The National Water Initiative:

A Personal Submission to the Productivity Commission

from Professor John Langford AM FTSE

1. Introduction

I'm writing to follow up a zoom conference call convened by Professor Rob Vertessy of the Academy of Technological Sciences and Engineering, and to share insights on water reform gained from 50 years of experience.

In addition to my role as and Honorary Professorial Fellow at the University of Melbourne I Chair the Board of the Alliance for Water Stewardship - Asia Pacific.

2. Reinvigorating the National Water Initiative

Since the foundation work for the national water initiative was concluded in 2004 climate change has emerged and is now recognized as impacting much of southern Australia. We have endured the Millennium Drought, unprecedented in the historical record. Recognizing that this Drought is only the harbinger of what is to come we should be preparing ourselves for more prolonged and severe droughts, punctuated by more destructive floods. History will not treat us kindly if we do not adequately prepare for this challenging future.

Innovation is vital. A cooperative effort linking the practitioners with researchers is most likely to deliver the necessary innovation, balancing theory with practice informed by experience gained from learning as we go. Collaboration between water professionals and economists is central to successful innovation. The Productivity Commission is in a good position to lead such collaboration.

The security of city and regional water supplies, and achieving a resilient, mutually beneficial balance between water allocated to productive irrigation, the ecological needs of the environment, and for the cultural purposes of our indigenous people should be the central to the reinvigoration of the National Water Initiative.

3. Security of City Water Supplies

The Millennium Drought reached its nadir in 2006 leaving most of Australia's large cities teetering on the brink of disaster with the very real prospect of running seriously short of water. Desalination plants were constructed in short order. Given the crisis situation and lack of foresight there were few other viable options to insure the security of water supplies against the Drought continuing. We now have the time to reflect on this experience and prepare for the inevitability of the next drought, keeping in mind that the assumption of stationary hydrological series fundamental to previous planning no longer holds.

3.1. Portfolio Theory: Managing Risk by Diversification

City Water planners have now embarked on a strategy of managing risk by diversifying the sources of water in other words building a portfolio of diverse water sources. The potential portfolios now include:

- desalination;
- non-potable recycling (with the future possibility of potable recycling);
- purchase of irrigation water entitlements;
- rainwater tanks or harvesting water from impervious surfaces;
- harvesting stormwater from city landscapes; and
- initiatives to improve water productivity.

The financial sector has developed considerable experience in managing risk by building portfolios of diverse investments. The benefits of reducing investment risk by diversifying investments is informed by Portfolio Theory. The risk associated with the annual returns on individual investments is based on the volatility or variance of these returns over a defined period of years. The risk associated with the mean investment return of a portfolio is calculated from the covariance matrix of the annual returns of all the investments in the portfolio, and the proportion of each investment in the portfolio.

Investments with a low covariance (or correlation) with other investments are more effective in managing the risk to the portfolio return. Mean-Variance Analysis (comparing the risk of obtaining a given mean return) has been developed to identify efficient portfolios, defined as "an obtainable mean-variance (risk return) combination is inefficient if another obtainable combination has a higher mean and no higher variance, or less variance and no less mean". Mean Variance Analysis provides a pathway to identifying optimum investment portfolios from the set of efficient ones.

Understanding the stability or otherwise of the covariance matrix under the stress of difficult economic times is vital to managing risk. The Global Financial Crisis (GFC) of 2007 was exacerbated by the covariance matrices of investment portfolios collapsing under extreme stress causing investment returns declining together, and portfolio returns reaching unacceptably low values. Central banks have taken the lessons of the GFC to heart and now require individual banks to stress test their investment portfolios under extreme stress.

The experience of the financial sector in optimizing investment portfolios for a defined appetite for risk, and in stress testing these investment portfolios are concepts that have potential application to city water supplies. Optimizing the cost of portfolios of diverse water sources for defined appetites for risk, and evaluating their behavior under the extreme conditions of a drying climate and prolonged droughts are important topics for research.

