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Executive Officer
Environment and Natural Resources Committee
Parliament House
Spring Street
East Melbourne VIC 3002

28 August 2008

To the Executive Officer,

Re: Inquiry into Melbourne's Future Water Supply

Thank you for the opportunity to contribute to the Environment and Natural Resources Committee's Inquiry into Melbourne's Future Water Supply. We understand that this Inquiry is aimed at assessing the relative merits of supplementing Melbourne's water supply by a range of means including water savings, stormwater harvesting, the re-use of treated wastewater, groundwater use, small local desalination plants, and any other means deemed appropriate. We believe that this inquiry is timely given the unprecedented challenges faced by Melbourne's metropolitan water sector (such as population growth, climate change, environmental degradation and supply scarcity) and the range of promising technological and governance solutions now available.

This submission has been prepared with input from Monash University researchers, academics and associates working at the forefront of best practice water management, governance, climate change and sustainability. This draws upon expertise across the Arts, Engineering, Science, and Law faculties at Monash University. Over the past few decades, Monash University has established itself as a centre of excellence for research into the sustainable management of water resources and urban sustainability and is host to prominent water related institutes and programs including: the National Urban Water Governance Program; the Institute for Sustainable Water Resources; the Water Studies Centre; the Monash Sustainability Institute; the Australian Centre for Biodiversity; the Monash Climate Group; and the Facility for Advancing Water Biofiltration.

It is from this perspective that we believe we can make salient, informed comments on delivering the water supply options that will offer the most sustainable and effective outcomes, while improving Melbourne's resiliency and liveability in the long-term.

We would welcome the opportunity to present our submission to the Environment and Natural Resources Committee at its public hearing. Please contact Nina Keath on (03) 9905 4618 or nina.keath@arts.monash.edu.au should you need any clarification on our submission.

Yours Sincerely,

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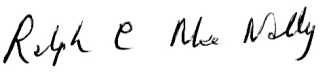

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MONASH University

Parliamentary Inquiry into Melbourne's Future Water Supply
Monash University Submission

The merits of a diversity of water sources with stormwater as an important element

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Introduction

Like many Australian cities, Melbourne has been almost exclusively dependent on water resources derived from the capture of rainfall runoff from largely rural or forested catchments. While this approach has served Melbourne well for many years, this reliance upon a single source has resulted in significant water supply vulnerability due to the effects of a changing climate, and higher water demand associated with a growing population.

A growing body of local and international commentators are calling for major changes to the way urban water systems are managed in order to address the increasing social and environmental challenges facing cities around the world (Brown *et al.*, 2008; Brandes & Kriwoken, 2006; Bulter & Maksimovic, 1999; Maksimovic & Tejada, 2001; Newman, 2001; Pahl-Wostl, 2007; PMSEIC, 2007; Tjandraatmadja *et al.*, 2005; Wong and Brown, 2008).

Best-practice urban water management

Best-practice urban water management is widely acknowledged as complex because it requires urban water planning to protect, maintain and enhance the 'multiple' benefits and services of the total urban water cycle that are highly valued by society. These include:

- supply security;
- public health protection;
- flood protection;
- waterway health protection;
- amenity and recreation;
- greenhouse neutrality;
- economic vitality;
- intra and inter-generational equity; and
- demonstrable long-term environmental sustainability.

Part of the complexity of realising this best-practice is the need for identifying and employing approaches that protect and enhance these multiple and interdependent benefits and services. In the past, water managers have often reduced this complexity by focussing on optimising singular parts of the water cycle such as 'supply security' in isolation and/or in absence of reliable consideration to the other dimensions of the cycle. This has often resulted in outcomes that compromise a significant proportion of the multiple objectives of best-practice urban water management (as listed above), therefore increasing the vulnerability of cities such as Melbourne.

Water supply solutions that best protect and enhance the full suite of values and benefits from a total water cycle perspective are likely to result in more resilient solutions over the long-term.

The merits of having a diversity of water sources: a portfolio approach

Melbourne can have access to a diverse range of water sources, many of which are available within the city (metropolitan) boundaries. These include groundwater, urban stormwater, rainwater (roof runoff), recycled wastewater and desalinated water.

