

# Managing water quality in Great Barrier Reef catchments

Report 20: 2014–15



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June 2015

The Honourable P Wellington MP  
Speaker of the Legislative Assembly  
Parliament House  
BRISBANE QLD 4000

Dear Mr Speaker

**Report to Parliament**

This report is prepared under Part 3 Division 3 of the *Auditor-General Act 2009*, and is titled *Managing water quality in Great Barrier Reef catchments*.

In accordance with s.67 of the Act, would you please arrange for the report to be tabled in the Legislative Assembly.

Yours sincerely

A handwritten signature in black ink, appearing to read 'Andrew Greaves', written over a light grey horizontal line.

Andrew Greaves  
Auditor-General



# Contents

<b>Summary</b> .....	<b>1</b>
Background .....	1
Conclusions .....	2
Program governance and design .....	3
Program implementation and outcomes .....	3
Monitoring, evaluation and reporting .....	4
Recommendations .....	5
Reference to comments .....	5
<b>1 Context</b> .....	<b>7</b>
1.1 Reef degradation .....	7
1.2 The response .....	10
1.3 Roles and responsibilities .....	13
1.4 Program funding .....	16
1.5 Monitoring and reporting progress .....	18
1.6 Audit objective, method and cost .....	19
1.7 Report structure .....	20
<b>2 Program governance and design</b> .....	<b>21</b>
2.1 Background .....	22
2.2 Conclusions .....	22
2.3 Program governance .....	22
2.4 Program design and evaluation .....	28
2.5 Recommendation .....	30
<b>3 Land management practices</b> .....	<b>31</b>
3.1 Background .....	32
3.2 Conclusions .....	33
3.3 Paddock programs .....	33
3.4 Catchment programs .....	38
3.5 Recommendation .....	41
<b>4 Monitoring and reporting change</b> .....	<b>43</b>
4.1 Background .....	44
4.2 Conclusions .....	44
4.3 Catchment modelling .....	45
4.4 Data limitations .....	46
4.5 Reef report card .....	53
4.6 Recommendations .....	57
<b>Appendix A— Comments</b> .....	<b>61</b>
<b>Appendix B— Audit method</b> .....	<b>69</b>
<b>Appendix C— Natural Resource Management regions relevant to the reef</b> .....	<b>71</b>
<b>Appendix D— Great Barrier Reef timeline</b> .....	<b>73</b>
<b>Appendix E— Reef Plan programs</b> .....	<b>75</b>
<b>Appendix F— Catchment monitoring site locations and land use</b> .....	<b>83</b>
<b>Appendix G— Management practice rating frameworks</b> .....	<b>89</b>
<b>Appendix H— Glossary</b> .....	<b>91</b>



# Summary

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## Background

The Great Barrier Reef (the reef) is the earth's largest coral reef system and was listed as a world heritage site in 1981 for its outstanding universal value to humanity. It stretches 2 300 kilometres down the Queensland coast and covers approximately 344 400 square kilometres; making it 50 per cent larger than the State of Victoria. This unique reef system is valued around the world and is critically important to local communities and industries, supporting recreation and livelihoods.

Protecting this Australian icon for future generations means first understanding the complexity of the reef system and the risks to its health, and then striking the right balance between social, economic and environmental obligations in managing the reef.

This report deals with the Queensland Government's contributions to improving the quality of water that enters the reef from adjacent terrestrial catchments, specifically agricultural runoff. It does not deal with other potential stressors, such as dredge spoil or the broader impacts of climate change; nor does it examine the activities or programs of the Australian Government.

Commencing with the first *Reef Water Quality Protection Plan* (Reef Plan) in 2003, the Australian and Queensland Governments have worked to reduce the impact of the diffuse source water pollutants that arise from broadscale, agricultural land use. Both governments have continued to collaborate through two further iterations of the Reef Plan (2009 and 2013).

The 2008 Scientific Consensus Statement, an output of the first Reef Plan prepared by a group of multidisciplinary scientists, found that sugarcane and grazing were the two agricultural industries contributing most to poor quality water entering the reef. The most recent Scientific Consensus Statement in 2013 reaffirmed that these agricultural activities contribute most to the excess nutrients, fine sediments and pesticides that enter the reef marine environment. It also concluded that improved land and agricultural management practices are proven to reduce the runoff of suspended sediment, nutrients and pesticides from farms and catchments.

The goal of the current 2013 Reef Plan is to ensure that by 2020 the quality of water entering the reef from broadscale land use does not have a detrimental impact on its health and resilience. Both the 2009 and 2013 Reef Plans had specific, timed targets for improvements in water quality, and for improvements in land and catchment management practices.

The *Environment Protection Act 1994* makes the Department of Environment and Heritage Protection (DEHP) primarily responsible for reducing the impact of agricultural activities on the quality of water entering the reef. However, the programs and activities that have been attributed to achieving Reef Plan goals are being delivered across a number of departments. Each of the departments spends part of the \$175 million that was committed by the state over five years under the 2013 Reef Plan.

Given the widely accepted nexus between land and agricultural management practices and pollutants entering the reef, we examined the effectiveness of:

- the major programs and activities that aim to improve land and catchment management
- the governance over, and the design of, these state programs
- the program for monitoring the quality of water entering the reef
- the reliability of the associated public reporting of Reef Plan outcomes.

## Conclusions

While there is the Reef Plan, there is no cohesive state based reef program to support its achievement. The Queensland Government's response to its Reef Plan commitments has lacked the programmatic rigour needed to address the serious issue of poor quality water entering the reef from catchments. Queensland's response has lacked urgency and purpose, characterised by disparate projects with no central authority and no clear accountability for their delivery or for achievement.

In the more than 12 years since the first Reef Plan, Queensland has yet to develop an overarching program for its contribution to the Reef Plan. Many of the initiatives that departments attribute to achieving the Reef Plan goal existed before the original Reef Plan in 2003. Some do not have improvement of water quality as their primary objective and have not aligned their objectives to the achievement of Reef Plan targets. While the Reef Plan targets may be ambitious, this does not lessen the need for targeted responses. Nor does it obviate the need for strong accountability to ensure that the funds committed under the plan have been invested in a coordinated way; and that they are being used to produce the greatest advancement towards the targets.

Land management practice programs are not achieving the changes needed to realise the Reef Plan goal within the established timelines and the extent and sustainability of change is not being comprehensively monitored at the farm scale.

Improving agricultural land management practices in the sugarcane and grazing industries is a key strategy of the Reef Plan. Results indicate that the right balance has not been achieved between industry-led, voluntary approaches and regulatory enforcement. The limitations that result from the missing rigour in overall program design are evident in the lack of clear, appropriate incentives and disincentives in the design of these voluntary Best Management Practice (BMP) programs.

The recent relaxation of land clearing rules also increases the risk of adverse consequences from sedimentation run-off, and could work against the achievement of Reef Plan water quality targets. Such conflicts between improving agricultural production while reducing run-off would be more apparent and better managed through a single point of responsibility. Those responsible should have the requisite authority and clear accountability for delivering on the environmental imperatives from the Reef Plan. This has not existed under the governance arrangements to date.

The water quality and land management improvement targets set in the 2013 Reef Plan are unlikely to be achieved under the current level of practice change. Yet this outcome is not as evident as it should be, because of what is publicly reported and how it is reported.

The latest Great Barrier Reef Report Card (reef report card) released June 2014 stated that the goal to *'halt and reverse the decline in water quality entering the reef'* had been achieved, but there is significant uncertainty associated with the progress reported to date. Therefore the veracity of this statement needs to be treated with caution.

There are gaps in knowledge between the paddock and end of the river catchments, and there is a need to account for climatic variability, all of which require several assumptions to be made to produce modelled results.

The lack of water quality monitoring sites, to verify modelled outputs to measured results, across the catchments necessarily results in lower levels of confidence that the quality of water entering the reef is actually improving. The headline reporting on progress does not make this lack of confidence clear to the reader, potentially allowing them to, incorrectly, infer the reported results as unequivocal, established fact.



## Program governance and design

Queensland has been contributing to the Reef Plan since its inception in 2003. Over this period there has been no single Queensland public sector body accountable for overall coordination, management and evaluation of the numerous programs attributed to the Reef Plan.

Queensland chose to meet its obligation to safeguard the reef and contribute to Reef Plan primarily by aligning a collection of pre-existing programs. The water related benefits of some of these programs are tenuous and are often secondary to other program objectives, which are not congruent with improving water quality entering the reef's catchments. Positive aspects however are that these programs cover a cross-section of the reef ecosystem and the BMP and education and extension programs are targeted to high risk areas and catchments.

The improvement targets in the Reef Plan—to reduce pollutants and improve management practices—have been set in isolation from the existing programs. This makes the linkages between the programs and the achievement of the Reef Plan targets hard to discern. It means also that the responsible state departments cannot readily demonstrate that their programs are effectively contributing towards the Reef Plan targets or goal. From a whole-of-government perspective, the departments cannot be sure that the right activities are being carried out in the right places to achieve the desired Reef Plan outcomes.

Research is only now underway to determine what the targets should be if these programs are to deliver on the desired reef outcomes. This research will not be completed, and the revised targets available, until early 2016.

The fragmented program response is mirrored by fragmented governance arrangements. One consequence of this is that there is no strong accountability for the program expenditures that have been attributed to achieving the Reef Plan goal and targets. Departments arbitrarily attribute proportions of costs incurred on statewide programs to reef locations and informally aggregate this information to track whether the present commitment to invest around \$35 million annually is being achieved.

On 7 May 2015, the day before we issued this report for comment, the Minister for the Great Barrier Reef announced that the functions of the reef secretariat would be expanded and transferred into DEHP as an Office of the Great Barrier Reef. The stated purpose is to coordinate, monitor and assist in delivering the state's contribution to the Reef Plan and the Long Term Sustainability Plan. The Minister also announced the establishment of an interdepartmental committee and a Great Barrier Reef Water Science taskforce. In principle, if implemented effectively, these changes should address the governance issues we have identified.

## Program implementation and outcomes

The state based improvement programs we examined are:

- the industry-led best management practices (BMP) programs
- extension and education activities
- natural resource management
- research, development and innovation
- catchment monitoring and modelling.

A mix of voluntary and regulated mechanisms are used in the implementation of these programs. While some of these programs are in their infancy, results have been mixed. For example there has been some positive uptake in the Grazing BMP but a low level of adoption for the Smartcane BMP.

In agricultural improvement programs, like the Smartcane BMP program, the balance between producing more, making more money and looking after the environment is tilted towards the former two. This deliberate strategy is intended to encourage industry participation in these voluntary programs. However, more specific, direct incentives to give the voluntary programs the best chance of success, are missing.

Preliminary results from the vegetation management programs indicate a rise in woody vegetation clearing rates over the last four years in reef catchments. Increases in tree clearing rates may contribute to increased soil erosion. This result is counter-productive as it increases the risk of run-off. It also has the potential to contradict the Reef Plan targets of no net loss of natural wetlands and an increase in riparian vegetation.

## Monitoring, evaluation and reporting

The Paddock to Reef Integrated Monitoring, Modelling and Reporting Program (P2R program) is funded jointly by the Australian and Queensland governments. It uses five lines of evidence to evaluate progress towards Reef Plan targets, including:

- effectiveness of management practices to improve water quality
- prevalence of adoption of management practices, and change in catchment indicators
- long-term catchment water quality monitoring
- paddock and catchment modelling to provide a relative assessment of progress towards meeting water quality targets
- marine monitoring of inshore water quality and the health of coral reefs and seagrass in the reef lagoon.

Outputs from the P2R program catchment model are used to estimate progress towards the water quality targets and, along with the other lines of evidence, produce a report card. Experts agree the model is sophisticated and meets the needs of the program; however internal government and external independent reviews have determined that improvements are required to input data. Not all of these deficiencies have been addressed to date. More work is needed to improve the effectiveness of monitoring to better verify outputs and close the current gaps.

The statement in the 2012–13 reef report card that the 2009 goal of halting and reversing the decline in water quality entering the reef was achieved is easily misinterpreted as fact. There is a high level of uncertainty in the modelled outcomes on which this statement is based because of the number of assumptions and data limitations in such a complex model. This uncertainty is not evident in the headline (tier one) report card, and public reporting would be enhanced if the report card was more transparent.

The outputs from the P2R program model feed into the research and development (R&D) priorities for the program. The list of R&D priorities is growing, while progress has been slow in finishing existing R&D activities. There are also gaps in funding some R&D initiatives.

## Recommendations

It is recommended that:

1. the newly formed Office of the Great Barrier Reef be provided with sufficient and appropriate management and administrative authority, so that it can be properly made responsible and held accountable for Queensland's reef management strategies and programs
2. the design and implementation of the suite of programs attributed to the Reef Plan is reviewed to establish they are the most effective and efficient
3. catchment monitoring is expanded to aid in determining the effectiveness of practice management change and to enhance the confidence in modelled outcomes
4. a rigorous verification process is applied to data on land management practice change, and deficiencies in model inputs be addressed, to improve confidence in, and the accuracy of, inputs into catchment modelling
5. unambiguous references be included in the tier one reef report card which disclose the degree of uncertainty and levels of potential variability in the reported results.

## Reference to comments

In accordance with section 64 of the *Auditor-General Act 2009*, a copy of this report was provided to the Departments of:

- the Premier and Cabinet
- Environment and Heritage Protection
- Natural Resources and Mines
- Science, Information Technology and Innovation
- Agriculture and Fisheries

with a request for comments.

Their views have been considered in reaching our audit conclusions and are represented to the extent relevant and warranted in preparing this report.

The comments received are included in Appendix A of this report.



# 1 Context

The Great Barrier Reef (the reef) is one of the world's great natural attractions, stretching 2 300 kilometres down the Queensland coast. The reef is recognised as the world's largest coral reef system and an area of rich biological diversity. It supports Queensland's regional economies, contributing \$5.6 billion per annum through tourism, recreation, commercial fishing and scientific research.

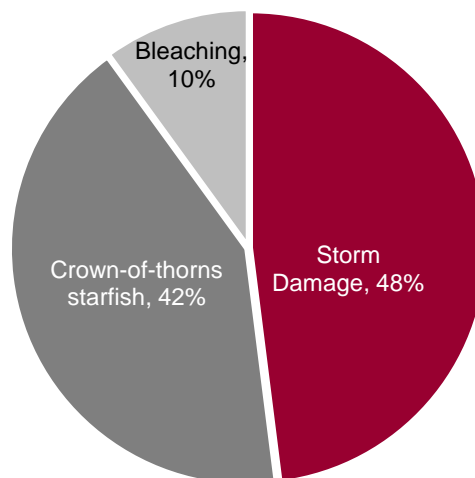
Adjacent to the Great Barrier Reef lie 35 major catchments draining 424 000 square kilometres of coastal Queensland, an area which is greater than the size of Japan. Within these catchments agriculture contributes another \$4.7 billion each year to Queensland's economy, predominantly through grazing and sugarcane production.

## 1.1 Reef degradation

The Australian Institute of Marine Science (AIMS) monitored the extent of coral cover between 1985 and 2012. It reported a loss over the 27 year period of approximately 50 per cent of coral cover for reefs adjacent to developed coasts; whereas it observed no overall decline in coral cover in the relatively undeveloped Cape York region.

Figure 1A depicts the major direct causes of coral cover loss throughout the whole Great Barrier Reef.

Figure 1A  
Causes of coral loss in the Great Barrier Reef



Source: Queensland Audit Office adapted from Reef Water Quality Protection Plan 2013 and 'The 27 year decline of coral cover on the Great Barrier Reef and its causes'

AIMS research, published in 2010, linked increases in the frequency and severity of the coral-eating crown-of-thorns starfish outbreaks with elevated nutrient levels running off farms. While this link is not yet proven, preliminary work indicates that the elevated nutrient levels promote algal outbreaks. Algae is the primary source of nourishment for crown-of-thorns starfish larvae, so these outbreaks increase their survival rates.

The Reef Water Quality Protection Plan's (Reef Plan) most recent Scientific Consensus Statement (2013) states that inshore coral reef ecosystems are directly and negatively affected by increases in turbidity and sedimentation that reduce the light over inshore coral reefs and sea-grass ecosystems, especially after extreme weather events. Elevated nutrient levels increase the likelihood of coral bleaching.

The Great Barrier Reef Marine Park Authority's Marine Monitoring Report (MMR) identified that the inner reefs (closer to shore) had the greatest decline in coral cover, particularly in the Wet Tropics, Fitzroy and Burdekin catchments. Coral health was assessed against a five tier standard scoring system from very poor to very good. The most recent MMR assessed coral health in the Fitzroy as very poor, the Wet Tropics and Burdekin as poor, and the Mackay-Whitsunday as moderate. Cape York and Burnett-Mary were not assessed.

### 1.1.1 Water quality and agriculture

In 2008, a mid-term review of the Reef Plan resulted in the first Scientific Consensus Statement on reef water quality. It was authored by a multi-disciplinary science group. In 2013, the Scientific Consensus Statement was updated by a similar group and reviewed by the Reef Plan Independent Science Panel. Each group of scientists reviewed and synthesised the scientific knowledge of water quality issues in the reef to reach consensus on the current understanding of the entire system from paddock to reef.

The 2008 Scientific Consensus Statement found that sugarcane and grazing were the two agricultural industries contributing the most to poor water quality. The 2013 Scientific Consensus Statement noted that compared to pre-European settlement conditions within the catchments:

- mean annual sediment loads have increased 3.2 to 5.5 fold
- mean annual total nitrogen loads have increased 2.0 to 5.7 fold
- mean annual total phosphorus loads have increased 2.5 to 8.9 fold.

There is a legacy of more than 100 years of land clearing and farming in reef catchments. The scientific community has shown that the increased loads of sediments and nutrients in rivers emptying into the coastal seas are due to human activity in the catchments; a view endorsed by the Reef Plan Independent Science Panel. Three decades of monitoring by AIMS has shown a 50 per cent decline in coral cover on the two-thirds of the reef adjacent to these developed catchments. This is in contrast to an absence of change in coral cover over the same time period on reefs adjacent to the relatively undeveloped catchments of Cape York.

The most recent 2013 Scientific Consensus Statement reaffirmed previous positions by drawing the following conclusions:

- *The decline of marine water quality associated with terrestrial runoff from the adjacent catchments is a major cause of the current poor state of many of the key marine ecosystems of the Great Barrier Reef.*
- *The greatest water quality risks to the Great Barrier Reef are from nitrogen discharge, associated with crown-of-thorns starfish outbreaks and their destructive effects on coral reefs, and fine sediment discharge which reduces the light available to seagrass ecosystems and inshore coral reefs. Pesticides pose a risk to freshwater and some inshore and coastal habitats.*
- *Recent extreme weather (heavy rainfall, floods and tropical cyclones) have severely impacted marine water quality and Great Barrier Reef ecosystems. Climate change is predicted to increase the intensity of extreme weather events.*
- *The main source of excess nutrients, fine sediments and pesticides from Great Barrier Reef catchments is diffuse source pollution from agriculture.*
- *Improved land and agricultural management practices are proven to reduce the runoff of suspended sediment, nutrients and pesticides at the paddock scale.*

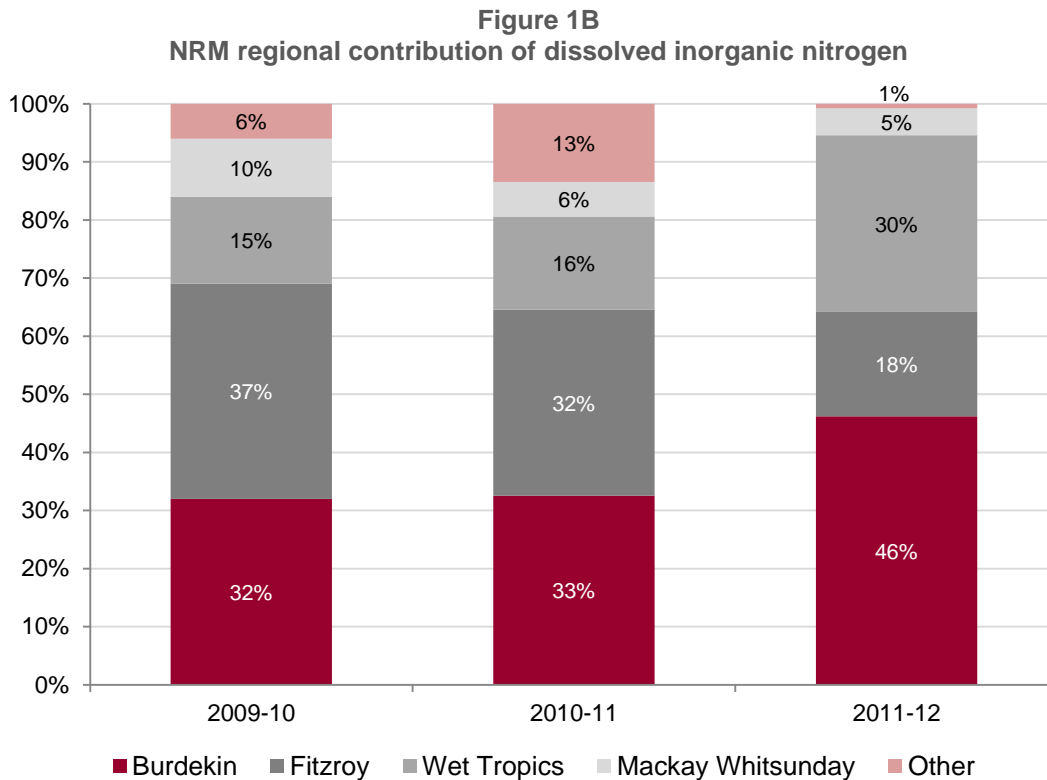
#### Diffuse and point source pollution

Diffuse source pollution occurs over a large area and is not attributable to any one place. In this sense agricultural land use is a diffuse source. By contrast, point source pollutants come from a singular and identifiable source of pollution, such as ports, mining, urban or industrial areas.

## 1.1.2 Catchment load contributions

The Great Barrier Reef Catchment Loads Monitoring Program determines which reef catchments are contributing the greatest amount of dissolved inorganic nitrogen (DIN) and total suspended sediment (TSS) for a respective year. Figures 1B and 1C summarise the last three reports (2009–10 to 2011–12 respectively) by natural resource management (NRM) region. A map of Queensland's 14 NRM regions, highlighting the six mainland NRM regions adjacent to the reef is in Appendix C.

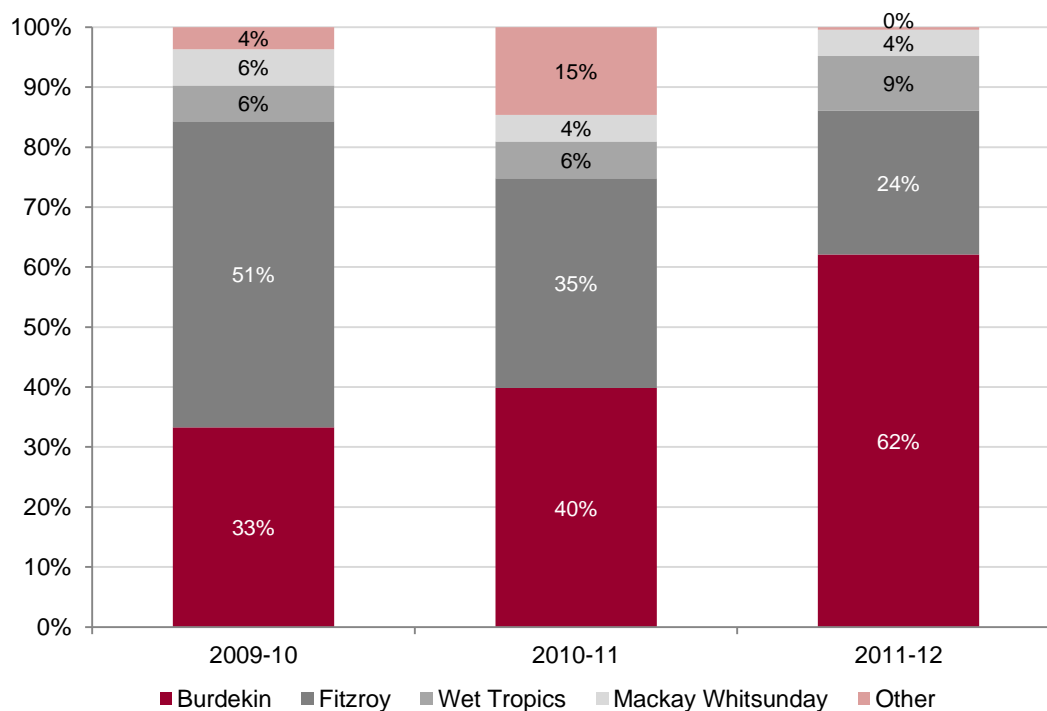
Figure 1B shows the Burdekin, Wet Tropics and Fitzroy regions contribute approximately 81 to 94 per cent of the total DIN load.



Source: Queensland Audit Office adapted from Great Barrier Reef Catchment Loads Monitoring Program reports

Figure 1C shows the Burdekin and Fitzroy regions also contribute 75 to 86 per cent of the TSS loads.

**Figure 1C**  
**NRM regional contribution of total suspended sediments**



Source: Queensland Audit Office adapted from Great Barrier Reef Catchment Loads Monitoring Program reports.

## 1.2 The response

In 1975 the Great Barrier Reef Marine Park was created to protect and preserve the marine ecosystem. Appendix D lists the key events in managing the reef since this time.

