BLIGH TANNER

Townsville Regional Stormwater Strategy

Part 1: Literature Review and Consultation

Part 2: Analysis Report

Part 3: Recommended Strategy

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1 LITERATURE REVIEW

This Literature Review is the first step towards the development of the Townsville Regional Stormwater Strategy. It is intended to summarise relevant existing information to help ensure the strategy is developed mindful of the extent of existing knowledge and information.

This literature review will also be used as a basis to inform the stakeholder consultation which will occur as the next phase in this project.

Key documents Reviewed

- TCC Planning Scheme and Development Manual
- Water Quality Improvement Plan
- GIS datasets
- Draft amendments to WSUD aspects of the development manual
- Stormwater offsets reports
- Reef Rescue reports

1.1 State Planning Policy

The State Planning Policy (SPP) sets out the State's interest in terms of water quality management in Queensland. The Sustainable Planning Act 2009, which is the head of power for the SPP, states that if there is an inconsistency between a state planning policy and another planning instrument (except for a state planning regulatory provision), the state planning policy prevails to the extent of the inconsistency.

Key performance outcomes and acceptable outcomes for that policy are shown in Table 1 below.

*Table 1-1 S*tormwater Quality Design Objectives (extract from the SPP Code 201*4*)

PO1 The development is planned and designed considering the land use constraints of the site for achieving stormwater design objectives.	AO1.1 A site stormwater quality management plan (SQMP) is prepared, and: a) is consistent with any local area stormwater management planning; and b) provides for achievable stormwater quality treatment measures meeting design objectives listed in Table A (construction phase) and Table B (post construction phase), or current best practice environmental management, reflecting land use constraints, such as: • erosive, dispersive and/or saline soil types; • landscape features (including landform); • acid sulphate soil and management of nutrients of concern; or • rainfall erosivity.

For the Dry Topics Table B of the State planning Policy sets load reduction targets being 80% reduction in TSS, 60% reduction in TP, 40% reduction in TN and 90% reduction in gross pollutants (relative to traditional urban development). It also notes Townsville's locally adopted target of 65% TP reduction.

The term '*best practice environmental management*' is defined in the EP Act 1994 S21 as:

> *The management of the activity to achieve an ongoing minimisation of the activity's environmental harm through cost-effective measures assessed against the measures currently used nationally and internationally for the activity.*

1.2 Living Waterways

In response to concerns that the State Planning Policy stormwater targets were resulting in the creation of single-purpose stormwater quality assets that are not aligned with broader waters sensitive urban design principles, Healthy Waterways Ltd recently produced the Living Waterways framework. EHP has deemed this as reflecting environmental best practice management (as outlined above).

Living Waterways are healthy and attractive for people and their communities, and protect and enhance our environment. Living Waterways is a best practice environmental approach to deliver enduring, engaging and affordable places. The Living Waterways approach is site-driven and aligns traditional stormwater principles with place-making benefits based around the four key themes of Living Water; Living Places; Living Communities; and Living Local Economies.

A series of principles and values underpin each theme and are embedded in the scoring system. The scoring system details a range of ways to achieve improved on-ground outcomes using an illustrative and flexible approach and by focusing on places and communities as well as the treatment of stormwater. It provides a defined framework; encourages collaboration and continuity; and aims to

ensure efficient and accountable outcomes. For further information see:
http://waterbydesign.com.au/living-waterways/

1.3 TCC Planning Scheme and Development Manual

The new Townsville City Plan was adopted in October 2014. Its key stormwater quality provisions are contained in section 9.4.2 Healthy Waters Code. The code contains provisions for:

- Protecting water quality
- Hydrological processes
- Stormwater drainage
- Point source waste water management
- Constructed Lakes and artificial waterways
- Efficiency and whole of life cost.

The code tends not to provide acceptable outcomes, and instead refers to the Development Manual Planning Scheme Policy SC6.4

- SC6.4.3.8 Stormwater management plans for development
- SC6.4.3.9 Water sensitive urban design guidelines. This generally adopts the design standards outlined in the Water by Design Technical Design Guidelines for South East Queensland, except for the introduction and chapter on constructed wetlands. It specifies design objectives for stormwater management consistent with the State Planning Policy (2014), being 80% reduction in TSS, 65% reduction in TP, 40% reduction in TN and 90% reduction in gross pollutants (relative to traditional urban development). Note that this policy does not appear to reflect the provisions for best practice environmental management, and exemptions for low impact development, contained within the SPP. Nonetheless, the new Planning Scheme has received support and praise from EHP as part of the State interest check.
- SC6.4.6.1 Water sensitive urban design construction and establishment requirements

1.4 Water Quality Improvement Plan

The Black Ross (Townsville) Water Quality Improvement Plan (WQIP) was published in May 2010 and provides a best practice management framework. It was established and supported under the Federal Governments Coastal Catchment Initiative, and is consistent with The Reef Water Quality Protection Plan 2003. The objective of the plan is to protect environmental values within the high environmental value receiving environments. The Water Quality Improvement plan establishes appropriate water quality objectives in three main areas:

- Water quality targets
- Load reduction targets
- Event mean concentrations

These targets and concentrations were developed by reference to published guidance from the National Water Quality Management Strategy, Queensland Water Quality Guidelines 2006, Australian Water Quality Guidelines (ANZECC 2000), Australian Drinking Water Guidelines (NHMRC 2010), and provide advice that is consistent with the current State Planning Policy (2014).
The plan identifies eight Management Outcomes that are associated with 25 priority action areas. The outcomes are intended to be achieved by addressing specific management actions (Management Action Targets).

The Black Ross (Townsville) Water Quality Improvement Plan provided an extensive review of landuse and pollutant contributions, both point and non-point sources across urban, peri-urban and

rural land uses. Main pollutants of concern across these land uses where similar, being nutrients and sediment of concern across all land uses, heavy metals and pathogens of concern to urban and peri urban land uses and herbicides and insecticides of concern across rural landuses.

The WQIP takes considers both immediate and long term questions of sustainability. Importantly, the WQIP models and provides guidance as to how to achieve sustainable management of pollutant loads out to 2045. Table 6.10 of the WQIP details eight management outcome targets as described in Section 1.2.1, By establishing the expected loads under population growth scenarios, the WQIP identifies the need to implement management actions across various diffuse and point pollutant sources. The 2045 sustainability targets for reduction of pollutant loads established in Table 5.15 within the WQIP can provide guidance as to the effectiveness of, for example, any proposed environmental offset schemes. However, these indicative load reduction targets have been determined by modelling the achievable load reductions "based on 100% adoption rate for 'WSUD' in Greenfield developments, a 50% adoption rate for 'Retro' i.e. WSUD in existing urban areas, and an 80% rate for 'Rural' BMP". It is important to distinguish that this methodology does not establish load reduction targets based on the needs of receiving environments, and hence may not be a reflection of sustainable load targets.