The proposed desalination plant and Sugarloaf Interconnector pipeline, as 'external' supply inputs, form a part of a strategic portfolio of diverse water sources for

Melbourne. Notwithstanding this, the Monash team hold a number of concerns about the environmental, social and economic costs. Effort needs to be directed at ensuring that the desalination plant and Sugarloaf Interconnector pipeline are not adopted as 'silver-bullets' that would eliminate the need to further investigate and develop other options of lower economic and environmental cost as part of a portfolio approach to enhance supply resilience into the future.

With works on the desalination plant and Sugarloaf Interconnector pipeline now commenced, efforts need to be directed at further research, planning and development for a diverse supply strategy for Melbourne.

The importance of water conservation

Water conservation is critical to the resilience of Melbourne's future water supply strategy. This can be achieved through a sophisticated host of formal and informal interventions that influence societal expectations and behaviours in relation to water use. The scope of these interventions is broad and includes strategies such as community education, public participation, community co-design and co-management of future supply infrastructures and services, water restrictions and a host of other strategies identified by the community for the community. It must no longer be an assumption of water supply policy that communities wish to be passive consumers of water supply. There is increasing evidence that communities wish to be involved in a range of ways, from providing information on preferences through to being co-producers of future supplies through stormwater and wastewater harvesting.

In comparison to other Australian cities, Melbourne has been successful with achieving a good level of positive social capital and behavioural change around water use (i.e. less overall water consumption). The successful introduction of permanent water conservation measures across Melbourne is testament to the overall socio-political support from Melbourne's community. These permanent water conservation measures are viewed by the Monash team as encouraging long-term water-wise behaviour. They demonstrate how restrictions can and should be used in strategic ways to reinforce positive and increasing social capital. It is likely that water conservation measures will have potential benefits for more sustainable consumption behaviours with other resources consumed by the Melbourne community (such as energy and packaging). As new diverse water sources become available, it will be important that Melbourne's positive gains in social capital are not undermined by the scaling back of existing water conservation measures.

It would be remiss if the Government set the objective of future 'levels of service' at an unrestricted level of water consumption given not only the significant investment in achieving this social capital gain, but perhaps more importantly, Melbourne's unique success in behavioural change, community awareness and knowledge of the water cycle.

Cost, reliability and risk of diverse water sources

The unit prices of water from a range of possible sources and scales are shown in Figure 1 below (Marsden Jacob, 2006).

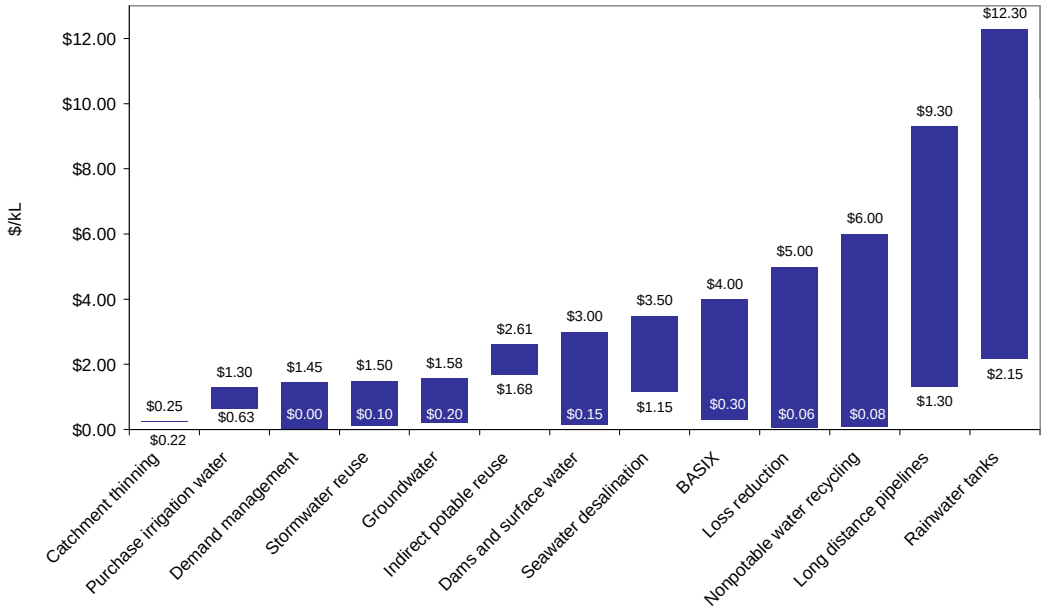

Figure 1. Unit price of water from a range of diverse water sources (Marsden Jacob, 2006)

Each of the possible diverse water sources have unique reliability, environmental risk and cost profiles with the tendency for sources of high reliability to also have associated high cost and environmental risk profiles and vice versa.

