

National Environmental Science Program

Tropical Water Quality Hub

RESEARCH PLAN v5

Tropical Water Quality Hub Research Plan Version 5 - V.02

VERSION CONTROL REVISION HISTORY			
Version	Date revised	Reviewed by (Name, Position)	Comment (review/amendment type)
V0.x	11/7/2018	Kylie Kulper, Science Partnerships	Revised for RPV5.
V0.1	17/9/2018	Dr Julie Carmody, RRRC	First draft
V0.2	7/11/2018	Dr Julie Carmody, RRRC	Review and amend for resubmission

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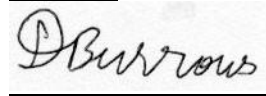
CERTIFICATION OF RESEARCH PLAN

Hub Leader Certification

As the Hub Leader, I certify that:

- the research projects contained in the Research Plan are linked to the Activity Outcomes for the Tropical Water Quality Hub as outlined in the Funding Agreement;
- the research projects in the Research Plan address the NESP Research Priorities for Tropical Water Quality Hub;
- funds are available to meet all approved projects and the additional projects included in this Research Plan; and
- this Research Plan was prepared in consultation with the hub steering committee.

Signed:



Hub Leader Name: Professor Damien Burrows

Date: 9 November 2018

Hub Steering Committee Chair Certification

As the steering committee chair, I certify that:

- this Research Plan was prepared in consultation with the hub steering committee;
- any issues of concern or matters raised during steering committee meetings or the Department during its assessment process have been adequately resolved, amended or incorporated into this Research Plan; and
- this Research Plan was endorsed by the steering committee on 9 November 2018.

Signed:



Hub Steering Committee Chair Name: Leith Bouilly

Date: 9 November 2018

INTRODUCTION

The National Environmental Science Program

The National Environmental Science Program (NESP) is a long-term commitment to support environmental and climate research. The key objective of the NESP is to improve our understanding of Australia's environment through collaborative research that delivers accessible results and informs decision making. The focus of NESP is on practical and applied research that informs on-ground action and that will yield measurable improvements to the environment.

The Program builds on its predecessors - the National Environmental Research Program and the Australian Climate Change Science Program – in securing for decision makers the best available information to support understanding, managing and conserving Australia's environment.

The NESP is delivered through multi-disciplinary research Hubs or consortia, hosted by Australian research institutions.

The NESP seeks to achieve its objective by supporting research that:

- is practical and applied and informs on-ground action
- addresses the needs of the Australian Government and other stakeholders by supporting and informing evidence-based policy and improving management of the Australian environment
- is innovative and internationally recognised
- enhances Australia's environmental research capacity
- is collaborative and builds critical mass by drawing on multiple disciplines, research institutions and organisations to address challenging research questions
- produces meaningful results accessible to government, industry and the community
- includes synthesis and analysis of existing knowledge
- builds relationships between scientists and policy-makers to encourage collaborative problem solving on environmental issues.

NESP end-users will be a broad range of stakeholders whose decisions may impact on the environment, and include the Australian Government, state governments, industry, business, community groups and Indigenous land managers (or Indigenous Communities).

The intended outcomes of the NESP are:

- Enhanced understanding of, and capacity to manage and conserve Australia's environment.
- Improved climate and weather information for Australia through a greater understanding of the drivers of Australia's climate.
- Timely research that is used by policy and decision-makers to answer questions and provide solutions to problems.

- Research outcomes that are communicated clearly to end-users and the general public, and stored in a manner that is discoverable and accessible.

Hub Role

The NESP Tropical Water Quality (TWQ) Hub is researching coastal water quality and coastal management focused on the Great Barrier Reef, Torres Strait and other tropical waters. The NESP TWQ Hub will provide innovative research for practical solutions to maintain and improve tropical water quality from catchment to the marine environment with a particular focus on supporting the priorities of the Reef 2050 Long Term Sustainability Plan and the Reef Trust.

The NESP Tropical Water Quality Hub began in early 2015, and shortly after was provided with a list of initial research priorities by the DoEE that had been developed by consultation within the Department, other departments and with the Minister. These research priorities, grouped under three themes, were presented in Research Plans 1, 2, 3 and 4. In 2017, the DoEE provided the Hub with a slightly revised set of research priorities for Research Plan v4, grouped under the same three themes. These are presented in the Research Priorities section.

The Hub engages research-users in a collaborative process to co-develop projects in current and emerging priority areas, including:

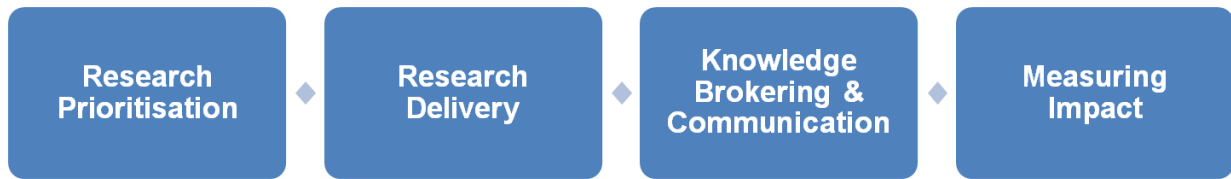
- Mitigation and management of crown-of-thorns starfish outbreaks.
- Reduction of sediment and nutrient export from catchments.
- Cumulative catchment, coastal and marine habitat repair.
- Planning and managing interventions in the marine and coastal environment
- Indigenous co-management of cultural keystone species and habitats.

Purpose of Research Plan

This Research Plan has been developed by the NESP Tropical Water Quality Hub, in consultation with the Department of the Environment and Energy and other key stakeholders.

The purpose of the Research Plan is to outline:

- the research priorities the Hub is funded to investigate
- the research projects that will address these priorities
- how the output of the research will be communicated and brokered to key stakeholders
- how the impact of the research will be measured
- how Hubs will work collaboratively within and across Hubs.



This Research Plan also provides appropriate detail on the management and governance of the Hub, including outlining the broader funding profile, key staff and research organisations, and the risks needing to be monitored to ensure success.

HUB ADMINISTRATION & GOVERNANCE

Hub Leadership and governance

Hub governance involves a specific stakeholder engaged framework, with strong cross-Hub interactions and enhanced linkages to key national initiatives such as the Reef 2050 Long Term Sustainability Plan, Northern Australia Development, and Indigenous Advancement Strategy. The NESP TWQ Hub is hosted by the Reef and Rainforest Research Centre Ltd (RRRC), a consortium of research providers, key industry groups, and an independent Chair, Dr Ian Poiner.

Governance of the NESP TWQ Hub includes direct communication between the Hub Host (RRRC), the six partner institutions, the Hub Leader (Professor Damien Burrows) and the Department of the Environment and Energy (DoEE). The independent Hub Steering Committee chaired by Leith Bouilly reports directly to the DoEE, and have open communication lines with the Hub Leader. Research results are disseminated by the Hub Host to stakeholders via strategic and quality controlled mechanisms, such as the Knowledge Brokering and Communications Strategy, Indigenous Engagement and Participation Strategy, nominated Project Leaders, and Project Associates (Figure 1).

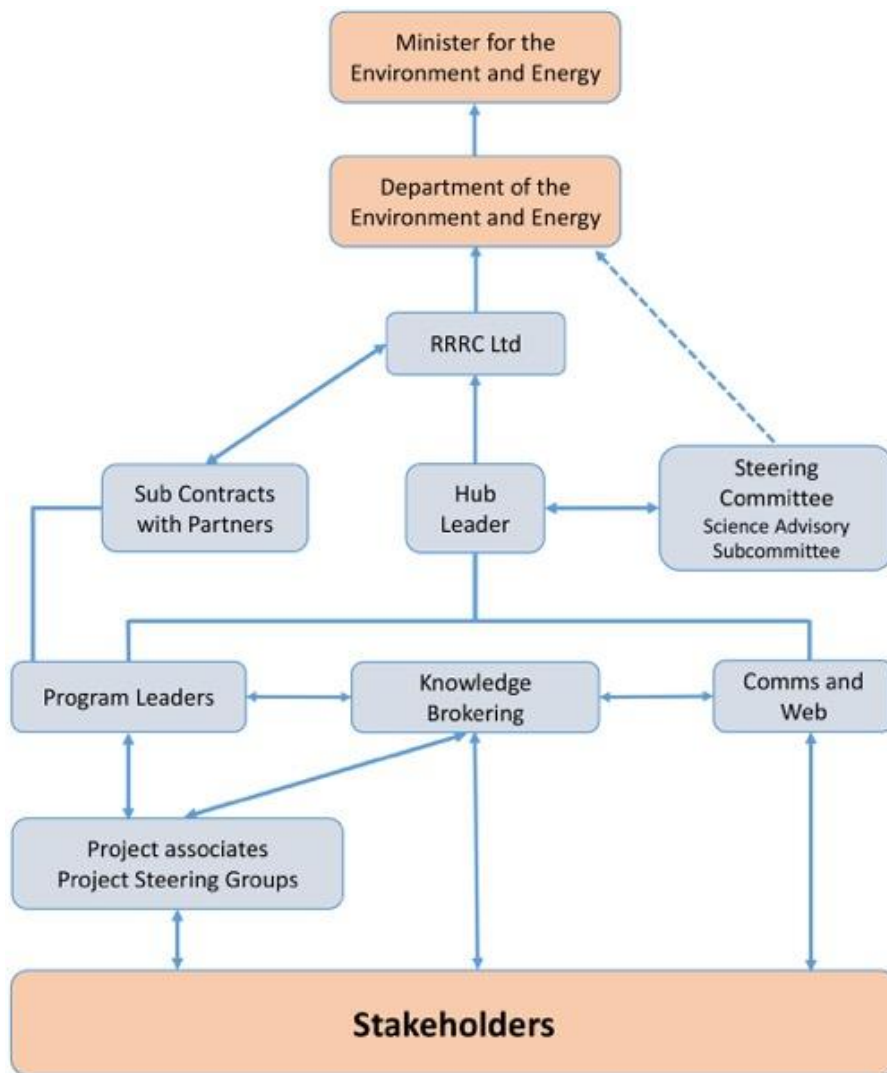


Figure 1: Governance structure of the NESP Tropical Water Quality Hub

Steering Committee

The Hub Steering Committee provides strategic supervision over the Hub's performance against its objectives. The roles, responsibilities and membership of the Steering Committee are outlined in its terms of reference, and include;

- ensuring the alignment of research activity to the policy needs and interest of the Department and other key stakeholders
- connecting the Hub's research questions, activities and outputs to relevant research activity and policy initiatives outside the Department
- overseeing the development and implementation of the Research Plan, including the review and amendment of the Research Plan, as required
- directing, and endorsing, the development, and delivery of any reporting, monitoring and evaluation requirements under this agreement
- review, monitor and guide project performance.

