

REEF WATER QUALITY



ADDENDUM to

**Reef Water Quality Research, Development
and Innovation Strategy 2014/15–2018/19**

June 2016

Purpose of the Addendum

The Department of Environment and Heritage Protection's (EHP's) *Reef Water Quality Research, Development and Innovation Strategy 2014/15–2018/19* (the RD&I Strategy) was released in February 2015.

Since its release, the priorities and knowledge gaps identified in the RD&I Strategy have guided investment under the Reef Water Quality (RWQ) Science Program.

The current program builds on the first RWQ Science Program (2009–14) which focused on prioritisation and addressing knowledge gaps in relation to cane, grazing and banana farm management systems. Current activity aims to extend the results of projects with land managers in a way that facilitates practice change on farm. It enhances and develops guidance, systems and tools that support decision-making.

An interim review of the RD&I Strategy has been conducted to consider the evolving priorities and direction until June 2019. The outcomes have been consolidated in this *Addendum to the RWQ RD&I Strategy 2014–2019* (the Addendum), and take into account contemporary research, investment to date, and alignment with other programs such as the National Environment Science Program (NESP) and Reef Trust.

Read together, this addendum and the RD&I Strategy outline the research themes and priorities under the RWQ Science Program for 2016 to 2019. Future investment decisions and collaborations will be guided by both documents.

The Addendum also provides an outline of investment to date and suggests areas of future investment focus. Both provide context to the current RWQ Science Program.

The RD&I framework for the RWQ Science Program (refer to Figure 1) has been updated as a result of this refinement process.



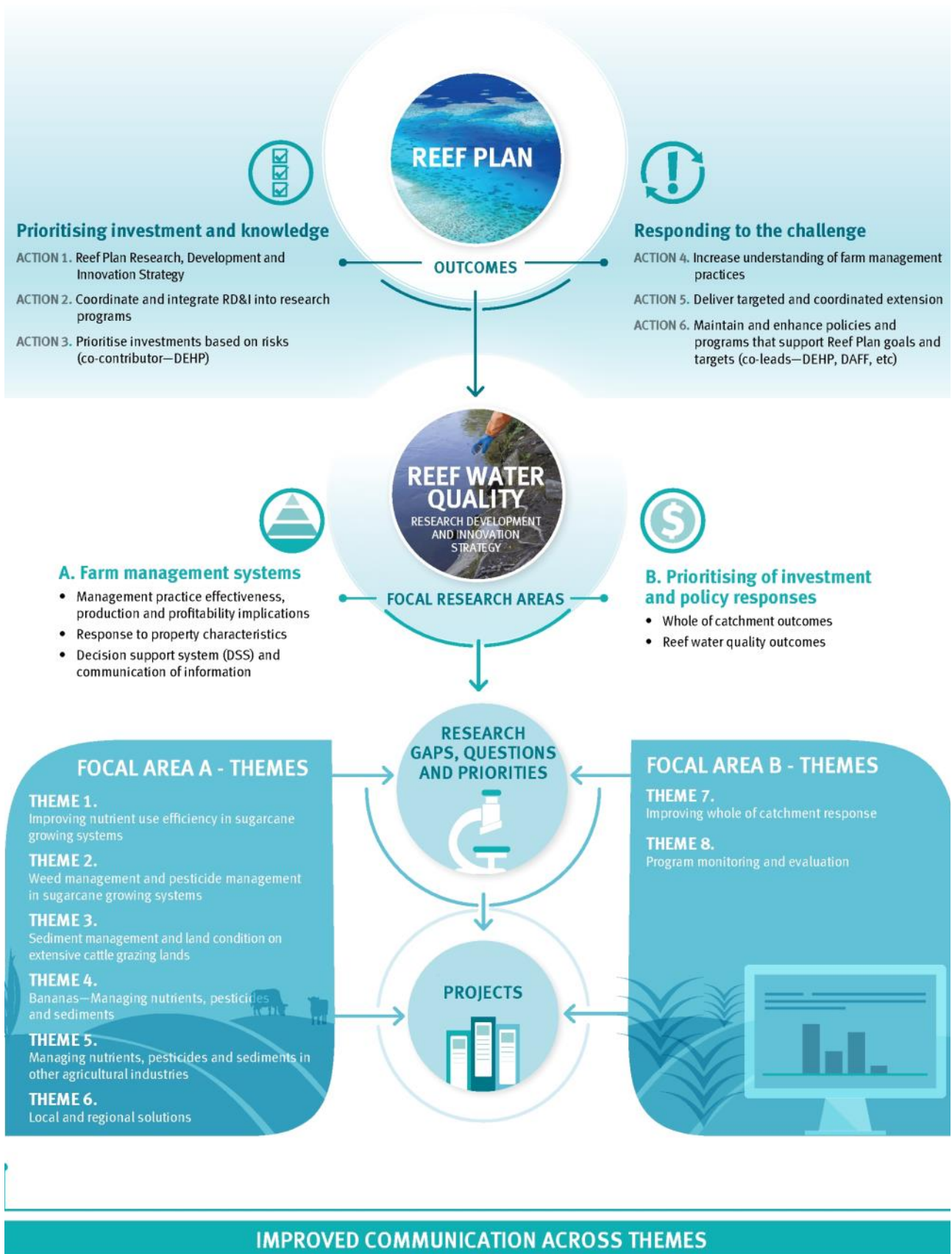


Figure 1—RD&I Framework for RWQ Science Program

We continue to evolve

The RD&I Strategy identifies ongoing and emerging research priorities under 'focal areas' while acknowledging that priorities may evolve in light of emerging information, investment focus and collaborations. The RD&I Strategy guides the direction of the RWQ Science Program. Since 2015 it has been influenced by:

- results of projects completed under the 2009–2014 RWQ Science Program
- synthesis reports which collated emerging science since the 2013 Scientific Consensus Statement with respect to pesticides and nutrient use efficiency in sugarcane, and gully and streambank management in grazing lands, amongst others
- Australian Government Reef Trust Phase 1, 2, 3 and ongoing implementation
- Water Quality Improvement Plans (WQIPs) across reef catchments.

A critical consideration for Queensland Government investment is the Government's response to the recommendations of the Great Barrier Reef Water Science Taskforce (the Taskforce) released in May 2016. The Taskforce recommended that investment should focus on improved market approaches and incentives, more effective and targeted extension and outcome based regulation. It also identifies the need for improved science and information that can be applied through these programs.

The Queensland Government will use the recommendations to guide its \$90M investment. The RWQ Science Program seeks to provide evidence to support on-ground responses and align investment with the Queensland Government's response.

How to use this Addendum

This document highlights where investment has concentrated to date under the RD&I Strategy themes, and where there may be future investment focus over the next three years. Table 1 can be used as a reference guide where readers can find information related to Themes across both this Addendum and the RD&I Strategy.

New Themes under Focal Area B expand on the two existing questions (see B1 and B2, page 16) expressed on page 10 of the RD&I Strategy.



Table 1 – Reference guide for RD&I themes

	RD&I Strategy 2014/15–2018/19 (February 2015)	Addendum to RD&I Strategy 2014/15–2018/19
Focal Area A. Farm management systems		
Theme 1. Sugarcane–nutrient use efficiency	Page 12	Page 8
Theme 2. Sugarcane–weed and pesticide management	Page 14	Page 10
Theme 3. Cattle grazing–sediment management and land condition	Page 16	Page 11
Theme 4. Banana–managing nutrients, pesticides and sediment	Page 19	Page 12
Theme 5. Other agricultural industries	See Themes 1, 2 & 3 Pages 12, 14, 16	Page 13
Theme 6. Local and regional solutions	See Themes 1, 2, 3 & 4 Pages 12, 14, 16	Page 13
Focal Area B. Prioritising investment and policy responses		
Theme 7. Improving whole of catchment response	See B1 and B2, page 10	Page 15
Theme 8. Program monitoring and evaluation	See B1 and B2, page 10	Page 18

RWQ Science Program so far

Providers of science, research and extension, including other government departments, federal and regional agencies, agricultural industry bodies and groups of producers, have been engaged to deliver projects under the various themes of the RD&I Strategy.

To date, the RWQ Science Program has funded projects that have evaluated the effectiveness of improved farming practices and developed tools to support the sugarcane, cattle grazing and banana industries to improve land management practices and improve water quality from catchments feeding into the Great Barrier Reef (GBR). It has also funded projects that have enhanced understanding of the agricultural activity impact on reef water quality. The results have contributed to the synthesis of emerging science to guide policy development, investment decisions and on-ground programs—such as Best Management Practice (BMP), extension and regulatory programs.

Since 2014, the RWQ Science Program has:

- commissioned reviews with respect to: agricultural chemicals management, prioritisation systems, current knowledge and knowledge gaps
- extended or commissioned 23 projects (listed in table 2) related to improved farm management systems in cane, grazing and bananas
- established collaborative research programs and projects with Sugar Research Australia (SRA) and the National Environmental Science Program (NESP), amongst others.

Descriptions of projects completed since the commencement of the Science Program in 2009 are listed in the [Reef Water Quality Science Program 2009-2015, Our research investment](#) document.



Changes to themes

The 2015/16 review of the RD&I Strategy sought to confirm the themes and priorities to guide investment until June 2019. It considered other reef water quality related programs and transferability of outcomes across reef catchments and greater Queensland to ensure that the RWQ Science Program continues to maximise investment and optimise outcomes.

The RD&I priorities for the existing themes 1–4 are unchanged. This Addendum adds to the original RD&I Strategy by describing future investment focus for each of these themes. Four new themes have been added, two in Focal Area A and two in Focal Area B.

