Wet Tropics Major Integrated Project (WT MIP)

Concept Category	**Farm Scale Water Quality Monitoring**
Concept NAME:	**Integrated Farm to Reef Water Quality Monitoring (WQM)**

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Matrix summary

Types of actions	Location	Conditions for success	Risks	Potential costs (labour)	Potential costs (material/ infrastructure)	Sequencing and timing	Precursors for it to be able to occur	Constraints /challenges	How do we measure success or monitor (KPI'S; M & E)
Paddock monitoring Sub-catchment monitoring Catchment monitoring (DSITI)	Farm Services sites in Tully & Johnstone Sub-catchments downstream from paddock sites (ideally aligning with catchment modelling nodes) Euramo, Coquette Pt	Grower co-operation Grower cluster engagement Close liaison with DSITI	Lack of co-operators Disease outbreak or quarantine issues Adverse weather Linkages don't work effectively	$2,024,000 (Option A) $1,654,000 (Option B) Refer to Resource required & estimated budget – this document	$1,267,595 Refer to Resource required & estimated budget – this document	Appoint staff Develop detailed project plan Site evaluation with Farm Services Commission & install equipment Monitor, maintain and liaise Reporting back to growers, project partners & community	Recruitment of appropriate staff Close collaboration with Farm Services monitoring and extension team Access to data from GBRLMP Laboratory expertise & capacity	Personnel availability? Grower engagement – suitable landholders in targeted areas	**Monitoring** Representative water samples collected and analysed Ability to track impact of land management from paddock to sub-catchment scale **Reporting** Data available at desired timeframes (instant to interpreted) Reports prepared at relevant times Results reported to landholders in appropriate formats **Engagement** Increased understanding of impact of land management on water quality Improved water quality demonstrated from A practice Information used in land management decisions Improved confidence by community in relevance of monitoring

Executive Summary

This report is for the Wet Tropics Major Integrated Project (WT MIP) panel on the best way to engage growers and the community in understanding and managing the impacts of land use and management on water quality. A priority as per Water Quality Taskforce recommendations is improved management of the sugarcane and bananas industries in the Tully and lower Johnstone catchments to improve Great Barrier Reef water quality. The improved management applies particularly to loss of N and sediment from paddocks, while at least maintaining farm productivity and profitability.

A critical understanding from the MIP public meetings and other local experience was the lack of trust or disconnection with previous and current water quality monitoring programs in the region. This must be addressed if there is to be substantial progress towards improved water quality.

The main features of this program are:

- Water quality monitoring for nutrient and sediment at three scales
  - new sites at paddock and farm cluster (or sub-catchment) scale focussing on sugarcane and banana production
    - paddock sites will allow the direct comparison of conventional management practices vs 'MIP-best' management practices
    - farm cluster sites allow for the engagement of farmers within the sub-catchment to give direct feedback on their collective management efforts. Adoption of improved management practices can be monitored overtime. This will also provide additional validation data for catchment models.
  - strong spatial and hydrological links to the existing whole catchment monitoring by the Queensland Department of Science, Information Technology and Innovation (DSITI)
- Data and information communicated to growers and landholders at three time-scales,
  - real time data available on demand from the internet
  - blocks of data and interpreted information from paddock and sub-catchment sites communicated at intervals relevant to hydrology and management of the sites (likely four week intervals during the wet season and two month intervals during the dry)
  - annual data and information that has been compiled and analysed over a yearly crop cycle (and independently reviewed)
- Close linkages with the monitoring and extension components of the Farm Services program

The multiple scales of monitoring will track the impact of land management on water quality down the catchment. The blocks of data and information will comprise raw data plus interpreted data by both water quality and extension staff. This will improve both the understanding of the crop/soil/water system and of the impact of land management on water quality. The timeliness of delivery from the recent hydrologic events, while they may still be fresh in the minds of land managers, is an important innovation. This is aimed to embed 'cause and effect' with growers for improved on-farm decision making to minimise risk of pollutant losses by feeding back into the My Farm planning process in the Farm Services program and enabling a fast adaptive response.

Scope

The program is restricted to the lower Johnstone and Tully catchments and focusses on the sugarcane and banana industries. Additional sites will monitor natural sites and urban contribution, mainly as a landholder engagement tool for increased understanding of relative contributions and system function. Because of the common driving forces of contaminant movement (high rainfall, agricultural industries, application of agrochemicals etc), the results will have applicability across the wet tropics.