The Department of the Environment and Energy

The Department of the Environment and Energy has responsibility for managing the National Environmental Science Program, including the approval of this Research Plan, assessment of progress of projects under this Research Plan and payment of any funding associated with the Hub agreement.

Importantly, the Department is the key end user of research under the NESP, and works closely with the Hub and other key stakeholders in determining and negotiating the delivery of research under the Research Plan.

The Minister

The Minister for the Environment and Energy provided approval to fund the NESP Tropical Water Quality Hub and has authority to approve major changes to the scope and funding allocation to the Hub and to endorse annual versions of the Research Plan.

RESEARCH PRIORITIES

The NESP Tropical Water Quality Hub is committed to a body of activity that includes short and long-term research projects. Each activity year the Department of the Environment and Energy will work with the Minister, the Hubs and other key stakeholders to identify and refine research priorities and develop projects that align with these priorities.

This research prioritisation is a rolling process and key milestones in each activity year, like the Annual Progress Report and submission of the next Research Plan, will inform the process.

This constant consideration and evaluation of research output and impact builds confidence in the performance of the Hub and the effectiveness of the program. It also provides the basis for the flexibility needed in the NESP Tropical Water Quality Hub to engage in new themes of research in an adaptive manner, and ensures that the Hubs' focus is fixed on the delivery of relevant and practical research.



Broadly, the research priorities of the NESP Tropical Water Quality Hub are:

Research Plan V2 Priorities

From the list of research priorities provided at the TWQ Hub's inception, via consultation with a wide variety of end users, a shorter list of key research priorities was developed for Research Plan V2 as listed below. From these, 18 projects were funded (presented in Attachment A).

Priority 1: Reducing water quality impacts: Identify and prioritise practical management actions capable of protecting and improving water quality in the Great Barrier Reef region.

- a) Local scale identification of priority contaminant export loss (hot spots) for better targeting of on-ground works and extension activity.
- b) Determining the source and marine fate of environmentally relevant sediments.
- c) Develop/evaluate practical on-farm nutrient and sediment loss mitigation and capture and land management practices that will influence behavioural change and improve water quality outcomes – link to field trials.
- d) Develop/evaluate practical methods for 'off farm' nutrient and sediment loss mitigation and capture – link to field trials.
- e) New methods for encouraging behaviour/practice change/improving compliance with BMP.
- f) Compare the ability of different social and/or economic levers to encourage practice change in different contexts.
- g) Methods for assessing cumulative impacts from human activities and measures/approaches for ensuring a net environmental benefit.

Priority 2: Water quality monitoring and reporting

- a) Developing effective and cost-effective catchment and marine water quality indicators, thresholds and sub-lethal health-indicators for key marine organisms and processes in support of the Reef Integrated Monitoring Program.
- b) Use of citizen science in monitoring ecosystem health and connectivity, GBR water quality and/or catchment runoff to the GBR.

Priority 3: Protecting the Reef: Crown-of-thorns starfish

- a) Development of a systematic approach to the on-ground management of Crown of Thorns Starfish (CoTS) current and future outbreaks.

Priority 4: Reducing potential impacts: Dredging activity

- a) Determine critical turbidity and sedimentation tolerance thresholds for environmental resources likely to be influenced by dredging activities.

- b) Quantify sediment transport pathways and water quality over relevant timeframes to better understand interactions with, and contributions to, the broader catchment inputs within the GBR.
- c) Understand the potential environmental risks associated with dredging activities, especially land-based disposal and reclamation, and identify impact mitigation techniques that will reduce identified significant risks.

Priority 5: Impact of water quality and climate factors on economically relevant reef species

- a) Early warning and detection systems for forecasting jellyfish/irukandji occurrence.

Priority 6: Protection of identified Reef systems of high biodiversity value

- a) Identifying and evaluating emerging water quality and ecosystem health threats to the Far Northern GBR (particularly the Torres Strait region) by runoff from the Fly River.

Priority 7: Supporting traditional co-management

- a) Building capacity of Indigenous Rangers by linking with scientists/managers for estuarine/wetland repair, key species management, co-management/planning, identifying key heritage sites.

Research Plan V3 Priorities

In the NESP TWQ Hub third round of funding (Research Plan v3) that commenced on 1 January 2017, the research priorities provided by the DoEE at the TWQ Hub's inception, were narrowed, via consultation with a wide variety of end users to those listed below. From these, 15 projects were funded (presented in Attachment A).

1. Water Quality Improvement

- a) Provide science to support existing field trials that develop/evaluate practical on-farm nutrient and sediment loss mitigation/capture and land management practices that will influence behavioural change and improve water quality outcomes. Field trials should include key growers and change agents and demonstrate water quality outcomes.
- b) Provide science that demonstrates effectiveness and enables improved targeting of streambank erosion and on-ground remediation works to achieve improved water quality outcomes. This should enable better understanding of cause and effect (where and how investments should be targeted) and may include evaluating past investments.
- c) Examine the fate, persistence and exposure characteristics of existing and/or alternate pesticides used in GBR catchments, in freshwater and marine environments, to develop water quality/ecotoxicity guidelines and to support ecological risk assessments. Specify the rationale or process for pesticide selection.
- d) Innovative approaches for using economic levers for achieving nutrient/sediment loss reductions and/or to encourage land use or practice change.

2. Improved Monitoring/Reporting/Assessment

- a) Undertake research for the Reef 2050 Integrated Monitoring and Reporting Program (RIMReP) to develop cost-effective indicators and metrics for key GBRWHA biophysical and human dimension values and identification of associated ecosystem thresholds and guidelines for grading scores, linked to specific objectives and targets in the Reef 2050 Plan.
- b) Development of a method to be adopted by the Reef 2050 Integrated Monitoring and Reporting Program (RIMReP) to monitor and assess aesthetics in the GBRWHA. Define/determine how these relate to the ecological health of the Great Barrier Reef environment.

3. Improved Management of Key Species/Habitats

- a) Evaluate the links between water quality and coral bleaching thresholds and how these contribute to management objectives. Water quality parameters evaluated should include those amenable to reductions via catchment management.
- b) Evaluate existing or future management solutions for coastal freshwater wetland systems repair (incl. artificial wetlands and improved irrigation management where this benefits existing natural wetlands). Must examine these management solutions via linkage to existing projects/programmes and must address water quality benefits and/or connectivity with marine habitats.
- c) Define the values of the ecological system of the Great Barrier Reef that lie outside of the GBR marine park and world heritage boundaries (e.g. Torres Strait, Hervey Bay, Coral Sea) and how their management and connectivity does or should be incorporated into GBR protected area management. This is expected to be a scoping study level desktop project.

Research Plan V4 Priorities

For the NESP TWQ Hub fourth (and current) round of funding (Research Plan v4) due to commence on 1 January 2018, the research priorities were narrowed, via consultation with end users, stakeholders and the Department of the Environment and Energy. These are listed below. Research priorities in bold are considered higher priority.

Priority 1: Improved understanding of the impacts, including cumulative impacts, and pressures on priority freshwater, coastal and marine ecosystems and species

- **Further development of a systematic approach to Crown of Thorns (COTS) control. Identify and trial risk abatement, and prioritisation strategies in response to Crown of Thorns outbreaks, extreme events and biosecurity threats. Develop and implement a plan to reduce Crown of Thorn numbers by two million.**
- **Develop practical improvements to land management practices that will influence behavioural change and improve outcomes for tropical water quality and ecosystem health.**

- **Improve our knowledge of cumulative pressures on environmental and social values of the Great Barrier Reef to determine more effective management actions.**
- Evaluate the practicalities of restoring connectivity to freshwater, coastal and marine ecosystems and the resilience of dependent species.

Priority 2: Maximise the resilience of vulnerable species to the impacts of climate change and climate variability by reducing other pressures, including poor water quality

- **Improve our understanding of the consequences of climate change for the health and resilience of vulnerable freshwater, coastal and marine species, and ecosystems.**
- Develop practical, cost-effective, climate change adaptation options that are accessible to the managers of coastal and marine ecosystems and their catchments.
- **Identify practical management actions capable of protecting and improving water quality on the Great Barrier Reef. Including evaluating actions with the potential to protect highest priority ecosystems and species or to reinstate severely impacted ecosystems and species.**
- Investigate the feasibility of water quality improvement where reduced nitrogen use on cane farms can be turned into a credit that can be traded.
- Identify sustainable populations and the effectiveness of zoning on the health and resilience of target fish species and tropical ecosystem biodiversity.

