

Technical Report

Roe Gold Project

Consolidated Aquatic Ecology Study of Lake Roe, Peripheral Wetlands and Regional Lakes



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Executive Summary

Ramelius Resources Ltd (Ramelius) is proposing to develop the Roe Gold Project (the Project), associated with the Bombora gold deposit, on the southwestern edge of Lake Roe, located 100 km east of Kalgoorlie. The Project is expected to comprise three open pit gold mines, waste rock landforms, and supporting infrastructure. Dewatering discharge of hypersaline groundwater from mining pits may also be required, potentially to nearby Lake Roe.

Previous environmental studies completed by Stantec Australia Pty Ltd (Stantec) included a desktop assessment (Stantec 2018a) and 2019 baseline survey of Lake Roe and peripheral wetlands (2019 study), to support environmental approvals (Stantec 2020b). Subsequently, Ramelius requested that Stantec undertake a 2025 study of Lake Roe and regional waterbodies to increase understanding of ecological values (consolidating the 2019 and 2025 datasets) and verify the distribution of potentially significant taxa.

As part of the 2019 and 2025 studies, field surveys were conducted in May 2019 and April 2025, in predominantly dry conditions. A range of abiotic and biotic components were assessed across sites at Lake Roe and its peripheral wetlands, Lake Yindarlgooda, Lake Yindana, and regional wetlands. This included sampling for surface water (where present) and sediment quality, algae (and diatoms), macrophytes, aquatic invertebrates, waterbirds and riparian vegetation. Due to the dry conditions, sediment was also collected for rewetting trials, which conducted in the laboratory to simulate flooded conditions, providing an indication of the resident aquatic biota.

Summary of Ecological Values

The results of the 2019 and 2025 studies indicate that Lake Roe likely supports a productive biological community during flooding, characterised by broad salt tolerant taxa, comparable to other salt lakes throughout the Goldfields region, with similar ecological values. The northwestern section of the lake also provides a more permanent surface water source, with corresponding higher ecological values during the predominantly dry conditions. During larger flood events, it is expected that the ecological values of Lake Roe and the peripheral wetlands increase, as these inland waters create considerable habitat in a typically dry environment. These waterbodies are likely to host a diverse and abundant assemblage of algae, macrophytes, aquatic invertebrates and waterbirds, dependent on water quality and habitat availability. It is also likely that riparian vegetation will experience substantial germination and recruitment along the margins of Lake Roe. As water levels recede and surface water salinities increase in the lake, only salt tolerant biota will persist, before the lake dries out completely. A summary of the key findings of this study is presented in Table ES-1 and detailed in the summary sections provided below, for each of the ecological components assessed.

Water Quality

During the 2025 study, isolated pools of surface water were present at Lake Roe and Lake Yindarlgooda, while one regional wetland was also inundated. The pH ranged from neutral (6.5 to 7.6) to alkaline (>7.5) (Table ES-1). Salinity (dominated by sodium and chloride) was comparable between Lake Roe and Lake Yindarlgooda, classified as hypersaline (>70,000 $\mu\text{S/cm}$), while the regional wetland was classified as mesosaline (30,000 to 70,000 $\mu\text{S/cm}$). In comparison, the results of the 2019 and 2025 rewetting trials suggested that during a major flood event, conditions at Lake Roe, the peripheral salinas, regional wetlands, Lake Yindarlgooda and Lake Yindana were likely to be alkaline, with salinity ranging from hyposaline, at the onset of flooding to hypersaline as the hydroperiod progresses. In the field, nutrients (TN and TP) were higher at the regional wetland, compared to Lake Roe and Lake Yindarlgooda, which were similar. Elevated total nitrogen and total phosphorus were likely associated with allochthonous inputs from riparian vegetation to the regional wetland. Dissolved metal concentrations were typically low; however, cadmium and copper exceeded their respective ANZG (2018) DGVs for marine waters at Lake Yindarlgooda (cadmium and copper) and the regional wetland (copper only). Naturally elevated background concentrations of these metals are likely related to differences in local geology throughout the region.

Sediment Quality

Sediment pH at Lake Roe, the peripheral wetlands, Lake Yindarlgooda, Lake Yindana and the regional wetlands ranged from strongly acidic to moderately alkaline across the 2019 and 2025 studies (Table ES-1). Acidic conditions at Lake Roe, the peripheral salinas and Lake Yindana were potentially related to acidic groundwater common throughout the region. Sediment salinity at Lake Roe was variable (42,800 mg/kg to 105,000 mg/kg), fluctuating according to site geomorphology and the influence of drainage lines. In comparison, Lake Yindarlgooda and Lake Yindana had a narrower salinity range (53,500 mg/kg to 69,400 mg/kg). Sediment salinity was typically higher at the peripheral wetlands and



regional wetlands with most sites above >75,000 mg/kg, except at regional wetland RW01, which recorded a comparatively lower concentration (<20,000 mg/kg).

Nutrient concentrations were comparable between Lake Roe, Lake Yindarlgooda and Lake Yindana (**Table ES-1**), although the latter two lakes exhibited a narrower range, likely attributed to the lower number of sites sampled. The peripheral wetlands and regional wetlands had higher nutrients than the lakes, which was likely due to increased allochthonous inputs of organic matter. Concentrations of total metals in the sediments of Lake Roe and the peripheral wetlands, Lake Yindarlgooda, Lake Yindana, and regional wetlands were generally low during the 2019 and 2025 studies and were mostly below the ANZG (2018) DGVs. Exceptions included chromium and nickel, which exceeded the ANZG (2028) DGVs at most sites, attributed to natural mineralisation. Sites located along the eastern and southern sections of Lake Roe were typically characterised by lower metal concentrations, due to differences in catchment geology.

Algae

A total of 29 algal taxa were recorded during the 2019 and 2025 studies, all of which are known more broadly from inland waters throughout Australia (**Table ES-1**). Most of the records were from Lake Roe (16 taxa), compared to the peripheral wetlands (11 taxa) and remaining waterbodies (10 taxa), although this may be a function of increased sampling effort at the former. Three phyla were represented, dominated by Bacillariophyta (diatoms) and Cyanophyta (cyanobacteria), while Chlorophyta (green algae) contributed to the algal composition, albeit to a lesser degree.

Diatom taxa such as *Hantzschia* sp. aff. *baltica* and *Navicula* sp. aff. *incertata* were prevalent across both Lake Roe and the peripheral wetlands during the 2019 rewetted trials and are considered important primary producers in salt lakes. Filamentous cyanobacteria, comprising taxa such as *Planktolyngbya*, *Phormidium* and *Planktothrix* (**Table ES-1**) were also common in Lake Roe, with the former also recorded in the peripheral wetlands and Lake Yindarlgooda during the 2025 rewetted trials. In 2025, field sampling in the northwestern portion of Lake Roe found the cyanobacterium *Microcoleus* sp. was dominant in the benthos. While green algae were generally depauperate, the salt tolerant *Dunaliella* was abundant in the regional wetland RW01 in 2025 and was also present in Lake Roe and the peripheral wetlands in 2019. The assemblage of algae recorded throughout the region during the 2019 and 2025 studies varied widely, with water quality, and specifically salinity and nutrients considered to be the main drivers of composition.

Diatoms

A total of 35 diatom taxa were recorded from the rewetted trials conducted during the 2019 and 2025 studies (**Table ES-1**), with an assemblage characterised by halophilic taxa including *Amphora*, *Navicula* and *Hantzschia* representatives. There were no significant taxa identified, with all species also known from other salt lakes throughout Australia. Species diversity was higher at Lake Roe (24 taxa), compared to the peripheral wetlands (16 taxa), Lake Yindarlgooda (seven taxa), Lake Yindana (5 taxa) and the regional wetlands (17 taxa), although this was likely attributed to increased sampling effort at the former. However, the lakes and wetlands were dominated by common saline water species comprising *Navicula* sp. aff. *incertata*, *Navicula* sp. aff. *salinicola*, *Hantzschia* sp. aff. *baltica*, and *Amphora coffeaeformis* (**Table ES-1**). In addition, at Lake Yindana, *Pinnularia divergens* was prevalent, corresponding to the acidic sediment conditions, whereas in the regional wetlands, *Navicella pusilla* and *Navicula cincta* were more common, attributed to the geographic distinction of these waterbodies and associated heterogeneity of habitat.

Macrophytes

Three macrophyte taxa were recorded from Lake Roe and its peripheral and regional wetlands during the 2019 and 2025 studies (**Table ES-1**), comprising species typical of inland waters. The charophyte, *Chara* sp., was the most widespread, germinating across Lake Roe and the peripheral wetlands during the 2019 rewetted trials. This taxon was most abundant in the southwestern part of the lake. *Ruppia tuberosa* was also relatively widespread at Lake Roe during the 2019 rewetted trials and was recorded in the field at inundated site LR04_W (inundated on a semi-permanent basis), located in the northwestern section of the lake. A second charophyte, *Lamprothamnium* sp., germinated at one regional wetland during the 2025 rewetted trials. Based on the results of the 2019 and 2025 studies, Lake Roe supports a limited number of submerged macrophytes, considered typical of large inland salt lakes. Macrophyte productivity appears to be predominantly associated with the northern and southern parts of the lake, which also likely function as collection points for propagules.

Aquatic Invertebrates

The aquatic invertebrate assemblage identified during the 2019 and 2025 studies, which included rewetted trials and a limited number of field samples, was dominated by crustaceans (ostracods and *Parartemia*) (**Table ES-1**). More than



8,000 aquatic invertebrates, representing a total of 28 taxa were recorded from Lake Roe (14 taxa), the peripheral wetlands (10 taxa) and surrounding waterbodies, including Lake Yindarlgooda (nine taxa) and the regional wetlands (13 taxa). The ostracods *Diacypriis phoxe*, *Reticypriis* 'BOS1088', and *Patcypris outback* were widespread, while the anostracans *Parartemia veronicae* and *Parartemia serventyi*, were also relatively common. In addition, the inundated regional wetland RW01 comprised both crustacean and insect taxa.

Most of the taxa identified are known from inland waters throughout Australia or have been documented from lakes and wetlands throughout the Goldfields region, having broad salinity tolerance limits. However, four ostracod taxa recorded during the 2019 and 2025 studies represent potentially new or undescribed taxa (*Australocypris* 'BOS1364', *Diacypriis* 'BOS1969', *Reticypriis* 'BOS1088', and *Reticypriis* 'BOS1363'), with records from Lake Roe, the peripheral wetlands and/or Lake Yindarlgooda (Table ES-1). The key factors influencing the aquatic invertebrate assemblage included the water quality (specifically salinity) and habitat, with considerable heterogeneity in waterbodies throughout the region. While sampling was limited during flooding, Lake Roe and the regional lakes and wetlands are expected to have substantial productivity during flooding, providing an important food source for waterbirds.

Waterbirds

Seven species of waterbirds representing three families were identified at Lake Roe, Lake Yindarlgooda and a regional wetland (Table ES-1), as part of opportunistic observations recorded during the 2025 study. The highest diversity (four species) was recorded from the inundated site LR04_W, in the northwestern section of Lake Roe. Most waterbirds identified were common species, including the duck *Anas gracilis* (Grey Teal), *Cygnus atratus* (Black swan) and *Recurvirostra novaehollandiae* (Red-necked avocet). However, *Charadrius cucullatus* (hooded plover), listed as Priority 4 under the BC Act, was an exception, and was observed at site LR04_W. Lake Roe, similar to other inland waterbodies in the Goldfields is likely to provide important foraging and breeding habitat for waterbirds during major flood events.

Riparian Vegetation

Two habitat types were identified within the riparian zone of Lake Roe, including hypersaline lake margins and the margins of saline peripheral wetlands, comprising four distinct vegetation types. Vegetation within the riparian zone was dominated by chenopod shrubland, including four vegetation types, characterised by halophytic genera such as *Tecticornia*, *Frankenia* and *Maireana* (Table ES-1). During the 2019 study (predominantly dry conditions) 46 flora species from 25 families were recorded, with Chenopodiaceae the most diverse family (20 taxa), while an unidentified *Frankenia* sp. and *Atriplex nana* were the most widespread taxa (Table ES-1). *Tecticornia indica* subsp. *bidens* and *Tecticornia pergranulata* subsp. *divaricata* were also common and widespread. There were no introduced taxa recorded. Riparian vegetation plant density, cover and health was low, although was comparable between Lake Roe and the peripheral wetlands (Table ES-1). It is expected that following substantial rainfall, improved plant health and recruitment will occur.

The results of the consolidated *Tecticornia* (samphires) dataset from the 2019 study and targeted 2025 survey work identified 21 taxa, recorded across the riparian zone of Lake Roe and the peripheral wetlands (Table ES-1). Nineteen taxa were recorded from the lake margins, with eight taxa found within the margins of the peripheral wetlands. *Tecticornia indica* subsp. *bidens* and *Tecticornia* sp. Dennys Crossing were the most widespread species. The majority of *Tecticornia* (12 taxa) were common and/or widespread, while two were considered of other significance (potentially new species). Eight taxa were also sterile, although likely to belong to one of the verified species. Most species had a broader distribution throughout the area or across bioregions in Western Australia. However, a possible exception was *Tecticornia* sp. nov. 1, a potentially new species, which was recorded from a single site, located adjacent to the proposed pits. This taxon likely requires further consideration for environmental impact assessment and approvals.

Recommendations

The 2019 and 2025 studies have provided an understanding of baseline conditions at Lake Roe within a local and regional context, providing a likely indication of the diversity and productivity that can be expected during flooded conditions. Although four new aquatic invertebrate taxa were recorded from Lake Roe, these also occurred in the peripheral wetlands and nearby Lake Yindarlgooda. There were also two *Tecticornia* taxa identified which may represent new species and a further six *Tecticornia* taxa that remain unverified. These results are considered typical of inland salt lakes, which have often not been comprehensively studied. Additional survey work during major flood events may also lead to new species being recorded in the future. Following the completion of the study, the remaining knowledge gaps, which may need to be addressed for environmental impact assessment and approvals, include:



- Sampling of aquatic biota and waterbird populations associated with Lake Roe and peripheral wetlands during a major flood event, to document diversity and productivity and verify these results.
- Assessing water and sediment quality at Lake Roe and surrounds to understand the variation over the course of the hydroperiod during a major flood event.
- Targeted *Tecticornia* survey work to understand the distribution of novel taxa, specifically *Tecticornia nov. 1*, which currently appears to be restricted to the margins of Lake Roe, in the vicinity of proposed pits.

Several recommendations are also provided for consideration by Ramelius, in relation to the Project layout and potential dewatering discharge (if this proceeds), available at the end of this technical report.



Table ES-1: Summary of key findings and ecological values of Lake Roe, peripheral wetlands, Lake Yindarlgooda, regional wetlands and Lake Yindana during the 2019 and 2025 studies.

Ecological Aspects	Key Findings and/or Ecological Values	Dominant Taxa	Total Taxa	Lake Roe Taxa	Peripheral Wetland Taxa	Lake Yindarlgooda Taxa	Regional Wetlands Taxa	Lake Yindana Taxa	Taxa of Significance
Surface Hydrology	<ul style="list-style-type: none"> Lake Roe fills entirely on average once every five to 10 years Most of lake fills to depth of 2 to 3 m (1% AEP rainfall event) Lake holds surface water longest (semi-permanent) in northwestern section (likely an expression of groundwater) 	• N/A	• N/A	• N/A	• N/A	• N/A	• N/A	• N/A	• N/A
Water Quality	<ul style="list-style-type: none"> Lake Roe and Lake Yindarlgooda neutral to alkaline and hypersaline, with low nutrients Regional wetland alkaline and hyposaline, with higher nutrients. Metals above ANZG (2018) DGVs at Lake Yindarlgooda (Cd and Cu) and the regional wetland (Cu only) Conditions typically alkaline ranging from hyposaline to hypersaline in the lakes and wetlands during the rewetting trials 	• N/A	• N/A	• N/A	• N/A	• N/A	• N/A	• N/A	• N/A
Sediment Quality	<ul style="list-style-type: none"> Sediment pH variable ranging from strongly acidic to moderately alkaline across the lakes and wetlands Comparable salt loads in the lakes, although Lake Roe more variable, with low nutrients Typically higher salt loads and nutrients in peripheral wetlands and regional wetlands Variable metals with Cr and Ni above the ANZG (2018) DGVs 	• N/A	• N/A	• N/A	• N/A	• N/A	• N/A	• N/A	• N/A
Algae	<ul style="list-style-type: none"> Diatoms and blue-green algae dominant at Lake Roe, peripheral wetlands, Lake Yindarlgooda, Lake Yindana and regional wetlands, typical of temporary salt lakes Northwestern section of Lake Roe dominated by an extensive benthic algal mat of <i>Microcoleus</i> sp. during field sampling in 2025 Variable assemblage across the waterbodies spatially and temporally, attributed to varying water quality, specifically salinity and nutrients 	<ul style="list-style-type: none"> <i>Hantzschia</i> <i>Navicula</i> <i>Microcoleus</i> <i>Planktolyngbya</i> <i>Phormidium</i> <i>Planktothrix</i> <i>Dunaliella</i> 	• 29	• 17	• 11	• 8	• 6	• 0	• N/A
Macrophytes	<ul style="list-style-type: none"> Patchy distribution of species typical of saline waters In Lake Roe, predominately associated with the northern and southern parts of the playa 	<ul style="list-style-type: none"> <i>Chara</i> <i>Lamprothamnium</i> <i>Ruppia tuberosa</i> 	• 3	• 2	• 2	• 0	• 1	• 0	• N/A
Diatoms	<ul style="list-style-type: none"> Assemblages of Lake Roe, peripheral wetlands, Lake Yindarlgooda, Lake Yindana and regional wetlands characterised by halophilic and aerophilic taxa Greater total diversity at Lake Roe, attributed to increased sampling effort <i>Pinnularia</i> representatives dominant at Lake Yindana, reflecting acidic sediment conditions Greater variability in community composition at regional wetlands, attributed to heterogeneity of habitat and broader geographic distribution 	<ul style="list-style-type: none"> <i>Amphora coffeaeformis</i> <i>Hantzschia</i> sp. aff. <i>baltica</i> <i>Navicula</i> sp. aff. <i>incertata</i> <i>Navicula</i> sp. aff. <i>salinicola</i> 	• 35	• 24	• 16	• 7	• 17	• 5	• N/A
Aquatic Invertebrates	<ul style="list-style-type: none"> Composition dominated by crustaceans including ostracods and anostracans Inundated regional wetland RW01 comprised both crustacean and insect taxa Greater total diversity at Lake Roe, attributed to increased sampling effort Assemblage influence by key factors including water quality (salinity) and habitat heterogeneity 	<ul style="list-style-type: none"> <i>Diacypis phoxe</i> <i>Reticypis</i> 'BOS1088' <i>Patcypris outback</i> <i>Parartemia veronicae</i> <i>Parartemia serventyi</i> 	• 28	• 14	• 10	• 9	• 13	• 0	<ul style="list-style-type: none"> <i>Australocypris</i> 'BOS1364' <i>Diacypis</i> 'BOS1969' <i>Reticypis</i> 'BOS1088' <i>Reticypis</i> 'BOS1363'
Waterbirds	<ul style="list-style-type: none"> Opportunistically observed utilising residual surface waters present in the northwestern section of Lake Roe and central section of Lake Yindarlgooda and an inundated regional wetland Dominated by common and nomadic taxa 	<ul style="list-style-type: none"> <i>Anas gracilis</i> (Grey teal) <i>Cygnus atratus</i> (Black swan) <i>Recurvirostra novaehollandiae</i> (Red-necked avocet). 	• 7	• 4	• 0	• 2	• 3	• 0	• <i>Thinornis rubricollis</i> (Hooded plover) (P4)
Riparian Vegetation	<ul style="list-style-type: none"> Composition dominated by salt tolerant chenopods Assemblage typical of salt lake riparian vegetation No declared rare or priority flora or weeds 	<ul style="list-style-type: none"> <i>Tecticornia</i> spp. <i>Frankenia</i> sp. <i>Atriplex nana</i> 	• 48*	• 43*	• 19	• N/A	• N/A	• N/A	Potential new taxa: <ul style="list-style-type: none"> <i>Tecticornia</i> sp. nov. 1 & 2 Sterile material <ul style="list-style-type: none"> <i>Tecticornia</i> spp. (1-7) <i>Tecticornia</i> sp. 3 (2025)

Note: * indicates result based on the 2019 study only.

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1. Introduction

1.1 Project Background

Ramelius Resources Ltd (Ramelius) is proposing to develop the Roe Gold Project (the Project), located on the southwestern edge of Lake Roe, approximately 100 km east of Kalgoorlie, in the eastern Goldfields region of Western Australia (**Figure 1-1; Figure 1-2**). The resource comprises the Bombora deposit, occurring in a 150 m wide zone, beginning at 5 m below surface, and extending along a strike length of over 3.7 km, comprising high grade gold.

The history of the Project extends back to the 1990s, with recent, exploration in 2014 by Breaker Resources NL (Breaker), leading to the Bombora discovery in 2016, during the maiden drilling program, which intersected visible gold. Resource delineation drilling continued, and in 2023, Breaker and its wholly owned subsidiaries were acquired by Ramelius. Drilling is ongoing, to convert inferred resource to indicated resource, alongside exploration of several regional targets and prospects.

The Project will include the development and operation of a greenfield gold mine, comprising the following key elements:

- Development of three open mining pits (including Bombora 1800, Bombora 1100 and Bombora 700), with subsequent underground mining of Bombora 1800;
- Ore stockpiles, topsoil stockpiles and any waste rock landforms;
- Mine-related infrastructure including workshops, laydown areas, offices, mine dewatering infrastructure and explosives magazines;
- General and linear infrastructure including a power station, communications systems, and access roads; and
- Haulage of mined ore along a 65 km route from the Roe Project to Rebecca operations.

Dewatering of hypersaline groundwater from the pits may also be required for the Project, with Lake Roe identified as a potential discharge option due to its proximity. Previous environmental studies completed by Stantec Australia Pty Ltd (Stantec) for Breaker included a desktop assessment (Stantec 2018a) and 2019 baseline survey of Lake Roe and peripheral wetlands (2019 study), to support environmental approvals (Stantec 2020b). Subsequently, Ramelius requested that Stantec undertake a 2025 study of Lake Roe and surrounding waterbodies during flooding, to increase understanding of ecological values, incorporating the 2019 study, and aligning with regulatory expectations and guidance.

1.2 Objectives and Scope

This technical report presents the findings of the 2019 and 2025 studies as a consolidated dataset to address the following objectives:

- Assessment of the ecological values of Lake Roe and regional waterbodies, including collation of the 2019 and 2025 studies; and
- Verification of the distribution of new and/or restricted macroinvertebrate taxa previously recorded from Lake Roe.

To address the objectives, the following scope of works was undertaken:

- Completion of a field survey, analysing water and sediment quality, assessment of aquatic biota including periphyton (diatoms), phytoplankton, macrophytes, and aquatic invertebrates, opportunistic observation of waterbirds and targeted collection of *Tecticornia* from the riparian zone;
- Identification of taxa to species level (where possible), with data interrogation, collation and analysis to determine trends between sites, habitat types and communities, providing comparison between the 2019 and 2025 results; and
- Mapping of new, restricted or significant taxa, and preparation of a technical report summarising key findings, and outlining the ecological values of the lake and surrounding waterbodies.



1.3 Inland Waters, Guidance and Legislation

Ephemeral salt lakes and inland waters are numerous throughout the arid and semi-arid regions of Western Australia. Spatial and temporal variability over the course of the hydroperiod drive changes in surface water and sediment quality, and the biological assemblage and associated productivity. Lake sediment supports microorganisms (Pulford and Flowers 2006) and the dormant eggs and spores of aquatic biota (Boulton and Brock 1999). Resident, salt-tolerant aquatic biota (algae, macrophytes and aquatic invertebrates) can also persist in the sediment as resting stages (desiccation-resistant spores and eggs), emerging with the onset of major flooding (Boulton and Brock 1999).

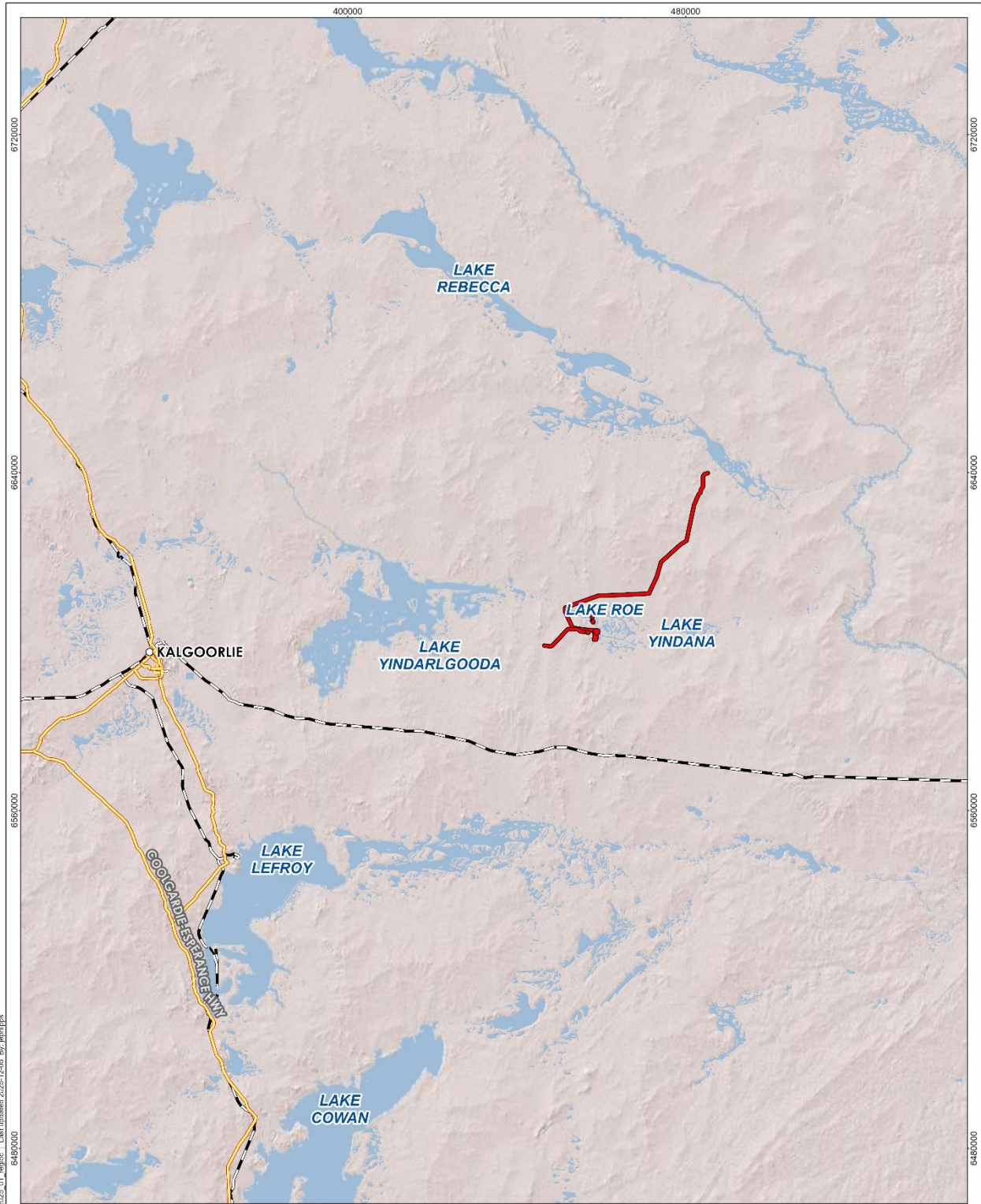
During the initial stages of flooding, when salinity is lower, salt lakes support an abundance of primary producers and crustaceans that provide a food source for higher trophic consumers such as waterbirds, where surface water persists over several months. However, as salinity increases and the lakes enter the drying phase, the diversity of aquatic biota decreases (Williams 1998), with only a limited number of taxa able to tolerate hypersaline conditions (>50,000 mg/L). As water levels recede, organisms complete their lifecycles, replenishing resting stages within lake sediment. In comparison, the peripheral wetlands on the margins of salt lakes are often freshwater (EPA 2018), and may support a diverse range of aquatic biota, often comprising restricted taxa. The riparian zone on the margins of salt lakes and peripheral wetlands is typically dominated by chenopods, including samphires, which are adapted to saline conditions and periodic inundation (Datson 2002).

The characteristics of the inland waters may be considered unique in a regional context, and therefore require comprehensive investigation to understand environmental values in the context of environmental impact assessment (EIA). The 2019 and 2025 studies were undertaken in accordance with relevant legislation and regulatory guidelines including:

- Environmental Factor Guideline: Inland Waters (EPA 2018).
- Goldfields Environmental Management Workshop: DWERs Approach to Assessment of Mine Dewatering Discharge to Salt Lakes and Claypan Environments (DWER 2018).
- Technical guidance for environmental factors including Flora and Vegetation (EPA 2016a) and Terrestrial Fauna (EPA 2016b), where applicable to the EPA's Inland Waters factor.

In addition, this technical report has been prepared to support Part IV and Part V environmental approvals and applications associated with the Western Australian *Environmental Protection Act 1986* (EP Act) and the *Biodiversity Conservation Act 2016* (BC Act).





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Regional Location

Aquatic Ecology Study and Dewatering Discharge Assessment for the Roe Gold Project

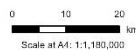
Client: Ramelius
 Project: 304501786
 Project Code: 10e_ag_2025_01

Drawn By: SR, Checked By: TV, KW
 Date: 2025-12-05



- Proposed Roe Gold Project Layout
- Waterbodies
- Major Road
- Railways

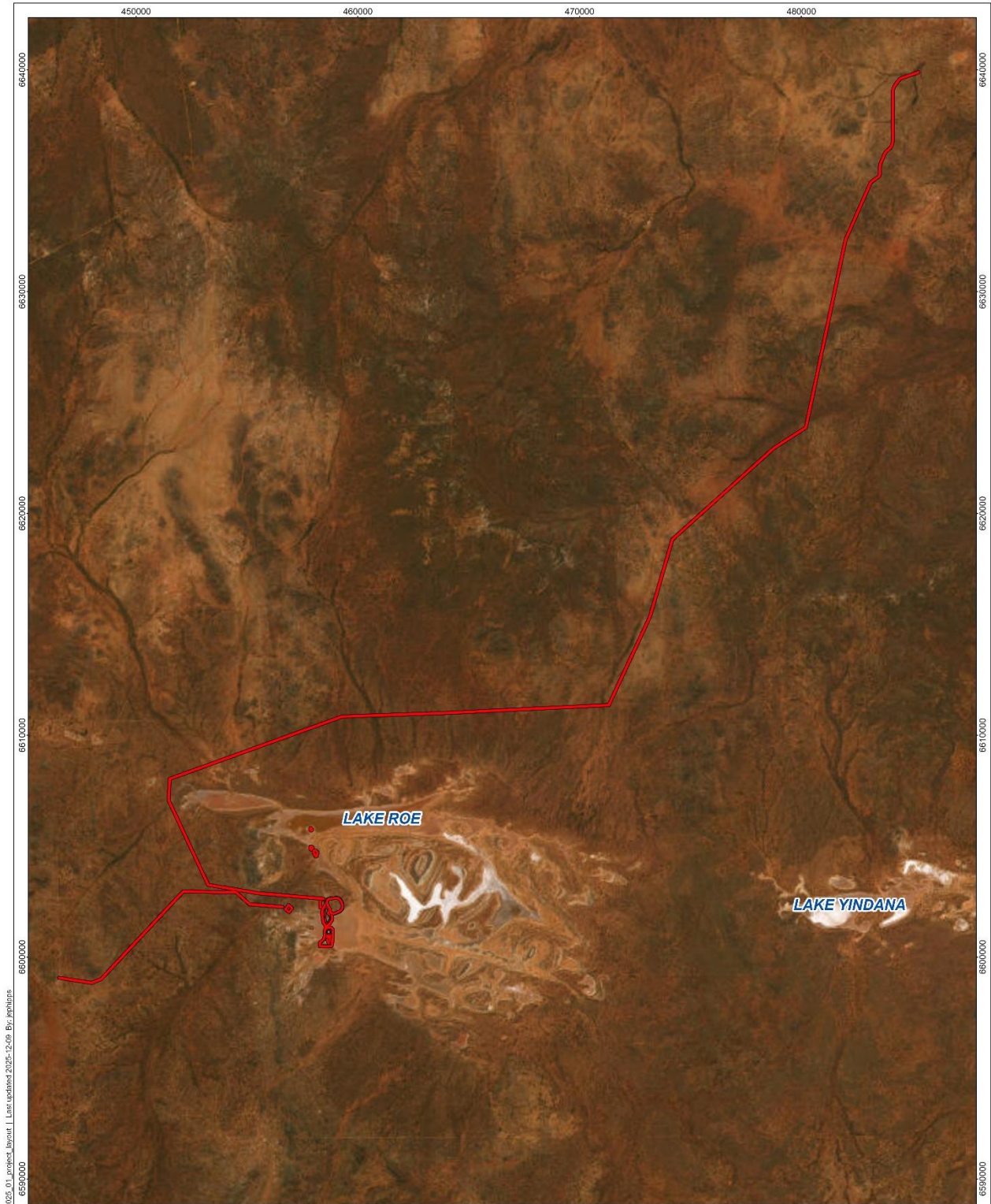
Notes:
 1. Map displayed in GDA 1994 MGA Zone 51
 2. Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2025).
 3. Background: Copyright:(c) 2014 Esri



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Figure 1-1: Regional location of the Roe Gold Project.





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Project Layout
 Aquatic Ecology Study and
 Dewatering Discharge
 Assessment for the Roe Gold
 Project
 Client: Ramelius
 Project: 304501786
 Project Code: lroe_aec_2025_01
 Drawn By: JP, Checked By: TV, JP
 Date: 2025-12-09

Proposed Roe Gold Project Layout

Notes:
 1. Map displayed in GDA 1994 MGA Zone 51
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 Information Authority trading as Landgate (2025).
 3. Background: Earthstar Geographics



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Figure 1-2: Proposed Roe Gold Project layout, in relation to Lake Roe.



2. Existing Environment

2.1 Biogeographic Location and Land Use

The Project is located within the Eastern Goldfields Subregion (COO3) of the Coolgardie bioregion, in Western Australia (**Figure 2-1**), and covers an area of 5,102,428 ha (Cowan 2001). The subregion is underlain by the Yilgarn Craton, which forms a large section of the Western Shield geotectonic unit (DEC 2010b). It is characterised by gentling undulating plains interrupted in the west by low hills and ridges of Archaean greenstones, and in the east by a horst of Proterozoic basic granulite (Cowan 2001).

The region exhibits low topographic relief and the underlying strata are eroded flat and covered with Tertiary sand and gravel soils, scattered exposures of bedrock and plains of calcareous earths (Kern 1996b). Early Tertiary sediments are preserved in the palaeochannels within an infilled palaeodrainages, concealed by thick sequences of Cainozoic deposits (Johnson *et al.* 1999). Soils in the subregion vary widely from deep sands to cracking clays, and most landforms are hard lime at depth. However, surface geology is typically characterised by neutral red earths on the plains, calcareous loams and brown calcareous earths in the hills and saline soils in around playa lakes (McKenzie *et al.* 2003).

Vegetation is characterised by mallee woodland, *Acacia* thickets and shrub-heaths on sandplains. Eucalyptus woodlands surround saline playas, occur on ranges and in valleys. There are numerous salt lake systems throughout the subregion such as Lake Yindarlgooda and Lake Yindana which the remnants of ancient major drainage lines. These salt lakes support dwarf shrublands of samphire, in particular *Tecticornia* along the fringe of the playa and in nearby low-lying plains (Brearley 2002; Stantec 2020a; b). The Project area also lies in the Coolgardie Botanical Zone of the Southwestern Interzone (Beard 1978; 1990), and is located within the internationally significant Great Western Woodlands (DEC 2010a). This area supports more than 3,000 flowering plant species and is a centre of endemic Eucalypt species diversity (DEC 2010a).

The primary land uses within the subregion comprise Unallocated Crown Land (UCL) and Crown reserves as well as native grazing pastures (37.8%) and freehold land (7.15%) (Cowan 2001). The Project area is situated on Pastoral Lease Yindi (PL N09512). Pastoralism, especially sheep and cattle grazing, has been the major land use over the past 100 years, resulting in degradation and erosion (McKenzie *et al.* 2003). The Assessment observed cattle activity and remnant fence lines in and around the salt lake basins. The subregion is rich in mineral deposits, especially gold and nickel, exploration and mining are also prevalent (Fullerton 2013). The township of Kurnalpi (65 km north-west of the Project), was a thriving gold centre from the late 1800's to the early 1900's, however, has since been abandoned.





Figure 2-1: Location of the Roe Gold Project within the East Goldfield subregion, Western Australia.



2.2 Hydrology and Drainage

The Lake Roe catchment area is approximately 1,515 km² and is located along the southern limit of the larger Raeside-Ponton Catchment (approximately 116,000 km²) (**Figure 2-2**). The Raeside-Ponton Catchment is part of the vast Salt Lake Basin (440,000 km²), which extends across much of central Western Australia and includes several large, sub-parallel, southeast trending salt lake drainage systems (Groundwater Resource Management 2010).

Lake Roe comprises a series of convoluted and constrained playas (pans), which are typically flat and subdued, with some separated by low-lying plains or more elevated ridges and hills. Surface gradients over the lake are low (typically <0.01%) and there are no significant river systems or watercourses in proximity. The lake is predominantly dry except following periods of substantial rainfall-runoff, which results in surface water pooling in discrete areas (**Figure 2-3**). An area in the northwest section of the lake is most frequently inundated based on Water Observations from Space (WOfS) imagery from 1987-2024 (**Figure 2-3**). This is most often associated with the remnants of tropical cyclones or intense summer storms. Within a 200 km radius of the lake, the frequency that remnant tropical cyclones influence the area, is on average, approximately once every six years (Groundwater Resource Management 2010).

Widespread inundation across the lake has occurred on five occasions between 1986 and 2025, according to satellite imagery (Stantec 2025). This corresponds to major flooding events, when the lake completely fills, occurring on average approximately once every five to 10 years, with inundated conditions typically remaining for six to 12 months. While major events are rare and infrequent, partial flood events occur more often, usually every three to five years (Stantec 2025). Hydrological modelling indicates that most of the lake appears to fill to approximately 2 to 3 m following a 1% Annual Exceedance Probability (AEP) rainfall event, with an area in the northwest representing the deepest section (3 to 4 m) (AQ2 2025).

Natural flow within the lake is from the northwest to southeast, although this is interrupted by the presence of islands throughout the playa. There are two sub-catchments upstream of the lake, limited to approximately 178 km²; the Southwestern and Southern Sub-catchments, which are 165 km² and 13 km² in size, respectively. Runoff from these sub-catchments reports to Lake Roe via two distinct drainages (**Figure 2-2**), the discharge points of which are approximately 700 m apart along the lake shore (Groundwater Resource Management 2018).

2.3 Hydrogeology

Drainage in the Yilgarn Craton is derived from an ancient river system that radiates from a broad drainage divide (Anand and Paine 2002). Extensive alluviation of valley floors has occurred forming chains of salt lakes over geological time scales (Kern 1995a; Kern 1995b). These salt lakes are the deflated remnants of the palaeorivers (palaeochannels) and act as a basin for the accumulation of salts and sediment, often connected to local and regional groundwater systems (Salama 1997). The Project lies along the southwestern margin of Lake Roe, which is part of the Roe Palaeodrainage system (Kern 1996a; b).

The hydrogeology of the Project area (Kern 1995b) is underlain by weathered and fractured Archaean bedrock, overlain locally by palaeochannel deposits and widespread alluvium and lake deposits. The bedrock forms part of the Yilgarn Goldfields fractured-rock groundwater-province (Kern 1995b; Kern 1996a; b). The fractured bedrock is characterised by secondary permeability resulting from tectonic and decompression fracturing enhanced by chemical dissolution along fracture lines. Fractured-bedrock aquifers occur more commonly in mafic, ultramafic, and granitic rocks than in sedimentary or felsic volcanic and volcanoclastic rocks. Open fractures occurring to depths of 120 m and 150 m have been reported and similar depths could be expected along major faults and shear zones (Kern 1996b).

The Roe Palaeodrainage system is extensive (**Figure 2-4**), comprising three main tributaries extending from 80 km west northwest, to 60 km west of Kalgoorlie, through over 200 km east to northeast of Kalgoorlie, where the palaeodrainage feature becomes obscured by the Eucla Basin Coastal Barrier (Kalaitzis *et al.* 2004; Kern 1995b; Kern 1996a). The main drainage of the palaeochannel is in the vicinity of the Project area and Lake Roe (Kalaitzis *et al.* 2004) (**Figure 2-4**). The key palaeochannel sediments comprise the Wollubar Sandstone, which is at least 30 m thick and consists of unconsolidated quartz sand, with minor conglomerate, silt, clay, and lignite. This is overlain, obscured and confined by the Perkolilli Shale, a multicoloured clay with minor sandy clay beds up to 40 m thick (Kern 1996b).

The Wollubar Sandstone is highly permeable and contains significant volumes of groundwater. Minor amounts of groundwater occur in the alluvial and lacustrine deposits. Minor mafic and ultramafic dykes occur in the southern half of the area. They are undeformed, typically appear to lack open fractures, and are possible hydraulic barriers to groundwater movement. However, no significant dykes are known in the immediate vicinity of the Project area. A regional water table



occurs in the Project area, the depth to which ranges from less than 1 m in the vicinity of Lake Roe, to more than 50 m in elevated areas (Kalaitzis *et al.* 2004).

2.4 Climate

The Eastern Gold Fields Region has a semi-arid climate, characterised by hot summers and cool winters (Pringle *et al.* 1994). Rainfall is variable most of which is associated with winter or summer systems. During the summer months (December to February), high intensity, short duration rainfall events can occur, linked to tropical lows formed in the north of the state (Clarke 1994). Temperatures range from below zero in winter, to more than 40°C during summer. Evaporation exceeds rainfall and is highest in summer, with an average annual rate of 2400 mm/year (Johnson *et al.* 1999).

