Environmental Review

Metropolitan Region Scheme Amendment 1388/57 – Wattle Grove South

EPA Assessment No: 2335

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Invitation to make a submission

The Environmental Protection Authority (EPA) invites people to make a submission on this Environmental Review for Metropolitan Region Scheme (MRS) Amendment 1388/57 – Wattle Grove South.

The Western Australian Planning Commission (WAPC) is proposing to rezone approximately 126 hectares (ha) of land in the Wattle Grove locality from 'Rural' to 'Urban' in the MRS to enable future residential development within the MRS amendment area.

The EPA has determined that the MRS amendment is to be assessed under Part IV of the *Environmental Protection Act 1986* and that an Environmental Review is required.

This Environmental Review document has been prepared in accordance with the EPA's *Procedures Manual*. The Environmental Review document is the report by the Responsible Authority (the WAPC) on their environmental review which describes the proposed MRS amendment and its likely effects on the environment.

The Environmental Review document and MRS amendment is available for a public review simultaneously. The Environmental Review document is available for a public review period of **60** days from **8 October 2024**, closing on **9 December 2024**.

Information on the proposed MRS amendment from the public may assist the EPA to prepare an assessment report in which it will make recommendations on the proposed MRS amendment to the Minister for Environment.

Why write a submission?

The WAPC seeks information that will inform the EPA's consideration of the likely effect of the proposed MRS amendment, if implemented, on the environment. This may include relevant new information that is not in the Environmental Review, such as alternative courses of action or approaches.

In preparing its assessment report for the Minister for Environment, the EPA will consider the information in submissions, the Responsible Authority's responses, and other relevant information.

Submissions will be treated as public documents unless provided and received in confidence, subject to the requirements of the *Freedom of Information Act 1992*.

Why not join a group?

It may be worthwhile joining a group or other groups interested in making a submission on similar issues. Joint submissions may help to reduce the workload for an individual or group. If you form a small group (up to 10 people) please indicate the names of each participant. If your group is larger, please indicate how many people your submission represents.

Developing a submission

You may agree or disagree with, or comment on information in the Environmental Review.

When making comments on specific elements in the Environmental Review document:

- Clearly state your point of view and give reasons for your conclusions.
- reference the source of your information, where applicable.
- suggest alternatives to improve environmental outcomes.

What to include in your submission

Include the following in your submission to make it easier for the EPA to consider your submission:

- Your name and address.
- Date of your submission.
- Whether you want your contact details to be confidential.
- A summary of your submission, if it is long.
- A list of points so that issues raised are clear, preferably by environmental factor.
- Refer each point to the page, section and if possible, paragraph of the Environmental Review document.
- Attach any reference material, if applicable. Make sure your information is accurate.

The closing date for public submissions is **9 December 2024.**

The WAPC prefers submissions to be made electronically via email: info@dplh.wa.gov.au.

Alternatively, submissions can be:

- Posted to: Chairman, WAPC Locked Bag 2506, Perth WA 6001
- Delivered to: WAPC, 140 William Street, Perth WA 6000

If you have any questions on how to make a submission, please contact WAPC/DPLH on (08) 6551 8002.

Scoping checklist

Task	Required Work	Section
Environmental Factor 1 – Inland Waters		
1.	Identify and assess the values and significance of hydrological and geological characteristics within the amendment area and surrounding area including for the broader Wattle Grove Urban Expansion and Urban Investigation area, particularly in relation to the GBSW, and describe these values in a local and regional context.	5.4.2 5.4.5 5.4.6
2.	Identify and map wetlands and watercourses within and adjacent to the amendment area including urban expansion and urban investigation areas and through work from the instructions below identify any areas proposed to be impacted.	5.4.4 5.4.5 5.4.6 5.5.1
3.	Map groundwater contours for the regional and perched groundwater tables over the amendment area using site specific monitoring data and monitoring data from other nearby bores including the Department of Water and Environmental Regulation (DWER) and Department of Biodiversity Conservation and Attractions (DBCA) sites to establish the groundwater flow direction. Assess results in comparison to previous regional mapping completed within the local area (amendment area, urban expansion and investigation areas). Liaise with DWER to obtain any monitoring data further to the publicly available data base. Additional long-term and extensive groundwater flow direction investigations (such as additional monitoring bores and an extended period of data collection) may be required to support groundwater flow mapping that is not consistent with the DWER mapping. Ensure that all superficial bores used in creating the regional groundwater contours are not perched and represent the groundwater in superficial aquifer.	5.4.3 Appendix B
4.	Map the surface water catchment for the amendment, urban expansion and urban investigation areas, and map the contribution of pre-development surface water flows to the surrounding wetlands and water courses.	5.4.4 Appendix B
5.	Describe the total water cycle for the amendment area in the context of it being within the Yule Brook Catchment and with consideration of the surrounding urban expansion and urban investigation area. Discuss the hydrology and hydrogeology, particularly as it relates to wetland and ecological diversity within and nearby to the amendment area. Include information and discussion on the water budget for the area, the existing drainage management practices and any known impacts on the wetlands and waterways in, and nearby to the amendment area.	5.4.2 5.4.5 5.4.6 5.5.1 Table 5-28
6.	Using a pre and post development water balance model, characterise the existing hydrology of the site and existing sub surface flow contribution to the GBSW; and assess the potential impacts (direct and indirect) of the proposed change in land use associated with the amendment, and urban expansion and investigation areas, on water quantity and quality of surface and ground waters and subsurface flow contribution in relation to nearby significant wetlands and waterways. The following should be considered in the development of any model: The model should be developed in consultation with DWER and DBCA and consider inputs of the PRAMS groundwater flow model inputs. • Provide details of the existing geological and hydrogeological conditions used in conceptualising any modelling undertaken.	5.4.2 5.4.5 5.4.6 5.5.1 Table 5-28 Appendix B

Task	Required Work	Section

	• The groundwater water balance and groundwater resources in the Superficial aquifer should consider PRAMS input parameters using the flow-net analysis with the Darcy equation. Groundwater throughflow from the site toward the GBSW should be calculated with consideration of the Darcy equation.
	• Demonstrate the water balance is based on an understanding of both the groundwater minimum and maximum for the amendment area and the GBSW. The assessment of soil/sediment gravimetric and volumetric water contents, where perched aquifers are suspected, is also required to adequately inform the water balance.
	• Minimum data and information required to support an appropriate water balance is listed below with accompanying published data.
	  ○ Minimum groundwater levels (collected April-May) – as shown in the published data logger data presented in WA wetlands conference poster (Bourke et. al. 2018).
	  ○ Groundwater levels (minimum and maximum) presented in metres below ground level – required to assess wetland flora and fauna and terrestrial vegetation groundwater dependency and threats (e.g. waterlogging, acidification and salinisation). (Lambers 2019).
	  ○ Volumetric water content, water retention and hydraulic conductivity – see Davis and Cahill (2018a) for horizontal hydraulic conductivity calculations using surface nuclear magnetic resonance (SNMR).
	  ○ Water quality within GBSW is known to be spatially varying (Davis and Cahill 2018a, and Lambers 2019). A spatial, temporal and lithological interpretation of water quality data is therefore required against water balance modelling outcomes to assess threats to wetland flora and fauna and terrestrial vegetation.	

7.	Calculate the additional recharge from the proposed change in land use associated with the amendment, and the resultant impact to the groundwater flow velocity and direction toward the GBSW. This should also include identification of the additional recharge from the urban expansion and investigation areas.	Table 5-28 5.5.1 Appendix A Appendix B
8.	Demonstrate that predevelopment surface water and groundwater flows to the Yule Brook and GBSW are maintained post development as a result of the proposed change in land use associated with this amendment, and urban expansion and investigation areas.	5.5.1 Appendix A Appendix B
9.	Estimate post development nutrient input and export rates resulting from the proposed change in land use, including through the use of DWER's Urban Nutrient Decision Outcomes (UNDO) model.	5.4.4.4 Appendix B
10.	Predict the extent, severity and duration of potential impacts further to items 5 to 9, including changes to local and regional groundwater flows and levels, drawdown, local water quality and impacts to other groundwater users as a result of the proposed change in land use associated with the amendment, and urban expansion and investigation areas, and provide measures to mitigate these impacts.	5.4.2 5.4.5 5.4.6 5.5.1 Table 5-28 Appendix A Appendix B

Task	Required Work	Section
11	Determine the boundaries of wetlands and/or buffer requirements to wetlands within and adjacent to the amendment area proposed to be retained. Boundary and buffer studies should consider the characteristics of hydrology, hydric soils and wetland vegetation, and the water balance of the wetland/wetland dependent vegetation.	5.4.5 5.4.6 Appendix C
12	In the context of the below, items 6, 8 and 11 should model existing conditions of, and potential changes to, groundwater and surface water chemistry, particularly in relation to salinity and soil sodicity, that will result from the proposed change in land use associated with this amendment, and urban expansion and investigation areas. Research in the southern area of the GBSW has shown the area is characterised by aquifers with locally elevated salinities and a water table that fluctuates from at or above the surface, to below ground level and there may be a risk from the provision of more groundwater or surface water to the GBSW, as this may persist into summer months and concentrate solutes in the root zone as it evaporates.	5.5 Appendix A Appendix S within Appendix B
13.	Describe how the principles of water sensitive urban design will be incorporated and implemented in the amendment area, consistent with the Better urban water management framework (WAPC 2008) and the Stormwater Management Manual for Western Australia (DWER 2004-2007) and other relevant guidelines.	5.5.1 Appendix A Appendix B
14.	Detail and discuss how future drainage practices within the site, is to be managed, considering the broader catchment. This management should ensure the hydrological balance and water quality of significant wetlands and watercourses within and nearby to the amendment area (such as the GBSW and Yule Brook) will be maintained.	5.5.1 Appendix A Appendix B
15.	Describe how drainage management practices could be adapted in the future to mitigate impacts of climate change on significant wetlands and waterways, within and adjacent to the amendment areas.	5.5.1 Appendix A Appendix B
16.	Using the mitigation hierarchy, detail and discuss how development activities will avoid and manage mobilisation of potentially poor-quality groundwater resulting from past agricultural land uses.	Table ES-1-2 Table ES-1-3 5.5.1
17.	Describe the planning or other mechanisms that will ensure drainage management will protect significant wetlands and watercourses within and adjacent to the amendment area.	5.5.1 Appendix B
18.	Describe the ongoing management requirements for the amendment area to ensure the hydrology of significant wetlands and watercourses within and nearby to the amendment area is maintained.	5.5.1 Appendix B
19.	Prepare a district water management strategy in accordance with the Guidelines for district water management strategies (DoW 2013).	5.5.1 Appendix B
20.	Prepare a monitoring program including management objectives, baseline conditions, public reporting and measures to be implemented in the event of non-compliance to management objectives.	5.5.1 Appendix B

Task	Required Work	Section
21.	Based on the outcomes of the above and taking into consideration the principles of avoidance and minimisation, identify an environmentally acceptable area for development.	5.5.1
22.	Provide a summary of residual impacts of future development and associated infrastructure within and adjacent to the amendment areas.	5.5.1 Appendix B
23.	Describe any proposed avoidance, mitigation and management measures that demonstrate the EPA's objectives can be met.	5.5.1 Appendix B
24.	Describe the planning mechanisms that are to be applied to ensure impacts are managed to meet the EPA's objectives.	5.5.1
Environmental Factor 2 – Flora and Vegetation		
25.	Identify and characterise the flora and vegetation present and likely to be present within the amendment area, in accordance with EPA Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment, December 2016. For existing flora and vegetation surveys completed for the amendment area, demonstrate (provide justification) how surveys are relevant, representative and demonstrate consistency with current EPA policy and guidance set out below. Include a summary of survey findings for the amendment area and an analysis of the significance of flora and vegetation in local and regional context in accordance with relevant EPA guidelines. Note: Ensure species database searches and taxonomic identifications are current. IBSA data packages should be provided in accordance with EPA guidance.	6.4 6.5
26.	For lots within the amendment which are accessible, Threatened Ecological Communities (TEC) identification and analysis to be undertaken in accordance with the most current version of Methods for survey and identification of Western Australian threatened ecological communities. Draft for consultation, currently Version 3: 14 April 2022. Individual quadrat data should be analysed to determine the FCT present using single site insertions against the Gibson et al. (1994) and Keighery et al. (2012 - Bush Forever) datasets, to minimise disruption. A combination of methods including cluster, nearest neighbours and similarity indices are also advised. Critical analysis of the logic of the outcomes of analysis is then required. The typical broad habitat features such as soil and landform, and hydrological status of quadrats established for Gibson et al. (1994) should also be explicitly discussed and compared in reporting.	6.5.6.3 Appendix E
27.	Provide maps depicting the survey effort (for existing and any future surveys) in relation to the amendment area, recorded locations of significant flora, ecological communities, and vegetation in relation to the amendment area in accordance with the relevant guidelines set out below. Clearly show any areas unable to be surveyed and indicate likelihood of occurrence of TECs and threatened and priority flora within these areas. Ensure species database searches and taxonomic identifications are up to date. Provide vegetation condition mapping.	6.4 Figure 6-1 to Figure 6-6

Task	Required Work	Section
28.	Identify and assess the potential direct, indirect and cumulative impacts of future development on the identified environmental values. Include a quantitative assessment of levels of impact on significant flora, listed ecological communities and all vegetation units. Describe and assess the extent of any cumulative impacts within local and regional contexts as appropriate. Provide a map(s) depicting areas of flora and vegetation detailing communities (including Floristic Community Type), units, and quality, to be retained and protected. Determine the ecological water requirements of; and identify buffers to significant vegetation.	6.6 Figure 6-1 to Figure 6-6
29.	Provide a quantitative assessment of impact: For significant flora, this includes: • Number of individuals and populations in a local and regional context; • Numbers and proportions of individuals and populations directly or potentially indirectly impacted, and • Numbers/proportions/populations currently protected within the conservation estate (where known). For all vegetation units (noting threatened and priority ecological communities and significant vegetation) this includes: • Area (in hectares) and proportions directly or potentially indirectly impacted, and • Proportions/hectares of the vegetation unit currently protected within conservation estate (where known).	6.6 Figure 6-1 to Figure 6-6
30.	Describe the planning or other mechanisms that will ensure vegetation identified for retention will be protected.	Table ES-1-2 Table ES-1-3 6.7 13
31.	Describe the ongoing management requirements to ensure retained areas of vegetation within the amendment area are managed appropriately and identify which planning or other mechanisms are required to ensure this management is implemented.	Table ES-1-2 Table ES-1-3 6.7 13
32.	Describe the ongoing management requirements for the amendment area, and broader urban expansion and investigation area, which would ensure the hydrological requirements of vegetation within the amendment and nearby (including GBSW) is maintained, and what planning or other mechanisms are required to ensure this management.	Table ES-1-2 Table ES-1-3 6.7 13
33.	Describe any proposed avoidance, mitigation and management measures that demonstrate the EPA's objectives can be met.	Table ES-1-2 Table ES-1-3 6.7 6.8 13

Task	Required Work	Section
34.	Identify, describe, and quantify the potential residual impacts (direct, indirect, and cumulative) that may occur after considering and applying the mitigation hierarchy.	Table ES-1-2 Table ES-1-3 6.7 6.8 13
35.	Based on the components of the amendment, determine and quantify any significant residual impacts by applying the Residual Impact Significance Model (page 11) and WA Offset Template (Appendix 1) in the WA Environmental Offsets Guidelines (2014). Where significant residual impacts remain, propose an appropriate offsets strategy. Spatial data defining the area of significant residual impacts for each environmental value should be provided (e.g. vegetation type, vegetation condition, specific fauna species habitat.).	11
36.	Describe the planning mechanisms that are to be applied to ensure impacts are managed to meet the EPA's objectives.	Table ES-1-2 Table ES-1-3 6.7 13
Environmental Factor 3 – Terrestrial Fauna		
37.	In accordance with the requirements of EPA guidance conduct a desktop study to identify and characterise the fauna and fauna habitats for the amendment area to inform local and regional context. Based on the results of the desktop study undertake the appropriate level survey and habitat assessment. • This should include survey/assessment within the amendment area and consideration of cumulative impacts. For identified significant (Threatened and Priority) fauna, this must include information on: • The abundance, distribution, ecology, and habitat preferences, together with baseline information and mapping of local and regional occurrences. • Population size and importance of the population from a local and regional perspective; and • Information on conservation value of each habitat type (e.g. breeding, migration, feeding, roosting etc.) from a local and regional perspective, including the percentage representation of each habitat site in relation to its local and regional extent. Note: Surveys should include both Terrestrial Vertebrate Fauna and Short-range Endemic (and/or other significant) Invertebrate Fauna. Survey design should ensure that adequate local and regional contextual data are collected and should consider cumulative impacts. If multiple surveys have been undertaken to support the assessment, a consolidated report should be provided including the integrated results of the surveys. Where surveys were undertaken at the referral stage, survey results and a demonstration of how the guidance has been followed are to be included in the Environmental Review. Ensure species database searches and taxonomic identifications are current. IBSA data packages should be provided in accordance with EPA guidance. Ensure species database searches and taxonomic identifications are up to date.	7.4 7.5

Task	Required Work	Section
38.	Provide a map of the survey effort applied in relation the fauna habitat, the study area and amendment area illustrating the known recorded locations of conservation significant species, other significant fauna and fauna habitat in relation to the amendment area. Clearly show any areas/lots unable to be surveyed. Mapping should also identify the direct and indirect impact areas.	7.4 Figure 7-1 to Figure 7-8
39.	Identify and describe the characteristics of the fauna and fauna habitat that may be impacted directly and indirectly by the amendment, development and provision of associated infrastructure and describe the significance of these values in a local and regional context. Describe significant habitats, including but not limited to: refugia, breeding areas, key foraging habitat, movement corridors and linkages. Habitats that are important to significant species, and the reasons for their importance, should be identified. Discussions of habitats should quantify the absolute and relative areas of the habitats in question, and that these discussions should be supported by tables and figures that illustrate the extents of habitats.	7.5 Figure 7-2 to Figure 7-9
40.	Identify significant fauna and describe in detail their known ecology, likelihood of occurrence, habitats, and known threats. Map the locations of significant fauna records in relation to the fauna habitats, the study area, the scheme amendment area, and potential direct, indirect, and cumulative impact areas.	7.5 7.6 Figure 7-1 to Figure 7-8
41.	Provide a map depicting areas of fauna habitat to be retained and protected from future subdivision, development and provision of associated infrastructure.	7.5 Figure 7-2 Figure 7-4 to Figure 7-7
42.	Detail, map and quantify areas of fauna habitat not proposed to be retained.	7.6.1 Figure 7-2 Figure 7-4 to Figure 7-7
43.	Describe and assess the extent of direct and indirect impacts as a result of the proposed change in land use associated with the amendment to terrestrial fauna taking into consideration cumulative impacts and the significance of fauna and fauna habitat. This should include an assessment of the risk posed to any significant species as a result of future development and associated infrastructure. For significant species, this should be done on a species-by-species basis. Significant species discussed should include short-range endemic and other significant invertebrates. Note: The likelihood of SRE fauna occurring within a given development area should be considered early in the environmental scoping stage. Preliminary SRE fauna risk assessments can then be used to set the context for a given assessment and as a reasoned basis to identify the extent of any surveys required.	7.6.1 7.6.2 7.6.3
44.	Apply the mitigation hierarchy and describe any proposed avoidance, mitigation and management measures that demonstrate the EPA's objectives can be met.	Table ES-1-2 Table ES-1-3 7.7
45.	Identify, describe and quantify the potential residual impacts (direct, indirect and cumulative) to fauna assemblages, habitats and significant species, that may occur following implementation of the amendment after considering and applying avoidance and minimisation measures, in a local and regional context.	Table ES-1-2 Table ES-1-3 7.7 7.6

Task	Required Work	Section
		7.8
46.	Based on the components of the amendment, determine and quantify any significant residual impacts by applying the Residual Impact Significance Model (page 11) and WA Offset Template (Appendix 1) in the WA Environmental Offsets Guidelines (2014). Where significant residual impacts remain, propose an appropriate offsets strategy.	11
47.	Describe the planning mechanisms that are to be applied to ensure impacts are managed to meet the EPA's objectives.	Table ES-1-2 Table ES-1-3 7.7 13
Environmental Factor 4 – Social Surroundings		
48.	Characterise the heritage and cultural values within the amendment area to identify sites of significance and their relevance within a wider regional context.	8.4 8.5
49.	Conduct appropriate consultation with Traditional Owners to identify areas of significance and any concerns in regard to environmental impacts as they affect heritage and cultural matters.	8.4
50.	Provide a description and figure(s) of the heritage and cultural values and proposed direct and indirect impacts within and adjacent to the amendment area (including the GBSW).	8.4 8.5
51.	Assess the direct and indirect impacts on known heritage sites, values and/or cultural associations, associated with the changes in land use which may impact on cultural and heritage significance (including the GBSW).	8.6
52	Predict the residual impacts on heritage sites, values and/or cultural associations, for direct, indirect and cumulative impacts after consideration of the mitigation hierarchy.	8.6
53.	Outline the mitigation and management measures to ensure impacts to heritage site, values and /or cultural association (direct and indirect) are minimised, and not greater than predicted.	8.7
54.	Identify and discuss the potential visual amenity impact from the change in land use on residents within and adjacent to the amendment area, and broader area.	8.6
55.	Describe the planning mechanisms that are to be applied to ensure impacts are managed to meet the EPA's objectives.	Table ES-1-2 Table ES-1-3 8.7 13

Task	Required Work	Section
Environmental Factor 5- Greenhouse Gas		
56.	Estimate the expected Scope 1 (direct) and Scope 2 (indirect) net greenhouse gas emissions (i.e. quantity of carbon dioxide equivalent (CO2-e)) on an annual basis and over the life of the scheme amendment inclusive of changes to land use (clearing of vegetation). Breakdown estimated emissions by source (e.g. changes to land use, clearing of vegetation). Detail the methods used to estimate the net greenhouse gas emissions.	9.5
57.	Describe the considered and proposed mitigations that demonstrate all reasonable and practicable measures have been applied at each step of the mitigation hierarchy to avoid, reduce and/or offset greenhouse gas emissions over the life of the scheme amendment.	9.6
58.	Where scope 1 emissions are estimated to exceed 100,000 tonnes per equivalent per annum, develop a Greenhouse Gas Management Plan in accordance with the EPA's Environmental Factor Guideline: Greenhouse Gas Emissions and demonstrate how the EPA's objective for this factor can be met.	NA

Executive summary

The Western Australian Planning Commission (WAPC) is proposing to rezone approximately 126 hectares (ha) of 'Rural' zoned land for 'Urban' use residential purposes, under the Metropolitan Region Scheme (MRS) Amendment 1388/57. The MRS amendment area is located within Wattle Grove, bound by Welshpool Road East and Crystal Brook Road to the north, and Tonkin Highway to the west. The MRS amendment area is located within the City of Kalamunda and is approximately 16 kilometres (km) south-east of Perth Central Business District (CBD).

Land use and development within the amendment area is controlled by the MRS and the City of Kalamunda Local Planning Scheme (LPS) No. 3. The MRS amendment area is currently zoned 'Special Rural' and 'Rural Composite' under the City of Kalamunda LPS No. 3. The MRS amendment also proposes to concurrently rezone the area to 'Urban Development' under the City of Kalamunda LPS No. 3.

A summary of the proposed MRS Amendment is provided in Table ES 1-1.

Table ES-1-1: Summary of MRS Amendment

Proposed MRS Scheme Amendment	**MRS Amendment 1388/57 – Wattle Grove South**
Responsible Authority	Western Australian Planning Commission
Location	Wattle Grove – land bound by Tonkin Highway (west), Welshpool Road East (north), Crystal Brook Road, Victoria Road and Easterbrook Road (east) and the rear boundaries of lots fronting Victoria Road (south).
Short Description	The amendment seeks to rezone approximately 126 ha of land in Wattle Grove from the 'Rural' zone to the 'Urban' zone under the MRS, and concurrently rezone the area to 'Urban Development' zone under the City of Kalamunda Local Planning Scheme No. 3, to allow for future structure planning, subdivision, development and use of land for urban purposes (Figure 1-2).

On 14 April 2022 the Environmental Protection Authority (EPA) advised MRS amendment 1388/57 – Wattle Grove South (Assessment No. 2335) was to be assessed under Part IV of the *Environmental Protection Act 1986* (EP Act). The EPA issued the Instructions for the Environmental Review (Assessment No. 2335) on 15 August 2022.

In accordance with the EPA's Environmental Review Instructions for MRS amendment 1388/57 – Wattle Grove South (Assessment No. 2335) and the Department of Planning, Land and Heritage's (DPLH) direction, a suite of environmental investigations, technical studies and documentation have been prepared for public review and the EPA's assessment. The EPA in its assessment and advice to the Minister for Environment must be satisfied that the identified potential environmental impacts associated with the implementation of the MRS amendment can be appropriately mitigated in accordance with the EPA's objectives for Inland Waters, Flora and Vegetation, Terrestrial Fauna and Social Surroundings.

Key environmental factors

This Environmental Review has been prepared by an industry leading consultant team on behalf of the Responsible Authority and provides an assessment against preliminary key environmental factors identified by the EPA.

The preliminary key environmental factors identified by the EPA for this Environmental Review are:

- Inland Waters
- Flora and Vegetation
- Terrestrial Fauna
- Social Surroundings
- Greenhouse Gas

The potential impacts, proposed mitigation and environmental outcomes identified for each environmental factor are summarised in Table ES-1-2, with further details on each environmental factor (and associated technical investigations) provided within this Environmental Review document.

Table ES-1-3 details the Environmental Management Framework, which demonstrates the robust statutory process containing numerous checks and oversight at each stage of the planning process. It ensures that land will be subdivided or developed within the MRS amendment area through its implementation and in compliance with the relevant implementation conditions recommended by the EPA and imposed by the Minister for Environment and in agreement with the Minister for Planning via the MRS amendment process. These conditions will be applied to the MRS amendment under Part IV of the EP Act or the *Planning and Development Act 2005* (PD Act) and administered through the planning process by the EPA, WAPC and City of Kalamunda on the expert advice of the relevant environmental agencies.

The mitigation hierarchy of avoid, minimise, rehabilitate and offset has been considered in the assessment of this MRS amendment. This assessment has determined that implementation of the concurrent MRS and City of Kalamunda LPS land use rezoning, will not have significant residual impacts and is considered environmentally acceptable if implemented in accordance with the mitigation measures proposed in this Environmental Review. Therefore, the EPA's objectives for Inland Waters, Flora and Vegetation, Terrestrial Fauna and Social Surroundings can be met.

Table ES-1-2: Summary of Potential Impacts, Proposed Mitigation and Proposed Environmental Outcomes

Potential impacts	Mitigation hierarchy	Residual impacts	Predicted outcome	Assessment of offsets (if relevant)
Key environmental factor: Inland waters				
• Impacts to current surface and ground water cycles (alteration of hydrological regimes) resulting in impacts to significant wetlands and waterways within and nearby to the amendment area, including the Yule Brook and the GBSW. • Impacts to water quantity and quality of significant wetlands and waterways within and nearby to the amendment area. • Impact to the hydrology and biodiversity of the Greater Brixton Street Wetlands (GBSW). • Loss of foreshore functions and groundwater and/or surface water dependent vegetation and impacts to other water dependent ecosystems.	***Avoid***: • The MRS amendment area excludes the GBSW. • Construction works within the MRS amendment area will only commence post the future adoption of a Local Structure Plan by the City of Kalamunda and the WAPC and a WAPC subdivision approval. Importantly, all future proposed works or construction activities will occur within the MRS amendment area outside of the mapped GBSW or Yule Brook areas. ***Minimise***: • Preparation and implementation of: o District Water Management Strategy (DWMS). o Local Water Management Strategy (LWMS). o Urban Water Management Plan(s) (UWMP) and associated detailed engineering and landscape plans. o Construction Environmental Management Plan (CEMP). o Acid Sulfate Soils Management Plan (ASSMP) if required. • Future LWMS and UWMP(s) will define the location and the stormwater bioretention swales/basins and the detailed engineering and landscape design of the swales and basins, and POS areas. • The water management framework embedded in the DWMS (Appendix B) along with the management of acid sulfate soils (ASS)/contamination and civil construction will be implemented throughout the sequential (or tiered) planning framework, and in accordance with: o Better urban water management (WAPC 2008). o State Planning Policy 2.9 Planning for Water (SPP 2.9). o Environmental Guidance for Planning and Development – Guidance Statement 33 (EPA 2008). o The WAPC's existing Model Subdivision Conditions (DPLH 2024b) has an established condition addressing the investigation and if required the management of ASS and contamination risks. o The preparation and implementation of the CEMP will be a requirement as a condition of subdivision and/or development application approval. ***Rehabilitate***: • N/A	***Groundwater*** • The pre-development total outflow estimate from the MRS amendment area was 158,567 kilolitre (kL)/year of broadly flowing toward the GBSW area. Pre-development, the groundwater contours for the Superficial Aquifer across the MRS amendment area range from approximately 16 m Australian Height Datum (AHD) in the north-eastern region to approximately 19 m AHD on the western boundary, with a groundwater depth ranging from 4 m to 20 m below natural surface. • Post development assuming a 'fully developed scenario' the increase in the Superficial Aquifer from surface water recharge is 65,976 kL/year. The recharge under the 'MRS amendment area developed only scenario' is estimate at 60,421 kL/year. • The proposed 'Urban' land use will increase groundwater levels due to reduced evapotranspiration and greater infiltration and recharge of the superficial aquifer, via runoff from roads, roofs, and other hard surfaces. • Seasonal and site-specific data (within the amendment area and the GBSW area) defined the local geology and groundwater contour mapping and groundwater flow direction. These technical assessments identified: o A steep hydraulic gradient at the western boundary of the MRS amendment area associated with low permeability geology. o A distinct groundwater mound beneath a former turf farm located along the western boundary of the amendment area. o The groundwater mound in combination with the local geology (i.e. Guildford Formation clays) strongly influences the local groundwater flow direction. Specifically, the seasonal groundwater flows confirm a radial flow direction (i.e. flowing north-west to flowing south-east) from the mound. o The groundwater mound beneath the former turf farm ranges up to 5 m in height and extends westward beneath the Tonkin Highway approximately 1.5 km west and north-west into the GBSW. o Regional groundwater depth ranged from 4 m to 20 m below natural surface (Figure 5-8). o The MRS amendment area has good clearance (maximum seasonal levels ranging from 4 m to 20 m below natural surface) to the Superficial Aquifer from permeable Yoganup Formation soils in contrast with the Guildford Formation geology and associated shallow perched groundwater within the GBSW area. o There are no unlined open drains within the MRS amendment area which incepts the Superficial Aquifer (Hyd2o 2024). o The ceasing of the turf farm irrigation (from the Leederville Aquifer) will alter the groundwater mound resulting in a reduction in groundwater levels from the turf farm extending approximately 1.5 km west and north-west into the GBSW. • Importantly, the increase in groundwater recharge in combination with locating stormwater management areas in the vicinity of the existing groundwater mound underpin the key hydrological objective of: o Maintaining the groundwater mound consistent with pre-development environment. • By maintaining the groundwater mound (consistent with pre-development conditions), via the groundwater recharge and focused surface water infiltration (in drainage basins/swales in the vicinity of the	**EPA Objective**: To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected. • Post development the groundwater quantity flowing towards the GBSW will be consistent with the pre-development flow. • The Water Balance Assessment (WBA) (Emerge Associates 2024) and Wattle Grove DWMS (Hyd20o 2024) confirm the 'Urban' land use will result in a net increase in surface water and groundwater. This is attributable to the increased areas of impermeable surface and removal of pasture and/or vegetated areas that will likely occur because of urbanisation within the MRS amendment area and the adjacent UE and UI areas. • This increase in water recharge into the Superficial Aquifer will assist (in combination with the DWMS stormwater management approach) to maintain the pre-development conditions • Maintaining post development recharge in the vicinity of the groundwater mound has been adopted as a key principle for the proposed stormwater management system to meet EPA's Inland Waters objective of maintaining the existing hydrological regime and maintain existing groundwater flows at this location post development. • Accordingly, post-development groundwater flows will be comparable with pre-development conditions and will continue to flow radially away from the groundwater mound flowing north-west flowing south-east and away from the GBSW area. • Further, the risk(s) post development to the Superficial Aquifer is not considered significant to the existing groundwater cycles that it would result in impacts to significant wetlands and waterways within the GBSW due to: o Groundwater flow post development will be in alignment with pre-development flow direction and will move radially away from the groundwater mound with dominant flows towards the north-west to flowing south-east and away from the GBSW area. o The recharge flow is within the deeper Superficial Aquifer (i.e. not the shallow perched water table). o The GBSW is situated atop of the alluvial Pinjarra Plain which is characterised by soils of the Guildford Formation. Within areas of the GBSW, the Guildford Formation clay form layers a complex sequence of clay lenses that are laterally and vertically varied which form a low permeable barrier between the perched water table, wetlands, and the Superficial Aquifer. • Any potential interaction between the Superficial Aquifer and the perched groundwater table within the GBSW is unlikely to be spatially unform across the GBSW (or the	The residual impacts are not considered so significant as to require offsets.

