utilising additional groundwater sources.

This could be done by installing and using temporarily additional bores at Jandakot and Neerabup. Extraction from these bores would be less environmentally sensitive than Gnangara Mound, and hence might accommodate additional abstraction on a temporary basis.

Using the Water Corporation sprinkler ban model we found that introducing Neerabup and Jandakot from 2008/9, Logue Brook from 2009/10 and Harris dam in 2013/4 and 2014/5 was sufficient to keep the probability of a total sprinkler ban below 3%. The volumes extracted at Neerabup were assumed to increase from 3 GL to 13 GL pa, with Jandakot increasing from 2 GL to 5 GL pa. In both cases extractions would cease after 2014/5, when the second desalination plant is assumed to run at full capacity.

The present value cost of the portfolio is $1,046 million. Figure 5 shows the assumed scheme stack.

Figure 5 **AT scheme planning under post 2000 climate scenario**

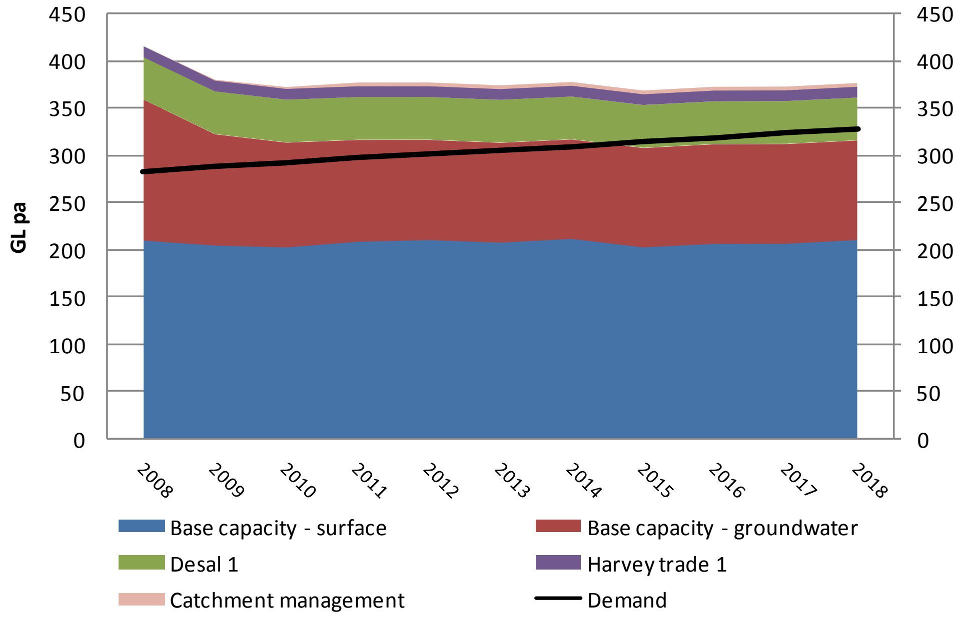


3.6 Smaller schemes portfolio under post 1975 scenario

However the real value of the small scheme portfolio lies in its greater flexibility. Should inflows revert to the post 1975 inflow pattern, then many of the schemes can be delayed or avoided. For example, only Logue Brook and the catchment management trial would be needed to keep the probability of a total sprinkler ban below 3%.

The present value of the future cost of this portfolio, given the improved inflows, is much lower at $40 million[7]. Figure 6 shows the scheme stack for this revised portfolio, in the event that inflows recover to post 1975 levels.

Figure 6 **AT planning under post 1975 climate scenario**



3.7 Expected value of portfolios

The expected value of the cost of alternative scheme portfolios can be assessed by attaching probabilities to the likelihood of different climate outcomes. For example, if it was considered that a 50% probability attaches to the most likely inflow scenario (post 1997 inflows), with a 25% probability attaching to the post 1975 and post 2000 scenarios, then the expected cost in NPV terms of the portfolio is 0.5 x $967m + 0.25 x $40m + 0.25 x $1.046m = $755m.

Under Water Corporation's planning approach, the expected cost of the portfolio is 0.5 x $1,114bn + 0.25 x $863m + 0.25 x $1,205 m = $1,074m – very significantly greater than that of the small scheme adaptive planning approach.

[7] The first Perth desalination plant could again be run at half capacity, although in this case only until the end of 2014/15 if the probability of a total sprinkler ban is to be kept below 3%. Taking account of this would increase the cost of the alternative portfolio somewhat (by $95 million) but it would remain substantially cheaper than the 1975 inflow Water Corporation portfolio.

