



Darling Baaka River Health Project 2023 to 2025

Chapter 8 Landscape disturbance

Department of Climate Change,
Energy, the Environment and Water



Acknowledgement of Country

Department of Climate Change, Energy, the Environment and Water acknowledges the Traditional Custodians of the lands where we work and live.

We pay our respects to Elders past, present and emerging.

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Artist and designer Nikita Ridgeway from Aboriginal design agency Boss Lady Creative Designs created the People and Community symbol.

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Environment and Heritage

Department of Climate Change,

Energy, the Environment and Water

Locked Bag 5022, Parramatta NSW 2124

Phone: +61 2 9995 5000 (switchboard)

Phone: 1300 361 967 (Environment and Heritage enquiries)

TTY users: phone 133 677, then ask for 1300 361 967

Speak and listen users: phone 1300 555 727, then ask for 1300 361 967

Email info@environment.nsw.gov.au

Website www.environment.nsw.gov.au

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8. Landscape disturbance

8.1 What is landscape disturbance?

Landscape disturbance refers to human-induced alteration of the natural land surface within a catchment. These disturbances including roads, irrigation, mining, grazing and land clearing, can directly or indirectly impact water quality, water flow and overall river health.

Originally developed for the 2023 River Condition Index (RCI) as the Catchment Disturbance Index (DPE 2023a), this project has renamed the index to the Landscape Disturbance Index. Renaming of the indicator is more representative of the disturbances within each subcatchment, as the Catchment Disturbance Index boundaries were not watershed catchments in a meaningful sense. The focus of this project on the lower Darling Baaka River means that analyses do not account for disturbances within the vast catchment area upstream of Wilcannia, and as such it is more appropriate to call this index a Landscape Disturbance Index.

8.2 Why use landscape disturbance in river health?

Understanding landscape disturbances is critical for effective environmental monitoring and water resource management (Zheng et al. 2024). These disturbances, driven by human activities, can impact river functions across multiple spatial and temporal scales (Downs and Piégay 2019).

Increasing intensity and extent of anthropogenic activities are frequently linked to declines in water quality, degradation of riparian vegetation, and loss of aquatic biodiversity (Figure 1; Zia et al. 2013; Henriques et al. 2022; Damseth et al. 2024). Quantitative metrics that assess landscape change offer valuable insights into the extent of human-induced modifications within a catchment and their potential impacts on river condition (Kashaigili & Majaliwa 2010).

There are three major categories of disturbance relevant to river health: land use, infrastructure and land cover change. Urban development, mining and agriculture can substantially impact river health, due to the alterations in surface runoff and water quality, combined with the widespread removal of native vegetation (DPE 2023a; Miller and Hutchins 2017; Liu et al. 2021). Infrastructure such as weirs, dams, and roads significantly disrupt flow regimes and fragment hydrological connectivity leading to impaired river health (Harris et al. 2017; Mbaka and Mwaniki 2017; Cooke and Xia 2020). Incorporating indicators which measure landscape disturbance into assessments of river health is required to fully understand the stressors placed on rivers.

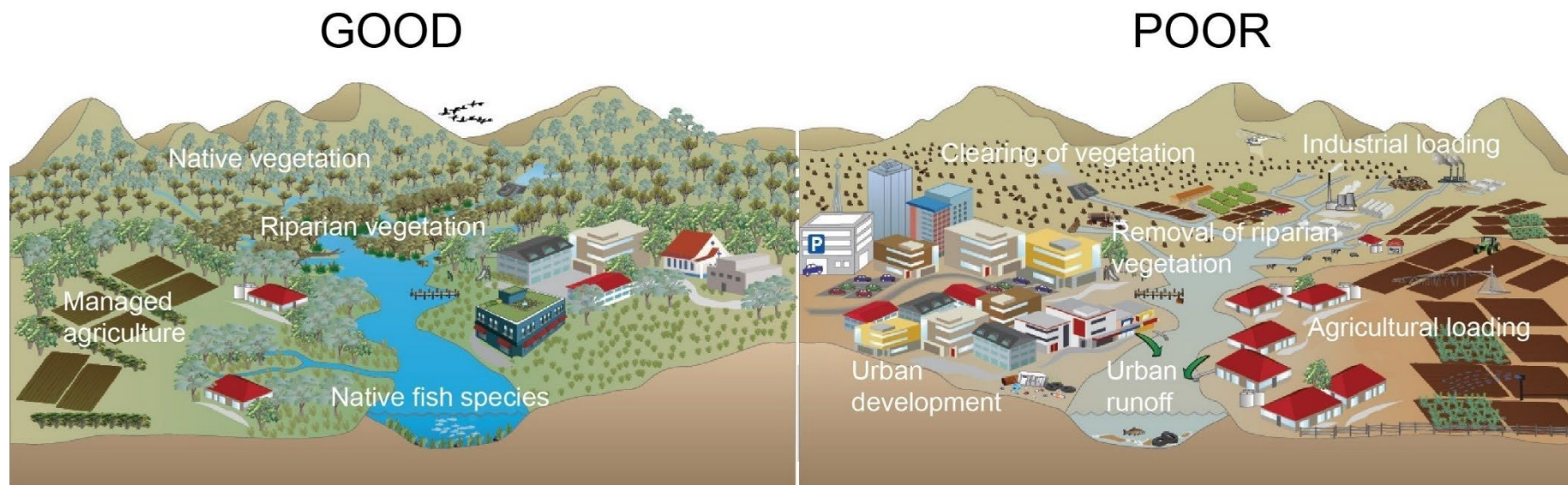


Figure 1 **Good versus poor landscape condition (Source: DPE 2023a)**

Left: Good catchment condition with low coverage of infrastructure, low land use and low/no loss of vegetation.

Right: Poor catchment condition with high coverage of infrastructure, intense land uses and high loss of vegetation.

8.3 Assessing landscape disturbances

The landscape disturbance index was developed by adapting the methods used to calculate the Catchment Disturbance Index described in the *River Condition Index: method report* (DPE 2023a), which was based on Norris et al. (2007) and Healey et al. (2012). The Landscape Disturbance Index incorporates three key indicators of widespread disturbances that impact river health: land use, infrastructure and land cover change. Each indicator incorporates several metrics that are numerically combined to give an overall indicator score. The 3 indicator scores are then averaged to produce the final Landscape Disturbance Index grade for the subcatchment. Detailed methodologies are provided in section 8.4.