In the future, Melbourne will have the best supply resilience if the city has the capacity to dynamically access, over short and longer timeframes, a portfolio of diverse sources that would continually deliver an appropriate balance of economic and environmental costs, and supply security, that reflects the prevailing local climate and socio-demographic conditions.

A diversity of decentralised, precinct and centralised water supply infrastructure

A city's water supply resilience is at its strongest when its diverse sources are accessed through a diversity of infrastructures at different scales including decentralised, precinct and centralised water supply schemes. This can range from the simple rainwater tank on an individual property for non-potable use, through to neighbourhood-based stormwater harvesting schemes, and out to city-scale indirect potable reuse schemes and the 'pipeline grid' linking regional reservoirs.

The process of dynamic optimisation will be based on local climatic and other governing conditions at the time. It is this dynamism, at a mix of delivery scales that will overcome the current vulnerability associated with reliance on a single water source (rural and forested catchment runoff captured by dams located outside city boundaries) and ultimately underpin Melbourne's resilience to the impact of climate change, and the (future) volatility of the energy market, to urban water supply security.

A diversity of water sources accessed at a mix of scales (decentralised, precinct and centralised infrastructure) ensures preferential access of available sources of lowest

economic cost and environmental risk ahead of options with higher cost and environmental risk.

Development of urban stormwater as part of the portfolio of supplies

There has been a good level of scientific investigation and industry-based discussion on a number of the available water sources including desalinated water, wastewater recycling (indirect potable reuse and non-potable water recycling shown in Figure 1), rural/urban water transfer through long distance pipelines, and rainwater harvesting. However, to date, there has been limited attention placed on the significance of urban stormwater as an important element of a city's portfolio of water sources. While much debate has focussed on rainwater tanks this is only one of a host of options in relation to the management of rainfall and stormwater as a resource. It is evident (from Figure 1) that precinct and regional-scale stormwater harvesting schemes can often offer higher cost-effectiveness.

Further, harvested stormwater, if treated to potable standards, can readily be an alternative source of water that contributes to a centralised water supply scheme, as is the case in a number of cities including the city of Singapore. Many centralised water supply schemes comprise an amalgamation of local decentralised schemes serviced by balancing reservoirs and stormwater harvesting technologies are suitable for servicing such schemes.

Urban stormwater is a readily available and under-utilised resource in cities that can be cost effective and environmentally sustainable. It can be accessed through the full spectrum of scales – from the local household scale through to precinct, regional and city scales.

Harvesting urban stormwater delivers multiple benefits to society

There are opportunities for developing integrated urban design solutions that employ stormwater not only as an important water supply source but also as a solution to several problems that currently challenge our cites including:

- *enhancing urban water supply security* – urban stormwater is a significant source of water, generated close to where it is needed;
- *building resilience to climate change* – stormwater harvesting systems can function with very low energy use. Treatment of urban stormwater through vegetated stormwater treatment technologies has been researched and proven. These systems can also be used to improve the urban microclimate, therefore reducing air-conditioning requirements and energy use and improving public health;
- *improving urban waterway health through pollution and hydrologic controls* – it is well documented that uncontrolled stormwater runoff from urban areas degrades creeks and waterways (e.g. Walsh *et al*, 2004). Treatment and harvesting of urban stormwater leads to positive management of the water quality and natural hydrology of urban creeks and waterways to improve waterway ecosystem health (Fletcher *et al*, 2007);
- *improving urban design* – stormwater harvesting using green infrastructure enhances social amenity and opportunities for public recreation in addition to its potential for influencing micro-climates in urban areas.
  - The significance of keeping water within the landscape, combined with the role of vegetation and orientation of building elements, are urban design

issues that will be critically influence the urban micro-climate (Endreny, 2008).