Priority 3: Natural resource management improvements based on sound understanding of the status and long term trends of priority species and systems

- **Identify and trial practical methods to improve reef resilience, such as the transplantation of coral and coral genetics.**
- Understand trends in Dugong and turtle populations, including breeding cycles and trends in seagrass and habitats. Develop better methods for the protection of important habitat for Dugong and turtles.
- Combine existing indicators and monitoring programmes to develop a cost-effective integrated monitoring programme to support natural resource management, evaluate results and communicate trends.
- **Identify regionally-specific management interventions to achieve or maintain realistic desired states for tropical environmental, social, cultural and economic values.**
- Develop and implement better tools, including spatial information, to support the prioritisation of on-ground investments and interventions and assess their success.
- Explore the opportunities for citizen science and Indigenous participation to improve tropical water quality awareness and outcomes.

In addition to the above research priorities, DoEE also identified four cross-cutting issues that are relevant across multiple NESP hubs. Highlighting these issues supports their integration across the NESP. These cross-cutting issues are:

1. consider current and future climate risks in the research design, delivery and recommendations, as appropriate, as recommended by the State of the Environment Report 2016
2. consider the social and economic value of the environmental asset/s and research outcomes, as appropriate
3. where possible, and where other considerations are equal, be targeted at areas with high conservation value such as National and World Heritage places and Ramsar wetlands
4. be designed with consideration of how it may intersect and integrate with the priorities of other NESP hubs.

For the current research plan (Research Plan v5), the Hub is continuing to address priorities developed under Research Plan v4 due to the dramatic nature of the 2016 and 2017 coral bleaching events that affected most of the Great Barrier Reef and the impacts of Cyclone Debbie. To address these impacts, the research emphasis has shifted more towards prioritisation and direct management interventions in the marine environment. This shifting emphasis maintains alignment with the research priorities and strongly supports the first cross-cutting issue (current and future climate risks). As all projects relate to the Great Barrier Reef, all are relevant to the third cross-cutting issue, improving water quality emanating from catchments.

Unlike in previous research plans which were mostly developed on an open-call basis and therefore subject to more broadly-worded priority descriptions, all projects in this round were directly brokered by the Hub Leader after seeking advice from the Hub Steering Committee. Many of the projects in Research Plan v5 are extensions to existing or previously completed projects from Research Plans v2 and v3. Grouped under three headings, the research projects proposed for Rpv5 (n=15) can be grouped under three headings:

1. ***Supporting Direct Interventions in the Marine Environment***
2. ***Informing Reef Management in a Post-Bleaching/Increased Cyclone Frequency World***
3. ***Improving Water Quality Emanating from Catchments***

This current Research Plan (v5) has continued to focus on the research priorities outlined above.

A matrix of the Research Plan v5 approved projects addressing the research priorities is provided below.

	Theme 1: Improved understanding of the impacts, including cumulative impacts, and pressures on priority freshwater, coastal and marine ecosystems and species				Theme 2: Maximise the resilience of vulnerable species to the impacts of climate change and climate variability by reducing other pressures, including poor water quality				Theme 3: Natural resource management improvements based on sound understanding of the status and long term trends of priority species and systems						
	1.1 Further development of a systematic approach to Crown of Thorns (COTS) control. Identify and trial risk abatement, and prioritisation strategies in response to Crown of Thorns outbreaks, extreme events and biosecurity threats. Develop and implement a plan to reduce Crown of Thorn numbers by two million	1.2 Develop practical improvements to land management practices that will influence behavioural change and improve outcomes for tropical water quality and ecosystem health	1.4 Improve our knowledge of cumulative pressures on environmental and social values of the Great Barrier Reef to determine more effective management actions	1.6 Evaluate the practicalities of restoring connectivity to freshwater coastal and marine ecosystems and the resilience of dependent species	2.1 Improve our understanding of the consequences of climate change for the health and resilience of vulnerable freshwater, coastal and marine species, and ecosystems	2.2 Develop practical, cost-effective climate change adaptation options that are accessible to the managers of coastal and marine ecosystems and their catchments	2.3 Identify practical management actions capable of protecting and improving water quality on the Great Barrier Reef. Including evaluating actions with the potential to protect highest priority ecosystems and species or to generate severely impacted ecosystems and species	2.5 Investigate the feasibility of water quality improvement where reduced nitrogen use on cane farms can be turned into a credit that can be traded	2.6 Identify sustainable populations and the effectiveness of zoning on the health and resilience of target fish species and tropical ecosystem biodiversity	3.1 Identify and trial practical methods to improve reef resilience such as the transplantation of coral and coral genetics	3.2 Understand trends in Dugong and turtle populations, including breeding cycles and trends in seagrass and habitats. Develop better methods for the protection of important habitat for Dugong and turtles	3.3 Combine existing indicators and monitoring programmes to develop a cost-effective integrated monitoring programme to support natural resource management. Evaluate results and communicate trends	3.4 Identify regionally-specific management interventions to achieve or maintain realistic desired states for tropical environmental, social, cultural and economic values	3.5 Develop and implement better tools, including spatial information, to support the prioritisation of on-ground investments and interventions and assess their success	3.6 Explore the opportunities for citizen science and indigenous participation to improve tropical water quality awareness and outcomes
Project 5.1 – Matching the COTS IPM to the scale of the new control program	✓														✓
Project 5.2 – From exposure to risk: novel experimental approaches to analyse cumulative impacts and determine thresholds in the GBRMMA			✓												
Project 5.3 – Benthic light as ecologically-validated GBR-wide indicator for water quality: drivers, thresholds and cumulative risks					✓	✓	✓								
Project 5.4 – Deriving ecologically relevant targets to meet desired ecosystem condition for the Great Barrier Reef: a case study for seagrass			✓	✓						✓		✓	✓	✓	✓
Project 5.5 – Measuring aesthetic and experience values using Big Data approaches			✓						✓			✓			✓
Project 5.6 – Designing the Aesthetics Long Term Monitoring Program (ALTMP)			✓								✓		✓	✓	✓
Project 5.7 – Assessment and communication of the spatial variability in bleaching severity throughout the Great Barrier Reef following back-to-back bleaching events in 2016 & 2017 (FACT TRACK PROJECT)			✓					✓				✓	✓		
Project 5.8 – What's really damaging the Reef? Tracing the origin and fate of the environmentally detrimental sediment and associated bioavailable nutrients			✓												
Project 5.9 – Gully remediation effectiveness			✓	✓			✓								✓
Project 5.10 – Development and application of automated tools for high resolution gully mapping and classification from LIDAR data			✓	✓									✓		
Project 5.11 – Improved Water Quality Outcomes from On-Farm Nitrogen Management		✓						✓					✓		✓
Project 5.12 – Scoping land use conversion options for high DIN risk, low-lying sugarcane areas in Burdekin and Mackay Whitsunday regions				✓	✓	✓	✓	✓			✓	✓	✓	✓	✓
Project 5.13 – Coastal wetland systems repair across GBR catchments – Values Based Causal Framework validation				✓	✓	✓	✓	✓			✓	✓	✓	✓	✓
Project 5.14 – Identifying the water quality and ecosystem health threats to the high diversity Torres Strait from the Fly River runoff					✓	✓	✓	✓							✓
Project 5.15 – eAtlas extension: Data management for environmental research											✓				

LIST OF RESEARCH PROJECTS

A list of research projects funded under the NESP Tropical Water Quality Hub can be found at Attachment A – Research Projects. For more detail on each specific project, please refer to the NESP Tropical Water Quality Hub website, www.nesptropical.edu.au.

Research Plan – Version 1

Project	Project Name	Project Leader	Lead Organisation	NESP Funding	Other Contributions	Timeframe	Research Priority
1.1	Establishing the future NESP CoTS research framework including an ecologically-based approach to the management of CoTS at multiple scales	David Westcott	CSIRO	100,000	119,710	01/07/15-31/12/15	1.1 Further development of a systematic approach to management of Crown of Thorns Starfish (CoTS) outbreaks.
1.2	Developing an approach to evaluate the effectiveness of investments in riparian management in the GBR catchments	Rebecca Bartley	CSIRO	99,972	84,972	01/07/15-31/03/16	1.2.1 Update and improve knowledge of sources, and identify roles of key pollutants and their long term fate to enable the identification of key sources of poor water quality.
1.3	A validation of coral geochemical records to reconstruct suspended sediment loads to the Great Barrier Reef lagoon	Stephen Lewis	JCU	22,500	38,950	01/07/15-31/01/16	1.2.1 Update and improve knowledge of sources, and identify roles of key pollutants (including emerging contaminants), and their long-term fate to enable the identification of key sources of, and vulnerable regions to, poor water quality.
1.5	Legacy of the Lower Burdekin Water Quality Tender	Romy Greiner	JCU	39,795	39,795	01/07/15-31/12/15	3.5.1 Review policy and regulatory instruments to assess their effectiveness and appropriateness in promoting improved land and water management
1.6	Multiple and cumulative impacts on the GBR: assessment of current status and development of	Sven Uthicke	AIMS	99,944	109,507	01/07/15-31/03/16	1.4 Improve our knowledge of cumulative pressures on environmental and social values of the Great Barrier Reef to determine more effective management actions.

