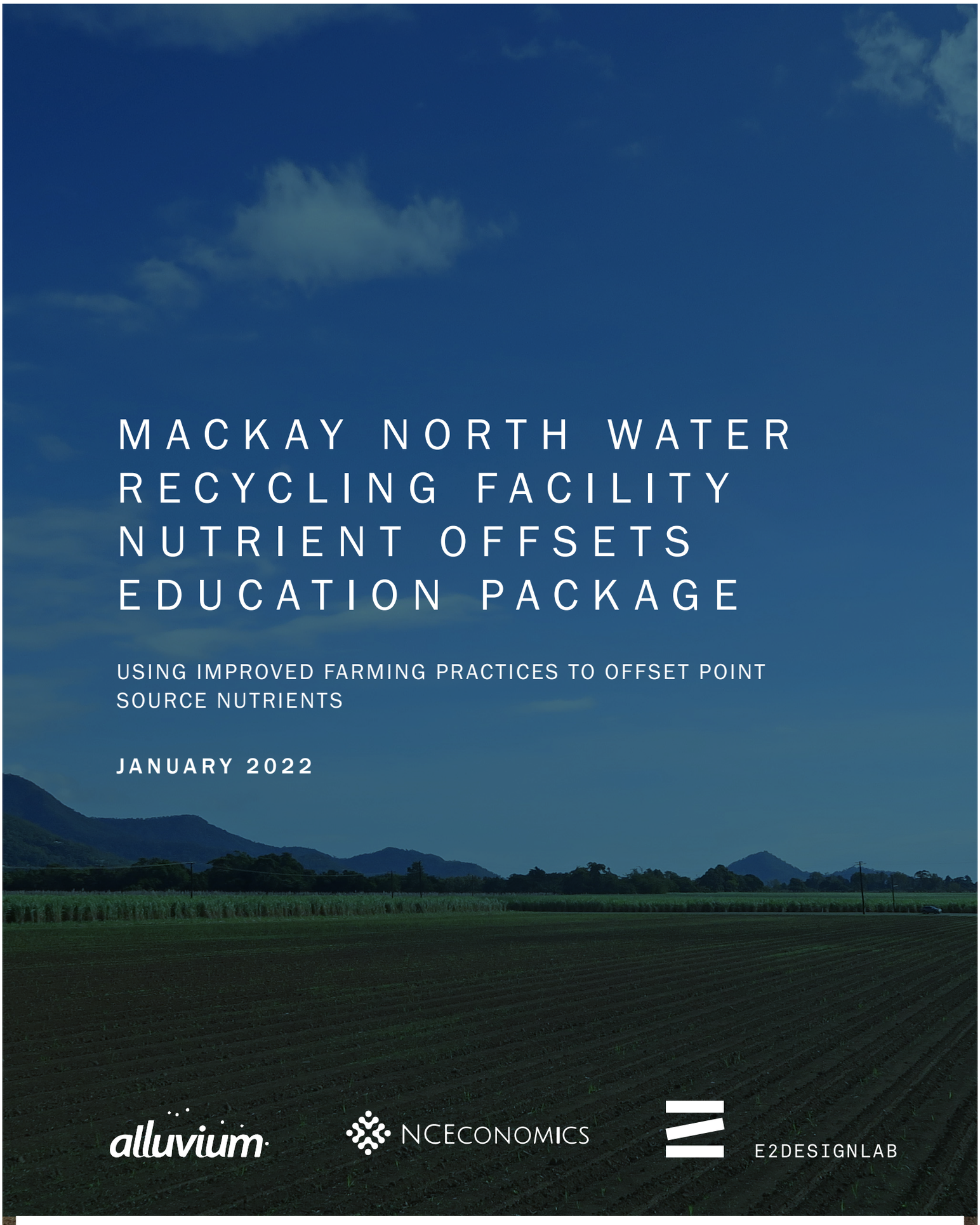

MACKAY NORTH WATER RECYCLING FACILITY NUTRIENT OFFSETS EDUCATION PACKAGE

USING IMPROVED FARMING PRACTICES TO OFFSET POINT SOURCE NUTRIENTS

JANUARY 2022

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Queensland Government

Mackay REGIONAL COUNCIL

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PURPOSE OF THIS EDUCATION PACKAGE

