

Great Barrier Reef Water Science Taskforce

Full Interim Report–December 2015

Clean water for a healthy reef



The work of the Taskforce has called substantially on a wide body of research and evaluation that is summarised in the appendices.

Prepared by: The Great Barrier Reef Water Science Taskforce, and the Office of the Great Barrier Reef, Department of Environment and Heritage Protection

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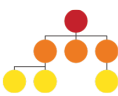

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Feedback:

Consultation with the public and stakeholders is an important component of the Taskforce's work, and the Taskforce is interested in your views on this interim report. Please visit the GBR website at <http://www.gbr.qld.gov.au/> to provide your feedback.

CONCLUSIONS AND RECOMMENDATIONS

Principles	Category	Conclusions	Recommendations
The Reef water quality targets are ambitious but important	Targets 	We need faster progress towards the targets The water quality targets are ambitious, and the focus should be on accelerating progress towards the targets.	1. KEEP AND REVIEW IN 2016 Retain the current targets and review in 2016 as part of the planned mid-term review of the Reef Water Quality Protection Plan and establish regional targets for all pollutants for Reef health.
A mix of tools are needed, not just one tool	Incentives and market approaches 	Incentives for change will be needed In order to make the significant changes needed to improve water quality for Reef outcomes, land managers will need support through financial and other incentives.	2. GREATER USE OF MARKET APPROACHES Greater use of market approaches is required to help deliver the significant change needed to improve water quality most cost effectively. These market approaches could include: <ul style="list-style-type: none"> • Concessional loans • Stamp duty relaxation for farm amalgamations • Voluntary retirement of marginal land from production • Stewardship payments for restoration • Water quality grants for practice change Access is conditional on improving management to achieve water quality outcomes.
	Regulation 	Tailored regulation will be needed Tailored regulation will be needed to reduce all sources of water pollution and should apply to agricultural, urban and industrial activities within Reef catchments. Future development should be regulated to ensure no net increase in water pollution. Any regulatory regime needs to be simple, easily measured and developed consultatively.	3. INTRODUCE MORE OUTCOMES-BASED REGULATIONS FOR ACTIVITIES IN A STAGED WAY Introduce outcomes-based regulations for activities that impact on Reef water quality, staged over time. This should include: <ul style="list-style-type: none"> • Determining pollution load limits at sub-catchment and end-of-catchment scales to meet the water quality standards. • Developing options for farm-scale and point source water quality permit schemes. • Concurrently developing low cost options for measuring water quality. • Developing evidence-based regulations to protect riparian areas and wetlands in all Reef catchments. • Implementing continuously improving water quality practice standards.
	Extension 	Better extension is fundamental Agricultural extension (the application of scientific and new knowledge to improve land management), particularly when aligned with other mechanisms such as incentives, is fundamental for improved land management.	4. INVEST IN MORE EFFECTIVE, TARGETED AND COORDINATED EXTENSION Invest in more effective, targeted and, coordinated extension for improved Reef water quality outcomes. Through agreement build capacity and networks across local delivery organisations. Use smarter and more innovative approaches including facilitated peer to peer learning.
Smart delivery and much better communication will be critical to success	Communication 	Leadership and communication are essential Leadership and communication are essential for improving water quality for a healthy reef.	5. IMPROVE COMMUNICATION AND INFORMATION COMMENSURATE WITH A MAJOR CHANGE PROGRAM OF THE SCALE REQUIRED Develop collaboratively, and implement, an integrated communications strategy, commensurate with a major change campaign of the scale required to provide clear, consistent information to landholders, industry, peak bodies and the broader community and build unity around the need to improve water quality and communicate progress.

Principles	Category	Conclusions	Recommendations
Smart delivery and much better communication will be critical to success	Investment planning 	Additional resources and leveraging will be needed Reaching the targets is likely to require funds well beyond those allocated by both governments. Strategic leveraging, e.g. through public-private partnerships and innovative funding vehicles, will be required.	6. DEVELOP A STRATEGIC INVESTMENT PLAN AND ESTABLISH PUBLIC-PRIVATE PARTNERSHIPS Develop and implement a strategic investment plan for the \$90 million, combined with Queensland's existing \$35 million per year expenditure (and the Reef Trust \$140 million) and use this to better leverage corporate and philanthropic funds through public-private partnerships.
	Knowledge, science and innovation 	Innovation will be needed to achieve targets Transformational change is required to deliver substantial water quality improvement, through policy, land management practices, new technology and monitoring. There is non-alignment of R&D across various research funders currently.	7. BETTER ALIGN SCIENCE AND FUND DEVELOPMENT OF NEW IDEAS AND SOLUTIONS Strongly align science to deliver solutions to priority Reef water quality problems. Fund synthesis and communication of knowledge to ensure it supports policy development, investment decisions and on ground action. Use some of the available funding to facilitate further development of new ideas and technologies to prove and successfully transfer these ideas for wide adoption.
	Monitoring, modelling and reporting 	Current investment in monitoring, modelling and reporting is insufficient Current investment in monitoring and modelling is not enough to adequately measure GBR-wide water quality status and trends for both catchment and marine systems. It also cannot evaluate the impact of practice change on land at appropriate scales. Regular and clear reporting on progress towards the targets is vital and should be part of broader reporting for the Reef 2050 Long Term Sustainability Plan and Reef Water Quality Protection Plan (e.g. through Outlook reporting and annual Reef report cards).	8. FUND ADDITIONAL REEF-WIDE AND FINER SCALE MONITORING, MODELLING AND REPORTING Provide additional Reef-wide funding to fill high priority monitoring and evaluation gaps to enable better understanding of the current adoption of management practices across the industries and the effectiveness of programs in addressing water quality. As part of the two major integrated projects provide funding for finer-scale catchment monitoring and modelling that can be used for evaluation purposes and that can be fed back to stakeholders to influence farm practices and provide effective evaluation of these projects to inform further roll-outs. Ensure monitoring and modelling feeds into regular, harmonised reporting across the State and Commonwealth.
	Governance 	Current governance is too complex Reef-wide, water quality governance arrangements from policy to on ground delivery are complex with relatively poor coordination across the system.	9. SIMPLIFY GOVERNANCE (AND CLARIFY ROLES AND RESPONSIBILITIES), POOL RESOURCES AND BETTER ALIGN PROGRAM DELIVERY Simplify the current governance arrangements (and clarify roles and responsibilities), pool resources and better align funding, program delivery and communication for improved effectiveness.
Bringing it all together in a few areas will provide an important demonstration of impact	Major projects 	Consider a small number of major projects as proof of concept Major projects are needed in a small number of hot spots that integrate and evaluate the combined effectiveness of a range of tools and innovative approaches as a proof of concept for ongoing investment.	10. IMPLEMENT TWO MAJOR DEMONSTRATOR PROJECTS (ONE IN THE WET TROPICS AND ONE IN THE BURDEKIN) TO EVALUATE TOOLS TO INFORM DESIGN OF FUTURE PROGRAMS Implement two major integrated projects, one on sediment (e.g. in the Bowen catchment of the Burdekin) and one on nutrients and pesticides (e.g. in the Johnstone and Tully catchments in the Wet Tropics) to demonstrate and evaluate how to best reduce pollutants reaching the Reef and inform design of future programs.

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INTRODUCTION AND BACKGROUND

1. An overview of the Great Barrier Reef

- **The Great Barrier Reef (the Reef) is the world's largest coral reef system**, comprising approximately 3000 reefs and extending over 2000 km along the Queensland coast.
- **The Reef was listed on the World Heritage Register in 1981 due to its 'Outstanding Universal Value' because of its natural significance which is so exceptional as to transcend national boundaries and to be of common importance for present and future generations of all humanity.**
- While the 450 species of coral build reefs that are the most visible natural 'value' in the Reef ecosystem, it is the **Reef ecosystem as a whole** (including seagrasses, mangroves, sandy and muddy communities, coastal wetlands, islands and continental slope depths) that are important. It is the broader ecosystem that was recognised in the World Heritage Area listing.
- **The Reef contains the greatest species diversity of any World Heritage Area on the planet**, including:
 - 56% of the world's hard coral species
 - 1/3 of the world's soft coral and sea pen species
 - 6 of the world's 7 species of marine turtles
 - 54% of the world's mangrove diversity
 - 23% of the world's seagrass diversity
 - 13% of the world's species of starfish, sea urchins and cucumbers
 - Seabird breeding colonies on islands of world significance, and
 - One of the world's most important populations of dugongs.
- Traditional owners have cared for the Reef for thousands of years and have a special connection with it.
- **The contribution of the Reef to the Queensland and Australian economy is estimated to be close to \$6 billion a year**, generating over 69,000 jobs across the tourism, recreation, commercial fishing, and scientific research and management industries.

- **Agriculture is a dominant land use in the catchments adjacent to the Reef**, employing over 35,000 people and contributing approximately \$3.7 billion annually in gross value of production.
- For decades the Reef has been regarded as the best managed coral reef in the world, as a result of many years of joint management by governments and collaboration with stakeholders.
- The **Reef 2050 Long Term Sustainability Plan** (Reef 2050 Plan) completed in 2015 provides a 35 year blueprint for its management. Improving water quality is an important priority in that plan.



Further information:

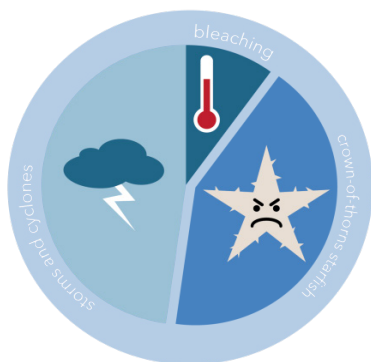
As part of the work of the Taskforce, a comprehensive '**Current Situation Analysis**' was prepared.

It can be found online at www.gbr.qld.gov.au

2. The problem

- **The Reef is facing a number of serious challenges.**
- Over the last 30 years, **coral cover has declined by nearly 50% on mid-shelf and offshore reefs.**
- Though the causes of this change are not fully understood, **coral cover is impacted significantly by outbreaks of crown-of-thorn starfish and cyclones, and to a lesser extent, bleaching events.**
- Since 1985, the shallow (less than 20m depth) hard coral cover has declined from 28% to 13.8% mainly in the southern two-thirds of the Reef.
- Significant, **widespread losses of seagrass** have occurred in areas directly affected by cyclones Yasi (2011), Marcia (2015) and Nathan (2015); seagrass abundance south of Cooktown has declined since 2009.
- The dugong population south of Cooktown has drastically declined from 1962 levels.
- Every five years, the **Great Barrier Reef Marine Park Authority** provides an assessment of the outlook for the Reef. The most recent **Outlook Report (2014)** concluded that: **‘Even with the recent management initiatives to reduce threats and improve resilience, the overall outlook for the Great Barrier is poor, has worsened since 2009 and is expected to further deteriorate in the future. Greater reductions of threats at all levels, Reef-wide, regional and local, are required to prevent the projected declines in the Reef and to improve its capacity to recover.’**

This diagram is illustrative and depicts the causes of major coral loss in mid-shelf and off-shore reefs over the past 30 years, based on the Australian Institute of Marine Science long term monitoring of coral.



- The 2014 Great Barrier Reef Outlook Report stated the **highest risks are:**
 - 1) climate change,**
 - 2) land-based run-off** (with the greatest effect on the in-shore areas as well as mid and outer areas),
 - 3) coastal land-use change,** and
 - 4) some aspects of direct use** (such as fishing, shipping and port activities).
- **The most serious future threat to the Reef are the likely impacts of climate change such as sea level rise, ocean acidification, temperature increases and increased intensity of storm events.** While efforts to reduce global climate change are underway, the focus must be on reducing other pressures to improve the Reef's resilience, giving it a greater capacity to bounce back from disturbances.
- **Improving water quality now should give the Reef its best possible chance to build resilience and survive well into the future.**

Catchment run-off impacting water quality:

- It has been recognised that coral reef resilience to long-term system-wide pressures such as climate change is strongly dependent on reducing more immediate pressures such as catchment run-off.
- Land, water and marine use has meant more erosive capacity, increased stream power, less filtering and trapping by vegetated riparian areas and functioning wetlands, an increase in certain nutrients, the presence of various deleterious chemicals and an overall reduction in net primary productivity.
- **Agricultural land uses are the main source of nitrogen, sediment and pesticides into the Reef.**
- Other land uses, such as industrial, mining, port development, dredging and urban development overall contribute relatively small loads of pollutants to the Reef, however can be locally significant. These industries are generally more heavily regulated than agriculture.
- **One of the most manageable impacts on the Reef is human-induced run-off of pollutants from rivers flowing to the Reef.**
- The understanding of the highest risk pollutants to ecosystems in the Reef and the relative priorities between the areas has improved significantly over the last five years.

- The 2013 **Scientific Consensus Statement** on land use impacts on Reef water quality and ecosystem condition was prepared by an independent panel of 40 leading scientists. It identified **the greatest water quality risks to the Reef are from excess nitrogen discharges and fine sediment discharge**, while for coastal and freshwater ecosystems pesticides can also pose a significant risk:
 - **Excess nutrients** in the marine environment are associated with **outbreaks of destructive coral eating crown-of-thorns starfish** as well as increased susceptibility of corals to disease and bleaching as well as the promotion of microalgae growth.
 - **Fine sediment** discharges reduce **light** available to seagrass ecosystems and inshore coral reefs.
 - **Pesticides inhibit primary production, seagrass and coral growth** and at high concentrations, can lead to mortality.
- The dominant source of **nitrogen** and pesticides are from agricultural fertiliser and agrichemical use in intensive cropping, predominantly **sugarcane farms**, where large amounts of nitrogen fertiliser are used to maximise crop production.
- A large proportion of **sediment** losses are derived from **grazing** lands.
- **Erosion**, particularly in grazing lands, is a significant source of particulate nutrients. Efforts to reduce erosion and sediment run-off will also help in reducing nutrient loads.
- The important role of wetlands and coastal ecosystems in regulating water quality and providing connectivity to the Reef for many species is becoming more and more apparent. Many wetlands and coastal ecosystems have been lost over the last 100 years and their restoration is expected to contribute to water quality improvement, but by how much, is still somewhat unclear.

Attributes which contribute to the health of corals include:

- **Water temperature:** it should not fall below about 19 degrees or rise above about 33 degrees Celsius.
- **Acidity:** low pH is fatal to corals, yet it is falling in Reef waters mainly from the absorption from the atmosphere of CO₂ generated by the use of fossil fuels, leading to the generation of carbonic acid in the water column. Even smaller, non-lethal increases in acidity slow down coral growth, severely impacting their resilience to other stressors.
- **Increased nutrient levels in the water column:** arising mainly from run-off from farmland, these reduce coral resilience to thermal stress and enhance algae growth. Algae then tend to dominate the ecosystem at the expense of corals. Enhanced algae in the water column also increases the survival of crown-of-thorns starfish larvae.



Priority areas of concern:

- There is a much better understanding now of the highest risk pollutants and areas (Table 1).
- The **Wet Tropics and Burdekin regions** are the priority for reducing **nutrient run-off**.
- The **Burdekin and Fitzroy regions** are the priority for reducing **sediment run-off**.
- The **Lower Burdekin and Mackay Whitsunday regions** are the priority regions for reducing **pesticide run-off**.
- Within each region, there are individual catchments that are high priorities for the different pollutants (e.g. Normanby and Mary Rivers for sediment run-off).

Table 1: Water quality relative risk assessment

A combination of qualitative and semi-quantitative assessments was used to estimate the relative risk of water quality constituents to Great Barrier Reef ecosystem health (Brodie et al. 2013).

Note: The outputs of the relative risk assessment from 2013 were based on the best available information at the time. Further information has become available since then through the water quality improvement plans (WQIPs) and may allow for the risk assessment to be updated, particularly for Burnett Mary. Regardless, the risk assessment is relative and the results should not be considered absolute differences in the risk to the Reef. In this regard, even the lowest ranked regions of the Burnett Mary and Cape York region may pose a risk to Reef ecosystems.

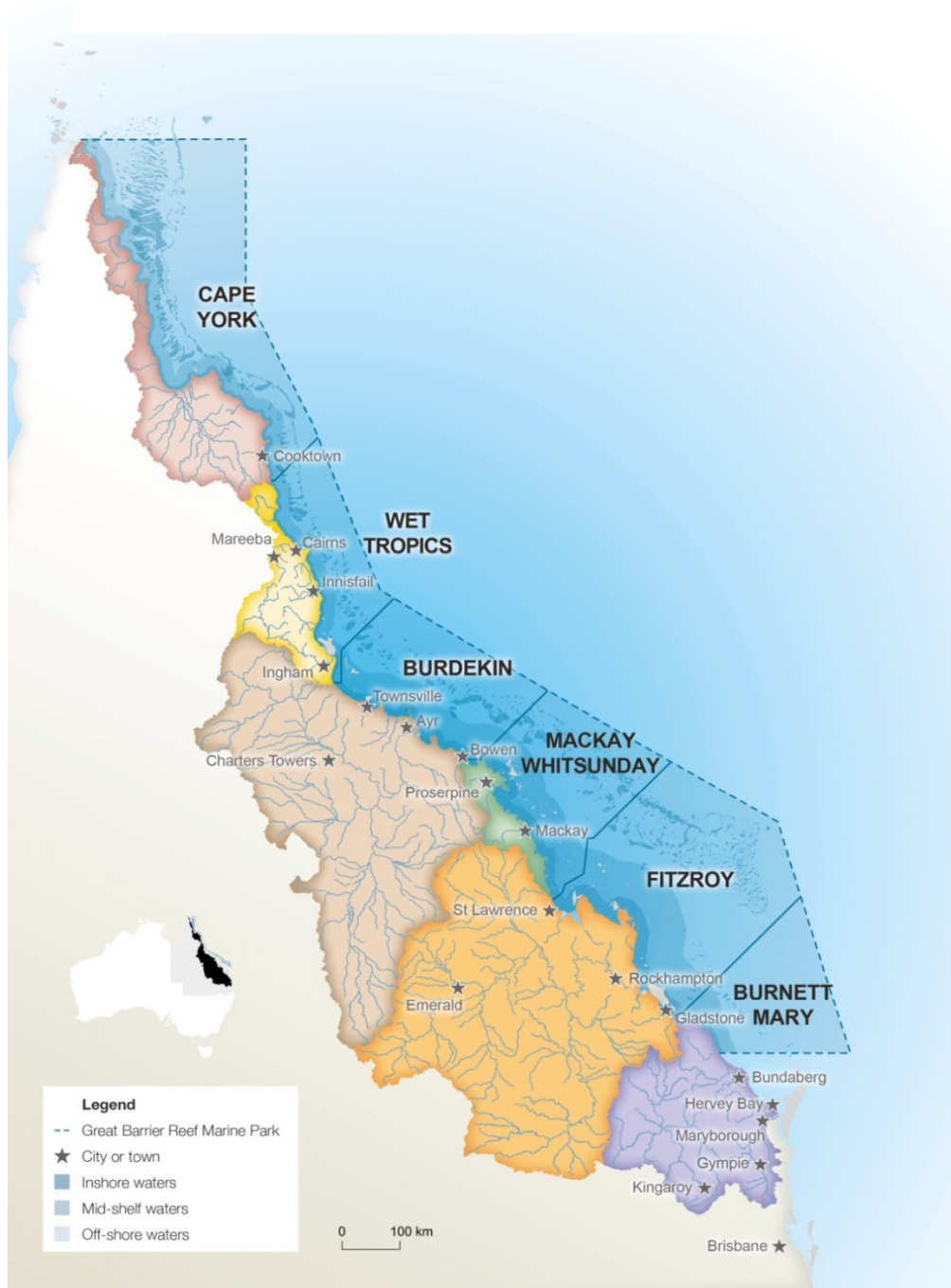
Region	Overall relative risk	Priority pollutants for management		
		Nitrogen	Pesticides	Sediment
Cape York	LOW			
Wet Tropics	VERY HIGH			
Burdekin	HIGH	*		
Mackay Whitsunday	MODERATE			
Fitzroy	HIGH			
Burnett Mary	UNCERTAIN**			

* Lower Burdekin and Haughton focus

** Most reefs and seagrass meadows in this region were not included formally in the analysis and therefore the validity of the result has high uncertainty



Map of the Great Barrier Reef and catchments, with NRM regions shown.