Due to the differences in methodologies, comparing the results for the 2023 RCI and 2025 Darling Baaka RCI is not a true indication of changes to landscape disturbance over time. It is important to understand the differences between the 2023 RCI and the 2025 Darling Baaka RCI presented in this report (see Chapter 9).

8.3.1 Data used to assess the Landscape Disturbance Index

The Landscape Disturbance Index uses recent datasets to amend and further develop the 2023 Catchment Disturbance Index at a finer spatial scale for the lower Darling Baaka River study area (Table 1). The Landscape Disturbance Index includes published datasets that are particularly relevant to the lower Darling Baaka River to assess and quantify the impacts of human activities on waterway health (Table 1). The land use indicator has a number of sub-indicators, comprised of several metrics (Table 1).

The Landscape Disturbance Index presented in this report uses the Analytic Hierarchy Process (AHP) (Saaty 1980) as the weighting method for the multicriteria analysis in each of the 3 indicators. This process was chosen due to its transparency and reproducibility, making it an ideal approach for complex decision-making processes that involve multiple criteria (Saaty 1980; Lahdelma et al. 2000; Huang et al. 2011). The AHP requires a pairwise comparison of the relative importance of different factors to derive weights and is fully described in each of the following sections.

Table 1 Datasets used to calculate the Landscape Disturbance Index (LDI)

Indicator	Sub-indicator	Datasets for LDI metrics
Land use	Land use	Land use 2017 v1.5 (DCCEEW 2023b)
	Feral animals	Feral animal layer (DPI 2025)
	Mining	Mining data (Department of Regional NSW 2019)
Infrastructure	–	GIS 101 spatial dataset (department dataset) 11 road types Buffers defined by cadastre (Spatial Services 2024) Location of dams/weirs (departmental dataset) Specified weightings using analytical hierarchy analysis.
Land cover change	–	Sentinel-2 imagery (DCCEEW 2022a) SLATS (Statewide Landcover and Tree Survey) – Woody vegetation change – NSW 2017–2020 (DCCEEW 2022b) SLATS – Non-woody 2018, 2019 and 2020 (DCCEEW 2023c).

Land use indicator

The land use indicator considers the proportion of land devoted to different uses within each subcatchment and is comprised of three sub-indicators (Table 1). The Land use sub-indicators include horticulture, transport, agriculture and cropping, production forests, grazing and natural reserves. Land uses were assessed using the most recent land use spatial mapping of the region, NSW Land use 2017 v1.5 (DCCEEW 2023b). There have been two additional sub-indicators added to the RCI framework for the 2025 Darling Baaka RCI assessment, feral animals and mining.

It was considered important to account for the number of feral animals in the land use indicator as they can have negative impacts on river health and contribute to widescale landscape disturbances such as vegetation change and soil damage (Głowacz and Niżnikowski 2018). Dominant feral species for the region include goats (*Capra hircus*), pigs (*Sus scrofa*) and rabbits (*Oryctolagus cuniculus*); with goats and pigs having the higher impact on landscapes and waterways. The NSW Government conducts regular mapping of feral animal presence, with recent observations in the study area indicating goats are prevalent (DPI 2023). The impact of feral animals was considered a significant land use disturbance and was consequently built into the RCI framework for assessing the lower Darling Baaka River.

Mining activities were also added as a metric in the land use indicator in the RCI calculations. Mining can have severe impacts on nearby streams, rivers and surrounding vegetation by increasing soil erosion and causing water, soil and air pollution (Mwakesi et al. 2021; Mardonova and Han 2023). The environmental impact of mining varies depending on factors such as the scale, method, type of mineral and stage of

mining (Mardonova and Han 2023). There are currently 2 datasets available for mining information (mineral drill holes and occurrences) (Department of Regional NSW 2019). Both datasets were used to indicate impacts of mining, with full details provided in section 8.4.1.

Infrastructure indicator

The infrastructure indicator uses a range of datasets to determine the relative degree of impact of infrastructure on river health, including roads, dams and weirs (Table 1). The road metrics has been expanded to include 11 road types: primary, arterial sealed, sub-arterial sealed, local sealed, sealed urban service lanes, unsealed arterial, sub-arterial unsealed, unsealed local, unsealed urban service lanes, track vehicular and walking tracks (see section 8.4.2, Table 6). In addition to this, the buffer zones around infrastructure were determined by cadastre (Spatial Services 2024).

The infrastructure indicator used for the Darling Baaka River Health Project incorporated the number of weirs and dams in the Landscape Disturbance Index calculation. Weirs and dams are disproportionately important forms of infrastructure in terms of the potential impacts they have on rivers, as they directly impact river flow and sediment dynamics (Casserly et al. 2021). These structures influence flow dynamics and water quality, fish passage and the hydrological connectivity between channels and the floodplain. Pipelines and telecommunication lines as well as railways were assessed using spatial information including railway cadastre layers.

Weighting of the infrastructure indices was completed using an Analytic Hierarchy Process (AHP) (Saaty 1980). Further explanation of the weighting system is provided in section 8.4.2.

Land cover change indicator

The land cover change (loss of vegetation) indicator of the Landscape Disturbance Index quantifies the extent of woody vegetation change based on Sentinel-2 imagery over time using the Statewide Landcover and Tree Survey (SLATS) (DCCEEW 2022b). The 2023 RCI (DPE 2023a) specifically focused on the reduction of woody vegetation cover, which plays a crucial role in soil stabilisation, water retention and biodiversity support (Chirico et al. 2013; Shachak et al. 2008). However, in the lower Darling Baaka region, non-woody vegetation is important for stabilisation of the riparian zone and the provision of habitat (Abernethy and Rutherford 1999). This project incorporated both woody and non-woody vegetation in the Landscape Disturbance Index (Table 1).

8.4 Methods

8.4.1 Land use indicator

The land use component of the Landscape Disturbance Index considers the proportion of land devoted to different uses within each subcatchment to understand the human disturbances to the landscape.

Land use sub-indicator

The NSW Land Use 2017 v1.5 dataset (DCCEEW 2023b) was used for analysis in this study. The pairwise comparison in the AHP used weighted values (determined by expert opinion in the 2023 RCI [DPE 2023a]) to stipulate the relative importance of land use categories.

