

Stormwater Management Design Objectives

DISCUSSION PAPER SUMMARY REPORT

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Introduction

The waterways of Queensland provide a range of values and ecosystem services that support the environmental, social and economic prosperity of the state and need to be managed in ways that protect and enhance those values and services.

Threats and impacts from urban areas (both new and existing) on our waterways can take a range of forms, including increased stormwater runoff volumes and frequency, increased pollutant loads and concentrations, erosion, siltation and destruction of waterway habitats and loss of abundance and diversity of the flora and fauna that relies on these.

Recognising the threats to the values of our waterways, the Queensland Government has established urban stormwater management design objectives that apply to new developments in Queensland. While these objectives have helped to increase awareness and enshrine urban stormwater management in mainstream practice, there is a need to review the current situation to ensure that our urban waterways continue to provide for the values that the community desires. The purpose of this paper is to discuss the frameworks that have been established to help protect and enhance waterway values from the impacts of urban stormwater and examine the ability of the design objectives for urban stormwater to deliver outcomes that assist in this.

The project scope included the requirements for:

- a literature review of current scientific knowledge in this area;
- a review of implementation to date of the existing Design Objectives;
- evidence-based proposals / recommendations for alternative waterway health objectives;
- links to existing policies and frameworks such as Living Waterways 2.0 (Water by Design 2017);
- the practical application of the Design Objectives, triggers for adoption and applicability of offsite measures; and
- insights on potential barriers to adoption, how these new objectives can instigate widespread adoption.

More specifically, there was a requirement to focus on whether there was sufficient information to provide guidance on revised design objectives for hydrology and water quality criteria.

This executive summary includes key findings from the report, and suggests recommendations for both the types of objectives needed to effectively manage stormwater impacts, and changes to the frameworks for their implementation.

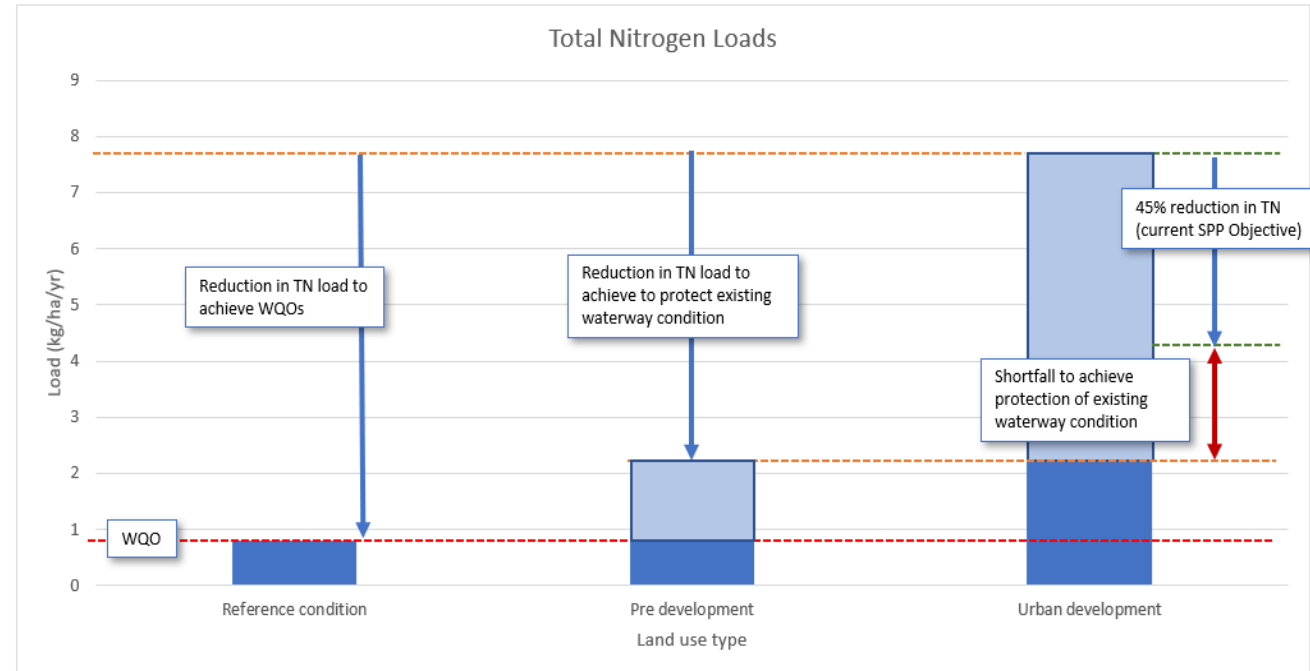
The history of the design objectives

Within Queensland, our current focus in developing design objectives stems from the late 1990s, when the Environmental Protection (Water) Policy was released that allowed for the setting of water quality objectives across Queensland.

These objectives were designed to protect and enhance community agreed Environmental Values consistent with the National Water Quality Management Strategy. Local governments responded to this by developing approaches that required assessments of compliance with concentration-based water quality objectives to be considered in new urban developments. Some Councils, notably City of Gold Coast, required that developers demonstrate a "no-worsening" of water quality as part of their developments.

The results of these early approaches were that concentration-based objectives on their own were able to be manipulated quite easily to demonstrate compliance. The monitoring of stormwater quality at the time suggested that the greater runoff volumes from increased imperviousness of urban areas, and therefore greater overall load of pollutants was the important issue to focus on. For this reason, local governments moved towards pollutant load reductions from the developed future land use as it could be demonstrated that this would also address the concentrations of pollutants in most cases.