The nearest operating Bureau of Meteorology (BoM) weather station with complete long-term and recent climatic data is Kalgoorlie-Boulder Airport (station number 12038), located approximately 100 km east of the Project (BoM 2025). The long-term (1939-2025) mean annual rainfall recorded at Kalgoorlie-Boulder Airport is 265 mm. The highest monthly rainfall is recorded during late summer to early autumn January to March, with February having the highest monthly average rainfall (32 mm) (**Figure 2-5**). However, substantial rainfall can occur throughout the winter months (June to August), typically peaking in June (28 mm). January and February are the hottest months of the year, with daily maximum temperatures regularly exceeding 35°C, while July and August are the coolest months of the year, with minimum temperatures falling below 5°C (**Figure 2-5**).

Rainfall can vary markedly from year to year, depending on the strength of northern tropical lows during summer and southern cold fronts during winter. Long-term rainfall data from Kalgoorlie-Boulder Airport indicates that 2000, 2011 and 2024 were the wettest years in the last 25 years, with more than 370 mm of rain recorded annually (**Figure 2-6**). Above average (265 mm) rainfall conditions have also occurred in 2003, 2004, 2008, 2013, 2014, 2016 to 2018, 2021 and 2025 (**Figure 2-6**). In the 12 months prior to the 2019 Study, total rainfall was below average (250 mm), although substantially above average rainfall was recorded in October 2018 (69 mm), November 2018 (62 mm) and April 2019 (36 mm) (**Figure 2-7**). In contrast, during the 12-months prior to the 2025 study total rainfall exceeded the long-term average (369 mm), attributed to substantial monthly rainfall (>70 mm) recorded in June 2024 and November 2024 (**Figure 2-7**). Regardless, lake conditions remained predominately dry during both studies.



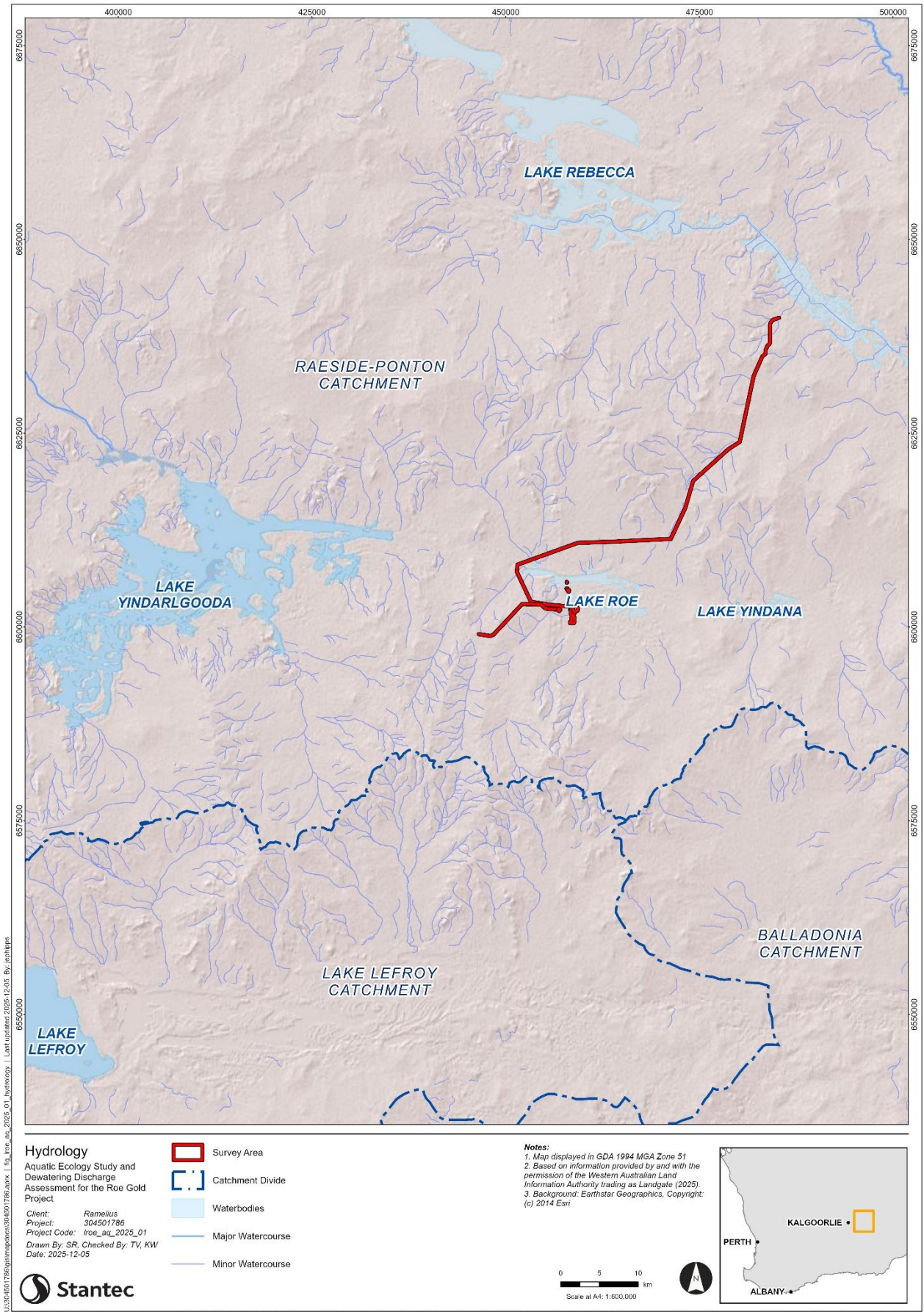


Figure 2-2: Regional surface hydrology of Lake Roe, Lake Yindargooda and Lake Yindana.



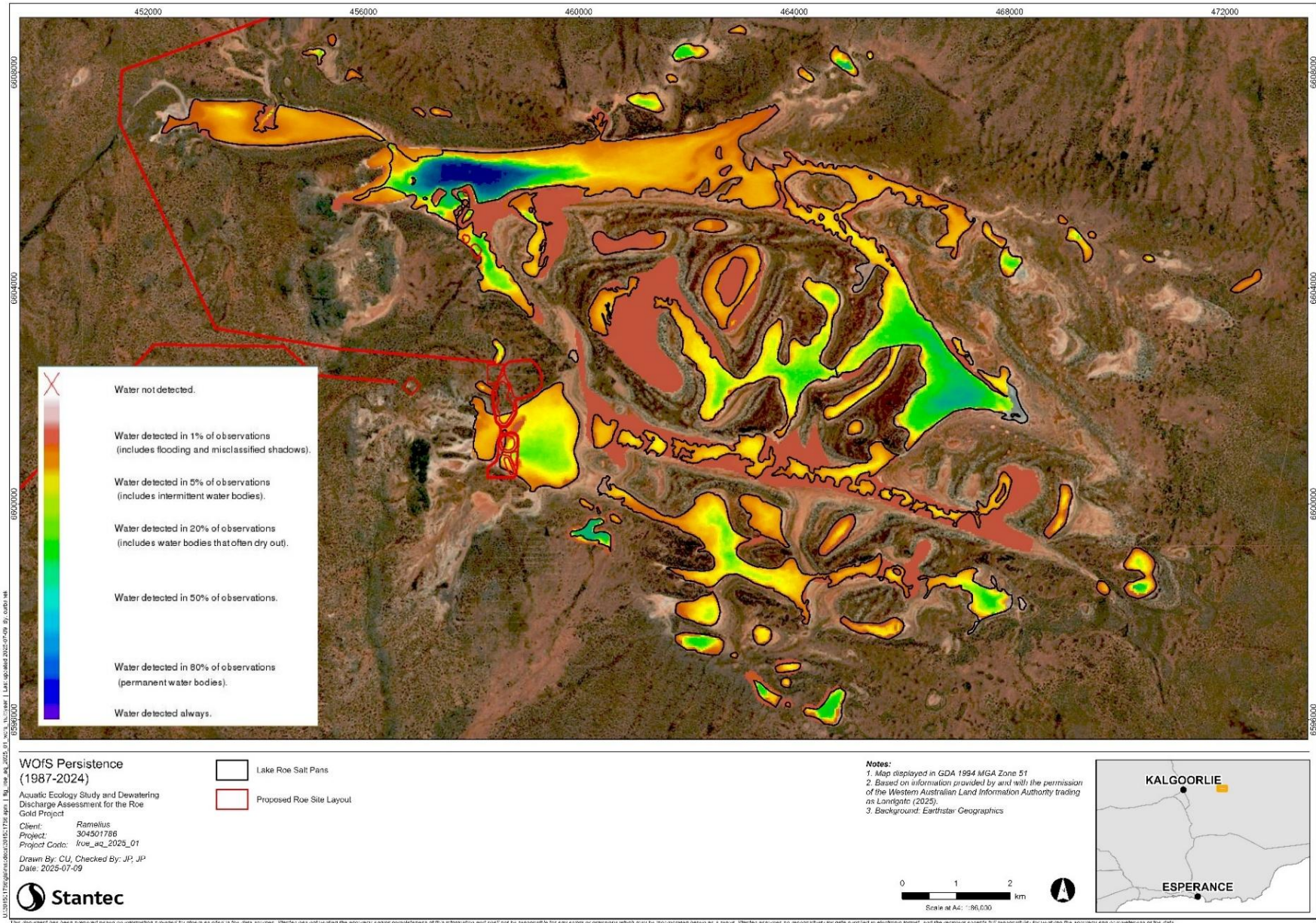
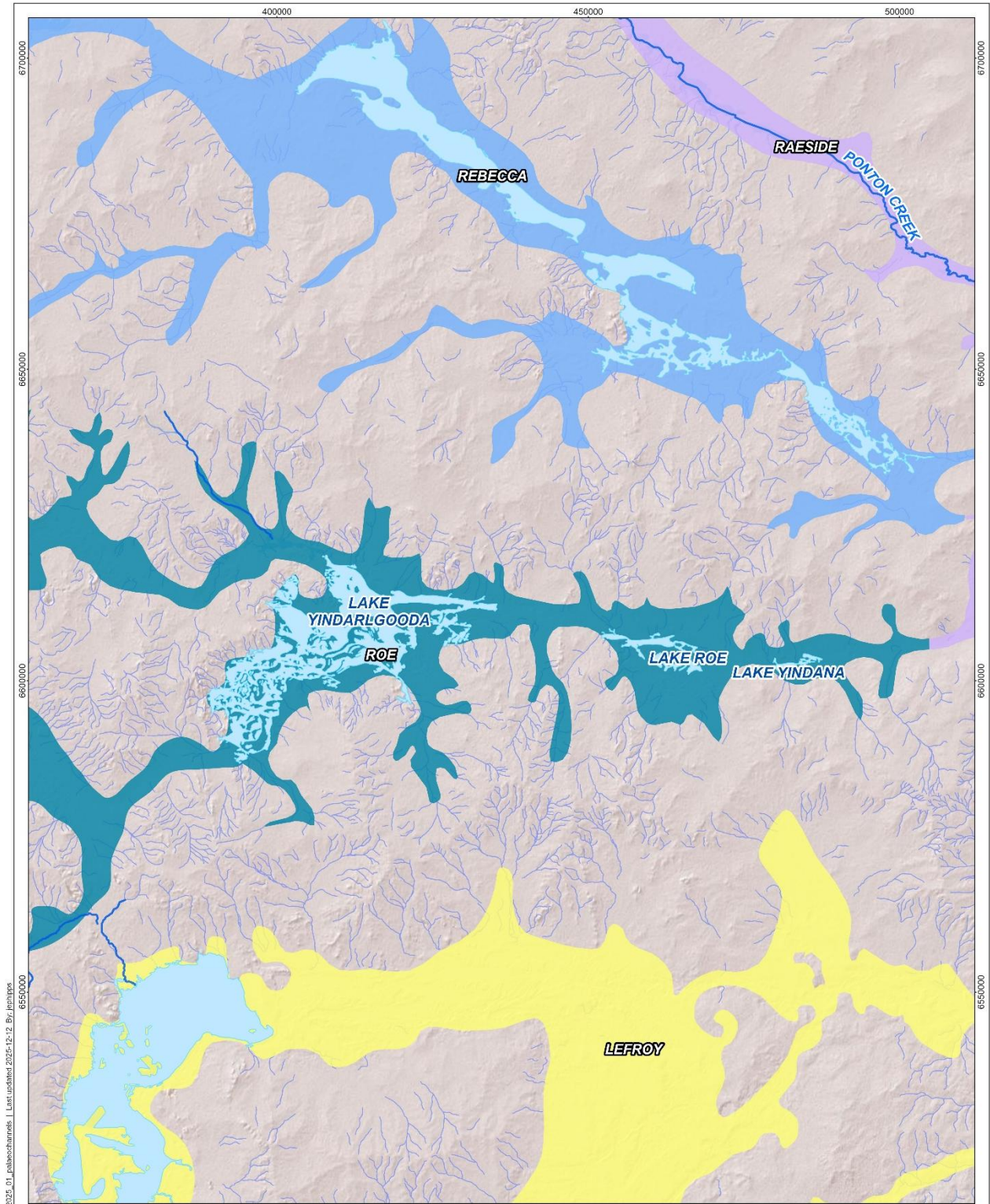


Figure 2-3: Inundation persistence at Lake Roe based on Water Observed from Space (WofS).





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Regional Palaeochannels
 Aquatic Ecology Study and Dewatering Discharge Assessment for the Roe Gold Project
 Client: Ramelius
 Project: 304501786
 Project Code: lroe_aq_2025_01
 Drawn By: SR, Checked By: TV, KW
 Date: 2025-12-12



- Palaeochannels**
- Lefroy
 - Raeside
 - Rebecca
 - Roe

- Waterbodies
- Major Watercourse
- Minor Watercourse

Notes:
 1. Map displayed in GDA 1984 MGA Zone 51
 2. Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2025).
 3. Background: Earthstar Geographics, Copyright: (c) 2014 Esri



Figure 2-4: Regional palaeochannel systems surrounding Lake Roe.



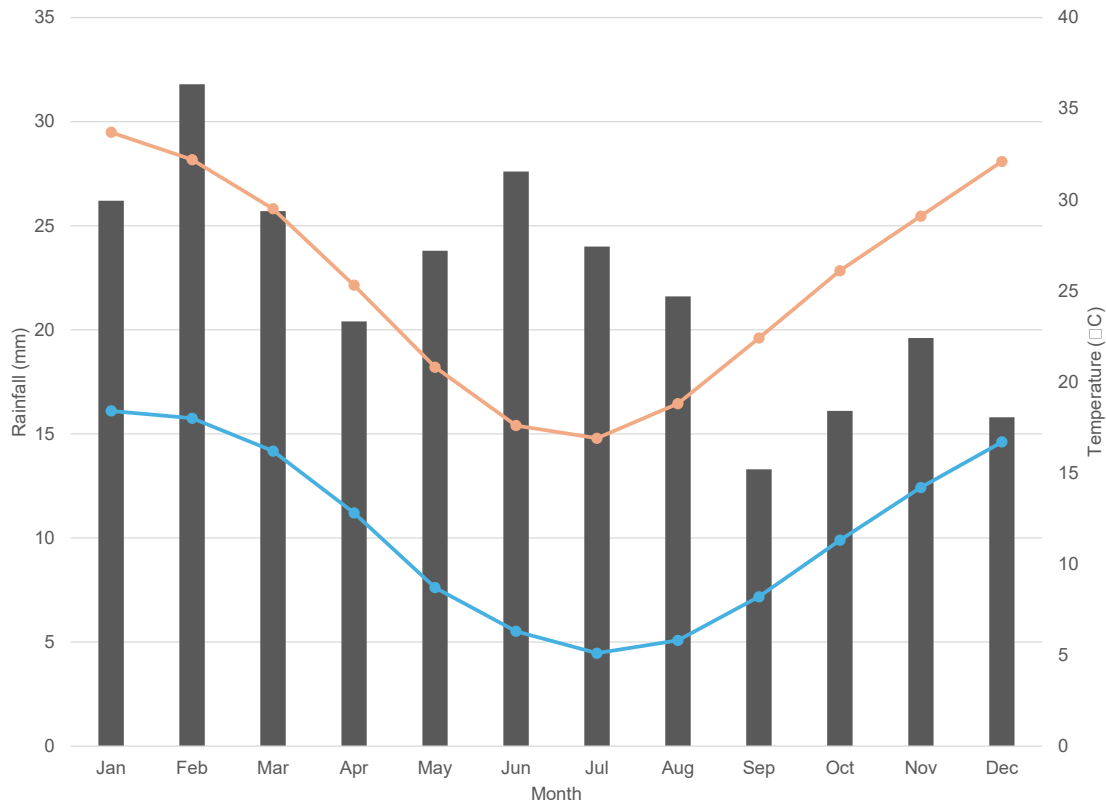


Figure 2-5: Long-term mean rainfall (■) and mean maximum (●) and minimum (●) temperature (1993-2025) recorded at Kalgoorlie-Boulder Airport (Station No. 12038).

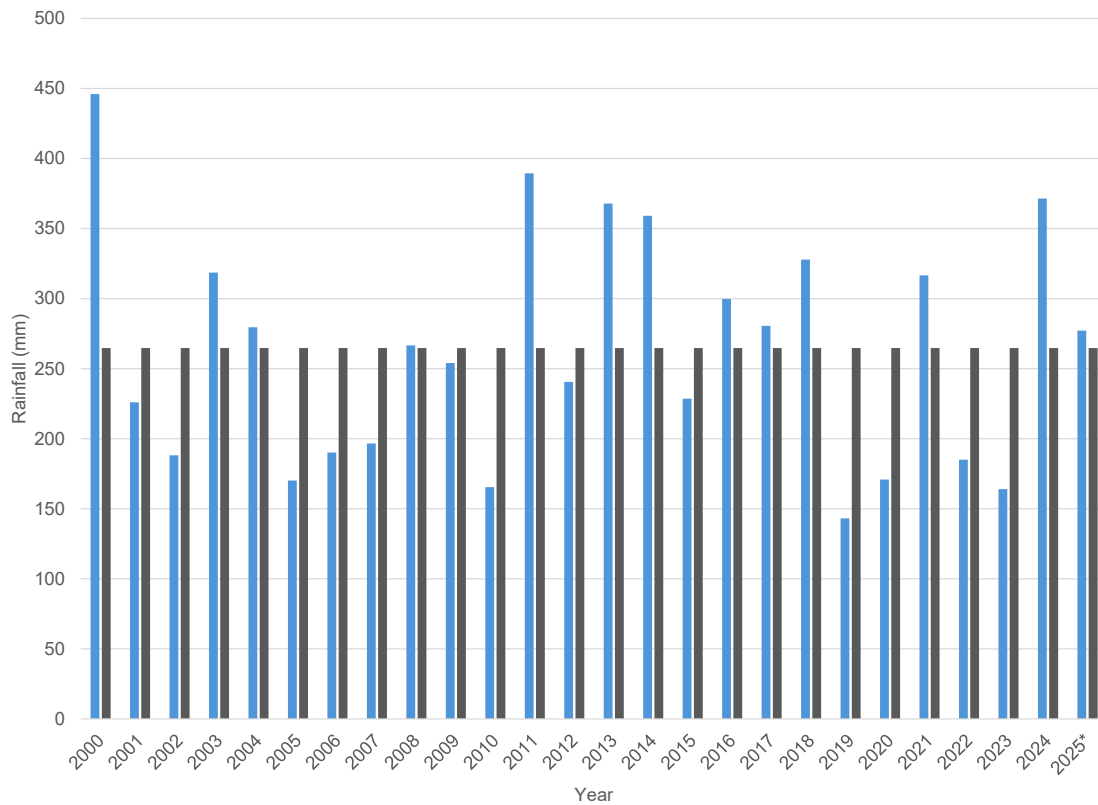


Figure 2-6: Annual rainfall recorded at Kalgoorlie-Boulder Airport (■), compared to the Kalgoorlie-Boulder Airport long-term annual average rainfall (■) (* indicates that dataset is incomplete).



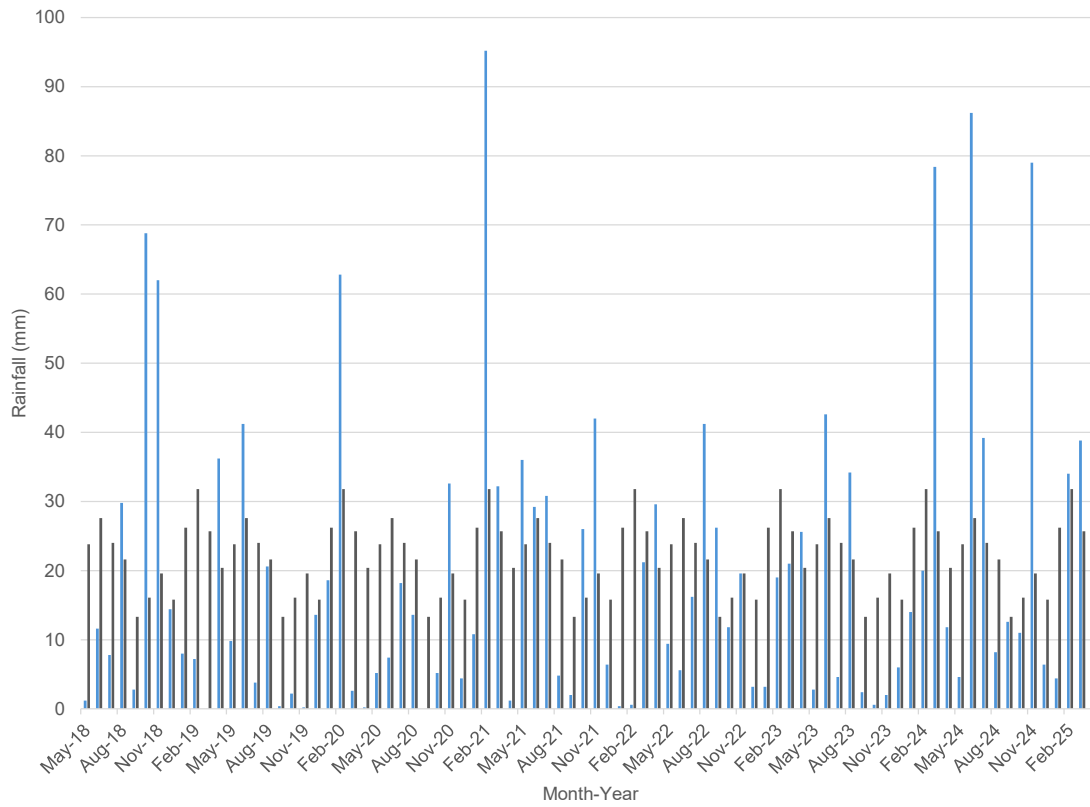


Figure 2-7: Monthly rainfall recorded at Kalgoorlie-Boulder Airport weather station (■), compared to the Kalgoorlie-Boulder Airport long-term monthly average rainfall (■).

3. Methods

3.1 Survey Design and Site Classification

For each of the 2019 and 2025 studies a field survey was undertaken by Stantec scientists (**Table 3-1**). These field surveys were conducted during dry conditions over a five-day period during May 2019 and April 2025, respectively. The 2019 study targeted the lake and peripheral wetlands, while the 2025 study included Lake Roe and regional lakes (Lake Yindarlgooda and Lake Yindana) and wetlands (**Table 3-1**; **Figure 3-1**; **Figure 3-2**). The sampling and components assessed during these field surveys included aquatic biota and riparian vegetation (**Table 3-2**). Habitat characterisation, photographic monitoring and georeferencing were completed at all sites across the two field surveys, a summary of which is presented in **Table 3-3**. Sampling for the 2019 and 2025 studies was approved by the DBCA under Licences to Take Fauna (Biological Assessment) Regulation 27 (BA27000066 and BA27001276, respectively) and to Take Flora (Biological Assessment) Regulation 62 (FB62000111 and FB62000810, respectively).

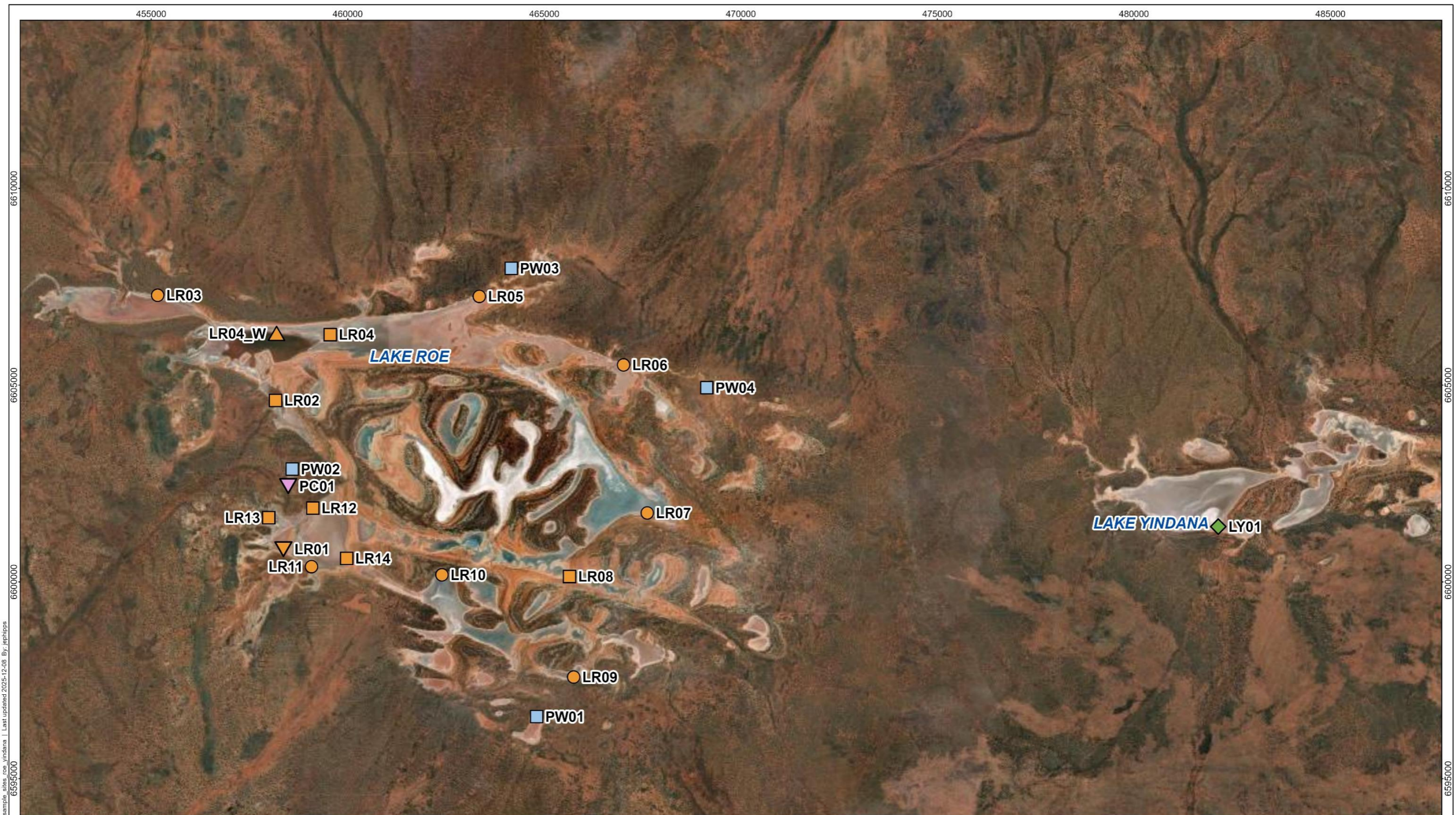
During the 2019 study a total of 18 sites were established, incorporating 14 sites on Lake Roe and four peripheral wetlands (salinas) (**Table 3-2**; **Figure 3-1**), with associated riparian vegetation transects located in the adjacent riparian zone (**Figure 3-3**). In comparison, a total of 15 sites were sampled in 2025, which included eight previously established sites on Lake Roe (**Figure 3-1**), with targeted collection of flowering plants (*Tecticornia*) from the riparian zone (**Figure 3-3**). An additional seven sites were established on Lake Yindarlgooda (three sites), Lake Yindana (one site) and regional wetlands (three sites) (**Figure 3-1**; **Figure 3-2**). The location of site LR04 was repositioned in 2025 to ensure sampling of residual surface waters on Lake Roe (indicated by 'W' suffix added to site name).

Prevailing dry conditions during the 2019 and 2025 studies limited sampling methods to the collection and analysis of surficial sediment for chemical analysis and for the assessment of aquatic biota from rewetting trials, as well as assessment of riparian vegetation from Lake Roe and peripheral wetlands (**Table 3-1**). The rewetting trials aimed to simulate flooding of sediment in the laboratory under controlled conditions, to assess the diversity and abundance of resident aquatic biota comprising algae and crustaceans that emerged (**Table 3-2**). During the 2025 study, three sites were inundated or partially inundated with residual surface water, enabling comprehensive sampling to be undertaken which included algae and invertebrates and waterbirds. In addition, prior to the 2019 study an opportunistic aquatic invertebrate sample was collected from one inundated peripheral claypan in October 2018. Detailed methods associated with each of the sampling components are presented in subsequent sections, with rewetting trial methods are outlined in **Section 3.8**, and riparian vegetation assessment is presented in **Section 3.7**.



Table 3-1: Summary of field survey timing, conditions, personnel, sites and components of the 2019 and 2025 studies.

Study	Survey Timing	Season / Rainfall / Lake Condition	Field Personnel	Number of Sites Sampled						Ecological Assessment Components
				Lake Roe	Peripheral Wetlands	Lake Yindarlgooda	Regional Wetlands	Lake Yindana	Total	
2019	20-25 May 2019	<ul style="list-style-type: none"> Season: late Autumn Rainfall: below average Lake condition: dry 	Nick Stevens, Emma Dobinson	<ul style="list-style-type: none"> 14 aquatic 13 riparian 	<ul style="list-style-type: none"> 5 aquatic 4 riparian 	-	-	-	<ul style="list-style-type: none"> 29 aquatic 17 riparian 	<ul style="list-style-type: none"> Collection of sediment for chemical analysis and rewetting trials Riparian vegetation transect/quadrat assessment
2025	7-11 April 2025	<ul style="list-style-type: none"> Season: mid Autumn Rainfall: above average Lake condition: predominately dry 	Jay Puglisi, Charles Corr	<ul style="list-style-type: none"> 8 aquatic 8 riparian 	-	<ul style="list-style-type: none"> 3 aquatic 	<ul style="list-style-type: none"> 3 aquatic 	<ul style="list-style-type: none"> 1 aquatic 	<ul style="list-style-type: none"> 15 aquatic 8 riparian 	<ul style="list-style-type: none"> Collection of sediment for chemical analysis and rewetting trials Targeted flowering plant collection in riparian zone (refer to Section 3.7)



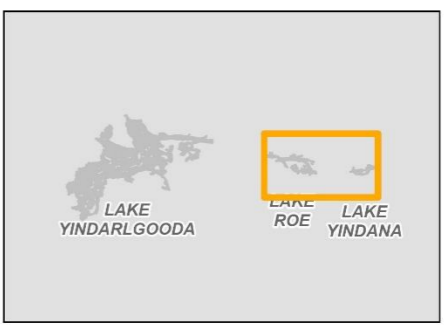
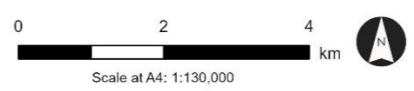
Survey Sites - Lake Roe and Lake Yindana
 Aquatic Ecology Study and Dewatering Discharge Assessment for the Roe Gold Project
 Client: Ramelius
 Project: 304501786
 Project Code: Iroe_aq_2025_01
 Drawn By: TV, Checked By: SR, JP
 Date: 2025-12-08



- Survey Sites**
- Lake Roe**
- Dry, 2019 & 2025
 - ◻ Dry, 2019
 - ▽ Wet, 2019
 - ▲ Wet, 2025
- Lake Yindana**
- ◇ Dry, 2025
- Peripheral Salina**
- ◻ Dry, 2019
- Peripheral Claypan**
- ▽ Wet, 2019

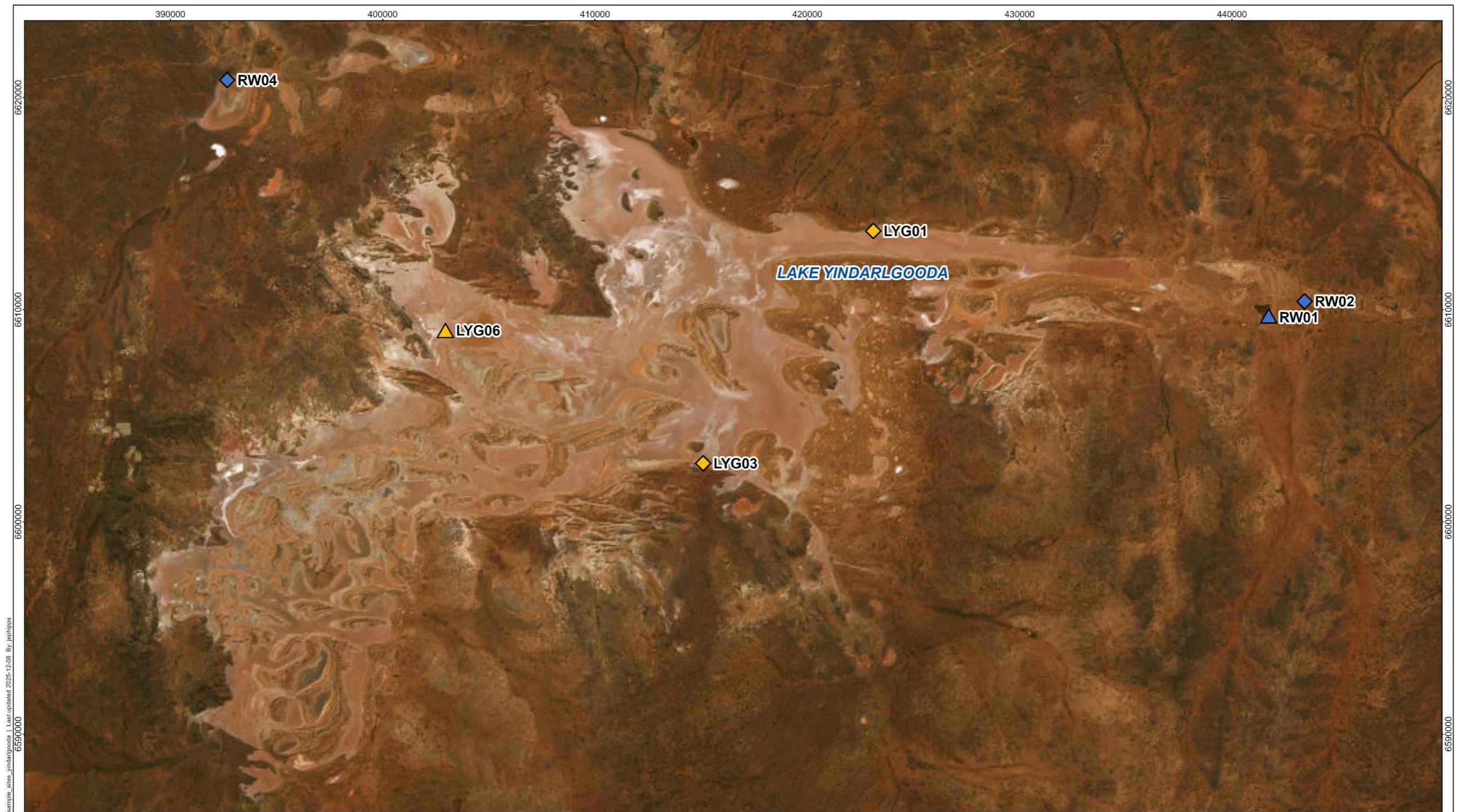
Notes:

1. Map displayed in GDA 1994 MGA Zone 51
2. Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2025).
3. Background: Earthstar Geographics



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Figure 3-1: Aquatic survey sites at Lake Roe and peripheral wetlands and Lake Yindana during the 2019 and 2025 studies.

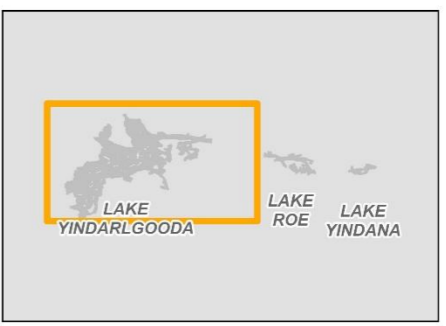


Survey Sites - Lake Yindarlgooda
 Aquatic Ecology Study and Dewatering Discharge Assessment for the Roe Gold Project
 Client: Ramelius
 Project: 304501786
 Project Code: iroe_aq_2025_01
 Drawn By: TV, Checked By: SR, JP
 Date: 2025-12-08

Survey Sites
Lake Yindarlgooda
 ◆ Dry, 2025
 ▲ Wet, 2025
Regional Wetland
 ◆ Dry, 2025
 ▲ Wet, 2025



Notes:
 1. Map displayed in GDA 1994 MGA Zone 51
 2. Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2025).
 3. Background: Earthstar Geographics



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Figure 3-2: Aquatic survey sites at Lake Yindarlgooda and regional wetlands during the 2025 study.



Riparian Vegetation Survey Sites - Lake Roe
 Aquatic Ecology Study and Dewatering Discharge Assessment for the Roe Gold Project
 Client: Ramelius
 Project: 304501786
 Project Code: lroe_aq_2025_01
 Drawn By: JP, Checked By: TV, JP
 Date: 2025-12-12

- Survey Sites**
- Lake Roe**
- Transect assessment (2019) and targeted sampling (2025)
 - Transect assessment (2019)
- Peripheral Salina**
- Transect assessment (2019)



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Notes:
 1. Map displayed in GDA 1994 MGA Zone 51
 2. Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2025).
 3. Background: Earthstar Geographics

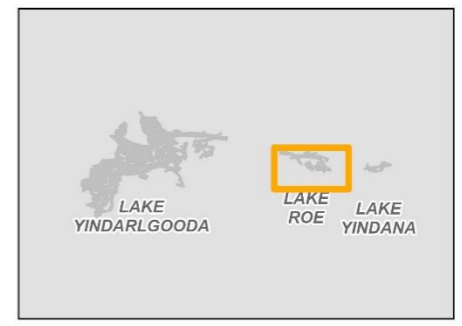


Figure 3-3: Location of riparian vegetation assessment (2019) and targeted sampling (2025) locations at Lake Roe and peripheral wetlands during the 2019 and 2025 studies.



Table 3-2: Summary of the abiotic and biotic componets assessed during the 2019 and 2025 studies (■ Lake Roe, ■ peripheral claypan, ■ peripheral salina, ■ Lake Yindarlgooda, ■ regional wetland, ■ Lake Yindana).

	Sites	Waterbody	Study	GPS Coordinates (UTM, Zone 51J)		Field Sampling								Rewetting Trials						
				Easting	Northing	Water Quality	Sediment Quality	Phytoplankton	Benthic Algae	Macrophytes	Aquatic Inverts.	Waterbirds	Riparian Vegetation	Basic Water Quality	Phytoplankton#	Benthic Algae+	Diatoms	Macrophytes	Aquatic Inverts.	
Lake Roe	LR01	Playa	2019	458363	6600832		•				•		•	•		•	•	•	•	
	LR02	Playa	2019	458163	6604611		•						•	•		•	•	•	•	
	LR03	Playa	2019, 2025	455161	6607176		•						• [^]	•	•	•	•	•	•	•
	LR04	Playa	2019	459554	6606285		•						• [^]	•		•	•	•	•	•
	LR04_W	Playa	2025	458187	6606342	•	•	•	•	•	•	•	• [^]	•	•	•	•	•	•	•
	LR05	Playa	2019, 2025	463365	6607217		•						• [^]	•	•	•	•	•	•	•
	LR06	Playa	2019, 2025	467022	6605518		•						• [^]	•	•	•	•	•	•	•
	LR07	Playa	2019, 2025	467636	6601735		•						• [^]	•	•	•	•	•	•	•
	LR08	Playa	2019	465642	6600138		•						•	•		•	•	•	•	•
	LR09	Playa	2019, 2025	465772	6597648		•						• [^]	•	•	•	•	•	•	•
	LR10	Playa	2019, 2025	462407	6600183		•						• [^]	•	•	•	•	•	•	•
	LR11	Playa	2019, 2025	459129	6600378		•						• [^]	•	•	•	•	•	•	•
	LR12	Playa	2019	459112	6601876		•						•	•		•	•	•	•	•
	LR13	Playa	2019	457990	6601633		•						•	•		•	•	•	•	•
LR14	Playa	2019	459839	6600949									•		•	•	•	•	•	
Peripheral Wetlands	PC01*	Claypan	2018	458486	6602436						•									
	PW01	Salina	2019	464806	6596577		•						•	•		•	•	•	•	
	PW02	Salina	2019	458585	6602867		•						•	•		•	•	•	•	
	PW03	Salina	2019	464160	6607970		•						•	•		•	•	•	•	















	Sites	Waterbody	Study	GPS Coordinates (UTM, Zone 51J)		Field Sampling								Rewetting Trials					
				Easting	Northing	Water Quality	Sediment Quality	Phytoplankton	Benthic Algae	Macrophytes	Aquatic Inverts.	Waterbirds	Riparian Vegetation	Basic Water Quality	Phytoplankton#	Benthic Algae+	Diatoms	Macrophytes	Aquatic Inverts.
	PW04	Salina	2019	469134	6604936		•						•	•		•	•	•	•
Lake Yindarigooda	LYG01	Playa	2025	423110	6613710		•						•	•	•		•	•	•
	LYG03	Playa	2025	415097	6602761		•						•	•	•		•	•	•
	LYG06	Playa	2025	402955	6609071	•	•	•			•	•	•	•	•		•	•	•
Regional Wetlands	RW01	Salina	2025	441730	6609756	•	•	•			•	•	•	•	•		•	•	•
	RW02	Salina	2025	443423	6610394		•						•	•	•		•	•	•
	RW04	Playa	2025	392679	6620823		•						•	•	•		•	•	•
Lake Yindana	LY01	Playa	2025	482145	6601406		•						•	•	•		•	•	•






Note: * indicates site sampled opportunistically in October 2018; ^ indicates riparian vegetation transect monitoring in 2019 and opportunistic flowering collection in 2025; # indicates phytoplankton collected in 2025 only; + indicates benthic algae collected in 2019 only.












