



Follow-up of *Managing water quality in Great Barrier Reef catchments*

Report 16: 2017–18



Your ref:
Our ref:

26 June 2018

The Honourable C Pitt MP
Speaker of the Legislative Assembly
Parliament House
BRISBANE QLD 4000

Dear Speaker

Report to parliament

This report is prepared under Part 3 Division 3 of the *Auditor-General Act 2009*, and is titled Follow-up of *Managing water quality in Great Barrier Reef catchments* (Report 16: 2017–18).

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 blue ink, appearing to read "Brendan Worrall".

Brendan Worrall
Auditor-General

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Audit objective and scope

In this follow-up audit, we examined whether departments have effectively implemented the recommendations we made in *Managing water quality in Great Barrier Reef catchments* (Report 20: 2014–15). We have also assessed whether the actions taken have addressed the underlying issues that led to our recommendations in that report.

The audit scope included three departments:

- the Department of Environment and Science, which includes the Office of the Great Barrier Reef
- the Department of Agriculture and Fisheries
- the Department of Natural Resources, Mines and Energy.



Glossary

Term	Definitions
Best Management Practice program	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.
Catchment	A natural drainage area that collects water and rainfall.
Crown-of-thorns starfish	A marine invertebrate native to Indo-Pacific waters that feeds on coral.
Diffuse source pollution	Pollution that may be attributed to a variety of sources.
Dissolved inorganic nitrogen	Nitrogen incorporated into liquid from a non-organic source, for example, fertiliser.
Dissolved organic nitrogen	Nitrogen incorporated into liquid from an organic source, for example, 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>	Act with the objective to protect Queensland's environment while allowing for ecologically sustainable development.
Environmental values	Derived from the framework within the <i>Environmental Protection (Water) Policy 2009</i> .
Extension and education programs	Programs aimed at developing producers' awareness and understanding (education) of the needs and benefits of changing practices, and assisting them (extension) to best apply that knowledge and understanding.
Great Barrier Reef Catchment Load Monitoring Program	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.
Great Barrier Reef Science Taskforce	A taskforce established in May 2015 by the Queensland Government to provide advice on how to achieve water quality targets and priorities for investing \$90 million over five years.
Gullies	Occurs when run-off is concentrated and the strong flows carve a gully. This progressively widens or deepens when subsoils are more susceptible to erosion.
Management practice change	The change in agricultural actions by landholders.



Term	Definitions
Nitrogen	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, for example, fertiliser pellets.
Pollutant load	The amount of stress placed upon an ecosystem by pollution, physical or chemical, released into it by man-made or natural means.
Producer	Refers to agricultural producers inclusive of cane and grazing industries.
Queensland Land Use Mapping Program	Land Use Mapping project undertaken by the Department of Environment and Science 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	Provides the principal structure for the management of the reef between 2015 and 2050.
Riparian vegetation	Vegetation in the area between land and a river or stream.
Run-off	The draining away of water (inclusive of substances within) from the surface of an area of land.
Scalds	A form of erosion that occurs when wind and water remove the top soil; a crust can then occur, limiting water infiltration.
Sediment	Particulate matter in water (affects seagrass).
Statewide Landcover and Trees Study	A program run by the Department of Environment and Science 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 is removed. It is the subsequent erosion of the stream bank and bed.
Sub-catchments	A division of a catchment.
Queensland Reef Water Quality Program	Queensland Government's five-year program of actions from 2017–2022 to implement the Great Barrier Reef Water Science Taskforce's recommendations.



Key facts

The reef's estimated value as an iconic global asset is \$56 billion.

Source: Reef 2050 Water Quality Improvement Plan

Climate change is the single biggest threat to the Great Barrier Reef.

Source: Reef 2050 Water Quality Improvement Plan

Improving water quality flowing from land to the Great Barrier Reef is a critical contributor to the reef's health

Increases in pollutant loads from agricultural run-off contribute to inshore reef degradation.

Source: 2017 Scientific Consensus Statement

It contributes \$6.4 billion annually to the Australian economy through tourism, recreation, commercial fishing, scientific research and reef management.

Source: Reef 2050 Water Quality Improvement Plan

It is Earth's largest coral reef system. It stretches 2 300 kilometres down the Queensland coast.

Source: Great Barrier Reef Water Science Taskforce



Summary of audit findings

Please note this is a summary of the audit findings. More information is in the following chapters.

Report 20: 2014–15

On 10 June 2015, we tabled *Managing water quality in Great Barrier Reef catchments* (Report 20: 2014–15) in the Queensland Parliament.

In our report, we examined the Queensland Government's contributions to improving the quality of water entering the Great Barrier Reef (the reef) from adjacent catchments, specifically agricultural run-off.

We found the Queensland Government did not have a cohesive program to support its achievement of the goal (to 'halt and reverse the decline in water quality entering the reef') it set out in its Reef Water Quality Protection Plans in 2003 and 2009. This goal was changed in Reef Water Quality Protection Plan 2013 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'. We concluded that Queensland's response lacked urgency and purpose. It was characterised by disparate projects with no central authority and no clear accountability for their delivery or achievement. The fragmented program response and unclear governance arrangements meant there was no strong accountability for program expenditures.

We also found that land management programs to improve agricultural practices in the sugarcane and grazing industries were not achieving the changes needed to realise the Reef Water Quality Protection Plan's goal within established timelines. The state had not achieved the right balance between industry-led voluntary approaches and regulatory enforcement of land management practices.

In addition, the limited number of water quality monitoring sites across the catchments restricted government departments' ability to verify modelled outputs against measured results. (Modelled outputs estimate average annual loads of key pollutants for each catchment draining to the reef, while measured results track long-term trends in water quality entering the reef from high-priority catchments.)

This provided uncertainty and variability (low levels of confidence) in modelled results indicating the quality of water entering the reef was improving. Public reporting on progress did not make this lack of confidence in the modelled results clear, potentially inferring the results were actual measured outcomes.

In our original report we made five recommendations, all of which were accepted by the departments.



Progress made by departments

In December 2017, we set out to establish whether departments have effectively implemented the recommendations we made in Report 20: 2014–15.

We found the departments have made significant efforts to address the recommendations. They have fully implemented four and partially implemented one.

Figure A shows our assessment of the implementation status of each recommendation.

Figure A
Implementation status of recommendations made in Report 20: 2014–15

	Recommendation made in original audit	QAO 2018 assessment of status
1	That 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.	Recommendation fully implemented
2	That 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.	Recommendation fully implemented
3	That catchment monitoring is expanded to aid in determining the effectiveness of practice management change and to enhance the confidence in modelled outcomes.	Recommendation fully implemented
4	That 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.	Recommendation partially implemented
5	That 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.	Recommendation fully implemented

Note: The tier one Reef Report Card is a high-level progress overview, at whole-of-reef level and by region, using modelled data.

Source: Queensland Audit Office.

Program management and investment

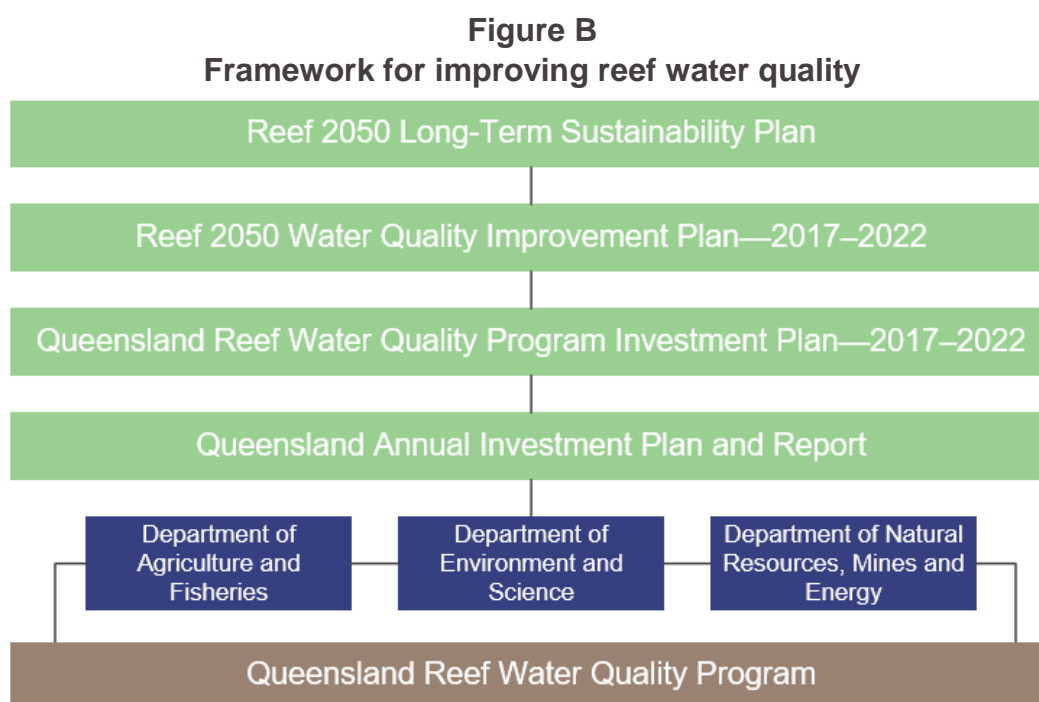
In addition to Commonwealth funding, the Queensland Government commits \$35 million annually for reef water quality action. In 2015, it provided an additional \$90 million over five years. In the 2018–19 budget, Queensland Government announced increased funding of \$13.8 million over four years to support the cane, grazing and banana industries in Great Barrier Reef catchments to improve water quality. It also included funding for other Great Barrier Reef and climate change initiatives.



Establishing the Office of the Great Barrier Reef (within the Department of Environment and Science) has improved the state’s reef program governance, design, management, and investment planning. The office manages, coordinates, and is accountable for the state’s contribution to achieving the *Reef 2050 Long-Term Sustainability Plan* (the Long-Term Plan) goals and targets. The Long-Term Plan (jointly developed by the Australian and Queensland governments) provides the overarching framework for managing and protecting the Reef until 2050.

The Queensland Government has reviewed its reef water quality projects and plans to ensure they align with the Long-Term Plan. Its current projects and activities are based on scientific evidence with a specific purpose of (or link to) improving water quality in the reef catchments.

Figure B shows how the plans fit within the framework of delivering reef water quality improvement.



Source: Queensland Audit Office adapted from the *Queensland Government Annual Investment Plan 2016–17*.

The Office of the Great Barrier Reef provides a single point of reporting on the total package of reef water quality investments, but many departments still contribute to the activities within the program and are responsible for the delivery of their investments.

Over the 2015–16 and 2016–17 financial years, the Queensland Reef Water Quality Program actual expenditure was about \$12.8 million short of the planned investment. Annual investment reports provide examples of where total planned expenditure was not spent, but they do not acquit actual expenditure against planned investment for each program. This decreases transparency and accountability. It is important that any underspend is carefully and transparently managed and acquitted to ensure confidence in the management of public funds. It would also demonstrate that necessary actions to improve water quality are undertaken on a timely basis.



Catchment monitoring

The Queensland Government's Great Barrier Reef Catchment Loads Modelling Program estimates average annual loads of key pollutants (sediment, nutrients and pesticides) for each of the 35 catchments draining to the Great Barrier Reef as part of the Paddock to Reef program. It assesses progress towards the reef water quality targets by reporting on baseline levels and the change in loads for each subsequent year due to adoption of improved land management practices.

The number of catchment monitoring sites has almost doubled. The Great Barrier Reef Catchment Loads Monitoring Program conducted a clear and logical process to ensure the funding and site prioritisation would provide the highest benefit to the reef.

The program now monitors all intensive land use catchments. It includes 43 monitored sites across 20 key catchment areas for monitoring sediments and nutrients, and 20 sites for pesticides. This represents a significant improvement on the 26 monitoring sites in 14 of the 35 catchments in 2015. The additional monitoring is at both the end-of-catchment and sub-catchment scales.

Fifteen of the 35 catchments are still not monitored. These catchments are low priority and represent the predominantly low-intensity land use areas, for example, nature conservation areas.

Expanding the number of sites means the program monitors and analyses more water samples for total suspended sediments and nutrients discharged to the reef. Currently, between 86–100 per cent of sediment, nitrogen, and pesticide loads discharged from rivers to the reef are monitored. This compares to 75–86 per cent in 2015. This increase in monitoring means the program can calibrate and validate modelled outputs with greater confidence. The increased data strengthens the verification of and increases confidence in modelled reporting.

Paddock to reef program

Model inputs

The departments have made significant efforts to address the model input deficiencies identified in the original audit. They have implemented changes to improve confidence (reduce the degree of uncertainty and potential variability) in the data, although some limitations remain in the complex models used. The departments are committed to further improving the model verification and accuracy.