1.4.1 Water Quality Improvement Plan Management Outcome Targets

The WQIP outlines eight management outcomes targets for urban water quality management, to be achieved through specific management actions targets (MATs) as follows:

1. Management of development in urban and peri-urban areas: To ensure all new development in Townsville is managed appropriately to achieve agreed water quality improvement outcomes including sediment load reductions.
2. Management of existing urban areas: To ensure the existing urban areas of Townsville are managed appropriate in order to achieve agreed water quality improvement outcomes including sediment, nutrient and other pollutant load reductions.
3. Management of peri-urban areas: To ensure all peri-urban areas in Townsville are managed appropriately to achieve agreed water quality improvement outcomes including sediment, nutrients and pesticide load reductions.
4. Management of rural areas: To ensure all rural areas in Townsville are managed appropriately to achieve agreed water quality improvement outcomes including sediment load reductions from grazing lands and nutrient and pesticide load reductions from intensive agricultural land use.
5. Strategic planning: To ensure relevant water quality improvement initiatives, information and activities are investigated and integrated where appropriate into Council strategic policy and planning instruments.
6. Ecosystem health improvement: On-ground actions are prioritised for improving water quality and ecosystem health.
7. Community involvement and capacity: All sectors of the Townsville community have access to the information and training required to contribute to implementation of relevant water quality improvement actions in the Black Ross WQIP area.
8. Monitoring, evaluation and reporting: To ensure water quality improvement actions are effective in improving water quality and results are communicated appropriately to the Townsville community

Some notable MATs include:

MAT 1.1	Erosion and sediemtn control principles and measures implemented across all new development by 2011
MAT 1.2	Locally specific guidelines and associated tools developed to support the implementation of best practice stormwater management in Townsville by 2013
MAT 1.3	WSUD (stormwater) principles and actions are progressively incorporated in the design of all new development reaching a 100 per cent adoption by 2021
MAT 1.4	By 2014 locally specific WSUD guidelines and associated tools developed and tested to support the implementation of best practice stormwater management in Townsville

MAT 2.1	One waterway management and rehabilitation plan for a priority urban waterways developed annually commencing in 2010 with implementation actions underway by 2011
MAT 2.2	Best practice erosion and sediment control principles and actions being implemented across all infill and retrofit development by 2011
MAT 2.3	Options investigated, areas prioritised and implementation plan developed for retrofit of appropriate water quality improvement decies into community infrastructure by 2012
MAT 2.4	An integrated draft urban stormwater quality management plan for the Townsville City Council LGA prepared by 2013, as a sub component of a Total Water Cycle Management Plan for Townsville
MAT 2.5	All water quality improvement devices managed and maintained appropriately over the life cycle of the asset to ensure treatment efficiencies are maintained
MAT 2.6	Stormwater quality service levels agreed and incorporated into strategic infrastructure planning (Priority Infrastructure Plan) by 2012
MAT 3.1	A locally relevant catchment management plan and/or guidelines for managing peri-urban land use for water quality improvement prepared by 2012
MAT 3.2	Peri-urban diffuse source pollutant loads reduced through cost effective approaches to the management of priority pollutant source areas
MAT 3.3	All on-site wastewater treatment facilities (including septic tanks) managed according to approved best management practice over the life cycle of the asset
MAT 3.4	Best practice management actions being implemented within the catchment of the Ross Dam to ensure the improvement in the quality of water draining into Lake Ross
MAT 4.1	Grazing best practice programs being implemented in the rural areas of Townsville
MAT 4.2	Intensive agriculture (horticulture and sugar cane cropping) best practice management actions being implemented within rural and peri-urban catchments across Townsville
MAT 4.3	Non-urban diffuse source pollutant loads reduced through cost effective approaches to erosion prevention and property management in priority sediment source catchments

1.5 Local Stormwater Quality

Townsville has some local stormwater quality data. This data is derived from focused monitoring programs over two wet seasons, and is summarised in the following reports:

1. Townsville WQ report Vol 1 (06/07 wet season)
2. Townsville WQ report Vol 2 Appendices (06/07 wet season)
3. Black Ross WQIP (07/08 wet season)

The first year included more sites and the report was more comprehensive and the second year utilised less sites (budget constraints), although the same sites were used in the abridged monitoring program in the second year.

The Executive Summary to the first report above notes: '*This was a short term study that utilised only a few sites per catchment. A low resolution monitoring program of this kind does not provide a definitive basis for assessing risks, especially within complex urban subcatchments that contain a diversity of potential pollutant sources. Nevertheless, it proved possible to identify some key differences in the amounts and concentrations of contaminants that were transported from subcatchments with different dominant land uses.'*

Raw data from this monitoring program has been obtained.

Based on this data, Townsville has developed recommended local event mean concentration (EMC) values for key urban stormwater pollutants for a range of land use categories. A snapshot of the water quality results is included below, which highlights the disproportionate contribution of construction phase impacts to overall water quality. This highlights the importance of considering construction phase water quality impacts within the scope of the Regional Stormwater Strategy.

Note that no dry weather concentration data has been identified to characterise the quality of baseflows.

Also, there are no data on turbidity (NTU) in this dataset. While TSS (measured in mg/L) provides a useful indication of sediment loads, in catchments where there are dispersive soils there can be very high levels of turbidity associated with low-moderate TSS loads, as the fine clays held in suspension play a key role in restricting light penetration into the water column yet have comparatively little mass.

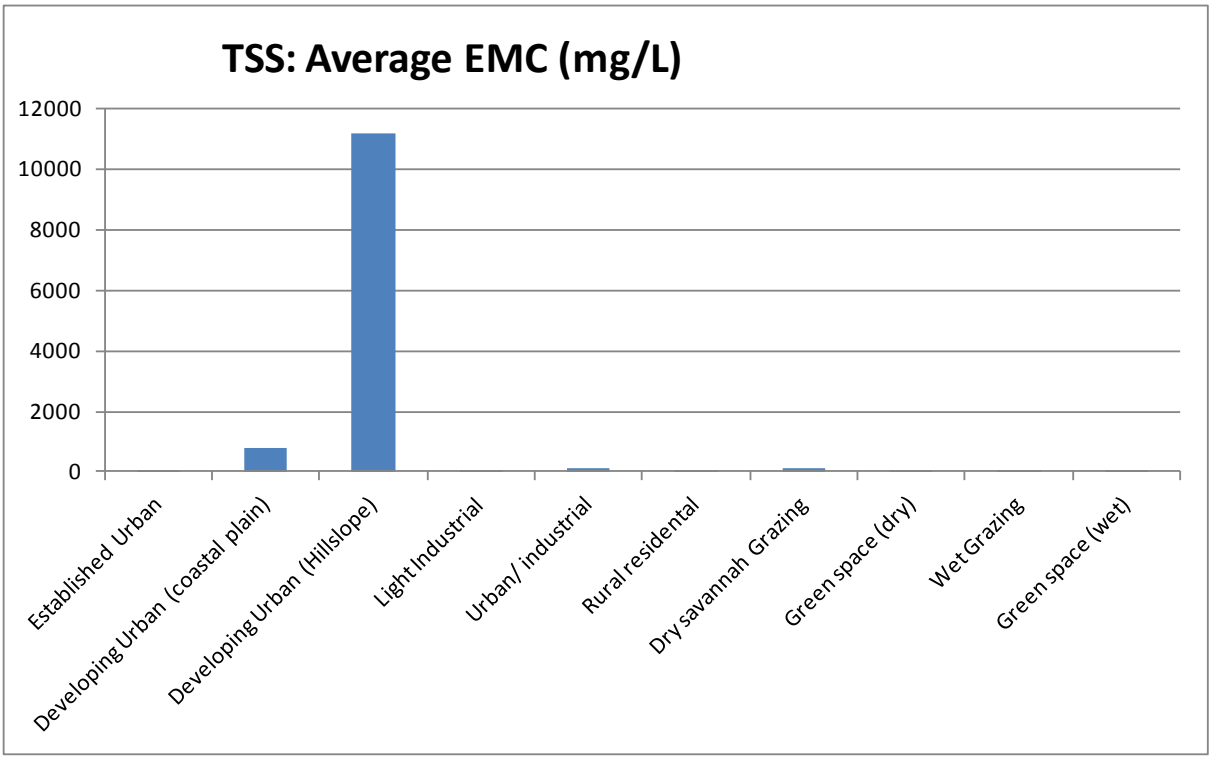

Figure 1-1 TSS data collected from local monitoring programs in 2006/07 and 2007/08. Note that total sediment loads may be significantly under-represented in this figure, given the relatively flat topography of the majority of Townsville's urban environment and that hillside composition generates more coarse material than can be captured in event based TSS monitoring.

