1 ARE TRADE-OFFS ACCEPTABLE OR ARE WE ACCEPTING DEFEAT

1.1 Context – Stormwater management in QLD

Queensland has been blessed with outstanding natural assets including the world heritage listed Great Barrier Reef worth $6.4 billion a year to the Australian economy and supporting 39,000 direct jobs [1] and the Ramsar listed Moreton Bay off the coast of Brisbane which is home to abundant wildlife and recreation opportunities for residents.

In order to help protect these assets the Queensland Government regulates stormwater pollution discharge from all new developments. So far our management interventions to protect and maintain values have been ad hoc across the state and mainly focuses on the 'fully developed' phase stormwater quality. Construction phase erosion control (a key threat) was often ineffective. Attempts have been made to regulate hydrology however these have been hit and miss. Stated in the Environmental Protection Act 1994 (Qld) is the need to Protect and Enhance waterway values. While there is much focus on protecting the waterways (and this is important because once biodiversity is gone it cannot easily be replaced) the need for enhancement of waterways is often side-lined. However perhaps the biggest relative gains (biodiversity, waterway health, social capital) can be achieved by enhancement works. Especially when a key habitat reconnection is constructed. Water by Design surveyed stormwater practitioners in 2014 and again in 2017 [2]. Major issues with the stormwater treatment industry include:

- There was little appreciation of the risk pathway; how a hazard comes to diminish waterway value
- Industry focuses on a narrow band of hazards (i.e. TSS, TP, TN and Gross Pollutants) and values (clean water), as a result key risks are left unmitigated and key values are left unsupported
- Management actions are applied in a blanket 'one size fits all' application of stormwater regulations across the state and do not recognise the inherent variations and distribution of risk and value
- Management actions were predominately risk focussed, as a result opportunities to enhance values were ignored
- There were questions regarding the value for money with the current approach
- Implementation of management actions was inconsistent

In summary the problem is twofold; a lack of appreciation of the complexity of the system and very little effort to prioritise projects in order to maximise returns.

2 ANALYSIS

As summarised below there are 6 key reasons why a one size fits all approach is not satisfactory:

1. The **values** derived from a waterway are quite *diverse* and the current strategy of investment in just one set of parameters (TSS, TP, TN and Gross Pollutants) may come at the expense of other benefits (e.g. cultural, recreational or terrestrial biodiversity, etc).
2. There is a *broad* range of **threats** within the catchment and a narrow focus on just a few parameters may result in some threats going unmitigated resulting in value diminishment of the waterway
3. The spatial distribution of **values** and **hazards** throughout the catchment is not evenly distributed
4. The **benefit** acquired from a given management action is not linear and is dependent on whereabouts in the catchment it is applied
5. The **temporal** nature is not adequately considered with the current focus on chronic threats. This does not take into account the severe damage that acute threats such as floods can have on a waterway
6. The natural attributes of a given waterway (i.e **resilience and recovery potential)** is not considered. This means that some investments in a waterway may be ineffective (due to poor recovery) and result in no value gain and others may be unwarranted due to a high natural recovery rate

2.1 Waterway Values – Issue 1

Waterway values can be grouped into three categories: environmental, social and economic (i.e. the triple bottom line).

Table 1: Waterway values

Environmental values	Social values	Economic values
Waterways have intrinsic value in and of itself Supports a healthy ecosystem	Cultural Recreational Spiritual	Fishing Drinking water Irrigation water Tourism

Typically in Queensland the focus of stormwater regulation is on water quality only. **Key point**: there is a much bigger array of values that need to be protected. A values management process is required to maximise a balanced mix the social, environmental and economic value of waterways.

For example, a proposed development may fulfil the statutory requirement to treat stormwater prior to discharge via a simple bioretention system. However, with a little extra investment in a combined treatment wetland / water feature there may be additional benefits realised for amenity, education, stewardship and habitat. In this instance we would encourage to waterway manager to look at a broader array of values and be strategic with investments so as to maximise triple bottom line return.

2.2 Threats – Issue 2

There are a diverse range of threats to these waterway values including: pollutants, hydrologic change, disturbance and external threats. These are descried below in more detail.

Table 2: Waterway threats

Pollutants / toxicity	Hydrologic change	Disturbance
Sediment Phosphorus Nitrogen Gross pollutants Heavy metals Plastics Hydrocarbons Pesticides Physical parameters	Too much flow caused by urbanization. Concentration of flow causing local impacts. Redirection of flow – too dry in some areas too wet in others. Impervious land leads to reduced infiltration of flow.	Weeds, Pest species, Unintended public access Motor bikes, SUV's Livestock Clearing of riparian areas

External threats (climate threats)

There is a fourth class of threats namely external threats or climate threats. These threats are typically out of the control of waterway managers and include climate change and natural disasters (e.g. droughts and floods etc).