Table 3-3: Habitat characterisation for sites sampled during the 2019 and 2025 studies (■ Lake Roe, ■ peripheral claypan, ■ peripheral salina, ■ Lake Yindarlgooda, ■ regional wetland, ■ Lake Yindana).

Sites	Distance to Pits (km)	Photo	Hydrology	Geology	Biology	Land use
LR01	0		Dry low-lying playa located in wide (approx. 500 m) embayment, created by a narrow peninsula to the east. Significant drainage inflow to the west.	Pustular sediment comprising sandy loam and silt with numerous quartz stones and pebbles.	Riparian vegetation characterised by sparse <i>Tecticornia</i> low-shrubland.	Previous disturbance evident from recent mining exploration (tracks and drilling) land uses.
LR02	3.2 (east)		Dry low-lying playa within narrow (approx. 200 m) embayment, adjoining main playa via a narrow (60 m) channel. Partially inundated with shallow film of surface water. Significant drainage inflow located to the south.	Sediment comprising clay-loam on playa and light-brown sand along shore and riparian zone.	Riparian vegetation characterised by <i>Tecticornia</i> and <i>Frankenia</i> low-shrubland.	Previous disturbance evident from recent mining exploration (tracks and drilling) land uses.
LR03	6.7 (north west)		Dry low-lying playa, within wide (approx. 600 m) embayment, adjoining main playa to east via a narrow (100 m) channel. Significant drainage inflows located to the west on northern shoreline.	Sediment comprising red-brown clay, with fine salt crust, and light brown sand and quartz along shoreline and riparian zone. Thick anoxic layer present in sediments in 2025.	Riparian vegetation characterised by <i>Tecticornia</i> low-shrubland. <i>Eucalyptus</i> woodland occurring with elevation.	Previous disturbance evident from pastoralism (livestock) land use.
LR04	4.8 (north)		Main playa, large and elongate, broad and open with significant drainage inflow located to the east.	Sediment comprising clay on playa, with fine salt crust, and light-brown coarse sand with quartz pebbles underlain by sand-loam along shoreline.	Riparian vegetation characterised by <i>Tecticornia</i> low-shrubland. <i>Eucalyptus</i> woodland occurring with elevation.	Previous disturbance evident from pastoralism (livestock) land use.
LR04_W	4.9 (north)		Main playa, large and elongate, broad and open, inundated with large body of shallow clear residual surface waters in the centre.	Sediment comprising brown clay over red brown clay, overlain with scattered quartz pebbles. Anoxic layer present in underlying sediments and some woody debris in surface waters	Benthic algal mat throughout surface waters, with abundant aquatic invertebrates (<i>Parartemia</i>) supporting numerous waterbirds.	Previous disturbance evident from pastoralism (livestock) land use.
LR05	7.4 (north east)		Dry low-lying playa within narrow (approx. 200 m) elongate embayment, opening to main play to west. Significant drainage inflow located to north-east.	Sediment comprising moist red-brown clay, overlain with fine speckled salt crust and scattered quartz pebbles. Clay covered with light-brown sand along the shoreline, overlain by quartz pebbles and chips. Thin patchy anoxic layer present in sediments in 2025.	Riparian vegetation characterised by <i>Tecticornia</i> low-shrubland. <i>Eucalyptus</i> woodland occurring with elevation.	Previous disturbance evident from pastoralism (livestock) land use.

Sites	Distance to Pits (km)	Photo	Hydrology	Geology	Biology	Land use
LR06	9.2 (north east)		Dry low-lying playa, within narrow convoluted embayment. Drainage inflows located to south-east and north-west.	Sediment comprising clay, with a thin salt crust, on playa and sand loam along shoreline and riparian zone. Thick (3cm) anoxic layer present in 2025.	Riparian vegetation characterised by sparse <i>Tecticornia</i> low-shrubland.	Previous disturbance evident from pastoralism (livestock) land use.
LR07	9.0 (east)		Main playa, broad and open. Partially inundated with shallow film of surface water.	Sediment comprising grey brown clay, overlayer of thick coarse sand with gypsum crystals. Thin speckled salt crust on surface of playa. Low-lying dunes with coarse sand in riparian zone. Anoxic layer observed in 2025.	Riparian vegetation characterised by very sparse <i>Tecticornia</i> low-shrubland.	Previous disturbance evident from pastoralism (livestock) land use.
LR08	7.5 (east)		One of a chain of discrete playas separated from the main playa by low-lying convoluted islands.	Sediment comprising moist dark clay with organics on playa and coarse sand loam along shore and riparian zone. Low-lying sandy dunes.	Riparian vegetation characterised by very sparse <i>Tecticornia</i> low-shrubland.	Previous disturbance evident from historical pastoralism (livestock) land use.
LR09	8.0 (south east)		Low lying playa, with small low-lying islands and numerous small inflows. Part of a poorly connected and convoluted part of the Lake Roe playa. Thin surface layer of water present on playa in 2019.	Sediment comprising grey brown clay, overlying brown clay. Thin speckled salt crust on playa. Thick anoxic layer present in 2025. Low-lying dunes with light brown clay loam and calcareous sediments and gypsum.	Riparian vegetation characterised by sparse <i>Tecticornia</i> low-shrubland. <i>Eucalyptus</i> woodland occurring with elevation.	Previous disturbance evident from historical pastoralism (livestock) land use.
LR10	4.0 (east)		Dry low-lying playa, located in wide (approx. 600m) embayment.	Sediment comprising clay, with anoxic layer (2019 and 2025), over coarse sand on playa and soft loam and coarse light-brown sand along shore. Low-lying, gently rising sandy dunes, backed by steep rise.	Riparian vegetation characterised by <i>Tecticornia</i> low-shrubland. <i>Eucalyptus</i> woodland occurring with elevation.	Previous disturbance evident from historical pastoralism (livestock) land use.
LR11	0		Dry playa, broad and open, wide channel to south. Drainage inflows located adjacent and further to the east. Elevated banks and dunes on southern and eastern margin with some erosion and terracing.	Sediment comprising brown fine clay sand on playa, with underlying clay layer. Scattered quartz pebbles and speckled salt crust on surface and light-brown sand along shore and riparian zone. Drill holes present on playa, with piles of grey green pebbles.	Limited riparian zone. Riparian vegetation characterised by <i>Tecticornia</i> low-shrubland. <i>Eucalyptus</i> woodland occurring with elevation.	Previous disturbance evident from recent mining exploration (tracks) land use.

Sites	Distance to Pits (km)	Photo	Hydrology	Geology	Biology	Land use
LR12	0		Dry playa, broad and open.	Sediment comprising clay, silt and sand on playa and light-brown sand loam along shore and riparian zone.	Riparian vegetation characterised by <i>Tecticornia</i> low-shrubland.	Previous disturbance evident from recent mining exploration (tracks and drilling) land use.
LR13	0		Mouth of major drainage inflow, braided with small islands, terminating into a wide embayment of Lake Roe.	Sediment comprising clay on playa, surrounded by sandy loam with silt and quartz.	Riparian vegetation characterised by <i>Tecticornia</i> low-shrubland. <i>Melaleuca</i> shrubland over <i>Triodia</i> with elevation.	Previous disturbance evident from recent mining exploration (tracks) land use.
LR14	1.3 (east)		Dry playa, broad and open. Separated from an easterly chain of discrete smaller playas by a broad expanse of low-lying islands.	Sediment comprising clay, silt and sand on playa.	Riparian vegetation characterised by <i>Tecticornia</i> low-shrubland.	Previous disturbance evident from recent mining exploration (tracks and drilling) land use.
PC01	1.2 (north)	No photo available.	Small low-lying vegetated claypan, located approximately 150 m south of PW02 of Lake Roe playa. Local terminus of a wide, diffuse floodplain. Surface waters present.	Sediment comprising clay, loam and light-brown coarse sand.	Pan vegetated by sparse <i>Tecticornia</i> low-shrubland. Aquatic invertebrates (<i>Triops</i> and ostracods) observed in surface water.	Previous disturbance evident from pastoralism (livestock) land use.
PW01	7.9 (south east)		Large open salina, located to the south of Lake Roe. Drainage inflow to the south-west.	Sediment comprising sandy loam, overlain with salt crust. Rising sand dunes along the southern shoreline. Narrow to no riparian zone along the north shoreline.	Riparian vegetation characterised by sparse <i>Tecticornia</i> low-shrubland.	Previous disturbance evident from pastoralism (livestock) land use.
PW02	2.0 (north)		Small lunette salina located approximately 750 m southwest of main northern playa. Small drainage inflows present to north and southwest.	Sediment comprising loam with quartz pebbles, becoming more abundant in the north. Elevated rocky shoreline on western margin. Eastern margin comprising low-lying sandy dunes.	Limited riparian zone in the western, comprising elevated rocky shore supporting <i>Eucalyptus</i> woodland. Riparian vegetation present on low-lying eastern bank, comprising <i>Tecticornia</i> low-shrubland.	Previous disturbance evident from recent mining exploration (tracks and drilling) land use.

Sites	Distance to Pits (km)	Photo	Hydrology	Geology	Biology	Land use
PW03	8.5 (north east)		Small salina, characterised by numerous small low-relief islets and forming part of a small chain of pans with drainage towards Lake Roe. Located approximately 700 m northeast of main northern playa.	Sediment comprising clay, loam and light-brown coarse sand.	Narrow riparian zone supporting sparse <i>Tecticornia</i> low-shrubland, backed by <i>Melaleuca</i> shrubland and <i>Eucalyptus</i> woodland.	Previous disturbance evident from pastoralism (livestock) land use.
PW04	11.0 (north east)		Small salina, located approximately 2 km east of Lake Roe playa, connected by a meandering drainage channel. Drainage inflows to north and east of site. Thin surface layer of water present in the centre of the pan.	Sediment comprising soft, moist clay, with sand and silt, overlain with a speckled salt crust in the north.	Evidence of recent water bird activity around surface waters. Riparian vegetation comprising <i>Tecticornia</i> low-shrubland, with numerous seedlings along shoreline. <i>Melaleuca</i> shrubland with elevation.	Previous disturbance evident from pastoralism (livestock) land use.
LYG01	37.6 (north west)		Dry low-lying playa, broad and elongate. Site located adjacent to a substantial drainage line with a small island 20m into playa from lake edge. Low fringing dunes with elevated hills behind.	Sediment comprising brown clay sands with quartz pebbles. Light brown clays along fringe, becoming red brown clay loam in the riparian zone.	Riparian vegetation characterised with <i>Tecticornia</i> low-shrubland, backed by mulga tall shrubland with elevation. Abundant woody debris deposited on playa by drainage inflow.	Previous disturbance evident from pastoralism (livestock) land use. Cattle tracks and scats across playa.
LYG03	43.5 (west)		Dry low-lying playa, wide and open. Large rocky elevated island to west and headland to north, steep rocky banks with cliffs. Low-dunes along southern shoreline, with numerous inflows and washouts.	Mosit brown clay sediments with fine sand, overlain with speckled salt crust and scattered quartz stones and chips. Fringing dunes comprising light brown clay loam sediments with quartz.	<i>Tecticornia</i> low-shrubland dominating riparian zone, backed by <i>Calitris</i> low woodland. Woody debris deposited on lake bed.	Previous disturbance evident from pastoralism (livestock) land use. Cattle tracks across playa.
LYG06	56.2 (west)		Large low-lying open playa. Site located towards centre of basin with large body of residual surface water.	Soft brown clay sediments, overlain by scattered quartz stones	Abundant <i>Parartemia</i> and ostracods throughout surface waters. Numerous waterbird tracks throughout.	Previous disturbance evident from pastoralism (livestock) land use.
RW01	18.9 (north west)		Irregular low-lying salina, inundated. Inflows along the southern margin, characterised by a low-lying plain. Elevated dunes and hills on western and northern margins.	Sediments comprising soft brown clay, easily disturbed and suspended into overlying surface water. Quartz pebbles and gravel.	Surface waters inhabited by abundant aquatic invertebrates and numerous waterbirds. Riparian vegetation characterised by low dwarf <i>Tecticornia</i> shrubland on fringing plain.	Previous disturbance evident from pastoralism (livestock) land use.

Sites	Distance to Pits (km)	Photo	Hydrology	Geology	Biology	Land use
RW02	17.7 (north west)		Dry, small, low-lying irregular salina. Substantial drainage inflows immediately to west and south of site. Steep, elevated banks with limited fringing zone, interspersed by low-lying dunes. Island in center of playa.	Brown clay sediments, becoming more sandy with depth. Scattered fine quartz on surface. Dunes and rises comprised of brown loam and calcareous sediments, with small drainages.	Abundant woody debris on playa. Low <i>Tecticornia</i> shrubland along riparian zone, backed by Eucalypt woodland on elevated rises.	Previous disturbance evident from pastoralism (livestock) land use. Cattle tracks and scats across playa.
RW04	68.9 (north west)		Penny Lake. Dry, large, roughly ovoid, low-lying playa. Low lying dunes on periphery, with gentle elevation. Substantial inflows along northern margin to the east.	Playa sediments comprising brown clay with fine sand, overlain with scattered quartz pebbles. Light brown sandy loam sediments in dunes with ironstone gravel.	Fringing low <i>Tecticornia</i> shrubland. Scattered woody debris on playa.	Previous disturbance evident from historical mining land use. Historical discharge outfall located on northern periphery, from inactive mine approximately 1 km to north.
LY01	23.2 (east)		Dry, large irregular low-lying playa, broad and open. Lake fringe typified by steep elevated banks with drainages and gullies.	Firm, grey, brown clay sediments with coarse sand, and gypsum crystals, with scattered quartz on surface. Speckled salt crust present, becoming thicker and intact towards the center of main basin.	Numerous water bird tracks in area of previous inundation. Limited riparian zone due to steep elevated banks, backed by tall eucalyptus woodland over spinifex hummock shrubland	No evidence of previous disturbance.

3.2 Water Quality

During the 2025 study, surface water samples were collected from inundated sites, including LR04_W, RW01 and LYG06. Sterilised bottles were provided by the NATA-accredited Australian Laboratory Group (ALS), containing preservative where required. The bottles were filled with water at each site and sealed, excluding air from the samples (following instructions provided by ALS). Following collection, samples were couriered to ALS (Perth) for analysis of a range of parameters (**Table 3-4**). Samples collected for the analysis of dissolved metals were filtered in the laboratory and analysed by the ICP-MS (inductively coupled plasma mass spectrometry) method.

Holding times were met for most parameters, except for pH, total dissolved solids and alkalinity where results should be considered indicative only. Basic water quality parameters were also measured *in situ* at inundated sites during field sampling using a TPS 90FLMV hand-held meter. Measurements included pH, salinity, electrical conductivity, dissolved oxygen, temperature and redox potential (**Appendix B**).

Table 3-4: Water quality suite assessed during the 2025 study.

Basic Parameters	Nutrients	Anions and Cations	Dissolved Metals and Trace Elements	
pH	Total Nitrogen (TN)	Bicarbonate	Arsenic	Iron
Electrical Conductivity	Nitrite + Nitrate (NO ₂ + NO ₃)	Carbonate	Aluminium	Manganese
Total Dissolved Solids (TDS)	Total Kjeldahl Nitrogen	Calcium	Barium	Mercury
Electrical Conductivity (EC)	Total Phosphorous (TP)	Chloride	Beryllium	Nickel
		Potassium	Chromium	Selenium
		Sodium	Cobalt	Vanadium
		Magnesium	Cadmium	Lead
		Silicon	Copper	Zinc
		Sulphate		

Surface water pH was also classified according to the system developed by (Foged 1978), comprising acidic (4.5 to 6.5), circumneutral (6.5 to 7.5), and alkaline (>7.5) conditions, and salinity was based on the classification system developed by Hammer (1986); freshwater (<5,000 µS/cm), hyposaline (5,000 to 30,000 µS/cm), mesosaline (20,000 to 70,000 µS/cm) and hypersaline (>70,000 µS/cm) (Foged 1978; Hammer 1986). Metals data was compared to the ANZG (2018) guideline trigger values for the protection of 80% species in marine water (for highly disturbed ecosystems).

3.3 Sediment Quality

During the 2019 and 2025 studies, at each site, the top two to three centimetres of lake sediment was scraped into a sterilised glass container, which was sealed and sent to ALS for analysis (**Table 3-5**). Samples were collected and stored using containers and instructions provided by ALS. The analysis of total metals in sediment was by the ICP-AES (inductively-coupled plasma-atomic emission spectrometry) method. Holding times were met for most parameters, except for pH, where results should be considered indicative only.

Sediment pH was also classified according to (Hazelton and Murphy 2007), which ranges from very strongly acidic (<5.0) to very strongly alkaline (>9.0). Where limited metals data was available, values were also assessed against the ANZG (2018) guideline Interim Sediment Quality Guideline (ISQG-High) trigger values.



Table 3-5: Sediment quality suite assessed during the 2019 and 2025 studies.

Basic Parameters	Nutrients	Anions and Cations	Total Metals and Trace Elements	
pH	Total Organic Carbon	Bicarbonate	Arsenic	Lead
Total Soluble Salts	Total Nitrogen	Carbonate	Aluminium	Manganese
Moisture Content	Total Phosphorous	Calcium	Barium	Mercury
	Nitrite + Nitrate	Chloride	Beryllium	Nickel
		Magnesium	Boron	Selenium
		Potassium	Cadmium	Silicon
		Sodium	Chromium	Vanadium
		Sulphate	Cobalt	Zinc
			Copper	
			Iron	

3.4 Algae

3.4.1 Phytoplankton

During the 2025 study, phytoplankton (free-floating algae) was sampled from surface water at LR04_W, RW01 and LYG06. A 25 µm mesh net was towed through the water along an L-shaped transect (30 x 30 m), perpendicular to the shoreline. Each sample was transferred into a 70 mL vial and kept cool to preserve the algae. In the Stantec laboratory, three representative slides were prepared and observed under a compound microscope at 40X magnification. Algae were identified to genus or species level by Senior Environmental Scientist Richard de Lange using appropriate taxonomic literature. The relative abundance was recorded for each taxon, calculated per cell, colony or filament, dependent on the morphological form.

3.4.2 Benthic Algae & Macrophytes

During the 2025 study, benthic algae and submerged macrophytes (aquatic plants) samples were opportunistically sampled from inundated sites where observed. Samples were placed into a 70 ml vial or air-sealed bag and kept cool to preserve structure. In the Stantec laboratory, fresh slide mounts were prepared for the benthic algae, and examined at 40X magnification under a compound microscope, with the relative abundance recorded for each taxon. Macrophyte samples were examined under a dissecting microscope and identified. Taxonomic verification of benthic algae and macrophytes was undertaken to genus and species level respectively, by Richard De Lange, using appropriate taxonomic literature.

3.5 Aquatic Invertebrates

During the 2019 study aquatic invertebrates were collected opportunistically from surface water at LR01 and PC01. The samples were collected by hand using a 250 mL polycarbonate vial and refrigerated to preserve specimens. During the 2025 study, microinvertebrate (zooplankton) and macroinvertebrate samples were collected from surface water at LR04_W, RW01 and LYG06. A 53 µm mesh net was towed through the water column to sample zooplankton, while a 250 µm D-frame mesh net was used to sample macroinvertebrates, targeting the benthic environment. For both nets, a 30 x 30 m L-shaped transect was undertaken at each site. Samples were transferred into 250 mL polycarbonate vials and preserved in 100% undenatured ethanol.

Sorting of all samples was completed in the Stantec laboratory under a dissecting microscope, with the abundance of invertebrates recorded, and specimens separated into their broad taxonomic groups and placed into microvials. Further identification of taxa to genus or species level was completed in-house, using appropriate literature and keys by Principal Environmental Scientist Emma Thillainath. Specialist identification of the microcrustaceans was undertaken by Dr Stuart Halse (ostracods) and Jane McRae (copepods and cladocerans) of Bennelongia Environmental Consultants. For the purposes of reporting, the microinvertebrate and macroinvertebrate data were combined.



3.6 Waterbirds

Opportunistic observations of waterbirds were undertaken at each site during the 2025 study. Waterbirds were identified in the field and recorded.

3.7 Riparian Vegetation Assessment

3.7.1 Survey Effort, Targeted Survey and Timing

A summary of the riparian vegetation field surveys undertaken in 2019 and 2025 is provided in **Table 3-6**. A total of 17 transects and 170 quadrats were assessed during the 2019 study. The 2025 work focused on targeted surveying of flowering samphire specimens, with a total of 45 flowering *Tecticornia* plants collected and georeferenced from throughout the riparian zone of Lake Roe only. Season and rainfall are important considerations for flora and vegetation surveys. The 2019 study was undertaken during a period of below average rainfall when Lake Roe and peripheral wetlands were dry, and the 2025 study was undertaken during a period of above average rainfall when residual surface water was present on Lake Roe (**Table 3-6**).

3.7.2 Transect Assessment

During the 2019 study riparian vegetation was assessed at thirteen Lake Roe sites and four peripheral wetlands. At each site transects, 30 m in length, were established perpendicular to the shoreline from the edge of the lake or peripheral wetland. Along each transect, ten quadrats (3 m x 3 m) were assessed for species diversity, plant health, plant cover (percentage) and plant abundance, for each species within each quadrat. Photographic monitoring was also undertaken to support the assessment.

Plant health during the 2019 study was rated on a scale of 1 to 5 for each quadrat within a transect, based on the system by Keighery (1994), as follows:

1. = dead/no live vegetation;
2. = poor/declining vegetation health;
3. = good/improving vegetation health;
4. = very good vegetation health/no change from previous monitoring if relevant; and
5. = excellent health, new germinants.

3.7.3 Taxonomic Verification

All plant specimens collected during the 2019 and 2025 studies were identified by experienced Stantec botanists. *Tecticornia* specimens were submitted to specialist Dr Kelly A. Shepherd (Senior Research Scientist) of the Western Australian Herbarium (WAH) for taxonomic verification.



Table 3-6: Riparian vegetation field surveys undertaken at Lake Roe and peripheral wetlands during the 2019 and 2025 studies.

Study	Survey Timing	Season / Rainfall / Lake Condition	Field Personnel	Number of Sites Sampled	Method
				Lake Roe	
2019	20-25 May 2019	<ul style="list-style-type: none"> Season: late Autumn Rainfall: below average Lake condition: dry 	Nick Stevens, Emma Dobinson	<ul style="list-style-type: none"> 13 Lake Roe sites 4 peripheral wetland sites Aligned with aquatic ecology sites 	<ul style="list-style-type: none"> Transect/quadrat method 30 m transect comprising 10 3 m x 3 m contiguous quadrats Species diversity, abundance, cover (%) and health recorded for each species in each quadrat
2025	7-11 April 2025	<ul style="list-style-type: none"> Season: mid Autumn Rainfall: above average Lake condition: predominately dry 	Jay Puglisi, Charles Corr	<ul style="list-style-type: none"> Targeted flowering <i>Tecticornia</i> specimen collection (45 specimens) from 8 existing Lake Roe sites. 	<ul style="list-style-type: none"> Targeted specimen collection and georeferencing only.



3.8 Rewetting Trials

During the 2019 and 2025 studies, rewetting trials were undertaken using sediment samples collected during the field surveys. These trials aim to simulate flooded conditions, to germinate algae and macrophytes, and hatch aquatic invertebrates. In the Stantec laboratory, dried sediment was placed into transparent 20 L containers, to which dechlorinated water was added. Artificial aerators increased dissolved oxygen levels in the containers and liquid fertiliser was added to the water to promote biological productivity. Albite® hydroponic lights were applied to increase light intensity and maintain heat within the containers, based on a diurnal cycle.

For each study, the rewetting trials were undertaken over approximately 12 weeks, to allow aquatic biota to emerge, develop and mature, simulating various stages of the hydroperiod. Basic water quality (pH, total dissolved solids, electrical conductivity and temperature) was measured on a regular basis. Containers were also checked daily for the emergence of aquatic biota, including macrophytes and aquatic invertebrates. Dechlorinated water was added as required to top up the containers and algal pellets were used as a food source for aquatic invertebrates. Any aquatic invertebrate taxa that hatched were recorded and allowed to develop to maturity, before being periodically harvested.

For the purposes of data analysis and reporting, aquatic biota recorded during the rewetting trials were combined with the results from opportunistic field samples. It should be noted that laboratory conditions cannot fully replicate naturally flooded conditions and instead provide a likely representation of the resident algae and aquatic invertebrates that may emerge.

3.8.1 Algae, Diatoms and Macrophytes

During the 2019 study, part-way into the rewetting trials benthic algal samples growing in the containers were collected for identification. A small portion of each sample was mounted onto a slide and assessed using a compound microscope (40X). The abundance (using a broad ranking system) and diversity of algae was recorded for each site. Identification to genus level was completed by principal taxonomist Dr Erin Thomas (Stantec), using appropriate taxonomic guides.

At the conclusion of the rewetting trials phytoplankton samples were collected for identification, during the 2025 study. The water from each container was filtered through a 25 µm mesh net. In the Stantec laboratory, representative sub-samples were fresh mounted on glass microscopy slides and examined under a compound microscope at 40X magnification. The abundance of algal taxa was recorded per cell, colony or filament, dependent on morphological form, by senior environmental scientist Richard de Lange (Stantec), using appropriate taxonomic guides.

Sediment samples from each site were collected from the containers at six weeks (2019 study) and at the conclusion of the rewetting trials (2025 study), for the processing of the microalgae diatoms (Bacillariophyta). Samples were treated in 70% nitric acid to remove organic material, and permanent slides were prepared according to (John 1983). One slide was made from each sample, and enumeration was carried out at 100X magnification using a compound microscope. The abundance and diversity of diatoms was recorded for each site. A maximum of 100 diatoms were counted from each site, or at sites where diatoms were considered sparse, the total number of diatoms was counted. Species were identified using relevant literature by aquatic scientist Jake Daviot and principal taxonomist Dr Fiona Taukulis (2019 study), and Richard de Lange (2025 study), of Stantec.

Macrophyte samples growing in rewetting trial containers were collected opportunistically throughout (2019 study), and at the conclusion (2025 study) of the rewetting trials for identification and typically require a longer period to mature than aquatic invertebrates. The specimens were examined under a dissecting microscope in the laboratory and identified to genus or species level using morphological and reproductive features. A relative macrophyte abundance ranking was provided. Verification of macrophytes was undertaken by principal taxonomists Dr Erin Thomas and Dr Fiona Taukulis (2019 study), and Richard de Lange (2025 study), using appropriate taxonomic literature.

3.8.2 Aquatic Invertebrates

Aquatic invertebrates were collected from the rewetting trial containers when specimens were deemed mature for taxonomic resolution. A small 50 µm mesh net was used to collect the specimens from the containers, with the resultant samples preserved in 100% undenatured ethanol. The samples were sorted, with an estimate of abundance recorded. The specimens were separated into their broad taxonomic rank, with identification to the lowest possible level completed by Dr Erin Thomas and Thomas de Silva (2019 Study) and principal environmental scientist Emma McQuie (2025 study) of Stantec. Specialist taxonomist sub consultants (Bennelongia Environmental) provided species level resolution of the ostracods.



3.9 Multivariate Statistical Analysis

Multivariate analysis involves the statistical analysis of more than one parameter at a time and was used to investigate trends in the data for the Study. Principal component analysis (PCA) was performed on sediment quality data, while non-metric multidimensional scaling (nMDS) and hierarchical classification was implemented for biological data (benthic algae, diatoms, aquatic invertebrates and riparian vegetation). These techniques were completed in the statistical package PRIMER, Version 7.0 (Clarke and Gorley 2006).

Principal component Analysis (PCA) is a technique used to reduce and identify key variables in a dataset, allowing for the detection of patterns and similarities. This information is expressed as summary indices or principal components. For sediment data, where values were below detection, a value equal to half the limit of reporting was substituted, while parameters with values mostly below detection were removed. Pre-treatment of the data involved removal of collinear variables and applying a square-root transformation to the data, to reduce skewness. PCA was undertaken on the refined dataset, the results of which are shown in the form of a plot, where sites with similar characteristics are located close together. Vectors radiate from the centre of the plot, representing the influence of parameters. Higher concentrations of a parameter tend to occur near the end point of the vector. The percentage variance is used to explain the strength of the PCA, presented over the first two axes of the plot. A value of more than 50% is considered a useful interpretation of the results (Clarke and Gorley 2006).

Hierarchical classification was used to investigate trends in the community structure of algae, diatoms, aquatic invertebrates and riparian vegetation. The Bray-Curtis coefficient calculated similarities between sites, with classification based on the group-average linking algorithm, considered suitable for biological data. The results of the hierarchical classification are presented in the form of a dendrogram (link-tree), showing the percentage similarity between sites (higher values represent greater similarity), based on the riparian vegetation assemblage (Clarke and Warwick 2001).



4. Results and Discussion

4.1 Water Quality

Ephemeral salt lakes are common throughout the inland regions of Australia and often exhibit substantial fluctuations in their chemical and physical properties (Geddes *et al.* 1981; Williams 1967). They are primarily influenced by their filling and drying phases, referred to as the hydroperiod (Boulton and Brock 1999). During the initial stages of major flood events, salt lakes often display relatively homogenous water quality conditions, with salinity increasing as water level recedes due to evapoconcentration (McComb and Lake 1990). In comparison, peripheral wetlands on the margins of salt lakes are often characterised as freshwater (Timms *et al.* 2006). Variable and changing water quality affect the aquatic biota assemblage of inland waters, influencing species diversity and composition (Ghetti and Ravera 1994).

During the 2025 study, surface water pH was classified as alkaline at LR04_W (7.9) and RW01 (8.3), and neutral at LYG06 (7.4) (**Table 4-1**) (Foged 1978), which is considered characteristic of inland salt lakes throughout the Goldfields Region (Gregory 2008). In comparison, mean pH recorded during the rewetting trials of the 2019 and 2025 studies indicated that Lake Roe (7.6 and 8.3), peripheral wetlands (7.7), Lake Yindarlgooda (8.6) and regional wetlands (8.5 to 8.6) were alkaline, while Lake Yindana (7.1) was considered neutral (**Appendix B**). When inundated, pH varies according to factors such as surface runoff (which may be poorly buffered), the presence of organic matter, and local catchment geology (Boulton and Brock 1999; Smith *et al.* 2004). Biological processes including photosynthesis and respiration also influence pH (Reddy and DeLaune 2008).

During the 2025 study, the salinity (measured as electrical conductivity; EC) of surface waters was classified as hypersaline (>70,000 $\mu\text{S/cm}$) at Lake Roe (162,000 $\mu\text{S/cm}$) and Lake Yindarlgooda (182,000 $\mu\text{S/cm}$) (**Table 4-1**) (Hammer 1986). In contrast, the salinity of regional wetland RW01 was substantially lower (22,800 $\mu\text{S/cm}$), classified as mesosaline, possibly due to the high level of inundation at this site, which was largely flooded. Over the course of the 2019 and 2025 rewetting trials, salinity was highly variable, ranging from hyposaline to hypersaline at Lake Roe (11,460 $\mu\text{S/cm}$ to 91,100 $\mu\text{S/cm}$), the peripheral wetlands (16,470 $\mu\text{S/cm}$ to 77,600 $\mu\text{S/cm}$) and the regional wetlands (6,442 $\mu\text{S/cm}$ to 98,500 $\mu\text{S/cm}$). In contrast a slightly narrower range was recorded at Lake Yindarlgooda (11,130 $\mu\text{S/cm}$ to 66,700 $\mu\text{S/cm}$) and Lake Yindana (10,210 $\mu\text{S/cm}$ to 63,900 $\mu\text{S/cm}$), classified as hyposaline to mesosaline (30,000 to 70,000 $\mu\text{S/cm}$) (**Appendix B**).

These results suggest that during a major flood event, the water quality of Lake Roe, the peripheral wetlands, Lake Yindarlgooda, regional wetlands and Lake Yindana is likely to be alkaline, with a salinity ranging from hyposaline at the onset of flooding, increasing to hypersaline (>70,000 $\mu\text{S/cm}$) as the hydroperiod progresses. While salt lakes in the Goldfields are subject to highly variable water quality conditions over the course of the hydroperiod, they generally exhibit a low salinity phase after major rainfall events that result in flooding. This initiates the emergence of aquatic biota and creates a productive biological community, which shifts to a more salt tolerant assemblage as salinity increases over time (Taukulis 2016; Taukulis *et al.* 2014).

During the field survey, the dominance of anions in the surface water at Lake Roe, Lake Yindarlgooda and the regional wetland followed $\text{Cl} > \text{SO}_4 > \text{HCO}_3$, while cations followed $\text{Na} > \text{Mg} > \text{Ca} > \text{K}$ within the lakes and $\text{Na} > \text{Ca} > \text{Mg} > \text{K}$ in the regional wetland (**Table 4-1**). The dominance patterns were considered typical of inland waterbodies in Western Australia (Gregory 2008; Hart and McKelvie 1986), with the dominance of minor cations (Ca, Mg) often interchangeable, and is likely a reflection of differing local geology across the sites affecting minor ionic constituents (Chakrapani 2002; Gorham 1961).

The concentration of total nitrogen was substantially higher than total phosphorous during the 2025 study at each site, considered typical of inland waters (**Table 4-1**) (Gregory 2008). Total nitrogen was highest at the Lake Yindarlgooda site LYG06 (4.9 mg/L) compared to Lake Roe site LR04_W (1.2 mg/L) and regional wetland site RW01 (1 mg/L), which were similar (**Table 4-1**). This trend was also observed for the concentration of nitrogenous compounds (NO_2 and NO_3) and total phosphorus and was likely associated with the release of nutrients from newly-wetted sediment and/or allochthonous input of organic material from riparian vegetation (Boulton and Brock 1999; Wetzel 2001).

The concentrations of metals recorded during the 2025 study were below the ANZG (2018) DGVs for marine water, with many also below the level of analytical detection (limit of reporting; LOR) (**Table 4-1**). However, it should be noted that LORs for several parameters including cadmium and copper were above the respective ANZG (2018) DGVs (**Table 4-1**). In comparison to the ANZG (2018) DGVs several exceedances were detected, summarised as follows:

- cadmium; Lake Yindarlgooda site LYG06 (0.0084 mg/L), 1.5x the ANZG (2018) DGV (0.0007 mg/L);



- copper; Lake Yindarlgooda site LYG06 (0.007 mg/L) and regional wetland site RW01 (0.002 mg/L), 5.4x and 1.5x the ANZG (2018) DGV (0.0013 mg/L), respectively.

The solubility of metals in surface waters is highly variable, dependent on factors such as pH, reduction-oxidation potential, and the availability of organic matter (Reddy and DeLaune 2008).



Table 4-1: Surface water quality from Lake Roe, Lake Yindarlgooda and regional wetlands during the 2025 study.

Water Quality Parameters		Lake Roe	Lake Yindarlgooda	Regional Wetlands	ANZG (2018) DGV 95% Marine
		LR04_W	LYG06	RW01	
Basic and Nutrients	pH (unit)	7.9	7.4	8.3	-
	Electrical Conductivity (µS/cm)	162,000	182,000	22,800	-
	Total Dissolved Solids	144,000	163,000	14,100	-
	Total Nitrogen	1.2	4.9	1	-
	Total Phosphorus	<0.05	0.68	0.04	-
	Total Kjeldahl Nitrogen	1.2	2.6	1	-
	Nitrite + Nitrate	<0.01	2.32	<0.01	-
Anions and Cations	Chloride	69,700	81,900	6,820	-
	Sulfate	8,600	8,670	1,610	-
	Bicarbonate	76	88	50	-
	Carbonate	<1	<1	<1	-
	Hydroxide	<1	<1	<1	-
	Sodium	46,300	55,900	3,820	-
	Calcium	1,770	1,700	558	-
	Magnesium	4,020	4,710	408	-
	Potassium	585	653	64	-
Metals and Trace Elements	Aluminium	<0.025	<0.025	<0.005	-
	Arsenic	0.0034	0.005	0.001	-
	Barium	0.149	0.151	0.052	-
	Beryllium	<0.0005	<0.0005	<0.0001	-
	Cadmium	<0.001	0.0084	<0.0002	0.0055
	Chromium	<0.0025	<0.0025	<0.0025	0.0044
	Cobalt	<0.001	<0.001	0.0003	0.001
	Copper	<0.005	0.007	0.002	0.0013
	Iron	<0.025	<0.025	<0.005	-
	Lead	<0.001	<0.001	<0.0002	0.0044
	Manganese	0.0068	0.0169	0.0005	-
	Mercury	<0.0005	<0.0005	<0.0001	0.0004
	Nickel	0.0053	0.0075	0.0021	0.07
	Selenium	<0.01	<0.01	<0.002	-
	Silicon	<0.002	<0.002	0.0027	-
	Vanadium	<0.0025	<0.0025	0.003	0.1
Zinc	<0.025	<0.025	<0.005	0.015	

Note: Units are in mg/L unless stated; red shading indicates exceedance of the ANZG (2018) DGV.



4.2 Sediment Quality

Lake sediment properties vary laterally and vertically (McKenzie *et al.* 2004), in association with changes in the hydroperiod of salt lakes throughout Australia (Boulton and Brock 1999; McComb and Qui 1998). Due to their temporary nature, lake sediment is also often the only medium available for analysis (Gregory 2008), which may provide an indication of conditions expected during flooding. In larger salt lakes, sediment quality may also be particularly heterogeneous (Simpson *et al.* 2005), due to differences in geomorphology and hydrogeochemical processes across the playa (URS 2013). Lake sediment also supports microorganisms (Pulford and Flowers 2006) and the dormant eggs and spores of aquatic biota (Boulton and Brock 1999), which contribute to the recovery and increased productivity of ephemeral wetlands during major flood events.

Sediment pH at Lake Roe in 2019 ranged from strongly acidic (4.7 at LR09) to moderately alkaline (8.0 at LR04 and LR12) (Hazelton and Murphy 2007), whereas in 2025, conditions were more uniform ranging from slightly acidic (6.5 at LR06) to moderately alkaline (7.9 at LR04_W) (**Table 4-2; Figure 4-1A**). These fluctuations in sediment pH are most likely related to changes in the hydroperiod and subsequent hydrogeochemical reactions and microbial activity, as well as differences in the concentrations of carbonate and organic matter (Connell 2005; Reddy and DeLaune 2008). The pH of peripheral wetlands was comparable to Lake Roe and ranged from slightly acidic (6.4 at PW01) to moderately alkaline (8.0 at PW04). Sediment pH at LY01 (5.0) in Lake Yindana was comparable to LR06 and LR09, classified as strongly acidic, evident in the PCA (**Figure 4-3**). In contrast, sediment pH at Lake Yindarlgooda and the regional wetlands was higher (7.7 to 8.2) classified as mildly to moderately alkaline. Regardless, sediment pH during the 2019 and 2025 studies is considered characteristic of wetlands in the Coolgardie bioregion (Gregory 2008), with acidic conditions at LR06, LR09, PW01 and LY01 potentially related to interaction with acidic groundwater, which is associated with the southwestern section of the Yilgarn block (Commander 1999; Mann 1982).

Sediment salinity (measured in total soluble solids; TSS) was highly variable between sites at Lake Roe, ranging from 56,600 mg/kg (LR13) to 104,000 mg/kg (LR06) in 2019 and 42,800 mg/kg (LR04_W) to 105,000 mg/kg (LR06) in 2025 (**Table 4-2; Figure 4-1B**), although average salinity was broadly similar between the two studies (79,354 mg/kg and 72,425 mg/kg, respectively) (**Table 4-2**). Sites located adjacent to inflows (LR11 and LR13), or which held surface water in 2019 (LR17) or 2025 (LR04_W) had comparatively lower salinities (<65,000 mg/kg) (**Table 4-3; Figure 4-1B**), likely attributed to sediment flushing following rainfall and dilution of salts from inundation. In contrast, sites LR06 and LR10 were the most saline ($\geq 100,000$ mg/kg) in 2019 and 2025, and were located within narrow and constrained embayments in the eastern and southern sections of the lake, which may represent areas of natural salt accumulation.

A narrower salinity range was recorded at Lake Yindarlgooda and Lake Yindana; 53,500 mg/kg (LYG06) to 69,400 mg/kg (LYG01) (**Table 4-2**), and salinity was typically lower than most Lake Roe sites, a trend reflected in the PCA (**Figure 4-3**). In contrast, salinity was typically higher at the peripheral wetlands (89,600 mg/kg to 137,000 mg/kg) and the regional wetlands (18,600 mg/kg to 107,000 mg/kg), with substantially higher salinity (>110,000 mg/kg) recorded at PW03 and PW04 (**Table 4-4; Figure 4-1B**), also evident in the PCA (**Figure 4-3**). Regional wetland RW01 was the exception which recorded low sediment salinity (<19,000 mg/kg), likely related to substantial inundation leading to dilution of salts in the sediments. The spatial heterogeneity observed in the sediment salinity throughout the lakes and wetlands is typical of the Goldfields (Gregory 2008), and can be attributed to differences in bathymetry and local geomorphological processes.

During the 2019 and 2025 studies, surface sediment at most Lake Roe, peripheral wetland, Lake Yindarlgooda, regional wetland and Lake Yindana sites was characterised by a thin speckled salt crust. Exceptions included two Lake Roe sites (LR07 and LR09) and two peripheral wetlands (PW01 and PW04) during the 2019 study, which recorded a thin intact salt crust up to 5 mm thick at LR09 and PW01. The salt crust was present at sites located in the eastern area of the lake, reflecting the accumulation of salts from catchment runoff and evapoconcentration over time (Boulton and Brock 1999). However, high rainfall prior in the 2025 study likely resulted in the dissolution and dissipation of salts on the playa of Lake Roe, which is a natural part of the hydrological regime associated with inland waters in WA (McComb and Lake 1990).

