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REPORT TO THE BORDER RIVERS-GWYDIR CATCHMENT MANAGEMENT AUTHORITY

Instream habitat rehabilitation plan for Bannockburn Creek

Assessment of strategic and sustainable removal of sediment.

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Instream habitat rehabilitation plan for Bannockburn Creek

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More information

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Cover photo: Bannockburn Creek infilled with granitic sediment near confluence with the Macintyre River 23 August 2012.

Job Track number: 11701

Executive Summary

This investigation builds on recommendations made by Soil Conservation Service in their Bannockburn Creek Catchment Assessment Report (June 2011), primarily the need for "assessment of strategic and sustainable removal of sediment" from the system. The aim of this study is to make an assessment of strategic and sustainable removal of sediment from Bannockburn Creek and the Macintyre River.

Properties through which Bannockburn Creek and the Macintyre River pass were inspected with the relevant landholder in late August 2012, identifying local issues, control points and potential sites for physical extraction of material.

It was concluded that the physical extraction of sand may provide potential "breathing space" for identified reaches within the sediment slug, but should be implemented in conjunction with other activities such as instream rehabilitation works (installation of woody debris) and works to control sediment input from the surrounding catchment.

Physical removal of sand will potentially reinstate refuge habitat for fish and other aquatic species and allow re-establishment of aquatic vegetation until these reaches begin to refill.

If physical extraction is deemed beneficial, it is recommended that a focus be placed at and near the confluence of Bannockburn and the Macintyre River and at and near the downstream end of the slug. By focusing on these locations, further infilling of habitat within the Macintyre River will be prevented and movement of sediment from Bannockburn Creek will be reduced. Extraction at the confluence of Bannockburn Creek and the Macintyre River will allow localised recovery of the Macintyre and possibly lead to improved sand scour as sediment replenishment is reduced.

At sites of physical extraction, it is recommended that sediment removal occurs from the apex of bends to encourage the development of pools that remain clear of sand due to the action of secondary circulation as noted by Rutherford *et al.* (2000).

Instream rehabilitation works will increase the potential for localised scouring and continued movement of sediment through the system. In the upper sections of Bannockburn Creek, stabilisation of sediment could be achieved by planting native reeds (such as common reed) which are already present in the upper reaches of the creek and will act to reduce sediment movement.

Works recommended by Soil Conservation Service should be implemented for priority sites within the Bannockburn Creek catchment including stock exclusion of these areas to reduce further sediment movement into the creek channel.

Any work site and access tracks should be rehabilitated (revegetated with local native species) following extraction activities. In the long term this should be using tree and shrub species in the riparian zone and during intermediary periods with native grasses.

Prior to undertaking sediment extraction activities, further assessments will be required to determine potential impacts on threatened species present. As works have not been identified in a river, land or water management plan, works are classed as designated development under the *EP&A Act 1979* and therefore require an Environmental Impact Statement to be developed.

If more than 30,000 cubic metres of material is extracted per year, a Pollution Licence and Extractive Industries Licence will be required from the NSW Office of Environment and Heritage and NSW Department of Primary Industries Catchments and Lands respectively. If materials extracted provide some commercial benefit, a Controlled Activity Approval will be required from NSW Department of Primary Industries Office of Water. NSW Department of Primary Industries Fisheries will need to be notified of proposed works and matters raised by the department will need to be considered. A Property Vegetation Plan and Weed Management Plan may also be required for the work sites (extraction points and locations for instream works).

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Introduction

The Border Rivers Gwydir Catchment Management Authority (BRGCMA) engaged NSW Department of Primary Industries Fisheries (DPI Fisheries) to undertake an assessment of Bannockburn Creek and the Macintyre River in the area of a large sand sediment slug that is moving through the lower reaches of the Bannockburn Creek and into the Macintyre River.

This investigation builds on recommendations made by Soil Conservation Service in their Bannockburn Creek Catchment Assessment Report (June 2011), primarily the need for "assessment of strategic and sustainable removal of sediment" from the system.

Study Area

This investigation primarily covered Bannockburn Creek and the Macintyre River where it is under the influence of the sand slug (a total length approximately 23km). Bannockburn Creek was assessed at properties visited as part of the Soil Conservation Service catchment assessment report (downstream of Yetman Road), with an additional site also visited located just upstream of Oakwood Road. The Macintyre River was assessed at two road crossings upstream of the sand slug, over the length of the sediment slug and at one road crossing downstream of the sand slug (Figure 1).

According to the catchment assessment report, Bannockburn Creek catchment is characterised by granites and alluvial basalts, with granite derived soils being considered the main source of sediment for the slug. The sediment slug itself appears to begin in the downstream (northern) 2/3 of the Bannockburn Creek catchment and extends ~13km to its confluence with the Macintyre River and for a further 10km within that river channel.

Background

The aim of this study is to make an assessment of strategic and sustainable removal of sediment from Bannockburn Creek and the Macintyre River.

The effect of the sand slug on the instream habitat of Bannockburn Creek and the Macintyre River is to infill all bathymetric variability (deep pools, riffles) and create a uniform, homogenous creek/river bed where the majority of water flows below the sediment surface and only shallow surface water flows are present. Landholders indicated that the movement of sediment has filled in some very deep pools in the Macintyre River that were previously used for swimming or accessing irrigation water (Sanderson, Donaldson, Stevens *pers. comm*.).

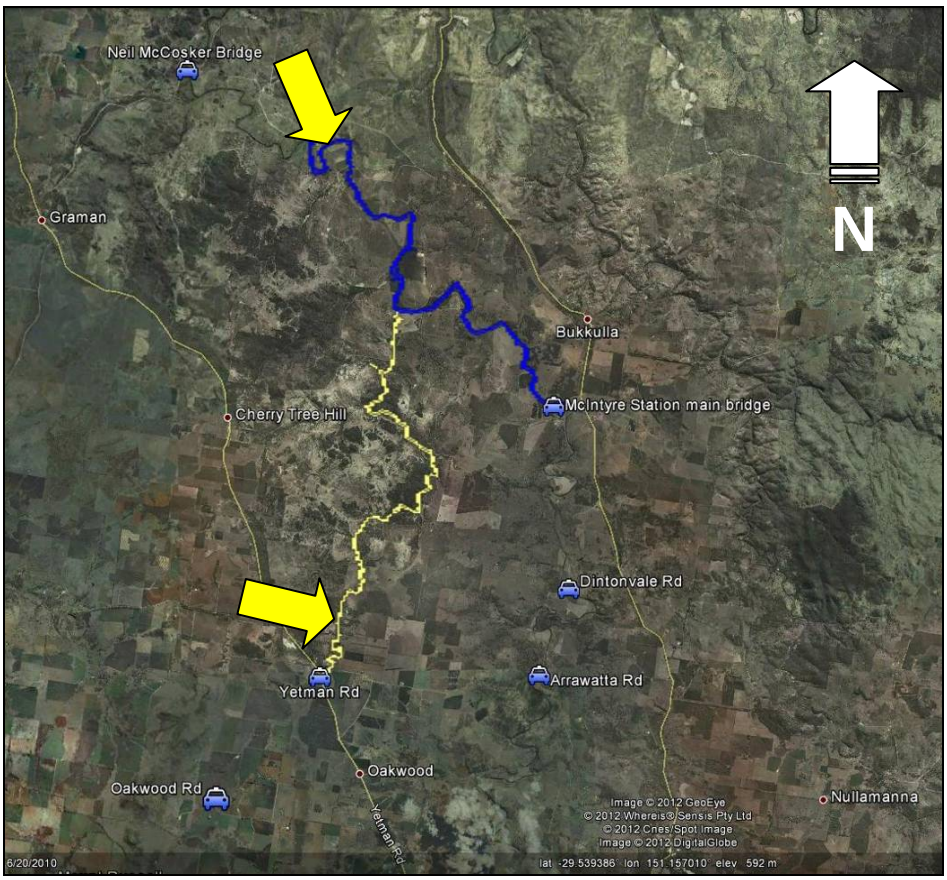
This has an impact on fish and other aquatic fauna and flora by eliminating potential habitat including deep refuge pools from the system and exposing them to increased water temperature variability and predation potential. Extended shallow surface water also creates migrational barriers as fish are physically and behaviourally no longer able to move freely within the system. This has the potential for long term effects on fish populations – effectively isolating populations upstream and downstream of the sediment slug until high flows occur in the system. Even with such drownout events impacts upon breeding and recruitment may persist as such events may not coincide with a species' migrational timing.

Field Inspections

Properties through which Bannockburn Creek and the Macintyre River pass were inspected by the author and relevant landholder between 22nd and 24th August 2012. Figure 3 indicates land ownership and cadastral boundaries for the relevant properties.

Figure 1 Bannockburn Creek (yellow) and Macintyre River (blue) study area including road crossings where additional observations were made.

Arrows indicate approximate upstream and downstream extent of sediment slug.

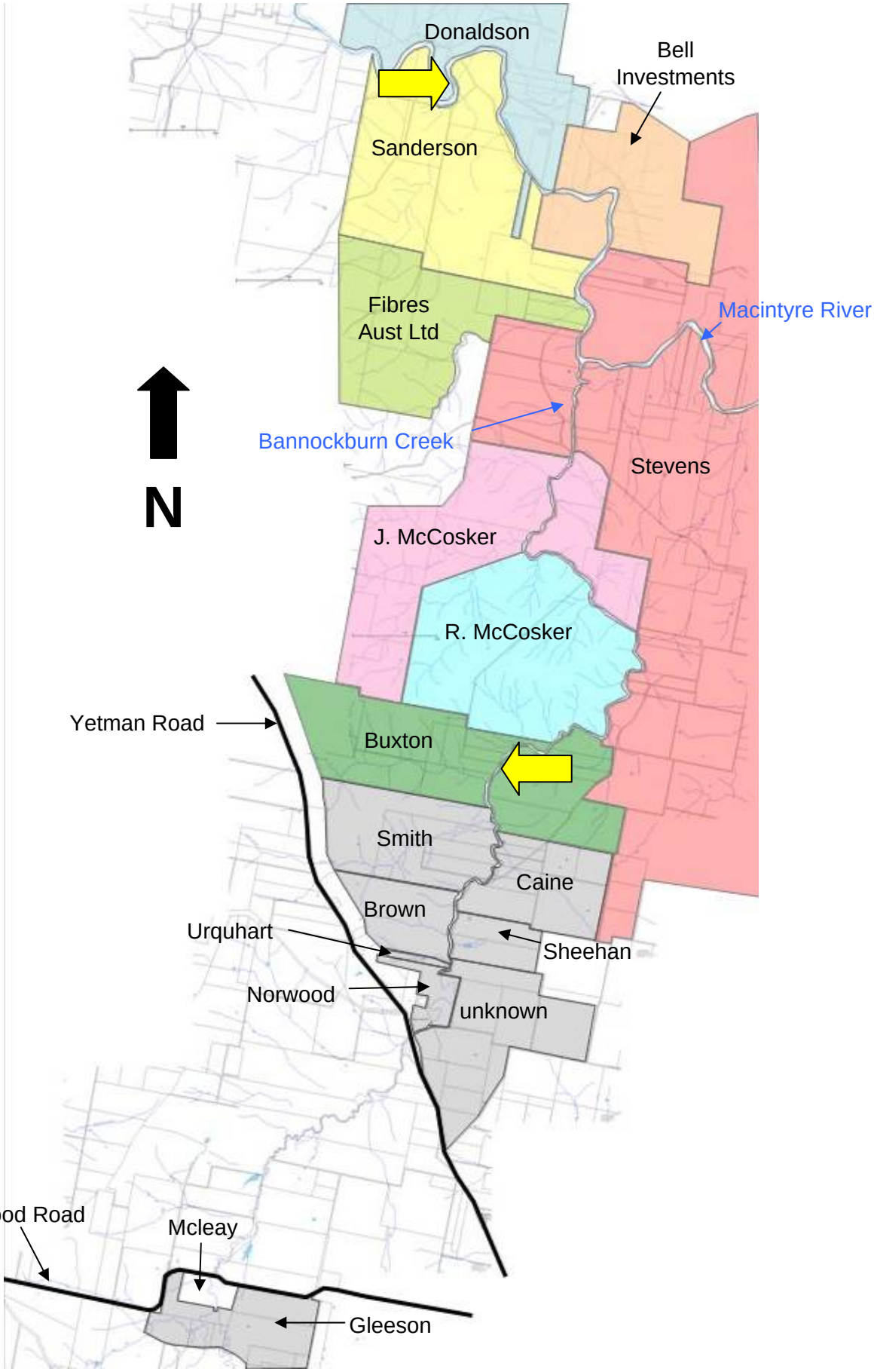


Imagery: Google Earth, 20/06/2010.