To implement the AHP, pairwise comparisons were undertaken for each of the land use metrics: horticulture, cropping, transport and utilities, grazing and production forest (Table 2). The comparison process used a scale of 1 to 9 to assign levels of importance between criteria, where 1 indicates equal importance and 9 represents extreme importance of one criterion over another. The nature reserves category was excluded from the pairwise comparison as it was previously assigned a weight of 0 in the 2023 RCI, which aligns with the AHP method's treatment of criteria of 'no impact'.

Table 2 Pairwise comparison matrix for land use categories

Criteria	Horticulture	Transport	Cropping	Grazing	Production forest
Horticulture	1	1	2	3	4
Transport	–	1	2	3	4
Cropping	–	–	1	2	3
Grazing	–	–	–	1	2
Production forest	–	–	–	–	1

The AHP uses the pairwise comparison to derive weights for each of the land use categories (Table 3). The consistency ratio of 0.8% for the pairwise comparisons is well below the generally accepted threshold of 10% (Saaty 1980), indicating a high level of consistency and reliability in the weighting process.

Table 3 Weighting of land use types for the calculation of the Landscape Disturbance Index (LDI)

Land use metrics	Subcategories	LDI weights
Horticulture, orchards, legumes, cotton, rice, non-cereal forage, crops	Intensive animal husbandry	0.319
	Intensive horticulture	
	Irrigated perennial horticulture	
	Irrigated seasonal horticulture	
	Perennial horticulture	
	Seasonal horticulture	
	Irrigated cropping	
	Grazing irrigated modified pastures	
Transport, utilities, urban uses, institutional uses	Manufacturing and industrial	0.319
	Mining	
	Residential and farm infrastructure	
	Services	
	Transport and communication	
	Utilities	
	Waste treatment and disposal	
	Channel/aqueduct	
	Reservoir/dam	
Cropping not included in intensive and irrigated agriculture	Cropping	0.184
Grazing	Grazing modified pastures	0.109
	Grazing native vegetation	
	Land in transition	
Production forests, farm forestry, plantations	Production forestry	0.068
	Irrigated plantation forestry	
	Plantation forestry	
Wilderness area, protected landscape, National Park, habitat/species, management area, strict nature reserve, national monument, managed resource	Estuary/coastal waters	0.00
	Lake	
	Managed resource protection	
	Marsh/wetland	
	Nature conservation	

Land use metrics	Subcategories	LDI weights
protected areas, unmanaged land, water	Other minimal use River	

Equation 1 (Norris et al. 2007) was used to determine the land use indicator of each subcatchment in NSW.

Equation 1: $LUI_{pnw} = 1 - ((FLUI_1 \times w_1) + (FLUI_2 \times w_2) + \dots + (FLUI_n \times w_n))$

where LUI_{pnw} represents the land use indicator for each subcatchment; $FLUI_1$, $FLUI_2$ and $FLUI_n$ refer to the fractions of each land use type within the area of each subcatchment; and w_1 , w_2 and w_n are the weightings assigned to each specific land use type (see Table 3).

Feral animal sub-indicator

In addition to land use categories (Table 3), the land use indicator analysis also includes feral animal distribution data (DPI 2023). In particular, the distributions and relative abundances of goats, pigs and rabbits are important for this region. Based on field observations and their grazing behaviour, goats were considered to have the most significant impact, followed by pigs and rabbits (Table 4).

The abundance of all feral animals in the relevant spatial datasets is qualitative, categorised as high, medium, low or absent. A pairwise comparisons of 9 criteria to weigh the impact of the 3 feral animals was conducted, excluding the 'absent' category as it has no impact. The weights for each criterion are shown in Table 5.

Table 4 Pairwise comparison matrix for feral animals

Criteria	Goat H	Goat M	Goat L	Pig H	Pig M	Pig L	Rabbit H	Rabbit M	Rabbit L
Goat H	1	2	3	4	5	6	7	8	9
Goat M	–	1	2	2	3	4	4	5	6
Goat L	–	–	1	1	2	3	3	4	5
Pig H	–	–	–	1	2	3	3	4	5
Pig M	–	–	–	–	1	2	2	3	4
Pig L	–	–	–	–	–	1	1	2	3
Rabbit H	–	–	–	–	–	–	1	2	3
Rabbit M	–	–	–	–	–	–	–	1	2
Rabbit L	–	–	–	–	–	–	–	–	1

Table notes: H = High, M = Moderate, L = Low

The consistency ratio of 1.7% for the pairwise comparisons demonstrated a high level of consistency and reliability (Table 5). To determine the disturbance caused by each of these feral animals, the proportion of the area covered by each abundance group (low, medium and high) was multiplied by their weights (that is, goat-high, goat-medium and goat-low) (see Equation 2).

Table 5 **Weights assigned to abundance categories for feral animal impacts**

Feral animal	High	Moderate	Low
Goat	0.332	0.192	0.124
Pig	0.121	0.078	0.049
Rabbit	0.048	0.032	0.023

Mining activities sub-indicator

There are currently 2 datasets available for mining information (mineral drill holes and occurrences) (Department of Regional NSW 2019). Each dataset has a different spatial distribution over the study area. Both datasets were used to indicate impacts of mining. This was completed by merging the datasets, and the disturbance was indicated by normalising the number of mineral drill holes and occurrences in each subcatchment (M_i). Then this normalised number was multiplied by the weight (0.319).

Overall calculation of land use indicator

Using Equation 2, feral animals and mining activities disturbance were incorporated into the overall land use indicator.

Equation 2: $LUI_n = LUI_{pnw} - (FF \times 0.109) - (M_i \times 0.319)$

where LUI_n represents the overall land use indicator, LUI_{pnw} represents the land use types with the AHP-generated weighting system applied (Table 3), FF represents the feral animals fraction, M_i represents mining activities impact index, and 0.109 and 0.319 denote the weights for feral animals and mining, respectively.

8.4.2 Infrastructure indicator

Road type metrics

The Landscape Disturbance Index calculations presented in this report used 11 types of roads: primary, arterial sealed, sub-arterial sealed, local sealed, sealed urban service lanes, unsealed arterial, sub-arterial unsealed, unsealed local, unsealed urban service lanes, track vehicular and walking tracks (Table 6). The proportion of the area occupied by each of these factors was calculated.

For road features, road buffer distances were calculated by averaging the measured width of the cadastre road corridor in 10% of each category of roads intersecting with the corridor to assign the relevant buffer distance for each road type (Spatial Services [2024]; Table 6). For walking tracks (paths) and vehicular tracks, buffer distances of 0.75 m and 1 m were used, respectively (Parnell 2021; Motha et al. 2004).

