WATER AND RIVERS COMMISSION

Proposals to update the current stream reserve system in the Southwest forest region of Western Australia

Introduction

The Water and Rivers Commission has reviewed the existing stream reserve arrangements under the Forest Management Plan of 1994-2003 with the view of improving protection of in-stream values and drinking water quality.

This has been done following a request from the Department of Conservation and Land Management (CALM), as input to current discussions on the Regional Forest Agreement.

This short note is designed to provide additional background to proposed changes to the levels of protection afforded different stream systems.

Background

Commission's Role

As the agency responsible for managing the water resources of the State the Commission sets aside water for the environment and controls the abstraction of water for consumptive uses to ensure that its use is sustainable. It protects water quality for both abstractive purposes and in-stream values. This is done through its own powers and through influencing land planning and land management practices throughout the State. In relation to the Regional Forest Agreement, the Commission has a direct interest in promoting the protection of water quality for in-stream values and public drinking water purposes throughout the study area. The Commission works with CALM to progressively improve forest management practices on CALM managed lands. The improvements are normally included in CALM's management plans, their codes of practice and implemented work of their field officers and contractors.

The importance of buffer zones and forest reserves along watercourses

The Commission places a high priority on protecting the ecological values of important watercourse networks and wetland systems. These systems and their adjacent areas have high species diversity (for Western Australian ecosystems), sustain a specialised aquatic fauna, and provide habitat for the majority of terrestrial fauna and birds of our forest areas. They provide an important role in connecting larger reserves and directly provide interconnected habitats for aquatic fauna. They can provide extremely important links for aquatic fauna from headwaters to the ocean where the watercourse network is also protected from water abstractions and artificial barriers.

Reserves and forest buffer systems established along the stream network are central to mitigating the impact of logging operations on water resource values. Relatively narrow buffers can play a major role in reducing stream turbidity and water temperature increases that may otherwise occur. While wider buffers and the phasing of logging operations are required to effectively avoid minor salinity increases following logging (see below), the maintenance of some deep-rooted vegetation near watercourses reduces the amount of groundwater discharge and limits the salinity increase.

Stream reserves that flank the larger rivers are very important in maintaining visual amenity values and enhancing water based recreation activities such as canoeing.

The Commission is strongly committed to improving the effectiveness of watercourse protection through the development of a more targeted system of stream reserve design where appropriate.

Opportunities for improving the 1994-2003 Forest Management Plan

The existing stream reserve system, set down in the 1994-2003 Forest Management Plan, identified reserves on all streams throughout State Forest areas. Widths of the stream reserves varied according to stream order, with the greatest protection occurring of the larger rivers (higher stream order). While this was a significant improvement on the design of earlier stream reserve systems, the plan took no account of differences in protection objectives or priorities between catchments with similar protection objectives.

The Minister for the Environment placed additional controls on the intensity and phasing of logging operations (Conditions 12 and 16) to minimise the risk of small and temporary increases stream salinity. The conditions are applied in second order catchments where the impact of such increases is considered to be significant.

Stream crossings have long been recognised as key point sources of turbidity in forest streams. There is scope to improve protection of streams from increased turbidity by increasing the areas of undisturbed vegetation near all stream crossings.

Suggested Changes to the Current Stream Reserve Arrangements

The Commission has proposed the establishment of a four-tier system of stream protection zones or formal/informal stream reserves. It is based on the need to provide additional protection in catchments used for drinking supplies and to provide additional protection to stream systems that have high ecological and in-stream values.

Widths of stream protection zones

The Commission identified all active water supply catchments and stream networks where only limited disturbance had occurred in their catchment. In each case the relative importance and the degree of protection necessary for each river system was determined and protection zones set on the basis of Table 1 below.

Table 1 – Proposed new stream protection zones

Stream order	**Total Width of Stream Protection Zone (metres) – for the given protection category**			
	Highest – 1st	Second highest –2nd	Third highest – 3rd	General
5+	400	300	300	300
4	300	200	200	200
3	200	100*	60*	60*
2 & 1	100*	80*	60*	30*

* Additional protection (to a minimum of 150 metres total width) is to be provided at stream crossings tapering to the width specified above for 100 metres upstream and downstream

Approach used in assigning stream protection categories

Streams in active water supply catchments

Streams in water supply catchments were assigned to the highest, second highest or third highest protection category depending on erosion risk. Streams with steep slopes, high erosion potential or where the water was directly supplied from pipehead dams were assigned the highest level of protection. Other streams were assigned as having the second highest or third highest priority. These categories commonly drain into large reservoirs where there is an opportunity for particulate material to settle and have lower erosion potential. (Note that additional protection measures are applied to logging operations near water supply reservoirs)

Stream networks with high in-stream water values

The Commission has recently assessed the relative importance of in-stream values of most of the river reaches in the regional forest agreement area (Pen,1997 and Bosveld et al, in press) .

