

# TECHNICAL REPORT 03

Updated flooding and hydrology assessment

## **Appendix E** Geomorphology assessment

NARROMINE TO NARRABRI PROJECT



Table E1 Watercourse description, geomorphology and stream power

Structure ID	Chainage	Watercourse Name	Catchment	Geomorphic Section	Soil Type	Geological Domain	Geotechnical Unit	Existing w (W/m) (upstream / centre / downstream)	River Style	Condition	Recovery Priority	Fragility	In-Channel Vegetation	Riparian Vegetation	Notes	
250-Civrt547281	547281	Boggy Cowal	MACQUARIE	Macquarie Floodplain: Flat or gently undulating topography underlain by weathered Ordovician metasediments and Devonian granite of the Lachlan Fold Belt. Flood-prone with deep alluvial soils.	Chromosols / Vertosols	Qab	ALV-1b	8-6-0						Sparse grasses	Sparse, grasses with occasional trees outside agricultural areas	Watercourse extends upstream to alignment when flooding. Modelling indicates ponding and increases in velocity upstream and downstream of embankment despite many proposed culverts.
250-Civrt552360	552360	Overland Flow	MACQUARIE		Chromosols (alluvial)	Qrx	COL-1a	0-0-1					As above	As above	Overland flow and sheetwash erosion. Indistinct, unnamed, unmarked incised, trapezoidal channel at 552.36.	Overland flow and sheetwash erosion Multi-thread (anastomosing) system in places, but single thread at crossing. Incised, moderately steep, uniform banks. Moderately sinuous, intermittent? Sand bed. Incised channel perched above surrounding land, indicating broad levees. Deeply incised into bedrock (deeply weathered Pilliga Sandstone with extremely weathered rock & residual soil), moderate sinuosity. Some photos near crossing. Banks moderately well vegetated - invasive willows. Perennial (?). Broad channel, few in-channel features from photos. Considerable quantities of LWD (snags & branches). Large trees unstable on bank (destabilising effect) - consider LWD in blockage effects under bridge. Planform change since 1974 has been limited to lateral erosion of the cut-off bend upstream.
250-Civrt553169	553169	Minor Watercourse	MACQUARIE		Chromosols (alluvial)	Qrx	COL-1a	15-16-15					Dense, tall grasses	Sparse, cleared for agriculture		
250-Civrt553970	553970	Wallaby Creek	MACQUARIE		Chromosols (alluvial)	Qrx	ALV-1b	31-25-37	Channelised fill	Poor	Low	Moderate		Moderately well vegetated, narrow, with invasive weeping willows		
250-BR562344	562344	Macquarie River	MACQUARIE		Dermosols / Sodosols	Qab	ALV-1b	287-126-103	Bedrock controlled, sand	Good	Conservation	Moderate	LWD and some trees			
250-Civrt566865	566865	Minor Watercourse	MACQUARIE	Undulating Agricultural Plains: undulating topography, rising in elevation and underlain by Ordovician metasediments / Devonian granite near Macquarie River, and deeply weathered Cretaceous Keelindi Beds sandstones. Cobocco land system, which is typically sodic, dispersive and saline, prone to vegetation die off and scalding.	Chromosols (alluvial)	Jklk	RS / EW-1	5-7-5					Sparse	Sparse	Highly dispersive. Extension of hydroline to west, although creek doesn't visibly extend upstream. Some pooling upstream of embankment to North.	Slightly incised, sinuous sand bed, multi-thread (anastomosing) channel. Corridor runs along meander bend. Tributary confluences just upstream of bridge. Culvert under road blocked indicating high sediment load. Indistinct channel. Hydroline probably not accurate. Excedance at road (flow concentration?).
250-Civrt568919	568919	Minor Watercourse	MACQUARIE		Chromosols (alluvial)	Jklk	RS / EW-1	7-7-6					Grasses	Grasses	Highly dispersive. Indistinct, low sinuosity watercourse. Grassy swale in agricultural land. No obvious erosion - disturbance of vegetation may trigger this. Next few culverts, increase in velocity is due to combination of embankment and road (undersized culverts under road?) - flow concentration. Water pools under road embankment	
250-Civrt575927	575927	Minor Watercourse	MACQUARIE		Chromosols (alluvial)	Jklk	RS / EW-1	5-2-3					Sparse grasses	Denuded, grasses, sparse trees	Slightly incised, narrow, meandering creek. Eroding banks, headcutting gullies and evidence of active erosion - livestock trampling. Nearby fields have contour banks to limit overland flow velocities and sediment erosion. Exceedances due to pooling upstream (west) of embankment	
250-Civrt577323	577323	Overland Flow	MACQUARIE		Chromosols (alluvial)	Jklk	RS / EW-1	No Flow					Grasses / Cropping	Cropping	Pooling upstream (west) of embankment	
250-Civrt582874	582874	Overland Flow	MACQUARIE		Chromosols (alluvial)	Jklk	RS / EW-1	1-1-0					Cropping	Cropping	Excedance due to pooling along western side of embankment and upstream of culvert, but flow velocities would be attenuated by existing farm dam	
250-BR595239	595239	Ewenmar Creek	MACQUARIE	Keelindi Alluvial Plains: Deep alluvial deposits at Ewenmar Creek. To the north, elevated, undulating topography is associated with the Keelindi Beds, characterised by shallow, deeply weathered sandstone. Extensive flooding of low lying areas.	Alluvium / Sodosol	Qat / v	ALV-1b	57-77-85	Planform controlled, low sinuosity, sand	Good	Conservation	High	Dense reeds, grasses, LWD	Grasses and narrow strip of moderate to dense trees	Slightly incised, sinuous sand bed, multi-thread (anastomosing) channel. Corridor runs along meander bend. Tributary confluences just upstream of bridge. Culvert under road blocked indicating high sediment load. Indistinct channel. Hydroline probably not accurate. Excedance at road (flow concentration?).	Variable sinuosity, sand bed - very similar morphology and condition to Ewenmar Creek, but with denudation and gullyng downstream. Slightly incised channel with in-channel benches (variable flow - ephemeral). Vegetated upper benches. Narrow active channel. Flood debris on fence-lines & LWD in channel. Resistant clay banks, silty sand bed. Ponding of water u/s of road (reeds), particularly upstream to southwest of proposed culverts. Hydroline in incorrect place.
250-Civrt599110	599110	Goulburn Creek	MACQUARIE		Sodosols	Qat / v	ALV-1b	9-12-7	Channelised fill	Poor	Low	Moderate	Dense reeds, grasses, LWD	Grasses and narrow strip of moderate to dense trees		
250-BR602663	602663	Emogandry Creek	MACQUARIE		Cobocco / Sodosols	Jklk	ALV-1b	36-46-37	Low sinuosity, sand	Moderate	Moderate	High	Reeds, trees, LWD	Cropping, moderate trees, grasses	Slightly incised, sinuous creek. Crossing is at road, with very small existing culvert. Sand bed with gravel. Indistinct channel with considerable in-stream vegetation.	
250-BR607145	607145	Native Dog Creek	MACQUARIE		Sodosol	Jklk	RS / EW-1	78-83-76	Planform controlled, low sinuosity, sand	Poor	Low	High	Grasses, reeds, sparse trees	Sparse trees, grazing	Pooling upstream of embankment, exceedances upstream and downstream of crossing. Broad, slightly incised anastomosing sand bed channel. Highly dispersive soil.	
250-BR608929	608929	Pint Pot Gully	MACQUARIE		Sodosol	Jklk	RS / EW-1	20-16-11	Channelised fill	Poor	Low	Moderate	Sparse	Dense trees	Incised, sinuous gully system with actively eroding gully heads upstream of crossing. Confluence with Kickabil Creek just downstream. Vegetation generally sparse, but dense at crossing. Vehicle 'play' area to south denuded and eroding.	