For pipelines and powerlines, buffer distances were the same as those used in the 2023 RCI analysis (Lucy Dobbs, pers. comms., 16 August 2024, Table 7). For railways, the railway cadastre layer (polygon) was used to calculate the proportional area in each subcatchment (Spatial Services 2024).

Dam and weir metrics

On-farm dams (polygon) and weirs (point) datasets were obtained from WaterNSW (Gurmeet Singh, pers. comms., 11/9/2024). The impact of weirs and dams was assumed to be equivalent, and both were assigned the same weight (0.397). For dams, the proportion of the area covered by each dam located in each subcatchment boundary was multiplied by the weight assigned to dams and weirs. For weirs, the normalised number of weirs in each subcatchment (*DW*) was multiplied by its relevant weight.

To derive weighting factors using the AHP, pairwise comparisons were conducted between the main infrastructure categories — that is, dams and weirs, road types, railways, pipelines and powerlines (Table 6). The pairwise comparison used in the AHP used weighted values (determined by expert opinion in the 2023 RCI) to stipulate the relative importance of infrastructure components. Walking tracks were excluded from the pairwise comparison as this was assigned a weight of 0 (zero) by expert opinion (DPE 2023a), which aligns with the treatment of criteria with ‘no impact’ in the AHP methodology.

To reflect the significant influence of dams and weirs on rivers, relative to other forms of infrastructure, dams and weirs were assigned the highest importance (9) in the pairwise comparison matrix (Table 6). All sealed roads (primary, arterial, sub-arterial, local, urban service lanes) are given equal importance and are slightly more important (2) than unsealed roads. All unsealed roads including arterial and sub-arterial roads, local roads, urban service lanes and track vehicular are considered equally important. Furthermore, railways are more important (3) than pipelines/powerlines which have equal importance in the pairwise comparison.

Table 6 Pairwise comparison matrix for infrastructure categories

Criteria	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Dams and weirs	1	9	9	9	9	9	9	9	9	9	9	9	9	9
2. Primary road	–	1	1	1	1	1	2	2	2	2	2	4	6	6
3. Arterial sealed road	–	–	1	1	1	1	2	2	2	2	2	4	6	6
4. Sub-arterial road	–	–	–	1	1	1	2	2	2	2	2	4	6	6
5. Local sealed road	–	–	–	–	1	1	2	2	2	2	2	4	6	6
6. Urban service sealed lane	–	–	–	–	–	1	2	2	2	2	2	4	6	6
7. Arterial unsealed road	–	–	–	–	–	–	1	1	1	1	1	3	5	5
8. Sub-arterial unsealed road	–	–	–	–	–	–	–	1	1	1	1	3	5	5
9. Local unsealed road	–	–	–	–	–	–	–	–	1	1	1	3	5	5
10. Urban service unsealed road	–	–	–	–	–	–	–	–	–	1	1	3	5	5
11. Track vehicular	–	–	–	–	–	–	–	–	–	–	1	3	5	5
12. Railway	–	–	–	–	–	–	–	–	–	–	–	1	3	3
13. Pipeline	–	–	–	–	–	–	–	–	–	–	–	–	1	3
14. Powerline	–	–	–	–	–	–	–	–	–	–	–	–	–	1

Table 7 Infrastructure metrics used for the Landscape Disturbance Index and associated Analytic Hierarchy Process (AHP)-derived weights and buffer distances

Infrastructure metrics	AHP-derived weights	Buffer distance (m)
Dams and weirs	0.397	– ^a
Primary road	0.070	50
Arterial sealed road	0.070	30
Sub-arterial sealed road	0.070	40
Local sealed road	0.070	15
Urban service lane sealed	0.070	3
Arterial road unsealed	0.041	30
Sub-arterial road unsealed	0.041	30
Local road unsealed	0.041	15
Urban service lane unsealed	0.041	3

Infrastructure metrics	AHP-derived weights	Buffer distance (m)
Track vehicular	0.041	1
Cadastre railway corridor	0.020	– ^b
Powerline - 500 kV	0.012	40
Powerline - 330 kV	0.012	30
Powerline – 132 and 220 kV	0.012	20
Powerline – Low voltage, 19.1, 22, 33, 6.6 and street light	0.012	15
Pipeline	0.012	20
Path	0.000	0.75

Table notes:

a) In this project, to calculate Landscape Disturbance Index, dam polygons and weir points were incorporated into infrastructure disturbance.

b) Railway cadastre corridor (polygon) was used to quantify the spatial extent of railway corridors in the study area (Spatial Services 2024).

Overall calculation of infrastructure indicator

Equation 3 was used to calculate the infrastructure indicator.

Equation 3: $InfraI_n = InfraI_{pnw} - (DW_i \times 0.397)$

where, $InfraI_n$ is the overall infrastructure indicator, $InfraI_{pnw}$ represents the infrastructure indicator with the AHP-derived weights applied (Table 6), DW_i is the dams and weirs impact index, and 0.397 denotes the weight for dams and weirs.

8.4.3 Land cover change

The land cover change (loss of vegetation) component of the Landscape Disturbance Index quantifies the extent of vegetation change based on Sentinel-2 imagery over time using Statewide Land and Tree Survey (SLATS). To calculate the land cover change for the 2025 Darling Baaka RCI, data for woody vegetation between 2017 and 2020 (DCCEEW 2022b) and the land cover change for non-woody vegetation between 2018 and 2020 (DCCEEW 2023c) were incorporated into the analysis. The method for calculating land cover change in this project was based on the RCI 2023 (DPE 2023a), where land cover change was assessed between 2017 and 2020, thus historical land clearing (prior to 2017) is not included in the analysis.

Woody and non-woody vegetation are considered equally important and, thus, we did not conduct an AHP analysis to weight this component. The land cover change indicator was calculated using Equation 4,

Equation 4: $LCCI_n = 1 - \left(\frac{\text{Loss of woody} + \text{non-woody vegetation area}}{\text{Total area of subcatchment}} \right)$

where $LCCI_n$ represents the updated land cover change index.

8.4.4 Overall calculation of the Landscape Disturbance Index

In line with Norris et al. (2007), Equation 5 was used to calculate the final Landscape Disturbance Index. Each of the index indicators were evenly weighted in the calculation of the index:

Equation 5: *Landscape Disturbance Index* = $LUI_n + InfraI_n + LCCI_n - 2$

where LUI_n represents the land use indicator, $InfraI_n$ represents the infrastructure indicator, $LCCI_n$ represents the land cover change indicator.