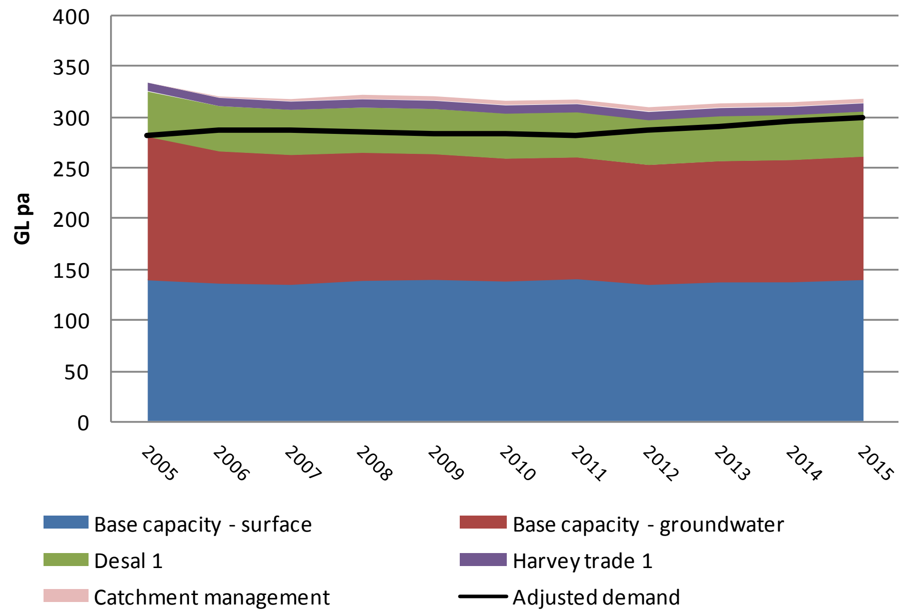
Even under a more conservative assumption, with equal probabilities attached to the post 1997 and post 2000 inflow scenarios, the expected value of the smaller scheme portfolio is lower than the Water Corporation strategy. ($1,006 million versus $1,160 million).

Full options modelling would need to take into account the fact that there will not be a definitive resolution of the nature of the climate pattern for a long time to come. This may mean some additional costs in maintaining adequate insurance – but seems unlikely to undermine the argument that there appears to be scope for substantial cost saving while managing the risks implied by the 8-year scenario.

3.8 Accelerated demand management to avoid commitment

As discussed above, there are issues involved in some of these smaller schemes. An alternative approach could use accelerated demand management to defer irreversible commitment to the major schemes.

Figure 7 **Scheme planning under post 1997 climate and accelerated demand management**



Under this approach, accelerated demand management at the scale flagged earlier is used to halt the growth in demand for long enough to determine likely future inflows. The matching of costs to need is critical – as is the flexibility to avoid some costs if the post 1997 inflow scenario does not persist.

The accelerated demand management is assumed to be relatively expensive, with a levelised cost of water saved of around $1.20/kL. In addition accelerated demand management involves additional user costs.

The present value (of supplier only) costs for this portfolio is $400 million, substantially less than the cost of the alternative portfolio because the accelerated demand management allows deferral of the second desalination plant beyond the planning horizon.

Moreover, this portfolio also provides valuable flexibility. Should inflows revert to post 1975 levels, the accelerated demand management programme would not be required at all (with the catchment management and existing Harvey water trades providing sufficient capacity to meet the sprinkler ban constraint.

In practice, there is likely to be a 'ramp up' time in gaining traction with these accelerated demand management schemes. Policy decisions with funding would need to be taken and an adequate skills base to deliver the services would need to be assembled in a very tight labour market. However, the earlier comments are relevant – once the process is under way, and the demand management reductions forthcoming, this delivers greater security even ahead of actual delivery of the demand reductions. The security assessment paradigm will need to be reviewed.

Importantly, based on work we have been involved in other jurisdictions, the package of potential accelerated demand management options is likely to range from quite cheap to very expensive. The scope for 'cherry-picking' these alongside prioritised use of the smaller supply side options could prove very attractive – and might also allow some earlier traction to be achieved through some of the supply schemes.

3.9 Probing the optimal portfolio

The portfolios presented above are illustrative, and do not necessarily represent the optimal approach. For example, major aquifer recharge combined with some of the other smaller schemes and/or demand management may provide a lower cost portfolio than the one set out in section 3.4, which incorporates the second desalination plant.

Moreover, the optimal approach may vary according to the probabilities attached to possible future outcomes. This can arise if an adverse climate change outcome meant that a large-scale scheme was cost effective – even after taking into account the time profile of water delivered to customers. Building in the flexibility to delay commitment to such a scheme would entail a higher cost outcome in the event that low inflows materialise. The expected cost of the more flexible portfolio is likely to remain lower than the expected cost of large-scheme portfolio, however, provided the probability of low inflows is not very high.

As much as anything, we have sought to illustrate an approach to probing the possibilities within an economic planning paradigm that we see as being appropriate to the task, given the nature of the risks and the possibilities for response. Within this paradigm, small size, scalability, deferability etc have major attraction. Large schemes with good project-based size economies can be very expensive compared to a package of schemes, and a sound adaptive decision process, even if the individual components appear to have poorer project economics.