2. Recommended sites and management actions

2.1 Key to linking management actions to sites

The table below describes the works proposed for sites identified on the reach maps. It is to be used in conjunction with the tables in the following sections (*2.2 to 2.5*) and the maps.

Site	Action code	Management action
1.1	1.D	Install sediment control measures e.g. culverts
1.2		
2.1	2.G	Bund diesel pump and bowser
2.2		
2.3	2.D	Remove instream blockage
2.4		
2.5	2.G	Bund diesel pump and bowser
2.6		
2.7		
2.8	2.F 2.P 2.R	Control stock access via fencing Revegetate behind rock beaching Undertake rock beaching*
2.9		
2.10	2.G	Bund diesel pump and bowser
2.11		
3.1	3.F 3.P 3.R	Control stock access via fencing Revegetate behind rock beaching Undertake rock beaching*
3.2	3.G	Bund diesel pump and bowser
3.3		
3.4		
3.5		
3.6	3.F 3.P 3.R	Control stock access via fencing Revegetate behind rock beaching Undertake rock beaching*
3.7	3.G	Bund diesel pump and bowser
3.8	3.D	Remove instream blockage
3.9	3.G	Bund diesel pump and bowser
3.10	3.F 3.P 3.R	Control stock access via fencing Revegetate behind rock beaching Undertake rock beaching*
3.11	3.G	Bund diesel pump and bowser
3.12	3.D	Remove instream blockage
3.13		
3.14	3.F 3.P 3.R	Control stock access via fencing Revegetate behind rock beaching Undertake rock beaching*
3.15	3.G	Bund diesel pump and bowser
3.16		
3.17	3.R	Undertake rock beaching*
3.18	3.G	Bund diesel pump and bowser
3.19	3.R	Undertake rock beaching*
3.20	3.F 3.P 3.R	Control stock access via fencing Revegetate behind rock beaching Undertake rock beaching*
3.21		

Site	Action code	Management action
4.1	4.N	Undertake rock beaching*
4.2		
4.3		
4.4		
4.5	4.F	Bund diesel pump and bowser
4.6	4.N	Undertake rock beaching*
4.7	4.C	Remove instream blockage
4.8	4.F	Bund diesel pump and bowser
4.9		
4.10	4.C	Remove instream blockage
4.11	4.F	Bund diesel pump and bowser
4.12	4.N	Undertake rock beaching*
4.13	4.F	Bund diesel pump and bowser
4.14	4.N	Undertake rock beaching*
4.15	4.N 4.I	Undertake rock beaching* Undertake willow replacement
4.16	4.C	Remove instream blockage
4.17	4.N	Undertake rock beaching*
4.18		
4.19		
4.20	4.C	Remove instream blockage
4.21	4.N	Undertake rock beaching*
4.22	4.C	Remove instream blockage
4.23	4.N	Undertake rock beaching*
4.24	4.N	
4.25	4.N	
4.26	4.C	Remove instream blockage
4.27	4.N	Undertake rock beaching*
4.28	4.C	Remove instream blockage
4.29	4.N	Undertake rock beaching*
4.30	4.N	
4.31	4.C	Remove instream blockage
4.32	4.N	Undertake rock beaching*
4.33		
4.34	4.C	Remove instream blockage
4.35	4.N	Undertake rock beaching*
4.36		
4.37		
4.38		
4.39		

*Log or timber brushing may be substituted for rock beaching.

Note: Where willows have been identified on the reach maps, phased replacement with native vegetation and stock management are the preferred management actions. The study showed that the priority level of willow replacement works varies among reaches. See Tables of Management Actions in section 2.2 – 2.5.

2.2 Reach 1 - Hogg's Hut to Damm's

This reach consists primarily of National Park on both sides of the river, incorporating Kosciuszko National Park on the eastern (NSW) bank and Victoria's Alpine National Park on the western bank. The river is contained within the valley floor and consists of fast flowing water with riffles, runs and scour pools and a cobble or gravel substrate. There are no sites of active erosion.

Native vegetation is continuous along both banks and is generally in excellent condition. This reach's position in the vegetated landscape and connectivity to large areas of native vegetation increases its overall high quality. The total cover of riparian weeds in the reach is relatively low, although infestations of pussy willow (*Salix cinerea),* crack willow (*Salix fragilis*) and blackberry (*Rubus fruticosus* agg.) are present.

2.2.1 Recommended actions – Reach 1

		Strategic Directions				
Action Code	**Management Action**	Reduce localised impacts on water quality	Reduce the impact of weeds	Improve ecological diversity	Protect and enhance remnant vegetation	Maintain the existing social values the Indi River provides
1.A	Eradicate Pussy Willow (*Salix Cinerea)* and control other willow		A	B	A	B
1.B	Implement a Blackberry control program.		A	B		
1.C	Implement a broad leaf weed control program in the vicinity of the access track.		A	B		
1.D	Install sediment control measures including culverts through depression on the access track	C				

Risk Rating	
Low	
Medium	
High	
Very High	
Priority	**C**

2.3 Reach 2 - Damm's to Biggara Bridge

This reach is located immediately downstream of the National Parks. Here the river is only partially confined by the valley margins with a floodplain of variable width, ranging from approximately 300 m to 1000 m. Earlier channels are evident in several locations. The river substrate is cobble and gravel, with several bedrock bars. Riffles and runs are common. Eleven sites of erosion occur within this reach; only two sites appear to be actively eroding. Stock exclusion and revegetation would improve all bank erosion sites within this reach. The river is partially blocked by willows at two locations.