The challenge with this approach is that it no longer considered the pre-developed land use, such that in certain circumstances, even with the pollutant reduction requirements applied, increases in overall loads from an area could occur.



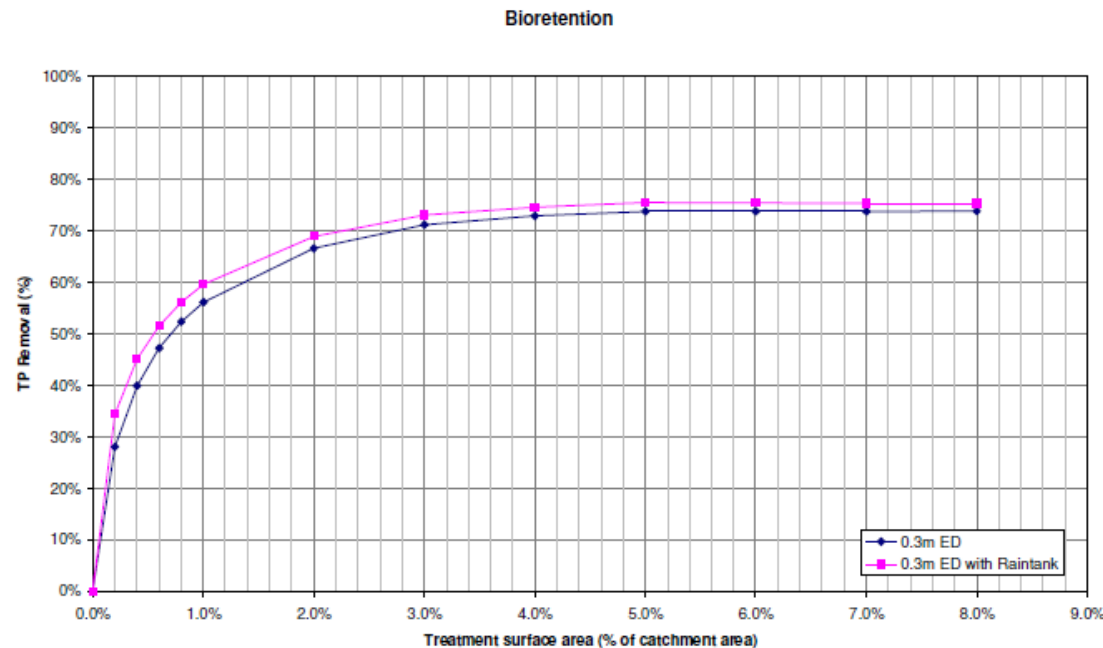
Illustrating the problem

The above chart shows that depending on the pre-existing land use, the application of a load based reduction on the developed land use will not return loads back to what they were prior to development, nor would they be sufficient to achieve water quality objectives in downstream waterways. This is meant to be an illustrative example, as in real cases, the results are highly dependent on the existing land use classification, but the issue is consistent across Queensland, especially for total nitrogen. What this means is that our current design objectives do not allow us to protect or enhance Queensland's waterways, but they do help to mitigate some of the impact of urban stormwater on downstream receiving environments.

Application of the existing design objectives

Application of the existing design objectives

To understand the cost-benefit of stormwater quality management, several business cases were developed in the last 20 years examining various combinations of stormwater treatment approaches. *These all showed that there are optimal sizes of treatments which, if over or undersized, would no longer be cost-effective to achieve load-based reductions.* This led to the development of stormwater design objectives based around the reductions in loads of pollutants that appropriately sized treatment measures could deliver based on these "diminishing return" curves as shown below.



These assessments lead to the development of different policy approaches which eventually became the load-based reduction objectives currently contained within the Single SPP within the Water Quality State Interest (SPP July 2017).

What is the problem – the objectives

Current approaches to managing urban stormwater have typically only focused on achieving compliance with the load reduction design objectives, with limited attempts to manage urban hydrologic change through waterway stability objective.

The use of the MUSIC model for compliance assessment has led to treatment measures that satisfy the SPP objectives most effectively in terms of model results, but do not consider all of the design outcomes needed to protect existing urban waterway health. This is not a fault of the tool itself, but its ease of use can lead to perverse outcomes where function is prioritised over form, as shown in the picture opposite. In these cases, the designer of the stormwater treatment measures has focused only on achieving the requirements of the SPP objectives through modelling and engineering, rather than considering the multiple objectives than can be achieved through proper integration into the built environment. The SPP objectives are therefore useful in driving the delivery of treatment measures that can achieve specific load reductions, but do not adequately drive the maximisation of benefits that true Water Sensitive Urban Design (WSUD) can deliver.

While the current approach has a number of issues as outlined above, it has provided a good mechanism for delivery of stormwater treatment outcomes to date, including:

- A balance of stormwater treatment and affordability
- Treatments that have been implemented can provide disconnection of impervious surfaces, slowing down flows
- The compliance approach is straight forward and easily modelled with MUSIC
- A reasonably equitable distribution of costs across developments in a jurisdiction
- Consistent approach across local governments
- There are only a small number of targets (in effect, 3 numbers only)
- Widespread adoption rates for new development types across Queensland



What is the problem – key points for the objectives

It is always easy to focus on the negative outcomes, but examination of a range of treatment measures implemented across Queensland show that even where they are not well integrated into the urban form, have aesthetic or nuisance issues or have some failure of asset integrity, they are usually providing their intended stormwater treatment function to a large degree. The challenge is therefore not only one of treatment function, but of better asset management and integration with a range of potential beneficial outcomes.