	improved approaches for management						
1.7	Reducing sediment sources to the Reef: testing the effectiveness of managing alluvial gully erosion	Andrew Brooks	GU	100,000	380,000	01/07/15-31/03/16	1.2 Develop practical improvements to land management practices that will influence behavioural change and improve outcomes for tropical water quality and ecosystem health.
1.8	Sub-catchment scale monitoring, modelling and extension design to support reef water quality improvement	Aaron Davis	JCU	100,000	160,000	01/07/15-31/03/16	1.2.2 Identify and support practical strategies to increase adoption of improved resource management actions, ensuring engagement with relevant stakeholders/institutions.
1.9	The establishment of a future NESP dredging research investment framework	Britta Schaffelke	AIMS	25,000	18,094	01/07/15-30/12/15	1.4 Improve our knowledge of cumulative pressures on environmental and social values of the GBR region to determine more effective management actions.
1.10	Identification, impacts, and prioritization of emerging contaminants present in the Great Barrier Reef and Torres Strait marine environments	Frederieke Kroon	AIMS	100,000	139,340	01/07/15-15/03/16	2.3.1 Update and improve knowledge of sources, and identify roles of key pollutants (including emerging contaminants), and their long-term fate to enable the identification of key sources of, and vulnerable regions to, poor water quality.
2.1	Assessing the cumulative impacts of climatic disturbances on inshore GBR coral reefs, identifying key refuges and testing the viability of manipulative reef restoration	Geoff Jones	JCU	85,000	180,612	01/07/15-31/03/16	2.1 Improve our understanding of the consequences of climate change for the health and resilience of vulnerable freshwater, coastal and marine species, and ecosystems.
2.2	A tradable permit scheme for cost effective reduction of nitrogen runoff in the sugarcane catchments of the Great Barrier Reef	Jim Smart	GU	99,721	232,820	01/08/15-29/02/16	2.5 Investigate the feasibility of water quality improvement where reduced nitrogen use on cane farms can be turned into a credit that can be traded.

3.1	Seagrass mapping synthesis – A resource for marine park and coastal management	Rob Coles	JCU	36,000	54,500	30/06/15-15/02/16	3.2 Understand trends in dugong and turtle populations including breeding cycles and trends in seagrass and habitats. Develop better methods for the protection of important habitat for dugong and turtles.
3.2	Improving historical estimates of abundance and distribution of dugongs and large green turtles in western and central Torres Strait	Helene Marsh	JCU	97,674	342,236	01/07/15-31/03/16	3.2.1 Improve understanding of dugong and marine turtle habitats including migratory corridors.
3.3	Light thresholds for seagrasses of the GBR: a synthesis and guiding document for managing seagrass	Catherine Collier	JCU	29,755	51,308	01/07/15-15/03/16	2.3.2 Develop environmental standards and spatial health indices to quantify ecosystem condition with the goal of maintaining healthy marine water quality and ecosystems
3.4	Developing and refining biological indicators for seagrass condition assessments in an integrated monitoring program	Catherine Collier	JCU	68,584	201,665	01/07/15-31/01/16	3.3.1 Review and evaluate existing and new indicators and monitoring programs to support development of the LTSP monitoring program.
3.5	Assessment of key dugong and turtle seagrass resources in the northern Torres Strait.	Michael Rasheed	JCU	99,696	149,768	01/07/15-31/03/16	3.2.1 Improve understanding of dugong and marine turtle habitats including migratory corridors.
3.6	Establishing a research framework for future NESP investment into better understanding of the presence of Box-Jellyfishes (Irukandji) and risks in the Great Barrier Reef	Mike Kingsford	JCU	30,000	57,705	01/07/15-28/02/16	3.3.3 Understanding the role of water quality and associated factors in determining abundance of Irukandji jellyfish, identify key issues for industries, environmental and communities, and develop strategies for control and mitigation.
3.7	Monitoring the effects of zoning on coral	Hugh Sweatman	AIMS	100,000	225,450	01/07/15-30/12/15	3.3.1 Review and evaluate existing and new indicators and monitoring

	reefs and their associated fish communities in the GBR Marine Park						programs to support development of the LTSP monitoring program.
3.8	Towards an integrated monitoring program: identifying indicators and existing monitoring programs to cost-effectively evaluate the Long Term Sustainability Plan	Prue Addison	AIMS	100,000	110,000	01/07/15-01/12/15	3.3.1 Review and evaluate existing and new indicators and monitoring programs to support development of the LTSP monitoring program.
3.9	Indigenous capacity building and increased participation in management of Queensland sea country	Melissa George	NAILSMA/ CSIRO	100,000	100,000	01/07/15-30/03/16	3.6.2 Develop methods that facilitate participation of Indigenous people in environmental management.
3.10	Benchmarking costs of NRM improvements for the GBR	John Rolfe	CQU	29,487	65,193	01/07/15-15/12/15	3.4.2 Identify and prioritise social and economic risks and uncertainties associated with natural resource management and evaluate the impacts these have on management and policy options for natural resource management and improvements to tropical water quality.
3.11	Monitoring and adaptively reducing system-wide governance risks facing the GBR	Allan Dale	JCU	55,537	99,286	01/07/15-15/03/16	3.4.2 Identify and prioritise social and economic risks and uncertainties associated with natural resource management and evaluate the impacts these have on management and policy options for natural resource management and improvements to tropical water quality.
3.12	Development of an offset financial contribution calculator for Reef Trust	Martine Maron	UQ	80,595	95,153	01/07/15-31/03/16	3.5.2 Evaluate and develop better tools (for example, economic, spatial information, statistical, systems and/or predictive models) to support the prioritisation and evaluation of on-

							ground investments and interventions.
3.13	eAtlas 2015 - NESP data management, Torres Strait NRM plan delivery platform and Torres Strait reef mapping	Eric Lawrey	AIMS	98,040	110,740	01/07/15-31/12/15	3.5.2 Evaluate and develop better tools (for example, economic, spatial information, statistical, systems and/or predictive models) to support the prioritisation and evaluation of on-ground investments and interventions.
TOTAL				\$1,797,300	\$3,166,804		

Research Plan – Version 2

Project	Project Name	Project Leader	Lead	NESP Funding	Other Contributions	Timeframe	Status (on track/delayed)	Research Priority
2.1.1	Integrated Pest Management of Crown-of-Thorns Starfish	David Westcott	CSIRO	604,722	755,722	01/01/16–10/12/18	On track	3) Protecting the Reef: Crown of Thorns Starfish
2.1.2	Scoping options for low-lying, marginal cane land to reduce DIN in priority wet tropics catchments	Nathan Waltham	JCU	94,000	158,404	01/01/16-28/02/17	Complete	1a) Local scale identification of priority contaminant export loss (hot spots) for better targeting of on-ground works and extension activity.
2.1.3	Harnessing the science of social marketing and behaviour change for improved water quality in the GBR: an action research project	Lynne Eagle	JCU	480,000	560,000	01/01/16-10/12/18	On track	1e) New methods for encouraging behavior/practice change/improving compliance with BMP
2.1.4	Demonstration and evaluation of gully remediation on downstream water quality and agricultural production in GBR rangelands	Rebecca Bartley	CSIRO	600,000	824,163	01/01/16-10/12/18	On track	1c) Develop/ evaluate practical on-farm nutrient and sediment loss mitigation and capture and land management practices that will influence behavioural change and improve water quality outcomes – link to field trials.
2.1.5	What's really damaging the Reef? Tracing the origin and fate of the environmentally detrimental sediment	Stephen Lewis	JCU	600,000	868,696	01/01/16-10/12/18	On track	1b) Determining the source and marine fate of environmentally relevant sediments.
2.1.6	From exposure to risk: novel experimental approaches to analyze cumulative impacts and determine thresholds in the GBRWHA	Sven Uthicke	AIMS	410,165	410,165	01/01/16-10/12/18	On track	1g) Methods for assessing cumulative impacts from human activities and measures/approaches for ensuring a net environmental benefit.
2.1.7	Engaging with farmers and demonstrating water quality outcomes to create confidence in	Aaron Davis	JCU	600,000	645,500	01/01/16-10/12/18	On track	1a) Local scale identification of priority contaminant export loss (hot spots) for better targeting of

	on-farm decision-making ("Project 25")							on-ground works and 'tailored extension' activity.
2.1.8	Improved water quality outcomes from on-farm nitrogen management	Mike Bell	UQ	700,000	1,507,903	01/01/16-10/12/18	On track	1c) On-farm nutrient and sediment loss mitigation and capture and land management practices to improve water quality outcomes.
2.1.9	Risk assessing dredging activities	Ross Jones	AIMS	515,806	1,031,486	01/06/16-10/12/18	Extension to 30/06/19	4a) Determine critical turbidity and sedimentation tolerance thresholds for environmental resources likely to be influenced by dredging activities.
2.1.10	Achieving maximum reductions of sediment loads to the GBR on the shortest possible timescales: the application and adaptation of mine site rehabilitation approaches to alluvial gully rehabilitation in the Bowen Catchment ("Project 26")	Andrew Brooks	GU	100,000	130,000	01/04/16-30/04/17	Complete	1a) Local scale identification of priority contaminant export loss (hot spots) for better targeting of on-ground works and extension activity.
2.2.1	Identifying the water quality and ecosystem health threats to the high diversity Torres Strait and far northern GBR from runoff from the Fly River	Jane Waterhouse	JCU	360,000	366,200	01/01/16-10/12/17	Extension to 30/10/18	6a) Identifying and evaluating emerging water quality and ecosystem health threats to the Far Northern GBR (particularly the Torres Strait region) by runoff from the Fly River.
2.2.2	Impacts of mine-derived pollution on Torres Strait environments and communities	Simon Apte	CSIRO	290,000	290,000	01/02/16-10/12/17	Extension to 30/10/18	6a) Identifying and evaluating emerging water quality and ecosystem health threats to the Far Northern GBR (particularly the Torres Strait region) by runoff from the Fly River.
2.2.3	Early warning systems to minimize the risk of box jellyfish stings by empowering stakeholders	Scott Condie	CSIRO	250,000	838,357	01/01/16-10/12/18	On track	5a) Early warning and detection systems for forecasting jellyfish/irukandji occurrence.
2.3.1	Benthic light as ecologically-validated	Barbara Robson	AIMS	499,471	527,371	01/01/16-10/12/18	Extension to 30/03/19	2a) Developing effective and cost-effective catchment and