Since 2003 the Queensland and Australian governments have coordinated their resources under the Reef Plan to improve the quality of water entering the reef and the reef's resilience, by detailing a list of actions and deliverables for lead and supporting agencies.

### 1.2.1 Legislation

Queensland's territorial responsibility extends three nautical miles offshore, at which point the Australian Government's responsibilities begin.

The *Environment Protection Act 1994* (Qld) tasks the Department of Environment and Heritage Protection (DEHP) with reducing the impact of agricultural activities (diffuse source) on the quality of water entering the reef.

Great Barrier Reef protection measures, commonly known as reef regulations (under Chapter 4A of the *Environmental Protection Act 1994*) became effective from 1 January 2010 through the amendments made by the *Great Barrier Reef Protection Amendment Act 2009* (Qld). The regulations require producers (primarily sugarcane farmers and graziers) in specific high risk reef catchments to maintain records on production practices and limit certain practices; for example regulation is used to limit fertiliser application. The regulations carry fines ranging from \$11 385 to \$34 155 for non-compliance.

The Queensland Government decided in 2012 not to enforce regulations while industry-led voluntary Best Management Practice (BMP) programs were being developed and implemented. The government committed to review the need for regulations once the BMP programs were able to demonstrate their effectiveness in improving water quality.



## 1.2.2 Reef Plan goals

The Australian and Queensland governments introduced the Reef Plan in 2003. The Reef Plan was reviewed and updated in 2009 and 2013 as greater understanding was obtained and synthesised in the 2008 and 2013 Scientific Consensus Statements.

The initial 2003 and 2009 Reef Plan goal was:

*...to halt and reverse the decline in water quality entering the reef [within 10 years / by 2013].*

The Australian and Queensland governments reported the goal as achieved by 2013.

The 2009 Reef Plan also included a longer-term goal:

*...to ensure that by 2020 the quality of water entering the reef from adjacent catchments has no detrimental impact on the health and resilience of the Great Barrier Reef.*

The 2013 Plan refined this long term goal to:

*...to ensure that by 2020 the quality of water entering the reef from broadscale land use has no detrimental impact on the health and resilience of the Great Barrier Reef.*

Rather than broadly addressing all sources of pollution (diffuse and point source) the focus of the 2013 Reef Plan is to reduce diffuse source pollution from agricultural activities such as grazing, sugarcane, grain cropping and other horticultural uses in catchments that flow into the reef.

The Australian and Queensland governments released the *Reef Long-Term Sustainability Plan 2050* (Reef LTSP) in March 2015. This is an overarching strategy for reef management, incorporating the Reef Plan. The Reef LTSP aims to address:

- water quality
- ecosystem health
- biodiversity
- heritage conservation
- community benefits
- economic benefits.

## 1.2.3 Reef Plan targets

The 2003 Reef Plan aimed to achieve its goal through improved land and resource management in the reef catchments. Emphasis was placed on establishing the required partnerships between various levels of government and other stakeholders.

Quantitative targets were initially not set because there was a limited understanding of the causes of poor water quality. It wasn't until the 2009 Reef Plan that targets for best farming practice adoption and pollutant reductions were established.

Figure 1D sets out the 2009 Reef Plan targets.

**Figure 1D**  
**2009 Reef Plan immediate goal and targets**

Category	Target
<b>Immediate goal by 2013</b>	<b>To halt and reverse the decline in the quality of water entering the Great Barrier Reef.</b>
Water quality targets to be achieved by 2013	<p>A minimum 50 per cent reduction in nitrogen and phosphorus loads at the end of catchments.</p> <p>A minimum 50 per cent reduction in pesticides at the end of catchments.</p> <p>A minimum of 50 per cent late dry season groundcover on dry tropical grazing land.</p>
Water quality target to be achieved by 2020	A minimum 20 per cent reduction in sediment load at the end of catchments.
Land and catchment management targets by 2013	<p>80 per cent of landholders in agricultural enterprises (sugarcane, horticulture, dairy, cotton and grains) will have adopted improved soil, nutrient and chemical management practices.</p> <p>50 per cent of landholders in the grazing sector will have adopted improved pasture and riparian management practices.</p> <p>There will have been no net loss or degradation of natural wetlands.</p> <p>The condition and extent of riparian areas will have improved.</p>

Notes: Measured against 2009 baseline data.

Source: Queensland Audit Office from the Reef Water Quality Protection Plan 2009

These targets were based on limited scientific understanding of what was then considered achievable. An action item in the 2013 Reef Plan aims to complete research to inform the development of ecologically relevant targets by January 2016.

The 2013 Reef Plan targets have two sub-categories, shown in Figure 1E.

**Figure 1E**  
**2013 Reef Plan targets to be achieved by 2018**

Category	Target
<b>Long term goal by 2020</b>	<b>To ensure that by 2020 the quality of water entering the reef from broadscale land use has no detrimental impact on the health and resilience of the Great Barrier Reef.</b>
Water quality targets	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.
Land and catchment management targets	90 per cent of sugarcane, horticulture, cropping and grazing lands are managed using best management practice systems (soil, nutrients 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.

Note: Measured against 2009 baselines data.

Source: Queensland Audit Office from the Reef Water Quality Protection Plan 2013

## 1.3 Roles and responsibilities

The Reef Plan is a collaboration between the Australian and Queensland governments. Each has its own actions to deliver in conjunction with natural resource management (NRM) bodies, agricultural industries and landholders.

### 1.3.1 Queensland Government agencies

Figure 1F lists the five Queensland departments that have key roles in the Reef Plan.

**Figure 1F**  
**Queensland Government key departmental roles in Reef Plan**

Department	Role in Reef Plan
Department of the Premier and Cabinet (DPC)	The Reef Secretariat within the department facilitates and coordinates Reef Plan committees and Great Barrier Reef Report Cards (reef report card).
Department of Environment and Heritage Protection (DEHP)	Funds and coordinates the delivery of activities to encourage graziers, cane and banana growers to adopt improved practices through Best Management Practice programs, extension and education, and research and development programs. Manages Queensland's Wetlands Program.
Department of Natural Resources and Mines (DNRM)	With support from DSITI, leads the paddock monitoring and modelling and catchment modelling. Leads the management of native vegetation through regulatory framework and the delivery of statewide surface water quantity and quality monitoring. Provides funding to DSITI to conduct catchment and wetland monitoring. Provides funding and support to Regional NRM bodies for sustainable agriculture, weed and pest management and water quality programs.
Department of Agriculture and Fisheries (DAF)	Plays a lead role in developing agricultural management practices and systems, and implements these practices through industry extension and education activities. Monitors the adoption of improved land and management practices in partnership with regional NRM bodies.
Department of Science, Information Technology and Innovation (DSITI)	Leads catchment monitoring, performs paddock and catchment scale modelling in conjunction with DNRM. Leads remote sensing of groundcover, riparian vegetation and gully indicators and wetlands extent mapping and assessment. Also undertakes research and development projects for DEHP.

Source: Queensland Audit Office

## 1.3.2 Australian Government agencies

Figure 1G details the three Australian Government agencies with major roles in the Reef Plan.

**Figure 1G**  
**Australian Government agency roles in regards to Reef Plan**

Agency	Role in Reef Plan
Great Barrier Reef Marine Park Authority (GBRMPA)	Legislative responsibility for the management, protection and zoning of the Great Barrier Reef Marine Park. Leads the marine monitoring program that subcontracts AIMS and other research bodies.
Department of the Environment (DoE)	Administers the Reef Trust and jointly administers Reef Programme with the Department of Agriculture. Provide funding for research programs and to DNRM and DAF for paddock scale water quality monitoring and modelling.
Department of Agriculture	Jointly administers Reef Programme with the DoE.

Source: Queensland Audit Office

## 1.3.3 Not-for-profit regional NRM bodies

There are 14 regional natural resource management (NRM) bodies in Queensland. The six mainland regional NRM bodies that border the reef are partners under Reef Plan and are listed in Appendix C. They are not-for-profit, non-governmental organisations funded by the Australian and Queensland governments, corporate and philanthropic sources.

These bodies, under contractual arrangements, support the Australian and Queensland governments in managing environmental grants and extension and education programs to the agriculture industry and community groups.

Five of the six NRM bodies are funded by the Queensland Government under the Reef Plan to deliver the following:

- extension and education activities to agricultural industries
- undertake land restoration programs
- administer Australian Government Reef Programme grants
- collect data on farm management practices.

## 1.4 Program funding

Figure 1H summarises the Queensland and Australian government funding commitments for the 2013 Reef Plan activities. It shows the Queensland Government has committed \$175 million over five years (approximately \$35 million per year). Appendix E breaks down Queensland's 2013–14 financial investment by department.

**Figure 1H**  
**2013 Reef Plan: Queensland and Australian government funding commitments**

Government	Five-year funding \$ million	Activities funded
Queensland	\$175	<ul style="list-style-type: none"> <li>industry-led Best Management Practice programs</li> <li>extension and education activities</li> <li>natural resource management</li> <li>research</li> <li>catchment monitoring and modelling.</li> </ul>
Australian	\$200	<p>\$160 million Reef Programme package:</p> <ul style="list-style-type: none"> <li>water quality grants delivered by NRM groups to producers and peak industry bodies</li> <li>controlling crown of thorns starfish</li> <li>research</li> <li>paddock and marine monitoring.</li> </ul> <p>\$40 million allocated to the Reef Trust:</p> <ul style="list-style-type: none"> <li>focussed primarily on improving water quality and species protection</li> </ul>
<b>Total</b>	<b>\$375</b>	

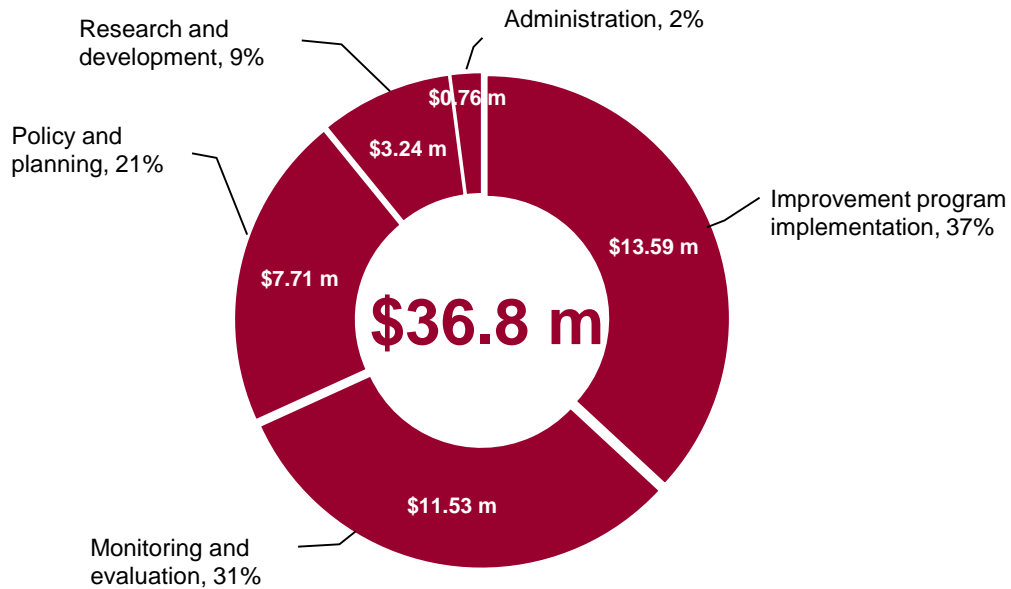
Note: On 21 March 2015 the Australian Government committed an additional \$100 million towards the Reef Trust's Long Term Sustainability Plan activities. The newly formed Queensland Government committed a further \$100 million towards Reef Plan and the Long Term Sustainability Plan activities. The funding has not yet been attributed to activities or programs.

Source: Queensland Audit Office

### 1.4.1 Analysis of Queensland's investment

Figure 11 shows how Queensland's 2013–14 estimated financial investment of \$36.8 million was allocated.

Figure 11



#### 2013–14 Queensland Reef Plan funding categorisation (\$m)

Source: Queensland Audit Office collated from departmental records

Appendix E provides a full listing of all Queensland programs attributed to the Reef Plan and their estimated funding for the 2013–14 year. It identifies 42 separately funded projects and activities across the five departments.

Improvement programs comprise 37 per cent (\$13.6 million) of Queensland's 2013–14 investment. These involve "on the ground" projects directly engaging and educating producers and communities, including:

- the voluntary Grazing and Smartcane Best Management Practice programs (approximately \$3.1 million)
- the regional NRM investment program (approximately \$4.3 million)
- extension and education activities (approximately \$3.7 million)
- vegetation management activities (approximately \$1.6 million)
- various other improvement programs listed in Appendix E (approximately \$0.9 million).

Monitoring and evaluation programs comprise 31 per cent (\$11.5 million) of Queensland's 2013–14 investment, including:

- DNRM's ambient surface and ground water monitoring networks (\$4.8 million)
- Paddock to Reef Integrated Monitoring, Modelling and Reporting Program (P2R program) components (\$3.2 million)
- Gladstone Healthy Harbour Partnership (\$2.0 million)
- various other monitoring and evaluation programs listed in Appendix E (approximately \$1.5 million).

## 1.5 Monitoring and reporting progress

The P2R program reports progress on achieving Reef Plan targets and goals.

This program was developed in 2009 through the Australian Government's *Caring for our Country* program and the Queensland Government's *Coasts and Country* initiative.

### 1.5.1 Monitoring and modelling progress

Figure 1J shows the P2R program integrates monitoring and modelling at three scales.

**Figure 1J**  
**Agencies that contribute to P2R program monitoring and modelling**

Component	Incorporates	Contributing agency
Paddock	Improved management practices and best practice adoption (inclusive of BMP results from industries), paddock monitoring, modelling and plot scale rainfall simulation trials.	Queensland Departments of Agriculture and Fisheries; Science, Information Technology and Innovation; and Natural Resources and Mines.
Catchments	Water quantity monitoring (near real-time), water quality monitoring for key pollutants (sediments, nutrients and pesticides), and extent of wetlands, groundcover and riparian areas.	Queensland Departments of Natural Resources and Mines; and Science, Information Technology and Innovation.
Marine	Water quality (including flood plumes monitoring), seagrass health and coral reef health.	Great Barrier Reef Marine Park Authority with support from the Australian Institute of Marine Science and other research bodies.

Source: Queensland Audit Office



## 1.5.2 Public reporting on progress

The Queensland Reef Secretariat (in DPC), in consultation with the Australian Government, publishes an annual reef report card and supporting reports. Progress towards the Reef Plan targets and goals is reported by the Reef Secretariat in three tiers:

- Tier one is a Great Barrier Reef-wide summary report card outlining key findings, summary results and contextual information. Progress towards the adoption of improved land management and marine conditions targets is measured (actual results), while catchment indicators are modelled (estimated results) based on improved land and management practices. The tier one reef report cards are publically available.
- Tier two provides detailed reef report card results, contextual information and summarises the methods and some key assumptions for each component of the reef report card. The tier two reef report cards are publically available.
- Tier three details the methodology and scientific papers that underpin the tiers one and two reef report cards. This provides the underlying assumptions, methodology, confidence levels and actual monitored data at each of the three scales outlined in Figure 1J. The authors or content owners of the scientific papers enforce, or are perceived to enforce, copyright restrictions. This prevents the Reef Secretariat from providing the journals and articles directly on their website and instead it links to a number of content owner sites.

The actual data obtained from measuring and monitoring is not publicly available. It is stored in agency databases including on the Spatial and Scientific Information Management for Reef (SSIMR) system maintained by the Department of Natural Resources and Mines. Scientists and research bodies can apply for access to SSIMR.

With the exception of wetland and riparian catchment indicators, which are reported every four years, all other indicators are reported annually.

## 1.6 Audit objective, method and cost

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The objective of the audit is to determine whether the adverse impact of broadscale land use on the quality of water entering the Great Barrier Reef is declining.

To determine this we focused on the efficacy of the activities and programs undertaken or funded by Queensland Government agencies to reduce diffuse source pollution from agriculture.

We focused also on the effectiveness of monitoring of these activities, programs and on the reliability of public reporting of outcomes, particularly the reporting on the achievement of the Reef Plan targets and progress toward long-term goals.

The audit was conducted in accordance with the Auditor-General of Queensland Auditing standards which incorporate Australian Auditing and Assurance Standards.

The audit cost was \$469 000.

## 1.7 Report structure

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The remainder of the report is structured as follows:

- Chapter 2 - Program governance and design
- Chapter 3 - Land management practices
- Chapter 4 - Monitoring and reporting change
- Appendix A contains responses received from audited departments
- Appendix B describes our audit method
- Appendix C has a map of natural resource management regions adjacent to the reef
- Appendix D contains a timeline of management of the reef
- Appendix E is a complete listing of Queensland's 2013–14 Reef Plan programs
- Appendix F has maps of the catchment monitoring site locations overlaid on land use
- Appendix G contains the practice management rating system
- Appendix H has a glossary of key terms and acronyms

## 2 Program governance and design

### In brief

#### Background

The State of Queensland is responsible for maintaining the health of reef catchment waterways. Since 2003, its means for doing this has been the various versions of the *Reef Water Quality Protection Plan* (the Reef Plan), which aims to improve the quality of water entering the Great Barrier Reef from diffuse source agricultural pollution. This involves a collaboration between state government agencies, the Australian Government and non-government entities.

Effective governance and robust design are essential to effectively deliver such a complex program involving multiple projects across federal and state jurisdictions and agencies. We expected to find fit-for-purpose governance and program design to deliver on Reef Plan targets and focus on realisation of the Reef Plan goal.

#### Conclusions

The design, implementation and governance of the collection of programs attributed to the achievement of Reef Plan goals over more than 12 years indicates an overall lack of urgency, priority and purpose. This has led to a response that is not well coordinated, has gaps and is unlikely to effectively contribute to achievement of the Reef Plan goals within aspired timeframes. Fundamentals of good program design are conspicuously missing, such as a single point of accountability and activities being specifically designed, evaluated and adapted to deliver Reef Plan outcomes efficiently and effectively.

#### Key findings

- There is no single point of accountability for the effective and efficient delivery of Queensland's Reef Plan programs.
- Queensland's programs which pre-date the Reef Plan have not been tailored or adjusted to maximise the achievement of water quality outcomes under the Reef Plan.
- Many of the state's programs have other primary objectives, with water quality a secondary benefit.
- Aggregate spend on Reef Plan at a state level is not tracked and reported and therefore there is uncertainty as to how much is actually spent each year on the Reef Plan. Agencies rely on estimates to report Reef Plan expenditure.
- Water quality improvements rely heavily on research and development. Currently the demands for research are greater than the funding available and there is uncertainty as to whether priority research and development needs are being appropriately addressed.

#### Recommendation

It is recommended that:

1. **the newly formed Office of the Great Barrier Reef be provided with sufficient and appropriate management and administrative authority, so that it can be properly made responsible and held accountable for Queensland's reef management strategies and programs.**

## 2.1 Background

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The Australian Constitution recognises that the State of Queensland is responsible for maintaining the quality of water in the river catchments. The *Reef Water Quality Protection Plan* (the Reef Plan) is a collaboration between the Queensland and Australian governments. Three Australian Government agencies, five Queensland Government departments, five regional natural resource management bodies and numerous industry bodies are involved in the delivery of the program.

Effective governance and program design are essential to successful delivery of this multi-jurisdictional, multi-agency, highly complex program. We expected to find clear lines of accountability for program delivery and for achieving the state's Reef Plan targets for improving water quality and land and catchment management practices.

Sound program design and implementation provide confidence that resources are being applied where needed, with the best prospects of success, and at a reasonable cost. We expected to find that the state government programs contributing to Reef Plan are:

- purposely designed and coordinated to achieve Reef Plan outcomes
- effectively coordinated to complement Australian Government programs
- implemented as intended
- evaluated
- supported by strong governance involving clear lines of accountability and reporting.

## 2.2 Conclusions

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As a policy response to a serious issue with significant consequences for Queensland and for our international reputation, the state's governance and design of its Reef Plan program falls short.

Many of the state's Reef Plan attributed programs are not designed with the Reef Plan goal and targets being the uppermost priority, and consequently do not clearly align with or link directly to Reef Plan outcomes. The majority of these programs pre-date Reef Plan; have other primary objectives, with water quality a secondary benefit; and were not evaluated at inception of the Reef Plan to determine the extent of their contribution.

The lack of rigour evident in program design provides little assurance that the scarce resources being applied to this issue are producing optimal results.

The situation is exacerbated by complicated state governance arrangements, with no one state entity having clear overall accountability for delivering Queensland's programs or for assessing their effectiveness.

The state's overall Reef Plan response would benefit from being re-examined and reconsidered from a strategic perspective, including all its attributed program elements. Stronger governance, coordination and oversight would provide confidence and assurance that public funds are being spent and monitored in a way that maximises our ability to reduce the harm to the reef.

## 2.3 Program governance

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The primary whole of Reef Plan decision-making body is the Great Barrier Reef Ministerial Forum (forum). Queensland and Australian government ministers are represented on the forum. The forum meets as required to make decisions at a whole of Reef Plan level—for example, endorsing the Reef Plan action items. The forum is informed by a series of committees and groups that specialise on specific aspects of the Reef Plan. The forum cannot make decisions that bind either tier of government to actions that are contrary to their stated policy positions.

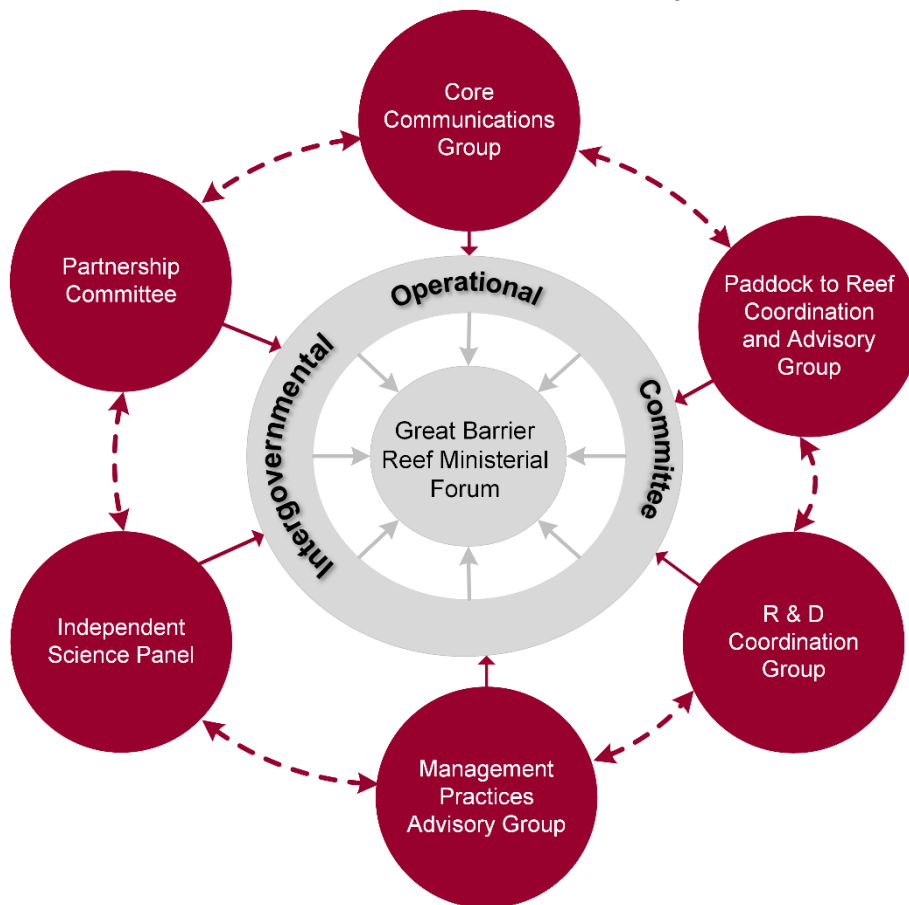
There is no single Queensland public sector body accountable for the coordination, management and evaluation of the state's agencies and programs attributed to the Reef Plan. Decisions about individual program components and how Reef Plan action items are to be delivered are made within individual agencies according to their internal governance practices. For example, governance over the formulation of Best Management Practice programs rests with the Queensland Department of Environment and Heritage Protection (DEHP).

Accountability is diluted through a complex program structure where, at the state level, it is difficult to determine reporting lines and responsibilities for key elements such as program design, evaluation and investment management.

### 2.3.1 Governance structure

Multijurisdictional involvement adds to the complexity of the overall governance and management of the state's programs—typified by the fact that the Reef Plan is overseen by a series of eight committees and groups. Their relationship is depicted in Figure 2A which shows that, while six committees informally share information, all report to the Intergovernmental Operational Committee, which makes recommendations to the forum.

**Figure 2A**  
Reef Plan committee structure as at May 2015



Note: Solid lines indicate a direct reporting relationship, dotted lines indicate informal or limited sharing of information

Source: Queensland Audit Office adapted from Reef Water Quality Protection Plan 2013

The various committees have evolved over time and bring together tiers of government, researchers, industry groups and conservationists. The intent of this structure is to provide credibility and an evidence based approach to policy development, in a consultative manner. Figure 2B summarises the membership and explains the role of each committee or group.