3. Our task

- **The Great Barrier Reef Water Science Taskforce was established in May 2015 to provide the Queensland Government with the best possible advice on how it can meet its ambitious long term water quality targets and recommend the priority actions for investing an additional \$90 million over five years.** An additional \$10 million has been allocated to fishing election commitments and the establishment of three net-free fishing zones in the Reef.
- In providing advice on investment priorities for the \$90 million, existing Queensland Government investment and future Australian Government investment are also considered.
- **The purpose of this Interim Report is to outline initial findings of the Taskforce** in terms of identifying where we are now, where we want to be and how to get there. This has resulted in a range of preliminary conclusions and recommendations. **This Interim Report provides the basis for broad consultation with stakeholders.** The Final Report of the Taskforce will be completed by May 2016.



Terms of Reference (Extract):

The Great Barrier Reef Water Science Taskforce will provide advice and recommendations to the Minister for Environment and Heritage Protection and Minister for National Parks and the Great Barrier Reef and the Queensland Government more broadly on:

- *the best approach to meeting the government's water quality targets, including the effectiveness and cost of robust regulations, incentives, Best Management Practice Programs, market-based trading mechanisms and other policy instruments, or a combination thereof.*
- *priority areas for investment for the additional \$100 million including:*
 - *upgrades to, and extension of the water quality monitoring network, scientific research where critical to support the recommended approach to meeting the targets, and/or facilitating the effective translation of current research into practice improvement*
 - *promoting environmentally sustainable industry practices especially to support primary producers in Reef catchments to reduce fertiliser and sediment run-off (including consideration of a potential net benefit policy)*
- *opportunities to align different sources of funding (e.g. from the Australian Government) and leverage Queensland Government investment effectively.*
- *opportunities to maximise and align other sources of funding such as private/philanthropic and various science funds (e.g. the Advance Queensland Initiative and National Environmental Science Programme).*
- *ensure outcomes can be effectively monitored and reported over time, including providing advice on the adequacy of existing monitoring and reporting activities.*

The key objective for the Taskforce is to provide advice to the Queensland Government on how to help ensure that clean water flows from the rivers to the sea to protect the Reef for future generations.

4. Water Quality Targets

- In 2003, the **Reef Water Quality Protection Plan** committed the Queensland and Australian governments to halting and reversing the decline in water quality entering the Reef within 10 years. An additional goal was added in 2009, which was to ensure that by 2020 the quality of water entering the Reef from adjacent catchments has no detrimental impact on Reef health and resilience. This was refined in 2013 to ensure that by 2020 the quality of water entering the Reef from broadscale land use has no detrimental impact on the Reef health and resilience.
- Pollutant load reduction targets for water quality improvement in the Reef have been used in the Reef Water Quality Protection Plan since 2009 to help guide water quality improvement programs. The evolution of water quality targets is shown in Table 2.
- The Reef Water Quality Protection Plan 2013 includes a number of water quality and catchment improvement targets for 2018.
- Since this plan was prepared, further scientific studies have recommended revised targets such as a 50-90% reduction in dissolved inorganic nitrogen in Burdekin and Wet Tropic catchments which may be required to meet the Great Barrier Reef Water Quality Guidelines (which identify the water quality thresholds that need to be met to ensure the health of coral and seagrass).
- As a result, more ambitious **targets were committed to by the Queensland Government and adopted in the Reef 2050 Plan**. The Taskforce has been tasked with addressing these targets, which are:
 - **Reduce nitrogen run-off by up to 80% in key catchments such as the Wet Tropics and the Burdekin by 2025.**
 - **Reduce total suspended sediment run-off by up to 50% in key catchments such as the Wet Tropics and the Burdekin by 2025.**
- These targets are based on the best available science, (e.g. Wooldridge et al (2006) and Brodie et al (2014)), but there are still knowledge gaps.
- The **Reef 2050 Plan**, with a wider focus than just water quality, is the overarching framework for protecting and managing the Reef from 2015 to 2050.
- The Reef 2050 Plan was developed jointly by Queensland and the Australian governments and the Great Barrier Reef Marine Park Authority in close consultation with stakeholders.
- It was submitted to UNESCO World Heritage Centre in March 2015 for consideration at the 39th session of the World Heritage Committee June/July 2015, where it was endorsed.
- The responsibility for implementation of the Reef 2050 Plan is shared between the Australian and Queensland governments.

- A planned review of Reef Water Quality Protection Plan targets in 2016 will be a timely opportunity to refine the targets and better define them at regional and potentially, basin scale. It will also ensure they are appropriately 'nested' within and help deliver on the Reef 2050 Plan.
- This review of targets in 2016 will utilise new information and modelling as a result of the innovative eReefs project (see details on eReefs on page 17).
- Experience from other regions such as Moreton Bay suggests that being able to clearly identify contributions to the total pollutant load from various sources is very useful in mobilising action. In South East Queensland, a simple nutrient and sediment budget (i.e. proportion of nutrient and sediment from different sources and how it moves through the system) was prepared to inform discussions with stakeholders. A similar approach could be taken in the Reef utilising the existing catchment modelling. Contributions to targets by different industries and regions could then be identified.



Table 2: History and evolution of the Reef water quality targets since 2009

Plan	Nutrient	Sediment	Pesticides	Basis of targets (best available at time)
2003 Reef Water Quality Protection Plan <i>Goal: Halting and reversing the decline in water quality entering the Reef within 10 years</i>	No specific nitrogen reduction target	No specific sediment reduction target	No specific pesticide reduction target	Available data and expert opinion
2009 Reef Water Quality Protection Plan Goals: <ul style="list-style-type: none"> 2013: Halt and reverse the decline in water quality entering the Reef by 2013. 2020: To ensure that by 2020 the quality of water entering the Reef from adjacent catchments has no detrimental impact on the health and resilience of the Great Barrier Reef. 	By 2013 there will be a minimum 50% reduction in total nitrogen and phosphorus loads at the end of catchments.	By 2020 there will be a minimum 20% reduction in sediment load at the end of catchments.	By 2013 there will be a minimum 50% reduction in pesticides at the end of catchments.	Stretch targets based on initial Water Quality Improvement Plans, available data and expert opinion.
2013 Reef Water Quality Protection Plan <i>Goal: To ensure that by 2020 the quality of water entering the reef from broadscale land use has no detrimental impact on the health and resilience of the Great Barrier Reef.</i>	By 2018 at least a 50% reduction in anthropogenic end-of-catchment dissolved inorganic nitrogen loads in priority areas. By 2018 at least a 20% reduction in anthropogenic end-of-catchment loads particulate nutrients in priority areas.	By 2020 there will be a minimum 20% reduction in sediment load at the end of catchments. By 2018 at least a 20% reduction in anthropogenic end-of-catchment loads of sediments in priority areas.	By 2018 at least a 60% reduction in end-of-catchment pesticide loads in priority areas.	Source Catchments modelling of best practice. Nitrogen target changed to Dissolved Inorganic Nitrogen (DIN). The phosphorus target was removed.
2015 Queensland Government election commitment targets	By 2025 reduce nitrogen run-off by up to 80% in key catchments such as the Wet Tropics and the Burdekin.	By 2025 reduce total suspended sediment run-off by up to 50% in key catchments such as the Burdekin.		Ecologically based targets are available in some regions (e.g. Wet Tropics, Burnett Mary)
2015 Reef 2050 Long-Term Sustainability Plan 2050 outcome: Reef water quality sustains the Outstanding Universal Value, builds resilience and improves ecosystem health over each successive decade.	By 2018 , at least a 50% reduction in anthropogenic end-of-catchment dissolved inorganic nitrogen loads in priority areas, on the way to achieving up to an 80% reduction in nitrogen by 2025. By 2018, at least a 20% reduction in anthropogenic end-of-catchment loads of particulate nutrients in priority areas.	By 2018 , at least a 20% reduction in anthropogenic end-of-catchment loads of sediments in priority areas, on the way to achieving up to a 50% reduction by 2025.	By 2018 , at least a 60% reduction in end-of-catchment pesticide loads in priority areas	Combines Reef Water Quality Protection Plan 2013 targets and Queensland Government election commitment targets
2016 Reef Water Quality Protection Plan: Mid-term Review	Targets to be determined	Targets to be determined	Targets to be determined	Available data and expert opinion, eReefs modelling

How the targets are derived

- Water quality targets are based on critical threshold levels for different water quality parameters to ensure that the marine ecosystem is adequately protected.
 - There are a range of policies in place that help set the relevant water quality thresholds from the national level to the local level – the Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000, the Water Quality Guidelines for the Great Barrier Reef Marine Park 2010 and the *Queensland Environment Protection (Water) Policy (2009)*.
 - Under these policies, water quality objectives are identified for different waterways and set out the long-term goals for water quality that will help protect and maintain the freshwater and marine ecosystem.
- Water quality objectives are numerical concentration levels of indicators (e.g. 2.0 µg/L Chlorophyll-a or Secchi disk depth in metres) that will ensure protection of the designated environmental values for those waters.
 - Water quality objectives are based on local, regional or national water quality guidelines depending on information available – the more locally relevant the better.
 - Empirical studies and/or catchment and marine modelling are then needed to estimate the end of river loads needed to achieve those water quality objectives (Figure 1). This also takes into consideration the impact of climate variability and flood cycles.

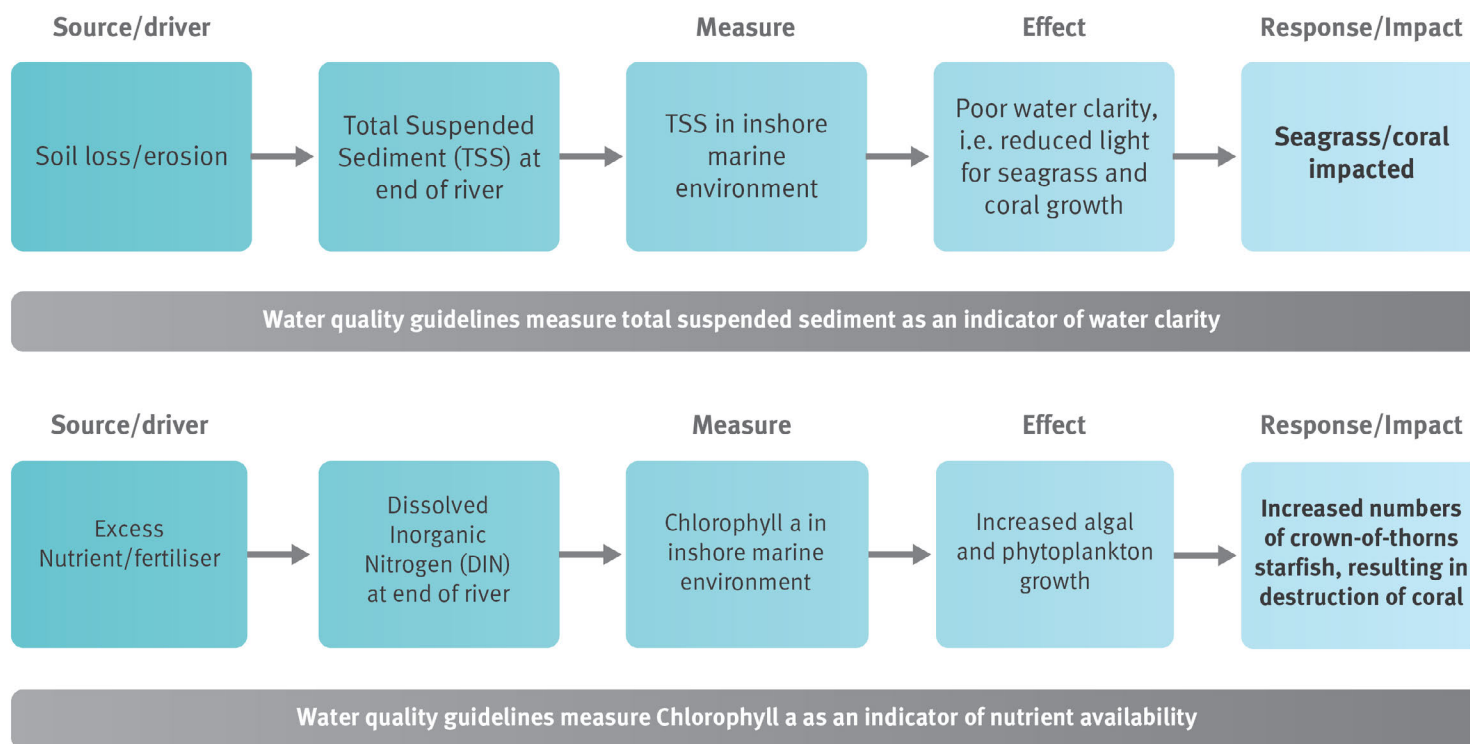


Figure 1: The impacts of excess nutrient and sediment

eReefs

- Due to the long-term nature of ecosystem responses, monitoring information alone does not give timely feedback on the effectiveness of management changes and improvements. It is also clouded by normal climate variation and natural complexity.
- **Marine water quality modelling** assesses how the marine environment responds to changes in end-of-catchment loads and helps evaluate if progress toward catchment targets is producing the expected outcomes for the Reef.
- The eReefs project will provide marine water quality modelling tools to cover the catchment to Reef continuum, helping to predict how water and pollutants move and affect the Reef. It will support near real-time water quality information in a manner similar to how meteorological modelling is used to help predict the weather.
- The project is developing the capability and tools to undertake integrated modelling, and improve the type and delivery of water quality information to end-users. The project commenced in 2012 and is now in phase 2. Early scenario results from the modelling are expected in 2016.
- The project is managed by the Great Barrier Reef Foundation with work undertaken by CSIRO, the Australian Institute of Marine Science, the Bureau of Meteorology and the Queensland Department of Science, Information Technology and Innovation.
- The project is partly funded out of the \$90 million funding allocation for water quality from the Queensland Government. The \$2 million allocation builds on a \$12 million investment from the Queensland and Australian governments and the private sector in the eReefs project, as well as historical investments by the Queensland Government.
- **The mid-term review of the water quality targets will incorporate new information and modelling from the eReefs project.**



CONCLUSION

We need faster progress towards the targets

The water quality targets are ambitious, and the focus should be on accelerating progress towards the targets.

RECOMMENDATION 1

Keep and review in 2016

Retain the current targets and review in 2016 as part of the planned mid-term review of the Reef Water Quality Protection Plan and establish regional targets for all pollutants for Reef health.

WHERE ARE WE NOW?

5. Progress to date

- **Progress has been made over the last twelve years to improve water quality in Reef catchments.**
- Some considerable changes have been made across many sectors (including local government, urban development, agriculture, tourism, resources and ports), and there is a strong commitment in these industries to improving sustainability to not only ensure the prosperity of these sectors and industries into the future, but also to protect the Reef.
- There has been significant investment made in reducing point source impacts, such as sewage treatment plant upgrades by local government and industry. The Queensland Government has supported local government with the upgrade of sewage treatment plants discharging into coastal waters that enter the Great Barrier Reef Marine Park. In addition, local government investment is significant. In 2014-15 local councils invested around \$230 million in protecting and managing the Reef, including improving sewage treatment and water quality, rehabilitating waterways and coastal areas, managing vegetation and pests, sustainable agriculture initiatives and local community education.
- In a number of cases, landholders have extensively invested their own funds to help improve water quality (e.g. up to \$1.80 was contributed by the landholder for every \$1 provided by the Reef Rescue program from 2008-13. \$202,500 was invested by the Queensland Government into the Reef Rescue program).
- **However, the resulting changes have not been rapid or widespread enough.**

Great Barrier Reef Report Card 2014

- The **Reef Report Card reports on progress towards targets in the Reef Water Quality Protection Plan 2013**. This includes targets for:
 - **land management practices for the main agricultural industries, and**
 - **catchment pollutant loads.**
- The Reef Report Card shows modelled long term average loads of five different pollutants (dissolved inorganic nitrogen (DIN); particulate nitrogen (PN), particulate phosphorus (PP), sediment and pesticides).
- But, as shown by the **Reef Report Card**, modelled long term average loads of **dissolved inorganic nitrogen have reduced by only 17% and sediment by 12% compared to a 2009 baseline** (Figure 2).

- **Despite significant investment and goodwill from all parties, not enough has been achieved to prevent further decline and accelerated uptake of improved practices is urgently needed to increase progress towards the targets.**
- The target for adoption of best practice land management is 90% of the land area by 2018 (Figure 3). The Reef Report Card shows the area of land managed under best management practice systems for each industry across the Reef was:
 - **sugarcane** - approximately 13% for nutrients, 30% for pesticides and 23% for soil
 - **grazing erosion** - approximately 28% for pastures, 47% for streambanks and 24% for gullies
- While the measured progress towards water quality targets in many areas is still far from fast enough or sufficient, considerable investment provides a strong foundation for further improvements using a mix of different policy mechanisms.

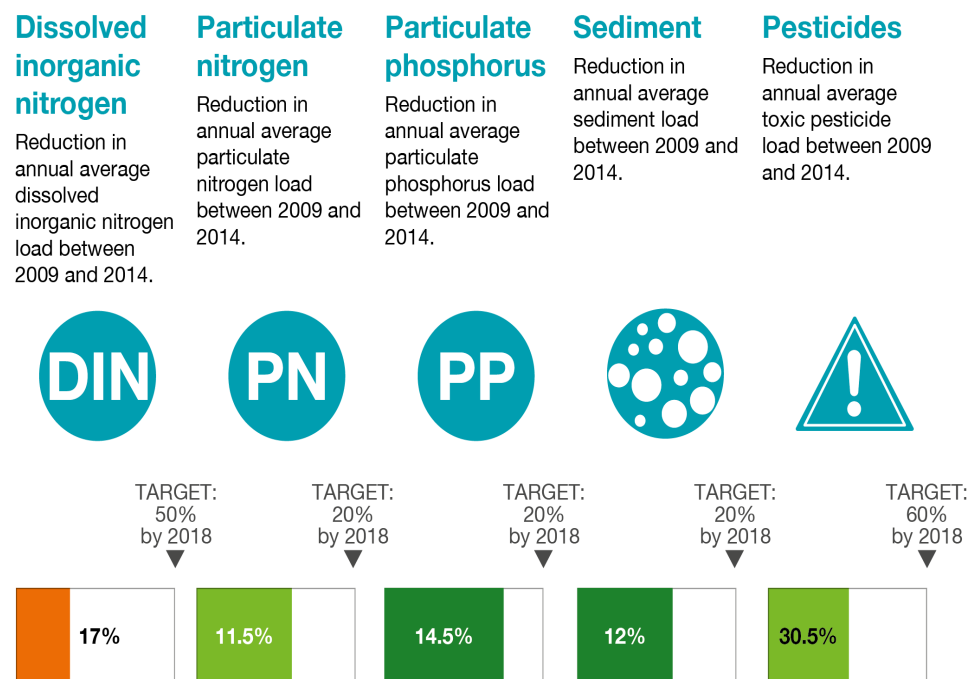


Figure 2: Reef Report Card 2014 catchment load results. Red = very poor; Orange = poor; Yellow = moderate; Light green = good; Dark green = very good.

Sugarcane

Area of sugarcane lands managed using best management practice systems as at June 2014.



Grazing

Area of grazing lands managed using best management practice systems as at June 2014.



Horticulture

Area of horticulture lands managed using best management practice systems as at June 2014.

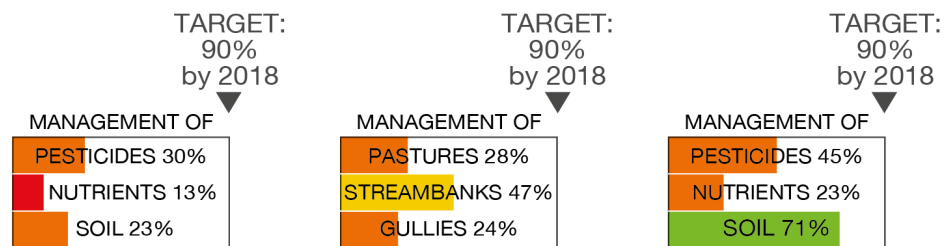


Figure 3: Reef Report Card 2014 management practices results for Sugarcane, Grazing and Horticulture. Red = very poor; Orange = poor; Yellow = moderate; Light green = good; Dark green = very good.