This education package has been developed to share key learnings from the Mackay North Water Recycling Facility Nutrient Offset Project (referred to in this package as the 'MNWRF Offsets Project'). This information is provided as a guide to be used by others to develop similar offsets programs. This Education Package should be read in conjunction with "MRC Nutrient Offsets Trial in Tin Pot Creek Catchment - Agronomic Report" (Farmacist Pty Ltd June 2021) and "Mackay North Water Recycling Facility Offset Project - Final Report" (Alluvium, October 2021).

MACKAY NORTH WATER RECYCLING FACILITY NUTRIENT OFFSETS PROJECT DESCRIPTION

Mackay Regional Council (MRC) received Queensland Reef Water Quality Program funding to trial the development of a point source offset scheme as a part of a case study linked to the Reef Council Rescue Plan Cleaner Wastewater Initiative. The trial is linked to the Mackay North Water Recycling Facility (MNWRF), with the main proposed mechanism of offset being improvements to nutrient (fertiliser) management practices on sugarcane farmland, with the initial focus on offsetting within Tin Pot Creek catchment area. Part of the rationale for focussing on Tin Pot Creek is that improving water quality through offsetting would have the co-benefit of reducing costs of treating drinking water in this system.

The MNWRF Offsets Project has quantified the water quality improvements associated with the alignment of farming practices with the Paddock to Reef (P2R) Water Quality Risk Framework and how this approach may offset or defer the timing of the Mackay North Water Recycling Facility upgrade. This pilot is intended to provide an approach that other Councils and utilities can use as a guiding framework to deliver similar projects.

PROJECT DRIVERS

- Manage pollutants entering the Great Barrier Reef from catchments across Mackay.
- Requirement for Water Recycling Facilities in the Great Barrier Reef (GBR) Catchments to ensure 'no-net-decline' (i.e. no increase in nutrient loads from those currently allowed in their Environmental Authority (EA)) as outlined in the *Environmental Protection (Great Barrier Reef Protection Measures) and Other Legislation Amendment Act 2019*.
- Understand if there are other options to address water quality instead of expensive wastewater treatment upgrades at the Mackay North Water Recycling Facility (MNWRF) which is nearing its capacity.
- Investigate potential water quality improvements that can be achieved with improving agricultural management practices in sugarcane farms which can be implemented instead of traditional wastewater treatment plant upgrades to improve waterway health.
- Begin stakeholder engagement with growers who have the potential to be involved in a future offset program.
- Provide landholders with an cost saving approach to reduce amount of chemicals and nutrients required without a reduction in farm yield.
- Pilot farms to become agents for change, communicating the benefits of this approach and leading to further uptake by landholders across the catchment.
- Develop and demonstrate a suitable approach that can be used by other Councils and at different scales to support broader application of the nutrient offset approach.

WHY WOULD YOU CONSIDER NUTRIENT OFFSETS?

- You have a sewage treatment plant (STP) or water recycling facility which is nearing its current capacity and will require upgrade / augmentation and there are limited options to reduce nutrient loads in the release water on-site.
- Cane farming is a dominant land use in your region and there are opportunities to address water quality by improving management of this land.
- You have cane farmers in your region willing to consider management practice improvement above minimum requirements if funding support for this was available.