	GBR-wide indicator for water quality: drivers, thresholds and cumulative risks							marine water quality indicators, thresholds and sub-lethal health-indicators for key marine organisms and processes in support of the Reef
2.3.2	'Human sensors' for monitoring GBR environmental changes and quality of marine waters through harnessing Big Data analysis	Susanne Becken	GU	227,145	239,892	01/01/16-10/12/17	Complete	2b) Use of citizen science in monitoring ecosystem health and connectivity, GBR water quality and/or catchment runoff to the GBR.
2.3.3	Building Indigenous livelihood and co-management opportunities in the northern GBR – ecosystem services and conservation governance for water quality	Marcus Barber	CSIRO	250,000	272,372	01/01/16-10/12/17	Complete	7a) Building capacity of Indigenous Rangers by linking with scientists/managers for estuarine/wetland repair, key species management, co-management/planning, identifying key heritage sites.
2.3.4	Working with Traditional Owners and local citizens to better manage GBR estuarine wetlands	Norman Duke	JCU	450,000	476,260	01/01/16-10/02/18	On track	7a) Building capacity of Indigenous Rangers by linking with scientists/managers for estuarine/wetland repair, key species management, co-management/planning, identifying key heritage sites.
2.3.5	eAtlas - Data management for environmental research	Eric Lawrey	AIMS	450,000	450,000	01/01/16-31/12/18	On track	
TOTAL				\$7,481,309	\$10,352,491			

Research Plan – Version 3

Project Number	Project Name	Project Leader	Lead Organisation	NESP Funding	Other Contributions	Timeframe	Status (on track/delayed)	Research Priority
3.1.1	Implementation of the crown of thorns starfish research strategy: regional strategies	David Westcott	CSIRO	682,542	959,411	01/01/17-10/12/19	On track	Research Plan v1 Priority 1.1: Further development of a systematic approach to crown of thorns eradication. Identify and trial risk abatement, and prioritisation strategies in response to crown of thorns outbreaks, extreme events and biosecurity threats. Develop and implement a plan to reduce crown of thorn numbers by two million.
3.1.2	Improving water quality for the Great Barrier Reef and wetlands by better managing irrigation in the sugarcane farming system	Yvette Everingham	JCU	458,103	506,878	01/01/17-30/06/19	On track	1a) Provide science to support existing field trials that develop/evaluate practical on-farm nutrient and sediment loss mitigation/capture and land management practices that will influence behavioural change and improve water quality outcomes. Field trials should include key growers and change agents and demonstrate water quality outcomes.
3.1.3	Harnessing the science of social marketing in communication materials development and behaviour change for improved water quality in the GBR: a desktop review (Project 2.1.3 – Stage 2)	Lynne Eagle	JCU	19,000	136,800	01/01/17-10/12/17	Complete	Research priority 1e (RPv2)
3.1.4	Optimizing the management of riparian zones to improve the health of the	Keryn Paul	CSIRO	178,491	178,833	01/01/17-30/04/18	Complete	1b) Provide science that demonstrates effectiveness and enables improved targeting of streambank erosion and on-ground remediation works to achieve improved water quality outcomes. This should enable better understanding of cause and effect (where and how

	Great Barrier Reef							investments should be targeted) and may include evaluating past investments.
3.1.5	Ecotoxicology of pesticides on the Great Barrier Reef for guideline development and risk assessments	Andrew Negri	AIMS	602,839	670,889	01/01/17-10/12/19	On track	1c) Examine the fate, persistence and exposure characteristics of existing and/or alternate pesticides used in GBR catchments, in freshwater and marine environments, to develop water quality/ecotoxicity guidelines and to support ecological risk assessments. Specify the rationale or process for pesticide selection.
3.1.6	Exploring trading in water quality credits as a cost-effective approach for managing water quality in the Great Barrier Reef	Jim Smart	GU	316,837	414,170	01/01/17-28/01/19	On track	1d) Innovative approaches for using economic levers for achieving nutrient/sediment loss reductions and/or to encourage land use or practice change.
3.1.7	Reducing Sediment loads to the Great Barrier Reef – developing optimal approaches for treating alluvial gully erosion	Andrew Brooks	GU	600,000	850,990	01/01/17-10/12/19	On track	Research priority 1d (RPv2)
3.1.8	Innovative economic levers: a system for underwriting risk of practice change in cane-farming	Peter Thorburn	CSIRO	400,000	404,330	01/01/17-10/12/19	On track	1d) Innovative approaches for using economic levers for achieving nutrient/sediment loss reductions and/or to encourage land use or practice change
3.2.1	Deriving ecologically relevant load targets to meet desired	Catherine Collier	JCU	497,765	813,459	01/01/17-30/06/19	On track	2a) Undertake research for the Reef 2050 Integrated Monitoring and Reporting Program (RIMReP) to develop cost-effective indicators and metrics for key GBRWHA biophysical and human dimension values and identification of associated ecosystem thresholds

	ecosystem condition for the Great Barrier Reef: a case study for seagrass meadows in the Burdekin region							and guidelines for grading scores, linked to specific objectives and targets in the Reef 2050 Plan.
3.2.2	The IMS 2050 Human Dimensions Project: cost-effective Indicators and metrics for key GBRWHA human dimensions	Allan Dale	JCU	150,000	251,693	01/01/17-28/01/18	Complete	2a) Undertake research for the Reef 2050 Integrated Monitoring and Reporting Program (RIMReP) to develop cost-effective indicators and metrics for key GBRWHA biophysical and human dimension values and identification of associated ecosystem thresholds and guidelines for grading scores, linked to specific objectives and targets in the Reef 2050 Plan.
3.2.3	Monitoring aesthetic value of the GBR by using artificial intelligence to score photos and videos	Susanne Becken	GU	99,028	209,275	01/01/17-28/01/18	Complete	2b) Development of a method to be adopted by the Reef 2050 Integrated Monitoring and Reporting Program (RIMReP) to monitor and assess aesthetics in the GBRWHA. Define/determine how these relate to the ecological health of the Great Barrier Reef environment.
3.2.4	Defining, assessing and monitoring Great Barrier Reef aesthetics	Nadine Marshall	CSIRO	105,336	117,662	01/01/17-10/12/17	Complete	2b) Development of a method to be adopted by the Reef 2050 Integrated Monitoring and Reporting Program (RIMReP) to monitor and assess aesthetics in the GBRWHA. Define/determine how these relate to the ecological health of the Great Barrier Reef environment.
3.2.5	Testing and implementation of the water quality metric for the 2017 and 2018 reef report cards	Britta Schaffelke	AIMS	140,000	493,000	01/01/17-10/12/17	Complete	2a) Undertake research for the Reef 2050 Integrated Monitoring and Reporting Program (RIMReP) to develop cost-effective indicators and metrics for key GBRWHA biophysical and human dimension values and identification of associated ecosystem thresholds and guidelines for grading scores, linked to specific objectives and targets in the Reef 2050 Plan.
3.3.1	Quantifying the linkages between water quality and the thermal	Neil Cantin	AIMS	590,264	590,400	01/01/17-10/12/19	On track	3a) Evaluate the links between water quality and coral bleaching thresholds and how these contribute to management objectives. Water quality parameters evaluated should include those amenable to reductions via catchment management.

	tolerance of GBR coral reefs							
3.3.2	Science evaluation of coastal wetland systems repair projects across GBR catchments	Nathan Waltham	JCU	536,932	885,583	01/01/17-10/12/19	On track	3b) Evaluate existing or future management solutions for coastal freshwater wetland systems repair (incl. artificial wetlands and improved irrigation management where this benefits existing natural wetlands). Must examine these management solutions via linkage to existing projects/ programmes and must address water quality benefits and/or connectivity with marine habitats.
3.3.3	Defining the values of the ecological systems that influence the GBR and lie outside the marine park and world heritage area boundaries	Johanna Johnson	JCU	256,030	257,366	01/02/17-28/02/18	Complete	3c) Define the values of the ecological system of the Great Barrier Reef that lie outside of the GBR marine park and world heritage boundaries (e.g. Torres Strait, Hervey Bay, Coral Sea) and how their management and connectivity does or should be incorporated into GBR protected area management. This is expected to be a scoping study level desktop project.
TOTAL				\$5,633,167	\$7,740,739			