The overall assessment has been based on the condition of the riparian vegetation along the river reach in question and on the degree of disturbance within the upstream catchment. Stream systems where the catchment "disturbance" was limited were identified. These streams were considered as having important values worthy of additional protection above the general level. Stream systems where more than 10% of the upstream catchments had been cleared for agriculture were generally assigned the general level of protection, even if the riparian vegetation of the river reach in question was in good condition. Exceptions were made in cases of major rivers used for water based recreation (for example the lower reaches of the Warren and Blackwood Rivers).

Where river systems were identified as having a higher than general priority further priority setting was carried out. Details are included in Annexure 1. The key in-stream values to be protected were identified and the criteria considered in the priority setting included

- the degree to which each stream was a good representation of the aquatic ecosystem of its Natural Resource Management Zone[1]
- the ease of fish passage given existing natural and man-made barriers
- the size of the stream network in terms of the range of stream orders included, and
- the water quality relative to the in-stream values being considered for protection.

Annexure 1also includes the dominant reason used to adopt the protection category.

Changes in control measures relative to the current forest management plan

Table 2 indicates that the width of the stream protection zone is equal or greater than under the existing system for all stream orders with the highest priority category. Equal or increased protection is also provided in the second or third highest categories except for the fifth order or greater rivers.

Increased protection occurs on the fourth order streams in the general category although reductions occur for first and second order and fifth order streams. These changes are a consequence of the stream protection zone widths of Table 1, which reflect a consistent

[1] As defined in Allison et al, 1993

gradation of widths between identified priorities and stream orders. Improvements to the design of drainage at stream crossings are considered more important to improving water quality than any potential reduction in water quality that could occur from reducing the width of the buffers on first and second order streams. Many of the streams in the general category have been significantly impacted by upstream disturbances such as agricultural clearing.

Changes to CALM's Timber Harvesting Manual have been proposed that reflect increased protection and better drainage design at stream crossings. These will be further developed. Similar protection is also required downslope of all landing sites within 75 metres of streams used during logging operations. Where the stream protection zones are proposed to be less that the minimum total width of 150 metres at stream crossings additional protection is to be provided for at least 100 metres upstream and downstream of each crossing. The initial tables of Annexure 1 include descriptions of how stream reserves would be tapered over the 100 metres from the crossing point to the minimum stream reserve width.

Table 2 - Changes in width of the Stream Protection Zones relative to the 1994-2003 Forest Management Plan Reserves

Stream order	Change in Total Width of Stream Protection Zone (metres) – for the given protection level priority			
	Highest – 1st	Second highest – 2nd	Third highest – 3rd	General
5+	0	-100	-100	-100
4	+150	+50	+50	+50
3	+140	+40*	+0*	+0*
2 & 1	+40*	+20*	+0*	-30*

* Additional protection (to a minimum of 150 meters total width) is to be provided at stream crossings tapering to the width specified above 100 metres upstream and downstream

Concluding remarks

The Commission is strongly supportive of the concept of a distributed system of linear protection zones along watercourses that complement the larger block reserve system. Extensive field observations and detailed hydrologic research has shown the benefits of stream reserves in reducing the adverse impact of logging operations on water quality.

Riparian reserves contribute significantly to the protection of local in-stream ecological values. When applied through representative stream networks covering each natural resource management zone of the region (ie major vegetation groupings sub-divided by rainfall zones and drainage basin) they make a major contribution to protecting the water dependent ecosystems of the region.

Riparian reserves also contribute to protecting ecosystem processes, water quality, and in the larger rivers, maintaining in-stream recreational and aesthetic landscape amenity values.

Increases in the benefits of stream reserves would result from implementing the proposed changes to the current system in the South-west forest region of Western Australia as proposed in this note. The redesign has been based on:

- identifying networks of representative stream systems with high ecological values, establishing their priority and giving additional protection relative to that priority
- providing additional water quality protection in priority catchment areas, and
- providing additional protection at all stream crossings.

