Three Moon and Monal Creeks Floodplain Land Management Plan

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Report Prepared for:
Burnett Mary Regional Group and
Burnett Catchment Care Association

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BCCA

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Electronic copies of this report and additional relevant maps are included on the attached CD. *Note:* The infrastructure and flow lines in the maps provided are those identified by workshop participants.

Summary

The Three Moon and Monal Creeks rise in the Dawes Range and join just upstream of Monto before discharging into the Burnett River. Their headwaters are steep with incised channels. Around their confluence, they have well developed alluvial floodplains which have two main restrictions – at Monto and Mulgildie. Several side streams flow onto these floodplains.

The floodplains support a range of agricultural enterprises. The Three Moon Creek Water Supply Scheme (Cania Dam plus a series of weirs) assists in recharging shallow aquifers that are used for irrigation across the floodplains.

Tropical cyclone Oswald caused severe flooding in the Three Moon and Monal Creeks during January 2013 - large parts of the floodplains were inundated to depths not previously seen and infrastructure damage and soil erosion were severe. Infrastructure on the floodplain modified flow depths and velocities and exacerbated this damage. The Queensland and Australian governments, via the Burnett Mary Regional Group (BMRG), provided funds to assist primary producers to restore productivity and address damage on these floodplains. BMRG, in conjunction with the Burnett Catchment Care Association (BCCA), undertook to develop a land management plan for the floodplains to guide dispersal of these funds.

A participative workshop approach involving all interested stakeholders was used as the core process in developing this land management plan and associated remedial actions. This approach maximizes stakeholder ownership through increased understanding of influencing factors and participation in the planning and implementation process.

Six workshops were held in Monto late 2013. At these, the flood related natural resource management issues needing rectification were identified. Causes and solutions to these issues were discussed and action plans developed to implement solutions (who, how, when).

Delivery of such a plan requires a leader. It is recommended that the BMRG, in conjunction with the BCCA, coordinate and manage the land management plan for the Three Moon Creek floodplain including seeking funds to support the plan.

The nature and extent of floodplain land use and management should be compatible with the risk involved and the degree of protection that can be practically implemented and maintained.

It is recommended that land downstream of the two Three Moon Creek floodplain restrictions (at Monto and Mulgildie) have a land use that requires no or infrequent cultivation and maintains a permanent vegetative cover such as a well managed permanent pasture or tree crop with a grass sward. In other areas, land management practices that maximise soil erosion resistance (least disturbance) and minimise flow erosive capacity (spread and slow the flow) be used. These practices include strip cropping with zero or minimum tillage (on the correct alignment), pasture ley rotations, land leveling and removal of things that concentrate flows.

The transport infrastructure present has altered flood flow conditions. Modification and changed management of this infrastructure and associated land is necessary to achieve future minimal impact on floodwater depth and velocity. This will require lowering of roads, more (and wider) cross-road drainage points, road realignment, removal of spoil heaps and

vegetation management (slashing) of road verges. As well, it is recommended that all floodplain stakeholders be part of future road planning and construction.

The shallower and slower flows are across floodplains, the easier they are to manage. This is best done by avoiding flow diversion – maintaining the natural flow paths – and using practices that encourage spreading. It is recommended that on-farm practices that assist in this regard be used including: removal and levelling of unnecessary fencing, use of 'flood friendly' fences if needed, access tracks to be correctly aligned, have a low profile and have sufficient cross drainage, sub-surface channels be used where drainage is required, removal of unnecessary levees and careful design and implementation of infrastructure.

A change of direction by Queensland Governments has led to a lack of soil conservationists to assist landholders implement these practices. It is recommended that the BMRG continue to provide this support.

The influence that man-made structures are having on flood flow depths and velocities and consequent erosion and sedimentation is unclear at two locations in particular, the Burnett Highway crossing and Hurdle Gully outfall. It is recommended that hydraulic and soil erosion and sediment transport modelling be carried out for these sections of the floodplain.

The Three Moon and Monal Creeks channels have intensifying meander patterns with natural levees often on both sides. Breaches – both natural and man induced - in these levees have led to increased soil erosion and flooding downstream. It is recommended that the levees at these breaches be reinstated and permanent vegetation established.

Riparian vegetation has an important role in maintaining a healthy watercourse - a role which is compromised when weeds or exotic plants dominate the vegetation mix. This leads to bank erosion and biodiversity dilution. It is recommended that, where it is cost effective, eroded creek banks be rehabilitated and appropriate permanent vegetation established. It is recommended that current weed mitigation and removal of exotics programs be encouraged.

In some areas, household 'rubbish' and other debris were deposited during the flood. This household 'rubbish' may contain hazardous substances such as medications. It is recommended that an 'awareness' program regarding the distribution and dangers of 'rubbish' during floods along with a 'post flood' rubbish pick-up and removal plan be established.

There is little reason, economically or environmentally, to remove natural debris from floodplains, unless it unduly disrupts normal operations or is hazardous. Similarly, large woody debris has important geomorphic and ecologic roles in stream dynamics and, generally, should be left there. It is recommended that only when there are adverse social and environmental impacts should this debris be removed.

Successful floodplain land management action planning and implementation is reliant on appropriate background data and information including types and location of infrastructure, topography and flow depths and velocities. Collection, verification, storage and dissemination of this data and information are important roles. It is recommended that the BMRG and BCCA take lead roles in this regard with priority be given to gathering high resolution topographic data for the remainder of the Three Moon Creek floodplain starting with the Hurdle Gully outfall area.

Floods are always going to be part of the scene, but the inconsistency of events leads to complacency and lack of attention to detail and 'readiness'. To this end, it is recommended that the BMRG and the BCCA take a pro-active extension role in this regard.

In order to start rehabilitation of the Three Moon floodplain whilst satisfying the current funding obligations and ensuring the communities' enthusiasm for the restoration work is maintained, it is recommended that work should commence in five areas (in no order of priority):

- Burnett Highway upstream;
- Burnett Highway crossing;
- Burnett Highway downstream;
- Airport East; and
- Hurdle Gully outfall.

Example of soil erosion on Three Moon Creek floodplain resulting from the January 2013 flood.

Contents

1 Setting the Scene

The Three Moon and Monal Creeks rise in the Dawes Range and join just upstream of Monto. Their headwaters are relatively steep and incised. Around their confluence, they have formed alluvial floodplains with migrating meandering main channels. These floodplains are relatively narrow and have natural levees alongside the main channels. Several side streams flow onto these floodplains collectively called the Three Moon Creek floodplain in this document. The location of the area of interest is shown on Figure 1.

The floodplain has two main restrictions – one at Monto (the Burnett Highway crosses here) and one at Mulgildie. These restrictions act as detention basins during floods with relatively large temporary flood storage areas upstream with consequent lower flow velocities and a predisposition to sediment deposition. Further, as flows pass through these restrictions, flow velocities are increased until the flows can spread onto the floodplain proper.

The floodplain supports a range of agricultural enterprises including dairying, grain growing, lucerne production and grazing. Irrigation from shallow aquifers is extensively carried out. The Three Moon Creek Water Supply Scheme (Cania Dam plus a series of weirs) assists in recharging the aquifers.

The floodplain has considerable infrastructure on it, including farm dwellings and sheds, stock fencing, access tracks, public roads, buried pipelines, irrigation bores and associated equipment and man-made levees and channels. This infrastructure has adversely impacted on natural flow paths on the floodplains and also on how and where flows enter or leave the main channels. In some cases, floodwaters now follow corridors where it did not previously. The impact of this development has only recently been realized following recent severe flooding.

Whilst some flooding of the floodplain is a regular event, the January 2013 flood in the Three Moon Creek caused by Tropical cyclone Oswald is regarded as a significant flood (estimated at having about a 100 year average recurrence interval – Peter Wilson, *pers comm.*); large parts of the floodplains were inundated to depths not previously seen and infrastructure damage and soil erosion was severe.

The Queensland and Australian governments provided funds to assist primary producers throughout Queensland to restore productivity and address major damage to waterways and floodplains following that flooding. These funds are being distributed via regional natural resource management groups including the Burnett Mary Regional Group (BMRG).

The BMRG selected the Three Moon Creek floodplain as one of their priority areas in which to concentrate their efforts with a focus on methods to control and coordinate flood flows across properties – all part of their On Farm Productivity and Riparian Flood Recovery Program. As part of this program, the BMRG, in conjunction with the Burnett Catchment Care Association (BCCA), undertook to develop a land management plan for the Three Moon Creek floodplain.

Integrated Catchment Management (ICM) is an approach to sustainable management of natural resources - land, water and other environmental aspects – using a catchment perspective, in contrast to a piecemeal approach that separates land management from water

management and so on. It requires that decisions regarding the natural resources, the economic productivity and people of a catchment are integrated. This approach seems reasonable to apply to managing the natural resources of the Three Moon Creek floodplain.

The upland areas of the Three Moon Creek catchment principally dictate the volume and rate of runoff that leads to flooding of the floodplain. How land is used and managed on those floodplains directly affects the impact and severity of that flooding on the economic development, environmental values and social consequences right across the floodplain.

Overland flow on floodplains is an important source of water for primary production. Harvesting this water, particularly the smaller flows into irrigation dams or rechargeing underground aquifers, has become very competitive. These same overland flows are also important to the dryland farmers on the floodplain who view this water as being part of the farming environment and valuable as natural irrigation. This equitable sharing of flows is an important aspect of floodplain management - natural flowpaths should be maintained except where the alterations are accepted by the community and are technically and environmentally sound.

The private and public infrastructure built up over the years, has significantly altered the natural flow patterns on the Three Moon Creek floodplain. This flowpath alteration resulted in unforeseen and, most likely, unintended repercussions during the January 2013 flood and has been the source of some angst amongst some of the community.

All the issues experienced by the Three Moon Creek floodplain community have been experienced by others in similar situations. Some of those communities have undertaken a collaborative process to develop guiding principles used in constructing and implementing land management plans for their floodplains – see, for example, McLatchey et al., (1994) (Brigalow Floodplain) McLatchey and Knowles-Jackson (1998) and Knowles-Jackson and McLatchey (2002) (Upper Condamine Floodplain). On-ground actions from those plans have resulted in reduced soil erosion, greater productivity and more harmonious communities.

Important aspects of those principles include collaboration of all with an interest in the floodplain, coordination of any action, minimization of change to flow patterns and properties and equality in flow sharing. These principles (Section 2) are directly applicable to the Three Moon Creek floodplain community.

As the involvement of all stakeholders in the planning and implementation of floodplain management plans is essential, the project team used an approach which facilitated that.

This report describes the strategy and process used to utilize the collective efforts of those responsible for management of the Three Moon Creek floodplain and its assets to develop a coherent, effective, transparent and sustainable land use and management plan. The more important actions within that plan agreed to by community members, and necessary to minimise adverse impacts by future large floods, are also listed.

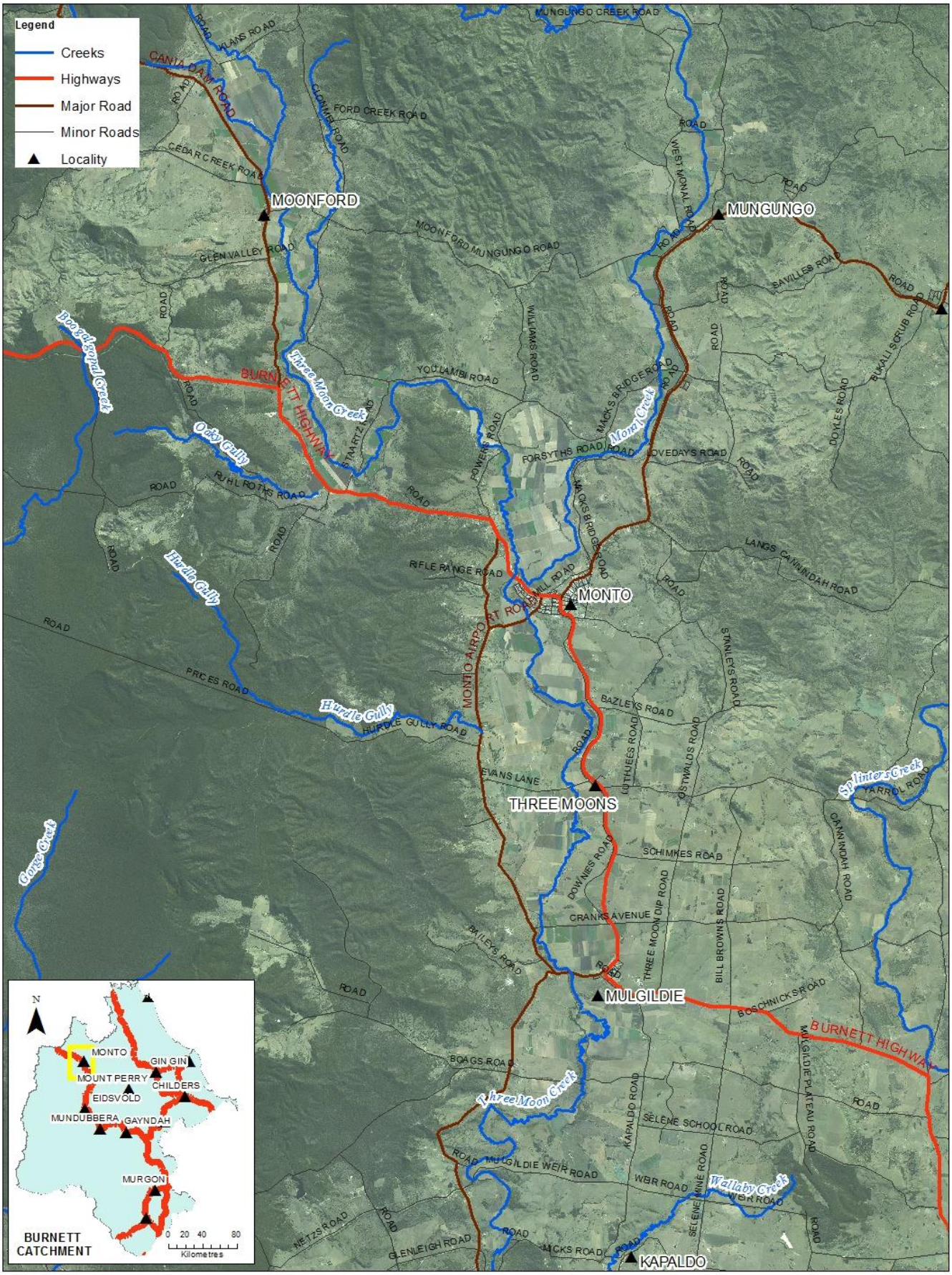


Figure 1: Location of the Three Moon Creek floodplain.