250-BR609715	609715	Kickabil Creek	MACQUARIE		Cobocco / Sodosols	Jklk	ALV-2b	47-53-36	Planform controlled, low sinuosity, sand	Moderate	Moderate	High	Reeds, moderate trees, LWD	Dense trees	Incised, sinuous creek with well-defined low-flow channel and dense riparian vegetation. Evidence of older gullyng, but densely vegetated with no evidence of fresh erosion. Infilled, with incised active channel and minor in-trench benches.	
250-BR616680	616680	Milpulling Creek	MACQUARIE		Cobocco / Sodosols	Jklk	ALV-2b	68-76-68	Channelised fill	Poor	Low	Moderate	Grass	Sparse trees, grass	Slightly incised, laterally eroding, narrow, sinuous active chanel within active meander belt. Gullies upstream and downstream are not active and show signs of recovery (weathered banks, in-channel vegetation). Pooling upstream to east side of embankment. Contour banks on land to south. Consider extending bridge.	
Within Operational Footprint	622300	Leeches Creek	MACQUARIE		Kandosol	Jklk	COL-1b	Not modelled					Grass	Sparse trees, grass	Minor Creek from farm dam. Land nearby is degraded. To east of crossing but within operational footprint. Assume undersized culvert.	
250-BR623146	623146	Bundjoe Creek	MACQUARIE		Cobocco / Sodosols	Jklk	ALV-2b	24-13-31	Planform controlled, low sinuosity, sand	Moderate	Moderate	High	Limited, possible grasses on point bars	Sparse trees, denser at crossing, grass	Incised, sinuous, sand bed. Eroding meanders, with right (north) bank erosion below bridge and close to western edge of embankment. Eroding banks and headcutting gullies up and downstream showing signs of some recovery. Some tributaries are discontinuous indicating subsurface flows and possible tunnelling (seepage) erosion. Bridge requires extending to south.	
250-Civrt627322	627322	Minor Watercourse	MACQUARIE		Cobocco / Sodosols	Jklk	RS / EW-1	2-0-0					Cropping	Cropping	Watercourse isn't obvious on aerials or LIDAR. May have been removed during contouring. Tributary of Boothaguy Creek. Pooling upstream, velocity exceedances downstream (assume undersized proposed culvert).	
250-Civrt628044	628044	Overland Flow	MACQUARIE		Cobocco / Sodosols	Qrx	COL-1b	3-7-6					Cropping	Cropping	Contour banks and artificial drainage. Note bank erosion to west of alignment adjacent to 631 - flow concentration, dispersive soils. Gravel lens.	
250-BR633677	633677	Marthaguy Creek	MACQUARIE	Basaltic Alluvial Plains: Depositional alluvial plain and alluvial backplain from basaltic Warrambungles. Meander deposits of Marthaguy Creek to the south, with gravel lenses associated with Castlereagh River meander alluvium to the north. Deep alluvial soils and vertosols, especially near Wyuna Road and Bardens Road near Curban railway siding. Deep ruts following rain in local roads.	Chromosols	Qac / m	ALV-2b	58-57-57	Low sinuosity, sand	Moderate	Rapid	High	Reeds, sparse trees, LWD (?)	Cropping to SE, Narrow with dense trees. Island between channels sometimes cultivated	Incised, highly sinuous, multi-thread at crossing, floodplain/overland flows. Sand bed channel. Actively meandering - evidence of abandoned meander bends, meander migration. Narrow riparian corridor. Occasional agricultural use of mid-channel island.	Major river - low sinuosity active channel (threshold of meandering/braided) within a deep, variable sinuosity trench with sand - gravel in-channel bars indicating a high, mobile bedload. Scroll bars on upstream and downstream point bars indicate meander migration. Landowners report deep flooding and high erodibility on floodplain, but erosion not observed on site. Said to be the fastest flowing inland river in Australia, with significant flow through the deep sandy bed. High velocities within well-adapted active channel.
250-BR651728	651728	Castlereagh River	CASTLEREAGH		Alluvium / Sodosol	Qac / m	ALV-1b	638-679-612	Planform controlled, low sinuosity, sand	Moderate	Moderate	High	Reeds, grasses, trees LWD	Narrow, moderate trees, grasses		
250-Civrt659058	659058	Judes Creek	CASTLEREAGH	Basaltic Colluvial Plains: Undulating topography associated with Keelindi beds, with extensive colluvial slope deposits above (Chromosols). Further north, flat colluvial outwash plan with deep cracking clays from basaltic Warrumbungle ranges.	Kandosols	Qrh	COL-1c	3-3-3	Valley fill, fine grained	Moderate	High	High	Grass	Grass	Indistinct grassy swale, with discontinuous sections of sandy channel. Geotech noted broad table drains and highly dispersive soils under NP road. 3 close culverts (this is northernmost). Pooling upstream of culverts.	Pristine sand bed river. Broad, sandy, braided channel with in-channel vegetation. Mature trees in channel may indicate recent sand sheet deposition. Sandstone bedrock at or very close to surface. Iron-rich soils. Incised with in-channel benches
250-BR661275	661275	Minor Watercourse	CASTLEREAGH		Kandosols	Qrh	COL-1b	3-3-3					Reeds, grasses	Trees along NP Road, grass		
250-BR673082	673082	Gulargambone Creek	CASTLEREAGH		Chromosols along creek corridor	Qac / m	ALV-2a	217-234-327	Planform controlled, low sinuosity, sand	Moderate	Moderate	High	Mature trees, grasses, reeds and LWD within trench	Sparse, pasture or ploughed	Broad, sinuous channel, scroll bars, high amplitude meanders - actively meandering - incised, bank erosion along outer banks. Flood cut-off across point bar to west of crossing. Compound channel, with in-channel benches. Flooding largely contained within the high-flow trench. Clay drape over gravelly sand bed. Alignment along channel rather than perpendicular. Extend bridge? Headcutting gullies just downstream. Dense vegetation in channel, sparse riparian corridor.	
250-BR682601	682601	Baronne Creek	CASTLEREAGH		Vertosols	Qrh	ALV-1b	128-106-123	Low sinuosity, fine grained	Moderate	Low	Moderate	Sparse grasses	Sparse trees and grasses	Narrow, incised, sinuous, with irregular meanders, within a broader incised flood trench. Actively eroding, with failing banks. Paleochannels indicating large abandoned meanders. Appears to be gullyng/sheet wash erosion to north of creek with loss of topsoil (and/or) gilgai? Creek narrowed due to agricultural activity? Recommend bridge is extended north beyond edge of eroding bank.	
250-Civrt686020	686020	Overland Flow	CASTLEREAGH		Chromosols	Qrh	COL-2b	No Flow					Sparse grasses	Sparse grasses	Minor area of exceedance where overland flows combine and flow across road. Flow velocities seem high, and related to road topography.	