References

Allison, H E, Brandenburg, S A, and Beeston, G R (1993). *Natural Resource Zones of the South West Land Division*, Environmental Protection Authority, Technical Series 55, October 1993, pp 26.

Bosveld,T, Pen , L and Hill, A (in press). *Systematic overview of the naturalness and representativeness of rivers and creeks in the Perth to Bunbury Region*, Water and Rivers commission, Water Resource Allocation and Planning Series, Report No WRAP 8, in preparation.

Pen, L, (1997). *A Systematic Overview of Environmental values of the Wetlands, Rivers and Estuaries of the Busselton-Walpole Region*, Water and Rivers commission, Water Resource Allocation and Planning Series, Report No WRAP 7, June 1997, 125 pp.

Water and Rivers Commission proposals to improve the existing stream reserve design

A mew protection stream zone (or informal/formal reserve) system based on 4 levels of priority for protection of in stream (aquatic biological and /or cultural and recreational) values.

Highest Level of Protection -
River and Stream Systems with High Aquatic Biological values (at low stream order level) and of high conservation and recreational value (at higher stream order levels)

Stream Order	Minimum Total Width	Any additional buffering or upslope restrictions on management	Other comments
1st	100 metres	Ministerial Condition 12 applies in 1st order catchments	Increased from a minimum of 60 metres total width
2nd	100 metres	Ministerial Condition 12 on all second order catchments Ministerial Condition 16 on selected catchments whose streams are sensitive to high salt discharge	Increased from a minimum of 60 metres total width
3rd	200 metres	Ministerial Condition 16 on selected catchments whose streams are sensitive to high salt discharge	Increased from a minimum of 60 metres total width
4th	300 metres	Ministerial Condition 16 on selected catchments whose streams are sensitive to high salt discharge	Few if any Condition 16 streams would be fourth order
5th +	400 metres	Minimum distance not changed – although aesthetic and landscape aspects need to be considered, and may add width particularly where recreational values are the main priority.	Visual Resource Management (VRM) Guidelines also apply.

Second Highest Level of Protection -
River and Stream Systems with Important Aquatic Biological values and recreational fishing values (at low stream order level) and of high recreational value (at higher stream order levels)

Stream Order	Minimum Total Width	Any additional buffering or upslope restrictions on management	Other comments
1st	80 metres	Ministerial Condition 12 applies in 1st order catchments. Minimum of 75 metres one side buffer width at road crossings Note drainage from landing sites to also have at least 75 metre buffer upslope from edge of stream	Increased from a minimum total width of 60 metres. The 150 metre minimum total width at road crossings to taper to a total of 80 meters within 100 metres upstream and downstream of the crossing
2nd	80 metres	Ministerial Condition 12 on all second order catchments.	Increased from a minimum total width of 60 metres
3rd	100 metres		Increased from a minimum of 60 metres
4th	200 metres		Increased from a minimum of 150 metres
5th +	300 metres	Aesthetic – landscape aspects need to be considered, and may affect the width required, particularly where recreational values are high priority. Some wider and some narrower buffers may result	Visual Resource Management (VRM) Guidelines also apply.

Third Level of Protection -			
River and Stream Systems with Moderate Aquatic Biological values and recreational fishing values (at low stream order level) and of high recreational value (at higher stream order levels) - based on the 1994 to 2003 Management Plan with increased protection at road crossing			
Stream Order	**Minimum Total Width**	**Any additional buffering or upslope restrictions on management**	**Other comments**
1st and 2nd	60 metres	Ministerial Condition 12 applies in 1st order catchments. Minimum of 75 metres one side buffer (150 metre total width) at road crossings Note drainage from landing sites to also have at least 75 metre buffer upslope from edge of stream Ministerial Condition 12 on all second order catchments.	The 150 metre minimum width at road crossings to taper to 60 meters within 100 metres upstream and downstream of the crossing
3rd	60 metres		
4th	200 metres		Increased from a minimum of 150 metres
5th +	300 metres	Aesthetic – landscape aspects need to be considered, and may affect the width required, particularly where recreational values are high priority. Some wider and some narrower buffers may result	Reduced from 400 metres minimum – However, visual Resource Management (VRM) Guidelines also apply.