Figure 2 Screen shot of 2004 helicopter flyover showing sand slug from Bannockburn Creek entering the Macintyre River, creating stream bed uniformity and shallow surface water flow.

Screen shot from DVD of helicopter flight over sand slug on the Macintyre River, 2004 – unknown videographer.

Figure 3 Land ownership and property boundaries for relevant properties. Arrows indicate approximate upstream and downstream extent of sediment slug.



Grazing (sheep and cattle) is the main landuse activity present on properties along Bannockburn Creek, although some cropping had occurred in the past on Macintyre Station near the confluence with Bannockburn Creek, toward the upper section of Bannockburn Creek (north of Yetman Road) and along the Macintyre River floodplain.

Cropping was generally restricted to “black soil country” and not the highly erosive granitic soils identified as the source of sediment for the slug.

Bannockburn Creek was observed to be generally around 10m wide, although this varied from 15m – 5m dependant on location. Its banks varied from steep (near vertical) drops to gently sloping. Granite boulder outcrops were observed throughout the system and most surrounding hills were vegetated with eucalypt (*Eucalyptus* spp.) and native cypress (*Callitris* spp.). Discussion with one landholder (R. McCosker) indicated that most of this woody vegetation was post World War 2 regrowth as labour employed to clear and maintain surrounding land went to war and did not return, allowing regrowth to proliferate.

Bannockburn Creek line was vegetated with eucalypt species and occasional bottlebrush (*Callistemon* spp.), mostly in the mid-upper section of the sediment slug (R. McCosker property). In this section, rocky outcrops allowed the formation of shallow pools where two goldfish (*Carassius auratus*) and several turtles (*Chelodina longicollis*) were observed in one such pool. The upper (around Oakwood Road) and mid (around Yetman Road) extent of Bannockburn Creek was dominated by shallow pools and cumbungi (*Typha* spp.: Figures 4 and 5). Around Yetman Road individuals of goldfish or koi carp (*Cyprinus carpio*: 1-2 fish) were observed.

Figure 4 Bannockburn Creek at Yetman Road upstream of sediment slug looking upstream.

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Figure 5 Bannockburn Creek at Yetman Road upstream of sediment slug looking downstream.

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The riparian zone of the Macintyre River was dominated by introduced willow trees (*Salix* spp.), occasional she oak (*Casuarina* spp.) and eucalypt in the area of the sediment slug. Either side of the sediment slug, willows again dominated the riparian vegetation (Figures 6 and 8) with patchy reeds (e.g. *Bolboschoenus* spp.), and occasional eucalypt and she oak, although some distance upstream large patches (>50m) of she oak were observed (Figure 7). Instream vegetation was also occasionally present, mostly comprising water milfoil (*Myriophyllum* spp.). In the vicinity of Neil McCosker Bridge, willows, eucalypts, she oak and bottlebrush were observed.

A redundant causeway was also observed just downstream of Neil McCosker Bridge which would act as a barrier to fish passage at low flows, including those observed during the field inspection 22 August 2012 (Figure 9). A stream gauge station present at this site (416068 – Macintyre River at Tintot) indicates flow on that date was 0.534m or 54.877ML/day.

Figure 6 Macintyre River upstream of sediment slug at Dintonvale Road showing grazed banks and willow growth.

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Figure 7 Macintyre River upstream of sediment slug near Arrawatta Road at a good patch of she oak trees.

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Field inspections identified a lack of riparian fencing along one or both sides of Bannockburn Creek, allowing stock to access the creek banks, bed and water. Discussion with one landholder determined that funding had been offered to him for fencing materials, with the proviso that he installed the fence, but that the task of fencing the riparian zone was seen as quite difficult due to the rocky terrain and that such works would take him away from other pressing farm activities. He had therefore declined the offer.

Figure 8 Macintyre River downstream of sediment slug at Delungra-Ashford Road showing deep pool with willow and she oak growth. Vegetation downstream of this site becomes dominated by native species.

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Figure 9 Macintyre River downstream of sediment slug at Delungra-Ashford Road showing redundant causeway which will block upstream fish passage at low flows.

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Riparian fencing was present for the length of the Macintyre River affected by the sediment slug.

Field inspections aimed to determine possible locations for instream sediment management and to view the extent of instream sedimentation. During inspections the landholder was asked to identify locations of waterway crossings and rocky outcrops / point bars on either Bannockburn Creek or the Macintyre River.

Identifying the location of rock outcrops and point bars was seen as important as these units would act as control points to limit any potential instream bed erosion that may arise from the physical removal of sand to between the two control points (Rutherford *et al.*, 2000).

It was therefore premised that if two suitably located control points could be identified, the area between them could be used as a “sacrifice zone” where sand could be extracted on a periodic but ongoing basis. This would allow the creation of short-term deeper water habitat until sand again moved in to fill the pool(s).

Continued extraction at one or more such locations from within Bannockburn Creek and the Macintyre River would create deep water refuge pools within the body of the sediment slug and potentially improve connectivity for aquatic fauna.

The location of waterway crossings were also identified during field inspections to determine relative ease of site access and distance to travel for excavation equipment and hauling vehicles.

Catchment Based Sediment Management

The aim of this study is to make an assessment of the strategic and sustainable removal of sediment from Bannockburn Creek and the Macintyre River. Whilst the focus is therefore on instream activities, it would be remiss to focus entirely on these without addressing the source of the sediment within the catchment.

Activities to remove or move sediment within the stream channel cannot be viewed in isolation and must be accompanied by activities to manage sediment input into the stream channel from tributaries and adjacent land. Sustainable removal of sediment therefore requires a suite of activities – both instream and beyond the main channel.

The Border Rivers-Gwydir Catchment Management Authority has been working with local landholders to address sediment input into Bannockburn Creek through activities identified within the Bannockburn Creek Catchment Assessment Report (Soil Conservation Service, 2011). The Catchment Assessment Report identified high priority locations for works, on C. Buxton’s and J. McCosker’s properties as shown in Table 1, with some of these works already implemented.

Included in the works recommended by Soil Conservation Service is the management of stock access around work sites to minimise further erosion and allow vegetation to re-establish. Given the highly erosive nature of the soil within the catchment this is an extremely important management tool, without which remediation works will not be as effective.

During field inspections it was noted that the banks of Bannockburn Creek were not fenced in their entirety, often with only one side being fenced from stock to create paddocks adjacent the creek channel.

Discussion with Soil Conservation Service (Tim Elder *pers. comm*. 07/08/12) indicated that for some sites where remedial works had been carried out, stock exclusion fencing had not been installed and works were therefore being compromised.

Discussion with one landholder indicated that although funding was offered from the CMA to fence the creek and work sites (paying for materials), this was not accepted and due to the requirement for him to install the fencing. This was identified as requiring a substantial time commitment working over difficult country (rocky outcrops, steep terrain) and would take him away from other more urgent farm activities. Although the offer for fencing was rejected, the landholder said he wasn’t opposed to fencing the creek and would like to divide the area near the creek into 3 paddocks, of which one could be a “creek paddock”.

Land management activities to control sediment input into the creek may therefore benefit from contractors being funded to fence areas of concern. Contractual arrangements should also be made with the landholder to ensure maintenance of fencing in the future.

Table 1 High priority actions to address sediment input into Bannockburn Creek and C. Buxton's and J. McCosker's properties.

Location	Issue	header
Buxton 1	Bed lowering in gully (1m x 10m)	Bed control structure
Buxton 2	Bed lowering in gully (1m x 10m)	Bed control structure
Buxton 3	Extensive bed lowering in tributary (2m deep x 500m long)	Bed control structure (several)
Buxton 3	Headcut	Rock ramp/chute
Buxton 4	Head of gully	Minor reshape, topsoil, seed, mulch Manage stock access
Buxton 5	Gully head	Gully control structure (dam)
J McCosker 1	Gully 2 (11m deep x 140m perimeter)	Bund to divert flow away from eroding edges Construction of dam in Gully 2 Incorporate low flow pipe and outlet to creek bed Construction of rock chute into Gully 2 Manage stock access (fence)
J McCosker 2	Gully 1 (4m deep x 140m perimeter) Bed lowering in adjacent creek	Diversion of flow to Gully 2 (diversion bank) Manage stock access (fence)
J McCosker 3	Bed lowering in 5 locations (each 1m x 5m approx)	Bed control structures

Instream Management Options

Localised scouring and formation of small (shallow) pools is evident around some of the natural rocky outcrops present within Bannockburn Creek (Figure 10).

The use of instream woody debris within the Bannockburn Creek and Macintyre Rivers systems has the potential to create localised changes to sediment collection and movement in-channel.

The difficulty with this site is the volume of sand present and the likelihood that any variability created by instream structures would be infilled over time and the structures themselves become swamped as the sand continued to move through the system (Brooks *et al.*, 2006).

Brooks *et al.* (2006) notes that the creation of scour pools within such a sediment affected system is a challenge and recommends avoiding strategies based on bed level control until the slug has passed. Instead he recommends that strategies based around channel constriction be attempted to improve instream pool habitat.

It should be noted that in addition to the risk of structures being swamped by sand moving through, there is a risk that as the sediment slug passes any works based on the bed level at time of installation will likely be undermined or not functioning correctly (Brooks *et al.*, 2006).

It is therefore necessary to understand that structures installed in the system will have a limited lifespan and may need to be revisited / modified at a later date. This will have implications for current and future funding allocation to this site.

In the upper sections of Bannockburn Creek, stabilisation of sediment could be achieved through planting of native reeds (such as common reed, *Phragmites australis*), which are already present further upstream. Encouraging the growth of reeds in these areas will help reduce sediment

movement downstream and could act to constrict the creek channel and encourage further scouring.

Figure 10 Rocky outcrop present on Buxton property where localised scour of sediment slug is occurring.

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Sand Management Options

Given the above limitations of instream structures, a secondary approach, such as the physical extraction of sand could provide a more direct option for managing the sediment moving through the system.