**Figure 2B**  
**Reef Plan governance groups roles**

Governance group	Membership and role
Ministerial Forum	Comprised of two ministers each from the Australian and Queensland Governments. The forum facilitates and provides strategic oversight for the implementation and achievement of the goals of Reef Plan.
Intergovernmental operational committee (IOC)	Senior representatives from Australian and Queensland Government agencies. The IOC provides implementation direction of Reef Plan activities.
Independent science panel	Comprised of multidisciplinary scientists appointed by the Ministerial Forum to provide independent scientific advice to the Reef Plan's knowledge gaps and scientific priorities.
Partnership committee	Comprising a variety of members from Australian and Queensland Governments, regional NRM bodies, industry and other stakeholders. Provides advice to the IOC on implementation of Reef Plan actions and deliverables.
Research and development coordination group	Membership is made up of Australian and Queensland Governments, industry, research bodies. Provides advice in which water quality research programs can be better coordinated and integrated.
Paddock to Reef coordination and advisory group	Members consist of monitoring and modelling experts from variety of Australia and Queensland Government agencies, regional NRM bodies and research institutions. Reviews and provides technical advice on the Paddock to Reef Integrated Monitoring, Modelling and Reporting Program (P2R program).
Management practices advisory group	Comprises a variety of members from Australian and Queensland Governments, regional NRM bodies, industry and other stakeholders. Provides strategic advice regarding farm management practices and to coordinate the delivery of extension, best management practice and incentive activities to maximise uptake.
Core communications group	Provides intergovernmental and regional input into Reef Plan communications activities and ensures coordination of communication tasks.

Source: Queensland Audit Office from 2013 Reef Plan

Queensland's *Environment Protection Act 1994* (the EPA Act) outlines requirements to:

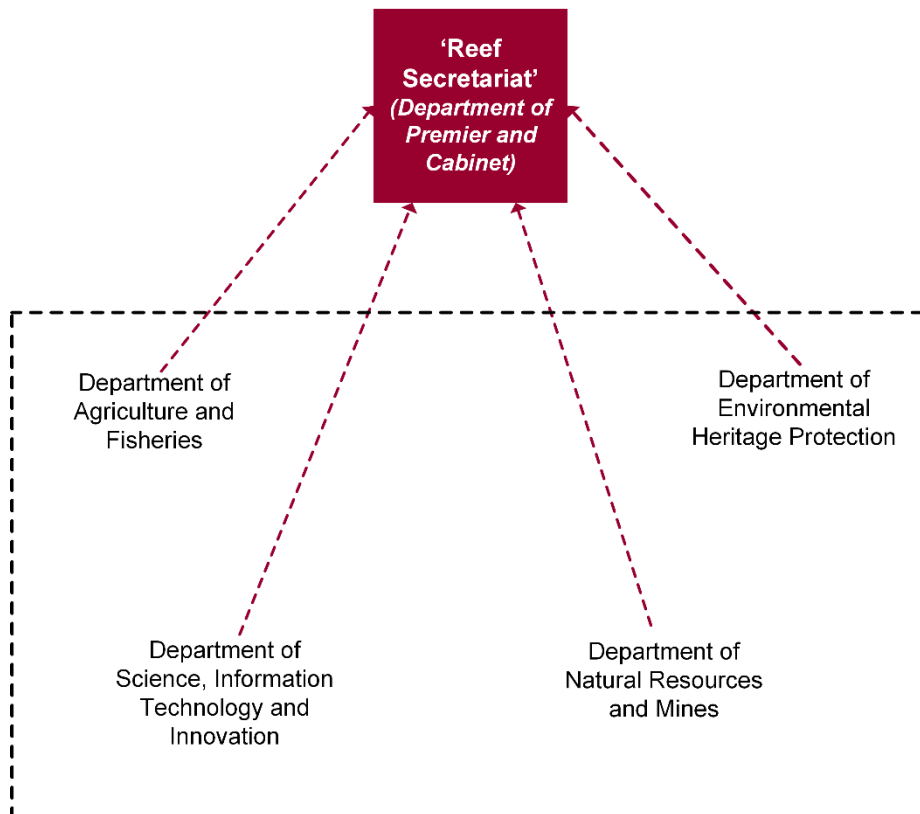
- reduce the impact of agricultural activities (diffuse sources) on the quality of water entering the reef
- contribute to achieving water quality targets.

While DEHP is responsible for administering the EPA Act, Queensland does not have a single agency that is accountable for, or manages, coordinates and evaluates, the state's contribution to achieving the Reef Plan goals and targets.

The Reef Secretariat (within the Department of the Premier and Cabinet) has assumed a central coordination role; providing secretariat services to Reef Plan committees and synthesising information to develop the annual Great Barrier Reef report card (reef report card). The Reef Secretariat is not accountable for Queensland's contribution to the Reef Plan, including delivering or managing improvement programs, reviewing programs for their effectiveness and providing a link between programs to maximise their effects towards improving water quality.

Figure 2C depicts the department relationships at a state level, outlining that departments have an informal reporting relationship with the Reef Secretariat.

**Figure 2C**  
**Queensland governance structure as at May 2015**



Note: Solid lines indicate a direct reporting relationship, dotted lines indicate informal or limited sharing of information

Source: Queensland Audit Office

The Queensland Government announced on 7 May 2015 that:

- the functions of the Reef Secretariat will be transferred into DEHP as an Office of the Great Barrier Reef and enhanced to coordinate, monitor and assist in delivering the state's contribution to Reef Plan and the Long Term Sustainability Plan
- an interdepartmental committee chaired by DEHP will coordinate and monitor the departments' Reef Plan action items and programs that contribute towards the Reef Plan and Long Term Sustainability Plan targets and goals
- a Great Barrier Reef taskforce has been formed to advise government on how to achieve the Reef Plan targets.

## 2.3.2 Investment governance

Five state departments are funded to deliver action items under Reef Plan, including:

- directly delivering outcomes
- managing grants programs, contracts or memorandums of understanding for service delivery

Figure 2D shows that Queensland's committed annual investment of \$35 million each year is spread across these five departments, each of whom are separately accountable for their expenditure and for the delivery of their programs.

One consequence of this distributed governance model is that there is no certainty as to how much is actually spent each year in total on the Reef Plan as it is not tracked and reported centrally.

Not all departments provided accurate, actual expenditure figures for prior years or committed funds in the forecast years for their Reef Plan activities. This is partly because many existing programs are funded from the various department's base appropriations rather than being tracked as separately funded initiatives. Regular machinery-of-government changes and the need to arbitrarily attribute proportions of costs incurred on statewide programs to reef locations, add further to the lack of strong accountability for Reef Plan expenditures.

**Figure 2D**  
**Estimated Queensland departmental contributions**  
**2012–13 and 2013–14**

Department	Estimated 2012–13 Contribution (\$M)	Estimated 2013–14 Contribution (\$M)
Department of Environment and Heritage Protection	14.14	13.25
Department of Natural Resources and Mines	16.77	17.58
Department of Science, Information Technology and Innovation	1.24	1.19
Department of Agriculture and Fisheries	3.94	3.94
Department of the Premier and Cabinet	0.88	0.88
<b>Total</b>	<b>36.97</b>	<b>36.84</b>

Source: Queensland Audit Office from departmental records and estimate committee hearings

The departments of National Parks, Sport and Racing and State Development both contribute towards the achievement of action items under Reef Plan. Their contribution towards water quality monitoring and regional planning respectively are excluded from the state's financial assessment.



The departments also do not provide periodic implementation status reports or an evaluation of their effectiveness to the Intergovernmental Operational Committee (IOC) or the Partnership Committee unless the project is an action item under Reef Plan.

This has limited the ability of departments to assess overall program effectiveness in contributing towards the Reef Plan goals. It also makes it difficult for them to take coordinated decisions to modify program elements to account for results in other programs or modelled water quality outcomes.

### 2.3.3 Research, development and innovation

The distributed governance and program management model creates uncertainty about who is responsible for delivery of Reef Plan research and development, whether there is sufficient funding and whether activities are being afforded appropriate priority.

The 2009 and 2013 Reef Plans are underpinned by scientific research which is supported by a Research, Development and Innovation Strategy (RDI strategy). The development of the RDI strategy is led by the Reef Secretariat under the guidance of the Research and Development Coordination Group (RDCG). The current RDI strategy (released in November 2014) outlines the key priorities for the next five years.

Under the Reef Plan, the Queensland Government funds two primary research programs (excluding monitoring and evaluation activities):

- DEHP's Reef Water Quality Protection Science Program
- Sugar Research Australia (SRA) projects funded by DAF.

DEHP's research is aligned to the 2013 RDI strategy (through their own RDI Strategy). The SRA research is not solely aligned to the Reef Plan RDI Strategy. The SRA research, in part funded by a mandatory levy on sugar producers, has a 'triple-bottom line' focus between profitability (making more money), productivity (producing more) and environmental outcomes (looking after the health of the environment).

Because of the voluntary and disjointed process by which research projects are allocated and funded, it is not clear to the RDCG or the Reef Secretariat whether the research in progress will sufficiently address all of the 2013–18 RDI strategic priorities within the required timeframes. The RDCG is in the process of collating which research projects have commenced or have been financially committed to, and aligning them with the RDI strategy.

The RDI strategy does not have guaranteed funding and acknowledges that research demands are greater than the funding available. Accordingly research projects are prioritised to guide investment decisions. Since December 2013, RDI priorities have been determined by the RDCG in consultation with industry, research bodies and Australian and state governments.

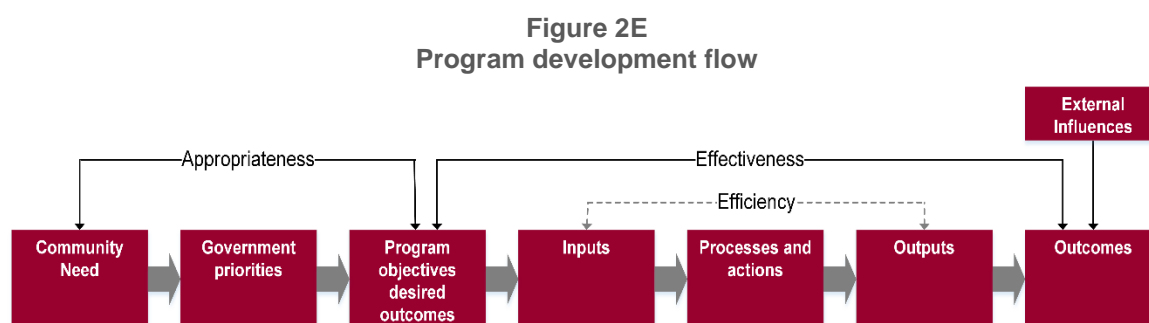
The RDI strategy relies on various stakeholders to fund the activities. Research projects are undertaken or sponsored voluntarily by individual organisations (such as departments, statutory bodies and universities) out of their own budgets and select projects that have a particular interest to their field of expertise. In 2013–14, the Queensland Government funded \$3.24 million (9 per cent of Queensland's Reef Plan financial investment) towards projects listed in the 2009 RDI strategy.

Findings from RDI projects are not centrally collated nor readily available publicly. This is partly due to copyright restrictions imposed by the sponsoring organisations. However research findings are broadly synthesised through the Scientific Consensus Statement. Limiting availability and relying on professional networks to share detailed information hinders the ability of stakeholders to proactively modify improvement programs and develop policies in response to emerging trends and findings.

## 2.4 Program design and evaluation

Figure 2E outlines a model approach for developing, implementing and evaluating programs to ensure they achieve desired outcomes. It has three distinct considerations:

- appropriateness: Will the program achieve the government's priorities and the community's needs?
- effectiveness: Are the outcomes achieving the programs objectives?
- efficiency: Are the programs using an optimal mix of time, effort and cost to deliver the outcomes?



Source: Queensland Audit Office from 'On efficiency and effectiveness: some definitions' by the Productivity Commission May 2013

### 2.4.1 Appropriateness

The Queensland Government contribution for Reef Plan involves a suite of activities:

- improvement programs
- monitoring and evaluation
- policy and planning for regulation, compliance and strategic activities
- research and development to increase understanding and better target investment.

Many of the projects and activities attributed to Queensland's reef water quality programs were not developed for, and have not since been customised to suit, the Reef Plan. These activities existed before the Reef Plan—shown in Appendix E—and total approximately \$20 million (54 per cent) of the \$36.8 million estimated to have been spent during 2013–14.

The primary objectives of the pre-existing programs were not to improve water quality to achieve ecologically relevant results—they were originally formed for other purposes.

For example, the primary objective of the weed and pest management program is to improve farming productivity and the resilience of native fauna and flora. It is not designed to improve the ecological processes that contribute directly to improved water quality, either by decreasing sediment run off or the elevated levels of nitrogen making it to the reef.

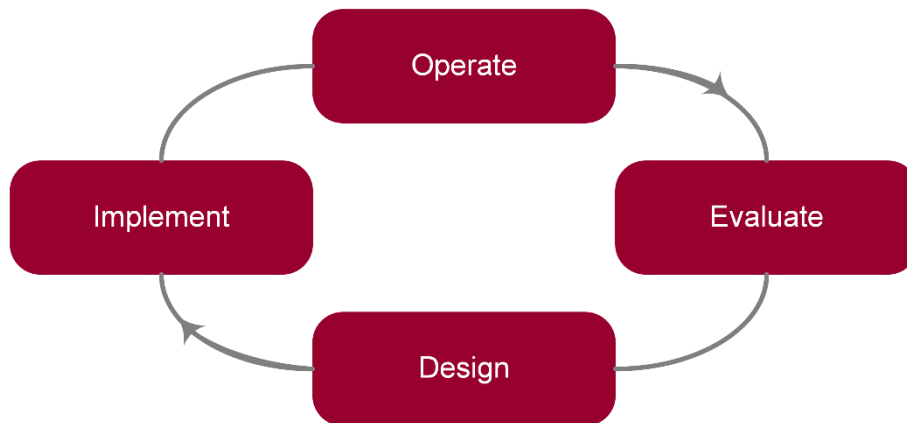
This does not mean that the pre-existing programs are not contributing to improvement of water quality and the Reef Plan targets and long term goals. However, identifying existing programs and attributing them to the Reef Plan after the event has meant the overall program design and coordination has lacked rigour from the outset.

Neither the Reef Secretariat, nor the individual departments, reviewed their pre-existing programs objectives, to consider whether they should change their focus to align more closely with the Reef Plan goals. It is difficult therefore to establish that the present suite of activities is the most cost effective use of the limited resources available.

### 2.4.2 Efficiency and effectiveness

Testing the impact of policies, strategies and programs to determine if they are delivering outcomes efficiently and effectively is an important part of program governance. Figure 2F is an example of the continuous improvement steps to be undertaken throughout the ideal program lifecycle.

**Figure 2F**  
**Program development flow**



Source: Queensland Audit Office

The assessment of the state's contribution to the Reef Plan is not effective or timely in addressing program gaps and program design change requirements. Currently the reef report card serves as the key evaluation point. However program evaluation goes beyond reporting statistics of results. Program evaluation is about asking questions such as:

- Does it meet the needs of the community?
- Is it achieving the intended outcomes? Or producing unintended outcomes?
- Has it been implemented as planned?
- Does it represent value for money?
- Should it be continued, expanded, modified, or discontinued?
- Are there better ways to achieve the same result?
- Can resources be allocated more efficiently?

With the state's programs focused on achieving their primary objectives, their effectiveness is being measured and evaluated against these objectives, not on their water quality improvement side-benefits. Also the combination of the state's activities and their collective impact on water quality is not being evaluated.

For example the Best Management Practice (BMP) programs do not result in direct water quality improvements, but serve to raise awareness and provide a level of education for producers to instigate change. Water quality will improve only if the producer undertakes a BMP program and then makes improvements to limit pollutant loads.

Further improvement will occur if there is also a strengthened riparian and wetland ecosystem. Current program targets for these ecosystems are not based on ecologically relevant water quality improvement targets and are not linked, or cannot be linked, to achieving Reef Plan targets. This inhibits the ability to work out whether or how, to adjust program activities to better align to Reef Plan outcomes.

Evaluation should also play a significant role in improving overall program design, to ensure any gaps in program coverage are identified and addressed. This can be done by introducing new programs or altering existing ones. For example, since at least 2009, agencies have identified the need to quantify and address erosion rates from scalds, gullies or river banks. The actual and perceived high costs of erosion remediation efforts has slowed progress towards addressing this issue. The program focus remains on understanding the potential effects and action is limited to recommending graziers fence off at-risk areas; rather than mapping and assisting graziers and land-owners in undertaking remediation works.

The success of a complex, long-term program like the Reef Plan relies on learning, adapting to changing environments, correlating results of evaluations and creating new research information. The revisiting of the Reef Plan targets for the program is a good example of where the program is learning and adapting to new information and aiming to develop more appropriate ecologically relevant targets by January 2016.

## 2.5 Recommendation

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It is recommended that, as a matter of priority:

1. **the newly formed Office of the Great Barrier Reef be provided with sufficient and appropriate management and administrative authority, so that it can be properly made responsible and held accountable for Queensland's reef management strategies and programs**

## 3 Land management practices

### In brief

#### Background

The Queensland Government's Reef Plan improvement programs focus on what occurs on the land and in the catchments. These state programs rely largely on voluntary participation, rather than regulatory enforcement. To be efficient and effective under this approach, programs need not only to be aligned to Reef Plan goals and targets, but also to achieve high levels of participation across targeted agricultural industries.

Land management practice change contributes to improvements in water quality when:

- there are high levels of industry participation by individuals and groups in the areas targeted for their contribution to poor water quality
- participation rates translate to actual land management practice changes, which in turn result in reductions in pollutants and sediment run off.

#### Conclusions

The Queensland Government's programs attributed to the Reef Plan have yet to achieve the scale of land management practice change necessary to contribute substantially to the achievement of the Reef Plan goal and targets within the aspired timeframes. The lack of incentives and disincentives combined with poor communication have seen slow industry take-up in some voluntary improvement programs.

The right mix of voluntary participation, through education and incentives, with regulatory enforcement has not yet been achieved. State programs emphasise improving farm profitability and productivity to encourage voluntary participation, in lieu of regulatory enforcement. This has coincided with a rise in land clearing rates which increases the risk of bare ground and the potential for more runoff resulting in adverse water quality outcomes.

#### Key findings

- The 2013 Reef Plan places a high emphasis on voluntary actions and market based drivers to achieve outcomes without clear mechanisms to support this approach.
- Industry participation in voluntary programs has been slow, particularly for the Smartcane Best Management Practice program. The rates of participation are not at levels needed to effectively contribute to the achievement of the Reef Plan water quality targets.
- The balance between productivity, profitability and environmental stewardship is tilted heavily towards the former two in order to encourage participation.
- The misalignment of state improvement programs with Australian Government incentive programs limits the ability of Best Management Practice programs to drive change.
- There has been an increase in woody vegetation clearing rates in reef catchments over the last three years. This has the potential to increase run off and sedimentation and therefore have an adverse impact on the achievement of Reef Plan targets. However, data on clearing rates specifically for the riparian corridors that border rivers or streams, which are critical to the health of the reef, are not available.

#### Recommendation

It is recommended that:

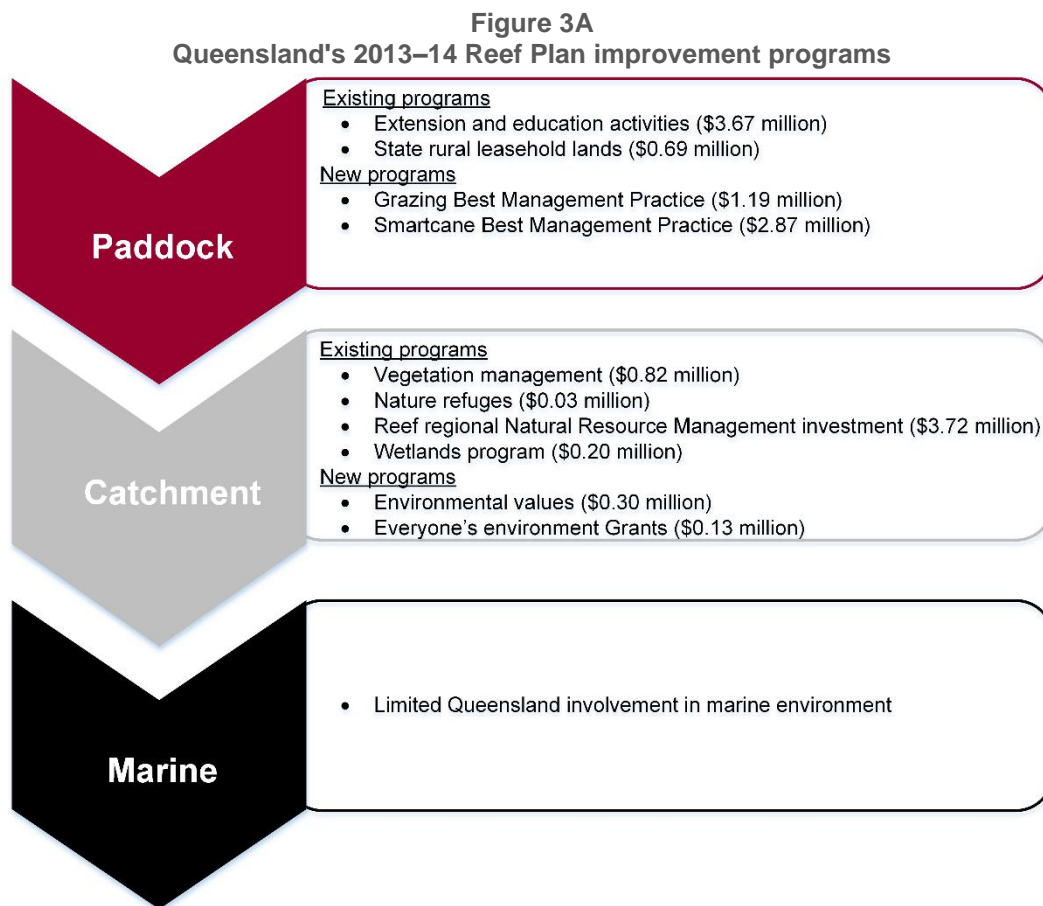
2. **the design and implementation of the suite of programs attributed to the Reef Plan is reviewed to establish they are the most effective and efficient.**

## 3.1 Background

The current Reef Plan goal is to ensure that by 2020 the quality of water entering the Great Barrier Reef (the reef) from broadscale land use has no detrimental impact on the health and resilience of the reef.

The Queensland Government's role in realising this goal includes educating farmers how to improve land management practices in key catchments, and in monitoring and modelling programs; for which it has committed \$35 million per year. The state programs are intended to pair with the Australian Government's incentive and research programs.

Figure 3A shows Queensland's Reef Plan improvement programs focus on what occurs on the land and in the catchments, not in the marine environment, which is the Australian Government's jurisdiction.



Note: Existing programs were operational prior to the Reef Plan. New programs have commenced post Reef Plan.

Source: Queensland Audit Office

The Best Management Practice (BMP) programs, extension and education activities and a portion of the Regional Natural Resources Management Investment Program aim to encourage agricultural producers to adopt improved land and management practices through voluntary mechanisms. Regulations governing management practice are not being enforced. The vegetation management program aims to prevent loss of wetland and riparian vegetation through policy, monitoring and compliance activities.

In 2013–14, approximately \$13.6 million (over one third of Queensland's investment) went towards programs attributed to on-the-ground improvements to water quality entering the reef.

## 3.2 Conclusions

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The state government programs attributed to the Reef Plan are not close to achieving the scale of land management practice change necessary to effectively contribute to the achievement of the Reef Plan goal and targets within the aspired timeframes. This is due to the government's disproportionate reliance on voluntary participation and slow industry take-up in improvement programs, especially with sugarcane growers. This lack of progress casts doubt that nitrogen and sediment reduction targets will be reached by 2018.

The skewing of state programs toward profitability and productivity rather than environmental responsibility is a direct result of a need to encourage or incentivise voluntary participation in lieu of regulatory enforcement. The imbalance has coincided with increased practices contrary to the achievement of water quality outcomes.

## 3.3 Paddock programs

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To improve management practices to reduce pollutants leaving farming properties, Queensland has adopted the following:

- voluntary education and extension activities:
  - whole-of-farm best management practice (BMP) programs
  - subject specific education and extension activities
- regulations applicable to cattle graziers with properties greater than 2 000 hectare and commercial sugarcane farmers in the:
  - Wet tropics
  - Mackay-Whitsunday
  - Burdekin.

The majority of producers have been engaged through the Department of Agriculture and Fisheries (DAF) and industry education and extension support activities to help them improve discrete aspects of their land and management practice. A smaller proportion use the BMP programs to holistically improve their whole-of-farm management practices.

### 3.3.1 Best Management Practice programs

The voluntary BMP programs are delivered by industry and regional NRM bodies under a contract with the Department of Environment and Heritage (DEHP). The BMP programs are an evolution from previous industry and government farming support programs. Delivery of the latest editions of the Grazing BMP modules commenced in July 2013 and the Smartcane BMP modules in December 2013.

