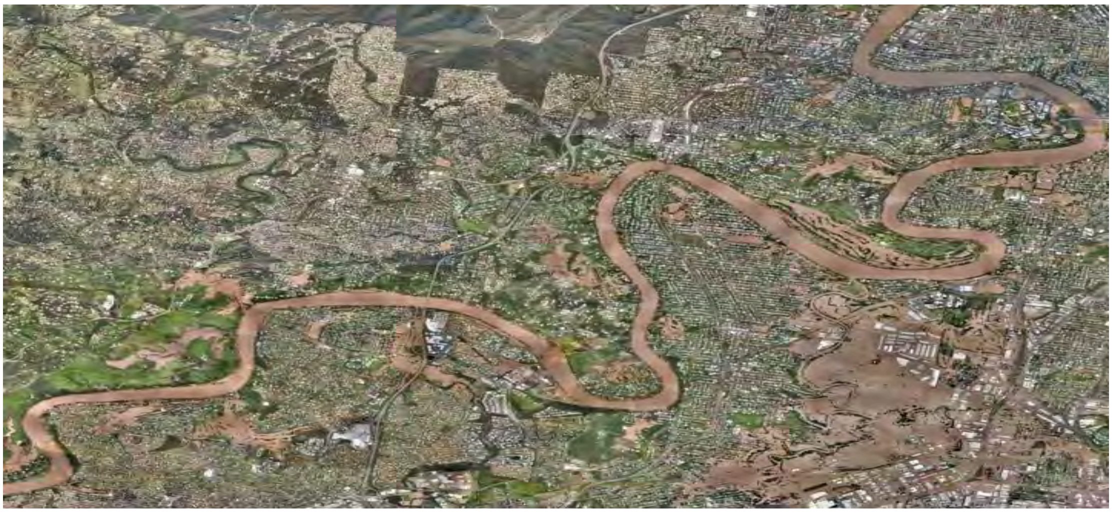

Submission to the Queensland Floods Commission of Inquiry

Restoring Ecological Infrastructure for Flood Resilience: The 2011 Southeast Queensland Floods and Beyond

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Executive Overview

SEQ Catchments is an environmental not-for-profit business which works with the community, the corporate sector and all levels of Government to enhance environmental sustainability in south-east Queensland. SEQ Catchments has been at the forefront of working with rural communities and Government to assist recovery following the 2011 floods.

The basic premise put forward in this submission is that poor floodplain and environmental management over the past one hundred and fifty years has decreased the environmental resilience of catchments and contributed significantly to the velocity and poor quality of flood waters. Loss of natural riparian and vegetation infrastructure has reduced the hydrostatic resistance of the upper catchments and had significant impacts on built infrastructure downstream. While hard engineering solutions are commonly put forward in response to flood events, they will be a poor substitute for enhanced floodplain management and improved environmental resilience.

SEQ Catchments have commissioned a number of geomorphic reports in the aftermath of the flood which will further document and evidence the arguments put forward in this submission. As such **SEQ Catchments request that these be accepted as supplementary reports in support of this submission**.

SEQ Catchments major recommendations are:

Recommendation 1

There is a need to restore damaged and degraded watercourses throughout South East Queensland. Healthy watercourses are resilient. They protect against bed and bank erosion, sediment transfer and slow the movement of water. They also provide a diverse range of biodiversity, aesthetic and conservation values in the landscape. SEQ Catchments believes that a medium to longer term commitment is required for restoring degraded watercourses throughout South East Queensland. This commitment is required to redress historic and current management practices many of which are the inadvertent result of government policy and programs of the past.

SEQ Catchments believes that it is appropriate that the community 'pays' for the enhanced ecosystem services that results from restoring degraded watercourses. Such recognition has occurred in Victoria, where medium-longer term funding for watercourse restoration is linked to bulk water pricing. There are a number of mechanisms for linking investment in the management of watercourses with payment for the ecosystem services that healthy watercourses deliver in South East Queensland including a levy on public infrastructure investment, redirecting off-set investments and charging beneficiaries of the ecosystem services. The SEQ Ecosystem Services Framework provides the mechanism to facilitate these payments. [1]

[1] Maynard, S, James, D and Davidson, A (2010), *The Development of an Ecosystem Services Framework for South East Queensland* Environmental Management: Volume 45, Issue 5, Page 881.

Recommendation 2

In the short term, restoration of watercourse reaches that were severely damaged during the 2011 floods should be undertaken as part of the restoration effort.

Recommendation 3

SEQ Catchments is of the view that in-stream and off-stream quarrying and sand extraction consistently results in significant degradation and bed and bank erosion which threatens both farm lands and infrastructure. The complex fluvial geomorphologic processes are not well understood by regulators nor reflected in licensing provisions. These are an extreme form of watercourse degradation, which SEQ Catchments believes should be the focus of expert evaluation and review.

Recommendation 4

There is a need to strengthen floodplain planning and management in south-east Queensland. Properly managed floodplains have a critical function during flood events. They filter sediments and slow storm-runoff velocities. By slowing runoff, they also allow infiltration of water into the soil profile and the recharging of groundwater. Poorly planned modifications to floodplains, such as levee banks, filling and draining change the behavior and function of floodplains: These changes should be clearly understood during the planning stage of floodplain management to avoid directing floodwaters towards vulnerable infrastructure, aggravating flooding for downstream communities and increasing the velocity of floodwaters.

SEQ Catchments notes that the administrative responsibility for floodplain planning and management in southeast Queensland is unclear. This needs to be rectified and resources need to be invested to ensure that there is capacity to better plan and manage this important environmental infrastructure going forward.

Recommendation 5

In the short-term, SEQ Catchments believes that a moratorium on floodplain development is appropriate while administrative responsibilities are clarified. SEQ Catchments further notes that if responsibility for floodplain development is vested in Local Governments they will need significant support in accessing the scientific or planning capacity needed to evaluate development proposals on floodplains.

Recommendation 6

SEQ Catchments experience in the pre and post flood is that new technologies such as LiDAR (Light Detection and Ranging) are invaluable tools for the planning and management of floodplains (Appendix 1). As such it is recommended that LiDAR surveying of the catchments of South East Queensland be undertaken as a priority where it has not occurred.