Even so, there are a number of issues identified with the current objectives, including:

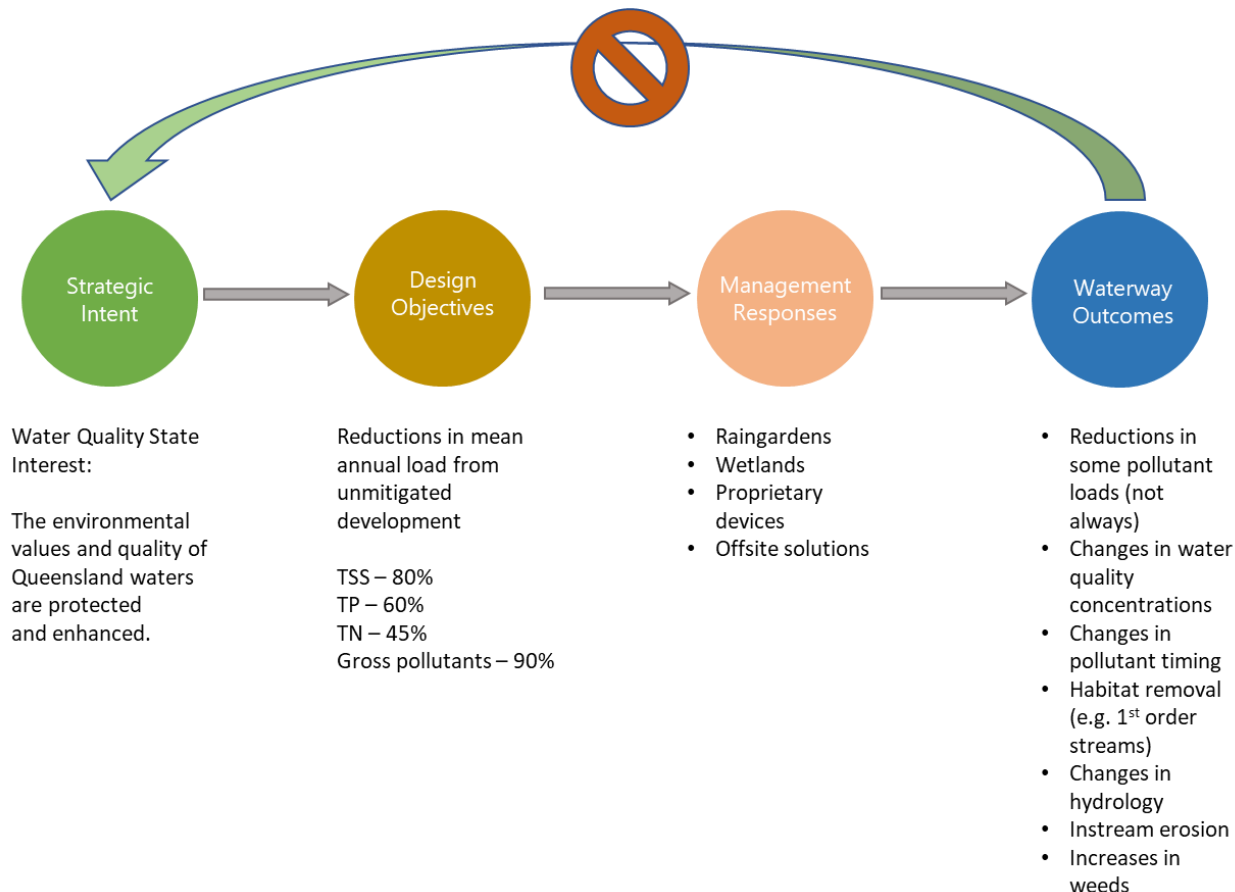
- Current design objectives are focussed on cost-effectiveness of treatment measures, not on waterway outcomes. Therefore, they do not provide a link between strategic intent of “protecting and enhancing” waterway quality, the management response of stormwater treatment measures and the outcome of achieving waterways which provide economic, social and ecological benefits.
- Hydrologic objectives have been developed previously, but not consistently applied, due to uncertainty in the outcomes delivered, the methods of assessment and the potential costs in implementation.
- Current compliance processes produce measures where function can be prioritised over form.
- Treatment function needs to be integrated with other beneficial functions and improved asset management.
- Current design objectives provide a simple approach for compliance - adding complexity to the objectives may therefore increase the assessment and compliance burden.



What is the problem - the existing policy frameworks

Within Queensland, the Environmental Protection (Water) Policy 2009 (EPP Water), provides the head of power for setting of environmental values (EVs) and concentration based water quality objectives (WQOs) across the State's waterways. This document links to mapping of the EVs as defined "management intents".

In addition to the EPP Water, the Water Quality State Interest in the State Planning Policy (SPP) 2017 is one of 6 State Interests that must be reflected into planning schemes to address stormwater impacts from new urban development. The current Stormwater Design Objectives are contained in Appendix 2 of the SPP and apply above a threshold (currently lots larger than 2500 m² in area, or greater than 6 lots). These design objectives are also set for different climatic regions across the state. The challenge is that the outcomes able to be delivered through the SPP objectives does not allow for consistency with the outcomes from the EPP Water because there is a missing link between the strategic intent of the SPP and the waterway outcomes it can drive, as shown in the diagram below.