Model quality improvements include better data collection processes and the use of custom-built geographic information system tools, aerial photography, and uniform grids for mapping purposes.

The main remaining data limitations relate to the impact of land clearing and to data on management practice change (the change in agricultural practices of landholders).

In our original audit, we found that data was not available on clearing rates for riparian vegetation corridors (vegetation bordering rivers and streams). The modelling still does not directly include data on land clearing. The model does, however, include remotely sensed ground cover, which may provide some indication of where land has been cleared.

Currently, there is insufficient data to know how much of the cleared land has subsequently been planted with crops. Further study is needed to evaluate the impact land clearing has had and its long-term effects. At present, the government does not know the net effect the impact of cleared land is having in offsetting any gains they make in land management practice programs.



Land management practice

Since the original audit, the Department of Agriculture and Fisheries has implemented several changes to improve confidence in the capture and analysis of management practice data. However, it is still unable to adequately report on the level of change in management practice. This is because it does not have all the management practice data it needs to measure the degree of change.

While the departments hold and analyse data, there are some projects and programs that are not providing satisfactory data. The most significant of these are the industry best management practice programs. The farm management practice data is currently held by industry groups that host the best management practice portals. Despite being funded by government, no information on site-specific management practices or changes in practice is provided to the departments, with industry groups citing 'privacy concerns'.

This information includes the level of practice and any progress made by individual producers in moving towards improved industry standards. These data restrictions mean government has no indication of what, if any, progress has been made. It means government cannot measure the degree of practice change or assess the value achieved from its investment of public funds. The Office of the Great Barrier Reef is currently negotiating with industry groups to gain access to the data the departments need and should have access to.

In the meantime, the rate of engagement and accreditation with best management practice programs is the only measure available to assess program performance. This is not an adequate measure for practice change.

Since our 2015 report, accreditation rates for the Grazing and Smartcane best management practice programs have increased. The number of accredited graziers has increased from 10 to 87 and the number of canegrowers from four to 256. However, despite significant efforts, best management practice programs are still only used by two per cent of graziers and seven per cent of canegrowers. Accelerated uptake is needed to meet the 2018 target (of 90 per cent of sugarcane, horticulture, cropping and grazing lands in priority areas being managed using best management practice systems).

The proposal to broaden and enhance the existing reef protection regulations seeks to ensure that minimum practice standards are utilised across key industries and land uses in all reef catchments. This means adoption of minimum practice standards will no longer be voluntary.

Reef report card

Since 2014, the Reef Report Cards include a confidence indicator graph that illustrates the model's level of uncertainty or potential variability for each of the major reporting themes measuring the land, catchments, and human dimensions affecting water quality. The approach compares the range and variability of reporting methods and data sets within the Paddock to Reef Integrated Monitoring, Modelling and Reporting Program (Paddock to Reef program). The metrics and rankings are reviewed by the Reef Independent Science Panel. To further aid readers' understanding of the reported results, the report could provide greater clarity that the results are based on modelled (estimated) rather than monitored (actual) results.

The Reef Report Cards from 2014 to 2016 show no change in confidence levels achieved from year to year.



From 2018, the Reef Report Card will report on revised water quality and land management targets. While most of the targets are relevant and informative, the three land management targets relating to riparian vegetation management and stakeholder and program engagement are ill-defined. They do not define or measure the desired increase in either the extent of riparian vegetation or engagement.

This means that government cannot adequately report on the effectiveness of the programs and projects contributing to these targets.



Audit conclusions

The Great Barrier Reef is vulnerable to threats that the Queensland Government cannot control or influence, such as extreme weather events. It can, however, influence other threats, such as the quality of water entering the reef from adjacent catchments—specifically agricultural run-off.

The Queensland Government now has an overarching program to coordinate and monitor reef strategies and its programs aimed at improving the health of the Great Barrier Reef. The Office of the Great Barrier Reef provides a single point of accountability for the effective and efficient delivery of the Queensland Reef Water Quality Program. This has resulted in stronger governance, coordination, and oversight, providing greater assurance that public funds are spent and monitored in a way that maximises Queensland's ability to reduce the harm to the reef.

There is a shared commitment among the departments and program partners to working cooperatively. The entities responsible for delivering the state's reef program are working together on clear policy objectives and intended outcomes.

Greater oversight, monitoring, tracking, and reporting of allocated investment at a whole-of-state-government level means there is now more clarity on how much is spent each year and on what. However, the Office of the Great Barrier Reef is not able to fully understand the effectiveness of this public investment, in part because it doesn't have access to key industry information related to some of the programs it funds. This inhibits it and the public in assessing value for money of this investment of public funds.

Ongoing improvements to the water quality model are essential for properly evaluating and reporting on investment outcomes and optimising program delivery. The increase in water quality monitoring sites, and therefore in measured data, means the government can better validate modelled data.

Practice change information held by industry groups is also a critical input to the model. It is incumbent on government to obtain the information needed from the funded non-government organisations holding this information.

Despite significant efforts, the rate of voluntary adoption of best management practices by producers is not yet sufficient to achieve water quality targets. The proposals underway to broaden and enhance existing reef protection regulations will go some way to achieving the right balance between industry-led voluntary approaches and regulatory enforcement. Once the legislation is amended, the adoption of minimum practice standards will no longer rely solely on voluntary participation.

While government has made some progress within the program, progress towards the *Reef 2050 Long-Term Sustainability Plan* targets has been slow. The present trajectory will not meet the targets. Scientific experts report that accelerated change is needed.

The significant work done by Queensland Government in the last three years to build a more effective reef program, targeting effort and investment on activities more likely to improve water quality in the Great Barrier Reef catchments, is a positive step towards change. It links well with Commonwealth Government reef efforts and initiatives. The program and supporting activities will, however, take time to establish results. Water quality outcomes will take even longer to determine, and the reef remains vulnerable to threats—including water quality from broadscale land use.



Recommendations

Department of Environment and Science

We recommend that the Department of Environment and Science:

1. acquits actual expenditure against planned investment for Queensland's Reef Water Quality Program, in future annual investment reports, to increase transparency and accountability (Chapter 2)
2. obtains reliable, timely, and adequate practice change information from relevant industry groups to understand the progress made, measure the degree of practice change, and account for outcomes for the public funds invested (Chapter 4)
3. work with the Commonwealth Department of Environment and Energy, to refine over time the land management targets in the *Reef 2050 Water Quality Improvement Plan 2017–2022* to define the increase in the percentage of riparian vegetation and the increase in stakeholder engagement targeted (Chapter 4).



1. Context

This chapter provides the background to the audit and the context needed to understand the audit findings and conclusions.

Risks to the reef

Scientific evidence shows that climate change is the single biggest threat to the reef. This includes storms and cyclones, flooding, and thermal stress. Bleaching events in 2016 and 2017 due to accumulated heat stress on the reef resulted in coral mortality. In addition, Tropical Cyclone Debbie affected reefs in the Mackay Whitsunday region and subsequent flooding also affected the Fitzroy region.

Other high risks to the health and resilience of the reef include land-based run-off, coastal land-use change, and aspects of direct use such as fishing, shipping, and port activities. The decline of marine water quality associated with land-based run-off from adjacent catchments is a major cause of the current poor state of many of the Great Barrier Reef (the reef) coastal and marine ecosystems. Improving the quality of water flowing from the land to the reef is a critical contributor to the reef's health and therefore, its ability to withstand and recover from climate change events.

Impact of water catchment run-off on water quality

Sediment, nutrient, and pesticide loads carried from the water catchment areas running into the reef contribute to the degradation of inshore reefs and the occurrence of crown-of-thorns starfish outbreaks. Increases in pollutant loads have been attributed to development adjacent to catchment areas.

The dominant sources of nitrogen and pesticides are from agricultural use in intensive cropping. For example, sugarcane farms use large amounts of nitrogen fertiliser to maximise crop production. Grazing lands contribute the most sediment delivered to the reef.

The Queensland Government's goal is to improve the quality of water entering the reef from adjacent catchments and ensure it will have no detrimental impact on the health and resilience of the reef.

Reef partnerships

Australian and Queensland governments, scientists, traditional owners, community and industry groups, conservation and natural resource management groups manage the Great Barrier Reef in partnership. These collaborations are vital to the success of the *Reef 2050 Water Quality Improvement Plan* (the Improvement Plan).

The projects and activities in the Improvement Plan guide how industry, government and the community will work together to improve the quality of water flowing into the Great Barrier Reef. Government uses the Improvement Plan to prioritise and target regional investment.



The Queensland Departments of Environment and Science; Natural Resources, Mines and Energy; and Agriculture and Fisheries are responsible, along with other supporting partners, for activities within the Queensland Government's Reef Water Quality Program.

Appendix F lists the departments' key roles in implementing the Queensland Reef Water Quality Program.

Our original audit in 2014–15

In *Managing water quality in Great Barrier Reef catchments* (Report 20: 2014–15), we examined the Queensland Government's contributions to improving the quality of water entering the reef from adjacent catchments—specifically agricultural run-off. Our audit did not deal with other potential stressors, such as dredge spoil or the broader impacts of climate change; nor did it examine the activities or programs of the Australian Government.

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

We examined the:

- efficacy of the activities and programs undertaken or funded by Queensland Government agencies to reduce diffuse source pollution from agriculture
- effectiveness of monitoring and the reliability of public reporting outcomes, particularly the achievements of the *Reef Water Quality Protection Plan* targets and progress toward long-term goals.

We concluded

While the Queensland Government had the *Reef Water Quality Protection Plan*, it did not have a cohesive, program to support its achievement. Queensland's response lacked urgency and purpose. It was characterised by disparate projects with no central authority and no clear accountability for their delivery or achievement. The fragmented program response and unclear governance arrangements meant there was no strong accountability for program expenditures.

We found

We found that land management practice programs were not achieving the changes needed to realise the *Reef Water Quality Protection Plan* goal within established timelines. The state had not achieved the right balance between industry-led voluntary approaches and regulatory enforcement. In addition, the limited water quality monitoring sites across the catchments restricted government departments' ability to verify modelled outputs to measured results. This created a high degree of uncertainty and level of variability (low levels of confidence) in modelled results indicating the quality of water entering the reef was improving. Public reporting on progress did not make this lack of confidence clear, potentially inferring modelled results were actual measured outcomes.

We recommended

We made five recommendations in *Managing water quality in Great Barrier Reef catchments* (Report 20: 2014–15), all of which were accepted by the departments.

Figure A on page six of this follow-up report outlines these recommendations.



Great Barrier Reef Water Science Taskforce

In May 2015, shortly after we tabled our original report, the Queensland Government established a Great Barrier Reef Water Science Taskforce (the taskforce) to provide advice on how to achieve water quality targets and priorities for investing \$90 million over five years.

The taskforce evaluated current and past water quality programs. Its 2016 report found the water quality targets to be ambitious, and that transformational change would be needed to achieve the set targets. The taskforce acknowledged that there have been improvements; however, they are not moving fast enough to successfully achieve necessary results.

The report recommended a mix of policy, regulation, and investment to accelerate progress towards reef water quality targets. The Queensland Government accepted the taskforce's recommendations in-principle and incorporated them into the *Reef 2050 Water Quality Improvement Plan*.

The taskforce considered the findings of our original audit in its deliberations. It noted that many of the recommendations in its report complemented Queensland Audit Office's conclusions.

2017 Scientific Consensus Statement

The Reef Independent Science Panel consists of subject matter experts who conduct scientific reviews of Reef 2050 Plan activities and initiatives. The Panel was commissioned by the Australian and Queensland governments to provide independent scientific advice and review in support of the *Reef 2050 Long-Term Sustainability Plan* and advances and innovations in monitoring and reporting activities.

All plans for managing the Great Barrier Reef are based on scientific evidence. The *2017 Scientific Consensus Statement—Land use impact on the Great Barrier Reef water quality and ecosystem condition* (the 2017 Scientific Consensus Statement) is a review of the advances in scientific knowledge of water quality issues in the Great Barrier Reef. It arrives at a consensus on the current understanding of the system. The statement is the foundational document that provides the scientific understanding underpinning the *Reef 2050 Water Quality Improvement Plan 2017–2022*.

The 2017 Scientific Consensus Statement confirms that current initiatives will not meet water quality targets and reports that more is needed to accelerate change. There is an urgent need for greater investment in voluntary practice change programs (to encourage changes in landholders' agricultural practices), for the use of regulatory tools, and for other policy mechanisms. Robust monitoring and evaluation programs are also needed to measure the rate and effectiveness of adoption.

The government aims to update the scientific consensus statement every five years to ensure that reef policy remains up to date and based on the best available evidence.