PROJECT APPROACH

STEP 1 REGULATION AND CATCHMENT UNDERSTANDING

- Desktop review of legislation, GIS and other data
- Catchment pollutant load modelling

OUTPUTS

- Understanding of regulatory requirements, catchment values and risks
- Quantified end of catchment loads

STEP 2 WATER QUALITY TARGETS

- Determine loads, delivery and environmental equivalency ratios
- Calculate draft water quality targets

OUTPUTS

- Water quality targets

STEP 3 LANDHOLDER ENGAGEMENT

- Outline of requirements from project stakeholders
- Mail-out and direct approach of potential landholders and / or other industry representative groups

OUTPUTS

- Stakeholder agreement to participate in the process

STEP 4 ON-FARM EVALUATIONS

- Benchmarking of current condition
- Identification of potential solutions
- Site based treatment performance assessment

OUTPUTS

- Quantified current pollutant loads
- Identification and quantification of potential on-site opportunities and pollutant load reductions

STEP 5 EVALUATION OF OFFSET SOLUTIONS

- Catchment scale treatment performance assessment
- Evaluation of potential offset reductions compared to targets
- Comparison of potential solutions in terms of cost effectiveness

OUTPUTS

- Quantified catchment pollutant loads reductions
- Comparison of diffuse pollutant loads and water quality targets
- Cost-effectiveness analysis (CEA)

KEY LEARNING

- Need to ensure you have adequate time to allow for effective engagement with the project stakeholders. For the MNWRF Offset Project, it took five visits over five months to sign up participating landholders. This included the development of a stakeholder agreement.
- It is also best to avoid clashes between initial engagement and peak harvest or planting times to maximise participation rates.

WHO NEEDS TO BE INVOLVED?

- Landholders
- State Government
- Local Government
- Local Natural Resource Management (NRM) group / growers peak organisation

Mackay Regional Council

Queensland Government

STEP 1 - REGULATION AND CATCHMENT UNDERSTANDING

REGULATORY REQUIREMENTS

It is important to understand the regulatory requirements for the offset project early. The following are key pieces of legislation and policy that are relevant to the operation of the Mackay North Water Recycling Facility (MNWRF) and any subsequent offsets in the Mackay region:

- The *Environmental Protection Act 1994* and ERA63 – this sets out the licence requirements for the STP which informed water quality targets for the offset program. The MNWRF has existing flow, load and concentration based licencing requirements. If an STP did not have EA conditions linked to nutrient concentrations or loads, offset requirements estimates can be generated based on what would be expected for an STP operating at current best practice (i.e. end of pipe release concentrations of 5mg/L TN and 1mg/L TP).
- Point Source Water Quality Offsets Policy 2019 – this is applied to point source polluters that have pollutant concentration limits imposed on their licenced conditions of discharge. The policy details how offsets may be applied to manage ERAs, including discharging wastewater effluent into waterways. It states that offsets may be achieved from reductions to on-farm nutrient runoff through improved fertiliser applications management actions above the minimum standard. Other means of offsetting are outlined in the Point Source Offsets Policy, but these have not been considered at this stage.
- Reef 2050 Water Quality Improvement Plan (WQIP) - this plan outlines targets for all 35 reporting regions across the Reef, providing the load reduction values needed to achieve ecologically relevant outcomes in the Great Barrier Reef lagoon. This plan sets a 70% load reduction for dissolved inorganic nitrogen and 20% reduction for both particulate phosphorus and particulate nitrogen for the Pioneer River catchment which is where the MNWRF is located and where a linked point source offset scheme is being considered.
- Reef protection regulations - the *Environmental Protection (Great Barrier Reef Protection Measures) and Other Legislation Amendment Act 2019* outlines the requirements and mechanisms to achieve 'no net decline' to reef water quality. These include record keeping, minimum practice agricultural standards, farm nitrogen and phosphorus budgets for cane farms and permit requirements for some new or expanded cropping or horticultural activities. Offsetting can only be done for the nutrient management improvement above the minimum legislative requirements.

CATCHMENT UNDERSTANDING

A review of the catchment is required to understand the key pollutants of concern and their sources. Pollutant sources can include:

1. Diffuse catchment stormwater pollutants
2. Point source pollutants (such as STPs).

This understanding of the catchment may be based on a combination of existing water quality monitoring data, catchment assessments and catchment models. For the MNWRF Offsets Project, there were two main sub-catchments within the broader Pioneer River Catchment of that were reviewed:

- Reliance Creek - the MNWRF discharges to this waterway and is nearing its discharge limit for TN.
- Tin Pot Creek - this creek has relatively high concentrations for Total Nitrogen (TN), Total Phosphorus (TP) and turbidity compare to other water courses monitored within the Pioneer River main channel catchment.