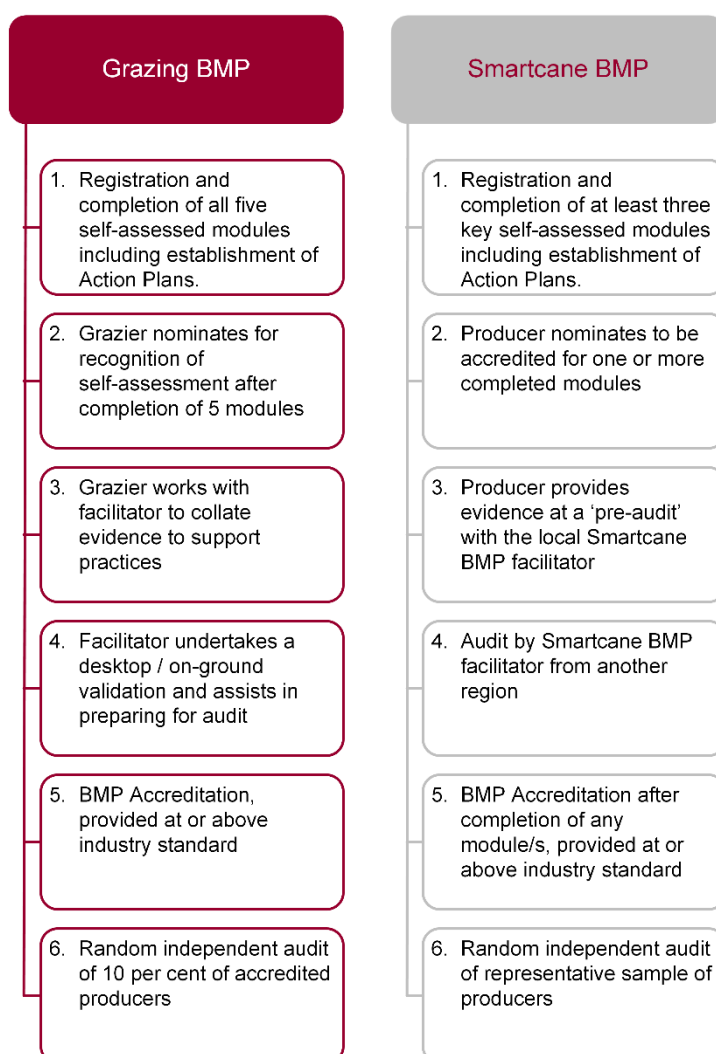
The Grazing BMP uses five modules and the Smartcane BMP uses seven modules to inform producers of best management practices for all aspects of their farm. They require participating producers to self-assess their current practices. There is no obligation on producers to alter their practices, have their practices verified or invest in capital improvements.

Figure 3B outlines the accreditation process for each of the BMP programs. The Grazing and Smartcane BMP programs follow similar paths for producers to be accredited at industry standard or better. The accreditation processes are designed to ensure verification of and confidence of self-assessed management practices.

Accreditation does not provide the producer with any competitive market advantage, only branding to demonstrate they are at or above industry standards.



**Figure 3B**  
**BMP accreditation process comparison**



Source: Queensland Audit Office

### Rate of uptake of BMP programs

The BMP programs have targets that relate to the number of producers:

- completing the modules (step 1)
- certification after completion of five modules (step 2 - Grazing BMP only)
- accredited (step 5)
- audited (step 6).

Producer participation targets were based on what was perceived as being achievable and providing a water quality outcome but are not linked to Reef Plan targets or an ecological relevant outcome.

Figure 3C shows that the Grazing BMP has met two of its three targets, and the Smartcane BMP has not achieved any, within its first contractual period (12 months since the commencement of each program). These trends have continued through the second contractual period, which is still in progress.



**Figure 3C**  
**Best Management Practice uptake as at end of first contractual period**

	Grazing BMP		Smartcane BMP	
	Target	Achievement	Target	Achievement
Self-assessment completion (step 1)	1 500 modules completed	1 789 modules	1 520 registered farmers with completion of at least one module (40.2 per cent of farms)	684 registered farmers that completed at least one module (18.1 per cent of farms)
Number of graziers certified for completing five modules (step 2)	360 graziers certified (7.7 per cent of farms)	738 graziers certified (15.9 per cent of farms)	Not applicable to Smartcane BMP.	
Producers accredited (step 5)	30 accredited graziers (0.6 per cent of farms)	10 accredited graziers (0.2 per cent of farms)	380 accredited farmers for at least one module (10 per cent of farms)	4 accredited farmers for at least one module (0.01 per cent of farms)
Producers audited after accreditation (step 6)	10 per cent of accredited graziers	100 per cent of accredited graziers	7 accredited farmers (0.01 per cent of farms)	0 audited
<b>Farms in reef catchments</b>	<b>4 649*</b>		<b>3 777</b>	

Note: \* Grazing BMP targets focused on Fitzroy and Burdekin catchments only

Source: Queensland Audit Office from Grazing and Smartcane BMP contracts and industry submissions

A sample (10 per cent for grazing and a representative sample for sugarcane) of accredited farms are audited under the ISO19011 management systems standard by independent third parties to verify the producers have the required evidence to show their land and practice management.

The required number of sugarcane farms and graziers has not been audited to gain a level of independent assurance of quality and rigour of the self-assessment process. The graziers that have been audited were not randomly selected, but volunteered. The low number of audited farms and the volunteer nature limits the degree of comfort that can be taken from any positive audit findings.

The sugarcane industry has argued its below target performance is due to delays in establishing the program and also that it is a time consuming process that can only be done in the off season (approximately five to seven months of the year, when the producers are not harvesting).

Another contributing factor is the lack of value producers perceive they will obtain from participating in the Smartcane BMP program. A review commissioned by the cane industry in 2014 found there is still difficultly convincing growers to:

- undertake the workshops in the first place
- self-assess their practices
- become certified (and thereby agreeing to be audited).

We corroborated this as part of our field site visits. However, producers who have participated in Smartcane BMP have expressed the importance to them and the perceived value of the program.

To encourage uptake, the BMP programs are marketed to producers as a means to increase profitability and productivity. The intent is to encourage producers to participate voluntarily. To this end DEHP aims for the BMP programs and their extension and education activities to balance productivity and profitability with environmental stewardship, which is referred to as the triple-bottom line. It means that changes to achieve environmental outcomes will not be incorporated into the program unless industry is convinced there is no adverse impact on production or profit.

The Independent Science Panel in September 2013 found that the Smartcane BMP program had a lesser focus on environmental stewardship than on productivity and profitability. Despite this, DEHP endorsed the Smartcane BMP program and gave the industry four years (to 2017) to make the necessary improvements to environmental stewardship through further agreed upon and focused research over 2014–16. The collaborative research program is not yet finalised and not all research programs will be completed by 2016.

It is not clear if the Smartcane BMP program will attract sufficient take-up to achieve the land and catchment management targets (90 per cent of sugarcane using best management practice systems). It is also not clear if the Smartcane BMP program will make sufficient changes to effectively contribute towards the water quality improvement targets (for example at least a 50 per cent reduction in dissolved inorganic nitrogen). Further, due to the non-linear relationship between reductions in pollutants and improvements in management practices, the contribution towards water quality reduction could be significantly less, particularly in the already ambitious nutrient targets.

### 3.3.2 Extension and education activities

DAF exceeded its extension and education engagement targets from 2009 to 30 June 2014. The primary aim of these activities is to apply research and new knowledge to grazing and sugarcane practices industries by educating producers and encouraging them to implement the research findings.

To encourage participation, DAF uses professional agricultural economists and extension officers (including agronomists) to identify knowledge and research gaps to inform industry on the most effective and efficient land and practice management techniques. A priority is cost benefit work regarding changing management practices. DAF is demonstrating to producers that, in many instances, they will financially benefit from improved practices. This is aimed at countering the lack of financial incentives to participate and showing the value in adopting improved practices that will not only increase profitability but provide secondary water quality benefits.

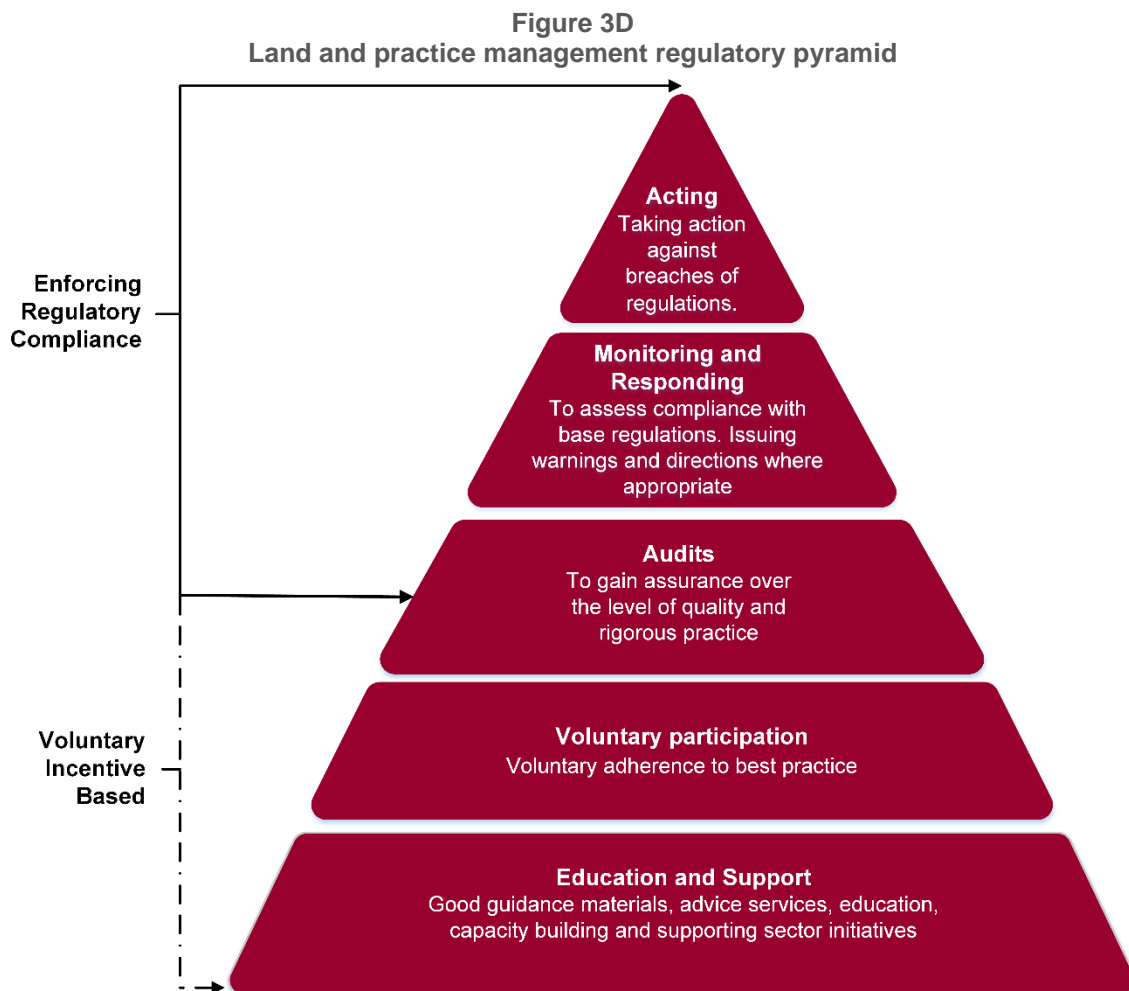
DEHP funds DAF (\$1.65 million in 2013–14) to deliver education and extension activities for sugarcane and grazing industries in the reef catchments. The activities aim to support producers to adopt improved practices, encourage them to participate in BMP and incentive programs, and advise them of legislative requirements. These activities are informed by research and development of new land and management practices from a variety of industry and government bodies. New practices often take many years of trials before widespread implementation; this presents a significant lag between research discoveries and water quality improvements.

DAF conducts surveys of the producers that participate and many indicate they see the quality of the activities. DAF also asked the producers of their intentions to change their practices. The results show that producers are either considering, or making, quantifiable changes. However the scale of change and water quality benefits are not able to be verified, therefore the effectiveness of these activities towards Reef Plan targets cannot be determined.

### 3.3.3 Regulatory compliance

The reef protection legislation for cattle graziers and sugarcane growers in key reef catchments was introduced in 2010. The effectiveness of the regulations in reducing pollutant loads was not assessed before the decision not to enforce them in 2012. At that time the Queensland Government committed to industry that regulations would not be enforced until the voluntary BMP programs were assessed for their effectiveness.

Queensland has a toolkit of education and extension engagement activities, voluntary programs and regulations to improve land condition and land and practice management. Figure 3D depicts how voluntary and regulatory mechanisms have the potential to interact.



Source: Queensland Audit Office

Given their recent inception, evaluations have yet to be undertaken to assess whether the Smartcane and Grazing BMP programs are effectively improving water quality at the end of catchment level. As a result, it is not possible at this time to determine whether the voluntary programs are appropriate replacements for the previous regulated requirements. Industries have committed to continually improve the practices in the modules and review the content annually. To date, the Smartcane BMP program has not made any fundamental changes to program content, while the Grazing BMP program has made minimal changes to account for advances in research.

The content of the Smartcane BMP program has not yet been reviewed and will not be until December 2015. The cane growing industry is working towards partnering with an international non-governmental body to develop a program by 2020 that will meet international environmental sustainability standards that are driven by big consumer companies' desire to be environmentally sustainable. Negotiations are still in early stages and as such alignment with Reef Plan outcomes are yet to be established.

The absence of external rewards, market drivers, or disincentives limits the ability of the voluntary BMP programs to attract a high number of producers. Without an active regulatory compliance framework, a greater emphasis is needed to establish effective incentives and disincentives to encourage participation.

There is no alignment between accreditation and eligibility for grant programs. However, the latest round of Reef Programme and Reef Trust funding in the Fitzroy and Wet Tropics does at least require producers to have completed a BMP self-assessment in the relevant module to receive grant funding. The lack of state incentives undermines the value of being an accredited producer or participating in the improvement activities.

## 3.4 Catchment programs

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### 3.4.1 Vegetation management

The Department of Natural Resources and Mine's (DNRM) administers the *Vegetation Management Act 1999 (Qld)* (VM Act) through the vegetation management program. The VM Act aims to control broadscale land clearing.

In 2002 a Queensland Government commissioned review found that extensive vegetation clearing has the potential to adversely affect water quality due to erosion and sediment run off. The introduction of the VM Act stabilised clearing rates.

The Department of Science, Information Technology and Innovation's (DSITI) monitoring of clearing indicates that approximately 95 per cent of cleared land is used for grazing. There is a high risk that sediment run-off will occur if pastures that replace woody vegetation do not have the opportunity to establish, or are too heavily grazed, prior to rainfall.

The vegetation management program has evolved over time. In 2013–14 \$1.64 million was allocated for management across the state. This program is made up of a number of activities, outlined in Figure 3E below.

**Figure 3E**  
**2013–14 Vegetation management program components**

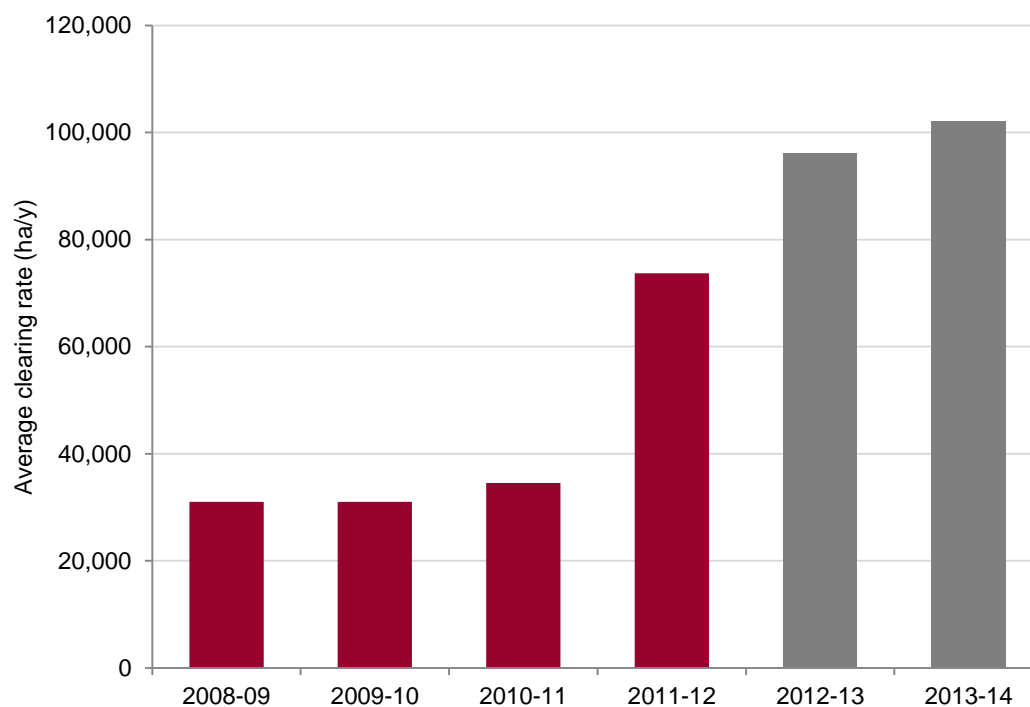
Program component	Component description
Vegetation management framework reforms	Reforms came into effect in December 2013 that allow for broadscale clearing for sustainable agricultural development, while attempting to manage environmental protection.
High value agricultural clearing	Clearing approval processes for development in areas that are suitable for agriculture, are economically viable and sufficient water is available for irrigation.  Applications for land clearing are assessed by DNRM to ensure sensitive areas (such as those with endangered or threatened species, at risk regional ecosystems, water courses and wetlands) are not cleared.
Reef watercourse protections	Regulating the clearing of native regrowth vegetation within 50 meters of the banks of watercourses in priority Burdekin, Mackay-Whitsunday and Wet Tropics catchments. The definition of 'watercourses' was narrowed in December 2013, resulting in additional low lying areas being excluded from these protections.
Regrowth reforms	Allows for the removal of high value regrowth vegetation (vegetation that has not been cleared since 31 December 1989) on freehold and indigenous land.
Self-assessable vegetation clearing codes	Broadened the use of self-assessable vegetation clearing codes which allow landholders to clear with on the ground considerations. Applies to low risk or routine clearing activities such as clearing for weed control.
Monitoring and compliance	Statewide satellite monitoring of clearing. Penalties are issued for infringements.

Source: Queensland Audit Office from Department of Natural Resources and Mines

Major reforms were introduced in 2013 to allow landholders to clear vegetation not cleared since 31 December 1989 or land that is suitable for economically viable agricultural development.

Figure 3F shows that land cleared in reef catchments increased by 229 per cent, from 31 000 ha per year in 2008–09 to 102 000 ha per year in 2013–14. This result may lead to an increase in the extent of bare ground which, depending on the occurrence of storms and the amount of ground cover provided by the replacement land use, increases the risk of soil erosion within the catchment. Therefore a rise in tree clearing rates can contribute greater sediment runoff.

**Figure 3F**  
**Woody vegetation clearing rates in reef catchments**



Note: 2012–13 and 2013–14 are preliminary conservative figures which have not been subject to a full quality assurance procedures

Source: Queensland Audit Office from *Land cover change in Queensland 2010–11 and 2012–13* and *Land cover change in Queensland 2012–13 and 2013–14 Preliminary Report* as produced by DSITI

The 113.4 per cent increase from 2010–11 to 2012–13 coincided with the policy change to reduce compliance activities. DNRM and the Reef Secretariat were unable to provide an assessment of the effect of these changes on the achievement of Reef Plan objectives, or to demonstrate whether the increased risk of sediment runoff was considered in making the changes.

Riparian vegetation (which grows alongside rivers and streams) is widely acknowledged and accepted as being critical for stream health and the health of the reef. Riparian vegetation is included in the above graph but has not been identified separately as this is only performed and reported every four years for the Great Barrier Reef report card and not for the purposes of vegetation management activities. Therefore data on clearing rates specifically for the riparian corridors that border rivers or streams are not currently available.

In addition recent changes to the *Water Act 2000* have potentially resulted in upper reaches of tributaries in small sub-catchments no longer being classified as watercourses. It is not known if these changes are likely to influence the clearing in these declassified areas.

### 3.4.2 Regional NRM investment program

The Regional NRM Investment Program provides funding to 14 regional natural resource management (Regional NRMs) bodies in Queensland. Regional NRMs are non-government organisations that aim to improve delivery of natural resource management outcomes in partnership with industry, community and government. The Queensland Government provided \$4.3 million in 2013–14 across five Regional NRMs in the reef catchments.

The state's funding is allocated to three categories (in addition to funding the administrative and support costs):

- water quality grants for improvements in coastal and inland catchments (\$1.1 million in 2013–14)
- weed and pest management to build resilience of natural flora and fauna (\$1.7 million in 2013–14)
- sustainable agriculture encouraging producers to adopt improved practices (\$1.2 million in 2013–14)
- administrative and support costs (\$0.3 million in 2013–14).

The sustainable agriculture activities are similar to the DAF extension and education activities with the triple-bottom line objectives and, as such, do not provide direct water quality improvements. Weed and pest management provides secondary benefits through the protection of wetlands and native species. Regional NRM groups also administer the Australian Government's Reef Programme water quality grants, the only practice changes that are somewhat quantified under the Reef Plan.

## 3.5 Recommendation

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**It is recommended that:**

- 2. the design and implementation of the suite of programs attributed to the Reef Plan is reviewed to establish they are the most effective and efficient.**





## 4 Monitoring and reporting change

### In brief

#### Background

The Paddock to Reef Integrated Monitoring, Modelling and Reporting Program (P2R program) uses data from rainfall simulation trials, land management practices, catchment level water quality results and various onshore and marine ecological variables to model outcomes in improving water quality.

The summarised results from the P2R program are published in the annual Great Barrier Reef report card (reef report card). More detailed tiers two and three reports are used to inform the Reef Plan's Research, Development and Innovation Strategy, the Investment Strategy and future re-designs of the P2R program itself.

#### Conclusions

The statement in the 2012–13 reef report card that the 2009 goal of halting and reversing the decline in water quality entering the Great Barrier Reef 'was achieved', is easily misinterpreted as fact.

There is a high level of uncertainty in the modelled outcomes due to the number of assumptions and data limitations in such a complex model.

The modelling tool used to inform this statement is robust; however the quality of inputs can be improved and additional monitoring undertaken to test and verify the model. These elements are required to increase confidence levels in the progress towards achievement of the Reef Plan targets and goal.

#### Key findings

- The modelling is complicated and sophisticated, but well respected and provides the opportunity to model potential impacts of the Australian and Queensland governments' investment and actions to the quality of water entering the reef.
- Although improvements in the quality and accuracy of data used as inputs to the model have been made, there are further gaps to be closed.
- The land management change data are not collected consistently, verified on the ground or independently audited to provide a high level of confidence in their accuracy.
- Erosion caused by gully, scalds and stream banks is not well understood or measured despite research indicating it may contribute sizable amounts of sediment entering the reef.
- Ecological processes between the paddock and marine environments, such as those provided by wetlands, are not extensively monitored and well understood.
- The lack of water quality monitoring sites across the catchments results in lower levels of confidence that the quality of water entering the reef is actually improving.
- There is no long-term monitoring to determine the full extent of pollutants leaching into groundwater.
- The level of uncertainty or confidence in reported data is not communicated in the tier one reef report card and is insufficiently reported in the tiers two and three reports.

#### Recommendations

It is recommended that:

3. **catchment monitoring is expanded to aid in determining the effectiveness of practice management change and to enhance the confidence in modelled outcomes**
4. **a rigorous verification process is applied to data on land management practice change, and deficiencies in model inputs be addressed, to improve confidence in, and the accuracy of, inputs into catchment modelling**
5. **unambiguous references be included in the tier one reef report card which disclose the degree of uncertainty and levels of potential variability in the reported results.**

## 4.1 Background

The Paddock to Reef Integrated Monitoring, Modelling and Reporting Program (P2R program) is complex by need and by design, consisting of 10 separate components. Due to this complexity the data are collected from a variety of sources. These are outlined in Figure 4A.

**Figure 4A**  
**Data collection methods used for P2R program components**

Component	Data collection method
Paddock runoff (i.e. water quality and quantity) monitoring Catchment loads (i.e. water quality and quantity) monitoring Inshore marine water quality monitoring and monitoring of the ecological condition of coral and sea grass	Water quality monitoring
Management practice adoption	Surveys of land managers
Ground cover extent Riparian vegetation extent Wetland extent	Remote sensing
Wetland risks, values and processes	Desktop and limited field assessments
Paddock modelling Catchment modelling	Variety of data from above

Source: Queensland Audit Office from various P2R program methods documents

The P2R program uses five lines of evidence to evaluate progress towards *Reef Water Quality Protection Plan* (Reef Plan) targets. These are:

- effectiveness of management practices to improve water quality
- prevalence of adoption of management practices, and change in catchment indicators
- long-term catchment water quality monitoring
- paddock and catchment modelling to provide a relative assessment of progress towards meeting water quality targets
- marine monitoring of inshore water quality and the health of coral reefs and seagrass in the reef lagoon.

The P2R program results are published through the reef report card and supplementary reports.

It is important that both the modelled data used and the publicly reported results are reliable to maximise the ability to measure water quality improvement and to maintain public and international confidence in the Reef Plan.

## 4.2 Conclusions

The modelling of the P2R program is highly commended in the scientific community and has improved with each phase. It provides a valuable means with which the effects of uncontrollable variables, such as extreme weather events, can be removed from the data.

In contrast, monitoring of actual conditions is not as effective. Agencies have not established with sufficient confidence that the quality of the water entering the reef from catchments is actually improving. There are simply too few monitoring sites across the reef catchments to achieve this and there is a tendency to report modelled rather than actual results, primarily due to significant fluctuations that can be caused by extreme weather events.

Significant gaps in knowledge regarding the processes between the paddock and end of catchments remain. To compensate for this lack of understanding and for the lack of comprehensive temporal and spatial data, several assumptions were made, thus reducing confidence in the modelled outputs.

