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WHAT NEXT FOR LIVEABILITY?

LEARNING FROM THE PAST AND PRIORITISING FOR THE FUTURE

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ABSTRACT

Urban development faces ongoing pressure from climate change, population growth and urbanisation. The New Urban Agenda, sets a global vision for future cities to be compact, inclusive, equitable, cohesive, participatory, resilient, sustainable and productive. Urban water management plays a role in achieving these outcomes in providing infrastructure and ecosystem services. In Australia, there is a continued focus on creating water sensitive cities that are sustainable, resilient and liveable. Of these, liveability has been the most recent shift for the Australian water industry. This paper looks at an approach to implementing water solutions that enhance liveability, so that these solutions move from the opportunistic and demonstrative to standard practice. A case study of the Cup and Saucer wetland is examined to show the liveability outcomes that have shifted Sydney Water's appetite and capacity for similar water sensitive urban design projects. The case study demonstrates how the wetland has contributed to improving water quality, community engagement, identification of upstream pollution sources, habitat, biodiversity and local climate as well as strengthened interagency rapport. In addition, it shows the economic value of the wetland and benchmarks the wetland against the liveability indicator metrics developed by the Water Services Association of Australia. This paper also uses the case study example to look at the local area transition to being water sensitive through benchmarking against the transition dynamics framework developed by the Cooperative Research Centre for Water Sensitive Cities. It is proposed that the transformation to incorporating water sensitivity as standard practice can be facilitated by: ensuring institutional commitment; benchmarking a city's state of urban water management and setting a common vision for the future state; using the transition framework to identify key gaps in the stages of transformation to set strategic goals; and using relevant indicators to better understand the full economic as well as non- monetary costs and benefits of the applied water solutions.

INTRODUCTION

Population growth and climate change are transforming our cities. In 2015 the world's population reached 7.3 billion and is currently growing by 1.18% per year, set to reach 8.5 billion people by 2030 (United Nations DESA, 2015). The majority of future communities will be city dwellers, in fact, as many as 66% of the world's population is projected to live in cities by 2050 (United Nations DESA, 2014). This population growth and urbanisation present significant challenges to sustainable urban development, particularly in terms of environmental sustainability, social equity and governance. Climate change adds to the significant challenge of the environmental sustainability and resilience of cities. With climate change the world has seen increasing frequency and intensity of drought, heat waves and rainfall events (IPCC, 2014). These extreme weather events result in large impacts to infrastructure, and to people's livelihood and wellbeing. Water is central to the social and environmental health of a city and so this context provides significant challenges for urban water management, but also opens up opportunities in the benefits that water can bring to urban areas.

In response to the challenges of population growth, urbanisation and climate change, the international community has included a goal in the United Nations Sustainable Development Goals to 'make cities inclusive, safe, resilient and sustainable' (SDG 11) and has developed the New Urban Agenda, which describes cities as being compact, inclusive, equitable, cohesive, participatory, resilient, sustainable and productive (UN General Assembly, 2015 and United Nations, 2016).

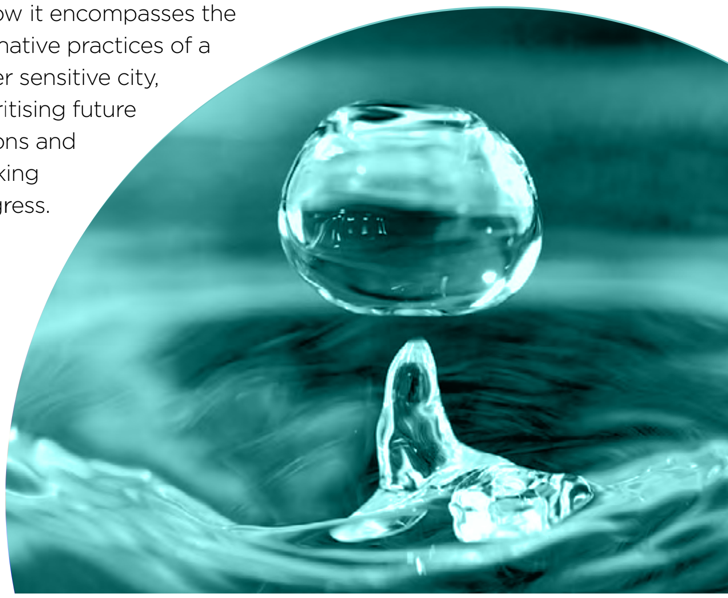
These global agendas are more than simply envisaging the sustainability and resilience that meets environmental challenges, but they also recognise the importance of the social and cultural aspects of a city. This global vision is well-aligned with the Australian concept of the Water Sensitive City. A Water Sensitive City maintains the long-standing normative values of water supply, wastewater management, flood mitigation, waterway protection and the consideration of the limits of natural resources; however, it goes further to incorporate societal values of sustainability, intergenerational equity and resilience to climate change (Brown *et al.*, 2009).