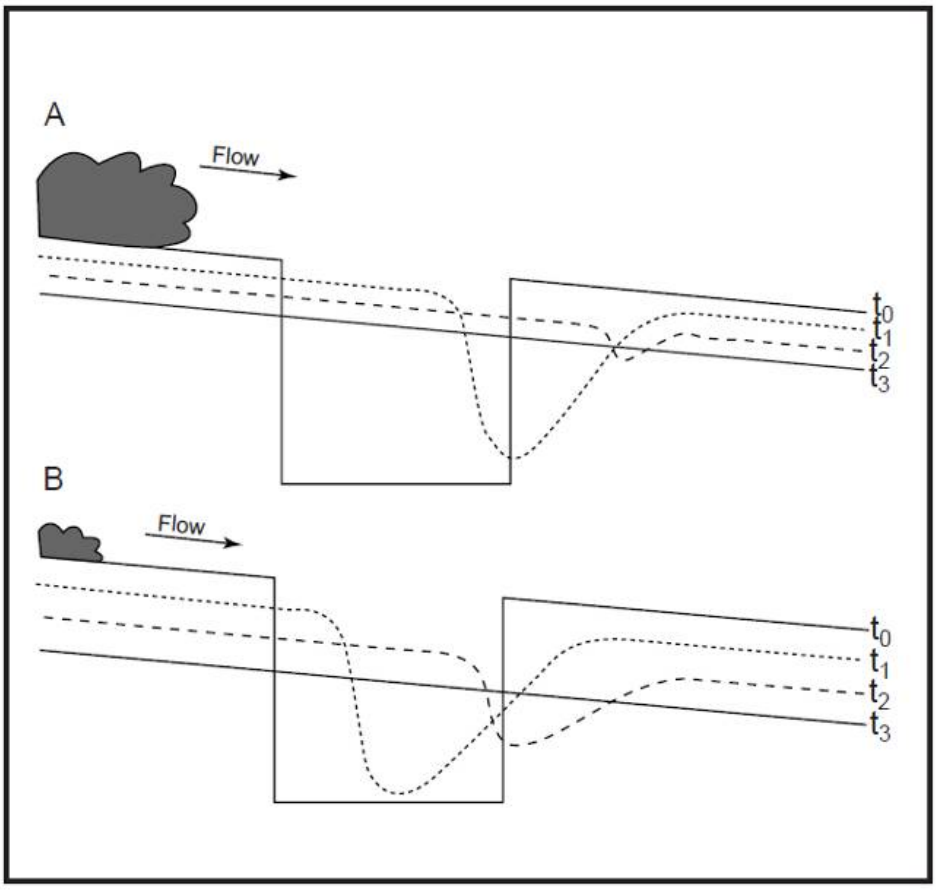
Rutherford *et al.* (2000) discuss sand and gravel extraction as a rehabilitation tool, although they cautioned that the removal of sand is only beneficial in rare circumstances and that in the majority of cases this activity should not be encouraged in waterways.

Where sediment is removed from an extraction hole, it will lead to bed degradation both upstream and downstream of the site as the stream bed moves to readjust itself. Rutherford *et al.* (2000) state that the main changes observed will be as follows:

1. The extraction hole will begin to fill with sediment moving in from upstream (the channel bedload). The proportion of sediment collected will be dependant on how large the hole is relative to the stream (the trap efficiency of the hole).
2. Following collection of sediment in the hole, the flow will pick up sediment downstream of the hole and cause downstream erosion. This will continue until the bed slope is reduced and sediment is no longer able to be picked up by the flow.
3. If there is no hydraulic control downstream of the extraction hole, the downstream scour will increase the water surface slope, triggering upstream progressing erosion. This will continue until the bed profile is smooth either side of the hole and will result in the bed being lowered by the same volume as was removed from the extraction hole.

Figure 11 Stream bed regrading following sediment extraction.

Key: t0 = aggraded bed level, t1 - t2 = bed level changes over time, t3 = resulting bed level).
A - where there is a large sediment loading (hole fills quickly and bed lowering is small), and
B - where there is a low sediment loading (hole fills slowly and bed lowering is considerable).



Source: Rutherford et al. (2000).

Knowing the rate of sediment movement into and out of a site is therefore useful to estimate sediment volumes that can be extracted and the expected time before extraction must be revisited, thus the viability of the operation. Rutherford *et al.* (2000) state that the bed load of a stream is the coarser fraction of the load that moves by jumping, sliding or rolling along the stream bed. The bed load of a stream can be estimated by determining how long it takes to fill an extraction hole below a bed control structure (such as a rock bar), although this relies on the bed load being able to move over the control structure and that the hole is large relative to the stream width.

Rutherford *et al.* (2000) also note that:

- Where it is deemed necessary to physically extract sediment, it is recommend to target the front (downstream end) of the slug, rather than the tail (upstream end) in order to prevent movement of sand into unaffected reaches and the consequent loss of instream habitat at that location.
- A good extraction site is one with up and downstream hard points (rock bars/stable riffles) that will limit the extent of degradation.
- Bed degradation may cause bank erosion if material is over-extracted (ie extraction rate is too fast and materials removed take some time to be replaced).
- Skimming from a point bar above low water level will lead to downstream erosion and potentially local erosion of the point bar itself upstream of the extraction site. However, this

method of removal will not usually result in degradation of the reach upstream of the site. Over time during bank full flows, sand would be expected to replace what was extracted, with clear water scouring sediment from the next downstream riffle and possibly the next point bar sediment deposit downstream.

- Extracting large volumes of sand from below the water level is possible from point bars or from the active channel. Removal from point bars will reduce plumes of sediment moving downstream.
- Extracting from the apex of bends may encourage the development of pools that remain clear of sand after extraction has finished due to the action of secondary circulation.
- Benches should not be extracted from as these may become stabilised and aid recovery of an aggraded (infilling) stream.
- The extraction process may result in damage to the riparian zone as the site is accessed and materials are stockpiled.

Discussion with Soil Conservation Service staff in reference to Bannockburn Creek and the Macintyre River indicated that limited removal of sand from the stream bed of may provide some benefit in controlling the impacts of the sediment slug on these environments (Tim Elder *pers. comm.* 07/08/12). It was suggested that sand could be skimmed from inside bend point bar deposits above the low water level and between two control points, so as not to cut into actual (pre-slug) stream bed and trigger head cut erosion that would move upstream beyond a particular reach. This precautionary approach will limit potential environmental impacts and encourage movement of sand away from the site as secondary circulation flows occur.

Discussion with sand and gravel extractor (and supplier) Mr Des Ward indicated that the sand present in the Bannockburn Creek sediment slug was usable material (Des Ward *pers. comm.* 21/09/12). Mr Ward indicated that sand extraction would require the use of a 20 tonne excavator to remove material from the creek or river bed and stockpile on the bank. Material would then be put onto a truck for transport using a front end loader.

For the process to be commercially viable, Mr Ward estimated he would need to be able to extract 6-10,000m^3 per year and that extraction points would need to be as close as possible to a road network for transportation to the processing depot.

Discussion with Inverell Shire Council (Karen McKenzie *pers. comm*. 20/09/12) indicated that sand could potentially be used in local projects, although volumes required were unknown.

It is therefore recommended that a bed survey be conducted for the length of sediment slug in both Bannockburn Creek and the Macintyre River. This will enable determination of the volume of sediment present in the slug, formal location of control points, depth of pools prior to aggradation.

The field inspection with landholders allowed the identification of potential control points (rocky outcrops and riffles), and access points for ease of removal and transportation. Visual assessment of Google Earth imagery identified further control points and a new crossing within Bannockburn Creek that were not visited in the field. These points are shown in Appendix A: Figures 14-17.

From these images, it can be seen that there are a number of control points along the length of Bannockburn Creek and into the slug affected Macintyre River. In addition, there are a number of access points for both waterways. However the location of both a suitable control point and a suitable access point do not necessarily coincide.

Field inspections of the Macintyre River with landowners identified five potential control points – four of which in the vicinity of the downstream end of the sediment slug (Appendix A: Figure 14). The only formal road crossing within the extent of the sediment slug, Pukawidgi Road (Figure 12), is also located in this area and is upstream of the four control points at the downstream end

of the sediment slug. This piped causeway crossing is likely to also be acting as a control point. On the upstream side sand has filled a deep hole which was previously swimmable (Sanderson *pers. comm*. 22/08/12). On the downstream side of the crossing some small scale scouring is evident from water jetting through the pipes in the crossing. The next control point upstream of Pukawidgi Road is a riffle sequence near the upstream end of the Donaldson property and would provide a reach of 2.3km to remove sand and over time potentially reinstate at least two deep holes.

Figure 12 Pukawidgi Road crossing, Macintyre River.

Key: A: road approaches (from left bank), B: scouring of sand downstream of crossing, C: shallow upstream bed level and water being sucked through pipes, D: upstream of crossing showing sand deposits in a previously swimmable hole.

A

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B

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C

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D

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Access to Pukawidgi Road is therefore not an issue, however the ability to extract sand from this location may be limited due to relatively steep surrounding banks and the road cutting into these. This would limit opportunities for machinery to turn around and for material to be stockpiled near the extraction site. As this is a public road, restrictions to local traffic would also need to be considered. In addition, the integrity of the structure would need to be investigated to determine if it could handle heavy machinery either working from the structure itself and/or accessing the river from it.

Farm tracks provide limited access to the other control points along the Macintyre River. If control points in this vicinity require access, then tracks will need to be formalised to access the river bank and localised excavation of the river bank itself required to create access tracks to potential extraction points.

In Bannockburn Creek near its confluence with the Macintyre River there are two control points in the form of rocky outcrops / riffles that are ~970m apart (Appendix A: Figure 15). In this area two access points are also present where farm tracks on Macintyre Station intersect the creek channel, allowing access to the creek bed and a cartage route. This provides an opportunity to remove sand from between the two control points prior to it entering the Macintyre River.

Further upstream within J. McCosker and R. McCosker's properties, there are a number of rocky outcrops that are acting as control points and to some extent creating local scour pools. The most downstream of these is ~1.8km upstream of the next control point downstream on Macintyre Station, with an access point also present in this area (Macintyre Station).

Excavation of sediment from between these control points and the next control point downstream would therefore allow sand removal from 2 adjacent reaches on Bannockburn Creek and restrict sand replenishment into the Macintyre River.

Within J. McCosker, R. McCosker and B. Buxton's properties numerous rocky outcrops are present in addition to 6 potential access points (Appendix A: Figures 15 and 16). Access points in this region are located where old farm tracks cross the creek and would need formalisation to allow machinery to access the creek bed and haulage trucks to cart material away. In addition, these old farm tracks pass through terrain that is steep at times, are some distance from any current formalised track and would require substantial improvement work to allow for heavy machinery access.

Toward the upper extent of the sediment slug (B. Buxton's property - Appendix A: Figure 16) there are fewer control points and only 2 potential access points present. As with those on the McCosker properties, these crossings are some distance away from formal farm tracks or roads and would require upgrading to accommodate heavy machinery.

In addition to the access restrictions for heavy machinery, and the requirement of track upgrades and stream access, Bannockburn Creek narrows substantially in the upper reaches of the project area. At its confluence with the Macintyre River, Bannockburn Creek is approximately 20m wide. This reduces to between 5 and 15m upstream with the channel generally becoming narrower toward the upper extent of the project site (and sediment slug), thus limiting the ability for larger machinery to move within the creek bed and limiting the volume of sediment that can be accessed.

Recommendation

It is recommended that physical removal of sediment be undertaken in conjunction with other activities such as instream rehabilitation works and erosion control works to reduce sediment input into Bannockburn Creek.

Instream rehabilitation works will increase the potential for localised scouring and continued movement of sediment through the system, although they will have a limited lifespan and will need to be revisited / modified at a later date.

In addition works recommended by the Soil Conservation Service, including stock control, should be implemented for priority sites within the Bannockburn Creek catchment to reduce the amount of sediment reaching the creek channel.