- There are approximately 3,100 cane growers and 9,000 graziers in the Reef catchments (Source: Australian Bureau of Statistics, Agricultural Commodities, State and NRM Region–Queensland–2012–13).
- Farmers across more than 40% of cane land area have implemented the voluntary, industry-led Smartcane Best Management Practice (BMP) program where they assess their practices against industry standards and identify opportunities for improvement. **While the number of growers participating is substantial since the program commenced in 2013 (1003), only 33 are actually accredited.**

- Similarly, for the Grazing BMP, 1178 have participated but only 17 are accredited.
- However, there has been some real achievement in improved practices that make up best management practice. For example, 92% of cane growers in the Wet Tropics have implemented green trash blanketing. Practices like minimum tillage and controlled traffic are almost the norm now and have helped to reduce sediment run-off from cane farms.
- The Reef Report Card 2014 concluded that accelerated improvements in land management will be needed to increase progress towards the Reef 2050 targets.
- Programs like Reef Rescue, which ran from 2009 to 2013, provided support for land management improvement and leveraged significant private investment from farmers and graziers, and were regarded as highly successful by many stakeholders. **Many of the right tools are available, such as extension, industry led BMP programs, grants and monitoring programs, but need to be better integrated and ramped up.**



6. Change needed

- The Taskforce considered the 2025 water quality targets aspirational in the prescribed timeframe and with the current resources available.
- **Transformational change is needed in management approaches over the next 5-10 years** if the targets have any chance of being achieved.
- Transformation change for Reef water quality outcomes will occur when there is a fundamental shift in the way the land is managed. For example, changed crops, calculating fertiliser based on zonal or 'management unit yield potential', better fertilisers that improve nitrogen use efficiency and retirement of unproductive, unprofitable land.
- **The challenge is to lead and manage a much needed and significant change program across such a vast scale.** A program of this scale is likely to require significantly more investment than currently available. **Leadership, clearly defined accountabilities, and adequate resourcing, are key.**
- To prevent any further decline in water quality, there must also be adequate protection of landscapes (e.g., riparian and wetland areas) that are still in good condition (applying a 'no worsening' principle).
- Figure 4 shows progress to date, the outcome of continued business as usual as per current investment, and an indicative steep trajectory that will be needed to meet water quality targets.
- Like any major change program, care must be taken to ensure that changes are locked in for the long term to avoid having to invest multiple times to achieve the same gains.



Nitrogen and Sediment load reductions required to meet 2025 targets

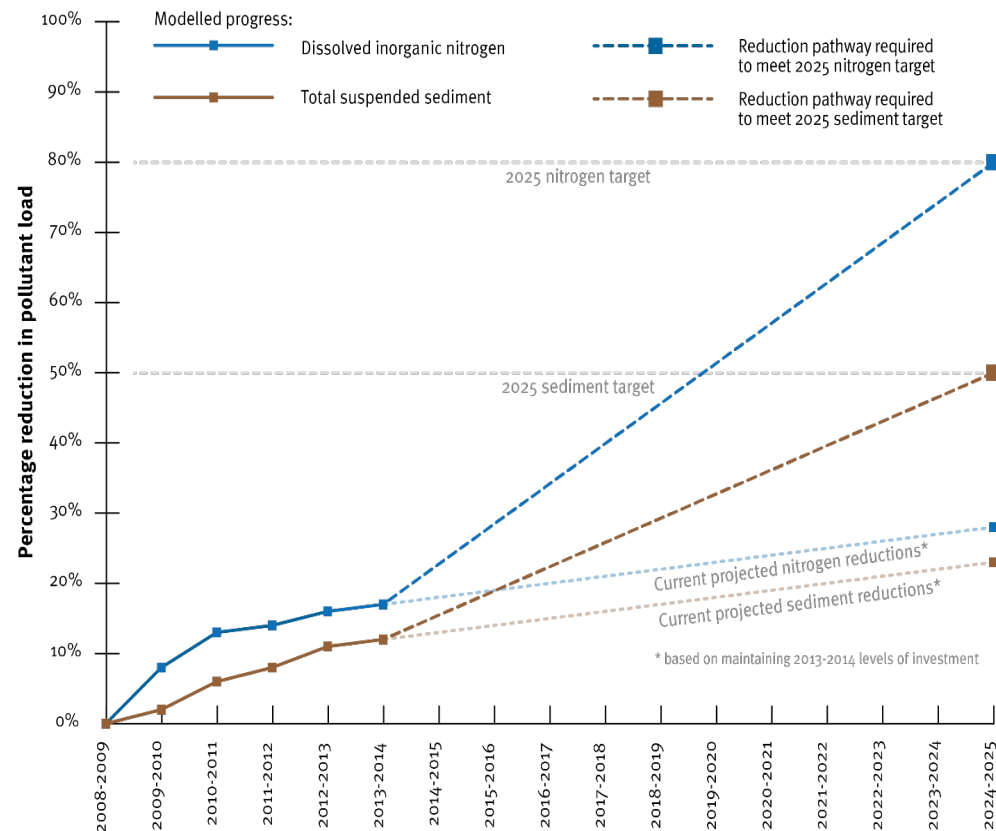


Figure 4: Indicative nitrogen and sediment load reductions required to meet 2025 targets

7. Stakeholder feedback

- Taskforce members engaged with multiple stakeholders to gather their views on what has worked well and what hasn't in recent years, and about potential investment priorities and the best approaches to meeting the targets.
- Key points of feedback include:
 - The need for a clear narrative about the water quality linkages from the paddock to the river to the Reef.
 - The need to pursue the most effective interventions for nutrient and sediment reduction considering the cost, likelihood of achievement and the ecological and potential economic benefits.
 - The need for improved monitoring and evaluation to better measure outcomes and communicate them back to landholders and the general community.
 - The currently complex and fragmented governance system needs to be greatly simplified to improve accountability and delivery of outcomes.
 - Stakeholders involved in the Reef want to be engaged, and recognised for their efforts.
 - Land managers have different priorities, so a range of methods must be used to see accelerated and effective changes to land management practices based on different costs and benefits.
- **A key driver for success will be widespread understanding, commitment and buy-in from landholders to achieve on-farm best management practice** (and innovation), highlighting the need for enhanced communication, engagement and extension to accelerate progress towards meeting the targets.



8. Queensland Audit Office feedback

- The Queensland Audit Office recently undertook an audit of Reef water quality programs and found:
 - While there is the Reef Water Quality Protection Plan, there is no cohesive State-based Reef program to support its achievement.
 - Queensland's response has lacked urgency and purpose, characterised by disparate projects with no central authority and no clear accountability for their delivery or for achievement.
 - Results indicate that the right balance has not been achieved between industry led, voluntary approaches and regulatory enforcement.
 - The fragmented program response is mirrored by fragmented governance arrangements. One consequence of this is that there is no strong accountability for program expenditures.
- The Queensland Government has not yet formally responded to the audit.
- The Queensland Government, through the Minister for the Great Barrier Reef, announced in May 2015:
 - that the functions of the Reef Secretariat would be expanded and transferred from the Department of the Premier and Cabinet into the Department of Environment and Heritage Protection as an Office of the Great Barrier Reef to coordinate, monitor and assist in delivering the State's contribution to the Reef Water Quality Protection Plan and the Reef 2050 Plan, and
 - the establishment of the Taskforce and an interdepartmental committee.
- The Queensland Audit Office noted that in principle, if implemented effectively, these changes should address the governance issues identified.
- The findings of the Queensland Audit Office along with the Queensland Government's actions have been noted by the Taskforce in their deliberations.
- **Many of the recommendations in this report complement the Queensland Audit Office conclusions and should help address their recommendations to the Queensland Government.**



9. Funding

- **The Queensland and Australian Governments are expected to invest approximately \$275 million and \$300 million respectively in Reef water quality initiatives over the next five years.** This includes:
 - Recently announced additional funding of \$100 million from Queensland Government and \$140 million from the Australian Government.
 - Existing/ongoing funding, which comprises:
 - \$35 million per year from the Queensland Government, made up of long-term base-funded activities and short-term budget allocations, e.g. the \$10 million per year Environment and Heritage Protection program and the \$6 million per year regional NRM program.
 - An average of \$32 million per year from the Australian Government through the Reef Programme (2013-14 to 2017-18).
- Figure 5 shows a summary breakdown of Australian and Queensland government funding 2015-20.

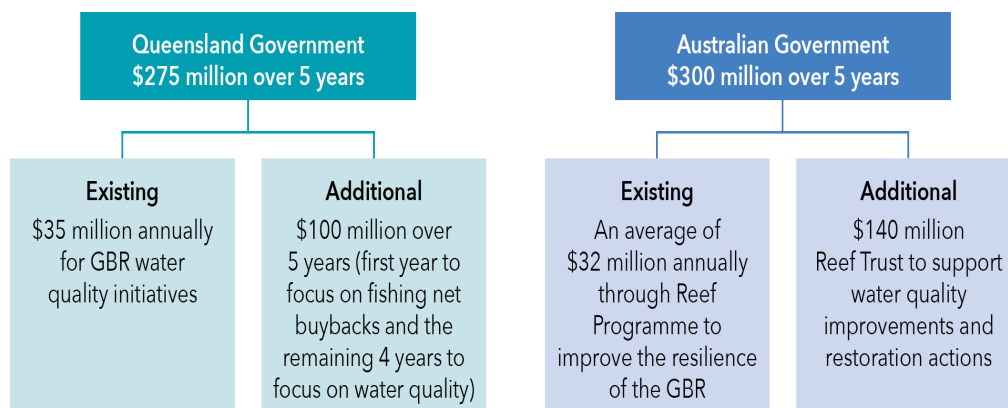


Figure 5: Australian and Queensland Government Reef water quality committed funding (2015-20)

- Investment needed to achieve the targets in the timescale proposed is likely to be well beyond the funds currently allocated by the Queensland and Australia governments.
- **Additional investment will be critical and leveraging the Queensland Government funding should be a priority, including through public-private partnerships, philanthropy and innovative funding vehicles.**
- Existing funding is disbursed via various groups – research organisations, industry, NRM bodies, and Queensland Government agencies – to carry out on-ground work, monitoring, targeted research and communication.
- In addition to the Queensland and Australian government funding, the local councils in the Reef catchments make large investments in activities that affect Reef health including on-ground activities, urban water quality and point source management (such as upgrades to sewage treatment plants and water treatment plants). A recent study to support the Reef 2050 Plan found that in 2013-14, 15 of the 27 councils collectively invested up to \$622 million in activities relevant to Reef health. **Ongoing investment and commitment by local councils will be critical to delivering a healthy Reef.**
- There is also considerable cash and in-kind investment made in Reef water quality initiatives by individual landholders, NRM body staff, volunteers, the resources sector, universities and research institutions. For example, under the first Reef Rescue program, up to \$1.80 was invested by landholders for every \$1 provided by the Australian Government (totalling \$157 million of industry investment).
- An investment baseline developed for the Reef 2050 Plan in 2015 identifies the range of other investments made to support broader Reef management.
- While the Reef Water Quality Protection Plan Investment Strategy outlines the range of water quality investments by different funders, in practice many of the funding decisions were already made prior to the Strategy being developed and it is not updated regularly enough to influence decision-makers on investment priorities.
- **The various funding programs currently appear fragmented**, with limited detailed supporting documentation to show how different programs contribute to achieving the water quality targets. Additionally, it is unclear how different funding programs mesh together – e.g. who funds what in the research and development space, and who provides funding for which region. In many cases it is up to the NRM bodies to identify different funding sources and tailor projects to those, based on their Water Quality Improvement Plans.

- Clearer identification of the linkages between initiatives/ programs and activities needed to achieve the targets, the outcomes that they are expected to achieve, the priority areas for investment and better communication between funders, may provide more rapid progress towards meeting the targets with existing and new investment.
- The Queensland Government should consider working with the Australian Government to pool resources through a single independent funding vehicle and develop a single investment strategy. This is provided that there are appropriate governance arrangements to provide transparency, accountability and clearly articulated and reported outcomes of investment.
- There has been considerable investment relating to Reef water quality since the launch of the first Reef Water Quality Protection Plan in 2003. Table 3 (on the following page) shows the key initiatives by the Queensland and Australian governments since this time, e.g. the Reef Water Quality Protection Plan and the Reef Rescue/Reef Programme. It also shows the funds allocated to Reef water quality work by research institutions, universities and not for profit organisations since 2013-14. The boxed column shows the last completed financial year.
- Table 3 also provides an indication of the estimated annual budget allocation to Reef water quality initiatives and significantly underestimates the total resources devoted to water quality activities as it does not capture cash or in kind investment by the private sector, community groups or volunteers. It should be seen as an indication of the minimum investment. The source of funding, not where funding has been dispersed, is shown to avoid double counting.
- Table 4 illustrates the breakdown of Australian and Queensland government Reef funding for the year of 2014-15.



Table 3: Investment in Reef Water Quality Initiatives 2003-04 – 2019-20 (\$ million)

		Reef Water Quality Protection Plan 2003-09						Reef Water Quality Protection Plan 2009-13				Reef Water Quality Protection Plan 2013-20						
Funding Source	Program/Initiative/Organisation	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20
Queensland Government	Reef Plan Funding (inc. \$6 million/year NRM program)	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.5	25.5	25.5	25.5	%	%	%
	Reef Protection program (regulations, science, extension and compliance)							10.0	10.0	10.0#								
	EHP Reef Water Quality Program (science, BMP and extension)										10.0	10.0	10.0	10.0	10.0	10.0	10.0	%
	Water Quality (\$100 million commitment)													12.0	22.0	22.0	22.0	22.0
Queensland Govt Sub-Total		25.0	25.0	25.0	25.0	25.0	25.0	35.0	35.0	35.0	35.0	35.5	35.5	47.5	57.5	%	%	%
Australian Government	Reef Rescue						29.8	39.6	34.1	45.1	53.9							
	Reef Programme and other Reef activities											48.0	45.2	42.9	15.8	12.2		
	Reef Trust												11.1	15.9	34.1	39.4	39.5	%
Australian Government Sub-Total							29.8	39.6	34.1	45.1	53.9	48.0	56.3	58.8	49.9	51.6	39.5	%
Combined Queensland and Australian Government Subtotal							54.8	74.6	69.1	80.1	88.9	83.5	91.8	106.3	107.4	%	%	%
Commonwealth funded research institutions and programs (Inc. institutions' core appropriation funding)	Commonwealth Environmental Research Facilities (Marine and Tropical Science Research Facility)			0.5^	2.3	2.4	2.3	2.4#										
	National Environmental Research Program (NERP) ¹								0.4^	1.0	1.0	1.0	1.0#					
	National Environmental Science Programme (NESP) ²												2.2	5.6	5.4	5.4	5.4	5.4

Table 3: Investment in Reef Water Quality Initiatives 2003-04 – 2019-20 (\$ million)

		Reef Water Quality Protection Plan 2003-09						Reef Water Quality Protection Plan 2009-13				Reef Water Quality Protection Plan 2013-20						
Funding Source	Program/Initiative/ Organisation	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20
Independent research institutions (examples)	ARC Centre of Excellence for Coral Reef Studies ³											..	..	..	..	..	..	..
	Australian Institute of Marine Science ⁴											1.9	2.4	%	%	%	%	%
	CSIRO											5.3	4.5	3	2.4	2.4	2.4	2.4
	GBR Foundation ⁵											2.4	2.1	2.0	1.5			
	GBR Marine Park Authority ⁶											..	..	..	..	..	..	..
	Griffith University											0.6 ⁷	0.8 ⁸	0.0 ⁹	0.0 ⁹	%	%	%
	James Cook University ¹⁰											0.2	0.2	0.2	0.2	%	%	%
	The University of Qld											0.7 ¹¹	0.7 ¹²	0.5 ¹³	0.3 ¹⁴	0.2 ¹⁵	0.6 ¹⁶	0.1 ¹⁶
	Reef and Rainforest Research Centre											0.1	0.3	..	..	..	..	..
Total (indicative minimum investment)		25	25	25	27.3	27.4	57.1	74.6	69.1	71.1	89.9	95.6	104.7	117.6	117.2			

Note: The figures in this table are preliminary and will require verification from appropriate sources. Subtotals include both known and projected funding.

Explanatory notes

Italics indicate future funding estimates which have not yet been verified

% indicates periods where the funding will occur, but the amount is still to be determined

^ indicates transition funding periods

indicates year when program/initiative terminated

* includes Reef related activities beyond water quality, e.g., targeted COTS control

.. indicates activities supported by non-dedicated resources

¹ The National Environmental Research Program Tropical Ecosystems Hub was provided with a total of \$3.86 million over four years for research into water quality of the Great Barrier Reef Figures reflect the average allocation to research over the four years ² Figures reflect total Australian Government funding committed to the National Environmental Science Programme Tropical Water Quality Hub Funding includes knowledge brokering, communication and administrative activities that support the delivery of research ³ The ARC Centre of Excellence for Coral Reef Studies spends only a very modest amount on catchment related research ⁴ includes ARC, JCU, corporate and AIMS base funding ⁵ Resilient Reefs and corporate funding ⁶ While GBRMPA contributes to RWQPP outcomes from its core resources, this is primarily non-dedicated staff time ⁷ Griffith base funding, Queensland Government Smart Futures Fund, Australian Government Natural Resource Managers Climate Change Impacts and Adaptation Grant ⁸ Griffith base funding, Queensland Government Smart Futures Fund, Australian Government Natural Resource Managers Climate Change Impacts and Adaptation Grant ⁹ Griffith base funding ¹⁰ Contribution from TropWATER ¹¹ ARC, CSIRO, corporate, private/non-profit, UQ base funding ¹² ARC, CSIRO, private/non-profit, UQ base funding ¹³ ARC, CSIRO, private/non-profit, UQ base funding ¹⁴ ARC, private/non-profit, UQ base funding ¹⁵ Private/non-profit, UQ base funding ¹⁶ UQ base funding ¹⁷ contributions in excess of NERP funding received

Table 4 illustrates the broad range of priority activities and experienced organisations operating at a range of scales in the Reef environment, providing a snapshot of funding in Reef water quality, systems repair and species protection. The Australian Government funds a range of entities, from community groups and regional NRM bodies through to the Great Barrier Reef Foundation, and supports water quality work indirectly through programs such as the National Environmental Science Programme (NESP), and research institutions while the Queensland Government both funds others, such as regional NRM bodies to undertake work and carries out water quality work itself.

Table 4: Break down of Australian and Queensland Government Great Barrier Reef funding for 2014-15

Allocation of funds (i.e. Who spends%) ↓	← Source of funds 2014/15 (millions) (i.e. Who Pays%) →			
	Australian Government		Queensland Government	
	Reef Programme and other Reef activities	Reef Trust	Reef Water Quality Protection Plan	EHP Reef Water Quality Program
Australian Government		\$1.2		
Queensland Government	\$3.3	\$3.0	\$17.0	\$4.8
Regional NRM Bodies	\$22.8	\$0.4	\$6.0	\$0.6
GBRMPA	\$12.2	\$1.2		
AIMS	\$0.2	\$0.1		
Regional Report Card Partnerships	\$1.1		\$2.5	
Reef and Rainforest Research Centre		\$1.8		
Community Groups	\$1.6	\$0.1		
GBR Foundation	\$3.1			
Others – Industry groups, research partners, WWF	\$0.8			\$4.6
Totals	\$52.9ⁱ		\$35.5	

ⁱ Residue of \$3.4 million yet to be allocated

10. Coordination and governance

- **The Taskforce observed that Reef-wide, water quality governance arrangements from policy to delivery levels are complex with relatively poor coordination across the system.** For example:
 - Multiple committees providing advice to different decision makers (Figure 6).
 - Challenges with different science prioritisation and procurement arrangements and stakeholder advisory arrangements.
 - Three levels of government, each with their own strategic agendas.
 - Multiple funders, multiple delivery agents and a lack of agreed policy around the most appropriate delivery architecture.
- Some strategies for water quality do exist at the Reef-wide level, but these rely on delivery agents to coordinate at the regional and local level without support.
- For example, the Reef Water Quality Protection Plan includes a range of actions and strategies at the Reef-wide level, but relies on support from regional NRM bodies to coordinate and deliver at the local level in keeping with its principles.
- Some broader policies (e.g. Northern Australia policy, vegetation management, urban development, climate change etc.) also have the potential to undo some of the positive changes made to land management and water quality outcomes. A more coordinated approach to water quality, water quantity, vegetation management, agricultural expansion is needed.
- There are multiple regulatory and planning frameworks that impact on water quality that are at times inconsistent in their outcomes (Figure 7).