Brown *et al.* (2009) describe the vision of a Water Sensitive City as one that uses adaptive, multi- functional infrastructure and urban design, while also ensuring the community is engaged, informed and committed to water sensitive behaviours. This type of city can be described as sustainable, resilient and liveable, and of these concepts, liveability has arguably been the biggest recent shift for the Australian water industry to understand and progress.

While the elements that make a specific city liveable are contextual and subjective, at the core, a liveable city provides access to goods and services as required and desired in the specific context (Ruth and Franklin 2014). In the past urban development has been thought of mostly in terms of built infrastructure, however, Birtles et al (2013) identified the importance of ecosystem services from natural environments within Sydney in improving liveability outcomes according to whether the services are life-enabling, life-sustaining or life- fulfilling. This research proposed a framework that categorised liveability interventions from ecosystem services and showed their value. These interventions must be coupled with built infrastructure to achieve the target liveability outcomes for the city. Australia has been working towards creating liveable cities for some years. For example, in 2011 the federal government released an urban policy detailing the liveability initiatives championed by the government, including making cities safe, accessible and affordable, as well as funding sustainable local infrastructure solutions (Australian Federal Government., 2011). The idea of liveability has continued to grow as the population is increasingly aware and engaged in what sort of city they want to live in. The water industry has responded to this with a focus on customer-centricity. Customer centric urban water management not only focuses on providing water services, protecting the environment, public health, and building resilience, it also seeks to understand what customers value and to make a positive contribution to people's quality of life. In this way, liveability has been embedded, not merely as a buzz word, but as a concept driving the priorities of the Australian water industry.

The Government and community's focus on liveability presents a challenge for the water industry to shift what has been, and remains, standard practice. There are many examples of projects which use multi-functional infrastructure and urban design as described as an element of a water sensitive city. However, these projects often happen through opportunistic funding rather than through prioritised strategy and consistent funding. To reach a water sensitive city state that exhibits sustainability, resilience and liveability it is necessary to integrate water sensitive practices into every infrastructure decision.

Some of the challenges to such a transformation include identifying a common vision for the future of the city, community participation, institutional capacity and governance and understanding the true costs and benefits (Ison, 2009). To inspire institutional commitment, set a vision and prioritise funding, it is helpful to first understand and attempt to quantify the sustainability, resilience and liveability impacts of existing projects through post-implementation evaluation of the monetary and non-monetary costs and benefits. There are many indicators available to help to quantify this evaluation. Understanding the value of these projects helps set a common vision; transitioning the city to that vision requires benchmarking the state of urban water management in how it encompasses the normative practices of a water sensitive city, prioritising future actions and tracking progress.



This paper demonstrates the benefit of looking back at past projects to understand what impact utilities can, and have had on liveability. While the concept of water sensitive cities encapsulates sustainability, resilience and liveability, the focus will be on liveability as this component requires a significant transformation of water industry practices. The paper examines a case study of a Water Sensitive Urban Design (WSUD) project and demonstrates how the outcomes have increased organisation appetite and capability for future WSUD projects. It also shows relevant indicators that can be used to measure the outcomes as well as examining the contribution that this project has had to progressing the city to a new state of urban water management. This evaluation and city state benchmarking can then be used to prioritise the focus of future projects so that incorporating water sensitivity becomes standard practice.

METHODOLOGY/ PROCESS

A case study of the Cup and Saucer Wetland, a small-scale, retrofit WSUD project in Sydney, was examined with two aims: to better understand the project's contribution to the liveability of the area; and to improve understanding of how to value potential future projects of the same nature.