250-Civrt694184	694184	Tenandra Creek	CASTLEREAGH	Basalt Mesa Plains: Basalt mesas. Extensive flooding in lower areas with colluvial sheetwash. Vertosols northwards from Tabletop Mountain to Baradine Road. Flat outwash plain of alluvial sediments and colluvial sheetwash from Basaltic uplands. Dispersive sodic soils with gullyng. Vertosols often gilgaied.	Vertosols	Qat / v	ALV-1b	68-86-75	Valley fill, sand	Moderate	Moderate	High	Sparse grasses	Sparse trees and grasses	Slightly incised, sinuous creek with artificial levees and point bar chute cutoff. Tenandra Creek channel has been realigned and constrained within levees. These have altered the natural functioning of the channel, possibly leading to exacerbation of flooding in the area. The levees could also prevent overland flooding entering the main channel. Outer banks eroding. Flooding is a significant issue - landowners lose fences due to floodwater depth and velocity, hence construction of levees? It is recommended that options for flood mitigation and erosion management are considered during detailed design.	Note vegetation clearance required. Wind erosion - friable, sandy topsoils? Road unsealed, highly erodible during rain. Channel slightly incised downstream of road culvert, presumably excavated to keep channel clear. Natural swale. As previous. Sediment from road transported into creek, which appears to be cleared to keep channel clear. Flow is artificially channelised through an embankment along Goorianawa Road. Dense trees and understorey vegetation. Hydroline not in correct place. Colluvium derived from basalt. Very reactive, erodible culvert under road. Indistinct, broad grassy swale. Overland flood flows diverted along Goorianawa Road. No sign of existing erosion.
250-Civrt697901	697901	Overland Flow	CASTLEREAGH		Chromosols	Qrx	COL-2b	14-12-15					Sparse, some LWD	Dense trees with little understorey		
250-BR700017	700017	Mungery Creek	CASTLEREAGH		Chromosols	Qrx	ALV-1b	27-14-9	Valley fill, sand	Moderate	Moderate	High	Sparse, some LWD	Some trees with little understorey		
250-BR701981	701981	Minor Watercourse	CASTLEREAGH		Chromosols	Qrh	ALV-1b	9-13-14					Grass	Grass, sparse trees		
250-BR702305	702305	Calerwi Creek	CASTLEREAGH		Chromosols	Qrh	ALV-1b	23-18-21	Low sinuosity, sand	Poor	Low	High	Sparse grasses, some trees	Sparse to moderate trees, grasses	To east of alignment. Slightly incised, recovering, grassy, small channel. Artificial (?) levees.	
250-BR704588	704588	Quanda Quanda Creek	CASTLEREAGH		Vertosols	Qrh	COL-1b	76-82-83	Planform controlled, low sinuosity, sand	Poor	Low	High	Grasses	Agriculture, grasses and sparse trees	Incised sinuous compound channel. Irregular meanders. Surrounding land largely cleared for agriculture. Eroding outer banks under proposed bridge location. Incised, highly sinuous, laterally eroding with highly variable bed elevation. No appreciable riparian corridor, agricultural use of floodplain. Landowners report flooding every 2-4 years with sheet flow and erosion	
250-BR705735	705735	Overland Flow	CASTLEREAGH		Vertosols	Qrh	COL-1b	Not modelled					Cropping	Cropping	Channel no longer exists other than discolouration of soil. Basalt soils - soft when wet, hardsetting. Not sure why the crossing at 705.75 is in worse condition than this.	
250-Civrt708474	708474	Black Gutter Creek	CASTLEREAGH		Vertosols	Qrx / Kld	COL-1b	9-9-10	Valley fill, sand	Moderate	Moderate	High	Cropping / grasses	Cropping / grasses	Gilgai in area, grassy swale. Hydroline doesn't look accurate.	
250-BR709266	709266	Salty Springs Creek	CASTLEREAGH		Vertosols	Qrx / Kld	COL-1b	116-157-80	Planform controlled, low sinuosity, sand	Poor	Low	High	Sparse grasses	Sparse grasses	Gilgai in area, slightly incised, low sinuosity, sandy channel. Straightened for agriculture, hence high velocities. Width constriction means that the channel can no longer accommodate flood flows, hence overbank spill and overland flows. Upstream sinuosity is high. On slight topographic rise, with flood flows to north. Close basalt mesa to south. Opportunities to improve creek functioning and reduce velocities could be explored in detailed design.	
250-Civrt709664	709664	Overland Flow	CASTLEREAGH		Vertosols	Qrx / Kld	COL-1b	2-4-10					Cropping	Cropping	Creek has been channelised around field downstream of track. Overland flows caused by creek narrowing and disruption of natural functioning. Exceedance is upstream where channel appearst to have been infilled. Suggest improvements to flow connectivity during detailed design.	
250-Civrt710830	710830	Overland Flow	CASTLEREAGH		Vertosols	Qrx / Kld	COL-1b	11-9-15					Cropping	Cropping	Imperceptable channel. Hydroline may be in wrong place.	
250-Civrt712750	712750	Minor Watercourse	CASTLEREAGH		Vertosols	Qrh	COL-1b	Not Modelled					Cropping	Cropping	Minor watercourse but no culvert - doesn't seem to be problematic. Imperceptable channel.	
250-Civrt713532	713532	Minor Watercourse	CASTLEREAGH		Vertosols	Qrh	COL-1b	5-5-0					Cropping	Cropping	Imperceptable channel.	
250-BR714593	714593	Calga Creek	CASTLEREAGH		Vertosols	Qrh	ALV-1b	54-59-65	Planform controlled, low sinuosity, fine grained	Moderate	Low	Moderate	Grass and broad leaf ground cover	Grass, sparse trees	Incised, moderately sinuosity, with pool/riffle sequences (ponds near bend apexes) intermittent? Sand bed. Outer banks of meanders actively eroding. Riparian corridor has been left uncropped. Embankment runs over tributary of Calga Creek, which will divert waters along the embankment into Calga Creek. This does not appear to adversely affect velocity or hazard. High velocities associated with active channel of creek, with small areas of modelled velocity increase. Consider extending bridge during detailed design.	
250-Civrt715376	715376	Overland Flow	CASTLEREAGH		Vertosols	Qrh	COL-1b	No Flow					Sparse grass	Grazing, grass, sparse trees	Small culvert, slightly incised watercourse. Downcutting begins at springline (?) of mesa to east.	
250-BR716029	716029	Minor Watercourse	CASTLEREAGH		Ferrosols	Qrx / Kld	COL-1b	Not Modelled					Sparse grass	Grazing, grass, sparse trees	Alluvial soils - highly erodible - gullies? Other drainage channels originating from basalt tabletop mountain to east. Only inundated in particularly large flood events.	
250-Civrt718164	718164	Noonbar Creek	CASTLEREAGH		Vertosols	Qrx / Kld	COL-1b	40-27-34					Grass	Grass, sparse trees	Minor creek. Intermittent gullies?	
250-Civrt719410	719410	Minor Watercourse	CASTLEREAGH		Vertosols	Qrh	COL-1c	7-7-18					Sparse grass	Grazing, grass, sparse trees	Slightly incised, low sinuosity. Downcutting begins at corridor, upstream, channel has been removed for agriculture	
250-BR722288	722288	Bucklanbah Creek	CASTLEREAGH		Chromosols	Qrh	ALV-1b	46-44-44	Low sinuosity, fine grained	Moderate	Low	Moderate	Sparse grass	Grass, sparse trees	Sinuosity, slightly incised sandy bed. Cropping right up to narrow riparian corridor.	
250-Civrt728111	728111	Small Creek	CASTLEREAGH		Vertosols	Qac / m	ALV-1b	5-8-5	Valley fill, sand	Moderate	Strategic	High	Grass	Grass	Indistinct channel. Hydroline in wrong place.	
250-BR730462	730462	Teridgerie Creek	CASTLEREAGH		Vertosols	Qac / m	ALV-1b	210-227-192	Planform controlled, low sinuosity, sand	Moderate	Moderate	High	Well-vegetated	Dense trees, grasses	Sinuosity, narrow, incised, sandy bed. In-channel vegetation and riparian corridor left as a buffer for cropping. Gullyng, degradation and denudation downstream of crossing. Very high velocities in active chanel of creek and associated with gully just downstream which is unlikely to be affected by the project. Bridge crosses what appears to be a naturally straight section, and should not exacerbate natural erosion, although north bridge pier should be extended further north, away from bank edge (perhaps to cover overbank flows to north).	