Introduction

Other submitters presenting to this Inquiry will tell the story of the magnitude of rainfall and water across the landscape, the tragic toll on human life, the adequacy of warning systems and the impacts on built infrastructure from the 2011 flood event. While significant attention has been paid to the operation of major built infrastructure there have been few questions asked about the condition of the catchments that delivered the enormous quantities of water and silt in such a short timeframe which caused most of the destruction. This submission will attempt to tell the flood story from an ecological infrastructure position and make recommendations regarding short and long-term floodplain management to reduce vulnerability and build resilience.

This submission to the Queensland Flood Inquiry is made by SEQ Catchments under section g of the terms of reference regarding: "all aspects of land use planning through local and regional planning systems to minimise infrastructure and property impacts from floods".

SEQ Catchments is a community-based business that sources and coordinates investment in activities that help maintain and restore Southeast Queensland's ecological infrastructure. SEQ Catchments takes a lead role in the strategic direction of natural resource management planning. SEQ Catchments is committed to developing a more sustainable community that cares for and values its natural resources and biodiversity. Mobilising and involving the community is an essential part of SEQ Catchment's work. Community engagement is used to set local and regional priorities that address environmental issues and guide the identification of projects and partnerships to deliver on-ground solutions. SEQ Catchments provide technical advice in the areas of data collection, mapping, vegetation management, soil conservation, water quality and property management planning. SEQ Catchments works closely with the Queensland Government to promote a balanced resource management approach to land development, infrastructure planning and economic growth through the SEQ Natural Resource Management Plan, a key implementation document for the SEQ Regional Plan.

The 2011 Flood and the Loss of Ecological Infrastructure in Southeast Queensland

Infrastructure is typically thought of as the outcome of human effort. Water infrastructure typically refers to the collection of dams, weirs, water treatment plants and pipes that deliver water services to the human population. Yet there is also another class of water infrastructure: 'the aquatic ecosystems that perform nature's work. Healthy rivers, floodplains, wetlands and forested watersheds supply much more than water and fish. When functioning well this eco-infrastructure stores seasonal floodwaters, helping to lessen flood damage. It recharges groundwater supplies, which can ensure that water is available during dry spells. It filters pollutants, purifies drinking water and delivers nutrients to coastal fisheries'[2]

The success of human societies has depended on the ecosystem services provided by the natural environment. Yet these services have historically been undervalued. While the benefits of built asset infrastructure such as dams and water treatment plants can be measured in metrics such as population served

[2] Postel S (2008) The Forgotten Infrastructure: Safeguarding Freshwater Ecosystems, *Journal of International Affairs*, Spring/Summer, Vol 61, no 2, pp75-90

or houses protected, the benefits of an environmental asset such as a riparian zone in reducing turbidity and therefore water treatment costs or of a wetland in reducing flood velocity historically seldom enter mainstream decision-making. Floodplains are resources of immense value as they support many of our productive rural industries yet there has been little coordinated effort in terms of planning or restoration.

Within a catchment, most rain falls on the hillslopes. In their natural, forested conditions, hillslopes intercept a component of rainfall and the remainder reaches the surface where it tends to be held in-situ by litter and ground plants. In all but the most extreme storm events, rainfall runoff as overland flow and rainfall is held at the surface and allowed to infiltrate into the soil. Water percolates both down through the soil profile to recharge groundwater and downslope where it discharges slowly as base flow into watercourses. It is this base flow that sustains stream flow during dry periods. Natural hillslopes generate little erosion, store rainfall, limit overland runoff and hence downstream flooding and sustain stream flow during dry periods. In a degraded state, where soils are exposed or compacted, or where surfaces are hardened for infrastructure development, hillslopes react quite differently. High proportions of rainfall, leave degraded hillslopes almost immediately as overland flow, which after short distances, coalesces into rills and then gullies before being transferred to streams and rivers. This runoff develops significant velocities and hence erosive forces with the result that percolation to groundwater and base flow are reduced, accelerated erosion of hillslope soils are observed and flash flooding and highly erosive overland flow occur even under moderate rainfall events.

Watercourses which have natural riparian vegetation are able to receive and transfer runoff while minimising bank and bed erosion. Moreover, the vegetation and other natural features include hydraulic roughness, which has the impact of slowing flow velocities and the movement of floodwaters to downstream communities[3]. Denuded, degraded and hardened watercourses have the opposite effect. They quickly transfer runoff waters downstream allowing the erosive forces to intensify, which ultimately results in massive watercourse bank and bed erosion and movement of higher volumes of faster flowing, sediment laden waters to downstream communities. Watercourses in this condition also have greatly reduced biodiversity, aesthetic and conservation values and are responsible for transferring significant sediment and nutrients to downstream aquatic and marine environments[4]. It should also be noted that the adverse effects of degraded watercourses are greatly magnified by in-stream and near-bank quarrying of sand and gravel. These activities fundamentally modify and destablise the hydraulic gradient and behavior of streams exerting very significant upstream forces which result in massive degradation, bed and bank erosion and loss of farming land and infrastructure. These riverine geomorphologic processes are not well understood by regulators and are not reflected in licensing provisions. SEQ Catchments is of the view that they require urgent review.

[3] Some landowners see this riparian function as counter-productive. The effect of slowing floodwaters means that watercourse banks are more likely to surcharge and floodplains fill. This is nature's way of slowing runoff, depositing any sediments before they are transferred downstream and recharging both soil water and groundwater stores. Those whose floodplains in upper catchments are so affected often argue to decrease the hydraulic roughness of streams by removing riparian vegetation and natural features, thereby limiting local flooding. The difficulty is that this merely accelerates runoff waters, results in further accelerated bed and bank erosion and aggravates and transfers the flooding problem to downstream communities.

[4] When significant sediment and nutrients are transferred into aquatic and marine systems under relatively low intensity rainfall/flood conditions, these systems lose their resilience and capacity to reinvigorate following damaging events, further reducing their environmental value.

The worst possible catchment outcome is to have degraded hillslopes draining into degraded watercourses. Where this occurs, flood impacts will be greatly magnified. SEQ Catchments actively promotes best practice hillslope management to optimise their ecological function during intense rainfalls. SEQ Catchments is of the strong view that watercourses should be restored where damaged and primarily managed for their ecosystem function. If damaged and degraded watercourses throughout south-east Queensland were remediated, significant watercourse bed and bank erosion would be eliminated, runoff waters would be slowed, flooding of downstream communities reduced, sediment and nutrient pollution and degradation of downstream aquatic and marine systems reduced and biodiversity and conservation values greatly increased. These environmental benefits would have very large positive benefits for urban areas, water supply systems, the fishing industry, the insurance industry and downstream infrastructure.