2 Catchment-wide Floodplain Land Management Issues and Policies

Recommendation:

That the following Floodplain Land Management Strategic Goals and Principles be adopted by the Three Moon Creek floodplain community to:

- **guide development on the floodplain;**
- **recognize and reinforce the need for an integrated approach to floodplain land management; and**
- **ensure that the community floodplain planning workshop outcomes are adhered to and delivered in a way that benefits all sectors of the floodplain community in an equitable, coordinated and balanced way.**

Floodplain Management Principles

1. Floodplain planning should be coordinated and involve all stakeholders, including the environment.
2. Natural flow paths should be maintained, except where alterations are accepted by the community and are technically and environmentally sound.
3. All developments should be coordinated across the floodplain and be in accordance with best management practice.
4. Change in flood heights and velocity caused by developments should be restrained to acceptable levels (linked to performance criteria).
5. Erosion should be minimised to an acceptable level (linked to performance criteria).
6. Each floodplain holding should have access to a share of overland flow as determined by a catchment planning process.
7. Each holding should be allowed to choose how best to make use of its share of overland flow.
8. The action or inaction of an individual or group should not impact adversely on other stakeholders.
9. Endeavour to maintain the security of existing investment for both irrigation and dryland farms and other stakeholders of the floodplains.
(Source: McLatchey and Knowles-Jackson, 1998)

Floodplain land management programs need to be proactive rather than reactive. A reactive program, as currently exists on the Three Moon Creek floodplain - responding only as a result of some demonstrated problem - serves to alienate the community and perpetuates serious degradation to the infrastructure as well as off-site damage to natural resources with sometimes considerable adverse and lasting consequences. Proactive programs require more communication and planning but this is made easier if all involved have similar goals and policies. An agreed planning and policy framework also helps bridge the gap from "good intentions" to "good planning outcomes".

The framework should contain **strategic goals** and **principles** to set the foundation for negotiating coordinated and focused actions to improve land management, planning and development mechanisms on the Three Moon Creek floodplain.

Strategic goals identify what the floodplain community members want to see happen on a broad scale. These goals were developed at the floodplain stakeholder workshops.

The **principles** provide the 'rules' or 'guidelines' for natural resource planning and management on the floodplains. They also help with the allocation of floodplain flows between competing users such as, dryland or irrigated cropping. The nine principles developed for the Upper Condamine floodplains (McLatchey and Knowles-Jackson, 1998) (above) seem appropriate for the Three Moon Creek floodplain.

Strategic Goals to achieve flow coordination

The strategic goals for natural resource management across the Three Moon Creek floodplain are:

1. Develop a floodplain management ethic across the whole floodplain community that encourages a coordinated approach to management and development on the floodplains.

Having a constructive attitude and an agreed system for working together on floodplain land planning, development and management issues creates an environment where the best possible outcomes can be reached. Successful floodplain land management can only be achieved with the cooperation of all land managers.

2. *Maintain and work with the natural flooding that underpins floodplain productivity*.

Floods are a natural and regular event on the floodplains. It is important to allow flooding (including creek breakouts) to occur. Containing flooding reduces the beneficial effects ecosystems (including some agricultural systems such as dryland farming and pasture) benefit from e.g. 'free irrigation', groundwater aquifer recharge and nutrient rich silt deposition.

3. *Maintain natural flow paths across the floodplains as much as possible*.

Diversion of flows can have negative effects downstream – often unforeseen and unintended. If flow is to be diverted from its natural flow path, then those downstream need to be aware of this and be prepared to accept the flow and have management practices in place to minimise any deleterious consequences.

4. Slow the flow - as contrasted with increasing its velocity.

The intent here is to be able to manage the flood 'as it comes' using management practices without 'passing the buck' on to someone else. As far as possible, the natural characteristics of floods should be retained and works that accelerate flow on to other areas avoided. As well, excessive ponding due to impediments to flow is also to be avoided.

5. Rectify specific local problems through targeted on-ground works.

This goal is about supporting targeted on-ground actions identified as necessary to remediate local problems. Achieving this goal will require the floodplain community to work in a co-coordinated complimentary manner.

6. Encourage 'floodplain friendly' infrastructure design.

There are cases of existing infrastructure which have inappropriate design for floodplains which leads to damage to natural resources as well as other infrastructure. These include roads, railway lines, fences, levee banks and irrigation infrastructure. This goal is about adopting a better approach to infrastructure design, maintenance and location (and re-design where feasible).

7. Develop and implement coordinated and accountable planning mechanisms to support good decision-making and development assessment on the floodplains.

Local governments and State agencies require clear guidelines, processes and information that allow transparent and justifiable decision-making on land planning and development assessments on the floodplain.

Floodplain management principles

The following principles have been developed elsewhere (McLatchey and Knowles-Jackson, 1998) but seem appropriate to guide decisions on development proposals and land use and management actions on the Three Moon Creek floodplain.

1. Floodplain planning should be coordinated in a whole-of-catchment context and involve all stakeholders including landholders, industry, Local and State governments, and indigenous and environmental interests.

This principle stresses the importance of adopting a coordinated approach to planning for the floodplain that includes all stakeholders and considers the "environment" as an equal stakeholder in the planning and decision-making process.

2. Natural flow paths should be maintained except where alterations are technically and environmentally sound.

The most technically feasible and fairest way towards land management is in accord with the natural flow paths of the floodplains. 'Natural' flow paths should be taken as those paths identified by topographic survey of the floodplain. Only part of the Three Moon Creek floodplain has topographic data suitable for accurately identifying those flow paths. It is recognized that the floodplains are dynamic and, through erosion and silt deposition, the flow paths will vary over geologic timescales. Short time frame diversions caused by infrastructure should be discounted when distinguishing natural flow paths.

3. Development on the floodplains should be coordinated and in accordance with best management practices.

At the whole of floodplain level (including relevant upland catchment areas), development best management practices (BMPs) may include structural flood mitigation works, land use planning controls, development and building controls and flood emergency measures. Performance indicators and data collection (including flood maps) are critical in supporting and assessing BMPs. BMPs provide the basis for farmers to contribute to flow coordination

objectives through sustainable land management practices that also have productivity and environmental benefits.

4. Local and cumulative impacts on inundation times and flood heights and velocity caused by existing or proposed developments should be restrained to acceptable levels as determined by agreed floodplain management and/or development criteria.

In order to minimise adverse impacts on existing or proposed infrastructure and natural resources, it is critical that further developments do not increase flow velocity or depth or inundation times above some agreed criteria. Assessment of changes to these factors (velocity, depth and timing) may require hydraulic modeling. Modification of proposals may be necessary to limit changes to these factors to within the criteria.

5. Natural resource impacts, including erosion, should be minimised to agreed acceptable levels.

Minimizing the impacts of accelerated natural resource decline, including erosion, during flooding may involve the modification of existing infrastructure and assessment of proposed structures.

6. *The action or inaction of an individual or group should not impact adversely on other stakeholders including those downstream of the floodplain*.

Floods affect the whole community and attempts to manage the overland flow of water on the floodplains by individuals in isolation have been shown in many cases to be a fruitless exercise. This sort of approach may even result in further difficulties being experienced by others. This is to be avoided if at all possible.

7. Water allocation including flow sharing should be equitable and guided by best available technical information applied to establish transparent criteria for determining access to and use of overland flows by individual floodplain holdings.

Although the focus of this particular activity is on flow management, the principles recognize the important need to address allocation issues in a complementary way using the best available information and in an objective and transparent process. Information and processes can utilize formal (such as water licensing under the *Water Act* 2000) and informal mechanisms (such as community workshops).

8. Each holding should be allowed to choose how best to make use of its share of overland flow.

Each landholder should be allowed to use their share of the water as they see fit and suits their enterprise so long as they have no deleterious effects on other stakeholders.

9. Endeavour to maintain the security of existing investment for both irrigation and dryland farms and other stakeholders of the floodplains.

Landholders on the Three Moon Creek floodplain have considerable investment in land and/or water resources which they have every right to protect. Actions by others should not put these investments at risk.

It is only when the stakeholders on the floodplains accept responsibility for management of their land that there will be improvements to the condition of the natural resources in the area.

Successful floodplain land management requires coordination of effort between stakeholders during both planning and implementation phases of any projects.

All stakeholders should realise (by now) that they require the support of their neighbours in order to solve the natural resources problems on the floodplain. Without this support, their actions, although well intentioned, are usually less than successful and can result in an expensive failure (including the threat of litigation). And of course as time goes on it becomes more and more expensive to resolve the problems.

The way forward:

Participation – Coordination – Cooperation – Synchronization – Implementation

3 Roles and Responsibilities

Recommendations:

- **Individuals and relevant entities use practices that minimise risks of damage to their land and to the interests of others;**
- **Individuals and relevant entities work cooperatively to find and deliver solutions for problem areas;**
- **That stakeholders implement good floodplain land management wherever possible without waiting for funding to become available;**
- **The BBMRG continue to view floodplain land management as a major issue;**
- **The BCCA on behalf of the Three Moon Creek floodplain community, continue to lobby and seek funding to support the development and implementation of appropriate floodplain land management practices works; and**
- **The BMRG, in conjunction with the BCCA, coordinate and manage the land management plan for the Three Moon Creek floodplain.**

The activities carried out on the floodplain are often diverse (e.g. farming, transport), each being (usually) legitimate but, sometimes, competing. The activities involve a wide range of individuals and entities and, to ensure fairness, it is best if the folk concerned work in a spirit of cooperation.

Individual farming properties have an interest in maintaining productivity of their land and as such should use industry best management practices in an effort to maintain their land in as productive a state as possible.

There are several approaches and mechanisms used in achieving floodplain management such as encouragement, assistance, insistence and purchase.

Encouragement and assistance is the modus operandi of local and regional groups with an interest in floodplains such as the North Burnett Landcare (with their wetlands rehabilitation project), the BCCA (with their weed control project) and the BMRG (with their flood recovery program).

All levels of Government (Federal, State and Local) have natural resource management related laws, policies and/or enforceable codes of practice or plans that have a bearing on land use and management across the Three Moon Creek floodplain. These regulatory instruments are usually focused on either publicly owned resources such as water and State land or critical areas. At the Federal level, the *Environment Protection and Biodiversity Conservation Act* 1999 and the *Water Act* 2007 have influence. There is a plethora of relevant State Acts and Policies, for example *Soil Conservation Act* 1986, *Land Act* 1994, *Environment Protection Act* 1994, *Vegetation Management Act* 1999, *Water Act* 2000, the *Strategic Cropping Land Act* 2011 and, more recently, the State Planning Policy of December 2013 within the *Sustainable Planning Act* 2009 auspices. Then there are the Local Government planning schemes. Often these regulations include requirements for property-level management plans that contain commitments by the landholder to sustainable natural resource management practices.

The Barrier Reef Water Quality Protection Plan, a joint commitment of the Australian and Queensland Governments, supports the actions of industry (grazing) and community groups (BMRG, BCCA) to improve the quality of water in the Great Barrier Reef. The primary focus is on improving land management in reef catchments to reduce non-point source pollution from broadscale land use.

At the State level, the Wide Bay Burnett Regional Plan is a Queensland Government statutory regional plan (under the *Sustainable Planning Act* 2009). It provides strategic direction and specific policy to deliver regional outcomes which align with the state's interests in planning and development.

In December 2013, the Queensland Government established a single state planning policy (SPP) that simplifies and clarifies state interests. This SPP replaces around a dozen separate policies (including the good quality agricultural land policy and the Strategic Cropping Land policy). It provides a clear, consolidated and comprehensive view of the state's interests in land use planning and development in one place. The SPP provides a set of principles to guide local governments in land use planning and development assessment.

The SPP covers a range of state interests including agriculture where the desire is to:

- reduce the potential for conflict between agricultural land and other uses;
- protect resources from inappropriate development;
- minimise encroachment to ensure viable tracts of agricultural land are maintained; and
- improve opportunities for increased agricultural investment, production and diversification.

The North Burnett Regional Council (NBRC) is required under The *Sustainable Planning Act 2009* (SPA) to prepare planning schemes which include a strategic land-use plan. Future local government planning schemes must take into account the SPP of December 2013.

Any activity undertaken at the individual property level should not adversely impact on others - we all have a duty of care to take reasonable care not to cause foreseeable harm to other people or their property (public and private) - the law of negligence. An example of this is if a landholder constructs a levee bank on their property and the construction alters the natural flow of water and/or interferes with the natural flow of water across land, and therefore causes a landowner downstream to have their land flooded and damage caused, when this would not usually occur, they could be held liable in the common law actions of nuisance or negligence.

Levee banks came under the scrutiny of the Queensland Floods Commission of Inquiry (2012). That Inquiry considered the impact of levees on flooding and the lack of uniform regulation of levees. The Report has made recommendations about levees, including how a levee should be defined and regulated. The Queensland Government is in the process of enacting new legislation for the reform and control of levee banks.

Levee banks are considered as "operational works", and so, to be "development" within the definition of the *Sustainable Planning A*ct (2009). Thus approval for levee bank construction must follow the prescribed procedure which includes providing a hydrology report that has assessed the potential impact of the proposed works on any adjacent watercourse or water body and surrounding floodplain.

Some activities such as removing or placing fill from/in watercourses may require a Riverine Protection Permit (*Water Act* 2000) from DNRM – land holders are exempt if removing or placing less than 500m^3 of fill but a set of minimum requirements covering the activity must be adhered to.

Note:
Delivery of a coordinated land management plan across the Three Moon Creek floodplain requires someone to take a leading role. This is an important role as, without this, the status of activities on the floodplain may potentially be no better off than prior to the January 2013 flood where the ad-hoc approach being used led to the need of a coordinated approach in the first place. As well, given the irregular occurrence of floods and other priorities coming to the fore a feeling that floods are a thing of the past can grow. Ongoing vigilance in this area is required to prevent this complacency developing.

It is necessary for community members (stakeholders) to remain focused on the same issue (a common enemy) for continued support. It is also strongly suggested that a representative 'committee' be formed and this committee keep other stakeholders informed on progress across the floodplain on subjects such as data collection, who has done what, development proposals and so on using personal visits, phone conversations, newsletters etc.

Ownership changes are going to continue and it is important that new owners are informed of progress to date and encouraged to participate in future programs.