250-Civrt737894 250-Civrt741964	737894 741964	<b>Ironbark Creek</b> <b>Overland Flow</b>	CASTLEREAGH CASTLEREAGH	<b>Pilliga Plains:</b> Flat outwash plain of alluvial sediments and colluvial sheetwash from Pilliga Sandstone uplands.	Alluvium / Sodosols Alluvium / Sodosols	Qrh Qrh	ALV-1b ALV-1b	4-4-4 1-1-2					Grass Cropping	Grass, sparse trees Cropping	Minor when alignment crosses. Only small culvert. Note highly erodible soils, loss of topsoil, gulying? Imperceptable channel through cropping fields
250-BR747768	747768	<b>Baradine Creek</b>	NAMOI		Alluvial sands	Qac / m	ALV-2b	132-202-168	Planform controlled, low sinuosity, sand	Moderate	Rapid	High	Reeds, grasses, LWD	Dense trees, grasses, mid-storey	Broad, deeply incised, bedrock in banks. Broad, mobile, sand bed channel with in-trench bench. Low sinuosity, with multiple channels and braiding in places. High sediment supply. Gully systems to north, but these are vegetated and not obvious on aerial imagery. Surrounding area woodland, rather than agriculture. Bridge requires extending to west to accommodate channel.
250-BR749279 750505 250-Civrt752479	749279 750505 752479	<b>Unnamed Creek</b> <b>Minor Watercourse</b> <b>Minor Watercourse</b>	NAMOI NAMOI NAMOI		Alluvium / Sodosols Alluvium / Sodosols Alluvium / Sodosols	Qrx / JkIk Qrx / JkIk Qff / p	ALV-2b RS / EW-1 ALV-2b	27-15-19 Not modelled 7-44-45					Grasses, trees Unknown Grass?	Moderate woodland Dense woodland Moderate woodland	Hydroline doesn't extend far enough upstream. Appears to be incised, well-defined, low sinuosity from flood modelling. Erosion downstream Hydroline doesn't appear to be in correct place. Minor creek. Incised gully tributary to Coolangla Creek. Thinned woodland, with grassy understorey vegetation. No obvious erosion, but creek is moderately sinuous.
250-BR752712	752712	<b>Coolangla Creek</b>	NAMOI		Alluvium / Sodosols	Qff / p	ALV-2b	44-33-36	Confined valley, sand	Moderate	Moderate	Moderate	Reeds / grasses on mid-channel bars	Dense woodland and undergrowth	Low sinuosity, coarse sand/fine gravel bed creek, incised into more resistant sediments, densely vegetated riparian corridor, in-channel deposition and vegetation, with in-channel bench. Note logging tracks in forest - no signs of gulying or preferential erosion. High sediment supply
250-BR756853	756853	<b>Minor Watercourse</b>	NAMOI		Alluvium / Sodosols	Qrx / JkIk	Alv-2b	27-15-19					Reeds / grasses on mid-channel bars	Dense woodland and undergrowth	Bedrock channel (sandstone), with some sand deposited - also clay in backwater (slippery to cross if wet). Low sinuosity. Minor exceedances along road.
250-Civrt758968	758968	<b>Cumbil Forest Creek</b>	NAMOI		Alluvium / Sodosols	Qrx / JkIk	COL-1b	3-2-4	Confined valley, sand	Moderate	Moderate	Moderate	Woodland Dense on mid-channel bars	Woodland	Indistinct channel to south of 16 Foot Track
250-BR763460	763460	<b>Etoo Creek</b>	NAMOI		Alluvium / Sodosols	Qff / p	ALV-2b	79-82-81	Low sinuosity, sand	Moderate	High	High	isolated trees in channel, flood debris	Dense forest	Pristine sand bed river. Broad, sandy, braided channel with in-channel vegetation. Mature trees in channel may indicate recent sand sheet deposition. Sandstone bedrock at or very close to surface. Iron-rich soils. Incised with in-channel benches (minor) and vegetated mid-channel bars. Broad sand sheets and splays in bed of channel overlying gravelly sands, indicating ready supply of eroded sediments (see photos in Geotechnical Report) and mobile sand bed. Velocities should be maintained to allow sediment throughput.
250-BR767941	767941	<b>Stockyard Creek</b>	NAMOI		Alluvium / Sodosols	Qff / p	ALV-2b	14-16-16					Grasses and reeds	Dense woodland and undergrowth	Small sand bed channel - dominant sediment storage / throughput. Trapezoidal. Vegetated.
250-BR769143	769143	<b>Rocky Creek 1</b>	NAMOI		Alluvium / Sodosols	Qff / p	ALV-2b	117-113-119	Confined valley, sand	Moderate	Moderate	Moderate	Grasses and reeds, with dense vegetation on mid-channel bars	Dense woodland and undergrowth	Broad, multi-thread (anastomosing?), vegetated, sand bed channel with sand sheets and splays. Macro-scale high sinuosity, braided / low sinuosity active channel. Possible rock close to bank surface. Incised with in-channel minor benches/high level bars.
250-Civrt773535	773535	<b>Tinegle Creek</b>	NAMOI		Colluvium / Sodosols	Qrx / JkIk	RS / EW-2	5-4-5	Lowland chain of ponds	Good	Conservation	High	Sparse	Dense woodland but little undergrowth	Indistinct creek to south (at bridge location), flowing through dense forest. Rilling of track as creek waters cross Pilliga Forest Way.
250-Civrt777559	777559	<b>Minor Watercourse</b>	NAMOI		Alluvium / Rudosols	Qrx / JkIk	RS / EW-2	5-30-23					Sparse	Dense woodland but little undergrowth	As above. Also at 778, 778.5. Minor sand bed creeks dominated by sediment storage / throughput.
250-BR779635	779635	<b>Talluba Creek</b>	NAMOI		Alluvium / Rudosols	Qat / v	ALV-2b	106-98-100	Confined valley, sand	Moderate	Moderate	Moderate	Sparse	Dense woodland but little undergrowth	Well-defined, broad sand bed creek, slightly incised with heavily vegetated banks. Multi-thread in places, with sand splays. Tributary at 779.8.
250-BR783652	783652	<b>Minor Watercourse</b>	NAMOI		Alluvium / Sodosols	Qrx / JkIk	ALV-2b	121-149-136					Moderate reeds, trees, grasses	Dense woodland but little undergrowth	Photos show flood debris piled up over a metre (?) up tree trunks and pooled above track. Clay bank material, clay & possibly bedrock in channel. Low sinuosity, well-defined channel. Vegetation in-channel. Debris.
250-BR786808	786808	<b>Minor Watercourse</b>	NAMOI		Alluvium / Sodosols	Qrx / JkIk	ALV-2b	47-28-35					Moderate	Sparse woodland with undergrowth	Rocky Creek tributary. Sand bed, braided with in-channel vegetation.
250-BR789380	789380	<b>Rocky Creek (2)</b>	NAMOI		Alluvium / Sodosols	Qrx / JkIk	ALV-2b	25-29-28	Confined valley, sand	Moderate	Moderate	Moderate	Moderate	Sparse woodland with undergrowth	As previous. Minor exceedance u/s of embankment and small area in-channel (vegetation artefact in model?)
250-BR796414	796414	<b>Coghill Creek</b>	NAMOI		Alluvium / Sodosols	Qrx / JkIk	ALV-2b	46-36-43	Confined valley, sand	Moderate	Moderate	Moderate	Dense in-channel vegetation	Dense woodland and undergrowth	Broad, moderately sinuous, incised sand bed channel, dense riparian and in-channel vegetation. Flood flows seem significant for morphological control.