Should the physical removal of sand be deemed appropriate and viable, the preferred location for sediment extraction is between control points at the downstream end of the sediment slug, at Pukawidgi Road crossing on the Macintyre River, at the confluence of Bannockburn Creek and

the Macintyre River and just upstream of the confluence in Bannockburn Creek. This is due to the location of control and access points within Bannockburn Creek and the Macintyre River and follows recommendations made by Rutherford *et al.* (2000).

Working from these four locations will:

- Limit sediment movement further downstream in the Macintyre River and protect unaffected habitats.
- Allow sand removal from a reach approximately 1km at the downstream end of the sediment slug.
- Allow sand removal from a reach approximately 2.3km long upstream of Pukawidgi Road.
- Allow sand removal from a reach approximately 970m long near the confluence of Bannockburn Creek and the Macintyre River, limiting sediment entering the Macintyre River.
- Allow sand removal from a reach approximately 1.8km long upstream of the confluence reach on Bannockburn Creek.

Sediment removal from the downstream end of the slug will require some formalisation of access points – including localised cutting into the river bank and formalisation of farm access tracks where required (likely to be easiest from the Sanderson property [left bank]).

Removal of material from Pukawidgi Road crossing will require investigation of structure stability for working from or accessing the river bed. Potentially some river bank work will be required to provide an area for stockpiling material. Traffic management procedures will need to be implemented during the course of works.

Removal of sediment from near Bannockburn Creek's confluence with the Macintyre River should occur between the 3 control points so as to restrict waterway impacts. Site access will need to be formalised, and connect into the existing farm track network.

Prior to any extraction activity taking place, detailed consultation with affected landholders must occur and all appropriate permits should be obtained from the relative agencies.

Legislative Requirements

Prior to undertaking any physical removal of sediment from Bannockburn Creek or the Macintyre River, landowners consent will be required to access extraction points and pass through private land. As a minimum, the following legislative requirements must also be adhered to – a summary of which is presented in Table 3.

Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

The *EPBC Act 1999* (Commonwealth) provides a mechanism for assessing environmental impacts of development proposals and other activities where there may be an effect on 'matters of National Environmental Significance' (NES). Any action that will or is likely to have a significant impact on a matter of NES is referred to the Commonwealth Minister for the Environment for determination as a controlled action, and where a possible significant impact on an NES matter is likely, a proposal should be referred to the Commonwealth Minister for approval.

In January 2007 the Commonwealth and NSW governments signed a Bilateral Agreement which accredits the assessment process under Part 3A, 4, and 5 of the NSW *EP&A Act* for assessment purposes under the *EPBC Act* where a proposal is determined as a controlled activity in relation to a NES matter. This would only apply if the current proposal was likely to impact significantly on an NES matter such as a threatened species.

In April 2012, the Federal Environment Minister listed Queensland, NSW and ACT koala populations as vulnerable under national environment law. As shown in Appendix B, there are records of koalas present in and around the study area.

The decision as to whether or not to refer a proposal in relation to the potential for a significant impact on the koala or other matters of national environmental significance rests with the proponent.

The Federal Department of Sustainability, Environment, Water, Population and Communities is currently developing *EPBC Act* referral guidelines for the vulnerable koala. These guidelines will assist proponents to determine whether they need to refer their actions for assessment under the *EPBC Act*.

In the interim, the department has developed preliminary advice on whether a proponent may need to refer their action. This document is called the "Interim koala referral advice for proponents" and lists secondary impacts such as an increase in vehicle-related koala fatalities leading to a long-term decline in a population as a potential reason for referral.

Although it is unlikely the extraction activities will have an impact on this species, an assessment of potential impacts must be undertaken to assess whether referral is required.

Environmental Planning and Assessment Act, 1979 (EP&A Act) and Environmental Planning and Assessment Regulation 2000 (EP&A Reg)

Under Part 5, Section 111 of the *Environmental Planning and Assessment Act 1979* (*EP&A Act*), a determining authority must undertake an environmental assessment of the proposed "activity" and take into account a range of matters prescribed in Clause 228(2) of the *Environmental Planning and Assessment Regulation 2000*, in its decision to approve an "activity" which does not require development consent (such as for environmental protection works).

This assessment may take the form of a Review of Environmental Factors (REF), or an Environmental Impact Statement (EIS) depending on whether the proposal is classed as a "designated development" and therefore the determined potential impact on threatened species, populations or ecological communities (in which case an Environmental Impact Statement will be required).

Under Schedule 3, Part 1(19) of the *Environmental Planning and Assessment Regulation 2000*, "designated development" includes extractive industries that obtain or process for sale, or reuse, more than 30,000 cubic metres of extractive material per year or are located within 40 metres of a natural waterbody, wetland or an environmentally sensitive area.

Under this same Part, extractive industries are not classed as "designated development" for reasons including if they are undertaken in accordance with a plan of management (such as river, estuary, land or water management plans), provided that:

(i) the plan is prepared in accordance with guidelines approved by the Director-General and includes consideration of cumulative impacts, bank and channel stability, flooding, ecology and hydrology of the area to which the plan applies, approved by a public authority and adopted by the consent authority and reviewed every 5 years, and

(ii) less than 1,000 cubic metres of extractive material is removed from any potential extraction site that is specifically described in the plan.

At Bannockburn Creek and the Macintyre River, the total annual volume of material is highly likely to be over 1,000m^3, with Mr Ward (commercial operator) requiring 6-10,000m^3 per year of material for an extraction operation to be commercially viable. This means that, in order to obtain a commercially viable amount of material, between 6-10 extraction sites would be needed to prevent the activity not being classed as designated development. This number of extraction sites is unlikely to be possible due to access restrictions.

In the absence of a river, land or water management plan identifying extraction activities as part of the plan, extraction activities will be classed as designated development.

As designated development, the proposal will therefore require production of an Environmental Impact Statement, which must be forwarded along with the request for approval to the consent authority and the Director-General responsible for the *Environmental Planning and Assessment Regulation 2000*.

Notice of the proposed activities must also be advertised and allow time for public submissions to be received (which must then also be forwarded to the relevant Director-General).

Interrogation of BioNet Atlas of NSW Wildlife website for the Inverell Shire LGA, identified three species of threatened fauna and two species of threatened plants in or surrounding the Bannockburn Creek and Macintyre River study area.

The location of threatened fauna and flora records from near the study area are shown in Appendix B. Threatened species identified are:

- Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*).
- Diamond Firetail (*Stagonopleura guttata*).
- Koala (*Phascolarctos cinereus*).
- Lobed Bluegrass (*Bothriochloa biloba*).
- Austral Toadflax (*Thesium australe*).

Should extraction works proceed, it is recommended that a formal flora and fauna assessment be undertaken to aid the development of an Environmental Impact Statement by identifying if any of these species are located within the works site(s) and may be affected by extraction activities.

Threatened Species Conservation Act 1995 (TSC Act)

The *TSC Act* requires that an assessment is undertaken to ensure that there will be no significant impact on Threatened Species, Endangered Populations and Endangered/Vulnerable Ecological Communities scheduled under the Act. The *TSC Act* is administered by the NSW Office of Environment and Heritage (OEH).

A Section 5A assessment under the *EP&A Act* is a similar requirement for threatened species listed under the *TSC Act* that are considered 'identified' subject species and that may be significantly impacted by a proposal or activity.

It is unlikely that any of the identified threatened species will be affected by extraction activities as these works will be localised associated with the waterways. However it is possible that access points and cartage tracks could intersect with threatened plant species or food species/habitat of the threatened fauna. The potential risk of harm to these species should be assessed prior to undertaking any works within the study area.

Protection of the Environment Operations Act 1997 (POEO Act)

The *POEO Act* gives the Office of Environment and Heritage (OEH) powers to prosecute for unlicensed polluting activities. The OEH must be consulted as part of the consultation/approval process associated with the project. OEH will provide advice in relation to any proposed measures that might be required to avoid impacts on threatened species or pollution of waters from sediments entering the stream flow as a result of the works.

The proposed works are defined in the Scheduled Works under the *POEO Act* as "water-based extractive activity" where the activity "involves the extraction of more than 30,000 cubic metres per year of extractive materials". As such a Pollution License is required for this proposal.

Fisheries Management Act 1994 (FM Act)

NSW Department of Primary Industries Fisheries (DPI Fisheries) administers the *Fisheries Management Act 1994*, in which extraction of material from a waterway is classed as dredging and generally requires a Part 7 Permit (informally known as a Dredge and Reclamation Permit).

Dredging can include the excavation or removal of material from a waterway such as large woody debris, aquatic vegetation, boulders, gravel and sediment beds. Reclamation includes draining, infilling and clearing of land and placement of material (such as soil, rock, artificial structures and woody debris) into a waterway.

Under Part 7 Division 3, Section 199, a public authority (other than local authority, but including the Minister administering the *Crown Lands Act 1989*) may carry out dredging or reclamation without the need for a Part 7 Permit provided:

- the public authority (other than a local government authority) gives the Minister written notice of the proposed work before it carries out or authorises the carrying out of dredging or reclamation work.
- it considers any matters concerning the proposed work that are raised by the Minister within 28 days after the giving of the notice (or such other period as is agreed between the Minister and the public authority).

Information required to aid the assessment of an extraction activity in a waterway include:

- the volume of sand proposed for extraction.
- operational plans, including extraction operations, location of stockpiles, volume of stockpiles, buffer zones, no go areas, etc.
- description and quantification of aquatic and riparian habitat present. This should include an assessment of the extent and condition or riparian vegetation and the extent and condition of freshwater aquatic vegetation and the presence of significant habitat features (e.g. gravel beds, snags, reed beds, etc).
- quantification of the extent of aquatic and riparian habitat removal or modification.
- threatened species assessment as per Part 7A of the *Fisheries Management Act 1994* (for silver perch (*Bidyanus bidyanus*); olive perchlet (*Ambassis agassizii*); and purple spotted gudgeon (*Mogurnda adspersa*)).
- details of the location of any waterway crossings or access tracks.
- Environmental Management Plans (EMPs) during operations, to monitor geomorphic stability, bed lowering, bank slumping, water quality, etc, particularly after flood events.
- location of extraction site(s) and distance from which it is being removed (reach affected).
- fluvial geomorphology study including:
    - sand deposition rates.
    - creek/river profiles (original bed level, bed grade and channel volume) overall, but in particular in the area around extraction points.
    - creek/river cross sections at extraction points (reach) between control points.
    - indication of likely geomorphic response of the waterway to extraction of large volumes of sand.
- rehabilitation plan.
- issues requested by Inverell Shire Council.

It should be noted that in recent times NSW Department of Primary Industries Office of Water and DPI Fisheries have generally been discouraging existing operations from works within the Gwydir River near Uralla.

However, discussions with the Fisheries Ecosystems Unit of DPI Fisheries (David Ward and Marcus Riches *pers. comm.*, 11/12/12) have indicated that there is no in-principle objection to a sand extraction proposal for habitat rehabilitation.

Water Management Act 2000 (WM Act)

NSW Department of Primary Industries Office of Water (DPI Office of Water) administers the *Water Management Act 2000*. Permits to undertake works in a waterway under the *Water Management Act 2000* are known as Control Activity Approvals. A Controlled Activity Approval confers a right on its holder to carry out a specified controlled activity at a specified location in, on or under waterfront land.

Public authorities are exempt from requiring a Controlled Activity Approval. In addition, as the works would be on Crown Land, the Extractive Industries Licence would be sufficient approval with concurrence from DPI (Fisheries) (Chris Binks *pers. comm.* 14/12/12). Despite not requiring a Controlled Activity Approval, a letter of concurrence for the proposed works should be sought from the DPI (Office of Water) prior to undertaking any works.