Potential impacts	Mitigation hierarchy	Residual impacts	Predicted outcome	Assessment of offsets (if relevant)
		mound) post-development groundwater flows are expected to be maintained comparable with pre-development conditions. • Specifically, post development, groundwater flow within the Superficial Aquifer will continue to flow radially from the groundwater mound with the dominant flow paths towards the north-west to flowing south-east consistent with the pre-development flows. Groundwater flows to the west will remain comparable to pre-development flows. • The groundwater assessment was premised on the 'fully developed scenario' i.e. inclusive of the Urban Investigation (UI)/Urban Expansion (UE) areas adjacent to the amendment area being subject to 'Urban' land use (Figure 1-1). • The assessment concludes there will be no impact(s) to Superficial Aquifer groundwater flows towards the GBSW or the Yule Brook from the proposed 'Urban' land use. • The Superficial Aquifer is several metres (4 m plus) below the shallow perched conditions experienced along the western boundary of the MRS amendment area and the portion of GBSW on the western side of Tonkin Highway. Accordingly, the minor change in groundwater recharge will not affect localised perched water conditions beneath GBSW The post-development contours for the Superficial Aquifer are expected to be consistent with the pre-development environment due to: o The increase recharge to the Superficial Aquifer. o The proposed stormwater management approach which maintains the groundwater mound. • The risk(s) post development to the Superficial Aquifer is not significant to the existing groundwater cycles that it would result in impacts to significant wetlands and waterways within the GBSW due to: o The recharge flow is within the deeper superficial aquifer (i.e. not the shallow perched water table). o The GBSW is situated above the alluvial Pinjarra Plain which is characterised by soils of the Guildford Formation. Within areas of the GBSW, the Guildford Formation clay form layers a complex sequence of clay lenses that are laterally and vertically varied which form a low permeable barrier between the perched water table, wetlands, and the Superficial Aquifer. o Key conclusions from hydrological assessment within the GBSW area confirm rainfall and ground water perching are the dominant hydrological process, for example: ▪ Semeniuk (2001) reported the wetlands within the GBSW area were maintained by surface and near surface perching of direct precipitation and by infiltration. During periods of below average rainfall groundwater in the Superficial Aquifer was considered likely to play only a minor part on the maintenance of the wetlands, with the major recharge mechanism for the wetlands identified as being direct precipitation, perching, infiltration, and sub surface perching. ▪ Bourke (2017) concluded in agreement with previous investigations was that the GBSW area was predominately a surface water feature and reliant largely on rainfall and surface water inflow. o The interaction between the Superficial Aquifer and the perched groundwater table within the GBSW is unlikely to be spatially unform across the GBSW (or the interaction is possibly limited to minor leakage through heavy clay layers).	interaction is possibly limited to minor leakage through heavy clay layers). • The Wattle Grove South DWMS (Hyd2o 2024) promotes an adaptive management approach for the MRS amendment area which is underpinned by the continued implementation of the current groundwater and surface water monitoring program. Figure 5-7 shows the local groundwater monitoring locations. • The monitoring program and reporting framework encapsulates monitoring of the Superficial Aquifer groundwater levels and quality (near the turf farm and the GBSW). This will enable: o Comparative and ongoing review of seasonal groundwater contours and flow direction pre-and post- development o The influence of the groundwater mound post development. o Comparative and ongoing review of groundwater quality. • The application of the inland waters' mitigation management measures via the sequential planning approval framework (established under the PD Act) in accordance with the Better urban water management guidelines (WAPC 2008) demonstrates the implementation of MRS Amendment 1388/57 (i.e. the 'Urban' land use) can satisfy the EPA's objective for Inland Waters.	

Potential impacts	Mitigation hierarchy	Residual impacts	Predicted outcome	Assessment of offsets (if relevant)

		Surface Water
		• The predicted increased in surface water volume exported from the MRS amendment area toward the GBSW is 24,524 kL/year assuming a 'fully developed scenario'. (Emerge Associates 2024). This consists of:
		  o 5,192 kL/year increase toward the GBSW area via the Boundary Road culvert and the former Crystral Brook tributary from the Boundary Road culvert
		  o 19,332 kL/year towards the Maddington Kenwick Strategic Employment Area (MKSEA) Precinct 2 open drains via Brentwood Road and Victoria Road culverts.
		  o Noting, the surface water outflows from the Urban Expansion (UE) and Urban Investigation (UI) areas (under the 'fully developed' scenario) contributes 13,674 kL/year of surface water flows to the MRS amendment area.
		• Surface water runoff to the GBSW will be mitigated through the adoption of stormwater management improvement via the use of water sensitive urban design techniques in accordance with:
		  o Better urban water management (WAPC 2008)
		  o Post development stormwater volumes and flows will be consistent with the existing surface water flows to the GBSW.
		• A net reduction in nutrients (63% total nitrogen reduction and 60% total phosphorus reduction) exported towards the GBSW because of the rural land use change and adoption of best practice water sensitive drainage design.
		Wetlands
		• The detailed wetland assessment recommends the existing REW management classification for the two REWs (UFI 8037 and portion of UFI 15257) within the MRS amendment area is revised to exclude/remove the two wetlands from the Department of Biodiversity, Conservation and Attractions (DBCA) Geomorphic Wetlands Swan Coastal Plain (GWSCP) dataset.
		• An application to amend the GWSCP dataset for the two REWs (UFI 8037 and portion of UFI 15257) within the MRS amendment area will occur concurrently with the finalisation of a future Local Structure Plan and LWMS.
		• The conclusion to remove the two Completely Degraded REWs (within the MRS amendment area) is consistent with DBCA's comments on the wetland's ecological values.
		• Portions of the wetland areas will be incorporated into POS and stormwater bio-retention areas adjacent to the Dampier to Bunbury National Gas Pipeline (DBNGP) and Water Corporation easement.
		• No significant residual impacts are predicted.
		Assessment
		• There will be no significant impacts to current surface and groundwater cycles resulting in impacts to significant wetlands and waterways within and nearby to the MRS amendment area including the Yule Brook and the GBSW.		

Potential impacts	Mitigation hierarchy	Residual impacts	Predicted outcome	Assessment of offsets (if relevant)
Key environmental factor: Flora and vegetation				

Direct and indirect loss of significant flora and vegetation, including threatened and priority ecological communities, threatened and priority flora, and vegetation complexes poorly represented in existing conservation reserves (Guildford Complex and Forrestfield and Southern River Complex).
 	
Potential impacts include:
 	
• Direct loss through clearing,
• Loss of fauna habitat (vegetation loss) short and long term,
• Impacts to wetland and riparian vegetation and groundwater dependant ecosystems within and nearby to the amendment area (including GBSW) through changes to hydrology,
• Spread or intensification of weeds and Phytophthora dieback,
• Fragmentation
	Avoid:
	
	• MRS amendment area does not extend over GBSW and does not include any high value wetland areas.
	• Retention and protection of all remnant vegetation (BaEpPf, BmXpEc and EmMpLp) in Good or better condition (3.61 ha) will ensure the following Threatened Ecological Community (TEC)/ Priority Ecological Community (PEC) are avoided and conserved for the long-term:
	  ○ Banksia Woodlands of the Swan Coastal Plain ecological community - Endangered (EPBC Act) and Priority 3 (DBCA listing).
	  ○ Probable FCT 20a *Banksia attenuata* woodlands over species rich dense shrublands WA TEC – Critically Endangered (BC Act).
	  ○ Probable FCT 20c Shrublands and Woodlands of the eastern side of the Swan Coastal Plain WA TEC – Critically Endangered (BC Act) and Federal TEC – Endangered (EPBC Act).
	
	• Current Conservation POS configuration will ensure retention of 84 conservation significant flora individuals within Conservation, including:
	  ○ 76 *Conospermum undulatum* (T)
	  ○ 14 *Isopogon autumnalis* (P3)
	
	However, final design and boundary of Conservation areas will ensure future LSP, subdivision and development retain all conservation significant flora.
	
	Mitigate:
	
	Preparation and implementation of:
	
	• Conservation Area Management Strategy and Plan(s)
	• Tree Canopy Retention and Landscape Management Strategy and Plan(s)
	• Local Water Management Strategy
	• Urban Water Management Plan(s)
	• Construction Environmental Management Plan
	• Environmental Offset Strategy and Plan(s) (if required)
	
	Rehabilitate:
	
	• Rehabilitation program to:
	  ○ manage TEC vegetation in Good or better condition
	  ○ restore TEC vegetation in degraded condition so that the vegetation condition rating of Good or better is achieved (should further survey with the areas identified Potential Future Conservation and Rehabilitation confirm the presence of TEC vegetation).
	
	• Revegetation and replanting of black cockatoo foraging trees
		• 0.08 ha of ha of Banksia Woodlands (BmXpEx) in Degraded condition, which is not considered to be a TEC due to its degraded condition.
		• 0.08 ha of Banksia Woodland (BaEpPf) in Completely Degraded condition, which is not considered to be a TEC due to its degraded condition.
		• Indirect impacts, including fragmentation, erosion, uncontrolled access, dust deposition and through the spread of weeds or disease.
		• As there will be no significant hydrological changes, there will be no significant impacts to wetland and riparian vegetation and groundwater dependant ecosystems in proximity to the MRS amendment area (including GBSW).
		
		Assessment
		
		• Low residual risk provided the mitigation hierarchy is followed and all conservation significant flora and remnant vegetation (BaEpPf, BmXpEc and EmMpLp) in Good or better condition is placed in Conservation areas, and any indirect impacts are managed through the Environmental Management Framework and preparation of the various environmental strategies and management plans.
			EPA Objective: To protect Flora and Vegetation so that biological diversity and ecological integrity are maintained.
			
			• No TEC/PECs will be lost as a result of clearing of native vegetation.
			• All conservation significant flora and vegetation will be avoided, retained, protected and managed.
			• No significant hydrological changes as a result of change in land use from rural to Urban, will ensure there are no significant impacts to wetland and riparian vegetation and groundwater dependant ecosystems within and nearby to the MRS amendment area (including GBSW).
			• All Southern River Complex and Forrestfield complex vegetation (in Good or better condition) will be avoided, protected and managed. Note: there are no areas of intact remnant vegetation within the area mapped as Guildford complex.
			• Implementation of environmental strategies and management plans will ensure impact mitigation measures are put in place during and post construction to prevent:
			  ○ Degradation of retained remnant native vegetation and conservation significant flora
			  ○ Introduction and increased spread of weeds and/or disease
			  ○ Hydrological changes
			  ○ Edge effects
			  ○ Fragmentation
			  ○ Dust deposition and erosion
			  ○ Uncontrolled access
				The residual impacts are not considered so significant as to require offsets.

Potential impacts	Mitigation hierarchy	Residual impacts	Predicted outcome	Assessment of offsets (if relevant)
Key environmental factor: Fauna				

• Loss of significant fauna habitat including black cockatoo habitat – breeding, roosting and foraging.
• Direct or indirect impacts or loss of other significant fauna and fauna habitat found to be present during survey
• Fragmentation of fauna habitat and loss of ecological connectivity.
• Degradation of fauna habitat and habitat modification from introduction and increased spread of weeds and/or disease, altered surface water flows, altered groundwater and edge effects.
• Fauna mortality as a result of construction activities.
• Disturbance to waterbirds (including migratory species) from impacts to wetlands.
• Altered fauna behaviour due to noise, lighting and human presence.
• Change in feral animal abundance and/or movement.
	Avoid:
	• 4.16 ha of Banksia Woodland fauna habitat to be retained, which comprise of:
	  ○ Medium and high-quality foraging habitat for Carnaby's cockatoo and Baudin's cockatoo.
	  ○ Low- and high-quality foraging habitat for Forest Red-tailed Black cockatoo
	  ○ 3 potential nesting trees for Black cockatoos
	  ○ Habitat for quenda
	  ○ Retention and protection of 4.35 ha (95.35%) of Banksia Woodlands within MRS amendment area
	• 0.05 ha of Eucalyptus Woodland fauna habitat to be retained, which comprise of:
	  ○ High quality foraging habitat for all three Black cockatoo species
	  ○ 4 potential nesting trees for Black cockatoos.
	  ○ Habitat for quenda
	• 0.32 ha of trees (both native and introduced) scattered across the MRS amendment area, which comprise of:
	  ○ Medium to low quality foraging habitat for Carnaby's cockatoo
	  ○ Low quality foraging habitat for Baudin's cockatoo and Forest Red-tailed black cockatoo
	
	Mitigate:
	Preparation and implementation of:
	• Conservation Area Management Strategy and Plan(s)
	• Local Water Management Strategy
	• Urban Water Management Plan(s)
	• Construction Environmental Management Pla
	• Tree Canopy Retention and Landscape Management Strategy and Plan(s)
	• Environmental Offset Strategy and Plan(s) (if required)
	
	Rehabilitate:
	• Revegetation and replanting of black cockatoo foraging trees
	• Rehabilitation of vegetation and fauna habitat in areas identified as Potential Future Conservation and Rehabilitation
		• 0.16 ha of degraded Banksia Woodland fauna habitat which comprise of:
		  ○ Low quality foraging habitat for Baudin's and Forest Red-tailed Black cockatoo
		  ○ Low and medium quality foraging habitat for Carnaby's
		  ○ 0 potential nesting trees for Black cockatoos
		  ○ Habitat for quenda
		• 26.58 ha of trees (both native and introduced species) scattered across the MRS amendment area, which comprise of:
		  ○ Mostly low-quality foraging habitat for all three Black cockatoos
		  ○ 0.72 ha and 0.80 ha of medium quality foraging habitat for Carnaby's cockatoo and Baudin's cockatoo, respectively
		  ○ 140 potential nesting trees for Black cockatoos
		  ○ Low quality habitat for quenda due to the absence of dense understorey
		  ○ However, it is likely there will be retention of these individual scattered native trees in future POS and road reserves, in line with the Environmental Management Framework and the requirement for a Tree Canopy Retention and Landscape Management Strategy and Plan(s), which is in line with typical contemporary urban development practices
		• 2.8 ha of trees and plants (both native and introduced species) dispersed across planted gardens in the MRS amendment area, which comprise of:
		  ○ Low quality foraging habitat for all three Black cockatoos
		  ○ 6 potential nesting trees for Black cockatoos
		  ○ Potential habitat for quenda
		• As there will be no significant hydrological changes, there will be no significant impacts to wetland and riparian vegetation and groundwater dependant ecosystems in proximity to the MRS amendment area (including GBSW) and therefore, no disturbance to waterbirds.
		
		Assessment:
		• Low residual risk provided the mitigation hierarchy is followed, and all conservation significant vegetation and high-quality black cockatoo foraging habitat and fauna habitat are placed in Conservation areas, and any indirect impacts are managed through the Environmental Management Framework and preparation of the various environmental strategies and management plans.
			EPA Objective: To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.
			• All high value fauna habitats will be avoided, retained, protected and managed for the long-term.
			• All high-quality foraging habitat for all three black cockatoos will be avoided, retained, protected and managed for the long term.
			• No MRS amendment related disturbance of conservation significant terrestrial fauna or fauna habitat outside of the MRS amendment area.
			• Implementation of environmental strategies and management plans will ensure impact mitigation measures are put in place during and post construction to prevent:
			  ○ Degradation of retained fauna habitat
			  ○ Introduction and increased spread of weeds and/or disease
			  ○ Hydrological changes
			  ○ Edge effects
			  ○ Fauna mortality
			  ○ Altered fauna behaviour due noise, lighting and human presence
			  ○ Change in feral animal abundance and/or movement
			  ○ Fragmentation
			  ○ Dust deposition and erosion
			  ○ Uncontrolled access.
				The residual impacts are not considered so significant as to require offsets.

Potential impacts	Mitigation hierarchy	Residual impacts	Predicted outcome	Assessment of offsets (if relevant)
Key environmental factor: Social surroundings				

• Disturbance to Aboriginal heritage places and/or cultural association within the area
• Changes to environment which may impact on Aboriginal heritage places
• Impacts to the natural, social and historical heritage values of the GBSW
• Impacts to the visual amenity associated with the natural and semi-rural character of the area
	Avoid:
	
	Physical Surroundings
	
	• MRS amendment area does not extend over GBSW.
	• Impacts to the Brentwood Road Swamp registered Aboriginal heritage site (if it still exists) will be avoided by virtue of its location in the easement for the *Dampier to Bunbury Natural Gas Pipeline Corridor. Statutory controls exist under the Dampier to Bunbury Pipeline Act 1997*, that preclude development within this easement.
	
	Minimise
	
	Physical Surroundings
	
	• Application for Section 18 approval under the *Aboriginal Heritage Act 1972*, for development within the vicinity of the Brentwood Road Swamp registered Aboriginal heritage site.
	• An Archaeological Site Survey (and Archaeological Management Strategy if required) should be submitted with the Section 18 application.
	• A Construction Environmental Management Plan for any development within 100 m of the Brentwood Road Swamp Aboriginal heritage site, or any endemic trees that hold important cultural associations for the Whadjuk Noongar people and have been identified for retention.
	
	Mitigate:
	
	Physical Surroundings
	
	• Visual amenity impacts will be mitigated through the preparation and implementation of:
	  ○ An 'Interface Transition Zone' (from rural to urban landscape character) along Crystal Brook Road.
	  ○ Local Visual Amenity Management Strategy.
	  ○ Visual Impact Assessment for development over three storeys (if required).
	• If endemic trees that hold important cultural associations for the Whadjuk Noongar people are identified through engagement with Traditional Owners an Interpretation Plan aimed at increasing awareness of their special meaning will be prepared.
	
	Biological Surroundings
	
	• Through the implementation of the mitigation measures for Inland Waters, potential impacts to the hydrological regime, plant life and fauna of wetlands and waterways in the region can be managed.
		• No residual impacts are anticipated once mitigation measures have been applied.
		
		Assessment:
		
		• Low residual risk
			EPA Objective: To protect social surroundings from significant harm.
			
			• Protection and conservation of the natural, social and historical cultural heritage values of the GBSW.
			• Protection and conservation of the Brentwood Road Swamp artefacts scatter (registered Aboriginal heritage site #4343) located within the MRS amendment area.
			• No impacts to other registered Aboriginal heritage sites in the region surrounding the MRS amendment area.
			• Retention and/or replanting of any endemic trees within the MRS amendment area that may hold important cultural associations for the Whadjuk Noongar people of the region.
			• Mitigation of potential impacts to visual amenity and landscape values through the implementation of appropriate mechanisms throughout the planning process.
				As no residual impacts are anticipated, there is no requirement for offsets.

Potential impacts	Mitigation hierarchy	Residual impacts	Predicted outcome	Assessment of offsets (if relevant)

	• In turn subsequent impacts to social surroundings can also be managed, including protection of the following values:
	  ○ The cultural heritage values of the GBSW, in particular its social and educational values.
	  ○ Endemic trees of the GBSW that hold important cultural associations for the Whadjuk Noongar people of the region.
	  ○ The registered Aboriginal heritage site, Yule Brook / Mandoorn and its mythological association with the Waugyl.
	  ○ The registered Aboriginal heritage site, Maamba Reserve and its association with Yule Brook.
	Rehabilitate:
	• Provisions within the Tree Canopy Retention and Landscape Management Plan for the retention and/or replanting of endemic trees that hold important cultural associations for the Whadjuk Noongar people (if any are identified through engagement with Traditional Owners).			

Key environmental factor: Greenhouse gas emissions				
• Greenhouse gas emissions through clearing and decomposition of vegetation.	Avoid: • Retention and protection of 4.21 ha to protect mapped native vegetation and associated fauna habitat Rehabilitate: • Revegetation and replanting of black cockatoo foraging trees	• Potential greenhouse emissions from clearing of native and non-native vegetation and loss of bio-sequestration capacity following development facilitated by the MRS amendment would be 11,360 tCO2-e.	**EPA Objective**: To minimise the risk of environmental harm associated with climate change by reducing greenhouse emissions as far as practicable. • The Amendment will result in Scope 1 emissions of no more than 11,360 tCO2 associated with clearing of native and non-native vegetation.	The residual impacts are not considered so significant as to require offsets.

Table ES-1-3: Environmental Management Framework

Planning mechanism	Legislation or agreement regulating the activity	Decision making authority	Stakeholder engagement in decision making	Environmental outcomes
Metropolitan Region Scheme (MRS)				
Binding statutory environmental conditions will be included in Schedule 1 of the MRS Text that require the following for each environmental factor:	***Environmental Protection Act 1986*** Ministerial conditions set pursuant to Part IV	**Minister for Environment**	**Minister for Planning**: Responsible for engaging with the Minister for Environment on the implementation of any conditions for the MRS amendment, pursuant to Part IV of EP Act. **EPA**: Responsible for advising Minister for Environment whether the MRS amendment can be implemented and if it should be subject to any conditions. **DWER and DBCA**: Responsible for providing expert advice to the EPA on any potential environmental impacts of the MRS amendment and their management.	**OVERARCHING** Conditions in Schedule 1 of the MRS Text will establish environmental management requirements for each stage of the planning process. The environmental conditions will ensure the significant environmental values are spatially identified and addressed prior to Local Structure Plan and/or subdivision/development, to ensure appropriate assessment and further environmental impact avoidance, minimisation, mitigation, protection and rehabilitation/offset (if required) measures are implemented. Future Local Structure Plans and/or applications for subdivision and development will be required to comply with the environmental conditions in Schedule 1 of the MRS Text and any associated Ministerial conditions set by the Minister for Environment in agreement with the Minister for Planning (Assessment No. 2335).
INLAND WATERS 1) A Local Water Management Strategy is to be submitted and approved at Local Structure Plan stage. 2) Urban Water Management Plan(s) are to be submitted and approved with all applications for the subdivision of land. 3) Local Water Management Strategy and Urban Water Management Plan(s) are to be prepared and approved in accordance with: a) The District Water Management Strategy endorsed as part of Assessment No. 2335 and any associated Ministerial conditions pursuant to Part IV of EP Act. b) All DWER and City of Kalamunda policies and guidance relating to urban water management. 4) Applications for the subdivision of land (and the endorsement of subsequent plans and diagrams of survey) will be conditional upon the preparation, approval and implementation of Urban Water Management Plan(s).				**INLAND WATERS** The requirement for future Local Water Management Strategy and Urban Water Management Plan(s) to be consistent with the District Water Management Strategy endorsed as part of Assessment No. 2335 will ensure that any specific requirements or objectives of the EPA will be satisfied in later stages of the planning process, including but not limited to: • Requirements for post development water monitoring. • Implementation of adaptive measures. This in turn will facilitate the protection of water quality, hydrology and environmental values of the Brixton Street Wetlands and Yule Brook.
FLORA and VEGETATION 1) Retention of all remnant patches of vegetation communities BaEpPf, BmXpEc and EmMpLp (in Good or better condition), containing conservation significant flora and/or high-quality foraging habitat for all three black cockatoos 2) Retention and rehabilitation of vegetation and conservation significant flora in areas identified as Potential Future Conservation and Rehabilitation on the Conservation Concept Plan, with the final boundary to be determined following detailed flora and vegetation surveys and development design. 3) Any applications to subdivide or develop land that was not previously the subject of onsite surveys for flora, vegetation and fauna at the date of the Minister for Environment's decision on Assessment No. 2335 must include an onsite survey of flora, vegetation and fauna (in accordance with EPA guidance) to be submitted: a) As the time of the subdivision or development application, or b) As part of a Local Structure Plan preceding the application. 4) The following management strategies are to be submitted and approved at Local Structure Plan Stage: a) Environmental Offsets Strategy (if required). b) Conservation Area Management Strategy (CAMS). c) Tree Canopy Retention Landscape Management Strategy. 5) The following is to be submitted and approved with all applications for the subdivision of land: a) A plan of subdivision that designates any remnant patches of vegetation communities BaEpPf, BmXpEc and EmMpLp (in Good or better condition) on the land for Conservation purposes. b) A Conservation Area Management Plan (CAMP) for any Conservation Areas within the subdivision area. c) A Tree Canopy Retention and Landscape Management Plan (TCRLMP).	***Planning and Development Act 2005*** **Part 4 – Region Planning Schemes** The MRS amendment (including the incorporation of environmental conditions in MRS Text) must be implemented in accordance with any Ministerial conditions set pursuant to Part IV of the EP Act.	**WAPC**	**EPA, DWER and DBCA**: Responsible for providing expert advice to the WAPC on the environmental conditions in Schedule 1 of the MRS Text. **Local Community**: Opportunity to provide written submissions during public advertising period for the MRS amendment and associated Environmental Review.	**FLORA AND VEGETATION** The environmental conditions included in Schedule 1 of the MRS Text will: • Ensure all patches of vegetation communities BaEpPf, BmXpEc and EmMpLp (in Good or better condition), (and conservation significant flora within the patches) are retained in the future subdivision and development of the land. • Retention and rehabilitation of vegetation and conservation significant flora in areas identified as Potential Future Conservation and Rehabilitation on the Conservation Concept Plan, with the final boundary to be determined following detailed flora and vegetation surveys and development design. • Provide for the identification and management of any additional ecological values on land that has not yet been subject to suitable onsite surveys for flora, vegetation and fauna. • If required, ensure that any potential significant loss to conservation significant vegetation in future subdivision and development proposals is appropriately offset in accordance with the Environmental Offset Framework endorsed as part of Assessment No. 2335.

Planning mechanism	Legislation or agreement regulating the activity	Decision making authority	Stakeholder engagement in decision making	Environmental outcomes
d) An Environmental Offset Management Plan (EOMP), if required by the Environmental Offset Management Strategy in the LSP. e) Prepare and implement a CEMP for all subdivision works within 100 m of remnant patches of vegetation communities BaEpPf, BmXpEc and EmMpLp (in Good or better condition), conservation significant flora and black cockatoo habitat identified for retention. 6) All of the above management strategies and plans (at LSP and subdivision application stage) are to be prepared and approved in accordance with: a) The Environmental Offsets Framework endorsed as part of Assessment No. 2335. b) Any specific matters to be addressed within the management strategies and plans, as required by any Ministerial conditions set in respect of Assessment No. 2335. c) All other relevant EPA guidance. 7) Applications for the subdivision of land (and the endorsement of subsequent plans and diagrams of survey) and/or Development Applications will be conditional upon: a) The designation of all remnant patches of vegetation communities BaEpPf, BmXpEc and EmMpLp (in Good or better condition) for Conservation purposes. b) The preparation, approval and implementation of CAMP's, TCRLMP's, EOMP's and CEMP's.				
TERRESTRIAL FAUNA As above for Flora and Vegetation.				**TERRESTRIAL FAUNA** As above for Flora and Vegetation.
SOCIAL SURROUNDINGS 1) Nil. Potential impacts to biological surroundings are mitigated via implementation of the recommended measures and planning mechanisms for Inland Waters, while potential impacts to physical surroundings can be adequately mitigated at later stages of the planning process. 2) The Brentwood Road Swamp Aboriginal heritage site (if it still exists) is also afforded protection under other legislation i.e. *the Dampier to Bunbury Pipeline Act 1997* (by virtue of its location in the DBNGP easement) and the *Aboriginal Heritage Act 1972*. 3) It is recommended that any development within the vicinity of the Brentwood Road Swamp heritage site be subject to an application for Section 18 approval under the Aboriginal Heritage Act 1972.				**SOCIAL SURROUNDINGS** Potential impacts will be adequately mitigated through the recommended measures and planning mechanisms for Inland Waters, at later stages of the planning process and through other legislation.
GREENHOUSE GAS Nil. No mitigation measures required.				**GREENHOUSE GAS** The MRS amendment meets the EPA's objective for Green House Gas.
Local Planning Scheme (LPS)				
Concurrent City of Kalamunda LPS No.3 amendment to 'Urban Development' zone.	***Planning and Development Act 2005*** **Section 123(3):** Provides for concurrent amendment of MRS and LPS maps, to rezone land for urban use. **City of Kalamunda LPS No.3** **Section 4.2.1:** The preparation and adoption of a structure plan is required for land zoned 'Urban Development'.	**Minister for Planning**	**WAPC**: Responsible for recommendation to Minister on concurrency of amending the MRS and LPS maps. **City of Kalamunda**: The WAPC is required to consult the relevant local government authority when amending the MRS and LPS maps concurrently before making its recommendation to the Minister.	• The 'Urban Development' zone in the City of Kalamunda LPS No.3 requires that a structure plan(s) be prepared for the subject land, to guide future subdivision and development. • The structure plan(s) will give visibility to the environmental conditions in Schedule 1 of the MRS Text and any Ministerial Conditions set in respect of Assessment No. 2335, ensuring they are appropriately implemented in later stages of the planning of process, through conditions of subdivision and development approval. • Conditions in Schedule 1 of the MRS Text will continue to have effect.

Planning mechanism	Legislation or agreement regulating the activity	Decision making authority	Stakeholder engagement in decision making	Environmental outcomes
Local Structure Plan (LSP)				
All LSP's for land within the MRS amendment area shall include the following at the time of lodgement with the City of Kalamunda: **INLAND WATERS** 1) A Local Water Management Strategy prepared in accordance with the environmental conditions in Schedule 1 of the MRS Text. **FLORA and VEGETATION** 1) An LSP map that designates the retention of all remnant patches of vegetation communities BaEpPf, BmXpEc and EmMpLp (in Good or better condition), containing conservation significant flora and/or high-quality foraging habitat for all three black cockatoos, for Conservation purposes. 2) The following management strategies prepared in accordance with the environmental conditions in Schedule 1 of the MRS Text: a) CAMS for all remnant patches of vegetation communities BaEpPf, BmXpEc and EmMpLp (in Good or better condition) identified on the LSP map to be retained for Conservation purposes. b) Tree Canopy Retention and Landscape Management Strategy. c) Environmental Offsets Strategy (if required). A suitable onsite survey of flora, vegetation and fauna for any land within the LSP area that was previously not surveyed at the date of the Minister for Environment's decision on Assessment No. 2335. **TERRESTRIAL FAUNA** As above for Flora and Vegetation. **SOCIAL SURROUNDINGS** 1) An LSP map that designates an 'Interface Transition Zone' along the boundary of Crystal Brook Road, to provide for a transition in visual landscape character from 'rural' to future 'urban' at this location. 2) Provisions in Part 1 of the LSP requiring future subdivision and development within the 'Interface Transition Zone' to: a) Reflect a contemporary rural aesthetic responsive to its surrounds. b) Provide for the retention of existing mature trees along Crystal Brook Road, where possible. 3) A Local Visual Amenity Management Strategy that provides for the identification and management of landscape values of local significance. 4) A Visual Impact Assessment (VIA) for any precincts with a proposed density coding that would permit development over three storeys in height. The VIA will need to demonstrate that the height and scale of	***Planning and Development (Local Planning Schemes) Regulations 2015*** **Deemed Provisions (Part 4):** Provides that Local Structure Plans must be prepared and submitted in a manner and form approved by the WAPC. This enables the WAPC to ensure the environmental conditions in Schedule 1 of the MRS Text are implemented at LSP stage. **Planning and Development (Local Planning Schemes) Regulations 2015, WA Planning Manual – Guidance for Structure Plans (WAPC)** Provides additional guidance on the preparation of LSP's and the requirement to address environmental matters.	**WAPC**	**City of Kalamunda**: Responsible for accepting, and endorsing LSP's, before forwarding onto the WAPC for final approval. **DWER and DBCA**: Responsible for providing expert advice to the City of Kalamunda and the WAPC on LSP's and all associated environmental management strategies. **Local Community**: Opportunity to provide written submissions during the public advertising period for LSP's.	**OVERARCHING** Detailed environmental strategies prepared to support LSPs (and in accordance with environmental conditions in Schedule 1 of the MRS Text), will provide further detail and structure to environmental management and the protection of significant environmental values, to guide the next stages of subdivision and development. **INLAND WATERS** Local Water Management Strategy will set the framework for ensuring future development is in accordance with the principles established in the Wattle Grove South DWMS, endorsed as part of Assessment No. 2335. This in turn will facilitate the protection of water quality, hydrology and environmental values of the Brixton Street Wetlands and Yule Brook. **FLORA AND VEGETATION** The Conservation Area Management Strategy will identify and characterise how the retention of all remnant patches of vegetation communities BaEpPf, BmXpEc and EmMpLp (in Good or better condition), containing conservation significant flora and/or high-quality foraging habitat for all three black cockatoos within the LSP area, are to be retained and protected, as well as the principles to be applied during the subdivision and development phases, to avoid and minimise any impact. The CAMS will establish a framework for the protection, enhancement and management of Conservation Areas, including: • Weed management. • Rehabilitation/revegetation requirements. • Fencing and access restriction. • TECs and/or conservation significant flora requirements. • Terrestrial fauna habitat requirements. • City of Kalamunda long-term management actions. • Any further studies required to prepare site specific CAMP(s) for each conservation POS area. If required, the Environmental Offset Strategy will be informed by the CAMS and Tree Canopy Retention and Landscape Management Strategy. It will consider the benefits of retention of existing habitat, offsets within the LSP area and potential offsets external to the LSP area (if required). **TERRESTRIAL FAUNA** As above for Flora and Vegetation. **SOCIAL SURROUNDINGS** • The implementation of an 'Interface Transition Zone' along Crystal Brook Road will enable the integrity of the 'rural look and feel' along this road to be retained. • The requirement for development over three storeys in height to be subject to a VIA will ensure that urbanisation does not interrupt the integrity of the panoramic views from Lions Lookout in Korung National Park. • The Local Visual Amenity Management Strategy will enable the integrity of any landscape values of local significance to be respected within the new urban environment.