The BMRG and the BCCA seem well placed to take on this role of stewardship and awareness promotion and for sourcing funds in order to address some of the issues raised by the Three Moon Creek floodplain community.

Where some of the eroded soil finished up – the Burnett River outlet. (Source: Chris Hadfield.)

4 Strategy

Coordination of the Three Moon Creek floodplain land management planning process.

Recommendations:

- **The BMRG continue to view floodplain management across their area as a major issue;**
- **The BCCA, on behalf of the Three Moon Creek floodplain community, continue to lobby and seek funding to support the development and implementation of works that address issues identified during the workshop process; and**
- **The BMRG in conjunction with the BCCA coordinate and manage the land management plan for the Three Moon Creek floodplain.**

There are many stakeholders on the Three Moon Creek floodplain with a variety of interests. To minimise conflicts and misunderstandings and to maximize benefits, co-ordination of planning and the implementation is paramount. Coordination of a total Three Moon Creek floodplain land management program, including funding applications, lobbying and so on, would vastly improve efficiencies. In addition, addressing issues relating to natural resource management on the floodplain requires an integrated catchment-wide planned approach rather than an ad hoc piecemeal basis as has been the case to date.

Successful floodplain land use and management plans have been developed and implemented elsewhere using a strategy that is built around:

- ensuring participation of the whole of the floodplain community in the development and coordination of actions;
- building and making available relevant data sets that can be used by community members to make informed decisions;
- adopting a set of principles and criteria to guide decisions regarding land use and management and development of floodplains;
- identifying issues affecting natural resource management across their floodplains and then developing a works program that addresses those issues;
- being able to source a secure and unbiased technical service to assist with implementation of on ground works;
- developing a long-term communication strategy to keep the community informed and focused on floodplain programs and initiatives; and
- putting in place a process for gathering, collating and storing further information and knowledge required for effective ongoing floodplain planning and management.

That strategy recognizes the roles of all stakeholders including the State and Local Governments and, most importantly, the local community. However without the support and involvement of the whole of the floodplain community, sustainable natural resource management that delivers benefits to all stakeholders cannot be achieved.

Community based workshops are the main step in implementing this strategy. At these workshops, the flood related natural resource management issues that need to be rectified are identified. Causes and solutions to these issues are discussed and action plans developed (who, how, when) to implement solutions.

5 Workshop Process

Objective: To maximize stakeholder/community ownership of natural resource management plans through increased understanding of influencing factors and participation in the planning process.

Floodplains are subject to broad-scale overland flows that can easily be diverted – wittingly or otherwise. These diversions can result in problems a long way from the cause. So, to develop a solution to the problem, stakeholders must identify and understand the real cause. As well, to ensure commitment in implementing remedial actions, it is essential that stakeholders have acceptance and ownership of these actions.

A participative workshop methodology, developed through necessity, has been widely used elsewhere and found to be very effective. As examples, this methodology has been used throughout the Brigalow Floodplain (91 000 ha and 250 landholders), the Jimbour Floodplain (30 000 ha and 80 landholders) and the Upper Condamine Floodplain (450 000 ha and 1 500 landholders) on the Darling Downs in Queensland (McLatchey *et al*., 1994, McLatchey and Knowles-Jackson, 1998 and Knowles-Jackson and McLatchey, 2002). An example of workshop content is given in Appendix 1.

These workshops are used to identify problems, the cause of the problem and develop actions (with a timetable) to rectify the situation. The reasoning behind the content chosen for the workshops is given in Table 1.

Process content	Purpose
1. Clearly state the purpose of the workshop, our role, their opportunity. Define floodplain land management	Provide focus and gain involvement
2. List issues of concern. Ask all to be 'up-front' and honest.	Give validity to personal issues and relieve tension.
3. (a) Use a model landscape to improve skills in topographic map reading. (b) Use a hypothetical catchment to apply new knowledge, identify problems and develop solutions in a non-threatening group environment.	Promote group learning and improve objective thinking.
4. Apply learning from the hypothetical exercise to own map. Use the template to design run-off management strategies.	Plan the real world - reflect on new knowledge and apply to participant's own area.
5. Revisit concerns listed at item 2.	(a) Participants develop an action strategy to deal with the issues. (b) Identify further needs.

Table 1: Why the workshop content is what it is.

The Three Moon Creek floodplain was divided into five (5) units of 'bite-sized' pieces on hydrologic and geographic bases and workshops held with stakeholders from each unit. A further workshop was held with landholders from the lower Monal Creek catchment. At each workshop, participants identified the flood related land management issues that needed to be

rectified. These issues were each given a number, collated into a schedule (Appendix 2) and their locations are shown on Appendix 4, Map 1.

The cause(s) of these issues were discussed and possible solution(s) developed. These solutions have been collated into action plans and recommendations produced. *The action plans, although they address a range of issues, are not stand-alone. They are complimentary and, while the impact of each is strategic, their effect is cumulative. The recommendations should be considered as a whole with careful thought given to synchronization of works between stakeholders. In many cases it will be essential for neighboring stakeholders to liaise and coordinate their activities in order to achieve the best results.*

Stakeholders discussing restoration options at a workshop. (Source: BCCA, 2013)

Stakeholders receive a report containing workshop outcomes, relevant maps, action plans and recommendations. This provides a record of the workshops and implementation strategies.

Experience has shown that average stakeholder workshop attendance rates are in the order of 80% but can be as low as 50%. For the Three Moon Creek floodplain workshops, about 60% of stakeholders attended – the area they represent - shown on Figure 3 had the worst damage. Attendance rates reflect the importance of the subject to stakeholders along with the fact that, prior to the workshops, rectification work may have been carried out and any issues resolved.

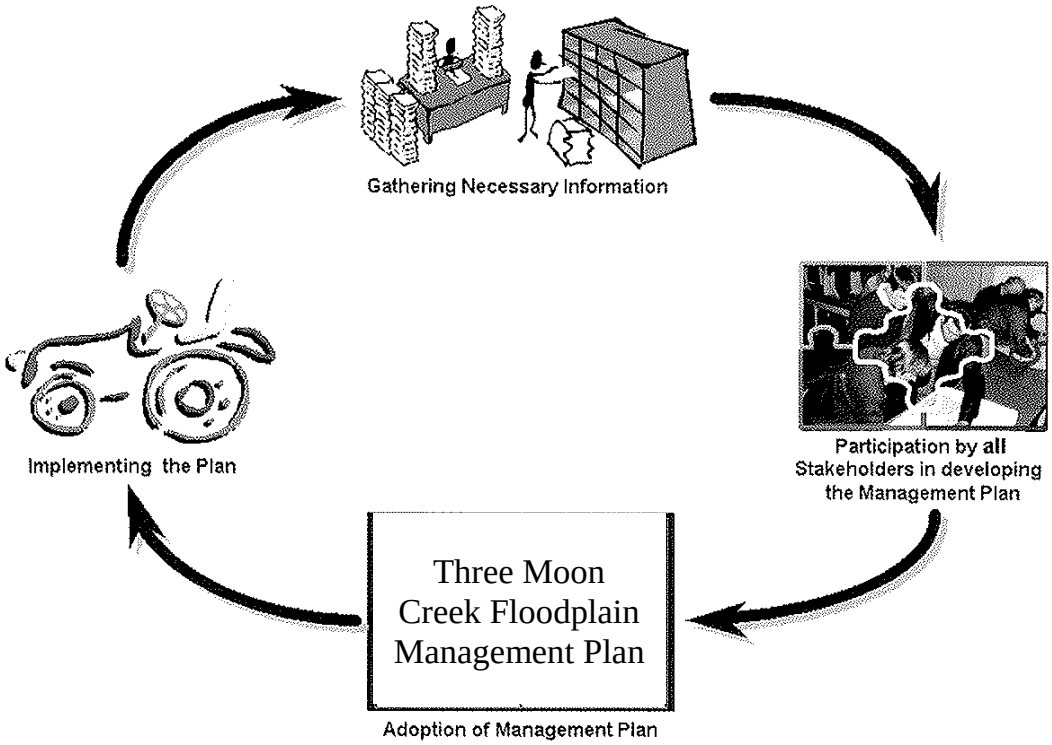
Generally, there is also a need to follow-up on proposed actions as other matters can 'take over' stakeholder priorities. As well, there is a need to keep stakeholders informed on progress. During the workshops, attendees were asked to nominate representatives for their respective areas to take on these roles. Subsequently ten landholders put their names forward representing the five workshop areas.

These landholders are:

Workshop Area 1	Tyson Jarvis, Brad Forsyth
Workshop Area 2	Wes Wolff, Fred Jarvis
Workshop Area 3	Russ Salisbury, Kendall Muller
Workshop Area 4	Jan Darlington, Scott Dowling
Workshop Area 5	Clinton Dederer, Robert Ogle

Common problems and advice on the use of the workshop process:

- Emphasize 'group ability' to be heard and value of co-ordinated planning.
- Emphasize the need for participants to 'make it happen'
- Emphasize the importance of local knowledge.
- Stay focused. A crisis is not always bad; it can assists in focusing the community.
- Limit workshop numbers to 15 – 20 to maximize participation.
- Workshops have to be made up of contiguous landholders and service providers because co-ordination is a major goal.
- Maximize 'communication' between neighbours.
- A presentation team of about 4 is required.
- Adapt the process, don't 'transplant' it



Action programs involve the whole community

Figure 2: Development and implementation of floodplain management plan.

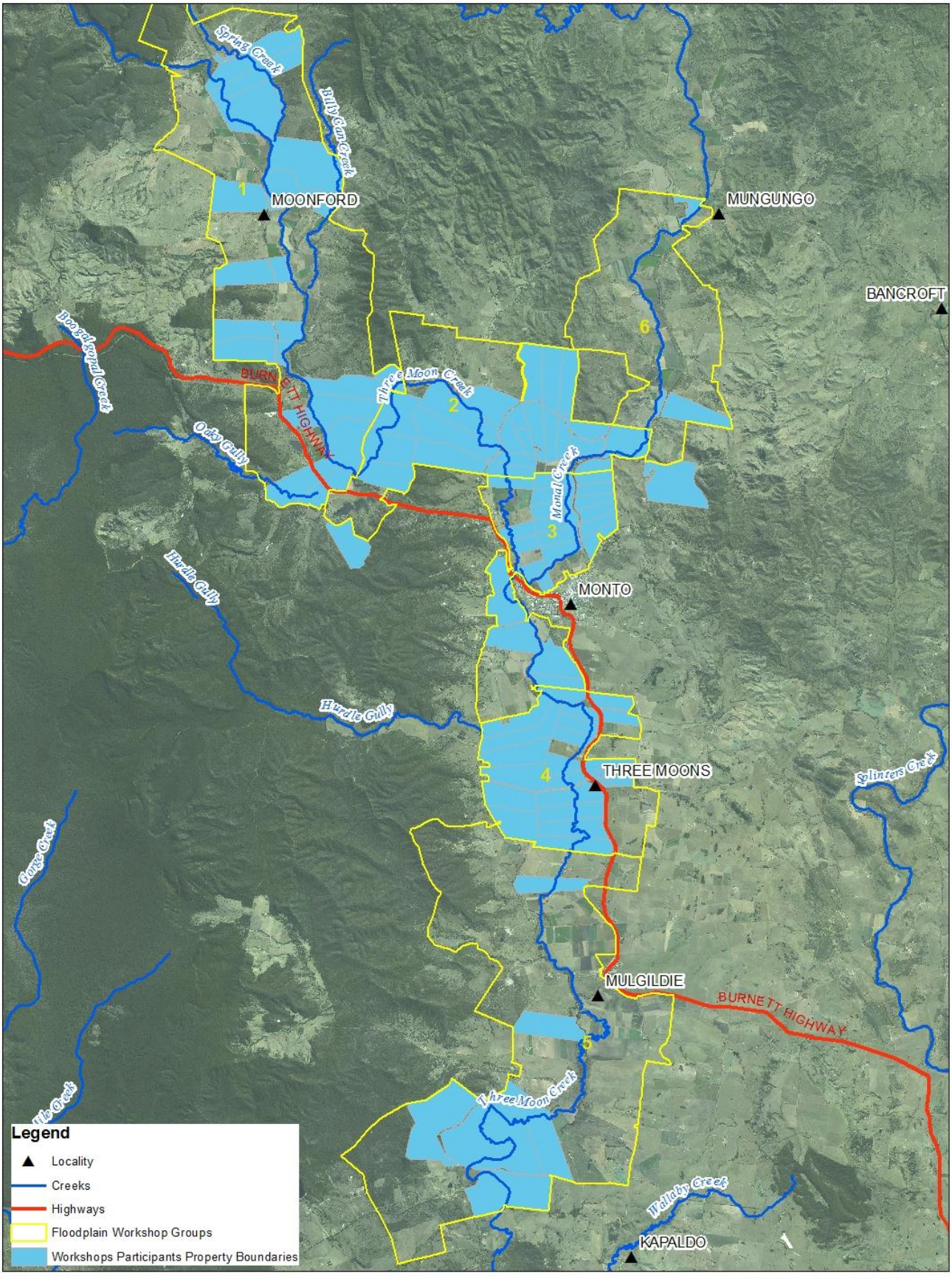


Figure 3: Workshops Participants

Project: Three Moon Creek Floodplain Action Planning
Date: Feb 2013
Prepared by: BCCA

BCCA

Burnett Mary Regional Group

0 1 2 4 6
Kilometres

Datum: GDA94
Projections UTM (MGA Zone 56)

N

Figure 3: Area covered by workshop participants

6 Floodplain Land Management Action Program

Introduction

The issues identified at the workshops by stakeholders were grouped and remedial actions identified. The following eight (8) Action Programs represent those grouped remedial actions. They also represent community expectation as to what is required to address some of the natural resource issues on the Three Moon Creek floodplain. These Action Programs are complimentary to each other and need to be considered as a whole in order to overcome any further decline in the resource base.

Not everyone within the Three Moon floodplain community attended the workshop series but nonetheless it is hoped that these Action Programs will benefit the whole of the floodplain community.

Irrigator in need of repair following January 2013 flood

6.1 Action Program 1 - Land capability and land use

Recommendations:

- **Floodplain land use should be compatible with the risk involved and the degree of protection that is practical - land subject to frequent flooding and high soil erosion levels be retired from cultivation;**
- **Where land is cropped, management practices that maximise soil erosion resistance and minimise flow erosive capacity be used; and**
- **Land managers consider the implications of future climate scenarios on land use decisions.**

Discussion:

A decision to use a piece of land for a particular purpose should be made with the knowledge that a feasible management system can be put in place such that the land will continue to support that land use without causing damage, that is, within its capability. Land capability assessment takes into account the physical nature of the land (e.g. geology, soils, slope), requirements of the land use, e.g. soil water availability, plus the risks of degradation associated with the land use, e.g. flooding and erosion. It does not take into account the economics of agricultural production, social or political factors.