Typically in Queensland we regulate stormwater only for Sediment, Nitrogen, Phosphorus and Gross Pollutants. Our management actions generally focus on these target pollutants and the assumption is that if we manage these items then we will have waterway health. This is not the case, waterways continue to degrade on our watch despite these interventions to filter stormwater discharge. Threats such as hydrologic change, disturbance and external threats however are under-regulated and often result in what we can call 'barrier bypass' e.g. the hazard bypasses the mitigation measure and attacks and diminishes the waterway values. **Key point**: there is a much bigger array of threats to ecosystem values that need to be considered.

The 2011 Brisbane River Flood can be used as an example of where an external threat has caused barrier bypass. Up until January 2011, parts of the Brisbane City catchment had received a considerable investment in WSUD treatment systems however when the flood pushed through it released magnitudes more sediment and pollutants into the bay than had been reduced through these stormwater treatment programs. This is not to say that treatment isn't important, only that it should be seen in context and that a diverse array of threats need to be addressed by waterway managers.

2.3 The Spatial Dimension – Issue 3

In order for a hazard to compromise a value it needs to be proximal and there needs to be a connection (for example a flow path). It is not always possible to separate a hazard from a value in practice. The **key point** is that the distribution of risks and values throughout the catchment is not homogenous (Figure 1 and 2) nor should it be treated as such. The current stormwater management regulations in Qld however apply a 'one size fits all' approach to stormwater treatment that fails to recognise the inherent variation in hazards and values across the catchment. For example the soil type varies significantly over the state with sodic and acid sulphate soils

producing a higher threat than other types of soils. There is also a significant variation in waterway values distributed across the state, from highly modified waterways to pristine waterways (with high protection needs).

It is also important to note that the insertion point of the hazard within the catchment. Due to increased contact time a hazard released in the upper catchment has the potential to do more damage than a hazard released at the river mouth reinforcing the need to understand the risk pathway.

Figure 1 – Spatial distribution of Hazards throughout the catchment

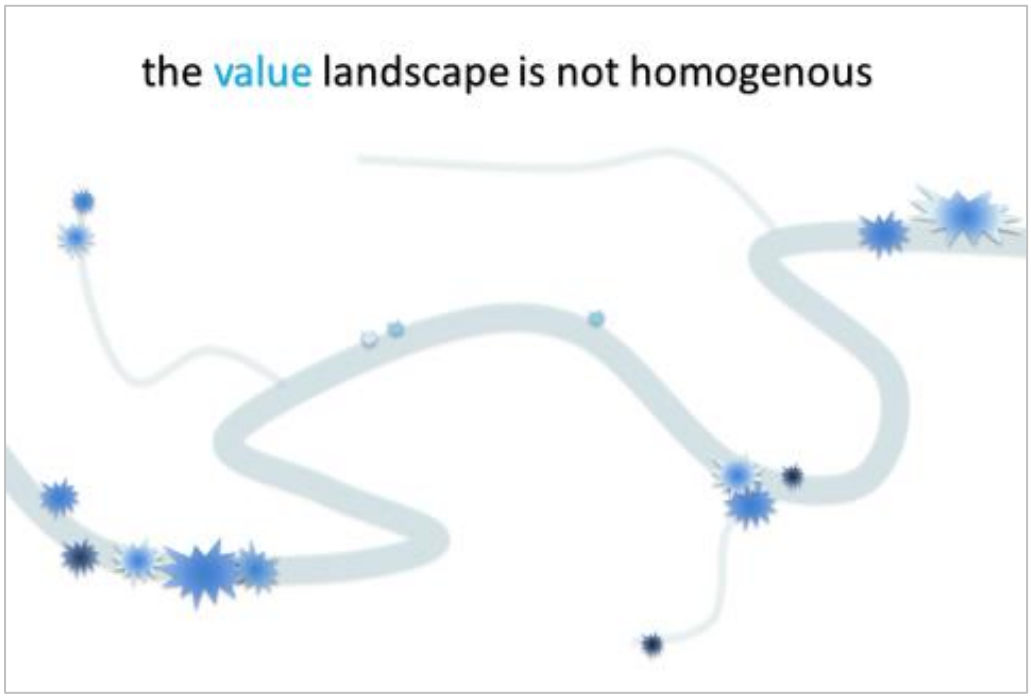

Figure 1 – Spatial distribution of Values throughout the catchment

2.4 Management response and resulting benefit – Issue 4

As demonstrated in the following two figures the increase in value derived from a management intervention is not linear and depends upon the location in the catchment. Management actions should focus on areas where the largest threats coincide with the areas with the greatest value (Figure 3).