Rationale (why this approach?)

What do we already know?
Water quality studies in the region, nationally and internationally clearly demonstrate the impact of land use and management on off-site water quality. Contaminants of concern for the Wet Tropics include dissolved inorganic nitrogen (DIN), pesticides and sediment.

However, it appears that previous and current water quality programs have not had sufficient impact with growers and the community, despite considerable investment of money and scientific horsepower (e.g. many monitoring sites and individual projects, large number of analyses undertaken, reports reviewed to a high standard).

The reasons include scepticism about numbers reported by programs such as the GBR Loads Monitoring Program (Queensland Department of Science, Information Technology and Innovation (DSITI)) for a range of reasons - 'remoteness' of end-of-catchment water quality monitoring sites from the farm, slow delivery of information to landholders and community or delivery in inappropriate formats. This is reflected in the comments recorded during the WTMIP workshops such as the need for 'direct farm measurement cause and effect', 'fine scale and real time monitoring' and 'show me it's my N reaching the reef'. The use of modelling to 'fill in the gaps' has not achieved credibility, despite a number of local presentations by experienced modellers at regional workshops for the Paddock to Reef program (Queensland government).

In contrast, a current project in the Mackay region, Sandy Creek on-farm change for water quality improvement, is achieving good engagement with local growers. (https://www.qld.gov.au/environment/agriculture/sustainable-farming/reef-projects-current/#RP167C). Aspects of that project, including rapid delivery of project information with the support of local technical staff, have been incorporated into this report. Similarly, a recent National Environment Research Programme (NESP) funded project in neighbouring sugarcane catchments of the wet tropics ('Project 25') emphasises greater industry ownership and control of monitoring effort, and rapid, locally targeted provision of water quality information back to industry.

Grower and community engagement is a major challenge and a priority for this project. To meet this challenge, the project includes monitoring at a range of scales in the Tully and Johnstone catchments coupled with data and information provided to growers and the community over various time frames (data in real time, blocks of information, compiled scientific reports).

Delivery framework

Water Quality Monitoring Team

A team of four full time staff has been identified for Water Quality Monitoring team (WQM. In addition, the workshop members have proposed the appointment level for the staff (Queensland public service scale). This is based on more than 180 years of experience by members including considerable local experience with water quality programs. Monitoring programs with a high landholder engagement focus and multiple sites were identified as being very demanding on staff.

Water quality leader (PO5 level, minimum)
- Manage the project (high level project management and communication skills required)
- Lead the interpretation of water quality data
- Links to the Farms Services team monitoring and extension staff (critical component)
- Links to sugar and banana industry staff in region

Water quality scientist (PO3 level)
- Two staff working as a team under the Leader
- Responsible for equipment installation and maintenance, sample collection and processing for dispatch to the laboratory

- Assist with data management and interpretation

Water quality technician (TO3 level)
- Maintain field equipment, assist with sample collection and processing for dispatch to the laboratory

Support staff (peak sampling and sample processing times)
These have been identified as the extension staff from the Farm Services program. It is anticipated that the support would only be required for short periods during the wet season to help at critical times. Apart from providing physical help, this will improve communication and understanding between this program and the Farm Services program.

Communication and sensor cloud operation and maintenance staff
These staff are identified in the budget under Option A for communication of the instrumentation to the sensor cloud and sensor cloud maintenance and access by a range of users. They are expected to be located in other organisations and available on 'as needs' basis. These have been proposed to add credibility to the data on sources and accumulation of pollutants. An existing commercial alternative is included (Option B).