Floodplains are attractive for agricultural use as they have reasonably level topography, have access to water and, usually, fertile soils. As such, they are often cultivated but this places them at risk to damage from flooding.

Flooding occurs from overbank flow from streams, run-on from upslope areas or because the area lies in a topographic depression. The risks to land associated with flooding include water logging, soil erosion and structural damage and debris accumulation. The frequency and timing of flooding will determine the level of impact. The nature and extent of floodplain land use should be compatible with the risk involved and the degree of protection that can be practically implemented and maintained.

Soil is eroded by flowing water when the flows hydraulic shear stress (a function of flow depth, slope and its sediment load and transport capacity) is greater than the soils resistance (a function of the soils texture, aggregate stability, moisture content etc.). Erosion risk can be minimised by lowering the flows shear stress at the soil surface (keeping flows as shallow as possible, using vegetative or other cover, etc.) and increasing the soils resistance (not loosened by cultivation, stock trampling etc.).

For land with a low flood risk (infrequent and low level flooding) cropping may be practiced with appropriate soil conservation measures such as strip cropping, zero tillage combined with stubble retention perpendicular to the flow line, land levelling, removal of things that concentrate or pond flows and carrying out any cultivation necessary when floods are least likely – late autumn (April) to early spring (September) – bear in mind that floods can occur at any time.

For land with a moderate flood risk (frequent but low level flooding) cropping may be practiced but with a higher level of soil conservation measures including those above, use of pasture leys and strip cropping.

For areas with a high risk (frequent high level flooding and fast flows), such as downstream of the two Three Moon Creek floodplain restrictions, it is best to have a land use that requires no or infrequent cultivation and maintains a permanent vegetative cover such as a well managed permanent pasture/irrigated lucerne, tree crop with a grass sward under layer or forestry.

Many factors affect land management and land use decisions and how often that decision must be made is dependent on the particular decision type – see table below – but, for sustainability, land capability is extremely important.

Decision Type (eg. only)	*Frequency (years)*
Logistics (eg. scheduling of planting / harvest operations)	**Intraseasonal (> 0.2)**
Tactical crop management (eg. fertiliser / pesticide use)	**Intraseasonal (0.2 – 0.5)**
Crop type (eg. wheat or chickpeas)	**Seasonal (0.5 – 1.0)**
Crop sequence (eg. long or short fallows)	**Interannual (0.5 – 2.0)**
Crop rotations (eg. winter or summer crops)	**Annual / biennial (1 – 2)**
Crop industry (eg. grain or cotton, phase farming)	**Decadal (~ 10)**
Agricultural industry (eg. crops or pastures)	**Interdecadal (10 – 20)**
Landuse (eg. agriculture or natural systems)	**Multidecadal (20 +)**
Landuse and adaptation of current systems	**Climate change**

Relationship between time frame and decision type (Source: Stone et al., 2013).

6.2 Action Program 2 - Management of road reserves and transport infrastructure

Recommendations:

- **That stronger links be formed between all floodplain users and road reserve managers to ensure there is close participation by all at all stages of road and other infrastructure construction from initial investigation to completion; and**
- **That all stakeholders start programs to restore and maintain natural flow paths by modifying infrastructure and other items that have led to flow diversions.**

Discussion:

The Queensland Government is one of the largest and most extensive landholders on the Three Moon Creek floodplain – mainly road reserves and the creek bed and banks. This land is managed by Queensland Rail, the Department of Transport and Main Roads (MRD), the Department of Natural Resources and Mines and the North Burnett Regional Council and used predominantly as transport and communication corridors. This land and associated transport infrastructure, irrespective of whether it is redundant or not, are important assets of the State and the local community.

Those corridors and associated infrastructure criss-cross over the entire length of the floodplain and, as such, any management actions within these corridors can and do have significant impacts on floodflows. The infrastructure and vegetation on those corridors in their current state are both a moderator to, and an accelerator of, soil erosion.

Given this influence, it is essential that the Government agencies mentioned play a proactive role in floodplain land management alongside their administrative function. The collective value of the capital works these agencies have in these corridors is enormous. It is therefore not unreasonable to assume that the managers of these corridors have much to gain by being part of this proposed floodplain land management plan. As well, transport corridor managers have an obligation not to take actions that result in damage to other floodplain stakeholders.

The transport network received significant adverse comment at the workshop series and a number of major issues that need to be addressed were identified. These relate to:

- lack of involvement of adjoining landholders at the design and construction stages;
- pondage and flow diversion due to high roads;
- pondage due to insufficient cross-road drainage;
- breaching of the natural creek levee below the Burnett Highway bridge;
- siltation and debris on and upstream of road reserves; and
- soil erosion downstream of high roads – waterfall effect.

Modification and management of the transport infrastructure and associated land with the cooperation and participation of the neighboring landholders may be necessary to achieve minimal impact on floodwater depth and velocity particularly at strategic locations on the floodplain. Maintenance of natural drainage patterns is a key point here and, in some instances, the natural drainage pattern may have to be re-established. This may require lowering of roads, more (and wider) cross-road drainage points (inverts, floodway sections), road realignment, removal of spoil heaps and vegetation management (slashing).

Guidelines on appropriate design criteria for roadways and farm tracks on floodplains are given in Marshall (1993) and Knowles-Jackson *et al.* (1999).

Any actions should embrace the entire width of the corridor along with adjacent properties. This philosophy applies to on-farm roads as well. Without this coordinated approach works undertaken by an individual stakeholder may potentially be compromised.

It is not only embankments that influence floodflow patterns - vegetation of all types can also do this. For this reason, management of vegetation in the transport corridor and elsewhere has to have serious consideration. Regular slashing particularly in strategic situations such as below cross-road drainage points must be undertaken.

Where fence lines are required, extra care should be taken to ensure that the inlets and outlets of the transport corridor drainage are not blocked. Any unnecessary fence should be removed (retaining portion boundary identification posts) and any scours or soil buildup in the area adjacent both up and downstream levelled. Whoaboys or spur banks (broad-based low earthen banks) may need to be established at strategic places to 'force' runoff across any roads and prevent parallel flows developing along fence lines adjacent to the transport infrastructure.

Burnett Highway Three Moon Creek crossing during the January 2013 flood
(Source: B Woltmann, 2013).

6.3 Action Program 3 - On-Farm infrastructure and practices - soft engineering

Recommendations:

- **That the BMRG continue to provide floodplain land management technical support;**
- **Landholders remove fences and associated plough banks and man-made levees generally - except to protect infrastructure;**
- **Landholders establish whoa-boys where necessary to prevent run-off following farm roads/tracks;**
- **Landholders endeavour to spread runoff by land leveling and operating on the contour;**
- **Faming practices that maximize vegetative cover and minimise soil disturbance be used, and**
- **All stakeholders take into account the effects of structures such as flood irrigation layouts and levees on co-ordination of overland flows before construction.**

Discussion:

The shallower and slower flows are across floodplains, the easier they are to manage. In general, this is best done by avoiding flow diversion – maintaining the natural flow paths – and using farm practices that encourage spreading. Several instances of farm infrastructure and land management practices causing flow diversion and resultant soil erosion and increased flooding were raised at the workshops. Some landholders were keen to alleviate this problem but were not sure on how to go about it – a need for technical advice became apparent. As well, there is always a need for support and encouragement of these landholders to maintain momentum.

(A) Fences:
The preservation of redundant fence lines often exacerbates flow diversions. Any unnecessary fence should be removed (retaining portion boundary identification posts) and any scours or soil buildup in the area adjacent both up and downstream levelled. Where fence lines are required, whoaboys or spur banks (short broad-based low earthen banks) may need to be established at strategic places to 'force' runoff through the fence and prevent parallel flows developing along the fence lines. 'Flood friendly' or electric fencing is recommended for use on floodplain.

(B) Tracks:
Tracks may need realignment or the addition of 'whoa-boys' to preserve flow integrity. Whoa-boys - short banks designed to prevent runoff following the road/track - are broad enough to be easy to cross and high enough to take the water off. They need to be designed and constructed so that as floodwaters rise the whole bank along its length is submerged at the same time and flows are not unnecessarily diverted. Allowance for cross-road drainage may be needed to eliminate possible upstream pondage.

(C) Crop alignment:
In order to minimise flow concentration and maximize spreading, farming operations should be aligned with the contour. Accurate topographic information and technical input to the

design and implementation of crop alignment layouts is imperative. Readily available topographic information suitable for such design purposes is available for parts of the floodplain only at this stage. It is strongly advised that controlled traffic farming layouts not be installed in 'up/down slope' arrangements as wheel tracks and crop lines can easily divert flows, increase flow velocities (and soil erosion) and, unless maintained, wheel tracks become deeper over time exacerbating the problem.

(D) Maximising vegetative cover:
Anchored vegetative cover (dead or alive) is useful in reducing flow velocities and, hence, soil erosion. In cropped area, weed control using chemicals rather than mechanical measures is recommended. A viable alternative where chemical weed control is not an option is strip cropping, where crops are grown in alternate strips across the flow direction with the aim of having a crop on at least half the land at any time. Strip cropping will be most effective where it is practiced on contiguous properties to avoid flow diversion around the end of strips. Again, correct strip alignment is essential.

In parts of the Three Moon Creek floodplain, such as immediately downstream of the constriction points, flows can be too fast to rely on this land management tool to control soil erosion. It is recommended that permanent pasture (irrigated or dryland) be established in those areas. High vegetative cover levels should be retained in these areas using appropriate grazing management (where grazed) or, if harvested for hay, seed etc, preserving as much cover for as long as possible during the 'flood season'.

(E) Minimise soil disturbance.
Soil disturbed by cultivation, hoofed animals, traffic etc, leave it in a state where it is more easily eroded. In cropping areas, use of zero or minimum till is recommended. Where the land is grazed, stock pads should be guarded against and high vegetative cover levels maintained.

(F) Ponding:
After the subsidence of flood flows, there are often areas of water ponded against headlands, roads, fences, rank vegetation, silt deposits etc. The removal of the cause of these ponds if possible is recommended. This may involve cooperation with neighbours or a permit from the North Burnett Regional Council or Department of Transport and Main Roads to slash the road reserve. Several such projects are already taking place. Where use of a drain is required, these drains should be subsurface with no above ground bank.

(G) Land Levelling:
Land levelling or land planeing is advantageous in spreading flows. It should be carried out in a way that gives runoff more space, not to tip it in another direction. This may be a tool used following flood events to fill eroded areas and removal of silt deposits that causes flow diversion and/or pondage.

(H) Levees:
Natural levees on the sides of water courses must be maintained and stabilized. If they are cut through such as at road crossings, runoff will exit the creek before natural surcharge and can cause unnecessary damage.

Man-made levees, unless necessary to protect infrastructure, should be removed and the area landplaned. It may be necessary to carryout this work in conjunction with neighbours so it is imperative to communicate with each other prior to action.

Levees necessary to protect infrastructure should be no longer than necessary to do the job.

(I) Irrigation:

Irrigation infrastructure, particularly as part of flood irrigation systems, can have adverse impacts on floodplain runoff – leading to flow concentration and diversion. It is noted that most of the irrigation systems on the Three Moon Creek floodplain are spray types. Care is still required in design of these systems and layouts to minimise flood flow concentration and diversion. Landholders are urged to take into account the implication of their structures on their neighbours (and themselves) and not to rest on the fact that a development permit may not be required to install these systems. Any proposed works should be communicated to neighbours to address concerns that they may have prior to the commencement of those work

Example of soil erosion on Three Moon Creek floodplain due to flow diversion by a levee during the January 2013 flood

6.4 Action Program 4 - Geomorphology, hydrology and hydraulics of Three Moon Creek

Recommendations:

- **Hydraulic, soil erosion and sediment transport modelling be carried out for the sections of Three Moon creek upstream and downstream of the Burnett Highway and at the Hurdle Gully outfall;**
- **Sunwater give consideration to releases from Cania Dam prior to anticipated large runoff events;**
- **Sunwater give consideration to the removal of vegetation and silt as necessary along the length of Three Moon and Monal Creeks to maintain stream integrity; and**
- **Land managers consider the implications of future climate on land use choices.**

Discussion:

The Three Moon and Monal Creeks rise in the Dawes Range and join just upstream of Monto. Briefly the geology of the area is - the Kroombit Tops began forming about 215 million years ago when volcanoes erupted and a crater about 40 km across collapsed beneath them. About 25 million years later, the area was covered by ocean depositing sand beds that were eventually compressed to form sandstone. Over time, the surrounding countryside eroded leaving the sandstone capped volcanic rocks which form the Kroombit Tops plateau. Since then, streams draining the plateau, such as the Three Moon and Monal Creeks, have created steep-sided gullies and deep gorges with high sandstone cliffs (DNPRSR 2013).

These streams have then deposited the eroded material downstream forming alluvial floodplains with migrating meandering main channels. These floodplains of Three Moon and Monal Creeks are relatively narrow (0.2km - 3km wide) and are made up of permeable quaternary gravel, sand and silt deposits (with a maximum depth of 20m - 27m) overlain by relatively impermeable clay deposits (up to ~12m thick) (GHD Pty Ltd and AGT Pty Ltd 2011). The main creek channels often have natural levees alongside.

Several side streams form alluvial fans as they enter the floodplain. As well, since their flows cannot enter the main stream due to the natural levees, they form Yazoo streams running parallel to the main stream. These streams create similar problems with regard to soil erosion and deposition as the main creek with Hurdle Gully being the main offender.

The Hurdle Gully outfall area has had considerable alteration over recent time with levees, channels, dams etc being constructed piecemeal. These structures may well be altering flood levels and velocities and making the situation worse. It would be advisable to carry out a hydraulic modeling exercise to determine the impact of existing structures along with any proposals of removal or construction of others before any further on-ground action is taken.