- Recent work on mortality and extreme temperature shows a marked threshold temperature beyond which significant increases in mortality occur (Nicholls *et al*, 2007), so even relatively slight ameliorations of extreme temperature through improved urban design can have the potential to save lives.

Availability and reliability of stormwater in Melbourne

Figure 2 below shows the amount of stormwater and wastewater generated in Australian capital cities compared to the external water supplied to these cities to meet water demands (PMSEIC, 2007). It is important to highlight that as much as 90% of water demands in cities do not require potable water quality standard and it is evident that the combined total of wastewater and stormwater generated within the city footprint far exceeds the water demand of each city. The wastewater that is generated is closely linked to population. The urban stormwater runoff is generated every time rain occurs, and unlike rural or forested rainfall runoff, the nexus between soil moisture and rainfall runoff in urban environments is significantly weaker leading to higher volume reliability in urban areas. From impervious areas such as roads, an annual runoff coefficient (ie. the amount of rainfall that forms runoff) of 90% is common, whilst in forested or rural catchments, only around 10-20% of the rainfall becomes runoff, with the rest lost to evapotranspiration.

There appears to be a widely held perception that there is a lack of space for stormwater retention in the urban footprint. Catchment yield (ie. the volume of stormwater that can be effectively harvested) is dependent on complex inter-relationships of climate, density of development (i.e. imperviousness), storage size, demand volume, demand type, etc. With harvested stormwater currently used almost exclusively for garden and open space watering, the main impediment to achieving higher stormwater yield is the mis-match of demand pattern and supply pattern. For example, with high summer water demand and higher winter supply, the need for significant storages to provide the necessary storage buffer has been perceived as a major cost impediment to stormwater harvesting. In a recent study undertaken at Monash University (Mitchell *et al*., 2006), it was shown that a stormwater yield of between 13% and 32%, depending on development density, can be achieved by providing a total stormwater storage volume of 100 kL/Ha. The corresponding yield figures increase to 22% and 58% respectively when harvested stormwater is also supplied to meet a more uniform demand pattern associated with toilet flushing.

Harvesting stormwater for non-potable household uses could lead to a 20% to 60% reduction in the demands on mains potable water supply. While the volume of stormwater runoff varies annual, there is the potential to reliably harvest up to 150 GL of stormwater annually.

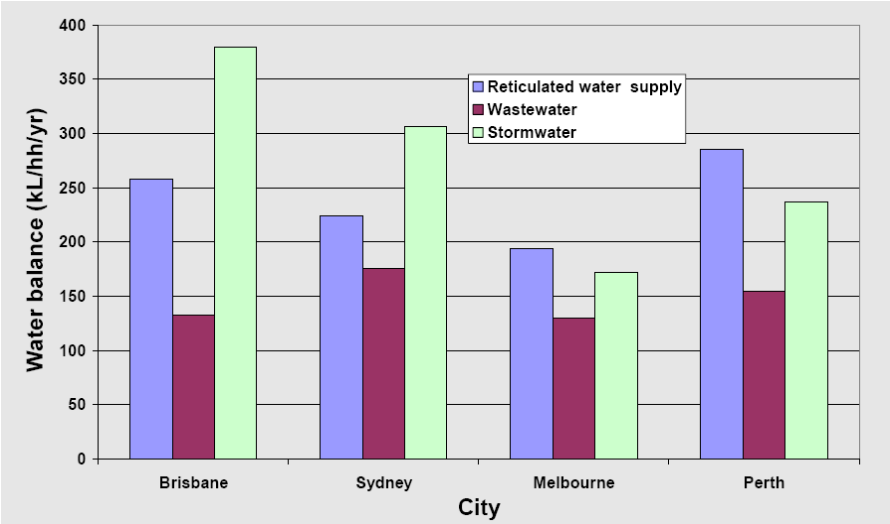

Figure 2. Wastewater and stormwater generated in Australian Cities (PMSEIC, 2007)

Technologies for stormwater treatment and harvesting

Water sensitive urban design (WSUD) has been a feature of Melbourne's urban development and re-development projects over the past 5 years (Wong, 2006; Brown and Clarke, 2007) and the recent revision to Clause 56.07 of the Victorian Planning Provisions has formalised the requirements for WSUD in new residential subdivisions.