1.6 GIS Data

An extensive amount of GIS data has been provided by Council relating to infrastructure, planning and population, and natural resources.

A series of maps have been prepared based on those layers identified as being most relevant to this project, and are included as an attachment. Maps are described below:

- **Development Areas:** This shows the Plan of Development (urban footprint), Priority Development Areas, and developed urban areas (digitised aerial photography).
- **Subcatchments and zoning**: This provides a breakdown of land use within each subcatchment area. The tabulated data which underpins this map will be one of the major inputs to the water quality analyses during subsequent stages of the project)

- **Stormwater Treatment Device**: This map shows those stormwater treatment devices which are known to exist and have been recorded in the relevant GIS layer. This is expected to be only a subset of the existing stormwater treatment assets. Stormwater treatment investigation areas are also shown on this map.

Other GIS data reviewed and considered relevant includes:

- Waterways and stream order
- Protected vegetation and protected areas, which set no-go areas for regional stormwater treatments.
- Slope, which affects the selection of water quality measures, with wetlands most suited to flat terrain, while revegetation is most effective on steeper slopes prone to erosion.
- Soil erodibility, however the source and basis of GIS layer showing different levels of soil erodibility (0 – 2e scale) has not yet been established.

1.7 Stormwater quality management

Stormwater quality management is an important aspect of water sensitive design, and is often intrinsically linked to the management of stormwater hydrology, which seeks to provide safe drainage systems to prevent nuisance flooding, as well as mitigate changes to the hydrology of natural systems. This link between stormwater quality, and runoff management, and water sensitive urban design needs to be kept in mind when considering any stormwater quality offset scheme, because integrated designs which reduce impervious surfaces, and which capture, detain and treat runoff, are often able to meet multiple objectives in a coherent, attractive and cost effective manner.

For example, the State Planning Policy (Table A) provides a generic waterway stability objective that may apply to some non-degraded waterways, and local authorities may establish more fit-for-purpose waterway flow objectives. The Queensland Urban Drainage Manual (QUDM), and local government planning schemes, also set relevant drainage and flood management standards.

Designers and local authorities need to consider the specific needs of any waterway and the objectives that apply at any site, to ensure that the relevant objectives are viewed as a package and managed holistically.

Any discussion about stormwater quality should be mindful of the evidence indicating that construction sites contribute many times more sediment than established urban areas, yet currently erosion and sediment control practise across Queensland is very poor. Not only does sediment laden construction site runoff pose an acute risk to ecosystem health, it is also the main cause of harm to stormwater quality assets.

The State Planning Policy (2014) which specifies the default load-based reduction targets for stormwater quality management in Queensland. Those targets are based on how well bioretention systems can improve the quality of urban stormwater runoff, without the treatment systems becoming excessively large (i.e. where further increases in the size of the bioretention system would lead to diminishing water quality benefits). The targets do not necessarily achieve a no-worsening of pollutant loads compared to current or natural catchment conditions.

In developing those targets, the following was not explicitly taken into account:

- The actual needs of various waterway types (lakes, streams, rivers, estuaries and coastal waters)
- The real costs to developers, especially the value of land occupied by treatment measures
- Site constraints (including physical constraints and conflicting design standards for other urban infrastructure)

- The net maintenance burden to local government and how this might be funded
- How the necessary investment in long-term capacity building might be funded
- What alternative strategies might exist to improve stormwater quality outcomes.

While the performance of many water sensitive design practices in improving water quality is well established, there is a lack of evidence about its measurable benefits in improving waterway health. In particular, there is a lack of information on the effectiveness of WSUD in the coastal dry tropics zone, such as Townsville. There is a lack of consensus amongst ecologists about what factors are critical in achieving healthy waterways in urban environments (a range of factors are acknowledged, including instream habitat, riparian cover, water quality and hydrology).

The precautionary principle would suggest a 'do no harm' approach, however the current development system in Queensland generally allows environmental harm to occur as an inevitable consequence of urban development. For example, the State Planning Policy was recently revised so that stormwater quality targets only apply to developments larger than 2500 m^2.

1.8 Stormwater offset policy

There are a number of key drivers for stormwater quality offsets including:

- Less than optimal outcomes on small constrained sites
- The maintenance burden associated with maintaining stormwater quality assets (especially large numbers of small, poorly performing assets)
- The assumption that offsets would provide 'better bang for buck'
- Flexibility to deliver better integrated outcomes
- Control over the type of asset being delivered to provide consistency and easier maintenance
- Developer and political pressure, particularly where stormwater quality management is seen an 'impost'
- Building internal capacity within Council, through management of projects from design through to ongoing maintenance.

Part 2 of the Townsville Regional Stormwater Strategy discusses recommendations for managing the implementation of stormwater offset policies.

1.9 Environmental Offsets Act

The Environmental Offsets Act (Act 33 of 2104) was assented to 28 May 2014.

The Environmental Offsets Act 2014 provides the foundation for what an offset is and how it is to be provided, complementing assessment provisions in existing legislation, which govern if and when an offset is to be required as a condition of an approval. Activities for which an offset may be a relevant consideration are prescribed in section 9 of the Environmental Offsets Act 2014 and reflect assessment requirements under other legislation. An offset may be required where an assessment of a proposed prescribed activity has demonstrated that any prescribed environmental matter may be significantly impacted by the prescribed activity despite all reasonable avoidance and mitigation measures[1].

Purpose:

1. The main purpose[2] of this Act is to counterbalance the significant residual impacts of particular activities on prescribed environmental matters through the use of environmental offsets.

[1] Queensland Environmental Offsets Policy - DEHP (not in effect).
[2] Part 2 S 3.

2. The main purpose is achieved primarily by—
    (a) establishing a framework for environmental offsets; and
    (b) recognising the level of protection given to prescribed environmental matters under other legislation; and
    (c) providing for national, State and local matters of environmental significance to be prescribed environmental matters for the purpose of this Act; and
    (d) coordinating the implementation of the framework in conjunction with other legislation.

The Environmental Offsets Act is principally intended for major infrastructure and resource development projects, and currently has little relevance to stormwater quality offsets.

- It is possible that some urban development may require consideration of offset requirements, depending upon the assessment requirements under existing legislation and whether or not it will impact on a prescribed environmental matter.
- **Water quality** is not a prescribed environmental matter for the purposes of the offsets framework.
- **As water quality is not a prescribed environmental matter, the policy is not relevant**. However, there are circumstances where offset outcomes to benefit prescribed environmental matters may provide multiple benefits, including improvements in water quality.

The Offsets Act 2014 amends a range of other legislation, including the Sustainable Planning Act. However, against expectations, there is no amendment to SPA s347 within the Environmental Offsets Act 2014 which limits the imposition of a charge, and hence offsets must remain voluntary.

EHP has developed a framework for voluntary market-based mechanism for regulated point source operators (e.g. sewage treatment plants), but does not yet have a similar framework for stormwater quality.

1.10 Off-site Stormwater Quality Solutions - Discussion Paper (Healthy Waterways 2014)

Note that because the Environmental Offset Act (described above) does not make provisions for stormwater offsets, the Queensland Government has discouraged Healthy Waterways from using the term offset in this paper. Nonetheless, offsets is a term that is broadly understood by the industry and aptly describes the concept.