The aquifers of the alluvial deposits, the major source of irrigation and town water supplies are recharged from surface waters. The Three Moon Creek Water Supply Scheme, Cania Dam (catchment area 280km^2) and associated channels and five weirs (see diagram below), was constructed to boost loss rates to the groundwater aquifers. It also includes a diversion

channel between Three Moon Creek and Monal Creek. Sunwater has been granted an Interim Resource Operations Licence (IROL) to operate the Scheme.
The IROL pertains to irrigation water only apart from a requirement to support a platypus community during dry times. The IROL has no flood mitigation requirements although Cania Dam does have a minor flood detention effect - Tomerini (1991) estimated the pre-dam peak flow rate at the dam site for a 100year average recurrence interval flood (Qp100) at1020 m^3/s and the post- dam Qp100 at 560 m^3/s. The peak discharge rate for the January 2013 flow seems to be around 1100 m^3/s.

The Scheme has maintenance requirements. The weirs do silt up, but, while siltation within the ponded area of the weirs may be limiting recharge performance, and there is suggestion from landholders that some weirs are unstable desilting is unlikely to be justifiable from an economic perspective (GHD 2005).

The only existing stream gauges on Three Moon Creek upstream of Monto are the Sunwater operated Cania Dam headwater and tailwater gauges which came into operation following completion of the dam (1983). Prior to Cania Dam, the catchment was gauged at two sites - Meldale (1948-81) and Cania Gorge (1962-89). Currently, DNRM operate two gauging stations in the Three Moon Creek catchment – 136101C, Three Moon Creek at Abercorn (since 1964) and 136108A, Monal Creek at Upper Monal (since 1962). The estimated peak discharge at gauging station 136108A (catchment area 92km^2) during January 2013 was about 920m^3/s.

Rainfall is summer dominated (see table below) with cyclones often being influential - the Bureau of Meteorology cyclone database shows that 28 cyclones tracked within 200 km of the Burnett and Nogoa Rivers confluence between 1906-7 and 2006-7. Climate change model projections are that there will be a decrease in numbers of lower category cyclones but potential for an increase in the more extreme events (Category 4 or 5) with a shift in average recurrence intervals – current 100 year average recurrence interval events will have an average return period of 20 years (Stone *et al.*).

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean rainfall (mm)	113.8	113.8	77..8	44.6	44.7	38.0	35.6	24.8	24.4	55.3	74.8	94.0
Maximum rainfall (mm)	446.3	434.2	246.2	200.0	225.4	162.7	152.4	101.2	124.0	201.4	213.9	499.2

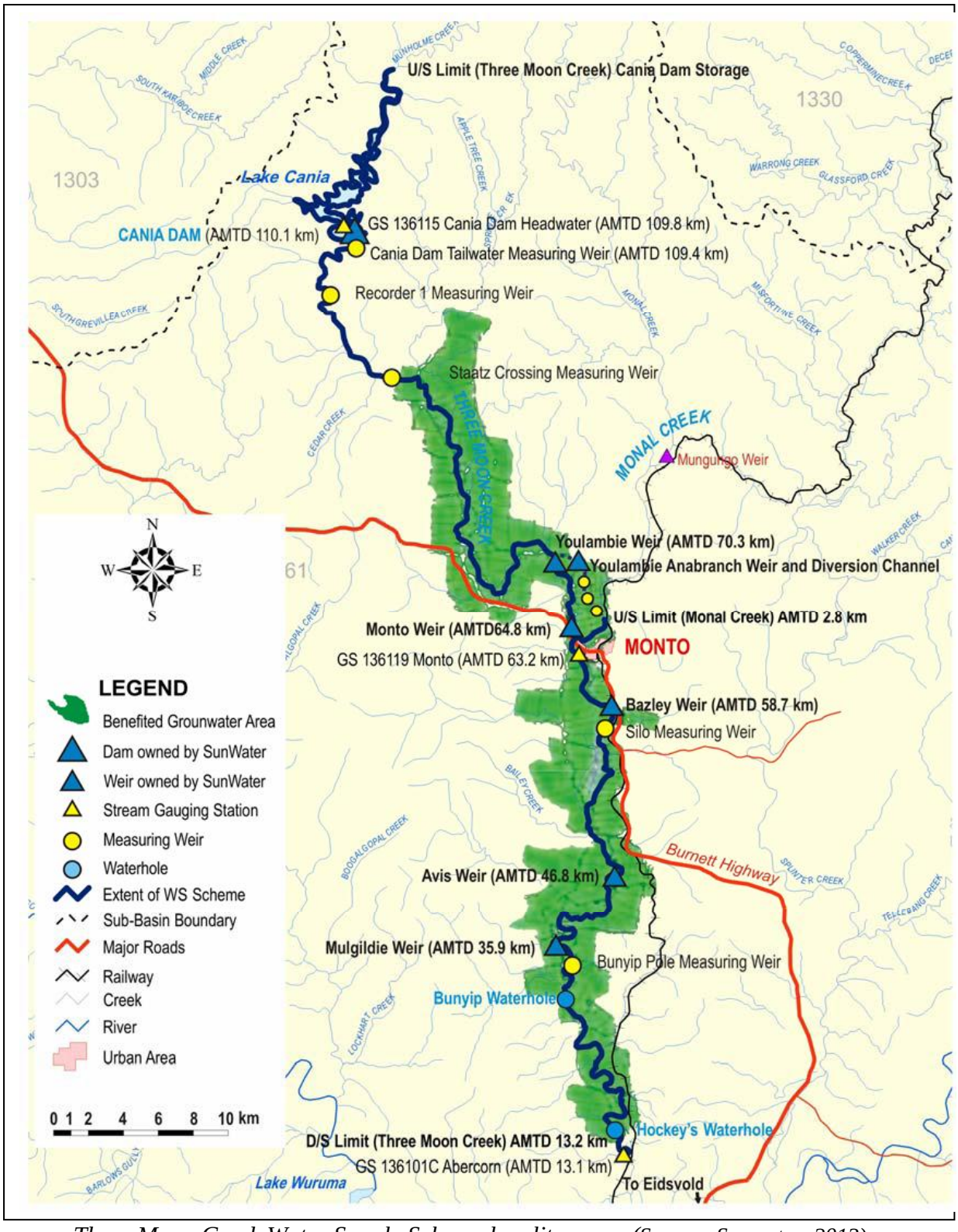
Monthly rainfall, Monto. (Source: Bureau of Meteorology).

In general, the Three Moon Creek floodplain appears to be aggrading - the supply of sediment is greater than the amount of material the system is able to transport leading to an increase in land elevation due to the deposition of sediment. This is particularly so above the Burnett Highway. There are sections that are degrading – where more material is being entrained than deposited – such as immediately downstream of the Highway.

There seems to be no remnant fluvial terraces in the section of the watercourse below the Highway leading one to believe this degradation is a recent phenomenon. Whilst one can speculate as to the cause, hydraulic, soil erosion and sediment transport modeling of this section of the creek would give a more definitive answer.

The Queensland Department of Transport and Main Roads carried out some hydraulic modelling prior to rebuilding the Burnett Highway across Three Moon Creek (P Wilson, *pers comm.*). Anecdotal evidence is that the January 2013 flood resulted in considerable change in land levels both upstream and downstream of the Highway due to soil erosion/deposition with resultant changes in flow patterns. It would be advisable to carry out further modelling of this area taking into account current land levels.

Cania Dam spillway during the January 2013 flood. (*Source: B Dunwoodie, Ergon Energy, 2013)*



Three Moon Creek Water Supply Scheme locality map. (Source: Sunwater, 2013)

6.5 Action Program 5 - Stability of creek banks and natural levees

Recommendations:

- **Recognise that watercourse channels will surcharge during floods and that consequent overbank flows require management;**
- **Breaches in the natural levees of Three Moon and Monal Creeks be restored and permanent vegetation established;**
- **Landholders cease to interfere with the natural levees along the Three Moon and Monal Creeks without prior approval from DNRM;**
- **Appropriate creek bed and bank vegetation be established and maintained;**
- **Where it is cost effective, creek bank rehabilitation be carried out; and**
- **Management and use of natural levees be commensurate with the risk of erosive breakouts.**

Discussion:

The main channels of the Three Moon and Monal Creeks have developed meanders which intensify over time. At bends, the water's momentum increases on the outer bank making it a little deeper than at the inner bank. The increased depth results in higher flow velocity and this, combined with the greater inertial force on the outer bank, leads to bank and channel erosion. The shallower inner bank flows are slower leading to deposition of sediment as point bars. Meanders migrate downstream and grow laterally as the bank erosion continues.

Bank erosion occurs either by scour - the direct removal of bank materials by the physical action of flowing water - or slumping – where blocks of the bank collapse as a result of undercutting or other structural weakness within the bank. Erosion can also be accelerated by factors such as:

- stream bed lowering or infill;
- inundation of bank soils followed by rapid drops in flow after flooding;
- saturation of banks from off-stream sources;
- redirection and acceleration of flow around infrastructure, debris or vegetation;
- removal or disturbance of protective vegetation from stream banks; and
- bank soil characteristics such as poor drainage or seams of readily erodible material.

Natural bank erosion fulfils several purposes: it renews ecological habitats; is part of the natural balance of streams; and, as sediment is eroded and deposited downstream, flow energy is dissipated. However, accelerated erosion may jeopardise infrastructure, reduce water quality and lead to an oversupply of sediment.

Prevention of bank erosion is much easier than cure. Once accelerated erosion is occurring, the response should be proportionate to the scale and significance of the erosion, both for people and the environment. Consideration must be given to the cost effectiveness of restoration works, the risk of future flooding before they are established / stabilised and maintenance of the works.

Bank erosion potential can be reduced by maintaining an appropriate vegetation mix on the banks. In general, vegetation along banks or within the mainstream channel (in order to

reduce speed) needs to be securely-rooted, preferably with a spreading, fibrous root mat that will thoroughly penetrate bank soil, and with a flexible upper portion that can bend and move during flows. In the lowest parts of the bank, there should be grasses, reeds, and shrubs with flexible stems and branches. Further up, shrubs and small trees with an understorey of grassy species are best and at the top, large trees with a shrub / grass understorey.

It is important that species that reduce the channel capacity or lead to erosive flow swirls either by themselves or by accumulating debris be minimised.

There are many ways to rehabilitate slumps but most have a combination of: toe protection (using large rock, logs, groins etc), bank battering (to natural bank slope) and revegetation (preferably with native species).

When channels overtop onto the floodplain, flow velocity decreases and sediment deposition occurs. This sediment gradually builds up as levees eventually raising the stream above its floodplain. As this occurs, the slope and the transport power of the stream decrease, the channel fills gradually with sediment, and finally (often during a flood) the stream will breach its levee (a process called avulsion) and follow a steeper (shorter) path. These 'breakout' flows have a higher velocity, and since their sediment concentration is initially lower, have a high erosion potential. This can lead to considerable soil loss unless the land below the breakout is suitably protected.

These breakouts occur naturally in several places down Three Moon and Monal Creeks, often on the outside bend of meanders, some being created or expanded during the January 2013 flood. There are also instances where landowners/managers have cut channels through the levee to drain ponds, divert flows into storages for irrigation purposes or as part of road or other infrastructure construction.

If these breakouts are resulting in unacceptable downstream problems, unless they provide some useful service, they should be reinstated. This could take the form of filling and shaping to match the natural landform.

Any activities within the creek bed and banks may require a Riverine Protection Permit from DNRM.

6.6 Action Program 6 - Weed mitigation

Recommendations:

- **The current North Burnett Landcare Group and North Burnett Regional Council weed-mitigation programs be endorsed and annexed to this plan;**
- **Weed control be carried out on a strategic, catchment wide basis;**
- **Focus attention on channels, floodplain flow paths and road reserves;**
- **Remove excess woody weed vegetation from watercourses as part of weed control programs; and**
- **Encourage regular slashing of roadsides and unutilized grass areas.**

Discussion:

Riparian vegetation (on stream banks and the floodplain) has an important role in maintaining a healthy watercourse such as reducing soil erosion, filtering out sediment and pollutant and providing habitat and food for wildlife living in and near the water. However, this role is compromised when it becomes dominated by weeds or exotic plants. As well productivity of the surrounding land is reduced.

It is desirable, therefore, to utilize a weed mitigation program such as those the North Burnett Landcare Group and the North Burnett Regional Council (with assistance from the BMRG and the BCCA) are delivering. These programs are using an integrated approach involving chemical, biological and mechanical controls with ground cover to manage invasive weeds.

While work crews in those programs are concentrating on Cat's claw, Blue heliotrope and Parthenium in particular, they are also controlling exotic woody weeds in watercourses where possible. Discussion at the workshops included the practice of leaving heads of woody species in the riparian zone when they are cut off and chemical applied. Whilst these heads will relatively quickly rot away, there is a possibility that future flows will gather these up into debris piles with resultant flow diversion and soil erosion. It is best if these could be removed from any danger zones. There is a need for closer contact between landholders and the work crews and their managers with regard to alleviating this problem.

On the floodplain, the weed control program should include regular slashing of road verges and the like to reduce runoff diversion and silt accumulation. In some cases this may involve preparatory work to remove existing silt build up, spoil heaps and so on and to make the areas 'slashable'.

Lippia (*Phyla canescen*) has been seen on the floodplain. This plant, associated with streambank and soil erosion and reduced productivity is difficult to control. Its eradication should be persevered with.

6.7 Action Program 7 - Debris and household rubbish removal

Recommendations:

- **That an 'awareness' program be established regarding the distribution of rubbish during flood time;**
- **The dangers of medications in debris be included in the 'awareness' program;**
- **That North Burnett Regional Council work with representatives of this project to develop a 'post flood' rubbish pick-up and removal plan;**
- **Remove debris piles that reduce stream channel capacity or induce erosion but retain large woody debris unless it is actively causing erosion;**
- **Remove floodplain debris where farm operations are hindered; and**
- **Remove household rubbish particularly if unsightly or hazardous.**

Discussion:

A range of things make up flood debris including mud, stones, rocks and plant material. The value of that debris in a steam is dependent on the debris size, location and type – what is beneficial in one place may be a nuisance or cause harm elsewhere.

Large woody debris (LWD) (pieces larger than about 1m long and 100mm thick) can have geomorphic and ecologic impacts in streams. It slows flows, stores and distributes sediment, creates channel features, such as pools, riffles, and waterfalls – habitat for macroinvertebrates and fish – and supplies and traps organic matter to be processed by in-stream organisms.

LWD will not impact on water levels unless it is blocking more than about 10% of the channel cross-sectional area. LWD, if incorrectly aligned, may induce erosion and flooding – it best aligned pointing downstream at $20\text{-}40^0$ to the banks.

Large in-stream debris piles can impact on fish migration, sediment transport, channel stability and increase the threat of flooding. When these result in adverse social and environmental impacts they should be removed in order to restore channel function and reduce possible harm.