During the 2019 study the dominant cation in the sediment was Na throughout the Lake Roe and peripheral wetland sites, while the dominance of the minor cations (Ca, Mg and K) was interchangeable (**Table 4-3**). While Na was the dominant cation at several Lake Roe sites (LR03, LR04_W, LR05 and LR11) and one Lake Yindarlgooda site (LYG01) in 2025, Ca was prevalent at four Lake Roe sites (LR06, LR07, LR09 and LR10), two Lake Yindarlgooda sites (LY03 and LY06), three regional wetlands (RW02 and RW04) and Lake Yindana (LY01), with Mg dominant at the regional wetland RW01 (**Table 4-3; Table 4-4**). Although Ca and Mg are usually considered a minor ionic constituent, this change is likely to represent localised mineralisation and weathering (De Deckker 1983). In contrast, anions tended to followed a more uniform $\text{Cl} > \text{SO}_4 > \text{HCO}_3$ at all sites in 2019 and 2025 (**Table 4-3; Table 4-4**), considered typical of inland waterbodies in



Western Australia (Gregory 2008; Hart and McKelvie 1986), with the exception of regional wetland site RW01, where SO₄ was dominant (**Table 4-4**).

Total nitrogen (TN) was greater than total phosphorus (TP) in the sediment at the majority of sites across the 2019 and 2025 studies (**Table 4-3; Table 4-4**). There was also a high degree of variability in TN and TP concentrations between the sites. The former ranged from 80 mg/kg (LR03 in 2025) to 1,610 mg/kg (PW04), while the latter ranged from 19 mg/kg (LR07 in 2025) to 386 mg/kg (LR05 in 2019), respectively (**Figure 4-1C,D**). In Lake Roe, TN concentrations ranged from 140 mg/kg (LR11) to 630 mg/kg (LR10) and TP ranged from 60 mg/kg (LR07) to 386 mg/kg (LR05) in 2019. In 2025, TN and TP had mostly decreased, ranging from 80 mg/kg (LR03) to 1,190 mg/kg (LR10) and 19 mg/kg (LR07) to 223 mg/kg (LR06), respectively, a trend also evident on the PCA (**Figure 4-3**). Nutrient concentrations in the sediment of salt lakes varies in response to changes in the hydroperiod and mineralisation of organic matter by microbes (Boulton and Brock 1999). Nutrient concentrations were more homogenous across Lake Yindarlgooda and Lake Yindana sites, with TN ranging from 141 mg/kg (LYG03) to 230 mg/kg (LYG01), and TP ranging from 53 mg/kg (LY01) to 138 mg/kg (LYG03) (**Table 4-2, Figure 4-1C,D**) likely attributable to the lower number of sites sampled. However overall, average TN and TP concentrations were largely comparable between the three lakes (**Table 4-2**).

Overall, mean TN and TP concentrations were higher in the peripheral wetlands (835 mg/kg and 212 mg/kg, respectively) and regional wetlands (653 mg/kg and 203 mg/kg, respectively), compared to Lake Roe, Lake Yindarlgooda and Lake Yindana (**Table 4-2**), with elevated TN (>1,300 mg/kg) at PW03 and PW04 (**Figure 4-1C**), evident in the PCA (**Figure 4-3**). The higher concentrations in peripheral wetlands and regional wetlands may reflect increased allochthonous inputs of organic matter from riparian vegetation (supported by higher total organic carbon concentrations) (**Figure 4-2A**). In addition, the peripheral wetlands and regional wetlands may support a higher diversity of algae and aquatic invertebrates during flooded conditions, contributing to nutrients within the sediment due to the boom bust ecology of temporary inland waters (Boulton and Brock 1999).

The concentrations of several metals and trace elements, including beryllium, cadmium and mercury, were below the analytical limits of reporting (LORs) at most sites during the 2019 and 2025 studies (**Table 4-3; Table 4-4**). Overall, the majority of metal concentrations across Lake Roe, peripheral wetlands, Lake Yindarlgooda, regional wetlands and Lake Yindana were below the ANZG (2018) DGVs (**Table 4-3; Table 4-4**). Chromium was an exception, which exceeded the ANZG (2018) DGV (80 mg/kg) at most sites, including Lake Roe (nine sites in 2019 and four sites in 2025), peripheral wetlands (three sites), Lake Yindarlgooda (three sites) and regional wetlands (three sites) (**Figure 4-2B**). The highest concentration was recorded at LYG01 (224 mg/kg), located on the northern margin of Lake Yindarlgooda, which was almost three times the DGV (**Figure 4-2B**). Comparatively higher concentrations (>150 mg/kg) were also recorded at LR02 (172 mg/kg) and LR12 (161 mg/kg) on the western side of Lake Roe, and RW01 (162 mg/kg), a regional wetland located between Lake Yindarlgooda and Lake Roe, which were more than twice the DGV.

In addition, nickel also exceeded the ANZG (2018) DGV at most sites and the DGV-High at several northern Lake Roe sites, including LR03 (54.6 mg/kg), LR05 (73.3 mg/kg) and LR11 (53 mg/kg) in 2019 and LR06 (55 mg/kg) in 2025, as well as the regional wetlands RW01 (54 mg/kg) and RW04 (65 mg/kg), which at the maximum was more than 1.4 times the ISQG-High trigger value (52 mg/kg) (**Figure 4-2C**). In contrast, sites located along the eastern and southern sections of Lake Roe (LR07, LR08, LR09 and LR10) typically recorded comparatively lower concentrations of metals, including aluminium, barium, chromium, cobalt, copper, manganese and zinc (**Table 4-3**), also supported by the PCA (**Figure 4-4**). Concentrations of these metals were also comparatively low at sites located along the southern margins of Lake Yindana (LY01) and Lake Yindarlgooda (LYG03).

Spatial variations in metals are consistent with many inland salt lakes throughout Western Australia, which can be attributed to natural catchment mineralisation (Gregory 2008). Further, salt lakes in the Goldfields are often enriched with metals including chromium and nickel, attributed to natural mineralisation within their catchments (Förstner 1977; Gregory 2008) and therefore is unlikely to pose a toxicity risk to the aquatic biota that have evolved to cope with these conditions (Metals Environmental Risk Assessment Guidance 2007).



Table 4-2: Minimum, maximum and average sediment quality values at Lake Roe, peripheral wetlands, Lake Yindarlgooda, regional wetlands and Lake Yindana during the 2019 and 2025 studies.

Sediment Quality Parameters		Lake Roe						Peripheral Wetlands			Lake Yindarlgooda			Regional Wetlands			Lake Yindana
		2019			2025			2019			2025			2025			2025
		Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	LY01
Basic and Nutrients	pH (unit)	4.7	7.3	8.0	6.5	7.1	7.9	6.4	7.2	8.0	7.7	7.9	8.2	7.8	7.9	8.0	5.0
	Total Soluble Salts	56,600	79,354	104,000	42,800	72,425	105,000	89,600	110,900	137,000	53,500	62,333	69,400	18,600	67,533	107,000	56,700
	Moisture Content (%)	16.9	23.8	31.8	15.2	24.5	32.5	23.8	32.3	42	17.1	20.4	24.8	25.8	29.7	33.5	19.2
	Total Nitrogen	140	397	630	80	373	1,190	100	835	1,610	110	177	230	550	653	800	120
	Total Phosphorus	60	173	386	19	117	223	176	212	253	104	117	138	133	203	306	53
	Total Organic Carbon (%)	0.02	0.16	0.54	0.05	0.16	0.36	0.15	0.50	0.94	0.08	0.10	0.12	0.34	0.42	0.46	0.16
	Total Kjeldahl Nitrogen	140	397	630	80	373	1,190	100	835	1,610	110	177	230	550	650	800	120
	Nitrite + Nitrate	<0.1	0.2	1.1	<0.1	0.4	1.4	<0.1	<0.1	<0.1	0.1	0.2	0.2	0.1	2.9	8.4	0.2
Anions and Cations	Sodium	23,600	31,569	45,500	17,300	31,900	55,000	33,800	52,350	76,600	21,600	23,500	26,000	7,380	31,093	50,400	20,600
	Calcium	750	4,387	8,730	800	64,385	173,000	1,700	7,357	11,900	4,270	31,790	62,900	14,000	59,866	94,600	83,500
	Magnesium	1,800	3,721	6,020	3,890	8,196	13,700	2,960	5,987	7,940	7,550	9,317	10,300	15,200	16,767	17,600	3,140
	Potassium	260	428	710	1,120	3,294	6,880	430	795	1,160	1,320	1,607	1,990	2,860	5,037	6,710	1,580
	Chloride	41,400	54,615	73,300	24,000	46,775	78,000	55,000	86,350	121,000	29,700	35,966	39,600	6,720	46,373	83,600	29,400
	Sulfate	6,950	17,495	32,600	9,330	21,117	33,900	16,600	28,625	37,500	8,250	15,683	21,000	14,200	23,667	35,800	18,500
Metals and Trace Elements	Aluminium	2,380	12,015	23,000	2,940	10,870	19,600	6,910	13,378	18,000	5,110	6,943	8,380	12,100	18,333	23,800	7,330
	Arsenic	<1	4.25	13.3	<5	<5	<5	2.44	3.46	4.69	5	7.67	12	<5	7.5	14	<5
	Barium	10	84	180	<10	44	110	30	42.5	60	30	63	80	20	70	120	20
	Beryllium	<1	<1	2	<1	1.3	4	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Cadmium	<0.1	<0.1	<0.1	<1	<1	<1	<0.1	<0.1	0.2	<1	<1	<1	<1	<1	<1	<1
	Chromium	12	98	172	23	73	110	72	99	127	108	158	224	114	132	162	35
	Cobalt	1.1	14.6	61.4	<2	23.3	63	10.6	18.6	27.7	6	8.7	12	13	16	21	<2
	Copper	2.9	20.0	33.5	<5	19.7	36	17.8	27.7	52	11	19.3	25	34	42.7	59	8
	Iron	3,160	34,450	64,000	4,490	26,899	46,100	20,400	39,900	78,000	21,300	36,733	56,400	35,900	43,067	53,100	13,200
	Lead	<1	6.0	16.8	<5	<5	9	2.6	8.1	16.3	<5	<5	6	<5	6.8	9	<5
	Manganese	27	462	2,140	39	446	1,390	107	301	414	231	381	571	548	554	563	20
	Mercury	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Nickel	4.4	33.4	73.3	7	32	55	25.9	39.4	51.9	30	34.3	39	51	56.7	65	7
	Selenium	0.1	0.3	0.6	<5	<5	<5	0.1	0.3	0.4	<5	<5	<5	<5	<5	<5	<5
	Silicon	3	11	20	5	13	25	5	10	16	7	7	7	10	13	18	7
Vanadium	8.8	90.1	167	15	63.6	124	46	100.1	197	44	77.3	130	78	90.3	97	28	
Zinc	4.8	24.1	44.9	6	15.4	24	21.6	28.8	38.1	17	24.7	39	31	40.3	47	<5	

Note: units are mg/kg unless stated.



Table 4-3: Summary of analytical results for sediment quality at Lake Roe during the 2019 and 2025 studies.

Sediment Quality Parameters		2019												2025									
		LR01	LR02	LR03	LR04	LR05	LR06	LR07	LR08	LR09	LR10	LR11	LR12	LR13	LR03	LR04_W	LR05	LR06	LR07	LR09	LR10	LR11	
Basic and Nutrients	pH (unit)	7.8	7.7	7.3	8	7.5	5.4	7.6	7.8	4.7	7.7	7.9	8	7.4	6.8	7.9	6.6	6.5	6.9	6.9	7.5	7.8	
	TSS	91,500	70,200	69,200	74,000	96,200	104,000	58,900	82,200	77,200	100,000	63,300	88,300	56,600	60,200	42,800	83,500	105,000	60,000	70,100	103,000	54,800	
	MC (%)	25.8	22.6	19	21.2	27.9	31.8	26.5	29.3	20.6	29	19.4	19.5	16.9	15.2	19.7	22.9	32.2	26.6	32.5	30.3	16.3	
	TN	570	400	290	210	450	430	270	570	400	630	140	480	320	80	140	250	650	330	240	1190	100	
	TP	248	159	223	177	386	262	60	69	124	120	95	151	171	154	54	175	223	19	87	122	98	
	TOC (%)	0.18	0.05	0.07	0.02	0.12	0.21	0.04	0.08	0.23	0.54	0.05	0.26	0.23	0.08	0.07	0.16	0.29	0.05	0.19	0.36	0.09	
	TKN	570	400	290	210	450	430	270	570	400	630	140	480	320	80	140	250	650	330	240	1190	100	
	NO _x	0.4	<0.1	0.1	<0.1	1.1	<0.1	<0.1	<0.1	0.1	<0.1	0.3	<0.1	<0.1	0.2	<0.1	0.8	<0.1	0.2	0.2	<0.1	1.4	
Anions and Cations	Na	34,800	26,200	26,600	28,700	42,700	44,200	23,600	31,100	25,500	45,500	24,200	33,600	23,700	20,300	17,300	37,100	50,100	22,700	30,800	55,000	21,900	
	Ca	3,260	4,340	750	1,480	3,850	8,590	7,480	8,390	950	8,730	850	7,070	1,300	1,100	2,680	24,900	76,600	173,000	130,000	106,000	800	
	Mg	5,550	3,570	3,640	2,870	4,060	6,020	1,800	3,050	3,140	4,160	3,440	3,660	3,410	5,150	3,890	8,410	13,700	4,720	6,500	12,300	10,900	
	K	430	370	280	400	600	710	260	420	420	570	280	530	300	1,520	2,320	5,290	6,880	1,120	2,680	3,290	3,250	
	Cl	62,400	46,900	48,100	50,500	72,200	73,300	41,400	53,000	45,600	73,200	43,800	57,600	42,000	40,200	24,000	58,100	78,000	32,800	48,700	56,000	36,400	
	SO ₄	16,400	18,100	8,180	10,000	19,100	32,600	20,400	24,700	6,950	29,300	8,850	24,000	8,860	10,900	9,330	33,100	33,900	18,700	27,100	26,300	9,610	
	HCO ₃	260	24	22	35	28	5	9	15	<1	14	36	25	6	NR	NR	NR	NR	NR	NR	NR	NR	
	CO ₃	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NR	NR	NR	NR	NR	NR	NR	NR	
Metals and Trace Elements	Al	18,300	8,160	10,300	12,600	23,000	22,600	2,630	2,380	22,100	6,650	10,600	10,200	6,670	6,970	8,260	17,400	19,600	2,940	12,400	7,590	11,800	
	As	4.14	5.96	5.23	4.03	6.15	4.72	<1.00	<1.00	1.47	1.32	3.69	4.18	13.3	<5	<5	<5	<5	<5	<5	<5	<5	
	Ba	40	110	50	150	80	40	10	<10	60	20	140	180	130	80	60	40	30	<10	10	20	110	
	Be	<1	<1	<1	<1	1	2	<1	<1	<1	<1	<1	<1	<1	<1	<1	4	<1	<1	2	<1	<1	
	B	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	<50	<50	<50	50	<50	<50	<50	<50	
	Cd	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<1	<1	<1	<1	<1	<1	<1	<1	
	Cr	118	172	140	98.8	109	94.4	22.2	12	56.7	46.4	105	161	144	110	88	75	86	23	35	57	106	
	Co	16.7	10.1	61.4	10.8	29.3	10.5	1.4	1.1	3.7	4	18.3	10.6	11.9	55	8	63	19	<2	23	5	12	
	Cu	33.5	23.8	26.9	17.4	31.7	22.9	3.4	2.9	15.8	7.8	26.6	22.3	24.7	24	14	36	30	<5	14	11	26	
	Fe	42,300	64,000	52,300	34,300	42,500	31,900	5,790	3,160	21,200	11,500	39,700	48,000	51,200	46,100	30,600	29,600	31,300	4,490	12,700	18,200	42,200	
	Pb	4.5	6.3	16.8	7.1	11.9	4	<1.0	<1.0	1.4	2.2	9.9	6	7	8	5	<5	9	<5	6	<5	<5	
	Mn	305	235	2,140	275	887	94	68	27	29	93	1,080	332	450	1,390	256	553	515	39	327	88	407	
	Hg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
	Ni	45.2	27.8	54.6	35.1	73.3	42.9	5.4	4.4	23.6	13.8	53	30.8	24.3	36	22	38	55	7	48	19	31	
	Se	0.4	0.4	0.6	0.3	0.6	0.6	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.4	<5	<5	<5	<5	<5	<5	<5	
	Si	13	7	13	9	20	16	5	3	15	7	12	7	11	11	7	25	20	5	19	8	12	
V	105	167	150	81	97.9	80.7	14.7	8.8	47	30.8	98.4	135	155	124	69	62	68	15	30	41	100		
Zn	44.9	20.1	24.6	31.4	43.2	26.6	5	4.8	10.2	13.7	28.6	32.6	27.3	11	15	17	24	6	13	14	23		

Note: Units are mg/kg unless stated; N/R indicates not recorded; yellow shading indicates exceedance of the ANZG (2018) DGV; red shading indicates exceedance of the ANZG (2018) GV-High value.



Table 4-4: Summary of analytical results for sediment quality at peripheral wetlands (■), Lake Yindarlgooda (■), regional wetlands (■) and Lake Yindana (■) during the 2019 and 2025 studies.

Sediment Quality Parameters	2019				2025							
	PW01	PW02	PW03	PW04	LYG01	LYG03	LYG06	RW01	RW02	RW04	LY01	
Basic and Nutrients	pH (unit)	6.4	7.6	6.8	8	8.2	7.8	7.7	8	7.8	8	5
	TSS	89,600	102,000	115,000	137,000	69,400	64,100	53,500	18,600	77,000	107,000	56,700
	MC (%)	23.8	32.5	30.8	42	17.1	19.4	24.8	29.9	25.8	33.5	19.2
	TN	270	100	1,360	1,610	230	110	190	550	610	800	120
	TP	185	176	253	235	104	108	138	306	170	133	53
	TOC (%)	0.27	0.15	0.94	0.63	0.12	0.11	0.08	0.34	0.45	0.46	0.16
	TKN	270	100	1,360	1,610	230	110	190	550	600	800	120
	NO _x	<0.1	<0.1	<0.1	<0.1	0.1	0.2	0.2	0.3	8.4	0.1	0.2
Anions and Cations	Na	33,800	47,900	51,100	76,600	22,900	26,000	21,600	7,380	35,500	50,400	20,600
	Ca	7,490	1,700	8,340	11,900	4,270	62,900	28,200	14,000	71,000	94,600	83,500
	Mg	2,960	6,830	7,940	6,220	10,300	7,550	10,100	17,500	15,200	17,600	3,140
	K	430	540	1,050	1,160	1,510	1,320	1,990	6,710	5,540	2,860	1,580
	Cl	55,000	82,300	87,100	121,000	38,600	39,600	29,700	6,720	48,800	83,600	29,400
	SO ₄	25,100	16,600	35,300	37,500	8,250	21,000	17,800	14,200	21,000	35,800	18,500
	HCO ₃	2	16	7	31	N/R	N/R	N/R	N/R	N/R	N/R	N/R
	CO ₃	<1	<1	<1	<1	N/R	N/R	N/R	N/R	N/R	N/R	N/R
Metals and Trace Elements	Al	17,100	6,910	18,000	11,500	7,340	5,110	8,380	23,800	19,100	12,100	7,330
	As	4.16	2.44	4.69	2.53	6	5	12	<5	6	14	<5
	Ba	60	30	50	30	80	30	80	70	120	20	20
	Be	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	B	N/R	N/R	N/R	N/R	<50	<50	<50	90	60	60	<50
	Cd	0.2	<0.1	<0.1	<0.1	<1	<1	<1	<1	<1	<1	<1
	Cr	112	127	84.2	72.1	224	108	142	162	114	121	35
	Co	19.6	27.7	10.6	16.4	8	6	12	14	13	21	<2
	Cu	21.2	52	19.8	17.8	22	11	25	35	34	59	8
	Fe	31,800	78,000	29,400	20,400	56,400	21,300	32,500	53,100	35,900	40,200	13,200
	Pb	16.3	2.6	6.7	6.7	6	<5	5	9	9	<5	<5
	Mn	295	386	107	414	340	231	571	563	552	548	20
	Hg	0.01	<0.01	0.01	<0.01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Ni	36.7	25.9	43.2	51.9	34	30	39	54	51	65	7
	Se	0.4	0.1	0.4	0.3	<5	<5	<5	<5	<5	<5	<5
	Si	9	16	9	5	7	7	7	18	10	12	7
V	94.7	197	62.9	46	130	44	58	97	78	96	28	
Zn	31.3	38.1	24	21.6	18	17	39	47	31	43	<5	

Note: Units are mg/kg unless stated; N/R indicates not recorded; yellow shading indicates exceedance of the ANZG (2018) DGV; red shading indicates exceedance of the ANZG (2018) GV-High value.

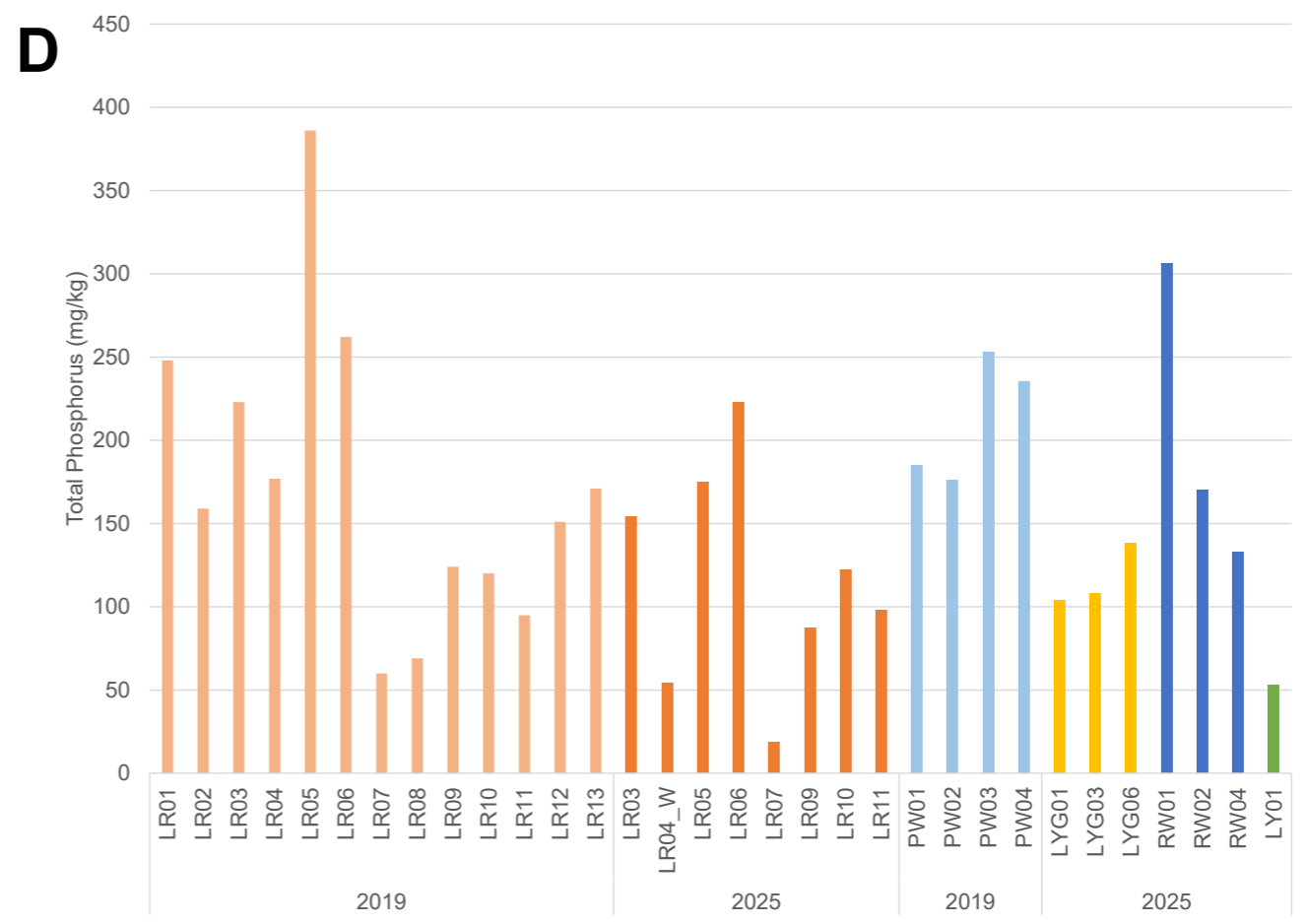
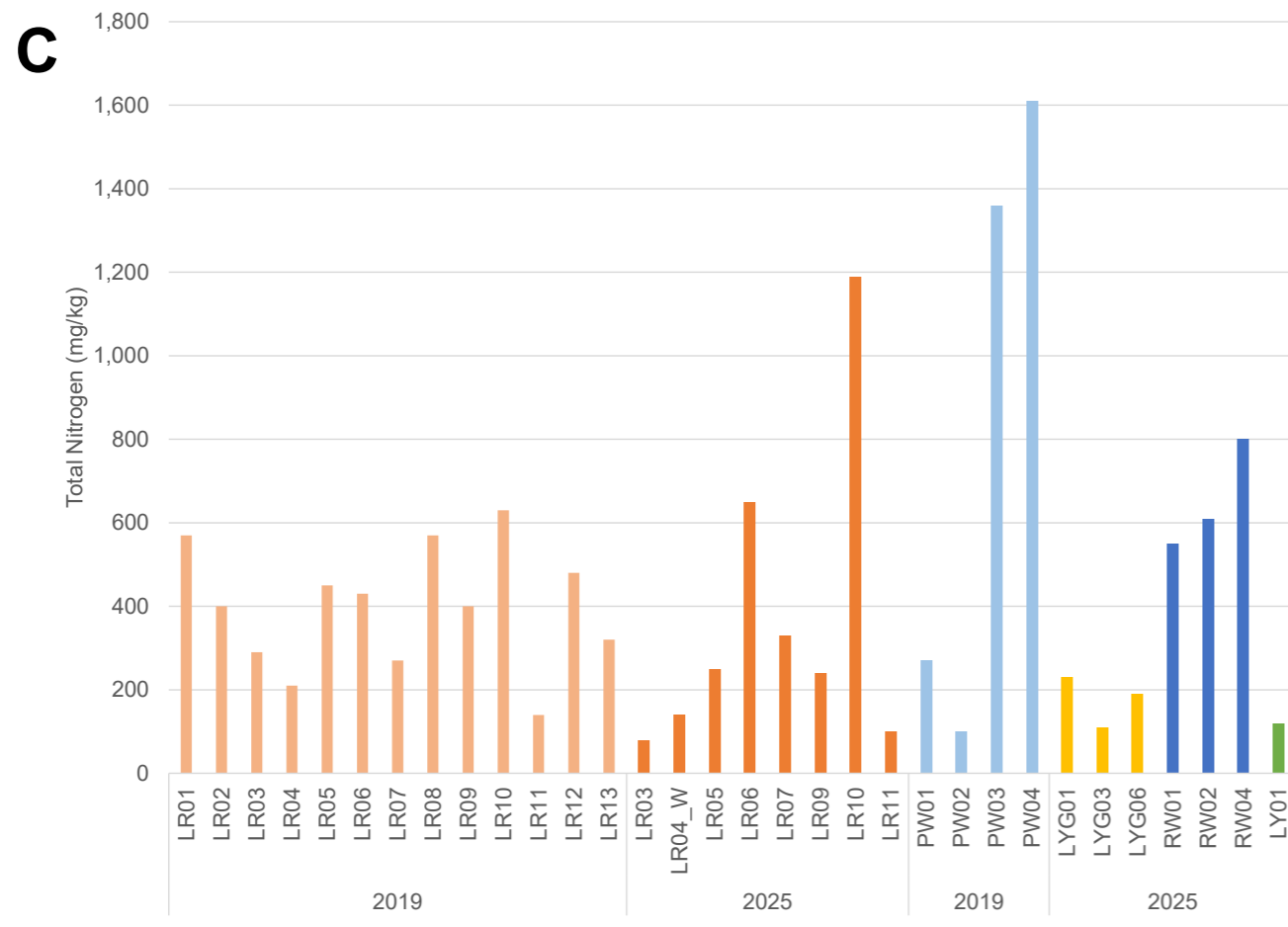
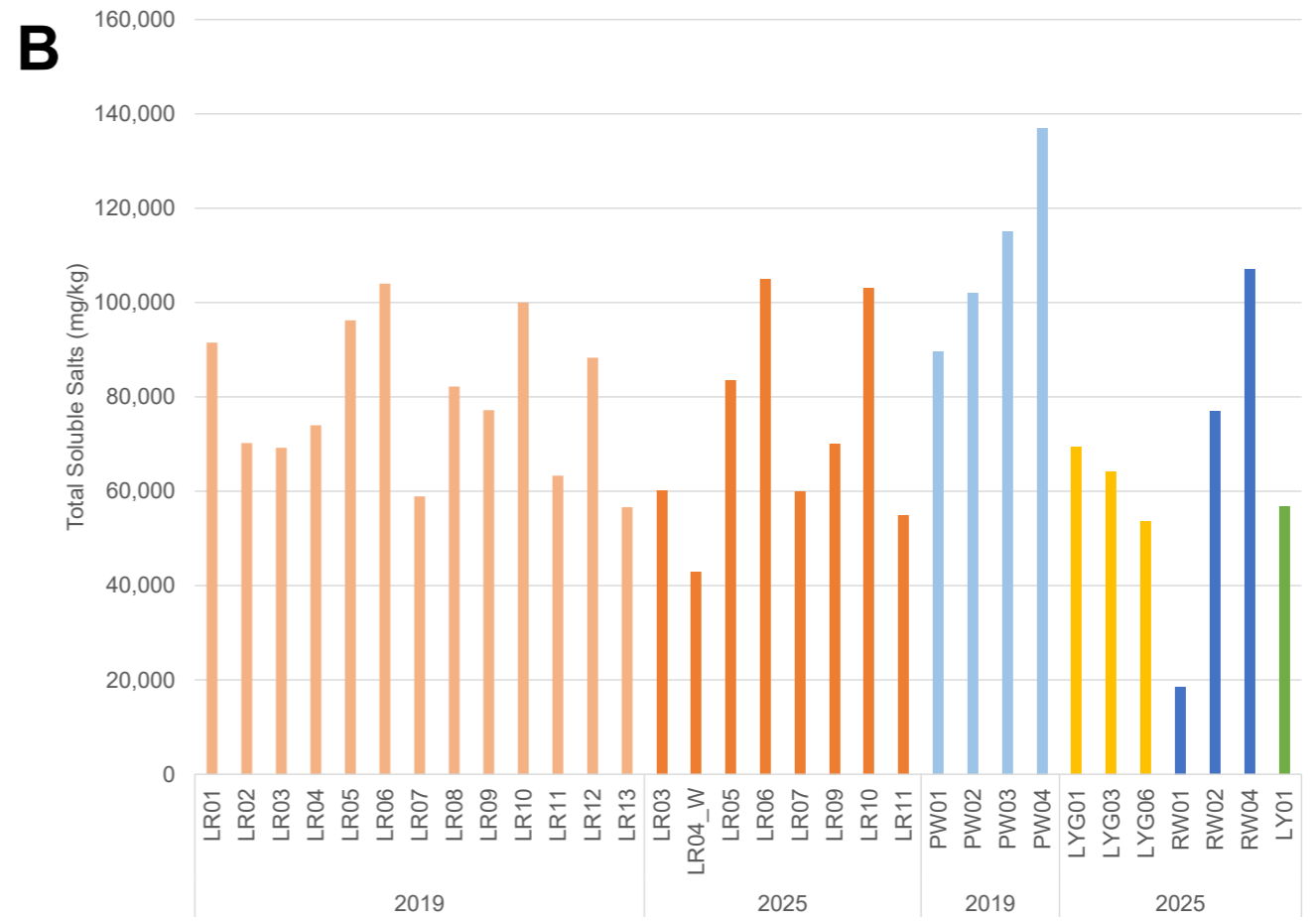
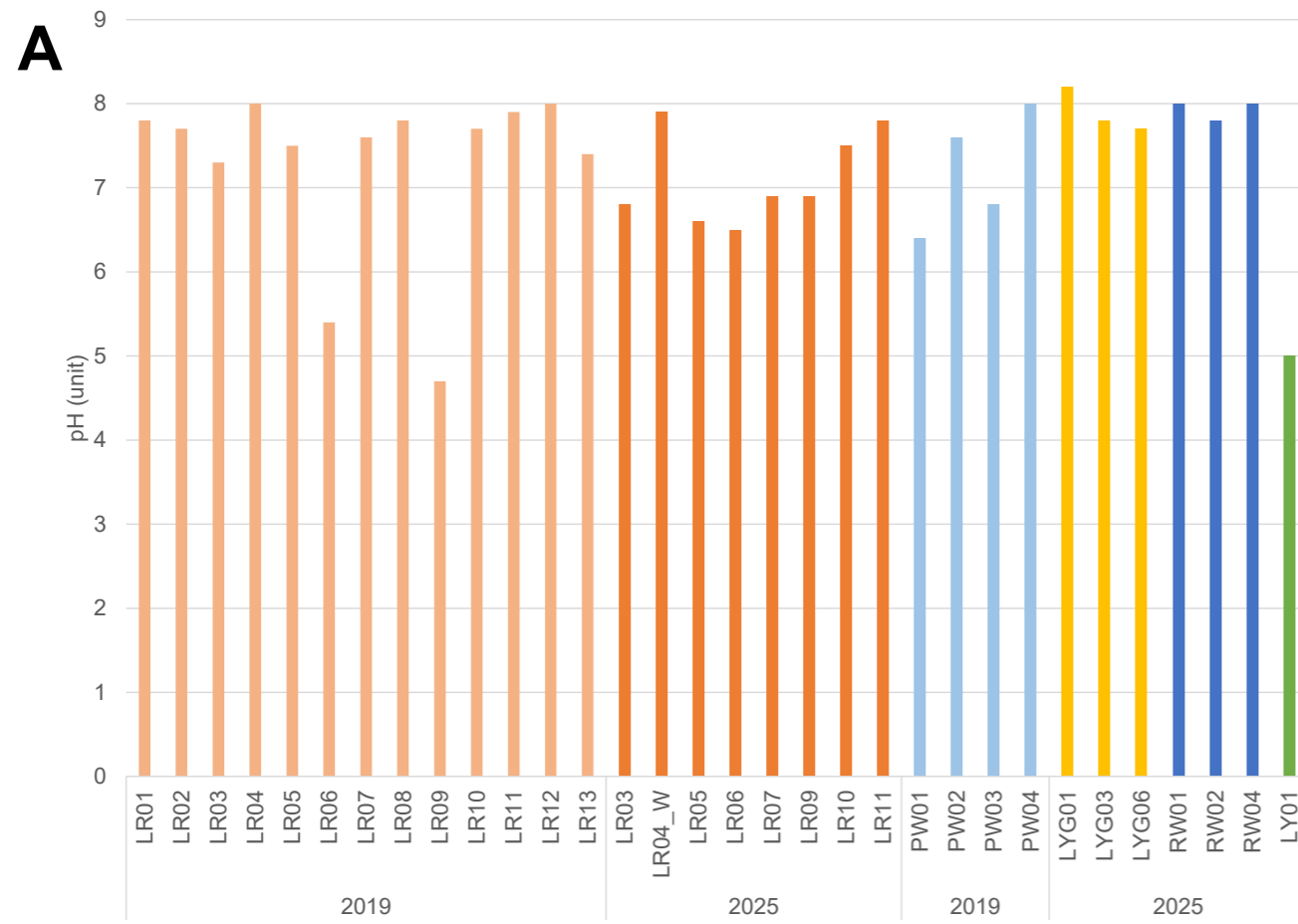


Figure 4-1: Sediment quality of Lake Roe (■, ■), peripheral wetlands (■), Lake Yindarlgooda (■), regional wetlands (■) and Lake Yindana (■) during the 2019 and 2025 studies; (A) pH, (B) salinity, (C) total nitrogen and (D) total phosphorous.



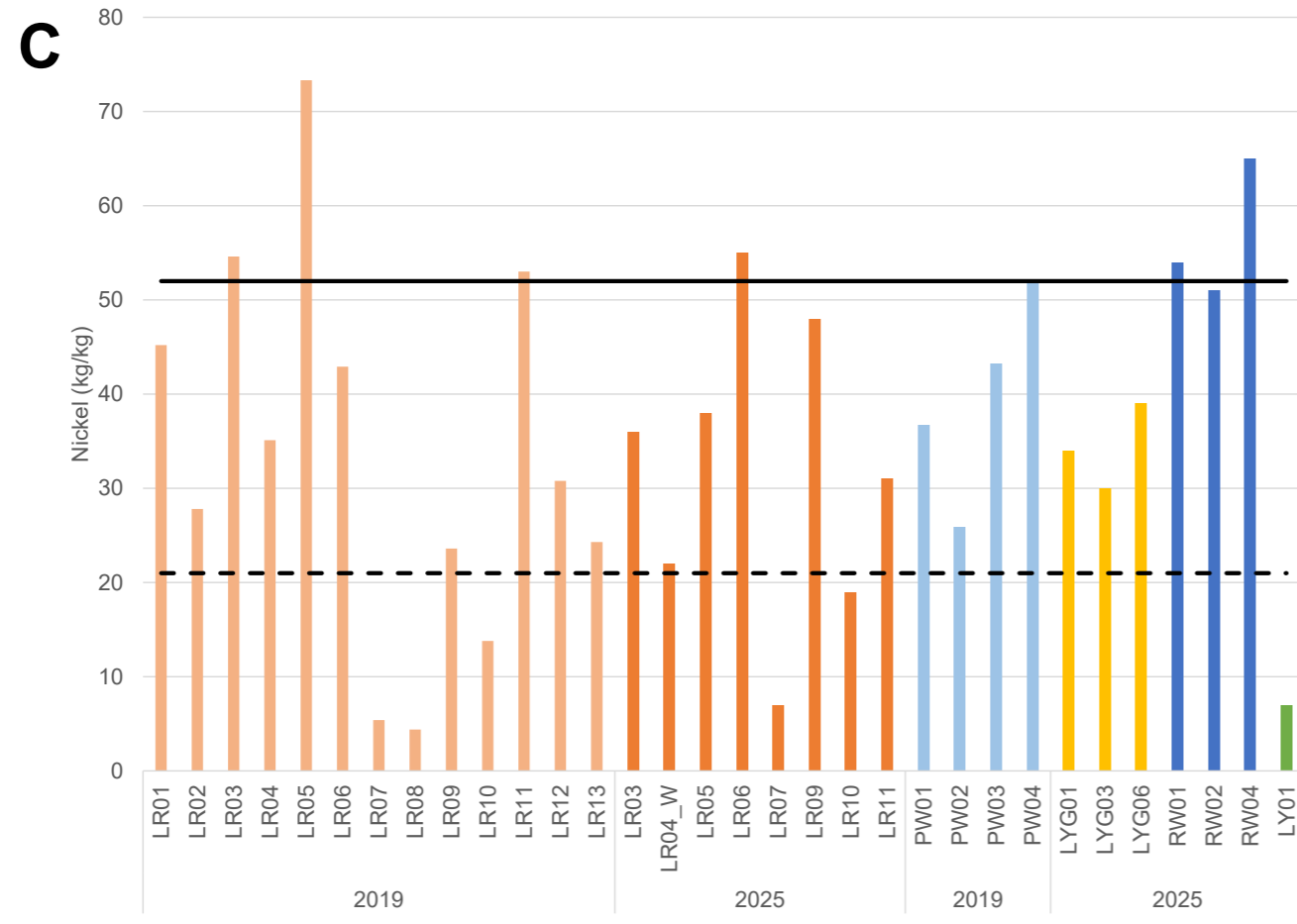
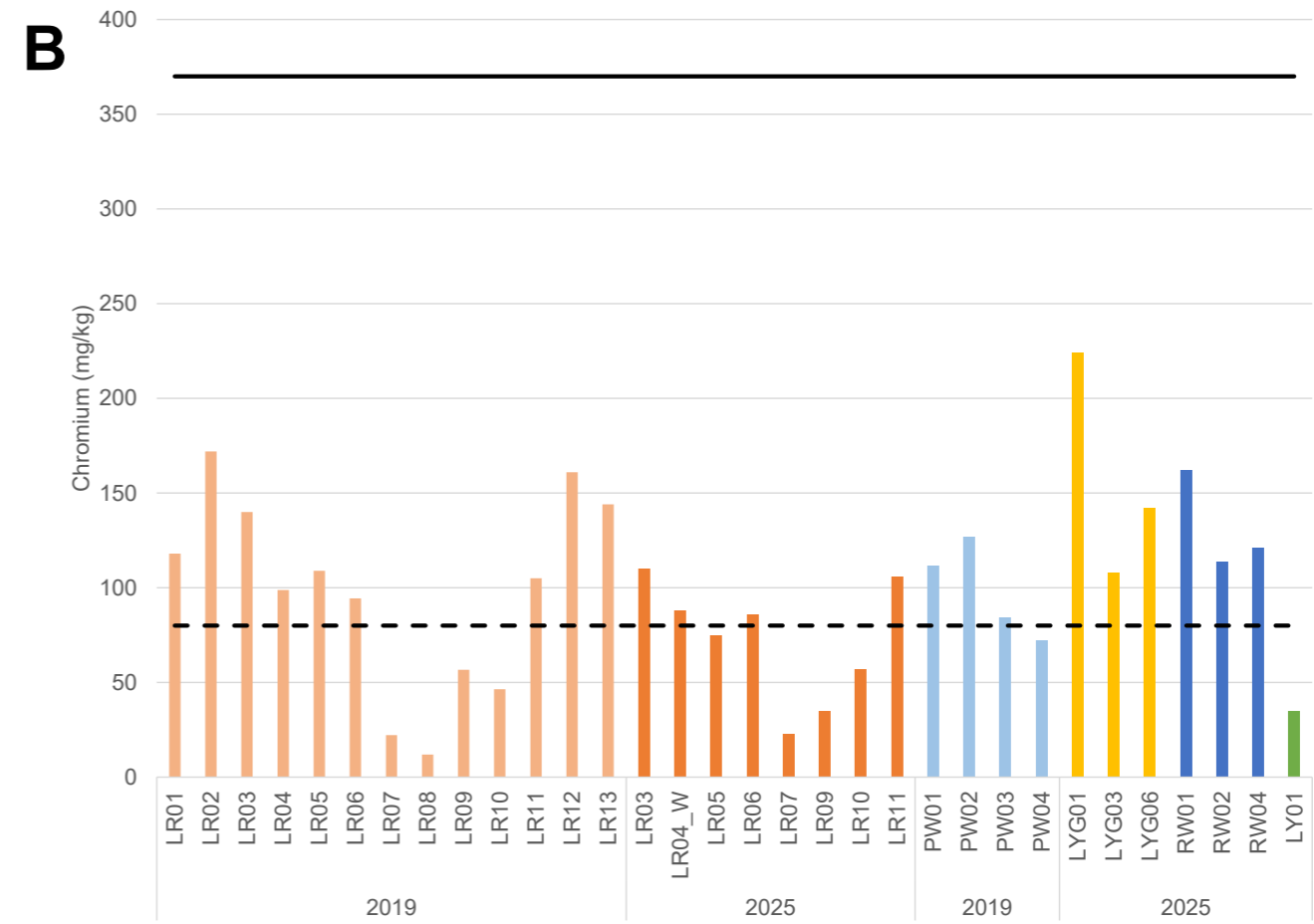
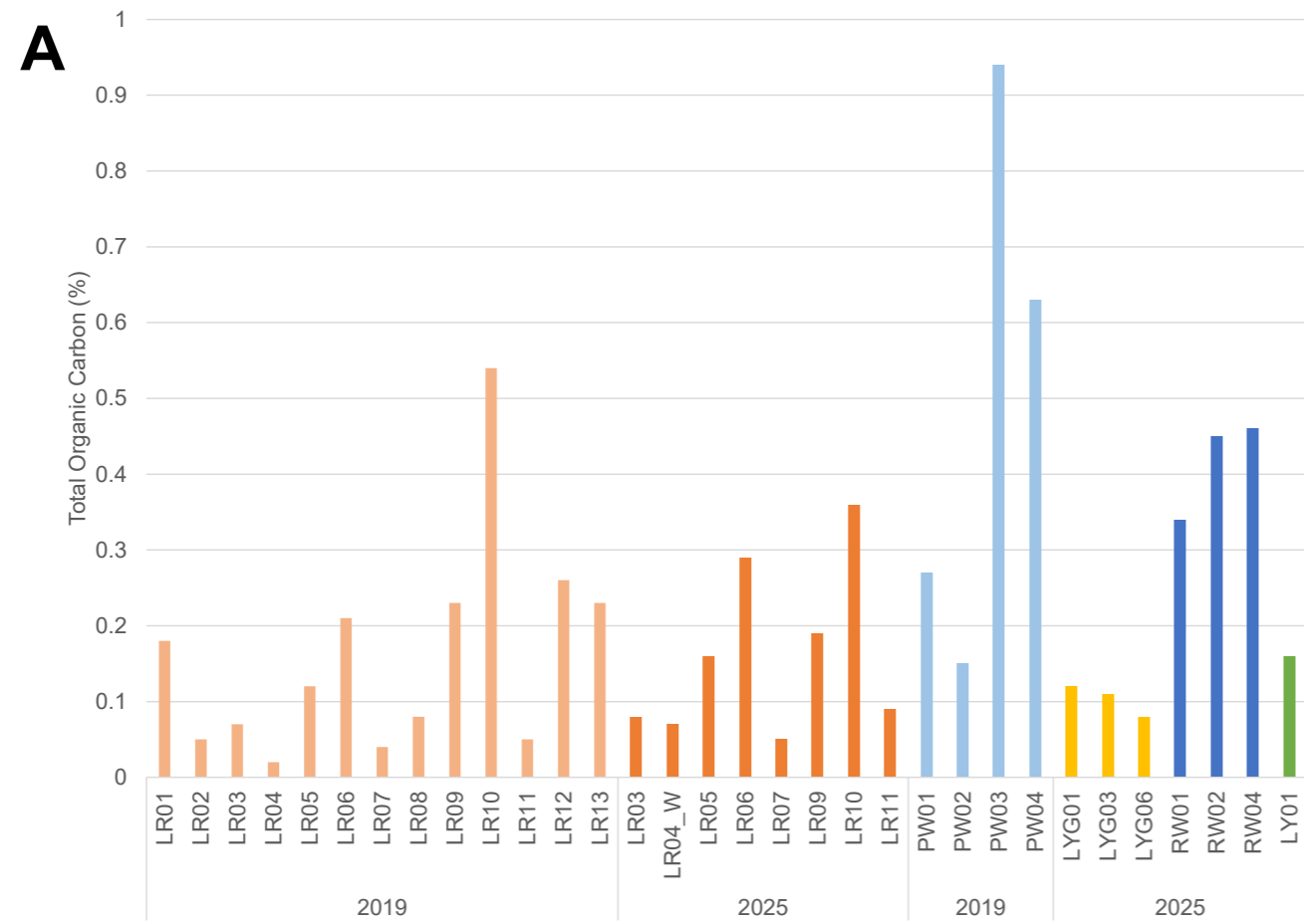


Figure 4-2: Sediment quality of Lake Roe (■, ■), peripheral wetlands (■), Lake Yindarlgooda (■), regional wetlands (■) and Lake Yindana (■) during the 2019 and 2025 studies; (A) total organic carbon, (B) chromium and (C) nickel.