Planning mechanism	Legislation or agreement regulating the activity	Decision making authority	Stakeholder engagement in decision making	Environmental outcomes
any development over three storeys will not interrupt the integrity of the panoramic views from Lions Lookout in Korung National Park. A strategy for the retention and/or replanting of any endemic trees that hold important cultural associations for the Whadjuk Noongar people of the region. The strategy is to be guided by engagement with the Traditional Owners of the land and incorporated into the TCRLMS.				Any endemic trees that hold important cultural associations for the Whadjuk Noongar people will be afforded recognition in the new urban environment (if any such trees are found to be present in the area).
GREENHOUSE GAS Nil. No mitigation measures required.				**GREENHOUSE GAS** The MRS amendment meets the EPA's objective for Green House Gas.
Subdivision (and Development)				
Any applications for the subdivision of land within the MRS amendment area shall include the following at the time of lodgement with the WAPC:	***Planning and Development Act 2005*** **Part 10** **Section 143(1)(c):** Provides that the WAPC can place binding statutory conditions on applications for the subdivision of land that: • Require preparation, approval and implementation of the environmental management plans in Schedule 1 of the MRS Text. • Addresses any ecological values identified in new site surveys submitted for previously unsurveyed land. **Part 10** **Section 145(4):** This section of the Act provides that the WAPC's endorsement of a diagram or plan of survey for the subdivision is subject to the WAPC being satisfied that all conditions of the subdivision approval have been complied with, including the implementation of environmental management plans.	**WAPC**	**DWER, DBCA and City of Kalamunda**: Responsible for providing expert advice to the WAPC on: • Subdivision applications and recommended conditions of approval. • Compliance with subdivision conditions at the time of endorsing a diagram or plan of survey.	**OVERARCHING** Conditions imposed on applications for subdivision and development will require compliance with the environmental conditions in Schedule 1 of the MRS Text and any Ministerial conditions pursuant to Assessment No. 2335.
INLAND WATERS 1) An Urban Water Management Plan prepared in accordance with the environmental conditions in Schedule 1 of the MRS Text.				**INLAND WATERS** Implementation of approved Urban Water Management Plan(s) will ensure subdivision and development meets the principles and objectives established in the Wattle Grove South DWMS, endorsed as part of Assessment No. 2335. UWMP's will also facilitate ongoing surface and groundwater monitoring in the post development environment, to: • Ensure there is no adverse impact on the hydrological regime of the area or the GBSW and Yule Brook. • Inform the implementation of adaptive management measures (if required). Total water cycle management and water sensitive urban design principles will be implemented to ensure that subdivision and development is consistent with current best practice management and planning for the sustainable use of water resources, including water quality objectives to mitigate any impacts to the surrounding environment, including the GBSW and Yule Brook.
FLORA and VEGETATION 1) A plan of subdivision that designates the retention of all remnant patches of vegetation communities BaEpPf, BmXpEc and EmMpLp (in Good or better condition) containing conservation significant flora and/or high-quality foraging habitat for all three black cockatoos for Conservation purposes. 2) A CAMP for any Conservation Areas within the proposed subdivision. The plan will address: a) Rehabilitation and weed control. b) Fencing and any other measures required to limit public access. c) TECs or conservation significant flora requirements. d) Terrestrial fauna habitat requirements. e) Erection of educational signage f) Requirements for ongoing environmental management and maintenance. 3) A Tree Canopy Retention and Landscape Management Plan, which confirms: a) The location of existing trees to be removed. b) The location, species, size and structural health of trees to be retained. c) The location of new trees and planting schedule, including species, number of trees planted, planting size, mature height and spread. d) The percentage of canopy coverage achieved. 4) An Environmental Offset Management Plan, if required by the Environmental Offset Management Strategy in the LSP. 5) A Construction Environmental Management Plan (CEMP) for any subdivision or development works within 100 m of remnant patches of vegetation communities BaEpPf, BmXpEc and EmMpLp (in Good or				**FLORA AND VEGETATION** • All remnant patches of vegetation communities BaEpPf, BmXpEc and EmMpLp (in Good or better condition) containing conservation significant flora and/or high-quality foraging habitat for all three black cockatoos will be retained in Conservation Areas. • Implementation of the CAMP(s) will provide for the appropriate protection and management of vegetation communities BaEpPf, BmXpEc and EmMpLp (in Good or better condition) and conservation flora. • Implementation of the Tree Canopy Retention and Landscape Management Plan will achieve best practice sustainable outcomes, including: • Retention and enhancement of habitat, particularly black cockatoo habitat. • An urban tree canopy cover that reduces heat island effect and preserves and improves landscape amenity. • Implementation of CEMP(s) will ensure appropriate management of a number of environmental factors and mitigate the risk to the surrounding environment during subdivision and development works.

Planning mechanism	Legislation or agreement regulating the activity	Decision making authority	Stakeholder engagement in decision making	Environmental outcomes
better condition), conservation significant flora and black cockatoo habitat identified for retention. The plan will address: a) Weeds and pathogen management. b) Fauna management. c) Access management (preventing access during construction). d) Dust management. An onsite site survey for flora, vegetation and fauna (in accordance with Schedule 1 of the MRS Text, for any land that that was not previously surveyed at the date of the Minister for Environment's decision on Assessment No. 2335.				
TERRESTRIAL FAUNA As above for Flora and Vegetation.				**TERRESTRIAL FAUNA** As above for Flora and Vegetation. Additionally, implementation of Environmental Offset Management Plan(s) (if required) will facilitate the retention of quality black cockatoo habitat and suitable revegetation / offsetting of any black cockatoo habitat that is removed.
SOCIAL SURROUNDINGS 1) A Visual Amenity Management Plan that provides for the implementation of the 'Interface Transition Zone', Local Visual Amenity Management Strategy and Visual Impact Assessment for development over three storeys (if required). 2) Provisions within the Tree Canopy Retention and Landscape Management Plan for the retention and/or replanting of endemic trees that hold important cultural associations for the Whadjuk Noongar people (if any are identified following engagement with Traditional Owners at LSP stage). 3) Subject to the above, an Interpretation Plan for educating the community about the special meaning that any such endemic trees retained and/or planted hold for the Whadjuk Noongar people. 4) A CEMP for any subdivision or development works within 100 m of the Brentwood Road Swamp Aboriginal heritage site (#4343), or any endemic trees that hold important cultural associations for the Whadjuk Noongar people and have been identified for retention.				**SOCIAL SURROUNDINGS** • Implementation of the Visual Amenity Management Plan will ensure that existing landscape values and significant viewing experiences are managed within the new urban environment. • Any endemic trees that hold important cultural associations for the Whadjuk Noongar people will be afforded recognition in the new urban environment (if any such trees are present in the area). • The significance of such trees will be further recognised through the implementation of an Interpretation Plan. CEMP(s) will provide for the protection of any endemic trees identified for retention, as well as the Brentwood Road Swamp Aboriginal heritage site (if it still exists), during subdivision and development works.
GREENHOUSE GAS Nil. No mitigation measures required.				**GREENHOUSE GAS** The MRS amendment meets the EPA's objective for Green House Gas.

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1. Introduction

The Metropolitan Region Scheme (MRS) is a high-level statutory planning instrument that defines the future use of land and provides the legal basis for planning in the Perth metropolitan region, dividing it into broad zones and reservations. From time to time, amendments are made to the MRS to change the zoning or reservation of land to allow for a different land use. The Western Australian Planning Commission (WAPC) is the Responsible Authority for the MRS.

On 27 October 2021, the WAPC initiated Amendment 1388/57 to the MRS, which proposes to rezone approximately 126 hectares (ha) of land in Wattle Grove from the 'Rural' zone to the 'Urban' zone. The rezoning will facilitate the development of future residential and supporting uses. The Wattle Grove (South) MRS amendment area has been identified for urbanisation in strategic planning documents.

The MRS amendment area is approximately 16 kilometres (km) south-east of the Perth Central Business District (CBD), located within the area bound by Welshpool Road East and Crystal Brook Road to the north-east, and Tonkin Highway to the west, within the City of Kalamunda (Figure 1-1).

1.1 Land description

Land uses across the MRS amendment area are predominantly rural-residential in nature and currently comprises numerous landholdings and contains a mixture of land uses including residential and rural living, composite business along Welshpool Road and horticulture. A former turf farm is located within the MRS amendment area and extends across Lots 303, 53, 214 and 213, south of Brentwood Road. There is a former poultry farm located at Lot 251 within the south-west portion of the MRS amendment area that ceased operations over a decade ago. The Dampier to Bunbury Natural Gas Pipeline (DBNGP) traverses the western edge of the MRS amendment area adjacent to Tonkin Highway. Access is provided from Tonkin Highway and Welshpool Road into lower-order roads including Crystal Brook Road, Kelvin Road and Victoria Road.

The prevailing lot size is approximately 1-2 ha, but the pattern of subdivision is inconsistent, creating a mix of lot shapes and sizes. There are 77 individually titled properties which are generally privately owned. The area has long been identified for some form of land use intensification, however, a significant obstacle to achieving this has been the fragmented landownership.

Most of the MRS amendment area has been cleared of native vegetation, although discrete, isolated pockets of remnant vegetation ranging from Excellent to Good condition remain and generally correspond with the recorded occurrences of conservation significant flora species listed under State and Commonwealth legislation. Mature scattered trees occur across the MRS amendment area, and these are a mix of remnant specimens and both native and non-native specimens planted by landowners over time, particularly in rows along boundary fence lines.

There is significant strategic planning context for the urbanisation of the MRS amendment area in the form of the North-East Sub-regional Planning Framework, the City of Kalamunda's Local Planning Strategy and Local Housing Strategy and the Crystal Brook Concept Plan and Report. Further discussion on these strategic planning documents and how they are guiding future urban development within Wattle Grove South is provided in Section 2.1 of this Environmental Review.

Finalisation of an 'Urban' zoning under the MRS and the concurrent implementation of an 'Urban Development' zoning under the City's local planning scheme will enable structure planning to progress and environmental protection measures and management plans to be implemented.

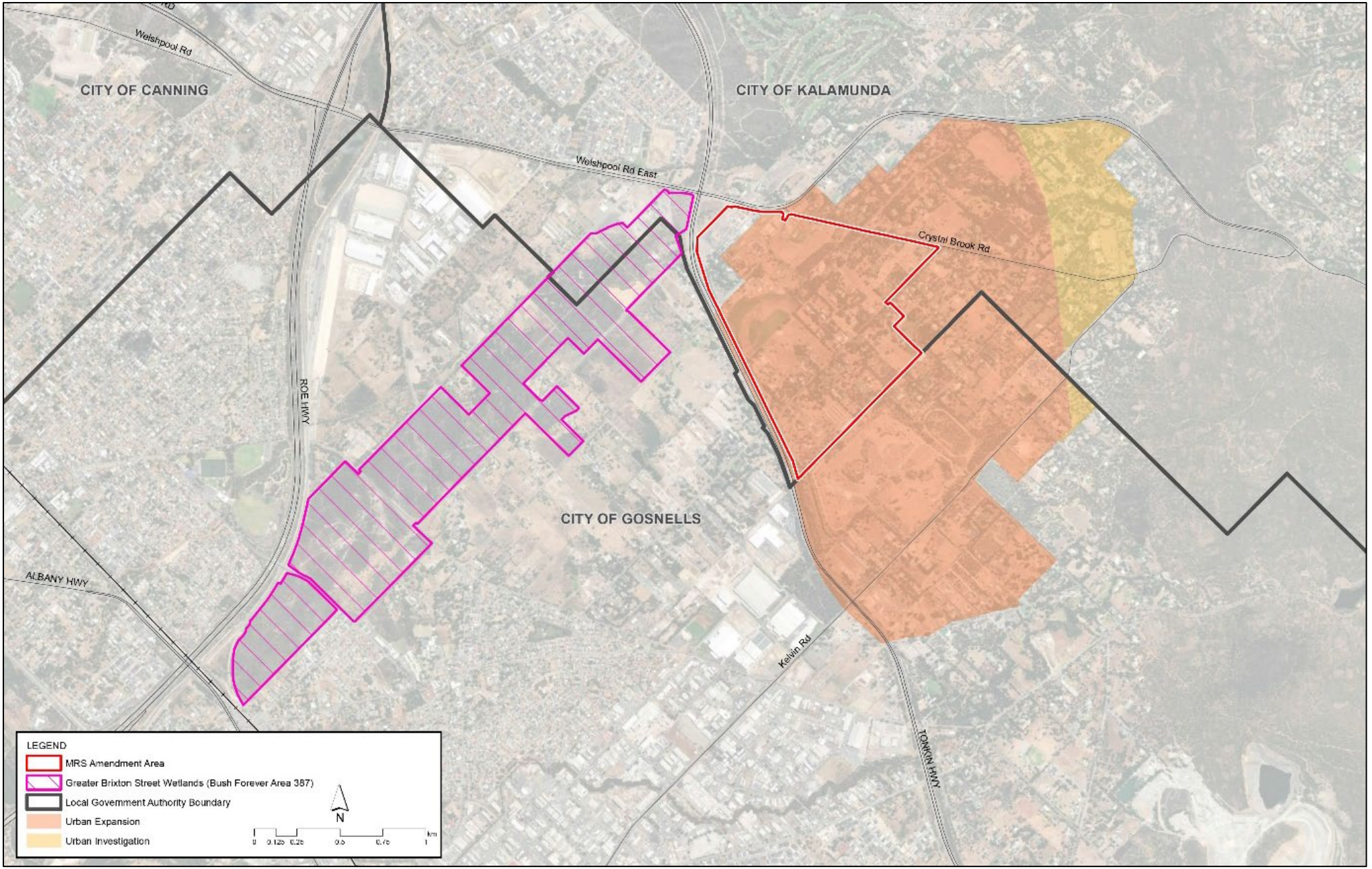

Figure 1-1: Wattle Grove MRS amendment area

1.2 Environmental Review – Purpose and scope

The EPA has determined that MRS Amendment 1388/57 is to be assessed under Part IV, Division 3 of the *Environmental Protection Act 1986* (EP Act), because it has the potential to have a significant effect on the following environmental values within and nearby the MRS amendment area:

Inland waters

- Waterways and wetlands of conservation significance, including:
  - Yule Brook (Canning River system)
  - Nationally important Greater Brixton Street Wetlands (GBSW)
  - Conservation Category Wetlands (CCW) and Resource Enhancement Wetlands (REW) and associated buffers.

Flora and vegetation

- Vegetation complexes that are poorly represented on the Swan Coastal Plain
- Threatened ecological communities (TECs) listed under the State *Biodiversity Conservation Act 2016* (BC Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and State listed priority ecological communities (PECs)
- Habitat for threatened flora listed under the BC Act and EPBC Act, and State listed priority flora.

Terrestrial fauna

- Habitat for threatened fauna listed under the BC Act and EPBC Act, and State listed priority fauna.

Social surroundings

- Aboriginal heritage sites
- Visual amenity associated with the natural and semi-rural character of the area
- Social value of the GBSW.

This document has been prepared in accordance with the EPA's Environmental Review Instructions (Assessment No. 2335), Instructions on how to prepare an Environmental Review Document (EPA 2021a) and Template – Environmental Review Document (EPA 2023a).

1.3 MRS Amendment

The proposed MRS amendment is described in Table 1-1 and the extent of the MRS amendment area is defined in Figure 1-2.

Table 1-1: Summary of MRS Amendment

Scheme Amendment	**MRS Amendment 1388/57 – Wattle Grove South**
Responsible Authority	Western Australian Planning Commission
Location	Wattle Grove – land bound by Tonkin Highway (west), Welshpool Road East and Crystal Brook Road (north-east), Victoria Road and Easterbrook Road (south-east) and the rear boundaries of lots fronting Victoria Road (south).
Short Description	The amendment seeks to rezone approximately 126 ha of land in Wattle Grove from the 'Rural' zone to the 'Urban' zone under the MRS, and concurrently rezone the area to 'Urban Development' zone under the City of Kalamunda Local Planning Scheme No. 3, to facilitate the future structure planning, subdivision, development and use of land for residential and associated purposes.

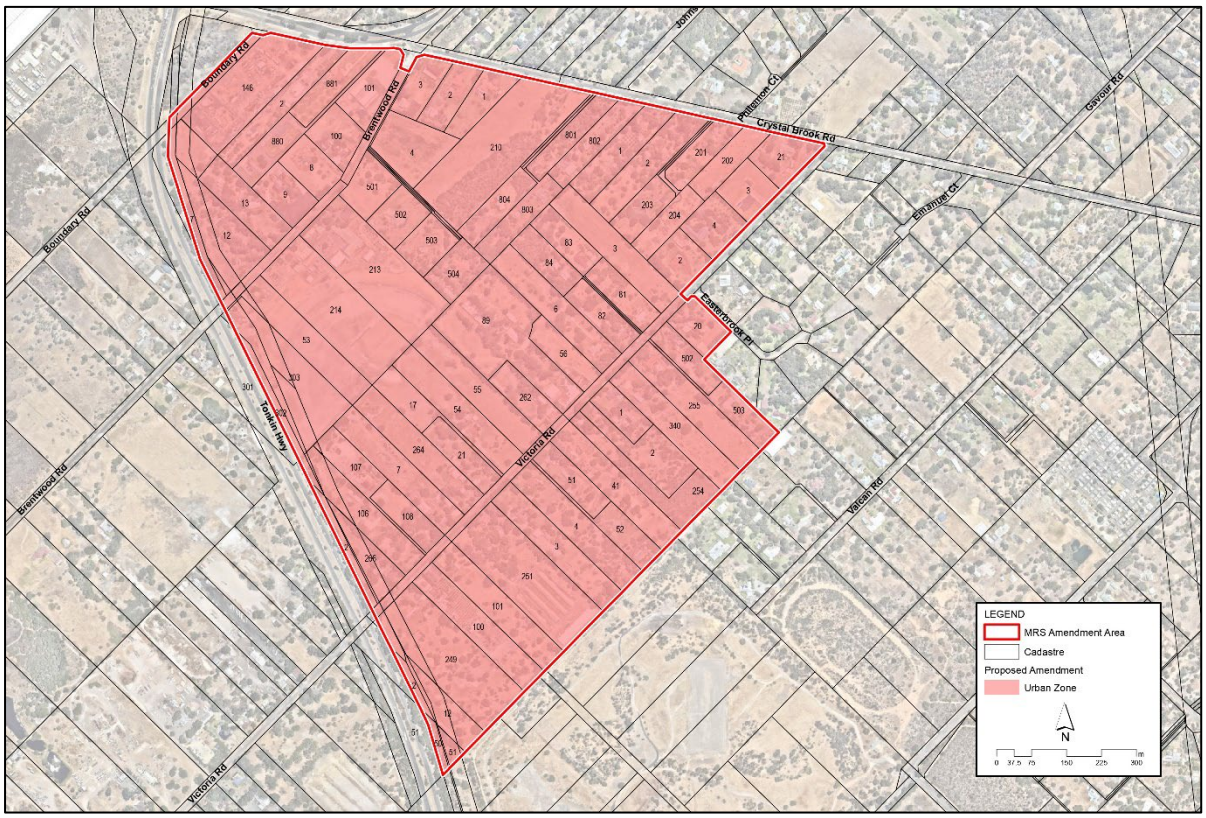

Figure 1-2: Extent of land included in MRS Amendment 1388/57 (WAPC 2021)

1.4 Regional and local context

1.4.1 Land use history

First available aerial imagery over the MRS amendment area was taken in 1953, where several large rural lots had already been subdivided and cleared for rural land uses. There is evidence of infilling of native vegetation and wetland areas to support market gardens, livestock paddocks and rural dwellings as well as extraction activities in the southern portion of the MRS amendment area between 1953 and 1974.

Remnant vegetation remained present across many lots in the northern and central portions of the MRS amendment area prior to 1974, with the occurrence of some regrowth or planting. Some rural residential dwellings were constructed by 1974, and part of the MRS amendment area is understood to have been developed for horse rearing/breeding and equestrian activities. Most of the clearing within the area had been completed by 1995, and the development of lots for predominantly rural residential and lifestyle uses has continued since this time.

The MRS amendment area comprises numerous landholdings (ranging in size from approximately 1 ha to 5 ha) and is a mixture of land uses, including large residential and rural living lots, composite business along Welshpool Road, landscape supply business and horticulture. A former turf farm is located centrally along the western boundary of the amendment area (Lots 303, 53, 214 and 213) south of Brentwood Road. A former poultry farm (which ceased operations over a decade ago) is located at Lot 251 within the south-western portion of the amendment area, only the poultry farm sheds remain.

The Maddington Kenwick Strategic Employment Area (MKSEA) is located adjacent to the MRS amendment area, on the western side of Tonkin Highway. The City of Gosnells proposes to rezone land in MKSEA Precincts 2 and 3B from 'General Rural' to 'Business Development' under its Town Planning Scheme (TPS) No.6 (CoG 2019). These scheme amendments (Nos. 166 and 169) were assessed by the EPA under Part IV, Division 3 of the EP Act and the EPA's Report and Recommendations was issued on 3 April 2024. It is understood that the Office of the Appeals Convenor is currently investigating an appeal against the EPA's Report and Recommendations and will prepare a report to the Minister for Environment.

1.4.2 Swan Coastal Plain

The Interim Biogeographic Regionalisation for Australia (IBRA) describe a system of 85 'biogeographic regions' (bioregions) and 405 subregions covering the entirety of the Australian continent (DCCEEW 2022). Bioregions are defined on the basis of climate, geology, landforms, vegetation and fauna.

The MRS amendment area is located within the Perth subregion (SWA02) of the Swan Coastal Plain bioregion of Western Australia, which is described by Mitchell et al. (2002) as:

> 'The Swan Coastal Plain is a low lying coastal plain, mainly covered with woodlands. It is dominated by Banksia or Tuart on sandy soils, Casuarina obesa on outwash plains, and paperbark in swampy areas. In the east, the plain rises to duricrusted Mesozoic sediments dominated by Jarrah woodland. The climate is Warm Mediterranean. Three phases of marine sand dune development provide relief. The outwash plains, once dominated by C. obesa-marri woodlands and Melaleuca shrublands, are extensive only in the south.'

The Perth subregion is composed of colluvial and aeolian sands, alluvial river flats, coastal limestone. Heath and/or Tuart woodlands on limestone, Banksia and Jarrah-Banksia woodlands on Quaternary marine dunes of various ages, Marri on colluvial and alluvial. Rainfall ranges between 600 and 1000 mm annually and the climate is Mediterranean. The subregional area is 1,333,901 ha.

1.4.3 Regional climate

The climate of the Swan Coastal Plain subregion is Mediterranean with wet winters and dry hot summers. The mean maximum temperatures range from 18.0°C in July to 31.8°C in January (Hyd2o 2024).

Based on Bureau of Meteorology Station 009172 (Jandakot Aero), the long-term average annual rainfall since 1973 has been 818 mm. Since 2000, the average annual rainfall has declined to 758 mm, a reduction of 7%. Most of the rainfall occurs between the months of May and September

(Hyd2o 2024). Local rainfall in the context of the MRS amendment area is discussed in the Inland Waters section of this Environmental Review (Section 5.4) and Section 2.2 of the Wattle Grove South District Water Management Strategy (DWMS) (Appendix B).

1.4.4 Regional geology

The Swan Coastal Plain comprises five major geomorphologic systems that lie parallel to the coast: the Quindalup Dunes, Spearwood Dunes, Bassendean Dunes, Pinjarra Plain and Ridge Hill Shelf (Churchward and McArthur 1980; Gibson et al. 1994). Each major system is further subdivided into detailed geomorphologic units (Churchward and McArthur 1980; Semeniuk et al. 1990; Gibson et al 1994).

The geology within the MRS amendment area is discussed in the Inland Waters section of this Environmental Review (Section 5.4) and Section 2.3 of the DWMS (Appendix B).

1.4.5 Conservation areas

State Planning Policy 2.8: Bushland Policy for the Perth Metropolitan Region (SPP 2.8) aims to provide a policy and implementation framework that ensures bushland protection and management matters throughout the Perth Metropolitan Region are adequately addressed and integrated with broader land use planning and decision-making (WAPC 2010). In accordance with SPP 2.8, scheme amendments and development proposals must recognise regionally significant bushland and outline methods by which they will avoid, minimise, and offset any likely adverse impacts on regionally significant bushland. SPP 2.8 predominantly deals with two distinct subjects, Bush Forever areas and local bushland.

No conservation areas exist within the MRS amendment area. A description of Bush Forever sites and conservation areas within the vicinity of the MRS amendment area is provided below and shown in Figure 1-3. There are no DBCA managed lands within the site, with the nearest conservation reserve being the GBSW, which is approximately 100 m west of the site boundary.

1.4.5.1 Bush Forever

No Bush Forever sites occur within the MRS amendment area. The closest points of the nearest Bush Forever sites are approximately 100 m to the west on the opposite side of Tonkin Highway (Site 387, the Greater Brixton Street Wetlands) and approximately 90 m to the north-west on the opposite side of Welshpool Road East (Site 320, Hartfield Road Bushland).

1.4.6 Regional ecological linkages

Ecological corridors have been identified in the Perth metropolitan region to limit the effects of fragmentation across areas of remnant bushland. Within the MRS amendment area there is one regional ecological linkage located at the north-western perimeter of the MRS amendment area (Link ID: 40), which connects the GBSW and the Hartfield Road Bushland (Molloy, et.al. 2009). The small portion of the regional ecological linkage which falls within the MRS amendment area (specifically within portions of Lot 146 Welshpool Road East and Lot 12 Brentwood Road) has been extensively cleared of native vegetation and filled. An approved commercial landscape supply yard occurs within Lot 146 Welshpool Road East. Figure 1-3 Illustrates the regional ecological linkages in proximity to the amendment area.

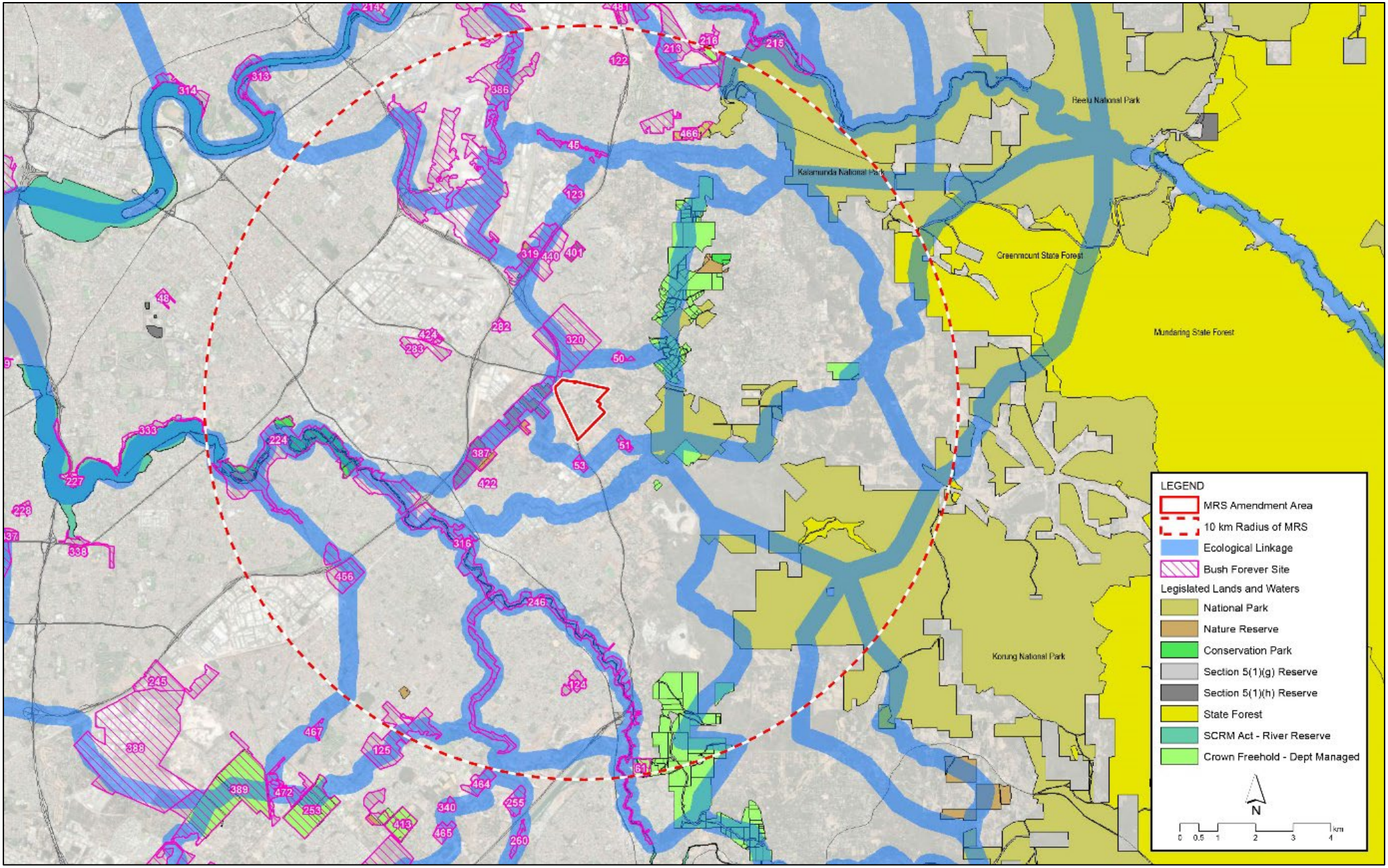

Figure 1-3: Conservation areas and regional ecological linkages

1.4.7 Environmentally Sensitive Areas

Environmentally sensitive areas (ESAs) are declared by the Minister for Environment under section 15b of the EP Act. ESAs are classes or areas of native vegetation where exemptions for clearing vegetation under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* do not apply.

Eight ESAs are mapped within the site according to the dataset available through DWER (2020) (Figure 1-4).

Each ESA is described in Table 1-2. Many of the ESAs mapped within the site are associated with the locations of historically recorded declared rare flora; however, based on surveys undertaken by AECOM (2020) many of these areas have since been cleared and the Threatened flora associated with the ESA boundary are no longer present. Accordingly, many of the corresponding ESAs are no longer considered to be applicable.

Table 1-2: Summary of Environmentally Sensitive Areas within MRS amendment area

ESA feature number	ESA purpose	Comment
1150432	Within 50 m of Conservation Category Wetland	Associated within the small area of mapped CCW on Lot 501 external to the MRS amendment area that is within/adjacent the proposed Tonkin Highway/Welshpool Road East intersection upgrade. Further, Lot 501 has historically been significantly altered including clearing of native vegetation and infilling of wetland areas to establish transport corridors and the construction (and maintenance) of DBGNP and Water Corporation pipeline easements.
125161	Within 50 m of Conservation Category Wetland and associated with Threatened or Rare Flora	Associated with the small area of mapped CCW on Lot 501 external to the MRS amendment area. This CCW is within/adjacent to the proposed Tonkin Highway/Welshpool Road East intersection upgrade. Lot 501 has historically been significantly altered including clearing of native vegetation and infilling of wetland areas to establish transport corridors and the construction (and maintenance) of DBNGP and Water Corporation pipeline easement. This wetland has an inferred ecological community associated with GBSW threatened ecological community (TEC). The association between this wetland (or Lot 501) and the GBSW has been severed with the construction of the four lane Tonkin Highway and the construction (and maintenance) of DBNGP and Water Corporation pipeline easement. This CCW is located over 100 m from the GBSW separated by Tonkin Highway.
122572	Within 50 m of Conservation Category Wetland	Associated within the small area of mapped CCW on Lot 501 external to the MRS amendment area. This CCW is within the proposed Tonkin Highway/Welshpool Road East intersection upgrade. Area within the site has been significantly altered. Further consideration of the interface is required following detailed design by MRWA.
116753	Associated with Threatened Ecological Community	Associated with TEC located within the mapped GBSW area which is located on the western side of Tonkin Highway and is more than 100 m west of the MRS amendment. Portions of this mapped ESA within the MRS amendment area have been significantly altered through historical clearing and associated semi-rural land uses which includes livestock paddocks and residential dwellings.
118323	Threatened or Rare Flora	Associated with the historic record of a *Conospermum undulatum* in this location. This area has been significantly altered through historical clearing and associated semi-rural land uses which includes livestock paddocks and residential dwellings. There is no evidence of this flora being present at this location (within the MRS amendment area) from the AECOM (2020) flora and vegetation.
118326	Threatened or Rare Flora	Associated with the historic record of a *Conospermum undulatum* in this location. This area has been significantly altered through historical clearing

		and associated semi-rural land uses which includes livestock paddocks and residential dwellings. There is no evidence of this flora being present at this location (within the MRS amendment area) from the AECOM (2020) flora and vegetation.
118327	Threatened or Rare Flora	Associated with the historic record of a *Conospermum undulatum* in this location. This area has been significantly altered through historical clearing and associated semi-rural land uses which includes livestock paddocks and residential dwellings. There is no evidence of this flora being present at this location (within the MRS amendment area) from the AECOM (2020) flora and vegetation
118324	Threatened or Rare Flora	Associated with the historic record of a *Conospermum undulatum* in this location. Remnant vegetation in the immediate area has been identified as locally significant vegetation and is proposed to be retained.