This point can be illustrated by using the example of a fictitious residential estate that goes to great expense to install a stormwater treatment train only to have flows discharge into a concrete lined drain with no habitat or social value. On the other end of the spectrum there may be a development that puts in the minimum required stormwater treatment systems only to fall well short of the required water quality needs of a sensitive downstream waterway. So looking at the bigger picture, while having clean water is still important (and the effort will be felt at the regional scale) the effort should be directed to where it will have the biggest payoff (i.e. a location with regional *and local impacts*).

Importantly there also needs to be consideration of the potential value increase provided by pursuing opportunities (Figure 4). This could mean that instead of investing several hundred thousand dollars in stormwater treatment for a new housing estate, the money is reinvested in the waterway to install a fish ladder reconnecting several kilometres of habitat for migratory fish species.

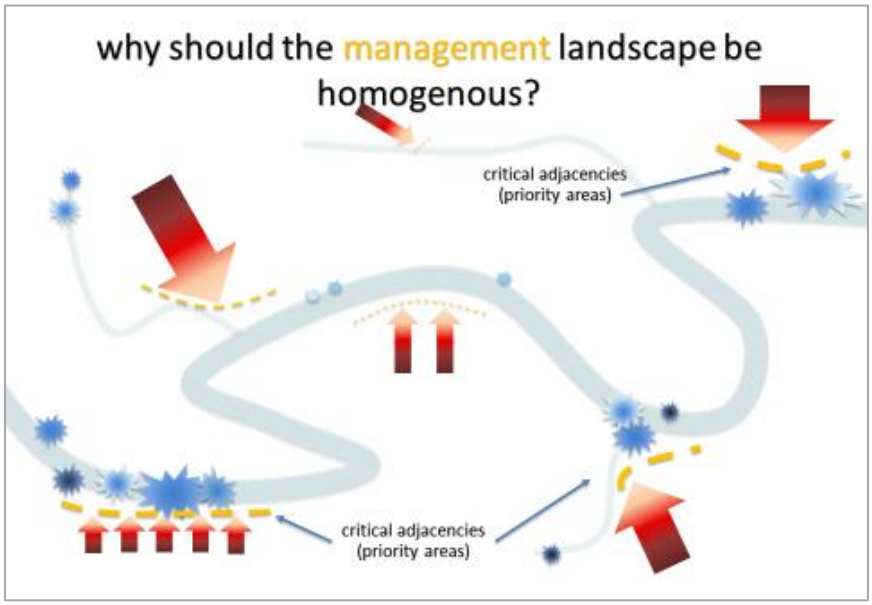

Figure 3 - Management response to threats within the catchment

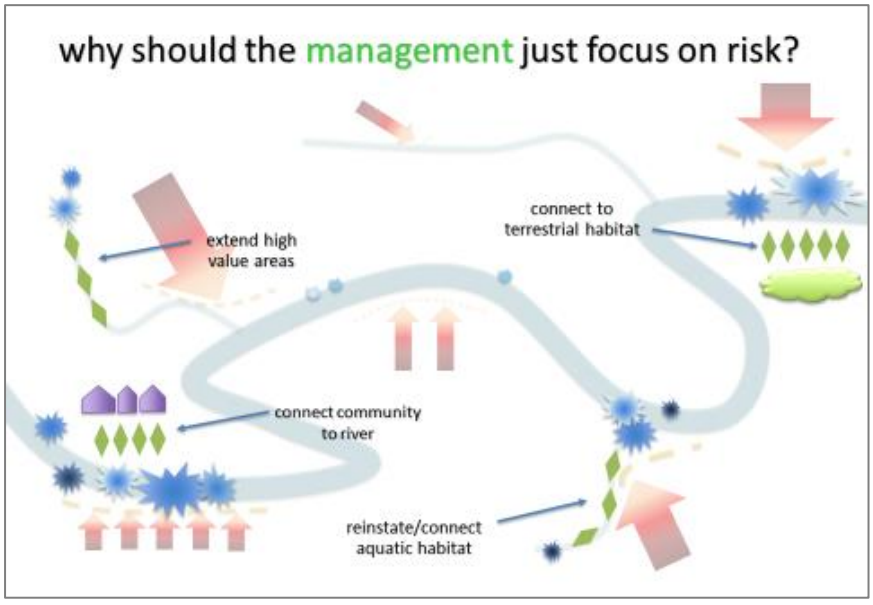

Figure 4 - Management response to opportunities within the catchment

2.5 The Temporal Dimension – Issue 5

Life can adapt, given enough time, to a surprising array of circumstances. **Key Point:** more often than not it is not the change itself that is the problem but *the rate of change*. There are two time scales of threats (Figure 5):