Appropriate management of floodplains has an important role in protecting communities from the long-term environmental cost of environmental degradation. For example following the Great Mid Western Flood in America in 1993 it was estimated that the restoration of 5.3 million hectares in the upper portion of the Mississippi-Missouri watershed at a cost of $2 to 3 billion dollars would have absorbed enough floodwater to have substantially reduced the 16 billion dollars in flood damages that resulted from that one event[5] .

A large proportion of the total stream and river network in southeast Queensland that makes up the water ecological infrastructure is small gullies.

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[5] Postel S (2008) The Forgotten Infrastructure: Safeguarding Freshwater Ecosystems, *Journal of International Affairs*, Spring/Summer, Vol 61, no 2, pp75-90

For much of the time, these are dry and not easily identifiable as important parts of the waterways, however after rain, they become the drainage lines channeling runoff. A vast branching network is formed that eventually coalesces to form larger streams and rivers. In southeast Queensland these gullies or ‘first order streams’ make up a very large proportion (approximately 7,500 km) of the total waterway length (almost 16,000 km). Many of these smaller gully networks have been poorly managed in the past and have lost most of their native vegetation. Vegetation plays an important role in holding the soil in place and preventing gully erosion, particularly during heavy rainfall. Moreover these smaller networks play an important role in slowing the flow of water across the landscape.

It is too soon after the event to calculate how well environmental intervention to improve floodplain functionality would have lessened flood impact. However it is defensible to say that floodplain management and environmental management more generally has been poor in South East Queensland. The Healthy Waterways Report Card that is published annually consistently shows poor scores for waterway health and ecological functionality. The loss of ecological function is most apparent in the Lockyer and Upper Brisbane Catchments, two of the areas most heavily impacted by the flood. This submission will focus on these two as case studies and make a set of general recommendations to the Commission of Inquiry.

The Lockyer Catchment

The Lockyer Catchment covers 2,954sq km. The Lockyer Creek is the main stream system. It flows in an easterly direction for about 100km from the

Great Dividing Range in the west to its confluence with the Brisbane River near Lowood, downstream from the Wivenhoe Dam. Major tributaries are the Tenthill, Ma Ma, Flagstone and Buaraba creeks. Clearing and settlement of the region began in the 1840s with most of the floodplains of the Lockyer Creek and associated waterways cleared by 1940. Typically the upper ridges of the catchment remain forested with only scattered vegetation remnants across the rest of the area. Grazing occurs predominantly on the cleared foothills with intensive agricultural production occurring on the fertile floodplain area. Figure 1 provides a map of the Lockyer Catchment showing the extensive clearing and lack of protected areas.

Erosion and sediment rates in the area are estimated to be thirty times that of pre-European settlement[6]. Sediment tracing studies show that the majority of sediment entering Moreton Bay and impacting on its ecological effectiveness are coming from the Lockyer Valley.

[6] Olley J(2006), Wilkinson S, Caitcheon G and Read A (2006) Protecting Moreton Bay: Reducing Sediment and Nutrient Loads by 50%, River Symposium, 2006, Brisbane.