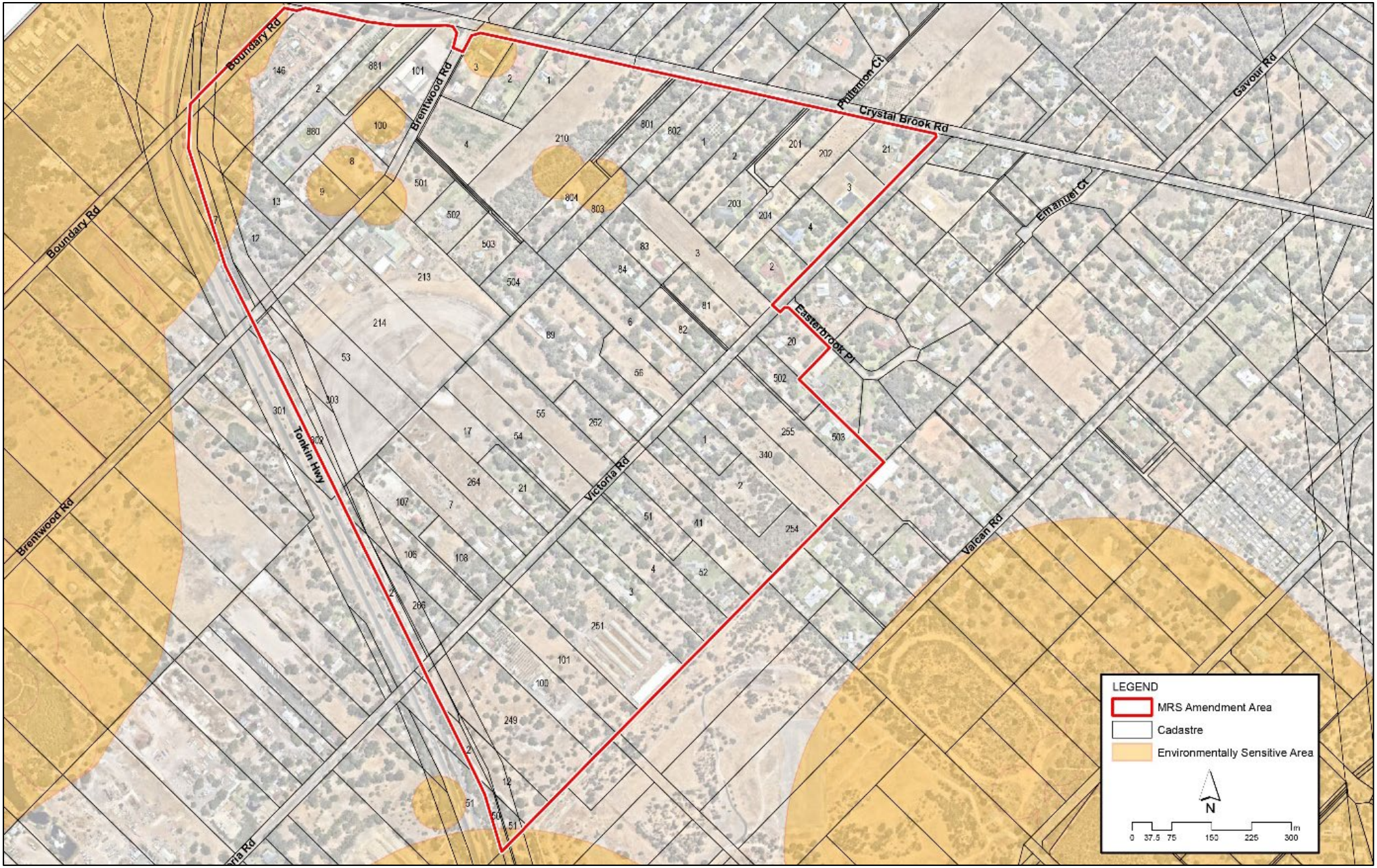

Figure 1-4: Environmentally sensitive areas within MRS amendment area

1.4.8 Wetlands

The wetlands on the Swan Coastal Plain have been evaluated and assigned a management category, providing guidance on how they should be managed and protected (EPA 2008):

- Conservation (CCW) – Wetlands that support a high level of attributes and functions. These wetlands are afforded the highest level of priority and protection.
- Resource Enhancement (REW) – Wetlands which may have been partially modified but still support substantial ecological attributes and functions. These wetlands are afforded priority with an emphasis on retention and rehabilitation.
- Multiple Use (MUW) – Wetlands with few remaining important attributes and functions. Land use, development and management of such wetlands should be considered in the context of ecologically sustainable development.

By area, 20% of wetlands across the Swan Coastal Plain retain high ecological values, making them the highest priority for conservation (CCWs). About 72% of wetlands have been degraded to the extent that they are not a priority for conservation (MUWs). Figure 1-5 presents the wetlands mapped within and in proximity to the MRS amendment area.

Wetlands relevant to the MRS amendment area is discussed in in Section5.4 and the Wetland Assessment Report (Appendix C).

1.4.8.1 Greater Brixton Street Wetlands

There are no DBCA managed lands within the site, with the nearest conservation reserve being the Greater Brixton Street Wetlands (GBSW) in Kenwick, approximately 100 m west of the MRS amendment area at the closest point, separated by Tonkin Highway (Figure 1-5).

The GBSW are of international, national and regional environmental significance and are one of the most important wetlands on the Swan Coastal Plain, with biodiversity attributed to the unique geological, geomorphic and hydrological characteristics (EPA 2022). The extent of the GBSW includes the combined boundaries of *A Directory of Important Wetlands in Australia* (DIWA) (Brixton Street Swamps) and Bush Forever Site 387. The GBSW are also included on the Register of the National Estate.

The GBSW are characterised by outstanding and unique botanical diversity, with over 650 plant species recorded, including locally restricted species and distinct vegetation communities supporting conservation significant fauna, attributed to the specialised plant adaptations to the complex soils, chemistry and hydrology of the site (EPA 2022). The wetlands, located at the base of the Darling Scarp, are supported by Crystal Brook and Yule Brook and other surface and sub-surface water inputs. The area supports naturally vegetated wetlands that are rare or no longer exist elsewhere, and it is one of the largest consolidated wetland areas of high conservation value on the Swan Coastal Plain (EPA 2022).

In October 2022, the EPA published advice on the GBSW pursuant to section 16(j) of the EP Act recognising the significance of the GBSW and the potential risks to environmental values from existing and emerging pressures. The advice considers:

- The environmental values of the GBSW, the existing and potential pressures on those values
- Recommendations for enhancing the environmental protection of the GBSW
- Expectations for responsible authorities and proponents with schemes and development proposals that have the potential to impact the environmental values.

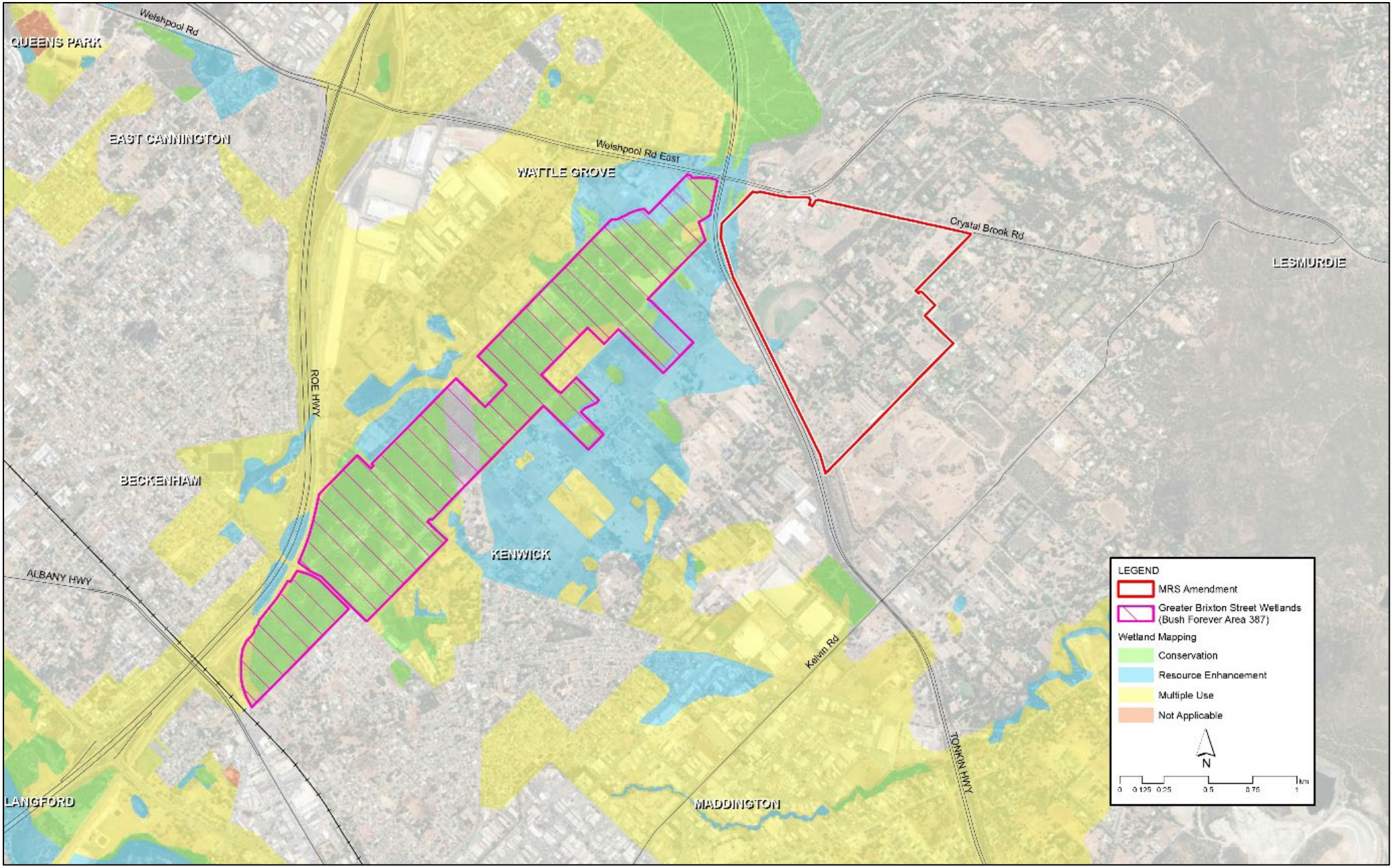

Figure 1-5: Wetland mapping and Greater Brixton Street Wetlands

The EPA requires future activities and development to be compatible with the protection of the environmental values of the GBSW, such that direct and indirect impacts to the environmental values of the GBSW can be avoided to the greatest extent possible and practicable (EPA 2022). Of relevance to the proposed MRS amendment and associated future development is the mitigation of any potential impacts to ensure:

- the existing hydrological regime of the GBSW is maintained
- the groundwater dependant flora and vegetation and ecosystems within the wetlands is protected.

This is discussed further in Section 5.7. Other EPA expectations and where they are addressed within this Environmental Review, are described in Table 1-3.

Table 1-3: EPA expectations for consideration in assessment of impacts to the GBSW

EPA expectations	Consideration
GBSW – Environmental Impact Assessment • Protection of ecological and hydrological values • Direct and indirect impacts to the environmental values of the GBSW should be avoided to the greatest extent possible and practicable.	• The proposed change in land use to Urban is not proposed within the GBSW nor immediately adjacent to it. Tonkin Highway physically separates the MRS amendment area from the GBSW. • Section 5.4.7 presents the predicted changes to the water balance of the MRS amendment area in the post development environment and considers these in the context of potential impacts to the ecological and hydrological values of the GBSW, as well as climate change scenarios.
Buffers • Buffers are an important mechanism for protecting the environmental values of the GBSW, by minimising the risks of impacts from nearby land uses and development. • Proposed activities and developments will need to consider appropriate buffers to protect the environmental values of the GBSW. Buffer widths should be determined, based on site-specific studies and best available scientific evidence.	• The MRS amendment area currently compromises numerous landholdings and contains a mixture of land uses including residential and rural living, composite business, horticulture, a turf farm and former poultry farm. The MRS amendment area is approximately 100 m away from GBSW to the west at its closest point. There is significant infrastructure and transport corridors separating the amendment area to the GBSW including the DBNGP and a Water Corporation pipeline easement located along the western edge of the MRS amendment area and the Tonkin Highway. These infrastructure and transport corridors provide a significant physical barrier to the GBSW. • In combination with the implementation of the Better urban water management guidelines (WAPC 2008) across the MRS amendment area, the proposed land use change and provides an opportunity to improve water quality and quantity and counteract potential effects of climate change.
Hydrological and hydrogeological investigations • Responsible authorities and proponents will need to demonstrate that proposed developments, related activities, and any water abstraction will not adversely impact the environmental values of the GBSW directly or indirectly. • Site-specific hydrological and hydrogeological investigations should be undertaken, supported by relevant and accepted scientific evidence. • Potential impacts on the local water balance, hydrological regime, and water-dependent environmental values, as well as potential changes in surface and groundwater flow and	• A pre and post development water balance model has been developed to characterise the existing hydrology of the MRS amendment area (the assessment included the UE and UI areas - Figure 1-1) and hydrological connections with the GBSW. The water balance model also predicts post development change to the hydrological regime. • The water balance in combination with three years of groundwater and surface water monitoring data, and site specific geotechnical and geophysical assessments were utilised to assess the potential impacts of the proposed change in land use associated with the MRS amendment on significant wetlands and waterways within the surrounding locality, including the GBSW and the Yule Brook. • The water balance model was informed by extensive hydrological and hydrogeological investigations, review of relevant previous studies (in the local region inclusive of the GBSW area) and publicly available data provided by DWER.

EPA expectations	Consideration
quality, in a local and regional context, will need to be addressed. • Demonstrate changes to hydrological regimes will not adversely affect the flora and vegetation of the GBSW.	• Surface water and groundwater (which commenced in November 2020) will continue across the sequential planning assessment phases (including post development phase). This will build on existing datasets and improve understanding of the hydrology and water flows towards the GBSW and its behaviour in a changing climate.
Stormwater management and drainage Application of best practice stormwater and drainage management to ensure changes to the hydrology of the GBSW are minimised. This should include • Appropriate water sensitive design approaches and treatment of stormwater runoff. • Indicative design and placement of any stormwater infrastructure in the context of the GBSW. • Demonstrating that any potential changes to the water balance, hydrological regime, or water quality will not adversely impact the environmental values of the GBSW.	• The DWMS (Appendix B) is underpinned by the following key elements: o The implementation of best stormwater and groundwater management practice in alignment with Better urban water management (WAPC 2008) and the sequential land use planning approvals process. o Continuation of the existing surface water and groundwater monitoring program. o The implementation of an adaptive management framework, which guides future water management across the MRS amendment area (in collaboration with regulatory authorities) with a focus on maintaining and/or improving the hydrological outcomes for the GBSW. o Maintaining post development recharge in the area of the groundwater mound has been adopted as a key principle for the proposed stormwater management system of the MRS amendment area, which is in accordance with EPA's Inland Waters objective of maintaining the existing hydrological regime and existing groundwater flows at this location post development. • Proposed urban development presents an opportunity to implement best practice surface water management (currently the rural landholdings within the MRS amendment area are devoid of any active surface water management infrastructure) with the potential to counteract potential effects from climate change (specifically future rainfall decline and associated surface water flows) on the GBSW.
Traditional Owner Engagement • Demonstrate explicit regard for Aboriginal knowledge, connection to country and protection of Aboriginal cultural and environmental values. • It should be demonstrated that Traditional Owners have been consulted, that cultural and environmental values are identified, and potential impacts will be avoided where possible, or minimised.	• Section 8 identifies and describes the cultural heritage sites and values within the MRS amendment area and the wider regional context, including the GBSW. A discussion of direct and indirect impacts and their mitigation strategies has also been provided. • The approach to Whadjuk engagement has been guided by 'Kaart, koort, waarnginy ~ Head, heart talking: Aboriginal Engagement Framework' DevelopmentWA (2019). A Traditional Owner Group was established under the guidance of consultant Brendan Moore, acting as the Noongar Group Facilitator. • Engagement with this Whadjuk Reference Group, including a site visit in December 2022, has informed the identification of cultural heritage sites and values and consideration of impacts.
Climate Change Considerations • While aquifer recharge as a result of rainfall and surface flows is likely to continue to decline, urban development may result in an increase in recharge to the wetlands from groundwater. Modifications to land surfaces through the removal of vegetation, construction of roads, and development of drainage infrastructure is likely to affect the dynamics of aquifer recharge. The spatial	• Bourke (2017) reported that the decline in rainfall in south-west WA over the last 30 years had likely already resulted in changes to the hydrological cycle of the GBSW and that it would continue to do so in the future. • DWER datasets provide predicted future climate data in daily intervals for three climate scenarios (Cwet, Cmid, Cdry) at time horizons of 2050 and 2100. • Section 5.4.7 considers the modelled climate change (completed as part of the water balance model for the MRS amendment) for the dry scenario for both the 2050- and 2100-time horizons. These

EPA expectations	Consideration
concentration of recharge points in modified urban systems may also affect groundwater processes in the GBSW. • There is also the potential for any increase in recharge to result in a higher salt loading when combined with lower surface flows and direct rainfall. The higher evaporation from hotter summers has the potential to change the hydrochemistry of the groundwater and soils in the wetlands, which is likely to change the biodiversity of the GBSW.	two scenarios were based on rainfall reductions of 4.4% and 34.5% respectively, compared to the 2010-2020 baseline. • These rainfall reductions associated with predicted climate change reduce surface water runoff leaving the MRS amendment area and results in a decrease in groundwater recharge, compared to the post development modelling that does not consider climate change. • Through the proposed change in land use and implementation of the Better urban water management framework, the urbanisation of the MRS amendment area provides an opportunity to counteract the potential effects of climate change on the GBSW.
Cumulative impacts The cumulative impacts of existing and proposed activities and development in the area must be explicitly considered to ensure that the environmental values of the GBSW are protected. Given that the GBSW are already under pressure from existing activities, development and climate change, the EPA is of the view that avoidance and minimisation of disturbance should be a priority for all proponents and responsible authorities.	• The cumulative impacts of the proposed change in land use within the MRS amendment area, in the context of existing and reasonably foreseeable activities in the surrounding region, have been considered for each key environmental factor individually and then considered in terms of interconnections with other key environmental factors with common values affected by similar pressures/activities in Section 12.

2. Legislative and planning context

2.1 Strategic planning framework

2.1.1 Perth and Peel @3.5 Million and the North-East Sub-regional planning framework

The WAPC (2018) *Perth and Peel @ 3.5 Million* suite of documents, cabinet endorsed and adopted in 2018, provides strategic guidance to government agencies, local governments and the development industry on land use, land supply, land development, environmental protection and infrastructure provision across Perth and Peel. It sets out a 'Sub-regional Planning Framework' (Framework) for each of four sub-regions.

The MRS amendment area is located within the North-East planning sub-region and is identified almost entirely as an 'Urban Expansion' (UE) area in the relevant Framework report. This is the highest priority category for new urban land not already zoned 'Urban' under the MRS. The MRS amendment will serve to implement the State governments key strategic planning objectives.

A small portion of the MRS amendment area (approximately 10 ha) adjacent to the Tonkin Highway and Welshpool Road intersection is identified for 'Rural' purposes in the Framework. However, this small area is contiguous with the UE area and considered an anomaly. Accordingly, the WAPC consented for this small area 10 ha area to be included in the MRS Amendment 1388/57 land use rezoning and enable its inclusion in a future structure plan.

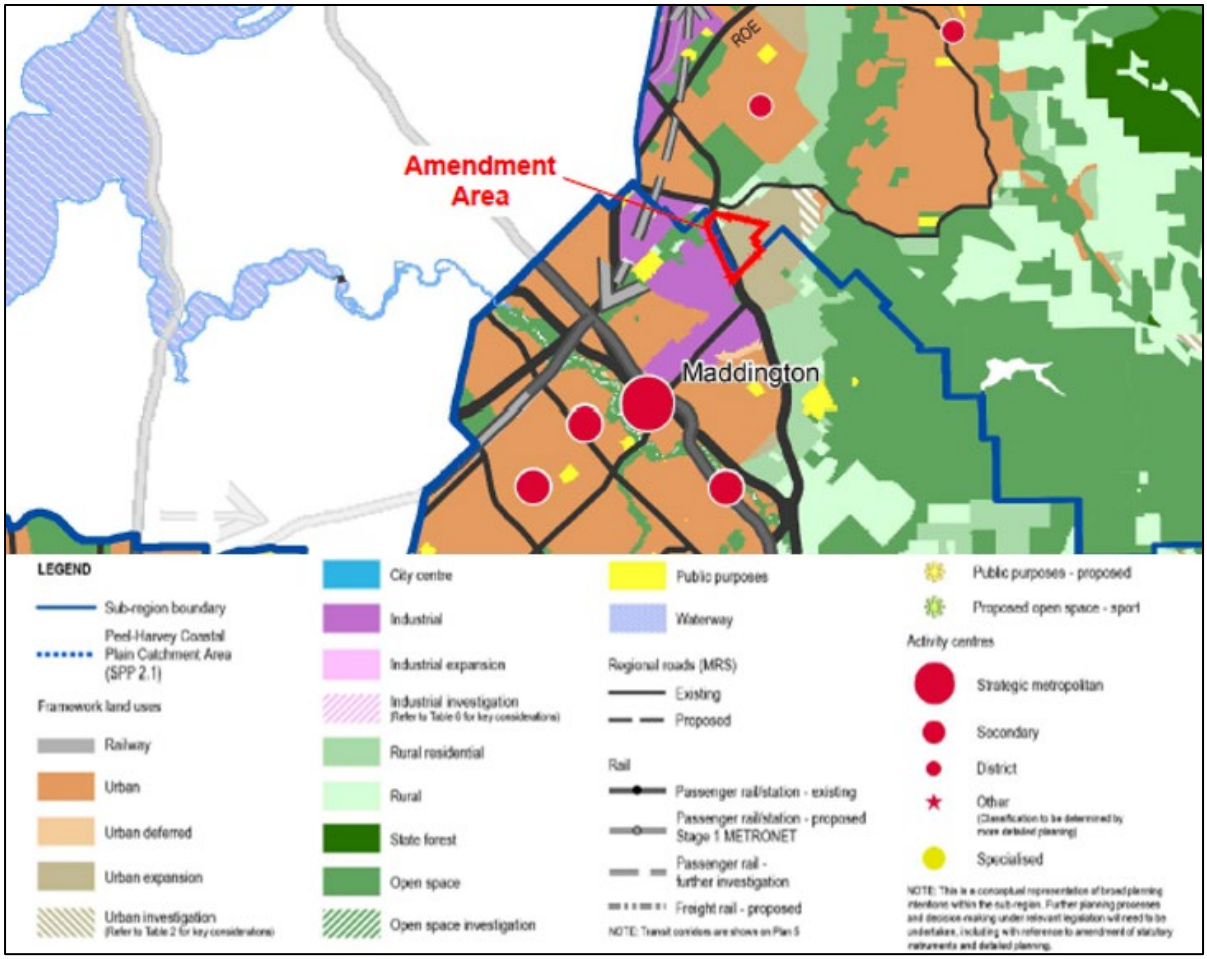

Figure 2-1: Extract from the North East Sub-Regional Planning Framework (WAPC 2018)

2.1.2 City of Kalamunda Local Planning Strategy

The *Planning and Development (Local Planning Schemes) Regulations 2015* (the Regulations) requires local government to prepare a Local Planning Strategy summarising the long-term planning directions and rationale for the land use zones and reserves which would be applied through their Local Planning Scheme. Local Planning Strategies are prepared to the satisfaction of the WAPC and apply all relevant State or regional policy to the Local Planning Strategy area.

The City of Kalamunda (2013) *Local Planning Strategy 2010* (Strategy) was adopted by the City in October 2011 and endorsed by the WAPC in February 2013. It has a twenty-year lifespan and is augmented by various supporting sub-strategies including a Local Housing Strategy adopted in 2021 and an Urban Forest Strategy adopted in 2023.

The Strategy identifies the MRS amendment area as an 'Urban Investigation' (UI) area. This reflects an earlier, similar designation in the Outer Metropolitan Sub-regional Strategy document that formed part of the 'Directions 2031 and Beyond' policy suite, which is the predecessor of Perth and Peel @ 3.5 Million. The City's Strategy highlights the need for its UI area to be subject to 'comprehensive planning to ensure a co-ordinated and sustainable approach' to development.

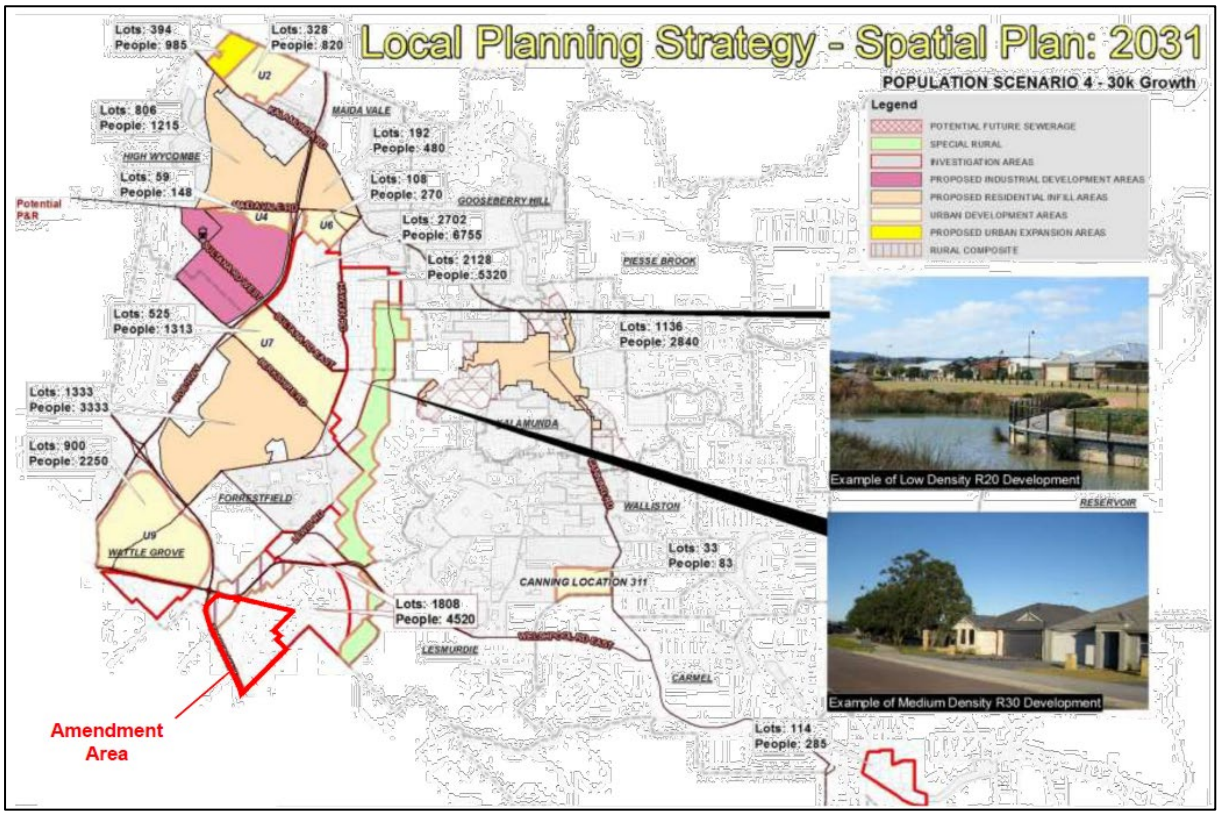

Figure 2-2: Local Planning Strategy (City of Kalamunda 2013)

2.1.2.1 City of Kalamunda Local Housing Strategy

The City of Kalamunda (2021a) Local Housing Strategy 2021 informs the City's Strategy and post-dates the Framework and adopts its recommendations for a UE area (including the MRS amendment area) and UI area in Wattle Grove, which it refers to as the 'Crystal Brook' precinct. The City's Housing Strategy notes that in 2019, the Council resolved that the City 'would not consider any industrial land use outcomes for the area' and elected to prioritise residential development.

The Housing Strategy refers to the Crystal Brook Concept Plan and Report (covered in the following section) as being the relevant planning strategy for the Crystal Brook precinct, performing the role of a District Structure Plan. However, the Council had resolved to cease further planning for the precinct in November 2020, so the Concept Plan and Report was never progressed to a greater level of detail. Delivery of the Housing Strategy's objectives for the area in terms of residential land supply and the supporting services and infrastructure therefore currently depends on private sector leadership.

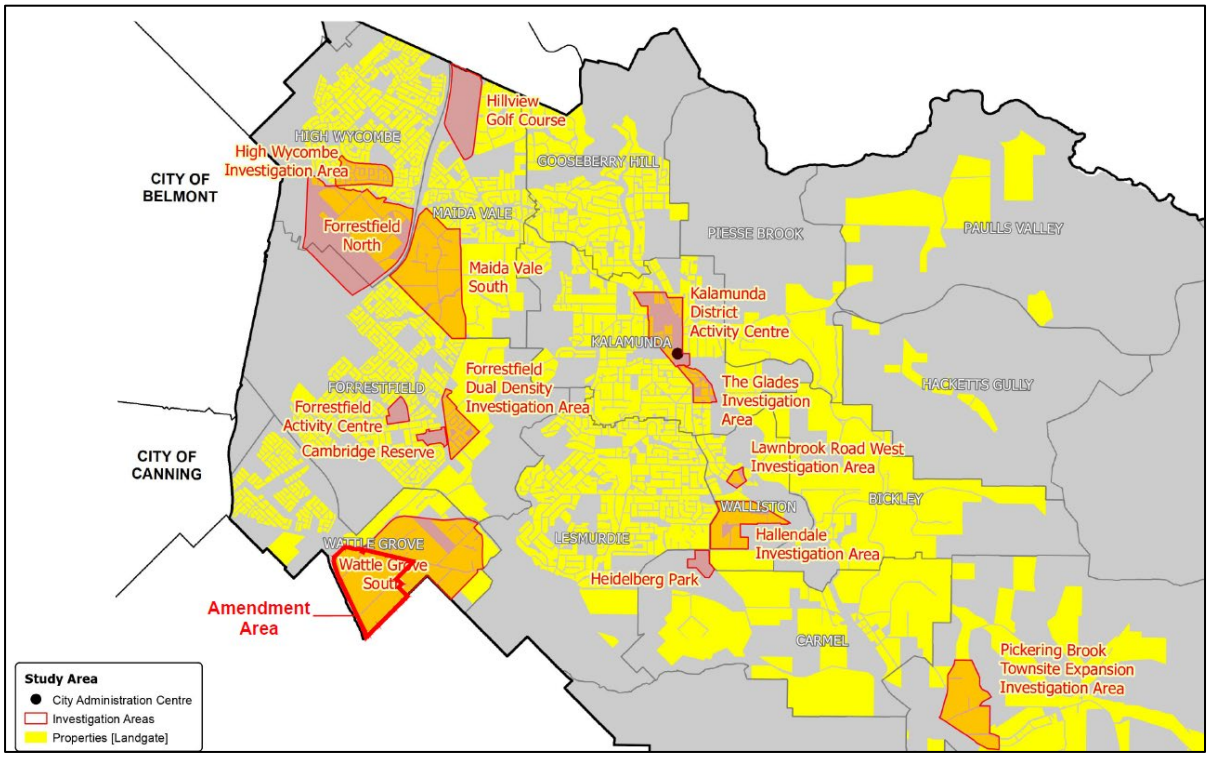

Figure 2-3: Local Housing Strategy (City of Kalamunda 2021a)

2.1.2.2 City of Kalamunda Urban Forest Strategy

The City of Kalamunda (2023) Urban Forest Strategy was adopted in 2023 and provides a robust basis for the City to require the retention of high-quality remnant vegetation in relevant structure plans for new urban areas. It was prepared in the context of the WAPC (2023a) *Better Urban Forest Planning* and specifies various objectives and strategies aimed at achieving a targeted list of goals.