Continuing research undertaken over the past 3 years by the Facility for Advancing Water Biofiltration at Monash University [www.monash.edu.au/fawb/] has delivered the necessary 'proof-of-concept' of biofilter technologies further strengthening the technical basis underpinning water sensitive urban design (Read *et al.*, 2008, Hatt *et al.*, 2007 Bratieres *et al.*, in-press).

On-going research and development at Monash University involving porous paving has further advanced the suite of available technologies for the effective harvesting and treatment of stormwater.

Interactions between groundwater and stormwater

There is a wide variety of available groundwater across the Melbourne metropolitan region (Leonard, 1992), often of suitable quality, that is similar to stormwater and acceptable for irrigation uses (Mudd *et al.*, 2004). As such, there is a wide array of choices with respect to groundwater resources, and this could represent an important local supply of water at low energy cost. A major option for groundwater is that of 'aquifer storage and recovery' or ASR, whereby water of a given quality, such as stormwater or recycled water, is injected into groundwater aquifers for storage until required (Mudd *et al.*, 2004). This has two principal benefits, namely alleviating the urban water storage problem and minimising evaporation losses from surface water systems.

A recent study on the potential of ASR in Melbourne (Dudding *et al.* 2006) found that a large area of Melbourne has aquifers potentially suitable for ASR at bore yields of greater than 1 ML/day, shown in Figure 3.

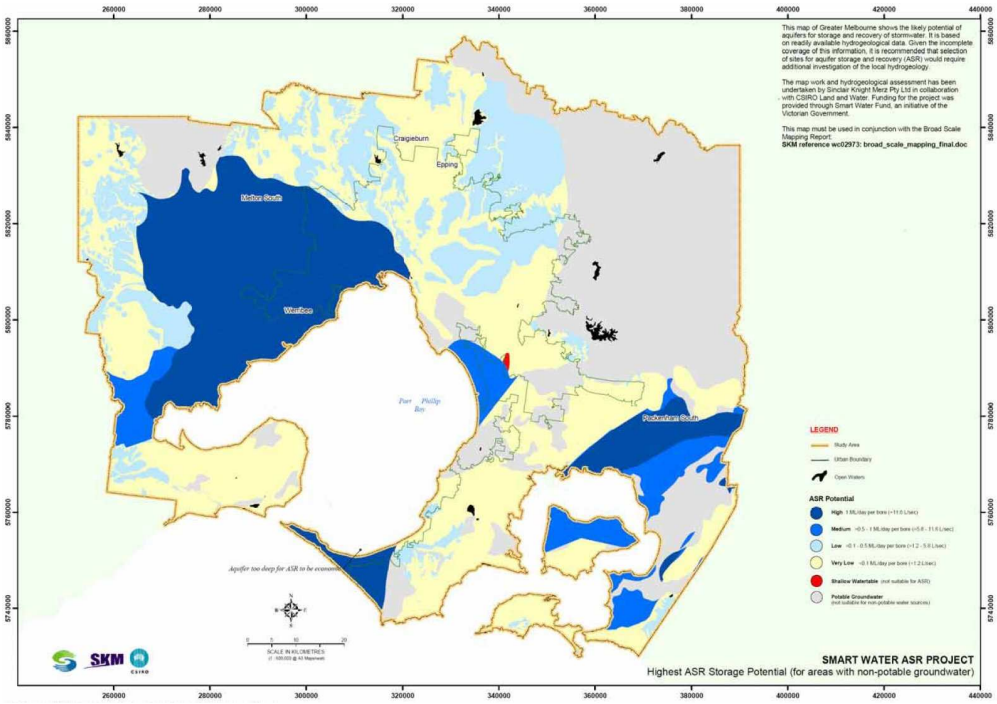

Figure 3: Highest potential for aquifer storage and recovery (ASR) projects across the Port Phillip region (Dudding *et al*., 2006)

Given that ASR projects are commonly practiced at the site of use and are compatible with a range of water sensitive urban design approaches (eg. wetlands, recycling), they are very efficient water projects for urban areas and easily demonstrable as a truly sustainable long-term component of urban water infrastructure and resources.