In summary, major changes to the RD&I Strategy reflected in this Addendum and Figure 1 are:

a) All reef catchments

The regional focus will widen from the Wet Tropics, Burdekin, Fitzroy and Mackay–Whitsunday regions to be able to respond to priority research needs in other GBR catchments.

b) Other agricultural industries (Theme 5)

A new theme has been created to accommodate projects that align with priority research gaps related to nutrient, sediment, pesticide or herbicide management across commodities other than the cane, banana and grazing industries.

c) Local and regional solutions (Theme 6)

‘Science delivery’ or extension projects have demonstrated great potential to influence farm management decisions. These projects sometimes utilise local water quality monitoring with extension activities to increase producers’ understanding of localised pollutant (nutrient, pesticide, sediment) losses and management options. This new theme consolidates these projects and enables RWQ to support other innovative approaches to motivating practice improvement across sectors.

d) Catchment approaches

Under Focal Area B, catchment-wide approaches and off-farm approaches to reducing agricultural pollutant loads are now explicitly considered and potentially may link with ecosystems repair. Two new themes (Theme 7. Improving whole of catchment response and Theme 8. Program monitoring and evaluation) have been added.

e) Communication and engagement

There is an increased emphasis on engagement and communication of emerging science information and its integration into the technical advice given to producers. Figure 1 recognises it as underlying the entire RWQ Science Program.

Table 2 – RWQ Science Program (2014–2019): Contracted projects by theme (as at April 2016)

1. Cane—nutrients management	
RP102C	A sub-catchment adaptive management approach to water quality in sugarcane for the 2014–2016 season
RP101C	Partnering with MSF Sugar to improve nitrogen use efficiency in sugarcane
RP20/14C	Burdekin nitrogen use efficiency trials (extended 2010–14 project)
RP151C	Developing guidelines for the use of mill by-products
RP120C	EHP and Sugar Research Australia (SRA) collaborative NUE research program: <ul style="list-style-type: none"> • 069/PM003–Decision support for informed nitrogen management: soil nitrogen mineralisation test and the assessment of soil crop N contribution to crop N requirements • 065/DS007–Improving NUE for sugarcane crops with constrained yield potential • 070/RB005–Spatially explicit estimation of Achievable Yield Potential—an improved basis for fertiliser management • 074/WW001–Improved management practices of legume crop residues for maximal economic and environmental benefits • 075/YE002–How big will that crop be? Incorporating climate forecasting into nitrogen management in the Wet Tropics
RP109C	Enhancements to SafeGauge for Nutrients—SG2
RP110C	Assessing the risk of off-site P movement from soils amended with mill mud products
RP155C	Sub-soil constraints mapping to inform nutrient management in cropping industries
NESP2.1.8	Improved water quality outcomes from on-farm nitrogen management
2. Cane—pesticides and herbicides management	
RP57C	An evaluation of the prevalence of non-regulated pesticides of environmental concern in regulated catchments
RP123P	Johnstone River water quality monitoring site (completed)
RP104C	Pesticide synthesis report—Advancing out understanding of the source, transport and impacts of pesticides on the Great Barrier Reef 2011–2015 (completed)
RP103C	Dual Herbicide Sprayer—evaluation, testing and training in the Mackay–Whitsunday, Burdekin and Wet Tropics cane-growing regions
RP129C	Development of alternative pesticides guideline values
3. Grazing—sediment management	
RP128G	Sources of available particulate nutrients and organics
RP112G	Mapping erodible soils in grazing lands—Fitzroy catchment
RP105G	Spatial arrangement and seasonal dynamics of cover in grazing lands
NESP2.1.4	Demonstration and evaluation of gully remediation in GBR rangelands
NESP2.1.5	Tracing origin and fate of environmentally detrimental sediment
4. Bananas—nutrients, pesticides and sediment management	
RP140B	Banana BMP economics

Table 2 – RWQ Science Program (2014-2019): Contracted projects by theme (as at April 2016) continued

6. Local and regional solutions	
RP122P	Herbert water quality monitoring program (extended from 2011–14 project)
RP144C	Hotspot water quality monitoring in Sandy Creek
RP161C	Burdekin Cane Farmer Engagement: Complete Nutrient Management for Cane Farming
NESP2.1.7	Engaging with farmers and demonstrating water quality outcomes
7. Whole of catchment—investment response	
RP154P	Enhanced findings of the 2013 Scientific Consensus Statement (gaps and opportunities)
RP145P	Prioritisation tool review
RP141P	Support for Burdekin Water Quality Improvement Plan WQIP Part A—spatial prioritisation
RP152P	Cost-effective restoration of wetlands
8. Monitoring and evaluation	
RP150P	Monitoring and evaluation review reef catchments and BMP



Focal area A—Farm management systems

Theme 1. Improving nutrient use efficiency in sugarcane growing systems

Investment to date

Investment under this theme has been guided by the synthesis of knowledge regarding nutrient use efficiency (NUE), in the Sugar Research Australia Ltd (SRA) report [A Review of Nitrogen Use Efficiency in Sugarcane](#) (Bell, M.J. 2015).

The report confirmed the RD&I Strategy research priorities which are focussed on supporting:

- development of guidance for optimal nutrient management
- action research in priority catchments—Wet Tropics, Mackay–Whitsunday, recognising that there is existing RWQ Science Program funded research in the Burdekin (e.g. RP102C)
- producer adoption of practices to support reef water quality targets (e.g. RP20/14C *Burdekin nitrogen use efficiency trails*).

The SRA synthesis report also informed a major program of co–investment through to 2018 with SRA and RWQ partnering to support the five projects listed in Table 2 above that address priority research needs.

Most of the projects included in the 2014–19 RWQ Science Program align with the gaps related to the need to refine methods for improving NUE on farm and to demonstrate the effectiveness of improved practices in high priority catchments.