Equal intervals were used to categorise the Landscape Disturbance Index scores (Table 8). For more information on the grades used in the RCI indicators see Chapter 1.

Table 8 **Landscape Disturbance Index (LDI) score and associated River Condition Index (RCI) condition grade**

LDI score	RCI condition grade
0.0 to <0.2	Very poor
0.2 to <0.4	Poor
0.4 to <0.6	Moderate
0.6 to <0.8	Good
0.8 to 1.0	Very good

8.5 Results and discussion

The Landscape Disturbance Index is calculated at the subcatchment level, with figures also showing the river reach zone (refer Chapter 2, Figure 2). The measurements of landscape disturbances are summarised below.

8.5.1 Land use indicator

The land use in the region has been assessed as not placing considerable stress on the aquatic ecosystem or river health, as evidenced by the generally high index scores (Figure 2). There are, however, regions where land use stress on river health is higher. The subcatchments surrounding and to the west of Pooncarie (subcatchments 1475, 1484 and 1467; Figure 2) are under the most stress from land use. This is potentially due to changes in land use in the region, as there has been recent establishment of cropping in this area, which is different to land use (mainly grazing) in the wider study area. The Pooncarie South river reach zone (see Chapter 2, Figure 2) and subcatchment 1495, in the Great Darling Anabranh zone west of Pooncarie, have the highest levels of mining in the study area (although this sand mining still only covers a small area). Pooncarie South zone is also impacted by farm dams and weirs.

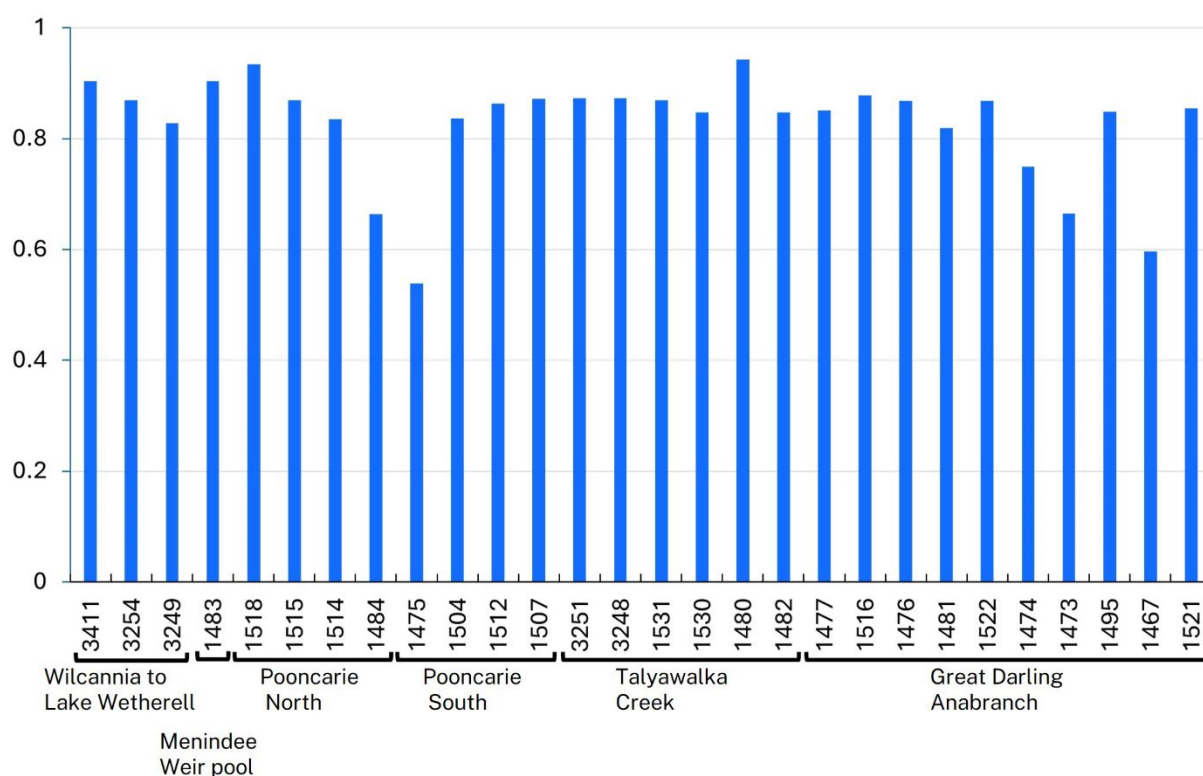


Figure 2 Land use indicator scores for subcatchments of the lower Darling Baaka River

8.5.2 Infrastructure indicator

The region between Wilcannia and Wentworth is very remote. There are few main roads and the majority of roads are unsealed. Powerlines and pipelines are generally restricted to main thoroughfares, with very limited infrastructure throughout the region.

These factors all contribute to the generally low disturbance by infrastructure across the study area (Figure 3).

Only one subcatchment was assessed with an infrastructure score less than 0.6. This was Lake Wetherell subcatchment (1483; Menindee weir pool river reach zone), where major weir infrastructure resulted in a low score (0.455). This subcatchment contains 66% of the total weir infrastructure within the study area. As dams and weirs directly impact river functioning, they have been weighted as the most significant form of infrastructure impacting river health in this assessment. The Lake Wetherell subcatchment (1483) is heavily influenced by the Menindee Main Weir, which forms Lake Wetherell. The extent of disturbance to river function caused by Main Weir in the Lake Wetherell subcatchment is considerably higher than most other subcatchments within the study area.