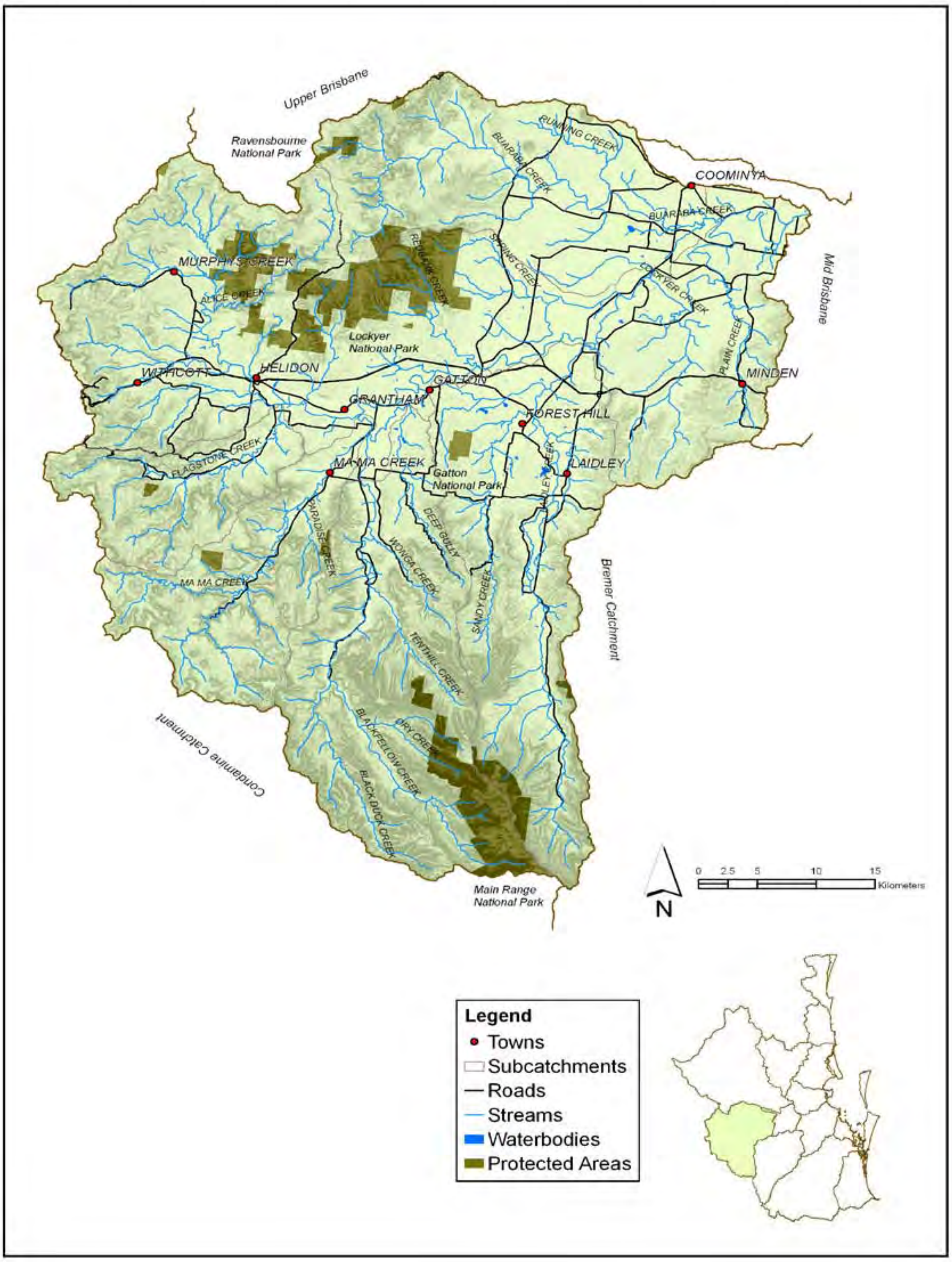

Figure 1 – Map of the Lockyer Valley

Sediment coming from the Lockyer Valley also impacts heavily on the quality and quantity of water supplied to South East Queensland. Seqwater extracts large volumes of water from the Mt Crosby Weir pool located downstream of the Lockyer Creek/Brisbane River confluence to feed their two major water treatment plants. High sediment levels associated with flows from the Lockyer

Creek significantly increase the costs of treating water and are associated with increased human health risk and taste and odour issues.

The latest flood event and associated erosion and sedimentation issues are the most recent in a long line of events. Major erosion and sediment movements are recognized as strongly episodic and associated with intense rains and heavy flooding. The bulk of sediment delivered to Mt Crosby and Moreton Bay happens in sporadic events often separated by several years.

The extent of land degradation exacerbated by past government land management policies in the Lockyer Catchment has been well recognized with numerous reports detailing landslips, saline outbreaks, sheet and gully erosion and the over extraction of groundwater. 25% of all cultivated land has been degraded by sheet and rill erosion with the worst areas being cultivated sloping land. Approximately 12% of alluvial plains have been scoured by and affected by erosive flooding[7].

Grazing activities within the catchment contribute less sediment per hectare than intensive agriculture but its extensive area of activity means it is a major sediment source. The amount of sediment generation from grazing land is strongly associated with levels of ground cover. Stock access to rivers and creeks however is recognized as a major cause of waterway degradation and erosion. Grazing within the riparian zone and unrestricted stock access to streams destroys vegetation that binds banks leaving them more susceptible

[7] Shaw J.H 1979 Land Degradation in the Lockyer Catchment, Division of Land Utilisation Technical Bulletin No.39, Queensland Department of Primary Industries, Brisbane.

to erosion. It leads to the destruction of soil structure in some areas retarding the growth of protective plants and increases sedimentation[8].

Intensive agricultural production occurs on the alluvial soils which make up about 7% of the Lockyer Valley. Severe storm events cause the majority of erosion within these cultivated areas. Records from the 1996 floods show that 15 to 30cm of topsoil was scoured off approximately 550 hectares of land. This was equated to 1500 to 3000 tonnes of soil loss per hectare. While considerable soil was redistributed within 100 to 500m of the eroded area a large amount was transported to Moreton Bay[9]. Similar if not greater soil loss was experienced in the 2011 flood event.

In major rainfall events the main creeks, the Lockyer, Laidley and Sandy, do not have sufficient capacity to absorb water discharge from the upper catchments. Consequently low lying areas are subject to flood flows which cause major erosive damage to the alluvial sediments[10]. The pre-settlement hydrological regime would have involved similar events however the extensive clearing of upper slopes and riparian zones have increased the velocity and impacts of these episodic events. The role of built infrastructure such as major roads and railway lines in directing flood flows within the Lockyer Valley is worthy of examination and it is hoped that the Commission of Inquiry or submitters to it will carefully examine the role of such floodplain development in the extent of damage caused particularly to smaller communities.

[8] Southeast Queensland Healthy Waterways Partnership, 2008, Land Management Best Practices Implementation Plan Lockyer Creek catchment, SEQHWP Secretariat, Brisbane.
[9] Roberts M, Shoecraft P, Heck B, 1996, Flood Damage in the Lockyer Valley, Department of Natural Resources.
[10] Davidson A, Greenaway C and Hempseed (2003) An Assessment of the Natural Resources of the Lockyer Catchment, Lockyer Catchment Association, Forest Hill, Qld.

The 2011 flood event highlighted that a key factor in soil movement from channels and banks is the lack of protective riparian cover and catchment vegetation. Due to creek banks being poorly vegetated, the floods of 2011 resulted in substantial bank slumping and scouring. Bank slumping is caused by the saturation of the creek bank soil and lack of vegetation to provide mechanical resistance to the slumping. Slumping can be lessened by having trees down to the water level and an area of vegetation at the top of the bank as far back as the creek is deep[11]. Erosive scouring is the result of the force of flowing water exceeding the resistance of the bank surface and is usually most pronounced on the outside meander bends. The amount and type of vegetation on the bank and surrounding riparian area profoundly influence scour rates. Vegetation clearance not only reduces bank protection in the immediate area it also allows water to flow faster creating more erosive flow downstream.[12]

During the intensive rainfall and associated flooding of January 2011, large volumes of water continued down the Toowoomba Range via tributaries of the Lockyer Creek including Murphys Creek as well as the Warrego Highway itself. The heavy rainfall in an already soaked catchment caused major localized flooding in all the Lockyer Valley subcatchments. SEQ Catchments staff during rapid reconnaissance of Murphys Creek, Buaraba Creek, Lockyer Creek, Sandy Creek and Lower Tenthill Creek in the days following the flood identified extensive areas of bank erosion, gully erosion, landslips, sediment redistribution, topsoil loss, channel redirection and vegetation loss.

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[11] Abernathy B and Rutherford I, 2000, Stabilising streambanks with riparian vegetation, Natural Resource Management 3, 2-9.

[12] Southeast Queensland Healthy Waterways Partnership, 2008, Land Management Best Practices Implementation Plan Lockyer Creek catchment, SEQHWP Secretariat, Brisbane.