Governance model for Reef 2050, Reef Water Quality Protection Plan and Great Barrier Reef Water Science Taskforce

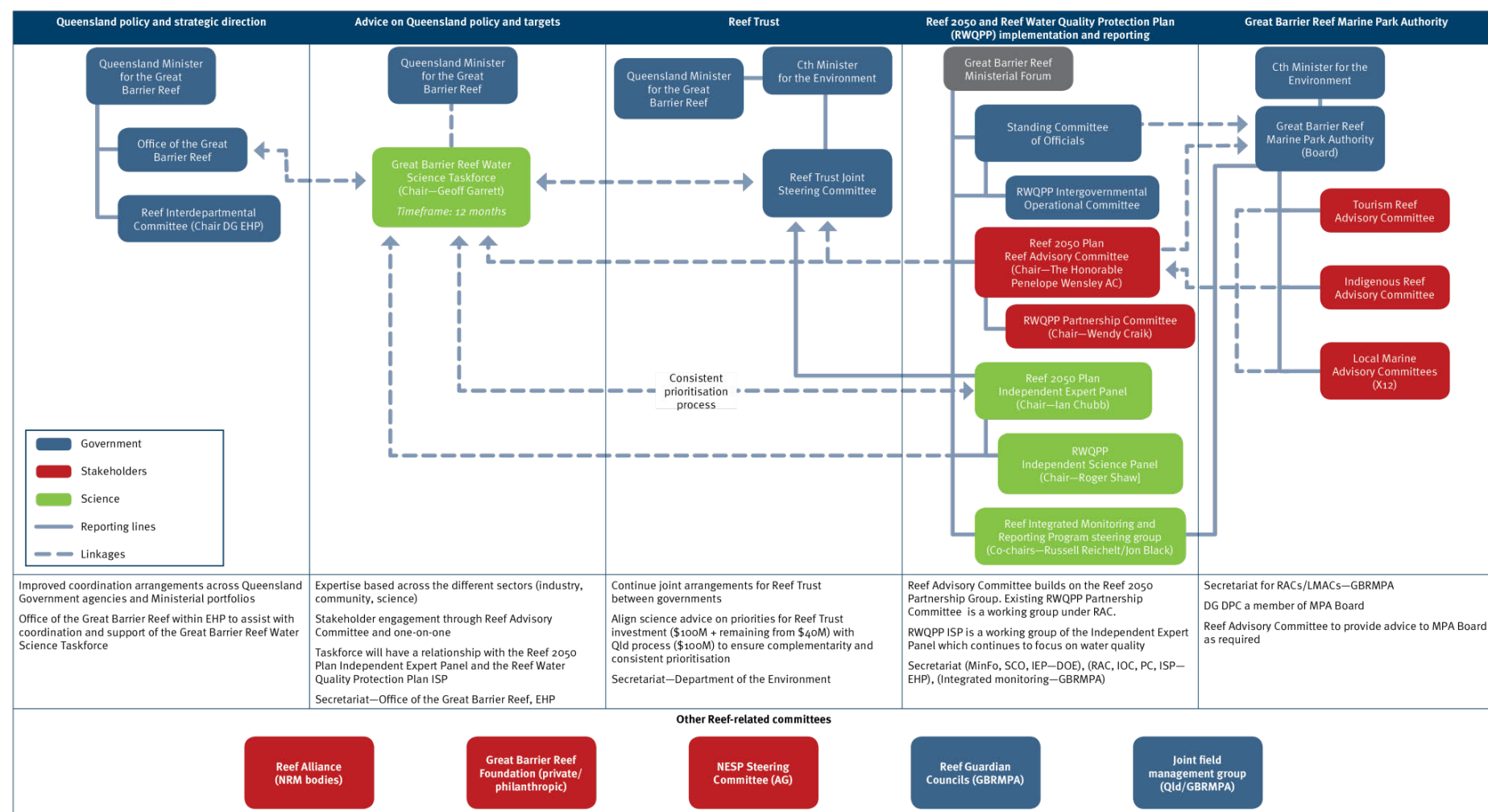


Figure 6: Current Governance arrangements for Reef management

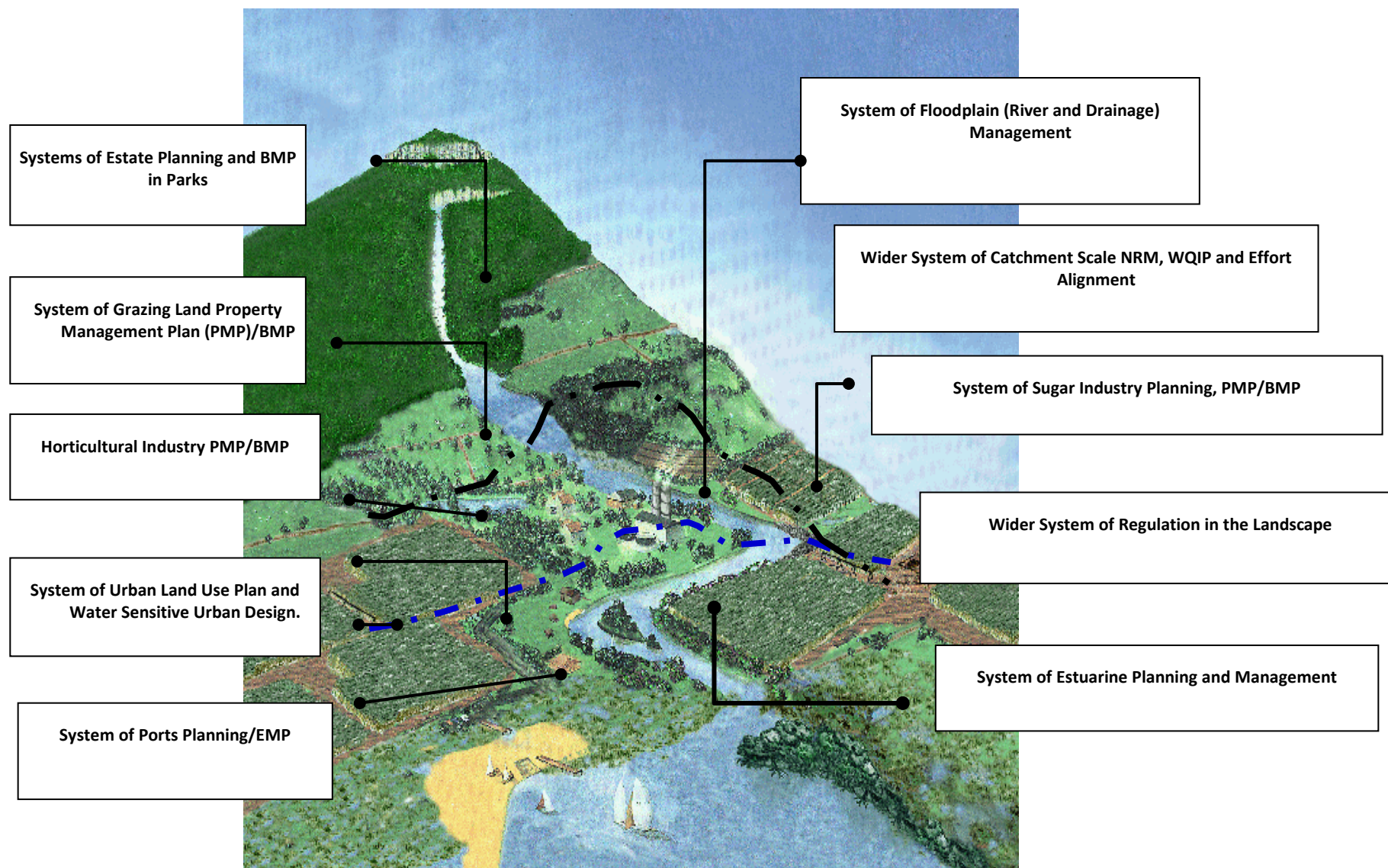


Figure 7: Regulatory and planning frameworks that impact on water quality

(Source: Vella, K.J., Bellamy, J.A. and McDonald, G.T. 1999. "Looking Beyond the Fences: Institutional challenges to integrated approaches to catchment management." In *The 1999 International Symposium of Society and Resource Management: Application of Social Science to Resource Management in the Asia Pacific Region, Brisbane*, edited: University of Queensland, as provided by Professor Allan Dale).

11. Key Issues

- There are a number of delivery issues that are barriers to effective program delivery (Figure 8):
 - **Systematic complexity** – governance structures and program delivery continue to be highly complex, making engagement difficult.
 - **Poor communication and engagement** – fundamentally, many individual landholders don't see a direct relationship between their land management practices and the health of the Reef. There has been no consistent narrative and poor engagement with landholders regarding the scientific evidence for this link, and the need for change.
 - **Fragmentation of policies and delivery efforts** – poor coordination of multiple authorities has resulted in fragmented programs, funding and policies, contributing to confusion and ineffectiveness.
- Efforts have previously been spread too thinly and across too many areas, reducing effectiveness and impact, and there has been a failure to coordinate efforts at larger scales.
- Despite significant effort over the past twelve years:
 - application rates of fertilisers remain well above what is deemed industry best practice, resulting in excess nutrients leaving the property (Figure 9), and
 - best management practice for water quality is only used by a small proportion of the agricultural and grazing industry (e.g. 13% in nutrient management in cane, as referenced earlier this document in Figure 3).

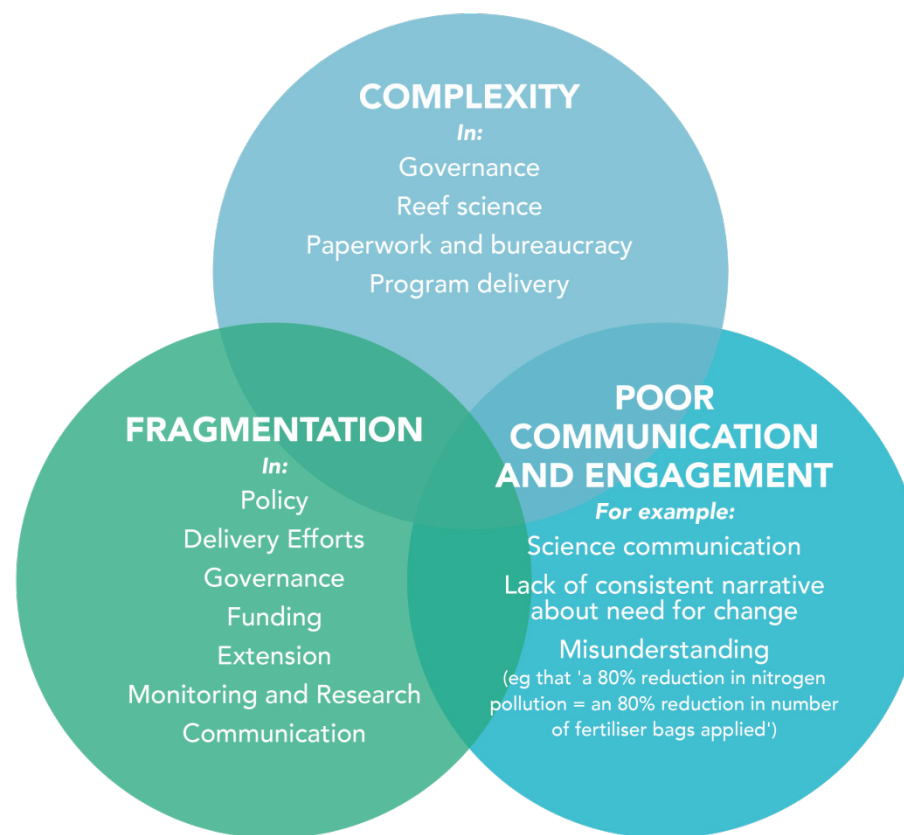


Figure 8: Barriers to effective program delivery

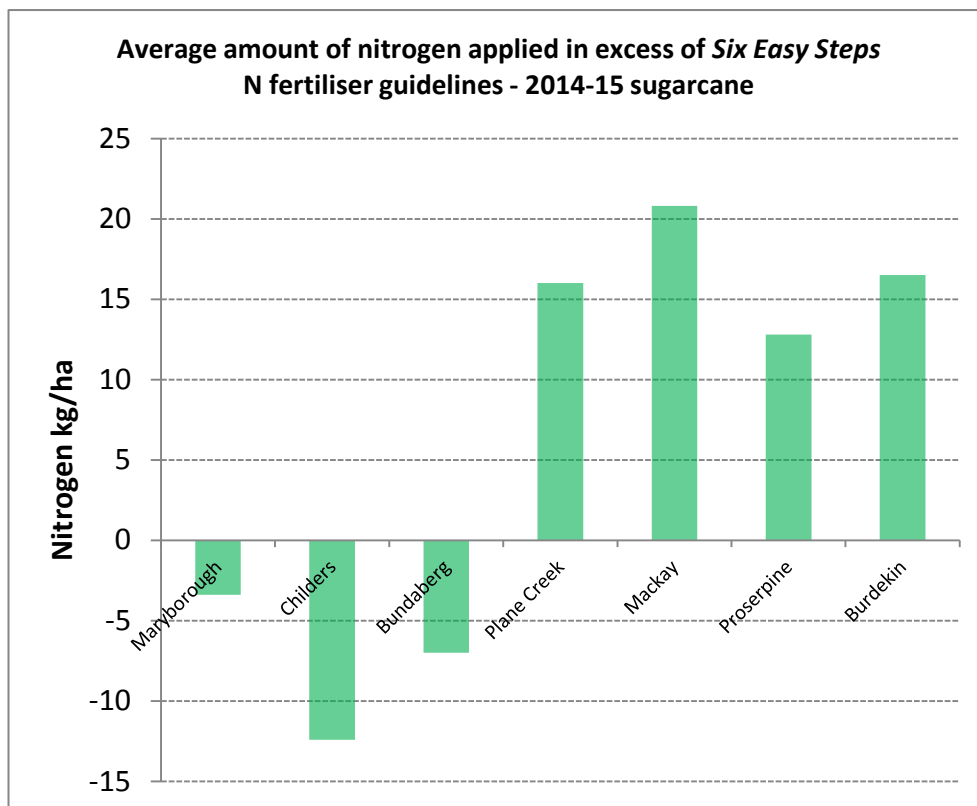


Figure 9: Nitrogen fertiliser applications in excess of Six Easy Steps guideline values: (Source: Paddock to Reef Program)

The Six Easy Steps program provides a sound nutrient budgeting framework for sugarcane growers. A starting point for calculating nitrogen fertiliser application requirements is provided in guidelines which account for soil fertility and district crop yield potential. The figure contains estimates of the amount of nitrogen (N) fertiliser applied in excess (or under) the N fertiliser guideline values for certain production areas in 2014.



WHERE DO WE WANT TO BE?

12. A vision for the future

- The Taskforce's vision for the Reef's future is that it will be **healthy and resilient** and continue to support an iconic and wondrous ecosystem, world class tourism, viable industries and sustainable communities.
- To achieve this, the future must include programs where everyone is doing their bit to look after the Reef – farmers, graziers, developers, resources sector, community members and tourism operators.
- The community must be part of the solution – owning the challenge and delivering the solutions.
- Good stewardship is good for the Reef and good for the economy long term.
- The desired future articulated in the Reef Water Quality Protection Plan continues to be relevant and important as we move forward (Figure 10).
- **However, the desired future must be broadened to include all parts of the community, not just agriculture.**

Principles for the Future

- Everyone must be part of the solution!
- Tailored local solutions
- Clear accountability for actions
- A focus on innovation
- Transparency – decision making, delivery and reporting
- Clear communication
- Alignment between programs
- Cost-effective allocation of resources
- Leveraging private investment
- Adaptive management
- Monitoring and evaluation to determine the effectiveness of outcomes from investment is crucial

Our desired future



Figure 10: The desired future for the Reef as articulated in Reef Water Quality Protection Plan

WHAT SHOULD WE DO ABOUT IT?

- There has been considerable work done to address water quality issues in the Reef, dating back well before the release of the first Reef Water Quality Protection Plan in 2003. As a result we have some very useful indicators as to what does and what does not work, and what needs to be explored further. This provides an invaluable framework on which to develop more tailored, integrated actions and responses to water quality challenges.
- Looking ahead, the **Reef 2050 Plan** provides an overall agenda for the protection and management of the Reef from 2015 to 2050 with land based run-off (and resultant poor water quality) identified as one of the major threats to the Reef.
- To be successful every future intervention needs to be cleverly designed to maximise contribution towards continuing improvement in the management of the giant system connecting land and Reef.
- Efforts need to be aligned within a framework of emerging consensus about the big systemic forces driving decline in Reef health, and through commitment to serious monitoring and evaluation of each intervention so that analysis of its costs and benefits guides the next, more efficient and adaptive step on the longer journey.

Roadmap to a healthy reef

- **We need a clear roadmap to guide us towards 2050 and the long-term targets for good water quality and a healthy and resilient Reef.**
- The roadmap (over the page) needs to set out the steps needed to achieve our goals.
- The roadmap depicts a simple overview of the three phases that the Taskforce sees as important. It builds on the many lessons that have been learnt prior to 2015, through programs and plans such as the Reef Water Quality Protection Plan.

- o **Phase 1: 2015 – 2020**
 - o **The Explore Phase** – where the \$90 million investment will build on existing funding and programs, and be available to innovate, explore and test new approaches to improving water quality.
- o **Phase 2: 2020 – 2030**
 - o **The Expand Phase** – where we embed, as part of our normal practices, the actions that are necessary for long-term change.
 - o This phase will see additional investment in Reef health through co-investment and public–private partnerships
- o **Phase 3: 2030 – 2050**
 - o **The Enable Phase** – where the new ‘norm’ is to maintain resilience
- Along the way to 2050 there will be checkpoints and major milestones, with major reports on Reef water quality, including the Outlook Report.
- The \$90 million investment will provide a much needed boost to improving water quality and Reef health. It will provide a platform for change and kick-start further investment along the journey to 2050.
- Keeping such a long-term and systemic perspective in clear view through all phases of a complex task is hard work. The Taskforce aims to demonstrate commitment to this course by providing advice towards investment in interventions most likely to give a significant push towards system-wide improvement, according to current knowledge.
- The roadmap flags the Taskforce’s recommended actions for investment, which are discussed in further detail in following sections.