RD&I priorities

The NUE priorities set out in the RD&I strategy (February 2015) will continue to guide future investment, refer to RD&I strategy, page 12, Table 2.



Future investment focus

There is an ongoing need to validate and extend advice on the effectiveness of nutrient management strategies and systems available to increase nitrogen and phosphorus use efficiency, particularly in the Burdekin and Wet Tropics priority areas. The aim is to promote the broad-scale adoption of these best management practices.

Continuing and adapting the successful model of extension and demonstration used in existing NUE projects is a priority. This is particularly so in the Burdekin and Wet Tropics regions where nitrogen is a Reef Plan priority pollutant for management. Future projects will look to further demonstrate nitrogen application in line with SIX EASY STEPS™ (6ES) method.

Adapting the RP20/14C *Burdekin nitrogen use efficiency trials* project model to be implemented in the Wet Tropics is being considered given the project's success in promoting the adoption of improved nitrogen application practices.

The 6ES methodology has been developed by industry and provides guidance to optimise nutrient management on farm. Potential research projects for the RWQ Program could focus on refining nutrient application using the full 6ES methodology (steps 1–6) applied at the management/productivity zone (or finer) by conducting further trials, including grower trials. Other research and action research projects might focus on for example; the development or refinement of decision support tools and information; improved climate forecasting; specific management for late cut cane; ameliorating soil constraints; or the use of enhanced efficiency fertilisers (EEFs) to improve NUE.

There is widespread industry and researcher support for further trialling of EEFs. They represent a new generation of fertiliser technology enabling nutrient release to better match crop requirements during growth. Consideration must be given to:

- improving advice and understanding the role of EEFs in improving NUE in cane farming systems
- improving understanding of EEF products' implications for the environment, including an assessment of water quality impacts and ecological toxicity.

This work is currently being scoped, and would be linked to wider research and activities such as the EHP/SRA funded projects and those funded through NESP, Reef Trust and potentially the Task-force recommended Major Integrated Projects (MIPs).

There has been some limited investment to date in identification of soil physical constraints (RP109C) in sugarcane and other cropping systems that may limit the efficacy of nutrient management approaches.

A key challenge for the industry and its advisers is how to best improve productivity and NUE through appropriate on farm responses to soil constraints and soil health enhancements. Potential responses include:

- extending paddock/production unit scale soil mapping across cropping lands in reef catchments to identify sub-soil constraints associated with nutrient management
- improving technical guidance in relation to nutrient management systems on lands with sub-soil constraints
- extending SafeGauge for Nutrients through incorporating with current industry nutrient recommendation software and workshops.

There is also potential to support investigations into improved irrigation use efficiency where there are implications for plant nutrient uptake and nutrient loss off-farm i.e. improved nutrient use efficiency.

Critically, emerging science will need to be included in technical advice given to producers and their advisers.



Theme 2. Weed management and pesticide management in sugarcane growing systems

Investment to date

In 2014, RWQ commissioned James Cook University to produce a synthesis report (*Advancing our understanding of the source, management, transport and impacts of pesticides on the Great Barrier Reef*) which confirmed the critical research gaps related to pesticide management and environmental impact.

The report, released in 2015, confirmed the 2014–19 RWQ Science Program research priorities and knowledge gaps and supported the investment to date. Projects have focused on:

- monitoring non-regulated pesticides use that are of environmental concern in regulated catchments
- assessing the relative environmental risk of priority regulated pesticides against the non-regulated alternative pesticides
- using water quality data collected from paddock or farm run-off after rain events to demonstrate farm practice impacts
- water quality monitoring and extension in 'hotspot' catchments such as Sandy Creek (in the Plane Creek catchment)
- constructing a new monitoring station on the Johnstone River as part of the Great Barrier Reef Catchment Loads Monitoring Program (GBRCLMP).

The RWQ Science Program has also funded the construction of three Dual Herbicide Sprayer (DHS) units to demonstrate more efficient pesticide application in priority reef catchments. The demonstration, training and extension components are funded through the EHP and Department of Agriculture and Fisheries (DAF) extension program.

RD&I priorities

The priorities set out in the RD&I Strategy (February 2015) will continue to guide future investment, refer RD&I Strategy, page 14, Table 3.

Future investment focus

There is a need for clearer guidance on chemical products and water quality guidelines, and improved communication with sugarcane growers and other producers about the ecological risk of pesticides commonly used in GBR catchment farming systems and how to minimise these risks.

Collaborations to support guideline values creation for alternative pesticides (alternatives to the priority PSII pesticides) as well as the subsequent communication of these guidelines are being explored.

Continued pesticide presence in water quality monitoring results shows the need for greater uptake and application of appropriate pesticide management strategies by producers within reef catchments. Innovative extension, research and communication approaches that explore the barriers to, and encourage improved practice continue to be a priority, particularly in hotspot catchments such as the Herbert, Sandy, Barratta and Johnstone (refer Theme 6—Local and regional solutions).



Theme 3. Cattle grazing—sediment management and land condition

Investment to date

Since 2009, RWQ Science Program investment under this theme has focussed on developing tools and information to support graziers to make decisions that will minimise sediment loss and maintain good land condition. Significant investment has focussed on the Burdekin catchment.