250-BR800445	800445	<b>Mollieroi Creek</b>	NAMOI		Alluvium / Sodosols	Qat / v	ALV-2b	39-39-36	Confined valley, sand	Moderate	Moderate	Moderate	Dense in-channel vegetation	Dense woodland and undergrowth	Topographically broad channel masked by dense in-channel vegetation with elevated loose sand bars. Water pools upstream of road. Considerable flood debris.
250-Civrt802534	802534	<b>Minor Watercourse</b>	NAMOI		Alluvium / Sodosols	Qat / v	ALV-1b / ALV-2b	2-2-2					Dense in-channel vegetation	Moderate to dense woodland and undergrowth	Not at hydroline. Minor sand/gravel bed creek with densely vegetated banks.
250-Civrt803653	803653	<b>Black Creek</b>	NAMOI		Alluvium / Sodosols	Qat / v	ALV-1b / ALV-2b	16-16-20					Dense vegetation on in-channel bars	Moderate to dense woodland and undergrowth	Topographically broad channel masked by dense in-channel vegetation with mid-channel vegetated bars.
250-BR805743	805743	<b>Minor Watercourse</b>	NAMOI		Alluvium / Sodosols	Qff / p	ALV-2b	5-4-7					Sparse	Dense forest but little undergrowth	Some rock in channel, otherwise as previous. Clay drape over sandy gravel bars with some cobbles.
250-Civrt808364	808364	<b>Goona Creek</b>	NAMOI		Alluvium / Sodosols	Qff / p	ALV-2b	1-1-1	Low sinuosity, sand	Moderate	High	High	Moderate in-channel vegetation	Dense forest but little undergrowth	Tributary of Goona Creek. Similar to Rocky Creek, wandering, low sinuosity planform.
250-BR817650	817650	<b>Bundock Creek</b>	NAMOI		Alluvium / Sodosols	Qff / p	ALV-2b	35-33-27	Lowland chain of ponds	Moderate	Strategic	High	Moderate, trees, grasses and LWD	Dense forest but little undergrowth	River Style indicates Chain of Ponds, but the morphology is very different from Bohena Creek. Seems similar to other creeks - incised, wandering, irregularly meandering sand bed, with heavily vegetated banks and riparian corridor; some water pools visible along meanders on aerial photographs. Headcutting gullies eroding away from incised bankline. Flooding expands into creek to west - dispersed flow through forest
250-Civrt822065	822065	<b>Mollee Creek</b>	NAMOI	<b>Pilliga Plains:</b> Flat outwash plain of alluvial sediments and colluvial sheetwash from Pilliga Sandstone uplands. Dispersive sodic soils with Vertosols often gilgaied. Gulying.	Vertosols	Qrh	ALV-1a	No Flow					Sparse	Sparsely vegetated agricultural land	Ephemeral creek extends upstream of hydroline, with a similar unconfined, sinuous morphology. Also a similar tributary crossing at culvert 250-Civrt820891. Prior to clearance, creek would have been flowing through the densely vegetated Pilliga Forest, but likely that vegetation clearance has caused morphological change.
250-BR828222	828222	<b>Bohena Creek</b>	NAMOI	<b>Namoi Floodplain:</b> Pronounced channel at Bohena Creek with older terraces away from active channel, dominated by recent sandy alluvium. North, topography undulates gently with landforms associated with subtle changes between piedmont alluvium and colluvial sheet wash. Gilgai associated with clayey colluvial sheet wash. Broad meander plan present between Namoi and Narrabri Creek. Numerous abandoned and palaeochannels. North of Narrabri Creek = deep cracking clays in alluvial back plain sediments. Clays from Nadewar Range east of Narrabri.	Alluvium / Sodosols	Qff / p	ALV-2b	32-33-35	Lowland chain of ponds	Moderate	High	High	Dense grasses, moderate trees	Narrow to broad moderate to densely vegetated riparian corridor	Chain of ponds within a variable sinuosity high flow channel.Sorting of bed material - clay in low energy areas, sand bed. Well-vegetated bed. Unusual morphology: lowland chain of ponds, with variably located and spaced pools separated by indistinct, often swampy flow paths. Northern bank is steep (bedrock?), southern bank less-steep and prone to flooding. 1970 image does not show ponds clearly, and in-channel vegetation is sparser. Dense riparian and in-channel vegetation. Rilling of banks and tracks nearby. Note gilgai in areas to south. High sensitivity due to rare morphology and unusual flow structure. Proposal bridge extends over a longer section of floodplain than Newell Highway bridge, which has not significantly impacted the creek morphology. Moderate assessed sensitivity, but should be treated as high sensitivity due to rare morphology and unusual flow structure.
250-Civrt830477	830477	<b>Overland Flow</b>	NAMOI		Sodosols	Qff / p	ALV-2a / ALV-2b	1-0-1					Dense reeds, grasses	Moderate trees, dense grasses	As below
250-BR834450	834450	<b>Overland Flow</b>	NAMOI		Sodosols	Qff / p	ALV-2b	30-55-23					Dense reeds, grasses	Moderate trees, dense grasses	Also large trib at 834.5 and bend of Bohena River - note piling in channel for bridge along the outer bank of a laterally eroding meander bend. Inner bank has erosion typical of livestock access / trampling. Broad floodplain connected to Bohena floodplain.
250-Civrt842924	842924	<b>Overland Flow</b>	NAMOI		Sodosols	Qff / p	COL-1c Deep,	No Flow					Sparse	Sparse	Floodplain with gilgai (heavy clay subsoils)
250-BR844116	844116	<b>Namoi River</b>	NAMOI		Sodosols	Qac / m	interbedded ALV-1a/b and ALV-2b/c Deep,	23-24-19	Low sinuosity, gravel	Poor	Low	Moderate	Sparse trees and some grasses(?)	Narrow riparian corridor with mature trees	Mendering with pooled water around bends (similar to chain of pools), levees (?). Incised, possibly gravel bed. Eroding banks with headcutting gully systems and interconnecting tributaries, likely from floodwaters. Topsoils have been denuded in areas (scalds). Evidence of appreciable livestock erosion. Splay deposits at downstream extent of flooding.
847500	847500	<b>Narrabri Creek</b>	NAMOI		Sodosols	Qac / m	interbedded ALV-1a/b and ALV-2b/c	Not modelled	Low sinuosity, gravel	Poor	Low	Moderate	Sparse	Sparse trees with grasses and denuded areas	Area between Namoi and Narrabri is all channels/floodplain (see above). Long span bridge. Narrabri is gravel bed with some cobble/boulder sized sediment. Armoured bars. Incised, broad channel, in-channel benches (variable discharge). Perennial. In-channel vegetation. Narrabri is cut off during floods. North of Narrabri creek has highly reactive soils. Water sits on black soil for weeks indicating poor drainage. Narrabri Creek is actively meandering with distinct pool/riffle sequences and evidence of recent meander migration. See comments for Namoi River.