There is little reason to remove natural debris scattered about on floodplains economically or environmentally unless it unduly disrupts normal farm or other business operations or is hazardous in any way.

The subject of household rubbish was raised by landholders at the workshops. All sorts of household 'rubbish' were found after the flood. Knowing what can happen in a flood may help people to be more careful in the storage of hazardous substances such as medications and the containment of household rubbish.

Whose responsibility is it? Normally, the *Waste Reduction and Recycling Act* 2011 and *Environmental Protection Act* 1994 pertain to household and industrial rubbish disposal. These have a polluter pays philosophy – i.e. costs associated with the management of the waste should be borne by the persons who generated the waste. With regard to household and industrial rubbish deposited during floods, there is often a problem identifying the source and responsible person(s).

As well, there may be difficulty in identifying the waste itself (e.g. labels may be missing from containers). This makes the Waste Hierarchy (Avoid, Reduce, ReUse, Recycle, Recover, Treat, Dispose) difficult – if not impossible - to safely implement leaving disposal as the only viable option. Advice from some Councils in general is, if confronted with this situation, contact Queensland Emergency Services.

There is a cost involved and it is probably unfair that the landholder on whose place the rubbish is deposited on bears this cost. It seems that, during recent floods, this cost has been shared between the landholders and all levels of Government with considerable volunteer assistance.

Note: Landholders have to recognize and understand their responsibilities under the *Workplace Health and Safety Act* 2011 during any cleanup operations.

Example of debris deposited during the January 2013 flood.

6.8 Action Program 8 - Data collection, verification, storage and dissemination

Recommendations:

- **BMRG and BCCA take a lead role in sourcing, verification, collation, storing and disseminating data and information necessary for successful floodplain land management; and**
- **Effort be put into gathering high resolution topographic data for the remainder of the Three Moon Creek floodplain starting with the Hurdle Gully outfall area.**

Discussion:

Successful floodplain land management planning and actions are reliant on appropriate background data and information such as types and location of infrastructure, topography, flow depths and velocities during floods, soil erosion amounts and location during floods and land conditions at the time of previous floods. Collection, verification, storage and dissemination of this data and information are important roles and should encompass the entire floodplain.

Following the January 2013 Three Moon Creek flood a number of agencies embarked on information gathering exercises pertinent to their interests, e.g. the Queensland Government (via DNRM) collected topographic information using Light Detection And Ranging (LiDAR) technology for part of the floodplain and BMRG collected information on the level and location of major soil erosion instances (Wilson 2013).

There is a cost involved in all stages of data and information gathering, verification and handling and many agencies / companies etc. rightly seek recompense for use of what is theirs. The DNRM and BMRG data / information is publically available but one needs to be aware of data ownership, licence agreements and the like when sourcing and using this material.

It would be difficult to develop an equitable answer to the flooding and soil erosion issues that exist around the Hurdle Gully outfall without further high resolution topographic data. Given the community angst in this area, gathering of this data should take priority.

It would seem appropriate that the BMRG and the BCCA take a lead role in a data and information gathering and dissemination program for the Three Moon Creek floodplain.

7 Where to next?

In order to start rehabilitation of the Three Moon Creek floodplain whilst satisfying the current funding obligations and ensuring the communities' enthusiasm for the restoration work is maintained, it is recommended that work should commence in key areas as soon as possible.

Five areas on the Three Moon Creek floodplain (Figure 4) have been identified as areas where works should be undertaken as soon as possible. These areas received the greatest number of comments during the workshop series and any works undertaken in these areas would result in the greatest impact to the wider floodplain community.

These areas are (in no order of priority):

- Burnett Highway upstream;
- Burnett Highway crossing;
- Burnett Highway downstream;
- Airport East; and
- Hurdle Gully outfall.

The following specific recommendations are made in relation to these five areas.

1. **Burnett Highway upstream**

This area has experienced widespread erosion, siltation, diversion and pondage. It is recommended that existing funds be used to assist with:

- removal and levelling of redundant fencelines, levelling under and replacement of necessary ones with 'flood friendly' types;
- levelling of silt deposits;
- removal and levelling of all banks that divert and interfere with overland flows;
- removal and disposal of debris from the creeks;
- removal of deposited material that predisposes the creeks to future low flow breakouts (subject to Riverine Protection Permits);
- levelling and continued slashing of the road reserves; and
- restoration of the natural levees of the water courses(subject to Riverine Protection Permits).

2. **Burnett Highway crossing**

During the workshop series the Burnett Highway received by far the greatest number of comments as the community felt that it was having a significant impact on ponding, erosion, diversion and siltation both upstream and downstream of the highway. Although the reconstruction of the highway has only recently been completed, the DTMR representative present agreed that, in view of the recent flood, there was a need for further hydraulic and sedimentation modeling to be undertaken to determine what part the highway played in these issues. Results from such a study should be discussed with the community as part of developing any actions by DTMR. It is recommended that:

- the road reserve be levelled and kept slashed;
- the natural levee to Three Moon Creek on its western side immediately downstream of the bridge on the Burnett Highway be reinstated; and

- any redundant infrastructure on the downstream side of the highway in the road reserve be removed.

3. Burnett Highway downstream

This area was completely inundated during the recent floods and experienced severe erosion, siltation, diversion and pondage. It is recommended that existing funds be used to assist with:

- removal of all man made levees in the area;
- implementing a change of land use on affected properties to one of permanent vegetative cover (e.g. pastures/irrigated lucerne);
- silt spreading/removal, gully filling and land levelling in the area immediately downstream;
- removal and levelling of redundant fencelines, leveling under and replacement of necessary ones with 'flood friendly' types; and
- repair of the severely eroded areas to include gully filling and planting of permanent vegetative cover.

4. Airport East

This area experienced severe erosion, siltation and diversion during recent floods. Some of the erosion has subsequently been repaired. It is recommended that existing funds be used to assist with:

- removal of any remaining levees/banks in this area:
- land levelling where necessary;
- restoration of the natural creek levee (subject to Riverine Protection Permits);
- leveling and continued slashing of the road reserves; and
- removal and levelling of redundant fencelines, levelling under and replacement of necessary ones with 'flood friendly' types.

5. Hurdle Gully outfall

This area has experienced severe erosion, siltation and diversion during recent flooding. Before any funds are used in this area it is recommended that a hydraulic study be undertaken of the Hurdle Gulley outfall. This study should investigate the impact of existing and proposed infrastructure including levees, drains, and roads/tracks on flow depths and velocities along with possibilities for spreading flows as they enter the floodplain.

Once the study has been completed, any available funds should be used to assist with:

- removal of any redundant banks in this area;
- removal and levelling of redundant fencelines, leveling under and replacement of necessary ones with 'flood friendly' types;
- lowering of access tracks and installation of whoa-boys to allow for the free flow of overland flows; and
- repair of any severe erosion in this area.

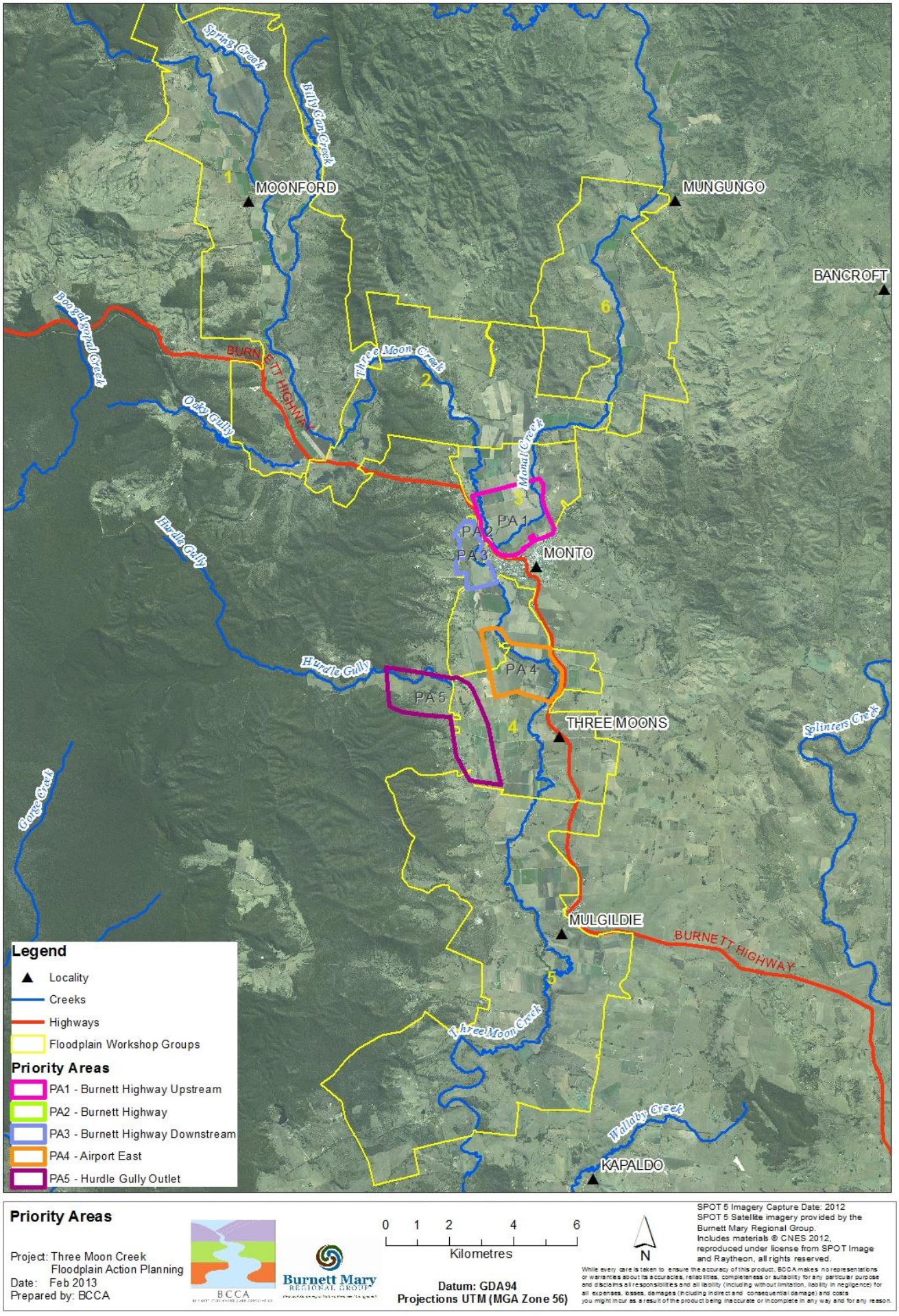


Figure 4: Location of priority areas.

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9 Appendices

Appendix 1 - Example agenda of Participative Planning workshop

1. **Welcome** (5 mins. Community Chairperson)
- Warm-up

2. **Introduction to workshop** (20 min.)
- Agenda for the day.
- Workshop process. (5 min)
- Establish ground rules.

3. **Property inventory** (20 min.)

(a) Individual orientation exercise (10 min.) – mark the property details on overlay for own use.

(b) Group activity. 4 - 5 per group – use overlays to record "where the runoff water goes now". (in green) (existing flow paths)

4. **Problem area identification** (what and where) (30 min.)
- Stakeholders are asked to "write down on post-it notes the issues affecting the management of the natural resources on their farm even if the problems start somewhere else in the catchment area – be specific and up-front". Issues to be stated as "The problem is….".
- About 5min are allowed for people to get their thoughts together and to write down issues on the post-it notes.
- Stakeholders place a post-it dot (with a number on it) on a large map to mark the location of the issue; and the post-it note (with the same number) attached to the edge of the map.

5. **Understanding a topographic map** (10 min)
- Use a model hill and associated map to demonstrate interpretation of contour lines.
- Explain practical uses of topographic maps e.g. heights, distances, pumping etc.

6. **Hypothetical catchment** (50min).
- Small group learning exercise called "Great Expectations" where an example floodplain is used to allow participant to identify natural and current flow lines, identify possible flow related issues and solutions to those issues.
- Small groups report back to the whole group and discuss the issues identified and possible solutions. Discussion of farm contribution to water management on the floodplain.

Note - all team members should be guiding workshop participants in interpreting the map and identifying the problems.

Break (30 min)

7. **Back To The Real World** (20 min)
- Group activity (4-5 per group)

- Where the water should go. Identify natural flow paths of workshop area in blue on overlays (application of learning from session 5).

8. Benefits of water management (20 min)

- For example, "Runoff water is a resource to be managed". Include a series of slides of floodplain issues.

9. Develop an action plan (40min)

- Work through the issues listed, determine cause(s), possible solution(s) and then develop an action plan to implement that solution(s) – who, when, where.

Note - the overlays with green lines (where the water goes now) and the blue lines (where the water should go) are located over the imagery and used as a base for discussion.

10. Wind – Down Exercise (5 min)

- Measuring areas with dot grids.

11. Where to From Here? (10 min. Community Chairperson)

- When will the outcomes of the workshop be distributed?
- What the participants can do now.
- Select area champions to keep the process alive and active.

CLOSE

Appendix 2 - Compendium of issues identified by workshop participants.