One of the goals is to 'Grow the urban forest on public and private land through new tree plantings', and an objective relevant to the MRS amendment area is for 'All new Urban…developments to achieve 20% canopy cover (at maturity).'

When the City provided its original recommendation to the WAPC on the MRS amendment in 2021, it noted that the retention of existing trees within new public open space areas, streetscapes and larger lots and the introduction of substantial tree planting in streets, public open space and other appropriate areas will achieve tree canopy areas and local amenity as the site develops.

2.1.3 Crystal Brook Concept Plan and Report

The Crystal Brook Concept Plan and Report (Concept Plan) was prepared by the City of Kalamunda (2021b) over the course of 2020 following a 2019 resolution by the Council not to contemplate any industrial land uses in the UI area defined in the Strategy. This decision came after a period of planning investigation and community engagement responding to the area's identification for UI in the Strategy.

The Council's 2019 resolution included a decision to undertake a community engagement process to help inform the City's intentions for the area, using the following guiding design principles (City of Kalamunda 2019):

1) Exclude any general or light industrial land uses.
2) Reflect and acknowledge existing lifestyle and recreational opportunities of the area.
3) A high-quality residential outcome that includes a range of densities.
4) Include an appropriate amount of commercial development based on best practice design principles, including but not limited to public transport, technology, educational, medical and retail opportunities.
5) Retain existing vegetation and tree canopy cover where possible.
6) Consider tourism development opportunities that embrace the environmental, social and financial aspects of the City of Kalamunda.
7) Provide for modern sustainable housing design principles including renewable energy capture, water sensitive urban design, storage, sharing capabilities and smart city initiatives.
8) The subject area 'Wattle Grove South' to also include the land to the north of Welshpool Road East bounded by Tonkin Hwy, Lewis Road and Hartfield Golf Course.'

The outcome was the Crystal Brook Concept Plan. This identifies a number of strategic principles and possible implementation strategies for the area and designates two land use typology areas, being 'Urban Landscape' and 'Rural Landscape'.

The MRS amendment area is part of the 'Urban Landscape' area, which is for residential and commercial purposes. The Concept Plan, including its strategic outcomes, community engagement results and outcomes of a supporting ecological report were noted by the Council in November 2020.

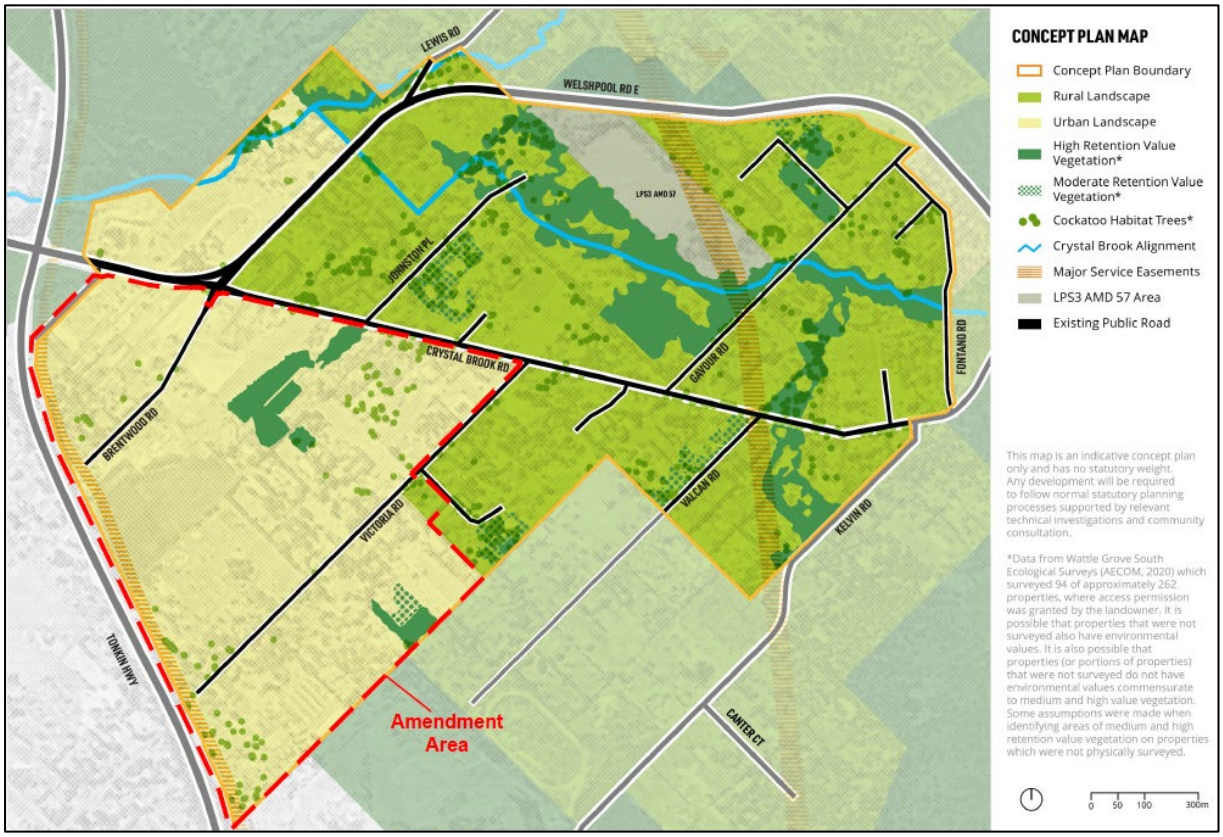

Figure 2-4: Crystal Brook Concept Plan Map (City of Kalamunda 2021b)

2.1.4 Statutory planning framework

2.1.4.1 Metropolitan Region Scheme

The MRS applies zones and reserves across the Perth metropolitan region. Its purpose is to co-ordinate planning across local government areas by defining and protecting land for public purposes and designating broad zones to guide local-level planning controls.

The MRS amendment area is currently zoned 'Rural'. The MRS amendment proposes to rezone the area to 'Urban' to fulfil the strategic planning direction outlined above via the North-East Sub-regional Planning Framework, with a concurrent Local Planning Scheme amendment to rezone the corresponding area to 'Urban Development' Zone (refer below).

2.1.4.2 City of Kalamunda Local Planning Scheme No.3

The *Planning and Development Act 2005* (PD Act) provides local governments with the statutory authority to prepare and maintain local planning schemes to make 'suitable provision for the improvement, development and use of land in the local planning scheme area'.

Local Planning Schemes comprise three parts:

- Deemed Provisions that apply to all Local Planning Schemes through the Regulations
- Scheme Text, which is encouraged to be consistent with the Model Provisions in the Regulations
- Scheme Maps that illustrate the spatial extent of the various zones and reserves.

The MRS amendment area is currently zoned 'Special Rural' and 'Rural Composite' under the City's Local Planning Scheme No. 3 (LPS 3). This reflects the historical and current use of the area. Rezoning to 'Urban' under the MRS will necessitate the area being rezoned accordingly under LPS 3.

MRS amendment 1388/57 proposes for the City of Kalamunda's LPS 3 to be concurrently rezoned to an 'Urban Development' zone, pursuant to Section 126(3) of the PD Act. This section of the PD Act provides the WAPC with the authority to amend the local planning scheme to ensure consistency with the relevant region planning scheme; in this case the MRS and any applicable Schedule 1 conditions and to require the preparation of a local structure plan for future subdivision and development proposals.

2.1.4.3 Local Structure Plan

The WAPC (2023b) *WA Planning Manual - Guidance for Structure Plans*, requires structure plans to co-ordinate *'future zoning, subdivision and development of land'* and contain *'a set of steps, measures and controls that are necessary to guide the plan's implementation through progressive subdivision and development of the land'.* They contain written and cartographic provisions.

Local structure plans implemented in 'Urban Development' zones under local planning schemes are prepared in accordance with various guidelines led by the Guidance for Structure Plans (WAPC 2023). These require 'standard' structure plans (which is relevant for this MRS amendment) to comprise two parts, namely:

- Part 1: Implementation, which contains statutory provisions and requirements to guide decision-making under the structure plan.
- Part 2: Explanatory, which provides background information and the rationale for the content of the structure plan, informing decision-making under Part 1.

The template for structure plans outlined in Appendix 1 of the Guidance includes the heading 'Protection or Management of Environmental or Landscape Features'. Importantly, it is here that any environmental conditions imposed by the Minister for Environment in agreement with the Minister for Planning via the MRS amendment process will be listed. These conditions could relate to actions undertaken before or during the structure plan process and/or required after the local structure plan has been approved. In the latter scenario, the required actions would also be listed in the 'Additional Details' section of the structure plan as:

- Actions to be taken prior to the lodgement of a subdivision or development application
- Actions to be taken pursuant to conditions of subdivision approval, including in the context of subsequent development proposals
- Actions to be taken prior to, or during implementation of, a development proposal.

2.2 Other approvals and decision-making authority processes

In the event the MRS amendment is approved, future land uses will be subject to a range of additional approvals that are regulated by a range of policies, guidelines and legislations under the decision-making authorities (DMA) identified in Table 2-1.

Table 2-1: Other decision-making authorities and processes that can mitigate potential impacts on the environment

Relevant legislation/policy	Approval required	DMA	How the DMA process mitigates environmental impacts on the environment and likely environmental outcome
Rights and Water in Irrigation Act 1914	Groundwater abstraction: Section 5C Licence to Take Water Section 26D Licence to Construct Wells	Department of Water and Environmental Regulations (DWER)	• Some future development works within the MRS amendment area may involve interaction with groundwater and/or surface water resources, such as installation of groundwater bores, and abstraction of groundwater. • Applications to undertake such activities will be required to be lodged with DWER, who will assess such proposals and determine whether to issue approvals and any associated conditions. • Opportunity for public comment on the proposed licence/licence amendment. • Licence specifies location of groundwater abstraction, maximum abstraction rate and compliance requirements. • Operating Strategy (licence condition) specifies abstraction, monitoring, and reporting details. • Licence contains outcome-based conditions (including operating strategy) that can maintain the hydrological regimes of surface water to protect environmental values, to meet the EPA's objective for Inland Waters.

State Planning Policy 2.9 Planning for Water
 	
Better urban water management
 	
State Planning Policy 2.9: Water Resources
	Alteration to surface water and wetlands	DWER	• State Planning Policy 2.9 (SPP 2.9) Planning for Water (WAPC 2021).
			  ○ This policy outlines the integration of water resource management into planning processes. This policy applies to proposals prepared and assessed under the PD Act i.e. scheme amendments, LSP and subdivisions.
			  ○ Proposals in accordance with the SPP 2.9 require the following actions:
			  ▪ Identify wetlands and their buffers and waterways and their foreshore areas and/or reserves.
			  ▪ Ensure waterways and wetlands have adequate foreshore areas and wetland buffers to protect,

Relevant legislation/policy	Approval required	DMA	How the DMA process mitigates environmental impacts on the environment and likely environmental outcome
			manage and conserve water quality and quantity, native vegetation, aquatic and riparian habitats, ecological linkages, and associated biodiversity values. ▪ Ensure the maintenance of natural flows in waterways, groundwater levels and inundation of wetlands to sustain aquatic and terrestrial habitats through the delivery of appropriate stormwater and groundwater management systems. o Water management plans including DWMS and LWMS are available for public and agency/local government review and comment. o DWMS, LWMS and UWMP includes key hydrological assessments/ data and water management framework including groundwater/surface monitoring program(s). o Specific conditions may be required to address, wetlands/waterways management as a condition of subdivision. • Better urban water management provides guidance on implementing State planning policy 2.9: Water resources (WAPC 2008) o Better urban water management was designed to guide water management at the regional, district, local and subdivision stages of the planning process by ensuring consideration is given to the total water cycle at each stage of planning and development. o A DWMS is a high-level water management report which is required: ▪ in accordance with Better urban water management guidelines (WAPC 2008) ▪ underpins the water management principles for MRS land use rezonings ▪ to establish the water management framework for sequential water planning management documents including Local Water Management Strategies and Urban Water Management Plan(s). o The purpose of a DWMS, as outlined in Better urban water management (WAPC 2008), is to demonstrate that the land can support the change in land use and is able to achieve appropriate urban water management outcomes. The DWMS informs the decision-making process associated with the proposed land use change. This involves demonstrating (in this instance) the change to Urban land use: ▪ will not detrimentally impact water resources and associated environmental values. ▪ can manage surface water and groundwater. ▪ can be serviced with water and wastewater.
Environment Protection and Biodiversity Conservation Act 1999	Environmental approval	Department of Climate Change, Energy, the Environment	Where individual proponents of future development propose an action which is likely to result in significant impacts to Matters of National Environmental Significance (MNES), the action must be referred to DCCEEW under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Relevant legislation/policy	Approval required	DMA	How the DMA process mitigates environmental impacts on the environment and likely environmental outcome
		and Water (DCCEEW) Federal Minister for the Environment	If the proposed action is likely to significantly impact MNES, then DCCEEW will undertake an environmental assessment of the proposed action, and the Minister for the Environment will determine whether to issue an approval subject to conditions and ongoing compliance.
Biodiversity Conservation Act 2016	Ministerial authorisation to disturb or take, listed threatened flora, fauna and/or ecological communities.	Department of Biodiversity Conservation and Attractions (DBCA) Minister for Environment	The B*iodiversity Conservation Act 2016* (BC Act) provides for the protection of threatened flora, fauna, and ecological communities in Western Australia. Should future subdivision and development applications require to take or disturb a threatened species or modify a threatened ecological community a Ministerial authorisation under s.40 of the BC Act will be sought. Ministerial authorisation under the BC Act aligns with meeting the EPA objectives for Terrestrial Fauna and Flora and Vegetation.
Contaminated Site Act 2003 ***Contaminated Sites Regulations 2006***	Identification, reporting and classification of contaminated sites in Western Australia	WAPC DWER	Contaminated sites are regulated through the *Contaminated Sites Act 2003* (CS Act) and the Contaminated Sites Regulations 2006. The WAPC under the PD Act (and the CS Act) attends potential contamination risks through standard model subdivision conditions (DPLH 2024b): • Prior to commencement of subdivision works, investigation for soil and groundwater contamination is to be conducted to determine if remediation is required. If required, remediation, including validation of remediation, of any contamination identified shall be completed prior to the issuing of titles on advice from the DWER. • Investigations and remediation are to be carried out in compliance with the CS Act and current DWER Contaminated Sites Guidelines. This subdivision condition would require all investigation, reporting and remediation actions to be subject to review/approval by and 'independent auditor' and then by DWER.
Acid Sulfate Soils Planning Guidelines	Identification and investigation of acid sulfate soils and acidic landscapes Treatment and management of soils and water in acid sulfate soil landscapes	DWER	Acid Sulfate Soils Planning Guidelines outline a range of matters that need to be addressed at various stages of the planning process to ensure that the subdivision and development of land containing acid sulfate soils is planned and managed to avoid potential adverse effects on the natural and built environment. The WAPC under the PD Act (and the CS Act) attends potential ASS risks through standard model subdivision conditions (DPLH 2024b): • An acid sulfate soils self-assessment form and, if required as a result of the self-assessment, an acid sulphate soils report and an acid sulphate soils management plan shall be submitted to and approved by DWER before any subdivision works or development are commenced. Where an acid sulphate soils management plan is required to be submitted, all subdivision works shall be carried out in accordance with the approved management plan.

Relevant legislation/policy	Approval required	DMA	How the DMA process mitigates environmental impacts on the environment and likely environmental outcome
Aboriginal Heritage Act 1972 (WA)	Section 18 consent	Minister for Aboriginal Affairs	Where future development is likely to harm an Aboriginal site, the proponent will be responsible for obtaining consent from the Minister under section 18 of the *Aboriginal Heritage Act 1972* (AH Act). The proponent gives notice - known as a section 18 notice - to the Aboriginal Cultural Heritage Committee (Committee) who will make a recommendation to the Minister. The proponent may need to undertake consultation with traditional owners of the land prior to lodge a Section 18 application with the Department of Planning, Lands and Heritage for consideration. The Minister for Aboriginal Affairs determines whether to approve a Section 18 consent, and whether any associated conditions are placed on the approval.

3. Stakeholder engagement

3.1 Key stakeholders

The key stakeholders in the proposed MRS amendment and this Environmental Review include:

- The Whadjuk Noongar people, as the traditional owners of the land within which the MRS amendment area is located.
- Landowners of freehold lots, residents and business operators within the MRS amendment area and the surrounding localities.
- Any person, organisation or group with an interest in the MRS amendment or this Environmental Review, by virtue of their functions, interests or activities, including but not limited to:
    - Friends of Brixton Street Wetlands
    - University of Western Australia
    - Urban Bushland Council
    - EcoVision
    - Other groups and organisations with an interest in the GBSW, including but not limited to the Beeliar Group, Kwongan Foundation, South West Wildlife Learning and Discovery Network Inc and the Wildflower Society of WA.
- The EPA, as the authority responsible for assessing the environmental acceptability of the MRS amendment under the EP Act, and DWER as the state government agency that assists the EPA in carrying out its functions under the EP Act.
- The WAPC, as the responsible authority for the MRS amendment, and DPLH as the state government agency that assists the WAPC in carrying out its functions under the PD Act.
- State government agencies responsible for providing specialist advice to the WAPC and EPA on the MRS amendment and the assessment of its environmental acceptability. This includes, but is not necessarily limited to:
    - DBCA
    - Department of Fire and Emergency Services (DFES)
    - Main Roads Western Australia (MRWA)
    - Water Corporation
    - Department of Education (DoE)
    - Department of Health (DoH)
    - Public Transport Authority (PTA)
    - Department of Mines, Industry Regulation and Safety (DMIRS)
- The City of Kalamunda, in its advisory capacity to the WAPC and the EPA, representing the interests of its community within the MRS amendment area and the surrounding localities.
- The City of Gosnells, in its advisory capacity to the WAPC and EPA, representing the interests of its community within localities immediately adjacent to the MRS amendment area.

3.2 Stakeholder engagement process

The potential for the MRS amendment area to accommodate future urban development has been the subject of various statutory and strategic planning proposals for over a decade. The development of these proposals has and will continue to involve engagement with key stakeholders.

Wattle Grove was first earmarked for future urban development in 2010, when the City of Kalamunda released its Local Planning Strategy. This strategy identified a potential future urban development area within Wattle Grove that encompassed the MRS amendment area.

The potential for Wattle Grove to accommodate future urban development then became recognised by the WAPC in the *Perth and Peel at 3.5 Million – North-East Sub Regional Planning Framework*, which was released to the public in 2018. This policy framework identified land within the locality of Wattle Grove as UE and UE areas, meaning that the potential for the land to accommodate future urban development may be contemplated by the WAPC, subject to further detailed investigations.

This in turn became the catalyst for the City of Kalamunda to complete more detailed planning for the potential urbanisation of Wattle Grove, culminating in the release of the Crystal Brook Concept Plan. This strategic planning document was informed by a community engagement process that ran for several months. The final report on the Crystal Brook Concept Plan, including a summary of the key themes that came out of the community engagement process, was released in January 2021.

Prior to this, in late 2020, a proposal to rezone a portion of the Wattle Grove UE from 'Rural' to 'Urban' in the MRS was presented to the WAPC. Whilst the WAPC is the responsible authority for the MRS, it is common practice for the technical investigations that inform MRS amendments to be led by landowners and/or development proponents.

The WAPC agreed to progress the technical investigations that would inform a decision on the MRS amendment. It in turn became formalised as MRS Amendment 1388/57 – Wattle Grove South, which is the subject of this Environmental Review.

The WAPC expects landowners and development proponents to engage with relevant state and local government agencies when undertaking the required technical investigations for proposed MRS amendments. This early engagement for the MRS amendment in Wattle Grove South was carried out during late 2020 and 2021.

On 27 October 2021, the WAPC resolved to initiate the MRS amendment. This resolution of the WAPC was informed by:

- The written advice of state and local government agencies, which were formally invited by the WAPC to independently comment on the proposed MRS amendment.
- Written comments received from interested members of the community.
- Deputations made by interested parties at the meeting of the WAPC held on 27 October 2021.

Following the initiation of the proposed MRS amendment by the WAPC, it was then forwarded to the EPA for consideration, pursuant to Section 48A of the EP Act and Section 38 of the PD Act. The EPA decided that the MRS amendment would be subject to a formal environmental impact assessment, inclusive of a public submission period on the Environmental Review.

Consistent with standard WAPC practice and the DPLH's guidance, the required technical studies and documentation for the Environmental Review has been assembled, for the WAPC (as the Responsible Authority) to satisfy itself that any potential environmental impacts associated with the MRS amendment can be appropriately mitigated t.

Once the Environmental Review has been considered by the WAPC and forwarded and accepted by the EPA as sufficient for public advertising, it will be advertised for a period of 60 days, along with the MRS amendment itself. During this advertising period, the community, local and state government agencies and other relevant stakeholders will have the opportunity to review and provide written feedback on the Environmental Review and the MRS amendment.

The feedback received during the public advertising period will then inform the EPA and the Minister for Environment, when making their respective recommendations and decision on the environmental acceptability of the MRS amendment.

3.3 Stakeholder engagement outcomes

The key stakeholder engagement undertaken to date for the MRS amendment includes:

- The early engagement with local, state and federal government agencies, which was undertaken prior to the WAPC's initiation of the MRS amendment.
- The written submissions received by the WAPC from local and state government agencies, as part of the formal statutory process associated with the initiation of the MRS amendment.
- Deputations made by interested parties at the meeting of the WAPC held on 27 October 2021.
- Ongoing engagement between the DPLH/WAPC, technical consultants and state and local government agencies, to inform the technical studies required for this Environmental Review.
- Engagement with a reference group of Whadjuk traditional owners, which was established to guide decisions on the proposed MRS amendment and this Environmental Review from an Aboriginal cultural heritage perspective.

The outcomes of these five phases of stakeholder engagement are presented below.

3.3.1 Early engagement prior to MRS Amendment initiation

Prior to the WAPC's decision to initiate the MRS amendment, early engagement was undertaken with a range of local, state and federal government agencies, including the following:

- DWER (including EPA Services Branch)
- DBCA
- DFES
- City of Kalamunda
- Water Corporation
- DoE
- MRWA
- PTA
- Perth Airport

Table 3-1 below provides a summary of the outcomes of this early government stakeholder engagement with key stakeholders that raised environmental matters relevant to this Environmental Review. For example, engagement with MRWA on road network capacity or DoE on primary school requirements has not been discussed.

3.3.2 Written submissions to the WAPC

The WAPC received seven written submissions from state and local government agencies that were invited by the WAPC to provide advice on the MRS amendment:

- DWER
- DBCA
- DFES
- Water Corporation
- Public Transport Authority
- City of Kalamunda
- City of Gosnells

The WAPC also received one written submission from a community-based group, EcoVision.

Table 3-2 below provides a summary of the written submissions received. Only those submissions that raised environmental matters relevant to this Environmental Review have been discussed.

3.3.3 Deputations at WAPC meeting on 27 October 2021

At the WAPC meeting on 27 October 2021, deputations were made on behalf of four parties:

- EcoVision
- South West Wildlife Learning and Discovery Network Inc.
- Hesperia
- City of Kalamunda

Table 3-3 below provides a summary of the environmental matters relevant to this Environmental Review that were raised in the deputations.

3.3.4 Engagement during preparation of Environmental Review

From early 2022 through to the present time, there has been ongoing engagement between DPLH (on behalf of the WAPC), the technical consultants, officers of DWER (including the EPA Services Branch) and DBCA. The engagement has predominantly focussed on the following matters:

- Seeking clarification on the scope of the Environmental Review instructions.
- Seeking agency feedback on the results of the site-specific groundwater monitoring program.
- Seeking agency feedback on mapping of groundwater contours and flow direction.
- Seeking agency feedback on assumptions and approach taken in Water Balance Assessment.
- Sharing of relevant data and studies to inform the Environmental Review.

Where agency feedback or clarification has been provided, it has been addressed or incorporated within this Environmental Review or its supporting technical studies.

3.3.5 Engagement with Traditional Owners

Engagement was undertaken with a group of Whadjuk Traditional Owners, who hold the kaartdijin (knowledge) about the MRS amendment area and the surrounding region. The Whadjuk Reference Group was established under the guidance of consultant Brendan Moore, acting as the Noongar Group Facilitator. The engagement took place on 5 December 2022.

The outcomes of the engagement with the Whadjuk Reference Group are detailed in Section 8 of this Environmental Review, which addresses the environmental factor of Social Surroundings, considers and responds to the matters raised by the Traditional Owners.

Table 3-1: Early government stakeholder engagement prior to initiation of MRS Amendment

Stakeholder	Key outcomes	Response to matters raised
DWER **EPA Services Branch** **DBCA**	Purpose of the engagement was to meet with officers of DWER and DBCA, to provide a briefing on the proposed MRS amendment and seek feedback on: • Relevant environmental values. • Potential environmental impacts. • District Water Management Strategy. • Water monitoring outcomes to date. • Treatment of wetlands within MRS amendment area. Officers requested that the MRS amendment documentation be updated to address the following: • Additional information on hydrology and biodiversity values of the GBSW. • Hydrological relationship of MRS amendment area to the GBSW. • Pre and post development flows towards the GBSW. • Draft DWMS to recognise the environmental values of the GBSW and ensure they are a key driver in the hydrological design of the MRS amendment area. • Other minor amendments to the draft DWMS prior to endorsement. • Assurance of environmental outcomes. Additional water monitoring was also requested to improve understanding of the MRS amendment area.	Response: All the matters raised by DWER and DBCA during this early engagement meeting, prior to initiation of the MRS amendment, have been addressed in this Environmental Review. Specifically, refer to Sections 5 and 6 of this Environmental Review – Inland Waters and Flora and Vegetation.

Table 3-2: Written Submissions on MRS Amendment Received by WAPC

Stakeholder	Key outcomes	Response to issues raised
DWER	DWER advised: The MRS amendment area contains areas of remnant vegetation which may support Carnaby's Black Cockatoos. DWER recommended these areas be retained for conservation purposes and would require further consideration in subsequent planning stages. DWER and DBCA raise no objections to the draft District Water Management Strategy, which will require approval prior to a final determination being made on the proposed MRS amendment.	Response: Refer to Section 7 of this Environmental Review – Terrestrial Fauna. Refer to Section 5 of this Environmental Review – Inland Waters.

DBCA	DBCA advised:
	
	• Threatened Ecological Communities / Priority Flora
	  ○ Existing good quality native vegetation will be retained in conservation POS. This will include areas of remnant Banksia Woodlands listed as 'Endangered' under the EPBC Act, including the FCTs 20a and 20b which are both listed as 'Endangered' under the BC Act, and the flora *Conospermum undulatum*, listed as 'Threatened' under the BC Act, and 'Vulnerable' under the EPBC Act.
	
	• Wetlands
	  ○ The REW (UFI 15257) partially intersects the site, but this area has been significantly modified during the construction of Tonkin Highway and the Dampier-Bunbury Natural Gas Pipeline. The proponent provides a commitment that an assessment will be undertaken to determine the environmental values of this wetland and if required, a Wetland Management Plan.
	  ○ A second REW (UFI 8037) has been cleared and filled and no longer exists.
	  ○ DBCA and DWER have recently undertaken a review of the environmental values of the wetlands currently mapped in the Geomorphic Wetlands Swan Coastal Plain (GWSCP) dataset. The result of the mapping indicates that the two REW within the amendment area (portion of UFI 15257 and UFI 8037) have values commensurate with a Multiple Use wetland.
	  ○ The proposed development will reduce impacts on the GBSW by improving water quality and reducing the nutrient levels exported from the site.
	
	It is not clear whether kangaroos are present on the site. An assessment of whether kangaroo management is required should be undertaken early in the planning process.
		Response:
		
		Refer to Section 6 of this Environmental Review – Flora and Vegetation.
		
		Refer to Section 5 of this Environmental Review – Inland Waters.
		
		Refer to Section 5 of this Environmental Review – Inland Waters.
		
		Refer to Section 5 of this Environmental Review – Inland Waters.
		
		This can be addressed at later stages of the planning process and prior to any development.

Stakeholder	Key outcomes	Response to issues raised
	The DBCA supports having a perimeter road between residential development and conservation POS, for reasons of public safety, protection of the bushland within the POS and fire safety.	Refer to Section 6 of this Environmental Review – Flora and Vegetation. This can be addressed as part of the future environmental management plans.
City of Kalamunda	City of Kalamunda advised: On 24 August 2021, the Council resolved to endorse its 'Preliminary Submission' on the proposed MRS amendment and forward it to the WAPC. In its submission, the City raised no objections to the proposed MRS amendment. The environmental matters raised in its submission were: • Site specific flora surveys will need to be undertaken for properties not yet surveyed. • The site vegetation is described as highly fragmented. The City recommends that a feature survey is provided at structure plan stage where all natural assets are mapped and prioritised to determine which are to be retained in corridors of POS and road reservations. • The linkages should be designed having regard for ecological principles, which is to ensure they are appropriate for the movement of target organisms. • It should be noted that Cape Lilac are a known food source for Black Cockatoos in the City and subsequently have a role to play in this landscape. • Quenda are known to co-habitat in this area. It is recommended to undertake additional surveys to better understand the population of quenda and measures should be put in place at structure plan stage to ensure their population is not detrimentally impacted. • An assessment of the Rainbow Bee Eater population should be conducted as they are known to nest in bare open sandy paddocks as well as within remnant bushland. • Bush Forever sites are within proximity of the subject site. Attempts should be made to best link the areas between these sites and the subject site through ecological linkages. • It is important that the remnant areas of high ecological value are not only retained but buffered with suitable land uses that increase the capacity of the remnants to be resilient. • The tree retention plan should provide details of all trees, not just those greater than 300 mm DBH. A comprehensive plan on retention, buffering, connection and rehabilitation of important linkages should be undertaken as part of the structure planning process. • The District Water Management Strategy does not contain a water balance.	Response: The majority of the City's environmental comments relate to the conservation of flora, vegetation and fauna. Refer to Sections 6 and 7 of this Environmental Review – Flora and Vegetation and Terrestrial Fauna where the matters raised by the City are broadly addressed. The City's comment on the absence of a Water Balance Model in the DWMS has been addressed. Refer to Section 5 of this Environmental Review – Inland Waters.
City of Gosnells	City of Gosnells advised: **Environmental**: The site contains a diverse range of significant environmental values including: • Resource Enhancement Wetlands.	Response: Environmental Issues:

Stakeholder	Key outcomes	Response to issues raised
	• Environmentally Sensitive Areas - 8 mapped areas with declared rare flora. • Regional Ecological Linkage which connects with the Greater Brixton Street Wetlands. • Threatened Ecological Communities (two state listed and one Federally listed). • Recorded populations of Threatened and Priority Flora *Conospermum undulatum* (T) and *Isopogon autumnalis* (P3). • Potential habitat for conservation significant fauna. • Potential foraging habitat for the three threatened Black cockatoo species. **Drainage**: The DWMS needs to include the depth of the bores to determine if coffee rock occurs in the area. This will allow a greater understanding whether the groundwater level is perched or not. The DWMS needs to be updated to factor in one additional box culvert drain under Tonkin Highway at the southern corner of the turf farm. The City supports the commitment for an LWMS and UWMPs to be prepared and implemented in accordance with the DWMS and Better urban water management, including demonstration of a reduction of pre-development nutrient rates and maintenance of predevelopment flows.	Refer to Sections 5, 6 and 7 of this Environmental Review – Inland Waters, Flora and Vegetation and Terrestrial Fauna. Drainage: Refer to Section 5 of this Environmental Review – Inland Waters.
EcoVision	Summary: The written submission from EcoVision discusses environmental matters including biodiversity, conservation significant flora, vegetation and fauna and Yule Brook Regional Park.	Response: Refer to Sections 5, 6 and 7 of this Environmental Review – Inland Waters, Flora and Vegetation, and Terrestrial Fauna.
DFES	DFES advised in written correspondence to the WAPC: The BMP has adequately identified issues arising from the bushfire hazard level assessment and considered how compliance with the bushfire protection criteria can be achieved at subsequent stages of the planning process. DFES also advised that minor modifications to the BMP can be undertaken at later structure planning and subdivision stages of the planning process.	Response: Managing bushfire risk is identified in this Environmental Review as potential risks to conservation significant flora, vegetation and fauna habitat. Specifically, refer to Sections 6 and 7 of this Environmental Review – Flora and Vegetation and Terrestrial Fauna.