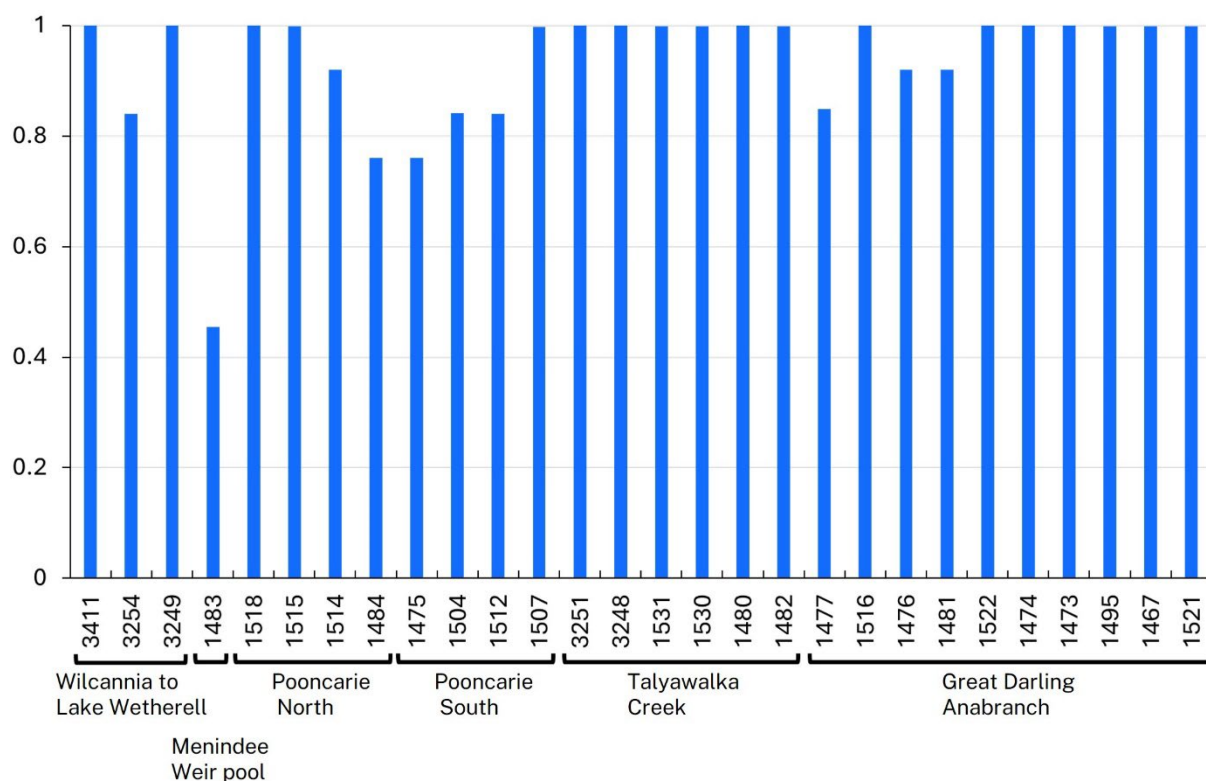


Figure 3 Infrastructure indicator scores for subcatchments of the lower Darling Baaka River

8.5.3 Land cover change indicator

Historically, a significant amount of land has been cleared of native vegetation in the study area. Much of the clearing between Wilcannia and Wentworth was completed over 20 years ago, thus the changes in land use over recent times has been minimal as the land cover change indicator does not reflect long-term historical clearing. This is reflected in the land cover change scores, where analysis of all subcatchments indicated minimum recent land clearing (Figure 4). However, this may not be a true reflection of the impacts of land cover clearing over time on the river health.

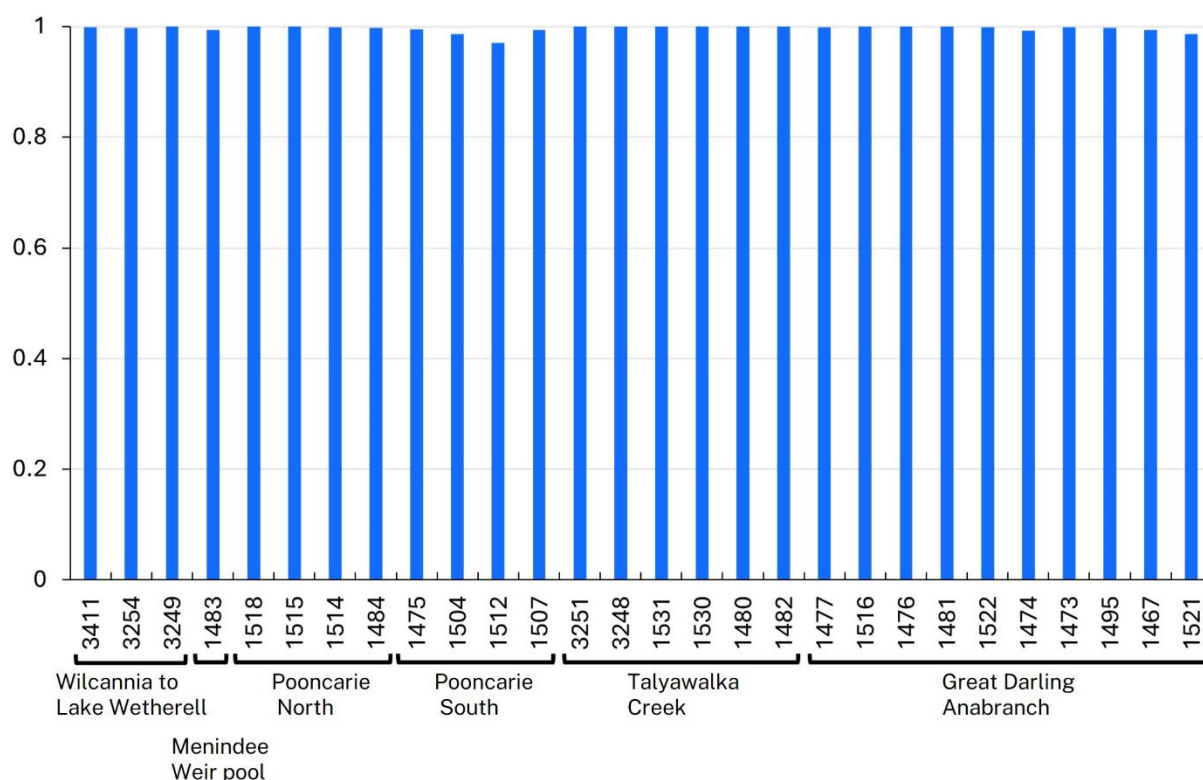


Figure 4 Land cover change indicator scores for subcatchments of the lower Darling Baaka River

8.5.4 Final Landscape Disturbance Index score

Over 86% of the subcatchments in the study area were found to be in very good or good condition in terms of landscape disturbances (Table 9). With the exception of farm dams and weirs, there is relatively minimal infrastructure influencing river health in the catchments, with low levels of roads, tracks and powerlines throughout the study area. Land use in the region is dominated by grazing, with minimal urban regions and mining, thus land use is not seen as a major contributor to landscape disturbances.