2. Program management and investment

This chapter covers progress made by the departments in addressing recommendations one and two of the original audit report.

It addresses actions taken to improve the reef program design, management, and investment planning.

Introduction

In our original audit, we found that the Queensland Government did not have a cohesive state-based program to support its achievement of its *Reef Water Quality Protection Plan 2013*. We concluded that Queensland's response lacked urgency and purpose and was characterised by disparate projects with no central authority and no clear accountability for their delivery or achievement. The patchy program response, mirrored by fragmented governance arrangements, meant there was no strong accountability for program expenditures.

We also found that the state was not evaluating the combined effect of its activities on water quality.

We made recommendations to improve program governance, design, and management, and investment planning.

Program oversight

Previously, the Reef Secretariat (within the Department of the Premier and Cabinet) had assumed the central coordination role. The Reef Secretariat essentially supported the committees and synthesised information to develop an annual Great Barrier Reef Report Card. It was not accountable for Queensland's contribution to the *Reef Water Quality Protection Plan*. Individual departments made decisions about individual program components. The complex program structure that existed diluted accountability and made it difficult to determine reporting lines and responsibilities for key elements such as program design, evaluation and investment management.

Progress made

In response to our audit, and just prior to us tabling our report, the Queensland Government established the Office of the Great Barrier Reef, within the Department of Environment and Science, on 11 May 2015.



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

The Office of the Great Barrier Reef provides oversight and coordination of the Queensland Reef Water Quality Program on behalf of the Minister for Environment and the Great Barrier Reef. The office is accountable for the success of the program and is responsible for coordinating:

- state commitments to the *Reef 2050 Long-Term Sustainability Plan* (the Long-Term Plan)
- a program of work including on-ground remediation, monitoring, innovation, extension, incentives, and regulation in response to the Great Barrier Reef Water Science Taskforce recommendations. They do this through the *Reef 2050 Water Quality Improvement Plan* (the Improvement Plan)
- the *Great Barrier Reef Queensland Reef Water Quality Program Investment Plan*
- the evaluation of state programs attributed to the the Improvement Plan.

The office is held accountable through external reporting, including:

- reporting against an objective in the Department of Environment and Science's Service Delivery Statement—to protect the Great Barrier Reef (This is supported by two effectiveness measures.)
- reporting in the *Reef 2050 Plan Annual Report and Implementation Strategy* on whether actions in the the Long-Term Plan and the the Improvement Plan are on track or complete.

Integrated government services

To provide integrated services, governments must work 'horizontally' or across agencies rather than in the more traditional single agency environment. This method of service provision across agencies needs to be well planned, sufficiently resourced, well-coordinated across participant agencies and external stakeholders, and regularly monitored, reviewed, and evaluated.

The departments work effectively and cooperatively together on the Queensland Reef Water Quality Program, demonstrating the value of such integrated approaches to complex multi-agency programs.

Figure 2A shows some of the collaborative features of this program.



Figure 2A
Queensland Reef Water Quality Program integrated services

Element	What we found
Governance	<ul style="list-style-type: none"> • There is a clear lead entity in the Office of the Great Barrier Reef to ensure that the program meets the government’s objectives. • Leadership is strong and ongoing, and there are sound processes. • There is an overarching, high-level implementation plan, coordinated by Office of the Great Barrier Reef, that clearly defines cross-entity responsibilities. • There is an inclusive approach involving use of consultative governance and coordination arrangements—designed to harness relevant skills and expertise from all partners.
Planning	<ul style="list-style-type: none"> • There is structured program implementation and investment planning. • Scientific evidence and lessons learned are used to inform planning and decisions. • A program logic approach has been adopted. • There has been integrated planning by the three departments (the departments of Environment and Science; Agriculture and Fisheries; and Natural Resources, Mines and Energy), involving key partners and stakeholders with knowledge and expertise.
Resources	<ul style="list-style-type: none"> • The Office of the Great Barrier Reef has capabilities and capacity to lead program implementation. • Skilled and experienced people are available in all departments to support program implementation, and there is access to appropriate external expertise. • Information systems and project management resources have been established to support the implementation.
Coordination	<ul style="list-style-type: none"> • There are established processes and tools for sharing information and data between the entities involved. • There are communication and coordination processes in place to facilitate successful program development and implementation, such as committees and working groups.
Monitoring, review, and evaluation	<ul style="list-style-type: none"> • There are processes for coordinated monitoring and reporting of activities and projects. • Senior management across all entities are informed of the progress of key initiatives and projects. • There is continual process improvement to support timely and quality data collection, performance measurement, analysis, and reporting. • Risks are regularly reviewed, and results are provided to senior management.

Source: Queensland Audit Office.



Governance framework

Appendix F shows agency roles and responsibilities and the reef governance structure.

In the original audit, we found that a series of eight committees and groups exchanged information informally and all reported to a committee with representatives from both Australian and Queensland Government agencies. This multi-jurisdictional involvement added to the complexity of the overall governance and management of the state's programs.

Since the original audit, in July 2015, the Queensland Government formed the Great Barrier Reef Interdepartmental Committee. Its purpose is to provide a forum for coordination and governance of funding programs across Queensland Government agencies, advice on improved efficiencies, and oversight of public reporting. The Director-General of the Department of Environment and Science chairs the Inter-Departmental Committee, and membership includes all Queensland Government agencies impacted by the Improvement Plan.

The government has formed or retained other steering committees and advisory groups to provide project management leadership and direction for specific programs.

Program management

The Office of the Great Barrier Reef has adopted a structured and consistent approach to program management. This provides greater clarity about what the Queensland Government's contribution to the Improvement Plan is, what the key activities are, and who is delivering them.

A program oversight team performs the role of a program management office. This has led to consistent and documented processes for compiling and sharing information, making decisions, and managing the Queensland Reef Water Quality Program.

Individually, the departments contributing to the Queensland Reef Water Quality Program retain responsibility and accountability for the delivery of their specific projects. They also undertake project management, governance, and prioritisation activities.

Program planning and design

Our original audit found that many of the projects and activities attributed to Queensland's reef water quality programs were not developed or customised to suit the *Reef Water Quality Protection Plan*. The primary objective of pre-existing programs was not to improve water quality to achieve ecologically relevant results. This meant that the overall program design and coordination lacked rigour from the outset.

We recommended that the government review the design and implementation of the suite of programs attributed to the *Reef Water Quality Protection Plan* to establish they were the most effective and efficient.



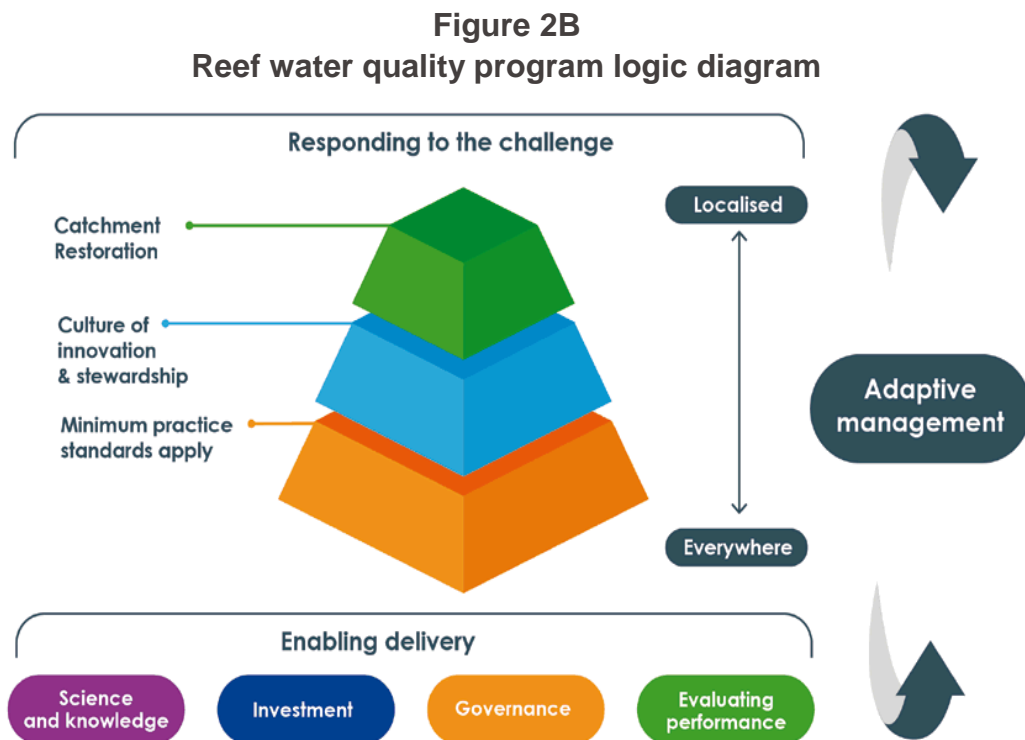
Progress made

The Office of the Great Barrier Reef coordinated a review of all programs attributed to the *Reef Water Quality Protection Plan*. Its review was informed by evidence-based scientific knowledge including the:

- *Great Barrier Reef Science Taskforce report 2016*
- *2017 Scientific Consensus Statement—Land use impact on the Great Barrier Reef water quality and ecosystem condition* (the 2017 Scientific Consensus Statement).

The review brought together relevant government agencies and stakeholders, and used available data and technical expertise. It took an adaptive management approach. This involves regularly monitoring management actions to gain new knowledge about how well these actions are working, so they can be continuously modified and approved.

It also used a program logic approach to guide the process. This brought together science, government, and stakeholder knowledge to identify how actions would lead to desired water quality outcomes and also to identify where new knowledge was needed to create change. The outcomes and actions of the plan were categorised into two work areas: responding to the challenge; and enabling delivery. Figure 2B shows the elements that make up the two work areas.



Source: *The Office of the Great Barrier Reef*.

Queensland Reef Water Quality Program

The Queensland Reef Water Quality Program is the Queensland Government's program of actions to implement the recommendations of the Great Barrier Reef Water Science Taskforce and address water quality impacts affecting the Great Barrier Reef. It delivers activities as part of implementing the Improvement Plan, which supports the water quality elements of the Long-Term Plan.

The Improvement Plan supersedes the *Reef Water Quality Protection Plan 2013*. The Improvement Plan sets the strategic priorities for the whole reef catchment. Regional water quality improvement plans, developed by regional natural resource management bodies, support the plan by providing locally relevant information and guiding local priority actions within regions.

The key objectives of the Queensland Reef Water Quality Program are to:

- improve progress towards the water quality targets under the Improvement Plan
- ensure the Queensland Government's investment in reef water quality is coordinated, effective, and aligned to water quality outcomes
- capitalise on activities that are proving successful across the reef catchments
- support landholder management practices to reduce nitrogen, pesticides, and sediment run-off to the reef while ensuring productivity, profitability, and sustainability of farm enterprises
- ensure the best and most cost-effective approaches are used for maximum reef water quality benefit through trialling, research, and ongoing monitoring and evaluation.

The Queensland Government has expanded the plan to include urban, industrial, and public lands. Previously, the protection plan addressed only agricultural sources of water pollution. The improvement plan also considers the human dimension—social, cultural, and economic values—that drive adoption of actions to improve water quality. It sets targets at the catchment and regional scales rather than just at the whole-of-reef scale. This means actions can be prioritised by catchments.

Program evaluation

In our original audit, we found that the state was not evaluating the performance of the combined effect of the state's reef-related activities on water quality. This meant that it could not assess how effectively the adopted implementation approach contributed to program objectives.

The Office of the Great Barrier Reef has engaged an external program evaluation team to develop a Queensland Great Barrier Reef Water Quality Program Evaluation Framework (the framework) and conduct an annual review of the program each year for three years. It completed a draft framework in March 2018.

The framework aims to evaluate current governance and program management measures and to determine how effective the program has been in delivering projects to meet its objectives. It also aims to identify criteria and evaluation mechanisms that should be incorporated into projects within the program, to track overall effectiveness.

The framework means that, from 2017–18, the Queensland Government can evaluate all the state's activities and collective impact on water quality. The results will further guide the delivery and investment of the Queensland Reef Water Quality Program.

Evaluation activities contribute to continuous learning and improvement processes. They identify pertinent lessons from the implementation of programs and ensure relevant knowledge and learnings are applied to refining the implementation approach.