Bank erosion was significant along the entire length of the creek systems surveyed. The long wet period from late December 2010 appeared to have reduced bank stability along the majority of the creek system resulting in major bank erosion. In many cases the erosion caused substantial widening of the creek channel. The Lockyer Creek at Gatton was approximately 150mm lower than 1974 flood levels at the bridge, however creek bank erosion was substantial. In lower sections of the Lockyer Creek the levees were breached resulting in overland flow, bank erosion and the activation of gullies. Dozens of landslips were identified on hillslopes. Sediment redistribution and loss in the catchment was identified. Course grained sediment and gravel was carried downstream. Finer grained sediment was deposited in some floodplain areas such as Plain Creek or carried beyond the catchment into the Brisbane River system and Moreton Bay. Loss of topsoil occurred locally which will potentially impact on the sustainability of producers in more marginal horticultural areas where soil depth becomes a limiting production factor. Some creeks, notably Buaraba, Black Duck, Blackfellow and Tenthill Creeks, changed course resulting in major impacts to infrastructure including roads and fences[13].

Figures 2 – 5 on the following pages provide a graphic representation of the importance of vegetation in riparian zones. Figure 2 shows the confluence of Murphy and Alice Creek before the flood, while Figure 3 shows the same area after the event. While there has been an extensive loss of in-stream vegetation the surrounding riparian vegetation has retained its integrity. Figure 4 shows the Flagstone Creek at Helidon pre flood and the lack of riparian

[13] SEQ Catchments, 2011, Flood Impacts Report, SEQ Catchments Brisbane.

coverage can be seen. Figure 5 shows the same area after the event and widescale erosive damage can be clearly seen.

Figure 2 Confluence of Murphy and Alice Creeks pre-flood

Figure 3 Confluence of Murphy and Alice Creeks post-flood

Figure 4 Lockyer Creek at Helidon pre-flood

Figure 5 Lockyer Creek at Helidon post-flood

The following images from the Lockyer Catchment provide photographic evidence of the extensive sediment and erosion mobilisation that occurred in the 2011 flood event.

Figure 6 Bank erosion in the lower Lockyer after the 2011 flood

Figure 7 Gully erosion in the lower Lockyer after the 2011 flood

Figure 8 Lockyer Creek at Gatton after the 2011 flood showing extensive bank erosion

Figure 9 Lockyer Creek after 2011 flood

Upper Brisbane Catchment

The Upper Brisbane Catchment is located within the larger Brisbane River Catchment. The Upper Brisbane Catchment flows are intercepted by Lake Wivenhoe which is the major water supply source for South East Queensland. The total catchment area of the Upper Brisbane Catchment is 4497 sq km. Upstream of Lake Wivenhoe the Brisbane River and its major tributaries the Cooyar, Emu and Cressbrook Creeks flow from the Jimna, Brisbane and Great Dividing Ranges to the west. Other tributaries include the Ivory/Maranghi, Neara, Spring and Gregors Creek. Figure 10 provides a map of the Upper Brisbane Catchment.

The catchment prior to European settlement was dominated by eucalypt woodlands and open forest and contained a wide range of other significant vegetation communities, including dry rainforest and vine thickets, tall open forests, brigalow and fringing riparian communities. The dominant land use across the catchment now is grazing of beef cattle, with dairying and farming concentrated along fertile alluvial valleys and basalt uplands. The timber industry remains significant with production from managed native forest and large areas of Hoop Pine plantations. Similar to other areas of South East Queensland the catchment suffers from land degradation exacerbated by extreme climactic events such as drought and flood which have both been witnessed in the past ten years.

Clearing in the catchment since European settlement has been extensive. Riparian zones used to consist of lowland rainforest and closed forest, with open grassy blue gum and iron bark woodlands on the floodplains[14]. Riparian zones in the catchment are generally described as being highly degraded and disturbed due to vegetation clearing, exotic species invasion, cattle grazing, agricultural development, roads and stream and river gravel extraction. Riparian vegetation where it does exist is often fragmented and narrow with a high percentage of exotic species. Riparian vegetation near sand and gravel extraction sites was rated as very poor[15]. Similar to Lockyer Catchment in-channel grazing, riparian vegetation removal and hillslope and catchment soil disturbance have all combined to push current sediment export rates far beyond those of pre European settlement. Many of the creeks, streams and rivers of the region have lost the dense riparian vegetation, coarse in-stream armour layers and vegetation protecting the bed, well vegetated hill slopes and stable vegetated stream banks that kept much of the sediment in place.

Extensive sand and gravel mining operations have occurred in the Upper Brisbane with significant environmental impacts. The impacts of in-stream and floodplain sand and gravel extraction are well documented. They include bed degradation, increased channel migration, increased bank erosion, increased sediment transport and bed mobility and altered patterns of erosion and deposition. The cumulative effects of multiple mining operations along a river reach can be much greater than the effects at just one site due to up or downstream migration of channel changes. The extensive sand and gravel mining operations in the Upper Brisbane are considered unsustainable from the perspectives of total sediment supply, bed stability, suspended sediment

[14] Brigza S.O, Finlayson B.L 1996, Geomorphological study of the upper Brisbane River , Queensland Department of Natural Resources, Brisbane.
[15] Shellberg A.J. and Brooks A, 2007, A Fluvial Audit of the Upper Brisbane River: Catchment Disturbance, Sediment Production and Rehabilitation Potential, SEQ Catchments, Brisbane.

and nutrient production, riparian corridor function and ecosystem integrity. According to Shellberg and Brooks (2005) approximately 167% of the average annual bed material load is being extracted each year. Sand and gravel extraction is counterproductive to reducing suspended sediment loads as it destabilises the channel and increases fine sediment production. Within the upper Brisbane it limits the re- establishment of a full riparian zone capable of mitigating the transport of fine sediment from hillslope erosion.

Fieldwork by SEQ Catchments staff in the aftermath of the recent flood event indicates that sites of sand extraction have contributed significantly to ecological degradation. The Harlin reach of the Upper Brisbane has a long history of instability due to ongoing large scale extraction immediately downstream over many years. Following the flood event this reach shows classic symptoms of bed lowering, removal of nearly all instream features (vegetated bars, terraces), channel widening, severe bank erosion up to 10 m high and realignment of primary flow channel. It is now in a severely degraded state and there appears to have been degradation of all sites on the River visited to date.