The program's reliance on modelled results comes with a high level of responsibility to ensure transparency about the assumptions, limitations and lack of precision of the modelled results. The regular public reporting fails in this regard, lacking transparency at best, and being misleading at worst. This is because the annual report cards do not openly report the inherent limitations, assumptions and error bands associated with Reef Plan monitoring and modelling.

### 4.3 Catchment modelling

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The water quality model used is complicated. Its sophisticated design enables it to be used over a wide and complex geographic area. Its outputs are not measured loads, but modelled average annual pollutant load reductions. These results are indicative of the likely (theoretical) effects of adopting improved land management practices for a given scenario, rather than a measured reduction.

The model uses data on the level of adoption of improved practices (including their effects in terms of load reductions), groundcover and rainfall in the catchment. It then estimates the loads of sediment, nutrients and pesticides for natural resource management (NRM) regions and the entire reef.

Water quality and quantity data, collected at 25 sites in reef catchments during wet weather events, are used to validate the model predictions. The estimated effects of long term average loads, including floods, are compared with 2009 baseline values to assess progress towards Reef Plan targets.

The P2R program differs from other waterway monitoring and modelling programs through its primary reliance on modelled rather than monitored data. Most monitoring programs collect a significant amount of water quality data before they try to develop predictive computer models. This assists in understanding the system and the variability associated with it. The P2R program did not allow for the lead times required to collect this data. Instead, it took an approach of modelling based on limited empirical data.

Additional monitoring to validate modelling improves confidence in modelled results. In a balanced framework, monitoring supports and enhances modelling. Monitoring is not necessarily a standalone metric for program achievement.

### 4.3.1 Review of modelling

Experts undertook a review of the P2R program's modelling in 2012. They concluded that, while the P2R program was fit for purpose to report on water quality improvements from on-ground management changes, several enhancements could be made. The improvements included:

- quantifying the actual (spatially explicit) area over which paddock-scale management practices are applied, not just the proportion of landholders adopting improved practices
- incorporating seasonal variation to ground cover into the sediment sourcing modelling
- improving how the nitrogen surface-groundwater (water tables and aquifers) interactions are used in the model, especially in respect to coastal areas which may be downstream of the gauging station used for end-of-catchment calibrations
- modelling horticulture contaminants to better estimate their contribution to contaminant loads
- being more systematic about modelling decisions and assumptions taken and quantifying their consequences
- using new monitoring sites to reduce important uncertainties in modelled loads spatially and temporally.

The remaining data limitations are discussed in section 4.4 below.

## 4.4 Data limitations

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The P2R program was redesigned based on the recommendations from the 2012 review, resulting in two distinct phases:

- phase one for years 2009 to 2013 (Reef Plan 2009)
- phase two for years 2013 to 2018 (Reef Plan 2013).

All reef report cards (2009 to 2012–13) have been published under the design of phase one. The first reef report card under phase two will be for progress up to June 2014. It is due for release in September 2015.

### Phase one limitations

The catchment model requires verified data (inputs) to accurately predict load reduction results (outputs). There are numerous assumptions and inherent limitations about the inputs in the model, a selection of which is included in Figure 4B.

**Figure 4B**  
**Key assumptions and limitations for P2R program modelling**

**Key modelling assumptions for phase one**

- The management practice change data provided from regional NRM bodies were not supplied for each individual management component (i.e. soil, nutrient and herbicides). For example, the assumption was that a change from a 'B' practice to an 'A' practice in herbicide management also resulted in a shift from 'B' to 'A' for soil and nutrient management. This assumption had the potential to overstate the water quality benefits.
- Regional natural resource management (NRM) and industry bodies supplied spatial scale management practice change data where the producer had received an Australian Government grant resulting in an improved change. Not all producers in catchments had received grants and were not included. Where this occurred the management improvement change was averaged across the catchment. This resulted in instances where a load reduction was reported that, in reality, had no investment in land management improvement.
- Land use in the model remains constant and was based on the latest available data, 1999 in some cases.
- Paddock model runs used to populate the catchment models represented typical management practices within a region and did not reflect the actual array of management practices used.
- Application rates of herbicides used to populate the paddock models were derived through consultation with relevant industry groups and stakeholders and were not verified or tested.
- Benefits of adopting an improved management practice were assumed to occur in the same year the investment was made, regardless of whether the actual effects may take significantly longer to be realised.
- Gully density mapping was largely based on 2001 mapping.
- Recycling of water running off paddocks (tailwater) was not included in reporting due to a lack of data on the extent of capture and reuse.
- Groundwater (water tables and aquifers) quality was not factored into the model.

Note: This is not a complete listing of assumptions for the Phase one P2R program modelling.

Source: Queensland Audit Office from Reef plan's "Modelling reductions of pollutant loads due to improved management practices in the Great Barrier Reef catchments"

### Phase two limitations

The second phase of the P2R program has addressed many of these concerns; however data gaps and assumptions remain in the following areas:

- Land and management practice data is not independently verified or audited.
- Groundwater pollutants, such as nitrogen leaching through soils, are not regularly monitored or fully modelled.
- Gullies, scald and stream bank erosion rates are not regularly monitored, well understood and until updated mapping is finalised, outdated layers are incorporated into the model.
- There has been no net increase in the number of pollutant load monitoring sites, but the number of catchments monitored increased (by one) with an equal decrease in sub-catchment monitoring sites.

#### 4.4.1 Land and management practice data

The P2R program has facilitated the monitoring of changing land and management practices since 2009, the results of which are reported in the reef report cards. Data are collected by industry and regional NRM bodies from producers that are engaged through the Australian Government's Reef Programme (formerly Reef Rescue).

The ability to determine the effects from land and management practice change on improving water quality were limited in phase one. This is due to the lack of integrity, consistency and verification of this data.

As more producers in a catchment self-assess or are assessed via a survey, a better picture of management practice emerges. However the government's understanding of changing management practices is subject to variability in the quality, consistency and accuracy of the self-assessments.

### Baseline integrity

The geographic size of the reef catchments and varying farm sizes requires that spatial practice change information be collated and used in the model.

However, in phase one of the P2R program, the proportion of the number of landholders, not the area under management, was used to measure change. This had the potential to distort the measured change in practices as many small scale producers (by area) making improvements will result in a larger than representative change in modelled results. Conversely, a few large producers making improvements will understate the potential modelled results.

The change in practice is measured from a 2009 baseline. However, the 2009 baseline was calculated by hindcasting from 2011 industry reviews and the change predicted during 2010 and 2011. This approach was undertaken as new information indicated the management practices were significantly different to what was initially believed to be the case.

In phase two, the 2009 baselines are again being adjusted, this time to represent the land area for priority catchments, rather than the number of producers. Data has been collected through randomised grazer surveys conducted in 2011–2014 and a 2014 cane industry study commissioned by regional NRM bodies. The 2009 baselines for management practices will then be hindcast using assumed change from prior reef report cards in conjunction with this data. This will provide a more accurate baseline to measure future changes against, if reported changes are accurate.

### Management practice ratings

Producers that are beneficiaries of Reef Programme grants are given an aggregate management practice rating for soil, nutrient and herbicide components, instead of individual component ratings. The four tiered aggregate rating (A, B, C or D, as explained in Appendix G) is used as an input into the P2R program to determine reductions in pollutants. Capturing individual components allows for improved accuracy and reliability of data. Individual component ratings are being collected for phase two but the model still uses an aggregate.

The BMP program practice change data will not be used for the first phase two report card because of the lack of confidence and veracity of the area being managed under particular practices. Ratings are supplied on aggregate and de-identified for confidentiality purposes. Including de-identified BMP data may cause double-counting should a producer also engage in the Australian Government's Reef Programme. Should these limitations be overcome, there is potential to capture the modelled effectiveness of these programs within the P2R.

The Paddock to Reef Program Design 2013–18 has highlighted a concern with the consistency and integrity of collection practices and the accuracy of data, because the determination of the practice change ratings is a subjective process that varies between assessors and regions. This variability can result in inconsistencies in data collection and the inability to determine what actions were taken that resulted in an improved rating. This remains a gap in phase two, despite revising the survey questions that the data is based upon.

### Data verification processes

Regional NRM bodies collate their regions' land and management practice change data for the grazing, sugarcane and horticulture industries. Producers are not surveyed in subsequent years to determine if they have sustained their improved land and management practices.

A panel of industry experts evaluates the regional datasets by considering seasonal context, and identifying data gaps and drivers of change specific to each region. This evaluation is used to amend the ratings based on local knowledge about the specific events that affected practice adoption for that particular year.

These revised ratings are not independently audited before being supplied to a single officer at the Department of Agriculture and Fisheries (DAF) who measures and reports the change. The DAF officer verifies the ratings by visiting a sample of producers and phoning others. The sample size is not based on a statistical methodology to ensure it is valid, but is as extensive as time and allocated budget allows.

No changes to the data verification process are being made for phase two despite this weakness being identified in other reviews.

## 4.4.2 Pollutants in groundwater

The quality of water running off paddocks is not regularly monitored to measure nutrient changes in groundwater (water tables and aquifers).

While some work has been performed to assess the significance of pollutant loads within groundwater, results vary depending on the NRM region.

Preliminary findings in the lower Burdekin have found high levels of dissolved inorganic nitrogen loads, a presumed by-product of fertiliser leeching into groundwater. Figure 4C presents a case study that shows the significance of contaminated groundwater.

**Figure 4C**  
**Case Study - Burdekin Nitrogen Farmers**

### Recognising the potential contribution of groundwater nitrates in the Burdekin

The Burdekin Bowen Integrated Floodplain Management Advisory Committee is running a project to help sugarcane farmers understand the level of nitrates within groundwater tables. Raising the awareness of the level of nutrient contamination allows farmers to adjust their nitrogen budgets to reduce the amount of fertiliser that they apply.

Research strip trials use the nitrogen-rich groundwater to fertilise sugarcane crops with little or no additional nutrient applications. Preliminary results are variable with some producers having no adverse effects on yield, while others are required to supplement nutrients at a reduced rate to ensure their yields are not affected.

*Source: Queensland Audit Office from the Burdekin Bowen Integrated Floodplain Management Advisory Committee*

The Paddock to Reef Program Design 2013–18 recognises the need to continue to improve the understanding of the fate of nutrients under different management regimes and further research has been proposed to close this gap. This has been determined a high priority research question by the Reef Plan Research and Development Coordination Group.

## 4.4.3 Gullies, scalds and stream bank erosion

The 2003 Reef Plan identified that sediment from land based sources was affecting the inner reefs. There has been a long standing lack of spatial data and mapping which captures the location, processes and contributions of surface and subsurface sediment sources which includes gullies, stream banks and scalds. Recent work in the Burdekin and Fitzroy catchments has begun to address this issue, but a significant knowledge gap remains in terms of these erosion sources.

The 2009 RDI strategy included a series of projects to understand how much sediment was available to run-off into the reef catchments and identified that understanding the sources of sediment was a priority.



CSIRO research (2014) in the Burdekin catchment over a ten year period (commencing in 2004) found that the focus on groundcover to reduce sediment did not result in significant improvements due to erosion from gullies, scalds and stream banks. An increased focus on land condition, in particular gullies, scalds and stream banks is listed as a high research priority under the current RDI Strategy. This project has not commenced.

Griffith University research (2015) complements the CSIRO research in finding that channel erosion (stream bank and stream bed) plays a significant role in water quality. The findings covered three rivers, two of which were in the reef catchments, and cannot be assumed to apply to all Queensland rivers.

The study found in these three rivers that stream power is not the major driver of channel erosion that the P2R program assumes. This reduces confidence in modelled sediment reductions and highlights the need for process understanding to inform future improvements in the modelling of channel and sediment transport at the catchment scale.

Figure 4D shows how the model estimates the relative change in gully and stream bank erosion rates based on change in land management practices from C class land condition (conventional land condition— an explanation of the ratings framework is provided in Appendix G).

It illustrates that a B class farm is assumed to have 10 per cent less gully erosion and 25 per cent less stream bank erosion than a C class property. The estimates are used to predict reductions in pollutant loads. The actual extent to which improving grazing practices reduces scald, gully and stream bank erosion is currently unknown. The Paddock to Reef Program Design 2013–18 recognises, in part, this issue, but the reef report card does not outline these limitations.

**Figure 4D**  
**Reduction in assumed gully and stream bank erosion rates relative to C class**

Grazing practice change	"A" Aspirational	"B" Best practice	"C" Conventional	"D" Dated
Relative gully erosion rate	25%	10%	No reduction	(25%)
Relative stream bank erosion rate	40%	25%	No reduction	(10%)

Source: Queensland Audit Office from DNRM's "Modelling reductions of pollutant loads due to improved management practices in the Great Barrier Reef catchments - Burdekin NRM region"

#### 4.4.4 Catchment monitoring sites

The 2012 P2R program external modelling review recommended additional monitoring at the sub-catchment scale, with consideration of temporal and spatial factors, to calibrate and validate modelled outputs with greater confidence. Despite the review's recommendation, the number of monitoring sites has not increased.

The Great Barrier Reef Catchment Load Monitoring Program (GBRCLMP) monitors sediment and nutrients at 25 monitoring sites in 14 of the 35 reef catchments. Fifteen monitoring sites are located at the sub-catchment level and ten monitoring sites at the end of the river systems (end of catchment). DSITI also collects samples from 11 (16 in Phase two) monitoring sites to measure and model pesticide loads.



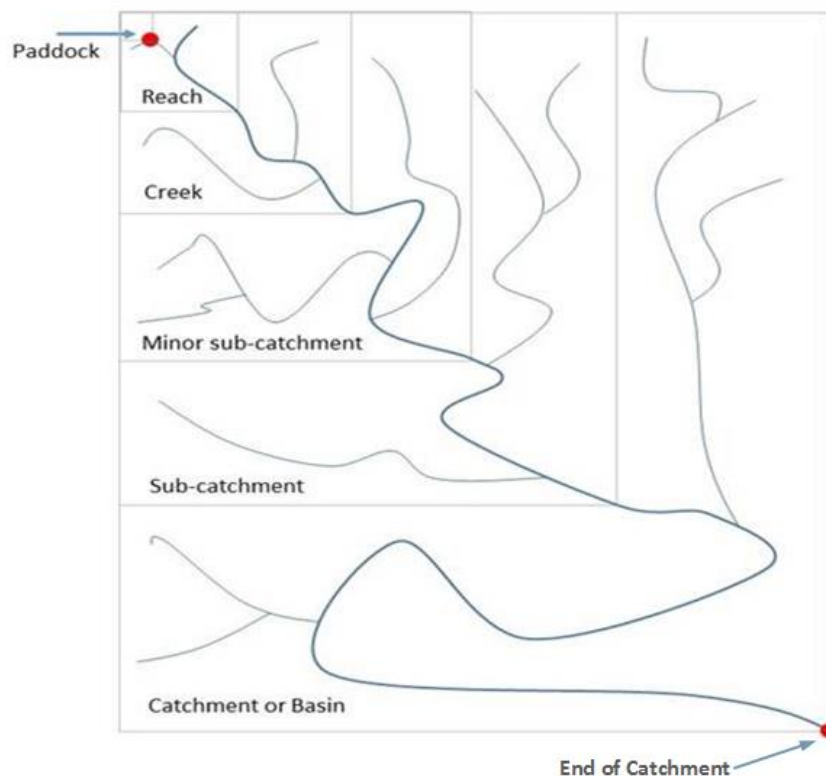
Catchment monitoring site locations within each of the six NRM regions are shown on land use maps in Appendix F. These maps show the disparate nature of the catchment monitoring sites across the large scale of the reef catchments and the difficulty in segregating useful information to:

- target improvement programs beyond the NRM regional level
- understand the effects of ecological processes.

The monitoring sites were chosen to provide coverage across the reef catchments; sites were selected based on the location of existing stream gauging stations (water flow).

Figure 4E conceptually depicts how the current program measures at the paddock and end-of-catchment scales (red circles) and illustrates the numerous scales in between where there is currently limited monitoring and understanding of catchment processes.

**Figure 4E**  
Conceptual diagram showing disparity of monitoring



Source: Queensland Audit Office

For phase two of the P2R program, the monitoring sites have been reviewed and in some cases changed in an attempt to compensate for the lack of spatial data. However the relocation of existing sites has prevented P2R program staff from establishing site specific trend data.

Figure 4F also illustrates how the disparate monitoring sites over large geographical areas limits the ability to identify high polluting areas that require greater education and extension efforts, or low polluting areas to use as case studies for wider application.

The case study in Figure 4F explains the benefits of having this knowledge.

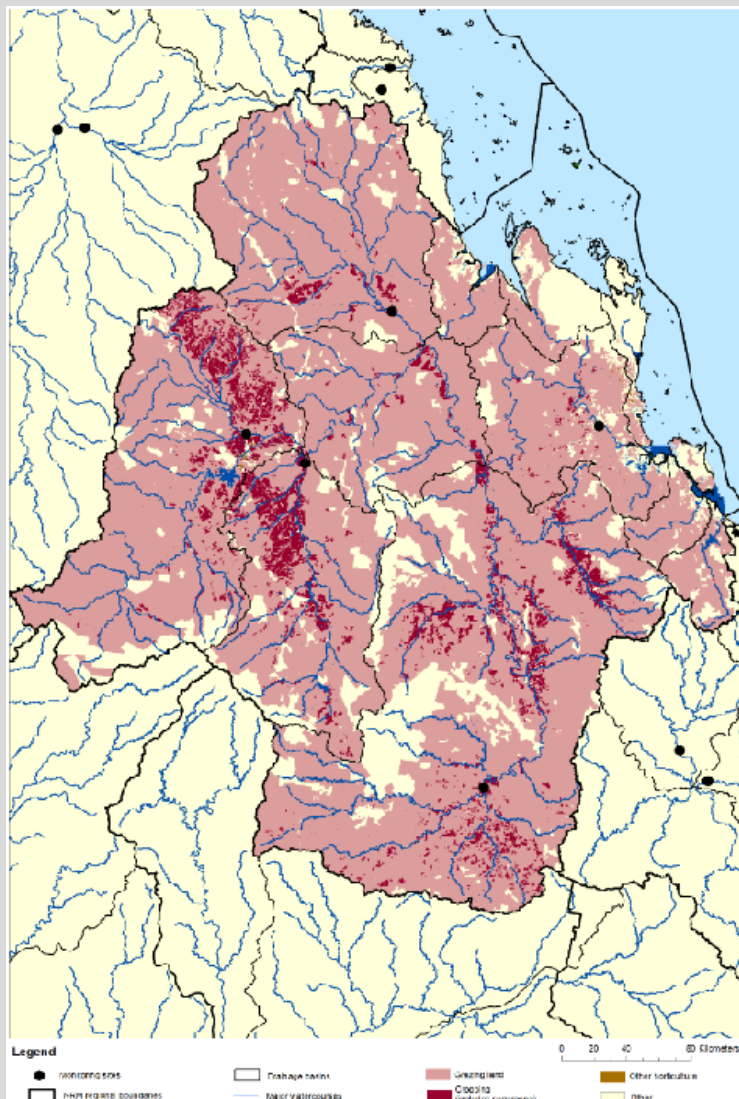
**Figure 4F**  
**Case study**

**Increasing our understanding of ecological processes—the Fitzroy catchment**

The Reef Plan does not use an extensive network of monitoring sites from P2R program with stations in between to monitor changes in water quality. Understanding the effect of ecological and geomorphological processes on water quality in the reef catchments is poor.

The Fitzroy catchment covers 142 665 square kilometres—57 per cent larger than the size of Tasmania—and has five water quality monitoring stations at various levels. There are 47 gauging stations (monitoring the volume of water flowing) in the Fitzroy catchment. These could be used to collect water quality data. The number and positioning of monitoring stations used for the Reef Plan limits:

- capturing empirical water quality data at a range of spatial scales
- obtaining a practical and functional understanding of the linkages and processes occurring at different spatial scales within reef catchments
- the defensibility of the monitoring program that aims to complement, and more strongly underpin, the model
- understanding which farming communities are contributing to improved water quality and which are falling behind.



Source: Queensland Audit Office using data from the Queensland Land Use Mapping Program and the Great Barrier Reef Catchment Loads Monitoring Program

### 4.4.5 Understanding ecological processes

The present lack of ecological-hydrological understanding (the interactions of water and ecosystems) of reef catchments makes it more challenging for models to accurately predict the effect of improved practices from the paddock to the catchment scale.

For example, there is a lack of understanding of ecological processes, such as how wetlands play their part in improving water quality entering the reef. This lack of understanding has meant that these processes are excluded as an input into the model. A pilot program by Department of Environmental Heritage Protection aims to assess the extent of this gap when measuring the wetlands process and values target.

The Reef Plan targets themselves are not based on ecologically relevant targets; they have been termed 'no regrets targets'. An Australian and Queensland government's research project working to determine what the targets should be to achieve the long-term goal is behind the Reef Plan scheduled completion date of June 2015.

This project did not begin in 2003 when it was determined that agricultural activities were having an adverse impact on the reef and was again delayed by the Intergovernmental Organisational Committee in early 2012, while they sought political input. In the interim, improvement programs have not known how much effort is needed and how widely they need to reach, to achieve the long-term goal.

## 4.5 Reef report card

---

The annual reef report card presents data on three of the five lines of evidence associated with the P2R program:

- data on the level of adoption of improved land management practices
- modelled data on the reduction of sediment, nitrogen and pesticide loads (based on dot point one)
- synthesised data on water quality and the condition of seagrass and coral in the inshore marine environment.

The reef report card does not currently report on:

- the effectiveness of management practices to improve water quality
- the long-term monitoring of catchment water quality collected by the Catchment Loads Monitoring Program.

Progress towards the 2009 Reef Plan targets are shown in Figure 4G. One of six targets was reported as having been achieved by the 2013 deadline. The remaining five targets were not achieved. There are three more targets, where two were not reported on (riparian and wetland extent) and another (sediment reduction) was not due yet.

The most recent reef report card (2012–13), the last under the 2009 Reef Plan, reported that the immediate goal to "halt and reverse the decline in water quality entering the reef" was achieved. The assumptions and limitations behind the figures are extensive and cast doubt over the accuracy of claiming the goal was achieved.

The only empirical (measured) data in the reef report card are on the condition of the inshore marine environment and remote sensing data used to calculate groundcover and riparian and wetland extent (reported every four years). The rest of the data in the report card is either modelled or based on surveys (sample basis). The data on management practice adoption are provided by industry and NRM bodies and, while this is a successful collaborative arrangement, the P2R program has limited ability to audit or assess the veracity of the data.

**Figure 4G**  
**2009 Reef Plan targets and immediate goal**

Category	Target	Reported progress for 2013	Reported Result
<b>Immediate goal by 2013</b>	<b>To halt and reverse the decline in the quality of water entering the Great Barrier Reef.</b>		<b>Achieved</b>
Water quality targets to be achieved by 2013	A minimum 50 per cent reduction in nitrogen and phosphorus loads at the end of catchments.	Not achieved	10 per cent for nitrogen, and 13 per cent phosphorus (not reported since 2010).
	A minimum 50 per cent reduction in pesticides at the end of catchments.	Not achieved	28 per cent
	A minimum of 50 per cent late dry season groundcover on dry tropical grazing land.	Achieved	84 per cent
Water quality target to be achieved by 2020	A minimum 20 per cent reduction in sediment load at the end of catchments.	Significant progress	11 per cent
Land and catchment management targets by 2013	80 per cent of landholders in agricultural enterprises (sugarcane, horticulture, dairy, cotton and grains) will have adopted improved soil, nutrient and chemical management practices.	Not achieved	49 per cent for sugarcane, and 59 per cent for horticulture
	50 per cent of landholders in the grazing sector will have adopted improved pasture and riparian management practices.	Not achieved	30 per cent
	There will have been no degradation of natural wetlands.	Not reported in 2013	Unclear - reported every 4 years
	The condition and extent of riparian areas will have improved.	Not reported in 2013	Unclear - reported every 4 years

Notes: Measured against 2009 baseline data. Reported progress was aggregated over all Great Barrier Reef catchments.

Source: Queensland Audit Office from the Reef Water Quality Protection Plan 2009 and the Reef Plan Report Card 2012 and 2013.