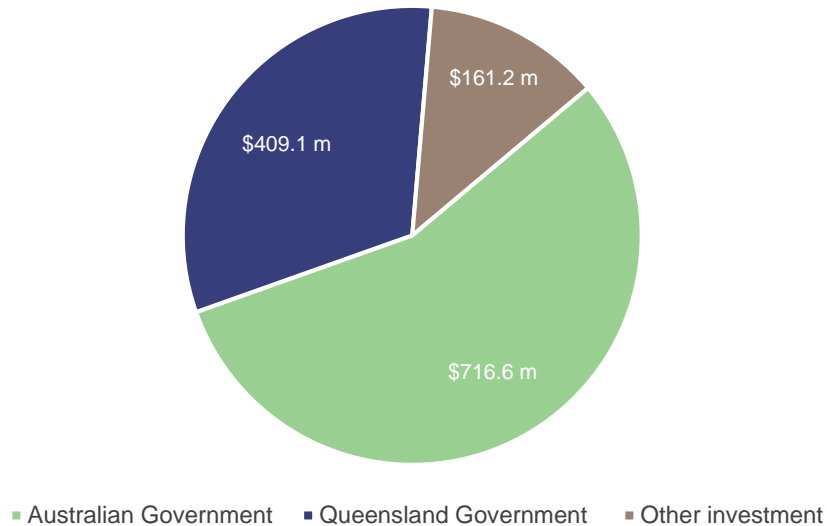
Investment planning and reporting

Our original audit found that funding for improving reef water quality was fragmented and needed more accountability for expenditure on programs and activities. The Queensland Government did not track or report on the aggregate spend on reef program activities at a state level. This led to uncertainty as to how much it spent each year on the *Reef Water Quality Protection Plan*. Departments relied on estimates to report plan expenditure.

Between 2016 and 2021, Australian governments are investing over \$1.287 billion in the Reef 2050 Plan actions.

Figure 2C shows the sources of \$1.28 billion in funding for the five-year period 2016–2021.

Figure 2C
Funding sources 2016–2021



Source: *Reef 2050 Plan Investment Framework*.

The \$1.287 billion excludes the additional funding of \$560 million recently announced by the Australian Government (\$60 million in January 2018 and \$500 million in May 2018). It also excludes the \$330 million funding the Queensland Government recently announced in its 2018–19 budget for Great Barrier Reef and climate change initiatives. Not all of the \$330 million relate directly to reef initiatives.

The \$1.287 billion will go towards achieving water quality improvements in catchment areas, managing crown-of-thorns starfish, increasing monitoring and public awareness, and reducing the environmental impact of surrounding businesses. The governments have allocated \$573.5 million of this funding to actions to improve water quality. Figure 2D shows the \$1.287 billion in funding by *Reef 2050 Long-Term Sustainability Plan* area of investment for the five-year period 2016–2021.

Figure 2D
Funding by Reef 2050 Long-Term Sustainability Plan
area of investment



Source: Reef 2050 Plan Investment Framework.

The Queensland Government commits \$35 million annually for reef water quality action. In 2015, it provided an additional \$100 million over five years. Of the \$100 million, it allocated \$90 million to water quality improvement and \$10 million to the creation of net-free fishing zones. Its aim for this additional investment was to fast track progress toward reef water quality targets, taking direction from the recommendations of the Great Barrier Reef Water Science Taskforce.

Progress made

The Office of the Great Barrier Reef provides greater investment governance through the oversight, monitoring, tracking, and reporting of allocated investment at a whole-of-state-government level. It has done this by implementing finance systems and processes to track and report spend against annual investment plans. It has also used modelling scenarios, local and regionally developed plans (such as regional water quality improvement plans), and other decision support tools to prioritise investment to achieve the best water quality outcomes.

The Office of the Great Barrier Reef coordinated the first Queensland Government water quality annual investment plan and report for the financial year 2015–16. This was in response to our recommendation and similar recommendations raised by the Great Barrier Reef Water Science Taskforce.

The purpose of the annual investment plan is to ensure that investment is targeted at activities that genuinely address water quality improvement for the reef and to avoid duplication across Queensland Government. For example, similar activities carried out by multiple agencies and funded separately were identified and combined into joint projects.

Our review of the Queensland Government annual investment plans for reef water quality protection in 2015–16 and 2016–17 found they show the allocated investment for individual program within the total Queensland Reef Water Quality Program. The annual investment reports include the outcomes achieved for each individual program, but only report the actual money spent for the total Queensland Reef Water Quality Program.

Figure 2E compares actual expenditure against planned investment for 2015–16 and 2016–17.

Figure 2E
Reef water quality planned versus actual expenditure 2015–17

	2015–16	2016–17
Planned investment	\$35 150 000	\$58 450 000
Actual expenditure	\$33 385 000	\$47 409 835
Difference	\$1 765 000	\$11 040 165

Source: *Queensland Government Annual Investment Plan 2016–17 Reef Water Quality Protection Plan and Queensland Government Annual Investment Report 2016–17 Reef Water Quality Protection Plan*.

Each year, any underspent funds are rolled over from the previous year. In the case of the \$90 million allocated to implementing the taskforce recommendations, funds can be moved to another area or project if program priorities change.

Almost all the \$11 million not expended in 2016–17 (\$10 935 484) was allocated to the ‘responding to the challenge’ work area in the program logic model. This covers on-ground delivery actions to implement the changes required to make progress towards the targets.

Reasons given in the *Queensland Government Annual Investment Report 2016–17* for the underspend include the time required to establish the new program and execute contracts and partnerships, as well as the impacts of unfavourable weather conditions on some projects.

While the report provides examples of where total planned expenditure was not spent, it does not acquit actual expenditure against planned investment for each program. This would identify for stakeholders which specific programs have underspent in that year and increase transparency and accountability. It is important that any underspend (especially of the magnitude that occurred in 2016–17—\$11 million or 19 per cent) is carefully and transparently managed and acquitted. This is to ensure that there is confidence in the management of public funds and that potential risks are appropriately mitigated, including risks:

- to the achievement of overall program objectives
- to the delivery of individual projects
- to future funding needs and allocations
- of subsequent misuse or waste of the unspent funds.

For 2017–18, the Office of the Great Barrier Reef has replaced the annual investment plan with a five-year *Queensland Reef Water Quality Program Investment Plan 2017–18 to 2021–22*. This plan combines the program and investment plans. It aligns the Queensland Reef Water Quality Program activities to the *Reef 2050 Water Quality Improvement Plan* and for each activity, states the lead agency responsible, funding source, annual investment commitment, and program allocation over five years.

While each agency retains formal accountability for the delivery of its investments, the Office of the Great Barrier Reef provides a single point of reporting on the total package of reef water quality investments.

3. Catchment monitoring

This chapter covers progress made by the departments in addressing recommendation three of the original audit report.

It addresses actions taken to expand the catchment monitoring program to improve confidence in modelled outcomes.

Introduction

Water quality monitoring and modelling conducted in the Great Barrier Reef catchments informs progress towards water quality targets. The results are summarised in an annual Great Barrier Reef Report Card.

Our original audit found that, while the modelling tool used to inform reporting was robust, there were not enough monitoring sites to verify modelled output data. This meant that confidence levels in the reported water quality improvements were low, because the results were being reported against modelled (estimated) data as opposed to measured data. For many of the catchment and sub-catchment areas, it wasn't possible to verify the accuracy of the reported data.

We also found that there was no long-term monitoring in place to determine the full extent of pollutants leaching into ground water. This was largely due to the lack of sub-catchment monitoring sites. This contributed to the limitations of the reporting in the Reef Report Card.

We recommended that the government expand the catchment monitoring program to help determine the effectiveness of practice management change (changes to farmers' agricultural practices, which reduces nitrogen, pesticides, and sediment run-off), and to enhance confidence in modelled outcomes.

Monitoring sites

The Queensland Government allocated \$3 million over four years for an additional 12 monitoring sites across reef catchment areas. It has expanded the Great Barrier Reef Catchment Loads Monitoring Program in response to our original audit and to recommendations made in the *Great Barrier Reef Water Science Taskforce report 2016*.

The Great Barrier Reef Catchment Loads Monitoring Program conducted a clear and logical process to ensure the funding and site prioritisation would have the highest benefit to the reef.



Progress made

The Office of the Great Barrier Reef engaged with major stakeholders to develop a rationale for site determination. These included leaders from the Paddock to Reef Integrated Monitoring, Modelling and Reporting Program (the Paddock to Reef program), which is a collaboration between government and non-government bodies and landowners. They also included catchment modellers as well as personnel from the Great Barrier Reef Catchment Loads Monitoring Program; Department of Natural Resources, Mines and Energy; and the Australian Government’s Great Barrier Reef Marine Park Authority Marine Monitoring Program.

The Great Barrier Reef Catchment Loads Monitoring program developed a matrix and undertook a series of workshops to prioritise site selection. It identified 85 additional sites at end-of-catchment and sub-catchment scales where monitoring could potentially add value to the spatial enhancements or meet modelling requirements. These sites were further prioritised using data and information from report cards, catchment models, and monitoring sites; instances where water quality guidelines were exceeded; risk assessments; and extension and education services.

The program now monitors all intensive land use catchments. It includes 43 monitored sites across 20 key catchment areas to monitor sediments and nutrients and 20 sites for pesticides. This represents a significant improvement on the 26 monitoring sites in 14 of the 35 catchments in 2015. The additional monitoring reported against is at the end of catchment and sub-catchment scale.

Fifteen of the 35 catchments are still not monitored. These catchments are low priority as identified in the *2017 Scientific Consensus Statement—Land use impact on the Great Barrier Reef water quality and ecosystem condition*. They represent predominantly low-intensity land use areas, for example nature conservation areas.

Expanding the number of sites means the program monitors a larger proportion of loads discharged to the Great Barrier Reef. This increase in monitoring means the program can calibrate and validate modelled outputs with greater confidence.

Figure 3A compares the proportional loads monitored at the time of the original audit in 2015 to proportional loads currently monitored.

Figure 3A
Proportion of loads monitored in 2015 compared to 2018

Monitored loads	2015	2018
Total suspended sediment	86%	92%
Dissolved inorganic nitrogen	75%	88%
Photosynthesis II herbicides	85%	100%

Source: Office of the Great Barrier Reef.



Further improvements

Further improvements to the accuracy of catchment monitoring data include:

- projects to support further expansion of catchment monitoring and provide extension data to the modellers
- a project to provide an additional 34 pesticide monitored sites by manual sample collection
- development of robust, portable, low maintenance, and low-cost sensors, enabling precise and reliable monitoring of dissolved inorganic nitrogen.

Both our original audit and the taskforce report identified the need for monitoring directly related to landholder actions. The taskforce reported strong support for finer scale (end of farm) monitoring in a bid to engage producers. Finer scale monitoring identifies nutrient, pesticide, and sediment losses so that extension, incentives, and better management practice programs can be effectively targeted at pollutant hotspots.

Figure 3B shows a case study example of a sub-catchment water quality monitoring project developed in response to consistent exceedance of acceptable levels of pesticides in the Sandy Creek catchments.

Figure 3B
Sandy Creek sub-catchment water quality project

Project objectives	Actions
Encourage industry-led monitoring to engage growers and industry, create ownership of results, and improve understanding of chemical loss from farming systems.	<ul style="list-style-type: none"> • industry-led workshops and extension activities • continuous monitoring of hotspots over two years • focused monitoring in selected sub-catchments to inform future extension work.
Conduct sub-catchment monitoring to link farm practice to in-stream water quality and direct extension activities to sub-catchments where water quality exceeds guidelines.	<ul style="list-style-type: none"> • collection of water data to assess expected improvements over time • monitoring over first three rainfall events of 2016–2017 and 2017–2018 wet seasons • modelling discharges to quantify mass load of pesticide and nutrient losses occurring at the sub-catchment scale.
Demonstrate that profitable practices can minimise the impact on water quality.	<ul style="list-style-type: none"> • trials used to compare water quality from farm practices to show objectives can be achieved cost-effectively • grower participation in treatment and collection of samples to demonstrate that adopting improved practices leads to improvement in water quality.
Increase adoption of management practices that will result in improved water quality outcomes.	<ul style="list-style-type: none"> • industry-led extension activities with farm managers to support and increase adoption of better practice • behavioural study engagement with Griffith University to analyse barriers to practice change and develop strategies to overcome barriers.
Progress of outcomes	
<p>Sandy Creek sub-catchment project was initially a one-year project. It was extended to three years due to strong stakeholder engagement.</p> <p>Canegrowers in the Sandy Creek sub-catchment region have positively engaged with the project. Growers have ownership of management practice change and water quality sampling.</p>	

Source: Queensland Audit Office.



4. Paddock to Reef program

This chapter covers progress made by the departments in addressing recommendations four and five of the original audit report.

It addresses actions taken to improve the quality of data used in modelling and reporting water quality outputs.

Introduction

Our original audit identified deficiencies in model inputs including data that was not regularly monitored or well understood. We also found that departments did not consistently collect or verify data associated with changes in how producers manage land. This level of uncertainty or confidence in reported data was not communicated in the tier one Reef Report Card (which is a high-level progress overview, at whole-of-reef level and by region, using modelled data.)