Loss of vegetation cover can dramatically change the hydrological cycle through reducing infiltration capacity, changing the way water is routed to stream channels, changing the timing and volume of runoff, and changing water velocity in overland flows and in channels. A reduction of forest cover on hillslopes can reduce rainfall interception during modest events and increase overland flow volume and velocity. After the Comet River basin was largely cleared of native vegetation in the 1960s there was a 40 to 78% increase in annual runoff[16].

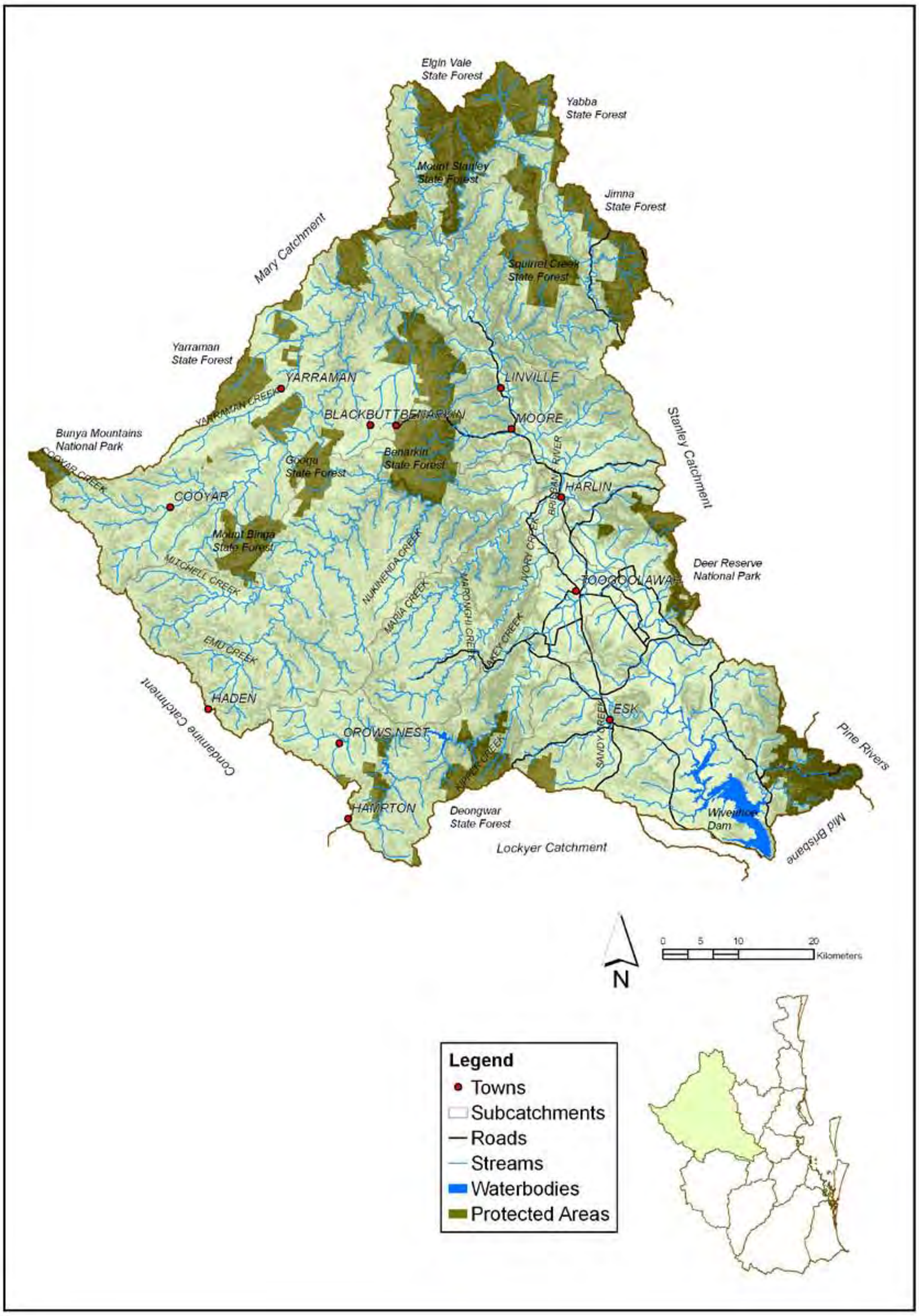


Figure 10 Map of the Upper Brisbane Catchment

[16] Siriwardena *et al* 2006 quoted in Shellberg aJ and Brooks A, 2007, A Fluvial Audit of the Upper Brisbane River: Catchment Disturbance, Sediment Production and Rehabilitation Potential, SEQ Catchments, Brisbane.

The 2011 flood event caused extensive damage to existing riparian areas. Bank erosion and slumpage was extensive across the catchment. Numerous landslips were recorded, particularly in areas cleared of native vegetation.

Figure 11 Main Esk Hampton Road post flood showing significant damage.

Figure 12 Landslip near Mt Stanley Upper Brisbane River

Figure 13 Creek damage near Linville

Figure 14 Aerial view of riparian erosion in Upper Brisbane Catchment

Figure 15 Aerial view of riparian erosion in Upper Brisbane Catchment

Figure 16 Aerial view of riparian erosion in Upper Brisbane Catchment

Figure 17 Aerial view of streambank erosion in Upper Brisbane Catchment

Figure 18 Aerial view of streambank erosion in Upper Brisbane Catchment

Figure 19 Aerial view of hillslope erosion in Upper Brisbane Catchment

Figure 20 Bank erosion at mining site in the Upper Brisbane Catchment

Summary

Heavy rainfall and episodic flood events are an inevitable part of the sub tropical climate of South East Queensland. Climate change predictions suggest that episodic heavy events are likely to become more frequent.

Land management practices in the time since European settlement have dramatically changed the hydrostatic capacity of the ecosystem. The loss of ecological infrastructure in terms of vegetation cover and riparian zone functionality have increased both the volume and velocity of flood events. Agricultural and sand and gravel mining practices have contributed to the mobilisation of sediment across the region with resulting impacts on both water treatment for human use and the health of Moreton Bay.