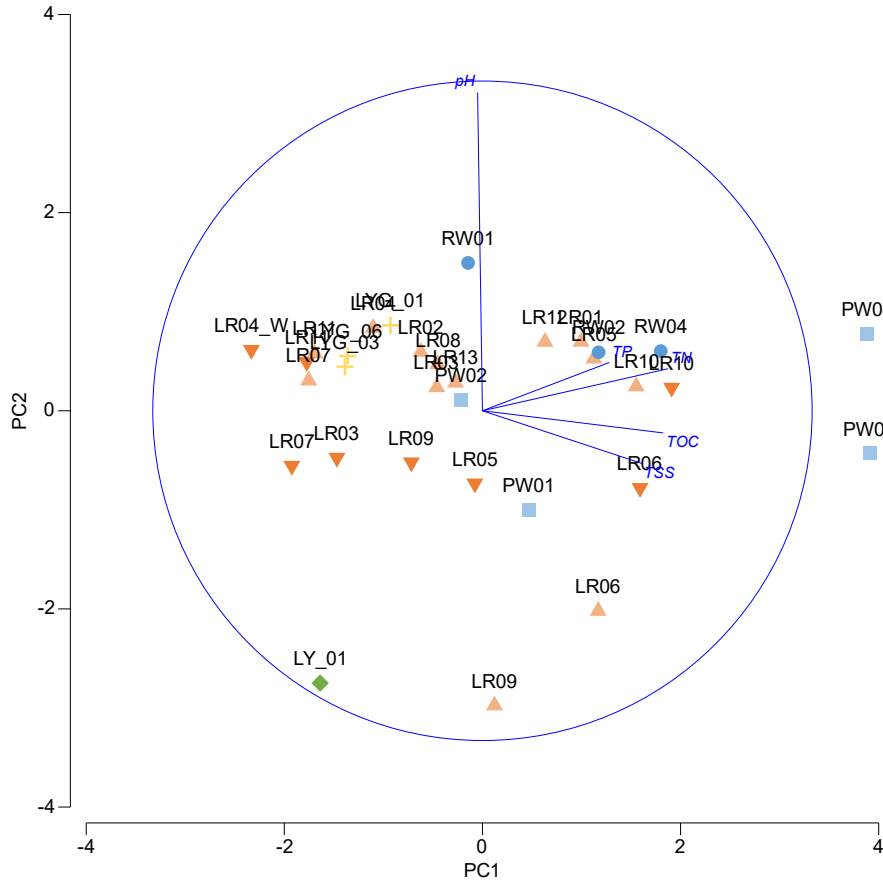


Figure 4-3: PCA of basic sediment quality of Lake Roe (▲ 2019, ▼ 2025), peripheral wetlands (■), Lake Yindarlgooda (+), regional wetlands (●) and Lake Yindana (◆), during the 2019 and 2025 studies, with 71.3% variation in the data explained by the first two axes.

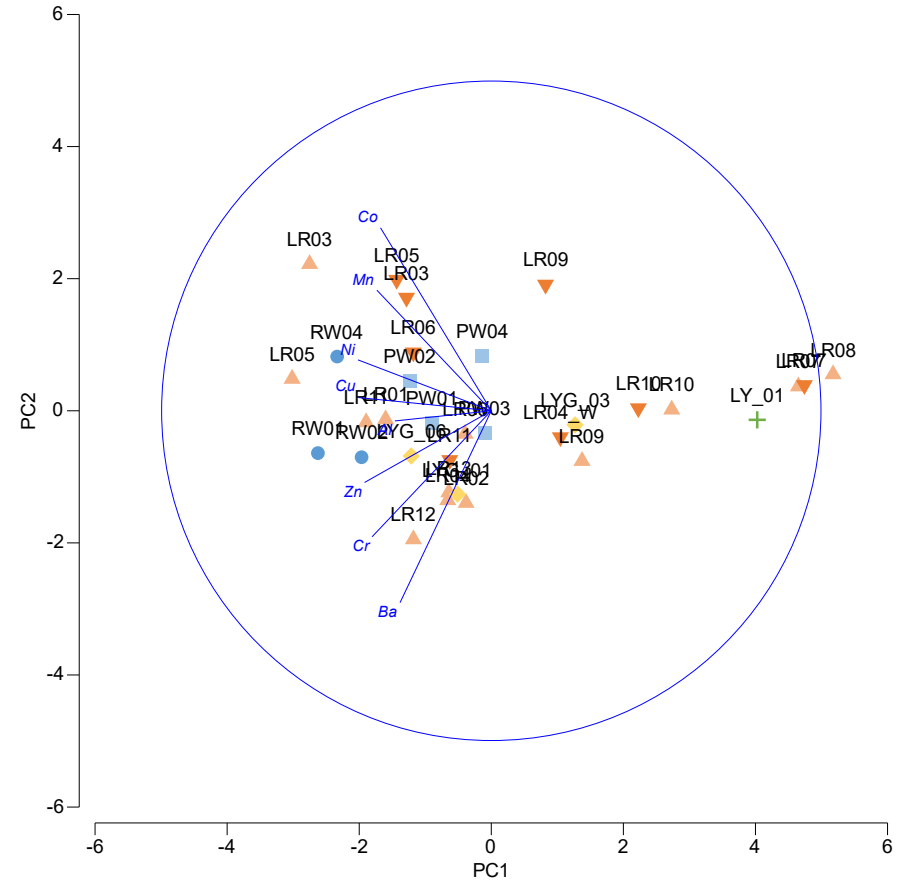


Figure 4-4: PCA of sediment metal concentrations of Lake Roe (▲ 2019, ▼ 2025), peripheral wetlands (■), Lake Yindarlgooda (+), regional wetlands (●) and Lake Yindana (◆), during the 2019 and 2025 studies, with 75.9% variation in the data explained by the first two axes.



4.3 Algae (Benthic & Phytoplankton)

Algae are widespread in ephemeral salt lakes, including benthic forms (living attached to lake sediment) and phytoplankton (occurring as free floating in the water column). Algae have a fundamental role as primary producers and in nutrient cycling in inland waters, supporting higher order consumers during major floods (Bellinger and Sigeo 2010). Benthic algal mats, often dominated by filamentous cyanobacteria, are considered a key contributor to ecosystem function in salt lakes (Bauld 1986), typically developing with the onset of flooding. Algae can be influenced by a range of factors, however, water quality and specifically salinity, is a major determinant of community structure (Handley 2003).

A total of 29 algal taxa, including benthic algae and phytoplankton, were identified from Lake Roe, the peripheral wetlands and surrounding waterbodies (lakes and regional wetlands) during the 2019 and 2025 studies. These results are predominantly based on rewetting trials, with only limited field sampling conducted (**Table 4-5; Table 4-6**). Algae comprised representatives from three phyla; Bacillariophyta (diatoms), Chlorophyta (green algae), and Cyanophyta (blue-green algae). Most taxa belonged to Bacillariophyta (17 taxa), with Cyanophyta representatives also common (10 taxa), and Chlorophyta limited to two taxa (**Figure 4-5**). Of the waterbodies assessed, Lake Roe was the most diverse (although this may be a function of increased sampling effort), with 16 taxa recorded (**Table 4-5**), while the peripheral wetlands also supported 11 taxa and the remaining waterbodies had less than 10 taxa (**Table 4-6**). The benthic and phytoplankton assemblage was generally considered typical of inland waters in Western Australia (Handley 2003).

Site diversity was variable throughout the 2019 and 2025 studies, with Lake Roe ranging from zero (LR01) to six taxa (LR11), and reduced diversity evident in 2025, while the peripheral wetlands ranged from one (PW02) to eight (PW04) taxa, results that were derived from the 2019 rewetting trials (**Figure 4-6**). Lake Yindarlgooda ranged from zero (LYG03) to five taxa (LYG06), with the latter attributed to field sampling and the regional wetlands ranged from zero (RW03) to eight taxa at RW01 (also related to field sampling) (**Figure 4-6**). The higher number of taxa recorded from the peripheral and regional wetlands was likely attributed to lower salinities compared to the salt lakes, with elevated salinity known to reduce algal diversity (Hammer 1986).

During the 2019 and 2025 studies, Lake Roe was characterised by diatoms (seven taxa) and cyanobacteria (eight taxa), with only one green algal taxon recorded (**Table 4-5**). The most widespread diatom taxa, associated with the 2019 rewetting trials, were *Hantzschia* (sp. aff. *baltica*), recorded from 11 sites throughout Lake Roe and the peripheral wetlands, and *Navicula* (sp. aff. *incertata*), documented from eight sites in Lake Roe (**Table 4-5**). These diatom taxa have been commonly recorded throughout the region and more broadly from salt lakes throughout the wheatbelt and Goldfields regions, and are associated with saline conditions, with tolerance limits that exceed 125,000 $\mu\text{S}/\text{cm}$ (Taukulis 2007).

The filamentous cyanobacterium *Planktolyngbya* sp., was also relatively common throughout the area, recorded from seven sites, including Lake Roe and the peripheral wetlands during the 2019 rewetting trials and Lake Yindarlgooda during the 2025 rewetting trials (**Table 4-6**). Diatoms and filamentous cyanobacteria are important constituents of benthic algal communities in Western Australian salt lakes (Handley 2003), providing a food source and structural complexity for aquatic invertebrates (Rautio and Vincent 2006).

The most abundant benthic algal taxa recorded during the 2019 rewetting trials comprised filamentous cyanobacteria including *Phormidium* sp. 2 and *Planktothrix* sp. 1 and 2, identified from Lake Roe. In 2025, field sampling at Lake Roe (LR04_W), was found to be dominated by the cyanobacterium *Microcoleus* sp. (**Table 4-5**). *Phormidium* is a salt-tolerant filamentous cyanobacterium and is characteristic of benthic algae in waterbodies throughout the wheatbelt and Pilbara regions of Western Australia (John *et al.* 2017; Paling *et al.* 1989), with some representative species known to persist in salinities over 170,000 $\mu\text{S}/\text{cm}$ (Nagasathya and Thajuddin 2008). *Planktothrix* is associated with marine conditions and can also tolerate elevated salinities greater than 100,000 $\mu\text{S}/\text{cm}$ (Madkour and Gaballah 2012), while *Microcoleus* is common in Western Australian salt lakes and coastal environments (Handley 2003; John *et al.* 2009).

Typically, algal abundance was limited in 2025 rewetting trials, although the 2025 field sampling of a regional wetland (RW01), found the unicellular green alga *Dunaliella* sp. was abundant (**Table 4-6**). While not as common, *Dunaliella* was also recorded from several Lake Roe sites and the peripheral wetlands during the 2019 rewetting trials (**Table 4-5; Table 4-6**). *Dunaliella* is considered a dominant component of algal communities throughout Australian waterbodies (Borowitzka 1981), and is extremely salt tolerant, having been documented from salinities more than 300,000 $\mu\text{S}/\text{cm}$ (Williams 1998).



The highest number of algae recorded during the 2019 and 2025 studies was from Lake Roe and the peripheral wetlands, which also showed the highest degree of similarity across sites (close to or greater than 30%), according to hierarchical classification (**Figure 4-7**). Lake Yindarlgooda supported a lower diversity of algae during the 2025 study, with only five taxa recorded (four diatoms, one cyanophyte), with the regional wetlands having eight taxa (six diatoms, two chlorophytes), likely reflecting lower salinities (**Table 4-6; Figure 4-6**). There were no algae recorded from Lake Yindana rewetting trials in 2025. The assemblage of algae at these sites was also typically widely variable, also reflected in the hierarchical classification, with most sites having less than 20% similarity (**Figure 4-7**). In saline waters, true phytoplankton can be restricted (Borowitzka 1981; John 2001), and productivity can mostly be confined to benthic algae, which are often dominated by cyanobacteria and diatoms (Handley 2003), and may take several weeks to form cohesive mats during major flood events. The distribution and abundance of algae can be influenced by water quality parameters such as salinity (Smith *et al.* 2004) and nutrients (Rissik *et al.* 2009).



Table 4-5: Algal taxa recorded from Lake Roe during the 2019 and 2025 studies (algal abundance key: ● = few, ●● = common, ●●● = abundant).

Algal Taxa	2019														2025								
	LR01	LR02	LR03	LR04	LR05	LR06	LR07	LR08	LR09	LR10	LR11	LR12	LR13	LR14	LR03	LR04-W*	LR05	LR06	LR07	LR09	LR10	LR11	
Bacillariophyta																							
<i>Amphora (coffeaformis)</i> ^S					●			●●	●														
<i>Hantzschia (sp. aff. baltica)</i> ^S		●			●●	●	●●			●	●		●	●									
<i>Cyclotella</i> sp. ^S																●							
<i>Navicella (pusilla)</i> ^S									●														
<i>Navicula</i> sp. ^S																	●						
<i>Navicula (sp. aff. incertata)</i> ^S				●	●			●	●	●	●	●	●										
<i>Pinnularia (sp. aff. intermedia)</i> ^S											●												
<i>Pinnularia (sp. aff. divergentissima)</i> ^S									●●														
Chlorophyta																							
<i>Dunaliella</i> sp. ^S							●	●		●													
Cyanophyta																							
<i>Cyanothece</i> sp. ^S												●											
<i>Geitlerinema</i> sp. ^F																●							
<i>Microcoleus</i> sp. ^F																●●●							
<i>Phormidium</i> sp. 2 ^F											●●		●●●										
<i>Planktolyngbya</i> sp. ^F											●	●		●									
<i>Planktothrix</i> sp. ^F																	●●						●●
<i>Planktothrix</i> sp. 1 ^F			●	●●						●●●	●	●	●										
<i>Planktothrix</i> sp. 2 ^F			●	●●●																			
Diversity	0	1	2	3	3	1	2	3	4	4	6	4	4	2	0	3	2	0	0	0	0	0	1

Note: S=single cell and F=filamentous forms; * recorded from benthic and/or phytoplankton field sample.



Table 4-6: Algal taxa recorded from peripheral wetlands (■), Lake Yindarlgooda (■), regional wetlands (■) and Lake Yindana (■) during the 2019 and 2025 studies (algal abundance key: ● = few, ●● = common, ●●● = abundant).

Algal Taxa	2019				2025						
	PW01	PW02	PW03	PW04	LYG01	LYG03	LYG06*	RW01*	RW03	RW02	LY01
Bacillariophyta											
<i>Amphora (coffeaeformis)</i> ^S	●			●							
<i>Amphora sp.</i> ^S							●				
<i>Amphora (sp. aff. mira)</i> ^S				●				●●			
<i>Hantzschia sp.</i> ^S							●	●			
<i>Hantzschia (sp. aff. baltica)</i> ^S	●		●	●●							
<i>Cocconeis sp.</i> ^S							●●				
<i>Eunotia sp.</i> ^S								●			
<i>Navicella (pusilla)</i> ^S			●					●			
<i>Navicula sp.</i> ^S							●	●●		●	
<i>Nitzschia closterium</i> ^S								●●			
<i>Nitzschia (sp. aff. virgata)</i> ^S			●								
<i>Pinnularia (sp. aff. divergentissima)</i> ^S	●●		●								
<i>Pleurosigma (longum var. elongatum)</i> ^S				●							
<i>Tabularia (fasiculata)</i> ^S				●							
Chlorophyta											
<i>Closterium sp.</i> ^S								●			
<i>Dunaliella sp.</i> ^S				●				●●●			
Cyanophyta											
<i>Phormidium sp.</i> ^{1F}				●●●							
<i>Planktolyngbya sp.</i> ^F	●	●		●			●				
<i>Pseudanabaena sp.</i> ^F					●						
Diversity	4	1	4	8	1	0	5	8	0	1	0

Note: S=single cell and F=filamentous forms; * recorded from benthic and/or phytoplankton field sample.



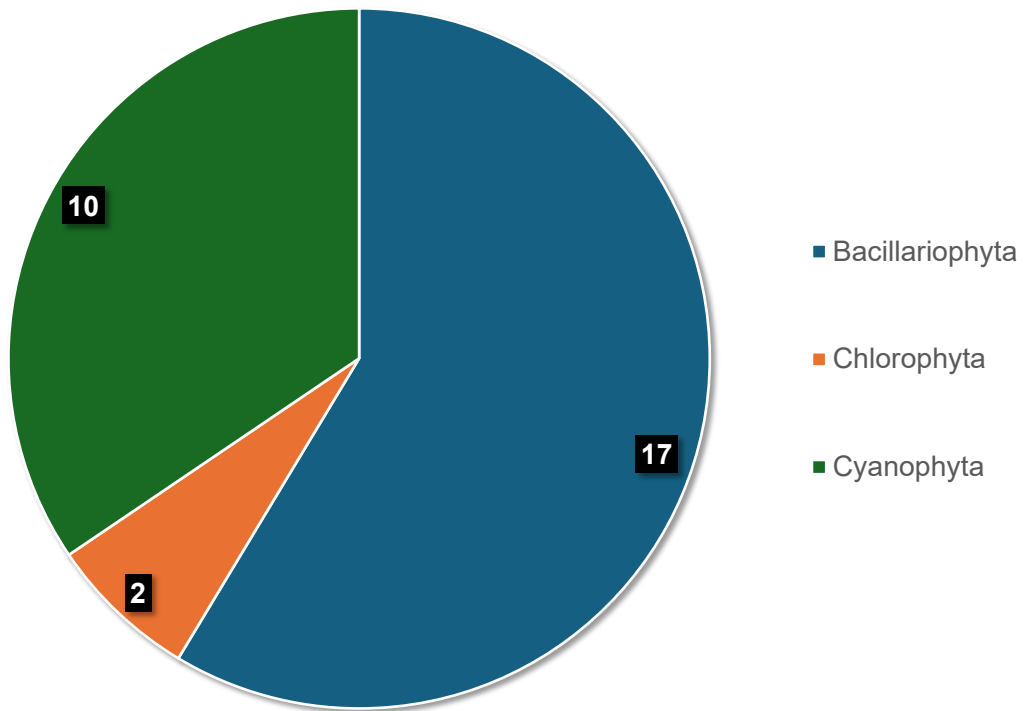


Figure 4-5: Algal taxa per phyla recorded during the 2019 and 2025 studies.

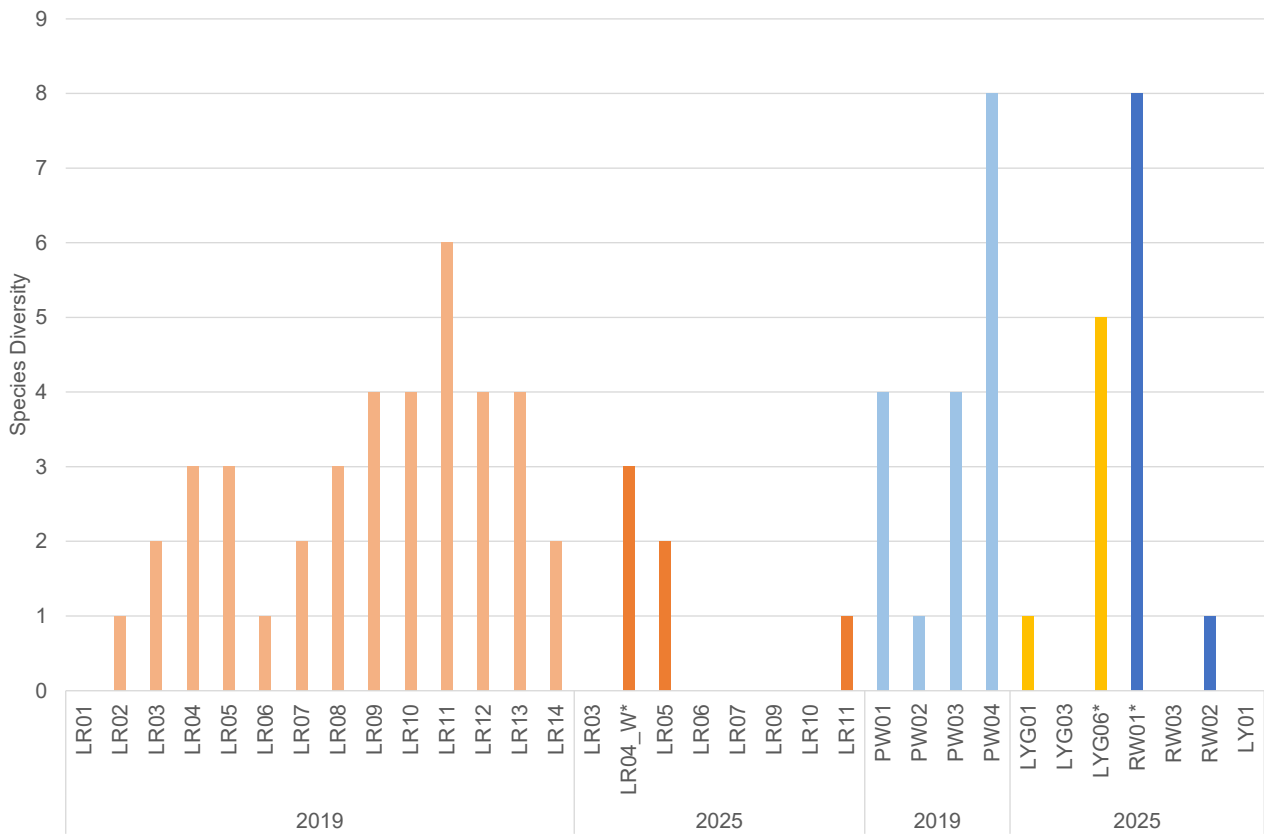


Figure 4-6: Diversity of algal taxa recorded at Lake Roe (■, ■), peripheral wetlands (■), Lake Yindarlgooda (■), regional wetlands (■) and Lake Yindana (■) during the 2019 and 2025 studies.



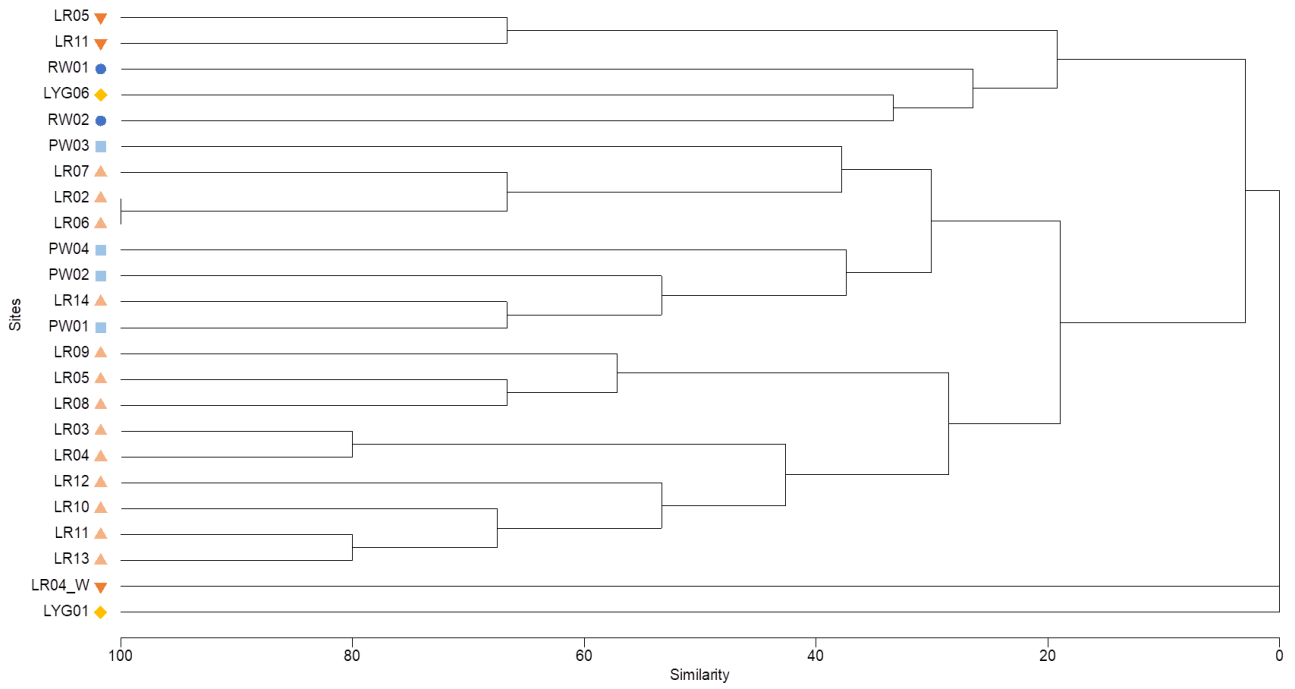


Figure 4-7: Dendrogram of the algal assemblage recorded during the 2019 and 2025 studies (▲=2019 Lake Roe, ▼=2025 Lake Roe, ■=peripheral wetlands, ◆= Lake Yindarlgooda and ●=regional wetlands).

4.4 Macrophytes

Macrophytes (aquatic plants and large green algae) are an important ecological component of inland waters, having submerged, free floating or emergent habits. They have a key role in nutrient cycling and in the provision of resources and habitat for aquatic invertebrates (Bunn *et al.* 2006; Porter *et al.* 2007; Sainty and Jacobs 2003). The macrophyte assemblage inhabiting salt lakes throughout Australia is closely associated with the hydroperiod and water quality factors such as salinity. However, the most dominant taxa persist during prolonged dry periods through the release of propagules, which lie dormant in the sediment (Humphries and Baldwin 2003), with emergence contributing to the recovery of ephemeral wetlands during major flood events (Bunn *et al.* 2006).

Macrophytes comprising common inland water taxa (Porter 2007) belonging to the Charophyceae (two taxa) and Ruppiaceae (one species) groups were recorded from Lake Roe, its peripheral and regional wetlands during the 2019 and 2025 studies (**Table 4-7**). The results were predominantly associated with rewetting trials, with only one opportunistic macrophyte recorded during field sampling.

Two macrophyte taxa were identified from Lake Roe comprising *Chara* sp. and *Ruppia tuberosa*, with both taxa also found in peripheral wetlands. The most widespread charophyte taxon was *Chara* sp., germinating from six Lake Roe sites and three peripheral wetlands sites during the 2019 rewetting trials (**Table 4-7**). This taxon was most abundant at Lake Roe site LR14 located in the southwestern part of the playa. *Chara* sp. was also common at several other sites on Lake Roe (LR10, LR11, LR12), located in proximity to LR14, as well as peripheral wetland PW01, on the southern margin of the lake (**Table 4-7**). The *Chara* genus is widespread, colonising a variety of aquatic habitats throughout Australia (Montoya 2009). It is often found in clear, alkaline waters and may be considered an indicator of healthy ecosystems (Casanova 2005; Coops 2002) and is typically associated with less saline (<10,000 mg/L) waterbodies (Brock and Lane 1983).

Ruppia tuberosa (Sea Tassel), was also relatively widespread and was common at Lake Roe sites LR10 (2019) and one peripheral wetland (PW04) in 2019, during the rewetting trials (**Table 4-7**). In addition, this species was also recorded in the field at inundated site LR04_W (2025), located in the northwestern section of the lake, which likely holds water on a semi-permanent basis (Stantec 2025). *Ruppia tuberosa* is a submerged angiosperm with a grass-like appearance, and is found in shallow, saline waters throughout Australia (Rogers and Paton 2009). In contrast to most macrophytes, the germination of *Ruppia tuberosa* is stimulated by elevated salinity, and once established, can persist in concentrations over 200,000 mg/L, often co-existing with the charophyte *Lamprothamnium* (Casanova and Brock 1990; Porter 2007).

Lamprothamnium sp. was recorded from one regional wetland (RW01) during rewetting trials for the 2025 study (**Table 4-7**). *Lamprothamnium* is a large, filamentous, branching green algae that is considered salt tolerant, and is common in coastal lakes (Casanova 2013). It is also one of the most common taxa found in inland salt lakes throughout Australia, and while requiring freshwater for germination (3,000 mg/L), this genus has an upper salinity tolerance limit of over 200,000 mg/L (Porter 2007).

Macrophytes have an important role in nutrient cycling and supporting diverse invertebrate fauna and waterbirds during major flooding (Casanova and Brock 1990; Porter 2007). Key factors such as water depth, light intensity, salinity and temperature are known to influence macrophyte distribution in inland waters throughout Australia (Casanova and Brock 1990; Porter 2007). These macrophytes also release propagules into the sediments of salt lakes, which remain dormant until a flood event (Humphries and Baldwin 2003). Propagules can have a patchy distribution in the sediments and can also be washed into lakes from surrounding tributaries (Bonis and Grillas 2002; Capon and Brock 2006). Based on the results of the 2019 and 2025 studies, Lake Roe supports a limited number of submerged macrophyte taxa (considered typical of inland salt lakes), which are predominantly associated with the northern and southern parts of playa, which may also function as collection points for propagules.



Table 4-7: Macrophyte taxa recorded from Lake Roe (■, ■) and peripheral (■) and regional (■) wetlands during the 2019 and 2025 studies (abundance key: ● = few, ●● = common, ●●● = abundant).

Macrophyte Taxa	2019						2025	2019			2025
	LR01	LR08	LR10	LR11	LR12	LR14	LR04_W*	PW01	PW03	PW04	RW01
Algae											
Charophyceae											
<i>Chara</i> sp.	●	●	●●	●●	●●	●●●		●●	●	●	
<i>Lamprothamnium</i> sp.											●
Angiosperms											
Ruppiaceae											
<i>Ruppia tuberosa</i>			●●		●	●	●●			●	
Diversity	1	1	2	1	2	2	1	1	1	2	1

Note: * indicates field sample only.



4.5 Diatoms

Diatoms are a type of microalgae, comprising a cell wall composed of silica (termed a frustule), living attached to substrates in waterbodies, including lake sediments (McQuoid and Hobson 1996). They are also important primary producers of inland waters throughout Australia and are a predominant food source for many aquatic invertebrates (Padhi *et al.* 2010). While being resilient, diatoms are highly sensitive to water quality and persist in the moist sediments of salt lakes, even during dry conditions, meaning they can provide an indication of changing conditions (Battarbee *et al.* 2001), reflected via a shift in species composition, with well-documented tolerance limits (John 1998; Smith *et al.* 2004).

Based on the results of the rewetting trials conducted for the 2019 and 2025 studies, a total of 35 diatom taxa were recorded, with maximum abundance (100 frustules) observed at most sites across Lake Roe, its peripheral wetlands, and the regional lakes and wetlands (Table 4-8; Table 4-9). The most diverse genera comprising *Nitzschia* (seven taxa), *Navicula* (six taxa) and *Pinnularia* (four taxa) (Figure 4-8). These genera and their associated taxa are considered characteristic of salt lakes and peripheral wetlands in the Goldfields region of Western Australia (Taukulis *et al.* 2012).

At Lake Roe, 24 diatom taxa have been identified compared to 16 taxa recorded from the peripheral wetlands across the 2019 and 2025 studies (Table 4-8). Increased diversity at Lake Roe was likely attributed to increased sampling effort spatially and temporally. The number of diatom taxa recorded from each site was variable at Lake Roe during the 2019 rewetting trials (ranging from two to 10 taxa). Site LR03 was the most diverse (10 taxa), followed by LR11 and LR13 (9 taxa each) (Figure 4-8). In addition, the peripheral wetlands had up to nine taxa (PW03) during the 2019 rewetting trials (Figure 4-8). While site diversity at Lake Roe was typically lower during the 2025 rewetting trials, the assemblage was more consistent, with most sites having between four to six diatom taxa.

The most dominant taxa included *Navicula* sp. aff. *incertata*, *Hantzschia* sp. aff. *baltica* and *Amphora coffeaeformis* in the lake and peripheral wetlands, which were recorded from most sites (Figure 4-10). This was also evident in the hierarchical classification, with more than 30% similarity in species composition (Figure 4-11). These species are associated with hypersaline conditions and have documented salinity tolerance limits above 100,000 mg/L (Taukulis 2007). Representatives from other diatom genera such as *Craticula*, *Entomoneis*, *Luticola*, and *Nitzschia* (Figure 4-10), were reasonably widespread and are well known from salt lakes throughout Western Australia (Campagna 2007; Taukulis 2007). *Hantzschia* and *Luticola* are aerophilic genera; known from non-submerged habitats (Ehrlich 1995), or eroded sediments (John 2000).

A total of seven taxa were recorded at Lake Yindarlgooda during the 2025 study rewetting trials, while five taxa were recorded from Lake Yindana (Table 4-9). This was consistent with previous studies of Lake Yindarlgooda, where seven diatom taxa and a comparable diatom assemblage were recorded from the playa (Campagna 2007). Lake Yindarlgooda was dominated by *Navicula* sp. aff. *incertata*, *Navicula* sp. aff. *salinicola* and *Amphora coffeaeformis*. The latter is one of the most common saline water diatoms known throughout Western Australian lakes and rivers (John 1998).

At Lake Yindana, *Pinnularia divergens* was prevalent, with several other *Pinnularia* representatives recorded to a lesser extent, with this site being distinct in the hierarchical classification (Figure 4-11). Taxa belonging to this genus were also common at Lake Roe site LR09 during the 2019 rewetting trials (Table 4-8). This genus is associated with acidic conditions (John 2000; Thomas 2007), corresponding to low sediment pH results, considered relatively common for salt lakes in the Goldfields (Stantec 2018b). Site diversity at Lake Yindarlgooda and Lake Yindana was comparatively lower than Lake Roe, with a maximum of six and five taxa, respectively (Figure 4-8).

The regional wetlands were more diverse, with a total of 17 taxa recorded (Table 4-9), reflecting the heterogeneity of habitat and the broader geographic distribution of these waterbodies. Diatoms including *Amphora coffeaeformis* were dominant, with *Navicella pusilla*, *Navicula cincta* and *Navicula* sp. aff. *salinicola*, also common (Figure 4-10). The majority of taxa (12 species) were recorded from RW04 (Table 4-9), also known as Penny Lake. While saline (sediment salinity >100,000mg/L), this lake is known to support extensive charophyte beds when flooded (*Lamprothamnium* sp.) (Campagna 2007), providing a colonisation substrate for diatoms.

The majority of diatoms recorded during the 2019 and 2025 studies are well known salt tolerant taxa documented from saline waters throughout Western Australia, corresponding to the saline condition of the lakes, peripheral wetlands and regional lakes and wetlands. Differences in community structure are likely attributed to variations in water quality (John 1998) during rewetting trials, microhabitat (Wolfe 1996) and lake geomorphology (Pereira *et al.* 2014; Reid and Ogden 2009). There were no unique or new diatom taxa identified during the studies, with the taxa recorded generally considered ubiquitous. The most dominant taxa inhabiting salt lakes can also persist in adverse dry conditions by thickening their cell wall to form a resting spore (McQuoid and Hobson 1996). However, during natural, major flood



events, it is likely that productivity and diversity will increase throughout Lake Roe, its peripheral wetlands and regional waterbodies, in response to inundation, which causes reduced surface water salinities and increased nutrients, stimulating diatom growth and development (Taukulis *et al.* 2014).



Table 4-8: Diatoms recorded from Lake Roe during the 2019 and 2025 studies.

Diatom Taxa	2019														2025										
	LR01	LR02	LR03	LR04	LR05	LR06	LR07	LR08	LR09	LR10	LR11	LR12	LR13	LR14	LR03	LR04	LR05	LR06	LR07	LR09	LR10	LR11			
<i>Amphora coffeaeformis</i>		46	14	31	1	19		10	16	6		14	7	38	36	31	2			62	57	11			
<i>Amphora sp. aff. mira</i>	2											3													
<i>Brachysira styriaca</i>																									
<i>Cocconeis placentula</i>																									
<i>Craticula accomoda</i>																		2							
<i>Craticula cuspidata</i>	4		3		1	1					1														
<i>Cymbella graciliformis</i>																									
<i>Cyclotella stelligera</i>											1														
<i>Entomoneis paludosa</i>				1							2			3	1	12						2			
<i>Hantzschia amphioxys</i>	2																								
<i>Hantzschia sp. aff. baltica</i>		7	32	18	26	21	96	4	6	12	32	8	8	35	12	35	90	12	14	15	25	67			
<i>Luticola mutica</i>	1		1	1	4	2					1		3			3	1								
<i>Mastogloia pumila</i>																									
<i>Navicella pusilla</i>	1	7	3	1					1	2		2	1												
<i>Navicula cincta</i>																			6						
<i>Navicula nivalis</i>			1		2	2							1												
<i>Navicula sp. aff. arvensis</i>									9																
<i>Navicula sp. aff. elegans</i>	1				1	1					4														
<i>Navicula sp. aff. incertata</i>	15	40	37	47	64	50	4	61	5	80	57	73	67	23	38	18	3	85	75	9	18	12			
<i>Navicula sp. aff. salinicola</i>			4										11		13	4			1			8			
<i>Nitzschia aurariae</i>																									
<i>Nitzschia nana</i>																			4	4					
<i>Nitzschia ovalis</i>			2	1					6																
<i>Nitzschia pellucida</i>													1	1											
<i>Nitzschia punctata former minor</i>			3		1	4																			
<i>Nitzschia sp. aff. virgata</i>																									
<i>Nitzschia subinflata</i>																				8					
<i>Pinnularia borealis</i>													1												
<i>Pinnularia divergens</i>																									
<i>Pinnularia sp. aff. divergentissima</i>									25								2			2					
<i>Pinnularia intermedia</i>									32		2														
<i>Pleurosigma longum var. elongatum</i>																									
<i>Pleurosigma salinarum</i>																									
<i>Rhopalodia musculus</i>																									
<i>Tabularia fasciculata</i>																									
Abundance	26	100	100	100	100	100	100	75	100	100	100	100	100	100	100	100	100	100	100	100	100	100			
Diversity	7	4	10	7	8	8	2	3	8	4	9	5	9	5	5	5	5	4	5	6	3	5			



Table 4-9: Diatoms recorded from peripheral wetlands (■), Lake Yindargooda (■), regional wetlands (■) and Lake Yindana (■) during the 2019 and 2025 studies.