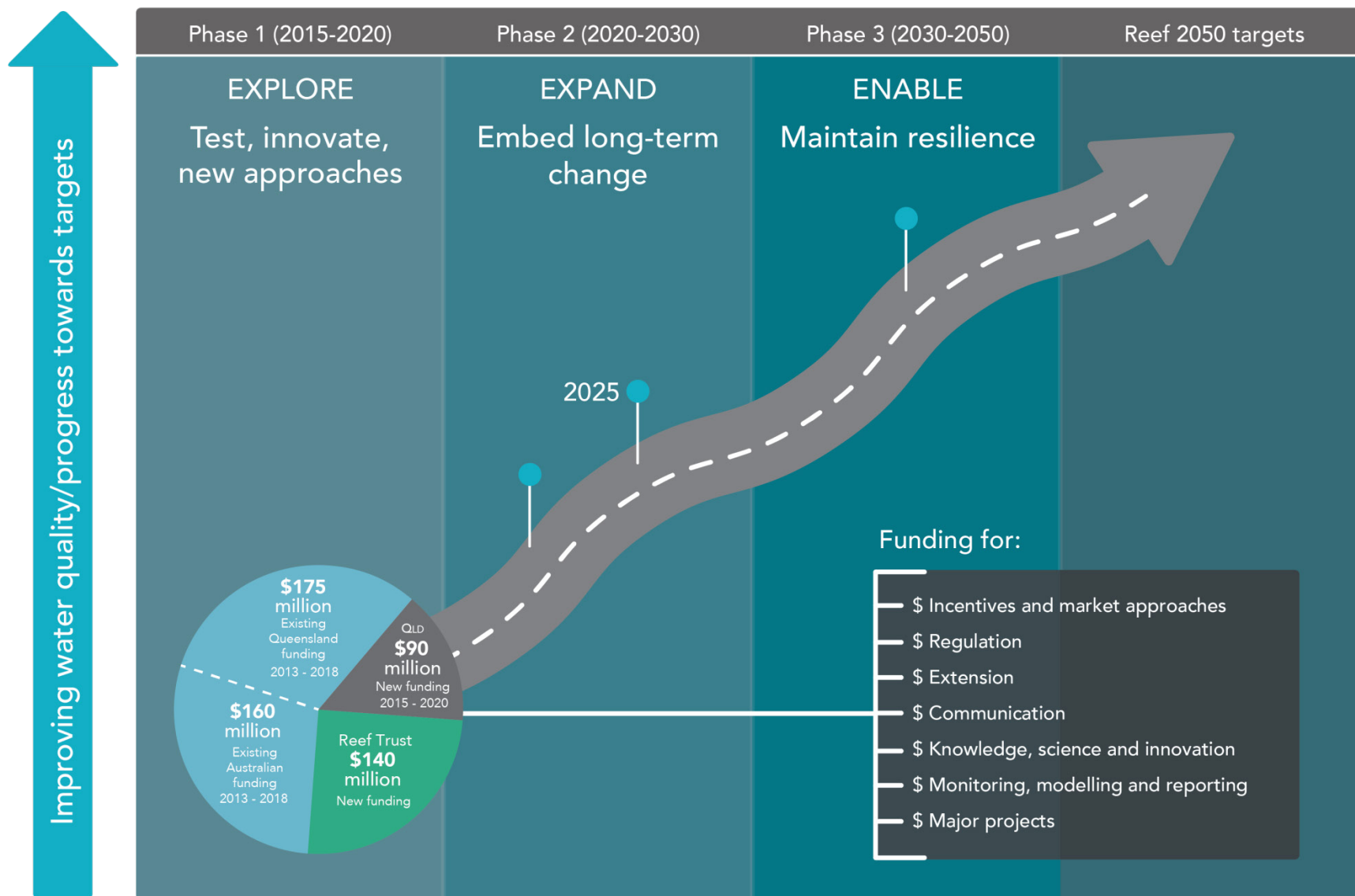


Figure 11: Roadmap to a healthy Reef

13. Options considered

- The Taskforce was asked to provide advice on the best approach to meeting the government's water quality targets, including the effectiveness and cost of robust regulations, incentives, BMP Programs, market-based trading mechanisms and other policy instruments, or a combination thereof, including an intensive focus in selected catchments.
- A flexible approach is needed in all Reef catchments to achieve the targets. This is likely to require a blend of different instruments – voluntary programs, regulation, market approaches, extension and education, support for innovation and others. Interventions will need to be tailored to individual needs.

Costs and effectiveness of improved practices

- Understanding the costs and effectiveness of interventions to improve water quality is essential to inform investment priorities in the Reef catchments. However, there has been very little analysis of the effectiveness of past investments in Reef catchments in terms of water quality outcomes.
- In order to provide information to support the Taskforce in accessing the most effective way to allocate the extra \$90 million for the Reef, two preliminary economic studies were undertaken.
- The studies provide an analysis of the costs and effectiveness to reduce sediment from grazing in the Burdekin and Fitzroy catchments and for nutrients from sugar cane in the Wet Tropics and Burdekin catchments.
- Both studies use a bio-economic modelling approach. Further economic analysis is also currently being undertaken (see box over page).
- The grazing study was limited to considering the cost of improving land condition and subsequent groundcover through reduced stocking rates. Increasing ground cover will have the greatest impact on hillslope erosion and provide some sediment reductions from streambanks and gully erosion.
- The costs and effectiveness of a mix of tools including extension, incentives and regulation were estimated for both grazing and sugar cane enterprises.
- The grazing study was limited to considering the cost of increasing groundcover through reduced stocking rates. Increasing ground cover will have the greatest impact on hillslope erosion and provide some sediment reductions from streambanks and gully erosion.

Results

- For grazing in the Fitzroy and Burdekin catchments, it is most cost effective to move landholders from C class (average land condition) to B class (good land condition) which is estimated to cost \$53.3 million with a reduction in end of paddock loads of over 320,000 tonnes of sediment. This is a reduction of 8% of the estimated total sediment loads from the Fitzroy and Burdekin. The cost of moving all landholders from B class (good land condition) to A class (best land condition) is estimated to be \$164 million with an estimated reduction of 657,000 tonnes of sediment. This is a reduction of 16% of the estimated total sediment load from the Fitzroy and Burdekin catchments.
- For cane, the data indicated that using a mix of extension, regulation and incentives could result in a reduction of 1000 tonnes of dissolved inorganic nitrogen for a cost of about \$12 million per year (ongoing). This is approximately 30% of the load reduction required to meet the water quality targets.
- The results of the modelling for cane suggest the most cost effective improvements in water quality will result from moving growers from a C class (average) practice to a B class (best) practice level. This change in practice appears to be only a small cost for most growers taking into account transactions costs and other barriers. The analysis also demonstrates that the costs are cheaper for larger farms, which supports a case to encourage farm consolidation or to consider targeted land retirement.
- The results also show that there should be a financial benefit for most cane growers to move to B class standard (best management practice). The reasons not all growers have moved to this standard indicates that there are other costs not captured by the analysis such as non-financial barriers (e.g., risk and uncertainty associated with practice change).
- The results show very little benefit of moving to A class practices that are aspirational and untested. Further practices, such as enhanced efficiency fertilisers should be tested to inform future A class standards.

Summary

- **Grazing:** the analysis for the grazing industry demonstrates that the **most cost effective investments will be in the eastern parts of the Reef region, in medium productivity land types**. This area has a higher delivery ratio for sediments to the Reef and is likely to be more responsive to change in management due to higher rainfall.
- **Cane:** the analysis for the modelling for the cane growing industry suggest the **most cost effective improvements in water quality will result from moving growers from C class (average) practice to B class (best) practice level**. This change in practice should only be a small cost for most growers taking into account transactions costs and other barriers.

Further economic work is currently being scoped to help determine what the total cost of achieving the targets may be. This is challenging because of the limited information on the costs and benefits from different policy approaches (e.g. grants, regulations, catchment restoration, and gully remediation). The Queensland Government is undertaking the costing work and the Taskforce will consider outcomes of this work that are available before it finalises its report.

It should be noted that paddock and catchment modelling suggests that even with full adoption of best practice the targets still won't be achieved and that land use and technology change will be required. These types of interventions are challenging to cost, particularly when those technologies don't yet exist (e.g. different enhanced efficiency fertilisers).



TOOLS

14. Market Based Approaches and Ecosystem Repair

Using Markets to enhance outcomes

- Market-based instruments encourage behaviour change through market signals such as changing the price of undertaking an action (e.g. grants), rather than through explicit directives such as regulation.
- Market-based instruments have the potential to provide incentives to improve the condition of the land and waterways at a lower cost than many traditional policies and regulation.
- Market-based instruments also include things such as grants, subsidies and tenders (e.g. reverse auctions where the government buys pollution reduction at the lowest cost). A number have been used to good effect in the Reef catchments to reduce run-off.
- Additional market based instruments such as stewardship payments, concessional loans and stamp duty relaxation need to be considered.
- Examples include:
 - Incentives such as reverse auctions and grants for equipment and change management should continue as appropriate.
 - The voluntarily buy-back of unproductive land to restore or convert to a use which is more sustainable (e.g. buying low productive cane land and restoring wetland functions).
 - Stewardship payments to provide financial support for landholders to improve land condition (e.g. through payments to temporarily destock grazing land to reduce gully erosion).
 - Concessional loans offered to farmers to implement improved management practices for improved property value (e.g. loans to implement precision agriculture which requires capital expenditure up front). This could be done in partnership with the banking sector.
 - An insurance mechanism to underwrite the risks of a practice change, where the science and economic analysis suggest that the change is a win-win for the environment and farmer's profitability is an option (e.g. crop insurance could cover yield or revenue loss associated with reduced nutrient application).
 - Stamp duty relaxation for best practice growers who want to expand their farms by buying neighbouring properties in poorer condition and committing to moving the new properties to best practice.

- Taxation as a market based approach that may apply specifically within the Reef catchments (e.g. on fertiliser) is not considered effective because of legal difficulties and the need for the tax to be very high to impact on grower behaviour.

Ecosystem Repair

- Coastal ecosystems, wetlands and riparian areas play an important role in regulating water quality and providing connectivity to the Reef for many species. Many wetlands and coastal ecosystems have been lost over the last 100 years and their restoration is expected to contribute to water quality improvement.
- Recognising that best management practice alone will not meet water quality targets, land use change and ecosystems repair such as restoration of riparian areas, wetlands and flood plains needs to be considered.
- In some areas the current land uses are not compatible with sustainable Reef outcomes. These areas may be appropriate for repair and restoration through either compensation or land buy-back in agreement with individual landholders. This could either be temporary (stewardship payments, temporary retirement) or permanent (land buy-back)).

Stewardship payments (payments for ecosystem services)

- Stewardship payments are payments made to a landholder for carrying out 'stewardship services' on their land to maintain or improve natural resource values and outcomes (e.g. for fencing off areas or restoring areas of land).
- These payments are based on the concept of the landholder providing a public service with the fee paid reflecting this. Their main benefit is that they can address more than one problem at a time (e.g. biodiversity and water quality outcomes) as well as maintaining existing environmental values (e.g. retention of native vegetation).
- The type and extent of stewardship payments is usually governed by a voluntary management agreement. Payments are generally ongoing (e.g. on an annual basis) and are offered for services above the expected minimum standard and are tailored to the situation.

Temporary retirement - compensation

- Temporarily retiring marginal land from production is likely to be successful in reducing nutrient and sediment loads. Programs where farmers are offered financial assistance in exchange for signing a contract to set aside land from production and payments continue for as long as the land remains out of production may be appropriate. For example, to reduce sediment erosion and remediate gullies, some grazing properties require de-stocking to enable ground cover to be restored to improve soil health and pasture resilience, and to make properties more sustainable overall.

- The form of compensation and criteria adopted needs careful consideration. Where farmers are expected to provide an ongoing management role, lump sum payments are unlikely to provide an ongoing incentive.

Voluntary Buy back

- In some situations, voluntary land buy-back is desirable followed by restoration to natural systems, and/or a lower impact alternative use. This may be associated with re-configuration of the land, with productive areas on-sold or placed under a protective covenant. There may be opportunities to link voluntary buy-backs to more flexible arrangements for urban water quality management (e.g. for sewage treatment and stormwater).



Trading systems

- In some cases, water quality trading schemes may be an appropriate tool to reduce pollution. While some national and international trading schemes have shown financial and environmental benefits, the low number of successful schemes overall demonstrates the challenges in successfully applying the concept, particularly to diffuse source pollution (i.e. pollution that doesn't come out of a single pipe).
- To successfully implement a trading scheme, significantly better information would be needed to establish, measure and monitor a cap and individual allocations. Instead, the Taskforce proposes a staged approach to regulations for nutrient management, which would over time provide individual discharge permits based on an estimation tool - effectively providing a cap. A trading scheme could be considered if a permitting system is established.

CONCLUSION

Incentives for change will be needed

In order to make the significant changes needed to improve water quality for Reef outcomes, land managers will need support through financial and other incentives.

RECOMMENDATION 2

Greater use of market approaches

Greater use of market approaches is required to help deliver the significant change needed to improve water quality most cost effectively. These market approaches could include:

- Concessional loans
- Stamp duty relaxation for farm amalgamations
- Voluntary retirement of marginal land from production
- Stewardship payments for restoration
- Water quality grants for practice change

Access is conditional on improving management to achieve water quality outcomes

15. Regulations

- Given the stated impacts on Reef water quality from agricultural, urban and industrial activities and scientific consensus that business as usual will not meet the targets, there is a clear need to consider regulation for these activities as part of a mix of policy instruments. The Taskforce also supports the regulation of new development to ensure no net increase in water pollution.
- The Taskforce supports a staged, tailored and outcome-based regulatory approach to drive continuous improvement dependent on evidence that the previous stage was insufficient in making appreciable progress towards meeting the water quality targets.
- **Regulations need to be simple, easily measured and developed consultatively.**
- Additionally, regulations should target practices of greatest risk, minimise impact on those undertaking appropriate practices, and be coupled with supporting mechanisms such as improved communication, education, extension, market based instruments and compliance.

Agricultural nutrient sources

- The main source of nutrients is cane farming (and to a lesser extent banana farming).
- Any regulatory approach should aim to optimise fertiliser use by maximising nutrient uptake by the crop and reducing losses off the farm.
- Regulatory options could include implementing water quality permits for individual farms for relevant industry sectors. Nitrogen permit schemes can be used to restrict the amount of nitrogen pollution discharged from relevant agricultural activities.
- A staged approach should be considered.
- The **first stage is setting the standard**. The standard should be based on best available scientific evidence (e.g. based on the water quality risk framework for farm management practices, and ensuring farmers tailor their nitrogen application rates to their individual needs not just the district average – i.e. moving to nitrogen application use based on the 'management unit yield potential').
- The **second stage is establishing individual permits to limit or cap the amount of off-farm nutrient discharge**. Permits would be based on a nutrient budgeting approach that takes into account all sources of inputs and outputs. This will also require an end of catchment load limit to be set. A nutrient budgeting tool and other low cost options for assessing water quality

is needed to support growers. Nutrient budgets will be documented in nutrient management plans.

- If application of the regulatory standard (stage 1) is effective at reducing nutrient loss across an industry sector, a nutrient permitting system (stage 2) may not be required.
- Other measures, such as water quality trading could be considered if a permitting system is established.

Agricultural sediment sources

- The main source of sediments is from grazing lands.
- Sediment loss can be minimised through a suite of farm management practices that maintains ground cover and reduces pressure on degraded lands.
- The introduction of a regulated outcomes based standard for sediment management across all Reef regions is needed.
- Translating best management practice requirements about minimising sediment loss into a statutory code of practice could be considered.

Improving water quality practice standards

- The Taskforce suggests the Government also look into other regulatory measures to drive continuous improvement in water quality standards. For example:
 - A review of the influence of sugar supply chain sectors, particularly the sugarcane mills for potential measures aimed at reducing farm nutrient losses.
 - A review of water allocation and irrigation practices to ensure that water is used efficiently in a manner which minimises run off.

Urban and industrial sources – nutrients and sediments

- In support of the Reef 2050 Plan, point source nutrient and sediment contributors such as sewage treatment plants, aquaculture facilities, mining, dredging and quarrying should continue to be licenced through the *Environmental Protection Act 1994* and all environmental authorities (permits) should be reviewed to ensure they meet modern water quality standards.
- Local governments are currently required to consider sediment run-off in their planning schemes and development decisions, particularly for the construction phase of development. As agreed in Reef 2050 Plan, capacity building is needed to support local government officers in decision making for urban run-off. Flexible arrangements should be considered if this

contributes to an overall water quality improvement through restoration work in upstream waterways.

Pesticides

- Minimising the risk of applied pesticides entering waterways is needed. For example, pesticide label instructions need to be carefully followed.
- An enhanced regulatory response may be required where the impact of pesticides on water quality doesn't improve.

Future development

- The regulatory focus must also be on ensuring any future development does not undo water quality outcomes associated with addressing the legacy of past developments (a 'no worsening' approach).
- New agricultural development including any agricultural expansion should be required to comply with outcomes based standards to ensure that there is no net decline in water quality which flows to the Reef.
- Queensland has an existing planning framework (through the State Planning Policy) that should be strengthened to better protect riparian vegetation and wetlands across all Reef catchments. There is a need for an evidence based approach to tailor the application of buffer widths to geographical location and other farm characteristics.



CONCLUSION

Tailored regulation will be needed

Tailored regulation will be needed to reduce all sources of water pollution and should apply to agricultural, urban and industrial activities within Reef catchments. Future development should be regulated to ensure no net increase in water pollution. Any regulatory regime needs to be simple, easily measured and developed consultatively.

RECOMMENDATION 3

Introduce more outcomes-based regulation for activities in a staged way

Introduce outcomes-based regulations for activities that impact on Reef water quality, staged over time. This should include:

- Determining pollution load limits at sub-catchment and end-of-catchment scales to meet the water quality standards.
- Developing options for farm-scale and point source water quality permit schemes.
- Concurrently developing low cost options for measuring water quality.
- Developing evidence-based regulations to protect riparian areas and wetlands in all Reef catchments.
- Implementing continuously improving water quality practice standards.

16. Extension and education

- **Currently farmers are getting information, advice and signals from multiple sources which can be conflicting** (Figure 12). This includes advice from Department of Agriculture and Fisheries, NRM bodies, Productivity Boards, mills, Sugar Research Australia, fertiliser sellers, BMP advisors and others.
- Agricultural stakeholders frequently raise the desirability of having access to increased and more effective extension services.
- There are insufficient extension officers to achieve this within government, NRM bodies or industry and the situation is exacerbated by a lack of funding and coordination across local delivery organisations.
- A variety of extension tools are needed. One-on-one and peer-to-peer learning are both effective, particularly when combined with on-farm trials. Follow-up contact as part of the extension program is also necessary.
- Multiple extension methods recognise that every farm is different and many best management practices need to be tailored to individual circumstances. Continuous improvement of extension programs is needed.
- Local delivery organisations need agreed approaches for integrated and coordinated effort.

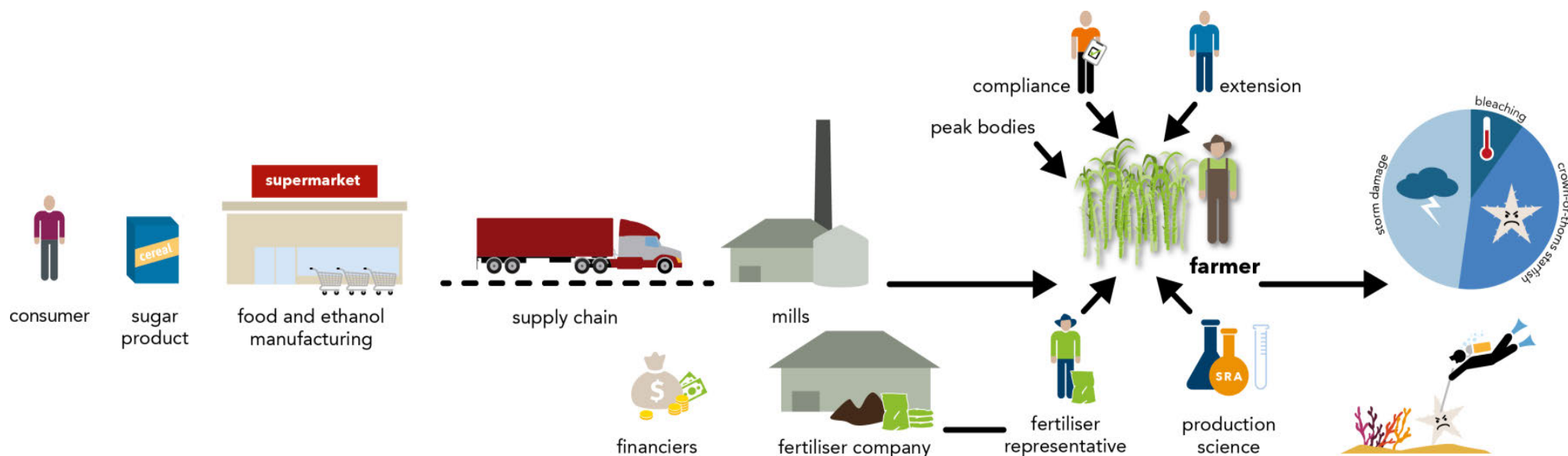


Figure 12: Demonstration of conflicting signals to farmers

CONCLUSION

Better extension is fundamental

Agricultural extension (the application of scientific and new knowledge to improve land management), particularly when aligned with other mechanisms such as incentives, is fundamental for improved land management.