Discussion with a representative from DPI Office of Water (Chris Binks *pers. comm*. 19/09/12) indicated that the requirement for an Environmental Impact Study (EIS) would be dependant on the volume of sand proposed for removal, with an area less than 200m in length unlikely to require such investigation.

Further information that will aid assessment of an extraction activity by DPI Office of Water is the presence of aboriginal heritage items or sites of significance.

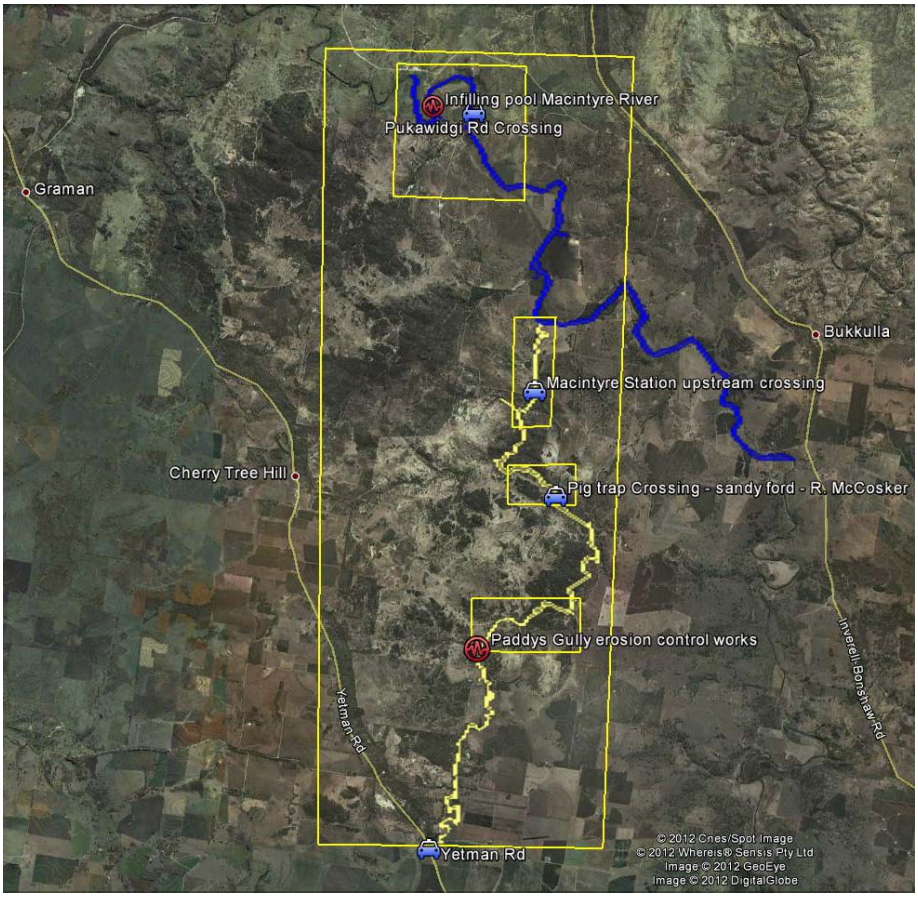
National Parks and Wildlife Act 1984 (NP&W Act)

Indigenous heritage items or places are protected under the *National Parks and Wildlife Act 1994*. Sites and items of significance are listed in the Aboriginal Heritage Information Management System (AHIMS), which is a database of all known sites where significant items have been found.

Interrogation of the AHIMS database with 50m and 1km radii was undertaken for the study area (length of Bannockburn Creek downstream of Yetman Road and the Macintyre River from upstream of the Bannockburn Creek confluence to past the extent of the sediment slug) in addition to smaller searches within the study area that related to potential extraction sites. These search extents are shown in Figure 13.

This search revealed no registered indigenous artefacts of significance within the largest search extent (the large rectangle in Figure 13); however one site of significance was noted within 1km of the search extent shown on the Macintyre River at the downstream end of the sediment slug (Table 2). It is unlikely that this artefact or site of significance lies within the potential extraction area as it was not identified during interrogation for the overall project site.

Figure 13 AHIMS database search extents – Bannockburn Creek and Macintyre River.



Imagery: Google Earth, 20/06/2010.

Table 2 AHIMS search findings for Bannockburn Creek and Macintyre River study area.

Search area	Coordinates	50m radii	1km radii	Item
Study area *(Bannockburn Creek downstream of Yetman Road; Macintyre River from upstream of sediment slug to small distance downstream)*	From Lat - 29.61393 and - 29.44027 to Long 151.07205 and 151.08062	0	0	-
Downstream end of sediment slug *(downstream of sediment slug to upstream of Pukawidgi Road)*	From Lat - 29.47101 and - 29.44069 to Long 151.02039 and 151.05387	0	1	Site (artifact)
Confluence *(downstream end of Bannockburn Creek)*	From Lat - 29.52147 and - 29.49733 to Long 151.05117 and 151.0605	0	0	-
McCosker properties *(centred around farm track crossing access point)*	From Lat - 29.53753 and - 29.52996 to Long 151.05039 and 151.06429	0	0	-
Buxton property *(downstream of Paddy's Gully erosion control works)*	From Lat - 29.57152 and - 29.56034 to Long 151.04032 and 151.0663	0	0	-

Crown Lands Act 1989 (CL Act)

NSW Department of Primary Industries Catchments and Lands (DPI Catchments and Lands) administers the *Crown Lands Act 1989*, which provides a regime for the ownership and management of Crown Land.

Cadastral boundaries in the project area indicate the bed of Bannockburn Creek and the Macintyre River belongs to the Crown for the area affected by the sediment slug.

Discussion with DPI Catchments and Lands (Armidale) indicated that under Part 34A of the *Crown Lands Act 1989*, an Extractive Industries Licence would be required to remove sand from Bannockburn Creek and the Macintyre River if the sand was on-sold as a commercial enterprise or used by local government (Rod O'Brien *pers. comm*. 06/12/12). If the material was used for environmental restorative purposes (i.e. no commercial gain) no such licence would be required. In this case a Letter of Authority would be provided from DPI Catchments and Lands that would last a period of 12-24 months, after which it would be reviewed.

At a minimum, a Review of Environmental Factors relating to the extraction process would be required to allow assessment of the activity prior to issuing either an Extractive Industries Licence or Letter of Authority.

The Extractive Industries Licence would have an open end date and when issued, it would have a number of conditions including the requirements of other agencies and those identified in the Review of Environmental Factors and local council development application.

Preferentially the licence would be issued to the extractive operator rather than the CMA to allow ease of monitoring of the operation (for the purposes of collecting royalties and ensuring licence conditions are met).

Costs incurred for an Extractive Industries Licence comprise an application fee ($383.60), an annual rent and a royalty based on the volume of material extracted. The annual rent will be dependant on the number of sites from which extraction is taking place (being in the range of hundreds of dollars per site), how much material is being removed and how often. A greater number of extraction sites will increase the rent, but rent charges will decrease with a greater volume of material removed. Royalties are currently charged at $2/tonne of material removed (December 2012).

A small application fee is the only cost incurred for provision of a Letter of Authority.

Native Vegetation Act 2003 (NV Act)

The Border Rivers-Gwydir Catchment Management Authority is the body responsible for the administration of the *Native Vegetation Act 2003*.

Currently, it is illegal to remove or damage vegetation, without a permit, from within 20 metres of the banks of nominated waterways in NSW (Category B State Protected Land or SPL). While the *Native Vegetation Act 2003* regulates clearing of live native vegetation, the clearing of dead native vegetation or exotic vegetation on SPL is still regulated by the old *Native Vegetation Conservation Act 1997*.

Under the *NV Act*, all clearing requires approval through either a Property Vegetation Plan (PVP) or a Development Consent, unless it is: (i) on land that is excluded from the Native Vegetation Act; (ii) categorised as excluded clearing; or (iii) a permitted clearing activity. Activities such as pruning, lopping or slashing of native groundcover, that do not kill the native vegetation, are not considered clearing.

Around the locations where extraction is recommended, little to no native vegetation is likely to be affected. The banks of the Macintyre River near the downstream end of the sediment slug are largely devoid of overstory species and are covered in native and exotic grasses and weed species such as burr (*Xanthium* spp.).

Near the junction of Bannockburn Creek and the Macintyre River, some mature eucalypts are present, although these are relatively sparse. Access to these locations will be across cleared farm paddocks, and for the most part along established farm tracks.

Within the river channel, minimal riparian vegetation is present but includes the presence of sedges, which may be affected by extraction operations.

It is recommended that a flora assessment be undertaken to determine location of vegetation that may be impacted by extraction activities, stockpiling and cartage.

Following any works undertaken in the area, the site (including stockpile locations and access points) should be revegetated with native species. Control of stock access will improve the potential for recovery.

The Noxious Weeds Act 1993 (NW Act)

At least one noxious weed species (*Xanthium* spp.) is present along the Macintyre River. *Xanthium* spp. are Class 4 noxious weeds requiring local control under the *NSW Noxious Weeds Act 1993*. As such, a weed management plan should be prepared to combat the spread of weeds prior, during and after extraction work.

Inverell Local Environment Plan 1988 (LEP)

The *Inverell Local Environment Plan 1988* (LEP) has the study area zoned Zone 1(a) – Rural (Agricultural) Zone.

Under the *Inverell LEP* development consent would normally be required for sand extraction as it is not a listed activity under Zone 1(a), however correspondence from Inverell Shire Council (Anthony Alliston, 20/11/12) states that works are “considered to be development permitted without consent”, and are therefore permissible under Council’s zoning provisions in the LEP. No fees will therefore be incurred. Appendix C presents this communication.

Within the LEP no European heritage items are listed in area of Bannockburn Creek and the Macintyre River where sand slug occurs.

SEPP Infrastructure 2007

Inverell Shire Council is also responsible for implementation of the *Infrastructure SEPP*. Under Regulation 129 of Division 25 of this SEPP development for the purpose of waterway or foreshore management activities may be carried out by or on behalf of a public authority without consent on any land. Waterway or foreshore management includes:

- construction works
- routine maintenance works
- emergency works including works required as a result of flooding, storms or coastal erosion, and
- environmental management works.

Correspondence from Inverell Shire Council (Anthony Alliston, 20/11/12) states that works undertaken at Bannockburn Creek and the Macintyre River to extract sand are being carried out for environmental benefit (/management) by, or on behalf of a public authority and are therefore exempt under the *Infrastructure SEPP*. Appendix C presents this communication.

SEPP (Mining and Petroleum Production and Extractive Industries) 2007

This SEPP attempts to standardise the approach throughout NSW to the assessment and approval of mining activities under Part 4 of the *EP&A Act*.

The SEPP contains provisions which:

- establish whether mining activities require development consent

- limit the ability of a local environmental plan to regulate when mining can be carried out
- declare minor aspects of a mining operation to be exempt or complying development
- require a consent authority to consider the compatibility of the proposed mining activity with other land uses in the area, and on surface and groundwater and
- require a consent authority to consider imposing conditions requiring the rehabilitation of land.

The consent authority for the purposes of this Policy (subject to the Act) is the Council of the area in which the relevant land is situated.

Under Regulation 7 of this SEPP, development permissible with consent includes mining and extractive industries in any part of a waterway of the State that is not in an environmental conservation zone.