The catchments around Pooncarie (catchments 1484, 1475) as well as further downstream on the Darling Baaka River (catchment 1504) display a moderate to high level of landuse disturbances which is reflected in the lower index scores (Figure 5) and poor to moderate Landscape Disturbance Index classifications (Table 9 and Figure 6). The Downstream Pooncarie subcatchment (1475) recorded the lowest index score of 0.29, caused by low scores in both the land use and infrastructure indicators. This is likely due to increased cropping, weirs and sand mining in this catchment.

All subcatchments along Talyawalka Creek received very good Landscape Disturbance Index grades, indicating minimal landscape disturbances (Figure 6). These subcatchments have relatively little built infrastructure and very little recorded land cover change (Table 9).

For subcatchments upstream of the Lake Wetherell subcatchment (1483) along the Darling Baaka River, the Landscape Disturbance Index ranged from very good to good.

This is due to limited farm dams and built infrastructure in this region. The catchments downstream and including Lake Wetherell show a much greater landscape disturbance (Figure 6). Lake Wetherell's low index score (0.35) and classification of poor is primarily attributed to the presence of weirs and water regulating infrastructure.

In general, landscape disturbances in the study area are low, with 24 of the 28 subcatchments (86%) assessed as being in good to very good landscape condition.

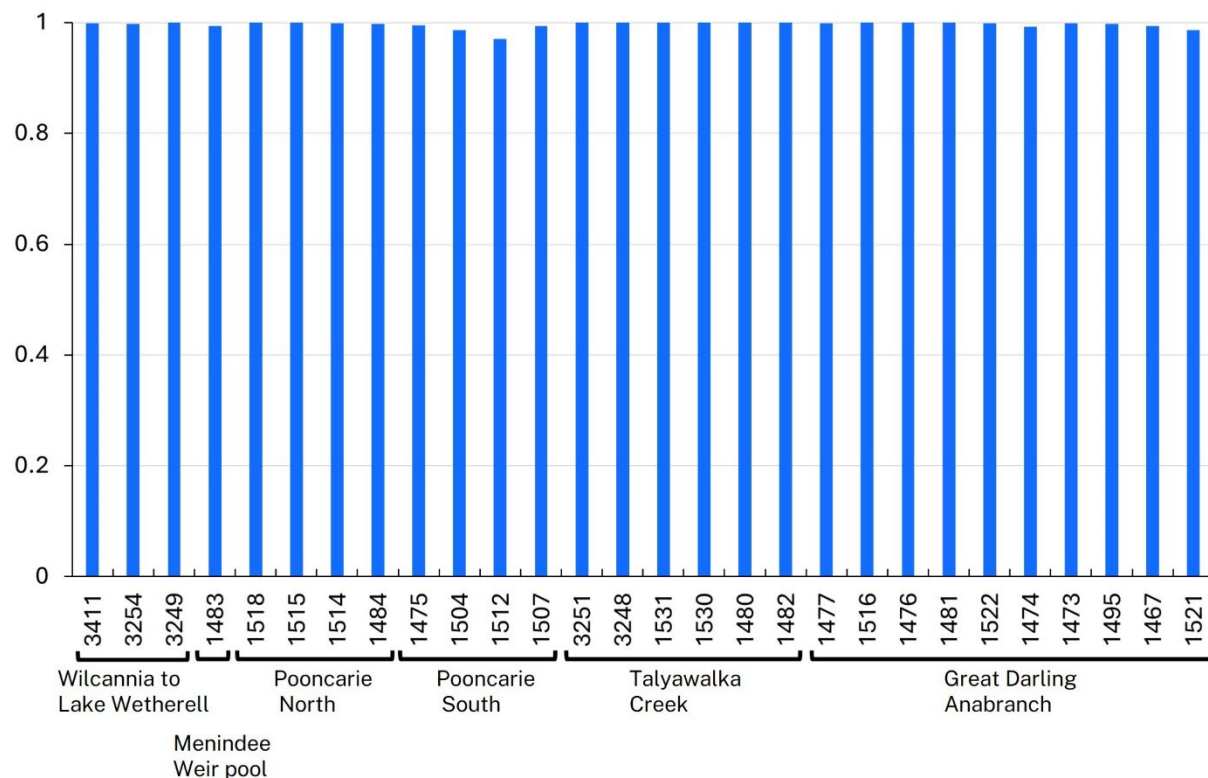


Figure 5 Landscape Disturbance scores for subcatchments of the lower Darling Baaka River

Table 9 **Landscape Disturbance Index (LDI) scores and grades for subcatchments of the lower Darling Baaka River and associated River Condition Index (RCI) condition grades**

Subcatchment number	Subcatchment name	Land use score	Infrastructure score	Land cover change score	LDI score	RCI condition grade
Darling Baaka River subcatchments						
3411	Lower Paroo	0.904	1.000	0.999	0.90	Very good
3254	Lake Woytchugga	0.870	0.840	0.998	0.70	Good
3249	Wilcannia Downstream	0.828	1.000	1.000	0.82	Very good
1483	Lake Wetherell	0.904	0.455	0.994	0.35	Poor
1518	Downstream Weir 32	0.935	1.000	1.000	0.93	Very good
1515	Lower Yampoola Creek	0.869	0.999	1.000	0.86	Very good
1514	Cuthero Creek	0.835	0.920	0.999	0.75	Good
1484	Upstream Pooncarie	0.664	0.761	0.997	0.42	Moderate
1475	Downstream Pooncarie	0.539	0.761	0.995	0.29	Poor
1504	Palinyewah	0.596	0.841	0.986	0.42	Moderate
1512	Lower Darling	0.836	0.840	0.970	0.64	Good
1507	Murray–Darling Confluence	0.855	0.998	0.994	0.84	Very good
Great Darling Anabranh subcatchments						
1477	Cawndilla	0.943	0.849	0.999	0.79	Good
1476	Lower Redbank Creek	0.851	0.920	1.000	0.77	Good
1474	Anabranh North Lakes	0.819	1.000	0.993	0.81	Very good
1481	Coonalhugga Creek	0.847	0.920	1.000	0.76	Good