3.2. Lessons for Planning City Water supplies

3.2.1. Stress Testing Water Source Portfolios

City water supply systems have inherited large reservoir storage capacity; the legacy of earlier policies to manage risk to supplies by increasing storage capacity. These large reservoirs are now complemented by desalination plants resulting from the crisis management required to avoid disaster during the Millennium Drought and its nadir in 2006.

These desalination plants are costly to operate raising questions about the best operational strategy should:

- desalination plants be operated at higher rates, incurring higher operating costs, to maintain the reservoirs at higher levels thereby reducing the risk of future crises? or
- savings be made in operating costs by allowing the reservoirs to be drawn down to low levels, and use the desalination plants to manage the ensuing crisis?

A research project involving a collaboration between the four Melbourne water utilities,the Victorian Department of Environment Land, Water and Planning and the University of Melbourne demonstrated the value of stress testing Melbourne's water supply system using relatively short periods of hydrological record (both historical and stochastically generated). These relatively short periods are more appropriate for stress testing a water supply system under a drying climate and non-stationary inflow series.

The magnitude of the supply deficits that is the difference between the water demand and the ability of the water supply system to meet that demand was used to calculate the cost of applying water restrictions to reduce the demand to the available supply. The costs of restrictions we're balanced against the additional costs of operating the desalination plant at higher levels.

The Project demonstrated that operating Melbourne's desalination plant at higher rates was more cost effective then allowing the storages is to fall further and use the desalination plants as a crisis management tool. This project also demonstrated that considerable cost savings could be made by shortening the construction time of future augmentations to the water supply system. A copy of the project report: "The Economic Value of Water in Storage" is attached for your information.

The value of stress testing water city water supply systems under the extreme conditions of a drying climate should be included in the rejuvenation of the National Water Initiative. All city and regional water supply systems should be regularly stress tested under extreme conditions, given the known initial reservoir storage Such stress testing will inform when to initiate augmentation and identify the best sequence of augmentations well in advance thus avoiding the panics of 2007, and allowing more effective community consultation. Timely identification of the sequence of augmentations will also facilitate the application of Real Options Analysis, reducing construction times, and saving considerable sums of money.

3.2.2. Optimizing Portfolios Under Stress

Optimization of portfolios of different water sources is another potential application of portfolio theory, informed by Mean Variance Analysis. Defining new risk metrics based on the mean and variance of supply deficits is crucial to success in this endeavor. The traditionally used time frequency of supply deficits, such as 95 years in 100 without restricting demand, is no longer valid in a drying climate. The performance of different water sources cannot be evaluated and compared without a defined risk metric, nor can the portfolios of different water sources be optimized. How would the performance of a High Reliability Water Entitlement be compared with that of a rain water tank, storm water harvesting system or a desalination plant? This is a serious defect in our current approaches. Research to define risk metrics is an essential first step before Mean Variance Analysis can be applied to simulations of system behaviour to optimize the cost of water portfolios supplying water demands with the required appetite for risk; both important subjects for research.

In applying Portfolio Theory to the diversity of water sources now available, the interaction of the various water sources with the large storage reservoirs, or the ability to increase the demand supplied by low reliability sources must be considered. A low reliability water source when included in a water supply system with a large reservoir can supply a larger increment in demand than the low reliability source considered in isolation. If the low reliability water source is given first preference in meeting demand, and supply from the large reservoirs used as a last resort in topping up the supply to meet the demand allowing the low reliability source to increase the storage level in the large reservoir (I am sure the Romans would have known this principle!) . This simple example illustrates the importance of considering operational policies when evaluating water portfolios. It also reinforces the point that the yield of individual sources must be evaluated in the context of the portfolio, not in isolation otherwise low reliability sources can be substantially undervalued.

If low reliability low cost water sources are available, such as low reliability irrigation water entitlements, or a multitude of small rain water tanks, the air space in the legacy water reservoirs can be used to improve the resilience of the water supply system under stress.