Water quality sampling sites – location and rationale

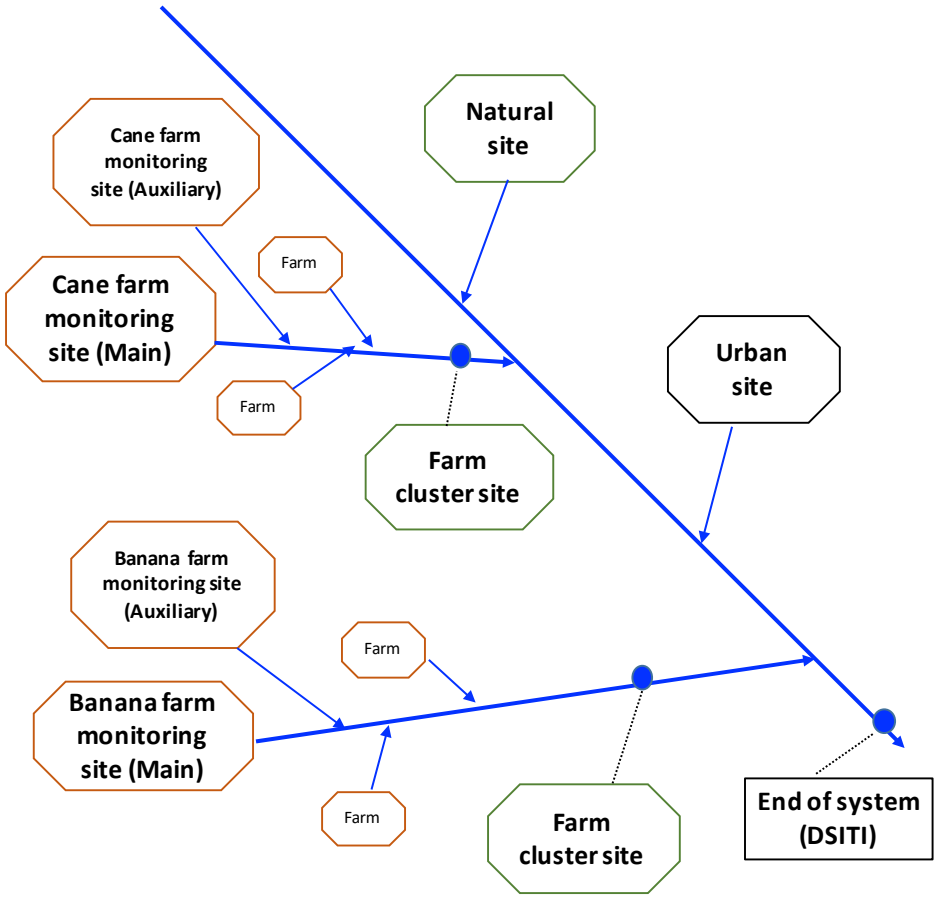
There are three scales for the water quality monitoring:
- Paddock
- Farm cluster or sub-catchment
- End of system (EOS, critical links with DSITI)

Additional sites are the natural or rainforest site in the Johnstone (potentially upper Liverpool Creek) and urban monitoring with manual sampling of both the Tully and Johnstone urban stormwater within the catchments.

This table is sourced from the Farm Services theme as the paddock scale water quality monitoring will be located on those sites.

Priority	Principle	Rationale
1	Agricultural DIN loads and Walking the Landscape priority mapping	Walking the Landscape process well documented Informed by local knowledge as well as geomorphology and hydrology Modelling information Best informed catchments for WQ improvement– aim to reduce 10 kg DIN per year per hectare from sugarcane and banana industries
2	Cooperative growers	Ability to network Extension opportunities Industry buy-in Ownership by grower More chance of successful implementation Partnership in delivering trial/demo without deviation Owner-operated (not corporate)
3	Nested sites in catchment that allow for good monitoring opportunities of water quality outcomes from practice change	Containment Good opportunity for cost-effective monitoring without other factors confounding the results Opportunity for wider engagement with growers Farmer evaluation

Schematic of monitoring sites on Tully or Johnstone river



Site monitoring

1. **Paddock scale monitoring sites**

   The Main monitoring sites should align with those of the Farm Services program. Additional monitoring sites (Auxiliary sites), possibly with less intensive monitoring, have been included. The Farm Services Feasibility Report recommends choosing one cane site and one banana site per catchment, based on the guiding principles reiterated below:

   Recommended Management Units

Recommended MU	Justification against guiding principles
Tully cane: MU7	High cane DIN load across industry High priority for practice change in WTL Nested monitoring opportunities within the catchment and links with other priorities High grower motivation and engagement; progressive farmer with high district credibility At least three different soil types within the one property Large area managed
Tully bananas: MU4	High banana DIN load across industry High priority for practice change in WTL Nested monitoring opportunities within the catchment and links with other priorities High grower motivation and engagement; progressive farmers with high district credibility; large area managed At least three different constraints evident and including different inter-row managements for sediment control
Johnstone cane: MU Moresby	Highest cane DIN load High priority for practice change in WTL due to end of catchment Links with other priorities High grower motivation and engagement; progressive farmer with high district credibility Variable constraints within the one property
Johnstone bananas: MU 3 MU East Palmerston	High banana DIN load High priority for practice change in WTL Nested monitoring opportunities within the catchment and links with other priorities High grower motivation and engagement; progressive farmers with high district credibility; large area managed Several different constraints evident and including different inter-row managements for sediment control

2. **Farm cluster or sub-catchment**

   The four sites, two each in the Tully and Johnstone catchments, are downstream of the paddock sites and should include several farms with the number to be determined by likely grower co-operation and site physical properties. An ideal location would align the monitoring site with a node from the Paddock to Reef catchment modelling program.