Table E2 Maximum velocity and stream power calculation summary

Chainage	Watercourse Name	Existing Reach Average Maximum Velocity (1%AEP, m/s)	Existing Vmax Class	Design Reach Average Maximum Velocity (1%AEP, m/s)	Design Vmax Class	Existing Reach Average Bankfull w (20%AEP, N/m)	CL	Design Reach Average Bankfull w (20%AEP, N/m)	CL	Existing Watercourse Sensitivity	Design Watercourse Sensitivity
547281	Boggy Cowal	0.9	L	0.8	L	4.5	VL	6.6	VL	M	M
552360	Overland Flow	0.4	VL	0.7	L	0.7	VL	1.6	VL	L	M
553169	Minor Watercourse	1.1	M	1.4	M	15.3	VL	29.9	L	L	M
553970	Wallaby Creek	1.1	M	1.2	M	31.3	L	42.6	L	L	M
562344	Macquarie River	1.6	H	1.5	H	171.9	H	171.9	H	H	H
566865	Minor Watercourse	0.6	L	0.5	VL	5.4	VL	4.4	VL	L	L
568919	Minor Watercourse	0.8	L	1.1	M	6.6	VL	3.9	VL	L	M
575927	Overland Flow	0.5	L	0.4	VL	3.4	VL	5.4	VL	M	M
577323	Overland Flow					Not Assessed					
582874	Overland Flow	0.4	VL	0.9	L	0.5	VL	0.8	VL	L	L
595239	Ewenmar Creek	1.3	M	1.8	H	78.0	M	78.0	M	M	H
599110	Goulburn Creek	0.7	L	1.0	M	9.3	VL	10.3	VL	L	M
602663	Emogandry Creek	1.8	H	1.7	H	41.7	L	41.7	L	M	M
607145	Native Dog Creek	2.0	H	2.0	H	74.0	M	74.0	M	M	H
608929	Pint Pot Gully	1.4	M	1.4	M	16.1	VL	16.1	VL	M	M
609715	Kickabil Creek	1.4	M	1.4	M	58.0	L	58.0	L	M	M
616680	Milpulling Creek	1.6	H	2.0	H	82.1	M	82.1	M	H	H
622300	Leeches Creek					Not Assessed					
623146	Bundijoe Creek	1.6	H	1.6	H	25.3	L	25.3	L	M	H
627322	Minor Watercourse					Not Assessed					
628044	Overland Flow	0.5	VL	0.9	L	5.3	VL	2.0	VL	L	L
633677	Marthaguy Creek	1.6	H	1.6	H	58.9	L	58.9	L	M	M
651728	Castlereagh River	3.0	VH	2.8	VH	662.0	VH	662.0	VH	H	H
659058	Judes Creek	0.3	VL	0.6	L	3.1	VL	5.3	VL	L	L
661275	Minor Watercourse	0.6	L	0.9	L	6.4	VL	6.4	VL	L	L
673082	Gulargambone Creek	2.3	H	2.1	H	251.5	H	251.5	H	H	H
682601	Baronne Creek	2.4	H	2.4	H	126.8	M	126.8	M	H	H
686020	Overland Flow					Not Assessed					
694184	Tenandra Creek	1.0	L	0.6	L	76.0	M	59.2	L	H	M
697901	Overland Flow	0.7	L	0.4	VL	13.7	VL	14.6	VL	M	M
700017	Mungery Creek	1.2	M	1.2	M	31.1	L	31.1	L	M	H
701981	Minor Watercourse	0.8	L	0.9	L	15.2	VL	15.2	VL	L	L
702305	Calerwi Creek	1.5	M	1.5	M	31.7	L	31.7	L	M	M
704588	Quanda Quanda Creek	1.5	M	1.5	H	78.1	M	78.1	M	H	H
705735	Overland Flow					Not Assessed					
708474	Black Gutter Creek	0.6	L	0.4	VL	9.0	VL	5.6	VL	L	L
709266	Salty Springs Creek	1.2	M	1.7	H	148.4	M	148.4	M	H	H
709664	Overland Flow	0.7	L	0.6	L	5.5	VL	2.7	VL	L	L
710830	Overland Flow	0.6	L	0.2	VL	11.4	VL	1.8	VL	L	L
712750	Minor Watercourse					Not Assessed					
713532	Minor Watercourse	0.5	L	0.4	VL	4.2	VL	1.1	VL	L	L
714593	Calga Creek	2.0	H	2.2	H	84.3	M	84.3	M	H	H
715376	Overland Flow					Not Assessed					
716029	Minor Watercourse					Not Assessed					
718164	Noonbar Creek	1.1	M	0.9	L	33.8	L	5.3	VL	M	M
719410	Minor Watercourse	0.9	L	0.7	L	10.7	VL	7.7	VL	M	M
722288	Bucklanbah Creek	1.4	M	1.6	H	46.2	L	46.2	L	M	H
728111	Small Creek	0.6	L	0.4	VL	6.2	VL	3.8	VL	L	L
730462	Teridgerie Creek	2.1	H	2.3	H	224.1	H	224.1	H	H	H
737894	Ironbark Creek	0.6	L	0.6	L	3.7	VL	3.1	VL	M	M
741964	Overland Flow	0.5	VL	0.4	VL	1.4	VL	1.2	VL	L	L
747768	Baradine Creek	2.8	VH	2.8	VH	177.2	H	177.2	H	H	H
749279	Unnamed Creek	1.0	L	1.0	M	23.3	L	23.3	L	M	M
750505	Minor Watercourse					Not Assessed					
752479	Minor Watercourse	1.4	M	0.8	L	31.9	L	12.6	VL	M	L
752712	Coolangla Creek	1.5	M	1.5	H	38.0	L	38.0	L	L	M
756853	Minor Watercourse	0.9	L	0.8	L	43.6	L	43.6	L	M	M
758968	Cumbil Forest Creek	0.4	VL	0.3	VL	2.8	VL	0.5	VL	L	L
763460	Etoo Creek	1.3	M	1.3	M	84.4	M	84.4	M	M	M
767941	Stockyard Creek	0.8	L	0.8	L	15.1	VL	15.1	VL	L	L
769143	Rocky Creek 1	2.0	H	2.1	H	126.2	M	126.2	M	M	M
773535	Tinegie Creek	0.4	VL	0.4	VL	4.5	VL	2.7	VL	M	M
777559	Minor Watercourse	0.6	L	0.9	L	19.1	VL	20.8	L	M	M
779635	Talluba Creek	1.3	M	1.3	M	91.5	M	91.5	M	H	H
783652	Minor Watercourse	1.4	M	1.4	M	132.4	M	132.4	M	M	M
786808	Minor Watercourse					Not Assessed					
789380	Rocky Creek (2)	1.0	M	1.1	M	26.7	L	26.7	L	M	M
796414	Coghill Creek	1.3	M	1.3	M	45.2	L	45.2	L	L	M
800445	Mollieroi Creek	1.1	M	1.3	M	41.6	L	41.6	L	M	M
802534	Minor Watercourse	0.3	VL	0.3	VL	2.1	VL	2.5	VL	L	L
803653	Black Creek	0.6	L	0.7	L	17.4	VL	39.5	L	L	L
805743	Minor Watercourse	0.5	VL	0.6	L	6.4	VL	6.4	VL	L	M
808364	Goona Creek	0.3	VL	0.3	VL	1.2	VL	0.5	VL	L	L
817650	Bundock Creek	1.2	M	0.9	L	35.4	L	35.4	L	M	M
822065	Mollee Creek	0.3	VL	0.3	VL	0.1	VL	0.0	VL	L	L
828222	Bohena Creek	2.1	H	2.1	H	39.2	L	39.2	L	L	M
830477	Overland Flow	0.4	VL	0.9	L	0.8	VL	7.5	VL	L	M
834450	Overland Flow	0.8	L	0.9	L	39.9	L	39.9	L	M	M
842924	Overland Flow					Not Assessed					
844116	Namoi River	2.9	VH	2.8	VH	22.3	L	22.3	L	M	H
847500	Narrabri Creek					Not Assessed					