Two synthesis projects were completed. One analysed grazing land management practices and their implications for water quality and the other captured current knowledge of erosion processes and sources within the Burdekin catchment. In addition, an economics analysis of grazing management practices was also undertaken.

Ground cover was mapped across GBR catchments and is being refined in the Burdekin and Fitzroy catchments. Erodible soils and gullies were mapped in the Burdekin catchment with the erodible soils mapping now being prepared for the Fitzroy catchment. The online FORAGE decision support tool was enhanced, providing a suite of reports for grazing land managers on ground cover, pasture growth and erodible soils, amongst others. Most reports are now available for the whole of Queensland. Dominant erosion processes, spatial source of sediment and temporal changes were identified in the Burdekin.

The Department of Science, Information, Technology and Innovation (DSITI) and the Department of Natural Resources and Mines (DNRM) are continuing to map the extent of gullies and improve spatial land mapping techniques.

The RWQ Science Program is supporting a project investigating nutrients attached to fine sediments to establish if there is a significant link to nutrient levels evident in the Burdekin catchment receiving waters. This project helps to identify sources and landscapes most likely to contribute this fine sediment to receiving waters. Protocols for sampling, processing and analysis of samples for particulate nutrients using the best indicators are being developed to ensure robust testing, results and interpretation for use in future monitoring programs.

Sediment Working Group

In 2015, an informal Sediment Working Group (SWG) was established to inform the adaptive management of hillslope, gully and streambank erosion across GBR catchments. A process has been set up to consistently monitor and synthesise information from the range of erosion related projects currently (or soon to be) underway.

The SWG has involved representatives from cross government programs, research, community and other organisations which aim to align ongoing and proposed programs, research under the RWQ Science Program and NESP, and the delivery of Taskforce recommendations.

RD&I priorities

The priorities set out in the RD&I strategy (February 2015) will continue to guide future investment but will be considered across all GBR catchments on a priority basis, refer to RD&I Strategy, page 16, Table 4.

Future investment focus

Future investment will focus on improving understanding and demonstration of management options' effectiveness in priority locations, including innovative solutions, that:

- minimise erosion and sediment run-off from grazing properties to the GBR
- fine tune decision-making for pastures and degraded land rejuvenation
- improve management of grazing lands and frontage country adjacent areas of gully or streambank erosion
- effectively respond to drought.

RWQ will seek to support action research projects related to prevention and remediation of gullies and stream bank erosion in priority locations. The priorities for action research and adaptive management with respect to gully and streambank management will continue to be guided by the SWG. It will consider opportunities to align with different Reef Trust phases, NESP and projects flowing from the Taskforce recommendations.

There may need to be continued investment in improving soil mapping and data layers to assist identification and management response in grazing and other agricultural lands.



Available soil mapping information should be evaluated in order to improve projects involving:

- erosion prevention and remediation of eroded areas
- land management advice and extension
- catchment modelling.

The science around fine sediments, identification of vulnerable soils and their spatial identification require further refinement. Also, further research into nutrients attached to sediments will depend on the outcomes of initial work (anticipated in 2017).

Understanding vegetation density changes (particularly thickening) including where and why they occur is an emerging priority. In response, appropriate land management strategies will need to be developed and communicated with producers.

Several grazing extension tools have been developed. Additional support for extension efforts with graziers and their advisors is required to guide on-farm decisions as well as support accreditation processes of the Grazing BMP program.

This could include investing in extension and development of new monitoring tools and/or maintenance or enhancement of existing tools and data that can provide consistent land condition assessment and improved reporting.

Such efforts would require collaborations with other state and federal programs, other reef water quality programs such as Reef Trust, and implementation which would take into account Taskforce recommendations.



Theme 4. Banana—managing nutrients, pesticides and sediments

Investment to date

The RWQ Science Program has funded DAF to undertake an economic assessment of the Banana Best Management Practice (BMP) program to be completed in June 2018. The Banana BMP covers practices across all aspects of banana farming including land and soil, pesticides and fertilisers.

RD&I priorities

The priorities set out in the RD&I Strategy (February 2015) will continue to guide future investment, refer RD&I Strategy, page 19, Table 5.

Future investment focus

A priority is to collaborate with the banana industry to maintain ground cover and directing and managing surface overflow to minimise sediment run-off with added benefits of reducing the risk of nutrient and pesticide transport off-farm.

If available funding permits, other research priorities may include:

- how to manage ground preparation and crop establishment to manage mineralised nitrogen in the plant crop
- phosphorus and nutrient budgeting
- support enhanced extension and communication of best management practice.

Future investment activities will be mindful of the needs for containment and response to Panama disease.



Theme 5. Managing nutrients, pesticides and sediments in other agricultural industries

All agricultural industries have a role in achieving the pollution reduction targets set under the Reef Long Term Sustainability Plan 2050 (Reef 2050 Plan). There will need to be continuous land management improvement to respond to potential increases in diffuse pollution associated with changing land uses across GBR catchments. For example, the extension or conversion of agricultural lands to crops used for biofuel feedstock is a potentially growing industry that will require investment to ensure that best practice is used in establishing these new land uses.