Subcatchment number	Subcatchment name	Land use score	Infrastructure score	Land cover change score	LDI score	RCI condition grade
1522	Popio	0.868	1.000	0.999	0.86	Very good
1516	Anabranh Offtake	0.878	1.000	1.000	0.87	Very good
1473	Anabranh North	0.868	1.000	0.999	0.86	Very good
1495	Lake Milkengay	0.750	0.999	0.998	0.74	Good
1467	Warrawenia Lake	0.665	0.999	0.994	0.65	Good
1521	Lower Anabranh	0.849	0.999	0.987	0.83	Very good
Talyawalka Creek subcatchments						
3251	Upper Talyawalka Creek	0.863	1.000	1.000	0.86	Very good
3248	Middle Talyawalka Creek	0.872	1.000	1.000	0.87	Very good
1531	Lower 3 Mile Creek	0.873	0.999	1.000	0.87	Very good
1530	Lower Talyawalka Creek	0.873	0.999	1.000	0.87	Very good
1480	Yampoola Creek	0.848	1.000	1.000	0.84	Very good
1482	Charlie Stones Creek	0.870	0.999	1.000	0.86	Very good

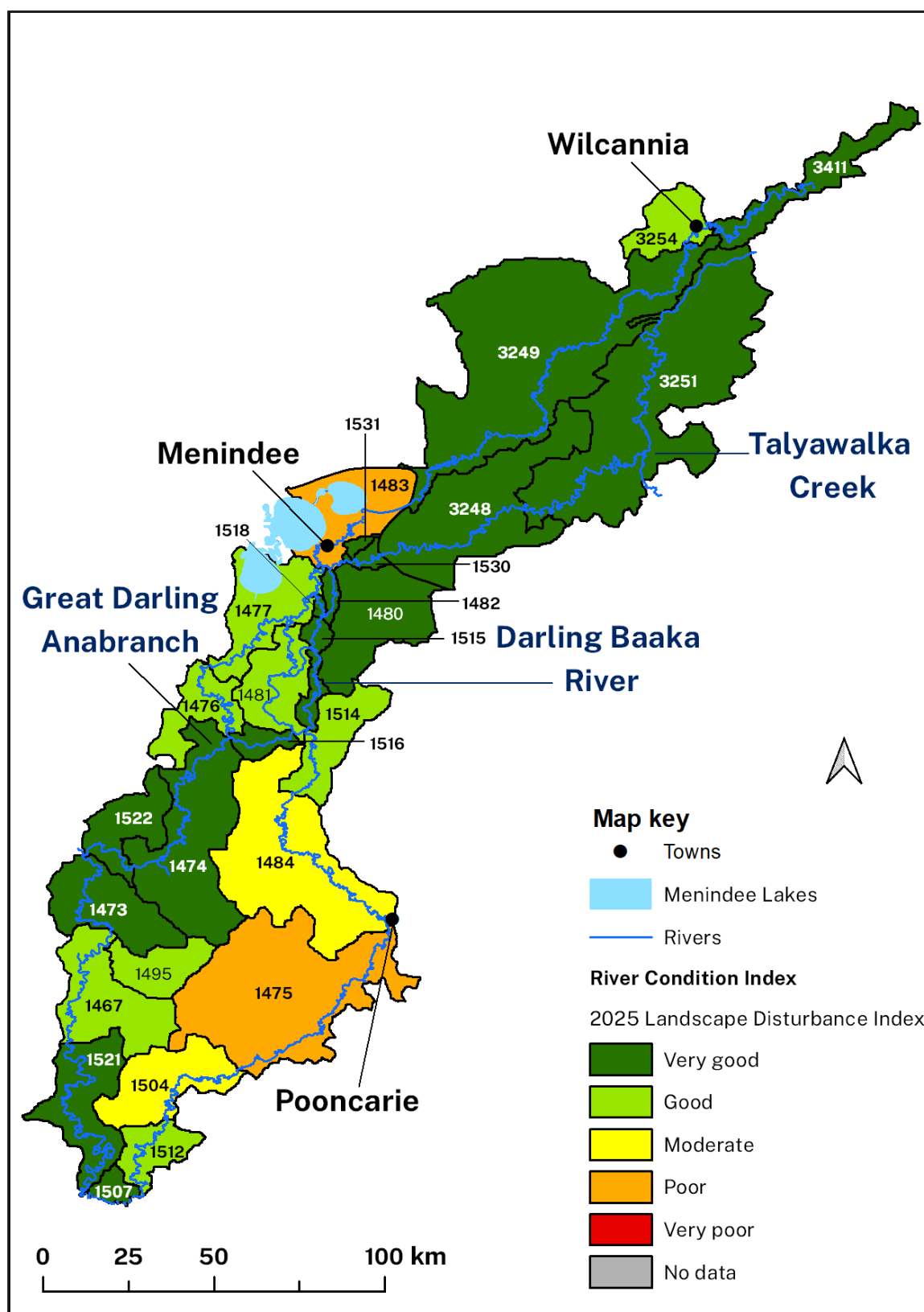


Figure 6 The 2025 Landscape Disturbance Index grades for the lower Darling Baaka River. Numbers refer to subcatchments (see Table 9)

8.6 Conclusion

Using the RCI framework, the majority of catchments have been identified as in good or very good condition in terms of landscape disturbances. These results somewhat conflict with on-ground observations that grazing, large feral goat populations and historic vegetation clearing in the study area appear to be contributing to riverbank destabilisation and the formation of gullies. These factors are known to contribute to poor water quality (Hubbard et al. 2004; Chua et al. 2019).

In the study area, sustainable land management such as stubble retention in cropping systems and maintaining >70% groundcover in grazing systems can have a greater impact on river health than the land use class itself. Rapid assessments via roadside surveys have proven suitable for assessing such impacts (Leys et al. 2016), however these were not completed for this project. Additionally, land cover changes in the last ~10 years in this area are minimal compared to historical land clearing that occurred earlier in the 19th and 20th centuries. Therefore, the majority of land clearing activity is not captured in the land cover change indicator. There is evidence of long-term elevated sedimentation rates in Murray–Darling Basin waterholes, which is associated with historical land clearing, reducing waterbody depth and therefore their persistence duration during drought (Tibby et al. 2023). Combined with the semi-arid nature of the region and the flat ancient landscape, calculating land cover change over short periods may not truly reflect the long-term pressure that land use clearing continues to exert on the river. It is recommended that the land cover change indicator may need to be refined for future applications of the RCI.

Considering the fragile nature of the flat western landscapes in the study area and the large impact water erosion can have on river health, an additional parameter measuring the appropriateness of land use in the study area should also be considered for addition to the RCI framework.