We recommended the need for a rigorous verification process to improve the quality and accuracy of data used as inputs to the model. We also recommended that the Reef Report Card include references to the level of confidence in the reported data.

The Paddock to Reef Integrated Monitoring, Modelling and Reporting Program (the Paddock to Reef program) is a collaboration between governments, industry bodies, regional natural management bodies, landholders, and research organisations.

Funded jointly by the Australian and Queensland governments, the program collects and integrates data and information on agricultural management practices, catchment indicators, catchment loads, and the health of the Great Barrier Reef. Monitoring and modelling from the Paddock to the Reef program allows government to measure and report on progress towards the *Reef 2050 Water Quality Improvement Plan's* (the Improvement Plan) goal and targets.

Appendix E shows the 10 interrelated components of the Paddock to Reef program.

The water quality model used to inform progress towards water quality targets is complicated. It uses data on the adoption level of improved land management practices (including their effects in terms of load reductions), groundcover, and rainfall in the catchment. It then estimates the sediment, nutrients, and pesticides loads for natural resource management regions and the entire reef.

Water quality and quantity data, collected at catchment monitoring sites during wet weather events, are used to validate the model predictions. The estimated effects of long-term average loads, including from floods, are compared with 2013 baseline values to assess progress towards the Improvement Plan targets.

The model 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.



Model inputs

The water quality model is used to simulate how catchment and climate variables affect run-off and how pollutants are transported to the reef, by integrating a range of component models, data, and knowledge.

Our original audit identified deficiencies in model data inputs including that:

- ground water pollutants such as nitrogen leaching through soils were not regularly monitored or fully modelled
- gully scald and streambank erosion rates were not regularly monitored, well understood, or measured
- ecological processes such as those that take place in wetlands were excluded from the model
- the impact of vegetation clearing was not modelled.

Progress made

The departments have undertaken a technical refinement of the model. It incorporates updated input layers into the model as they become available. Regional data collection processes and shortcomings in gully and streambank erosion rates are significantly improved. Water quality risk frameworks are being updated.

Ground water pollutants

Loss of dissolved inorganic nitrogen below the root zone can be a major loss pathway for nitrogen in sugarcane growing areas. Previously, this sub-surface flow was not monitored. This led to an under-prediction of particulate nutrients. Since the original audit, paddock monitoring trials using sub-surface flow monitors have been introduced. This means this data is now represented in the model. Improvements to ground water modelling mean that modelled loads now better reflect monitored data.

Gullies, scalds, and streambank erosion

Previous modelling approaches were limited by scale, low accuracy, or limited geographic extent. This meant that previous mapping approaches were of limited use in water quality modelling.

Improvements made to the quality of the model include the use of custom-built geographic information system tools, aerial photography, and uniform grids to allow operators to map the presence or absence of gully erosion within a grid. Ground-based observations and previous estimates are used to verify the accuracy of the predictive model.

The outcome is a predictive model that can generate gully density maps for all reef catchments. The tool is useful for natural resource management bodies in targeting investment in gully remediation projects.

Ecological processes

Coastal wetlands act as a filtration system for the reef—filtering out pollutants from rivers before they flow into the reef. Destruction of wetlands can result in an increased flow of sediment and nutrients into the reef.



The Reef Report Card has reported changes in wetland extent since 2011. In 2014, the former Department of Science, Information Technology and Innovation carried out a pilot study to:

- inform development of a program for monitoring wetland values in the reef catchments
- test the Wetland Field Assessment Tool for Monitoring, developed for the monitoring program.

During the dry months of 2015 and 2016, the department used a refined version of the tool to gather baseline data for anthropogenic (environmental pollution and pollutants caused by human activity) pressure on wetland environmental values and the state of wetland environmental values across the whole reef catchment from Cape York to the Burnett Mary region.

The outcome of this baseline study of wetland environmental values in the reef catchments is reported in the *Great Barrier Reef Report Card 2016*, under ‘wetland condition results’.

Land clearing

Generally, if tree clearing and any associated land use change exposes and/or disturbs the soil surface, then water and sediment loss are likely to increase, depending on how the land is subsequently used, and on the practices employed. This could work against the achievement of the Improvement Plan targets.

Our original report noted an increase in woody vegetation clearing rates in reef catchments between 2011 and 2014. The Queensland Statewide Landcover and Trees Study report shows 158 000 hectares (ha)/year of woody vegetation were cleared in 2015–16 in the reef catchments. This represents a 45 per cent increase from the prior year.

Figure 4A shows the woody vegetation clearing in the reef catchments for the 2012–13 to 2015–16 reporting periods.

Figure 4A
Woody vegetation clearing 2012–13 to 2015–16

Period	Rate of woody vegetation clearing (,000 ha/year)		Percentage of total clearing in Queensland
	Great Barrier Reef catchments	Total clearing in Queensland	
2012–13	106	261	40
2013–14	105	295	36
2014–15	109	298	37
2015–16	158	395	40

Source: Queensland Statewide Landcover and Trees Study reports.



In our original audit, we found that data was not available on clearing rates for the riparian corridors that border rivers or streams, which are critical to the health of the reef. Since then, the model input layers include mapping data from:

- the Queensland Statewide Landcover and Trees Study
- the Queensland Land Use Mapping Program (on land use patterns and changes across the state).

The Paddock to Reef program and the Reef Report Card both report against targets relating to riparian and wetland vegetation extent. While the modelling does not include specific data on land clearing, the remotely sensed ground cover (which is used in the modelling) may provide some indication of where land has been cleared. The government does not fully understand the extent to which land clearing in reef catchments impacts on water quality. Research is needed to scientifically assess these impacts and determine the extent to which land clearing should be incorporated into the modelling.

Ground cover is monitored four times per year and is used to set the cover factor within the modelling. The cover factor informs the amount of ground cover present in a given season and the contribution that it can make to sediment delivery. Increased bare ground from clearing detected in the remotely sensed ground cover imagery will impact on sediment generation within the catchment models. Equally, regrowth thickening of previously cleared land may result in increased cover in those areas.

The impact land clearing has on the reef water quality depends on what the land use transitions to, for example, from natural vegetation to grazing. These transitions take time to establish and stabilise, which means it takes time before they are reflected in land use mapping. There are plans to model scenarios on tree clearing to gain a better understanding of the impacts on hydrology and sedimentation. However, currently there is limited published literature to underpin these scenarios.

Management practice methods

Data on land management practice is a key input into the modelling process. The original audit found that agencies were not collecting land management practice change data consistently. Also, the data was not verified on the ground or independently audited to provide a high level of confidence in its accuracy.

Progress made

Since the original audit, the Department of Agriculture and Fisheries has implemented several changes to improve confidence in management practice data provided by service providers such as natural resource management organisations and industry groups. These changes include:

- providing specific project spatial data for all modelled and reported practice changes. This has increased the accuracy in terms of claims about change to management practices
- developing consistent water quality risk frameworks describing practices of greatest relevance to water quality
- developing a consistent way to describe management change detail to reduce the extent of differential reporting between regions and assessors
- using satellite imagery to verify the outcomes of investment.



However, the approach still has limitations that impact on the confidence level of the data. These include having access to sufficient evidence of management practice change, detecting any regression of practice, and managing how progress is reported.

Evidence of management practice change

Service providers receive funding to increase the adoption of best management practice by producers. Contracts with government require them to report on the impacts of their work.

They report on how individual sites or farm enterprises are managed—using the practice descriptions in the water quality risk frameworks—both before and after an intervention. Interventions include financial incentives (for example, cash grants), capacity-building extension, on-farm trials, private sector consulting, and remediation of severe erosion features.

Most external bodies can describe the extent of their engagement (that is, the people they interacted with) and offer some evidence of impact in terms of improved knowledge and skills of participants. However, not all provide evidence of the area of land covered by change (spatial extent) and the degree of change that could be attributed to the program. In some instances, this is due to privacy concerns, little or inadequate impact evaluation, or because the impacts are not yet apparent.

For best management practice programs, practice change information would show the progress and level of change made by individual producers in moving from ‘below industry standards’ to ‘meets industry standards’ to ‘above industry standards’. This detailed information is currently held by the industry groups who host the best management practice portals. Despite this work being funded by government, the information is not provided to government due to privacy concerns from the industry. Government funding for best management practice programs in 2015–16 was \$4.5 million and \$4.7 million in 2016–17. Current contracts with the industry groups require them to report improved practices to relevant government programs.

These data restrictions mean government does not have full visibility of the progress made and cannot measure the degree of practice change or assess the value achieved from its investment of public funds. The degree of industry engagement and accreditation with best management practice programs is currently the only metric available to assess program performance.

The Office of the Great Barrier Reef is currently working with industry partners to improve the capture, transfer, and use of best management practice data. This includes strengthening best management practice program contracts currently being negotiated by adding a clause specifying the provision of de-identified spatial farm data on practice standards and change each year. Renewed contracts are expected to take effect in 2018.

Management practice regression

The extent to which producers maintain best management practices in subsequent years currently remains unknown. This means that the reported proportion of lands managed using best management practice systems could be overstated. However, there is also the possibility that management improvements occur without intervention from external bodies and where management practice change is not detected or reported.

Generally, the departments do not test the long-term sustained implementation of adopted best management practices. Any regression of practices is difficult to detect, as these are unlikely to be reported. There is no evidence of independent auditing of data provided by external bodies.

However, the Department of Agriculture and Fisheries has undertaken actions to further improve the quality and accuracy of data used as inputs to the model. It has:

- led the development of a Paddock to Reef Geographical Information System that over time may indicate potential regression or improvement in practice change
- done a five-year review of adoption benchmarks to pick up practice regression and reduce data uncertainty
- led ongoing accreditation for producers engaged with best management practices assists with on-ground knowledge
- implemented systematic reviews of previously reported practice improvements.

Management practice results

Our original report noted that best management practice programs were not achieving the changes needed to realise the *Reef Water Quality Protection Plan* goal within the established timelines. Producers were not comprehensively monitoring the extent and sustainability of change at the farm scale. We found low uptake in the adoption of best management practice programs.

The proportion of improved management practice is critical to determining the proportion of land under best management practice and the catchment load reductions presented in the Reef Report Card. Total load reductions estimated within the models are predicated on changes in landholder management practice.

The Improvement Plan lists the current target for adoption of best practice as:

90 per cent of sugarcane, horticulture, cropping and grazing lands are managed using best management practice systems (soil, nutrient and pesticides) in priority areas by 2018.

Progress made

In 2014, the target for management practice changed from the number of landholders who have adopted improved practices to the area of land managed using best management practices. The area of land managed using best management practices is considered a more meaningful measure. This is because land area is the basis for water quality modelling. However, the target remains a measure of adoption rather than a measure of change.

Figure 4B shows the area of land managed in priority areas using best management practices for 2014–2016 against the 2018 target.



Figure 4B
Area of land managed using best management practices

Industry	2014	2015	2016	2018 target
Sugarcane	22%	23%	32%	90%
Grazing	33%	36%	36%	90%
Horticulture	46%	47%	47%	90%
Grains	NA	57%	57%	90%

Note: NA—not applicable. Grains best management practice program commenced in 2014–15.

Source: *Great Barrier Reef Report Card 2016*.

Despite significant efforts, best management practice for water quality is only used by a small proportion of the agricultural and grazing industry. Accelerated uptake is needed to meet the 2018 target.

Both the *Great Barrier Reef Science Taskforce report 2016* and the *2017 Scientific Consensus Statement—Land use impact on the Great Barrier Reef water quality and ecosystem condition* (the 2017 Scientific Consensus Statement) highlighted an urgent need for greater investment in voluntary practice change programs in addition to existing best management practice programs.

In its *Queensland Reef Water Quality Program Investment Plan 2017–2018 to 2021–2022*, the Queensland Government has allocated:

- \$50 million to support the industry-led best management practice programs
- \$66 million for additional practice and management change programs.

Best management practice programs

Best management practice programs are industry-led, government-supported agricultural programs that encourage voluntary uptake of improved land management practices. The programs take a holistic farm management approach that combines profitability, productivity, and environmental sustainability. Producers participate by benchmarking their operations and then becoming accredited to the industry standard for management practices.

Our original audit showed the participation and accreditation rates for the Grazing and Smartcane best management practice programs. At that time, only 10 graziers and four canegrowers were best management practice accredited. In 2018, this has increased to 87 graziers and 256 canegrowers. However, best management practice programs are still only used by two per cent of graziers and seven per cent of canegrowers.