   These monitoring sites are considered to be an important grower engagement tool to drive system understanding and to counter the belief 'it's not my molecule of N in the river'. The sites should have trailer-mounted sampling and monitoring equipment located on a stream that has been hydrographically rated so that flow can be measured. The advantage of this installation is that the equipment can be readily relocated at the end of the project, if needed.

3. **Urban sites**

   The urban sites have been selected so that the impact of the entire catchment on water quality is captured.

Johnstone catchment – manual samples collected from a stormwater drain. 12 samples/year for nutrients and pesticides (GCMS and LCMS suites).
Tully catchment - manual samples collected in Banyan Creek downstream of Tully township. 12 samples/year for pesticides (GCMS and LCMS suites).

4. **Natural sites**
   In the Tully, monitoring will be undertaken by the GCLM program (refer to 5. End of system sites below). In the Johnstone, a new monitoring site will be selected, possibly in upper Liverpool Creek.

5. **End of system sites**
   The existing DSITI GBR Catchment Loads Monitoring (GCLM) program is an important linkage as it is well established, has a high level of scientific rigour and is the basis for Reef Report cards and other reporting mechanisms. GCLM has agreed to expand the existing analytical suite to include pesticide monitoring at the Tully gorge site to assist with this program's extension/engagement. In addition, GCLM will install nitrate probes for real time monitoring of nitrate at Tully gorge and Coquette Point in the Johnstone catchment.

Summary of sites for program

Site	Tully	Johnstone
Paddock scale – main	2	2
Paddock scale – auxiliary	2	2
Farm cluster (sub-catchment)	2	2
Urban	1 manual	1 manual
Natural	Existing (DSITI)	New? Funding?*
End of system	Existing (DSITI)	Existing (DSITI)
Total MIP funded	7	7 or 8*
Total nested program	9	8 or 9*

*Site location to be determined. Site properties will determine feasibility of end of system site.

Monitoring methodology

The monitoring will combine conventional, scientifically-robust water quality monitoring with the newer (largely unproven) technology of real time sensors. Conventional water quality monitoring includes sample collection, processing and dispatch to accredited laboratories by operators trained to an appropriate quality assured standard.

The real time monitoring uses in-field sensors that communicate directly with the web to allow unverified data access at a time that suits the user. The selection of probes in addition to nitrate and turbidity will be determined by the WQM team based on availability, accuracy and reliability. Nitrate probes are proposed for installation at the farm and farm cluster sites in year 1. A procedure for grower and community engagement is needed to account for the fact that N may leave the paddock in appreciable amounts in forms other than nitrate, such as ammonium and urea. This is most likely in the early runoff events after fertiliser application. These additional forms of N may complicate the results and would require significant analysis and interpretation to reveal the complete impact of the tested management practices.

1. **Paddock scale monitoring sites**
   The sites would be monitoring with a trailer-based system. The trailers will contain ISCO refrigerated samplers, batteries, solar panels, nitrate and turbidity monitoring probes (real time) data logger, telemetry and connected to field-based pressure transducers and flumes. Representative water samples will be collected by the auto-sampler during runoff and submitted for laboratory analysis. The laboratory suite will include species of N and P and total suspended solids. The data from the nitrate and turbidity probes and from the pressure transducer (likely depth rather than flow measurements) will be communicated to the web and made available in real time.

a. **Main sites.** The sites should be located on the 4 proposed sites of the Farm Services program (4 trailers). The location of these is heavily dependent upon the physical, hydrologic and human characteristics (e.g. grower interest, leadership, influence) of the sub-catchments.