General Level of Protection – based on refinement of the 1994 to 2003 Management Plan with width reductions at the 1st, 2nd and 5+ order streams but additional protection at road crossings			
Stream Order	**Minimum Total Width**	**Any additional buffering or upslope restrictions on management**	**Other comments**
1st	30 metres	Ministerial Condition 12 applies in 1st order catchments	Reduced from 60 m minimum
2nd	30 metres	Ministerial Condition 12 on all second order catchments. To reduce erosion risk at road crossings with heavy traffic loads additional protection is required Minimum of 75 metres one side buffer (150 metre total width) at road crossings Note drainage from landing sites to also have at least 75 metre buffer upslope from edge of stream	General width reduced from 60 m minimum. At road crossings - tapering of one side buffer from 75 metres to 15 metres over a minimum distance of 100meters upstream and downstream of the crossing
3rd	60 metres	. To reduce erosion risk at road crossings with heavy traffic loads additional protection is required Minimum of 75 metres one side buffer (150 metre total width) at road crossings Note drainage from landing sites to also have at least 75 metre buffer upslope from edge of stream	At road crossings -suggested tapering of one side buffer from 75 metres to 30 metres over a minimum distance of 100 meters upstream and downstream of crossing.
4th	150 metres		
5th +	300 metres	Aesthetic – landscape aspects need to be considered ,and may affect the width required, particularly where recreational values are high priority	Reduced from 400 metres minimum – However, visual Resource Management (VRM) Guidelines also apply

Current stream buffer regimes – 1994 to 2003 - Forest Management Plan

Stream Order	Minimum Total Width	Any additional buffering or upslope restrictions on management	Other comments
1st	60 metres	Ministerial Condition 12 applies in 1st order catchments	
2nd	60 metres	Ministerial Condition 12 on all second order catchments Ministerial Condition 16 on selected catchments those streams are sensitive to high salt discharge	
3rd	60 metres		
4th	150 metres		
5th	400 metres		

List of priority streams classified under the proposed levels of protection for in-stream values

Stream Name and Reaches	Proposed Classification	Key in-stream values to be protected –		Criteria considered in selection/				Dominant reason for selection priority Selection in NRM zone	Likelihood of a large formal reserve in catchment
		Ecological	Social scientific or cultural values	NRM[1] Zone -	Fish Passage -- Stream Linkages	Degree of river system included	WQ rel. to value being protected		
Mitchell River	Highest	Best rep of aquatic ecosystems in NRM Zone	Benchmark Catchment	MeDnR2	No barriers - linked to sea artificially each season	Sub-catchment of river basin	High	Largest –least disturbed stream – pipehead foregone	Likely
Lower Frankland – higher order river reaches	Second highest	Effected by upstream impacts	Recreational fishing – introduced fish	WaFrR1, MeFrR2	No barriers -		Moderate – salinity high	Largest – high order stream with rec value in proposed reserve	Likely
Whole Deep River water course system including Condition 16 areas	Highest	Best rep of aquatic eco-systems in NRM zone - inc. Lamprey Migration –	Recreational fishing, in stream uses, tourism, in-stream recreation	WaShR1	No barriers, permanent link to ocean	Whole river basin – Higher stream order than Shannon	Very high	High ecological & recreational values – developments forgone	
Shannon River	Second highest	Good rep of NRM Zone aquatic ecosystem	Access limited for recreation	WaShR1	No barriers – natural seasonal link	Whole catchment	Very high	Good ecological values – already reserved	Already reserved
Little Quinninup Brook and Tinkers Brook	Second highest	Best rep of aquatic ecosystem with low level of disturbance in NRMZ	Values not high	MeWrR2	Downstream barriers	Max 3rd or 4th order stream and only sub-area of river basin	High – although down stream WQ affected	Best rep of eco-systems	Condition 16 area
Quinninup Brook	Third highest	Other options have higher value because of lack of recent disturbance	Values not high	MeWrR2	Downstream barriers	As above	As above	Other options have higher value before of lack of recent disturbance	

[1] Natural Resource Management Zone –Beard's Vegetation Classification zones sub-divided into three rainfall zones within each Drainage system – Allison et al (1993)