RD&I priorities and future investment focus

The research gaps for Themes 1, 2 and 3, set out in the RD&I Strategy (February 2015), will guide investment in industries alongside the priorities that might arise through the review of Reef Plan in 2016/17, the update of the Scientific Consensus Statement as well as results from existing RWQ Science Program projects.

Theme 6. Local and regional solutions

Investment to date

The current RWQ Science Program includes a number of 'science delivery' projects that use different methods to demonstrate water quality impacts of farm management practices to producers in order to encourage on-ground management practice change.

Projects that have been implemented (mainly under Themes 1 and 2) include those which utilise the following approaches to 'extending' science and/or engaging producers:

- a) **Water quality monitoring** (including real-time) at paddock, farm or sub-catchment scale coupled with producer involvement to directly link on-farm practice to off-farm impact to support producer adoption of improved practices. In some instances, participants have been able to capture and demonstrate improved outcomes resulting from traditional to improved practices. This has been effective with respect to management of pesticides and fertilisers in various catchments.
- b) **Demonstration/extension** through both on and off farm trials to demonstrate and compare a range of practices with producer involvement supported by evaluation and wider communication of program outcomes.



Future investment focus

To build on the success of these science delivery projects and refine the methodologies used, RWQ is looking to support more projects which focus on producer engagement and fostering commitment to long-term improved practice change, hence the creation of Theme 6.

This may occur through supporting:

- a) the expansion or continuation of projects that have demonstrated that they are leading the uptake of best management practices
- b) new projects that will harness and refine the approach to extending knowledge on the ground and instilling on-farm improved practice change.

Focus will be targeting practices that can be changed. They may involve:

- a substantial extension focus and/or farm demonstrations to attract wider groups of producers
- water quality monitoring, to demonstrate nitrogen, pesticides and sediment run-off from paddocks, with well-defined producer engagement strategies, and preferably on-farm extension.

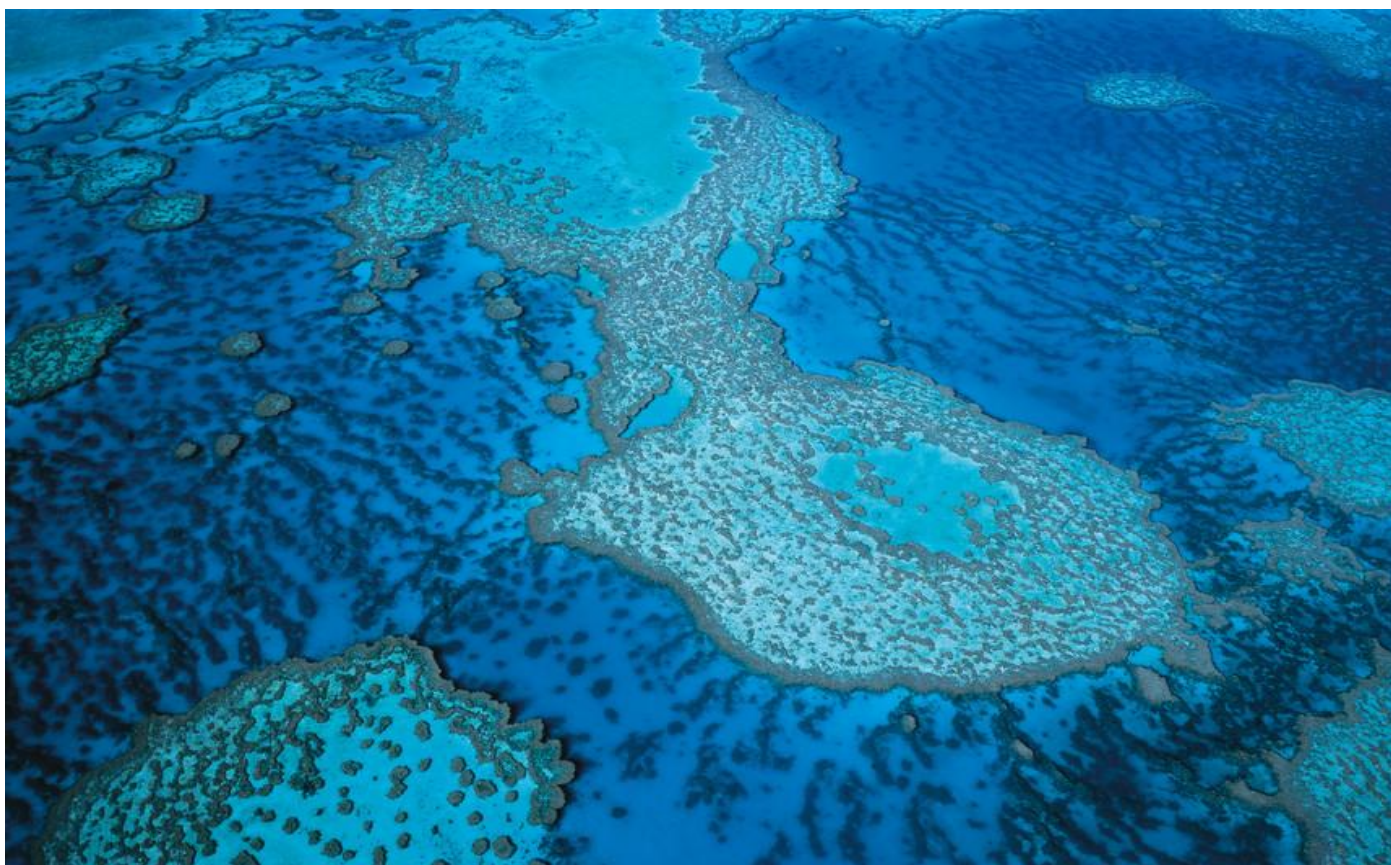
Specifically, RWQ is interested in supporting projects that will:

- develop and use a consistent framework for designing, implementing and evaluating local and regional water quality monitoring and practice change projects
- explore and evaluate the effectiveness of innovative and alternative communication, extension and data/information sharing approaches
- recommend options and actions to support local and regional farming communities in responding to issues identified through water quality monitoring and practice change projects.

Table 3: Project focus and priorities for Local and Regional solutions

Project focus	Priority
LSD31 Improving water quality outcomes through producer involvement in innovative approaches and communication and extension methodologies, which leads to improved practices	HIGH
LSD32 Identifying associated barriers and benefits of specific practices and developing strategies to address barriers	HIGH
LSD33 Improving evaluation and refining methodologies used to achieve practice change to optimise their effectiveness	HIGH
Geographic locations and industries for investment will be guided by priorities identified in Water Quality Improvement Plans and the future update of Scientific Consensus Statement in 2016/17	

The RWQ Science Program will consider alignment with other reef water quality investment and monitoring programs such as NESP, and the Paddock to Reef Integrated Monitoring, Modelling and Reporting Program (Paddock to Reef program).



Focal Area B—Prioritising and informing policy responses

The challenge of reaching targets set in the Reef 2050 Plan requires building, evaluating and communicating the evidence that guides producers and investors about where to direct on-ground action and innovative policy responses.

RWQ is responding to emerging issues with respect to agricultural land management in reef catchments. Through the synthesis of emerging science and knowledge, identifying how it influences programs and then integrating this into on-ground activities such as BMP and extension programs.

Projects that will be engaged under the following themes will align with research priorities under the Reef Plan RD&I Strategy. Reference is made to the appropriate Reef Plan gaps related to off-farm responses for example ecosystem repair such as wetlands and riparian restoration and improvement and implementation of water treatment systems.

A strategic review of currently available prioritisation frameworks and tools was undertaken by RWQ in consultation with key Reef Plan stakeholders.

This identified that prioritisation frameworks and tools have been applied very differently for applications requiring large-scale prioritisation (e.g. allocating resources across the GBR), when compared to prioritisation practices adopted within regions as part of regional WQIPs development. Whilst many of the prioritisation processes are relatively robust, there are critical gaps or improvements required to assist with targeting action.



Theme 7. Improving whole of catchment response

Investment to date

Since the 2013 Scientific Consensus Statement was issued, which also underpins the Reef Plan 2013, additional published literature and synthesis reports identifying emerging science and remaining knowledge gaps are being used to guide government investments. Many studies have been synthesised as part of the update and development of the GRB regional WQIPs in 2014 and 2015.

In response, a report was commissioned under the RWQ Science Program that provided an initial update on emerging science, where it may enhance the Scientific Consensus Statement and where improved information can be communicated now to regional stakeholders. This work will inform the planned review of the Reef Water Quality Protection Plan in 2016/17.

In 2016, EHP's RWQ program and the Queensland Wetlands Program (QWP) also contributed to a Advance Queensland Fellowship project—to develop a wetlands typology framework that will identify how different natural wetlands systems could contribute to management of run-off including nutrients and other pollutants once they have left the farm.

RD&I priorities

Research priorities reflect the need to provide guidance on 'Where, why and how do we invest in improving agricultural practices in Great Barrier Reef catchments?' and expand on the two existing questions (B1 and B2, page 16) in the RD&I Strategy (February 2015).



Table 4: Research gaps and priorities for improving whole of catchment response

Research gap	Priority
B1. Which pollutants and pollutant-generating practices and processes should be targeted? Which sub-catchment areas are contributing the most significant loads?	
WP34. Enhance knowledge about pollutants and pollutant-generating processes	MED-HIGH
WP35. Improve understanding of spatial priorities for response	MED-HIGH
WP36. Enhance understanding of the significance and contribution of pollutant risks for the GBR ecological systems	MEDIUM
B2. What management systems and policy changes relating to broadscale agriculture (and how it is changing) could enhance the quality of water entering the reef and improve its long term health and resilience?	
WMS37. Determine management systems, strategies, catchment approaches and programs (including communication) that are most effective at reducing the risk from pollutant loads	HIGH
WMS38. Review and refine models, methodologies and tools to support prioritisation, monitoring and evaluation of investment	MEDIUM
B3. Alignment of diffuse pollution management on agricultural land with ecosystems repair	
WER 39. Enhance understanding of potential responses of different ecosystem repair options (wetland restoration, streambank improvement) to improve water quality—sediment, pesticide, nutrient and cycling absorption	Reef Plan HIGH
B4. Alignment of diffuse pollution management on agricultural land with ecosystem treatment systems	
WER 40. Enhanced understanding of the efficacy and efficiency of different treatment systems for removing nutrients and pesticides and the landscapes and configurations in which these may be most effective	Reef Plan HIGH
WER 41. Identify wetlands characteristics in the landscape which maximise contaminant removal (linked to nutrient/pesticide management on cropping lands)	Reef Plan HIGH
WER 42. Synthesise information that supports extension resources for landholders and industry on best practice guidelines for remediation of stream bank erosion and riparian vegetation including cost-benefits of practice uptake (linked to sediment management—grazing)	Reef Plan HIGH