RECOMMENDATION 4

Invest in more effective, targeted and coordinated extension

Invest in more effective, targeted and coordinated extension for improved Reef water quality outcomes. Through agreement build capacity and networks across local delivery organisations. Use smarter and more innovative approaches including facilitated peer to peer learning.

DELIVERY

17. Communication, collaboration and stakeholder engagement

- **Common feedback from stakeholders was concern over poor communication, the lack of a clear narrative on the issues across the catchments and the Reef, and the need for change.**
- **Landholders also have a low level of trust in government** concerning the scientific evidence about the impacts of farming practices on the Reef, as well as the benefits of improved practices. Research also shows a low level of trust in the Australian and Queensland governments by the community to protect the Reef.
- Education and communication activities delivered by the various Reef-related agencies and programs need much improved collaboration to support innovation and shared learnings.
- There is a need for a collaboratively developed, integrated communication strategy to provide direct, clear and unambiguous information, and to build unity around the need to improve water quality and communicate progress.
- A major communication campaign aimed at long term behavior change is needed (e.g. like the successful campaign in SEQ during the drought to reduce water use to 120L per person per day, which has had enduring benefits even after the drought).
- Communication and collaboration is a joint process.
- Direct feedback and targeted conversations with the community is supported to develop a mutual understanding of water quality issues, and to collaboratively work on issues to embed changed practices.
- There is a need for lessons learnt from successful programs and advice from community champions and early adopters to be incorporated into policies and programs.
- Other opportunities for improved communication and stakeholder engagement include:
 - Peer-to-peer learnings through the provision of property specific and relevant local regional information (facilitated through extension and education activities), such as comparisons of an individual's groundcover or nitrogen application rates to local regional values (similar to electricity and water usage).

- Better and more modern communication tools and apps should be developed over time building on some of the systems in place like the Queensland Globe and FORAGE. Such tools should be used by all relevant parties including industry, and extension and education officers.
- The development of an 'information/ knowledge hub' about water quality issues with links to a range of related information to improve the currently fragmented set of communication products.

CONCLUSION

Leadership and communication is essential

Leadership and communication are essential for improving water quality for a healthy Reef.

RECOMMENDATION 5

Improve communication and information commensurate with a major change program of the scale required

Develop collaboratively, and implement, an integrated communications strategy, commensurate with a major change campaign of the scale required to provide clear, consistent information to landholders, industry, peak bodies and the broader community and build unity around the need to improve water quality and communicate progress.

18. Investment Planning

- **Reaching the targets will be challenging even with the additional funding and is likely to require funds well beyond those allocated by the Queensland and Australian governments.**
- **Every dollar must be used wisely and be well targeted.**
- Existing funding (\$35 million per year from the Queensland Government) should be used more effectively and in a more coordinated way and better aligned to outcomes (as the Queensland Audit Office also recommended). This should include:
 - Continuing to support industry led BMP programs, provided that the environmental standards are appropriate and widely adopted throughout industry leading to actual on-ground land management changes.
 - Introducing more contemporary, outcomes focused regulations including amending the existing 'Reef Protection regulations' which are supported through existing funding.
 - Continuing a small research fund to get matched funding into highest priority areas.
 - Better aligning the work of River Improvement Trusts and Rural Water Use Efficiency schemes to water quality.
- **Reduce fragmentation of existing funding:**
 - \$35 million per year is made up of multiple short term funding programs as well as some base funded programs. **This should be consolidated into a single funding program, which isn't reliant on cobbling together base and limited life funding. That is, implement the Queensland Audit Office recommendations regarding single point of funding allocation.**
- Explore as an urgent priority, potential integration and/or ensure maximum alignment with Reef Trust funding and projects.
- Also consider how to leverage other sources of funding (e.g. through public-private partnerships) and consider more innovative financing mechanisms.
- To ensure a coordinated approach to investment, a single investment plan for the \$90 million, combined with Queensland's existing \$35 million (and the Reef Trust \$140 million) should be developed prior to funding being allocated to ensure that funding is tied to outcomes and performance measures.

CONCLUSION

Additional resources and leveraging will be needed

Reaching the targets is likely to require funds well beyond those allocated by both governments. Strategic leveraging, e.g. through public-private partnerships, innovative funding vehicles will be required.

RECOMMENDATION 6

Develop a strategic investment plan and establish public-private partnerships

Develop and implement a strategic investment plan for the \$90 million, combined with Queensland's existing \$35 million per year expenditure (and the Reef Trust \$140 million) and use this to better leverage corporate and philanthropic funds through public-private partnerships.



19. Knowledge, science and innovation

- Much has been achieved recently in identifying sources of pollutants. The focus now needs to shift to identifying, evaluating – and implementing – a broader range of solutions for transformational change. This requires a strong knowledge and science foundation and a greater focus on innovation.

Knowledge and Science

- Ongoing water quality research and development is critical if we are to identify new technologies and the next generation of innovative practices that will support progress towards meeting the water quality targets.
- **Reef water quality research** has provided **valuable information** to decision makers.
- While significant funding is already allocated to Reef water quality research, it is **not always answering the most critical questions** and providing the tools needed for a major change program. Further, these programs and their funding are **not always aligned to an overarching priorities program/investment framework**.
- **For example**, while a Reef Water Quality Research, Development and Innovation Strategy has been developed collaboratively by government and stakeholders, its priorities do not always inform Reef related Research and Development (R&D) programs.
- There are a range of Reef R&D programs that can be more closely aligned with key Reef water quality priorities. For example:
 - the National Environmental Science Programme (NESP)
 - the Queensland Government Reef Water Quality Science Program
 - AIMS
 - Universities (e.g. Griffith University, James Cook University, The University of Queensland – both core funding and ARC grants)
 - CSIRO
 - the Advance Queensland set of initiatives, and
 - the emerging Cooperative Research Centre for Northern Australia.
- **There is a need to ensure greater alignment of research to priority needs**, through strong leadership and clear direction from funders and this may require incentives. The R&D coordination group under the Reef Water Quality Protection Plan should be provided greater ability to influence priorities.

- **Research should be more priority focused, integrated and coupled with stronger communication to improve its translation into water quality improvement.**
- **More R&D funding through the \$90 million is not the answer.** Instead it would be better to use existing funding to get matched funding from bigger research programs/providers. This principle should not prevent funding into major integrated projects (see Section 22), innovation and monitoring and evaluation.
- Existing funding from the Australian and Queensland governments should continue to further develop the knowledge base (e.g. NESP, Queensland Government's Water Quality Science program). However, **the \$90 million should be invested in applying already available knowledge.**
- **Better alignment and communication** within and between scientific disciplines, including the social sciences, **will also be needed to ensure maximum impact.**
- **One approach** is an **annual synthesis workshop** to **support adaptive management feedback** to applied research outcomes and **inform alignment of research programs.**

Innovation

- Current management initiatives are not providing the rate of change needed to meet the Reef water quality targets and ultimately to ensure the Reef's long-term survival. Actions that are currently making a difference need to be maintained in parallel with a greater focus on innovation.
- Innovation is needed not just in agriculture but across all industries in the Reef to deliver major change, along with maintaining current actions that are delivering positive outcomes.

Innovation is needed in:

The next generation of sustainable land management practices

- Evidence suggests that even the adoption of current best farming practices for cane and grazing across the entire Reef catchment would still not be sufficient to meet current water quality targets in the prescribed timeframe and secure the long-term future of the Reef.
- A greater focus on innovative approaches will be required to identify and embed the next generation of sustainable land management practices and drive major transformational change.
- Recent initiatives such as the Australian Government's Game Changer Programme and Project Catalyst (primarily funded by the Coca-Cola Foundation) have provided avenues for innovative practices in cane to be explored. Practices trialled through these programs include:

- Variable rate nutrient application guided by Electrical Conductivity Soil Mapping (EC Mapping), and EC Mapping to apply herbicides at a variable rate across a paddock according to soil texture.
- Enhanced efficiency fertiliser.
- Potential improvements to soil health using different strategies of crop husbandry.
- Variable rate nutrient application based on block or management zones and guided by age of the crop ratoon, historical yields and soil constraints.
- Low cost alternative irrigation, and in ground irrigation.
- Precision Agriculture GPS steered two row harvester.
- Conversion of green fallow into soybeans.
- Examples of approaches that show promise include the use of zipline banana harvesting systems to reduce erosion from steeper blocks, more intensive grazing systems, such as cell grazing and holistic management, and enhanced efficiency fertilisers particularly when combined with lower nitrogen application rates. Enhanced efficiency fertilisers have the ability to slow the release of nutrients for uptake or to alter the conversion of nutrients to other forms that may be less susceptible to losses. These fertilisers should lead to nitrogen use efficiency which in turn should result in reduced levels of nitrogen at the end of catchments.
- Innovation should also be explored in terms of monitoring and evaluation with greater use of technologies like Lidar (remote sensing technology), drones and satellite imagery that can provide a higher coverage than current approaches. Working with the private sector may help identify further innovations, such as cheaper monitoring alternatives.

Ecosystem repair

- In addition to management practices designed to reduce the risk posed by land-based run-off, there are also novel remediation initiatives emerging which could help to treat sediment and nutrient run-off and protect the Reef from other recognised threats. Work is needed to investigate the likely impacts and benefits and ensure these are 'no regrets' actions. Possible examples include:
 - James Cook University are exploring the use of algae as a filtering and water purification mechanism in reducing dissolved inorganic nitrogen from cane farm irrigation tail water.
 - Floating wetlands which treat suspended sediment and nutrients are a prospect which has largely been used to date in waste water treatment and could be considered in remediating agricultural run-off in irrigated systems.

Policy and funding mechanisms

- There are more innovative approaches to policy emerging that may provide greater funding opportunities and maximise existing private and public investment. For example, more flexible arrangements for urban sewage treatment and stormwater infrastructure could provide funds to treat upstream sources of nutrients and sediment instead of major investments in infrastructure upgrades to meet licence conditions.
- More innovative public and private partnerships should also be considered. For example, working with philanthropic organisations on a case by case basis and co-investing through initiatives such as the Ian Potter Foundation, the Paddy Pallin Foundation, or the Coles Nurture Fund which is providing \$50 million over five years to Australian farmers to develop new market-leading products, technologies, systems and processes. The corporate sector should also be engaged in terms of technology advancements (e.g. through international companies like GE, Microsoft, Google, etc).
- Similarly, greater innovation to leverage outcomes from other programs (e.g. like the Rural Water Use Efficiency program) to maximise water quality benefits would be beneficial.
- Novel funding mechanisms could also be considered such as green bonds and recognition of natural capital in banking.

CONCLUSION

Innovation will be needed to achieve targets

Transformational change is required to deliver substantial water quality improvement, through policy, land management practices, new technology and monitoring. There is non-alignment of R&D across various research funders currently.

RECOMMENDATION 7

Better align science and fund development of new ideas and solutions

Strongly align science to deliver solutions to priority water quality problems. Fund synthesis and communication of knowledge to ensure it supports policy development, investment decisions and on ground action. Use some of the available funding to facilitate further development of new ideas and technologies to prove and successfully transfer these ideas for wide adoption.

20. Monitoring, modelling, evaluation and reporting

- Reef-wide monitoring and evaluation for the Reef Water Quality Protection Plan is provided by the successful Paddock to Reef Program. It uses multiple lines of evidence to evaluate progress towards the water quality and catchment targets. The program includes monitoring and modelling at the paddock scale, catchment scale and in the marine environment, with both the Australian and Queensland Governments funding different program components (Figure 13).
- Approximately \$8 million per year is provided for the Paddock to Reef program (2013-18), with:
 - Australian Government funding of approximately \$3.7 million per year directed predominantly at the paddock and marine scales.
 - Queensland Government funding of approximately \$4.1 million per year directed to catchment scale monitoring, modelling and mapping activities.
- It includes paddock trials, management practice reporting, freshwater monitoring, catchment modelling, inshore marine monitoring, and remote sensing.
- Although the basis of the Paddock to Reef Program is sound, current monitoring and modelling investment is not sufficient to adequately test the effectiveness of a significant major change program at the scale needed for the proposed major projects, or to evaluate practice and actions as part of these projects to inform future program design.
- To improve evaluation and better understand the water quality outcomes from management practice adoption, **there is a need to increase monitoring and modelling coverage across Reef regions, at the appropriate scale**. This should include nested monitoring so we can track improvements from paddock/plot to sub-catchment to end of catchment to marine system in the long term.
- Monitoring data should be presented back to farmers and graziers in a user friendly way to demonstrate the impact of their changes and trials.** One positive example of this is the Herbert River monitoring program which provided data directly back to farmers.
- There are a number of high priority gaps in the existing Reef catchment monitoring and evaluation program which need to be addressed with additional funding to provide more effective evaluation of management programs and better target and refine these programs over time. Specifically, there are limited monitoring sites in the Cape York and smaller coastal catchments, and there is insufficient sub regional or fine scale monitoring. Sub-regional monitoring is particularly important for providing

specific water quality information to landholders, to help inform their practices.

- There is also a need to better understand and document current management practice adoption across the industries and use this information to better target programs to specific needs, building upon the existing practice adoption program under the Paddock to Reef Program. Further, this information could also be better used in terms of how it translates to on-ground change and most importantly water quality outcomes.

Monitoring and modelling from the paddock to the reef allows us to measure and report on progress towards the Reef Plan goal and targets.

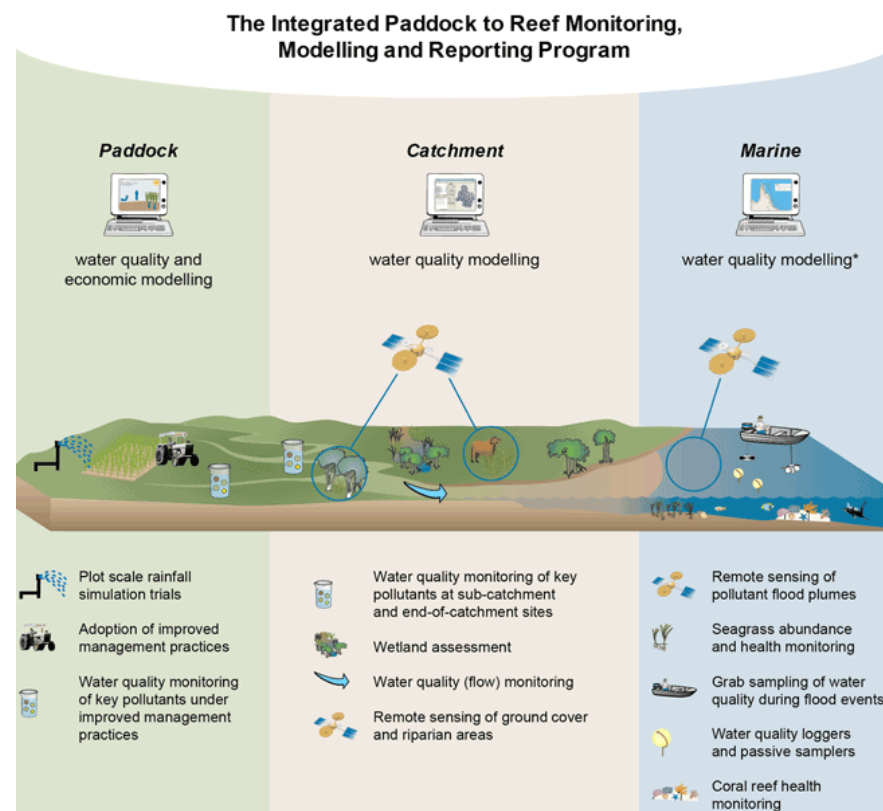


Figure 13: Integrated Paddock to Reef Monitoring, Modelling and Reporting Program

- The Great Barrier Reef Marine Park Authority is coordinating the development of an Integrated Monitoring and Reporting Program as part of the Reef 2050 Plan. This will be broader than water quality. \$8 million from

the Australian Government has been allocated to developing and implementing the program. These funds should be invested in developing a fit-for-purpose integrated monitoring program for the Great Barrier Reef World Heritage Area fully linked into catchment monitoring including upgrading existing monitoring and filling critical information gaps, as required, to fit this program.

- There are also a range of regional waterway health report card programs in place (Fitzroy, Gladstone and Mackay Whitsundays) and under development (Wet Tropics) that will bring together the range of monitoring available in the region (freshwater, estuarine, inshore and offshore marine) and consider the impact of all sources of pollutants (urban, industrial, agricultural, ports etc.) and engage all partners in identifying opportunities to improve waterway management across sectors.
- In making enhancements to the monitoring and modelling program, there is a need to address issues highlighted in the Queensland Audit Office recommendations:
 - *“Catchment monitoring is expanded to aid in determining the effectiveness of practice management change and enhance the confidence in modelled outcomes.”*
 - *“A rigorous verification process is applied to data on land management practice change to improve confidence in validation of the accuracy of inputs into catchment modelling.”*



Why use modelling to measure pollutant load reductions?

- Monitored pollutant loads leaving catchments vary significantly from year to year mainly due to differences in annual rainfall and run-off. To quantify changes in water quality due to land management change using monitoring data generally requires very long data sets (e.g. 5-20 years) to accommodate for the annual climate variability and time lags.
- Research suggests **time lags to monitor the improvements from land management practice change could range from years for pesticides up to decades for nutrients and sediments**. Therefore, to estimate the potential long term annual pollutant load reductions resulting from the adoption of improved land management practices, modelling is required.
- Modelling can remove the climate variability and provide an estimate of the likely affect the land management changes will have on water quality in the future. The models use measured changes in on ground management and well-documented and accepted methods and assumptions.
- **Long-term water quality monitoring data is critical to validate and improve the models, continuously improving confidence in the estimates of water quality over time.** Models can also be used to highlight where more data are needed in the future.

Modelled load reductions

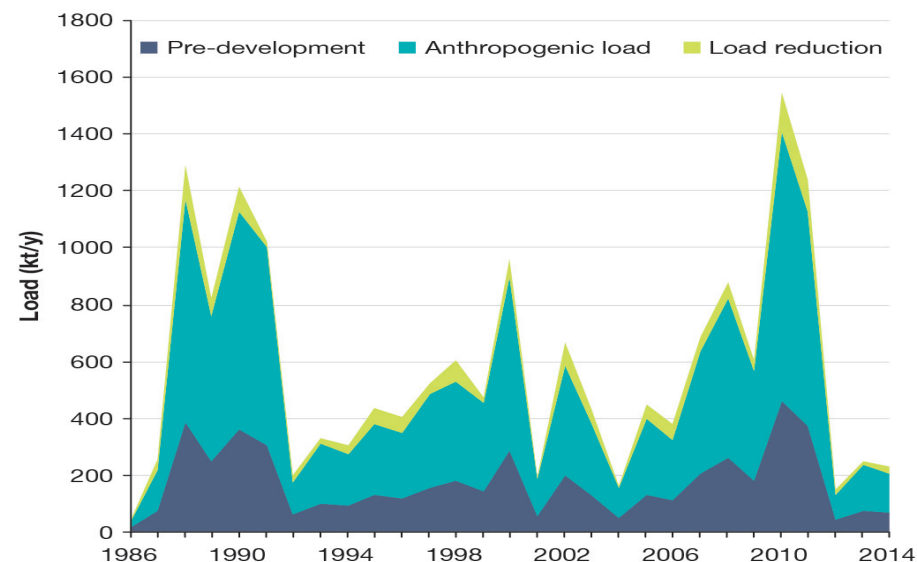


Figure 14: Example of modelled loads for natural (pre-development), human caused (anthropogenic) and the load reduction following investment in improved practices. The pollutant loads targets aim to reduce the anthropogenic load leaving catchments and running into the Reef lagoon.

Reporting

- The various monitoring and modelling programs inform a range of reporting products. In relation to the water quality targets, the key reporting product is the Reef Water Quality Protection Plan annual Reef report card produced through the Paddock to Reef Program. It reports on practice adoption, progress towards pollutant load reduction targets and inshore marine health. This information also feeds into 5 yearly Outlook Reports prepared by the Great Barrier Reef Marine Park Authority.
- Regional report cards also report on water quality at a finer spatial scale and in some cases report on progress towards objectives and targets under regional Water Quality Improvement Plans.
- The nested approach to reporting is summarised in Figure 15 on the following page.