Table 3-3: Deputations at WAPC Meeting on 27 October 2021

Stakeholder	Key outcomes	Response to issues raised
Ms Bev Dornan **Representing EcoVision**	Ms Dornan covered a range of matters in her deputation. With respect to environmental matters, she discussed the importance of Wattle Grove South to the environmentally sensitive hills area.	Response: Broadly addressed in all sections of this Environmental Review.
Mr Peter Forrest and Professor Hans Lambers **Representing South West Wildlife Learning and Discovery Network Inc.**	Mr Forrest and Mr Lambers presented on the environmental consequences for the biodiverse wetlands of the Alison Baird Reserve and GBSW, in relation to the proposed MRS amendment. Mr Forrest stated the area has significant plant diversity and surface landforms which have remained untouched for millions of years. He discussed the flow of the surface and sub-surface ground water and the importance of this flow through Crystal Brook, Wattle Grove and to GBSW. Mr Forrest stated that the water flow is gradually reducing due to climate change and surface warming, and that the introduction of residential zoning in this area would impact and pollute the sub-surface water flow. Mr Forrest stated that urban or industrial development in the area will result in the loss of the unique biodiverse wetlands.	Response: Refer to Section 5 of this Environmental Review – Inland Waters.
Mr Judd Dyer **Ms Gemma Davis** **Representing Hesperia** **Mr Darren Walsh** **Mr Matt Raymond** **Representing Strategen and Element**	Mr Dyer discussed the water management and wetland principals that will protect the environmental assets, nutrient flows and reduce carbon. Mr Dyer stated that water monitoring has been undertaken which was endorsed by DBCA. Mr Dyer stated that they have had long engagement with the Beeliar Group regarding the GBSW. Members queried if DWER had endorsed the water management. Mr Raymond stated that comments had been received from DWER and final endorsement is progressing.	Response: Refer to Section 5 of this Environmental Review – Inland Waters.
Mitchell Brooks **Representing City of Kalamunda**	Mr Brooks stated that the City undertook community consultation and prepared a concept plan to capture community views for the future of the area, and common themes were identified such as protecting environmental values and rural lifestyle of property north of Crystal Brook Road. Mr Brooks stated the Council had endorsed the proposal and requested special consideration of emission reduction with a focus on renewables. Comments had been provided on environmental values including assessment of tree retention and support for the maximum 20% canopy cover.	Response: Refer to Sections 6, 8 and 9 of this Environmental Review – Flora and Vegetation, Social Surroundings and Greenhouse Gas.

4. Object and principles of the EP Act

Section 4A of the EP Act establishes the object of the act being 'to protect the environment of the State' having regard to the principles identified in Table 4-1.

This section considers the application of the principles of environmental protection in relation to the MRS amendment; identifies the environmental factors relevant to the MRS amendment and outlines the overall environmental impact assessment methodology undertaken for each preliminary key environmental factor.

The Proponents consideration of the EP Act principles of environmental protection in relation to the MRS amendment is shown in Table 4-1.

Table 4-1: Environmental Principles of the *Environmental Protection Act 1986*

Principle	Consideration
1. The Precautionary Principle	A number of site assessments and surveys have been undertaken to provide an understanding of baseline environmental conditions and potential impacts associated with the MRS amendment. The risk of impacts to key environmental factors have been considered and options to avoid, minimise and mitigate any potential impacts to the environment have been adopted.
2**. The Principle of Intergenerational Equity**	The MRS amendment provides for strategic development of the wider Wattle Grove area, to manage potential hydrological impacts or urbanisation on the Yule Brook catchment and GBSW, rather than via ad hoc rezoning proposals for individual lots. MRS Amendment 1388/57 meets the principle of intergenerational equity by ensuring the health of the environmental values, maintaining ecological functions for future generations, whilst minimising any impacts on the environment.
3. The Principle of the Conservation of Biological Diversity and Ecological Integrity	The conservation of biological diversity and ecological integrity was a fundamental consideration in the assessment of this MRS amendment. This includes but is not limited to establishing conservation areas for the purpose of protecting conservation significant vegetation, flora and fauna habitat.
4. Principles Relating to Improved Valuation, Pricing and Incentive Mechanisms	Environmental constraint avoidance and management costs have been considered in the planning and design of the MRS amendment. Hesperia Pty Ltd will be responsible for prefunding the cost of environmental avoidance, mitigation and management measures (as part of the work) required to rezone the site. Future site development costs will include necessary charges related to environmental management (such as water use, drainage, sewerage).
5. The Principle of Waste Minimisation	Future works associated with development of rezoned land, will incorporate necessary waste hierarchy of controls, i.e. avoid, minimise, reuse, recycle and safe disposal.

4.1 Environmental factors and objectives

The preliminary key environmental factors identified by the EPA for the environmental review are:

- Inland Waters
- Flora and vegetation
- Terrestrial Fauna
- Social Surroundings
- Greenhouse Gas

The potential impacts identified for each key environmental factor and an assessment of the impacts and predicted significance, and outcomes has been undertaken in consideration of the following for each factor:

- EPA (2021) Statement of environmental principles, factors, objectives and aims of EIA.
- Relevant policy and guidance, and summary of how this guidance has been addressed.
- Description of the receiving environment.
- Definition of potential direct, indirect and cumulative impacts on the environmental.
- Assessment of the extent and significance of impacts to the environmental values for each factor.
- Application of the mitigation hierarchy (avoid, minimise, rehabilitate).
- Description of the residual impact and predicted environmental outcome as assessed against the EPA objective.

Table 4-2 describes the policy and guidance that has been considered with respect to all key environmental factors and objectives addressed in Sections 5 to 11 and as such is not repeated within the policy and guidance table of these Sections.

Table 4-2: Policy and guidance relevant to all factors

Policy and guidance	Key aspects
Statement of Environmental Principles, Factors, Objectives and Aims of EIA (EPA 2023)	This statement communicates how, for the purposes of environmental impact assessment (EIA), the EPA: • considers the object and principles of the EP Act • considers what the aims of EIA should be • uses environmental factors and objectives to organise and systemise EIA and reporting • considers significance throughout the EIA process • takes a holistic view of the environment and a proposal or scheme's potential impact on the environment • considers cumulative effects when assessing a proposal or scheme's potential impact on the environment.
WA Environmental Offsets Policy (GoWA 2011); and **WA Environmental Offsets Guidelines (GoWA 2014)**	The Western Australian Government's Environmental Offsets Policy seeks to protect and conserve environmental and biodiversity values for present and future generations. This policy ensures that economic and social development may occur while supporting long term environmental and conservation values. These guidelines complement and expand on the WA Environmental Offsets Policy 2011 (offsets policy) by clarifying the determination and application of environmental offsets in Western Australia.

Policy and guidance	Key aspects
How to prepare an Environmental Review Document Instructions (EPA 2021a); and **Environmental Review Document template (EPA 2023a)**	The purpose of these instructions is to ensure necessary information is provided to meet the requirements of section 40(2) (b) of the EP Act. This Environmental Review has been prepared in accordance with the EPA's 2021 ERD template and the instructions.
Environmental outcomes and outcomes based conditions Interim Guidance (EPA 2021b)	The purpose of this document is to: • explain what environmental outcomes are and their application throughout the environmental impact assessment (EIA) process • assist proponents to identify the environmental outcomes likely to result from their proposal as early as possible in the development of their proposal, and to continue to assess and refine the environmental outcomes throughout the assessment process • outline the EPA's usual process for setting outcome-based conditions. This guidance has informed the predicted environmental outcomes identified in this Environmental Review.
Instructions for the preparation of data packages for the Index of Biodiversity Surveys for Assessments (IBSA) (EPA 2021c)	These instructions are to assist proponents in preparing and submitting online Index of Biodiversity Surveys for Assessments (IBSA) data packages, as part of the assessment process under the EP Act. Refer to Section 14 of this Environmental Review for IBSA references relevant to this MRS amendment.

5. Key environmental factor - Inland waters

5.1 EPA objective

The EPA's objective for Inland Waters is:

To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.

The EPA defines the factor Inland Waters as:

The occurrence, distribution, connectivity, movement, and quantity (hydrological regimes) of inland water including its chemical, physical, biological and aesthetic characteristics (quality).

Inland waters include groundwater, such as superficial and confined aquifers, and surface water, such as waterways, wetlands and estuaries. A 'waterway' is any river, creek, stream or brook, including its floodplain and estuary or inlet. This includes systems that flow permanently, for part of the year or occasionally, and parts of the waterway that have been artificially modified.

5.2 Instruction for Environmental Review (Assessment No. 2335) for MRS Amendment 1388/57 - Inland Waters and Clarification

The EPA's Instruction for Environmental Review (Assessment No. 2335) for MRS Amendment 1388/57 identified 24 specific scopes of works for the Inland Waters environmental factor. In November 2022, post issuing of the Instruction for Environmental Review (Assessment No. 2335) for MRS Amendment 1388/57, DWER EPA Service Unit clarified inland waters scope of works requirements for tasks 3, 6, 7, 8, 10, 12 and 19.

Table 5-1 outlines the required work for the Inland Waters as a key environmental factor and defined in the Instruction for Environmental Review (Assessment No. 2335) (15 August 2022) and the agreed refined scope of works (24 November 2022) for requirements 3, 6, 7, 8, 10, 12 and 19.

Table 5-1: Inland waters - scoping requirements

Task	Required work	Clarification on the required work	Section
1.	• Identify and assess the values and significance of hydrological and geological characteristics within the amendment area and surrounding area including for the broader Wattle Grove Urban Expansion (UE) and Urban Investigation (UI) area, particularly in relation to the GBSW and describe these values in a local and regional context.		• Section 5.4.2- Receiving Environment. • Sections 5.4.5 and 5.4.6 - Wetlands and GBSW.
2.	• Identify and map wetlands and watercourses within and adjacent to the MRS amendment area including UE and UI areas and through work from the instructions below identify any areas proposed to be impacted.	• Undertake mapping of wetlands and watercourses within the UE and UI areas.	• Section 5.4.4 – Surface Water. • Section 5.5.1 - Potential Environmental Impacts.

3.	• Map groundwater contours for the regional and perched groundwater tables over the MRS amendment area using site specific monitoring data and monitoring data from other nearby bores including the Department of Water and Environmental Regulation (DWER) and Department of Biodiversity Conservation and Attractions (DBCA) sites to establish the groundwater flow direction.
	• Assess results in comparison to previous regional mapping completed within the local area (amendment area, UE, and UI areas). Liaise with DWER to obtain any monitoring data further to the publicly available data base. Additional long-term and extensive groundwater flow direction investigations (such as additional monitoring bores and an extended period of data collection) may be required to support groundwater flow mapping that is not consistent with the DWER mapping. Ensure that all superficial bores used in creating the regional groundwater contours are not perched and represent the groundwater in superficial aquifer.
		• Engage with DWER to access any additional groundwater monitoring data that is not publicly available.
		• Extended the superficial aquifer and perched groundwater monitoring program (commenced in 2020 with monitoring continued until present)
		• The monitoring program installed additional 16 bores within and adjacent to the MRS amendment area.
		• Groundwater mapping and flow directions will be refined based on peak levels winter period across all bores and correlated with DWER long term bore records.
		• Undertake a geophysical investigation using electrical resistivity tomography with the objective of:
		  ○ providing subsurface geological information
		  ○ interpreting and understanding the local groundwater contours specific to the
			• Section 5.4.3 - Groundwater.
			• Appendix B - Wattle Grove South District Water Management Strategy (DWMS) (Hyd2o 2024).

Task	Required work	Clarification on the required work	Section
		MRS amendment area and the regional groundwater mapping.	
4.	• Map the surface water catchment for the amendment, UE, and UI areas, and map the contribution of pre-development surface water flows to the surrounding wetlands and water courses.	• Surface water catchment and predevelopment and post development flows will be calculated for the UE and UI areas to the wetland areas.	• Section 5.4.4 - Surface Water. • Appendix B - Wattle Grove South DWMS (Hyd2o 2024).
5.	• Describe the total water cycle for the amendment area in the context of it being within the Yule Brook Catchment and with consideration of the surrounding UE and UI area. Discuss the hydrology and hydrogeology, particularly as it relates to wetland and ecological diversity within and nearby to the amendment area. Include information and discussion on the water budget for the area, the existing drainage management practices and any known impacts on the wetlands and waterways in, and nearby to the amendment area.	• The UE and UI areas will be included in the total water cycle assessment.	• Sections 5.4.2 - Receiving Environment. • Sections 5.4.5 and 5.4.6 - Wetlands. • Section 5.5.1 - Potential Environmental Impacts. • Table 5-28
6.	• Using a pre and post development water balance model, characterise the existing hydrology of the site and existing sub surface flow contribution to the GBSW; and assess the potential impacts (direct and indirect) of the proposed change in land use associated with the amendment, and UE and UI areas, on water quantity and quality of surface and ground waters and subsurface flow contribution in relation to nearby significant wetlands and waterways. • The following should be considered in the development of any model: o The model should be developed in consultation with DWER and DBCA and consider inputs of the PRAMS groundwater flow model inputs. o Provide details of the existing geological and hydrogeological conditions used in conceptualising any modelling undertaken. o The groundwater water balance and groundwater resources in the superficial aquifer should consider PRAMS input parameters using the flow-net analysis with the Darcy equation. Groundwater throughflow from the site toward the GBSW should be calculated with consideration of the Darcy equation.	• Site specific groundwater, soil and geotechnical data located within the MRS amendment area and existing bores in the surrounding locality (west of the MRS amendment area) will underpin the water balance model. • The UE and UI areas will be modelled based on an extrapolation from the groundwater, soil and geotechnical data collected from within the MRS amendment area. • The water balance model will assume the entire extent of the UE and UI areas are 'urbanised'. This assumption presents a potential 'worst case' scenario for changes to the hydrological cycle. The Environmental Review acknowledges: o The inclusion of the UE and UI areas in the Environmental Review, DWMS.	• Sections 5.4.5 and 5.4.6 - Wetlands and GBSW. • Section 5.5.1 - Potential Environmental Impacts. • Table 5-28 • Appendix B - Wattle Grove South DWMS (Hyd2o 2024).

Task	Required work	Clarification on the required work	Section
	○ Demonstrate the water balance is based on an understanding of both the groundwater minimum and maximum for the amendment area and the GBSW. The assessment of soil/sediment gravimetric and volumetric water contents, where perched aquifers are suspected, is also required to adequately inform the water balance. • Minimum data and information required to support an appropriate water balance is listed below with accompanying published data: ○ Minimum groundwater levels (collected April-May) – as shown in the published data logger data presented in WA wetlands conference poster (Bourke et. al. 2018). ○ Groundwater levels (minimum and maximum) presented in metres below ground level – required to assess wetland flora and fauna and terrestrial vegetation groundwater dependency and threats (e.g. waterlogging, acidification and salinisation). Lambers (2019). ○ Volumetric water content, water retention and hydraulic conductivity – see Davis and Cahill (2018) for horizontal hydraulic conductivity calculations using surface nuclear magnetic resonance (SNMR). ○ Water quality within GBSW is known to be spatially varying (Davis and Cahill 2018, and Lambers 2019). A spatial, temporal, and lithological interpretation of water quality data is therefore required against water balance modelling outcomes to assess threats to wetland flora and fauna and terrestrial vegetation.	○ The water balance model is not an 'endorsement' for a re-zoning of landholdings within the UI and UE areas. ○ Any future rezoning proposals within the UE and UI areas will only be considered by the WAPC as separate and discrete MRS amendments (and therefore subject to a separate EPA assessment inclusive of hydrological and geological assessments), distinct from MRS amendment 1388/57.	
7.	• Calculate the additional recharge from the proposed change in land use associated with the amendment, and the resultant impact to the groundwater flow velocity and direction toward the GBSW. This should also include identification of the additional recharge from the UE and UI areas.	• The additional groundwater recharge will be calculated for the MRS amendment area will be inferred to estimate the additional recharge from the UE and UI areas.	• Table 5-28 • Section 5.5.1 - Potential Environmental Impacts. • Appendix A- Water Balance Assessment: Wattle Grove South MRS Amendment (Emerge Associates 2024). • Appendix B - Wattle Grove South DWMS (Hyd2o 2024).

Task	Required work	Clarification on the required work	Section
8.	• Demonstrate that predevelopment surface water and groundwater flow to the Yule Brook and GBSW are maintained post development as a result of the proposed change in land use associated with this amendment, and UE and UI areas.	• Event based flows and annual flows will be used to demonstrate maintenance of predevelopment flows to the Yule Brook and the GBSW post development of the MRS amendment area and the UE and UI areas.	• Section 5.5.1 - Potential Environmental Impacts. • Appendix A - Water Balance Assessment: Wattle Grove South MRS Amendment. • Appendix B - Wattle Grove South DWMS (Hyd2o 2024).
9.	• Estimate post development nutrient input and export rates resulting from the proposed change in land use, including through the use of DWER's Urban Nutrient Decision Outcomes (UNDO) model.		• Section 5.4.4.4 - Surface Water Quality. • Appendix B- Wattle Grove South DWMS (Hyd2o 2024).
10.	• Predict the extent, severity, and duration of potential impacts further to items 5 to 9, including changes to local and regional groundwater flows and levels, drawdown, local water quality and impacts to other groundwater users as a result of the proposed change in land use associated with the amendment, and UE and UI areas, and provide measures to mitigate these impacts.	• The prediction of impacts from the UE and UI areas will be informed by groundwater monitoring/geotechnical and geological assessments inferred from the MRS amendment area.	• Sections 5.4.2 - Receiving Environment. • Sections 5.4.5 and 5.4.6 – Wetlands and GBSW. • Section 5.5.1 - Potential Environmental Impacts. • Table 5-28 • Appendix A - Water Balance Assessment: Wattle Grove South MRS Amendment (Emerge Associates 2024). • Appendix B - Wattle Grove South DWMS (Hyd2o 2024).
11.	• Determine the boundaries of wetlands and/or buffer requirements to wetlands within and adjacent to the amendment area proposed to be retained. Boundary and buffer studies should consider the characteristics of hydrology, hydric soils and wetland vegetation, and the water balance of the wetland/wetland dependent vegetation.		• Sections 5.4.5 and 5.4.6 - Wetlands and GBSW. • Appendix C - MRS Amendment Area Wetland Assessment (Pentium Water 2024).
12.	• In the context of the below, items 6, 8 and 11 should model existing conditions of, and potential changes to, groundwater and surface water chemistry, particularly in relation to salinity and soil sodicity, that will result from the proposed change in land use associated with this amendment, and UE and UI areas. • Research in the southern area of the GBSW has shown the area is characterised by aquifers with locally elevated salinities and a water table that fluctuates from at or above the surface, to below ground level and there may be a risk from the provision of more groundwater or surface water to the GBSW, as this may persist into	• The assessment of the water chemistry will be premised on the existing groundwater data and soil logs collected from the monitoring bores within the MRS amendment area. This assessment will include: ○ Potential changes to salinity and sodicity and potential impacts at the soil surface as a result of the 'Urban' land use.	• Section 5.5 - Potential Environmental Impacts. • Appendix A - Water Balance Assessment: Wattle Grove South MRS Amendment (Emerge Associates 2024). • Potential Salinity and Sodicity Impacts of the Wattle Grove Urban Development on the Greater Brixton St. Wetlands (MBS 2024) included as Appendix S within Appendix B - Wattle Grove South DWMS (Hyd2o 2024).

Task	Required work	Clarification on the required work	Section
	summer months and concentrate solutes in the root zone as it evaporates.	○ The outcomes from the water balance model assessment. • The water chemistry for the UE and UI areas will be inferred from the MRS amendment area groundwater and the soil log data sets.	
13.	• Describe how the principles of water sensitive urban design will be incorporated and implemented in the amendment area, consistent with the Better urban water management framework (WAPC 2008) and the *Stormwater Management Manual for WA* (DWER 2022) and other relevant guidelines.		• Section 5.5.1 - Potential Environmental Impacts. • Appendix A - Water Balance Assessment: Wattle Grove South MRS Amendment (Emerge Associates 2024). • Appendix B - Wattle Grove South DWMS (Hyd2o 2024).
14	• Detail and discuss how future drainage practices within the site, is to be managed, considering the broader catchment. This management should ensure the hydrological balance and water quality of significant wetlands and watercourses within and nearby to the amendment area (such as the GBSW and Yule Brook) will be maintained.		
15.	• Describe how drainage management practices could be adapted in the future to mitigate impacts of climate change on significant wetlands and waterways, within and adjacent to the amendment areas.		
16.	• Using the mitigation hierarchy, detail and discuss how development activities will avoid and manage mobilisation of potentially poor-quality groundwater resulting from past agricultural land uses.		• Table ES-1-3 - Summary of Potential Impacts, Proposed Mitigation and Proposed Environmental Outcomes. • Section 5.5.1 - Potential Environmental Impacts.
17.	• Describe the planning or other mechanisms that will ensure drainage management will protect significant wetlands and watercourses within and adjacent to the amendment area.		• Section 5.5.1 - Potential Environmental Impacts. • Appendix B - Wattle Grove South DWMS (Hyd2o 2024).
18.	• Describe the ongoing management requirements for the amendment area to ensure the hydrology of significant wetlands		• Section 5.5.1 - Potential Environmental Impacts.

Task	Required work	Clarification on the required work	Section
	and watercourses within and nearby to the amendment area is maintained.		• Appendix B - Wattle Grove South DWMS (Hyd2o 2024).
19.	• Prepare a district water management strategy in accordance with the Guidelines for district water management strategies (DoW 2013).	• The assessment of the UE and UI areas in the DWMS will be commensurate with the DWMS requirements set out in the Better urban water management Guidelines (WAPC 2008). • Any future rezoning proposals within the UE and UI areas will require a 'stand-alone' DWMS to support a separate MRS amendment and EPA assessment under s.48(a) of the EP Act.	• Section 5.5.1 - Potential Environmental Impacts. • Appendix B - Wattle Grove South DWMS (Hyd2o 2024).
20.	• Prepare a monitoring program including management objectives, baseline conditions, public reporting, and measures to be implemented in the event of non-compliance to management objectives.		• Section 5.5.1 - Potential Environmental Impacts. • Appendix B - Wattle Grove South DWMS (Hyd2o 2024).
21.	• Based on the outcomes of the above and taking into consideration the principles of avoidance and minimisation, identify an environmentally acceptable area for development.		• Section 5.5.1 - Potential Environmental Impacts.
22.	• Provide a summary of residual impacts of future development and associated infrastructure within and adjacent to the amendment area.		• Table ES-1-3 - Summary of Potential Impacts, Proposed Mitigation and Proposed Environmental Outcomes. • Section 5.5.1 - Potential Environmental Impacts.
23.	• Describe any proposed avoidance, mitigation and management measures that demonstrate the EPA's objectives can be met.		• Table ES-1-3 - Summary of Potential Impacts, Proposed Mitigation and Proposed Environmental Outcomes. • Section 5.5.1 - Potential Environmental Impacts.
24.	• Describe the planning mechanisms that are to be applied to ensure impacts are managed to meet the EPA's objectives.		• Section 5.5.1 - Potential Environmental Impacts.

5.3 Relevant policy and guidance

The relevant government policy and guidance for inland waters are summarised in Table 5-2.

Table 5-2: Policy and guidance relevant to Inland waters

Policy and guidance	Key aspects
Environmental Factor Guideline: Inland Waters (EPA 2018)	• This guideline provides an outline of how Inland Waters is considered by the EPA in the EIA process, including assessment of potential environmental impacts, implications of cumulative impacts, the mitigation hierarchy (direct and indirect impacts), management approaches and predicted residual impacts.
A methodology for the evaluation of wetlands on the Swan Coastal Plain, Western Australia (DBCA 2017)	• This guidance document has been utilised in this Environmental Review in the assessment of two Resource Enhancement Wetlands (REW; UFI 8037 and portion of UFI 15257) which intersect the MRS amendment area.
Draft Guideline for the Determination of Wetland Buffer Requirements (WAPC 2005)	• An assessment of wetland buffers within approximately 150 m of the MRS amendment area was completed in accordance with the Draft Guideline for the Determination of Wetland Buffer Requirements (WAPC 2005). The wetlands subject to the buffer assessment include: ○ East of Tonkin Highway: ▪ Two Conservation Category Wetlands (CCW) (UFI 8026 and UFI 8027) are located within Lot 501. Lot 501 also contains a portion of Resource Enhancement Wetland (REW) UFI 15257. ○ West of Tonkin Highway: ▪ The GBSW area which incorporates numerous DBCA mapped CCW and REW features. The mapped wetlands located in the GBSW within 150 m of the MRS amendment area include, three CCW UFI 8025, UFI 8028, UFI 14962, one REW UFI 5257 and a Multiple Use Wetland (MUW) UFI 8030.
Better urban water management **(WAPC 2008)**	• The Wattle Grove South DWMS (Hyd2o 2024) has been prepared to specifically satisfy the requirements of this policy document. • The drainage strategy incorporates Water Sensitive Urban Design principles to minimise impacts on sensitive water resources and wetlands.
Identification and investigation of acid sulphate soils and acidic landscapes (DER 2015)	• Considered in defining the management response to the potential impacts of acid sulphate soils identified in this Environmental Review.
Environmental values and pressures for the Greater Brixton Street Wetlands on the Swan Coastal Plain – Advice in accordance with Section 16(j) of the *Environmental Protection Act 1986* (EPA 2022)	• In October 2022, the EPA released the 'Environmental values and pressures for the GBSW on the Swan Coastal Plain – Advice in accordance with section 16(j) advice of the EP Act.' • This section 16(j) advice is applicable to the proposed MRS amendment and this Environmental Review. In the advice, the EPA defines the following key aspects: ○ The environmental values of the GBSW. ○ The existing and potential pressures on those values. ○ Recommendations for enhancing the protection of the GBSW. ○ Expectations for proposals and planning schemes that have the potential to impact the environmental values of the GBSW. • This Environmental Review responds to the EPA's Section 16(j) advice by: ○ Analysing appropriate and site-specific hydrological and hydrogeological investigations to inform the EIA.

Policy and guidance	Key aspects
	○ Addressing potential impacts on the local water balance, hydrological regime, and water-dependent environmental values, as well as potential changes in surface and groundwater flow and quality, in a local and regional context. ○ Assessing the potential changes to hydrological regimes and the impacts of this on the flora and vegetation of the GBSW. ○ Completing a direct, indirect and cumulative impact assessment. ○ Demonstrating in the DWMS best practice water management, with adaptability in design to protect the environmental values of the GBSW and support its ecological and hydrological processes. ○ Demonstrating that any potential changes to the water balance, hydrological regime, or water quality as a result of the proposed change in land use will not adversely impact the environmental values of the GBSW.

5.4 Receiving environment

5.4.1 Studies and investigations

Table 5-3 outlines the scope and spatial coverage of the technical hydrological, hydrogeological, geological, and geotechnical studies that have been undertaken to inform the DWMS prepared by Hyd2o (2024), as well as the Water Balance Assessment undertaken by Emerge Associates (2024) (Appendix A) and the wetland assessment undertaken by Pentium Water (2024) (Appendix C). The table also outlines the sequential water management framework defined in the DWMS (Appendix B) which aligns with the statutory planning framework and Better urban water management guidelines (WAPC 2008).

Table 5-4 outlines the scope and spatial coverage of relevant hydrological, hydrogeological and wetland studies and datasets undertaken by other parties within the local area including the MKSEA Precincts 1, 2, 3A and 3B, the GBSW area which complement the Wattle Grove South technical investigations and reports.

Table 5-3: Inland waters key technical investigations, surveys and reports

Aspects	Investigations	Scope	Spatial coverage
Geotechnical	• The following technical investigation reports are within the Wattle Grove South DWMS (Hyd2o 2024) – Appendix B: ○ Report on Preliminary Geotechnical Investigation Proposed Wattle Grove Development Victoria Road, Wattle Grove (Douglas Partners 2022). ○ Report on Preliminary Geotechnical Investigation Proposed Wattle Grove Development Precinct 1, Victoria Road, Wattle Grove (Douglas Partners 2020). ○ Geophysical Subsurface Investigation at Proposed Land Development Site Wattle Grove (GBG Group 2024).	• **Geotechnical Scope**: Douglas Partners undertook a geotechnical assessment within the MRS amendment area for the following purpose: ○ Assessing via test pits the subsurface soil and groundwater conditions to provide geotechnical assessment on following aspects relevant to Inland Waters: ○ The presence of soil, rock or coffee rock, clay and clayey soils and the distribution of clayey soils. ○ The thickness of sand and clayey soils. ○ The depth to groundwater and/or perched water. ○ Permeability testing of the encountered soils and clayey soils. • **Geophysical Scope**: GBG Group undertook a subsurface electrical resistivity for the following purpose: ○ Assessment of subsurface permeability. ○ Assist in the interpretations of groundwater flow direction and perched groundwater assessment in the vicinity of the GBSW area.	• Wattle Grove South MRS amendment area • UE - geophysical assessment
Groundwater	• Water Balance Assessment: Wattle Grove South MRS Amendment (Emerge Associates 2024) - Appendix A. • Wattle Grove South DWMS (Hyd2o 2024) – Appendix B. • Groundwater monitoring data was incorporated from the following sources: ○ Wattle Grove South 2019 - 2020 Water monitoring report (Urbaqua 2020). ○ 2030 Planning Base Scenario Results for PRAMS 3.5.2 (Department of Water 2016). ○ Hydrological Study of the Greater Brixton Street Wetlands (Semeniuk 2001). ○ MKSEA Surface Water and Groundwater Monitoring and Investigation (Endemic 2012).	• Groundwater Scope: Groundwater baseline investigation and assessment inclusive of: ○ Establishing a groundwater monitoring program which integrates 23 bores within the MRS amendment area and adjacent areas plus 3 DWER bores. The objective of monitoring program is to capture seasonal groundwater levels, groundwater flow and quality within the Superficial Aquifer and the perched aquifer system. The monitoring program commenced in November 2020 and is ongoing. ○ Incorporating the groundwater bore sites and monitoring data from the following sources into the hydrological assessments: ▪ The City of Kalamunda groundwater and surface water monitoring program which included the MRS amendment area (Urbaqua 2020). ▪ The hydrogeological assessment of MRWA's Tonkin Highway upgrade between Roe Highway and Kelvin Rd (Arup 2020). ▪ DBCA's hydrological monitoring within the GBSW and the Wannaping Block (2016 -2022).	• Wattle Grove South MRS amendment area • UI area • UE area. • Portions of the GBSW area

Aspects	Investigations	Scope	Spatial coverage
	○ Environmental Review - City of Gosnells Town Planning Scheme No. 6 Amendments 166 and 169 (Emerge Associates 2023b). ○ MKSEA Precinct 2 Local Water Management Strategy (Emerge Associates 2022c). ○ MKSEA Precinct 3B Local Water Management Strategy (Emerge Associates 2022d). ○ Local Water Management Strategy Lot 414 Grove Road, Maddington Kenwick Strategic Employment Area (Emerge Associates 2018a).	▪ MKSEA Precinct 1 groundwater and surface water monitoring from 2009 to 2011 (Endemic 2012). ▪ MKSEA Precinct 3A groundwater monitoring program and LWMS (Emerge Associates 2018b). ▪ MKSEA Precinct 1 2022 Urban Water Management Plan (UWMP) (Hyd2o 2022b). ▪ Hydrological study of the GBSW area which included geological assessment and groundwater monitoring over an 18-month period (Semeniuk 2001). • **Independent Review Scope**: Rockwater Pty Ltd (Rockwater) completed an independent assessment of the hydrogeological elements of the MRS amendment area and surrounds inclusive of: ○ Assessment of the regional/ local geology, geotechnical and geophysical data sets. ○ DWER regional groundwater levels. ○ Local (within the MRS amendment area) groundwater levels and mapped contours. ○ Provide an interpretation of DWER and Hyd2o (2024) groundwater contours and flow direction.	
Salinity and sodicity	• Potential Salinity and Sodicity Impacts of the Wattle Grove Urban Development on the Greater Brixton St Wetlands (MBS Environmental 2024) included as Appendix S in the Wattle Grove South DWMS (Hyd2o 2024) – Appendix B. • Water Balance Assessment: Wattle Grove South MRS Amendment (Emerge Associates 2024) - Appendix A. • Wattle Grove South DWMS (Hyd2o 2024) – Appendix B.	• Salinity and Sodicity Scope: MBS Environmental completed a technical assessment inclusive of: ○ Description and background of the project, GBSW system, local hydrogeology and potential changes associated with the development. ○ Discussion of salinity and sodicity and how these may relate to potential for impacts on the GBSW. ○ Collate and average source water quality data as available and hydrogeological settings to assign source terms against the water balance model terms. ○ Predict the post-development change in salinity and sodicity (conservative mixing/evaporation) using current assumptions for the three scenarios. Compare results to current conditions and guidelines for the assessment of risk.	• Wattle Grove South MRS amendment area • Greater Brixton Street Wetland area

Aspects	Investigations	Scope	Spatial coverage

Surface water	• Water Balance Assessment: Wattle Grove South MRS Amendment (Emerge Associates 2024) - Appendix A.
	• Wattle Grove South DWMS (Hyd2o 2024) – Appendix B.
	• Surface water monitoring data from the following sources:
	  ○ The City of Kalamunda's surface water monitoring program (Urbaqua 2020).
	  ○ The hydrological assessment of MRWA's Tonkin Highway upgrade between Roe Highway and Kelvin Rd (Arup 2022).
	  ○ Hydrological Study of the Greater Brixton Street Wetlands (Semeniuk 2001).
	  ○ MKSEA Surface Water and Groundwater Monitoring and Investigation (Endemic 2012).
	  ○ MKSEA Precinct 2 Local Water Management Strategy (Emerge Associates 2022c).
	  ○ MKSEA Precinct 3B Local Water Management Strategy (Emerge Associates 2022d).
	  ○ Local Water Management Strategy Lot 414 Grove Road, Maddington Kenwick Strategic Employment Area (Emerge Associates 2018a).
	  ○ Yule Brook, Swan Canning Catchment Nutrient Report (DWER and DBCA 2016).
		• **Surface Water Scope**: Surface water baseline investigation and assessment inclusive of:
		  ○ Site assessment to identify the surface water course(s) and drainage lines.
		  ○ Desktop assessment of the sub catchments.
		  ○ Undertaking surface water quality monitoring a 9 sampling sites. The objective of this monitoring program is to capture winter surface water flow levels and water quality within the site and downstream.
		  ○ Assessment of the predevelopment nutrient input and outputs consistent with DWER's Urban Nutrient Decision Outcomes (UNDO) tool.
			• Wattle Grove South MRS amendment area
			• UI area
			• UE area
			• Greater Brixton Street Wetland area

Wetlands	• Environmental Review City of Gosnells TPS No. 6 Amendments 166 and 169 (Emerge Associates 2023b).
	• Water Balance Assessment: Wattle Grove South MRS Amendment (Emerge Associates 2024) - Appendix A.
	• Wattle Grove South DWMS (Hyd2o 2024) – Appendix B.
	• A Jewel in the Crown of a Global Biodiversity Hotspot (Lambers 2019).
		• **Wetland Assessment Scope (within the MRS amendment area)**: The scope incorporates undertaking an assessment of the environmental values of the two Resource Enhancement Wetlands (REW) – portion UFI 15257 and 8037 located adjacent to Tonkin Highway within the MRS amendment area.
		• The wetland assessment adopted the methodology defined within the 'A methodology for the evaluation of wetlands on the Swan Coastal Plain, Western Australia' (DBCA 2017).
		• This assessment was inclusive of the following scope:
		  ○ Review of the DBCA GWSCP dataset using available regional scale data.
		  ○ Review current and historical land uses.
			• Wattle Grove South MRS amendment area
			• UI area.
			• UE area
			• Greater Brixton Street Wetland area

Aspects	Investigations	Scope	Spatial coverage
	• Flora, Vegetation and Wetland Assessment (Emerge Associates 2022f).	○ Determine the boundaries of wetlands and/or buffer requirements to wetlands within and adjacent to the MRS amendment area. ○ Detailed assessment of regional geology/soil, landforms, elevation/topography, groundwater, and vegetation. ○ Field survey of the wetlands assessment to describe vegetation units and condition, flora, and soil types. ○ Wetland condition description and summary of the wetland attributes. ○ Completion of the EPA Bulletin 686 wetland evaluation questionnaire to assist with determination of an applicable management category. • **Wetland Assessment Scope (adjacent to the MRS amendment area):** Assessment of the separation buffers in accordance with Draft Guideline for the Determination of Wetland Buffer Requirements (WAPC 2005) of the following mapped wetlands: ○ Within Lot 501: Two Conservation Category Wetlands (CCW) (UFI 8026 and UFI 8027) and portion of REW UFI 15257. ○ Within the GBSW area: Numerous mapped wetlands located within 150 m of the MRS amendment area. ○ The Draft Guideline for the Determination of Wetland Buffer Requirements (WAPC 2005) requires the completion of the following seven steps to determine the wetland separation: ▪ Step 1: Acknowledge existence of wetland. ▪ Step 2: Identify wetland attributes, wetland management category and establish management objective. ▪ Step 3: Define wetland function area. ▪ Step 4: Identify threatening processes. ▪ Step 5: Identify role of separation. ▪ Step 6: Establish separation requirement. ▪ Step 7: Apply separation requirement to proposal and assess its ability to achieve management objective. • The assessment of the environmental values of the wetlands within the MRS amendment area has been incorporated in the following document: ○ MRS Amendment 1388/57 - Wattle Grove South: Wetland Assessment report (Appendix C) (Pentium Water 2024).	