Research Plan – Version 4

Project Number	Project Name	Project Leader	Lead Organisation	NESP Funding	Other Contributions	Timeframe	Status (on track/delayed)	Research Priority
4.1	Crown-of-thorns starfish: surveillance and life history	David Westcott	CSIRO	497,500	553,770	01/01/18-10/12/19	On track	Theme 1: Direct interventions in the marine environment
4.2	Oceanographic drivers of bleaching in the GBR: from observations to prediction	Craig Steinberg	AIMS	537,852	832,480	01/01/18-10/12/20	On track	Theme 1: Direct interventions in the marine environment
4.3	Best practice coral restoration for the Great Barrier Reef	Ian McLeod	JCU	607,000	782,000	01/01/18-10/12/20	On track	Theme 1: Direct interventions in the marine environment
4.4	The traits of corals that survived recent bleaching events	Line Bay	AIMS	582,218	713,276	01/01/18-10/12/20	On track	Theme 1: Direct interventions in the marine environment
4.5	Guidance system for resilience-based management of the Great Barrier Reef	Peter Mumby	UQ	638,037	698,835	01/01/18-10/12/20	On track	Theme 2: Informing reef management in a post-bleaching/ increased cyclone frequency world
4.6	Recommendations for maintaining functioning of the Great Barrier Reef	Peter Mumby	UQ	299,583	384,577	01/01/18-10/06/19	On track	Theme 2: Informing reef management in a post-bleaching/ increased cyclone frequency world
4.7	Indigenous coral reef tourism	Henrietta Marrie	CQU	100,000	200,000	01/01/18-30/06/19	On track	Theme 2: Informing reef management in a post-bleaching/ increased cyclone frequency world
4.8	'Project 25' – farmers, water quality and on-farm decision-making	Aaron Davis	JCU	600,000	600,000	01/01/18-10/12/20	On track	Theme 3: Improving water quality emanating from catchments
4.9	Gully characterisation framework to underpin GBR	Andrew Brooks	GU	53,429	53,429	01/01/18-30/09/18	On track	Theme 3: Improving water quality emanating from catchments

	catchment water quality management							
4.10	Evaluating the costs and benefits of agricultural land conversion to wetlands	Nathan Waltham	JCU	482,947	525,083	01/01/18-10/12/20	On track	Theme 3: Improving water quality emanating from catchments
4.11	Sources, transformations and fate of dissolved organic carbon – implications for the GBR	Michele Burford	GU	26,470	99,867	01/01/18-30/09/18	On track	Theme 3: Improving water quality emanating from catchments
4.12	Longevity and cost-effectiveness of previous government reef program investments	Sharyn Rundle-Thiele	GU	404,985	475,471	01/01/18-10/12/20	On track	Theme 3: Improving water quality emanating from catchments
4.13	Assessing the Gulf of Carpentaria mangrove dieback	Norm Duke	JCU	200,000	250,000	01/01/18-10/12/19	On track	Project funded outside of the Research Plan schedule – jointly with Northern Hub
TOTAL				\$5,030,021	\$6,168,788			

Research Plan – Version 5

Project Number	Project Name	Project Leader	Lead Organisation	NESP Funding	Other Contributions	Timeframe	Research Priority
5.1	Matching the CoTS IPM to the scale of the new control program	David Westcott	CSIRO	494,360	519,060	01/01/19-10/12/20	Theme 1: Direct interventions in the marine environment
5.2	From exposure to risk: novel experimental approaches to analyze cumulative impacts and determine thresholds in the GBRWHA	Sven Uthicke	AIMS	120,000	193,052	01/01/19-30/06/20	Theme 2: Informing reef management in a post-bleaching/ increased cyclone frequency world
5.3	Benthic light as ecologically-validated GBR-wide indicator for water quality: drivers, thresholds and cumulative risks	Barbara Robson / Katharina Fabricius	AIMS	137,350	164,461	01/01/19-10/12/20	Theme 2: Informing reef management in a post-bleaching/ increased cyclone frequency world
5.4	Deriving ecologically relevant targets to meet desired ecosystem condition for the Great Barrier Reef: a case study for seagrass meadows in the Burdekin region	Catherine Collier	JCU	200,886	235,245	01/01/19-10/12/20	Theme 2: Informing reef management in a post-bleaching/ increased cyclone frequency world
5.5	Measuring aesthetic and experience values using Big Data approaches	Susanne Becken	GU	237,216	283,991	01/01/19-30/09/20	Theme 2: Informing reef management in a post-bleaching/ increased cyclone frequency world
5.6	Designing the Aesthetics Long Term Monitoring Program (ALTMP)	Nadine Marshall	CSIRO	149,743	150,631	01/01/19-30/06/20	Theme 2: Informing reef management in a post-bleaching/ increased cyclone frequency world
5.7	Assessment and communication of the spatial variability in bleaching severity throughout the Great Barrier Reef following back-to-back bleaching events in 2016 & 2017	Neil Cantin	AIMS	65,000	68,088	31/09/18-31/03/19	Theme 2: Informing reef management in a post-bleaching/ increased cyclone frequency world

	(FAST TRACK PROJECT)						
5.8	What's really damaging the Reef? Tracing the origin and fate of the environmentally detrimental sediment and associated bioavailable nutrients	Stephen Lewis	JCU	682,746	966,054	01/01/19-10/12/20	Theme 3: Improving water quality emanating from catchments
5.9	Gully remediation effectiveness	Rebecca Bartley	CSIRO	472,000	526,600	01/01/19-31/10/20	Theme 3: Improving water quality emanating from catchments
5.10	Development and application of automated tools for high resolution gully mapping and classification from LiDAR data	Andrew Brooks	GU	357,297	364,472	01/01/19-10/12/20	Theme 3: Improving water quality emanating from catchments
5.11	Improved Water Quality Outcomes from On-Farm Nitrogen Management	Mike Bell	UQ	418,000	785,200	01/01/19-10/12/20	Theme 3: Improving water quality emanating from catchments
5.12	Scoping land use conversion options for high DIN risk, low-lying sugarcane areas in Burdekin and Mackay Whitsunday regions	Nathan Waltham	JCU	185,850	255,525	01/01/19-01/09/20	Theme 3: Improving water quality emanating from catchments
5.13	Coastal wetland systems repair across GBR catchments – Values Based Causal Framework validation	Nathan Waltham	JCU	146,000	211,145	01/09/19-10/12/20	Theme 3: Improving water quality emanating from catchments
5.14	Identifying the water quality and ecosystem health threats to the high diversity Torres Strait from the Fly River runoff	Jane Waterhouse	JCU	445,445	403,151	01/01/19-10/12/20	Theme 3: Improving water quality emanating from catchments
5.15	eAtlas extension: Data management for environmental research	Eric Lawrey	AIMS	217,000	333,947	01/01/19-01/03/21	
TOTAL				\$4,328,893	\$5,460,622		

EXPECTED OUTCOMES AND OUTPUTS

The expected outcomes of the NESP are to produce research that:

- enhances our understanding of Australia's environment, climate and weather
- is communicated clearly to relevant stakeholders and the general public
- is discoverable and accessible
- informs decision-making and addresses environmental priorities.

Research under the NESP is expected to inform the policy and program delivery of the Department of the Environment and Energy. More broadly, it will engage and inform all key stakeholders with an interest in the outputs of environmental and climate science research, including state and local governments, business and industry, community groups, Indigenous land managers (or Indigenous Communities) and education institutions.

Hub Outcomes and Outputs

The expected outcomes of the NESP are to produce research that:

- enhances our understanding of Australia's environment, climate and weather
- is communicated clearly to relevant stakeholders and the general public
- is discoverable and accessible
- informs decision-making and addresses environmental priorities.

Research under the NESP is expected to inform the policy and programme delivery of DoEE. More broadly, it will engage and inform all key stakeholders with an interest in the outputs of environmental and climate science research, including state and local governments, business and industry, community groups, Indigenous land managers (or Indigenous Communities) and education institutions.

Hub Outcomes

Recognising the interests, rights and knowledge of all end users in the region, including industry, government, NRM groups, Traditional Owners and community, the predicted NESP TWQ Hub outcomes are:

- Innovative research that provides practical solutions to maintain and improve tropical water quality from catchment to coast to:
 - mitigate water quality impacts,
 - predict indirect and cumulative effects of human activities,
 - provide optimised management options and interventions,
 - facilitate Indigenous co-management and co-governance, and
 - identify and prioritise regionally-specific management interventions.
- Facilitate Indigenous participation in Hub governance and research.

- Conduct research that is relevant to and benefits end users, involving end users in the design and research, where applicable.
- Provide opportunities for Indigenous engagement, employment, skills transfer, sharing knowledge and increasing cultural awareness.
- Capacity building in the region through Indigenous and non-Indigenous research scholarships, early career researcher opportunities, TAFE Certificate courses, and a tropical environmental cohort program for PhD candidates and ECRs involving all partner institutions and end users.
- Extension and sharing of Hub research findings with end users including industry, government, NRM groups, Traditional Owners and community, using a variety of approaches, for example, technical reports, fact sheets, informal forums, symposia, posters, newsletters, audio-visual and social media.
- Collaborative research with other NESP Hubs to produce complementary and coordinated research outcomes.

Hub Outputs

Detailed project schedules (Attachment B) specify the obligations of each research project including outputs for each project. Expected outputs include:

- Milestone reports that report progress against identified project objectives and deliverables;
- Data exchange and data management of eAtlas online products to allow for accessible data;
- Stakeholder workshops and meetings, including focus meeting with Department staff to inform policy and decision-making;
- Communication products such as technical reports, fact sheets, informal forums, posters, audio-visual and social media outputs;
- Technical reports with clear plain English summaries that synthesise the key areas of relevance to DoEE and end users;
- Decision-support tools that can be applied to policy development and decision-making;
- Annual or biennial Hub conferences targeting delivery of outputs to end users;
- Annual progress reports (with traffic light indicators) of project progress and science delivery; and
- Audited annual finance reports.

COMMUNICATION AND KNOWLEDGE BROKERING

Integral to the success of the NESP in influencing decision-making is the clear and effective communication and brokerage of research outputs to key stakeholders. The NESP Tropical Water Quality Hub has developed and maintained a Knowledge Brokering and Communication Strategy that:

- strongly aligns with this Research Plan
- describes how the Hub will facilitate knowledge sharing between researchers and end-users
- includes activities that bring researchers, policy makers and environmental managers together to facilitate evidence-based decision-making
- details the research products and promotional material to be developed by the Hub
- describes how data produced by the Hub will be stored and made accessible to the general public
- identifies the FTE Communications and Knowledge Brokering roles associated with these activities.

Data Accessibility

The NESP guidelines expect that all information (including research data) produced under the program is made publically and freely available on the internet. The NESP Tropical Water Quality Hub recognises the need to promote open access to public sector and publicly funded information.