The majority of the floodplain and riparian zone in this reach has been cleared of native vegetation and is now dominated by exotic trees, with only isolated mature eucalypts in the riparian zone and on the floodplain. At several points the river adjoins sections of the Kosciuszko National Park, providing good connectivity between the riparian zone and large areas of intact native vegetation. There is also some natural regeneration of native shrubs and trees on gravel bars in the watercourse. There is good potential for recovery of this reach due to the presence of a native seed source at the valley margins.

The total cover of weeds in the riparian zone is very high, with willows present along 94% of the reach length. Crack willow (*Salix fragilis*), pussy willow (*Salix cinerea*), weeping willow (*Salix babylonica*), blackberry (*Rubus fruticosus* agg.), boxelder (*Acer negundo*), Lombardy poplar (*Populus nigra* var. Italica), *Prunus* spp., elm (*Ulmus* sp.) and fig (*Ficus* sp.) are present.

2.3.1 Recommended actions – Reach 2

Action Code	Management Action	Strategic Directions						
		Reduce localised and widespread impacts on water quality	Reduce the impact of weeds	Protect and enhance remnant vegetation	Maintain the stability of the Indi River at natural rates	Improve ecological diversity	Maintain the existing social values the Indi River provides	Maintain the existing economic values the Indi River provides
2.B	Establish a habitat linkage via revegetation			B		B		
2.C	Establish a grassed buffer to control nutrient runoffs	B				B		
2.D	Remove in-stream blockage		B		B			
2.E	Improve vegetation continuity via revegetation		B	B		B		
2.F	Control stock access via fencing	B	B	B	B	B		
2.G	Bund diesel pump and bowser	B						B
2.H	Investigate opportunities for 3 phase power supply to pumps	B						B
2.I	Eradicate Boxelder		B	B				
2.J	Protect native vegetation regeneration via fencing			B		B		
2.K	Undertake phased willow replacement		B	B	B	B		
2.L	Provide off-stream stock watering			B	B			
2.M	Widen the existing fencing or cropping setback			B	B	B		
2.N	Replace electric cross fencing with more appropriate fencing						C	
2.O	Undertake isolated blackberry control		B	B		B		
2.P	Revegetate behind rock beaching	B		B		B		
2.Q	Undertake willow control amongst rock beaching		B					
2.R	Undertake rock beaching				B			B
2.S	Allow minor gravel extraction to reduce perching				B			B
2.T	Undertake a geomorphic review from Damm's to Indi Backwater				B	B		
2.U	Eradicate Pussy Willow (Salix Cinerea)		B	B		B		
2.V	Develop a Stream Flow Management Plan for the Indi River					B	C	B
2.W	Implement water saving irrigation practices in New South Wales	B				B		B

Risk Rating	
Low	
Medium	
High	
Very High	
Priority	**C**

2.4 Reach 3 - Biggara Bridge to Indi Bridge

The river in this reach is largely unconfined within a floodplain of approximate width from 300m to 1300m. Previous channels are evident across the floodplain although large scale past use of willow to manage stream stability has potentially impeded lateral migration rates within this reach. The only bedrock impingement occurs where the river abuts the valley margin on the eastern bank. The bed gradient changes frequently through riffle, run and pool sequences.

While there is a similar number of erosion sites in this reach as in Reach 2, the majority here appear to be actively eroding. Factors contributing to the continuing erosion at these sites include a limited cover of woody vegetation and stock access. There is also considerable scouring behind exotic (*Salix* sp.) and native (*Eucalyptus* sp.) vegetation at several sites. There are three willow blockages in this reach, two of which are large and extend across the entire width of the river and a third that is less significant. Instream willow blockages need to be removed to prevent further blockages which in turn may impact upon channel stability.

The native vegetation in this reach is highly modified and is dominated by exotic trees with only isolated native vegetation. Natural recruitment on gravel bars is less common than in Reach 2. The total cover of weeds in the riparian zone is very high. Willows, mainly crack willow (*Salix fragilis*), are present along the entire reach, and occur in greater density and extend further off-stream than in Reach 2. Blackberry is scattered throughout the reach but only as minor infestations.