Table E3 Existing watercourse sensitivity assessment

Structure ID	Chainage	Geomorphic Unit	Watercourse Name	Erosivity		Stabilising		Erodibility		Watercourse Sensitivity
				Bankfull w (W/m)	Max Velocity (1% AEP)	In-Channel Vegetation	Riparian Vegetation	Presence of Existing Erosion	Geotechnical Soil Erodibility	
250-Clvrt547281	547281	Macquarie Floodplain	Boggy Cowal	VL	VL	L	L	M	L	L
250-Clvrt552360	552360	Macquarie Floodplain	Overland Flow	VL	VL	L	L	M	M	L
250-Clvrt553169	553169	Macquarie Floodplain	Minor Watercourse	VL	VL	L	L	M	M	M
250-Clvrt553970	553970	Macquarie Floodplain	Wallaby Creek	L	L	H	L	L	M	M
250-BR562344	562344	Macquarie Floodplain	Macquarie River	H	H	M	M	M	M	H
250-Clvrt566865	566865	Undulating Agricultural Plains	Minor Watercourse	VL	VL	L	L	L	L	L
250-Clvrt568919	568919	Undulating Agricultural Plains	Minor Watercourse	VL	VL	M	M	L	L	L
250-Clvrt575927	575927	Undulating Agricultural Plains	Overland Flow	VL	VL	L	L	M	L	L
250-Clvrt577323	577323	Undulating Agricultural Plains	Overland Flow	Not Assessed	Not Assessed	M	L	M	L	Not Assessed
250-Clvrt582874	582874	Undulating Agricultural Plains	Overland Flow	VL	VL	M	L	L	L	L
250-BR595239	595239	Keelindi Alluvial Plains	Ewenmar Creek	M	M	H	M	H	L	M
250-Clvrt599110	599110	Keelindi Alluvial Plains	Goulburn Creek	VL	VL	H	M	H	L	L
250-BR602663	602663	Keelindi Alluvial Plains	Emogandry Creek	L	L	H	M	H	M	M
250-BR607145	607145	Keelindi Alluvial Plains	Native Dog Creek	M	M	H	L	H	M	M
250-BR608929	608929	Keelindi Alluvial Plains	Pint Pot Gully	VL	VL	L	H	H	L	L
250-BR609715	609715	Keelindi Alluvial Plains	Kickabil Creek	L	L	H	H	M	H	H
250-BR616680	616680	Keelindi Alluvial Plains	Milpulling Creek	M	M	M	L	H	H	H
622300	622300	Keelindi Alluvial Plains	Leeches Creek	Not Assessed	Not Assessed	M	L	H	Not Assessed	Not Assessed
250-BR623146	623146	Keelindi Alluvial Plains	Bundijoe Creek	L	L	L	L	H	L	H
250-Clvrt627322	627322	Keelindi Alluvial Plains	Minor Watercourse	Not Assessed	Not Assessed	M	L	L	Not Assessed	Not Assessed
250-Clvrt628044	628044	Keelindi Alluvial Plains	Overland Flow	VL	VL	M	L	L	L	L
250-BR633677	633677	Basaltic Alluvial Plains	Marthaguy Creek	L	L	H	M	H	L	M
250-BR651728	651728	Basaltic Alluvial Plains	Castlereagh River	VH	VH	H	M	H	H	H
250-Clvrt659058	659058	Basaltic Colluvial Plains	Judes Creek	VL	VL	M	M	L	L	L
250-BR661275	661275	Basaltic Colluvial Plains	Minor Watercourse	VL	VL	H	M	L	L	L
250-BR673082	673082	Basaltic Colluvial Plains	Gulargambone Creek	H	H	H	L	H	M	H
250-BR682601	682601	Basaltic Colluvial Plains	Baronne Creek	M	M	L	L	H	L	H
250-Clvrt686020	686020	Basaltic Colluvial Plains	Overland Flow	Not Assessed	Not Assessed	L	L	L	L	Not Assessed
250-Clvrt694184	694184	Basalt Mesa Plains	Tenandra Creek	M	M	L	L	H	L	M
250-Clvrt697901	697901	Basalt Mesa Plains	Overland Flow	VL	VL	L	M	H	L	M
250-BR700017	700017	Basalt Mesa Plains	Mungery Creek	L	L	L	M	H	L	M
250-BR701981	701981	Basalt Mesa Plains	Minor Watercourse	VL	VL	M	M	L	L	L
250-BR702305	702305	Basalt Mesa Plains	Calerwi Creek	L	L	L	M	M	L	M
250-BR704588	704588	Basalt Mesa Plains	Quanda Quanda Creek	M	M	M	M	H	L	M
250-BR705735	705735	Basalt Mesa Plains	Overland Flow	Not Assessed	Not Assessed	M	L	L	L	Not Assessed
250-Clvrt708474	708474	Basalt Mesa Plains	Black Gutter Creek	VL	VL	M	M	L	L	L
250-BR709266	709266	Basalt Mesa Plains	Salty Springs Creek	M	M	L	L	M	L	M
250-Clvrt709664	709664	Basalt Mesa Plains	Overland Flow	VL	VL	M	L	L	L	L
250-Clvrt710830	710830	Basalt Mesa Plains	Overland Flow	VL	VL	M	L	L	L	L
712750	712750	Basalt Mesa Plains	Minor Watercourse	Not Assessed	Not Assessed	M	L	L	L	Not Assessed
250-Clvrt713532	713532	Basalt Mesa Plains	Minor Watercourse	VL	VL	M	L	L	L	L
250-BR714593	714593	Basalt Mesa Plains	Calga Creek	M	M	M	M	H	L	M
250-Clvrt715376	715376	Basalt Mesa Plains	Overland Flow	Not Assessed	Not Assessed	L	L	L	L	Not Assessed
250-BR716029	716029	Basalt Mesa Plains	Minor Watercourse	Not Assessed	Not Assessed	L	L	H	L	Not Assessed
250-Clvrt718164	718164	Basalt Mesa Plains	Noonbar Creek	L	L	M	M	H	L	M
250-Clvrt719410	719410	Basalt Mesa Plains	Minor Watercourse	VL	VL	L	M	H	L	M
250-BR722288	722288	Basalt Mesa Plains	Bucklanbah Creek	L	L	L	M	M	L	M
250-Clvrt728111	728111	Basalt Mesa Plains	Small Creek	VL	VL	M	M	L	L	L
250-BR730462	730462	Basalt Mesa Plains	Teridgerie Creek	H	H	H	H	H	L	M
250-Clvrt737894	737894	Pilliga Plains	Ironbark Creek	VL	VL	M	M	H	L	L
250-Clvrt741964	741964	Pilliga Plains	Overland Flow	VL	VL	M	L	L	L	L
250-BR747768	747768	Pilliga Forest	Baradine Creek	H	H	H	H	H	L	H
250-BR749279	749279	Pilliga Forest	Unnamed Creek	L	L	H	M	H	L	L
750505	750505	Pilliga Forest	Minor Watercourse	Not Assessed	Not Assessed	H	H	L	H	Not Assessed
250-Clvrt752479	752479	Pilliga Forest	Minor Watercourse	L	L	M	M	L	H	M
250-BR752712	752712	Pilliga Forest	Coolangla Creek	L	L	H	H	L	M	L
250-BR756853	756853	Pilliga Forest	Minor Watercourse	L	L	H	H	M	H	M
250-Clvrt758968	758968	Pilliga Forest	Cumbil Forest Creek	VL	VL	H	M	L	H	L
250-BR763460	763460	Pilliga Forest	Etoo Creek	M	M	H	H	H	H	M
250-BR767941	767941	Pilliga Forest	Stockyard Creek	VL	VL	H	H	L	L	L
250-BR769143	769143	Pilliga Forest	Rocky Creek 1	M	M	H	H	M	M	M
250-Clvrt773535	773535	Pilliga Forest	Tinegie Creek	VL	VL	L	M	H	L	L
250-Clvrt777559	777559	Pilliga Forest	Minor Watercourse	VL	VL	L	M	H	M	M
250-BR779635	779635	Pilliga Forest	Talluba Creek	M	M	L	M	M	L	M
250-BR783652	783652	Pilliga Forest	Minor Watercourse	M	M	M	M	M	M	M
250-BR786808	786808	Pilliga Forest	Minor Watercourse	Not Assessed	Not Assessed	M	H	L	M	Not Assessed
250-BR789380	789380	Pilliga Forest	Rocky Creek (2)	L	L	M	H	L	M	M
250-BR796414	796414	Pilliga Forest	Coghill Creek	L	L	H	H	L	M	L
250-BR800445	800445	Pilliga Forest	Mollieroi Creek	L	L	H	H	M	M	M
250-Clvrt802534	802534	Pilliga Forest	Minor Watercourse	VL	VL	H	M	L	L	L
250-Clvrt803653	803653	Pilliga Forest	Black Creek	VL	VL	H	M	L	L	L
250-BR805743	805743	Pilliga Forest	Minor Watercourse	VL	VL	L	M	L	L	L
250-Clvrt808364	808364	Pilliga Forest	Goona Creek	VL	VL	M	M	L	L	L
250-BR817650	817650	Pilliga Forest	Bundock Creek	L	L	M	M	H	L	M
250-Clvrt822065	822065	Pilliga Plains	Mollee Creek	VL	VL	L	L	M	L	L
250-BR828222	828222	Namoi Floodplain	Bohena Creek	L	L	H	H	L	H	M
250-Clvrt830477	830477	Namoi Floodplain	Overland Flow	VL	VL	H	H	H	L	L
250-BR834450	834450	Namoi Floodplain	Overland Flow	L	L	H	H	H	L	L
250-Clvrt842924	842924	Namoi Floodplain	Overland Flow	Not Assessed	Not Assessed	L	L	H	L	Not Assessed
250-BR844116	844116	Namoi Floodplain	Namoi River	L	L	L	M	H	L	H
847500	847500	Namoi Floodplain	Narrabri Creek	Not Assessed	Not Assessed	L	L	H	L	Not Assessed

**Classification Thresholds**  
**Unit Bankfull Stream Power (W/m)**

1	VL	<20
2	L	>20 and <60
3	M	>60 and <150
4	H	>150 and <300
5	VH	>300

After White *et al.* , 2004 and RiverSmart, accessed Dec 2021

**Max Velocity (1%AEP, m/s)**

1	VL	<0.5
2	L	>0.5 and <1
3	M	>1 and >1.5
4	H	>1.5 and <2.5
5	VH	>2.5

Based on QDLs, White *et al.* , 2004 and Gippel et al., 2008, Gippel 2020

**In Channel Vegetation**

3	L	Sparse
2	M	Medium density, grass
1	H	Dense

**Riparian Vegetation**

3	L	Sparse
2	M	Medium
1	H	Dense

**Soil Erodibility**

3	H	EC= 1 or 2, Sodosol, Loose sand, Geotechnical reports of erosion
2	M	Plastic, Non-sodic clay or bedrock channel
1	L	Do not exist

Note - shear strength superseded by chemical properties of soil and site observations of erosion

**Presence of Erosion**

3	H	Rilling and gullyng, active channel erosion
2	M	Sheet wash, incised channel but no recent erosion
1	L	No visible evidence of erosion