What is the problem – key points for the frameworks

Further to the previous page there are a number of issues identified with the current implementation frameworks, including:

- There is no clear line of sight between our overall high-level ideals and the outcomes we are trying to achieve for our urban waterways.
- There is no explicit link to the EPP Water in any of the policies within the SPP.
- The SPP does not group together or explicitly identify the interrelationship of state interests.
- It may be possible to create a discrete waterway and wetland state interest.
- There is currently no recourse to require development to deliver anything beyond the current design objectives.
- We need to apply systems thinking to design objectives to ensure we capture the integrated nature of how waterways operate.
- A clear line of sight between the high-level requirements and the outcomes delivered needs to be reflected in the objectives.
- Stormwater Design Objectives must be measurable and transparent and have a consistency of approaches for different development types while effectively adapting to recent science.
- We need Construction Design Objectives to manage the transition phase of urbanisation (after which the Stormwater Design Objectives will apply)
- We recognise that a “one size fits all” approach may not deliver all of the management responses needed to mitigate urban stormwater impacts.
- Local governments need to understand the higher-level strategic intent for waterways within their jurisdiction.
- Urban development processes cannot be the only method by which urban stormwater impacts are managed.
- Stormwater and environmental aspects can be a source of significant delay in assessment processes.
- Local governments are challenged by the resourcing implications for further studies and analysis created by the various SPP components.
- We need to ensure that water related SPP requirements are clear and practical.
- There is currently no process provided for how “protect and enhance” is to be achieved, even though this is the overall strategic intent of the SPP and EPP Water.
- 9 ➤ We need to provide for a range of assessment methods to evaluate compliance with design objectives.

What does the science say?

An assessment of the existing literature around stormwater impacts from urbanisation highlighted a number of significant areas for consideration, including:

- Approaches set around water quality targets alone are no longer going to achieve community expectations for urban impacted streams.
- Up to 70% of first order streams are lost through the process of urbanisation.
- Urbanisation impacts were clear on waterways downstream of urban development, with negative aquatic ecological impacts being identified as associated with changes in both water quality and hydrology, but also on habitat and connectivity.
- One single hydrologic objective for stream health protection has not been identified, though reduction in mean annual flow volumes is commonly expressed. It is likely that more than one objective is required to demonstrate that hydrologic impacts (and their links to ecological outcomes) are adequately managed.
- There is only one significant study on the linkage between hydrologic impacts and ecological outcomes in Queensland.
- The Urban Stormwater Impact Assessment (USIA) approach provides a very strong linkage between hydrology and ecology for streams in Western Sydney. The criteria developed are focussed on the hydrologic responses required at a reach by reach scale.
- Significant reductions in flows are needed from urban areas in order to maintain ecosystem health.
- The focus on only reducing mean annual nutrient and sediment loads does not account for the processes by which these contaminants impact urban waterways and suggests that the "blunt" lever of a % reduction in loads to facilitate actions that protect stream health needs to be reconsidered.
- As such, it appears that there may be a need to consider including concentration objectives in stormwater management objectives

What needs to change – the objectives

To consider what may need to change with the objectives, it is important to consider some key questions:

a) *Are the numerical objectives still applicable for Queensland given improvements in science in recent years?*

Water Quality

We believe that the current numerical load-based reduction objectives should be retained as a minimum standard required for urban stormwater management, but they are not the only objectives that could be used for water quality. From the literature, concentration based objectives may be needed in some waterways in addition to load based targets, but these would need to be confirmed through more detailed assessments. The existing Ecologically Relevant Targets (ERTs) in the Great Barrier Reef also provide a useful process for understanding the links between pollutant loads and receiving environment condition and may be a useful process to consider for sensitive waterways in Queensland.

Hydrology

The single stream stability objective is not likely to help mitigate the impacts of changes in hydrology from urban areas with the science recommending a number of objectives covering the different parts of the hydrologic regime important for ecological function. The objectives outlined in the City of Gold Coast's City Plan 2 documents indicate further objectives that may be useful, though much of the literature suggests that these should be identified on a reach by reach scale. The Urban Stormwater Impact Assessment (USIA) method being applied in Western Sydney shows considerable promise in providing criteria that link hydrology to ecological outcomes, but still need further support understanding the management responses in urban developments that may be needed to deliver the criteria.

b) *Do we need additional objectives to cover other contaminants or impacts?*

The current objectives do not protect urban waterways from a range of other impacts such as habitat loss, changes in amenity and recreational access and further objectives on these impacts need to be considered. Documents such as the Living Waterways framework provide methods for assessing and managing these and this is discussed further in Part 2. Our assessment is that further objectives for managing other waterway impacts from urbanisation are needed but need to be facilitated by a different implementation framework.



What needs to change - the objectives

c) *Do the objectives maximise other waterway benefits?*

Currently, the simple answer is no. The existing objectives are largely disconnected from the waterway benefits that they could achieve, so do not facilitate them. The actions that are put in place may have some secondary benefits, but this is not done through a proper design process that maximises them.

d) *Are the management responses (as a result of complying with the objectives) likely to protect and enhance waterway health if they are continued to be applied?*

Again, the answer to this question is largely no, and in some cases may lead to a deterioration in water quality downstream. There is no clear process that provides for protection or enhancement of waterways when complying with the existing objectives because they do not relate to what needs to be protected or enhanced.



What needs to change - the implementation frameworks

There are a number of themes of change for the implementation frameworks, including:

Theme 1 – Planning for Waterway outcomes

What is needed is for effective waterway planning to be required under policy or regulation. The process needs to identify what we already have in our waterways, what we want for them in the future and the pathways to move from one to the other. This will allow us to know what needs to be “protected” and what needs to be “enhanced” and will therefore drive the development of design objectives that can allow us to do both.