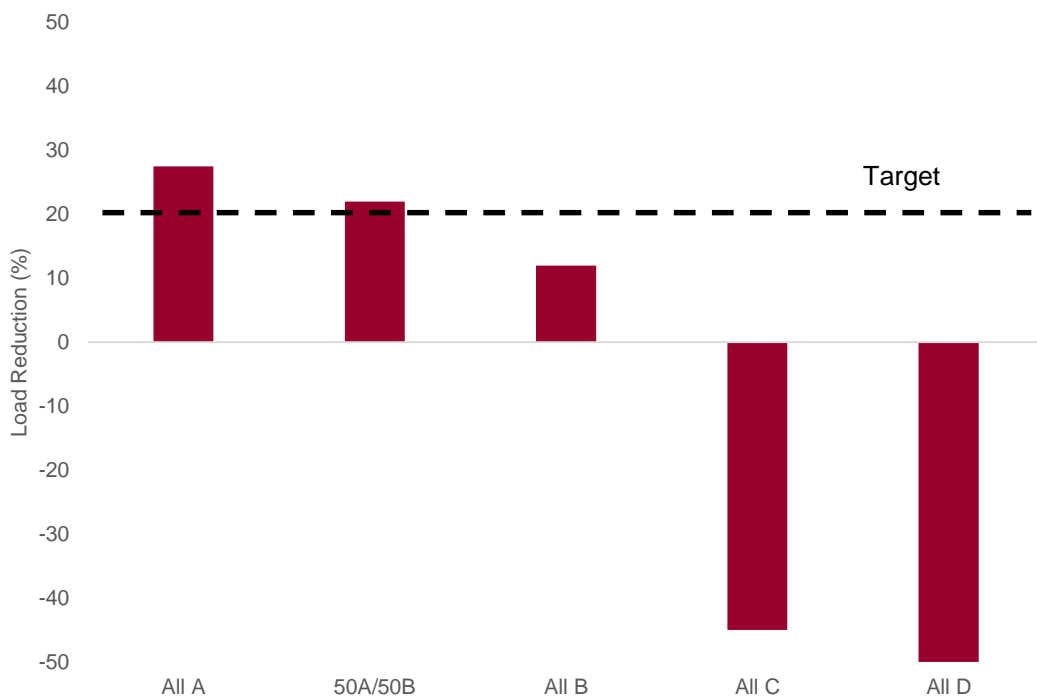
## Management practice adoption

DNRM produced a research paper modelling scenarios at various land and management practice levels (all 'A' class, 50 per cent 'A' class/50 per cent 'B' class, all 'B', all 'C' and all 'D') and considered the load reductions in dissolved inorganic nitrogen (DIN) and total suspended sediment (TSS) against the 2009 Reef Plan water quality targets of:

- 50 per cent load reduction in DIN by 2013
- 20 per cent load reduction in TSS by 2020

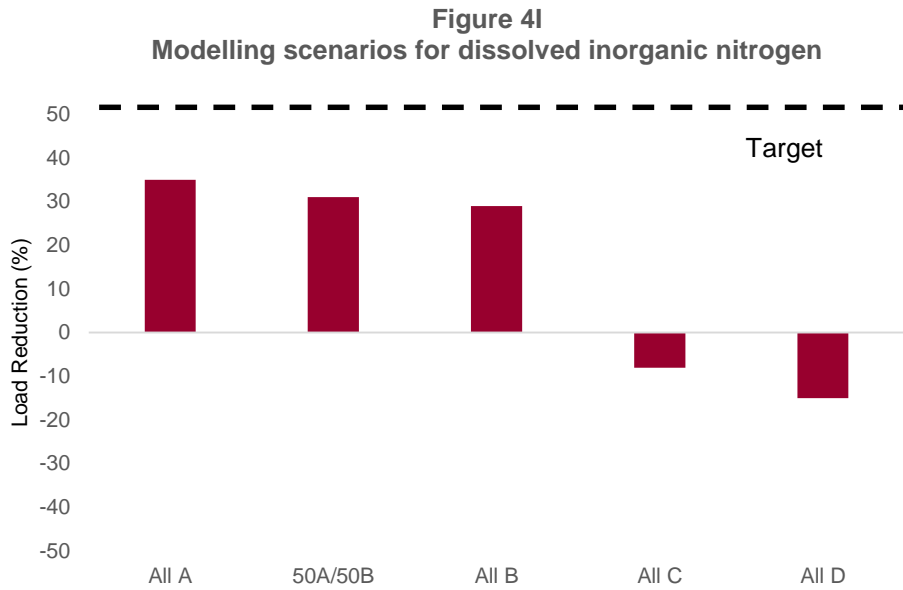
Figure 4H shows TSS scenarios that achieve the 20 per cent load reduction require 50 per cent of grazing and sugarcane farms to be A class (i.e. best practice) and 50 per cent to be B class in land and practice management. This is unlikely to be achieved given the current rate of Best Management Practice programs take up and the number of improvement projects being undertaken.

**Figure 4H**  
**Modelling scenarios for total suspended sediment**



Source: Queensland Audit Office adapted from DNRM's "Catchment modelling scenarios to inform GBR water quality targets"

Figure 4I show that even will full adoption at 'A' class, the highest achievable DIN load reduction is approximately 34 per cent, which is still well below the specified target.



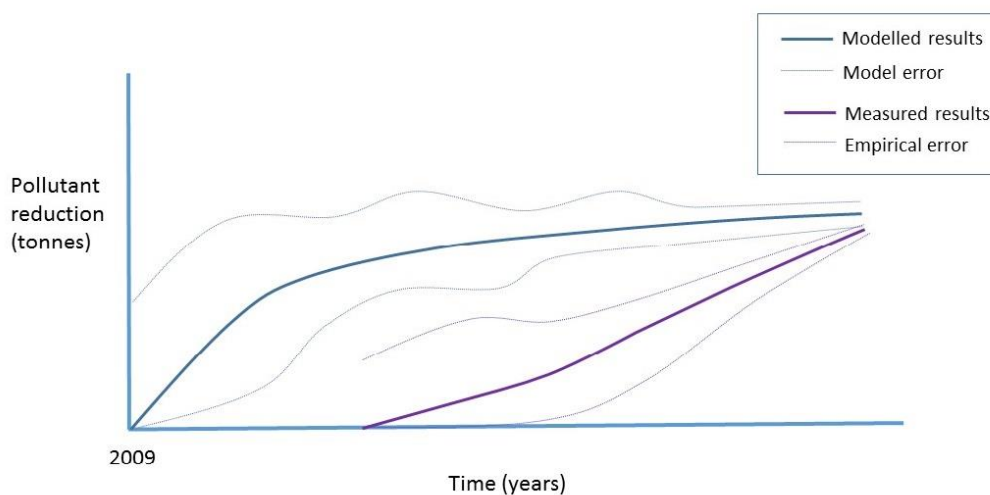
Source: Queensland Audit Office adapted from DNRM's "Catchment modelling scenarios to inform GBR water quality targets"

### Confidence levels

Confidence levels are calculated at a component level (monitored nitrogen loads vs modelled nitrogen loads at the catchment level) on a yearly basis. Confidence levels are not applied in the reef report card to qualify the effects that the assumptions and limitations have on the modelled result because of the scale of compounding errors.

A tier three supporting document outlines that the catchment model varies up to 50 per cent of the monitored pollutant loads every year. Researchers and modellers we spoke to recognised that there will be lags between management intervention and water quality improvement at the end of catchment. Modelled data will respond immediately whereas it may take years to detect a statistically significant improvement in water quality. Notwithstanding, if water quality is improving, it would be expected that the modelled and measured results should converge over time as depicted in Figure 4J.

**Figure 4J**  
**Conceptual diagram showing convergence of monitored and modelled data**



Source: Queensland Audit Office

Without users of the reef report card clearly understanding the assumptions and limitations of modelled progress, what is reported publicly could be easily interpreted, and therefore misconstrued, as fact.

## 4.6 Recommendations

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**It is recommended that:**

- 3. catchment monitoring is expanded to aid in determining the effectiveness of practice management change and to enhance the confidence in modelled outcomes**
- 4. a rigorous verification process is applied to data on land management practice change, and deficiencies in model inputs be addressed, to improve confidence in, and the accuracy of, inputs into catchment modelling**
- 5. unambiguous references be included in the tier one reef report card which disclose the degree of uncertainty and levels of potential variability in the reported results.**





# Appendices

<b>Appendix A— Comments .....</b>	<b>61</b>
Comments received from Director-General, Department of Environment and Heritage Protection .....	62
<b>Appendix B— Audit method.....</b>	<b>69</b>
<b>Appendix C— Natural Resource Management regions relevant to the reef.....</b>	<b>71</b>
<b>Appendix D— Great Barrier Reef timeline .....</b>	<b>73</b>
<b>Appendix E— Reef Plan programs .....</b>	<b>75</b>
<b>Appendix F— Catchment monitoring site locations and land use .....</b>	<b>83</b>
<b>Appendix G— Management practice rating frameworks .....</b>	<b>89</b>
<b>Appendix H— Glossary .....</b>	<b>91</b>



## Appendix A—Comments

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In accordance with s.64 of the *Auditor-General Act 2009*, a copy of this report with a request for comment was provided to the Departments of:

- the Premier and Cabinet
- Environment and Heritage Protection
- Natural Resources and Mines
- Agriculture and Fisheries
- Science, Information Technology and Innovation.

Responsibility for the accuracy, fairness and balance of the comments rests with the head of these departments.

## Comments received from Director-General, Department of Environment and Heritage Protection



Ref CTS 09735/15

29 MAY 2015

Mr Andrew Greaves  
Auditor-General  
Queensland Audit Office  
PO Box 15396  
CITY EAST QLD 4002

qao@qao.qld.gov.au

Dear Mr Greaves

A handwritten signature in black ink that reads 'Andrew'.

Thank you for your letter dated 8 May 2015 concerning the performance audit on managing water quality in Great Barrier Reef catchments.

The recently established Office of the Great Barrier Reef has consolidated feedback from all relevant Queensland Government agencies into the attached cross agency response to the QAO draft recommendations and report.

I acknowledge changes have been made subsequently to the draft report conveyed by you on 8 May. I was not aware until this week that QAO officers and agency officers were addressing matters in the draft. Therefore feedback attached to this letter has been adjusted accordingly.

I would like to recognise the complexity of the task undertaken by your officers to assess the efficacy of all the activities undertaken by the State Government to improve the quality of the water entering the reef lagoon. The challenge of improving water quality entering the Great Barrier Reef lagoon is no small task but I think your Report has identified areas where improvements can and must be made.

While scientific experts and stakeholders alike have all acknowledged that time lags in the system, from investment and action to results, will take decades to take full effect, we must not fritter investment or fail to constantly monitor and adjust actions. As a result, we are committed to improving monitoring and modelling to better understand the outcomes of our activities that must be well coordinated.

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Page 1 of 2

## Comments received from Director-General, Department of Environment and Heritage Protection

Therefore the recommendations outlined in Attachment 1 are agreed and significant progress is already being made in implementing these, including the establishment of the Office of the Great Barrier Reef.

Should your staff have any further enquiries, please ask them to contact Ms Elisa Nichols, Executive Director, Office of the Great Barrier Reef of the department on telephone 07 3330 5988.

Yours sincerely



Jonathan (Jon) PC Black  
**Director-General**

Attachment: Cross agency response to QAO recommendations

Copies:

Mr Jack Noye, Director-General, Department of Agriculture and Fisheries  
Ms Sue Rickerby, Director-General, Department of Science, Information Technology and Innovation  
Dr Brett Heyward, Director-General, Department of Natural Resources and Mines  
Mr Dave Stewart, Director-General, Department of the Premier and Cabinet

## Responses to recommendations

### Cross Agency Response to the Queensland Audit Office performance audit on managing water quality in the Great Barrier Reef catchments

Cross agency response to the QAO recommendations provided by Jon Black, Director-General, Department of the Environment and Heritage Protection, through the Office of the Great Barrier Reef, on behalf of Queensland Government agencies with a role in reef water quality programs.

29 May 2015

Recommendation	Response Agree/ Disagree	Timeframe for Implementation	Current Status	Additional Comments
<p>It is recommended that:</p> <p>1) The newly formed Office of the Great Barrier Reef be provided with sufficient and appropriate management and administrative authority, so that it can be properly made responsible and held accountable for Queensland's reef management strategies and programs.</p>	Agree	From July 2015	Partially implemented	<ul style="list-style-type: none"> <li>- The Office of the Great Barrier Reef was established on 11 May 2015 and is responsible for overseeing implementation of the Queensland government's reef management strategies and programs.</li> <li>- The Office of the Great Barrier Reef will play a key role in coordinating and reporting on the expenditure of the existing \$35 million a year investment, as well as the additional \$100 million over five years that the government has committed.</li> <li>- It is expected that the full reef investment (existing and new) will be referenced in the 2015/16 Budget to improve transparency and accountability.</li> <li>- In order to facilitate improved coordination and governance of funding, a Reef Inter-Departmental Committee (IDC) has also been established and will be tasked with ensuring investments are working together effectively and are well aligned to reef outcomes.</li> <li>- The Office of the Great Barrier Reef will support the IDC and be tasked with compiling and publishing an annual report on reef investments.</li> </ul>
<p>2) The design and implementation of the suite of programs attributed to the Reef Plan is reviewed to establish they are the</p>	Agree	From May 2016	Partially implemented	<ul style="list-style-type: none"> <li>- Queensland Government has made a number of election commitments in relation to the Great Barrier Reef, including an additional \$100 million over five years to improve reef water quality. A high level Great Barrier Reef Water Science Taskforce has been established to provide advice on the most appropriate blend of regulations, industry led programs, market trading or other measures</li> </ul>

Responses to recommendations

Recommendation	Response Agree/ Disagree	Timeframe for Implementation	Current Status	Additional Comments
most effective and efficient.				<ul style="list-style-type: none"> <li>to meet the government's targets, as well as investment priorities for the additional \$100M.</li> <li>The Great Barrier Reef Water Science Taskforce is required to provide an interim report by December 2015 and a final report by May 2016. This will inform the suite of programs to be delivered by Queensland Government to achieve the government's water quality targets.</li> <li>The Reef IDC will also consider improved alignment of current investments to reef outcomes and consider options to reprioritise investments where needed to improve effectiveness and efficiency of reef funding, particularly to integrate with the additional \$100M. This may include reprioritisation of some of the discretionary program funding out of the existing \$35M.</li> <li>Under the Reef 2050 Long-term Sustainability Plan, there is an action for the Queensland and Australian Governments to update the joint Reef Water Quality Protection Plan in 2018. The recommendations of the taskforce will be considered and incorporated into the next update of the Plan.</li> </ul>
3) Catchment monitoring is expanded to aid in determining the effectiveness of practice management change and to enhance the confidence in modelled outcomes.	<b>Agree</b>	From May 2016	Partially implemented	<ul style="list-style-type: none"> <li>The GBR Water Science Taskforce recommendations due in May 2016 will inform investment allocations from the \$100M, including potential extensions to the water quality monitoring network. The design of the monitoring program will need to be considered so that it effectively supports the recommended approach (e.g. voluntary, regulatory or market based).</li> <li>The Queensland Government is currently co-investing with the Australian Government to pilot intensive monitoring at a sub-catchment scale to investigate water quality pollutant changes in response to targeted management. This will inform the potential design improvements to the monitoring network.</li> </ul>
4) A rigorous verification process is applied to data on land	<b>Agree</b>	Ongoing from 2013-14	Partially implemented	<ul style="list-style-type: none"> <li>The Paddock to Reef Program uses a continuous improvement approach. Following the 2013 review of the program a number of enhancements have been implemented that address this</li> </ul>

## Responses to recommendations

Recommendation	Response Agree/Disagree	Timeframe for Implementation	Current Status	Additional Comments
<p>management practice change, and deficiencies in model inputs be addressed, to improve confidence in, and the accuracy of, inputs into catchment modelling.</p>				<p>recommendation as outlined below.</p> <p><b>Land management practice change:</b></p> <ul style="list-style-type: none"> <li>- The Phase 2 (2013-14 onwards) data capture and reporting process for land management practice changes is now based on the updated water quality risk frameworks which provide a basis for rigorous evaluation.</li> <li>- The vast majority (&gt;95%) of the land management change data utilised in reporting and modelling is now spatially explicit, meaning modellers no longer have to make assumptions about where land management improvements have been made within a sub-catchment.</li> <li>- The updated process now supplies the specific project spatial data (at the paddock level) in a consistent method directly to the modellers, along with a detailed description of the existing farm management and what it is changing to. New quality control and version control measures have also been implemented that have resulted in significant improvements in the quality of the data submitted.</li> </ul> <p><b>Model input improvements:</b></p> <ul style="list-style-type: none"> <li>- As part of the continuous program improvement, updated model input layers are incorporated when they become available. Phase 2 improvements already implemented include: seasonal ground cover, improved soils layer, better climate and flow data, finer resolution topographic data, expanded water quality monitoring data and improved paddock modelling outputs.</li> <li>- Gullies, scalds and stream bank erosion are modelled based on scientifically peer reviewed process understanding. Where updated gully maps are available these have been incorporated. A significant gully mapping program is continuing and further updates will be incorporated.</li> <li>- Pollutants losses via groundwater, such as nitrogen leaching through soils, are monitored at the Paddock to Reef farm trial sites and modelled through the paddock models. From Phase 2, the catchment</li> </ul>



## Responses to recommendations

Recommendation	Response Agree/ Disagree	Timeframe for Implementation	Current Status	Additional Comments
5) Unambiguous references be included in the tier one Reef Report Card which disclose the degree of uncertainty and levels of potential variability in the reported results.	<b>Agree</b>	September 2015	Partially implemented	<ul style="list-style-type: none"> <li>- modelling now represents this pollutant loss pathway as well.</li> <li>- The Paddock to Reef Program uses a multiple lines of evidence approach for evaluating management changes. The program is internationally recognised as a highly innovative, world leading monitoring, modelling and reporting program to quantify the effects of land management on water quality.</li> <li>- Inclusion of uncertainty rankings was a recommendation from the Phase 1 Paddock to Reef Program review.</li> <li>- A graphic feature to communicate this is intended to be included with results in the Reef Report Card 2014 (tier 1), due in September 2015.</li> </ul>



## Appendix B—Audit method

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### Audit objective

The objective of the audit is to determine whether the adverse impact of broadscale land use on the quality of water entering the Great Barrier Reef is declining.

We focused on the efficacy of the activities and programs undertaken or funded by Queensland Government agencies to reduce diffuse source pollution from agriculture.

We focused also on the effectiveness of monitoring and the reliability of public reporting of outcomes, particularly the achievement of the Reef Plan targets and progress toward long-term goals.

### Reason for the audit

The Great Barrier Reef (the reef) is the earth's largest coral reef system and was listed as a world heritage site in 1981 for its outstanding universal value to humanity. It stretches 2 300 kilometres down the Queensland coast and covers approximately 344 400 square kilometres; making it 50 per cent larger than the State of Victoria. This unique reef system is valued around the world and is critically important to local communities and industries, supporting recreation and livelihoods.

Protecting this Australian icon for future generations means first understanding the complexity of the reef system and the risks to its health, and then striking the right balance between social, economic and environmental obligations in managing the reef.

Commencing with the first Reef Water Quality Protection Plan (Reef Plan) in 2003, the Australian and Queensland Governments have worked to reduce the impact of the diffuse source water pollutants that arise from broadscale, agricultural land use. Both governments have continued to collaborate through two further iterations of the Reef Plan (2009 and 2013).

This report deals with the Queensland Government's contributions to improving the quality of water that enters the reef from adjacent terrestrial catchments, specifically agricultural runoff. It does not deal with other potential stressors, such as dredge spoil or the broader impacts of climate change; nor does it examine the activities or programs of the Australian Government.

### Performance audit approach

The audit was conducted in accordance with the Auditor-General of Queensland Auditing standards which incorporate Australian Auditing and Assurance Standards.

The audit was conducted between September 2014 and May 2015 and consisted of:

- interviews with officials from the Departments of:
  - the Premier and Cabinet
  - Environment and Heritage Protection
  - Natural Resources and Mines
  - Agriculture and Fisheries
  - Science, Information Technology and Innovation.
- interviews with:
  - Agforce
  - Fitzroy Basin Association
  - North Queensland Dry Tropics
  - Reef Catchments
  - Canegrowers (including several district offices)
  - Burdekin Bowen Integrated Floodplain Management Advisory Committee

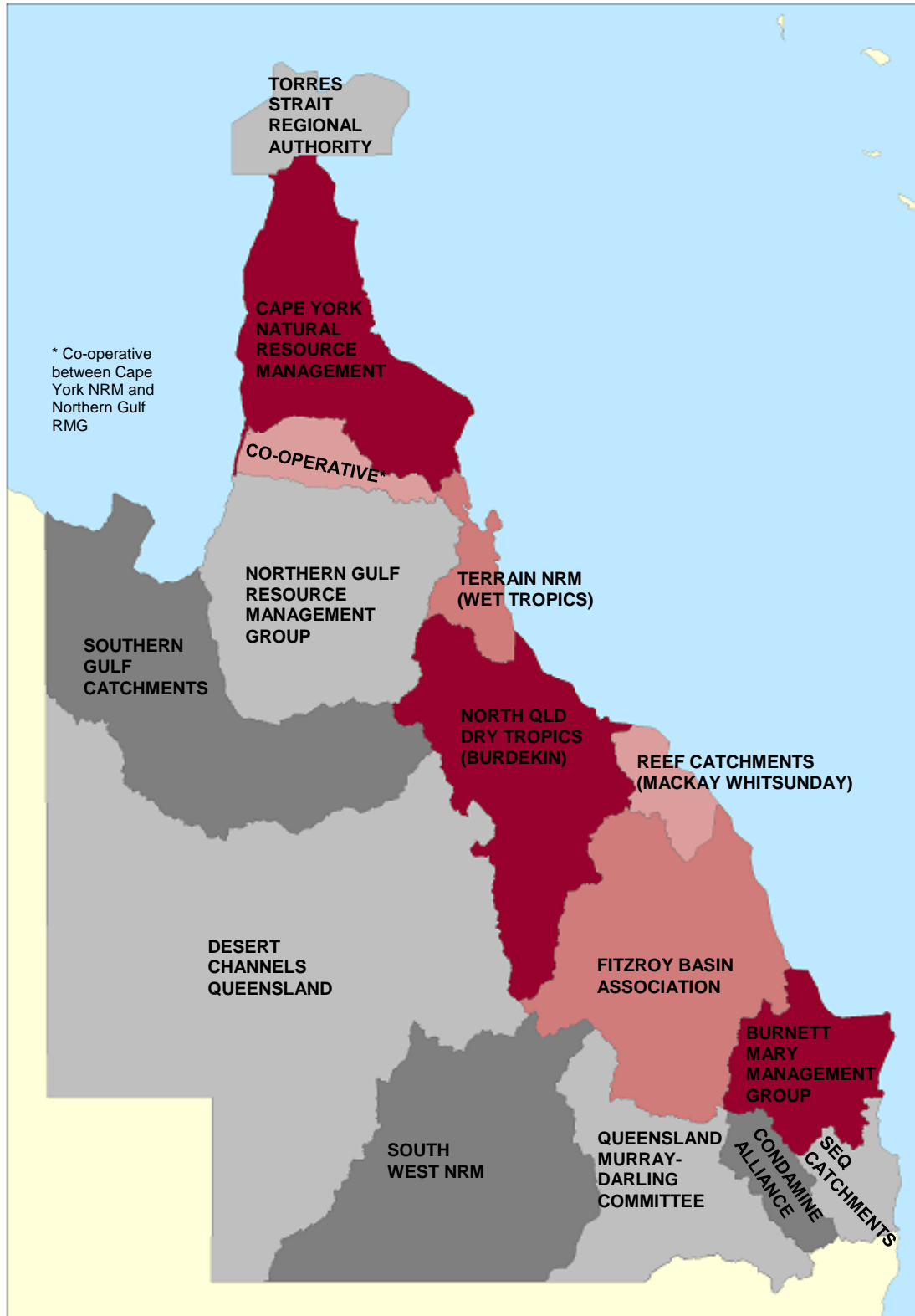
- Great Barrier Reef Marine Park Authority
- Australian Institute of Marine Science
- Mackay Area Productivity Services
- Farmers and Graziers
- Other stakeholders.
- fieldwork, including observations of workshops and farming practices, and interviews in locations around:
  - Ingham
  - Townsville
  - Ayr
  - Mackay
  - Rockhampton
- analysis of documentations including briefs to Directors-General and Ministers, policies, plans, guidelines, strategies and evaluation reports.

A team of subject matter experts were contracted to provide advice to the Queensland Audit Office on the monitoring and modelling utilised to inform the Reef Plan and the reef report cards. This report draws on those key findings and conclusions.

A reference panel of four scientists with knowledge of the Great Barrier Reef and the Reef Plan was convened to provide advice to the audit team during the fieldwork, at the end of fieldwork and during the report writing stage. The reference panel did not draft sections of the report.

The Australian Government Department of the Environment was provided a copy of the draft report for consultation.