**Watercourse Sensitivity Classes**

L	0 to 9
M	10 to 13
H	14+



Table E4 Design watercourse sensitivity assessment

Structure ID	Chainage	Geomorphic Unit	Watercourse Name	Erosivity		Stabilising		Erodibility		Watercourse Sensitivity
				Bankfull w (W/m)	Max Velocity (1% AEP)	In-Channel Vegetation	Riparian Vegetation	Presence of Existing Erosion	Geotechnical Soil Erodibility	
250-Clvrt547281	547281	Macquarie Floodplain	Boggy Cowal	VL	L	L	L	M	L	M
250-Clvrt552360	552360	Macquarie Floodplain	Overland Flow	VL	L	L	L	M	M	M
250-Clvrt553169	553169	Macquarie Floodplain	Minor Watercourse	L	M	L	L	M	M	M
250-Clvrt553970	553970	Macquarie Floodplain	Wallaby Creek	L	M	H	L	L	M	M
250-BR562344	562344	Macquarie Floodplain	Macquarie River	H	H	M	M	M	M	H
250-Clvrt566865	566865	Undulating Agricultural Plains	Minor Watercourse	VL	VL	L	L	L	L	L
250-Clvrt568919	568919	Undulating Agricultural Plains	Minor Watercourse	VL	M	M	M	L	L	M
250-Clvrt575927	575927	Undulating Agricultural Plains	Overland Flow	VL	VL	L	L	M	L	M
250-Clvrt577323	577323	Undulating Agricultural Plains	Overland Flow	Not Assessed	Not Assessed	M	L	M	L	Not Assessed
250-Clvrt582874	582874	Undulating Agricultural Plains	Overland Flow	VL	L	M	L	L	L	L
250-BR595239	595239	Keelindi Alluvial Plains	Ewenmar Creek	M	H	H	M	H	L	H
250-Clvrt599110	599110	Keelindi Alluvial Plains	Goulburn Creek	VL	M	H	M	H	L	M
250-BR602663	602663	Keelindi Alluvial Plains	Emogandry Creek	L	H	H	M	H	L	M
250-BR607145	607145	Keelindi Alluvial Plains	Native Dog Creek	M	H	H	L	H	M	M
250-BR608929	608929	Keelindi Alluvial Plains	Pint Pot Gully	VL	M	L	H	H	M	M
250-BR609715	609715	Keelindi Alluvial Plains	Kickabil Creek	L	M	H	H	M	L	L
250-BR616680	616680	Keelindi Alluvial Plains	Milpulling Creek	M	H	M	L	H	H	H
622300	622300	Keelindi Alluvial Plains	Leeches Creek	Not Assessed	Not Assessed	M	L	H	Not Assessed	Not Assessed
250-BR623146	623146	Keelindi Alluvial Plains	Bundijoe Creek	L	H	L	L	H	M	H
250-Clvrt627322	627322	Keelindi Alluvial Plains	Minor Watercourse	Not Assessed	Not Assessed	M	L	L	Not Assessed	Not Assessed
250-Clvrt628044	628044	Keelindi Alluvial Plains	Overland Flow	VL	L	M	L	L	L	L
250-BR633677	633677	Basaltic Alluvial Plains	Marthaguy Creek	L	H	H	M	H	L	M
250-BR651728	651728	Basaltic Alluvial Plains	Castlereagh River	VH	VH	H	M	H	H	H
250-Clvrt659058	659058	Basaltic Colluvial Plains	Judes Creek	VL	L	M	M	L	L	L
250-BR661275	661275	Basaltic Colluvial Plains	Minor Watercourse	VL	L	H	M	L	L	L
250-BR673082	673082	Basaltic Colluvial Plains	Gulgambone Creek	H	H	H	L	H	M	H
250-BR682601	682601	Basaltic Colluvial Plains	Baronne Creek	M	H	L	L	H	L	H
250-Clvrt686020	686020	Basaltic Colluvial Plains	Overland Flow	Not Assessed	Not Assessed	L	L	L	L	Not Assessed
250-Clvrt694184	694184	Basalt Mesa Plains	Tenandra Creek	L	L	L	L	H	L	M
250-Clvrt697901	697901	Basalt Mesa Plains	Overland Flow	VL	VL	L	M	H	L	M
250-BR700017	700017	Basalt Mesa Plains	Mungery Creek	L	M	L	M	H	L	H
250-BR701981	701981	Basalt Mesa Plains	Minor Watercourse	VL	L	M	M	L	L	L
250-BR702305	702305	Basalt Mesa Plains	Calerwi Creek	L	M	L	M	M	L	M
250-BR704588	704588	Basalt Mesa Plains	Quanda Quanda Creek	M	H	M	M	H	L	H
250-BR705735	705735	Basalt Mesa Plains	Overland Flow	Not Assessed	Not Assessed	M	L	L	L	Not Assessed
250-Clvrt708474	708474	Basalt Mesa Plains	Black Gutter Creek	VL	VL	M	M	L	L	L
250-BR709266	709266	Basalt Mesa Plains	Salty Springs Creek	M	H	L	L	M	L	H
250-Clvrt709664	709664	Basalt Mesa Plains	Overland Flow	VL	L	M	L	L	L	L
250-Clvrt710830	710830	Basalt Mesa Plains	Overland Flow	VL	VL	M	L	L	L	L
712750	712750	Basalt Mesa Plains	Minor Watercourse	Not Assessed	Not Assessed	M	L	L	L	Not Assessed
250-Clvrt713532	713532	Basalt Mesa Plains	Minor Watercourse	VL	VL	M	L	L	L	L
250-BR714593	714593	Basalt Mesa Plains	Calga Creek	M	H	M	M	H	L	H
250-Clvrt715376	715376	Basalt Mesa Plains	Overland Flow	Not Assessed	Not Assessed	L	L	L	L	Not Assessed
250-BR716029	716029	Basalt Mesa Plains	Minor Watercourse	Not Assessed	Not Assessed	L	L	H	L	Not Assessed
250-Clvrt718164	718164	Basalt Mesa Plains	Noonbar Creek	VL	L	M	M	H	L	M
250-Clvrt719410	719410	Basalt Mesa Plains	Minor Watercourse	VL	L	L	M	H	L	M
250-BR722288	722288	Basalt Mesa Plains	Bucklanbah Creek	L	H	L	M	M	L	H
250-Clvrt728111	728111	Basalt Mesa Plains	Small Creek	VL	VL	M	M	L	L	L
250-BR730462	730462	Basalt Mesa Plains	Teridgerie Creek	H	H	H	H	H	L	H
250-Clvrt737894	737894	Pilliga Plains	Ironbark Creek	VL	L	M	M	H	L	M
250-Clvrt741964	741964	Pilliga Plains	Overland Flow	VL	VL	M	L	L	L	L
250-BR747768	747768	Pilliga Forest	Baradine Creek	H	VH	H	H	H	L	H
250-BR749279	749279	Pilliga Forest	Unnamed Creek	L	M	H	M	H	L	M
750505	750505	Pilliga Forest	Minor Watercourse	Not Assessed	Not Assessed	H	H	L	Not Assessed	Not Assessed
250-Clvrt752479	752479	Pilliga Forest	Minor Watercourse	VL	L	M	M	L	L	L
250-BR752712	752712	Pilliga Forest	Coolangla Creek	L	H	H	H	L	L	L
250-BR756853	756853	Pilliga Forest	Minor Watercourse	L	L	H	H	M	L	L
250-Clvrt758968	758968	Pilliga Forest	Cumbil Forest Creek	VL	VL	H	M	L	L	L
250-BR763460	763460	Pilliga Forest	Etoo Creek	M	M	H	H	H	M	M
250-BR767941	767941	Pilliga Forest	Stockyard Creek	VL	L	H	H	L	L	L
250-BR769143	769143	Pilliga Forest	Rocky Creek 1	M	H	H	H	M	M	M
250-Clvrt773535	773535	Pilliga Forest	Tinegie Creek	VL	VL	L	M	H	L	M
250-Clvrt777559	777559	Pilliga Forest	Minor Watercourse	L	L	L	M	H	M	M
250-BR779635	779635	Pilliga Forest	Talluba Creek	M	M	L	M	M	L	H
250-BR783652	783652	Pilliga Forest	Minor Watercourse	M	M	M	M	M	M	M
250-BR786808	786808	Pilliga Forest	Minor Watercourse	Not Assessed	Not Assessed	M	H	L	M	Not Assessed
250-BR789380	789380	Pilliga Forest	Rocky Creek (2)	L	M	M	H	L	M	M
250-BR796414	796414	Pilliga Forest	Coghill Creek	L	M	H	H	L	M	M
250-BR800445	800445	Pilliga Forest	Mollieroi Creek	L	M	H	H	M	M	M
250-Clvrt802534	802534	Pilliga Forest	Minor Watercourse	VL	VL	H	M	L	L	L
250-Clvrt803653	803653	Pilliga Forest	Black Creek	L	L	H	M	L	L	L
250-BR805743	805743	Pilliga Forest	Minor Watercourse	VL	L	L	M	L	L	M
250-Clvrt808364	808364	Pilliga Forest	Goona Creek	VL	VL	M	M	L	L	L
250-BR817650	817650	Pilliga Forest	Bundock Creek	L	L	M	M	H	L	M
250-Clvrt822065	822065	Pilliga Plains	Mollee Creek	VL	VL	L	L	M	L	L
250-BR828222	828222	Namoi Floodplain	Bohena Creek	L	H	H	H	L	H	M
250-Clvrt830477	830477	Namoi Floodplain	Overland Flow	VL	L	H	H	H	L	M
250-BR834450	834450	Namoi Floodplain	Overland Flow	L	L	H	H	H	L	M
250-Clvrt842924	842924	Namoi Floodplain	Overland Flow	Not Assessed	Not Assessed	L	L	H	L	Not Assessed
250-BR844116	844116	Namoi Floodplain	Namoi River	L	VH	L	M	H	L	H
847500	847500	Namoi Floodplain	Narrabri Creek	Not Assessed	Not Assessed	L	L	H	L	Not Assessed