A Source model was then built to understand the total pollutant loads being generated from the broader Pioneer River catchment.

USEFUL CATCHMENT UNDERSTANDING TOOLS

For the MNWRF Offsets Project, there was already existing water quality monitoring data and catchment assessments which had identified the pollutants of concern in the Tin Pot Creek catchment.

A Source model was developed for the MNWRF Offsets Project to understand the total pollutant loads being generated across the catchment and enable testing of different catchment treatment solutions. There are other ways to determine and model pollutant loads across catchments including:

- Simple unit loading rates (i.e. tonnes per ha per year for specific land uses)
- MUSIC modelling

P2R catchment loads monitoring data is available for GBR catchments as a resource for developing Source models for use in offset development.

MNWRF OFFSETS PROJECT KEY OUTCOMES

- The pollutant of concern and focus for the MNWRF Offsets Project is nitrogen.
- The highest diffuse TN loads in the Pioneer catchment are derived from the Tin Pot Creek and Reliance Creek sub-catchments.
- Sugarcane farms are the largest diffuse source of TN loads in the study area.
- The improvement of management practices on sugarcane farms in the Pioneer River catchment are the focus for the MNWRF Offsets Project.

STEP 2 - IDENTIFY SUITABLE WATER QUALITY TARGETS

The key outcomes of the regulatory and catchment condition assessment (Step 1) can then be used to develop suitable water quality targets. For the MNWRF catchment, the water quality targets were based on the following offset calculation from the Water Quality Offsets Policy (2019):

Offset to be delivered = Annual tonnes to be offset × Delivery ratio × Offset environmental equivalency ratio

Where:

- The annual tonnes to be offset is the load of nutrients discharged in excess of the license limit. For the MNWRF Offsets Project, TN offsets are likely to be required from 2031 based on expected population growth.
- The delivery ratio considers the uncertainty about delivering an equivalent pollution reduction load in the receiving environment. For the MNWRF Offsets Project environmental equivalency ratios of both 1:1 and 1:1.5 were used to develop a target range.

MNWRF OFFSETS PROJECT KEY OUTCOMES

- Based on predicted future EP loads, TN offsets will be required from 2031 to reduce between 258 kg and 387 kg of TN (mean annual load) from being discharged to Tin Pot Creek.
- The ultimate (2046) offset water quality target is between 4,579 kg and 6,869 kg of TN (mean annual load).
- This range in the target reflects the two different environmental equivalency ratios examined in this project.

ENVIRONMENTAL EQUIVALENCY

The offset environmental equivalency ratio is applied for point source: diffuse source offsets to account for the uncertainty associated with the environmental equivalence (chemical form/species) between the point source wastewater emission and the water quality offset point source or diffuse source, to ensure the delivery of improved water quality in the receiving environment is assessed on a like-for-like chemical basis. The offset environmental equivalency ratio normally applied is 1:1, however the MNWRF Offsets Project examined ratios of 1:1 and 1:1.5 in the determination of the offset water quality target requirement.

STEP 3 - LANDHOLDER ENGAGEMENT

This type of project is reliant on the involvement of landholders and growers in the catchment who are able to implement the best practice farming practices. Early identification and engagement of these stakeholders is critical as it can take time to find interested landholders and take them on a journey to sign up and participate in the project.

Ideally the landholders should be located in high risk areas and also currently be at the minimum standard (B level [moderate-low water quality risk]) as they are ready to transition to a management practice level at which offsetting would apply. If there are not enough landholders who are already at this minimum standard, consideration could be given to approaching other landholders who will require initial improvements to first achieve the minimum required standard, followed by the additional improvements to allow offsetting to be achieved. The timing of the project may allow the local council to engage with the landholders in the region and support them in achieving the minimum standard before the offsets are required.