Workshop 1

Issue	Issue Number	Action Required	Who's Responsible	When
Need for improved road design	1, 2a, 2b, 11, 12	Discussion with all stakeholders.	Tyson Jarvis as contact. DTMR, NBRC. BMRG/BCCA to facilitate	Commenced and ongoing.
Debris in creeks	3	Contact DNRM for permits - BCCA to check on the moratorium. BCCA to get Peter Wilson (BMRG) to offer advice on debris removal (Robertson).	Landholders to check with DNRM, BCCA before acting.	ASAP
Creek bank stabilisation	4,14,23,6,20, 21,25,22	BCCA to provide factsheets and podcasts on stabilization techniques. Discussions with Peter Wilson (BMRG).	BCCA, BMRG, Sunwater	ASAP
Sheet erosion	5	Land leveling, realign cropping, zero till or permanent pasture	Brad Forsyth, Arthur Maynard	Ongoing
Glen Valley Gully erosion	9,10	Landholders need to revegetate banks upstream. DTMR to inspect infrastructure.	Landholders, Peter Wilson (BMRG)	ASAP
Fences washed away	7, 8, 13, 15	Refer to Best Management Practices (BMPs)	Chris Abbott	ASAP
Gully erosion	16	Soil conservation advice required.	Liz Robertson John Day (BMRG)	ASAP
Silt deposition	24	Land leveling- refer to BMP Manual.	Landholders-Katie Muller	ASAP
Ponding	18	Site Inspection and consider road design.	Peter Wilson (DTMR)	ASAP
Property access	17, 17A	Road design.	Brad Fosyth	ASAP
Fodder drops	27	Create Contact List Develop criteria to access to help		

Workshop 2

Issue	Issue Number	Action Required	Who's Responsible	When
Need for improved road design	30, 31, 30, 36, 41	Stakeholder meeting (DTMR, NBRC, Landholders). Reassessment of road design criteria.	All stakeholders Contacts: Wes Wolff and Fred Jarvis	ASAP
Debris in creek	28, 29, 34, 42, 33	Contact DNRM for permits - check on moratorium. Peter Wilson (BMRG) to undertake inspections. Advise Sunwater of issue. Develop funding proposal to remove debris.	BCCA/BMRG	ASAP
How do we pay for actions	46, 35	Prepare coordinated action plan.	Floodplain team	June 2014
Early warning systems	44	Develop communications systems.	Mark Pitt (NBRC)	Commenced
Contour data	32, 40	Distribute LIDAR where available, check licenses.	BCCA, landholders	ASAP
Weeds	37	Landholders contact BCCA / NBLG to raise issues and be part of existing programs	Landholders	ASAP
Irrigation infrastructure loss	43	Develop project to research irrigation design.	Irrigation groups NCCA @ USQ (contact Prof. Steve Rain)	ASAP
Fencing	38	Specifications for fencing in floodplain: refer to BMP	Landholders	ASAP
Site specific erosion	45	Contact BMRG soil conservationists for advice.	Landholders John Day, ,Craig Turton	ASAP
Cania Dam and flood mitigation	47	Review NBRC / Engeny Flood Mitigation Study.	All	When presented

Workshop 3

Issue	Issue Number	Action Required	Who's Responsible	When
Weeds	61, 62	NBLG Weed Flood Recovery Project, landholders can apply to BCCA for chemical.	Landholders, BCCA	ASAP
Trees left by NBLG in creeks and against bridges	58, 53	Contact NBLG to discuss options of possible removal. DTMR to review procedures and organize maintenance.	Keith Heading, BCCA to discuss with NBLG (Glenn Baker) Peter Wilson (DTMR)	ASAP
Levee Damage	60	Remove Levee.	Russ Salisbury, Matt Dendle	ASAP
Drainage Issues on Pound Paddock	63	Discuss with NBLG re- redesign of layout.	Glen Baker (NBLG), Michelle Atkinson, BCCA	ASAP
Erosions in paddocks	49	Remove bank, establish pasture.	Matt Dendle John Day, Craig Turton (BMRG)	4 December
Silt deposition	50, 51, 57, 54	Landholders to discuss with DNRM, DTMR and NBRC.	Russ Salisbury, Kendall Muller	ASAP
Access to Bowls Club and Airport Drive	51, 56, 59	Landholders to discuss options with NBRC.	Bowls Club, landholders, Paul Lobegeier (NBRC)	ASAP
Burnett Highway bridge at Three Moon Creek	55, 48	DTMR to investigate options.	Peter Wilson (DTMR)	ASAP

Workshop 4

Issue	Issue Number	Action Required	Who's Responsible	When
Burnett Highway bridge at Three Moon Creek	67, 75,83,84, 99,101	DTMR to investigate options.	Peter Wilson (DTMR)	ASAP
Even spread of water across floodplain	68,69,66,80, 82,81	Group discussion, coordinated planning and land levelling.	Scott Dowling, Wayne Smith, James Scott	Now and ongoing
Gully head	74	Seek soil conservation advice.	Allan Downie John Day and Craig Turton (BMRG)	ASAP
Creek bank stabilization	65, 87	NBLG to identify slumps. BMRG to provide advice.	Glenn Baker (NBLG) Craig Turton and John Day (BMRG)	Within 6 months
Hurdle Gully	64, 87, 76, 71, 70, 73, 86	Banks already being removed. Seek flood study for Hurdle Gully.	NBRC, Scott Dowling and Hurdle Gully group	ASAP
Bass Gully, Spletters Gully gullying, cross road drainage	72, 79	Site inspection by BMRG.	Jan Darlington John Day and Craig Turton (BMRG)	ASAP
Creek bank erosion	85, 77, 78	Consult with DNRM re creek re-alignment, natural levee reinstatement. Coordinate all works within area before any activities.		ASAP

Workshop 5

Issue	Issue Number	Action Required	Who's Responsible	When
88	Dredge weirs, siltation	Discuss policy with Sunwater—capacity of weirs reduced.	Landholders BCCA to check with Sunwater	ASAP
89	Creek crossing needing maintenance/upgrade	Check Sunwater policy.	BCCA to check with Sunwater Landholders	ASAP
90	Better flood warning system	Council undertaking project.	NBRC	Underway
91	Financial assistance for leveling	Finish floodplain plan. QRAA assessment criteria re-assessment: Contact State/ Federal Government members.	BMRG / AGFORCE	ASAP
92	Gully erosion	Contact BMRG for soil conservation advice	Landholders Craig Turton and John Day (BMRG)	ASAP
93	Loss of topsoil - replaced by rocks	Establish pasture. Seek assistance for seed from BMRG.	Clynton	ASAP
94	Household rubbish relocated downstream	Education program.	NBRCl	ASAP
95, 96	Erosion from water off roads	Advise NBRC. Inspection by BMRG soil conservationists.	NBRC, landholders, Craig Turton/ John Day (BMRG)	ASAP
97	Weeds on floodplain	NBLG project underway for creeks. Contact BCCA for funding for chemical.	Landholders, NBLG, BCCA	ASAP
99, 101	Burnett Highway bridge	See previous workshop		
100	Common sense	BMP on floodplains.		

Workshop 6

Issue	Issue Number	Action Required	Who's Responsible	When
102a, b	Improved road design	Lack of road drainage, main Gladstone - Monto Road both from upland and creek floodout.	Landholders, DTMR, NBRC	
103, 107	Weeds	Weed control.	Landholders, BCCA, NBLG	ASAP
104, 105	Creek bank slumping Gladstone-Monto Road	BMRG to provide advice.	Craig Turton and John Day (BMRG)	Within 6 months
106	Mungungo weir damage	Contact Sunwater re further repairs.	Landholder, Sunwater	ASAP
108	Erosion, loss of fertility / productivity	Seek soil conservation advice.	Landholders, Craig Turton and John Day (BMRG)	ASAP

BCCA - Burnett Catchment Care Association
BMRG - Burnett Mary Regional Group
DNRM - Department of Natural resources and Mines
DTMR - Department of Transport and Main Roads
NBLG - North Burnett Landcare Group
NBRC - North Burnett Regional Council
NCEA @ USQ National Center for Engineering in Agriculture, University of Southern Queensland

Appendix 3 - Three Moon Creek floodplain workshop attendees

Workshop 1
Chris Abbott
Peter Wilson (DTMR)
Liz Robertson
Paul Francis
Paul Lobegeier (NBRC)
Tyson Jarvis
Brad Forsyth
Lorraine Muller
Noelene Burton
Vanessa Radel

Workshop 2
T.L Pincott
Nev Wogandt
Wes Wolff
Alwyn Wolff
Gary and Lynette Muller
Russell Larsen
Fred Jarvis

Workshop 3
Kevin Fox
Henry Spletter
Peter Wilson (DTMR)
Barry Woodall
Kendall Muller
Carolyn Larsen
Matt Dendle
Michelle Atkinson
Keith Heading
Russ Salisbury

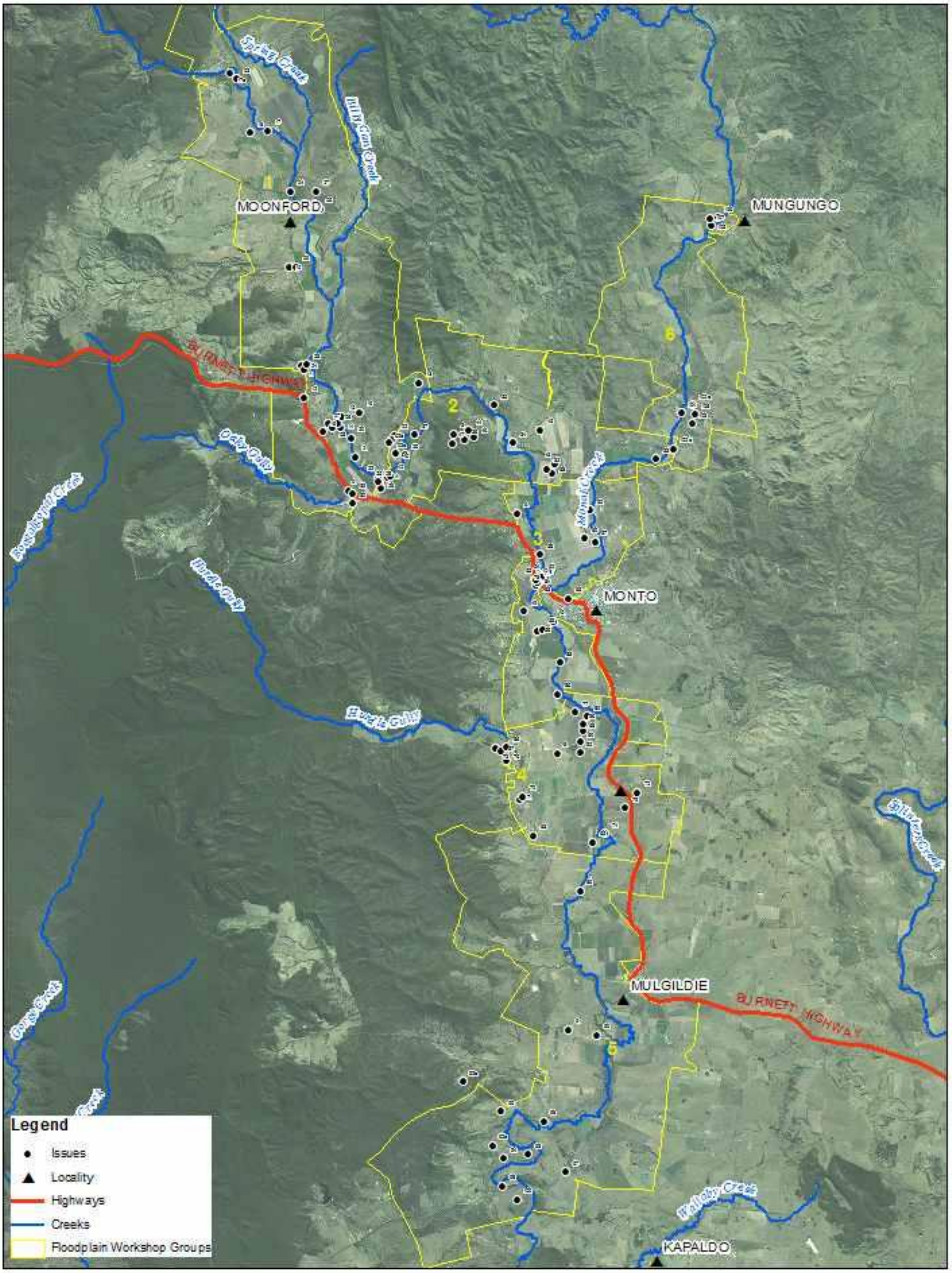
Workshop 4
James Scott
Wayne Smith
Scott Dowling
Henry Spletter
Richie Bowman
Allan Downie
Brian Hill
Nerida Jamieson
Jan Darlington
Bill Kelly
Neil Darlington

Workshop 5
Geoff Grubb
Ron Litzow
Robert Roth
George Lewis
Robert Olge
Clynton Dederer
Joan Dederer

Workshop 6
Eddie and Mrs Anderson
Karen Staines

Appendix 4 - Maps produced during workshops

Map 1: Issues identified in the workshops
Map 2: Public and private infrastructure.
Map 3: Current flowpaths.
Map 4: Natural flowpaths.
Map 5: Current and natural flowlines overlay.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MUNGUNGO
MONTO
MULGILDIE
KAPALDO
BURNETT HIGHWAY
Spring Creek
Mungungo Creek
Oaky Gully
Burdekin Creek
Burdekin Gully
Monto Creek
Silver Leaf Creek
Gorge Creek
Wallaby Creek
Legend
Issues
Locality
Highways
Creeks
Floodplain Workshop Groups
Issues Identified
Project: Three Moon Creek
Floodplain Action Planning
Date: Feb 2014
Prepared by: BCCA
BCCA
Burnett Mary
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Kilometres
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Datum: GDA94
Projections UTM (MGA Zone 56)
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SPOT 5 Imagery Capture Date: 2012
SPOT 5 Satellite Imagery provided by the
Burnett Mary Regional Group.
Includes materials © CNES 2012 / Distribution
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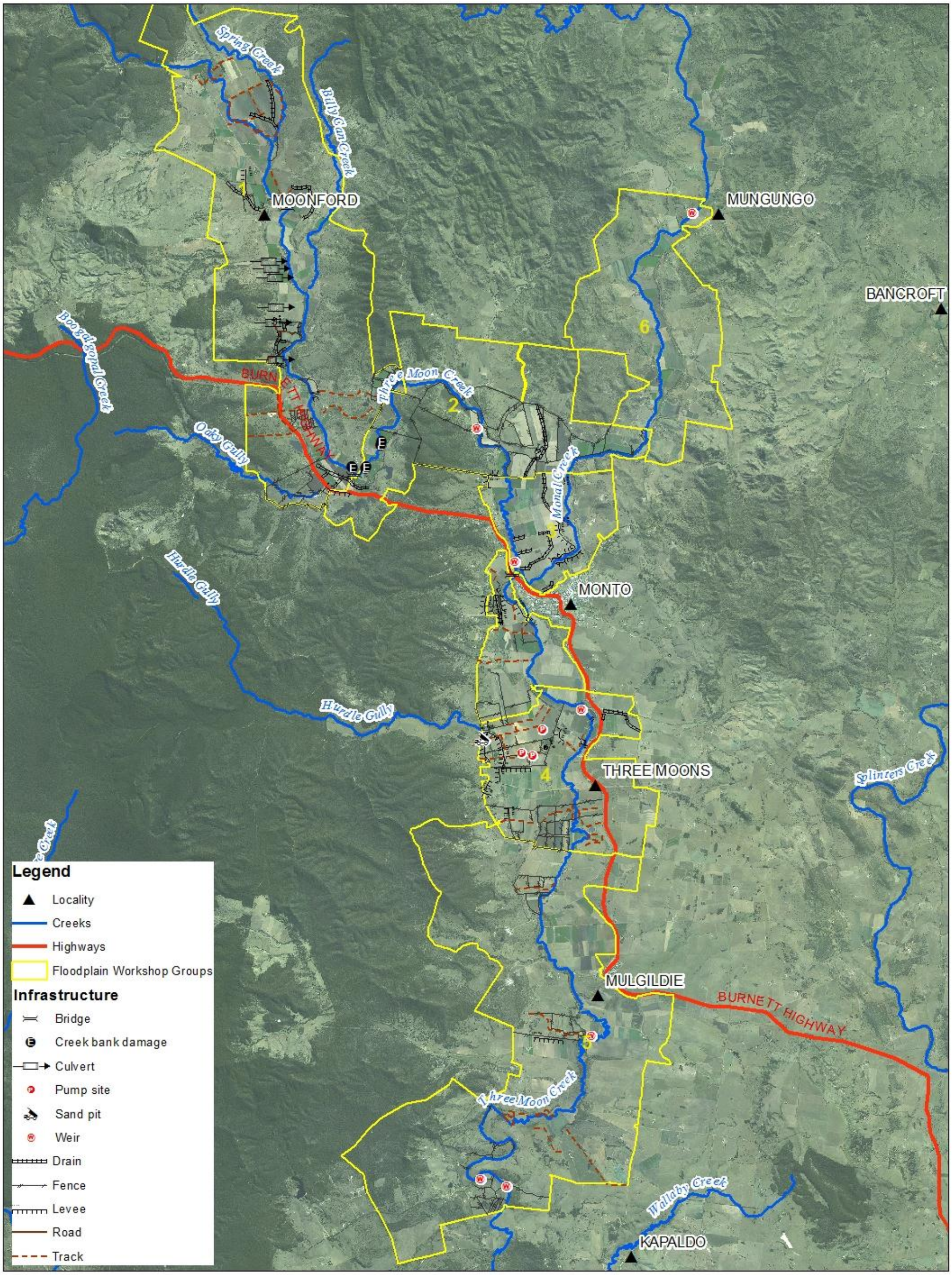