3.3. Integrated Water Management (IWM)

Integrated Water Management encompasses the whole water cycle of a city including water supply, storm water and sewerage (waste water). It has the objective of stimulating innovation with a focus on introducing local, decentralized options and the use of the city as a water supply catchment. The relatively high costs of greenfield developments on the city fringes, and renewal of ageing infrastructure, or construction of infill development in established urban areas provide opportunities for innovation and IWM.

The origins of IWM can be traced back to waterway management and the desire to reverse the ecological damage to urban water ways and receiving waters. IWM has made a substantial contribution to improving waterway management, and community amenity but is facing institutional, governance and regulatory challenges complicated by lack of incentives for innovation, that are limiting the potential scale of implementation. particularly in providing water supply and wastewater services.

Different organizations can be responsible for providing water services, and local government has a substantial influence on waterway management and local planning. The benefits of innovation may come at a cost to other service provision; lower sewerage costs through non potable recycling for development on the urban fringe can come at the cost of higher water supply costs. Water service providers are highly regulated and are caught up in a tangled web of regulatory and governance constraints that constrain innovation. Cost reflective developer charges and pricing of services that could provide financial incentives for innovation are "missing in action". The ongoing operation, maintenance and renewal of privately owned infrastructure installed by developers are problematic.

The discussion facilitated by Professor Rob Vertessy on behalf of the Academy of Technological Sciences and Engineering provided illustrations of the barriers facing IWM:

- Paul Greenfield spoke of an innovation in Queensland that would have resulted in a significant overall benefit to receiving waters, but the environmental regulator would not approve the innovation because it came at the cost of a slight increase in sewer overflows;
- Karlene Maywald referred to a storm water harvesting initiative in South Australia which "withered on the vine" through lack of maintenance; and
- Tony Wong lamented a lack of transparency in the economic analysis of a development at Fishermans Bend in Melbourne, that stymied innovation in water service provision.

How can these barriers to innovation allowing diversity in water service provision to occur where it is more cost effective? What is the ultimate potential of IWM on a city -wide scale?

During the developing of the first incarnation of the NWI I recommended the selection of a carefully selected set of "Icon Sites" of IWM occurring in Australia cities covering a range of physical, institutional, governance and regulatory settings. In effect establishing a set of exemplars of IWM and evaluate their performance including service provision, environmental benefits, resilience, longevity and cost effectiveness with the objectives of demonstrating the potential of IWM and identifying the conditions necessary to stimulate innovation; as time went by enthusiasm for establishing these exemplars waned and nothing happened.

Here we are 17 years later pondering the same questions; but we do have 17 more years of experience. As Mark Twain was quoted as saying "Good decisions comes from experience, and experience comes from making bad decisions".

The Productivity Commission is in a good position evaluate this 17 years of experience including both it's successes and failures to define the institutional, governance, regulatory frameworks and incentives that will lead to innovation and ongoing good performance of IWM initiatives: not seeking someone to blame but investigating what happened and how to fix it! A thorough economic evaluation of the costs, benefits, resilience and potential city-wide scale of IWM in a drying climate would provide an essential guide for the future.

3.4. **Water Productivity and Water Stewardship**

The substantial improvement in water productivity of city water supplies, that is supplying larger populations without commensurate increases in water demand, is one of the major achievements of Australian water reform over the past 40 years. Water demand in Melbourne has barely increased from levels experienced in the early 1980s despite the addition of millions of people. Without the reforms underlying this achievement there would be desalination plants up and down the Bass Strait coast burdening Melbournians with their substantial costs. Other Australian cities can demonstrate similar achievements. Water productivity is also a core element of IWM Improving water productivity has an advantage in applying to all water users in a city, and not restricted to greenfield sites or urban renewal.