The following should be considered when undertaking landholder engagement to encourage participation in the offset project:

- Timing - more than 6 months consultation time is required to do proper engagement and get farmers to begin signing on in sufficient numbers. Realistically, ongoing consultation over several years may be required to achieve the target amount of farmland to achieve the ultimate load offset.
- Funding requirements - providing financial assistance for more people resources to do the farm practice improvement and monitoring for this (i.e. not just buying more equipment).
- Clear outcomes - the inclusion of assistance with developing nutrient management plans as part of the on-boarding process.
- Shared resources - the provision of shared equipment resources (this will make it cheaper and not result in each farmer having to do extra equipment storage and maintenance).
- Capacity building / delivery support - assistance with funding, design and construction of on-site runoff WQ treatment solutions.

MNWRF OFFSETS PROJECT KEY OUTCOMES

- Two sugar cane farms within the Tin Pot Creek catchment agreed to be part of the offset project.

KEY LEARNINGS

It was important to have a clear outline of what was expected from the landholders upfront, for example time and resource commitments. This also included clarity on the type of data to be gathered and an understanding of how this would be used. Getting documented agreement on these roles, responsibilities and requirements is critical to ensure transparency and accountability between all parties.

Due to the timing of project commencement and the short duration of project funding, the planned initial engagement through shed meetings could not occur as it coincided with peak harvesting times. For similar offsets in other regions, the timing and means of engagement needs to be considered properly.

ENGAGEMENT METHODS

Effective stakeholder engagement is built upon trust and respect and therefore can be easier to achieve when there is a good existing relationship. Reaching out to existing contacts in the study catchment is therefore a good starting point, for example:

- existing relationships between council and cane farmers in their LGA
- existing relationships between farmers and their trusted advisor / advocacy groups / industry peak bodies

For the MNWRF Offsets Project Farmacist filled the role of the trusted agronomic advisor as they had a good track record of working with cane farmers in the region and existing relationships.

Broader engagement is also recommended and can include providing information about the project and a call for landholder interest using a number of different approaches including:

- Mail outs
- Social media
- Newsletters / newspapers
- Notice boards
- Shed meetings (scheduled outside of peak planting or harvest times)

For the MNWRF Offsets Project, a mail-out was undertaken from Council to landholders in the Tin Pot Creek Catchment. Farmacist also contacted landholders on their contact list in the catchment. Site visits were then organised with interested landholders.

STEP 4 - ON-FARM EVALUATIONS

Understanding current farming practices and their associated pollutant loads is required to understand the current benchmark for diffuse pollutant management. These benchmark pollutant loads are important to allow for future load reductions associated with improved farming practices to be quantified. Information collected for the MNWRF Offsets Project included:

- Soil type
- Existing equipment
- Nutrient application (TN (kg), TP (kg)).

This data was then entered into the P2R Projector tool to produce expected Dissolved Inorganic Nitrogen (DIN), fine sediment and pesticide load reductions from current management approaches.

Future best-case opportunities can then be identified for the farms. The pollutant load reductions should then be calculated to understand what improvements each individual farm is able to achieve. For the MNWRF Offsets Project, this tested:

- Expected practice change / minimum standard required under the reef water quality regulations (B level [moderate-low risk] practice)
- Best practice change (A level [low risk] practice).

These would be achieved through a mix of new equipment and treatment systems as well as improved farming practices, including chemical and nutrient application rates.

MNWRF OFFSETS PROJECT KEY OUTCOMES

- Both farms currently have Total Nitrogen (TN) export rates of 36 kg/ha.
- Sites and designs for recycle pits on both farms to capture nutrients and provide alternative water supplies.
- Potential identified for purchase of a seed planter to allow planting directly into sugarcane trash and use of legume crops to increase soil nitrogen reserves.
- Expected change (Class B) in practices could achieve an average 12 kg/ha reduction in Dissolved Inorganic
- Nitrogen (DIN). This cannot be included in the offset as it is a regulatory requirement.
- Best practice change (change from B to A level) could achieve an average 2.0 kg/ha reduction in DIN which is accountable as an offset.
- Nutrient and chemical management plans were developed with landholders to help improve farming practices.