   The trailers will monitor and collect water samples from a pair of flumes located on 2 paddock treatments (management systems). We anticipate that these treatments would be conventional and A class or 'MIP best' treatments. We note that term 'A class' is perceived by some growers to be an inappropriate term, but it is a concise term for the 'best of the best' paddock management systems, some unproven, to maximise farm productivity and minimise the environmental impacts.

b. **Auxiliary sites**. An additional 4 trailers may be located on other farms within sub-catchments of the Farm Services sites so that a total of 4 sugarcane and 4 banana paddocks are monitored. This monitoring is designed to increase the coverage of land management in the catchments, possibly across different soil types and management depending upon physical and sociological aspects of the sites.

2. **Farm cluster sites**

   These 4 sites, 2 in each of the Tully and Johnstone catchments, should be monitored with a trailer-mounted sampling system as for the paddock scale sites. They should be located on streams leaving sub-catchments that contain the Paddock scale monitoring sites. The location will again be heavily dependent upon the physical, hydrologic and human characteristics of the sub-catchments. The trailers will contain an ISCO refrigerated sampler, water quality monitoring probes (nitrate, turbidity), batteries, solar panels, data logger, telemetry and connected to field-based pressure transducers. The streams will be rated by experienced hydrographic staff so that the pressure transducer readings can be reliably converted to flow for the calculation of contaminant loads. A trailer-based hydrographic station has been selected so that the equipment can be relocated to another site at the end of the program, if needed. This contrasts with some other water quality programs that have abandoned monitoring site equipment after termination of the project.

   The data from the nitrate and turbidity probes and from the pressure transducer will be communicated to the web and accessible via a web interface. As well as continuous data from the on-line probes, representative water samples will be collected by the auto-sampler and submitted for laboratory analysis. The laboratory suite will include species of N and P and total suspended solids.

3. **End of system sites**
   The program will be reliant upon the GCLM program for the end-of-system monitoring at Euramo (Tully) and Coquette Point (Johnstone). Monitoring of the Moresby catchment should be assessed by the WQM team, if the Moresby catchment is selected for a Farm Services site.

4. **Natural reference sites**
   The GCLM program will continue to monitor the Tully gorge site as part of the existing program, but with additional equipment and analysis. An additional site will be required in the Johnstone with upper Liverpool Creek identified as a suitable site for targeted manual sampling (6/year).

   Local expertise has identified a range of information from the monitoring of pristine sites in earlier programs. These data, in at least the Herbert, Tully and Johnstone catchments, may be collated and packaged into a range of formats. This could include a scientific report so that the widely spread data is compiled into an accessible format, as well as formats suitable for dissemination to landholders and the community. Funding may be available from an alternative source and should be an important tool to address the persistent claims among some landholders that 'it's coming from the rainforest'.

5. **KP event samplers**
   The KP sampler was developed by BBIFMAC as a low cost, in-field sampler which takes composite

samples for analysis off-site. (http://www.bbifmac.org.au). This is proposed an effective grower engagement tool. However, local experience by CANEGROWERS, Innisfail has indicated that care is required in the selection and use of these samplers. Once the major scientific equipment for water quality monitoring is installed at the sites, and the site characteristics are understood, then the installation of these samplers can be considered (Year 2).

6. **Weather stations**
   Weather stations will be provided for installation in the Tully and Johnstone catchments, primarily in the sub-catchments where the paddock scale monitoring sites are located, but also at the wider scale. The stations are primarily a grower engagement tool (a hook to generate interest in the project and an understanding of the variability in rainfall and other data. The sites will be selected on the basis of location, relevance to monitoring sites, interest by growers and spatial data requirements within the catchments. Data from the stations will be available online from the sensor cloud. A Wi-Fi connection to the landholders' computer is required.

Delivery of monitoring data

Time frames for delivery of data and information
A distinction is made among data, information and knowledge. Data are simply numbers while information is that data packaged, interpreted to a standard suitable for the audience and communicated. Knowledge is the final step when the data and information are used for land management decisions. An appropriate definition of real time data is that the data are available when the user wants them.

Three levels of timeliness in reporting are proposed. These are:

- **Real time data** for nitrate concentrations and flow at the sub-catchment scales. These data should be hosted and accessed via the internet. Additional parameters such as turbidity, temperature and electrical conductivity may be included, depending upon the probes selected by the program (based on cost, availability and robustness).

  Two options for providing real time data presentation via the web are presented:
  - Option A. Communication from instruments to a sensor cloud and real time data access via the web provided by Consortium partners CSIRO and JCU. Budget $487,500.
  - Option B. Real time data access and presentation provided by a commercial supplier (currently in use by DSITI for the GBR Loads Monitoring program). Budget estimate $90,000.