Aspects	Investigations	Scope	Spatial coverage
Water Management	• Wattle Grove South DWMS (Hyd2o 2024) – Appendix B.	• **Water Management Scope**: A DWMS has been prepared for MRS Amendment 1388/57 which responds to: o PD Act. o Better urban water management guidelines (WAPC 2008). o State Planning Policy 2.9 Planning for Water (SPP 2.9). o Environmental Guidance for Planning and Development – Guidance Statement 33 (EPA 2008). o EPA's Inland Waters scope of work instructions for the Wattle Grove South Amendment 1388/57 (EPA 2022). o EPA's GBSW section 16(j) advice (EPA 2022).	• Wattle Grove South MRS amendment area • Urban Investigation area • UE area • Greater Brixton Street Wetland area

Table 5-4: Additional External Technical Investigations, Surveys and Reports

Aspect	Investigation	Scope	Spatial Coverage
Groundwater	• 2030 Planning Base Scenario Results for PRAMS 3.5.2 (Department of Water 2016).	• The objective of the Perth Regional Aquifer Model (PRAMS) is to provide a quantitative tool that can be used to assess alternative resource management strategies on the Swan Coastal Plain. • The PRAMS model was incorporated in the following assessments and reports: o Wattle Gove South DWMS specifically in the assessment of groundwater contours and flows Appendix B). o Water Balance Assessment: Wattle Grove South MRS Amendment (Emerge Associates 2024) aligns soil mapping, land uses, and groundwater range of values and the estimation of evapotranspiration published for the development of PRAMS (Appendix A).	Perth Metropolitan Area / Swan Coastal Plain
Surface/Groundwater	• Amendment Area Monitoring Program (Urbaqua 2020).	• Urbaqua (2020) previously undertook a monitoring program over an area which included the following: o The MRS amendment area on behalf of the City of Kalamunda from July 2019 to September 2020. This program initially installed numerous groundwater monitoring bores and six surface water monitoring	Wattle Grove South MRS amendment area

Aspect	Investigation	Scope	Spatial Coverage
		locations including the 2 x 900 mm diameter culverts under Tonkin Highway near the Welshpool Road intersection (Hyd2o 2023).	
Surface Water	• Swan Canning Catchment Nutrient Report – Yule Brook (DWER and DBCA 2019)	• Annual reporting on nutrient concentrations within Yule Brook. • Surface water monitoring results were incorporated into the Wattle Gove South DWMS (Hyd2o 2024).	Yule Brook catchment
GBSW	• Environmental Values and Pressures for the Greater Brixton Street Wetlands on the Swan Coastal Plain, Advice in accordance with section 16(j) of the *Environmental Protection Act 1986* (EPA 2022).	• The EPA both recognises and defines the environmental significance of the GBSW and has prepared this advice to examine the environmental values, and the existing and potential pressures on those values. • The EPA confirms specific recommendations for enhancing the environmental protection of the GBSW and outlines expectations for proposals and planning schemes that have the potential to impact environmental values. • The EPA's s.16(j) GBSW advice has been incorporated into the assessment of the Inland Waters environmental factor and the Environmental Review.	GBSW area and applied to the Wattle Gove South MRS amendment area
	• Characterising the condition and function of the Greater Brixton Street Wetlands, Kenwick Western Australia, to inform conservation management (DBCA 2018).	• High level summary of hydrological investigations, vegetation, flora, and weeds, weed management, fauna surveys and rehabilitation across the GBSW area.	GBSW area.
	• Hydrological Study of the Greater Brixton Street Wetlands (Semeniuk 2001).	• Study of the GBSW area geology, hydrogeology, and groundwater at a regional and local scale.	
	• A Jewel in the Crown of a Global Biodiversity Hotspot (Lambers 2019).	• A comprehensive review of the GBSW area and the Yule Brook using current research and understanding about the geology, hydrology, soils, flora, fauna, fungi, archaeology, history, and other aspects relevant to the proposed establishment of a Yule Brook Regional Park.	GBSW area and Yule Brook catchment.
	• Surface nuclear magnetic resonance sounding in the Greater Brixton Street Wetlands (DBCA 2018).	• Ground-penetrating radar (GPR) and electric-resistivity tomography (ERT) was used to obtain deep subsurface information to set the stratigraphic context for the soils and related plant communities. • Provides information on the local hydrology and geology within the Alison Baird Reserve portion of the GBSW area.	Wanaping Blocks / Alison Baird Reserve.

Aspect	Investigation	Scope	Spatial Coverage
	• Hydrological Function of the Greater Brixton Street Wetlands: Data Sourcing and Review (Bourke 2017).	• Summarises the local-scale hydrological function under the current climate and review against predictions made in previous investigations. • Conceptual hydrological (surface and groundwater) model of the study area (e.g. cross-sections showing geology and hydrogeology and maps of landscape units and surface water flow paths). • Prioritised works program formulated using conceptual model assumptions and acknowledging current hydrological knowledge gaps, including specifications for those works and costing of materials. • Provides an understanding of the local hydrological function within the Brixton and Wanaping blocks portion of the GBSW area.	
Maddington Kenwick Strategic Employment Area (MKSEA) Precincts	• Final MKSEA Surface Water and Groundwater Monitoring and Investigation (Endemic 2012).	• Surface and groundwater monitoring and investigation. • Provides hydrological context of MKSEA and GBSW area.	Entire MKSEA Area.

	• MKSEA Precinct 1 2022 Urban Water Management Plan (Hyd2o 2022b).
	• MKSEA Surface Water and Groundwater Monitoring and Investigation (Endemic 2012).
	• Environmental Review - City of Gosnells TPS No. 6 Amendments 166 and 169 (Emerge Associates 2023b).
	• MKSEA Precinct 2 Local Water Management Strategy (Emerge Associates 2022c).
	• Local Water Management Strategy Lot 414 Grove Road, Maddington Kenwick Strategic Employment Area (Emerge Associates 2018a).
	• MKSEA Precinct 3B Local Water Management Strategy (Emerge Associates 2022d).
		• The Local Water Management Strategies (LWMS) detail the water management approach to support the MKSEA Precincts 1, 2 and 3B structure plans. The purpose of these LWMS is to satisfy the requirement to prepare a LWMS in accordance with Better urban water management (WAPC 2008).
		• The LWMS is inclusive of:
		  ○ Geotechnical investigations
		  ○ Groundwater monitoring results
		  ○ Surface water monitoring results
		  ○ Yule Brook monitoring results.
		  ○ ASS investigation
		• Provides relevant and contemporary hydrological and geological data within and adjacent to the GBSW area.
			• MKSEA Precinct 2.
			• MKSEA Precinct 3B.

		• The EPA's instructions of the City of Gosnells TPS No. 6 Amendments 166 and 169 requires the following technical scope of work to address item 4 of the Inland Waters environmental factor:	• MKSEA Precinct 2. • MKSEA Precinct 3B.

Aspect	Investigation	Scope	Spatial Coverage
		○ *'Using a pre- and post-development water balance model, describe and assess the potential impacts (direct and indirect) as a result of future development and associated infrastructure including any drainage, dewatering/use of fill/impervious surfaces/ waste water, on water quantity and quality of surface and ground waters in relation significant wetlands and waterways.' (EPA 2018).* • The Water Balance Assessment: Wattle Grove South MRS Amendment (Emerge Associates 2024) was prepared to address this specific EPA Instruction for the Environmental Review (Appendix A).	
Geotechnical Investigation MKSEA Precincts 2, 3B, 3C	• Geotechnical Investigation MKSEA Precincts 2, 3B, 3C (JDSi 2017).	• Geotechnical assessments (Douglas Partners 2015; JDSi 2017). • The geotechnical datasets provided an understanding of the geology within the MKSEA and GBSW area.	• MKSEA Precincts 2, 3B, 3C.

5.4.2 Receiving environment

5.4.2.1 Regional geology

The regional geology of the MRS amendment area and surrounds, including the GBSW, is described in the following key geological and hydrogeological reports:

- Landforms and Soils of the Darling System in Atlas of Natural Resources, Darling System, Western Australia (Churchward and McArthur 1980)
- Hydrogeology and Groundwater Resources of the Perth Region, Western Australia. Geological Survey of Western Australia Bulletin 142 (Davidson, 1995)
- Perth Regional Aquifer Modelling System (PRAMS) Model Development: Hydrogeology and Groundwater Modelling (Davidson and Yu 2006)

The regional geology confirms:

- The MRS amendment area is near the eastern margin of the Perth Basin and lies about 1 km west of the Darling Scarp.
- The Yoganup Formation is centred on the eastern portion of the MRS amendment area and extends eastward towards the Darling Scarp.
- Bassendean Sand over Guildford Formation is mapped over the western and north-western margins of the MRS amendment area.
- Within the GBSW area, the superficial formations are predominantly Guildford Formation. The surface strata comprise either thin Bassendean Sand over Guildford Formation or alluvial clayey sand of the Guildford Formation.
- The Leederville and the Superficial Aquifers are separated by the impermeable Kardinya Shale.

A summary of the regional geological succession is provided in Table 5-5. The regional geology mapping is shown in Figure 5-1.

Table 5-5: Regional geological succession mapping

Stratigraphy	Lithology
MRS amendment area and adjoining Urban Expansion (UE) and Urban Investigation (UI) Areas	
Superficial Formations	
Bassendean Sand	Sand, minor silt and clay
Guildford Formation	Alluvial sand and clay with shallow-marine and estuarine lenses
Yoganup Formation	Sand with minor clay
Osborne Formation: • **Kardinya Shale Member** • **Henley Sandstone Member**	Siltstone and shale, minor sandstone/ claystone
GBSW area	
Superficial Formations	
Bassendean Sand	Sand, minor silt and clay
Guildford Formation	Alluvial sand and clay with shallow-marine and estuarine lenses
Osborne Formation: • **Kardinya Shale Member** • **Henley Sandstone Member**	Siltstone and shale, minor sandstone / claystone. Sandstone and minor siltstone.

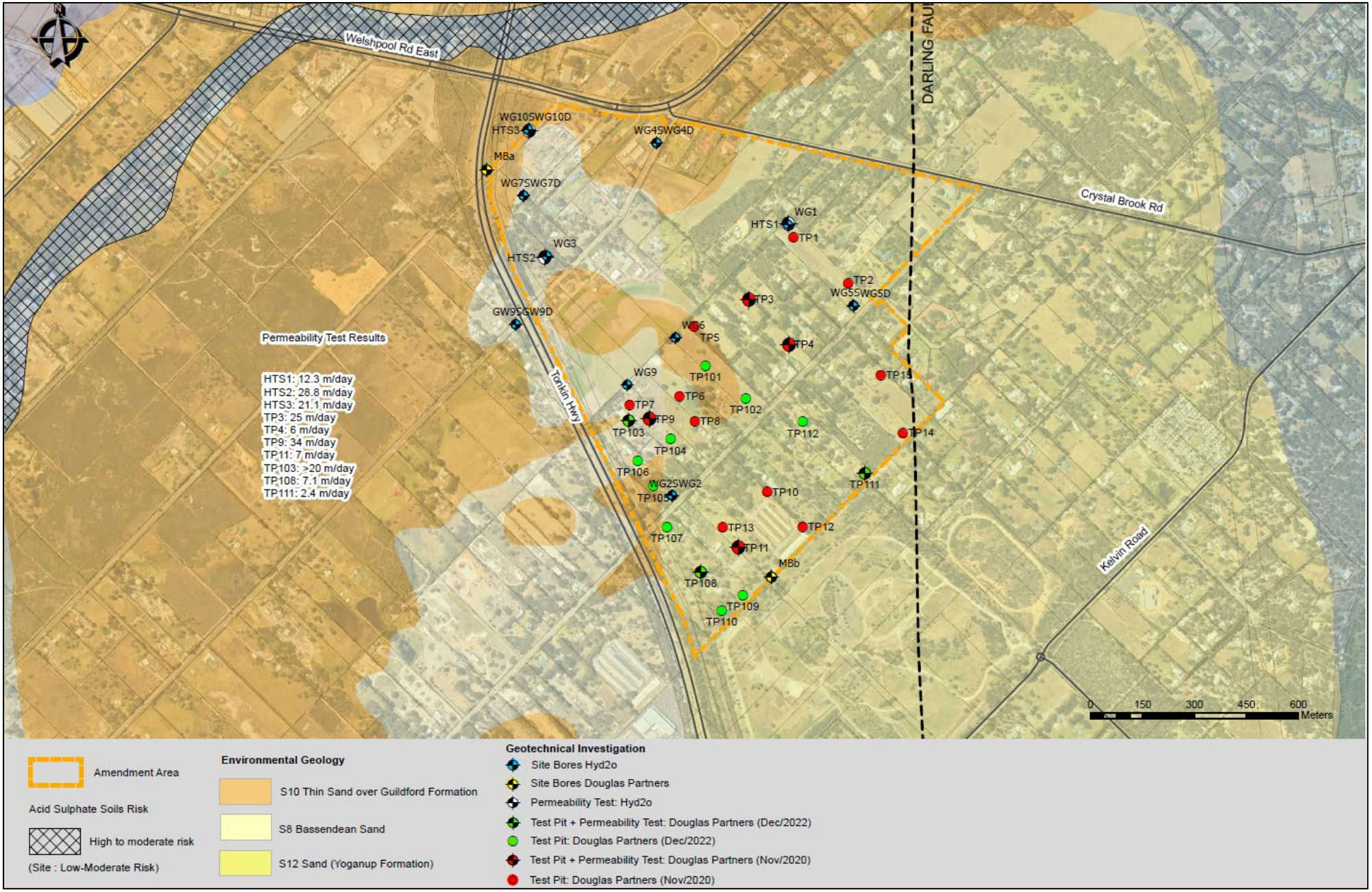

Figure 5-1: Regional Geology and Geotechnical Investigations (Hyd2o 2024)

5.4.2.2 Local geology

The local geological formations within the MRS amendment area are defined below:

- The dominant geological unit consist of the Yoganup Formation which extends eastwards from the Darling Scarp.
- Portions of the western and north-western boundary of the MRS amendment area is underlain by thin Bassendean Sand over sandy clay to clayey sand of the Guildford Formation. These sands and clays are interfingering making the geology heterogeneous. Guildford Formation, which is predominantly of fluvial origin and consists of clayey-sands and clays with lenses of coarse sands particularly at the base (Davidson 1995).
- The base of the superficial formations is between 0 m AHD – 8 m AHD, sloping downwards to the west.
- Based on ground surface elevations the superficial formations are about 20 m to 35 m thick.
- The superficial formations are underlain by the Kardinya Shale. This conclusion is supported by the lithological log for the turf farm irrigation bore (WIN ID 20019551) and DWER monitoring bore AM44 (located 2.5 km south-west of the MRS amendment area adjacent to Rehoboth Christian College) which identified black clay at depth (21 m to 40 m) which is typical of 'Kardinia Shale'.

A diagrammatic cross-section of the MRS amendment area showing the superficial formations and deeper stratigraphy is presented as Figure 5-2.

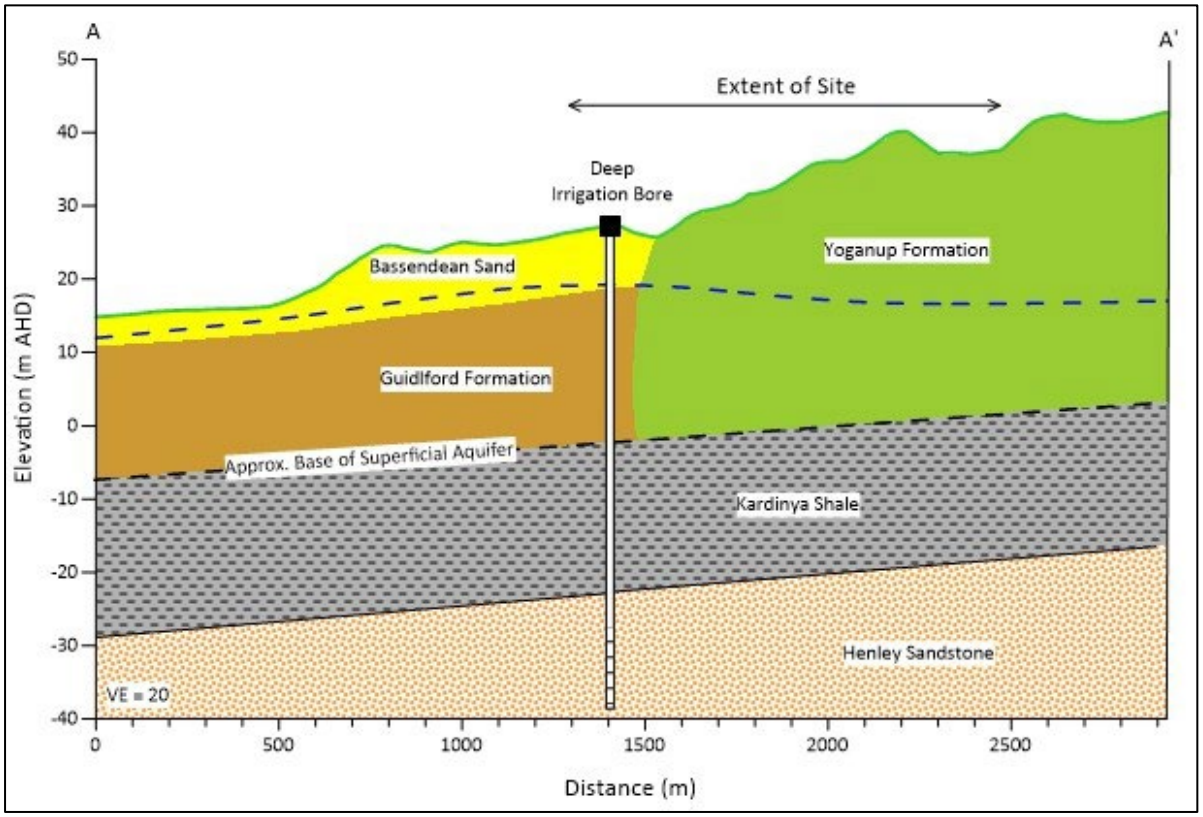

Figure 5-2: Diagrammatic deeper hydrogeological cross-section (Rockwater 2023)

Table 5-6 provides a summary of the surface geological units within the MRS amendment area.

Table 5-6: Surface geological units within the MRS amendment area

Unit	Description	Equivalent regional geological unit
S8	Sand – white to pale grey at surface, yellow at depth, fine to medium-grained, moderately sorted, subangular to subrounded, minor heavy minerals, of eolian origin.	Bassendean Sand (Qpb)
S10	Sand – S8 (sand) over sandy clay to clayey sandy of the Guildford Formation, of eolian origin.	Thin Bassendean Sand over Guildford Formation (Qpb/Qpa)
S12	Sand – structureless, yellow, fine-grained, subangular, and medium to coarse grained subrounded to rounded quartz, feldspar and heavy minerals common, minor silt and clay, of colluvial origin.	Yoganup Formation (Qpr)
Mgs2	Gravelly silt – strong brown, tough, common pebbles of fine to coarse-grained, sub-rounded granite, some dolerite and rare sandstone (SS), variable sand content.	Colluvium (Qc)
Ms4	Sandy silt – cream to pale brown, angular to rounded sand, low cohesion, of alluvial origin.	Alluvium (Qha)
Cs	Sandy clay – white/grey to brown, fine to coarse-grained, subangular to rounded sand, clay of moderate plasticity gravel and silt layers near scarp.	Guildford Formation (Qpa)

The geological interpretation was supported by:

- Geotechnical and lithological logging undertaken during construction of monitoring bores within the MRS amendment area and within the GBSW area (Hyd2o 2024; Emerge 2024 and Urbaqua 2020).
- Geophysical investigations (GBG Group 2024) identified geological areas of higher permeability (or lower resistivity) and the lower permeability (or high resistivity).

5.4.2.3 Acid sulfate soils

Acid Sulphate Soil (ASS) is the common name given to naturally occurring soil and sediment containing iron sulfides. When disturbed and exposed to air they oxidise and produce sulfuric acid, iron precipitates, and concentrations of dissolved heavy metals such as aluminium, iron and arsenic. The disturbance of ASS releases acid and metals which can cause significant harm to the environment and infrastructure.

The WAPC's Bulletin 64 (WAPC 2003) ASS risk mapping for the MRS amendment area indicates it is located within an area of moderate to low risk of ASS occurring within 3 m of natural soil surface.

5.4.2.4 Geotechnical assessment

Three geotechnical investigations were undertaken within and adjacent to the MRS amendment area. The geotechnical investigations (Douglas Partners 2020 and 2022) incorporated:

- Excavation of 27 test pits
- Perth sand penetrometer (PSP) testing adjacent to each test pit location
- Installation of groundwater monitoring bores
- Infiltration testing at seven locations.

The test pits were installed in the regionally mapped geological areas of Bassendean Sand, Guildford Formation (sandy clay and clayey sand) and Bassendean Sand over Guildford Formation. The location of the geotechnical test pits within and adjacent to the MRS amendment area is illustrated in Figure 5-1.

The geotechnical assessment across the MRS amendment area identified the following geological units (Douglas Partners 2020):

- Topsoil
    - Dark grey-brown and grey-brown, sandy topsoil with silt and roots, between 0.1 m to 0.15 m in thickness.

The topsoil overlays:

- Bassendean Sand (light grey sand):
    - SAND: varying loose to dense, fine to medium grained, light grey and light-yellow brown, with trace silt encountered underlying the topsoil or surficial fill to depths of between 0.5 m and test pit termination depths of 2.5 m at some test locations.
- Yoganup Formation (yellow-brown sand with various fines content):
    - Sand from the Yoganup Formation is yellow-brown and includes a fines content that increases with depth. The sand was logged as 'Sand trace silt and clay' (up to 5% fines content) near surface, gradually transitioning with depth to 'Sand with clay' (5% to 12% fines content) and then 'Clayey Sand' (greater than 12% fines content).
    - SAND: generally medium dense to dense, light brown and yellow-brown sand, with low plasticity to non-plastic fines content of between approximately 5% to 12%, underlying topsoil or surficial fill at some test locations and present below the Bassendean Sands at another from 0.8 m depth. Loose sand was encountered at one location to at least 1.0 m depth. Fines content typically increases with depth.
    - SAND/Clayey SAND: yellow-brown sand with clay/clayey sand (approximately 12% and greater content of low plasticity fines) was encountered from depths of between 0.1 m and 1.6 m extending to depths of between 0.6 m and termination depths of up to 2.5 m in some locations.
    - Clayey SAND: yellow-brown low plasticity clayey sand was encountered from depths of between 0.6 m and 1.5 m extending to termination depths of up to 2.5 m in some locations.

The exceptions to the above soil profile description were some localised areas of gravelly sand, fill sand and coffee rock.

Access to individual landholdings at some locations (i.e. near the north-western boundary) within the amendment area was limited. Other sources of bore log data was used to supplement geotechnical dataset. The geotechnical reports, geotechnical site figure and the monitoring bore details and logs are provided in the DWMS (Appendix B).

Soil permeability studies

The soil permeability studies undertaken by Douglas Partners (2020 and 2022) and Hyd2o (2022) aligns with the local geology profile, specifically:

- Douglas Partners (2020 and 2022): Within the MRS amendment area the soil hydraulic conductivity (K) ranged from 2.4 metres per day (m/day) to 34 m/day, with the higher rates associated with Bassendean Sands and lower rates within locations of variable clayey soils.

Hyd2o (2022): Soil hydraulic conductivity (K) ranged from approximately 12.3 m/day to 28.8 m/day in the northern region of the proposed development area across Bassendean Sand and thin Bassendean Sand over Guildford Formation soil units.

Table 5-7 summarises the field hydraulic conductivity testing results.

Table 5-7: Field hydraulic conductivity testing (Hyd2o 2024)

Test Site	Test Date	Depth (m)	Soil description	Ks - m/day
Hyd2o				
HTS1	27/10/2022	0.5	Fine to medium light grey sand	12
HTS2	27/10/2022	0.5	Fine white sand	29
HTS3	27/10/2022	0.5	Fine to medium grey sand	21
Douglas Partners within the MRS amendment area				
TP3	28/10/2020	0.55	Sand, light grey trace silt, dense	25
TP4	28/10/2020	1.0	Sand, yellow-brown with clay/clayey sand (fines content increasing with depth), medium dense	6
TP9	28/10/2020	1.0	Sand, light grey, trace silt, dense	34
TP11	28/10/2020	1.0	Sand, with clay (fines content increasing with depth), dense	7
TP103	1/11/2022	1.0	SAND SP, trace silt, medium dense, pale grey	>20
TP108	1/11/2022	1.0	SAND SP-SM, with silt, loose to medium dense, yellow-brown	7.1
TP111	1/11/2022	1.3	Silty SAND SM loose to medium dense, orange-brown	2.4
Douglas Partners within the eastern boundary of the GBSW				
BH01	18/11/2023	9.50 – 9.95	Silty SAND (SM): pale grey, fine to medium	2.7
		12.00 – 12.45	SAND (SP-SM), with silt: pale grey, fine to medium	8.4
		14.00 – 14.45	Silty SAND (SM): pale grey, fine to medium	1.4
BH02	18/11/2023	9.50 – 9.95	Silty SAND (SM): pale grey, fine to medium	1.9
		12.00 – 12.45	Silty SAND (SM): pale grey, fine to medium	3.5
		14.00 – 14.45	Silty SAND (SM): pale grey, fine to medium	2.3

In October 2023, Douglas Partners installed two boreholes to a depth of approximately 15 m west of Tonkin Highway adjacent to Boundary Road (in proximity to the eastern boundary of the GBSW). Soil samples were collected at approximately 9.5 m, 12 m and 14 m below ground level and falling head permeability testing performed. The results of this investigation implied a layer of sandy clay soil up to 2.9 m below ground level underlain by silty sands. The permeability tests indicated that the average vertical permeability of the deeper sandy soil is between 0.26 and 0.42 m/day, indicating a horizontal permeability value (using a conversion factor of 10) of 2.6 m/day to 4.2 m/day (Hyd2o 2024).

The soil hydraulic conductivity assessment(s) of the MRS amendment area are consistent with the following researched and measured assumptions on soil hydraulic rates for geological units across the Swan Coastal Plain. The adopted hydraulic conductivity is considered appropriate in the context of the non-uniformity of the local geology, the Hyd2o and Douglas Partners site specific soil permeability testing and range of researched permeability rates within Swan Coastal Plain geological units including:

- Silberstein et.al. (2013): in the 'Evaluation of changes in post-fire recharge under native woodland' used a saturated hydraulic conductivity for Bassendean Sand of 5 - 30 m/day.
- Xu et al. (2009): Perth Regional Aquifer Model (PRAMS) development applied a hydraulic conductivity value for Bassendean Sand of 10 m/day with a hydraulic conductivity value for Guildford Formation being as low as 0.01 m/day.

- Department of Water (2008): PRAMS hydrogeology and groundwater modelling defined the hydraulic properties of the Perth aquifers as:
    - Guildford Formation = 0.1 m/day
    - Bassendean Sand = 10 - 50 m/day (average of 15 /day)
    - Yoganup/Ascot Formation = 8 - 10 m/day

The geotechnical reports and soil permeability testing assessments are included in Appendix B of the Wattle Grove South DWMS (Hyd2o 2024), which can be found at Appendix B of this Environmental Review.

Geophysical study

GBG Group between 2022 to 2023, completed a two-phased Electrical Resistivity Tomography (ERT) geophysical investigation along sixteen transects within and adjacent to the MRS amendment area. The ERT transects totalled 6,910 m and encompasses Bassendean Sand over sandy clay to clayey sand of the Guildford Formation and the Yoganup Formation geological units.

Transect locations were identified and selected based on interpretation from previous geotechnical reports, groundwater monitoring data and bore logs, for the purpose of providing additional information which may assist in the interpretation of groundwater flow direction and perching in the vicinity of the GBSW area (Hyd2o 2024).

The ERT transects are shown in Figure 5-3 and Figure 5-4.

The objective of the geophysical investigation was to obtain subsurface electrical resistivity models for the assessment of interpreted material porosity and permeability, pertaining to geological units acting as aquifers and aquitards. The target depth of the investigation was 50 m below ground level. The results of the investigation were used in the interpretation of the hydrogeology and localised groundwater contours for the MRS amendment area.

The results of the geophysical investigation are presented in cross-sections. The cross-sections show the modelled electrical resistivity of the subsurface material including which allows variations in permeability/porosity and sediment type of the underlying geology to be interpreted. The following conclusions were made based on the distribution of these materials (GBG Group 2024):

- The ERT transects are generally non-uniform, indicating complex geology in proximity to the scarp.
- Several transects showed large masses of very high resistivity (low conductivity) below the groundwater table, and these zones as interpreted to represent low permeability areas. These occurred at approximately 10 - 15 m AHD extending to significant depth. This was evident at the south end of the Brentwood Road (T1) and Boundary Road (T2).
- Sections near Tonkin Highway showed other areas of very high resistivity (low conductivity).
- Lower resistivity (high conductivity) areas were associated with saturated sandy soils (extending to 50 m depth across much of the section) and were present along large sections of Crystal Brook Road and Victoria Road. The Johnson Road (T3) section similarly showed low resistivity (high conductivity) near Crystal Brook Road with very high resistivity (low conductivity) to the north.