Practice change programs

The 2017 Scientific Consensus Statement recommended introducing tailored practice change programs that target different groups of landholders and involve collaboration with landholders, industry organisations, and service providers to design and deliver programs. This includes programs that involve knowledge exchange between farmers, scientists, and others, and that provide trusted and diverse advisory services.

Figure 4C shows examples of how government is addressing these recommendations by investing in tailored practice change programs.

Figure 4C
Practice change case studies

Project	Actions
Major integrated projects in the Wet Tropics and Burdekin regions	
<p>\$31.7 million additional funding was committed to implement two major integrated projects to reduce nutrient, sediment, and pesticide loads into waterways in the Wet Tropics and Burdekin regions.</p>	
<p>Wet tropics major integrated project</p>	<p>Working with cane and banana growers in the Tully and Johnstone catchments to reduce nutrient and pesticide run-off. Initial plans are to trial 10 bioreactors, two landscape wetlands, two constructed wetlands, four sediment basins, and two riparian buffer zones. The project includes extension, incentives, and demonstration farms.</p>
<p>Burdekin major integrated project</p>	<p>Known as Landholders Driving Change, the project supports graziers in the Bowen, Broken, and Bogie catchments in reducing sediment and nutrient run-off.</p> <p>Actions include support programs encouraging graziers in improving their land management, remediating landscape, and trialling tailored solutions to control erosion.</p>
Projects targeting nitrogen reduction by canegrowers	
<p>\$4.6 million committed to ongoing projects based on SIX EASY STEPS to target nitrogen reduction by canegrowers. The SIX EASY STEPS program provides guidelines on how to implement balanced nutrition on-farm. The aim is to optimise productivity and profitability without adversely influencing soil fertility or causing off-farm effects.</p>	
<p>RP20 Burdekin Nitrogen Project</p>	<p>This was established to determine whether the SIX EASY STEPS method provided adequate nitrogen application rates following the introduction of regulations for nitrogen and phosphorous inputs in sugarcane production.</p> <p>RP20 covered 12 000 hectares of Burdekin cane land. The total nitrogen saving from this project was 499 tonnes, without compromising sugar yield and profitability.</p>
<p>RP161 Complete Nutrient Management Planning for Cane Farming</p>	<p>This builds on the results achieved through the RP20 Burdekin Nitrogen Project. It works with farmers to adjust their nitrogen rates in line with the industry standard, SIX EASY STEPS, without compromising their productivity and profitability.</p> <p>Expected outcomes include a significant increase in the amount of fertiliser taken up by the crop, and a reduction in excess fertiliser application. This will reduce nitrogen losses and run-off to local waterways. In the first year, growers have applied 82 tonnes less nitrogen over four and a half thousand hectares.</p>
Project Cane Changer	
<p>\$2 million allocated to the innovative industry-led Project Cane Changer</p>	<p>Canegrowers are working with behavioural psychologists to foster widespread practice change across the sugarcane industry.</p> <p>This is designed to better understand growers and help increase adoption of best management farming practices.</p>

Source: Queensland Audit Office based on the Reef 2050 Water Quality Improvement Plan.



Land management change is complex. Making changes often involves gaining new knowledge and skills, and sometimes investment in equipment and infrastructure. Recently funded on-ground programs need time to achieve results, but involvement in these projects and others indicate a willingness of producers to improve practices. Current and new projects need to be completed and evaluated before they can be rolled out on a larger scale.

Enhancing reef protection regulations

The *Environmental Protection Act 1994* is the primary state legislation relevant to the improvement of water quality in catchment areas. Chapter 4A of the Act includes provisions, commonly known as reef regulations, for issuing penalties related to diffuse sources of pollution into the reef.

The regulations include compliance requirements for land owners and managers on the application of agricultural chemicals, nutrients applied to soil, and sediment loss.

Improving agricultural land management practices in the sugar cane and grazing industries is a key strategy of the *Reef Water Quality Protection Plan* and the Improvement Plan. Our original audit noted that land management practice programs were not achieving the changes needed to realise the *Reef Water Quality Protection Plan* goal within the established timelines. Results indicated that the state had not achieved the right balance between industry-led voluntary approaches and regulatory enforcement.

The Great Barrier Reef Water Science Taskforce also recommended that government implement staged and targeted regulations to improve reef water quality.

Progress made

The Office of the Great Barrier Reef has made progress with implementing targeted regulations to improve reef water quality. In March 2017, it released the *Enhancing regulations to ensure clean water for a healthy Great Barrier Reef and a prosperous Queensland* discussion paper for feedback. The paper outlined high-level proposals for enhancing the existing reef protection regulations to reduce nutrient and sediment pollution across key industries in Great Barrier Reef catchments.

The Office of the Great Barrier Reef conducted information sessions on the proposals, followed by the release of a regulatory impact statement for public consultation in September 2017. The office is currently reviewing the submissions received following the consultation process.

The proposal to broaden and enhance the existing reef protection regulations seeks to ensure minimum practice standards are used across key industries and land uses in all reef catchments. This means adoption of minimum practice standards will no longer be voluntary.

These aim to eliminate high-polluting, outdated approaches that are the main source of pollution to the reef. The improved practices have profitability and productivity outcomes, while reducing the potential for nutrient and sediment run-off.

In April 2016, the Department of Environment and Science introduced a compliance program focusing on nitrogen and phosphorus use on cane farms in three regions. The initial approach of the program was to educate producers on their legislative obligations. This program has proven successful in the short term. Farm records audited by the department identified non-compliance with requirements. Follow-up audits found 75 per cent had returned to compliance.

Reef report card

There are three tiers to the Great Barrier Reef reporting:

- Tier one (Reef Report Card) provides a high-level progress overview—at whole-of-reef level and by region—using modelled data. It uses multiple infographics to communicate the results.
- Tier two is a detailed technical report, providing a breakdown on each major pollutant category, best management practice adoption, and streambank, gully, and wetland improvements. This is broken down by region and industry.
- Tier three reporting is the academic or peer reviewed research that supports the ongoing development of the water quality improvement programs.

The purpose of the Reef Report Card is to report modelled progress towards the previous *Reef Water Quality Protection Plan* and the current *Reef 2050 Water Quality Improvement Plan* targets and demonstrate the outcomes of investment. The Reef Report Card outlines the results from the Paddock to Reef Integrated Monitoring, Modelling and Reporting program.

Our original audit found a high level of uncertainty in the modelled outcomes due to the number of assumptions and data limitations in such a complex model. This level of uncertainty or confidence in reported data was not communicated in the tier one Reef Report Card.

This meant that readers of the Reef Report Card could interpret modelled outcomes as fact without having a clear understanding of the assumptions, uncertainties, and limitations underlying the modelled results.

We recommended that government include unambiguous reference in the tier one Reef Report Card that disclosed the degree of uncertainty and levels of potential variability in the reported results.

Progress made

The Paddock to Reef program developed a multi-criteria analysis approach to qualitatively score the confidence for each key indicator used in the Reef Report Card. Key indicators measure the land, catchments, and human dimensions affecting water quality. The approach combines the use of expert opinion and direct measures of error for program components where available.

The use of a single, consistent, multi-criteria analysis framework enables comparison across the range and variability of reporting themes and data sets within the Paddock to Reef program.

The program uses five standard criteria to determine the confidence level for each key indicator in the Reef Report Card:

- maturity of methodology used to determine reported data
- validation of modelled data
- representativeness of population survey data
- directness—relationship to reported indicators
- measured error.



Scoring for each criterion is against a defined set of scoring attributes. It ranks attributes from those that contribute weakly to the criteria (score of one) to those that have a strong influence (score of three). The Office of the Great Barrier Reef calculates and assesses the total score against a one to five bar qualitative confidence ranking. The Reef Independent Science Panel reviews and endorses the ranking. Appendix D provides more detail on the criteria scoring matrix and confidence score categories.

Readers of the Reef Report Card are now able to identify the confidence in the result from low to high. To improve the readers' understanding of the reported results further, the Reef Report Card could include:

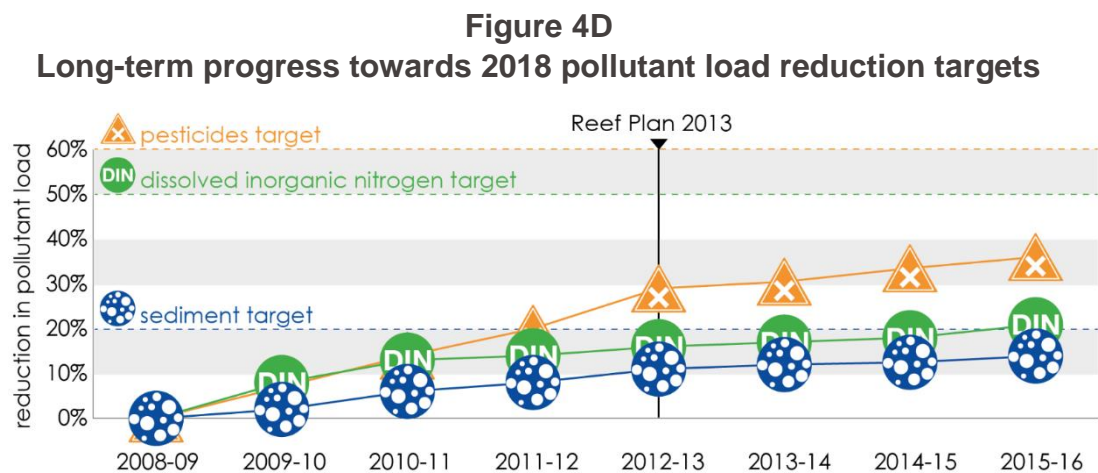
- greater clarity that the results are based on modelled (estimated) rather than monitored results
- percentages for each confidence level to provide the reader with some understanding of the potential variability associated with the estimate.

Examination of Reef Report Cards from 2014 to 2016 shows no change in confidence levels achieved from year to year.

Reef plan targets

From 2009 to 2016, the Reef Report Cards tracked the modelled progress towards the *Reef Water Quality Protection Plan* targets. They also reported on the modelled condition of the marine environment. The Reef Report Card is the prime mechanism for evaluating the success of the combined Australian and Queensland Government programs.

Figure 4D shows the long-term progress towards the 2018 pollutant load reduction targets.



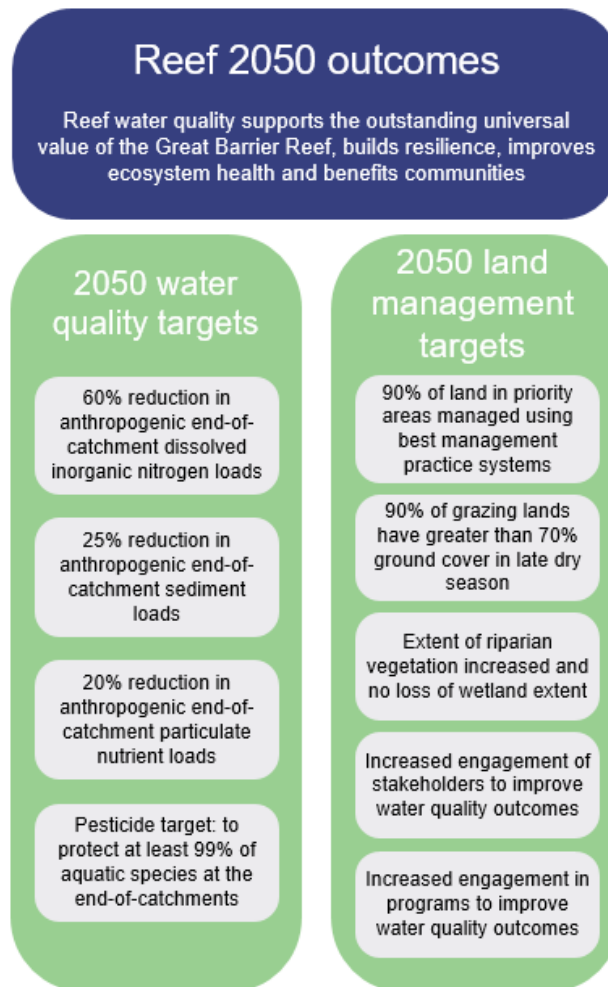
Source: *Great Barrier Reef Report Card 2016*.

While the governments have made some progress toward the *Reef Water Quality Protection Plan* targets, progress has been slow. The present trajectory, while tracking positively, will not meet the targets.

The draft *Reef 2050 Water Quality Improvement Plan* sets the targets for reducing water pollution by managing the land, catchments, and human dimensions affecting water quality.

From 2018, the Reef Report Card will report on the modelled progress of the *Reef Water Quality Improvement Plan 2017–2022*. Figure 4E shows the revised water quality and land management targets from the improvement plan.

Figure 4E
Summary of outcomes, objectives, and targets



Source: *Draft Reef 2050 Water Quality Improvement Plan 2017–2022*.