Diatom Taxa	2019				2025						
	PW01	PW02	PW03	PW04	LYG01	LYG03	LYG06	RW01	RW02	RW04	LY01
<i>Amphora coffeaeformis</i>	51	85	19	4		7	75	19	36	25	
<i>Amphora sp. aff. mira</i>				16				14		10	
<i>Brachysira styriaca</i>										1	
<i>Cocconeis placentula</i>										2	
<i>Craticula accomoda</i>											
<i>Craticula cuspidata</i>											
<i>Cymbella graciliformis</i>										3	
<i>Cyclotella stelligera</i>											
<i>Entomoneis paludosa</i>	1						1				
<i>Hantzschia amphioxys</i>							2	4	3	1	
<i>Hantzschia sp. aff. baltica</i>	3	7	15	56	7	5			11	10	
<i>Luticola mutica</i>			3					1			
<i>Mastogloia pumila</i>				1						11	
<i>Navicella pusilla</i>		1	7			15	4	9	21		
<i>Navicula cincta</i>								27	7		
<i>Navicula nivalis</i>			1								
<i>Navicula sp. aff. arvensis</i>											
<i>Navicula sp. aff. elegans</i>											
<i>Navicula sp. aff. incertata</i>	2	6	33	3	42	63	3		15	28	
<i>Navicula sp. aff. salinicola</i>	6		5		51	10	15	26	5		7
<i>Nitzschia aurariae</i>									2		
<i>Nitzschia nana</i>										6	
<i>Nitzschia ovalis</i>		1									
<i>Nitzschia pellucida</i>	9										18
<i>Nitzschia punctata former minor</i>											
<i>Nitzschia sp. aff. virgata</i>			1	1							
<i>Nitzschia subinflata</i>											
<i>Pinnularia borealis</i>											
<i>Pinnularia divergens</i>											45
<i>Pinnularia sp. aff. divergentissima</i>	28		16								16
<i>Pinnularia intermedia</i>											14
<i>Pleurosigma longum var. elongatum</i>				5							
<i>Pleurosigma salinarum</i>										1	
<i>Rhopalodia musculus</i>										2	
<i>Tabularia fasciculata</i>				14							
Abundance	100	100	100	100	100	100	100	100	100	100	100
Diversity	7	5	9	8	3	5	6	7	8	12	5



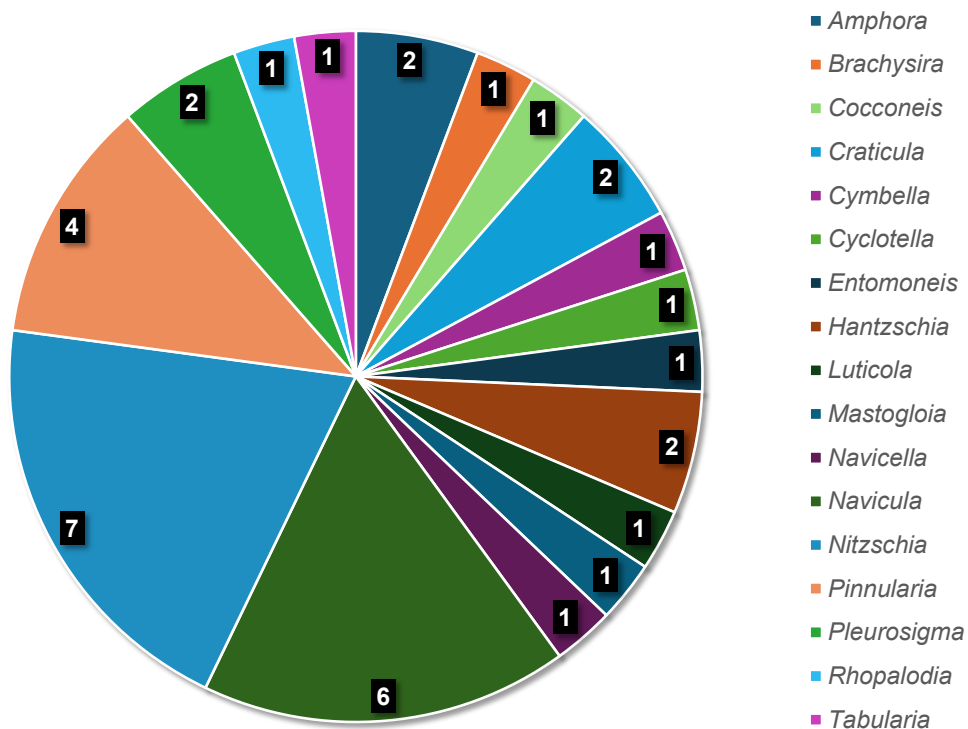


Figure 4-8: Diatom diversity by genera from Lake Roe, peripheral wetlands, Lake Yindarlgooda and regional wetlands during the 2019 and 2025 studies.

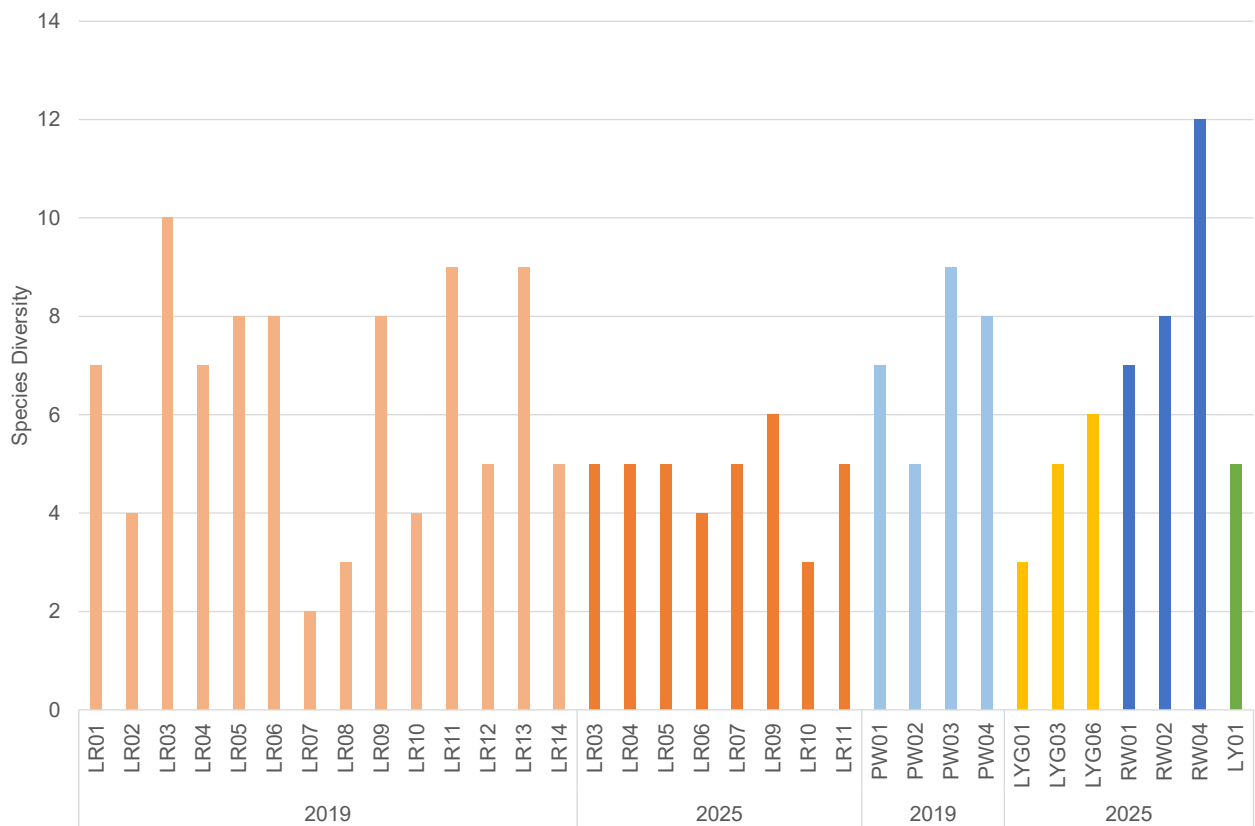


Figure 4-9: Diatom diversity recorded at Lake Roe (orange), peripheral wetlands (light blue), Lake Yindarlgooda (yellow), regional wetlands (dark blue) and Lake Yindana (green) during the 2019 and 2025 studies.



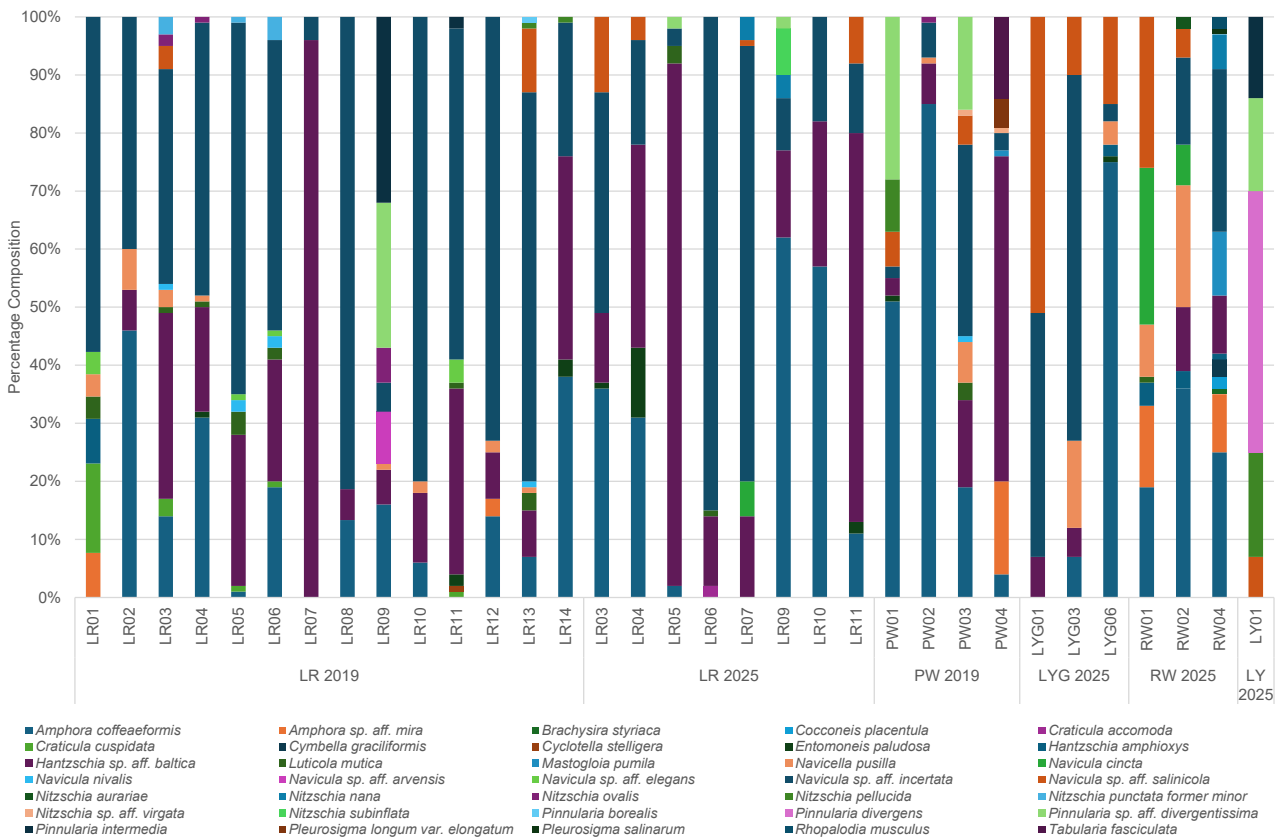


Figure 4-10: Diatom species composition from Lake Roe, peripheral wetlands, Lake Yindarlgooda and regional waterbodies during the 2019 and 2025 studies.

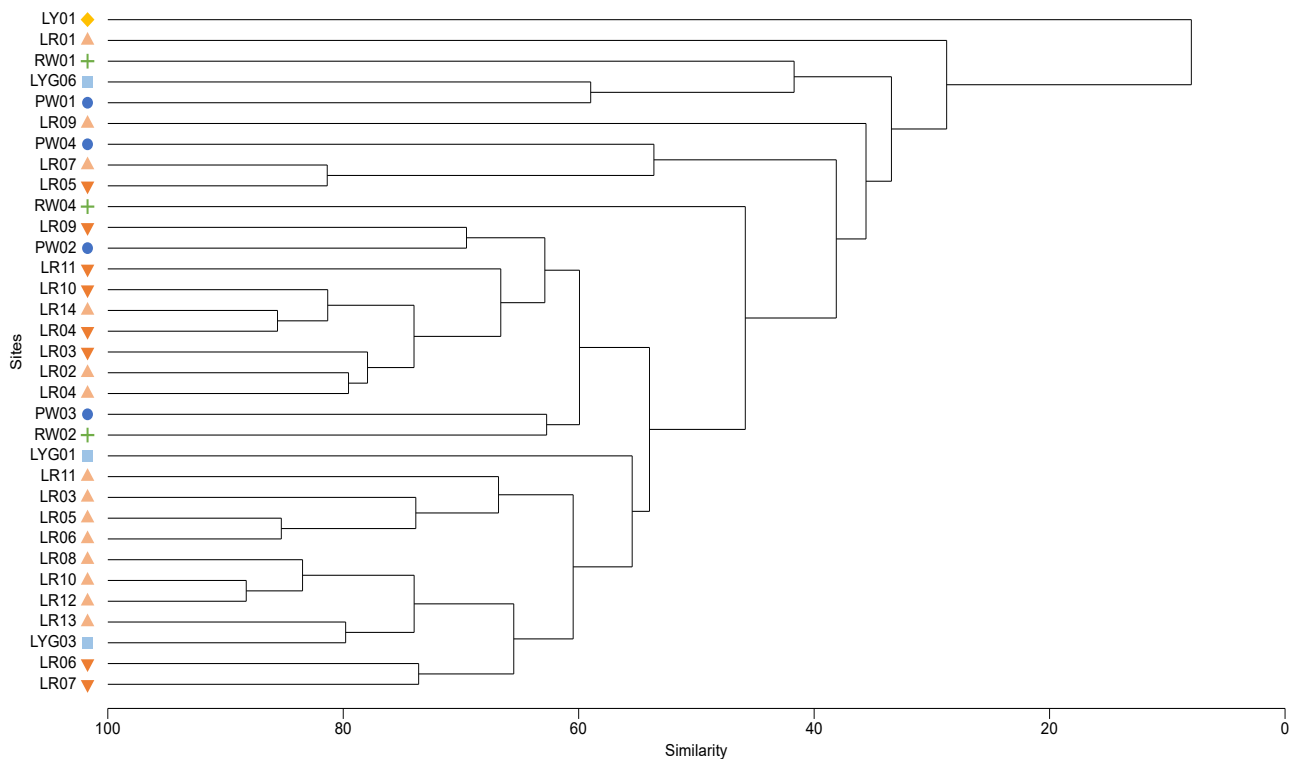


Figure 4-11: Dendrogram of the diatom assemblage recorded during the 2019 and 2025 studies (▲ = Lake Roe 2019; ▼ = Lake Roe 2025; ■ = peripheral wetlands; ◆ = Lake Yindarlgooda; ● = regional wetlands).



4.6 Aquatic Invertebrates

Aquatic invertebrates represent an important component of inland waters in Australia and occupy a range of submerged habitats. They have numerous roles ranging from consumers and detritivores through to predators, while also providing an important food source for waterbirds (Jones *et al.* 2009). In ephemeral wetlands, salinity is a key factor influencing the invertebrate assemblage, however hydroperiod, predation and resource availability are also important (Williams 1998). Aquatic invertebrates inhabiting salt lakes employ various mechanisms for survival during dry conditions and can typically be divided into two groups. These comprise resident invertebrate fauna (crustaceans), which persist in the sediment as desiccation-resistant eggs (resting stages), breaking dormancy with the onset of favourable conditions. Others, such as insects, are generally transient during their mobile adult phases, and can opportunistically colonise areas after flooding (King *et al.* 1996).

During the 2019 and 2025 studies, approximately 8,035 aquatic invertebrates, representing 28 taxa were identified from Lake Roe, the peripheral wetlands and surrounding waterbodies, including regional lakes and wetlands (**Table 4-10**). These taxa comprised crustaceans (25 taxa), considered resident fauna and opportunistic insects (three taxa). The groups represented under Crustacea were Spinicaudata (clam shrimp), Anostraca (brine/fairy shrimp), Copepoda (copepods), Notostraca (shield shrimp), Diplostraca (water fleas) and Ostracoda (seed shrimp) (**Figure 4-12**), while Insecta included Diptera (true flies) and Hemiptera (true bugs) (**Figure 4-12**). Ostracods, copepods and anostracans are considered characteristic salt lake invertebrate fauna, associated with inland waters throughout Australia (Hammer 1986; Timms 2012a).

At Lake Roe, a total of 14 taxa were recorded, compared to 13 taxa from the regional wetlands and 10 taxa from the peripheral wetlands during the 2019 and 2025 studies (**Table 4-10**). Nine taxa were recorded from Lake Yindarlgooda and no invertebrates emerged during rewetting trials from Lake Yindana. The higher total diversity at Lake Roe compared to the other salt lakes may have been attributed to the higher survey effort. In addition, the use of rewetting trials (due to a lack flooding), meant that crustaceans accounted for more than 99% of the total abundance. The dominant taxa were the ostracods *Diacypriis phoxe* and *Reticypriis* 'BOS1088', which were widespread, recorded from 14 sites each during the 2019 and 2025 studies (**Table 4-10**). The ostracod *Patcypris outback* was also prevalent (12 sites), while the anostracans *Parartemia veronicae* and *Parartemia serventyi* were also relatively common, with all three species known to produce desiccation resistant eggs in salt lakes (Lawrie *et al.* 2021). *Patcypris outback* is also common throughout salt lakes in Western Australia (Halse and Martens 2019), persisting in salinities over 120,000 mg/L (Stantec unpublished data).

The species diversity recorded from sites was, however, more variable (**Table 4-10**). At Lake Roe during the 2019 rewetting trials taxa numbers ranged from two (LR08, LR11, and LR13), to six (LR01), compared to the peripheral wetlands, which ranged from two (PW04) to five (PW01) taxa. In comparison, during the 2025 study, between one (LR07) to eight (LR04_W) taxa were recorded (**Figure 4-13**). Site LR04_W is located in the northwestern part of Lake Roe and exhibits a semi-permanent area of inundation, possibly due to groundwater expression (Stantec 2025), and likely contributes to supporting a more diverse invertebrate assemblage.

At Lake Yindarlgooda in 2025, four taxa were recorded from LYG03 and 11 taxa from LYG06, while the diversity of the regional wetlands sites ranged from two (RW02) to 14 (RW01) taxa (**Table 4-10; Figure 4-13**). Previous studies of this salt lake identified eight crustaceans, dominated by ostracods and *Parartemia* (Campagna 2007). The regional wetlands by comparison typically had a more diverse and abundant invertebrate assemblage. Specifically, field sampling occurred at RW01, which was flooded, and comprised species composition that included crustacean and insect taxa. This wetland had comparatively lower surface water salinity, which is known to support a higher diversity of aquatic invertebrates (Williams 1998).

The abundance of crustaceans recorded during the 2019 and 2025 studies also fluctuated, although ostracods were the prevalent group in both years (**Table 4-10; Figure 4-14**). For example, the majority of specimens (99%) identified during 2025 field sampling of Lake Roe site LR04_W belonged to *Diacypriis whitei* (1,172 specimens), with a smaller contribution from the anostracan taxon *Parartemia serventyi* (452 specimens). *Diacypriis whitei* has been recorded from the peripheral wetlands of Lake Lefroy in the eastern Goldfields (Stantec 2018b), and is known from salinities over 170,000 mg/L (Lawrie *et al.* 2021). *Parartemia serventyi* has a documented distribution throughout the wheatbelt and Goldfields regions of Western Australia, persisting in salinities over 250,000 mg/L (Timms 2010; 2012b). The remaining Lake Roe sites typically had total abundances of less than 150 specimens (**Table 4-10**).



The abundance of taxa recorded from the regional lakes and wetlands were mostly higher than Lake Roe (**Table 4-10**), accounting for more than 65% of taxa from the 2019 and 2025 studies (**Table 4-10**). This was driven by large numbers of anostracans (*Parartemia veronicae*) and ostracods (*Australocypris bennetti*) at Lake Yindarlgooda site LYG06 (>1,500 specimens), while at RW01, diplostracans (*Daphnia queenslandensis*) were abundant (>1,200 specimens) together with the ostracod *Cyprinotus kimberleyensis* s.l. (>950 specimens). *Australocypris bennetti* has been recorded from wetlands throughout southwest and central inland waters of Western Australia (Lawrie *et al.* 2021), while *Parartemia veronicae* is widely distributed throughout Goldfields salt lakes of the Goldfields (Timms 2012b). Both species have broad salinity tolerances and are known from salinities over 200,000 mg/L (Lawrie *et al.* 2021). In contrast, while *Daphnia queenslandensis* is also salt tolerant, its median salinity is documented as 20,000 mg/L, reflecting the lower surface water concentrations at this site (Lawrie *et al.* 2021).

The species composition at Lake Roe differed between the 2019 and 2025 studies (**Table 4-10**), which was also evident in the hierarchical classification, with sites typically displaying less than 30% similarity (**Figure 4-15**). The key difference was the prevalence of the ostracod *Diacypris phoxe*, which was the most dominant species recorded from the lake and peripheral wetlands in 2019 (**Figure 4-14**), however, was absent in 2025. This species has a patchy distribution throughout Australia, having only previously been recorded from a small number of sites in Western Australia (Lake Lefroy peripheral wetlands) (Stantec 2018b) and South Australia, having been documented in salinities over 60,000 mg/L (Lawrie *et al.* 2021). The species composition of the regional lakes and wetlands indicated there was limited similarity between site (typically less than 25%) and more variation in the invertebrate assemblage, demonstrated in the hierarchical classification (**Figure 4-15**).

During the 2019 study an opportunistic field sample was collected from an isolated claypan site (PC01) on the western margin of Lake Roe. The species composition at this site differed substantially from all other sites, reflecting a distinct freshwater system, clearly separated in the hierarchical classification (**Figure 4-15**). A limited number of species including the notostracan *Triops nr australiensis* and spinicaudatan *Caenestheria* sp. (**Figure 4-14**), were recorded, with both taxa associated with freshwater and low salinity ephemeral waterbodies throughout the Goldfields region (Quinlan *et al.* 2016; Timms *et al.* 2006; Timms and Richter 2002).

Four ostracod taxa recorded during the 2019 and 2025 studies represent potentially new or undescribed taxa, although were also recorded from Lake Roe, several peripheral wetlands, and/or Lake Yindarlgooda. While previously thought to be restricted to Lake Roe, however additional survey effort has demonstrated a broader geographic occurrence (**Figure 4-16; Figure 4-17**). Their known distributions can be summarised as follows:

- *Australocypris* 'BOS1364'; recorded from the east and northern sections of Lake Roe in 2019 (LR02, LR04, LR05, LR14) and 2025 (LR04_W), as well as Lake Yindarlgooda (LYG06) in 2025;
- *Diacypris* 'BOS1969'; abundant in the northern section of Lake Roe in 2025 (LR04_W) and found in limited numbers in the eastern section of the lake (LR06 and LR09), and in moderate abundance from two sites in Lake Yindarlgooda (LYG03 and LYG06);
- *Reticypis* 'BOS1088'; widespread, albeit in limited abundance throughout Lake Roe and peripheral wetlands (LR01, LR02, LR03, LR04_W, LR05, LR06 and LR08, LR13, PW01, PW02 and PW03), and Lake Yindarlgooda (LYG03 and LYG06); and
- *Reticypis* 'BOS1363'; abundant at a peripheral wetland (PW04) along the eastern margin of Lake Roe, found in low numbers in a peripheral wetland (PW01) along the southern margin of the Lake Roe, and in the southwestern section of the lake (LR14) in 2019, and recorded from Lake Yindarlgooda (LYG06) in 2025.

The aquatic invertebrate assemblage identified during the 2019 and 2025 studies, which included rewetting trials and a limited number of field samples, was dominated by crustaceans (specifically ostracods and *Parartemia*), considered typical of salt lakes in Western Australia. Most of the taxa identified are known from inland waters across Australia or have been documented from lakes and wetlands throughout the Goldfields region previously, except for the four undescribed ostracod taxa. The dominant taxa typically had broad salinity tolerance limits, reflecting the variable hydroperiod and heterogeneity in the conditions experienced in salt lakes (Brendonck and Williams 2000; Timms 1997; Williams 1998). While sampling was limited during flooding, Lake Roe and the regional lakes and wetlands are expected to have substantial productivity during flooding, providing an important food source for waterbirds (Boulton and Brock 1999).



Table 4-10: Aquatic invertebrate taxa recorded from Lake Roe (■, ■), peripheral wetlands (claypan (■), salinas (■)), Lake Yindarlgooda (■) and regional wetlands (■) during the 2019 and 2025 studies.

Aquatic Invertebrate Taxa	2019												2025				2019				2025					
	LR01^	LR02	LR03	LR04	LR05	LR07	LR08	LR10	LR11	LR12	LR13	LR14	LR04_W^	LR07	LR09	LR06	PC01#	PW01	PW02	PW03	PW04	LYG03	LYG06^	RW01^	RW02	
Crustacea																										
Branchiopoda																										
Anostraca																										
<i>Parartemia serventyi</i>								14		1			452								3					
<i>Parartemia</i> sp. imm/dam													50			1									7	
<i>Parartemia</i> spp.*													1,500											50		
<i>Parartemia veronicae</i>	21									2	1	1											1,550			
Diplostraca																										
<i>Daphnia queenslandensis</i>																									1,200	
<i>Daphniopsis</i> sp.																									1	
Spinicaudata																										
<i>Caenestheria</i> sp.																		11								
Notostraca																										
<i>Triops nr australiensis</i>																		4								
Copepoda																										
Cyclopoida																										
<i>Apocyclops dengizicus</i>																										117
<i>Meridicyclops platypus</i>																										117
Ostracoda																										
<i>Australocypris bennetti</i>																										875
<i>Australocypris</i> 'BOS1364'		50		2	1							1	78												6	
<i>Australocypris</i> sp.			2								1														9	
Cyprididae sp.																		3								
<i>Cyprinotus kimberleyensis</i> s.l.																										985
<i>Diacypris</i> 'BOS1969'													87		1	1						32	39			
<i>Diacypris fodiens</i>	7																									
<i>Diacypris phoxe</i>	6	60	3	133	20	72	1	62	10	100		56						2	100	50						
<i>Diacypris</i> sp.																									4	
<i>Diacypris whitei</i>													1,172													
Ostracoda spp.*													310		70							50	160	40		
<i>Patcypris outback</i>	2					4	191	23							8			12	17	1		9	1	6	2	
<i>Repandocypris austinensis</i>										1															34	
<i>Repandocypris</i> sp.	1			5														5							1	
<i>Reticypris</i> 'BOS1088'	2	2	5		10	3						7	1	1	10			2	3	8		5	2			
<i>Reticypris</i> 'BOS1363'												2						1			37		1			
<i>Trilocypris horwitzii</i>																					4				19	
Insecta																										
Diptera																										



Aquatic Invertebrate Taxa	2019												2025				2019				2025				
	LR01 [^]	LR02	LR03	LR04	LR05	LR07	LR08	LR10	LR11	LR12	LR13	LR14	LR04_W [^]	LR07	LR09	LR06	PC01 [#]	PW01	PW02	PW03	PW04	LYG03	LYG06 [^]	RW01 [^]	RW02
Chironomidae sp. (P)																								1	
Hemiptera																									
Anisops sp. imm/dam																								1	
Corixidae sp. imm/dam																								1	
Abundance	39	112	10	140	31	79	192	99	11	104	8	60	3,650	1	79	12	18	22	123	59	41	96	2,697	2,530	2
Diversity	6	3	3	3	3	3	2	3	2	4	2	4	8	1	3	3	3	5	4	3	2	4	11	14	1

Note: * indicates peak number from approximate count during rewetting trials, however majority of specimens did not meet maturity. Not included in diversity and abundance counts; ^ indicates field sample and rewetting trials; # indicates field sample only.



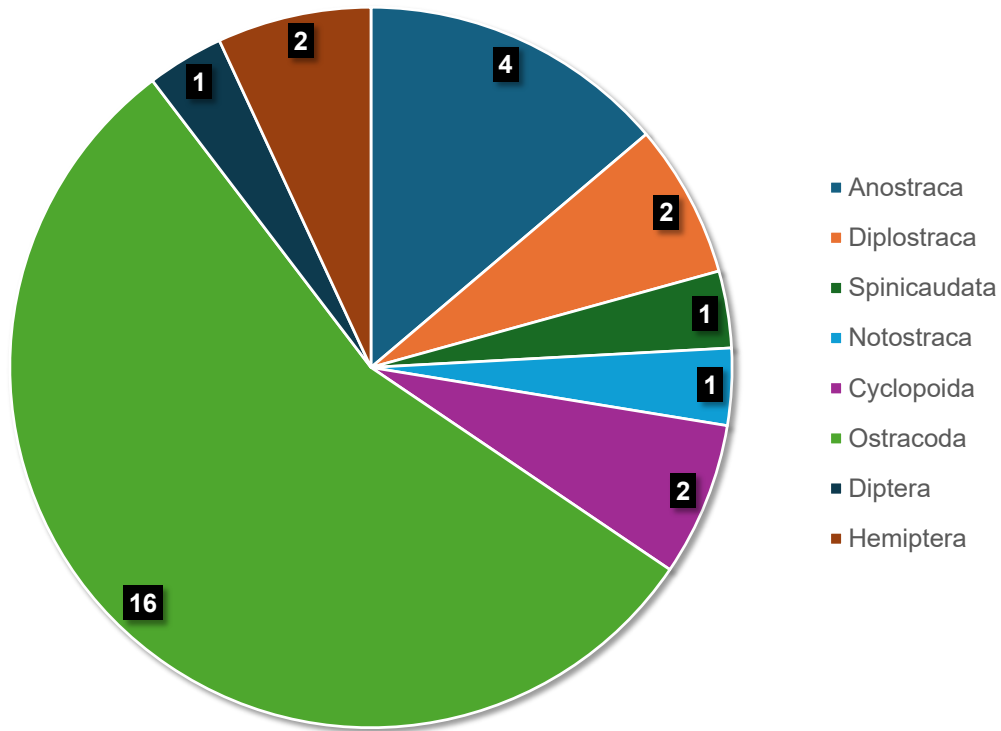


Figure 4-12: Aquatic invertebrate diversity by broad groups from Lake Roe, peripheral wetlands, Lake Yindarlgooda and regional wetlands during the 2019 and 2025 studies.

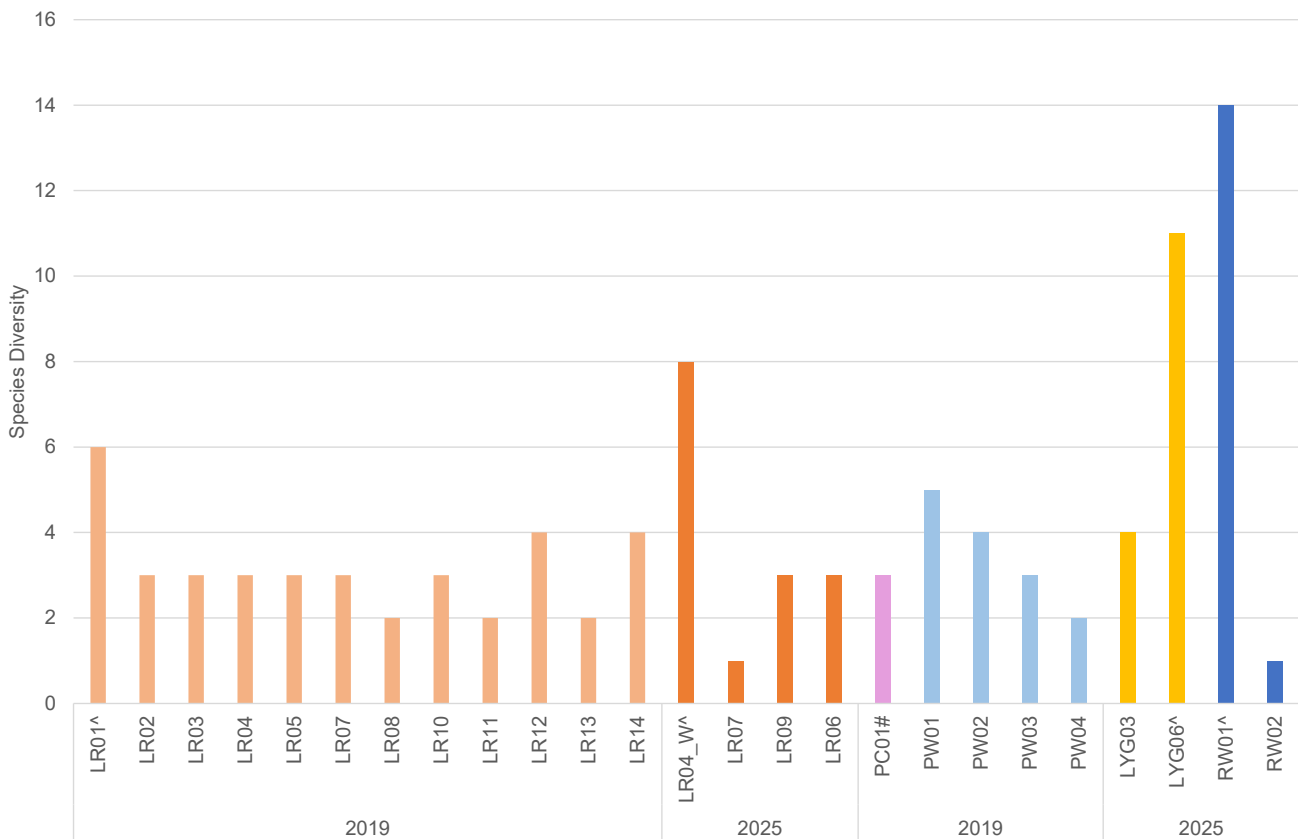


Figure 4-13: Aquatic invertebrate species diversity by site from Lake Roe (■, ■), peripheral wetlands (claypan (■), salinas (■)), Lake Yindarlgooda (■) and regional wetlands (■) during the 2019 and 2025 studies. Note: ^ indicates field sample and rewetting trials; # indicates field sample only.



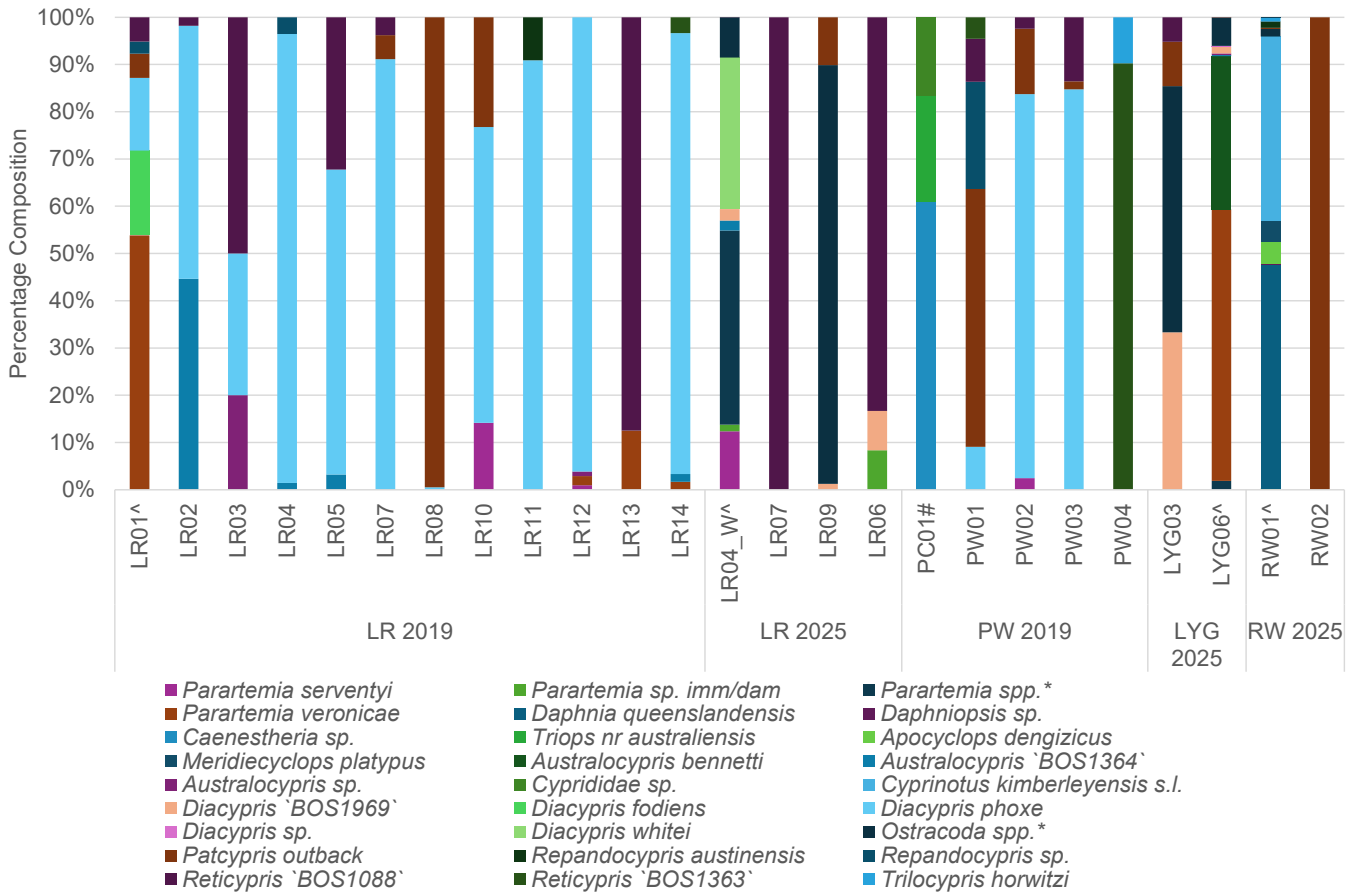


Figure 4-14: Aquatic invertebrate species composition from Lake Roe, peripheral wetlands, Lake Yindarlgooda and regional waterbodies during the 2019 and 2025 studies.

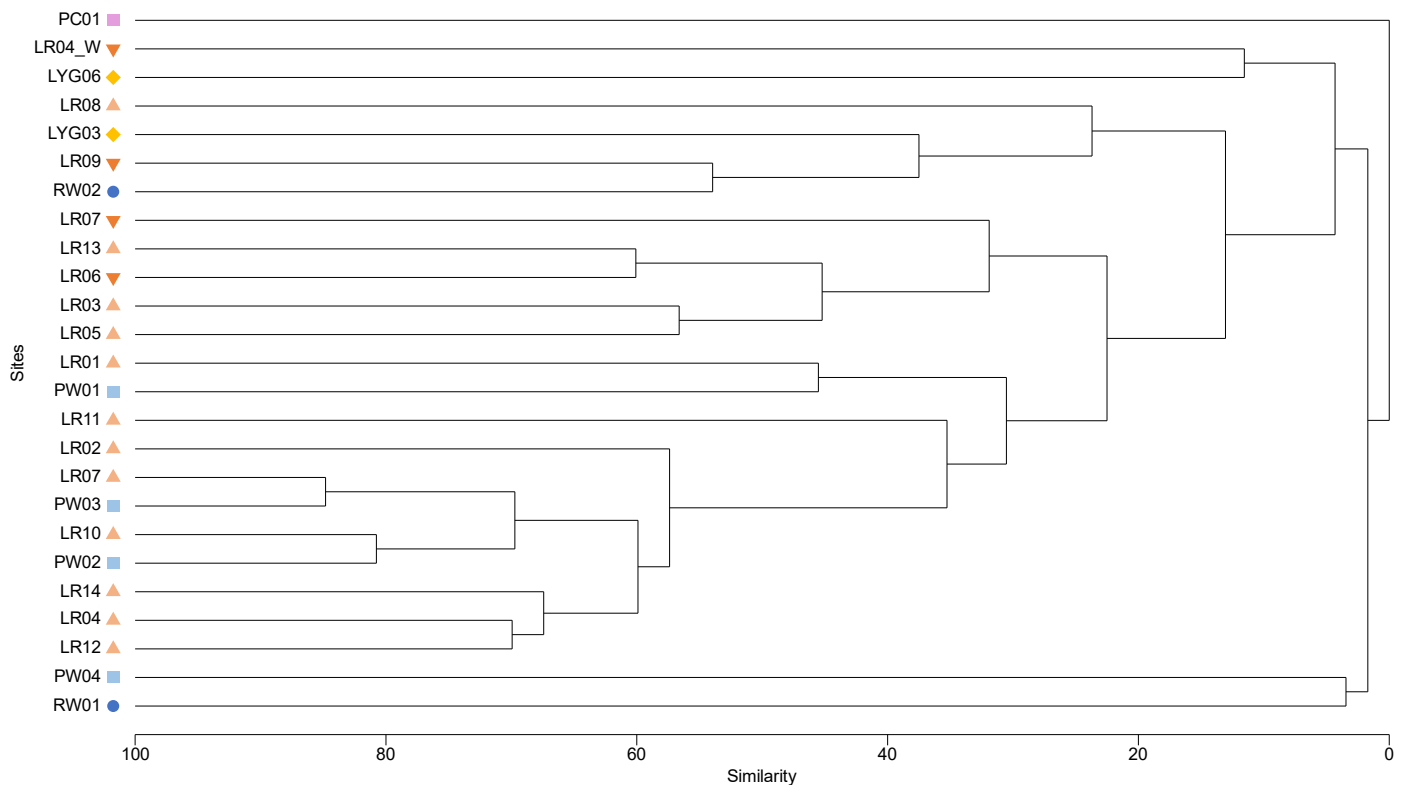


Figure 4-15: Dendrogram of aquatic invertebrate assemblage recorded during the 2019 and 2025 studies (▲ = Lake Roe 2019; ▼ = Lake Roe 2025; ■ = peripheral claypan; ■ = peripheral salinas; ◆ = Lake Yindarlgooda; ● = regional wetlands).