Anecdotal evidence of the wetland's impact on liveability was documented and has been a useful tool in promoting similar future projects. However, as Australia progresses towards creating water sensitive cities more effort has been made to develop measures to understand both the monetary and non-monetary costs and benefits. One example is the Water Services Association's (WSAA) liveability indicators. The Cup and Saucer Wetland case study is compared against these indicators to show the areas in which similar future projects could contribute to liveability.

More generally, Sydney's progress in the transition to a water sensitive state was also analysed using the transition dynamics framework. Gaps were identified to help prioritise future actions and projects.

RESULTS AND DISCUSSION

The Cup and Saucer Wetland is located in Sydney's inner west at Heynes Reserve, located at the confluence of Cup and Saucer Creek and the Cooks River. Cup and Saucer Creek drains water from an urban catchment covering approximately 503 ha, of which 49% is impervious. The Creek was converted into a 3.6 km concrete stormwater channel in the 1930s, which was in line with the urban drainage infrastructure of the time; a trend which has resulted in 89% of the Cooks River tributaries being converted from natural waterways to concrete and brick drainage structures (Cooks River Catchment Association of Councils, 1999).

Heynes Reserve was a low-use open space and was identified, with considerable support from the community, as a good location for a small wetland (Thompson Berrill Landscape Design, 2009). The Cup and Saucer Wetland was designed to treat only a portion of the flow from Cup and Saucer Creek; the wetland size and inflow volume was limited by the size of the reserve. The wetland size is 0.225 ha and a model using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) software was developed to determine the optimal flow rate for this size wetland. The modelling results showed that the best treatment results would be achieved with a maximum inflow of 0.2 m^3/s. At this flow the wetland would achieve an annual load reduction of 5,000kg/y (5.1%) for Total Suspended Solids, 130kg/y (0.9%) for Total Nitrogen and 40kg/y (3.7%) for Total Phosphorus (Martens & Associates Pty Ltd, 2009).

In addition to the engineering design for water quality improvement, other design features of the wetland include a viewing area, seating, outdoor classroom, interpretive signs and a vegetated fauna passage to facilitate the movements of turtles, eels and other animals between Cooks River and the wetland. Figure 1, below, shows the Heynes Reserve before construction and the wetland after a one year establishment period.

Figure 1. Heynes Reserve before construction and the wetland one year after construction

There were also a number of benefits offered by the wetland beyond the water quality improvements. These included community engagement, identifying pollution sources upstream of the wetland, improved habitat, biodiversity and local climate as well as strengthened interagency rapport, organisational capability and appetite.

Community support for the project was evident from the outset when 86 resident surveys on the concept design were returned indicating 90% agreement with the construction of a wetland to treat stormwater (Thompson Berrill Landscape Design 2009). This support was consistent throughout the project to the opening of the wetland, which 250 people attended (SMCMA 2011). This engagement has continued with a higher use of the reserve, including being the chosen location for a wedding. Moreover, direct feedback and monitoring of print and social media has shown positive reflections on the value of the public space (Cunningham and Birtles 2013).

The wetland water quality monitoring has also led to identifying several upstream pollution incidents. Not only has this resulted in remedial action, but has also helped educate the public in pollution prevention. The freshwater wetland has created a unique habitat that has improved the biodiversity of the area, including a variety of birds, macroinvertebrates, frogs and turtles. The organisations involved in this project have reported strengthened rapport with partner organisations and with the community.

Through this project the organisational capability for WSUD has improved as employees have been equipped with the required skills and confidence. Furthermore, the evidence of the positive impact on the environment and the community has strengthened organisational appetite for similar future projects. However, the wetland outcomes outlined above do not give a full picture of the monetary and non-monetary costs and benefits derived from the project. As articulated by Maksym Polyakov (2015), the evaluation of the costs and benefits of WSUD technologies tends to occur before construction to ensure the chosen option gives the most benefit to the community, but there are few examples in the literature of comprehensive project evaluation after completion. Post-completion project evaluation is important as it demonstrates and attempts to quantify the value the project economically, environmentally and socially. Since completion of this project, recent hedonic valuation work identified the Cup and Saucer Wetland construction and the naturalisation of 300m of the river bank adjacent were in the order of $16M using 2013 house prices (Morrison & Thomy, 2016).