Theme 2 – Declaring Waterway Outcomes and Strategic Intent

Our overall intent for urban waterways (and also non-urban waterways) is declared in both the SPP and EPP Water as protection and enhancement of environmental values and water quality. The existing environmental values could therefore be used to indicate the desired outcome for a waterway. Whether these need to be supplemented by others would be borne out through a planning process as noted above.

Theme 3 – Establishing clear linkages

We need to have a better connection between the EPP Water and SPP. The concept of environmental values and management goals is entrenched within the EPP Water and these are also referred to within the SPP. Currently, this connection within the SPP is quite weak. To resolve this, a modification of the Water Quality State Interest to be more focused on achieving outcomes for waterways and wetlands would provide the opportunity to directly link to the EPP Water to state that environmental values are to be protected or enhanced within the SPP.

Theme 4 – Integration and System Thinking

Our existing design objectives drive management responses that are largely focussed on achieving water quality outcomes. Obviously, this does not support the design process to consider other potential benefits of implementing those responses.

The Living Waterways framework facilitates both integration and consideration of system thinking but needs to be more strongly encouraged in the design process. It should also link to a better waterway management planning process to ensure that the integration considers the waterway outcomes needing to be achieved in specific waterways.

Theme 5 - Equitable management of stormwater impacts

Not all of the burden mitigating urban stormwater impacts should be borne by new urban development. There are also significant impacts from the runoff of existing urban and non-urban areas.

What is therefore needed are design objectives which can ensure that new urban development (both in greenfield and brownfield applications) achieves at least a minimum consistent standard, but integrates into an overall process for improving waterway outcomes, that may include improvements in practices in rural areas, addressing construction site runoff and community behavioural change (amongst others). Having a sound planning process for this would therefore be essential.

Changing the implementation framework – key points

Based on the themes for changing the implementation framework, the following key points are identified:

- Effective waterway planning should be required under policy or regulation (like previous requirements for Total Water Cycle Management Plans).
- Environmental values can be used to indicate the desired outcome for a waterway but need a planning process to define them.
- Flexibility in declaring the strategic intent is needed to ensure the intent for a waterway is consistent with local issues.
- There needs to be a better connection between the EPP Water and SPP.
- Developing a State Interest for Waterways and Wetlands would allow for a stronger linkage between the strategic intent of protecting or enhancing environmental values with a broader set of policies.
- The Living Waterways framework should be more strongly encouraged in the design process.
- A process by which the design objectives can ensure that new urban development achieves at least a minimum consistent standard is required, but also realising that stormwater design objectives in isolation cannot achieve all the required waterway outcomes.



How do we change - the objectives

What is obvious from the previous sections is the need for urban waterway management to have better connections between the strategic intent, management responses and desired outcomes required at different waterway scales. Numerical urban stormwater design objectives are but one element in providing those connections but can be far better integrated into a clear line of sight between what is intended to be achieved, the types of stormwater management responses we use and the specific stream and waterway outcomes they deliver.

The report identifies a number of recommendations for the objectives, including:

- 1. Set up framework to prevent deterioration of existing condition**
Establish a strategic framework to allow for the protection of the existing values of urban waterways. This should be seen as the default position for strategic intent
- 2. Further objectives for managing other waterway impacts from urbanisation are needed**
Test the application of the USIA framework in pilot waterways in Queensland, including an examination of the management responses needed to achieve hydrologic and ecologic criteria identified through the USIA framework and the ability of these responses to address other waterway objectives including water quality, amenity and flow conveyance.
- 3. Ensure minimum standard requirements for all development**
Retain the existing SPP Urban Stormwater Design Objectives as the minimum standard for urban development in Queensland, recognising that this may not be sufficient to protect and enhance urban waterways, but is part of a process for achieving this.
- 4. Developing Ecologically Relevant Targets (ERTs) for sensitive waterways across Queensland**
Develop Ecologically Relevant Targets for sensitive receiving environments within South East Queensland consistent with the process applied within the GBR regions to provide a scientific basis for the continued application of load-based reduction targets for existing and future urban and non-urban areas. This should be based on existing work completed within the region wherever possible.
- 5. Ensure that ERTs in the Great Barrier Reef basins are reflected in load-based reductions for reef urban areas**
Conduct a study to evaluate the consistency between the SPP Urban Stormwater Design Objectives and the Ecologically Relevant Targets within the GBR basins. This will ensure that urban areas within the GBR are able to achieve the levels of fine sediment and dissolved inorganic nitrogen reductions needed to achieve the ERTs in the relevant basin.



How do we change - the implementation frameworks

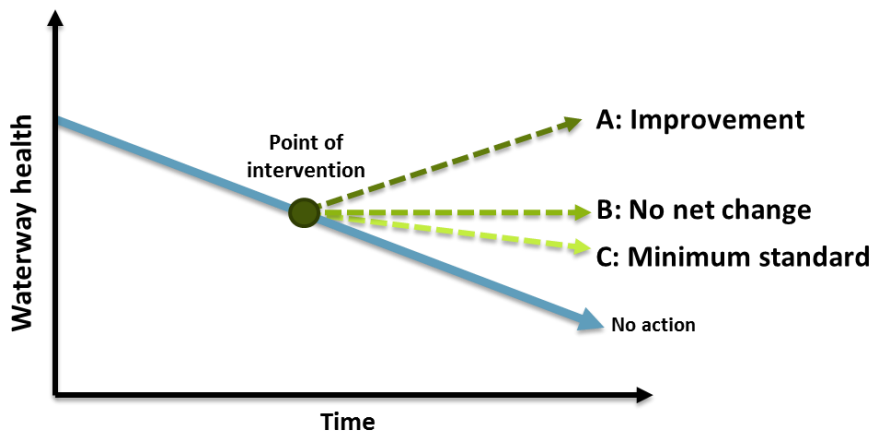
In this summary, we have identified the issues with the existing frameworks for implementing stormwater design objectives and what is broadly needed to address them. Outlined below are several potential approaches that could be applied to improve the use of design objectives in managing the impacts of urban stormwater on achieving waterway outcomes.