A drought is 1982/83 stressed Melbourne's water supply to breaking point stimulating initiatives to improve water productivity. The reforms included 3 key components:

- Regulation; such as mandating dual flush toilets in 1984 for new and replacement cisterns;
- User pays water pricing policies introduced in 1985; and
- Public education and engagement programs were launched (Don't be a Wally with Water!).

These reforms have been progressed with varying degrees of enthusiasm over the following 40 years reflecting the rise and fall in Melbourne's reservoirs. The Millennium Drought stimulated greater effort to improve water productivity, above and beyond the water restrictions that were introduced to avert a disaster.

It is important to recognize that every ML gained by improved water productivity of the non-seasonal component of demand: water used within the home, or most of the industrial and commercial demand; is equivalent to a ML of water produced by a desalination plant because both these water sources are independent of climate. Improving water productivity is therefore an essential component of a portfolio of water sources designed for a drying climate. The quantum of investment in water productivity can be determined by comparing the cost of achieving greater productivity with the consequent reduction in operating and augmentation costs, of desalination plants.

The question is: how can water productivity be improved further now that water pricing reform has run its course? Water Stewardship is an emerging international movement stimulating improved water productivity, water quality outcomes, improving water related environments, and community engagement. A rigorous international standard has been prepared to measure performance against defined goals. Regular audits ensure that the agreed performance goals are being met.

Water Stewardship encompasses a wide spectrum of activities:

- community engagement to build commitment, and encourage practice of good water stewardship;
- providing guidance to organizations and businesses informing them of the value of good water stewardship; and
- Accreditation against the international standard at either baseline, gold or platinum standards.

Accreditation requires significant investment including the costs of ongoing auditing and is appropriate for more sophisticated organizations, industries and businesses. The Renmark Irrigation Trust in South

Australia, and Inghams chicken processing plant in Somerville on the Mornington Peninsula are 2 examples of accreditation against the international standard.

Given that measured, and audited improvements in water productivity in the non-seasonal component of city water demand, will reduce operating and augmentation costs of desalination plants there is a strong argument for developing financial incentives for large water users to become accredited water stewards.

Implementation of IWM requires ongoing operation and maintenance of alternate water systems which are often beyond the scope of water utilities' responsibilities. Accreditation as good water stewards is an effective mechanism ensuring that community investment in IWM is protected and continues to deliver ongoing benefits long after developers have retreated from the scene.

The updated National Water Initiative should include measures to promote Water Stewardship for both the wider community and water using industries.

4. River Basin Management

Despite the cries of the critics, the current Murray Darling Basin Plan is a substantial step forward providing a solid foundation for adaptive management to drive continuing improvement based of the hard won experience of managing the current portfolio of environmental water entitlements. Sadly the public discourse has focused on the clash between environmental water needs and irrigation; as a "them versus us" argument.

If environmental and irrigation water entitlements are used as two buckets separated by an impervious barrier then both groups will miss out on mutually beneficial exchanges of water. How can such mutually beneficial exchanges by achieved?

4.1. Empowering the River Operating Authority

The river operating authority is in the best position to identify opportunities for mutually beneficial exchanges of water, and to engage with both interests to modify operation of river flows to better meet their needs. The functions of the river operator are already expanding from the traditional role of delivering irrigation water entitlements to include:

- delivery of environmental water entitlements;
- operating environmental works and measures; and
- shepherding environmental water flows down unregulated rivers.

The river operating authority should also have the additional operational role of enhancing both irrigation and environmental water productivity (both of which can be measured); while mitigating environmental damage (fish kills, toxic algal blooms, salinity, black water events etc). There is a strong argument for setting up the river operating authority as a separate organization outside the current Murray Darling Basin Authority. Separation of operations from policy and planning was a key feature of the original 1994 COAG Water Reform Agenda; at the very least the role and governance of the river operator should be reformed to empower and provide the river operator incentives to deliver mutual benefit.