- Acute threats – usually short sharp threats that leads to a step change. This can be considered as death by a single blow e.g. floods, spills
- Chronic threats – usually change occurs over a longer period of time that leads to a gradual degradation. This can be considered as death by a thousand cuts e.g. climate change, diffuse pollution

Each type of threat needs to managed, but managed differently. **Key Point:** although proportional effort should be given according to a risk's degradation potential, one can conclude that as a first priority we should be targeting acute threats and acute opportunities followed by chronic threats and opportunities. In the stormwater space the acute threats occurs after clearing and after paving a catchment (i.e. the biggest hydrologic change) and during the 'construction phase' when sediment discharge is common (i.e. the biggest water quality change). Our current focus on chronic 'operational phase' water quality discharge is important but should not be at the expense of addressing the acute issues mentioned above.

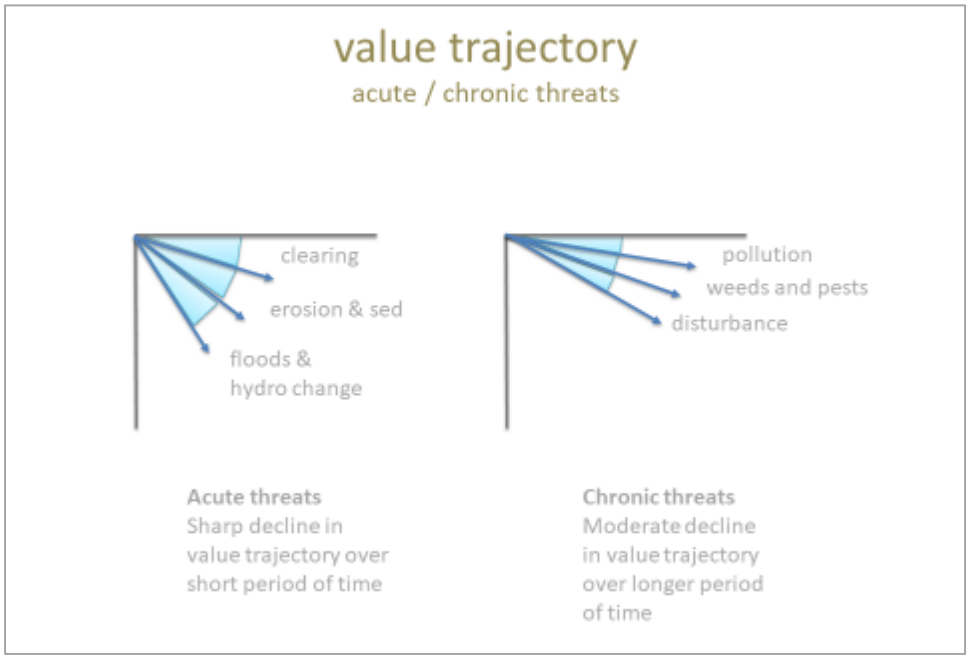

Figure 5 – Chronic and acute threats – value trajectory

2.6 The resilience dimension – Issue 6

It is important to understand the future trajectory of a waterway. The natural resilience of a given system may be so strong that it can restore itself to equilibrium regardless of management intervention. Alternatively the reverse may be true, the system may be so fragile that the slightest disturbance may cause irreversible loss of value. **Key point:** this is an area that needs more scientific research and usually depends on the local parameters of a given river.

Figures 6 and 7 give an example of how natural resilience can be harnessed to restore waterway value. The figures also highlight the need to target acute threats and opportunities as this is where the biggest value gains can be made.