1. Changing the current Water Quality State Interest to a Waterways and Wetlands State Interest

The existing Water Quality State Interest is constrained first by the limitation to a water quality definition, but also that other elements needed to achieve waterway outcomes are not easily integrated because they may be contained within other state interests. We therefore suggest changing the current Water Quality State Interest to a Waterways and Wetlands State Interest to improve the ability for policy elements in the SPP to deliver on a range of waterway outcomes, rather than just water quality.

2. Enable a framework for setting strategic intent

We therefore recommend that a three-tiered approach be considered for setting strategic intent, that both aligns with the EPP Water, but also allows for the establishment of intents that may provide for at least a minimum standard to be set. These should be based around the principles of adoption of a minimum standard as the baseline, with No net change (Protection) and Improvement (Enhancement) being identified through a waterway planning process as shown in the figures below.



<i>Strategic Intent</i> Waterway outcome related design objectives Management responses	C: Minimum Requirement Based on SPP minimum standard • WQ: 80/60/45 • Generic hydrologic targets Achieved by: • MUSIC modelling and results • Building treatments using G/L • Achieving threshold Living Waterways score	B: No Change in Waterway Value (Protect) Based on WAMP and HEV • Load and concentration $\Delta=0$ • Hydrologic criteria at reach scale • Retention of riparian vegetation Achieved by: • Living Waterways (higher threshold) • Riparian conservation • On-site measures to at least minimum standard • Additional on-site for no impact or trunk infrastructure or offsets	A: Improvement (Enhance) Based on WAMP Restoration Goals Reach based hydrologic criteria WQOs Conservation targets Recreation access improvement etc Achieved by: • Living Waterways (higher threshold) • On-site measures to at least minimum standard • Additional on-site for no impact • Trunk infrastructure • Offsets • Conservation strategy
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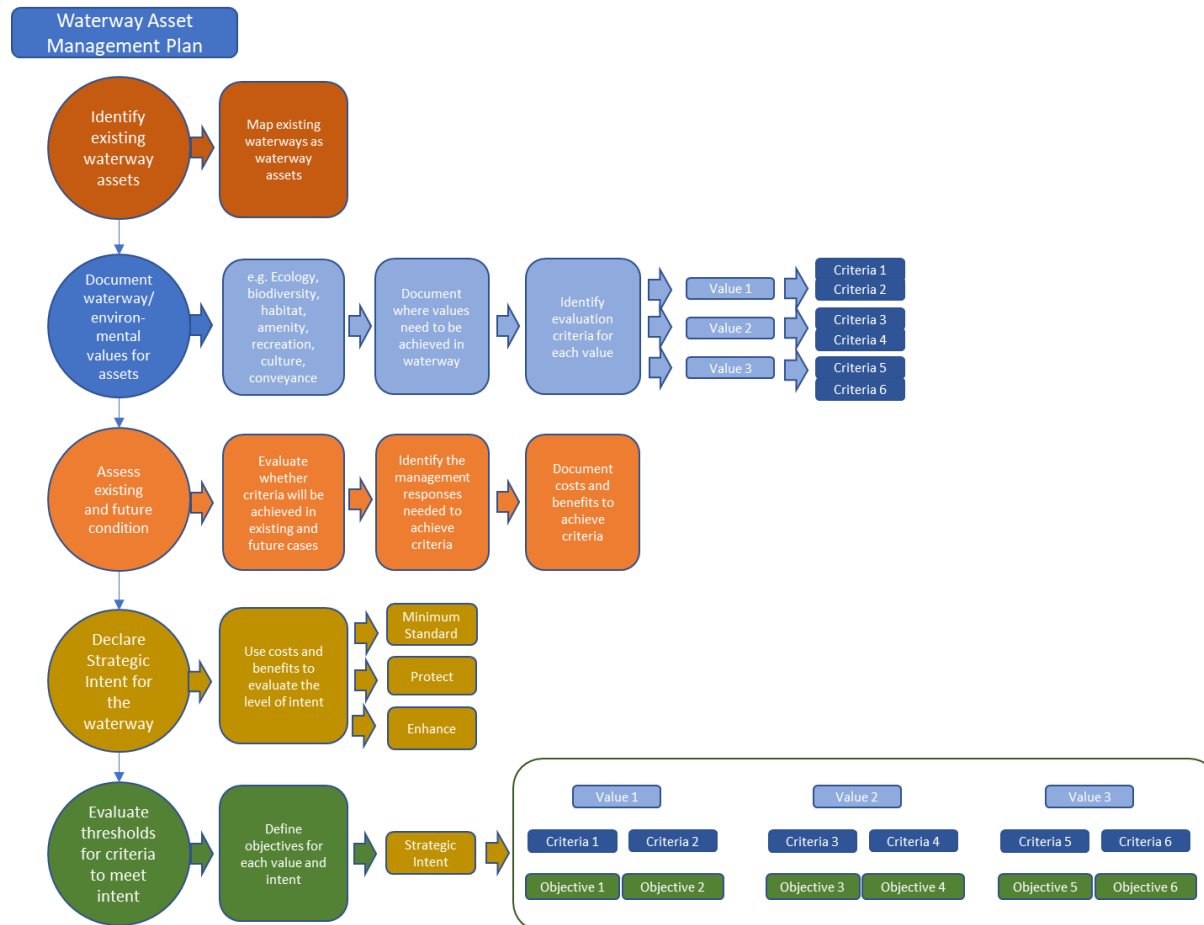
How do we change - the implementation frameworks