While most of the targets are relevant and informative, the three land management targets relating to riparian vegetation management and stakeholder and program engagement are ill-defined. They do not define or measure the desired increase in either the extent of riparian vegetation or engagement. This means that government cannot sufficiently report on the effectiveness of the programs and projects contributing to these targets.

Targets should be measurable to demonstrate the performance of the program. Reliable targets allow for reasonably consistent assessment of a program over time to appropriately report on the effectiveness and efficiency of the activities.



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A. Full responses from agencies

As mandated in Section 64 of the *Auditor-General Act 2009*, the Queensland Audit Office gave a copy of this report with a request for comments to the Departments of Environment and Science, Agriculture and Fisheries and Natural Resources, Mines and Energy.

The heads of these agencies are responsible for the accuracy, fairness and balance of their comments.

This appendix contains their detailed responses to our audit recommendations.



Comments received from Minister for Environment and the Great Barrier Reef, Minister for Science and Minister for Arts



Minister for Environment and the Great Barrier Reef,
Minister for Science and Minister for the Arts

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Our Ref: CTS 16359/18
Your Ref: 9170P

11 JUN 2018

Mr Brendan Worrall
Auditor-General
Queensland Audit Office
PO Box 15396
CITY EAST QLD 4002



Dear Mr Worrall

Thank you for your letter of 24 May 2018 regarding the Queensland Audit Office (QAO) Report 20: 2014-15, Managing water quality in Great Barrier Reef catchments.

I welcome the report that notes that government expenditure on the Great Barrier Reef is maximising the ability to improve the health of this precious icon. I am pleased that it finds improved governance and program design for the Queensland Reef Water Quality Program. Furthermore, it confirms that our projects are based on scientific evidence and that we are accountable for delivering on progress towards the water quality targets for Great Barrier Reef catchments.

I can advise that the Department of Environment and Science's (the department) response will be submitted to QAO by 14 June 2018.

If your officers require any further information, they can contact Ms Elisa Nichols, Executive Director, Office of the Great Barrier Reef of the department on telephone _____ or by email at _____

Yours sincerely

Leanne Enoch MP
Minister for Environment and the Great Barrier Reef,
Minister for Science and Minister for the Arts

Comments received from Acting Director-General, Department of Environment and Science



Department of
Environment and Science

Our Ref: CTS 16141/18
Your Ref: 9170P

Mr Brendan Worrall
Auditor-General
Queensland Audit Office
PO Box 15396
CITY EAST QLD 4002

Dear Mr Worrall

Thank you for your letter of 24 May 2018 regarding the Queensland Audit Office's follow up audit on Report 20: 2014-15 Managing water quality in the Great Barrier Reef catchments and the acquittal of comments raised by the Department of Environment and Science (the department) in response to the end of conduct brief.

The department has reviewed the recommendations noted in the table provided and comments have been added as per your indication.

Please extend our thanks to your audit team for their professional and warm interaction with the executives and staff of the Office of the Great Barrier Reef.

Should your officers require any further information, they may contact Ms Elisa Nichols, Executive Director, Office of the Great Barrier Reef of the department on telephone or by email at

Yours sincerely

A handwritten signature in black ink, appearing to read "R. Lawrence".

Rob Lawrence
Acting Director-General

11/16/18

Encl. (1)

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Responses to recommendations

● Queensland
● ● Audit Office
Better public services

Department of Environment and Science

Follow up of 'Managing water quality in Great Barrier Reef catchments'

Response to recommendations provided by Elisa Nichols, Executive Director, Office of the Great Barrier Reef, Queensland Department of Environment and Science.



Recommendation	Agree/ Disagree	Timeframe for implementation (Quarter and year)	Additional comments
We recommend that the Department of Environment and Science acquits actual expenditure against planned investment for Queensland's Reef Water Quality Program, in future annual investment reports, to increase transparency and accountability.	Agree	The Annual Investment Plan 2017-18 will be circulated in June in preparation for the 2018 investment acquittal. The Annual Investment Report 2017-18 will be published online by October 2018.	Departments will be asked to acquit their investment against the Annual Investment Plan 2017-18. This information will then be provided in the Annual Investment Report 2017-18 due for publication by October 2018.
We recommend that the Department of Environment and Science obtains reliable, timely, and adequate practice change information from relevant industry groups to understand the progress made, measure the degree of practice change, and account for outcomes for the public funds invested.	Agree	Already commenced. Practice change data is to be provided to the Paddock to Reef Program annually and the department will receive updates from this process.	Data will be collected through the industry led Best Management Practice (BMP) programs and other more specific practice change on-ground projects. Currently, negotiations about the next phase of BMP contracts include a mandatory clause on practice change data reporting through to the Paddock to Reef Program. All new practice change projects (contracted in 2018) already have mandatory practice change reporting requirements to Paddock to Reef. In addition, the Office of the Great Barrier Reef is pursuing commencing regular monitoring of environmental stewardship on practice change projects as early indication of practice change to create a clearer picture of a pathway growers take towards adopting new and improved farm management practices.



Recommendation	Agree/ Disagree	Timeframe for implementation (Quarter and year)	Additional comments
<p>We recommend that the Department of Environment and Science work with the Commonwealth Department of Environment and Energy, to refine over time the land management targets in the <i>Reef 2050 Water Quality Improvement Plan 2017–2022</i> to define the increase in the percentage of riparian vegetation and the increase in stakeholder engagement targeted.</p>	Agree	<p>Already commenced. New targets to be included in next version of the plan in 2022.</p>	<p>Riparian: There are a number of steps required to refine the riparian target. A scientifically robust baseline for riparian vegetation extent will be established over coming years. Erosion risk mapping for channel and streambank erosion is required. Modelling scenarios could then estimate the increases in riparian extent needed to reduce channel and streambank erosion risk. Due to the complexity in delivering this, it is proposed to focus initially on catchments that have a high channel and streambank erosion risk to develop and pilot a methodology.</p> <p>Stakeholder engagement: OGBR has contracted CSIRO to develop a baseline to provide data on the current levels of engagement and identify what barriers and opportunities exist. This information can be used to set more refined targets with the Australian Government over time to provide more meaningful measures of stakeholder engagement.</p>



Comments received from Director-General, Department of Agriculture and Fisheries

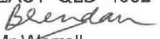


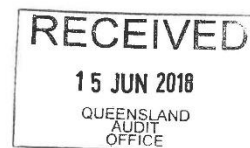
Queensland
Government
Department of
Agriculture and Fisheries

Our ref: CTS 16006/18
Your ref:

12 JUN 2018

Mr Brendan Worrall
Auditor-General
Queensland Audit Office
PO Box 15396
CITY EAST QLD 4002

Dear  Mr Worrall



Thank you for your letter of 24 May 2018 regarding the Queensland Audit Office's follow up audit on *Report 20: 2014-15 Managing water quality in the Great Barrier Reef catchments*.

Thank you for your efforts and consultation in compiling this proposed report. The Department of Agriculture and Fisheries (DAF) was invited to provide any comments in relation to the proposed report which will form part of your report to Parliament.

I am pleased that your findings indicate that the recommendations of the initial report have been largely implemented. My Department had some suggestions to improve clarity in a few places in the proposed report. These were discussed with staff from the Queensland Audit Office and the Department of Environment and Science. Based on these discussions, I support the proposed report.

My Department looks forward to continuing to work with the Office of the Great Barrier Reef and other partners to implement the *Reef 2050 Water Quality Improvement Plan 2017-2022*. While there are challenges and opportunities in any program as large and complex as this, there is a strong commitment to continual improvement in line with the recommendations of your final report.

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If you require any further information, please contact Ms Jenny Daly, Director, Resources and Planning, Strategic Policy and Planning on [redacted] or by email at [redacted]

Yours sincerely



Dr Elizabeth Woods
Director-General
Department of Agriculture and Fisheries



Comments received from Director-General, Department of Natural Resources, Mines and Energy

Your Ref 9170P
Our Ref CTS 17273/18
MO/18/1612

18 JUN 2018



Department of
**Natural Resources,
Mines and Energy**

Mr Brendan Worrall
Auditor-General
Queensland Audit Office
PO Box 15396
CITY EAST QLD 4002



Dear Mr Worrall

Thank you for your letter of 24 May 2018 regarding the follow up audit on Report 20: 2014–2015 Managing water quality in the Great Barrier Reef Catchments.

The proposed report 'Follow-up of Managing water quality in Great Barrier Reef catchments' has been reviewed and considered. The Department of Natural Resources, Mines and Energy is happy with its content and as such has no further comments on this document.

I would also like to take this opportunity to thank you and your team for their professional approach, help and support during this process.

If you have any questions, please contact Ms Karen Hopper, Director, Natural Resources Programs, Department of Natural Resources, Mines and Energy who will be pleased to assist you and can be contacted on

Yours sincerely

A handwritten signature in blue ink, appearing to read "James Purtill".

James Purtill
Director-General

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B. Audit objectives and methods

The objective of the audit is to assess whether departments have effectively implemented the recommendations made in *Managing water quality in Great Barrier Reef catchments* (Report 20: 2014–15).

The audit addresses the objective through the sub-objectives and lines of inquiry set out in Figure B1.

Figure B1
Audit scope

Sub-objectives		Lines of inquiry	
1	The departments have implemented the recommendations.	1.1	The departments have implemented the recommendations in accordance with their response or have taken appropriate alternative actions.
		1.2	The departments have implemented the recommendations in a timely manner.
2	The departments have addressed the underlying issues, which led to the recommendations.	2.1	The departments have addressed the issues that led to the recommendations.
		2.2	The departments' actions have resulted in improvements in how they deliver programs to improve water quality in the Great Barrier Reef.

Source: Queensland Audit Office.

Entities subject to this audit

- Department of Environment and Science, including the Office of the Great Barrier Reef
- Department of Agriculture and Fisheries
- Department of Natural Resources and Mines.



Audit approach

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

The audit was conducted between December 2017 and May 2018. The audit included:

- interviews with state government agencies, peak or representative bodies (for example, natural resource management bodies and industry groups), and participants in land management practice programs
- documentation review, including analysis of policies, plans, reports, guidelines, and manuals.

We visited the Burdekin and Mackay-Whitsunday natural resource management regions where we:

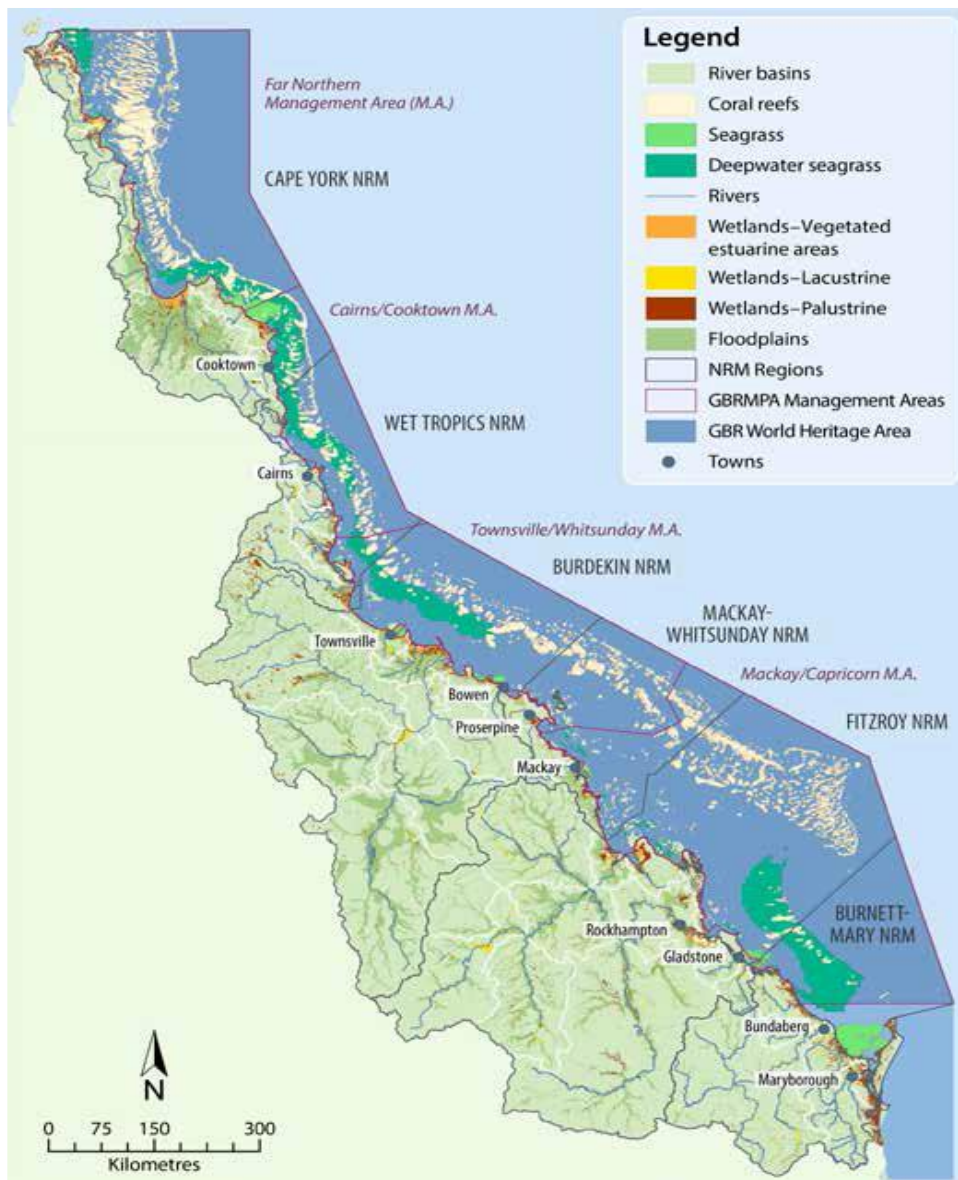
- met with participants, advisors, and extension officers for Grazing and Cane better management practice programs
- met with the water quality monitoring team and visited a water quality monitoring site.