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		Ecological	Social scientific or cultural values	NRM[1] Zone -	Fish Passage -- Stream Linkages	Degree of river system included	WQ rel. to value being protected		
Main Warren downstream of Dam Site 55	Second highest	Fish migration but impacted by upstream clearing – possible future upstream dam	Landscape amenity, recreational, fishing on large river	WaWrR1	Linked to sea – impacted by future dam	Only the higher order reaches of the river	Moderate-impacted by salinity -	Ranked second only because of possible long term dam proposals upstream	Some already in Nat. park
Upper Carey Brook	Second highest	Very good rep of aquatic eco-systems in NRM zone – inc Lamprey migration		WaDoR1	No barriers or proposed barriers -	3rd order stream to the Donnelly	Very high	Second only to the whole Barlee Brook river system	
"Pine Creek Road Creek"	Third highest	Currently good rep of aquatic eco-systems in NRM zone –		WaDoR1	Upstream of probable future major dam on Donnelly R	3rd order stream to the Donnelly	Very high	Upstream of future dam on Donnelly River	
Donnelly Upper Reaches down to confluence with Manjimup Brook-excluding Willow Spring Creek Catchment	Second highest	Currently good rep of aquatic eco-systems in NRM zones		MeDoR2 and WaDoR1	Upstream of probable future major dam	3rd to 4th order stream system	High	Includes the least disturbed stream in NRM – has other areas of recent disturbance	
"Willow Spring Creek"	Highest	Best rep of aquatic eco-systems in NRM zone		MeDoR2	Upstream of probable future major dam on Donnelly R	2nd and 3rd Order creek system	Very high	Least disturbed in NRM zone of this size	Includes Condition 16 areas
Barlee Brook – whole system down to the Donnelly and Donnelly to the sea- includes Big Easter Brook and Double Brook	Highest	Best rep of aquatic eco-systems in NRM zone - inc. Lamprey Migration		WaDoR1	No barriers – some private land in high rainfall area- all dam sites likely to be forgone	Whole river system – 4th or 5th order-linked to the sea	Very high	Largest river system in NRM with limited impact	
Blackwood Higher order reaches through the Donnybrook Sunklands	Second highest		Water based recreation	MeBlR2	No barriers –	only high order stream reaches	Moderate – salinity impacted	Large, high order river system with key recreational values	already listed as a possible reserve

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		Ecological	Social scientific or cultural values	NRM[1] Zone -	Fish Passage -- Stream Linkages	Degree of river system included	WQ rel. to value being protected		
Rosa Brook – whole systems down to the Blackwood River	Highest	Very good rep of aquatic eco-systems in NRM zone -		MeBlR2	No barriers –dam sites foregone	Up to 3rd order streams on NRM Zone	Very high	An example of a whole stream eco-system as a very good rep of the NRM zone	
St John's Brook – to Blackwood	Third highest -		Landscape amenity - Previously identified reserve	MeBlR2	Pipehead site possible		High – but some clearing	Although larger than Rosa – has some clearing	
Milyeannup Brook Floodplain – to Blackwood	Second highest	Very good rep of aquatic eco-systems in NRM zone		MeBlR2			Very high	Extensive wetlands as well as watercourses-complements Rosa Brook in this NRM	
Sabina River	Highest	Best rep of aquatic eco-systems in NRM zone -		MeBuR2	Linked to sea – but altered lower watercourses	Upper river system – lower stream not protected	High in area protected	Best rep. In NRM zone -no recent disturbance as managed for nature conservation since the 1970s	
Ludlow Abba Rivers	Second highest	Good rep of aquatic eco-systems in NRM zone		MeBuR2	Linked to sea – through altered watercourses and drains	Small River	High – downstream WQ impacted	Good rep of eco-systems – more recent disturbance although larger size than Sabina R	
Margaret River - North Branch	Third highest	Good rep of aquatic eco-systems in NRM zone with extensive wetlands		MeBuR2	Existing weir at town– future larger dam possible	Small River	High –	Lower ranking because of barriers and future dam development	
Margaret River - South Branch	Third highest	Good rep of aquatic eco-systems in NRM zone with extensive wetlands		MeBuR2	No current barriers – but future dam possible	Small River	High	Lower ranking because of barriers and future dam development	