Significant Aquatic Invertebrates & Waterbirds at Lake Roe

Aquatic Ecology Study and Dewatering Discharge Assessment for the Roe Gold Project

Client: Ramelius
 Project: 304501786
 Project Code: Iroe_aq_2025_01
 Drawn By: RM, Checked By: CU, JP
 Date: 2026-01-28



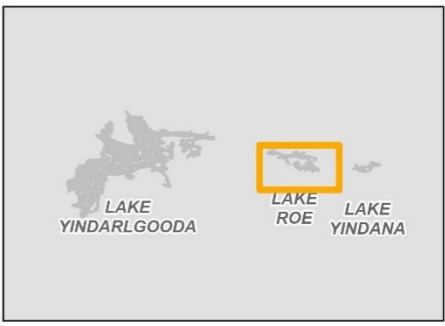
Significant Aquatic Invertebrate Records

- *Australocypris* 'BOS1364'
- *Diacypsis* 'BOS1969'
- *Reticypsis* 'BOS1363'
- *Reticypsis* 'BOS1088'

Significant Waterbird Records

- ◇ Hooded Plover (*Charadrius cucullatus*) (P4)

Notes:
 1. Map displayed in GDA 1994 MGA Zone 51
 2. Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2026).
 3. Background: Earthstar Geographics



This document has been prepared based on information provided by others as cited in the data sources. Stantec has not verified the accuracy and/or completeness of this information and shall not be responsible for any errors or omissions which may be incorporated herein as a result. Stantec assumes no responsibility for data supplied in electronic format, and the recipient accepts full responsibility for verifying the accuracy and completeness of the data.

Figure 4-16: Distribution of new aquatic invertebrate taxa and significant waterbird taxa recorded from Lake Roe and peripheral wetlands during the 2019 and 2025 studies.

4.7 Waterbirds

Many species of waterbirds in Australia are known to take advantage of ephemeral wetlands, migrating to the interior regions during major flooding (Pizzey and Knight 2012). Most of these are nomadic, and while they may function as top level predators, their presence is dependent on the availability of suitable foraging and breeding habitat. Inland waters, including salt lakes, flood infrequently and are typically only suitable to support populations of waterbirds once every five to two years, during widespread inundation events (DEWHA 2010). Salt lakes can host thousands of waterbirds such as the Banded Stilt when flooded, typically breeding on protected islands and feeding on crustaceans (BirdLife Australia 2025a). Migratory waterbirds (such as plovers, sandpipers and stints) also travel to their summer breeding grounds in the northern hemisphere, with their feeding areas located in the southern hemisphere, requiring a network of wetlands along their flyaway route (DBCA 2020). Migratory waterbirds are therefore often the focus of conservation (Kingsford *et al.* 2006).

During the 2025 Study, seven species of waterbirds representing three families were identified from three sites, including Lake Roe, Lake Yindarlgooda and a regional wetland (**Table 4-11**), as part of opportunistic observation. Three waterbirds were from the family Anatidae (ducks, geese and swans), while two taxa each were recorded from the families Charadriidae (plovers and lapwings) and Recurvirostridae (avocets and stilts) (**Table 4-11**).

Site diversity ranged from one taxon at Lake Yindarlgooda (LYG_06) to four taxa at Lake Roe (LR04_W) (**Table 4-11**). The most widespread and abundant waterbird was the duck *Anas gracilis* (Grey Teal), occurring in the northwestern section of Lake Roe (LR04_W) and a regional wetland (RW01). This species is highly nomadic and widespread throughout Australia, opportunistically utilising flooded habitats in the arid interior (Pizzey and Knight 2012). It persists in fresh or saline waters, feeding on plants and insects (Simpson and Day 2010; Slater *et al.* 2007).

Cygnus atratus (Black Swan) and *Recurvirostra novaehollandiae* (Red-necked avocet) were also relatively abundant (>30 individuals), recorded at LR04_W at Lake Roe and regional wetland RW01, respectively (**Table 4-11**), with the former associated with varied habitats including lakes, rivers, estuaries and temporary waterbodies throughout the arid interior of Australia. *Recurvirostra novaehollandiae* is also considered to be widespread but irregular (Pizzey and Knight 2012), using estuaries, tidal mudflats, salt lakes and claypans and inland waters in Western Australia considered key breeding habitat (Pizzey and Knight 2012). A single species, *Charadrius ruficapillus* (Red-capped Plover), observed at Lake Yindarlgooda site LYG06, is the most common and widespread beach-nesting shorebird in Australia, congregating within temporary waterbodies in the arid interior, particularly salt lakes (Pizzey and Knight 2012), where it forages along the fringes for small crustaceans (Marchant and Higgins 1990).

The majority of the waterbird species recorded during the 2025 study (**Table 4-11**) are all considered common and nomadic, typically responding to flooding of temporary waterbodies, and colonising a range of habitats (Simpson and Day 2010; Slater *et al.* 2007). However, one species of waterbird from the Charadriidae family; *Charadrius cucullatus* (Hooded Plover) is listed as a priority four (P4) species under the Western Australian *Biodiversity Conservation Act 2018* (BC Act) (DBCA 2024). This species was observed at site LR04_W, located in the northwestern section of Lake Roe (**Table 4-11**; **Figure 4-16**).

Charadrius cucullatus is endemic to southern Australia, occurring along coasts and inland saline lakes (Birdlife Australia 2025b; Weston *et al.* 2020). The south-western population breeds on the south-west WA coastline and inland salt lakes typical of arid environments, such as Lakes Cowan and Lake Moore, and occasionally as far inland as Lakes Arrow, Barlee, and Ballard (Birdlife Australia 2025b). Individuals of the species are known for being nomadic, breeding when suitable conditions prevail (Weston *et al.* 2020).

The northwestern part of Lake Roe likely supports a more permanent expression of groundwater at the surface (Stantec 2025). This area is likely contributing to a more productive aquatic invertebrate assemblage, which in turn may attract waterbirds. While currently unknown, Lake Roe, similar to other inland waterbodies in the Goldfields when inundated, likely provides an important foraging and breeding habitat for waterbirds, including migratory species, especially during periods of longer inundation.



Table 4-11: Waterbird taxa and abundance from Lake Roe, Lake Yindarlgooda and regional wetlands during the 2025 study.

Waterbird Taxa	Lake Roe	Lake Yindarlgooda	Regional Wetlands
	LR04_W	LYG_06	RW01
Anatidae			
<i>Anas gracilis</i> (Grey teal)	100		200
<i>Cygnus atratus</i> (Black swan)			55
<i>Tadorna tadornoides</i> (Australian shelduck)	15		
Charadriidae			
<i>Charadrius ruficapillus</i> (Red-capped plover)		18	
<i>Thinornis rubricollis</i> (Hooded plover) (P4)	19		
Recurvirostridae			
<i>Cladorhynchus leucocephalus</i> (Banded stilt)			1
<i>Recurvirostra novaehollandiae</i> (Red-necked avocet)	38		
Diversity	4	1	3

4.8 Riparian Vegetation

Ephemeral wetlands are characterised by a riparian vegetation zone, which in inland regions of Australia often comprise eucalypt woodlands and shrublands (Beard 1990). The dominant species typically represent Myrtaceae, Asteraceae, Chenopodiaceae and Poaceae families. Changes in these vegetation communities reflect underlying geology, with close associations between plant species and soil type (Beard 1990). The riparian vegetation of salt lakes is also strongly influenced by soil properties, distance to groundwater and topography. Chenopod shrublands, consisting of samphires (*Tecticornia*) are prevalent, due to the ability of this genus to withstand waterlogging and elevated salinities (Datson 2002), associated with infrequent, major flood events.

4.8.1 Vegetation Associations

The following habitat types were identified in association with the riparian zone of Lake Roe and the peripheral wetlands:

- the hypersaline lake margins of Lake Roe; and
- the margins of saline peripheral wetlands (salinas), which consist of similar species composition to the lake margins.

Vegetation within the riparian zone was dominated by chenopod (saltbush) shrubland, comprising four vegetation types (**Table 4-12**). These were predominantly characterised by halophytic genera including *Tecticornia*, *Atriplex* and *Frankenia* (Stantec 2020a).

4.8.2 Species Diversity and Abundance

During the 2019 study, a total of 48 plant taxa (including subspecies, varieties and forms), representing 25 genera and 13 families, were identified from the riparian zone of Lake Roe and the peripheral wetlands (**Table 4-13**). The most well represented families were Chenopodiaceae (chenopods), with 20 taxa and Asteraceae (daisies), with five taxa (**Figure 4-18**). The most diverse genera were *Tecticornia* (14 taxa) and *Maireana* (three taxa) (**Table 4-13**). The assemblage of plants was considered characteristic of the Coolgardie bioregion, where chenopods and halophytic samphire communities are associated with saline drainage areas (Cowan 2001).

There were 43 and 19 taxa recorded from the riparian zone of Lake Roe and the peripheral wetlands, respectively during the 2019 study (**Table 4-13**). At Lake Roe, species diversity ranged from one to 17 taxa, with sites LR12, LR11, LR04 supporting the highest number of species (>12) (**Figure 4-19**). In comparison, diversity at the peripheral wetlands ranged from three (PW03) to 11 (PW01) taxa. An unidentified *Frankenia* sp. (Frankeniaceae) and *Atriplex nana* were the most widespread taxa recorded during the at 14 and 13 sites, respectively (**Table 4-13; Figure 4-20**). *Frankenia* is commonly found in saline areas and grow with a wide range of salt tolerant vegetation in open shrublands (Mitchell and Wilcox 1994). *Atriplex nana* is known from salt lakes and salt flats throughout inland Western Australia (WAH 2025).

Tecticornia (samphires) were widespread within the riparian zone of the lake during the 2019 study, with at least two taxa collected from the majority of sites (**Table 4-13**). Of these, the most widespread taxa included an unidentified *Tecticornia* spp. (12 sites), *Tecticornia indica* subsp. *bidens* and *Tecticornia pergranulata* subsp. *divaricata* (six sites each). *Tecticornia pergranulata* subsp. *divaricata* is known from the Eastern Goldfields and Eastern Murchison regions (WAH 2025), whereas *Tecticornia indica* subsp. *bidens* is found throughout Western Australia, growing in well-drained saline soils (Datson 2002).

Other taxa including, *Carpobrotus* sp. (Aizoaceae) and *Surreya diandra* (Amaranthaceae) were also relatively widespread (eight sites each), particularly along the margins of Lake Roe during the 2019 study (**Table 4-13; Figure 4-20**). Along the periphery of the lake, *Tecticornia* dominates, growing in association with *Frankenia* and *Carpobrotus modestus* (inland pigface), transitioning to *Atriplex* (saltbush) and *Frankenia* heath, as distance from the edge of the playa increases (Stantec 2020a). This is typical of riparian vegetation zonation of salt lakes, with samphires forming the primary fringing community along the shoreline (Mitchell and Wilcox 1994).

The highest abundance of plants recorded during the 2019 study were corresponded to *Tecticornia* spp. (3,549 plants), *Frankenia* sp. (533 plants), *Tecticornia pergranulata* subsp. *divaricata* (264 plants) and *Tecticornia* sp. Dennys Crossing (257 plants) (**Figure 4-20**). A mass germination of *Tecticornia* spp. juveniles at peripheral wetland PW04 accounted for the substantially high abundance of this taxon. *Tecticornia pergranulata* subsp. *divaricata* was most abundant at the peripheral wetland PW04 (137 plants), with comparatively lower abundances at the playa sites. In contrast the majority of *Tecticornia* sp. Dennys Crossing specimens were recorded from Lake Roe site LR10 (135 plants). *Tecticornia* sp.



Dennys Crossing is known from the interior and coastal areas of Western Australia throughout the southwest, Murchison, Goldfields and Pilbara regions (WAH 2025).

Although several taxa were common to the majority of sites, differences were evident in community structure, with less than 20% similarity in composition according to the hierarchical classification (**Figure 4-22**). Sites located on the northern shoreline of Lake Roe (LR03, LR04 and LR05) were considered the most similar (>40%) and were also closely grouped with Lake Roe sites LR11 and LR12, located within the proposed development envelope (**Figure 4-22**). These sites also tended to support the most diverse assemblage of species (≥ 10 taxa), with the following taxa common to most sites; *Atriplex nana*, *Carpobrotus* sp., *Frankenia* sp., *Poaceae* sp., *Surreya diandra* and *Tecticornia* spp..

At a local scale, factors such as distance to groundwater, elevation and geology (including soil properties), are known to be strongly influential on the riparian vegetation zone (Barrett 2006; Datson 2002). However, on a regional scale, the riparian zone of Lake Roe and the peripheral wetlands (**Appendix A**) was considered typical of vegetation associations throughout the Coolgardie bioregion. In addition, there were no declared rare flora, priority species, or weeds recorded during the 2019 study, although several *Tecticornia* representatives were not flowering at the time of collection, and require species level verification.

4.8.3 Cover and Density

Riparian plant cover during the 2019 study was low and typically ranged between 5% and 12% across the sites (**Figure 4-21**). Plant cover was highest at the Lake Roe site LR13 (23%), followed by peripheral wetland PW01 (19%) and playa site LR09 (15%). The substantially higher plant cover at LR13 was attributed to large *Eucalyptus* and *Melaleuca* shrubs and dense *Triodia* hummocks in quadrats at distance and elevated from the lake shore. In contrast, the dominance of *Tecticornia*; a genus that often displays a wide growth form (Datson 2002) contributed to the comparatively higher plant cover at PW01 and LR13.

The lowest plant cover (<7%) during the 2019 Study was recorded at Lake Roe sites LR06, LR07, LR08 and LR11 (**Figure 4-21**). With the exception of LR11, these sites were low-lying and consisted of mobile sands supporting an open shrubland of stunted *Tecticornia* plants (**Appendix A**). Factors affecting vegetation zonation in salt lakes includes soil salinity, depth to saline-ground water table, ephemeral hydroperiod and aeolian deposition (Barrett 2006).

More broadly, plant density was considered low during the 2019 study, with most sites across Lake Roe and the peripheral wetlands recording fewer than 10 plants/3 m² (**Figure 4-21**), although this is generally typical of salt lake margins throughout the Goldfields. The notable exception was PW04, where over 100 plants/3 m² were recorded, attributed to recruitment of *Tecticornia* spp.. This site also had higher moisture content and nutrients in the sediment in 2019 (**Section 4.2**), which is favourable for the germination of *Tecticornia* seeds (Datson 2002).



Table 4-12: Riparian zone habitats and vegetation types described from Lake Roe and peripheral wetlands (Stantec 2020a).

Habitat	Vegetation Type/Code	Vegetation Type Description
Riparian zone (lake margin and peripheral wetland)	TpTsp.Fsp.Cm	<i>Tecticornia pruinosa</i> and <i>Tecticornia</i> sp. low open samphires over <i>Frankenia</i> sp. and <i>Carpobrotus modestus</i> isolated low shrubs.
	CcFspA?vAhEc	<i>Callitris columellaris</i> open woodland over <i>Frankenia</i> sp. and <i>Atriplex ?vesicaria</i> open low shrubland over <i>Enneapogon caeruleus</i> and <i>Aristida holathera</i> var. <i>holathera</i> very open tussock grassland.
	CsAvFsp.	<i>Cratystylis subspinescens</i> and/or <i>Atriplex vesicaria</i> , and <i>Frankenia setosa</i> and/or <i>Frankenia</i> sp. low shrubland.
	AvFsFp(Tsp.)Er	<i>Atriplex vesicaria</i> , <i>Frankenia setosa</i> and <i>Frankenia pauciflora</i> open low heath with <i>Enteropogon ramosus</i> very scattered tussock grasses.

Representative Photographs





AvFsFp(Tsp.)Er	CcFspA?vAhEc	CsAvFsp.	TpTsp.Fsp.Cm
			

Table 4-13: Riparian vegetation taxa recorded from Lake Roe (■) and peripheral wetlands (■) during the 2019 study.

Riparian Vegetation Taxa	LR01	LR02	LR03	LR04	LR05	LR06	LR07	LR08	LR09	LR10	LR11	LR12	LR13	PW01	PW02	PW03	PW04
Aizoaceae																	
<i>Carpobrotus</i> sp.	31		32	4	19	42					23	4					4
<i>Disphyma crassifolium</i>										5	7						
<i>Gunnioopsis quadrifida</i>			2	1	14				1			7	1				
Amaranthaceae																	
<i>Surreya diandra</i>			27	26	31	2				9	11	21				10	
Asteraceae																	
Asteraceae sp.^				2							1						
<i>Cratystylis microphylla</i>												5					
<i>Minuria leptophylla</i>						16											
<i>Minuria</i> sp.^		2															
<i>Siemssenia capillaris</i>														2			
Chenopodiaceae																	
<i>Atriplex nana</i>	5	68	2	8	4	49	21		1	5	19	2		1	8		
<i>Atriplex</i> sp.^												3					
<i>Maireana amoena</i>											2						
<i>Maireana erioclada</i>												6		1			
<i>Maireana</i> sp.^		28			5	13	2				5	8			1		
<i>Roycea divaricata</i>				7								5					
<i>Sclerolaena frimbiolata</i>									25								
<i>Tecticornia dolliformis</i>														6			
<i>Tecticornia indica</i> subsp. <i>bidens</i>			23				12	11				9		12		177	
<i>Tecticornia pergranulata</i> subsp. <i>divaricata</i>	1	42	23	35										26			137
<i>Tecticornia pergranulata</i> subsp. <i>pergranulata</i>						44											
<i>Tecticornia pruinosa</i>					50											10	
<i>Tecticornia pterygosperma</i> subsp. <i>pterygosperma</i>											10						
<i>Tecticornia</i> sp. 1 (sterile)^															3		
<i>Tecticornia</i> sp. 2 (sterile)^																	
<i>Tecticornia</i> sp. 3 (sterile)^						1				12			11	6			
<i>Tecticornia</i> sp. 4 (sterile)^							1										
<i>Tecticornia</i> sp. 5 (sterile)^										2			2				
<i>Tecticornia</i> sp. 6 (sterile)^	215																
<i>Tecticornia</i> sp. 7 (sterile)^														8			
<i>Tecticornia</i> spp.*	14	7	1	7			8	57	95		14	6		1		45	3294
<i>Tecticornia</i> sp. Dennys Crossing		66	29	15						135					12		
<i>Tecticornia undulata</i>	10										10						
Cupressaceae																	
<i>Callitris</i> sp.				1													
Frankeniaceae																	
<i>Frankenia setosa</i>												1					



Riparian Vegetation Taxa	LR01	LR02	LR03	LR04	LR05	LR06	LR07	LR08	LR09	LR10	LR11	LR12	LR13	PW01	PW02	PW03	PW04
<i>Frankenia</i> sp.^	38	52	69	33	121	27	25		7	85	27	1	3			3	42
Malvaceae																	
<i>Lawrenzia helmsii</i>							5		23								
Myrtaceae																	
<i>Eucalyptus</i> sp.^													2				
<i>Melaleuca</i> sp.^													3				
<i>Melaleuca subalaris</i>														3			3
Poaceae																	
<i>Enneapogon caeruleus</i>											2						
<i>Eragrostis falcata</i>	57	62			7	79	45										
Poaceae sp.^			3	90	33					43	28	31		1	19		
<i>Triodia</i> sp.^		10		6					1	14		36	32	18			
Santalaceae																	
<i>Exocarpos</i> sp.			3		1												
Sapindaceae																	
<i>Dodonaea viscosa</i> subsp. <i>angustissima</i>		1				3					5				1		
Scrophulariaceae																	
<i>Eremophila miniata</i>		2		1								2					
<i>Eremophila scoparia</i>												2					
Solanaceae																	
<i>Solanum nummularium</i>												1					
Average Plant Health	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Diversity	7	10	10	13	9	9	7	1	6	8	13	17	6	11	6	3	4
Total Diversity	43												19				
	48																

Note: ^ = insufficient fruits or flowers to undertake identification; * includes unidentified specimens and germinates, not included in diversity counts; *Tecticornia* sp. Dennys Crossing is *Tecticornia* sp. Dennys Crossing (K.A. Shepherd & J. English KS552).



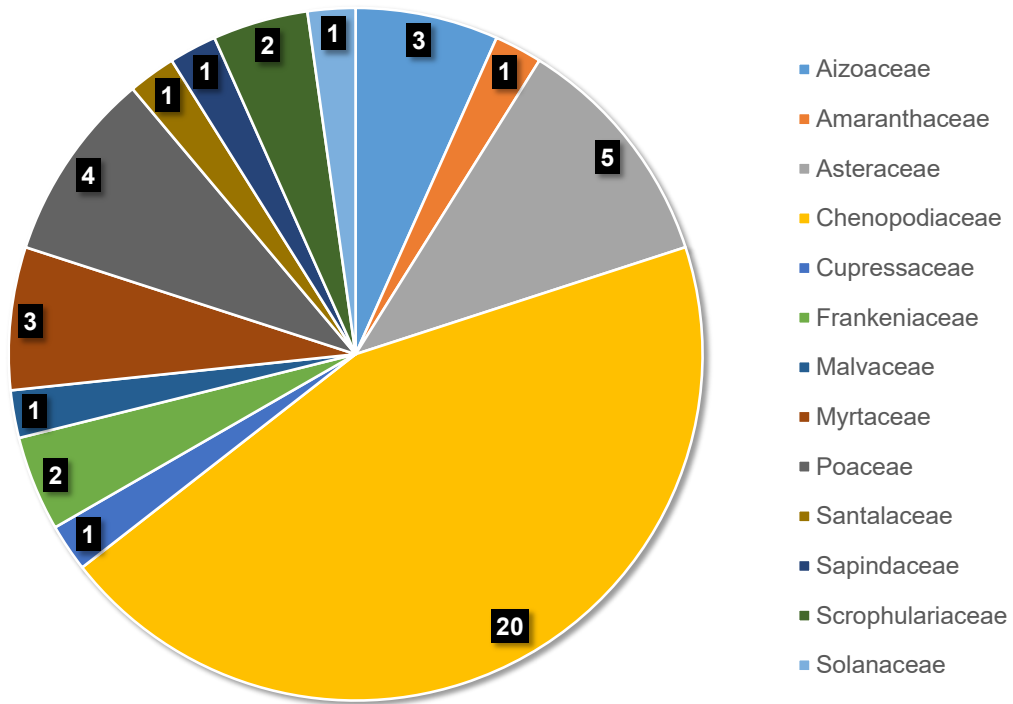


Figure 4-18: Diversity of riparian flora per family recorded during the 2019 study.

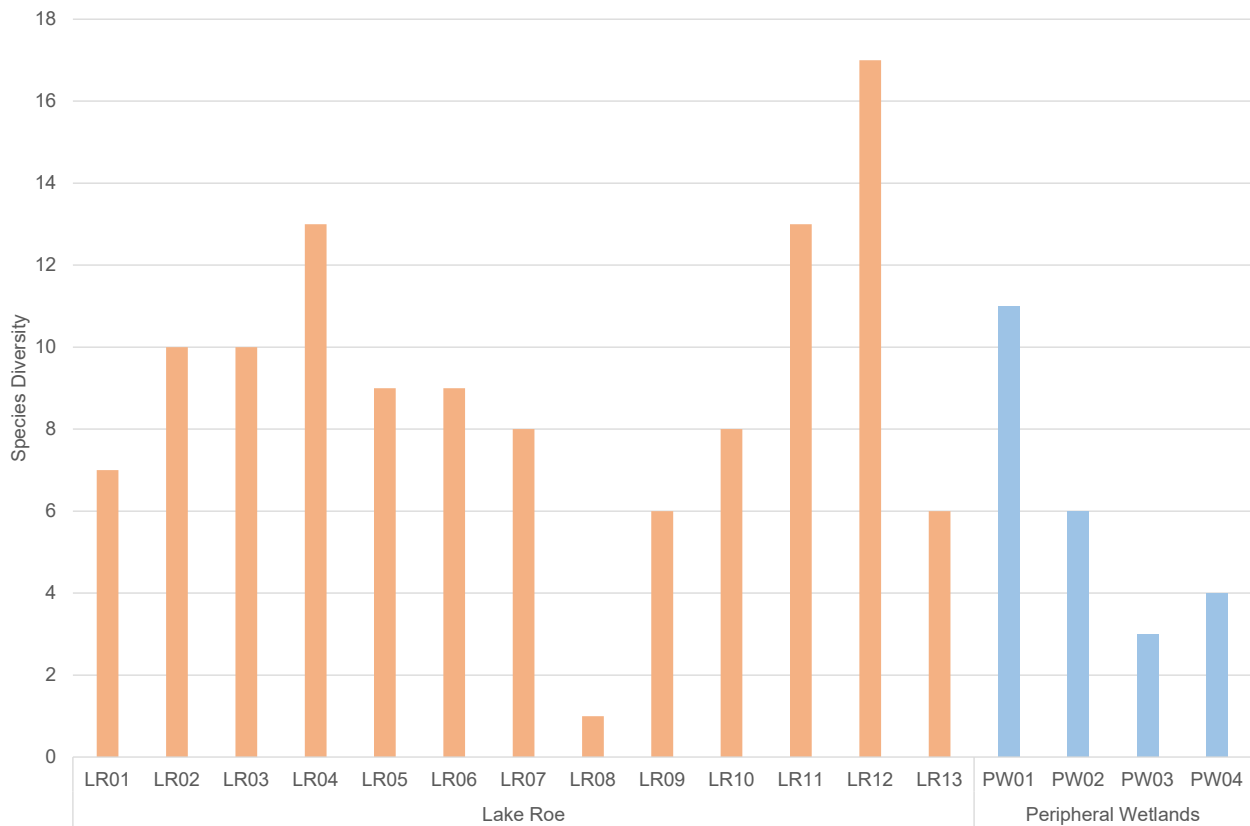


Figure 4-19: Diversity of riparian flora taxa per site recorded during the 2019 study.

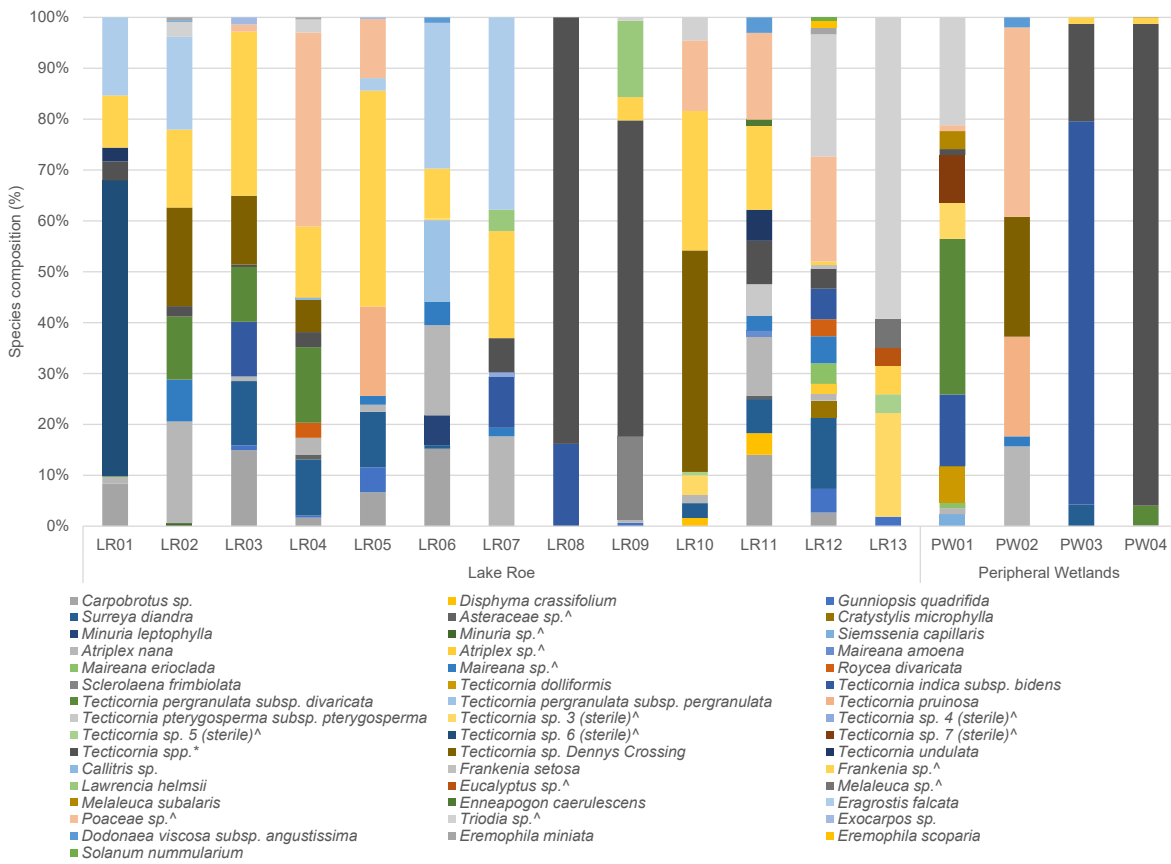


Figure 4-20: Percentage composition of riparian flora taxa recorded during the 2019 study.

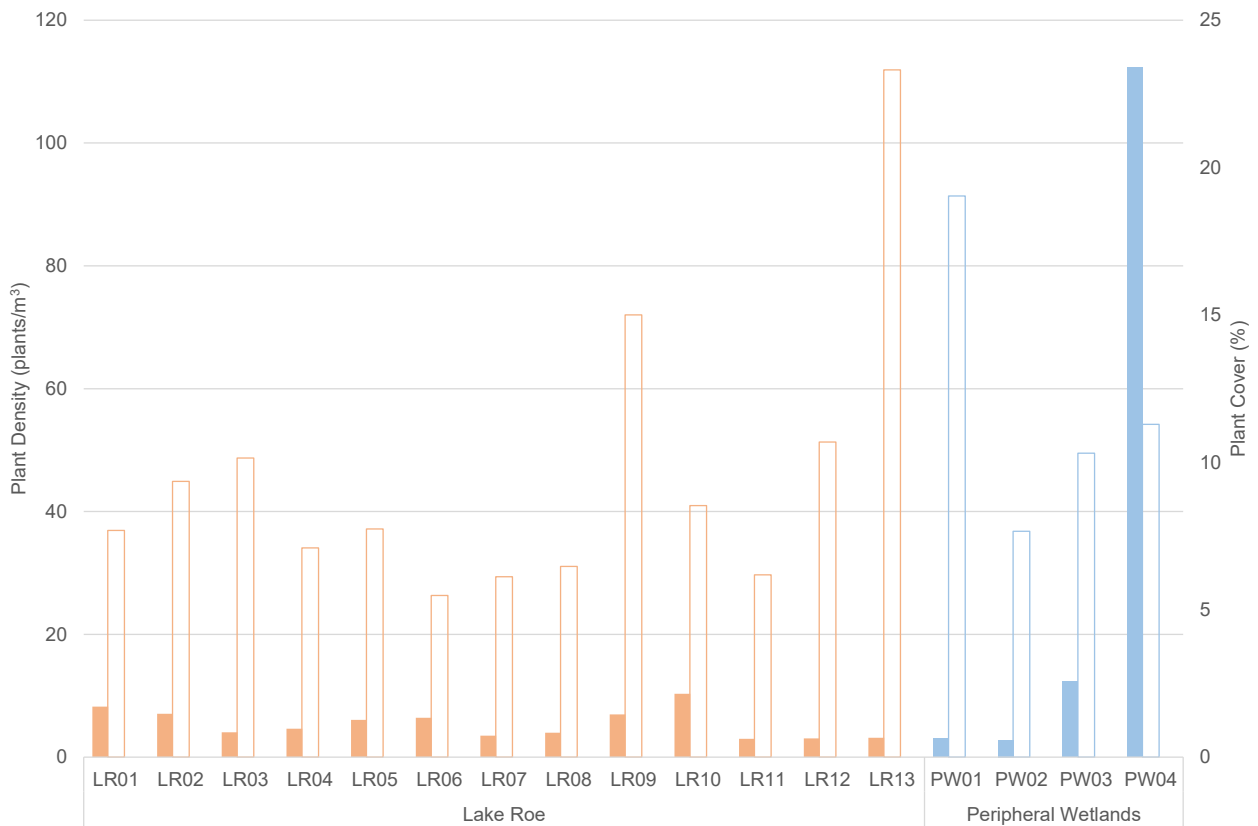


Figure 4-21: Plant density (solid fill) and cover (no fill) recorded during the 2019 study.



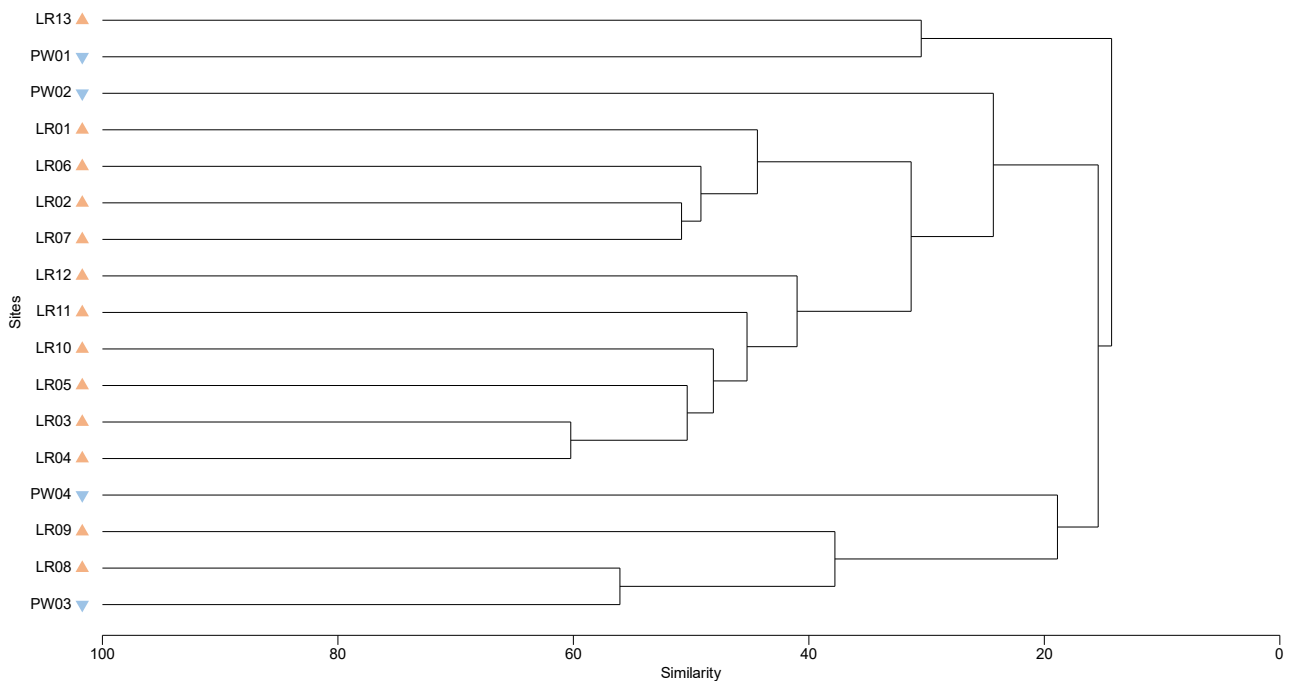


Figure 4-22: Dendrogram of the riparian vegetation assemblage recorded during the 2019 study (▲ =Lake Roe and ▼ =peripheral wetlands).

4.8.4 *Tecticornia* Assessment

Tecticornia taxa are members of the Chenopodiaceae family and are drought-tolerant, halophytic and able to withstand periods of inundation. While *Tecticornia* taxa are common inhabitants of the saline margins of salt lakes, they require freshwater to germinate and have varying soil salinity tolerances (Datson 2002). Elevation in the landscape, soil properties and distance to groundwater can influence the presence, dominance and species composition of *Tecticornia*. Zonation of *Tecticornia* spp. is common within chenopod shrublands of the riparian zone of salt lakes, although some species are more susceptible to waterlogging than others (Datson 2002).

4.8.4.1 Diversity

The total diversity of *Tecticornia* taxa recorded from Lake Roe and surrounds during the 2019 study and 2025 targeted survey work comprised 21 taxa, including 12 verified species and another nine sterile or novel taxa (Table 4-14; Table 4-15). There were 19 taxa associated with the riparian zone of the lake, while eight taxa were recorded from the riparian zone of the peripheral wetlands. Of these, 13 taxa were restricted to the riparian zone of Lake Roe (Table 4-14; Table 4-15) and three taxa were restricted to the peripheral wetlands, including *Tecticornia dolliformis*, *Tecticornia* sp. 1 (sterile) and *Tecticornia* sp. 7 (sterile).

The most widespread *Tecticornia* taxa included *Tecticornia indica* subsp. *bidens* and *Tecticornia* sp. Dennys Crossing, which occurred at 11 and 10 sites respectively, and were recorded during the 2019 and 2025 studies (Table 4-14; Table 4-15). Both taxa are considered to be widespread throughout Western Australia, and Australia more broadly, having been recorded from at least 30 and 12 IBRA bioregions, respectively (ALA 2025; WAH 2025), and nearby Lake Rebecca (Stantec unpublished data). *Tecticornia undulata* and *Tecticornia pergranulata* subsp. *divaricata* were also relatively common, recorded from six sites each, while the remaining taxa were recorded from between one and five sites (Table 4-14; Table 4-15).

4.8.4.2 Significance

During the 2019 study, seven taxa were sterile; *Tecticornia* sp. 1 to 7, while one taxon was sterile in the 2025 targeted survey work; *Tecticornia* sp. 3 (2025), with their taxonomy unable to be resolved due to a lack of fruiting or flowering parts (sterile specimens) at the time of collection. This was during dry conditions and these taxa are therefore considered species of other significance (EPA 2016c). These taxa were located within the riparian zone in the southern and eastern sections of Lake Roe, as well as being recorded from two of the peripheral wetlands (Figure 4-23). These unidentified taxa may belong to *Tecticornia* sp. Dennys Crossing, *Tecticornia indica* subsp. *bidens*, *Tecticornia undulata* or *Tecticornia pergranulata* subsp. *divaricata* (Table 4-15), based on verified taxon records from these sites.



In addition, two potential novel (new) taxa were also recorded during targeted searches from the 2025 targeted survey work at Lake Roe (Table 4-15; Figure 4-23), including:

- *Tecticornia* sp. nov. 1; with the closest affinity considered to be *Tecticornia* sp. Lake Wallambin (K.A. Shepherd KS 1157) (K. Shepherd pers. comm.), a Priority 1 species currently only known from the Avon Wheatbelt bioregion (WAH 2025), and
- *Tecticornia* sp. nov. 2; with the closest affinity considered to be *Tecticornia tenuis* (K. Shepherd pers. comm.)

Tecticornia sp. nov. 2 was recorded from six sites and is considered locally widespread, while *Tecticornia* sp. nov. 1 was restricted to a single site located in the southwestern section of the lake, adjacent to the proposed pits (Figure 4-23).

Due to the proximity of *Tecticornia* sp. nov. 1 to the proposed project, further study will likely be required to understand the distribution of this taxon for additional consideration in environmental impact assessment and approvals.

Table 4-14: *Tecticornia* taxa recorded from Lake Roe and peripheral wetlands during the 2019 and 2025 studies (■ indicates Lake Roe site sampled in 2019 and ● indicates Lake Roe site sampled in 2019 and 2025).

Riparian Vegetation Taxa	Lake Roe													Peripheral Wetland			
	LR01	LR02	LR03	LR04	LR05	LR06	LR07	LR08	LR09	LR10	LR11	LR12	LR13	PW01	PW02	PW03	PW04
<i>Tecticornia disarticulata</i>			●	●	●	●	●										
<i>Tecticornia dolliformis</i>														■			
<i>Tecticornia indica</i> subsp. <i>bidens</i>			▲	●	●	●	▲	■		●	●	■		■		■	
<i>Tecticornia moniliformis</i>						●			●								
<i>Tecticornia peltata</i>											●						
<i>Tecticornia pergranulata</i>																	
<i>Tecticornia pergranulata</i> subsp. <i>divaricata</i>	■	■	■	■										■			■
<i>Tecticornia pergranulata</i> subsp. <i>pergranulata</i>						■											
<i>Tecticornia pruinosa</i>				●	▲	●									■		
<i>Tecticornia pterygosperma</i> subsp. <i>pterygosperma</i>											■						
<i>Tecticornia</i> sp. 1 (sterile)															■		
<i>Tecticornia</i> sp. 2 (sterile)							■										
<i>Tecticornia</i> sp. 3 (sterile)						■				■			■	■			
<i>Tecticornia</i> sp. 3 (sterile) (2025)										■							
<i>Tecticornia</i> sp. 4 (sterile)							▲										
<i>Tecticornia</i> sp. 5 (sterile)										■			■				
<i>Tecticornia</i> sp. 6 (sterile)	■																
<i>Tecticornia</i> sp. 7 (sterile)														■			
<i>Tecticornia</i> sp. nov. 1											●						
<i>Tecticornia</i> sp. nov. 2			●	●		●	●			●							
<i>Tecticornia undulata</i>	■		●			●	●			●	▲						
<i>Tecticornia</i> sp. Dennys Crossing (K.A. Shepherd & J. English KS 552)		■	▲	▲	●	●	●		●	▲	●				■		
Diversity	19													8			

Note: ■ indicates record from the 2019 study; ● indicates record from the 2025 study; ▲ indicates record from the 2019 and 2025 studies.