Future investment focus

Prioritisation of interventions and investment in enhancing the GBR health is vital as current resources are insufficient to address all risks. Investments in this area are likely to be linked to research themes identified under **Focal Area A. Farm Management Systems**.

B1. Which pollutants and pollutant-generating practices and processes should be targeted? Which sub-catchment areas are contributing the most significant loads?

Funds have been committed to support the Scientific Consensus Statement update in 2016/17 as part of the Reef Plan update.

The Scientific Consensus Statement will synthesise information, including that from projects funded by the RWQ Science Program that will subsequently inform extension activities aimed at producers to undertake practice change (e.g. decision support tools, demonstration farms).

B2. What management systems and policy changes relating to broadscale agriculture (and how it is changing) could enhance the quality of water entering the reef and improve its long-term health and resilience?

The prioritisation review identified potential collaboration to improve or extend regional prioritisation tools, particularly regarding the improvement of underpinning data and consistency of approach. Consultation with key parties will be undertaken to identify key knowledge gaps and metrics identified in the WQIPs which, with RWQ funding support, potentially could be addressed, improved and used more broadly. There may be potential to collaboratively develop tools that better estimate load reductions associated with management interventions.

B3. Alignment of diffuse pollution management on agricultural land with ecosystems repair

Ecosystem repair is a critical area of work that will have updated actions developed under the Reef Plan review over 2016/17 with likely support from a new chapter in the associated Scientific Consensus Statement update.

Potential alignment activity may include:

- management interventions and responses associated with preventing or remediating sediment loss from gully and streambank erosion
- riparian management responses in grazing and other agricultural lands.

B4. Alignment of diffuse pollution management on agricultural land with ecosystem treatment systems

Ecosystems treatment processes is a critical area of work that will have updated actions to be developed under the Reef Plan review over 2016/17 with likely support from a new chapter in the associated Scientific Consensus Statement update.

Potential alignment activity may include consideration of treatment values of natural and engineered systems in addressing pollutant loads spatially and over time.



Theme 8. Program monitoring and evaluation

Investment to date

The ability to monitor, evaluate and adaptively manage operational programs is critical to achieving Reef 2050 Plan targets. Projects undertaken through the RWQ Science Program contribute to extension, industry led BMP programs, regulatory and other activities which aim to support improved practice.

The Paddock to Reef Program includes the Water Quality Risk frameworks which set out the monitoring and reporting requirements for measuring management practice adoption, and hence changes over time. Individual programs (e.g. Reef Programme grants) and commissioned services include requirements to evaluate outcomes and contribute data to Paddock to Reef Program reporting. The RWQ Science Program aims to provide additional support to improving evaluation processes and ensuring outcomes can be effectively monitored and reported over time.

During 2015–16, DAF and EHP commissioned a review of the framework for monitoring and evaluation of BMP and extension programs against the Water Quality Risk Framework, to identify potential improvements and consider where there may need to be changes. A critical aim is to better identify where these programs can report on contributions to GBR water quality improvements and other benefits associated with investments.

Future investment focus

Further investment is likely to be directed to support evaluation of the RWQ Science Program and other investments outcomes, where not already identified within program parameters.

In some cases, RWQ may contribute to other projects funded under other programs such as Reef Trust, regional extension or industry led research to evaluate the effectiveness of the management interventions and/or the associated impact for water quality (e.g. through real-time water quality monitoring, LiDAR evaluation etc.). Generally these will be evaluated taking account research priorities under Themes 1–4.

More information

Further information regarding the Reef Water Quality Science Program can be obtained from www.qld.gov.au/FarmingInReefCatchments webpage, by emailing Coordination.ReefProject@ehp.qld.gov.au or 07 3330 5642.



the 1990s, the number of people in the UK who are employed in the public sector has increased from 10.5 million to 12.5 million, and the number of people in the public sector who are employed in health care has increased from 2.5 million to 3.5 million (Department of Health 2000).

There are a number of reasons for this increase in the number of people employed in the public sector. One of the main reasons is the increasing demand for health care services. The population of the UK is ageing, and there is a growing number of people with chronic conditions such as heart disease, diabetes, and asthma. This has led to an increase in the number of people who are hospitalized and the number of people who are in long-term care.

Another reason for the increase in the number of people employed in the public sector is the increasing demand for health care services from the private sector. The private sector has been growing rapidly in the UK, and this has led to an increase in the number of people who are employed in the private sector. However, the private sector is not able to meet the demand for health care services, and this has led to an increase in the number of people who are employed in the public sector.

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