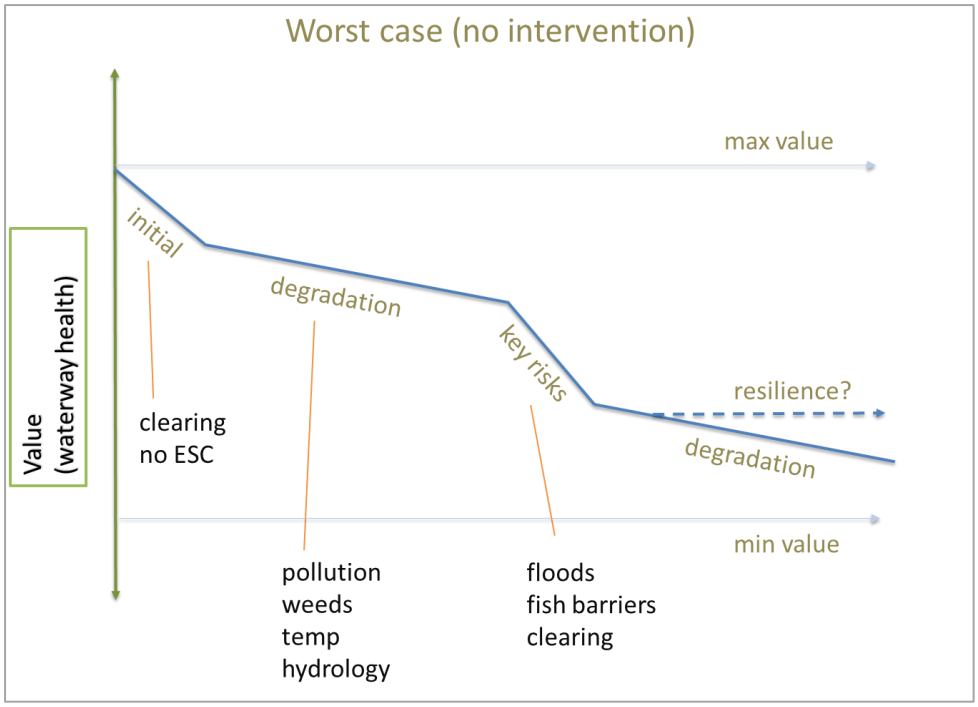

Figure 6 – Waterway value response to degradation over time

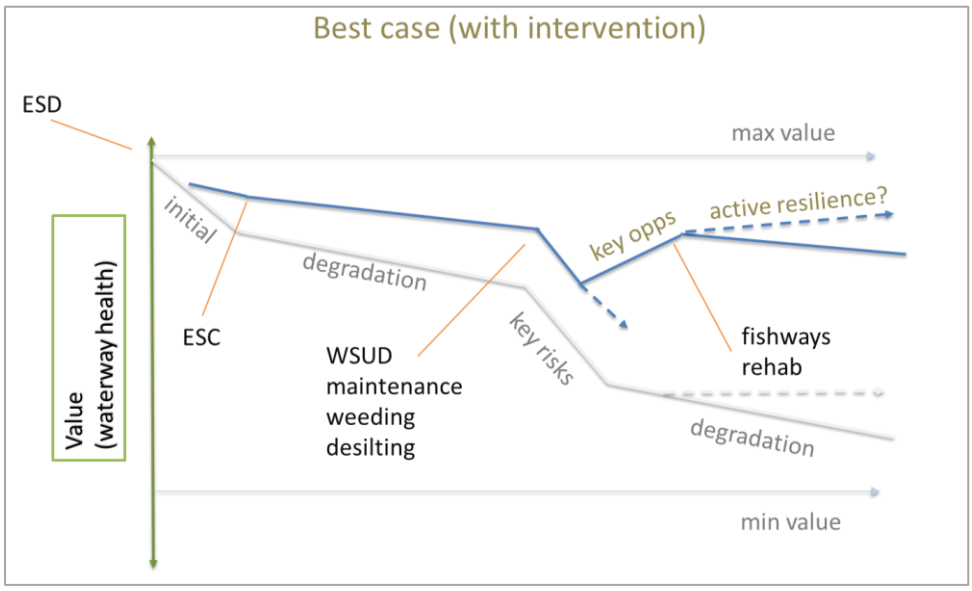

Figure 7 – Waterway value response to intervention over time

3 CONCLUSION

Through stakeholder research, this paper has identified two key problems with the stormwater management regulations; a lack of appreciation of the complexity of the risk/value landscape and an almost apathy towards investing in locations where there are priority hotspots (critical adjacencies) in order to maximise the net return on investment. It is important to recognise the temporal, spatial and resilience dimensions to this analysis. The position of this paper is that stormwater offsets (i.e. tradeoffs) are not only required to enhance flexibility for the development industry and councils, they are also very important for the six reasons as discussed above to maximise the effectiveness and net return on any given stormwater and waterway investment.

4 RECOMMENDATIONS

The following are suggestions for possible modifications to Queensland's waterway management policies:

1. Recognise a broader range of values and threats
2. Map the spatial dimension for values, threats and opportunities
3. Allow trade-offs between risks and opportunities to maximise potential benefits.
4. As a priority, address acute threats to waterway health (e.g. floods, DO, toxicity)
5. Understand the resilience and recovery potential for each waterway

Once the above items are addressed a policy framework should be put in place to promote the flow of investment dollars to where it is needed most and where it can have the biggest impact.

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