- **Water quality information in a timeframe determined by the grower engagement program**
  A four week delivery time for sampling, laboratory analysis, interpretation and reporting is proposed. This would allow two weeks for laboratory analyses to be completed and two weeks for interpretation by the team. These timely 'chunks' of data and information then need to be presented to relevant growers and landholders. This approach has been shown to be a powerful communication tool for landholders, when delivered in appropriate formats and timeframes. It should help develop an understanding of how the 'system works' and of the impact of recent land management on water quality. A critical component of the success is the method of delivery and involvement of landholders so that it is an education and potentially a skill-building exercise, and not a regulatory process.

  Examples of this approach are Project 25 in the Russell catchment and RP167C Sandy Creek On-farm change for water quality improvement (EHP project).

- **Annual reports**. These are the traditional, highly detailed scientific reports that summarise all aspects of the program. They are independently reviewed as a fundamental component of the program's quality assurance.

- Publications for both the scientific and extension community are similarly important for quality assurance and relevance to the international scientific community. However, publishing is a very time

consuming process and sufficient time is rarely allowed.

Data access

Data access and privacy will be need to be determined with the landholders with the understanding that this publically funded program must publish the aggregated and meaningful results from this program.

Access to the real time data can be controlled to multiple levels, from available to the world to access only by username and password. Additional options include the use of grower anonymity, particularly for the paddock sites (e.g. Site 1, Site 2) and an embargo period, which is an agreed period between making the data available to relevant landholders and then to the wider community. Precedents for embargo periods on data accessibility, giving the cane industry time to digest and implement management-extension responses to water quality data, already exist in similar projects such as the Herbert Water Quality Monitoring Program. We note the comment from the public forums that growers don't want to be first informed about poor water quality results by reading the Cairns Post.

Other

Laboratory analysis

Conventional laboratory analysis is needed to measure the full range of N and P at the paddock and sub-catchment levels, and to evaluate the accuracy and reliability of the nitrate probes. The laboratory should be selected on the basis of expertise in water analyses, quality assurance systems, convenience, cost and turn-around times. Both the DSITI and TropWater laboratories have advised that the two week turn-around time is achievable throughout the year. This timeframe is considered to be critical for the grower engagement. There are other suppliers such as Cairns Water and commercial laboratories.

Timeframes for Delivery

July-December 2017

- Recruit team members
- Develop detailed project plan
- Commence site evaluation and selection with Farm Services team
- Start construction/procurement of sampling equipment
- Installation of the paddock and sub-catchment monitoring sites would be highly desirable

January-December 2018

- Install and commission monitoring equipment
- Continue liaison with growers and grower clusters
- Collect, analyse, report water quality monitoring results

January-December 2019

- Review 2018 program
- Collect, analyse, report water quality monitoring results
- Continue liaison with growers and grower clusters

January-June 2020

- Review 2019 program
- Collect, analyse, report water quality monitoring results
- Continue liaison with growers and grower clusters
- Review entire project
- Consider 'where to from here?'

What is needed to evaluate the effectiveness of the monitoring program?

Audience	Tools to monitor				Framework for data/info delivery	What do we need to know? (for KPIs)
	Rainforest (pristine)	**Farm level**	**Urban**	**End of system**		
Feeds back into My Farm seasonal planning – paired site (conventional vs MIP best) for both cane and bananas	Tully Gorge (DSITI) and upper Liverpool Creek. Full suite plus nitrate probe and some pesticide samples	Flumes Autosampler Nitrate and turbidity probe, Flow. KP samplers (Year 2)	Manual sampling for nutrients, pesticides, flow		**Grower involvement** **Sampling, design, engagement up front** As quickly as possible	**Grower involvement** **Sampling, design, engagement** KASA (Knowledge, Attitude, Skills, Aspirations): Are growers they accessing the info? K Are we transferring the info effectively? A1 How are they using the new knowledge? S What management changes are being made? A2
Education/communication for farmer clusters/sub-catchments		Multiple farms. Flow, manual samples, Autosampler Nitrate and turbidity probe	Manual sampling for nutrients, pesticides, flow		**Grower involvement** **Sampling, design, engagement up front** Four weekly delivery time in wet season	**Grower involvement** **Sampling, design, engagement** KASA: Are farmers they accessing the info? K Are we transferring the info effectively? A1 How are they using the new knowledge? S What management changes are being made? A2
Education/communication to community and growers about urban runoff contributions			Manual sampling for nutrients, pesticides, flow Innisfail - stormwater drain Tully – Banyan Ck			Community acceptance of information (see above)
Catchment scale impact				Coquette Point and Euramo (DSITI)		