To investigate the merit and risks of stormwater offsets, promote discussion on their use, and propose a high level framework for their use. It is envisaged that feedback obtained on this discussion paper will form the basis of a future stormwater offset guideline.

The key aims of this discussion paper are to:

- Determine when a stormwater offset scheme may provide a net benefit
- Determine the costs and benefits of stormwater offset schemes
- Identify uncertainties and risks
- Highlight case studies where stormwater offset schemes have been used
- Define key principles for when it is appropriate to use stormwater offsets schemes in Queensland

The report provides marginal cost abatement curves for a range of water quality management practices. It also addresses common myths and misconceptions in relation to offsets.

The following **offset principles**, drawn from the international literature, are proposed to guide the development of any stormwater offset schemes:

1. Offsets should not replace or undermine existing environmental standards or regulatory requirements. Rather, offsets should be part of a cohesive suite of measures to address water quality objectives.
2. Offsets should only be used once reasonable technically feasible and cost effective measures to avoid and mitigate on-site impacts of development have been exhausted.
3. Any approved offset project should demonstrate the offset actions are additional to any business as usual.
4. Offsets should be environmentally, temporally and spatially equivalent to the impacts from the development.
5. Time lags between the impacts of the development and benefits of the offset should be minimised.
6. Offsets must be underpinned by secure legal agreements or an appropriate formal mechanism to ensure their ongoing provision for the period of the development's impacts.
7. Offsets should be independently and transparently monitored and their performance evaluated.

1.11 Stormwater Offset Schemes

1.11.1 Ipswich City Council.

Ipswich City Council has probably the most developed stormwater quality offsets policy in Queensland.

Under its Planning Scheme, ICC has prepared Implementation Guideline No. 24 (Stormwater Management). The Guideline was prepared to assist with the implementation of the Planning Scheme by providing guidance for the management of stormwater runoff as a resource), including the following, p.1:

- Protecting existing natural features and ecological processes,
- Maintaining the natural hydrological behaviour of catchments,
- Flood control or mitigating measures and avoiding the creation of nuisance flow/flood hazard situations as a result of development
- Erosion and sediment control,
- Protecting water quality of surface and groundwater

This Guideline provides objectives that proposed developments must achieve within the Ipswich local government area (LGA) including:

- Integrated water management
- Stormwater quantity and flood management (incl. Voluntary Water Quality Nutrient Offset Payment s. 3.2.3 criteria). These criteria are not precisely defined and this is a potential source of confusion and conflict.
- Stormwater quality and flow management
- Thresholds and stormwater quality and flow management solutions
- Deemed to comply requirements for stormwater quality
- Stormwater management plans
- Stormwater quality and flood management

The eligibility for the Voluntary Water Quality Nutrient Offset Payment is as follows (p.3):

- The catchment is mostly urbanised or is a small parcel of land within a broad land release area (in essence, infill development); or
- The waterway downstream is in poor condition; or
- The waterway downstream is not sensitive to hydrologic change resulting from development (i.e. no risk of increased waterway erosion).

Currently, there are differing interpretations of the strategic priorities of Council's offset scheme, and further work is required to clarify its clear strategic intent and expected outcomes. An Implementation Plan is currently being developed.

Overall, there appears to be a gap between the policy and its implementation, and greater clarity is needed around eligible and ineligible areas for offset collection (maps are proposed to address this). Nonetheless, Council has collected in excess of $1m in voluntary contributions and has a number of potential offset projects planned.

Offsets are currently priced at about $50,000 per hectare of development, with the price pegged at the equivalent capex of bioretention systems (ex land cost) as specified in Council's annual charges advice.

1.11.2 Logan City Council

Logan City Council (2013) state that the amount of offset charged for a particular development will be determined by the cost to Council of designing, constructing and establishing stormwater quality projects to achieve this outcome, with the actual charge determined by the weighted average cost of applicable Council stormwater quality projects at the time the application is assessed, and the area and type of development proposed. Water by Design (2014) cites Logan City Council's current charge rates per hectare of development (for voluntary water quality contributions), which range from $46,800 to $57,600, depending on geographic location.

1.11.3 Mackay City Council

Similar to IG24, Mackay City Council (2014) outlines a methodology to determine the offset contribution necessary (when permitted) – which is dependent on the (i) sensitivity of the waterway and size of the development and (ii) the development type. Offset contribution amounts are based on a two tiered system:

- Level 1 - where the local receiving waterway is resilient to nutrient loading. In this case, treatment of stormwater from the development is required to achieve the Total Suspended Solids objective (i.e. 75% removal of annual average TSS load) prior to discharge from the development site. The offset price is $15,000 per ha.
- Level 2 applies where the local receiving waterway is disturbed or where the development area is <0.5ha. The offset price is $42,000 per ha.

Similar to Ipswich City Council's IG24, these costs are based on an assumed 'design and construct' cost for bioretention systems of $400/m^2 (UDIA, 2013).

1.11.4 Melbourne

Melbourne Water (2014a) offers a stormwater quality offset ranging from approximately $18,000/ha to $41,000/ha for standard residential developments. The cost of offsite nitrogen treatment is currently calculated at $6,645/kg N (per kilogram of annual total nitrogen load) plus an administration fee of 8.9%, which is based on the cost of past stormwater treatment works constructed by Melbourne Water (Melbourne Water 2014a). Melbourne Water regularly reviews its offset price to ensure it covers the actual cost of abatement, as some of the low cost opportunities have already been exploited.

1.12 Reef Rescue

The Reef Plan lays out a strategy for the Great Barrier Reef Lagoon, and sets ambitious targets for improved water quality and land management practices, identifying numerous actions to improve the

quality of water entering the reef. Initially established in 2003, the plan was updated in 2009 and 2013. The 2013 plan details specific actions and deliverables to be completed by 2018, when Reef Plan will be reviewed.

The long term goal of the Reef Plan is to ensure that by 2020 the quality of water entering the reef from broad scale land use has no detrimental impact on the health and resilience of the Great Barrier Reef. Specifically, interim (2018) water quality targets include:

- At least a 50 per cent reduction in anthropogenic end-of-catchment dissolved inorganic nitrogen loads in priority areas.
- At least a 20 per cent reduction in anthropogenic end-of-catchment loads of sediment and particulate nutrients in priority areas.
- At least a 60 per cent reduction in end-of-catchment pesticide loads in priority areas.

While land and catchment management targets for 2018 include:

- 90 per cent of sugarcane, horticulture, cropping and grazing lands are managed using best management practice systems (soil, nutrient and pesticides) in priority areas.
- Minimum 70 per cent late dry season groundcover on grazing lands.
- The extent of riparian vegetation is increased.
- There is no net loss of the extent, and an improvement in the ecological processes and environmental values, of natural wetlands.

The Reef Plan is strongly agriculture focused since this is where the majority of pollutants loads originate, however urban development will continue to have impacts on whole of catchment water quality and in some instances when upstream of farming areas can exacerbate existing problems, particularly through increased impervious areas substantially increasing the volumes and intensity of stormwater runoff.

1.12.1 Guiding principles

The Reef Plan adopts the following guiding principles as part of project delivery, which are highly relevant to the current project and should be explicit in the assessment criteria for site selection.

Innovative approach

Integrate with best management practices and implement innovative practices that will deliver substantial improvements in stormwater runoff. Initiatives should be guided by best practice in stormwater design and management, however given their scale, there is also likely to be a strongly ecological component to the works which requires more than typical WSUD approaches but also an appreciation of pre-European floodplain and geomorphic processes (AWC, 2014).