Before determining an application for consent for development for the purposes of mining, petroleum production or extractive industry, the consent authority must consider and evaluate (amongst others):

- the potential impacts on other land uses in the area
- the potential efficiency of operation
- the respective public benefits
- impacts on significant water resources, including surface and groundwater
- threatened species and biodiversity.

Under the *Inverell LEP* development consent would normally be required for sand extraction as it is not a listed activity under Zone 1(a), however correspondence from Inverell Shire Council (Anthony Alliston, 20/11/12) state that works are considered to be development permitted without consent, and are therefore permissible under Council's zoning provisions in the LEP. No fees will therefore be incurred. Appendix C presents this communication.

SEPP 44 Koala Habitat Protection

Interrogation of the BioNet NSW Atlas of Wildlife found only one sighting record of a koala along Bannockburn Creek upstream of the sediment slug near Yetman Road, although several other records were listed from the surrounding area (Appendix B).

Although it is unlikely extraction works will affect them, there is potential for koala food trees to be located in the study area. Assessment of the affects of sand extraction activities on this species and its food trees is therefore recommended and will aid the development of an Environmental Impact Statement.

Summary of Legislative Requirements

Table 3 Summary of legislative requirements relating to sediment extraction from Bannockburn Creek and the Macintyre River.

Legislation	Activity	Required?
EPBC Act 1999	Assess whether the activity will have a significant impact on the koala as a nationally listed vulnerable species.	Assessment required
EP&A Act 1979 and EP&A Reg 2000	Environmental Impact Statement required as the activity is classed a "designated development" as it is not part of works identified in a river, land or water management plan and extraction volumes are greater than 1,000m^3).	EIS required
TSC Act 1995	Assessment of the potential risk of harm to threatened species (brown treecreeper, diamond firetail, koala, lobed bluegrass and austral toadflax).	Assessment required
POEO Act 1997	Pollution Licence required if extraction of more than 30,000m^3 per year of extractive materials.	Licence required
FM Act 1994	Part 7 Permit not required for a Public Authority, but notice must be given to the Minister and matters raised considered. Various issues required to be assessed to allow for comment. Includes works to install instream structures.	Assessment required
WM Act 2000	Public Authorities are exempt from requiring a Controlled Activity Approval (CAA), although concurrence from DPI Office of Water required. A Controlled Activity Approval is required if the operation is a commercial exercise.	CAA required if commercial operation, concurrence otherwise
CL Act 1989	Extractive Industries Licence required if operation is a commercial exercise or used by local government. If not a commercial exercise, then a Letter of Authority is required. Initial application and annual rent cost. Licence preferentially linked to extractor rather than CMA.	Licence required
NV Act 2003	If vegetation to be removed, a property management plan (PVP) is required to allow assessment and approval.	PVP required
NW Act 1993	Weed Management Plan (WMP) required for areas affected by noxious weeds – at least mainstem Macintyre River.	Assessment and WMP required
Inverell LEP 1988	Works are considered to be development permitted without consent, and are therefore permissible.	None required
SEPP Infrastructure 2007	Works being carried out for environmental benefit (/management) by, or on behalf of a public authority are exempt.	None required
SEPP Mining and Petroleum and Extractive Industries 2007	Works are considered to be development permitted without consent, and are therefore permissible.	None required
SEPP 44 Koala Habitat Protection	Assessment of the effects of the activity on koala and their food trees required.	Assessment required

Further Investigations Required

It is recommended that the following investigations be undertaken prior to initiating sediment extraction activities.

Fluvial geomorphology study

Bed survey (longitudinal profile, cross sections in areas of extraction)

A longitudinal bed survey will allow determination of the existing bed grade within Bannockburn Creek and the Macintyre River, potentially allowing calculation of the rate of readjustment following sediment extraction and likely geomorphic response to the removal of large volumes of sand.

A longitudinal bed survey of the previous river bed levels will allow identification of historic deep water habitats within the study area.

Cross-sections within the vicinity of sediment extraction (within the reach between the next upstream and downstream control points) will help determine sediment volumes likely to be extracted from the reach and therefore the efficiency of operation and whether it would be commercially viable to an operator.

Rate of sediment replenishment

As described by Rutherford *et al.* (2000), test hole(s) should be constructed to determine potential rates of refill for each reach where sediment extraction is occurring. This will enable determination of commercial viability, how often extraction activities will need to run for or be revisited (years / decades).

Flora and fauna assessment

A comprehensive survey of the study area, particularly in the areas proposed for sediment extraction and their access routes should be undertaken to determine the presence/absence of threatened species, in particular those listed above. This assessment will aid the development of an Environmental Impact Statement.

Further landholder consultation

Discussions with local landholders during the field inspections indicated support for improvement to the instream habitat of Bannockburn Creek and the Macintyre River, including the use of direct physical removal of sediment.

Further consultation is required for those landholders where such an activity would take place – being those at the downstream end of the sediment slug and Pukawidgi Road (Sanderson and Donaldson) and at the Bannockburn / Macintyre River confluence (Stevens, Bell Investments and Sanderson).

These landholders will be directly affected by extraction activities, including the presence of heavy machinery on or adjacent to their properties and travelling through them.

Conclusion

The physical extraction of sand may provide potential “breathing space” for identified reaches within the sediment slug. This will potentially reinstate refuge habitat for fish and other aquatic species and allow re-establishment of aquatic vegetation until these reaches begin to refill.

It is recommended that physical removal of sediment be undertaken in conjunction with other activities such as instream rehabilitation works (installation of woody debris in extraction and other reaches) and works to control sediment input into Bannockburn Creek.

Instream rehabilitation works will increase the potential for localised scouring and continued movement of sediment through the system. In the upper sections of Bannockburn Creek, stabilisation of sediment could be achieved through planting of native reeds (such as common reed), which are already present upstream. Reeds will act to collect and bind some sediment, whilst aiding scouring within the channel as growth acts to constrict the channel width.

In addition works recommended by Soil Conservation Service, including stock exclusion, should be implemented for priority sites within the Bannockburn Creek catchment to reduce the influx of sediment into the creek channel.

If physical extraction is deemed beneficial, a focus should be placed at and near the downstream end of slug and at and near the confluence of Bannockburn Creek and the Macintyre River. By focusing on these locations, further infilling of downstream habitat within the Macintyre River will be prevented and movement of sediment from Bannockburn Creek will be reduced. Extraction at the confluence of Bannockburn Creek and the Macintyre River will allow recovery of the upstream section of the Macintyre and potentially lead to improved sand scour as sediment replenishment is reduced.

At sites of physical extraction, it is recommended that sediment removal occurs from the apex of bends where possible. This may encourage the development of pools that remain clear of sand after extraction is completed due to the action of secondary circulation (Rutherford *et al.* 2000).

Any work site and access tracks will need to be rehabilitated (revegetated with local native species) following extraction activities. In the long term this should be using tree and shrub species in the riparian zone and during intermediary periods with native grasses.

Prior to undertaking sediment extraction activities, further assessments will be required to determine potential impacts on threatened species present. As works have not been identified in a river, land or water management plan, works are classed as designated development under the *EP&A Act 1979* and therefore require an Environmental Impact Statement to be developed.

If more than 30,000 cubic metres of material is extracted per year, a Pollution Licence and Extractive Industries Licence will be required from the OEH and DPI Catchments and Lands respectively. If materials extracted provide some commercial benefit, a Controlled Activity Approval will be required from DPI Office of Water. DPI Fisheries will need to be notified of proposed works and matters raised by the department will need to be considered. A Property Vegetation Plan and Weed Management Plan may also be required.

References

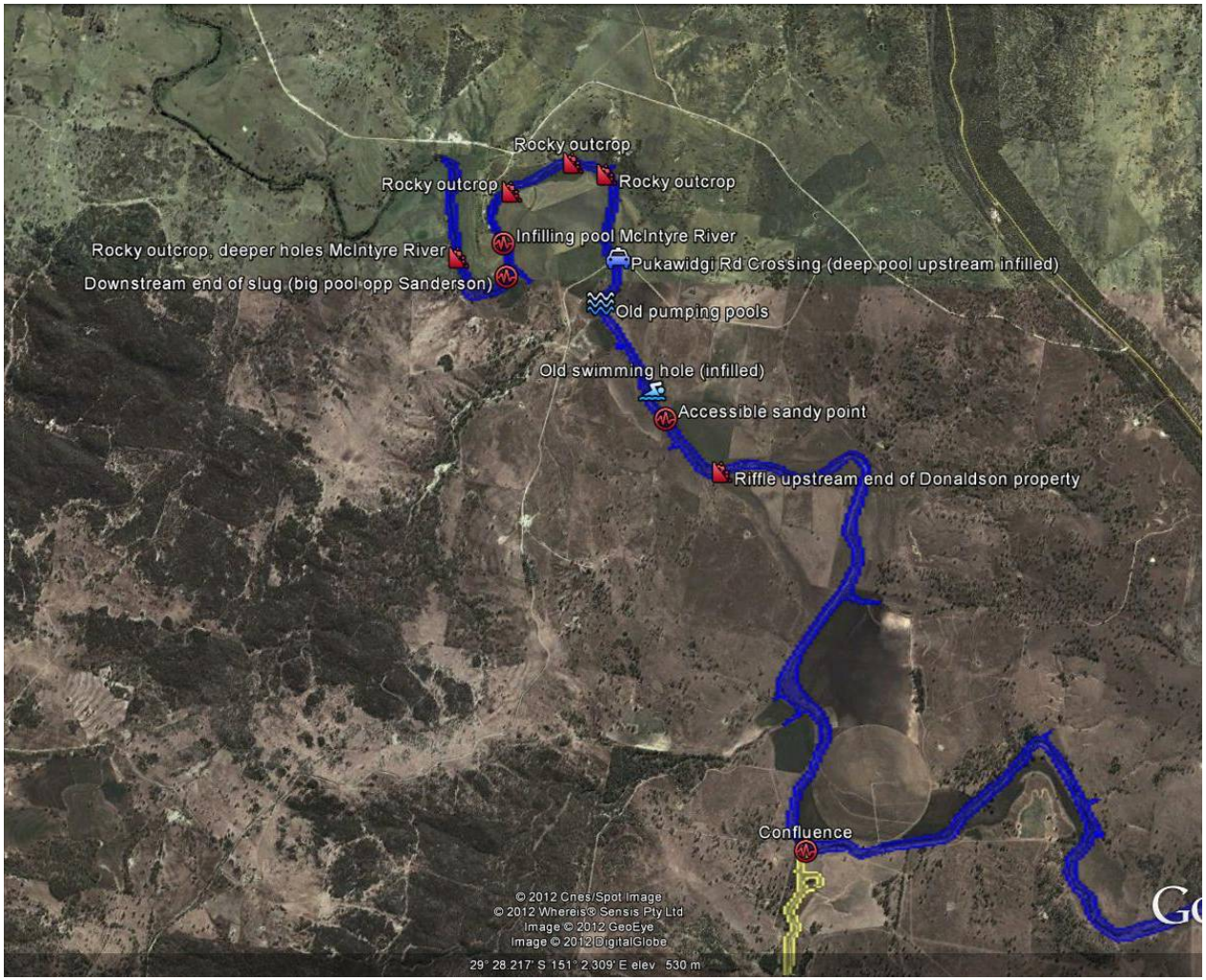
Brooks, A., Abbe, T., Cohen, T., Marsh, N., Mika, S., Boulton, A., Broderick, T., Borg, D. and Rutherford, I. (2006) *Design guideline for the reintroduction of wood into Australian streams.* Land & Water Australia, Canberra.