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		Ecological	Social scientific or cultural values	NRM[1] Zone -	Fish Passage -- Stream Linkages	Degree of river system included	WQ rel. to value being protected		
Veryiuca Brook	Second highest	Very good rep of aquatic eco-systems in NRM zone		WaBuR2	No barriers		Very High	Smaller that Yallingup Brk- -	Already reserved- although small upstream private land
Yallingup Brook	Highest	Best rep of aquatic eco-systems in NRM zone		WaBuR2	No barriers		Very High	Larger than Veryiuca Brk	Already reserved
Upper Thomsons Brook – westerd flowing trib's from eastern portion of Preston Block	Highest –	Best rep of aquatic eco-systems in NRM zone-Condition 16 trib. – low end of rainfall zone		MePeR2	Minor barriers – poor downstream WQ for aquatic biota	Creek	High – downstream WQ impacted	Least Impacted – Condition 16 Tributary	
Gavin Gully	Second highest	Good rep of aquatic eco-systems in NRM zone-Condition 16 trib.-		MePeR2	Minor barriers – poor downstream WQ for aquatic biota	Creek	High – downstream WQ impacted	At other end of rainfall range in NRM	
Upper Thomsons Brook – northerly flowing tributaries	Third highest	Good rep of aquatic eco-systems in NRM zone		MePeR2	Minor barriers – poor downstream WQ for aquatic biota	Creek	High – downstream WQ impacted	Similar to highest but recent logging	
Upper Ferguson River	Third highest	Good rep of aquatic eco-systems in NRM zone		MePeR2	Minor barriers – poor downstream WQ for aquatic biota	Creek	High – downstream WQ impacted	Private land reduces priority	Some Private uncleared land
Tributaries of "Glen Mervyn Dam Creek"	Third highest	Good rep of aquatic eco-systems in NRM zone – isolated by dam		MePeR2	None – Glen Mervyn Dam	Creek	High	Barrier of dam reduces priority	
Upper unnamed tributary of upper Preston River	Third highest	Good rep of aquatic eco-systems in NRM zone – isolated by dam		MePeR2	Minor barriers – poor downstream WQ for aquatic biota	Creek	High – downstream WQ impacted	Downstream private land reduces priority	
Harris River (assumed downstream of Reservoir?)	Third highest	Ecological values limited	Landscape amenity, recreation	DlCoR2	Wellington Dam downstream	Small River	High	Between dams – affects eco priority	Already partly reserved

Stream Name and Reaches	Proposed Classification	Key in-stream values to be protected –		Criteria considered in selection/				Dominant reason for selection priority Selection in NRM zone	Likelihood of a large formal reserve in catchment
		Ecological	Social scientific or cultural values	NRM[1] Zone -	Fish Passage -- Stream Linkages	Degree of river system included	WQ rel. to value being protected		
Upper Harris River	Highest	Very good rep of aquatic eco-systems in NRM zone – extensive wetlands –but isolated by dam		DlCoR2	Harris Dam downstream	Major Creek	Very high	Best Rep of eco-systems- extensive wetlands – although isolated by dam	Already mainly in Lane-Poole Reserve
Frederic River (Note cannot the Augustus and Ernest Rivers be added)	Second highest	Very good rep of aquatic eco-systems in NRM zone –		DlCoR1	Minor barriers from current irrigation diversion structures (– possible dam on Brunswick R in the future	?Small River	Very Good	Largest as yet unaffected stream by major barriers in NRM zone–	Left bank in Worsley Timber land - possible expansion if agreed with land owners
Roe Range Brook	Second highest	Good rep of aquatic eco-systems in NRM zone		DlCoR1	Only minor barriers– but lower Collie & Roe range Dams possible	Creek	High – but downstream WQ impacted	Small and near scarp but only minor barriers currently	
Collie R downstream from Wellington Dam	Highest		Landscape amenity, recreation	DlCoR1	Burekup Diversion Weir	River Section	Moderate to high– for values being protected	Recognition of an important social use of a modified flow regime	In proposed reserve under 1994 FMP
Tributaries west of Harris River Dam	Third highest	Reasonable rep of aquatic eco-systems in NRM zone – isolated by Harris Dam		DlCoR1	Harris Dam downstream	Creek	Very high	Lower priority as not as extensive wetlands as other upstream tributaries	
Mathilda River	Third highest	Very good rep of aquatic eco-systems in NRM zone- isolated by Beela Dam		DlCoR1	Beela Dam – possible future Dam on the Brunswick	Creek		Reduced priority by being on private land	On Worsley Timber Land