## Appendix C—Natural Resource Management regions relevant to the reef

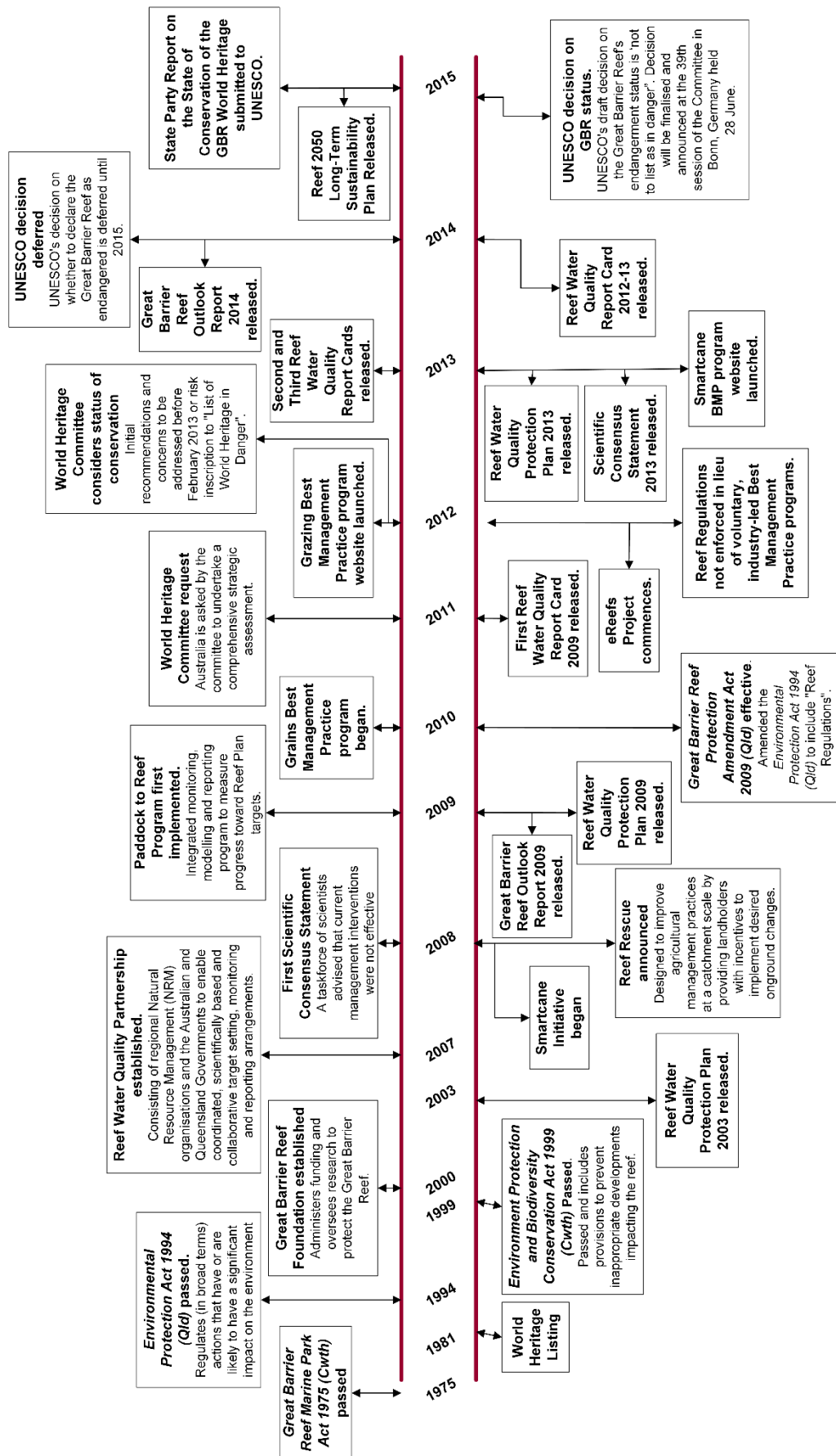


Note: Pink and maroon Natural Resource Management regions are relevant to Reef Plan activities

Source: Queensland Audit Office



# Appendix D—Great Barrier Reef timeline







## Appendix E—Reef Plan programs

Figure E1—Program summary by department  
2013–14

Department	2013–14 estimate \$ million
Environment and Heritage Protection	13.25
Natural Resources and Mines	17.58
Science, Information Technology and Innovation	1.19
Agriculture and Fisheries	3.94
Premier and Cabinet	0.88
<b>Total</b>	<b>36.84</b>

Figure E2—Listing of Queensland's Reef Plan programs

Program	2013-14 est. cost (\$m)	Category*	Description	Location
<b>Department of Environment and Heritage Protection (DEHP)</b>				
Reef Protection Program (aka the Reef Water Quality Program)			A package of BMP programs, extension and education program funding and research, development and innovation programs. The BMP programs were designed to provide the grazing and sugarcane industries an alternative to the reef regulations.  The main aim of these programs are to engage producers to voluntarily adopt improved land and management practices to increase profitability, productivity and environmental stewardship.	
• Smartcane BMP	\$2.87	100% Impr.	A self-assessment program consisting of seven modules (three of which have water quality aspects) led by CANEGROWERS Ltd, an industry body, with assistance provided by DAF and cane industry productivity services. Used to promote and change producers to improve management practices for profitability, productivity and environmental stewardship.	Statewide with particular focus on reef catchments for delivery
• Grazing BMP	\$1.19	100% Impr.	A self-assessment program consisting of five modules (two of which have water quality aspects) led by Fitzroy Basin Association (FBA), a Regional NRM body, with assistance provided by DAF and AgForce (an industry body). Used to promote and change producers to improve land and management practices for profitability, productivity and environmental stewardship. Grazing BMP existed prior to DEHP's involvement and was amended by DAF to have the required water quality outcomes before the official roll out.	Primarily focused on the Burdekin and Fitzroy regions for delivery but is available statewide

Program	2013-14 est. cost (\$m)	Category*	Description	Location
• Extension activities (MoU with DAF)	\$1.65	100% Impr.	Used to promote BMP programs and improve land and management practices. Main objective of these programs are to engage producers to voluntarily adopt improved land and management practices to increase profitability, productivity and environmental stewardship. The MoU with DEHP specifies that 19.2 FTEs will be provided by DAF for these purposes.	Reef catchments - primarily priority areas for pollutants
• DEHP's Reef Water Quality Science Program (RWQSP)	\$1.62	100% R,D&I	The RWQSP is made up of a suite of science projects to develop knowledge and tools to help producers better manage cane growing and grazing lands. The RWQSP targets research priorities that are identified in both the department's research and development strategy but also Reef Plan's research, development and innovation strategy. Between 2009 and 2014 DEHP has completed 44 reef related science programs and has 6 to be completed in 2014–15.	Reef catchments
• Salaries & opex	\$2.44	100% P&P	Staff and operating costs.	
<b>Sub-total</b>	<b>\$9.77</b>			
Gladstone Healthy Harbour Partnership (GHHP)	\$2.00	100% M&E	A partnership that is hosted by the FBA that brings together a forum of community, industry, science and government to maintain, and where necessary, improve the health of the Gladstone harbour.	Gladstone
Coastal planning	\$0.20	100% P&P Pre-existing	Seeks to ensure development on the coast is managed to protect and conserve environmental, social and economic coastal resources. Program has been scaled back after 2012-13 when all planning policies were merged into Department of State Development's State Planning Policy (SPP).	Reef catchments
Wetlands Program	\$0.20	100% P&P Pre-existing	Supports projects and programs that enhance the sustainable management of Queensland's wetlands.	Reef catchments
Environmental values (EVs)	\$0.30	100% Impr.	Water quality standards, expressed as EVs and water quality objectives (WQOs) for all surface water and groundwater are being established for all Reef catchments under the <i>Environmental Protection (Water) Policy 2009</i> . WQOs provide locally relevant water quality standards that are used to inform planning decisions as well as water quality report cards.	Reef catchments

Program	2013-14 est. cost (\$m)	Category*	Description	Location
Nature refuges	\$0.03	100% Impr. Pre-existing	Nature refugees within reef catchments. A nature refuge is an area of land voluntarily protected for conservation, while allowing compatible and sustainable land uses to continue. A nature refuge is negotiated through a legally binding, perpetual nature refuge agreement between the landholder and the state.	Reef catchments
Reef Plan oversight and support	\$0.10	100% P&P	One FTE resourced for the implementation of actions that DEHP is responsible under Reef Plan.	Not applicable
Everyone's environment grants	\$0.13	100% Impr.	Grants that can be related to reef water quality outcomes depending on the application. Successful projects undertake on-ground activities.	Reef catchments
Statutory planning	\$0.05	100% P&P	DEHP provides input into six of 16 state interests for planning - one of which is water quality. This input is considered under the SSP and considers impacts from development on the reef.	Reef catchments
Reef water quality offsets	\$0.10	100% P&P	Delivery of Queensland Environmental Offsets Framework, underpinned by the <i>Environmental Offsets Act 2014</i> . Assesses environmental impacts of a proposed project through the Department of State Development and if required provides guidance on how to offset said impact.	Reef catchments
Comprehensive reef strategic assessment	\$0.40	100% P&P	A strategic assessment of the Great Barrier Reef coastal zone performed in accordance with Part 10 of the <i>Environmental Protection and Biodiversity Conservation Act 1999 (Commonwealth)</i> to report on how impacts are avoided, mitigated and offset.	Not applicable
<b>DEHP Total</b>	<b>\$13.25</b>			
<b>Department of Natural Resources and Mines (DNRM)</b>				
Vegetation management	\$1.64	25% P&P 25% M&E 50% Impr. Pre-existing	Vegetation management framework reforms—amendments in December 2013 with the intention of balancing economic development with the conservation of vegetation and biodiversity values but have potential to increase land clearing for agricultural development and thus increase the risk of sediment runoff.  High value agricultural clearing—assessment of applications for clearing for development of agriculture where economically viable and (if required) where there is sufficient water. Applications are assessed to ensure impacts on sensitive ecological areas are minimised.	Statewide

Program	2013-14 est. cost (\$m)	Category*	Description	Location
			<p>Reef watercourse protections—regulating the clearing of native regrowth vegetation within 50 meters of watercourses within Burdekin, Mackay-Whitsunday and Wet Tropics Reef catchments.</p> <p>Regrowth reforms—allow the removal of high value regrowth vegetation on freehold and indigenous land. Allows landholders to take advantage of financial and environmental benefits through offset arrangements sought through the development industry.</p> <p>Self-assessable codes—allows for landholders to perform low risk or routine clearing by notifying with an intention to clear.</p> <p>Monitoring and compliance—satellite monitoring of vegetation clearing and penalties are issued against non-compliance.</p>	
State rural leasehold lands (formerly Delbessie)	\$0.69	100% Impr. Pre-existing	The State rural leasehold land strategy tied the length of term leases to land condition and required a Land Management Agreement (LMA) to be entered into for new, renewed and modified leases over rural leasehold land if the lease was for a term of 20 years or more and covered an area of 100 hectares or more. A LMA required the current leased land's condition to be re-assessed before the lease was extended. This program ceased in 2014.	Statewide
Water resource planning	\$2.70	100% P&P Pre-existing	To define availability and establish frameworks to manage the flow of fresh water as a resource so that it achieves a balance of economic, social and ecological outcomes. Four of the ten existing Water Resource Plans in the reef catchments specifically mention the maintenance of flows to sustain the Great Barrier Reef (Whitsundays, Wet Tropics, Fitzroy and Burdekin).	Statewide but apportioned for reef catchments
Catchment and regional planning	\$0.35	100% P&P Pre-existing	Input into statutory regional plans under the <i>Sustainable Planning Act 2009</i> , thorough assessment of environmental impact statements, and case management of complex development proposals.	Reef catchments
Water monitoring (ambient incl. SWAN and GWAN)	\$4.80	100% M&E Pre-existing	Ground Water Ambient Network (GWAN) water monitoring monitors ground water level and water quality information and Surface Water Ambient Network (SWAN) water monitoring operates to measure and keep publicly available records for water resource volumes and quality, primarily to fulfil legislative requirements under section 35 of the <i>Water Act 2000</i> .	Statewide

Program	2013-14 est. cost (\$m)	Category*	Description	Location
<b>Regional NRM Investment Program</b>				
<ul style="list-style-type: none"> <li>Reef Regional NRM body core/ project funding</li> </ul>	\$3.72	100% Impr. Pre-existing	<p>Suite of programs to be delivered by five regional NRM bodies.</p> <p>Made up of three key investments:</p> <ul style="list-style-type: none"> <li>sustainable agriculture</li> <li>weed and pest management</li> <li>water quality for the reef.</li> </ul> <p>Regional NRM bodies included are:</p> <ul style="list-style-type: none"> <li>Burnett-Mary Regional Group</li> <li>Fitzroy Basin Association</li> <li>Reef Catchments (Mackay-Whitsundays)</li> <li>North Queensland Dry Tropics (Burdekin)</li> <li>Terrain NRM (Wet Tropics)</li> </ul>	All reef catchments excluding Cape York
<ul style="list-style-type: none"> <li>Catchment loads monitoring</li> </ul>	\$0.50	100% M&E	Funding provided to DSITI to annually produce the Great Barrier Reef Catchment Loads Monitoring Program, measuring the end-of-system pollutant loads flowing out of priority reef catchments.	Reef catchments
<ul style="list-style-type: none"> <li>Catchment loads modelling</li> </ul>	\$0.50	100% M&E	Uses modelling tool to predict pollutant load reductions from the land and management practice changes. DSITI also contributes two FTE's in kind.	Reef catchments
<ul style="list-style-type: none"> <li>Wetlands program</li> </ul>	\$0.50	50% M&E, 50% Impr. Pre-existing	<p>Four programs delivered by three agencies:</p> <ul style="list-style-type: none"> <li>Critical support for programs run by DEHP which includes the coordination of wetlands network, FTE's and the website</li> <li>DAF extension and education to provide training, advice and resources to improve wetland management in agriculture</li> <li>DSITI wetland extent mapping - perform every four years through satellite imagery</li> <li>DSITI wetland processes and values - research and increased understanding of wetland processes.</li> </ul> <p>This is all performed to ensure the extent of wetlands does not decline. These reef programs are a subset of a greater collection of wetlands programs that are designed to increase the extent of wetlands (water quality improvements) and understand the ecological values and processes of wetlands.</p>	Reef catchments
<ul style="list-style-type: none"> <li>Regional NRM Program admin. comp. for Reef regions</li> </ul>	\$0.60	100% Admin. Pre-existing	Administrative component for the five regional NRM bodies—Mary Burnett Regional Group, Fitzroy Basin Association, Reef Catchments, North Queensland Dry Tropics and Terrain NRM.	Not applicable

Program	2013-14 est. cost (\$m)	Category*	Description	Location
• Groundcover and riparian mapping contribution	\$0.20	100% M&E Pre-existing	Satellite monitoring and mapping of groundcover performed annually and riparian vegetation performed every four years.	Reef catchments
• SSIMR data management for Reef - maintenance	\$0.13	100% Admin.	Spatial and Scientific Information Management for Reef (SSIMR) computer server (information system included) storing data for the reef projects.	Not applicable
<b>Sub-total</b>	<b>\$6.15</b>			
Enhanced Fitzroy monitoring program	\$0.61	100% M&E	Monitoring program to deliver an assessment of the cumulative effect of mine water releases, which also supports catchment-scale reporting through programs such as the Fitzroy Water Partnership for River Health.	Fitzroy
Fitzroy Water Partnership for River Health	\$0.12	100% M&E	The Queensland Government's contribution to support the delivery of the report card for the Fitzroy basin by the Fitzroy Water Partnership for River Health.	Fitzroy
Additional funding to DSITI for catchment loads monitoring	\$0.52	100% M&E	Additional cash items provided to DSITI in terms of the Great Barrier Reef Catchment Loads Monitoring Program to allow for sample collection from the 25 monitoring sites.	Reef catchments
<b>DNRM Total</b>	<b>\$17.58</b>			
<b>Department of Science, Information Technology and Innovation (DSITI)</b>				
Great Barrier Reef Catchment Loads Monitoring Program	\$0.15	100% M&E	Monitoring, collection and analysis of water quality samples of end-of-system pollutant loads (sediments, nutrients, pesticides) flowing out of priority reef catchments. Information is used to support the calibration of the catchment scale model.	Reef catchments
Great Barrier Reef catchment water quality modelling	\$0.22	100% M&E	Modelling program assesses the progress towards the pollutant load reduction targets due to the adoption of improved land management practices using modelling. Catchment modelling is used to generate sediment, nutrient and pesticide loads entering the reef lagoon from 35 reef catchments for a climate scenario averaged over a 23 year period (1986–2009).	Reef catchments
Reef remote sensing	\$0.24	100% M&E Pre-existing	Program designed to use remote sensing imagery to map groundcover, fire and gullies in grazing lands and develop improved mapping methods for water quality model parameterisation.	Reef catchments

Program	2013-14 est. cost (\$m)	Category*	Description	Location
DSITI Reef paddock modelling support	\$0.04	100% M&E	The paddock scale modelling provides information on the water quality leaving the end of the field for the sugarcane, grazing, banana and grains industries. The results are also used as inputs for the catchment scale modelling.	Reef catchments
Reef wetlands assessment	\$0.25	100% M&E	Assessments of freshwater wetlands processes and support the target for no degradation in the number of wetlands.	Reef catchments
Reef science oversight	\$0.04	100% Admin.	General oversight of reef related science programs.	Not applicable
QSCAPE (landscape processes research & development program)	\$0.25	100% M&E Pre-existing	Landscape scientific research and development, testing and application of innovative methods in sediment tracing, fire scar mapping and accessing high speed computational and information infrastructure.	Statewide however this is the component for reef catchments
<b>DSITI Total</b>	<b>\$1.19</b>			
<b>Department of Agriculture and Fisheries (DAF)</b>				
BSES/SRA and research stations - research, development and innovation	\$1.62	100% R,D&I Pre-existing	Funding for cane industry research through a MoU with Sugar Research Australia (SRA). Research programs aim to sustainably improve productivity and profitability. SRA delivered 16 projects in 2009–11.	Statewide, primarily reef catchments
Extension and education delivery and economic specialists	\$1.92	100% Impr. Pre-existing	Delivery of extension and education activities to the cane and grazing industries to promote improved land and management practices. Supplemented by economic research on land and management practices. Main objective of these programs are to engage producers to voluntarily adopt improved land and management practices to increase profitability, productivity and environmental stewardship.	Statewide, however this is the reef catchments component.
Reef Plan oversight and support	\$0.18	100% P&P	Two FTE's to provide Reef Plan support through policy and planning.	Not applicable
Extension program support	\$0.10	100% Impr. Pre-existing	One FTE to coordinate extension and education program activities.	Not applicable
Management practice adoption and P2R program support	\$0.10	100% M&E	One FTE to collect management practice adoption data for the P2R program.	Reef catchments

Program	2013-14 est. cost (\$m)	Category*	Description	Location
Partnership with JCU to enhance the Marine Monitoring Program (seagrass)	\$0.02	100% M&E	One year project in partnership with James Cook University (JCU) to enhance the monitoring of seagrass as a part of the marine scale monitoring portion of the P2R program.	Reef catchments
<b>DAF Total</b>	<b>\$3.94</b>			
<b>Department of the Premier and Cabinet (DPC)</b>				
Reef secretariat coordination	\$0.88	34% M&E, 66% P&P	Secretariat to committees and coordinates Reef Plan documents.	Not applicable
<b>DPC Total</b>	<b>\$0.88</b>			

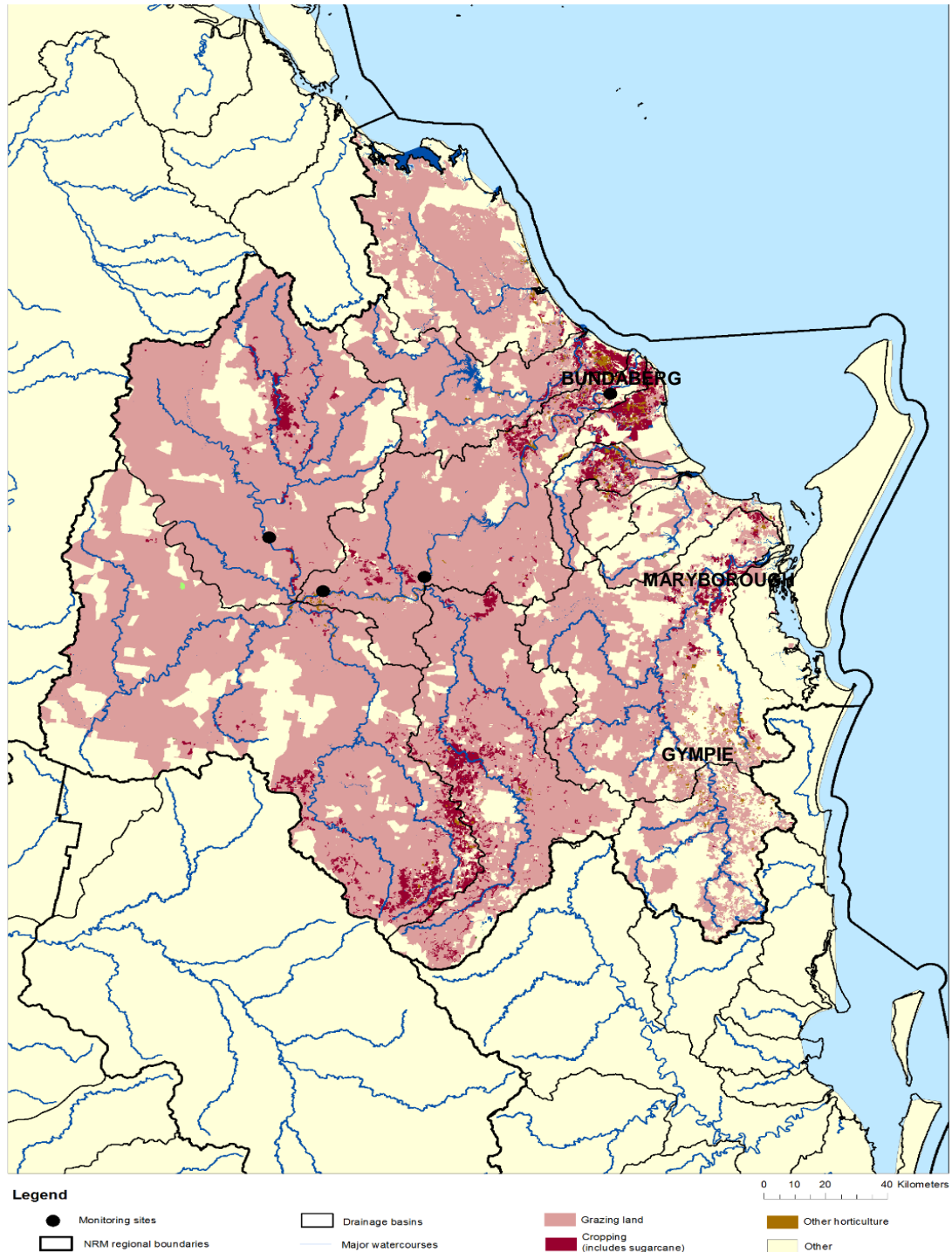
\* Notes: Impr = Improvement, R, D&I = Research, Development and Innovation, M&E = Monitoring and Evaluation, P&P = Policy and Planning, and Admin. = Administration. Pre-existing programs are stated. Figures may not add due to rounding.

Source: Queensland Audit Office based on departmental information and project descriptions



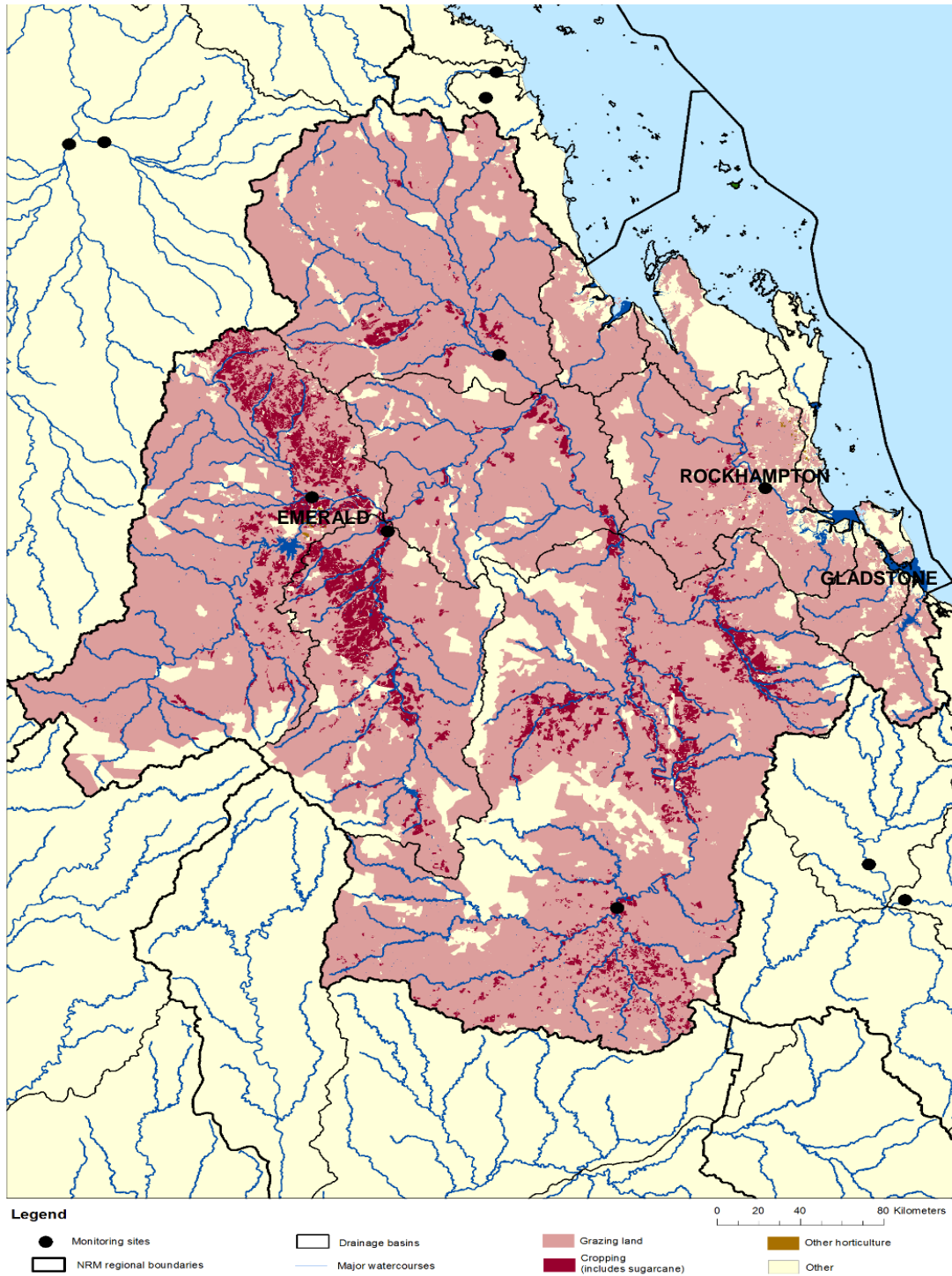
## Appendix F—Catchment monitoring site locations and land use