This valuation then supports the argument for the true costs and benefits of future projects, as currently these are often measured based on their financial viability, rather than the potential holistic benefits.

One way that the Australian water industry is trying to better measure the outcomes of these sorts of projects is through liveability indicators to capture and quantify, in a simplified way, the environmental and social benefits in addition to a financial evaluation. There are various indicators available; this paper focuses on the liveability indicators published in 2016 by the Water Services Association of Australia (WSAA, 2016). The indicators aim to help water utilities to contribute to amenity and community wellbeing, productivity, sustainability and future focus. WSAA have developed a "menu" of indicators, as seen in Table 2, and it is encouraged that urban water managers select a number of these indicators to focus their effort and measure their impact on liveability.

In the case of the Cup and Saucer wetland the below points show which indicators are relevant and, where possible, how they meet the indicator metric. Where evaluation against the metric is not available, the metric itself has been indicated in *italics*.

- Reducing urban heat
  - *Measured by number of days per annum exceeding critical heat threshold*
  - It is difficult to measure this metric on a local scale. Instead there are plans for heat mapping of the area.
- Infrastructure land available for the community purposes
  - 0.6 ha of land available
- Lengths of paths and cycleways providing connectivity
  - 0.28 km walking and bike paths
- Water Sensitive Urban Design
  - Up to a maximum of 17.28 ML/d of water treated through a WSUD feature
- Value-add of projects delivered through collaboration
  - *Measured by value added ratio dollars spent to dollars of value delivered (not currently measured by utilities)*
- Native vegetation gain
  - 5,000 m^2 of vegetation gain
- Community water literacy
  - *Not currently measured by utilities but potential to be useful metric*
- River health
  - *No metric specified, Cooks River health measured in line with Botany Bay & Catchment Water Quality Improvement Plan (Kelly and Dahlenburg 2011)*

In addition to the anecdotal evidence of improved liveability, these indicators show the various aspects of improved amenity, community wellbeing, productivity and sustainability. This outcome for Sydney Water has put a renewed focus on WSUD projects as delivering positive outcomes for customers. This has resulted in a momentum that has helped to unify our vision of the importance of these projects in being a customer-centric organisation and has seen an increase in similar projects, such as an extensive program of work to naturalise waterways.

Not only do these indicators provide a means of post-implementation evaluation to understand value, inspire institutional commitment and set a common goal, but are also important in setting direction and purpose at the beginning of a project. These measurable impacts help to plan and scope future projects to maximise Sydney Water's impact on the liveability of an area. However, project prioritisation must also be considered in the context of Sydney's vision and progression to being water sensitive. Brown, Rogers et al. (2016) have developed a transitions framework to assist with prioritising actions for this transformation to occur. Brown first sets out five areas where change and capacity building must occur. These areas have been defined as 'domains of change'. As a city transitions to being water sensitive each of these domains becomes more sophisticated and capable to progress change. To achieve the end goal in each domain there are six expected phases of transition from identifying and quantifying the problem, agreeing on and building confidence in the possible solutions, implementing the required policy and governance to embedding the new practices. Table 3 shows the domains of change and the indicators for how each domain moves through the transition phases.

City-wide benchmarking of a city's state and its progress through the transition stages occurs through a thorough assessment of the state of urban water management by reviewing the literature and engaging with a diverse range of stakeholders, including water and related sector professionals, researchers, community and government. The completed assessment is compared with the transition dynamics framework indicators, thereby highlighting which indicators require further work and prioritising the city's efforts in becoming water sensitive. Though not encapsulating the whole picture, the Cup and Saucer Wetland case study narrative through each transition phase has been included in Table 3 to visualise the use of the transition framework. The case study narrative demonstrates that the project has helped to progress to a local area urban water management state that values the protection of waterways as well as providing increased amenity. Table 1 summarises the outcome of the project in each domain of change. This then highlights which areas of change are still required to meet the end goal and therefore, which projects to prioritise for the future.