The riparian zones of both the Lockyer and Upper Brisbane Catchments are extremely degraded. Numerous riparian functions have been lost or impaired especially related to bed and bank sediment stabilization. The re-establishment of a riparian zone would do much to mitigate the transport of suspended sediment throughout the system. Brisbane's 'Mud Army' toiled partly to clean up the legacy of generations of poor flood plain management and neglect of the natural environment. Tens of millions of tonnes of sediment was stripped away in the flood event. From the 6th to the 13th of January, approximately 1,040,000 tonnes of sediment (equivalent to 30,000 dump trucks of sediment) was discharged into Moreton Bay. Preliminary estimates are that 676,469 tonnes or 19,000 dump trucks of sediment was generated from the Lockyer Valley alone.

Restoration activities within these areas is possible and effective in controlling impacts. Observations by SEQ Catchments staff in the post flood landscape show that battering back vertical, reestablishing bank vegetation and dedicated thickly vegetated riparian zones of appropriate width made a considerable difference.

Improvements in water quality and flood mitigation will only be achieved through changes to processes that continue to degrade rivers and streams in the upper catchments. Primarily sand and gravel extraction and in-channel grazing are inconsistent with the establishment of functional riparian zones and should be reassessed.

Sediment delivered from catchments in the rural and agricultural production areas of southeast Queensland have a highly detrimental impact on water quality in Moreton Bay. Without active intervention this impact will only continue to grow. SEQ Catchments have estimated that continued decline in environmental resource condition will have a social cost to the community of more than $5.2 billion dollars between 2009 and 2031 with the greatest costs relating to losses in river, stream and coastal condition[17].

Resources are required in the short term to address the environmental impacts of the flood event. Significant funding will be made available to repair the built infrastructure of the region and repair of environmental infrastructure should not be overlooked. While this submission focuses on the need to support land managers in rural catchments of SEQ to come to terms with a

[17] Marsden Jacob Associates, 2010, Managing what matters: The cost of environmental decline in southeast Queensland, SEQ Catchments, Brisbane.

lack of proactive floodplain management, sediment from urban and industrial land uses and development must also be considered in the total mix of action required to safeguard the health of the receiving waters of the coast and Bay into the future.

In the short term for the catchments described in this submission, over the next eighteen months between $12 and $15 million dollars should be made available for:

- Targeted and well designed on-ground repair and rehabilitation works in priority sub catchments
- Coordinated and professional cleanup of hazardous materials in waterways
- Projects to mitigate risks to tourism and recreation sectors to mitigate human health risks
- A contingency allocation to cover the possible eventuality of major algal blooms
- An evaluation of urban waterway management to prioritise repairs and inform future design and management

These are short term responses in relation to the flood event. Unless longer-term interventions are taken within the rural catchments the hydrostatic capacity of South East Queensland will continue to decline. Future flood events under a changed and more intense climate will be of greater velocity and carry more sediment unless significant intervention is undertaken.

Extensive work has been undertaken in South East Queensland in relation to the challenges of waterway management. The pilot Healthy Waterways initiative in South East Queensland has significantly increased the scientific understanding of key risks to waterway health, the drivers of those risks and actions to address the risks. The pilot program has demonstrated that intervention to change management practices and undertake on-ground works is possible and successful. As such, a full program is proposed for South East Queensland that should be supported. The portfolio of projects proposed has the potential to permanently reduce sediment loads by up to 20,000 tonnes per annum[18]. The total budget required is $78.1 million with a ramp up over three years with the majority of funding aimed at reducing rural diffuse sediment loads.

In addition to improved on-ground management practices and restoration activities at the property scale there is also a need for improvements in the way floodplains, rivers and streams are managed. The Best Practice Principles for Floodplain Management in Australia state that: "Previously, floodplain measures were introduced often only after a serious flood had occurred – a reactive approach. Typically, this approach was limited in scope and effectiveness and did little to control the growing levels of flood hazard across Australia[19]".

The 2011 flood event illustrates the need for proactive planning within the floodplain. Currently no clear authority exists in terms of floodplain

[18] Marsden Jacob associates, 2011, The Future of Our Bay: The Business Case for Managing and Enhancing southeast Queensland's Waterways (2011-2014), Marsden Jacobs, Brisbane.
[19] Standing Committee on Agriculture and Resource Management (2000) Floodplain Management in Australia Best Practice Principles and Guidelines, CSIRO Publishing, Canberra.

management within river basins in South East Queensland. Decision-making is disjointed and shared between numerous State Government Departments each pursuing individual agendas and often chronically under-resourced smaller local governments. Little consideration is given to the cumulative effect of individual planning decisions on the overall flood risk, floodplain health and downstream impacts. After the 1996 floods in the Lockyer Valley it was recommended that a floodplain management plan should be completed. It was recognized at the time that the greatest impediment to the plan beside funding was the absence of a formal and appropriate resource management structure for the catchment[20]. Little has changed.

[20] Water Studies, 2002, Lockyer Valley Flood Scoping Study, Lockyer Catchment Centre, Forest Hill.

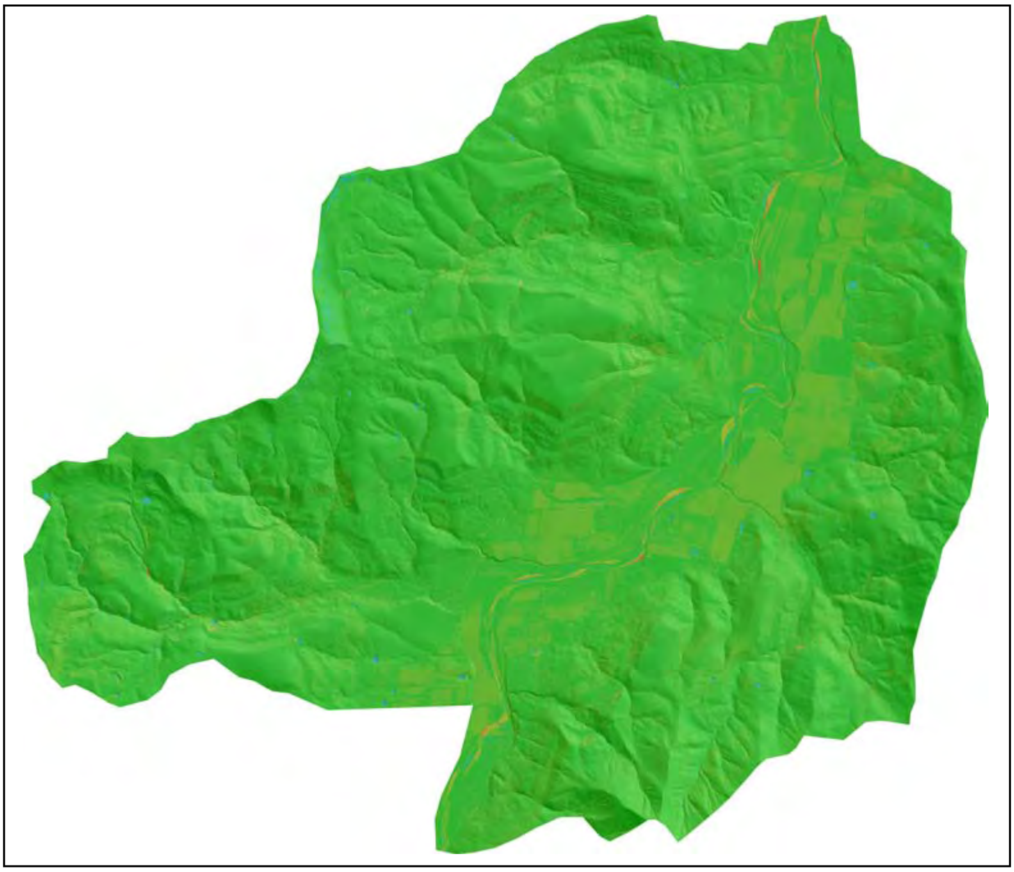
Appendix 1 Light Detection and Ranging (LiDAR) Imaging