Figure F1—Burnett Mary Management Group



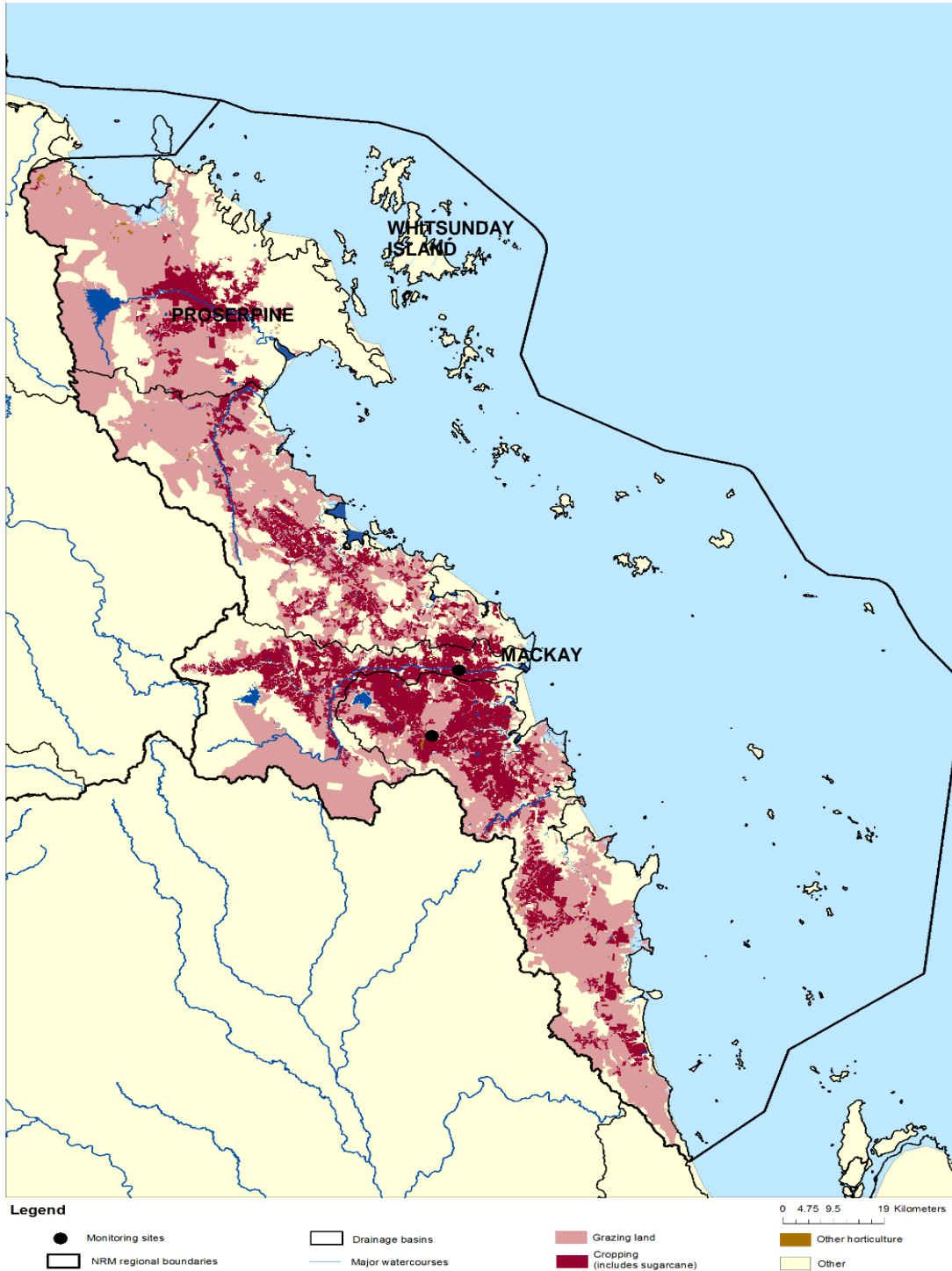
Source: Queensland Audit Office using data from the Queensland Land Use Mapping Program and the Great Barrier Reef Catchment Loads Monitoring Program

Figure F2—Fitzroy Basin Association



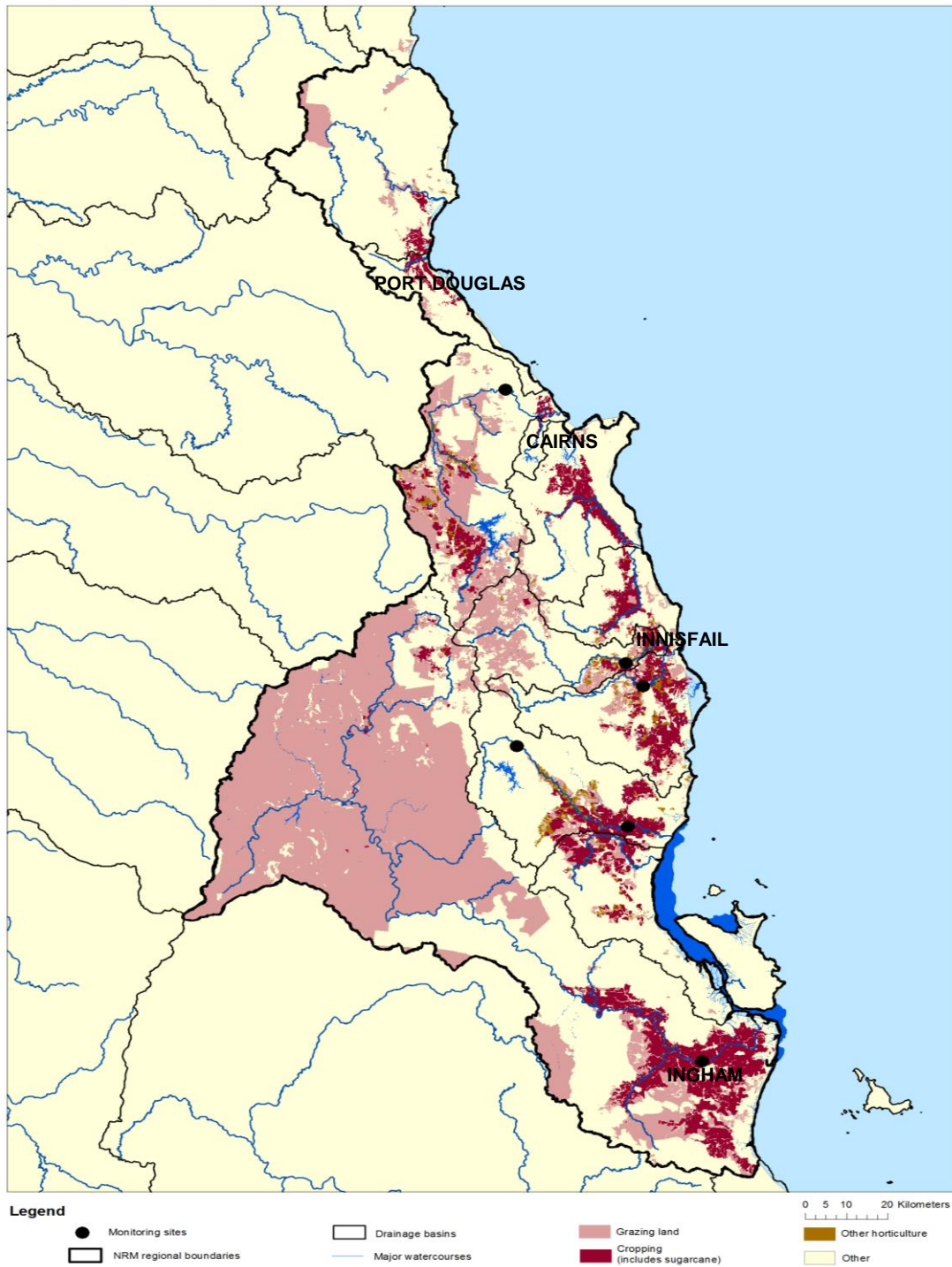
Source: Queensland Audit Office using data from the Queensland Land Use Mapping Program and the Great Barrier Reef Catchment Loads Monitoring Program

Figure F3—Reef Catchments (Mackay Whitsunday)



Source: Queensland Audit Office using data from the Queensland Land Use Mapping Program and the Great Barrier Reef Catchment Loads Monitoring Program

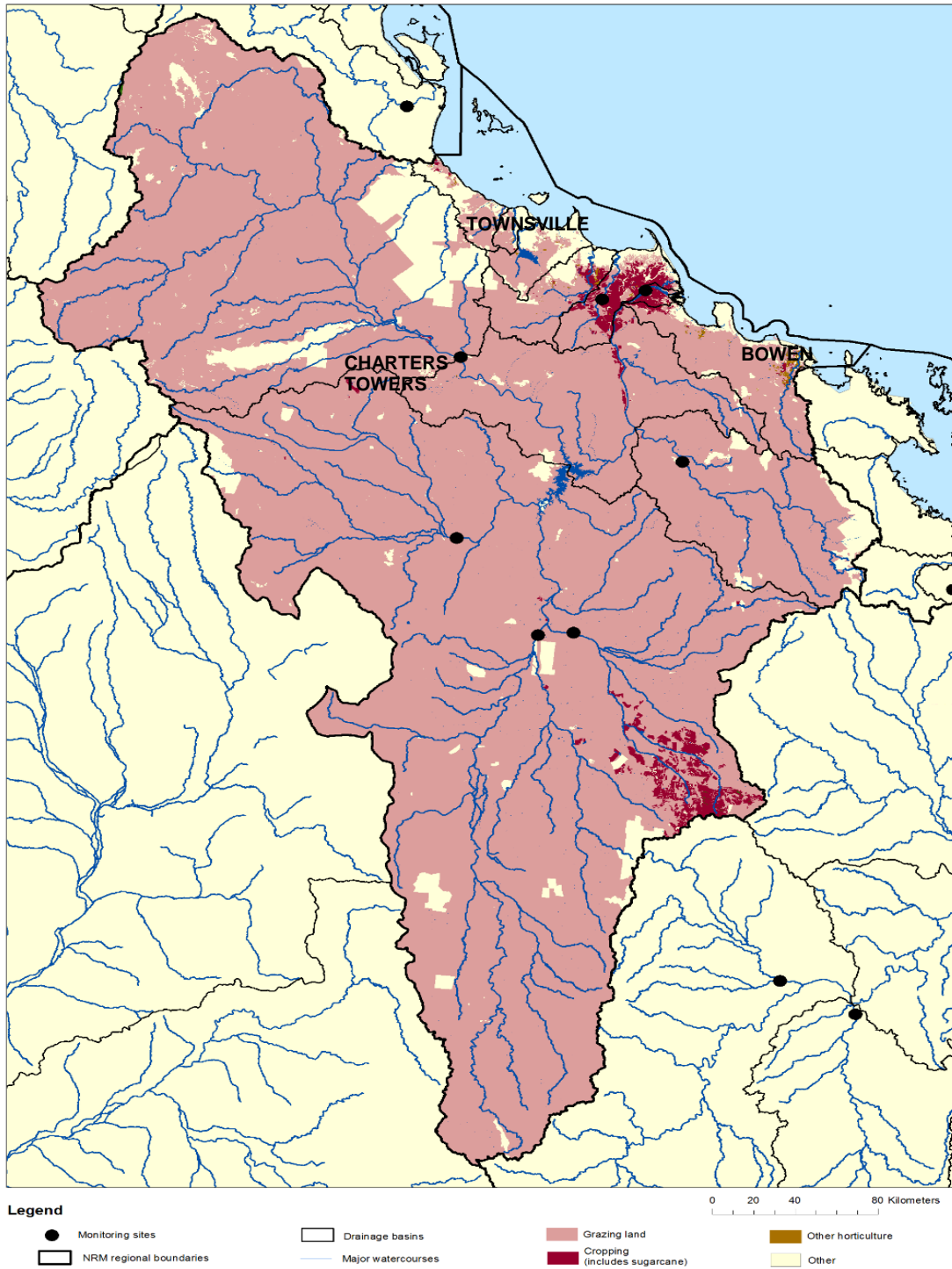
Figure F4—Terrain NRM (Wet Tropics)



Source: Queensland Audit Office using data from the Queensland Land Use Mapping Program and the Great Barrier Reef Catchment Loads Monitoring Program

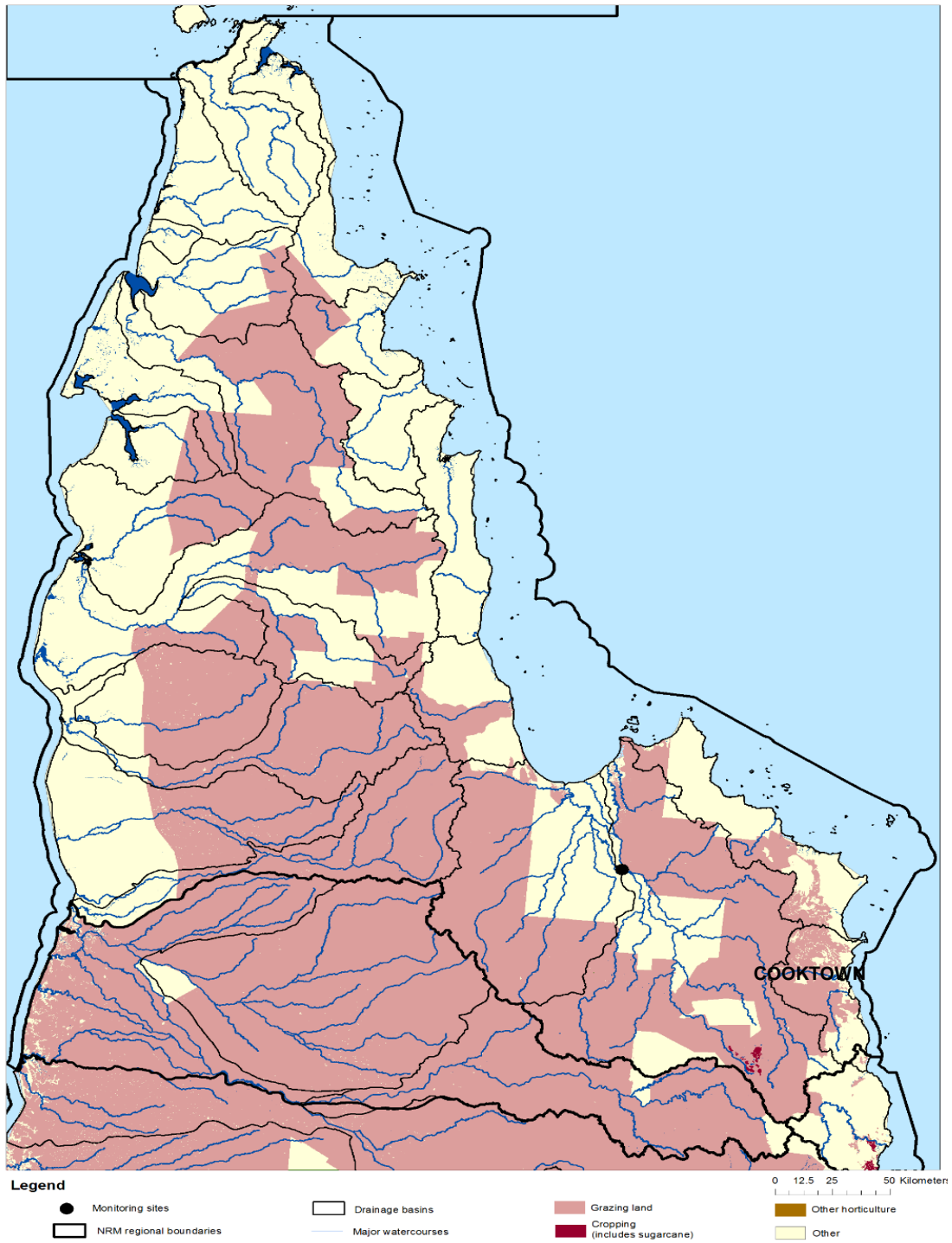


Figure F5—North Queensland Dry Tropics (Burdekin)



Source: Queensland Audit Office using data from the Queensland Land Use Mapping Program and the Great Barrier Reef Catchment Loads Monitoring Program

Figure F6—Cape York NRM



Source: Queensland Audit Office using data from the Queensland Land Use Mapping Program and the Great Barrier Reef Catchment Loads Monitoring Program

## Appendix G— Management practice rating frameworks

Producers engaged through the Australian Government Reef Programme (formerly Reef Rescue) participate in surveys on their management systems and under phase one of the Paddock to Reef Integrated Monitoring, Modelling and Reporting Program were rated as either 'A', 'B', 'C' or 'D' at a farm aggregate, not soil, nutrient or herbicide component level. This framework has been renamed from Reef Water Quality Protection Plan Paddock to Reef Water Quality Risk Frameworks and assigns risk ratings and will be used for future Reef report cards:

- lowest risk, commercial feasibility may be unproven (innovative)
- moderate-low risk (best practice)
- moderate risk (minimum)
- high risk (superseded).

Grazing is rated on a different criteria from the sugarcane, horticulture and grains industries.

Figure G1 shows the ABCD framework for the sugarcane, horticulture and grains industries:

**Figure G1—Management practice system ABCD classes and definition for sugarcane, horticulture and grains**

Class	Description of practice	Farm management plan	Community and industry standard	Effect on resource condition	Effect on profitability
A	Cutting-edge practices that require further validation of environmental, social and economic costs/benefits.	Yes, develops and tests innovative technology.	When validated is an acceptable practice for the long term. (May not be universally endorsed as feasible by industry and community).	When validated, practice likely to achieve long term resource condition goals if widely adopted.	When validated, improves profitability in the medium to long term. (May reduce profitability during transition.
B	Currently promoted practices often referred to as "Best Management Practices".	Yes, and utilises common technology.	Acceptable practice for the medium term.	Practice likely to achieve medium term resource condition goals if widely adopted.	Improves profitability in the short to medium term.
C	Common practices. Often referred to as "Code of Practice".	Basic.	Acceptable practice today but may not be acceptable in the medium term.	Practice unlikely to achieve acceptable resource condition goals if widely adopted.	Decline of profitability in the medium to long term.
D	Practices that are superseded or unacceptable by industry and community standards.	None.	Superseded or unacceptable practice today.	Practice likely to degrade resource condition if widely adopted.	Decline of profitability in the short to medium term.

Source: Great Barrier Reef Report Card 2012–13 Management Practice Methods

Figure G2 shows the ABCD framework for grazing.

**Figure G2—Management practice system ABCD classes and definition for grazing**

	A	B	C	D
Management practice category	Practices are highly likely to maintain land in good (A) condition and/or improve land in lesser condition.	Practices are likely to maintain land in good or fair condition (A/B) and/or improve land in lesser condition.	Practices are likely to degrade some land to poor (C) condition or very poor (D) condition.	Practices are highly likely to degrade land to poor (C) or very poor (D) condition.
Soil erosion and water quality risk associated with grazing land management	Very low risk.	Low risk.	Low to moderate risk.	Moderate to high risk.

Source: *Great Barrier Reef Report Card 2012–13 Management Practice Methods*

Farmers who participate in the BMP program and complete the self-assessments are rated on a question by question basis as either above, at or below industry standards. A farmer's self-assessment and accreditation is determined by their poorest practice per module.



## Appendix H—Glossary

Term	Acronym	Definition
Ambient	–	Relating to the immediate surroundings of something.
Best Management Practice program	BMP	A program designed to educate producers of the highest standards in a number of areas of farming and to assist them to reach these levels.
Broadscale land	–	Extensive area of land.
Bureau of Sugar Experiment Stations	BSES	Became SRA in 2013. See SRA.
Catchment	–	A natural drainage area that collects water and rainfall.
Crown-of-thorns starfish	COTS	A marine invertebrate native to Indo-Pacific waters which feeds on coral.
Diffuse source pollution	–	Pollution which may be attributed to a variety of sources.
Dissolved inorganic nitrogen	DIN	Nitrogen that has been incorporated into liquid and is from a non-organic source, e.g. Fertiliser.
Dissolved organic nitrogen	DON	Nitrogen that has been incorporated into liquid and is from an organic source, e.g. Decomposing leaves.
Ecological processes	–	Describe the cycling of water, the cycling of nutrients, the flow of energy and biological diversity.
Ecosystem	–	A community of living organisms in conjunction with the nonliving components of their environment, interacting together.
<i>Environmental Protection Act 1994 (Qld)</i>	EPA Act	Act with the objective to protect Queensland's environment while allowing for ecologically sustainable development.
Environmental values	EVs	Derived from the framework within the <i>Environmental Protection (Water) Policy 2009</i> .
Great Barrier Reef	the reef	The world's largest coral reef system stretching 2 300 kilometres down the east coast of Queensland.
Great Barrier Reef Catchment Load Monitoring Program	GBRCLMP	A monitoring program designed to capture changes in water quality for each of the catchments as part of the overall Paddock to Reef Integrated Monitoring, Modelling and Reporting Program (P2R program).
Ground Water Ambient Network	GWAN	Series of groundwater bore holes that are monitored for water quantity and quality.
Gullies	–	Occurs when run-off is concentrated and flows strongly carve a gully. This progressively widens or deepens when subsoils are more susceptible to erosion.
ISO19011	–	International Organisation for Standardisation is comprised of representatives from various national standards bodies. ISO19011 is a management systems audit standard.
Land management agreement	LMA	An agreement between a leaseholder and the DNRM for the on-going sustainable management of leased land.
Management practice change	–	The change in agricultural actions by landholders.

Term	Acronym	Definition
Memorandum of Understanding	MoU	Describes a bilateral or multilateral agreement identifying responsibilities and actions of parties involved.
Nitrogen	N	A nutrient required for plant growth, also found in several agricultural fertilisers.
Nutrients	–	A substance that provides nourishment essential for growth and life.
Particulate nutrients	–	Nutrients in solid form, e.g. Fertiliser pellet.
Point source pollution	–	Pollution which is attributable to a single source.
Producer	–	Refers to agricultural producers inclusive of cane and grazing industries.
Queensland Land Use Mapping Program	QLUMP	Land Use Mapping project undertaken by DSITI as part of the Australian Land Use Mapping Program.
Reef catchments	–	Unless specified otherwise, refers collectively to all catchments that drain into the Great Barrier Reef Marine Park.
Reef Long Term Sustainability Plan	Reef LTSP	The LTSP provides the principal structure for the management of the reef between 2015 and 2050.
Research and Development Coordination Group	RDCG	The RDCG will provide guidance in relation to the RDI strategy and prioritise areas of research importance.
Research, Development and Innovation Strategy	RDI Strategy	This strategy provides direction for research, innovation and developments in relation to the reef.
Riparian vegetation	–	Vegetation in the vicinity of the interface between land and a river or stream.
Runoff	–	The draining away of water (inclusive of substances within) from the surface of an area of land.
Scalds	–	A form of erosion which occurs when wind and water removes the top soil, a crust can then occur limiting water infiltration.
Sediment	TSS	Particulate matter in water (affects seagrass).
Single State Planning policy	SSP	Replaced multiple state planning policies to produce a single policy for land use planning and development.
Spatial and Scientific Information Management for Reef	SSIMR	A management system for storage, access and delivery of information of several projects for the reef.
Statewide Landcover and Trees Study	SLATS	A program run by DSITI monitoring the loss of extent of vegetation throughout Queensland in line with the <i>Vegetation Management Act (1999)</i> .
Stream bank erosion	–	Occurs when vegetation on river banks are removed and is the subsequent erosion of the stream bank and bed.
Sub-catchments	–	A division of a catchment.
Sugar Research Australia	SRA	An industry funded body coordinating research, development and extension activities for sugarcane growers.
Surface Water Ambient Network	SWAN	Series of stream gauging stations that monitor for water quantity and quality.
Terrestrial	–	On or relating to the earth.

Term	Acronym	Definition
Turbidity	–	The measure of water clarity and how much the material suspended in water decreases the passage of light.
Water quality	–	Refers to the chemical, physical, biological and radiological characteristics of water.
Water Quality Improvement Plans	WQIPs	Localised action plans for water quality management developed by regional NRM bodies in conjunction with other stakeholders.
Water quality objectives	WQOs	Objectives that aim to enhance or protect Environmental Values under the <i>Environmental Protection (Water) Policy 2009</i> framework.
Water resource plans	WRP	Plans developed by DNRM for the allocation and management of Queensland's water supplies.



# Auditor-General Reports to Parliament

## Reports tabled in 2014–15

Number	Title	Date tabled in Legislative Assembly
1.	Results of audit: Internal control systems 2013–14	July 2014
2.	Hospital infrastructure projects	October 2014
3.	Emergency department performance reporting	October 2014
4.	Results of audit: State public sector entities for 2013–14	November 2014
5.	Results of audit: Hospital and Health Service entities 2013–14	November 2014
6.	Results of audit: Public non-financial corporations	November 2014
7.	Results of audit: Queensland state government financial statements 2013–14	December 2014
8.	Traveltrain renewal: Sunlander 14	December 2014
9.	2018 Commonwealth Games progress	December 2014
10.	Bushfire prevention and preparedness	December 2014
11.	Maintenance of public schools	March 2015
12.	Oversight of recurrent grants to non-state schools	March 2015
13.	Procurement of youth boot camps	April 2015
14.	Follow up audit: Tourism industry growth and development	May 2015
15.	Results of audit: Education entities 2014	May 2015
16.	Results of audit: Local government entities 2013–14	May 2015
17.	Managing child safety information	May 2015
18.	WorkCover claims	June 2015
19.	Fraud Management in Local Government	June 2015
20.	Managing water quality in Great Barrier Reef catchments	June 2015