Rutherford, I., Jerie, K. and Marsh, N. (2000) *A rehabilitation manual for Australian streams. Volume 2. Intervention Tools: intervention in the channel*. Land and Water Research and Development Corporation, Canberra.

Appendix A – Points of interest in Bannockburn Creek and the Macintyre River

Figure 14 Macintyre River sites affected by the sediment slug.

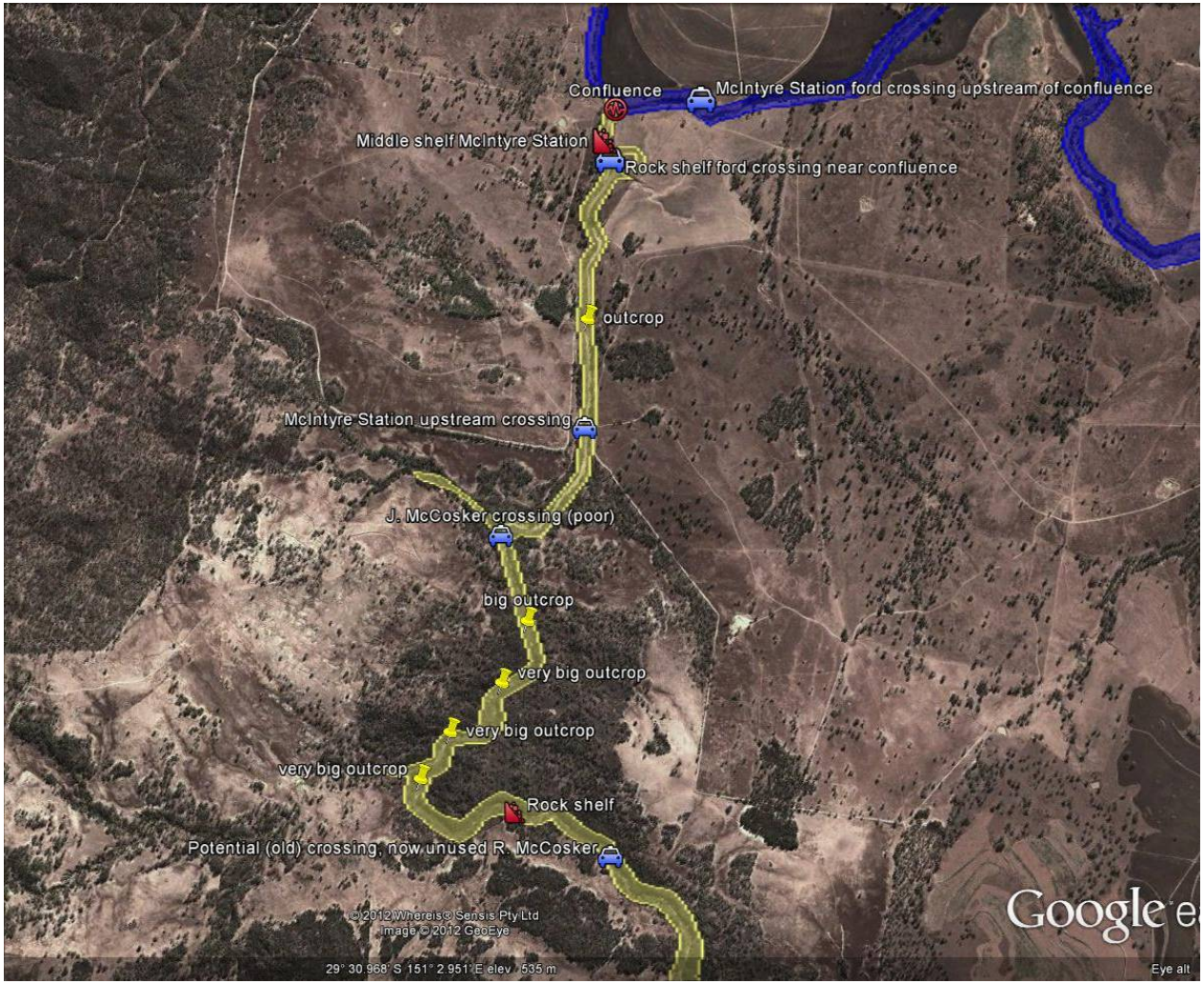
Sites were identified during field inspections with landholders August 22-24, 2012 control points (rock icon), potential access points (car icon) and other sites of interest (other icons).



Imagery from Google Earth, 20/06/2010.

Figure 15 Lower Bannockburn Creek sites.

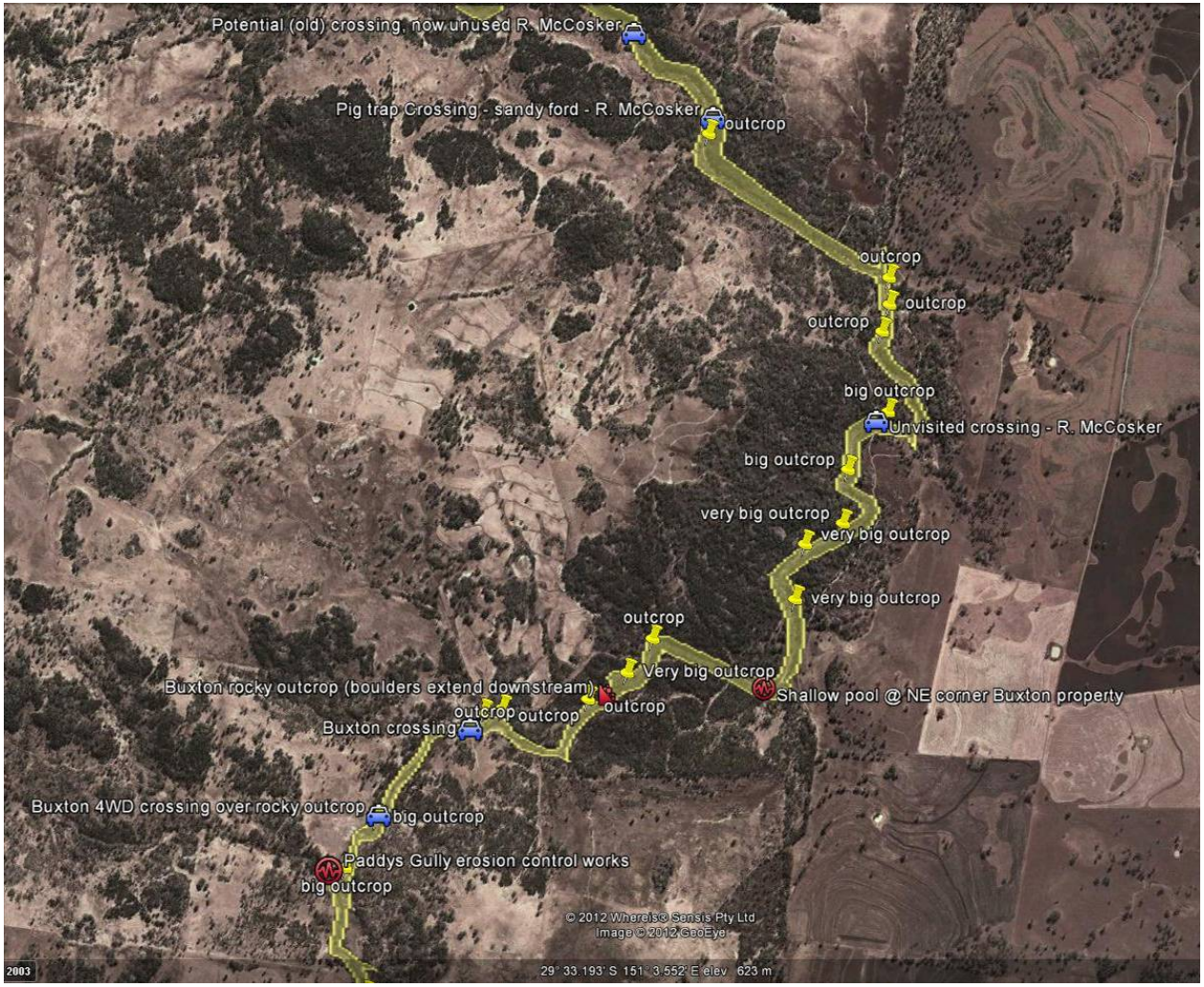
Sites were identified during field inspections with landholders August 22-24, 2012 including control points (rock icon) and potential access points (car icon) and those identified through analysis of Google Earth imagery (yellow pins).



Imagery from Google Earth, 20/06/2010.

Figure 16 Mid Bannockburn Creek sites.

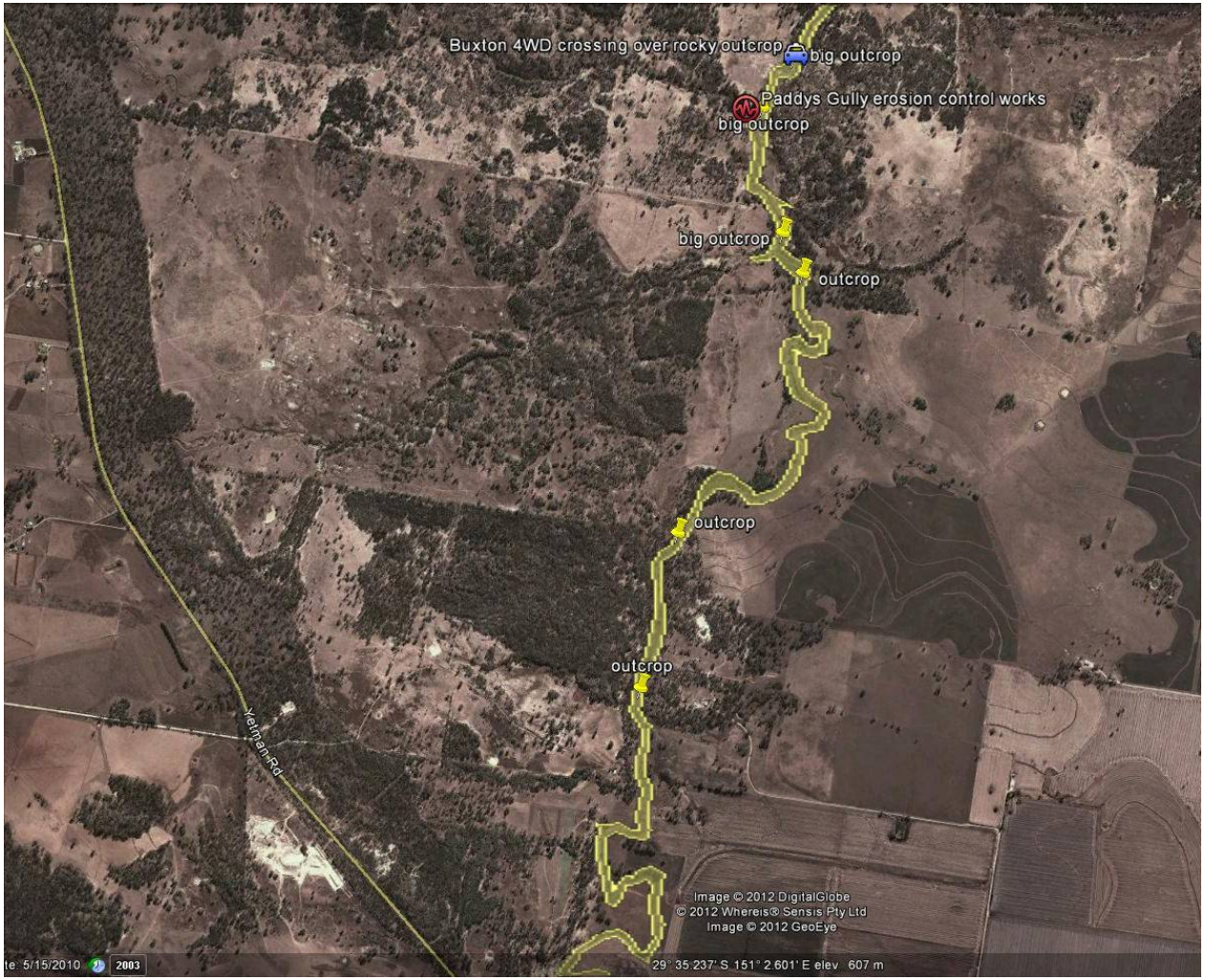
Sites were identified during field inspections with landholders August 22-24, 2012 including control points (rock icon) and potential access points (car icon) and those identified through analysis of Google Earth imagery (yellow pins).