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		Ecological	Social scientific or cultural values	NRM[1] Zone -	Fish Passage -- Stream Linkages	Degree of river system included	WQ rel. to value being protected		
Hamilton River	Third highest	Good rep of aquatic eco-systems in NRM zone – isolated by Wellington Dam – some past clearing		DlCoR1	Wellington Dam downstream	Creek		Some cleared land – lower reaches	
Stinkwood Brook	Third highest	Good rep of aquatic eco-systems in NRM zone – isolated by Wellington Dam –		DlCoR2	Wellington Dam downstream	Creek	Possibly affected by past clearing	Riparian zone impacted – but discharges into better Quality stream	
"Delayney Rd Brook"	Highest	Best rep of aquatic eco-systems in NRM zone – isolated by Wellington Dam		DlCoR2	Wellington Dam downstream	Major Creek	High – when flowing	Larger Size -	
"Batalling Rd Brook"	Second highest	Good rep of aquatic eco-systems in NRM zone – isolated by Wellington Dam		DlCoR2	Wellington Dam downstream	Creek	High – when flowing	Smaller example – feeds into a saline stream	
2 tributaries of upper Collie River South	Highest	Best rep of aquatic eco-systems in NRM zone – isolated by Wellington Dam		MeCoR2	Wellington Dam downstream	Creek	High	Only examples available	
Uppermost Harvey River (upstream from Stirling Reservoir and pine plantation)	Highest	Best rep of aquatic eco-systems in NRM zone – but isolated by Stirling Dam		DlHaR1	Stirling Dam downstream	Major creek	Very high	Largest size - alternatives are also impacted by dams	Low – Bauxite Mining in area
Upper Samson Brook	Third highest	Good rep of aquatic eco-systems in NRM zone – but isolated by Samson Dam		DlHaR1	Samson Brook downstream	Creek	Very high	Priority limited by downstream dams	Low – Bauxite Mining in area
Upper Logue Brook	Third highest	Good rep of aquatic eco-systems in NRM zone – but isolated by Logue Brook Dam		DlHaR1	Logue Brk Dam downstream	Creek	Very high	Priority limited by downstream dams	

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Falls Brook	Second highest	Very Good rep of aquatic eco-systems in NRM zone – but isolated by Harvey Weir		DlHaR1	None – Harvey Weir downstream	Creek	High	Links to existing reserve – past impact lower than upper Tallanalla Creek	
Upper Tallanalla Creek	Third highest	Good rep of aquatic eco-systems in NRM zone – but isolated by Harvey Weir		DlHaR1	None – Harvey dam downstream	Creek	Good	Priority limited by downstream dams	
Upper Serpentine River	Second highest	Very Good rep of aquatic eco-systems in NRM zone – but isolated by Serpentine Dam		DlMrR1 & DlMrR2	None-Serpentine Dam	Small River	Good	Largest upstream river system –	
Big Brook (off Serpentine River)	Third highest	Reasonable rep. of eco-systems in NRM zone		DlMrR1 & DlMrR2	None-Serpentine Dam	Small River	Good	Priority limited by downstream dams	
Upper South Dandalup River	Third highest	Reasonable rep. of eco-systems in NRM zone		DlMrR1 & DlMrR2	None -South Dandalup Dam	Small River	Good	Priority limited by downstream dams	
Upper North Dandalup River	Third highest	Reasonable rep. of eco-systems in NRM zone		DlMrR1	None-North Danadalup Dam	Small River	Good	Priority limited by downstream dams	
Bell Brook	Highest	Best rep of aquatic eco-systems in NRM zone – with no barriers to sea		DlMrR2	Yes – via Lane-Poole reserve	Creek	Moderate	Largest creek connected to ocean –	
Nanga Brook	Third highest		Recreational values high	DlMrR1	Yes – via Lane-Poole reserve	Creek	Moderate	Some recreational activity and downstream plantations	Partly in Lane-Poole reserve
Big Brook (off Murray River)	Highest	Best rep of aquatic eco-system of the NRM zone		DlMrR1	Yes – via Lane-Poole reserve	Creek	Moderate	Adds value to existing reserve	Mainly in Lane-Poole reserve
Yarragil Brook	Third highest	Reasonable rep. of eco-systems in NRM zone		DlMrR1 & DlMrR2	Only minor barriers	Creek	Moderate	Spans R1 and R2 zones	