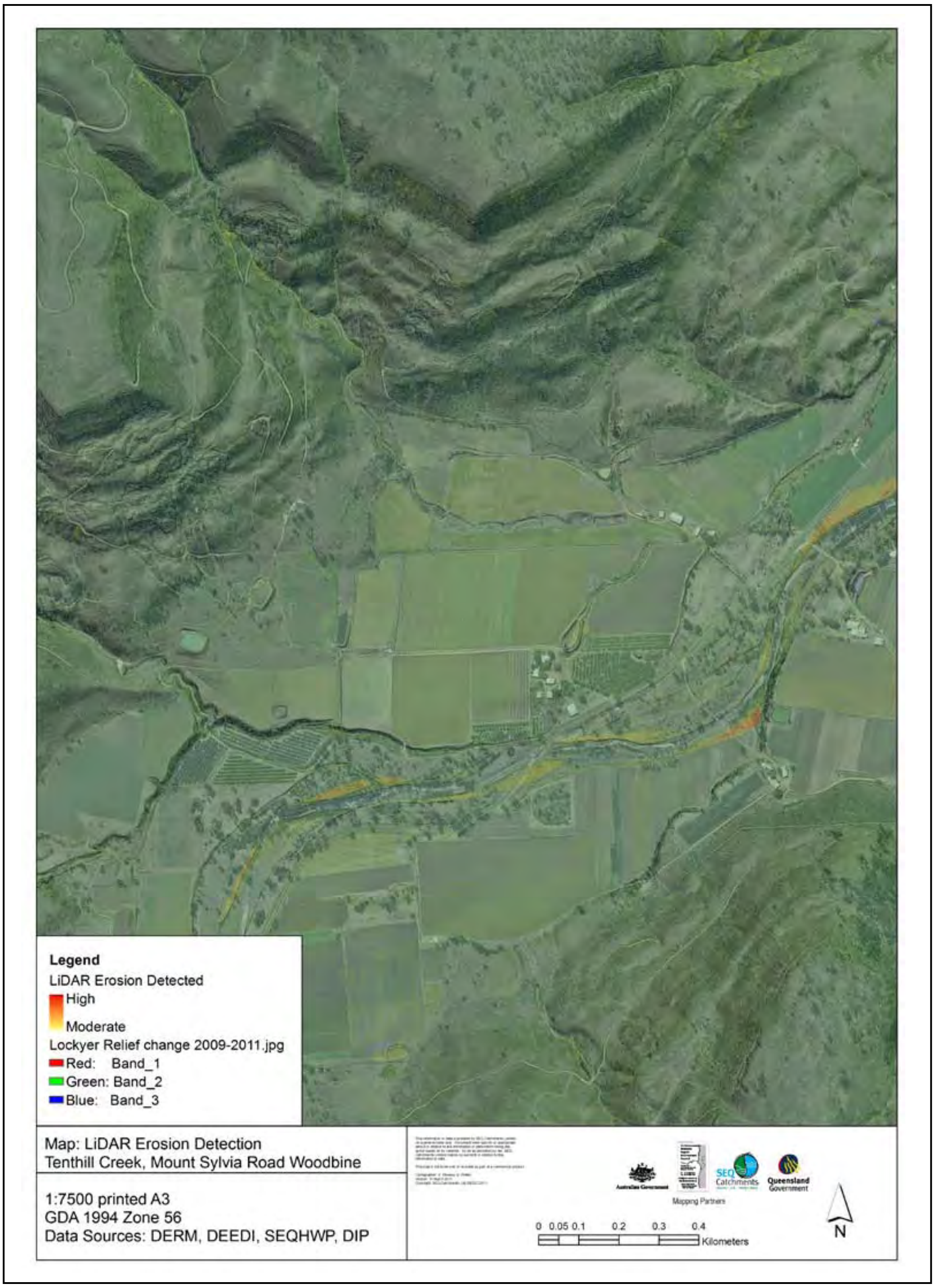
LiDAR provides information on surface comparison (erosion and deposition zones), vegetation canopy height comparison, change in bank width and height, along with a high resolution 1m digital elevation model (terrain and contours).

LiDAR allows for a landscape assessment of flood damage and prioritising of recovery work and proactive planning to mitigate or avoid future damage.

The following figures incorporating LiDAR display areas as described in the table:

Key	
Red	High Erosion - Sediment Loss
Yellow	Moderate Erosion – Sediment Loss
Blue	Deposition - Sediment Gain
Green	Background Colour




Legend
LiDAR Erosion Detected
High
Moderate
Lockyer Relief change 2009-2011.jpg
Red: Band_1
Green: Band_2
Blue: Band_3
Map: LiDAR Erosion Detection
Tenthill Creek, Mount Sylvia Road Woodbine
1:7500 printed A3
GDA 1994 Zone 56
Data Sources: DERM, DEEDI, SEQHWP, DIP
Mapping Partners
0 0.05 0.1 0.2 0.3 0.4
Kilometers
N