Imagery from Google Earth, 20/06/2010.

Figure 17 Bannockburn Creek sites downstream of Yetman Road.

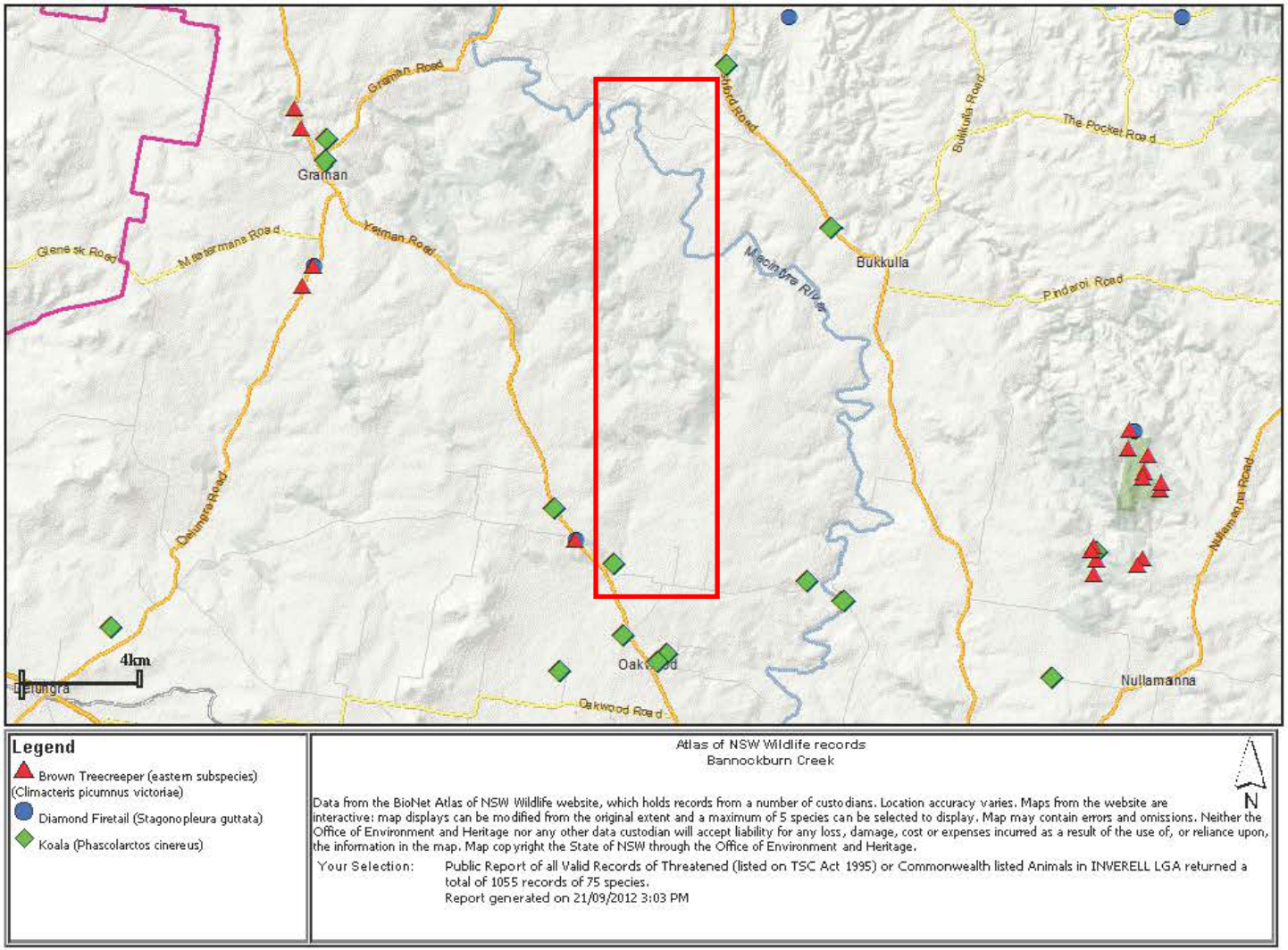
Sites identified during field inspections with landholders August 22-24, 2012 including potential access points (car icon) and those identified through analysis of Google Earth imagery (yellow pins).



Imagery from Google Earth, 20/06/2010.

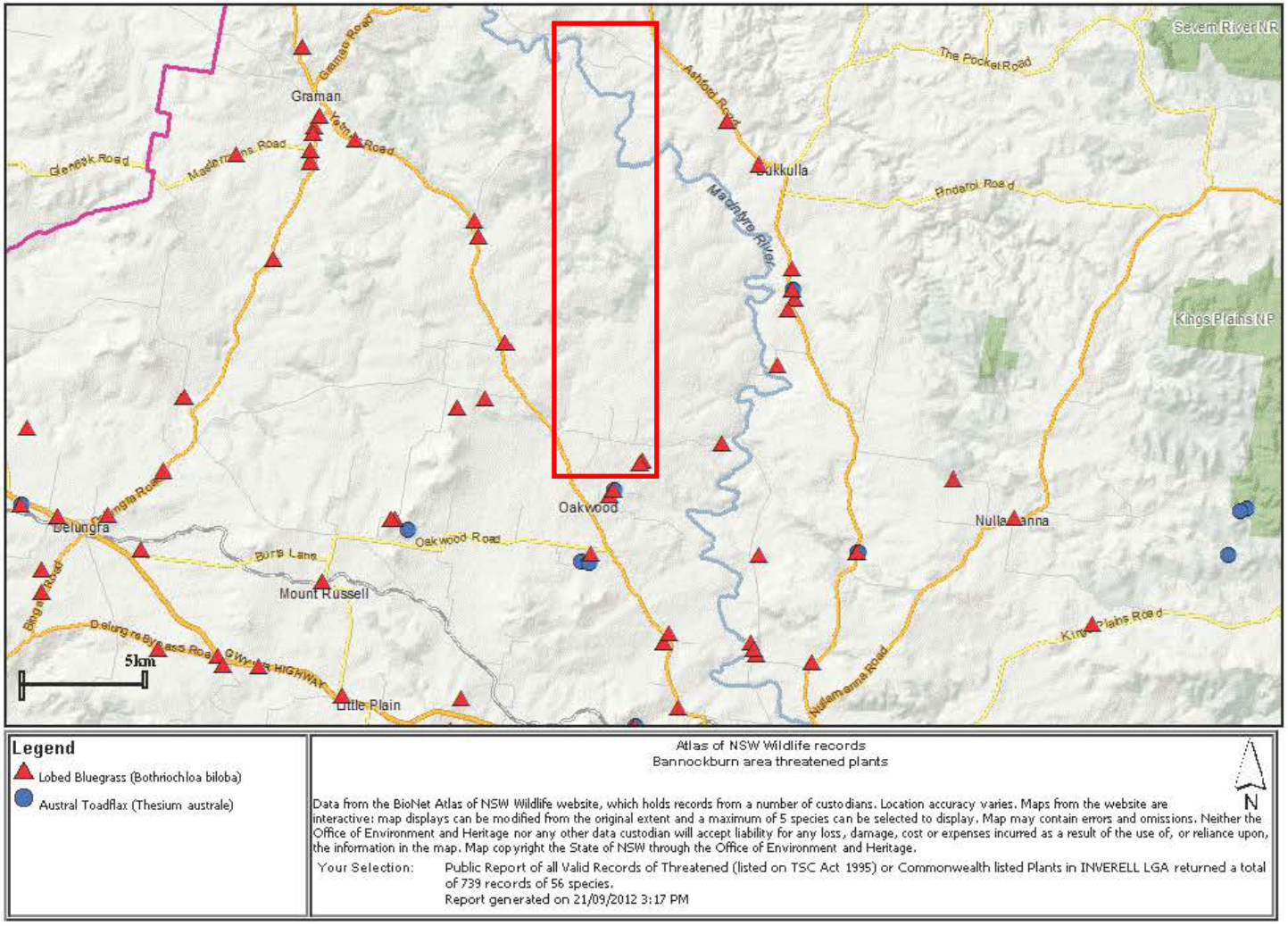
Appendix B – Threatened fauna near study area

Figure 18 BioNet Atlas of NSW Wildlife records for threatened fauna.



BioNet Atlas of NSw Wildlife report generated 21/09/2012.

Figure 19 BioNet Atlas of NSW Wildlife records for threatened flora.



BioNet Atlas of NSw Wildlife report generated 21/09/2012.

Appendix C – Inverell Shire Council correspondence regarding sediment removal

INVERELL SHIRE COUNCIL

Our Ref: s7.2.7; 12/24143
Author: Elise Lockwood, Trainee Town Planner

20 November 2012

NSW Department of Primary Industries
1243 Bruxner Highway
WOLLONGBAR NSW 2477

Attention: Scott Nichols

e-mailed: scott.nichols@dpi.nsw.gov.au

Dear Scott,

APPLICATION REQUIREMENTS FOR INSTREAM HABITAT REHABILITATION PLAN FOR PARTS OF BANNOCKBURN CREEK AND THE MACINTYRE RIVER

Reference is made to your e-mail dated 14 November 2012 requesting advice of any application requirements to undertake sand extraction as part of instream habitat rehabilitation for parts of Bannockburn Creek and the Macintyre River.

Council has reviewed the supplied information and as the works are for the purposes of environmental management they can be carried out as development permitted without consent as specified under clause 129 (2) (d) of *State Environmental Planning Policy (Infrastructure) 2007*. The requirements of clause 129 state that the works must be carried out by or on behalf of a public authority.

As the works are considered to be development permitted without consent there will not be any Council fees incurred and the works are also permissible under Council's zoning provisions in *Inverell Local Environmental Plan 1988*.

If you require anything further, please do not hesitate to contact Council's Planning Officers on 02 6728 8200.

Yours faithfully,

ANTHONY ALLISTON
MANAGER DEVELOPMENT SERVICES

Attaining Excellence Together

ADMINISTRATION CENTRE
144 Otho Street, Inverell NSW 2360
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THE GENERAL MANAGER
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Filename: Instream Hab Rehab Plan for Bannockburn Ck FINAL 220113.doc
Directory: G:\CAU\Contracts - CMA\Border Rivers - Gwydir\Bannockburn Creek Instream Rehabilitation Plan proposal\Final report
Template: D:\Documents and Settings\nichols\My Documents\DPI TEMPLATES\dpi_long _document_1_column_20121130.dot
Title: Instream Habitat Rehabilitation Plan for Bannockburn Creek
Subject: Options for managing sediment slug
Author: Scott Nichols
Keywords: sediment, river, Border Rivers-Gwydir CMA, extraction, catchment
Comments: Template version 8 August 2012
Creation Date: 22/01/2013 5:34:00 PM
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