Public & Private Infrastructure

Project: Three Moon Creek Floodplain Action Planning
Date: Feb 2013
Prepared by: BCCA

BCCA

Burnett Mary Regional Group

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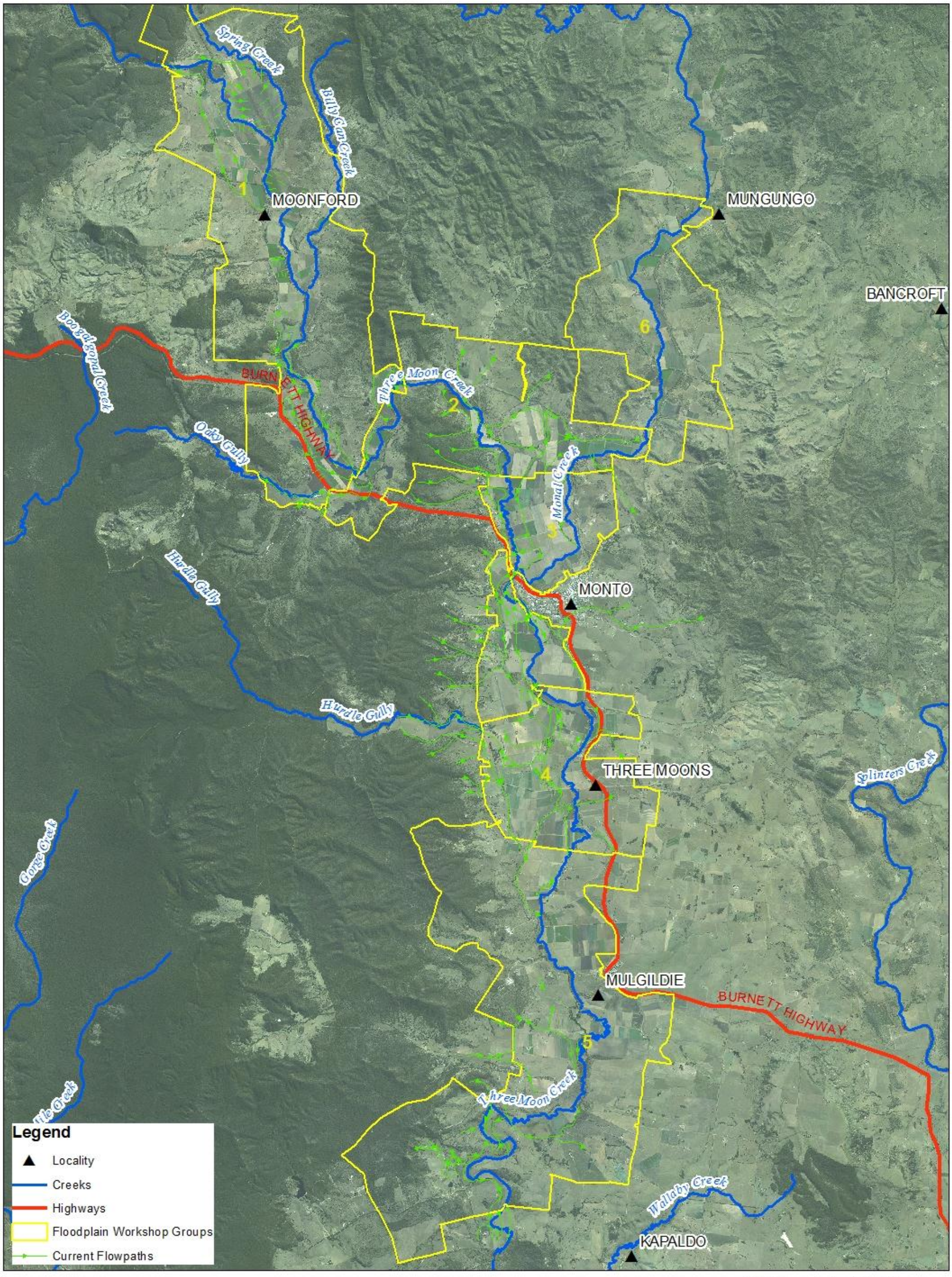

Current Flowpaths

Project: Three Moon Creek
Floodplain Action Planning
Date: Feb 2013
Prepared by: BCCA

BCCA

Burnett Mary
REGIONAL GROUP

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Datum: GDA94
Projections UTM (MGA Zone 56)

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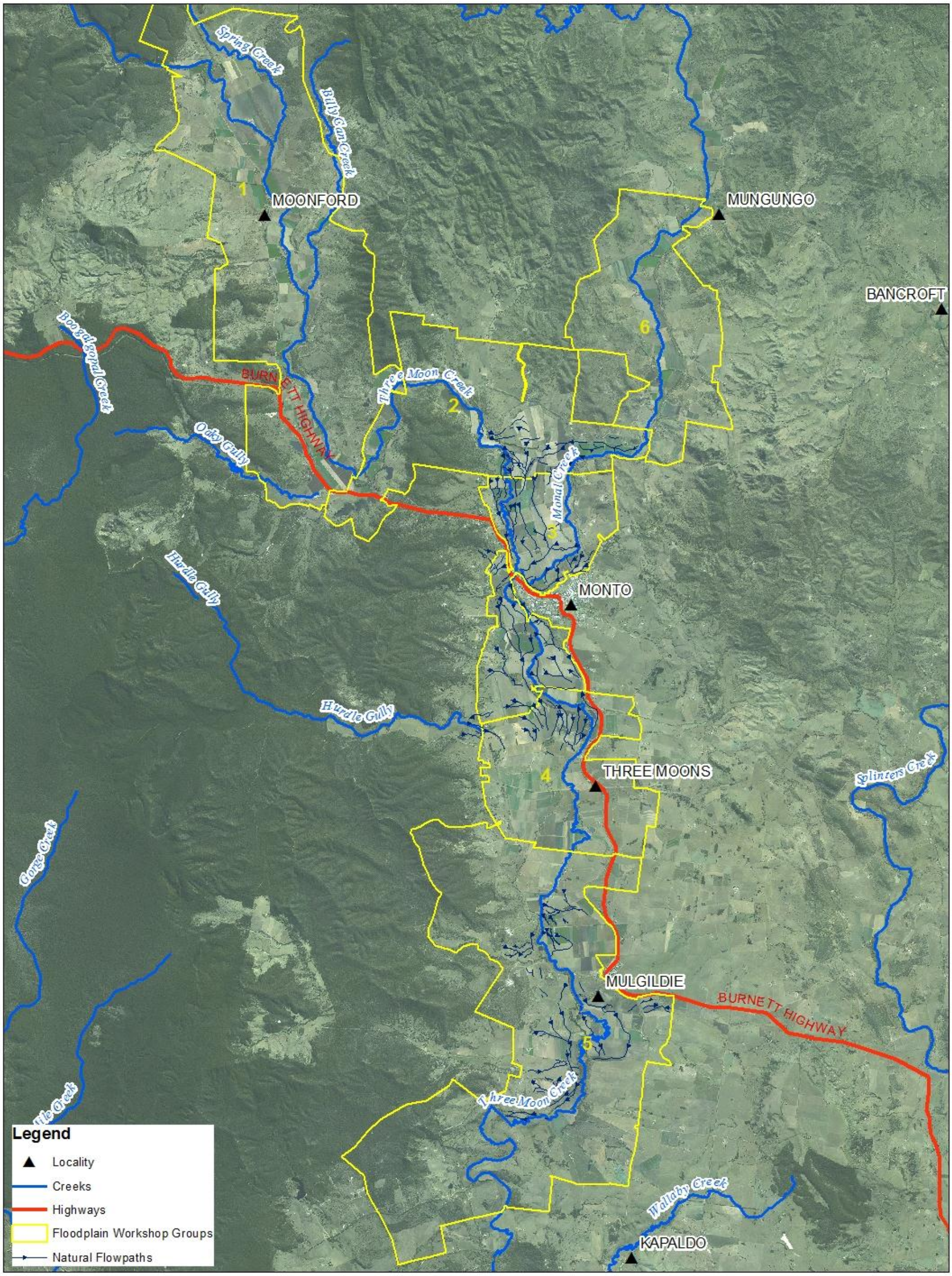

Natural Flowpaths

Project: Three Moon Creek Floodplain Action Planning
Date: Feb 2013
Prepared by: BCCA

BCCA

Burnett Mary Regional Group

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Kilometres
1:100,000
Datum: GDA94
Projections UTM (MGA Zone 56)

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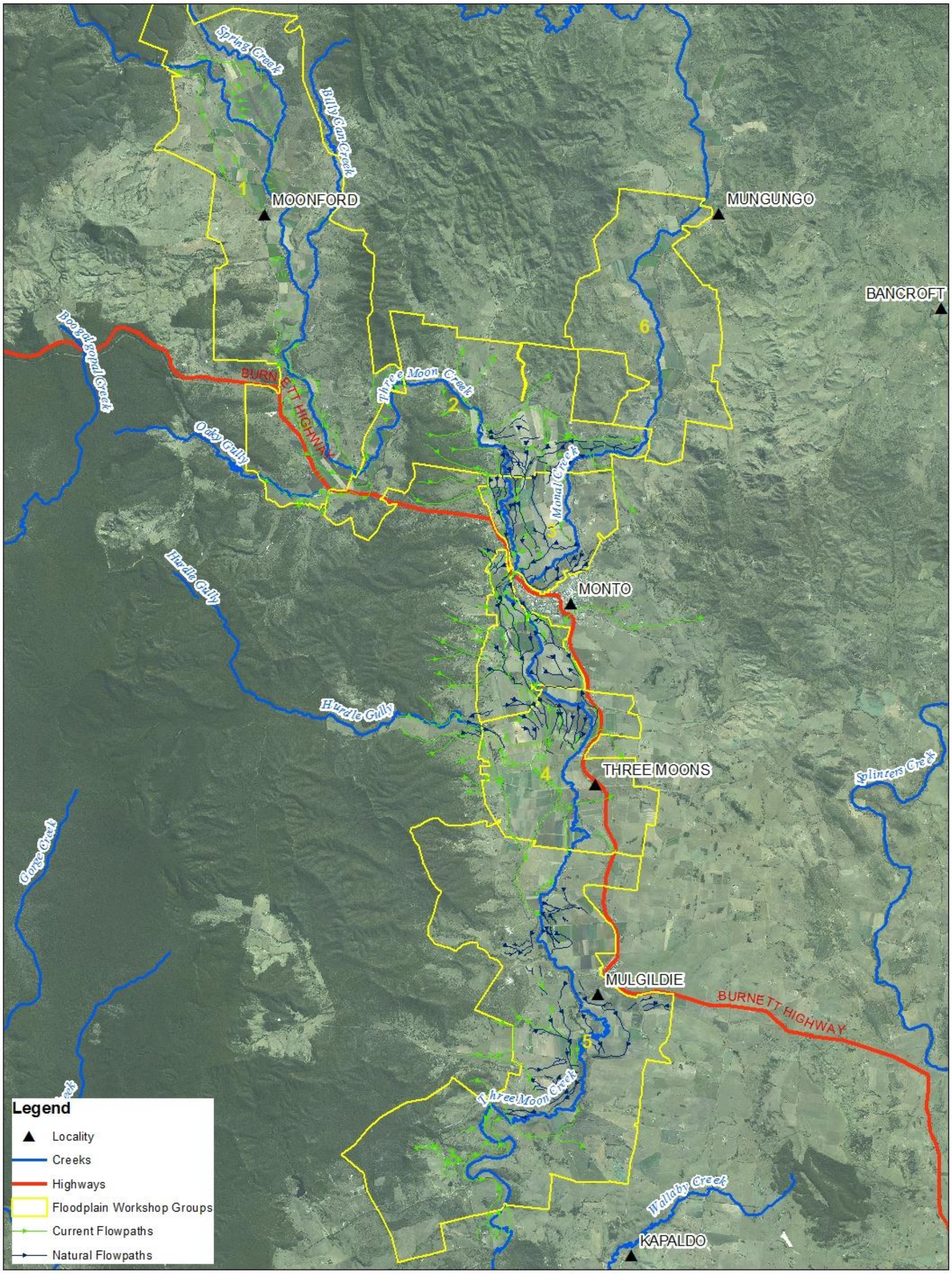

Current & Natural Flowlines

Project: Three Moon Creek Floodplain Action Planning
Date: Feb 2013
Prepared by: BCCA

BCCA

Burnett Mary Regional Group

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Kilometres
1:100,000
Datum: GDA94
Projections UTM (MGA Zone 56)

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