Targeted approach

Continue to reduce pollutant loads, particularly by targeting water quality improvement to the highest risk pollutants in the highest risk regions. This has parallels with the process for locating regional stormwater devices for managing urban runoff in strategic locations delivering the greatest benefits.

Whole-of-catchment

Protect and enhance key areas of the region, including wetlands and riparian areas, which have a water quality protection function and an intrinsic value in their own right.

Role of extension

A key goal of the Reef Plan is to *"Foster and recognise stewardship activities within farming, grazing, councils and schools across the Great Barrier Reef catchment that help achieve Reef Plan outcomes*". Extension activities are integral to supporting stewardship, but also to educate and raise awareness of why the works are important how they can be successfully integrated to a landscape in ways that enhance rather than hinder existing uses (Leach, 2014).

Achieving meaningful outcomes at a catchment scale requires widespread community support to ensure their success and longevity. Proposed regional solutions have the potential to substantially alter landscapes and environments due to their scale and it is essential that benefits clearly outweigh perceived or actual costs (Millar, 2007). Site selection and implementation must be aware of social and cultural context and substantial time and effort is required to win the support and endorsement of various stakeholders. The benefit of this approach is that significant leverage is gained through the participation of community members with a range of experiences, local knowledge and expertise (e.g. refer to Barron River Catchment case study: http://www.barronrivercatchment.org.au/). Actively engaged community members will also become champions of the works within the community, encouraging others to participate in the works.

Complementing existing initiatives

A key priority of the Reef Plan is to integrate with any relevant policies and programs which emerge from the comprehensive strategic assessment of the Great Barrier Reef World Heritage Area, the adjacent coastal zone and associated long term plans for sustainable development.

Key initiatives recently or currently being completed potentially of relevance to this strategy are listed in Table 1 below. It's clear that the philosophy and investigations being completed are very relevant to the Townsville strategy. The Reef Plan seeks to develop an agreed framework that requires water quality offsets to results in strategic and cohesive outcomes (Australian Government, 2013). There is a desire (and need) to prioritise coastal, urban and wetland activities that deliver meaningful water quality outcomes, while developing the means of measuring improvements for water quality within the GBR. The parallels therefore with the existing strategy are clear and need to be included within decision making criteria for site selection. Given the overlap between the two initiatives there should be scope for collaboration, knowledge sharing and efficiency for Townsville Council. From a community perspective it is also important that the distinction between initiatives is clear and that there is not a perception of conflicting advice received from Council and State Government agencies.

Table 1-2: Key initiatives recently or currently being completed potentially of relevance to this strategy

Action	Date	Lead Agency	Partner Agencies	Status/Comment
Establish an agreed framework for reef water quality offsets that delivers more strategic outcomes, including a net improvement to the outstanding universal value of the Great Barrier Reef World Heritage Area.	June 2014	EHP	GBRMPA,DSEWPaC,DAF	Reef Trust? Funding mechanism for offsets. Fed Govt $40M of seed money, + another $100M State Govt Joint offsets policy- EHP Website
Prioritise coastal, urban and wetland rehabilitation activities that improve water quality and Great Barrier Reef health in order to inform state, national and regional programs of work.	June 2014	GBRMPA	DSEWPaC,DEHP, regional NRM organisations ,DPC, DNRM industry groups,	Product – Blue Maps and Eco Calculator Blue Maps – connectivity mapping (to reef) Eco-Calculator – different ecosystems and landuses within a

			research groups, WWF	catchment existing vs historic
Help determine the pollutant load reductions required to meet marine water quality guidelines, by completing a receiving water model as part of the eReefs project.	June 2015	Great Barrier Reef Foundation	BoM, Queensland Government, DSEWPaC, CSIRO, DPC .	eReefs model is currently being developed but not yet complete

1.13 Reef Water Quality Protection Plan

The Reef Water Quality Protection Plan (2013) is a Commonwealth and QLD government collaboration which quantifies pollutant loads within subcatchments as well as the relative contribution of different land uses. The plan is also intended to support and inform decisions around funding of water quality initiatives delivered as part of the Reef Program.
Key findings of the plan were:

- Land used for agriculture occupies about 82% of the GBR catchment. Land used for cropping, dairy, grazing, horticulture (including bananas) and sugar cane contributes an estimated 56, 69 and 66 % respectively to the estimated anthropogenic loads of Total Suspended Solids (TSS), Particulate Nitrogen (PN) and Particulate Phosphorus (PP), plus an estimated 87 per cent of the anthropogenic Dissolved Inorganic Nitrogen (DIN) and 100 per cent of the Photosynthesis II herbicides (PSII) delivered to the GBR lagoon.

- Grazing (75 per cent of the area of the GBR catchment) contributes an estimated 45, 43 and 45 % respectively to the estimated anthropogenic loads of TSS, PP and PN and an estimated 21 per cent of the DIN load. The Burdekin and Fitzroy sub-catchments are rated as very high and high priority for investment in improving grazing management .

- Stream bank erosion contributes an estimated 39, 28 and 21 % respectively to the anthropogenic loads of TSS, PP and PN.
- Land used for sugar cane (1.3 % of the GBR catchment) contributes an estimated 56 and 94 % respectively (Figure 6, p. 36) to anthropogenic loads of DIN and PSII delivered to the GBR lagoon. The Burdekin (mainly East Burdekin), as high priority for investment in nutrient practices to reduce DIN loads.

- • Opportunities for improving practices for better water quality outcomes are identified. In the grazing industry these include supporting adoption of better herd management and targeting investment to reduce subsoil loss through gullying and stream bank erosion. In the sugar cane industry there are significant opportunities to reduce DIN loads, particularly by moving from district yield to block or zone potential yields to calculate nitrogen fertiliser applications.

- Recommendations are made on improvements in reporting, monitoring and modelling land management practices to track investment outcomes . Areas are identified for updating Source catchment modelling to reflect new understanding of sediment storage processes and to provide spatially detailed water quality outputs, especially for the Burdekin and Fitzroy sub-catchments.

1.13.1 Modelling load reductions within the Reef Water Quality Plan

Regional and catchment load reductions arising from improved land management practices in cane and grazing are modelled based on plot and paddock scale monitoring and modelling, and rainfall simulation experiments. A range of models were used within the Reef Water Quality Protection Plan

and model predictions of potential load reductions are considered conservative. The models used to generate the daily pollutant loads for current and improved practices within source catchments are likely to be different from models used for sizing Stormwater Quality Improvement Devices (SQIDs) for the current project (i.e. MUSIC).

For cane, APSIM (www.apsim.info, 2015) was used to model crop growth and DIN losses, with 'Howleaky' used to model phosphorus and herbicides. 'Howleaky' was used to model grains cropping (www.howleaky.net, 2015). The Revised Universal Soil Loss Equation (Renard et al. 1997) was used to model sediment loss from grazing lands.

The modelled output is used to report end of catchment pollutant loads for each of the 35 major sub-catchments flowing to the GBR lagoon for a baseline year, and changes relative to the baseline year for each subsequent year of reported changes in management practices. Understanding the relative contribution of each land use and catchment is important for prioritising investment and management options.

Loads per hectare data for agricultural land uses, shows percentage contributions of different land uses, with sugar cane is the largest contributor of DIN and herbicide (grazing is second). The relative contribution of different land uses is something to remember when selecting regional sites, as it is possible that if there is cane in the catchment, any effort to improve water quality may be dwarfed by runoff from cane land.