Table 1. Cup and Saucer Wetland outcome for each domain of change

Domain of change	End goal	Cup and Saucer Wetland outcome
Actors: Key networks of individuals	Multi-agency coalition	Good multi- agency coalition between Sydney Water, councils and community groups.
Bridges: (Semi) Formalised organisations, structures and processes for coordination and alignment	Formalised institution	No formalised bridging organisation. The collaboration was driven and coordinated by a few individuals.
Knowledge: Research, science and contextualised knowledge	Next research agenda	Used established technology and modelling to develop the wetland. Still building capacity for this knowledge to be widespread in organisations. However, this project did increase the WSUD appetite and capacity.
Projects: Experiments, demonstrations and focus projects	Standard Practice	This is one of numerous industry-led field experiments, however, the implementation of these projects still relies on opportunistic funding and is not yet standard practice.
Tools: Legislative, policy, regulative and practice tools	Political mandate, coordinating authority, comprehensive regulatory models and tools	The relevant local council requires collection and onsite detention of stormwater in the Development Control Plan, but no specific requirements for WSUD.

This framework can be used to prioritise areas for future projects across the city. For example, in this case the relevant local council did not have WSUD requirements in place. These requirements are in place for other local councils and need to continue to be introduced across Sydney. The case study also shows that while there was good multi-agency coalition, there was no formal bridging institution for coordination and alignment of water sensitive initiatives. Rather, a significant bridging role was undertaken by key staff within Sydney Water and the Catchment Management Authority. This has, in part, led to the support for and development of a dedicated regional bridging organisation network in later years. The Splash network has been funded via state government agencies, Sydney Water and local government and is focussed on industry and government staff capacity regarding climate change resilience and enhancing liveability through WSUD solutions.

The other key priority that remains is shifting projects from the opportunistic and demonstrative to standard practice within the context of city wide water servicing. This paper has shown that one part of moving in this direction is to use indicators to understand the true costs and benefits of projects that incorporate liveability goals to inspire institutional commitment and set a common vision. Then to benchmark the current urban water management state of the city to prioritise future strategic focus and to set future project goals with this strategy and these project indicators in mind.

CONCLUSION

The transition to water sensitive cities requires a major shift in current practice from mostly opportunistic projects through one-off funding sources to embedding water sensitive practices in all urban water management decisions. It is proposed that this shift can be facilitated by: ensuring institutional commitment; benchmarking a city's state of urban water management and setting a common vision for the future state; using the transition framework to identify key gaps in the stages of transformation to set strategic goals; and using relevant indicators better understanding the full economic as well as non-monetary costs and benefits of the applied water solutions.

Examining the Cup and Saucer Wetland case study has captured the anecdotal evidence and relevant liveability indicators to show the wetland's contribution to the liveability of the area. This project has helped to inspire a focus on similar future projects in demonstrating the benefits to the community. It can be seen that the liveability indicators can be used to set targets and measure outcomes for similar future WSUD projects. In addition to setting goals at a project level, the narrative and outcomes of the Cup and Saucer Wetland project show the project's contribution to transitioning to a more water sensitive city state. The gaps identified in this transition included establishing formalised bridging organisations and ensuring water sensitivity is standard practice for all future projects. These gaps can be used to set strategy and prioritise future projects. For examples, work is already being done on developing the Splash network as a formalised bridging organisation.

It has been demonstrated that prioritising actions to meet the needs and desires of future communities is highly relevant in Australia. Moreover, as reflected in the Sustainable Development Goals and the New Urban Agenda, this need is also important globally. There is an immediate need for an approach, such as the one presented, to ensure that sustainability, resilience and liveability are entrenched in urban water management so that future cities are inclusive, safe, resilient and sustainable.

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Dan Cunningham is an environmental leader with over 15 years' experience in waterway, stormwater and natural asset management. In his current role as a Lead Planner with Sydney Water he is championing some of the largest waterway restoration projects in Sydney as well as planning to improve waterway health as the city experiences unprecedented growth.