3. Require the development of Waterway Asset Management Plans in the EPP Water

Consistent with previous requirements to develop Urban Stormwater Management Plans and Total Water Cycle Management Plans (TWCMPs), establish the need to develop Waterway Asset Management Plans in the EPP Water. These plans should:

- Identify existing waterways as waterway assets.
- Document waterway values for each asset.
- Assess existing and future asset condition
- Decide on the strategic intent for the waterway.
- Evaluate the thresholds needed for each criterion within a waterway value according to the strategic intent.

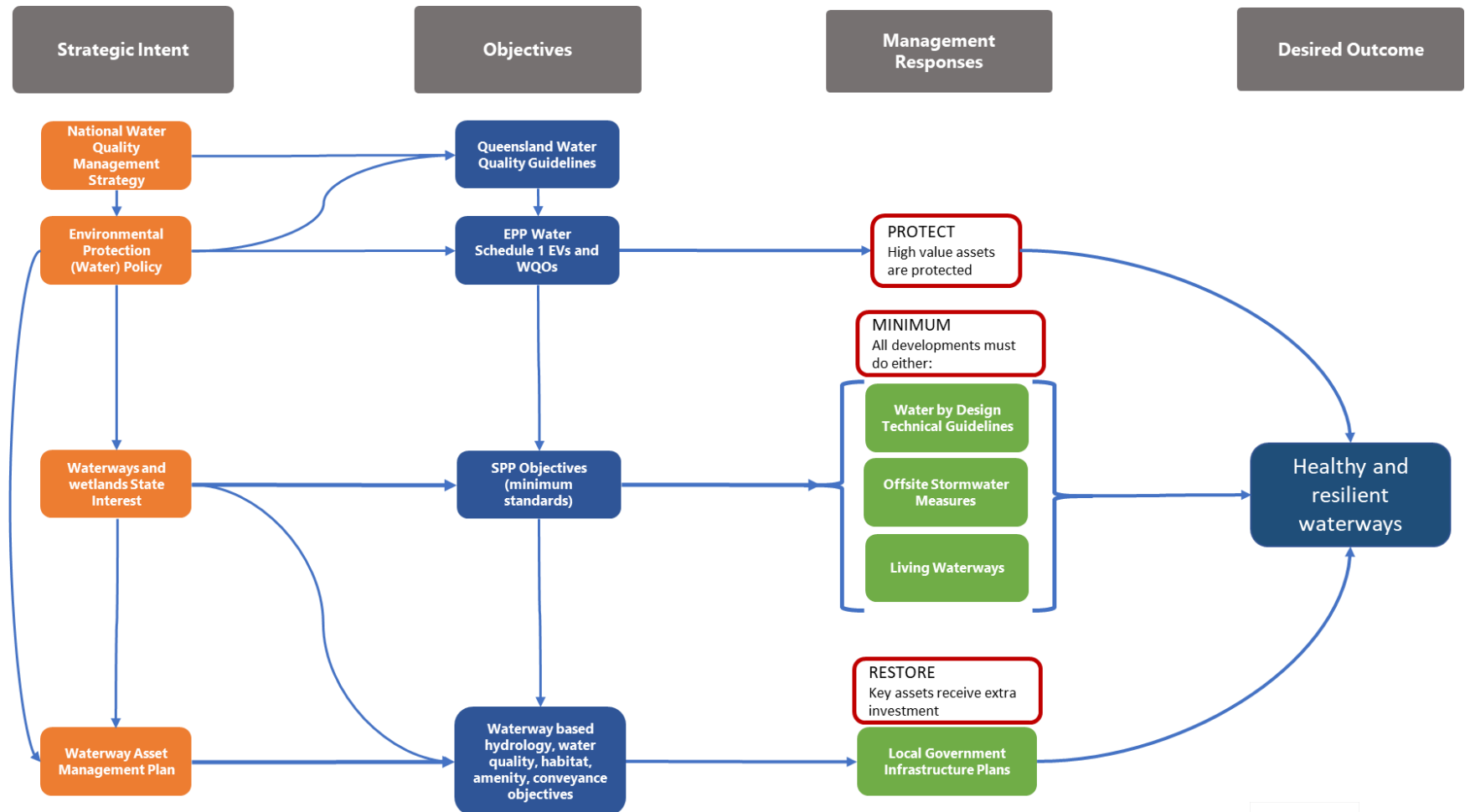
A schematic of how the plans may work is shown in the figure below. These would also build on previous waterway planning processes.



How do we change the implementation frameworks? (cont.)