2.4.1 Recommended actions – Reach 3

		Strategic Directions					
Action Code	**Management Action**	Reduce localised and widespread impacts on water quality	Reduce the impact of weeds	Protect and enhance remnant vegetation	Maintain the stability of the Indi River at natural rates	Maintain the existing social values the Indi River provides	Maintain the existing economic values the Indi River provides
3.B	Establish a habitat linkage via revegetation			D			
3.C	Establish a grassed buffer to control nutrient runoffs	B					
3.D	Remove in-stream blockage		D		D		
3.E	Improve vegetation continuity via revegetation			D			
3.F	Control stock access via fencing	B		D	D		B
3.G	Bund diesel pump and bowser	B					B
3.H	Investigate opportunities for 3 phase power supply to pumps	B					B
3.I	Eradicate Boxelder		D				

Action Code	Management Action	Strategic Directions					
		Reduce localised and widespread impacts on water quality	Reduce the impact of weeds	Protect and enhance remnant vegetation	Maintain the stability of the Indi River at natural rates	Maintain the existing social values the Indi River provides	Maintain the existing economic values the Indi River provides
3.J	Protect native vegetation regeneration via fencing			D			
3.K	Undertake phased willow replacement		D	D	D		
3.L	Provide off-stream stock watering	B		D	D		B
3.M	Widen the existing fencing or cropping setback	B		D	D		B
3.N	Replace electric cross fencing with more appropriate fencing						B
3.O	Undertake isolated blackberry control		D				
3.P	Revegetate behind rock beaching			D			
3.Q	Undertake willow control amongst rock beaching		D				
3.R	Undertake rock beaching				D		
3.S	Undertake a geomorphic review from Damm's to Indi Backwater			D			
3.T	Eradicate Pussy Willow (Salix Cinerea)				D		
3.U	Maintain existing timber brushing			D			B
3.V	Develop a Stream Flow Management Plan for the Indi River						B
3.W	Implement water saving irrigation practices in New South Wales	B					B

Risk Rating	
Low	
Medium	
High	
Very High	
Priority	C

2.5 Reach 4 - Indi Bridge to Indi Backwater

The river in this reach is largely unconfined by the valley margin and meanders between sandy banks across a broad floodplain approaching almost 2 km in width. Former channels are common and in some places have formed semi-permanent wetlands. Although vertical banks are present in several locations, lateral erosion does not appear to active, and bed deepening is not a significant issue. Pools and riffles are common within this reach, with the spacing of riffles increasing towards the downstream end. The size of bed material decreases to a gravelly sand throughout this reach. There appear to be no bedrock outcrops.

Twenty nine erosion sites of lengths varying between 10m and 200m occur in Reach 4. Five of these sites are considered to be relatively inactive. The actively eroding sites are large in size and are distributed on both inside and outside bends, tending to occur in areas of less woody vegetation. At many of these sites erosion is also associated with stock access; at the remaining sites it occurs as a result of fluvial processes. Eleven partial or complete willow blockage sites are present in this reach. These have occurred as a result of either overhanging willow branches or collapsed whole trees.

Native vegetation is severely depleted throughout this reach and woody vegetation in the riparian zone consists almost entirely of exotic trees. Native vegetation is never continuous except where there is contact with the valley margin and all other occurrences are isolated or scattered. Natural recruitment is very low and decreases in density with greater distance from large areas of native vegetation.

The total cover of weeds in the riparian zone is very high with large dense infestations of willow present along 70% of the reach length. Willows provide 50-100% canopy cover and occur with exotic grasses or other weeds. The dominant willow species are crack willow (*Salix fragilis*) and scattered weeping willow (*Salix babylonica*). Knotweed (*Persicaria* sp.) is abundant on gravel bars.

2.5.1 Recommended actions – Reach 4

Action Code	Management Action	Strategic Directions						
		Reduce localised and widespread impacts on water quality	Reduce the impact of weeds	Protect and enhance remnant vegetation	Maintain the stability of the Indi River at natural rates	Encourage improved flows to wetlands	Maintain the existing social values the Indi River provides	Maintain the existing economic values the Indi River provides
4.B	Establish a grassed buffer to control nutrient runoffs	B						
4.C	Remove in-stream blockage		D		D			
4.D	Improve vegetation continuity via revegetation			D				
4.E	Control stock access via fencing	B		D	D			B
4.F	Bund diesel pump and bowser	B						B
4.G	Investigate opportunities for 3 phase power supply to pumps	B						B
4.H	Eradicate Box Elder		D					
4.I	Undertake phased willow replacement		D	D	D			
4.J	Provide off-stream stock watering	B		D	D			B
4.K	Widen the existing fencing or cropping setback	B		D	D			B
4.L	Replace electric cross fencing with more appropriate fencing							B
4.M	Revegetate behind rock beaching			D				
4.N	Undertake rock beaching				D			
4.O	Undertake a geomorphic review from Damm's to Indi Backwater				D			
4.P	Maintain existing timber brushing				D			B
4.Q	Consider alternative bank stabilisation measures to replace pollarding willow		D		D			B
4.R	Undertake a detailed wetland review to determine the potential to re-establish flows to specific					D		
4.S	Develop a management plan for the reserve downstream of Indi Bridge						D	
4.T	Develop a Stream Flow Management Plan for the Indi River							B
4.U	Implement water saving irrigation practices in New South Wales	B				D		B

Risk Rating	
Low	
Medium	
High	
Very High	
Priority	C