1.13.2 Multi-criteria analysis for decision support

The Reef Water Quality Protection Plan used a multi-criteria analysis shell (MCAS-S) following ABARES (2011) to draw upon available evidence from water quality monitoring and modelling, research and practice as well as input from stakeholders throughout the catchments. The ABARES MCAS-S tool was developed by the Commonwealth Government and is available free. The model follows an assets, threats and solvability model for priority setting which is represented conceptually below. The fact that this MCA tool is now established as a decision making aid within the region, its use for decision making in the current project may be beneficial or even expected by some stakeholders.

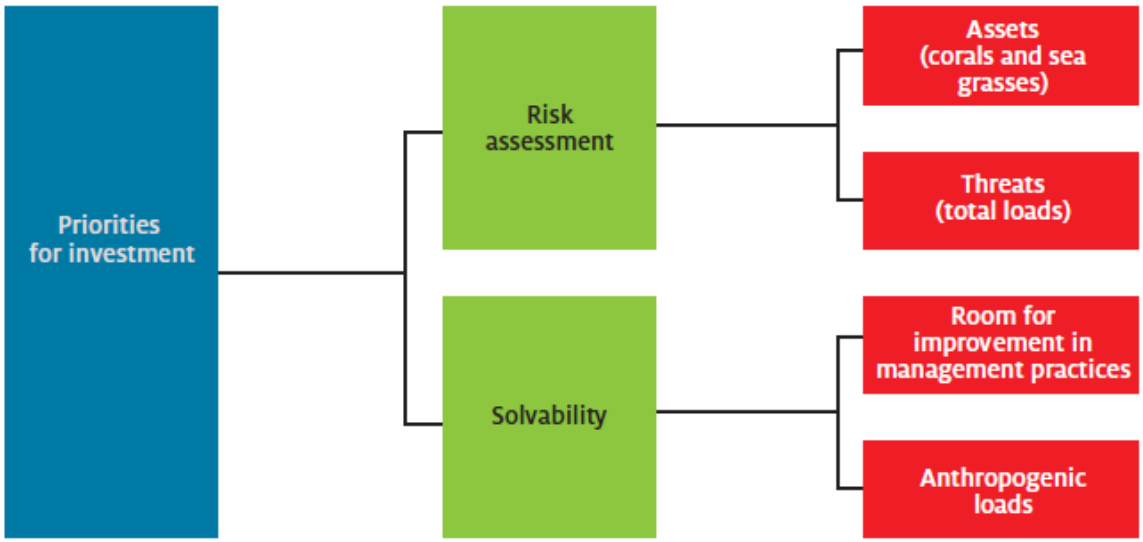

Figure 1: Reef Water Quality Protection Plan 2013 – generalised means to an end flow diagram.

1.14 Synergies with the Reef Water Quality Protection Plan and Townsville Regional Stormwater Strategy

The aim to reduce loads of nutrients, sediments, pesticides and herbicides reaching the reef through point source control, rehabilitation of flood plains and rehabilitation of waterways has strong parallels with the Townsville Regional Stormwater Strategy. Further through the Reef Urban Stormwater Management Improvement Group (RUSMIG) Townsville is committed to a collaborative effort to improve runoff to the reef. The vision of RUSMIG is for - *healthy catchments, waters and aquatic ecosystems.*

The Burdekin is a priority catchment for rehabilitation and water quality improvement works, with the Upper Burdekin delivering some of the highest sediment loads of any catchment into the lagoon. Sugar cane delivers high loads of DIN, while grazing delivers sediment. There are a combination of strategies proposed including education, improved farm practices, assistance with infrastructure improvements and improvement of water quality through activities including construction of vegetated swales, sediment basins and constructed wetlands (Australian Government, 2013).

Over the past 5-7 years numerous projects have been completed to identify and engage with landholders who are interested in having farm based water quality improvement measures incorporated into their properties. Numerous projects have been completed and with works generally limited to non-productive land including drainage lines and riparian zones, however there has also been instances of broad acre rehabilitation of former cane and grazing lands instances where farming has discontinued (e.g. AWC, 2014). These types of works are the most meaningful in terms of making significant inroads to pollution control and are also extremely cost effective on a per hectare basis compared to smaller scale works.

These type of broad acre works also provide significant ancillary benefits including habitat creation, carbon sequestration and ecological restoration. Some of the benefits for creation of regional stormwater facilities include:

- Economies of scale – generally cheaper to construct
- Reduced maintenance/less intensive maintenance
- Resilience – smaller edge to area ratio
- Different management expectations allowing less intensive maintenance than urban systems in high profile locations
- Significant ecological benefits including floodplain restoration, habitat creation, carbon sequestration.

These benefits are shown schematically in Figure 2.

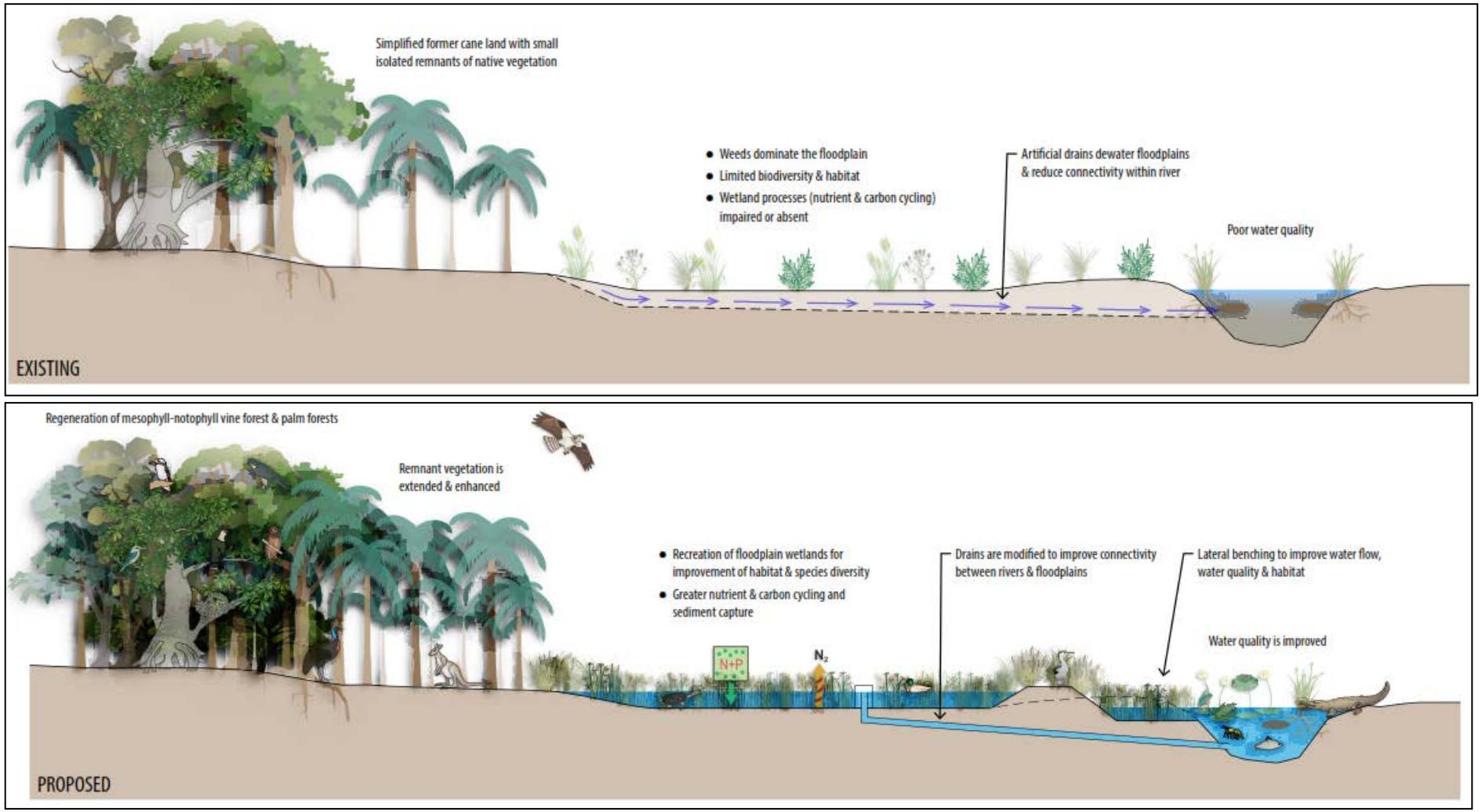

Figure 1-2 Proposed Babinda Swamp Constructed Wetland for water quality and habitat improvement (AWC 2014)

2 REEF RESCUE CASE STUDIES

Numerous stormwater quality improvement projects have been completed under the Reef Rescue and Reef Recovery projects with a selection profiled here which have potential relevance to the current project.