USEFUL ASSESSMENT APPROACHES

For the MNWRF Offsets Project, the following assessment approaches were used to get an understanding of the current farm condition and management:

- Electro-Magnetic (EM) surveying of farms using TSM equipment attached to a 4WD side-by-side Kubota to produce maps defining soil type variation.
- Existing equipment audits were done in discussion with landholders to identify how equipment and practices could lead to reductions in pollutant loads.
- Water quality monitoring was undertaken on one paddock for each farm to understand event based pollutant loads in paddock runoff.
- Paddock to Reef (P2R) surveys with farmers with results entered into the P2R Projector tool to produce expected DIN, fine sediment and pesticide reduction from current extension efforts.

STEP 5 - EVALUATION OF OFFSET SOLUTIONS

TREATMENT PERFORMANCE

Understanding how improved farming practices on individual farms can deliver overarching water quality targets, a catchment scale assessment is required. This will typically require a model to be used to represent farms across the whole catchment. This model needs to be set up to represent the current and future conditions to enable the calculation of the potential water quality offset achieved.

The following approach was adopted for the MNWRF Offsets Project:

- Existing condition - Source model was used to determine TN loads being generated from the 2 x individual farms using:

  TN load from farm = Total TN load from catchment x (area of sugarcane landuse on farm / area of sugarcane landuse in catchment)

- Future condition - The total possible offset from the 2 farms was calculated using the P2R data:

  TN offset = TN load from farms × fertilizer improvement (P2R)

The initial number of interested farmers in the offset program will not be enough to fully achieve the offset requirement and therefore the catchment model was used to understand how many more farms (i.e. area of farming) need to be included in the program to achieve the targets. For the MNWRF Offsets Project the Source model was used to model different rates of improved practice uptake (100%, 75%, 50% and 25%) across all of the cane farms within the Tin Pot Creek sub-catchment as well as the broader Reliance Creek and Pioneer Creek catchments.

KEY LEARNINGS

To achieve the required water quality improvements for the MNWRF Offsets Project, cane farm land management practice improvements will need to occur across the broader Pioneer River catchment. The MNWRF Offsets Project has identified the following important considerations during this offset evaluation phase:

- Understanding the relationship of the reef regulations to the Nutrient Offset Policy is important to evaluate the potential magnitude of available improvements.
- Understanding whether nutrient offsets can be obtained in adjacent catchments when the effluent discharge is currently to an estuarine outlet of a very small catchment needs to be explored further.

MNWRF OFFSETS PROJECT KEY OUTCOMES

- The total TN generated from both farms, as an annual average, is 4,254 kg/year.
- The total TN reduction potential from both farms is between 241 and 1,425 kg/yr. This is dependent upon the extent of implementation of low risk (A level) practices under the reef regulations.
- Modelling showed that:
  - 100% uptake of improvements from minimum standard (B level) practice to low risk (A level) practice across cane farms in the Tin Pot Creek catchment, the total TN reduction is 2,016 kg TN/yr which is only 29% of the target with 1:1.5 equivalency ratio or 44% of the target with 1:1 equivalency ratio.
  - 100% uptake of improvements from expected (B level) practice to low risk (A level) practice across cane farms in the Reliance Creek catchment, the total TN reduction is 2,862 kg TN/yr which is 42% of the target with 1:1.5 equivalency ratio or 63% of the target with 1:1 equivalency ratio.
  - 100% uptake of improvements from expected (B level) practice to low risk (A level) practice across cane farms in the broader Pioneer River catchment, the total TN reduction is 20,190 kg TN/yr. This means there only needs to be 23% to 34% uptake from cane farms to achieve the targets depending on the equivalency ratio adopted.
- Overall, the modelling highlighted that a change from minimum standard to best practice (B level to A level) is required across cane farms in the broader Pioneer River catchment covering 6,883 ha and 10,175 ha for 1:1 and 1:1.5 equivalency ratios, respectively, to achieve the targets.