The eAtlas hosted by AIMS was established during MTSRF (2006-2010) and will continue to be a primary data repository for the NESP TWQ Hub. The role of eAtlas within the NESP TWQ Hub program is to ensure metadata, imagery and research products are captured, documented, made easily accessible and discoverable via the web.

The eAtlas is an innovative website (<http://eatlas.org.au>) and mapping system for preserving, sharing and facilitating the use of environmental data. It has substantial data from the CRC Reef, CRC Torres Strait, MTSRF and NERP Tropical Ecosystems Hub already available, and has promoted greater use and application of research information by environmental managers, scientists and the community. During the NERP (2011-2014) many of the eAtlas systems were redeveloped or improved to allow integration with national data management standards and services, improved scalability for handling more datasets, better documentation of datasets and support for multiple sub-sites custom-made for different regions and topics. These capabilities allowed the development of a regional eAtlas for Torres Strait (<http://ts.eatlas.org.au>) and a topic based eAtlas for the Social and Economic Long Term Monitoring Program (SELTMP) (<http://seltmp.eatlas.org.au/seltmp>) in addition to the eAtlas. These data access tools have broad community and stakeholder appeal and will be fundamental access points for NESP TWQ Hub data. The eAtlas content continues to grow and now contains over 3,600 map layers, 220 datasets, 2,700 photos and 100 articles, forming an extensive library of reference and research data.

The information and results generated by the NESP TWQ Hub are aimed at facilitating real improvements in sustaining the ecosystems and catchments of the Great Barrier Reef and the Torres Strait marine regions. Accordingly, a substantial knowledge brokering, communication and engagement framework will support Hub research activities and data management and accessibility.

MONITORING & EVALUATION

Monitoring & Evaluation Plan

The Monitoring & Evaluation Plan (M&E Plan) provides the framework through which the progress and success of the Hub is measured. It enables clear performance assessment via a common set of high level indicators used across the program, along with qualitative, narrative based reporting of project progress and impact.

Key Performance Indicators for each NESP Hub are aligned to a number of key themes:



Two important elements of the Monitoring and Evaluation Plan are annual project reporting and the two program evaluations.

Project and Financial Reporting

Under the terms of the NESP funding agreement, the following reports are required to be submitted to demonstrate Hub performance and project progress:

- **Annual Progress Report:** to be submitted in April of each year and describes, in quantitative and qualitative terms, the progress of work against the Research Plan.
- **Financial information and Audit:** submitted with the Annual Progress Report to show amongst other matters the budget and actual income and expenditure of the Hub, and in summary the Other cash contributions and in-kind support.
- **A Final Report:** submitted at the conclusion of all Hub activity.

Evaluations

Two evaluations were scheduled as part of the program. The mid-term evaluation used data from Research Plans, Annual Progress Reports, surveys, interviews and focus groups and was completed in 2018. It made some suggestions for improvement, but demonstrated that the program is on track to meet its outcomes. A final evaluation is scheduled for the program conclusion.

Performance Measures

The single key performance indicator for the NESP in the Department of Environment and Energy's Annual Report is quantitative assessments that measure whether projects have at least one research user who is reporting that research outputs are being used for decision-making.

COLLABORATION AND PARTNERSHIPS

The NESP encourages a collaborative, multi-disciplinary approach to environmental and climate science research. Key to the success of the Hub will be the capacity to foster partnerships across Hubs and with a wide range of relevant research stakeholders.

The NESP TWQ Hub Administrator has an established track record of working collaboratively with other research programs and centres to maximise science output value. Ongoing negotiations aim to secure collaboration of the NESP TWQ Hub research with the Northern Australia Environmental Resources, Marine Biodiversity, Threatened Species Recovery, Earth Systems and Climate Change and Clean Air and Urban Landscapes Hubs. Research priorities that cut across these hubs and the TWQ Hub are addressed through collaborative partnerships between hubs to maximise value from cross-hub capacity. These joint priorities will be further addressed in future versions of the Research Plan.

The NESP TWQ Hub partners have collaborated for nearly two decades, and have established an extensive network of research end users across government, industry, NGO's, Indigenous groups and other community groups. The creation of credible biophysical, social and economic information to policy makers, natural resource managers, industry, community and other scientists has been, and will be, one of the key success elements for the NESP TWQ Hub.

Using the operational strategies below, the Hub will ensure outputs are useful to, and adopted by, end users through processes that:

- Develop research projects using an iterative process that identifies and addresses end-user issues; designed to encourage additional end-user co-investment.
- Conduct annual syntheses of current issues, knowledge gaps and possible solutions.
- Commission a series of industry dialogues on key issues in the form of end-user products.
- Ensure each project will have an end-user partner involved through all stages of the project from conception to final delivery.

The Hub links knowledge brokering and communications activities with other Hubs, particularly the Northern Australia Environmental Resources Hub, enabling synergies between engagement frameworks and critical analysis of contrasting approaches for continuous improvement.

The six partner institutions of the NESP TWQ Hub are:

Australian Institute of Marine Science

Over its 40-year history, AIMS has earned its reputation as an impartial and trusted advisor on tropical water quality issues. AIMS have the commitment and capacity to undertake multidisciplinary, long-term and large-scale scientific research that addresses the NESP TWQ Hub priorities. AIMS research has made significant contributions to the development and implementation of policies and guidelines, especially as part of the Reef Water Quality Protection Plan (Reef Plan). AIMS research has focused on documenting and understanding the condition, dynamics and trends of water quality and coral reef communities in the GBR

region, and linking these to changes in catchment and coastal use. AIMS has a strong track record of targeted research on current issues, such as the impacts of sediments, nutrients and agrichemicals on key organisms and communities, the impact and ecology of COTS on coral reefs, and the ecological responses and adaptation of marine species to future temperature increases and ocean acidification.

AIMS is well positioned to contribute to TWQ Hub priority outcomes through its niche capabilities in:

- *Water quality analysis and monitoring* to assess the fate and effects of pollutants and to provide sound baselines and trends to evaluate the success of long-term management activities.
- *Ecosystem monitoring and understanding* to provide long-term data series on ecosystem health. This data underpins ecosystem assessments and attribution of changes and impacts, including the development of novel health indicators on a molecular or microbial level.
- Development and application of *integrated hydrodynamic, water quality sediment transport and ecosystem response models* for long-term scenario testing.
- *Quantification of ecological responses to cumulative pressures* using world-class controlled environment experimental facilities (Seasim).
- *Ecotoxicology* using relevant tropical and sub-tropical species to test the effects of pollutants, such as herbicides, metals and hydrocarbons.

James Cook University

James Cook University (JCU) has significant expertise across all aspects of the Tropical Water Quality Hub's Research Investment Strategy. JCU is the most cited institution in the world for coral reef ecology (ISI Essential Science Indicators 2008–2013), received the highest rating for ecological applications and environmental science and management in the last round of Excellence for Research in Australia (ERA 2012) and is one of the top two Australian universities and in the top 30 in the world in environmental sciences and ecology (US News and World Report and NTU global rankings).

JCU staff have led large-scale, integrated, end-user driven research programs in the tropics for the last 25 years through their involvement in the CRC Reef and Torres Strait, Coastal CRC, TRaCK, MTSRF and NERP, and have developed trusted affiliations with key organisations including: GBRMPA, Wet Tropics Management Authority, Torres Strait Regional Authority, Queensland Government, local governments, NRM regional bodies, Traditional Owners, Regional Development Associations, tourism groups, agricultural and fisheries representative bodies and managers, environmental NGOs and port authorities.

CSIRO

Through the 'Land and Water', 'Agriculture' and 'Oceans and Atmosphere' Flagships, CSIRO is conducting long term, strategic and as well as industry relevant, applied research in the GBR and other tropical water systems to ensure the long-term protection and restoration of coastal and Reef ecosystems and the sustainability of agricultural land uses.

CSIRO is investing in integrated environmental, social and economic research to support the development, implementation and evaluation of on-ground actions, plans, policies and governance arrangements to improve tropical water quality.

In recent years our research has focused on:

- understanding the main pollutant sources and the process that affect pollutant loads
- informing the design and prioritization of land management strategies for water quality improvement
- helping with the selection of effective mechanisms for implementation of land management strategies
- enabling managers to strategically deal with the intrinsic uncertainty around the success of water quality improvement plans
- examining the factors that influence governance arrangements, partnerships, and stakeholder contributions and commitment to the effective delivery of water quality plans and policies
- informing the monitoring, reporting and adaptation of water quality improvement
- understanding the impacts of pollutant loads on freshwater and marine aquatic ecosystems.

CSIRO's project experience includes preparation of the Water Quality Improvement Plan – Tully Basin, and the completion of numerous Reef Rescue funded projects that quantified nutrient and sediment loads to the GBR, and identified priority areas within catchment for remediation of surface and gully erosion in grazing systems.

Central Queensland University

Central Queensland University (CQU) research is closely aligned with water quality issues and the natural environment in northern Australia. There is particular expertise in economics, water quality science, freshwater ecology, ecotoxicology, coastal ecosystems and social sciences. Researchers have focused on issues in the marine systems, as well as the agricultural-environmental interface which impacts on water quality draining into the GBR.

The expertise in resource economics translates community concerns about water quality and ecosystem health issues into policy settings, as well as linking ecosystem sciences and production issues together in bioeconomic models to identify opportunities for improved agricultural management to improve water quality. The expertise in freshwater science and ecology systems is relevant to a number of monitoring and restoration programs, as well as efforts to measure and report ecosystem health.