Stream Name and Reaches	Proposed Classification	Key in-stream values to be protected –		Criteria considered in selection/				Dominant reason for selection priority Selection in NRM zone	Likelihood of a large formal reserve in catchment
		Ecological	Social scientific or cultural values	NRM[1] Zone -	Fish Passage -- Stream Linkages	Degree of river system included	WQ rel. to value being protected		
Unnamed trib Murray R – in Pascoe Block – Pascoe Rd	Highest	Least disturbed aquatic eco-systems in NRM zone- condition 16 area		DlMrR2	Yes – Via Lane Poole reserve	Creek	High in creek– (moderate in passage)	Condition 16 Area	
Stony Gully	Third highest	Good rep of aquatic eco-systems in NRM zone		DlMrR2		Creek	High	Other options have less recent disturbance	
Chalk Brook	Third highest	Good rep of aquatic eco-systems in NRM zone		DlMrR2		Creek	High	Other options have less recent disturbance	
"Boggy Brook Road Brook"	Third highest	Good rep of aquatic eco-systems in NRM zone – on private land		DlMrR2		Creek	High	Private land reduces priority	
Upper Bannister River tributaries – Eastern Trib	Highest	Best rep of aquatic eco-system in NRM zone – isolated by cleared land & high stream salinity		DlMrR3	No major barriers – downstream quality poor	Creek	High –when flowing	The larger example	
Upper Bannister River tributaries – western Trib	Second highest	Good rep of aquatic eco-system in NRM zone – isolated by cleared land & high stream salinity		DlMrR3	No major barriers – downstream quality poor	Creek	High –when flowing	The smaller example	
Upper Canning River	Second highest	Very good rep of aquatic eco-system in NRM zone – extensive area but affected by some recent logging		DlSwR2	None – blocked by Canning Dam	Small River	High	Most extensive example	
Upper Wungong Brook	Third highest	Good rep of aquatic eco-system in NRM zone – active bauxite mining		DlSwR1	None- blocked by Wungong Dam	Major Creek	High – with minor turbidity		
Beraking Brook	Third highest	Good rep of aquatic eco-system in NRM zone –		DlSwR2	None- blocked by Mundaring Weir	Major Creek	High		
East Canning River	Highest	Best rep of aquatic eco-system in NRM zone – least disturbed		DlSwR2	None – blocked by Canning Dam	Major Creek	High when flowing	Includes Condition 16 stream	

Stream Name and Reaches	Proposed Classification	Key in-stream values to be protected –		Criteria considered in selection/				Dominant reason for selection priority Selection in NRM zone	Likelihood of a large formal reserve in catchment
		Ecological	Social scientific or cultural values	NRM[1] Zone -	Fish Passage -- Stream Linkages	Degree of river system included	WQ rel. to value being protected		
Upper Wootra Brook	Highest	Best rep of aquatic eco-system in NRM zone – isolated by salty streams & minor barriers		DlSwR3(i)	Minor barriers in lower reaches of Brockman R	Major Creek	High	Only example	
Pickering Brook	Highest	Best Rep of aquatic eco-systems – isolated by Mundaring weir		DlSwR1		Creek	High	Largest stream in NRM zone although some exotic species	
Upper Munday Brook	Third highest	Good Rep of aquatic eco-system- isolated by Victoria reservoir		DlSwR1	None – blocked by the new Victoria Dam	Creek	High	Some exotic species along watercourse	
Upper Churchmans Brook	Second Highest	Very good Rep of aquatic eco-system- isolated by Victoria reservoir		DlSwR1	None – blocked by Churchman's Brook Dam	Creek	High	Less exotic species along watercourse	
"Ridley Island Brook"	Second Highest	Good Rep of aquatic eco-system- isolated by Mundaring weir		DlSwR3(ii)		Creek	High –when flowing	Discharges into the Helena after some further dilution	
2 tributaries of upper Helena River	Third highest	Good Rep of aquatic eco-system- isolated by Mundaring weir		DlSwR3 (ii)		Creek	High –when flowing	Discharge into the more the salt affected Helena River	
2 tributaries of upper Darkin River	Highest	Very good Rep of aquatic eco-system- isolated by Mundaring Weir		DlSwR3 (ii)		Creek	High –when flowing	Discharge into less salt affected Darkin River	