ECONOMIC ASSESSMENT

A cost-effectiveness analysis (CEA) is an analytical tool commonly used in water treatment planning to facilitate the identification of a least cost options. This assessment can be used to compare the proposed offset solutions with the water treatment facility upgrades that would otherwise be required using a single metric (e.g. $/kg of TN). There are typically three components to a CEA:

- Assessment efficacy: For each option, an assessment of efficacy is undertaken (e.g. the expected nutrient load reduction)
- Assessment of cost: For each option, an assessment of costs must be undertaken. This includes relevant establishment and capital costs, annual operation and maintenance costs, and any relevant renewals / refurbishment costs.
- Calculation of cost-effectiveness and comparing options: For each option the CEA is determined as a calculation of cost divided by efficacy (e.g. $/kg of TN). Once the cost effectiveness of individual options has been determined, they can be ranked based on their cost-effectiveness.

The CEA was undertaken on the following options for the MNWRF Offsets Project:

- Option 1 - High technology Bardenpho Process upgrade of the MNWRF
- Option 2 - Offset solution involving practice change (change from B to A level) across cane farms in the broader Pioneer River Catchment

MNWRF OFFSETS PROJECT KEY OUTCOMES

- The lifecycle cost of the offsets solution is lower than the high technology MNWRF upgrade. The cheapest option assumes that offsets can be delivered using a 1:1 equivalency ratio.
- The MNWRF Bardenpho Process upgrade is more cost effective than the offsets in terms of TN removal. However, both options are cost effective when compared to the current estimated cost of $4,000 per kg of TN for the Mackay South Water Recycling Facility (OGBR, personal communication, 2021).

Table 1 - Summary of lifecycle costs and cost effectiveness analysis results comparing proposed offsets solutions with the MNWRF upgrade.

	Option 1 - MNWRF upgrade	Option 2 - Offsets	
		1:1 equivalency ratio (6,883 ha)	1:1.5 equivalency ratio (10,175 ha)
Lifecycle cost ($ million)	$38.03	$7.85	$11.61
CEA ($/kg TN)	$14	$35	

ASSESSMENT OF OTHER BENEFITS

CEAs only compare options based on the cost required to achieve a single benefit (i.e. TN removal). This doesn't include the other additional benefits that the offset solutions may provide when compared to the MNWRF upgrade such as significant reduction in CO2 emissions, waterway health improvement, reduced cost for treatment of drinking water in Tin Pot Creek, greater working relationships between Council and cane farmer constituents and potential increased cane farming profitability and resultant economic benefits to the region.

KEY LEARNINGS

While the economic assessment focused on the costs to support management practice change/ improvement (B level to A level), it is recognised that many of the landholders across the Pioneer River Catchment may require additional incentives from Council to support their improvement of current land management practices to meet the minimum standard required under the reef water quality regulations (B level [moderate-low risk] practice). This is a cost which Council may need to outlay, but regardless, farmers will only be able to contribute to the offsets scheme once they are operating at minimum standard practice level and start improving beyond this.

CONCLUSIONS

The MNWRF Offsets Project provides a demonstration of the development of a water quality offset feasibility assessment. This can be used by other Councils and utilities to undertake a similar process.

While improvement in farm practices on the currently engaged farms will not achieve the required water quality targets, this project has provided Council with an understanding of how much broader the adoption of this program would need to be to achieve the environmental outcomes sought and the relative costs and cost effectiveness of doing so compared to a high technology STP upgrade.

Recommended next steps for this project include:

- Engage with the regulator to review and agree on offset requirements, including equivalency ratios.
- Undertake further engagement with landholders and their peak industry bodies to encourage broader uptake of the project.
- Develop an implementation and governance framework to guide the future delivery of this program and establish a more detailed assessment of operation costs.

NOTES