Education/communication for overall MIP evaluation	All of above	All of above	All of above	Coquette Point and Euramo and DSITI	**Cluster engagement and info feedback on cluster basis.** Reporting conducted in real time (data) and in blocks of data and information, dependent upon season. Aggregated paddock data at each site to show practice change impact. Sub-catchment and catchment scale data from each catchment.	Are the clusters scaling up to the catchment level? Is there engagement at the cluster level? Level of grower acceptance of info (translation to knowledge). Is there a DIN reduction through practice change? (skills)

Resources required and estimated budget

				YEAR ONE		YEAR TWO	YEAR THREE		
Description	**Labour (HR includes oncosts)**	**Materials**	**Rate**	**July-Dec 2017**	**Jan-Jun 2018**	**July 2018-June 2019**	**July 2019-June 2020**	**Calculations**	**Details and notes**
FSM Leader	450,000		150000 per annum	75,000	75,000	150,000	150,000	Includes phone, laptop, car, hosting	
Water quality scientists (2 FTE)	720,000		120,000 per annum	120,000	120,000	240,000	240,000	Includes phone, laptop, hosting	
Water quality technical officer (0.5 FTE)	264,000		88,000 per annum	44,000	44,000	88,000	88,000		
Program support – science input and review	130,000		~40,000 per annum	20,000	20,000	40,000	50,000	Provided by MIP Consortium partners @1,200/day	As needs basis
Sample preparation and processing area		3,000		3,000					Shed space in kind from Terrain (must be a 'clean room'). Fridges and freezers for samples. Maybe share with Farm Services program.
Equipment setup		15,000		15,000					Eskies for sample transport, 2 covered trailers
Freight		16,500		1,000	1,500	7,000	7,000		Mainly for overnight to laboratories
In field monitoring 1. Equipment		469,920	58,740 per site	234,960	234,960			8 sites	Flumes, trailers, samplers & associated equipment
In field monitoring 2. Maintenance		40,000			15,000	15,000	10,000		ISCO backups, batteries, probes,
In field monitoring 3. Analytical		131,340	Nutrients 120, urea 30		26,268	52,536	52,536	488 samples/year for 8 sites	Laboratory analyses

				YEAR ONE		YEAR TWO	YEAR THREE		
Description	**Labour (HR includes oncosts)**	**Materials**	**Rate**	**July-Dec 2017**	**Jan-Jun 2018**	**July 2018-June 2019**	**July 2019-June 2020**	**Calculations**	**Details and notes**
Sub-catchment 1. Monitoring		355,200	88,800/site		355,200			4 sites	Trailers, samplers, probes, batteries, solar, telemetry, hydrographic rating
Sub-catchment monitoring 2. Maintenance		40,000			15,000	15,000	10,000		Repair and maintenance
Sub-catchment monitoring 3. Analytical		82,500	Nutrients 120, urea 30, pesticides 200		16,500	33,000	33,000	264 samples/year for 2&3, 132 for year 1, for 4 sites	(½ sample no. in year 1 due to setup time). Complete nutrient and pesticides (urban only)
Communication from field sensors		27,500			20,000	3,750	3,750		Communication hardware
Option A. Consortium partners (refer p.11) Communication and sensor cloud 2.	450,000			75,000	75,000	150,000	150,000		Communication between field equipment and sensor cloud
Option B. Commercial supplier (refer p.11) Real time data via web.	90,000			15,000	15,000	30,000	30,000		Real-time data presentation via the web
Catchment scale engagement tools 1. KP samplers		36,000	600/sampler			36,000		10 sites	
Catchment scale engagement tools 2. KP sample analysis		4,800	6/paired site			2,400	2,400	10 sites, $20/sample	Laboratory analysis for DIN only
Weather stations		18,000	600/station		18,000			30 stations across sub-catchments	
Sum. Option A	**2,014,000**	**1,239,760**		**587,960**	**1,036,428**	**832,686**	**796,686**		
Sum. Option B	**1,654,000**	**1,239,760**		**527,960**	**976,428**	**712,686**	**676,686**		
Total budget Option A	**3,253,760**								
Total budget Option B	**2,893,760**								