Pioneer River Basin Intensive Agriculture Treatment Train to Maximise Water Quality Benefit

Program: Biodiversity Fund – Reef Rescue
Project Manager: Reef Catchments (Mackay Whitsunday Isaac) Limited
Project Value: $1.77M

The Pioneer River basin is reportedly the most intensively developed agricultural developed agricultural landscape within the GBR catchment. The strategy aims to incorporate treatment train approach using constructed and rehabilitated wetlands, bioretention filters and environmental rehabilitation works to improve runoff to downstream freshwater, estuarine and marine environments, thereby treatment a combination of point source and diffuse pollutant sources. The project runs from 2013 to 2016.

Figure 2-1 Vegetated swale within agricultural lands. Source Reef Catchments, 2014.

Reef Rescue : Project: Burnett-Mary River Catchments Farm Based Stormwater Quality Improvement

Program: Biodiversity Fund – Reef Rescue
Project Manager: Burnett Mary River Catchment Management Group and AWC
Project Value: $0.5M

Eight projects were completed across the Burnett-Mary River catchment, typically less than 5000m^2 on private with input and collaboration of landholders. The works were a combination of constructed wetlands, vegetated swales and sediment basins with design completed by external consultants and construction varying between sites, but typically a combination of contractors, with some components being completed by the land holder, e.g. plant installation and watering.
Ongoing management is an issue, namely lack of time, resources and expertise at the landholder level. As part of a risk assessment it would seem prudent to consider the likelihood that the land holder can sustain the works or that the design is compatible with available skills and resources. This could be a case for consolidation at key locations rather than a series of smaller projects and clarity around maintenance requirements as well as the ability of a site to survive will little or no maintenance should be considered. This is mainly in the context of vegetation maintenance and weed invasion which may not threaten performance from a water quality perspective but may require expensive management is noxious weeds are found. Key weeds in the dry tropics include Hymenachne, Glush Weed and Singapore Daisy.

Figure 2-2 Landholder engagement and implementation works, Burnett Mary River Catchment. Source: AWC, 2012

Barron River Catchment - Slowing Storm-water run-off in catchments in the Atherton region

Program: Biodiversity Fund Reef Rescue 2013/14
Project Manager: Barron River Catchment Management Association Incorporated
Project Value: $1.8M

This project sought to address erosion and associated sedimentation of waterways through the implementation of detention basins within rural landscapes while maintaining the productivity of agricultural land to the greatest extent practical. Strategic works targeted high erosion areas by engaging with landholders to construct ephemeral detention basins within the floodplain, but at the same time addressing increased runoff from upstream urban areas. The designs are simple, low key and integrated with surrounding landuses to ensure minimal disruption to existing activities. The projects have also engaged community groups such as Landcare and local schools to ensure widespread community support and participation.

Figure 2-3 Construction and implementation works on the Atherton Tablelands, a combination of contractor and community participation. Source

Babinda Swamp Constructed Wetland

Program: Biodiversity Fund Reef Rescue 2013/14
Project Manager: Jaragun Pty Ltd
Project Value: $2.18M

The Babinda Swamp Constructed Wetland project will deliver broad scale floodplain rehabilitation works with the aim of improving water quality runoff from cane farming as well as rehabilitating floodplain habitats including notophyll vine forest and palustrine wetlands on coastal floodplains. The works include a 10 hectare constructed wetland which involved diverting base and low flow runoff from agricultural drains into disused cane land with inflows enabling rehabilitation through reinstatement of floodplain processes (wetting and drying) in combination with vegetation management strategies including cool burns, targeted weed control, direct seeding and planting.

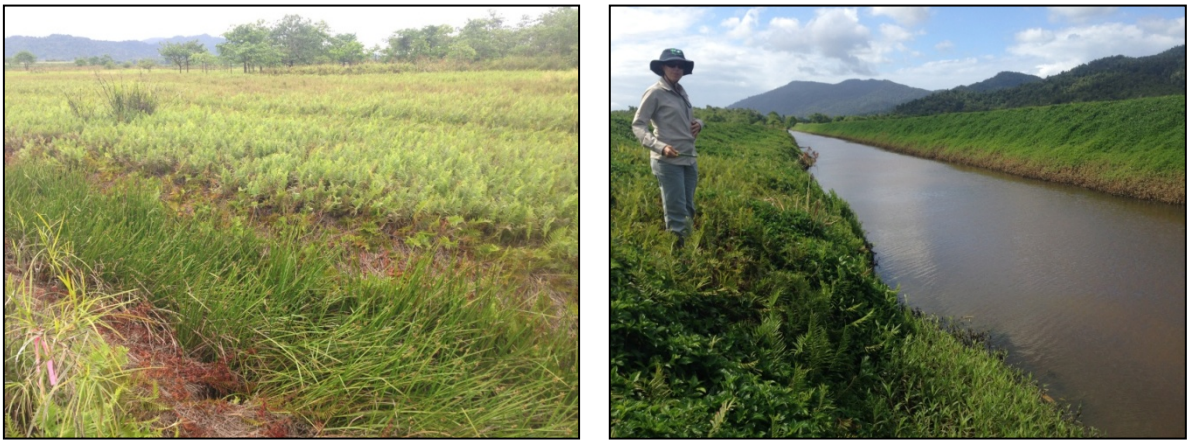

Figure 2-4: Existing agricultural drains and former cane lands with initial rehabilitation works.

3 STAKEHOLDER CONSULTATION

As part of the development of the Townsville Regional Stormwater Strategy, there has been an initial round of consultation with key stakeholders, both internal and external to Council.

This report provides a concise summary of the consultation that has occurred to date.

3.1 Process

Consultation occurred in three ways:

- An extended field trip with a Council officer experienced in water sensitive urban design to inspect a range of stormwater quality assets, as well as potential sites for regional treatment
- A one hour workshop with Council staff
- Individual interviews with external stakeholders on the 29th April 2015 at Council offices, with interviews conducted by Alan Hoban (Bligh Tanner) and Wesley Bailey and Amanda Rebgetz (Council). The purpose of these interviews was to listen to views and perspectives of key stakeholders about stormwater management issues, so that the Regional Stormwater Treatment Strategy is able to be developed in consideration of these matters. Interviews ran for 30 – 40 minutes duration.

3.2 Internal Stakeholder Consultation

The following internal stakeholders were consulted.