The location of CQU's campuses place substantial research expertise in the central and southern regions of the GBR and associated catchments, providing linkages to industry and stakeholders in the regions. Researchers have strong and ongoing involvement with major ecosystem and water quality programs in the Gladstone Harbour, Fitzroy River and other coastal and catchment areas.

University of Queensland

As a demonstration of our commitment to the NESP TWQ Hub Strategic Plan, the University of Queensland (UQ) has assembled an exceptionally strong team of researchers from the Global Change Institute, the Faculty of Science and the Faculty of Engineering, with demonstrated strength in water quality optimisation, social adaptation, environmental

assessment and modelling, and coastal management. UQ takes a multi-disciplinary approach, engaging a range of expertise across UQ, Australia and beyond, to undertake research addressing coastal and marine resource management issues and leading to on-ground solutions.

UQ is the lead university within the state for both research output and quality. It is currently a national leader in a range of water quality and coastal management research fields and incorporates these through a number of mechanisms to influence policy change. Expertise in relation to innovative monitoring techniques (e.g. remote sensing and economics), whole-of-system and cumulative modelling, historical baselines to understand status and long-term trends in coral reef systems, as well as socio-cultural implications of solutions are amongst the areas that UQ innovates in water-related and coastal management research, delivering world-class science in both fundamental and applied areas.

Griffith University

Griffith University's highly respected Australian Rivers Institute (ARI) has the largest group of university based scientists, with expertise in river, catchment and coastal research, in Australia. ARI's research capacity spans the biophysical, social and economic sciences and will generate important insights into the linkages, interconnectedness and interdependencies which affect water quality from the catchments to the reef.

Specific expertise includes: catchment and river processes; resource economics; fluvial geomorphology; rehabilitation science; ecosystem-scale modelling; aquatic ecology; nutrient and sediment processing, transport and tracking; coastal and estuarine ecosystem processes; ecotoxicology; aquatic ecosystem health monitoring and assessment; natural resource management (land owners and indigenous); and spatial optimisation and prioritisation of investment and management action.

With this expertise, ARI researchers can improve our understanding of the source and cause of sediment, nutrient and ecotoxin loads affecting the health of the reef, develop and test approaches to reduce this load, generate the processes and framework to optimise the investment in management actions while meeting multiple objectives (environmental, economic, social and cultural) and develop monitoring methods and tools to assess the effectiveness of actions and the response from the freshwater, estuarine and coastal ecosystems.

INDIGENOUS ENGAGEMENT

The NESP Tropical Water Quality Hub is committed to meaningful Indigenous engagement and collaboration during all phases of the delivery of the NESP. Where relevant, due consideration will be given to actively involving key indigenous stakeholders in research prioritisation, research delivery and, especially, the communication of research output. The Hub's approach to indigenous engagement is detailed in its Indigenous Engagement Strategy.

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The NESP TWQ Hub is strongly focused on the sustainable management of environmental assets of the GBR, Torres Strait, other tropical waters and their catchments. These geographical areas are strongly connected to the region's Aboriginal and Torres Strait Islander peoples. There are approximately 70 Traditional Owner clan groups whose land and sea country include the GBR Marine Park and coastal ecosystems. The Torres Strait has 20 Traditional Owner groups (19 Torres Strait Islander Corporations and one Aboriginal Native Title Corporation). Eight land and sea Indigenous Protected Areas (IPAs), one Indigenous Land Use Agreement (ILUA) and seven Traditional Use of Marine Resource Areas (TUMRA) are identified within the geographical region of the NESP TWQ Hub. Indigenous ecological knowledge is a fundamental pillar for the sustainable environmental management of the natural resources of north Queensland. The NESP TWQ Hub recognises the importance of Indigenous engagement in the understanding and management of north Queensland's natural assets.

The overall goal of the IEPS is to ensure a meaningful two-way engagement relationship that will recognise the interests, rights and Indigenous ecological knowledge (IEK) of Traditional Owners in land and sea country. The aim of this IEPS is to ensure research leaders consider and include opportunities for the engagement of Traditional Owners within projects. At all stages, research with Indigenous peoples must be founded on a process of meaningful engagement, respect, trust and collaboration between the research project team and Indigenous peoples.

The following objectives guide the achievement of the NESP TWQ Hub IEPS:

1. NESP TWQ Hub research is to be relevant and of benefit to Indigenous communities and organisations.
2. NESP TWQ Hub research is to be conducted according to the highest ethical standards and respects Indigenous priorities and values.
3. NESP TWQ Hub research will provide opportunities for Indigenous engagement, employment, skills transfer, sharing of knowledge and the increase of cultural awareness amongst all parties.
4. NESP TWQ Hub generated knowledge, data and research results will be effectively shared and communicated between Indigenous peoples, communities and organisations.
5. NESP TWQ Hub will facilitate effective Indigenous participation in Hub governance.

In order to ensure the process for the engagement of Traditional Owners within the NESP TWQ Hub research projects are clearly defined, the Hub Administrator has identified three category levels of Indigenous engagement which are proposed to match the type and methodology defined in each individual research project.

The definition of a **Category One** project, is a research project that is anticipated to be undertaken with direct collaboration with an Indigenous community, organisation, group or individual. As per the objectives of the IEPS, a Category One project will be expected to:

- Clearly identify how the research will be relevant, co-managed and of benefit to Indigenous communities and/or organisations.
- Provide opportunities for Indigenous engagement, employment or skills transfer, and the sharing of knowledge and the increase of cultural awareness amongst all parties.

- Ensure the research is conducted according to the highest ethical standards and respects Indigenous priorities and values.
- Develop a co-managed process for the generated knowledge, data and research results to be effectively shared, presented and communicated between Indigenous peoples, communities and organisations.

The definition of a **Category Two** project, is a research project that has a field component within the project, but does not have direct collaboration with an Indigenous community, organisation, group or individual. As per the objectives of the IEPS, a Category Two project will be expected to:

- Clearly identify how the research will be relevant and of benefit to Indigenous communities and/or organisations and if not, why.
- Ensure the research is conducted according to the highest ethical standards and respects Indigenous priorities and values.
- Explore opportunities for Indigenous engagement, employment, skills transfer, sharing of knowledge and the increase of cultural awareness amongst all parties.
- Develop a process for the generated knowledge, data and research results to be effectively shared and communicated between Indigenous peoples, communities and organisations.

The definition of a **Category Three** project, is a research project that is laboratory or desktop based and does not have direct collaboration with an Indigenous community, organisation, group or individual. As per the objectives of the IEPS, a Category Three project will be expected to:

- Develop a process for the generated knowledge, data and research results to be effectively shared and communicated between Indigenous peoples, communities and organisations.

Each project schedule has specific Indigenous engagement deliverables identified within the milestone table. The Hub Administrator will work with individual project leaders to assist with Traditional Owner engagement where appropriate.

FUNDING

The NESP Tropical Water Quality Hub is supported through funding from the Australian Government's National Environmental Science Program. Under the Department of the Environment and Energy Portfolio Budget Statements, the NESP provides for around \$142 million over the life of the Program.

The table below describes the funding from the NESP available to the Tropical Water Quality Hub over the life of the agreement which ceases on 30 June 2021.

	2015 Actual	2016 Actual	2017 Actual	2018 Budget	2019 Budget	2020 Budget	2021 Budget	Total
	\$	\$	\$	\$	\$	\$	\$	\$
NESP Funding ¹	2,200,000	5,630,000	8,100,000	5,400,000	5,400,000	4,700,000	550,000	31,980,000
Interest ²	500	0	578	0	0	0	0	1,078
Total NESP Funding	2,200,500	5,630,000	8,100,578	5,400,000	5,400,000	4,700,000	550,000	31,981,078
Expenditure³								
Research	918,252	3,779,713	4,690,727	7,023,715	5,512,480	2,771,258	0	24,696,145
Communications	347,478	684,300	649,062	702,000	702,000	680,060	392,500	4,157,400
Administration	266,307	293,605	262,173	457,715	324,000	157,500	157,500	1,918,800
	1,532,037	4,757,618	5,601,962	8,183,430	6,538,480	3,608,818	550,000	30,772,345
Balance⁴	668,463	891,429	2,490,366	-2,794,227	-1,138,480	1,091,182	0	1,208,733

1. As per funding agreement milestone payment schedule

2. Interest earned on NESP Funds held

3. Expenditure figures to be drawn from the Activity Budget summary tables (Attachment C)

4. This number should reconcile to the Budget Flexibility Allocation in the Activity Budget summary table (Attachment C)

Expenditure of NESP funding under the Hub is expected to be distributed amongst three main items of expenditure (Research, General Communications and Administration). The funding must be expressed, in the table below, as a percentage of the total for any given calendar year noting that funding for Research must total at least 80% of the funding. The balance (20%) of the funding can be allocated between General Communications and Administration with no more than 10% of the funding being allocated to Administration.

Research	80%
Research Facilitation	1%
General Communications	13%
Administration	6%

Under the terms of the NESP, the minimum total for recipient and other contributions for the life of the program is 100% of the funds paid by the Department under this agreement.

At Attachment C are the activity budget tables for the Hub for calendar year 2015 onward. It describes the actuals for past years (2015-2017) and budget for each Hub project, and includes recipient and other contributions.

All attachments are provided as **separate** documents.

**ATTACHMENT A – NESP TROPICAL WATER QUALITY HUB
RESEARCH PROJECTS**

**ATTACHMENT B – NESP TROPICAL WATER QUALITY HUB
PROJECT PLANS**

**ATTACHMENT C – NESP TROPICAL WATER QUALITY HUB
ACTIVITY BUDGET**

**ATTACHMENT D – NESP TROPICAL WATER QUALITY HUB RISK
ASSESSMENT AND TREATMENT PLAN**