3. (cont)

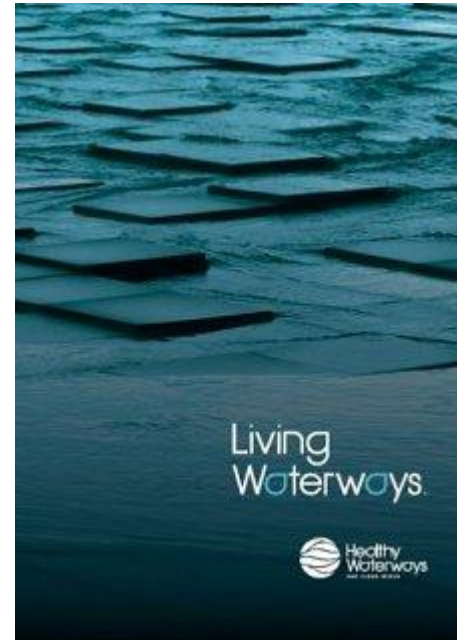
One of the other outcomes with the development of Waterway Asset Management Plans would be to provide much stronger linkages between strategic intent, design objectives, management responses and the desired waterway outcomes as shown below. In this case, all elements contribute to the overall outcome of healthy and resilient waterways, rather than the significantly fractured process that is currently in place.



How do we change the implementation frameworks? (cont.)

4. Embedding the Living Waterways framework in design processes

To improve integration and maximising multiple benefits from implementing revised design objectives, we recommend that the Living Waterways framework be more strongly embedded in the design process. This may take the form of an evaluation process, like the BASIX (Building Sustainability Index) system in NSW, whereby particular types of development (typically urban residential development) needs to demonstrate that a certain score is achieved to demonstrate the implementation of sustainable outcomes.



Conclusions

We need design objectives that actually link to waterway outcomes

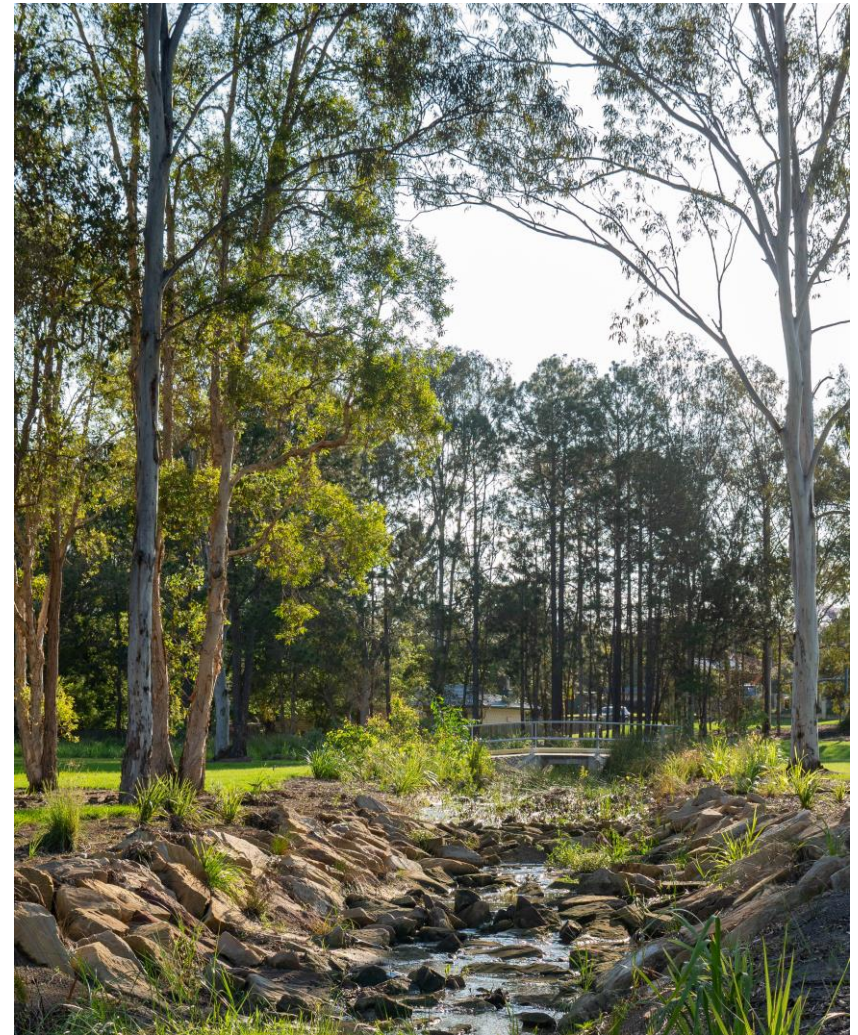
In developing the discussion paper, it is evidently clear that there is disconnection between the strategic intent for waterway management, the management responses we are currently delivering, and the waterway outcomes we are hoping that they achieve. This is further exacerbated by lack of clear connection between existing planning documents such as the State Planning Policy and the Environmental Protection (Water) Policy.

The science reviewed shows that other objectives may be needed to protect and enhance Queensland's waterways from the impacts of urban stormwater runoff and the existing objectives are insufficient to protect or enhance those waterways.

We also need to be cognisant of the existing objectives, in that they provide a solid basis for a minimum standard of action. These can be built on through the planning process to deliver design objectives that have a clear line of sight between the strategic intent, the management responses they drive and the waterway outcomes they achieve.

Underpinning all this will be the need for a proper planning process to determine what values our waterways currently provide and what they may need to provide in the future so that we can develop design objectives that will provide those outcomes.

Ultimately, we need a clear line of sight between our overall high-level ideals and the outcomes we are trying to achieve for our urban waterways if design objectives are to truly allow us to protect and enhance Queensland's waterways.



An aerial photograph of a river delta, likely the Murray-Darling River system, showing a complex network of channels and floodplains. The water is a mix of dark blue and light grey, indicating varying depths and sediment loads. The land is green with some brown patches, suggesting vegetation and bare earth. A semi-transparent grey text box is overlaid in the bottom right corner.

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