C. Map of Great Barrier Reef and catchments

Figure C1 is a map of the Great Barrier Reef and catchments that shows the natural resource management regions.

Figure C1
Map of Great Barrier Reef and catchments



Source: James Cook University from the 2017 Scientific Consensus Statement.



D. Reef Report Card confidence level scoring

Figure D1 shows the scoring attributes for each of the five confidence ranking criteria.

Figure D1
Confidence level scoring matrix

Criteria				
Maturity of methodology (weighting 0.5)	Directness of measure	Spatial/completeness	Strength of relationship between methodology, indicator reported, and measured data	Measured error
Score = 1 New or experimental methodology	Score = 1 <ul style="list-style-type: none"> Remote sensed data with no or limited ground truthing; or Modelling or survey with no ground truthing 	Score = 1 1:1,000,000 or Less than 10% population survey data	Score = 1 Measurement of data that has conceptual relationships to reported indicator	Score = 1 Greater than 25% error or error not measured or able to be quantified
Score = 2 Peer reviewed method	Score = 2 <ul style="list-style-type: none"> Remote sensed data with regular ground truthing (not comprehensive); or Modelling with documented validation (not comprehensive); or Survey with ground-truthing (not comprehensive) 	Score = 2 1:100,000 or 10–30% of population survey data	Score = 2 Measurement of data that has a quantifiable relationship to reported indicators	Score = 2 Less than 25% error or some components do not have error quantified



Criteria				
Maturity of methodology (weighting 0.5)	Directness of measure	Spatial/ completeness	Strength of relationship between methodology, indicator reported, and measured data	Measured error
Score = 3 Established methodology in published paper	Score = 3 <ul style="list-style-type: none"> Remote sensed data with comprehensive validation program supporting (statistical error measured); or Modelling with comprehensive validation and supporting documentation; or Survey with extensive on-ground validation or directly measured data 	Score = 3 1:10,000 or 30–50% of population	Score = 3 Direct measurement of reported indicator with error	Score = 3 10% error and all components have errors quantified

Source: Scoring system, *Great Barrier Reef Report Card 2016*.

The total score is calculated and assessed against the one to five bar qualitative confidence ranking shown in Figure D2.

Figure D2
Qualitative confidence ranking

2016 Confidence score categories	Ranking
less than 6	One bar
6.5 to 8	Two bars
8.5 to 9.5	Three bars
10 to 11.5	Four bars

Source: Scoring system, *Great Barrier Reef Report Card 2016*.



E. Paddock to Reef program

Figure E1 shows the 10 interrelated components of the Paddock to Reef Integrated Monitoring, Modelling and Reporting Program (Paddock to Reef program).

Figure E1
Paddock to Reef program components

Component	Description
Management practice adoption	Estimates management practice benchmarks and change across major agricultural industries of the reef catchments.
Paddock monitoring	Conducts a range of paddock trials in various regions to provide on-ground evidence of water quality improvements from different land management practices.
Paddock modelling	Models a suite of farm management scenarios to assess water quality improvements across different soil and climatic zones.
Catchment loads monitoring	Tracks long-term trends in water quality entering the Great Barrier Reef from high priority catchments. Used to validate the modelling.
Catchment loads modelling	Estimates average annual loads of key pollutants for each of the 35 catchments draining to the Great Barrier Reef and assesses changes against baseline levels due to improvements in land management.
Ground cover	Maps and reports ground cover levels annually; also used to improve water quality model parameters. Ground cover affects soil processes including infiltration, run-off, and surface erosion. Low ground cover increases sediment loss.
Riparian vegetation	Maps and reports on riparian vegetation extent and cover every four years; also used to improve water quality model parameterisation. Riparian vegetation helps remove water-borne pollutants and provides stability to stream banks and adjoining areas to reduce sediment loss.
Wetland extent	Maps and reports on the historic and current extent of wetlands and change in wetland extent every four years. Wetlands provide a natural filtration system to protect water quality. Destruction of wetlands can result in increased sediment and nutrients flowing into the reef.
Wetland values and processes	Assesses and reports on the state of, and pressures on, wetland environmental values and associated wetland processes to inform management of wetlands and catchments for improved landscape function and water quality.
Marine monitoring	Assesses trends in ecosystem health and resilience indicators for the Great Barrier Reef in relation to water quality and its linkages to end-of-catchment loads.

Source: *Paddock to Reef Integrated Monitoring, Modelling and Reporting Program*.



F. Queensland Reef Water Quality Program roles

Figure F1 lists the departments' main roles in implementing the Queensland Reef Water Quality Program.

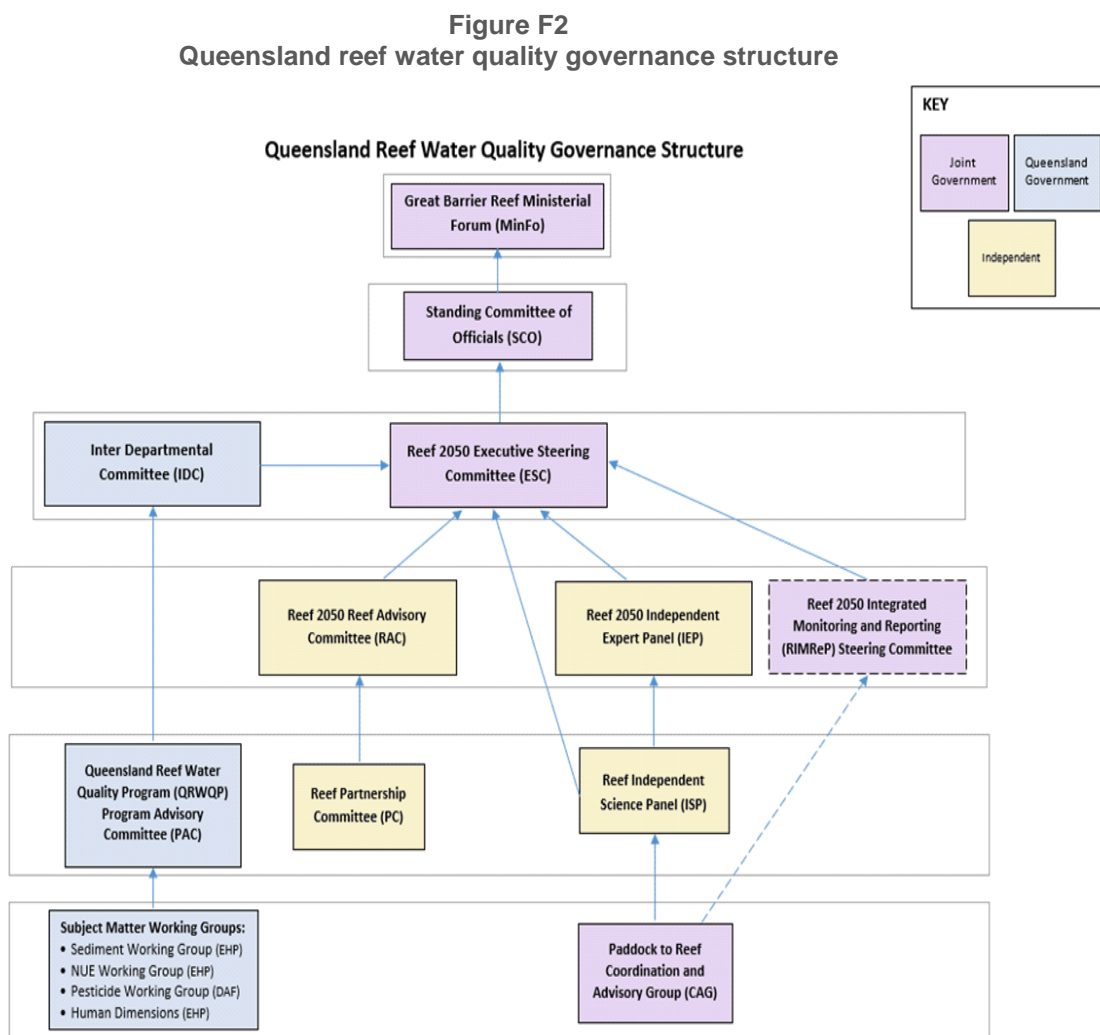
Figure F1
Queensland Reef Water Quality Program departmental roles

Department	Role in delivering the Queensland Reef Water Quality Program
<p>Department of Environment and Science</p>	<p>Office of the Great Barrier Reef</p> <p>Coordinates delivery of Queensland's reef management strategies, policy, and programs, including the Queensland Reef Water Quality Program.</p> <p>Oversees, monitors, tracks, and reports allocated investment at a whole-of-state-government level.</p> <p>Environment and Science</p> <p>Coordinates the Paddock to Reef Integrated Monitoring, Modelling and Reporting Program (Paddock to Reef program) across Queensland Government agencies, Great Barrier Reef Marine Park Authority (GBRMPA), and the Australian Government.</p> <p>Leads catchment monitoring and performs paddock and catchment scale modelling with Department of Natural Resources, Mines and Energy.</p> <p>Leads remote sensing of ground cover, riparian vegetation, and gully indicators, and wetlands extent mapping and assessment.</p> <p>Undertakes research and development projects.</p> <p>Manages Queensland's Wetlands Program.</p>
<p>Department of Natural Resources, Mines and Energy</p>	<p>Leads paddock monitoring and modelling and catchment modelling with the Department of Environment and Science.</p> <p>Leads native vegetation management through regulatory framework and delivery of statewide surface water quantity and quality monitoring.</p> <p>Provides funding and support to regional natural resource management bodies for sustainable agriculture, weed and pest management, and water quality programs.</p>
<p>Department of Agriculture and Fisheries</p>	<p>Leads development of agricultural management practices and systems, economic evaluation, and extension programs.</p> <p>Monitors the adoption of improved land management practices in partnership with regional natural resource management bodies.</p>
<p>All departments</p>	<p>Provide funding to partners to implement elements of the Queensland Reef Water Quality Program.</p>

Source: Queensland Audit Office.



Figure F2 shows the Queensland reef water quality governance structure and the relationship between joint, Queensland, and independent governance groups and committees.



Source: *The Office of the Great Barrier Reef.*



Auditor-General reports to parliament

Reports tabled in 2017–18

1.	Follow-up of Report 15: 2013–14 <i>Environmental regulation of the resources and waste industries</i>	September 2017
2.	Managing the mental health of Queensland Police employees	October 2017
3.	Rail and ports: 2016–17 results of financial audits	December 2017
4.	Integrated transport planning	December 2017
5.	Water: 2016–17 results of financial audits	December 2017
6.	Fraud risk management	February 2018
7.	Health: 2016–17 results of financial audits	February 2018
8.	Confidentiality and disclosure of government contracts	February 2018
9.	Energy: 2016–17 results of financial audits	February 2018
10.	Finalising unpaid fines	February 2018
11.	Queensland state government: 2016–17 results of financial audits	February 2018
12.	Investing for Success	March 2018
13.	Local government entities: 2016–17 results of financial audits	March 2018
14.	The National Disability Insurance Scheme	May 2018
15.	Education: 2016–17 results of financial audits	May 2018
16.	Follow-up of <i>Managing water quality in Great Barrier Reef catchments</i>	June 2018



Audit and report cost

This audit and report cost \$137 000 to produce.

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Performance engagement

This audit has been performed in accordance with ASAE 3500 *Performance Engagements*.



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