CONCLUSION

Current investment in monitoring, modelling and reporting is insufficient

Current investment in monitoring and modelling is not enough to adequately measure GBR-wide water quality status and trends for both catchment and marine systems. It also cannot evaluate the impact of practice change on land at appropriate scales.

Regular and clear reporting on progress towards the targets is vital and should be part of the broader reporting for the Reef 2050 Long-Term Sustainability Plan and Reef Water Quality Protection Plan (e.g. through Outlook reporting and annual Reef report cards).

RECOMMENDATION 8

Fund additional Reef-wide and finer scale monitoring, modelling and reporting

Provide additional Reef-wide funding to fill high priority monitoring and evaluation gaps to enable better understanding of the current adoption of management practices across the industries and the effectiveness of programs in addressing water quality.

As part of the two major integrated projects provide funding for finer-scale catchment monitoring and modelling that can be used for evaluation purposes and that can be fed back to stakeholders to influence farm practices and provide effective evaluation of these projects to inform further roll-outs.

Ensure monitoring and modelling feeds into regular, harmonised reporting across the State and Commonwealth.

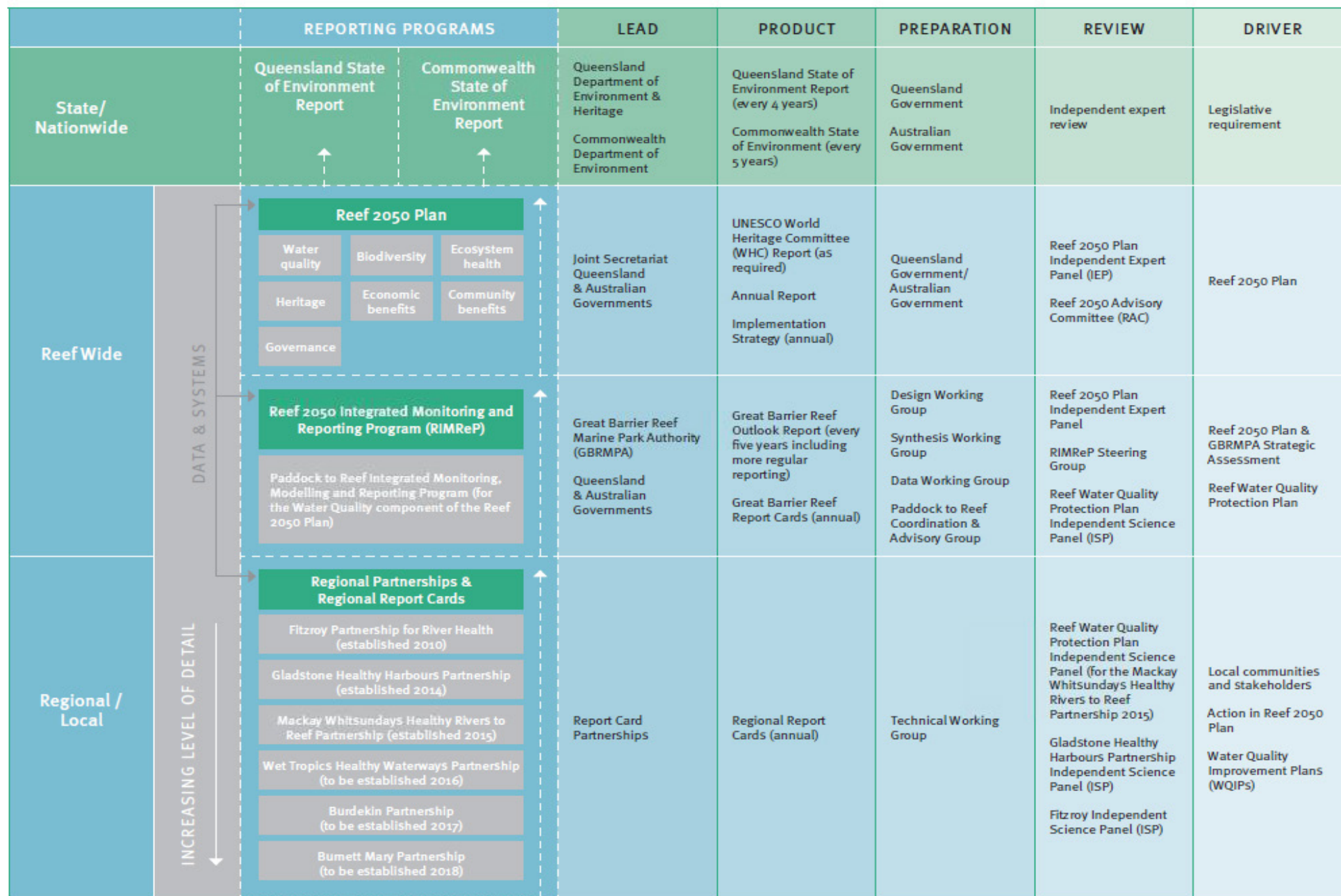


Figure 15: Nested approach to reporting

21. Governance

- **Simplifying complex governance arrangements is critical to efficient delivery.**
- Improved alignment and integration of Reef water quality programs, investment, delivery systems and communication will ensure all levels of government are combining their efforts.
- Establish a stronger program design and implementation with clear accountability for actions across governments, agencies and delivery organisations, clearly defining “who has to do what, by when”.
- **To reduce fragmentation the Queensland and Australian governments should:**
 - **Pool their funding** (in a Reef Trust more independent of government or other similar vehicle) to facilitate leveraging from private and philanthropic investments, locally and internationally.
 - **Develop five yearly joint investment plans** to provide certainty of funding and clearly address shared priority issues.
 - Bilaterally agree and **invest in the continuous improvement** of catchment scale delivery mechanisms required to deliver results.
 - **Continue co-funding monitoring** programs to properly evaluate outcomes of investment.
 - **Better align R&D funding** across multiple organisations (including universities and research organisations with their own core funding).
 - **Ensure continued alignment between strategies and programs** (e.g. Reef 2050 Plan, Reef Water Quality Protection Plan, Reef Trust, and Queensland funding programs).
 - **Unify communication/messaging** (e.g. a single website servicing both the Australian and Queensland entities regarding the Reef).
- It is recognised that existing governance structures are embedded in Reef 2050 Plan and the Reef Water Quality Protection Plan. The Taskforce has considered some ‘blue sky’ thinking about a potential longer term, simplified approach to governance (Figure 16).



CONCLUSION

Current governance is too complex

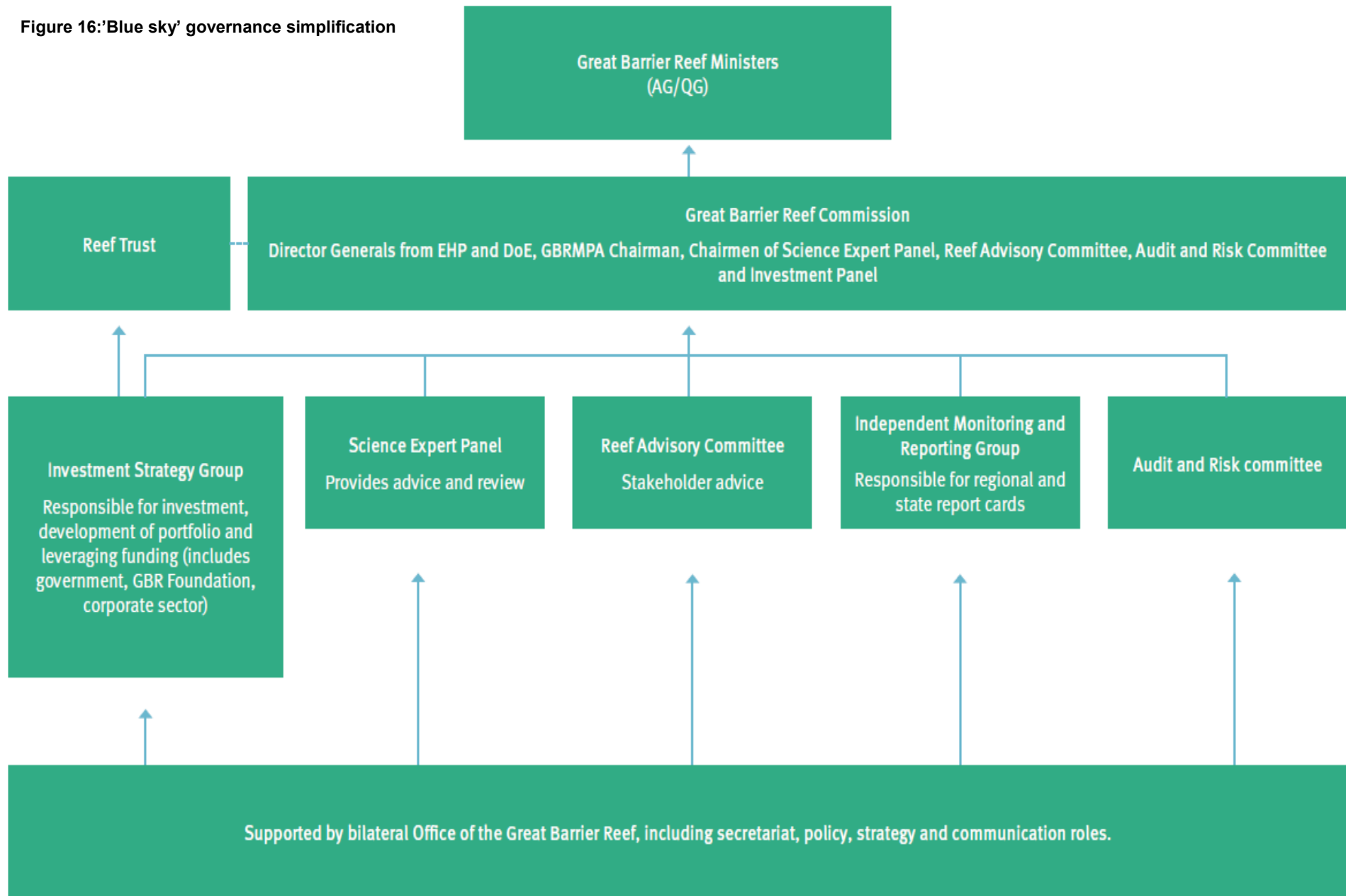
Reef-wide, water quality governance arrangements from policy to on ground delivery are complex with relatively poor coordination across the system.

RECOMMENDATION 9

Simplify governance (and clarify roles and responsibilities), pool resources, and better align program delivery

Simplify the current governance arrangements (and clarify roles and responsibilities), pool resources and better align funding, program delivery and communication for improved effectiveness.

Figure 16: 'Blue sky' governance simplification



22. Two major projects

- Transformational change will only come from implementing new innovations, coupled with better integration of existing tools and timely feedback of results to stakeholders on changes to nutrient and sediment loads.
- The Taskforce is recommending two major integrated projects be undertaken:
 1. **One program focussed on sediment in the Bowen catchment of the Burdekin.**
 2. **A second program focussed on nutrients and pesticides in the Johnstone and Tully catchments in the Wet Tropics.**
- **These locations are recognised as hot-spots** in terms of their contributions to sediment and nutrient loads respectively.
- The aim of the two major projects is to evaluate and communicate the environmental, economic and social benefits, and corresponding costs in terms of investment required, so that the approaches that prove successful and cost-effective can be appropriately applied across other Reef catchments.
- The work will build on the Water Quality Improvement Plans, the Walking in the Landscape approach, and BMP programs to identify costs and benefits of different actions, prioritise locations in the landscape for interventions and encourage improved land management.
- These major projects will evaluate the difference between business as usual, and implementing an intensive and flexible approach to land-use and practice change based on adaptive management. They will take account of the social, environmental and economic factors that influence change.
- **The projects will utilise a suite of tools tailored to optimise uptake and outcomes**, including:
 - Significantly improved collaboration, communication and extension that are targeted to individuals and support for peer-to-peer learning.
 - Fine-scale and nested monitoring within the catchments to demonstrate the effect of land practice changes to the stakeholders.
 - Trial and promotion of innovative practices such as enhanced efficiency fertilisers and 'management unit yield potential', gully prevention and remediation.
 - Improved and new user friendly and farm specific tools and apps. This includes building on some of the systems already in place applicable to

grazing such as Forage and VegMachine, as well as new tools and apps to allow farmers to match fertiliser application rates to promote outcome-focused innovative approaches to farm management.

- Stewardship payment or buy-back of marginal land.
- Restoration and rehabilitation of coastal ecosystems, wetlands and other areas critical for effective landscape function.
- The projects will test if and how the approach and interventions are suitable for broader application across Reef catchments, and whether they provide a significant change in trajectory of water quality outcomes.
- Early and on-going engagement with stakeholders such as landholders, community and industry at the program development and implementation phases will be undertaken and is the key to success.
- Project results will be widely communicated and used to inform broader application of the approach.
- Conceptual diagrams are provide below showing the diversity of management responses for the agricultural sector and possible measures that could be used to reduce excess nutrients and sediments generally, and as part of the two major projects.

CONCLUSION

Consider a small number of major projects as proof of concept

Major projects are needed in a small number of hot spots that integrate and evaluate the combined effectiveness of a range of tools and innovative approaches as a proof of concept for ongoing investment.

RECOMMENDATION 10

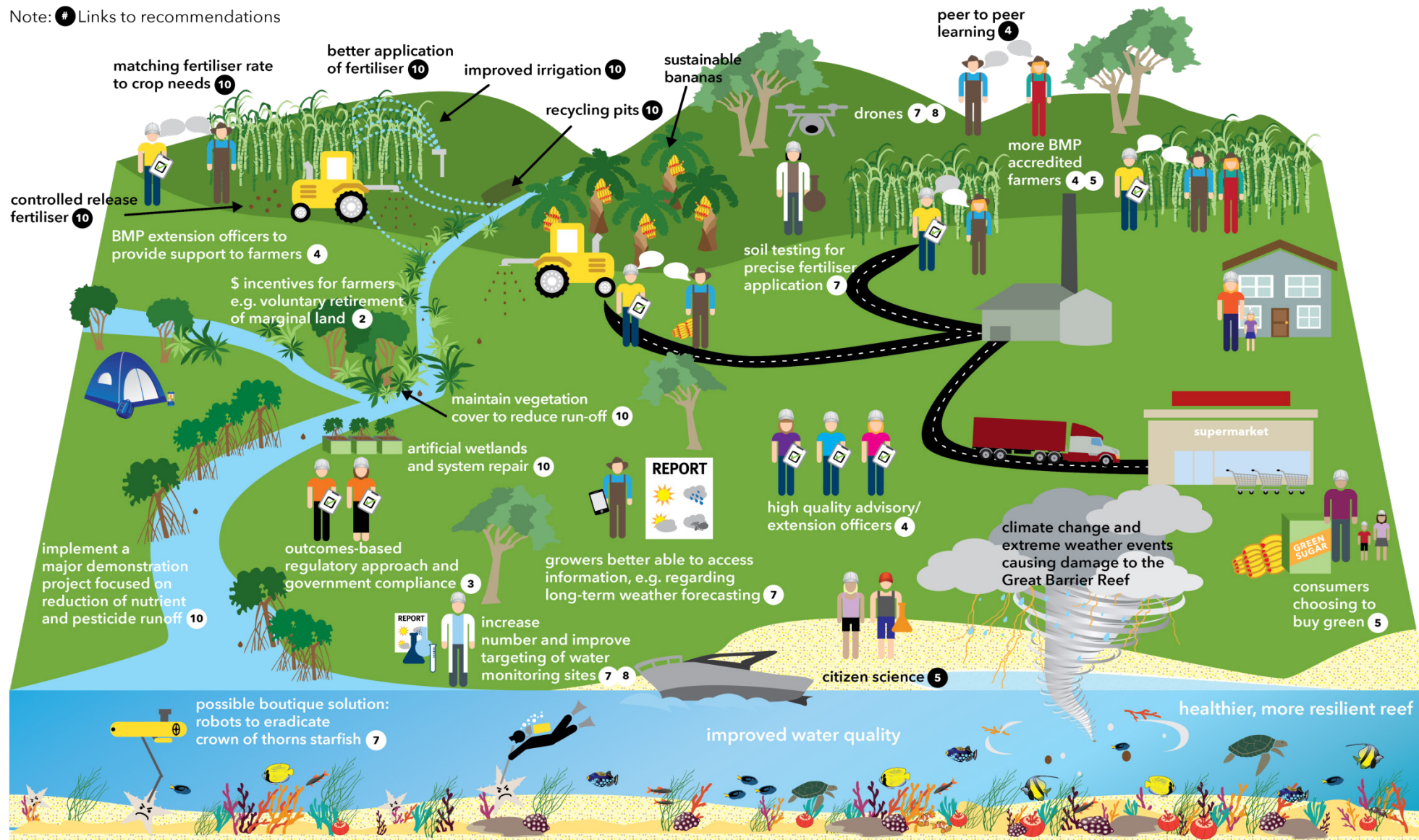
Implement two major demonstrator projects (one in the Wet Tropics and one in the Burdekin) to evaluate tools to inform design of future programs

Implement two major integrated projects, one on sediment (e.g. in the Bowen catchment of the Burdekin) and one on nutrients and pesticides (e.g. in the Johnstone and Tully catchments in the Wet Tropics) to demonstrate and evaluate how to best reduce pollutants reaching the Reef and inform the design of future programs.

23. Summary of tools recommended for nutrients and sediments for the agricultural sector

Nutrient Pollutant Reduction: summary of on-ground agricultural management responses

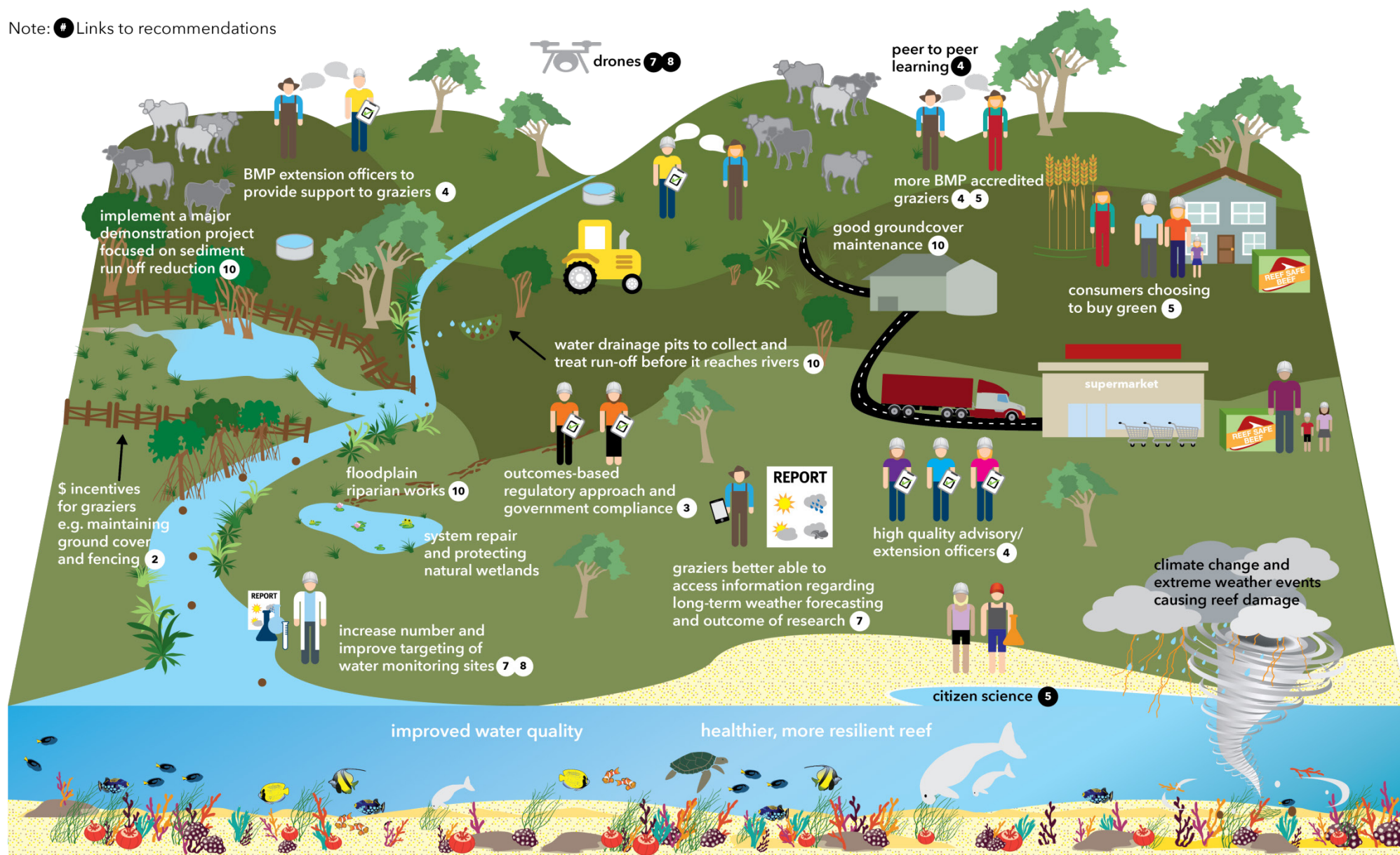
Note: # Links to recommendations



To test the effectiveness of these interventions, a major demonstrator project will be implemented in the Wet Tropics.