Table 4-15: Distribution, significance and descriptions of *Tecticornia* taxa recorded at Lake Roe and peripheral wetlands during the 2019 and 2025 Studies.

Taxa / Survey Records	Sites and Distribution	Significance	Description
<i>Tecticornia</i> sp. sterile 1, <i>Tecticornia</i> sp. sterile 2, <i>Tecticornia</i> sp. sterile 4, <i>Tecticornia</i> sp. sterile 5, <i>Tecticornia</i> sp. sterile 6, <i>Tecticornia</i> sp. sterile 7			
Stantec 2019	Sites: Lake Roe LR01, LR07, LR10, LR13; peripheral wetland PW01, PW02 Distribution: ●	Species of other significance – sterile material	<i>Tecticornia</i> sp. sterile 1, <i>Tecticornia</i> sp. sterile 2 and <i>Tecticornia</i> sp. sterile 4 to <i>Tecticornia</i> sp. sterile 7 were unsuitable for verification by K. Shepherd (WAH) as they were sterile. These taxa were generally recorded from a single site located on Lake Roe or a peripheral wetland (Figure 4-23). It is assumed these are likely to be <i>Tecticornia</i> sp. Dennys Crossing, <i>Tecticornia indica</i> subsp. <i>bidens</i> , <i>Tecticornia undulata</i> or <i>Tecticornia pergranulata</i> subsp. <i>divaricata</i> based on the 2019 and 2025 studies (Table 4-14), comprising a total of two field surveys and more than 85 specimens collected. These taxa were shown to be widespread and common within the riparian zone during the 2019 and 2025 studies (Table 4-14). Records from the same sites as which the sterile taxa were recorded were characterised by <i>Tecticornia</i> sp. Dennys Crossing, <i>Tecticornia indica</i> subsp. <i>bidens</i> , <i>Tecticornia undulata</i> or <i>Tecticornia pergranulata</i> subsp. <i>divaricata</i>
<i>Tecticornia</i> sp. sterile 3 (2019)			
Stantec 2019	Sites: Lake Roe LR06, LR10, LR13; peripheral wetland PW01 Distribution: ●●	Species of other significance – sterile material	<i>Tecticornia</i> sp. sterile 3 (2019) was unsuitable for verification by K. Shepherd (WAH) as they were sterile. This taxon was recorded from Lake Roe's riparian zone and a peripheral wetland located in the southern region of the lake (Figure 4-23). It is assumed that this taxon is likely to be <i>Tecticornia indica</i> subsp. <i>bidens</i> or <i>Tecticornia</i> sp. Dennys Crossing, based on the 2019 and 2025 studies (Table 4-14), comprising a total of two field surveys and more than 85 specimens collected. These taxa were shown to be widespread and common within the riparian zone during the 2019 and 2025 studies (Table 4-14). Records from the same sites as which the sterile taxon was recorded were characterised by <i>Tecticornia indica</i> subsp. <i>bidens</i> and <i>Tecticornia</i> sp. Dennys Crossing.
<i>Tecticornia</i> sp. sterile 3 (2025)			
Stantec 2025	Sites: Lake Roe LR10 Distribution: ●	Species of other significance – sterile material	<i>Tecticornia</i> sp. sterile 3 (2025) was unsuitable for verification by K. Shepherd (WAH) as they were sterile. This taxon was recorded from Lake Roe's riparian zone (Figure 4-23). It is assumed that this taxon is likely to be <i>Tecticornia</i> sp. Dennys Crossing, based on the 2019 and 2025 studies (Table 4-14), comprising a total of two field surveys and more than 85 specimens collected. This taxon was shown to be widespread and common within the riparian zone during the 2019 and 2025 studies, and also characterised the site which the sterile taxon was recorded (Table 4-14).
<i>Tecticornia</i> sp. nov. 1			
Stantec 2025	Sites: Lake Roe LR11 Distribution: ●	Species of other significance – anomalous features that indicated a potential new discovery	<i>Tecticornia</i> sp. nov. 1 may potentially represent a new species, with the closest affinity considered to be <i>Tecticornia</i> sp. Lake Wallambin (K.A. Shepherd KS 1157) (K. Shepherd pers. comm.), a Priority 1 species currently only known from the Avon Wheatbelt bioregion (WAH 2025). This taxon was recorded from Lake Roe's riparian zone (Figure 4-23).
<i>Tecticornia</i> sp. nov. 2			
Stantec 2025	Sites: Lake Roe LR03, LR04, LR06, LR07, LR10 Distribution: ●●	Species of other significance – anomalous features that indicated a potential new discovery	<i>Tecticornia</i> sp. nov. 2 may potentially represent a new species, with the closest affinity considered to be <i>Tecticornia tenuis</i> (K. Shepherd pers. comm.). This taxon was recorded from Lake Roe's riparian zone (Figure 4-23).
<i>Tecticornia disarticulata</i>			
Stantec 2025	Sites: Lake Roe LR03, LR04, LR05, LR06, LR07 Distribution: ●●●	Nil	The Atlas of Living Australia contains 489 records of <i>Tecticornia disarticulata</i> , the majority of which occur in WA and SA. The WAH contains 114 vouchered records, distributed across 12 bioregions within WA (WAH 2025). This taxon was recorded from Lake Roe's riparian zone.
<i>Tecticornia doliformis</i>			
Stantec 2019	Sites: peripheral wetland PW01 Distribution: ●●●	Nil	<i>Tecticornia doliformis</i> is widespread throughout WA and has been recorded from 11 IBRA bioregions (WAH 2025). This taxon was recorded from a peripheral wetland located in the southern region of the lake.
<i>Tecticornia indica</i> subsp. <i>bidens</i>			
Stantec 2019, Stantec 2025	Sites: Lake Roe (2019) LR03, LR07, LR08, LR12; Lake Roe (2025) LR03, LR04, LR05, LR06, LR07, LR10, LR11; peripheral wetlands PW01, PW03 Distribution: ●●●	Nil	<i>Tecticornia indica</i> subsp. <i>bidens</i> is a common, widespread taxon recorded from 30 IBRA bioregions across four states (ALA 2025; WAH 2025). This taxon was recorded from Lake Roe's riparian zone and the peripheral wetlands.
<i>Tecticornia moniliformis</i>			
Stantec 2025	Sites: Lake Roe LR06, LR09 Distribution: ●●●	Nil	<i>Tecticornia moniliformis</i> a common, widespread taxon recorded from 9 IBRA regions across three states (ALA 2025; WAH 2025). This taxon was recorded from Lake Roe's riparian zone.
<i>Tecticornia peltata</i>			
Stantec 2025	Sites: Lake Roe LR11 Distribution: ●●●	Nil	<i>Tecticornia peltata</i> is widespread throughout WA and has been recorded from 12 IBRA bioregions (WAH 2025). This taxon was recorded from Lake Roe's riparian zone.
<i>Tecticornia pergranulata</i>			
Stantec 2025	Sites: Lake Roe LR03, LR04, LR06 Distribution: ●●●	Nil	<i>Tecticornia pergranulata</i> is a common, widespread taxon recorded from 16 IBRA regions (WAH 2025). This taxon was recorded from Lake Roe's riparian zone.
<i>Tecticornia pergranulata</i> subsp. <i>divaricata</i>			
Stantec 2019	Sites: Lake Roe LR01, LR02, LR03, LR04; peripheral wetland PW01, PW04 Distribution: ●●●	Nil	The Atlas of Living Australia contains 183 records of <i>Tecticornia pergranulata</i> subsp. <i>divaricata</i> , the majority of which occur in SA. The WAH contains three vouchered records, distributed across three bioregions within WA (WAH 2025). This taxon was recorded from the Lake Roe's riparian zone and the peripheral wetlands.

Taxa / Survey Records	Sites and Distribution	Significance	Description
<i>Tecticornia pergranulata</i> subsp. <i>pergranulata</i>			
Stantec 2019	Sites: Lake Roe LR06 Distribution: ●●●	Nil	<i>Tecticornia pergranulata</i> subsp. <i>pergranulata</i> is a common, widespread taxon recorded from 12 IBRA regions (WAH 2025). This taxon was recorded from Lake Roe's riparian zone.
<i>Tecticornia pruinosa</i>			
Stantec 2019, Stantec 2025	Sites: Lake Roe (2019) LR05; Lake Roe (2025) LR04, LR05, LR06; peripheral wetland PW02 Distribution: ●●●	Nil	<i>Tecticornia pruinosa</i> is a common, widespread taxon recorded from 22 IBRA bioregions across four states (ALA 2025; WAH 2025). This taxon was recorded from Lake Roe's riparian zone and a peripheral wetland located in the central west region of the lake.
<i>Tecticornia pterygosperma</i> subsp. <i>pterygosperma</i>			
Stantec 2019	Sites: Lake Roe LR11 Distribution: ●●●	Nil	<i>Tecticornia pterygosperma</i> subsp. <i>pterygosperma</i> is a common, widespread taxon recorded from 18 IBRA bioregions across four states (ALA 2025; WAH 2025). This taxon was recorded from a single site located on the southern margin of Lake Roe, adjacent to the proposed pit.
<i>Tecticornia undulata</i>			
Stantec 2019, Stantec 2025	Sites: Lake Roe (2019) LR01; Lake Roe (2025) LR03, LR06, LR07, LR10, LR11 Distribution: ●●●	Nil	<i>Tecticornia undulata</i> is widespread throughout WA and has been recorded from 12 IBRA bioregions (WAH 2025). This taxon was recorded from Lake Roe's riparian zone.
<i>Tecticornia</i> sp. Dennys Crossing (K.A. Shepherd & J. English KS 552)			
Stantec 2019, Stantec 2025	Sites: Lake Roe (2019) LR02, LR03, LR04, LR10; Lake Roe (2025) LR04, LR05, LR06, LR07, LR09, LR10, LR11; peripheral wetland PW02 Distribution: ●●●	Nil	<i>Tecticornia</i> sp. Dennys Crossing is widespread and distributed throughout WA, and Australia more broadly, from 12 IBRA bioregions (WAH 2025). This taxon was recorded from Lake Roe's riparian zone and a peripheral wetland located in the central west region of the lake, and is previously known from Lake Roe (WAH 2025).

Note: • indicates localised and uncommon; ● indicates locally widespread and common; ●●● indicates regional distribution and abundant.

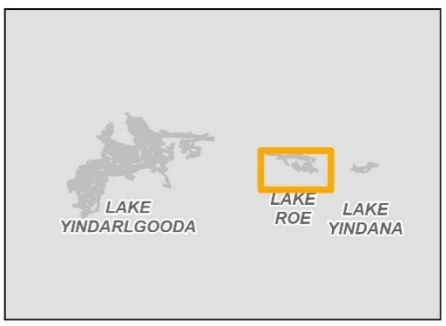


Significant Tecticornia Records
 Aquatic Ecology Study and Dewatering Discharge Assessment for the Roe Gold Project
 Client: Ramelius
 Project: 304501786
 Project Code: lroe_aq_2025_01
 Drawn By: TV, Checked By: SR, JP
 Date: 2026-01-28

Stantec

- Proposed Roe Gold Project Layout
- Species of Other Significance (Sterile Material)**
- ▲ Tecticornia sp. 1
- ▲ Tecticornia sp. 2
- ▲ Tecticornia sp. 3 (2019)
- ▲ Tecticornia sp. 3 (2025)
- ▲ Tecticornia sp. 4
- ▲ Tecticornia sp. 5
- ▲ Tecticornia sp. 6
- ▲ Tecticornia sp. 7
- Taxa of Scientific Interest**
- Tecticornia sp. nov. 1
- Tecticornia sp. nov. 2

Notes:
 1. Map displayed in GDA 1994 MGA Zone 51
 2. Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2026).
 3. Background: Earthstar Geographics



This document has been prepared based on information provided by others as cited in the data sources. Stantec has not verified the accuracy and/or completeness of this information and shall not be responsible for any errors or omissions which may be incorporated herein as a result. Stantec assumes no responsibility for data supplied in electronic format, and the recipient accepts full responsibility for verifying the accuracy and completeness of the data.

Figure 4-23: Distribution of significant Tecticornia taxa recorded from Lake Roe and peripheral wetlands during the 2019 and 2025 studies.

5. Conclusions

5.1 Summary of Ecological Values

The 2019 and 2025 studies provide baseline data on the aquatic and riparian ecology of the highly ephemeral Lake Roe and its peripheral wetlands, in the context of regional lakes and wetlands including nearby Lake Yindarlgooda and Lake Yindana. Sampling was completed on two occasions, in predominantly dry conditions, with rewetting trials undertaken in the laboratory and limited field collection carried out opportunistically at inundated sites. Assessment of the distribution, diversity and abundance of aquatic biota, waterbirds and riparian vegetation, as well as documenting significant and new taxa, provided an understanding of the ecological values at a local and regional level, considering hydrological processes.

The results of the 2019 and 2025 studies indicate that Lake Roe likely supports a productive biological community during flooding, characterised by broad salt tolerant taxa, comparable to other salt lakes throughout the Goldfields region, with similar ecological values. The northwestern section of the lake also provides a more permanent surface water source, with corresponding higher ecological values during the predominantly dry conditions. During larger flood events, it is expected that the ecological values of Lake Roe and the peripheral wetlands increase, as these inland waters create considerable habitat in a typically dry environment. These waterbodies are likely to host a diverse and abundant assemblage of algae, macrophytes, aquatic invertebrates and waterbirds, dependent on water quality and habitat availability. It is also likely that riparian vegetation will experience substantial germination and recruitment along the margins of Lake Roe. As water levels recede and surface water salinities increase in the lake, only salt tolerant biota will persist, before the lake dries out completely. A summary of the key findings of this study is presented in **Table 5-1** and detailed in the summary sections provided below, for each of the ecological components assessed.

5.2 Water Quality

During the 2025 study, isolated pools of surface water were present at Lake Roe and Lake Yindarlgooda, while one regional wetland was also inundated. The pH ranged from neutral (6.5 to 7.6) to alkaline (>7.5) (**Table 5-1**). Salinity (dominated by sodium and chloride) was comparable between Lake Roe and Lake Yindarlgooda, classified as hypersaline (>70,000 $\mu\text{S/cm}$), while the regional wetland was classified as mesosaline (30,000 to 70,000 $\mu\text{S/cm}$). In comparison, the results of the 2019 and 2025 rewetting trials suggested that during a major flood event, conditions at Lake Roe, the peripheral salinas, regional wetlands, Lake Yindarlgooda and Lake Yindana were likely to be alkaline, with salinity ranging from hyposaline, at the onset of flooding to hypersaline as the hydroperiod progresses. In the field, nutrients (TN and TP) were higher at the regional wetland, compared to Lake Roe and Lake Yindarlgooda, which were similar. Elevated total nitrogen and total phosphorus were likely associated with allochthonous inputs from riparian vegetation to the regional wetland. Dissolved metal concentrations were typically low; however, cadmium and copper exceeded their respective ANZG (2018) DGVs for marine waters at Lake Yindarlgooda (cadmium and copper) and the regional wetland (copper only). Naturally elevated background concentrations of these metals are likely related to differences in local geology throughout the region.

5.3 Sediment Quality

Sediment pH at Lake Roe, the peripheral wetlands, Lake Yindarlgooda, Lake Yindana and the regional wetlands ranged from strongly acidic to moderately alkaline across the 2019 and 2025 studies (**Table 5-1**). Acidic conditions at Lake Roe, the peripheral salinas and Lake Yindana were potentially related to acidic groundwater common throughout the region. Sediment salinity at Lake Roe was variable (42,800 mg/kg to 105,000 mg/kg), fluctuating according to site geomorphology and the influence of drainage lines. In comparison, Lake Yindarlgooda and Lake Yindana had a narrower salinity range (53,500 mg/kg to 69,400 mg/kg). Sediment salinity was typically higher at the peripheral wetlands and regional wetlands with most sites above >75,000 mg/kg, except at regional wetland RW01, which recorded a comparatively lower concentration (<20,000 mg/kg).

Nutrient concentrations were comparable between Lake Roe, Lake Yindarlgooda and Lake Yindana (**Table 5-1**), although the latter two lakes exhibited a narrower range, likely attributed to the lower number of sites sampled. The peripheral wetlands and regional wetlands had higher nutrients than the lakes, which was likely due to increased allochthonous inputs of organic matter. Concentrations of total metals in the sediments of Lake Roe and the peripheral wetlands, Lake Yindarlgooda, Lake Yindana, and regional wetlands were generally low during the 2019 and 2025 studies and were mostly below the ANZG (2018) DGVs. Exceptions included chromium and nickel, which exceeded the ANZG (2028) DGVs at most sites, attributed to natural mineralisation. Sites located along the eastern and southern sections of Lake Roe were typically characterised by lower metal concentrations, due to differences in catchment geology.



5.4 Algae

A total of 29 algal taxa were recorded during the 2019 and 2025 studies, all of which are known more broadly from inland waters throughout Australia (**Table 5-1**). Most of the records were from Lake Roe (16 taxa), compared to the peripheral wetlands (11 taxa) and remaining waterbodies (10 taxa), although this may be a function of increased sampling effort at the former. Three phyla were represented, dominated by Bacillariophyta (diatoms) and Cyanophyta (cyanobacteria), while Chlorophyta (green algae) contributed to the algal composition, albeit to a lesser degree.

Diatom taxa such as *Hantzschia* sp. aff. *baltica* and *Navicula* sp. aff. *incertata* were prevalent across both Lake Roe and the peripheral wetlands during the 2019 rewetting trials and are considered important primary producers in salt lakes. Filamentous cyanobacteria, comprising taxa such as *Planktolyngbya*, *Phormidium* and *Planktothrix* (**Table 5-1**) were also common in Lake Roe, with the former also recorded in the peripheral wetlands and Lake Yindarlgooda during the 2025 rewetting trials. In 2025, field sampling in the northwestern portion of Lake Roe found the cyanobacterium *Microcoleus* sp. was dominant in the benthos. While green algae were generally depauperate, the salt tolerant *Dunaliella* was abundant in the regional wetland RW01 in 2025 and was also present in Lake Roe and the peripheral wetlands in 2019. The assemblage of algae recorded throughout the region during the 2019 and 2025 studies varied widely, with water quality, and specifically salinity and nutrients considered to be the main drivers of composition.

5.5 Diatoms

A total of 35 diatom taxa were recorded from the rewetting trials conducted during the 2019 and 2025 studies (**Table 5-1**), with an assemblage characterised by halophilic taxa including *Amphora*, *Navicula* and *Hantzschia* representatives. There were no significant taxa identified, with all species also known from other salt lakes throughout Australia. Species diversity was higher at Lake Roe (24 taxa), compared to the peripheral wetlands (16 taxa), Lake Yindarlgooda (seven taxa), Lake Yindana (5 taxa) and the regional wetlands (17 taxa), although this was likely attributed to increased sampling effort at the former. However, the lakes and wetlands were dominated by common saline water species comprising *Navicula* sp. aff. *incertata*, *Navicula* sp. aff. *salinicola*, *Hantzschia* sp. aff. *baltica*, and *Amphora coffeaeformis* (**Table 5-1**). In addition, at Lake Yindana, *Pinnularia divergens* was prevalent, corresponding to the acidic sediment conditions, whereas in the regional wetlands, *Navicella pusilla* and *Navicula cincta* were more common, attributed to the geographic distinction of these waterbodies and associated heterogeneity of habitat.

5.6 Macrophytes

Three macrophyte taxa were recorded from Lake Roe and its peripheral and regional wetlands during the 2019 and 2025 studies (**Table 5-1**), comprising species typical of inland waters. The charophyte, *Chara* sp., was the most widespread, germinating across Lake Roe and the peripheral wetlands during the 2019 rewetting trials. This taxon was most abundant in the southwestern part of the lake. *Ruppia tuberosa* was also relatively widespread at Lake Roe during the 2019 rewetting trials and was recorded in the field at inundated site LR04_W (inundated on a semi-permanent basis), located in the northwestern section of the lake. A second charophyte, *Lamprothamnium* sp., germinated at one regional wetland during the 2025 rewetting trials. Based on the results of the 2019 and 2025 studies, Lake Roe supports a limited number of submerged macrophytes, considered typical of large inland salt lakes. Macrophyte productivity appears to be predominantly associated with the northern and southern parts of the lake, which also likely function as collection points for propagules.

5.7 Aquatic Invertebrates

The aquatic invertebrate assemblage identified during the 2019 and 2025 studies, which included rewetting trials and a limited number of field samples, was dominated by crustaceans (ostracods and *Parartemia*) (**Table 5-1**). More than 8,000 aquatic invertebrates, representing a total of 28 taxa were recorded from Lake Roe (14 taxa), the peripheral wetlands (10 taxa) and surrounding waterbodies, including Lake Yindarlgooda (nine taxa) and the regional wetlands (13 taxa). The ostracods *Diacypis phoxe*, *Reticypris* 'BOS1088', and *Patcypris outback* were widespread, while the anostracans *Parartemia veronicae* and *Parartemia serventyi*, were also relatively common. In addition, the inundated regional wetland RW01 comprised both crustacean and insect taxa.

Most of the taxa identified are known from inland waters throughout Australia or have been documented from lakes and wetlands throughout the Goldfields region, having broad salinity tolerance limits. However, four ostracod taxa recorded during the 2019 and 2025 studies represent potentially new or undescribed taxa (*Australocypris* 'BOS1364', *Diacypsis* 'BOS1969', *Reticypsis* 'BOS1088', and *Reticypsis* 'BOS1363'), with records from Lake Roe, the peripheral wetlands and/or Lake Yindarlgooda (**Table 5-1**). The key factors influencing the aquatic invertebrate assemblage included the water quality (specifically salinity) and habitat, with considerable heterogeneity in waterbodies throughout the region. While sampling was limited during flooding, Lake Roe and the regional lakes and wetlands are expected to have substantial productivity during flooding, providing an important food source for waterbirds.

5.8 Waterbirds

Seven species of waterbirds representing three families were identified at Lake Roe, Lake Yindarlgooda and a regional wetland (**Table 5-1**), as part of opportunistic observations recorded during the 2025 study. The highest diversity (four species) was recorded from the inundated site LR04_W, in the northwestern section of Lake Roe. Most waterbirds identified were common species, including the duck *Anas gracilis* (Grey Teal), *Cygnus atratus* (Black swan) and *Recurvirostra novaehollandiae* (Red-necked avocet). However, *Charadrius cucullatus* (hooded plover), listed as Priority 4 under the BC Act, was an exception, and was observed at site LR04_W. Lake Roe, similar to other inland waterbodies in the Goldfields is likely to provide important foraging and breeding habitat for waterbirds during major flood events.

5.9 Riparian Vegetation

Two habitat types were identified within the riparian zone of Lake Roe, including hypersaline lake margins and the margins of saline peripheral wetlands, comprising four distinct vegetation types. Vegetation within the riparian zone was dominated by chenopod shrubland, including four vegetation types, characterised by halophytic genera such as *Tecticornia*, *Frankenia* and *Maireana* (**Table 5-1**). During the 2019 study (predominantly dry conditions) 46 flora species from 25 families were recorded, with Chenopodiaceae the most diverse family (20 taxa), while an unidentified *Frankenia* sp. and *Atriplex nana* were the most widespread taxa (**Table 5-1**). *Tecticornia indica* subsp. *bidens* and *Tecticornia pergranulata* subsp. *divaricata* were also common and widespread. There were no introduced taxa recorded. Riparian vegetation plant density, cover and health was low, although was comparable between Lake Roe and the peripheral wetlands (**Table 5-1**). It is expected that following substantial rainfall, improved plant health and recruitment will occur.

The results of the consolidated *Tecticornia* (saphires) dataset from the 2019 study and targeted 2025 survey work identified 21 taxa, recorded across the riparian zone of Lake Roe and the peripheral wetlands (**Table 5-1**). Nineteen taxa were recorded from the lake margins, with eight taxa found within the margins of the peripheral wetlands. *Tecticornia indica* subsp. *bidens* and *Tecticornia* sp. Dennys Crossing were the most widespread species. The majority of *Tecticornia* (12 taxa) were common and/or widespread, while two were considered of other significance (potentially new species). Eight taxa were also sterile, although likely to belong to one of the verified species. Most species had a broader distribution throughout the area or across bioregions in Western Australia. However, a possible exception was *Tecticornia* sp. nov. 1, a potentially new species, which was recorded from a single site, located adjacent to the proposed pits. This taxon likely requires further consideration for environmental impact assessment and approvals.



Table 5-1: Summary of key findings and ecological values of Lake Roe, peripheral wetlands, Lake Yindargooda, regional wetlands and Lake Yindana during the 2019 and 2025 studies.

Ecological Aspects	Key Findings and/or Ecological Values	Dominant Taxa	Total Taxa	Lake Roe Taxa	Peripheral Wetland Taxa	Lake Yindargooda Taxa	Regional Wetlands Taxa	Lake Yindana Taxa	Taxa of Significance
Surface Hydrology	<ul style="list-style-type: none"> Lake Roe fills entirely on average once every five to 10 years Most of lake fills to depth of 2 to 3 m (1% AEP rainfall event) Lake holds surface water longest (semi-permanent) in northwestern section (likely an expression of groundwater) 	• N/A	• N/A	• N/A	• N/A	• N/A	• N/A	• N/A	• N/A
Water Quality	<ul style="list-style-type: none"> Lake Roe and Lake Yindargooda neutral to alkaline and hypersaline, with low nutrients Regional wetland alkaline and hyposaline, with higher nutrients. Metals above ANZG (2018) DGVs at Lake Yindargooda (Cd and Cu) and the regional wetland (Cu only) Conditions typically alkaline ranging from hyposaline to hypersaline in the lakes and wetlands during the rewetting trials 	• N/A	• N/A	• N/A	• N/A	• N/A	• N/A	• N/A	• N/A
Sediment Quality	<ul style="list-style-type: none"> Sediment pH variable ranging from strongly acidic to moderately alkaline across the lakes and wetlands Comparable salt loads in the lakes, although Lake Roe more variable, with low nutrients Typically higher salt loads and nutrients in peripheral wetlands and regional wetlands Variable metals with Cr and Ni above the ANZG (2018) DGVs 	• N/A	• N/A	• N/A	• N/A	• N/A	• N/A	• N/A	• N/A
Algae	<ul style="list-style-type: none"> Diatoms and blue-green algae dominant at Lake Roe, peripheral wetlands, Lake Yindargooda, Lake Yindana and regional wetlands, typical of temporary salt lakes Northwestern section of Lake Roe dominated by an extensive benthic algal mat of <i>Microcoleus</i> sp. during field sampling in 2025 Variable assemblage across the waterbodies spatially and temporally, attributed to varying water quality, specifically salinity and nutrients 	<ul style="list-style-type: none"> <i>Hantzschia</i> <i>Navicula</i> <i>Microcoleus</i> <i>Planktolyngbya</i> <i>Phormidium</i> <i>Planktothrix</i> <i>Dunaliella</i> 	• 29	• 17	• 11	• 8	• 6	• 0	• N/A
Macrophytes	<ul style="list-style-type: none"> Patchy distribution of species typical of saline waters In Lake Roe, predominately associated with the northern and southern parts of the playa 	<ul style="list-style-type: none"> <i>Chara</i> <i>Lamprothamnium</i> <i>Ruppia tuberosa</i> 	• 3	• 2	• 2	• 0	• 1	• 0	• N/A
Diatoms	<ul style="list-style-type: none"> Assemblages of Lake Roe, peripheral wetlands, Lake Yindargooda, Lake Yindana and regional wetlands characterised by halophilic and aerophilic taxa Greater total diversity at Lake Roe, attributed to increased sampling effort <i>Pinnularia</i> representatives dominant at Lake Yindana, reflecting acidic sediment conditions Greater variability in community composition at regional wetlands, attributed to heterogeneity of habitat and broader geographic distribution 	<ul style="list-style-type: none"> <i>Amphora coffeaeformis</i> <i>Hantzschia</i> sp. aff. <i>baltica</i> <i>Navicula</i> sp. aff. <i>incertata</i> <i>Navicula</i> sp. aff. <i>salinicola</i> 	• 35	• 24	• 16	• 7	• 17	• 5	• N/A
Aquatic Invertebrates	<ul style="list-style-type: none"> Composition dominated by crustaceans including ostracods and anostracans Inundated regional wetland RW01 comprised both crustacean and insect taxa Greater total diversity at Lake Roe, attributed to increased sampling effort Assemblage influence by key factors including water quality (salinity) and habitat heterogeneity 	<ul style="list-style-type: none"> <i>Diacypsis phoxe</i> <i>Reticypsis</i> 'BOS1088' <i>Patcypris outback</i> <i>Parartemia veronicae</i> <i>Parartemia serventyi</i> 	• 28	• 14	• 10	• 9	• 13	• 0	<ul style="list-style-type: none"> <i>Australocypris</i> 'BOS1364' <i>Diacypsis</i> 'BOS1969' <i>Reticypsis</i> 'BOS1088' <i>Reticypsis</i> 'BOS1363'
Waterbirds	<ul style="list-style-type: none"> Opportunistically observed utilising residual surface waters present in the northwestern section of Lake Roe and central section of Lake Yindargooda and an inundated regional wetland Dominated by common and nomadic taxa 	<ul style="list-style-type: none"> <i>Anas gracilis</i> (Grey teal) <i>Cygnus atratus</i> (Black swan) <i>Recurvirostra novaehollandiae</i> (Red-necked avocet). 	• 7	• 4	• 0	• 2	• 3	• 0	<ul style="list-style-type: none"> <i>Thinornis rubricollis</i> (Hooded plover) (P4)
Riparian Vegetation	<ul style="list-style-type: none"> Composition dominated by salt tolerant chenopods Assemblage typical of salt lake riparian vegetation No declared rare or priority flora or weeds 	<ul style="list-style-type: none"> <i>Tecticornia</i> spp. <i>Frankenia</i> sp. <i>Atriplex nana</i> 	• 48*	• 43*	• 19	• N/A	• N/A	• N/A	Potential new taxa: <ul style="list-style-type: none"> <i>Tecticornia</i> sp. nov. 1 & 2 Sterile material <ul style="list-style-type: none"> <i>Tecticornia</i> spp. (1-7) <i>Tecticornia</i> sp. 3 (2025)

Note: * indicates result based on the 2019 study only.

6. Recommendations

The 2019 and 2025 studies have provided an understanding of baseline conditions at Lake Roe within a local and regional context, providing a likely indication of the diversity and productivity that can be expected during flooded conditions. Although four new aquatic invertebrate taxa were recorded from Lake Roe, these also occurred in the peripheral wetlands and nearby Lake Yindarlgooda. There were also two *Tecticornia* taxa identified which may represent new species and a further six *Tecticornia* taxa that remain unverified. These results are considered typical of inland salt lakes, which have often not been comprehensively studied. Additional survey work during major flood events may also lead to new species being recorded in the future. Following the completion of the study, the remaining knowledge gaps, which may need to be addressed for environmental impact assessment and approvals, include:

- Sampling of aquatic biota and waterbird populations associated with Lake Roe and peripheral wetlands during a major flood event, to document diversity and productivity and verify these results.
- Assessing water and sediment quality at Lake Roe and surrounds to understand the variation over the course of the hydroperiod during a major flood event.
- Targeted *Tecticornia* survey work to understand the distribution of novel taxa, specifically *Tecticornia* nov. 1, which currently appears to be restricted to the margins of Lake Roe, in the vicinity of proposed pits.

Several recommendations are also provided for consideration by Ramelius, in relation to the Project layout and potential dewatering discharge (if this proceeds), outlined below.

Project Infrastructure and Layout

- Locate infrastructure in areas that minimise and/or avoid key aquatic and riparian vegetation habitat.
- Ensure the waste rock landform is suitably designed to reduce and/or prevent potential contaminant runoff into the lake via surface water and/or groundwater seepage.
- Ensure appropriate hydrological, hydrogeological and engineering studies are undertaken to optimise design and layout of Project infrastructure, minimising hydrological changes and the impacts of drawdown to the lake and surrounds.

Dewatering Discharge

- Review available digital elevation modelling of the playa to determine the most suitable proposed discharge outfall location, which should be on a large, open area of playa and within a deeper part of the basin, following natural drainage patterns, to minimise the backflow of water along tributaries and/or the riparian vegetation zone.
- Investigate pre-treatment options for the proposed discharge water, including settling ponds, if required, to reduce sedimentation and release of potential contaminants (metals and hydrocarbons) that may cause toxicity to aquatic biota and riparian vegetation.
- Ensure the proposed discharge infrastructure and outfall is appropriately designed, which may include securing the pipeline to the playa, to prevent movement during flooding, with energy dissipation at the outfall, to reduce flow and erosion.
- Consider ceasing any proposed hypersaline discharge to the lake during major flood events when salinity is low, to allow aquatic biota to emerge, persist and reproduce without the influence of hypersaline discharge water during the initial stages of flooding.

Addressing knowledge gaps and ensuring infrastructure and the proposed discharge outfall is appropriately positioned and designed will ensure the ecological integrity and hydrological regime of Lake Roe and the peripheral wetlands are maintained with minimal disturbance. It will also streamline environmental impact assessment related to inland waters and approvals for the Project.



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Appendices

Appendix A Riparian Vegetation Site Photographs, 2019 Study





Plate A1: Riparian vegetation sites assessed during the 2019 study. (A) LR01, (B) LR02, (C) LR03, (D) LR04, (E) LR05, and (F) LR06.





Plate A2: Riparian vegetation sites assessed during the 2019 study. (A) LR07, (B) LR08, (C) LR09, (D) LR10, (E) LR11, (F) LR12.



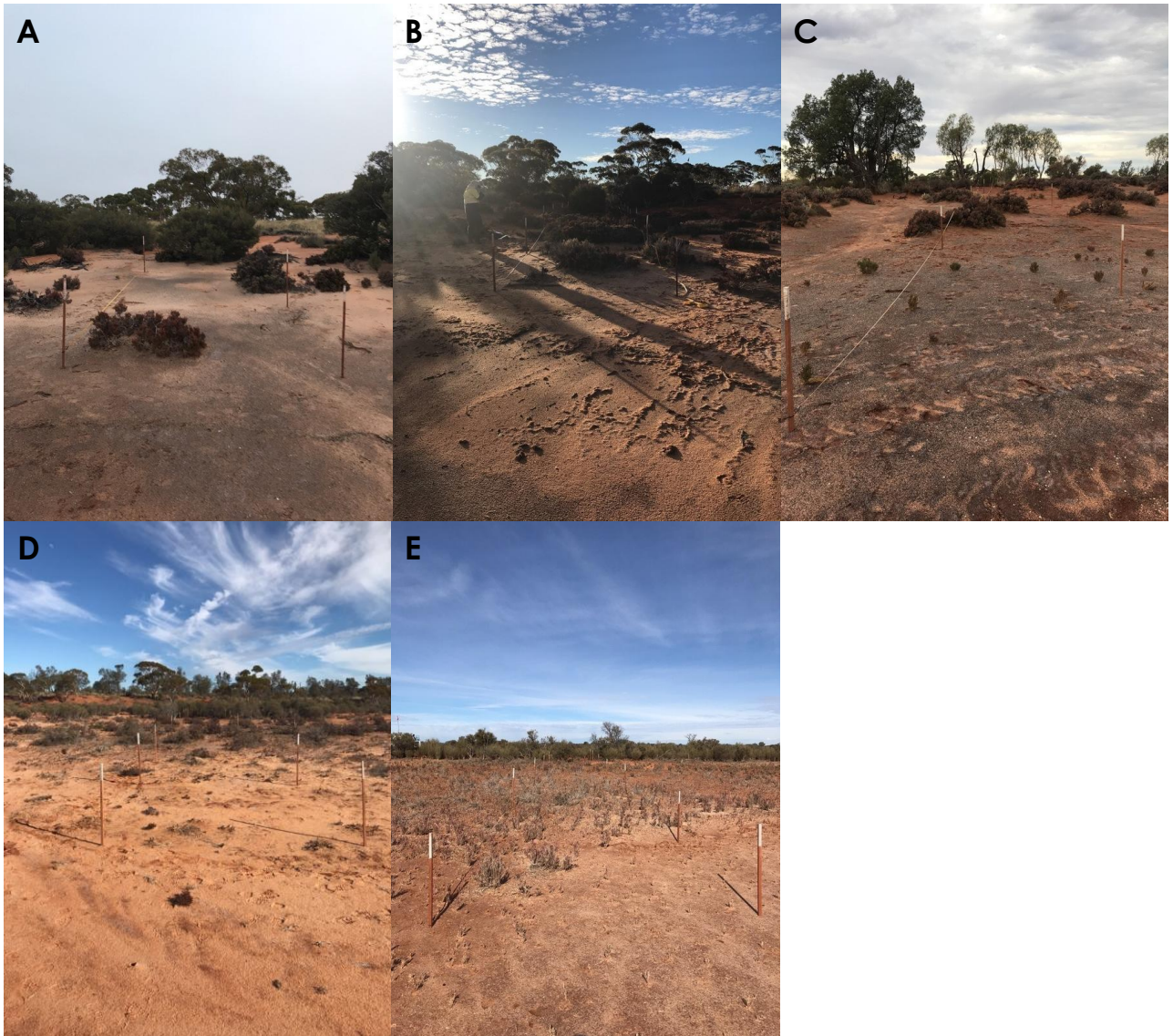


Plate A3: Riparian vegetation sites assessed during the 2019 study. (A) LR13, (B) PW01, (C) PW02, (D) PW03, (E) PW04.



Appendix B Rewetting Trials Water Quality
Summary Data for the 2019 and 2025
Studies



Table B-1: Summary of water quality ranges during rewetting trials for the 2019 and 2025 studies.

Rewetting Trials Water Quality Parameters		Lake Roe		Peripheral Wetlands				Lake Yindarlgooda	Regional Wetlands			Lake Yindana
				PW01	PW02	PW03	PW04		RW01	RW02	RW04	
		2019	2025	2019	2019	2019	2019	2025	2025	2025	2025	2025
pH (unit)	Min	4.3	6.5	7.1	7.3	6.8	7.3	7.2	7.3	6.7	7.2	4.7
	Mean	7.6	8.3	7.7	7.9	7.5	7.7	8.6	8.8	8.5	8.6	7.1
	Max	8.2	8.9	8.6	8.3	8.0	8.0	9.0	9.0	8.9	9.0	9.0
	St Dev	0.5	0.6	0.3	0.3	0.3	0.2	0.5	0.5	0.5	0.4	1.1
	No. Records	363	176	26	26	30	26	66	22	22	22	22
Total Dissolved Solids (mg/L)	Min	NR	5,734	NR	NR	NR	NR	5,568	3,222	7,902	4,981	5,106
	Mean	NR	28,129	NR	NR	NR	NR	22,488	8,871	27,763	33,155	18,996
	Max	NR	66,133	NR	NR	NR	NR	44,910	12,930	49,560	68,427	44,897
	St Dev	NR	10,095	NR	NR	NR	NR	8,453	2,330	9,166	15,283	9,703
	No. Records	NR	175	NR	NR	NR	NR	66	22	21	21	22
Electrical Conductivity (µS/cm)	Min	15,690	11,460	21,000	16,470	26,700	19,470	11,130	6,442	15,800	9,960	10,210
	Mean	43,753	53,169	44,658	39,253	51,391	52,937	42,438	20,169	52,870	60,362	35,853
	Max	91,100	89,300	57,800	66,900	74,400	77,600	66,700	73,971	76,000	98,500	63,900
	St Dev	11,766	16,816	9,692	12,624	13,709	13,973	14,167	12,921	15,410	23,104	16,486
	No. Records	364	172	26	26	30	26	64	22	22	21	22
Temperature (°C)	Min	20.5	22.7	22.9	22.6	22.6	22.5	23.1	23.6	23.8	23.6	22.9
	Mean	25.9	27.1	26.9	26.7	26.9	27.6	27.5	27.8	28.2	27.5	27.3
	Max	37.0	30.0	33.1	32.4	32.7	33.1	30.2	30.6	30.9	29.7	29.6
	St Dev	3.1	1.9	2.9	2.8	2.8	3.2	2.1	2.2	2.2	2.0	2.0
	No. Records	364	176	26	26	30	26	66	22	22	22	22



Appendix C *In situ* Water Quality Results



Table C-1: *In situ* basic water quality parameters recorded from surface waters during the 2025 study.

Parameter	Lake Roe	Lake Yindarlgooda	Regional Wetlands
	LR04_W	LYG06	RW01
pH (unit)	7.9	Surface water too shallow for analysis	8.8
Electrical Conductivity ($\mu\text{S}/\text{cm}$)	144,907		21,256
Total Dissolved Solids	86,020		12,650
Salinity (ppt)	126.2		13.9
Dissolved Oxygen	2.4		8.4
Redox Potential (mV)	83.2		88.4
Temperature ($^{\circ}\text{C}$)	21.1		21.0



Appendix D ANZG (2018) DVG and GV-High for Metals in Sediment



Table B-2: ANZG (2018) sediment quality guidelines DGV and GV-High values for metals.

Parameter	ANZG (2018)		
	DGV	GV-High	
Metals & Trace Elements	Arsenic	20	70
	Cadmium	2	10
	Chromium	80	370
	Copper	65	270
	Lead	50	220
	Mercury	0.15	1
	Nickel	21	52
	Zinc	200	410

Note: All units in mg/kg unless otherwise stated.



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