4.2. Counter Cyclical Water Trading

Countercyclical water trading involves the sale of carefully selected seasonal water allocations during dry years at relatively high prices, and use of the funds to purchase much larger volumes of seasonal allocations during wet years to enhance seasonal flooding of flood plains. Some years ago a National Water Commission funded project managed by the University of Melbourne entitled “Farms Rivers and Markets” sponsored a component project by Monash University to investigate the potential benefits of countercyclical water trading in protecting the riverine red gum forests of the Lower Goulburn River in Victoria. Ralph Macnally, Nick Bond and Dan Simpson were the researchers if my memory serves me correctly.

The research demonstrated that counter cyclical water trading could protect larger areas of red gum forest on the flood plains with significantly smaller volumes of environmental water entitlement and at lower cost. Removal of constraints to flooding the flood plain is an essential precondition to achieving these benefits. This research should be widened from the Goulburn system to include the to include all the major river red gum forests in the Murray Darling Basin. If nothing else this research would demonstrate the economic benefit of removing the constraints to flooding.

A copy of the summary report of the Farms Rivers and Markets Project is attached. The countercyclical trading research is described on pp 35 & 36. The Table on page 36 summarizes the potential benefits of countercyclical water trading.

5. Unfinished Business

AS far back as the early 1990s universal metering of all major water diversions was agreed as high priority. The COAG Water Reform Agenda of 1994 required universal metering; yet here we are in 2020 with large water diversions from the Darling River and its tributaries still unmetered. In 1995, the NSW signed up to putting a cap on diversions at the level possible with the infrastructure in place in 1993/1994. This cap on diversions from the Darling and its tributaries in NSW has not been honoured. At the very least all significant diversions of water should be metered and the diversions from unregulated rivers should all be telemetered to the river operator.

Given the history of this issue at the very least a register of all unmetered diversions should be prepared and published including the presence or absence of telemetering.

As water resources decline and the available resource becomes more valuable greater investment in water measurement and accounting makes sense. Inadequate measurement can result in significant errors, for example in estimates of water losses in river systems. The Farms Rivers and Markets Project referred to earlier provides a cautionary tale for the Broken River in Victoria. A review of the current water measurement networks in stressed river systems, and the consequences of likely errors, particularly in transmission losses, should be undertaken to guide future investment in more comprehensive measurement.

6. Summary and Conclusions

- Adaptation to climate change should be an explicit, overarching objective for the rejuvenated National Water Initiative. Charles Darwin made the comment that it is not the strong or intelligent that survive; it is those the adapt to change that survive!

- Stress testing of city and regional water supply systems should be mandated as a requirement of the National Water Initiative to avoid the undesirable outcomes of planning in a crisis.

- Research should be commissioned to inform the creation of optimum portfolios of water sources that better manage risk to the security of city and regional water supplies in a drying climate.

- The Productivity Commission should review the experiences of implementing IWM since the NWI was initiated in 2004 including the factors involved in successes and failures, with the objective of untangling the web of institutions, asset owners, regulations, governance, incentives or lack thereof, and acceptance of rigorous cost benefit analyses. The review should also explore the potential for large scale implementation of IWM.

- Incentives should be developed to improve the water productivity of the cities and regional towns, recognizing the value of improving the productivity of the non-seasonal components of water demand, through a disciplined approach to water stewardship.

- Achieving mutually beneficial exchanges of water between seasonal allocations for irrigation and the environment would make a constructive contribution to managing the Murray Darling Basin.

- The role of the river operator should be strengthened by reform of the governance separating the operational role from that of policy and planning. The river operator should be given the specific role of achieving mutually beneficial exchanges of water.

- Research should be commissioned to explore the benefits and risks of countercyclical water trading as tool for expanding the area of riverine red gum forest benefiting from environmental water allocations. The research should also help place a value of removing the constraints to flooding the flood plain.

- The number, volume and location of unmetered diversions for irrigation from rivers, including the presence of telemetry should be published annually.