Sediment Pollutant Reduction: summary of on-ground agricultural management responses

Note: # Links to recommendations



To test the effectiveness of these interventions, a major demonstrator project will be implemented in the Burdekin.

24. Priorities for the \$90 million

- The Taskforce has made preliminary recommendations of the investment priorities for the \$90 million based on an understanding of the existing investment and programs, and the need to demonstrate accelerated progress towards targets (Table 5). These recommendations include a low, middle and high range of potential funding across different areas of investment.
- The Taskforce recognises that the investment needed to achieve the targets in the prescribed timeframe is likely to be beyond the funds currently allocated by the government.
- It is recommended that:
 - A significant proportion of funding be allocated into two major integrated programs.
 - Ensure momentum continues in other regions and fill critical gaps:
 - Address the significant underfunding of extension
 - Fill critical monitoring gaps in other regions
 - Provide a specific focus on driving innovation, including celebrating successes and role modelling high performers and demonstrating the 'how to' and economic model for improved practice. This should include facilitating innovative projects to help test the more widespread application of novel practices that provide a water quality benefit.
Innovation = 'ideas/research successfully applied'.
 - Set aside a small amount of funds to help drive public-private partnerships into on-ground projects and leverage Queensland Government funding.
 - Provide significant funding to improve general communication, coordination and accountability and alignment of new investment within existing funding processes.
- Establish more contemporary, outcomes focused regulations (replacing the existing Reef Protection regulations which are supported through existing funding).
- Continue a small research fund to get matched funding into highest priority areas.
- Better align the work of River Improvement Trusts and Rural Water Use Efficiency schemes to water quality.
- Reduce fragmentation of existing funding
 - \$35 million per year is made up of multiple short term funding programs as well as some base funded programs. Consider consolidating this into a single funding program, which isn't reliant on cobbling together base and limited life funding. That is, implement the Queensland Audit Office recommendations regarding a single point of funding allocation.
- Actively explore potential integration and/or ensure maximum alignment with Reef Trust funding and projects

Priorities for other existing funding

- Use the Queensland Government's existing \$35 million per year funding more effectively and in a more coordinated way (as the Queensland Audit Office also recommended):
 - Continue to support industry led BMPs, provided that the environmental standards are appropriate and widely adopted throughout industry, leading to actual on-ground land management changes.



INDICATIVE INVESTMENT SCALE RECOMMENDED OVER THE NEXT 4 YEARS

1. Keep targets and review in 2016 (\$0m)

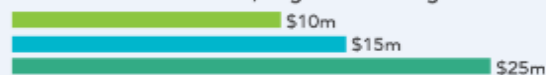
2. Greater use of market approaches and incentives



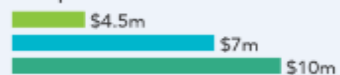
3. Introduce more outcomes based regulations



4. Invest in more effective, targeted and integrated extension



5. Improve communication and information



6. Develop a strategic investment plan and establish public-private partnerships (\$0m)

7. Enhance knowledge, science and innovation



8. Additional monitoring, modelling and reporting



9. Simplify governance, pool resources and better align delivery (\$0m)

10. Implement two major projects

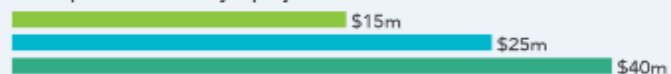


Table 5: Low, middle and high range of potential funding across different areas of investment, as per the Taskforce's recommendations



NEXT STEPS

25. Implementation of Taskforce Recommendations

- Ultimately, it is for the Minister for the Great Barrier Reef and the Queensland Government to determine to what extent the recommendations of the Taskforce are adopted and implemented. The Taskforce envisages that providing implementation oversight for adopted recommendations would be the responsibility of the Office of the Great Barrier Reef within the Department of the Environment and Heritage Protection.
- All adopted recommendations require a work plan that is congruent with the Reef 2050 Plan and other existing Reef work plans and programs, has clear accountability for actions (including specific responsibilities) with clear outcomes based on performance objectives. Implementation needs to be supported by adequate resources.
- The opportunities to integrate or build upon existing programs, plans or funding mechanisms such as Reef Trust and the Reef 2050 Plan is a high priority through the program design process.
- The data and outcomes of funded projects should be made publicly available.
- A program logic showing both funded programs and the recommendations which require government action (such as developing regulatory and market approaches, refining the water quality targets, and governance and coordination improvements) should be developed.
- Where applicable, for recommendations with allocated funding the government should develop programs and seek partnership arrangements to effectively implement the new programs. Partner and delivery organisations are likely to include:
 - Regional NRM bodies
 - Universities
 - Industry bodies
 - Local governments
 - Stakeholder and Traditional Owner groups
 - Government agencies
- A proposed timeframe (Figure 17) for implementing the recommendations of the Taskforce is provided below.



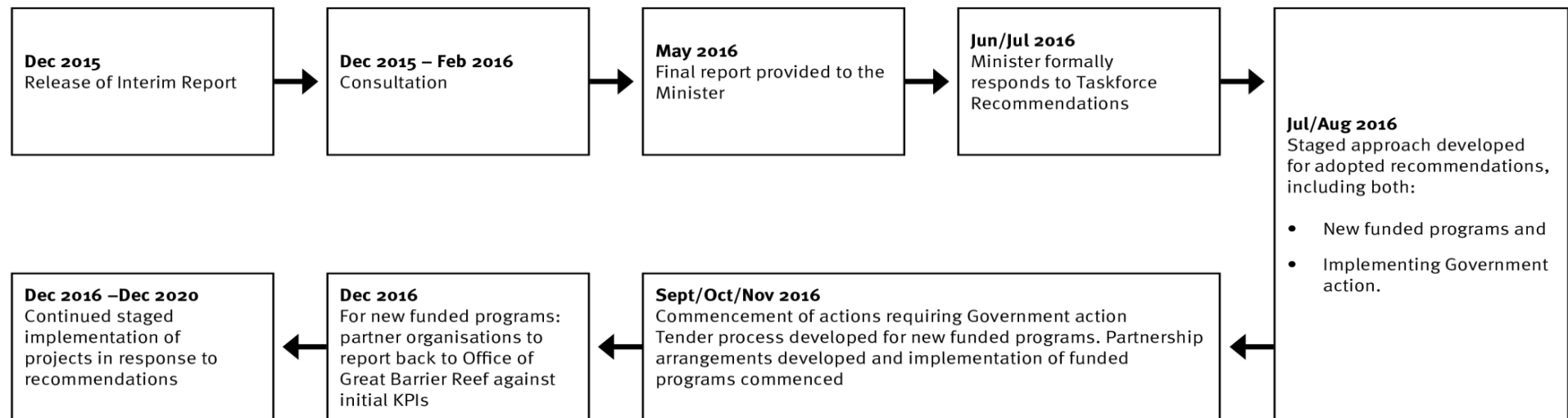


Figure 17: Proposed implementation timeframe

26. Share your views

The Taskforce wants to hear the views of stakeholders and interested members of the public.

Your views on the interim report will be considered as part of the Taskforce's work between now and May 2016, when a final report will be provided to the Minister for the Great Barrier Reef.

How to have your say

You can provide your feedback in a number of ways:

- Through an interactive survey on the GBR website: www.gbr.qld.gov.au
- In writing via email:
- OfficeofGBR@ehp.qld.gov.au



Simple glossary of terms

Adaptive management: a systematic process for continually improving management policies and practices by learning from the outcomes of implemented programs.

Best management practices: are defined in Reef Plan Water Quality Risk Frameworks for each major agricultural industry. These frameworks identify the management practices with greatest potential influence on off-farm water quality, and articulate a reasonable best practice level which can be expected to result in a moderate-low water quality risk. The levels described for each practice, where relevant, are:

- High risk (superseded or outdated practices)
- Moderate risk (a minimum standard)
- Moderate-low Risk (best practice)
- Lowest risk (innovative practices expected to result in further water quality benefits, but where commercial feasibility is not well understood)

The practice frameworks are used to measure progress against the Reef Water Quality Protection Plan management practice adoption targets and a range of investments in farm management change. Practices were initially classified as A, B, C or D (i.e., the 'ABCD framework'). The ABCD framework was updated in 2013 with the water quality risk frameworks, but is still commonly referred to.

Chlorophyll a: a green pigment, present in all green plants and in cyanobacteria, responsible for the absorption of light to provide energy for photosynthesis. Chlorophyll a indicates nutrient availability and productivity.

Crown-of-Thorns Starfish (COTS): the crown-of-thorns starfish (*Acanthaster planci*) is native to coral reefs in the Indo-Pacific region. On healthy coral reefs, the coral-eating starfish plays an important role, as it tends to feed on the fastest growing corals such as staghorns and plate corals, allowing slower growing coral species to form colonies. This helps increase coral diversity. However, outbreaks of this venomous invertebrate pose one of the most significant threats to the Great Barrier Reef.

Ecosystem services: actions or attributes of ecosystems of benefit to humans, including regulation of the atmosphere, maintenance of soil fertility, food production, regulation of water flows, water filtration, pest control and waste disposal. Ecosystem services also include social and cultural services, such as the opportunity for people to experience nature.

Ecologically relevant targets: define pollutant load reductions that would be required to meet the Great Barrier Reef Water Quality Guidelines, which are set at a standard considered to be suitable to maintain ecosystem health.

Ecosystem repair: a term used to describe wetland, riparian and mangrove protection and restoration, as well as on-ground projects to improve the quality of water entering the Great Barrier Reef from highly developed areas of the catchment.

Gully erosion: is the removal of soil along drainage lines by surface water run-off or where run-off concentrates. Gully erosion happens when run-off concentrates and flows strongly enough to detach and move soil particles. Splashback at the base of the gully head erodes the subsoil and the gully eats its way up the slope. In cultivation or pastures, advanced rill erosion can develop into gully erosion.

Groundcover: comprises organic material such as grasses, low shrubs and leaf litter. Maintaining ground cover minimises run-off and loss of nutrients and soil.

Nested: in general, something that is nested is fully contained within something else of the same kind. For example, a table within a table is a nested table.

Nutrients (including total nitrogen and total phosphorous): nutrients such as nitrogen and phosphorus can be derived from both natural and modified landscapes and can be present in various forms in run-off and or leaching from different land uses. Currently the Queensland Government's target for nitrogen does not specify the form of

nitrogen. Both dissolved and particulate forms of nutrients are important in driving ecological effects. The scientific consensus is that increased nitrogen inputs have more impact on water quality than phosphorus. Dissolved, inorganic forms of nitrogen and phosphorus are currently considered to be of greater concern than particulate or dissolved organic forms as they readily support algal and plankton growth.

Outcome based standards: standards can be used to meet performance requirements in two ways. Prescriptive standards specify exactly what actions must be taken to meet the desired level of performance. Outcomes based standards, while specifying the desired level of performance, allow discretion as to how the performance level is to be achieved.

Pesticides: collectively refers to herbicides, insecticides and fungicides. This includes PSII herbicides, which act to inhibit photosynthesis.

Program logic: identifies the links between resources, activities, outputs, impact and outcomes of policies and programs.

Riparian: riparian forest and ground cover is the vegetation beside waterways which can help reduce pollutant flow to waterways and stabilise stream banks.

Total suspended sediment: sediments can be derived from both natural and modified landscapes through erosion and can be present in various forms in water. Total suspended sediment is an indicator of particulate matter in water. The finer, mud-sized fraction (<63 µm) are a primary concern for the Great Barrier Reef.

Stream bank erosion: is a natural geomorphic process which occurs in all water channels as adjustments of channel size and shape are made to convey the discharge and sediment supplied from the stream catchment. However, human influence through catchment development, stream regulation, removal of large wood, and clearing of riparian vegetation, can greatly increase the rate of bank erosion, sometimes to unacceptable levels. Bank erosion includes two main groups of processes:

- Hydraulic processes at or below the water surface entrain sediment and directly contribute to erosion, particularly of non-cohesive banks, by processes of bank undercutting, bed degradation, and basal cleanout.
- Gravitational mass failure processes detach sediment primarily from cohesive banks and make it available for fluvial transport.

Water quality: refers to the chemical, physical, biological and radiological characteristics of water. It is a measure of the condition of water relative to the requirements of one or more biotic species and/or to any human need or purpose.

Water quality objectives: are numerical concentration limits or narrative statements that has been established to support and protect the designated uses of water at a specified site. It is based on scientific criteria or water quality guidelines, but may be modified by other inputs such as social or political constraints.

APPENDICES

Appendix A – Taskforce Membership

The Great Barrier Reef Water Science Taskforce is a group of experts from a range of fields, appointed by the Minister for the Environment and Heritage Protection and Minister for National Parks and the Great Barrier Reef. Members of the Taskforce are:

- Dr Geoff Garrett, AO FTSE, Queensland Chief Scientist (Chair)
- Steve Banney, Consultant, Grazing land management (Grazing industry)
- Dr Rebecca Bartley, Research Scientist, CSIRO (Sediment movement)
- Professor Susanne Becken, Director of Griffith Institute for Tourism, Professor of Sustainable Tourism, Griffith University (Tourism industry)
- Professor Mike Bell, Chair in Tropical Agronomy, Gatton Campus, The University of Queensland (Cane industry)
- Jon Black, Director-General, Department of Environment and Heritage Protection (Queensland Government) (up until Nov 2015)
- Colin Creighton, Principal Research Scientist, TropWATER, JCU and Director, Greening Australia (Natural resource management)
- Professor Allan Dale, Professor of Tropical Regional Development, Cairns Institute, James Cook University (Regional community expert)
- Dr Rob Fearon, Director, Innovation Partnerships, qldwater, Manager Queensland Water Regional Alliances Program (Local government)
- Professor Ove Hoegh-Guldberg, Director of the Global Change Institute, Professor of Marine Science, The University of Queensland (Tropical marine science)
- Euan Morton, Principal, Synergies Economic Consulting (Economics)
- Dr Steve Morton, Honorary Fellow, CSIRO Ecosystem Sciences (Conservation planning)
- Dr Chris Rawlings, Director, Queensland Energy Resources (Resources industry)
- Dr Russell Reichelt, Chairman and Chief Executive, Great Barrier Reef Marine Park Authority (GBRMPA)
- Dr Britta Schaffelke, Research Program Leader - Sustainable Coastal Ecosystems and Industries in Tropical Australia, Australian Institute of Marine Science (Water quality and research)
- Dr Roger Shaw, Independent consultant, Chair of the Reef Water Quality Protection Plan Independent Science Panel (Reef water quality science)
- Di Tarte, Independent Chair of the Mackay Whitsunday Healthy Rivers to Reef Partnership (Community engagement and partnerships)
- Malcolm Thompson, Deputy Secretary Environment Protection, Department of the Environment (Australian Government) (observer)
- Jane Waterhouse, Research Fellow, Catchment to Reef Processes, James Cook University (Water quality improvement planning)
- Brad Webb, Director of BM Webb Group (Ports industry)
- Dr Stuart Whitten, CSIRO Group Leader - Economics, Productivity and Sustainability Land and Water (Economics).

Taskforce Secretariat:

- Claire Andersen, Director, Reef Coordination and Partnerships, Office of the Great Barrier Reef
- Rachel D'Arcy, Manager, Reef Coordination and Partnerships, Office of the Great Barrier Reef
- Ben Hammill, Principal Policy Officer, Reef Coordination and Partnerships, Office of the Great Barrier Reef
- Sarah Hindmarsh, Principal Policy Officer, Reef Coordination and Partnerships, Office of the Great Barrier Reef
- Jenny Riches, Principal Project Officer, Office of the Queensland Chief Scientist

Appendix B – Review Group membership

The Review Group was established to provide feedback and peer review on the work and draft recommendations of the Taskforce. Review Group members are:

- Professor Paul Greenfield, AO FTSE, (Chair of Review Group), International Water Centre (Chair)
- Associate Professor Dr Eva Abal, Program Director, UQ Water, Global Change Institute
- Dr Andrew Ash, Former Director, Climate Adaptation Flagship, CSIRO
- John Bennett, Chief Scientific Officer, Reef Water Quality, Department of Environment and Heritage Protection
- Jim Binney, Principal, Mainstream Economics and Policy
- Dr Graham Bonnett, Research Director for the Integrated Agricultural Systems Program of CSIRO's Agriculture Flagship.
- Greg Bourne, Chairman, Australian Renewable Energy Agency (ARENA)
- Jon Brodie, Research Scientist, Centre for Tropical Water and Aquatic Ecosystem Research, James Cook University
- Professor Stuart Bunn, Director, Australian Rivers Institute, Griffith University
- Dr Peter Doherty, Fellow, Australian Institute of Marine Science (AIMS)
- Mike Grundy, Research Director, Sustaining Soil and Landscapes, Agriculture Flagship, CSIRO
- Lyall Hinrichsen, Executive Director, Land and Mines Policy, Department of Natural Resources and Mines
- Professor Terry Hughes, Director, ARC Centre of Excellence for Coral Reef Studies
- Dr Paul Lawrence, Director, Landscape Sciences, Science Division, Department of Science, Information Technology and Innovation
- Malcolm Letts, Executive Director, Regions and Industry Development, Department of Agriculture and Fisheries
- Tony McAlister, Group Manager – Water Quality, Water Technology
- Dr Chris McGrath, Senior Lecturer (Environmental Regulation) The University of Queensland
- Sheriden Morris, Managing Director, Reef and Rainforest Research Centre Ltd
- Professor Peter Mumby, ARC Australian Laureate Fellowship, School of Biological Sciences, The University of Queensland
- Professor Jon Olley, Professor of Water Science, Australian Rivers Institute
- Ian Poiner, Chair -Integrated Marine Observing System Advisory Board, Chair - Gladstone Healthy Harbour Partnership Independent Science Panel
- Professor Hugh Possingham, Director ARC Centre of Excellence for Environmental Decisions, The University of Queensland
- Professor Bob Pressey, ARC Centre of Excellence for Coral Reef Studies, James Cook University
- Carole Sweatman, CEO, Terrain NRM Ltd
- Rob Vertessy, Director of Meteorology and CEO, Bureau of Meteorology

Appendix C – Key References

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Appendix D – Supporting Taskforce reports

Supporting Taskforce reports provide detail on the conclusions and recommendations of the Taskforce, and can be found at: www.gbr.qld.gov.au

Documents available:

- Current situation analysis <http://www.gbr.qld.gov.au/documents/taskforce-situation-analysis-july2015.pdf>
- Terms of reference <http://www.gbr.qld.gov.au/documents/gbr-taskforce-tor.pdf>
- Background papers to Taskforce recommendations:
 1. Market based approaches
 2. Pathways to regulation
 3. Extension and education
 4. Communication, collaboration and stakeholder engagement
 5. Monitoring, modelling, evaluation and reporting
 6. Two major projects