- Alan Walker - DA Engineering/Infrastructure Coordination
- Clint Burgess - DA Environmental Engineering
- Peter Johnston - Technical Services
- Scott Hawkins - DA Landscape
- Ron Degenhart - DA Landscape
- Mahendra Mistry - Maintenance Services
- Chris Manning – Integrated Sustainability Services
- Jason Lange – Integrated Sustainability Services
- Wesley Bailey- Infrastructure Planning
- Amanda Rebgetz - Heritage and Urban Planning Unit (Project Manager)

3.2.1 Key issues raised

Stakeholders engaged in a broad ranging discussion about water sensitive urban design in Townsville. Key quotes, grouped according to theme, are summarised below.

General matters

- *It costs Council a lot of money to not do WSUD, such as desilting waterways.*
- *There's a lot of theory, but we need to know if these approaches actually work.*
- *There is no firm evidence of the benefits or lifecycle requirements.*
- *There are underlying questions about performance.*
- *A waterway health report card could be useful to help draw the link between on ground actions and waterway health.*
- *Need to retain good knowledge within Council.*

Design issues

- *We've got only two case studies and both are early iterations of WSUD in Townsville. Northshore was the 'guinea pig' and so that development needs to be taken in context and we need to be fair in criticism of it.*
- *Early failures set a bad precedent and reside in people's memory.*
- *Developers often do it because they have to, not because they want to.*
- *We need to understand what sort of assets we want to maintain, and then work backwards to the design.*
- *Local climate is a real challenge.*
- *Flat terrain is a real constraint – sometimes there is no receiving pipe to connect [a bioretention] into.*
- *The industry has a low capacity to deliver good designs, and DA has limited training.*
- *South East Queensland guidelines get used, but they have no regulatory relevance and are not climatically appropriate.*
- *We lack a basic understanding of treatment trains.*
- *Better guidance on what to do in small developments would help.*

Construction issues

- *Erosion and sediment control is not being done well*
    - *Very few fines are issued, especially at the subdivision stage.*
    - *There is limited education in the industry – it needs to be tailored to the audience (e.g. tradies)*

- *Fines are not big enough.*
- *There is a need for regional compliance/regulation framework for erosion and sediment control*

Asset Management

- *We need an asset management strategy that is supported by the Executive Management Team*
- *There is no consistency with assets.*
- *We don't even know where all our assets are.*
- *There is no high level recognition of biological assets.*
- *Maintenance budgets are shrinking yet the asset base is growing – something has to give.*
- *We're in tougher economic times*
- *Maintenance needs to be funded – it comes down to money at the end of the day.*

Offsets

- *There's a potential issue with non-payment.*
- *Industry will likely see is as a way to save lots of time and money, especially in relation to bonds and maintenance requirements, and so will help with cash flow.*

3.3 External Stakeholder Consultation

As noted above, external stakeholders were invited to share their views anonymously. A range of stakeholders were invited to participate and the final list of interviewees included:

- A town planning firm involved in large scale residential developments
- A town planning firm with a focus on commercial, industrial and small residential developments

A development company involved in large residential subdivisions

- A consulting civil engineer involved in large master planned developments
- A consulting civil engineer involved in small to medium developments
- A scientist involved in regional water quality programs.

3.3.1 Interview process and questions

Interviews were semi-structured and generally included the following questions:

- How well do you think stormwater quality is being managed in Townsville?
- What is your understanding of the regulatory requirements for stormwater management?
- How could practice be improved? What needs to be done differently? What is being done right?
- What are the pros and cons of:
  - Managing stormwater quality on a site by site basis?
  - Managing stormwater at a regional scale, such as through larger wetlands or waterway improvement works?
- How should regional measures be funded? (e.g. developer contributions, infrastructure charges, levies etc?).

Of the six interviewees, five provided written consent to an audio recording of the interview, on the basis of anonymity. Transcriptions of those interviews are provided as an attachment to this report, although note that one of those audio recordings was of a poor quality and not able to be transcribed. The transcriptions have been slightly edited in places to remove any key references to names etcetera that would affect anonymity.

3.3.2 Key findings

Generalised findings from the consultation are summarised below:

- Stormwater water quality management has wide support as it is seen as important to protect local waterways as well as the health of the reef.
- However, there are strong of concerns about whether the standard practices being used (like bioretention) are actually providing the expected water quality benefits, and whether they are appropriate for the local climate.
- Council is seen as being inflexible in trialling innovative approaches to stormwater quality management.
- There is broad support for a stormwater quality offset scheme, as it is perceived that this would simply and reduce the cost of preparing development applications, result in lower development costs, achieve more cost effective outcomes overall, reduce the overall maintenance burden, and provide more meaningful environmental outcomes.
- A voluntary payment of a stormwater quality offset, outside of the formal LGIP infrastructure charges process, was supported.
- For such a scheme to be effective, it would need to be simple and provide certainty for developers.
- Offset projects would not necessarily need to occur close to the contributing development, provided there was an overall strategy and logic for how the scheme worked.
- There would need to be transparency about how offset funds were spent and a genuine commitment to achieving comparable water quality outcomes.
- The timing of offset payments should be as late as possible to help address impacts on cash flow, either at plan sealing or even as late as settlement.
- Poor erosion and sediment control is a systemic issue but has large water quality impacts.
- Developers may be able to contribute in various ways, such as being a provider of offsets, contributions of land, or contributing works.
- The industry is aware of previous cases of offset commitments being abandoned, or commitments to performance testing not being followed through on.

As noted, transcripts are provided as an attachment. The following quote from one of those transcripts provides a good summation of some of the key messages:

“That's what I see the great strength the regional solution potentially would be. It probably provides an opportunity for a more clear outcome, clearer framework that would allow people to contribute to with some certainty.”

“I think at the moment there's some frustration that some of the solutions on a lot by lot basis might be piecemeal, not necessarily contributing to the broader objective. It's just to tick a box. I think that frustrates everyone, saying, well are we actually achieving what we should be achieving as a consequence of this. The development industry is mature enough. There are different ways to do all the outcomes well. Contribution may not necessarily be monetary, it might be delivery of the land, it might be delivery of land and works, or it might be a contribution depending on the nature of the development, whether it's a green field site, how they can contribute. They've got different avenues, I suppose, for how that contribution can be made.”

4 FIELD TRIP

On Tuesday 28th April 2015, a number of sites around Townsville were visited to understand issues associated with current stormwater management practices, and also to understand some key opportunities for regional treatment.

A series of photographs are included as Attachment B.

Some key observations are summarised below:

- Large bioretention systems were observed to be susceptible to:
    - Excessive sediment loads
    - Weed infestations (both aquatic and terrestrial)
    - Erosion of batters
    - Poor vegetation growth on batter slopes
    - Persistent baseflows, leading to *typha* growth at inlets
- Small to medium bioretention systems appeared to be in a better state than larger systems, and appeared to be less vulnerable to major weed infestations or failures.
- There is excessive lawn irrigation, which may be leading to both problematic baseflows into bioretention systems, and also excessive lawn clippings being washed or dumped into stormwater systems. Some turf species such as *zoysia spp*. appear to perform much better than other species.
- Any areas with shallow ponding of water or saturated soils, without good canopy cover, are prone to *typha* infestations.
- A number of open drains could potentially be transformed to create a more stable ecology, though improved canopy cover and structured understorey planting, however the water quality improvements that can be obtained at some of those sites appear limited due to the large upstream catchments and flashy nature of the local climate.
- Waterbodies, such as Freshwater Lake and its associated ponds, have complex water quality challenges, including being highly vulnerable to aquatic weed infestations such as *salvinia molesta* – leading to high ongoing maintenance costs for Council. Deep inlet pipes make it challenging to provide effective treatment at the inlets, and dry season water level fluctuations presents challenges for establishing effective wetland edges or treatment systems.

The potential options for regional treatment measures will be developed as part of subsequent stages of the development of the Townsville Regional Stormwater Strategy.