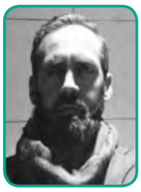

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Table 2. A menu of liveability indicators developed by WSAA

	Amenity and wellbeing **We work to maintain the health of our cities, and to understand our customers' values and aspirations for the liveability of our cities.**	**Productivity** **We harness the full productivity of our people and infrastructure to ensure that water services remain affordable.**	**Sustainability & future focus** **By applying science and understanding risk we contribute to the long term sustainability of our cities.**
Context	- Days exceeding critical heat threshold**	- Regional GDP** - Urban Growth**	Tree cover** or Canopy Coverage** Native vegetation gain**
Input	- Infrastructure land available for community purposes - Land assessed for liveability outcomes - Water available for parks gardens and amenity* - Length of paths/cycle-ways providing connectivity* - Community access to lakes and waterways - Assets with alternate/dual use for community outcomes*	- Existence of an integrated water management plan* - Recycled water supplied to industry - Contribution to WSUD/ stormwater harvesting	- Climate change adaptation program (phase) - Certified to an Environmental Management System - Water efficiency programs
Output	- Number of complaints related to amenity - Sewer overflows - Drinking water compliant with ADWG - Catchment water quality risk - Frequency and severity of restrictions - Water supply security* - Public Safety on or near water infrastructure & land* - Customers assisted through hardship program - Number of visitors to recreational areas - Beaches closed due to sewer overflows	- Water service connections available to lots released* - Value-add of projects delivered through collaboration* - Years to next major augmentation* - Total lifecycle cost of network* - Total lifecycle cost of treated water/wastewater* - Potable water use relative to target - Alternative water volume targets - Operating cost - Value of Agriculture using recycled water irrigation* - Cost of flooding above floor level* - Travel time impacts of infrastructure failure*	- Volume of water recycled - Energy/carbon intensity of treatment and transport - Renewable energy generated - Nutrients/ biosolids recovered - Efficient water use - Customer water efficiency - Community water literacy* - GHG Emissions - Infrastructure Leakage Index (ILI) - Electricity consumption from renewable sources - EA compliance of contractors* - Length of waterways naturalised* - Waterway quality guidelines** - Pervious surfaces*
Outcome	- Swimmable beaches - Customer satisfaction	- Affordability of water - Value of water dependent GDP*	- River health index** or Health of aquatic ecosystems** - Ecological footprint for total water services - Resilience*

Table 3. Transition dynamics framework from Brown, Rogers et al. (2016)

Domains of change						Example of transition to a new state of urban water management
Transition phase	**Actors**	**Bridges**	**Knowledge**	**Projects**	**Tools**	**Cup and Saucer Wetland**
1. Issue Emergence	Issue activists	N/A	Issue discovery	High profile scientific studies	N/A	Issue of water pollution in well established in 1990s. Water quality testing programs completed for Cooks River in 1990s.
2. Issue Definition	Science leaders	Science-industry	Cause-effect	Laboratory-based & scientific solution prototypes	N/A	Results of water quality testing informed stormwater management plans developed by 13 local councils, the catchment management committee, the metropolitan water utility and the state road and traffic authority.
3. Shared Understanding & Agreement	Technical solution coalition	Science-industry-policy	Basic technological solutions	Minor scientific field demonstrations	Draft best-practice guidelines	Stormwater management plan (1999) options were maintaining natural waterways, source control and "end-of-pipe" solutions such as GPTs, detention basins and litter booms and wetlands. Plan set action to build Cup and Saucer Wetland.
4. Knowledge Dissemination	Informal policy coalition	Science-industry-policy-capacity building	Advanced technological solutions	Major scientific field demonstrations	Best-practice guidelines, targets	WSUD technologies well developed and best-practice guidelines in place such as CSIRO WSUD Engineering Procedures. Cooks River Urban Water Initiative (2008-11) used a portfolio of best-practice solutions to address water quality issue.
5. Policy & Practice Diffusion	Policy & decision coalition	Science-industry-policy-capacity building	Modelling solutions, capacity building	Numerous industry-led field experiments	Legislative amendment, market offsets, national best- practice guidelines, regulatory models	Cup and Saucer wetland built in 2010 with design based on MUSIC modelling results. Industry-led application of WSUD, acknowledged benefits started to broaden from water quality to liveability. Major benefits included increased institutional and community capability and appetite for WSUD projects.
6. Embedding New Practice	Multi-agency coalition	Formalised institution	Next research agenda	Standard practice	Political mandate, coordinating authority, comprehensive regulatory models & tools	Successful multi-agency coalition. Still require further embedding of WSUD retrofit projects to become standard practice.