Professional support for stormwater as a water source

A recent on-line survey of over 420 urban water professionals in Melbourne by the National Urban Water Governance Program at Monash University [www.urbanwatergovernance.com] revealed a high level of support for adopting a diverse water supply approach in a fit-for purpose context (Brown *et al.*, 2007). As shown in Figure 3, 80-100% of urban water professionals responding to the survey believed that developing rainwater and stormwater as water supply sources were of 'high' or 'very high' importance. The lowest level of professional support was for new dams, seawater and groundwater.

0-19%	20-39%	40-59%	60-79%	80-100%
New Dams	Seawater Groundwater	Water Trading	Greywater Sewage	Rainwater Stormwater

Figure 3. Perceived importance amongst urban water professionals of developing diverse water sources in Melbourne (high and very high importance ratings) (Brown *et al*, 2007)

While the use of stormwater and rainwater was strongly supported by urban water professionals, they indicated that they did not feel supported by their organisations or by politicians who they believed were not fully committed to best practice principles of 'total water cycle management' or 'water sensitive urban design'.

Governance and service delivery models

Traditional governance and service delivery models for water management are being challenged and renegotiated as communities demand a greater level of engagement around water management and environmental sustainability.

To ensure ongoing water supply resilience, future governance and service delivery models will need to be adaptive and underpinned by a flexible institutional regime, and co-existing and diverse infrastructure designed to reinforce sustainable practices and social capital, recognising the implicit link between society and technology.

The key players involved in water management have now expanded to represent environmental protection needs through government departments, NGOs and professional communities advocating for urban stormwater quality management. As Melbourne incorporates and seeks to protect the suite of environmental and social values of the water environment, the distribution of functions and responsibilities will need to continue to be fundamentally reshaped.

Contemporary research suggests that for localised innovations to be successful, key stakeholders need to have ownership as well as a role in design to capitalise on their local knowledge. Therefore, the urban water sector will need to place a strong focus upon inter-sectoral partnerships between government, communities and the private sector for the co-design, and eventual co-management of stormwater harvesting (and other supply) approaches at the household, streetscape, and neighbourhood levels.

Balancing short and long-term water supply solutions

The proposed desalination plant and Sugarloaf Interconnector pipeline are elements that form part of a diverse water supply approach and provide a short-term response to Melbourne's looming water shortage, in spite of a number of concerns about their environmental and social costs. If Melbourne is to be resilient in the longer-term, it will be important that the investment in desalination and the pipeline are viewed as strategic solutions that can 'buy time' to invest in the long-term planning required for other more sustainable sources of water such as stormwater.

The timeframe for implementation of stormwater harvesting scheme is expected to be longer than the solutions associated with seawater desalination and rural/urban water transfer and will span the typical land renewal cycle of the city. Like the current practice of water sensitive urban design, the implementation of stormwater harvesting schemes will take advantage of opportunities presented by greenfield and brownfield (urban renewal) development projects, and the growing number of initiatives by local government to secure alternative water for public open space irrigation. Getting the policy and planning instruments in place is essential when implementation is tied to progressive urban development and redevelopment activities in Melbourne.

Unlike the traditional centralised water systems, which have benefited from over two centuries of dedicated research and development (and associated learning around appropriate governance mechanisms) urban stormwater harvesting systems at precinct and regional scales are relatively recent concepts.

Often stormwater harvesting schemes are inappropriately assessed in terms of their effectiveness as a sole or 'silver bullet' solution, whereas they form an integral part of

a solution strategy incorporating a diversity of water sources. These options, and the associated additional multi-benefits, require further research for 'proof of concept' and development of appropriate governance and servicing models.

If, in the future, Melbourne has evolved into a water supply catchment (i.e. the urban footprint is used to harvest and store diverse supplies) through its access to a wide diversity of water sources, it may be possible for Melbourne to supply water to rural and regional urban environments which are more vulnerable to the effect of climate change owing to their continued dependency on rural or forested catchment rainfall runoff for their water supply.

Future planning (now that solutions for the short-term requirements have commenced) must be directed at examining lower economic and environmental cost options for the implementation of a long-term sustainable water supply solution. This must be underpinned by a portfolio of water sources that are accessed through a mix of centralised and decentralised infrastructure to ensure Melbourne's resilience into the future.

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