The geophysical subsurface investigation is contained in Appendix C of the Wattle Grove South DWMS (Hyd2o 2024) which can be found at Appendix B of this Environmental Review.

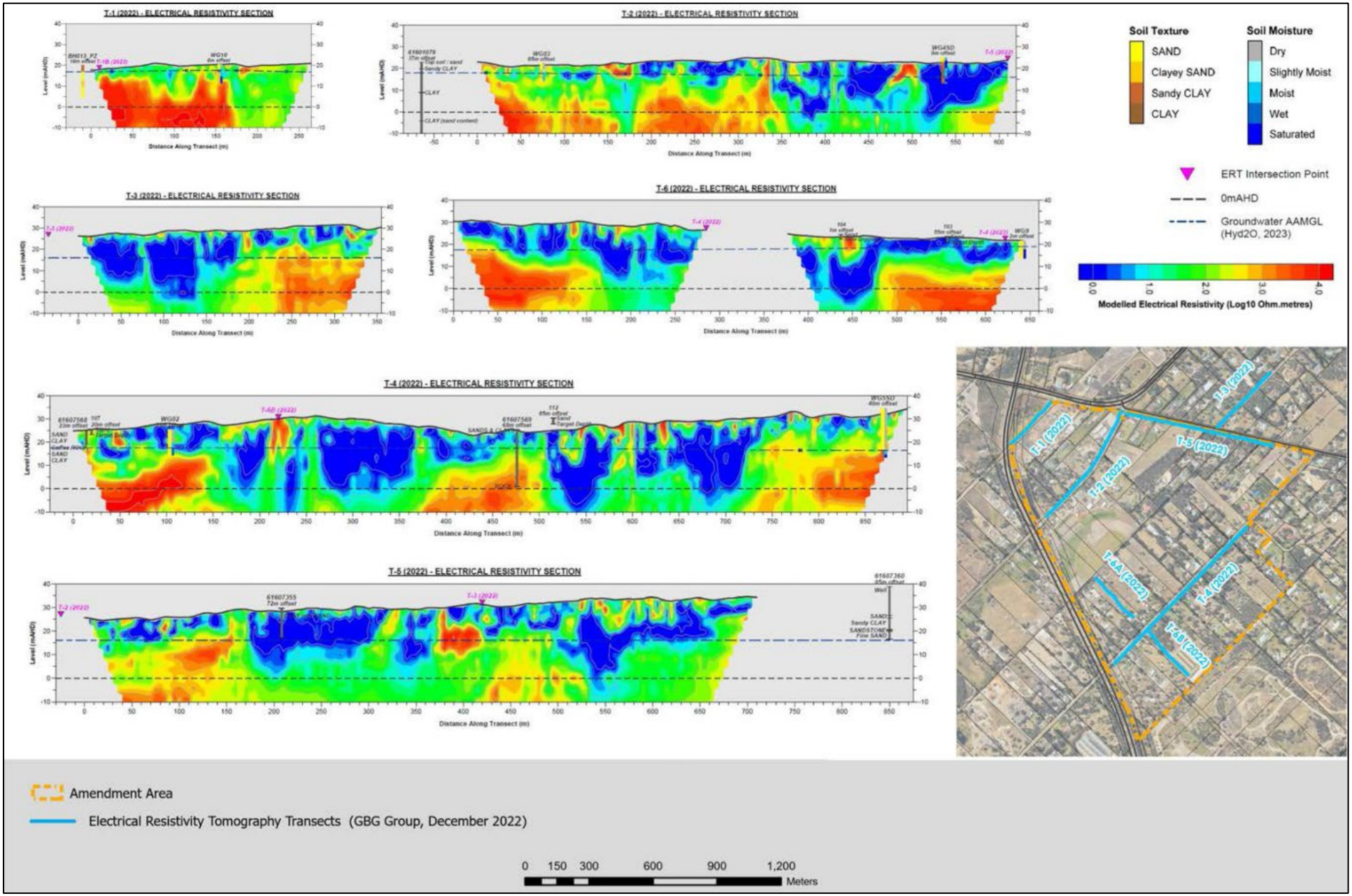

Figure 5-3: GBG Group ERT transect (GBG Group 2024)

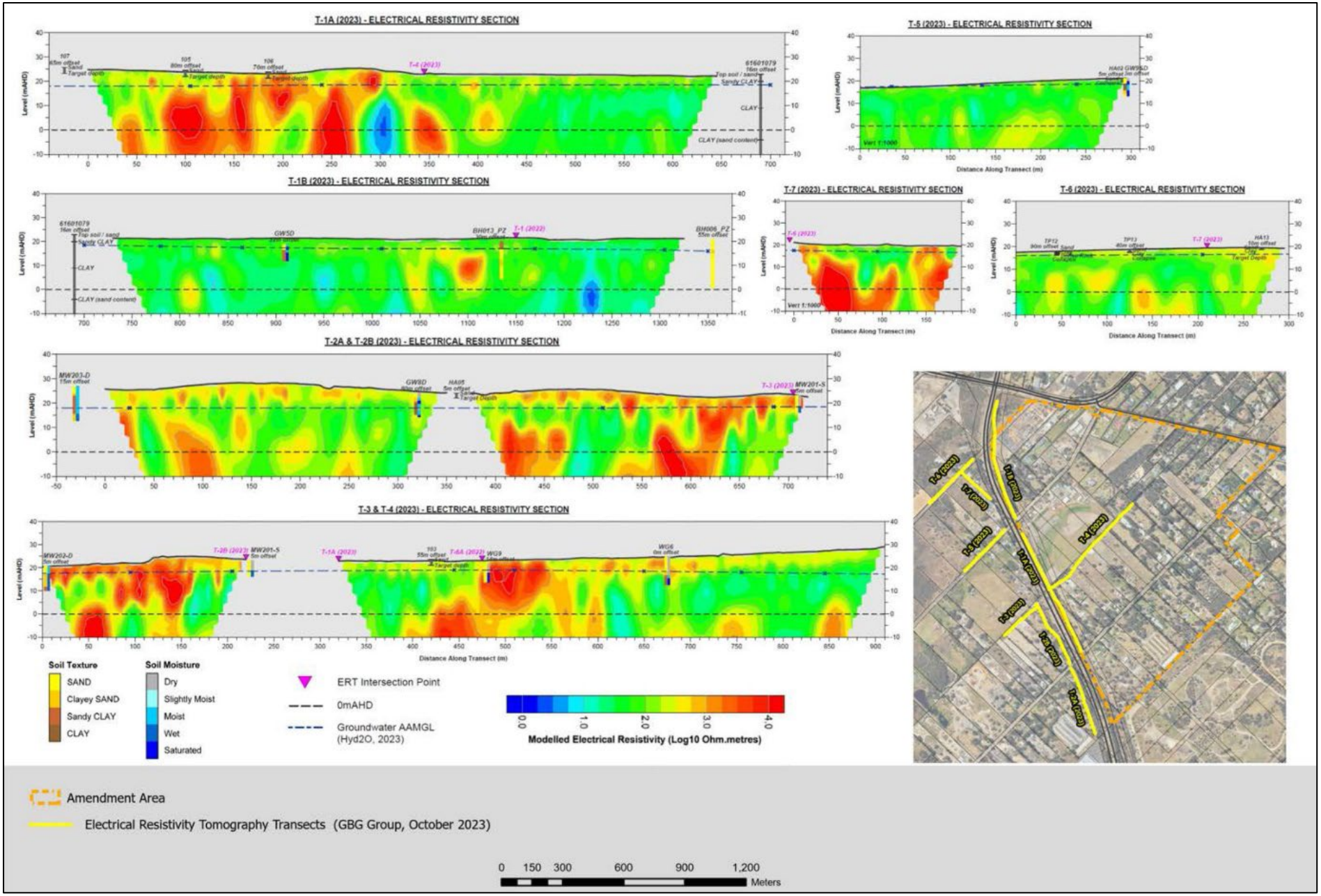

Figure 5-4: GBG Group ERT transect (GBG Group 2024)

5.4.3 Groundwater

5.4.3.1 Local groundwater abstraction

There are 14 active groundwater extraction licenses within the MRS amendment area. Collectively the total annual abstraction allocation in the MRS amendment area, in the Superficial Aquifer, is approximately 264,000 kilolitre (kL)/year, with the turf farm (located across Lots 303, 53, 214 and 213 Brentwood Road) accounting for 176,000 kL/year (Figure 5-5).

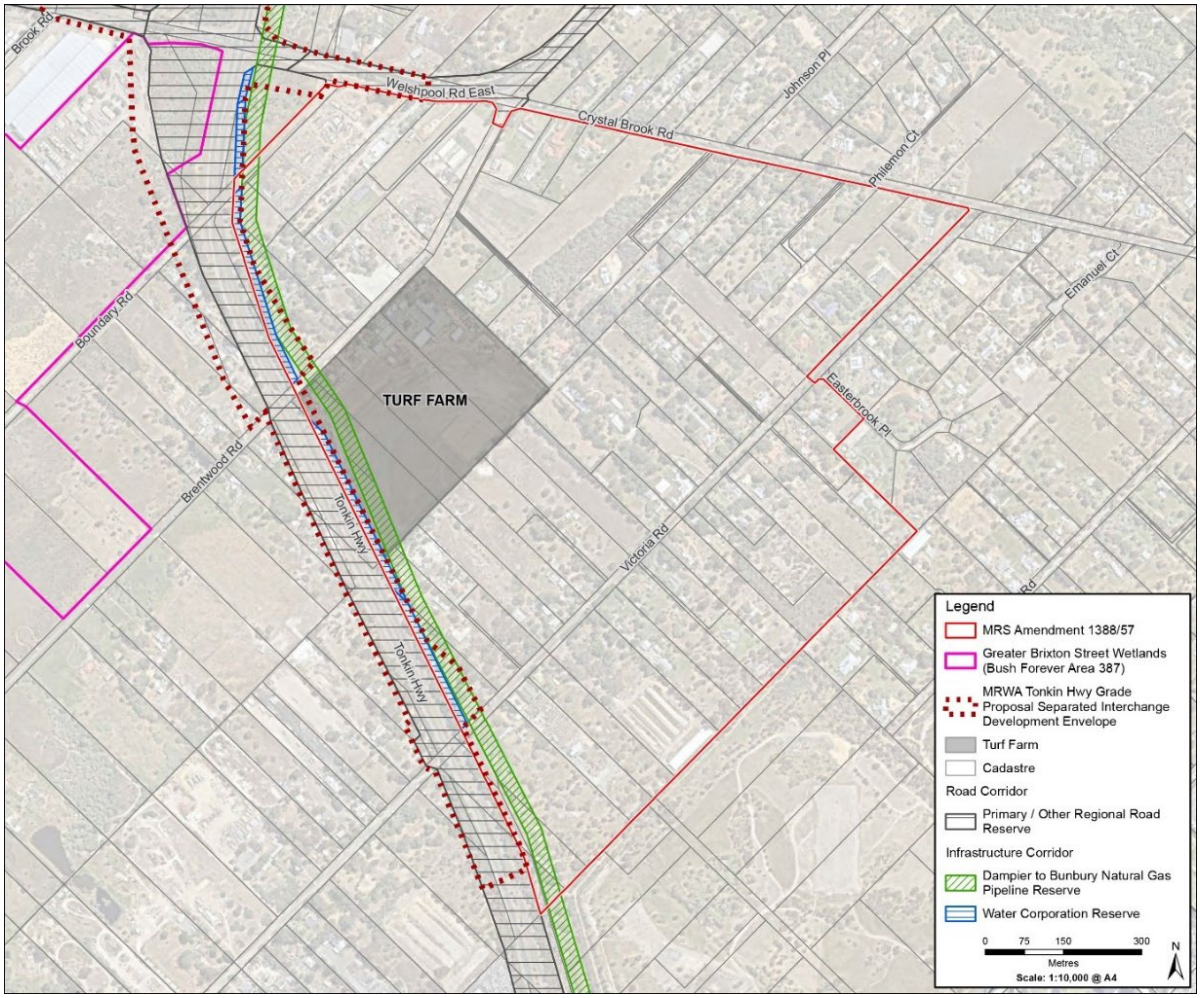

Figure 5-5: Commercial turf farm within Lots 303, 53, 214 and 213 Brentwood Road

5.4.3.2 Local groundwater monitoring program

City of Kalamunda - Water monitoring program (2019 - 2020)

The City of Kalamunda completed a surface and groundwater monitoring program between July 2019 to September 2020, inclusive of the Wattle Grove MRS amendment area, to inform the City's Wattle Grove South Concept Plan (Urbaqua 2020).

This monitoring program incorporated:

- Installation of three bores and the commencement of seasonal groundwater monitoring.
- Undertaking surface water monitoring at six locations, including the two culverts under Tonkin Highway at the western end of Boundary Road within the MRS amendment area.

The Wattle Grove South 2019 - 2020 water monitoring report (Urbaqua 2020) was reviewed by DWER. Post review, DWER advised this monitoring program satisfied the requirement for pre-development monitoring in accordance with Better urban water management (WAPC 2008). The local and regional monitoring programs reviewed and included in the DWMS water assessment is shown in the Figure 14 of the DWMS (Hyd2o 2024).

MRS amendment area - Water monitoring program (2020 – Present)

In recognition of the GBSW's proximity to the MRS amendment area, and the need for a robust monitoring dataset to inform the proposed 'Urban' land use, additional surface and groundwater monitoring program was commenced by Hyd2o in November 2020.

The objectives of this additional monitoring program were to:

- Characterise and define the hydrological and hydrogeological conditions of the MRS amendment area, including establishment of pre-development baseline hydrological and hydrogeological data.
- Characterise groundwater dependent environments and ecosystems within the surrounding locality (i.e. GBSW) that need to be protected.
- Inform the assessment of potential impacts of the proposed change in land use within the MRS amendment area on the hydrology, hydrogeology, and groundwater dependent environments within the broader locality.

The monitoring program developed in consultation with DBCA and DWER and builds on:

- The City of Kalamunda Wattle Grove South 2019 - 2020 monitoring program (Urbaqua 2020)
- DBCA's hydrological dataset within the GBSW area (Bourke 2017)
- MKSEA Precinct (1,2 and 3B) monitoring programs (Endemic 2012; Emerge Associates 2018a and Hyd2o 2022) and the Tonkin Highway monitoring program (Arup 2019).

Table 5-8 defines the monitoring program being undertaken and includes (Hyd2o 2024):

- Sampling groundwater quality and levels within, upstream, and downstream of the MRS amendment area, with the selection of sites to enable a review of data in the context of groundwater quality closer to the GBSW area. The monitoring bores included shallow and deep bores. Paired deep and shallow bores were installed at locations where the local soil types (e.g. Guildford Formation) indicated the possibility of seasonal perching.
- Surface water quality upstream and downstream of the MRS amendment area, and within the GBSW area where stormwater inflow and outflows occur.

Regional DWER monitoring bores, together with bores at other locations including within the GBSW and the MKSEA areas, were included in the monitoring program to correlate and complement the groundwater and surface water data collected within the MRS amendment area. The regional groundwater monitoring bore network incorporated in the monitoring program is outlined in Figure 5-6. The local groundwater and surface water monitoring locations is illustrated in Figure 5-7.

Table 5-8: Local Groundwater Monitoring Program (Hyd2o 2024)

Monitoring	Parameter	Location	Frequency and Timing
Groundwater level	Water level (m AHD)	23 bores within and in proximity to the MRS amendment area plus 3 DWER bores	Monthly – November 2020 to present
Groundwater quality	Physical parameters, Nutrients, Heavy Metals	20 bores within and in proximity to the MRS amendment area	Bi-Monthly – August 2020 to present

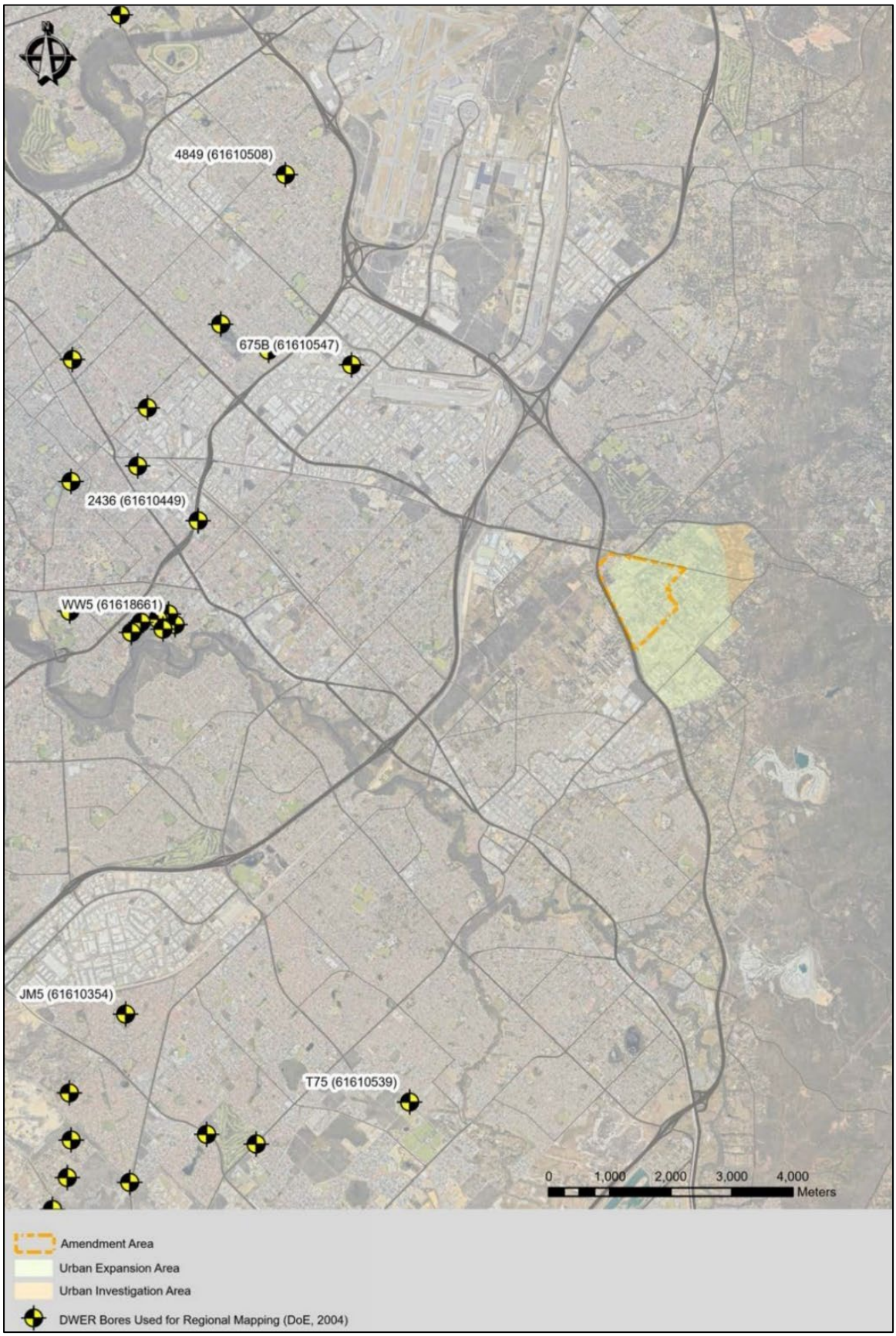

Figure 5-6: Regional groundwater monitoring bores (Hyd2o 2024)

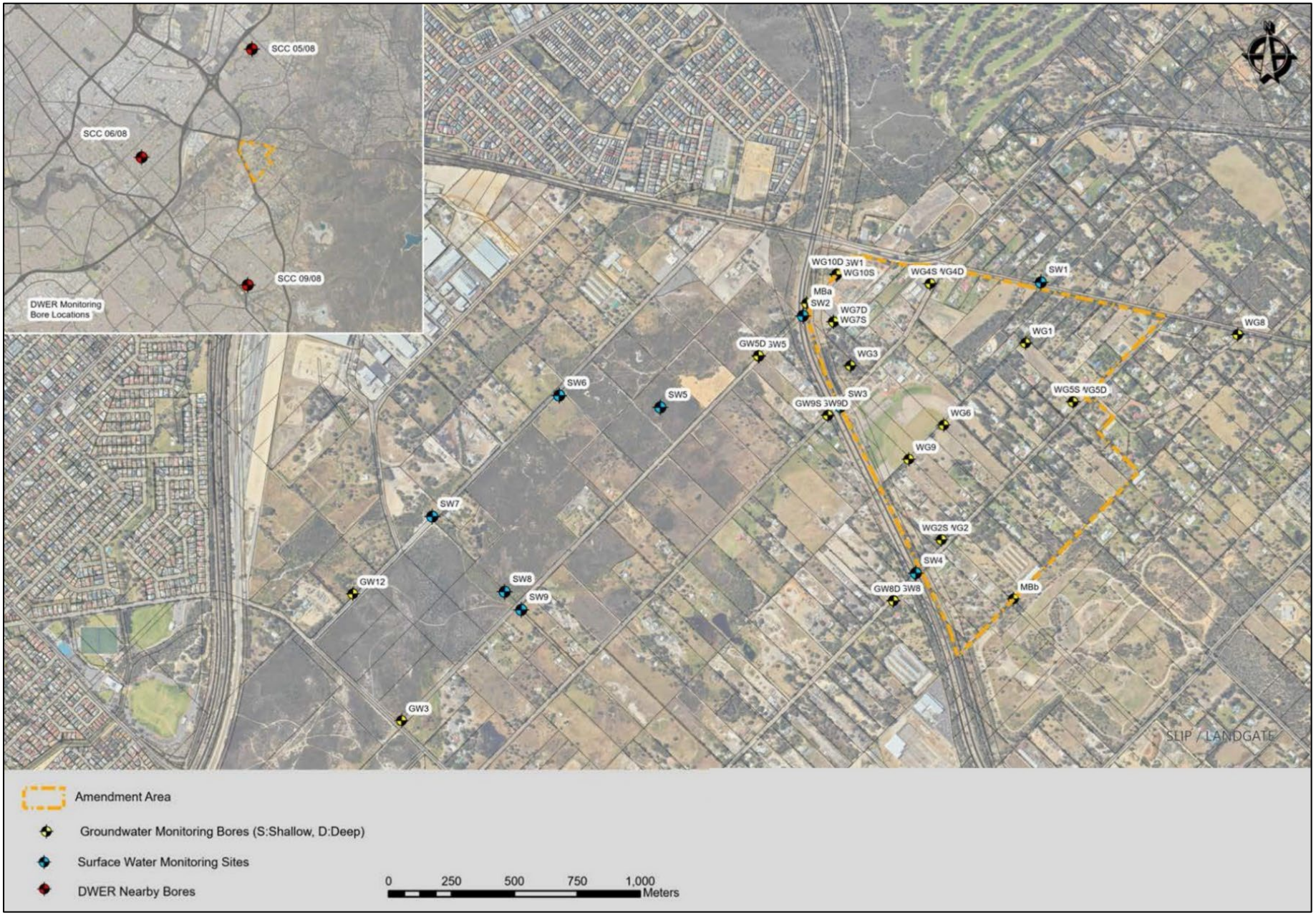

Figure 5-7: Local groundwater and surface water monitoring locations (Hyd2o 2024)

5.4.3.3 DWER regional groundwater contours

Until mid-2023, the Perth Groundwater Map provided two sets of groundwater contours for the Perth metropolitan area. The two groundwater contours data sets consisted of:

- Minimum groundwater level contours**:** contours based on May 2003 data, considered representative of a summer minimum groundwater condition.
- Maximum groundwater level contours**:** contours based on the historical maximum level recorded at each DWER bore, over the entire period that the data was collected.

These regional groundwater contours datasets in the context of the MRS amendment area are shown in Figure 5-8.

The DWER regional historical maximum contours did not cover the MRS amendment area. However, the minimum groundwater level contour dataset shows groundwater levels across the MRS amendment area ranged from approximately 11.5 m AHD in the north-western corner, to 16 m AHD at the elevated eastern boundary. The regional groundwater flow (based on the minimum groundwater level contour dataset) is broadly mapped in a westerly direction (Hyd2o 2024).

The groundwater contours, based on May 2003 summer minimum, are also shown in Figure 5-8.

In 2023, DWER amended the Perth Groundwater Map to report only the Gnangara Jandakot maximum and minimum groundwater level contours from their 2019 dataset. DWER advised the revised contours accounts for the seasonal declines and rises in water tables in recent decades and the impacts of current climate trends (Hyd2o 2024a).

The revised groundwater contours (based on the 2019 dataset) is also shown in Figure 5-8.

Key observations

The revised groundwater contours demonstrate a shift in the regional groundwater flow direction from the MRS amendment area compared to the previous 2003 DWER regional contours. Specifically:

- The nearest bores used for the regional groundwater mapping are located more than 15 km from the MRS amendment area. The DWER bores used in regional groundwater mapping in proximity to the MRS amendment area are detailed in Figure 5-6 and Figure 5-7.
- Groundwater flow is broadly mapped in a south-westerly direction from the site as opposed to westerly in previous mapping (Figure 5-8).
- The contours show groundwater flow from the MRS amendment area is largely not flowing in a westerly direction (or towards the GBSW area) when compared to the previous published version of the regional groundwater mapping.
- The regional groundwater depth has maximum seasonal levels within the MRS amendment area ranging from 4 m to 20 m below natural surface.

Accordingly, due to the absence of local groundwater and geological data in proximity to the MRS amendment area, the DWER regional mapping levels and flow direction is considered indicative only.

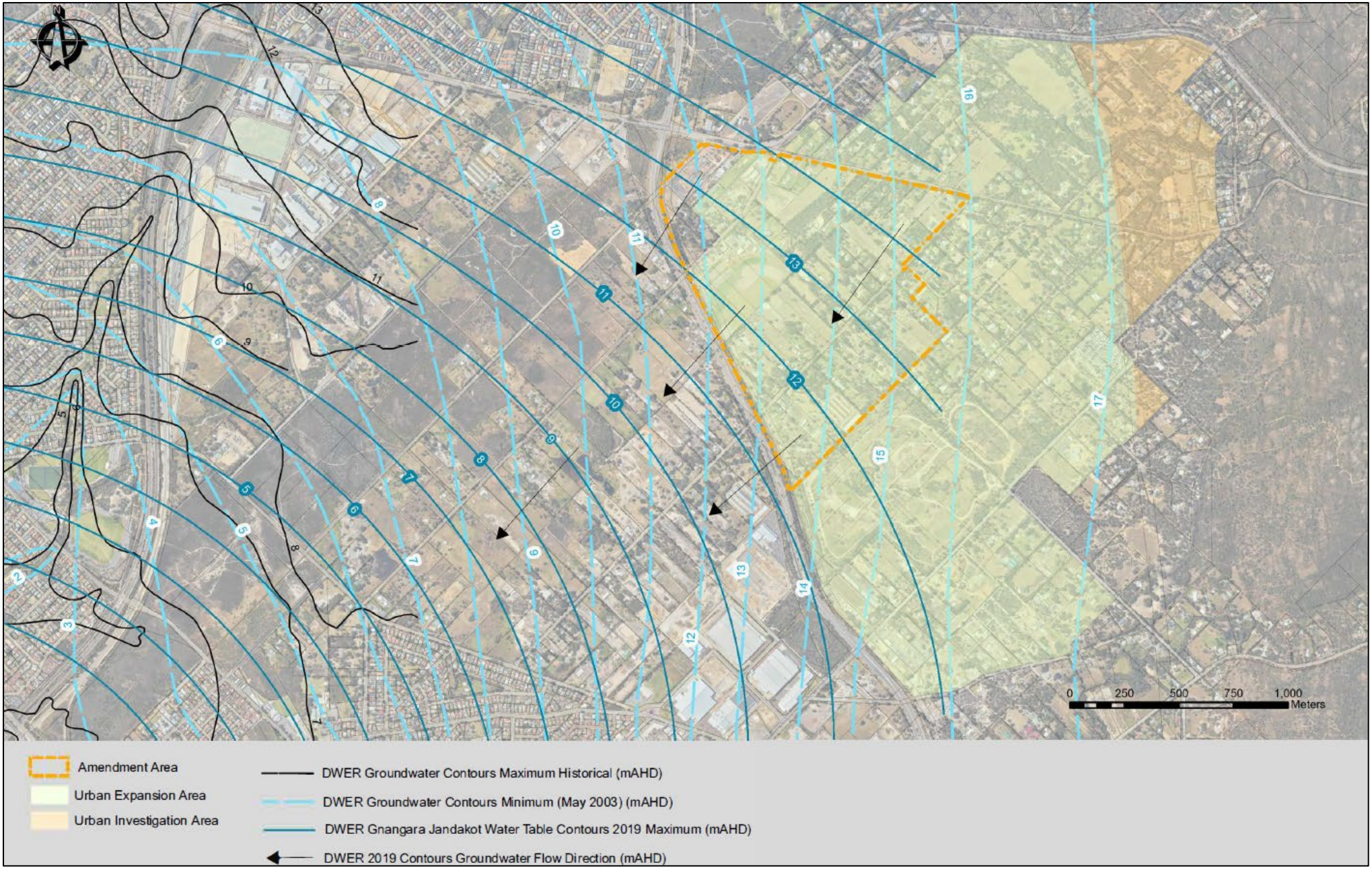

Figure 5-8: DWER regional groundwater contour mapping (Hyd2o 2024)

5.4.3.4 Local groundwater contours

Figure 5-9 presents the local groundwater level contours across the MRS amendment area and immediate surrounds based on three years of seasonal monitoring data, commencing in 2020. The average annual maximum groundwater level (AAMGL) contours and maximum groundwater level (MaxGL) contours for the Superficial Aquifer groundwater levels, in proximity to the MRS amendment area, were calculated and mapped using data collected from the bores installed and monitored by Hyd2o together with the following additional 17 monitoring sites (Hyd2o 2024):

- Main Roads bores along Tonkin Hwy (BH001, BH007, BH014, BH010)
- Closest DWER bores (SCC 06-08, SCC 05-8, SCC 09-08, 675B)
- DBCA bores in the GBSW area (WAN01, WAN02, WAN03)
- MKSEA Precinct 1 Bores (MW201S, MW202D, MW203D, MW205D, MW208D)
- Douglas Partners bore within the amendment area (Mbb).

Construction details and logs for these additional bores are also provided in Appendix G of the DWMS which can found in Appendix B of this Environmental Review.

The DWMS (Appendix B) provides additional information specific to the local groundwater contours including:

- Groundwater levels representative of a winter peak and representative of a summer condition for the amendment area (DWMS - Figure 16).
- The mapped AAMGL and MaxGL groundwater contours (DWMS - Figure 17 and Figure 18).
- The DWER bore hydrographs monitored by Hyd2o are provided in Appendix K,
- Longer term hydrographs based on DWER recorded data are contained in Appendix L.

The water contour data shows (Hyd2o 2024):

- Contours within the MRS amendment area range from approximately 16 m AHD in the north-eastern region to approximately 19 m AHD on the western boundary.
- The groundwater mound formed as a result of the former turf farm irrigation practices and geological factors which strongly influence the local groundwater flow direction. Specifically, the seasonal groundwater flows confirm a radial flow direction (i.e. flowing north-west to flowing south-east) from the mound.
- Regional groundwater depth ranged from 4 m to 20 m below natural surface.
- Monthly monitoring has shown that the seasonal variation in water table across the MRS amendment area varies. Bores WG1, WG2 and WG3 (Figure 5-9) which have been monitored since November 2020 has an average seasonal fluctuation of 0.8 m, 1.4 m and 2.4 m.

Figure 5-10 illustrates the estimated seasonal variation across the MRS amendment area.

Most of the MRS amendment area has a seasonal groundwater variation of less than 1.5 m apart from in the north-western corner (near Tonkin Highway), with less seasonal variation along portions of western boundary opposite the GBSW (Hyd2o 2024). This variability is attributed to:

- Depth to the Superficial Aquifer groundwater
- The sub surface geology (i.e. the presence of Guildford Formation) and soil permeability
- The proximity higher permeable soils (Yoganup Formation) with increased recharge.

5.4.3.5 Comparison between DWER groundwater contours and the local groundwater contours

It is not uncommon for groundwater contours to differ at a local scale from the regional mapping. Specific to the MRS amendment area, the data underpinning the local groundwater contours is based

on site specific groundwater monitoring, geological and geophysical investigations (Hyd2o 2024). Detailed investigations confirm the presence of the following hydrological and geological elements directly influencing the local groundwater flow direction within the MRS amendment area:

- Local geology: A steep hydraulic gradient west of the MRS amendment area associated with low permeability geology.
- Groundwater mound: A distinct groundwater mound has been identified and mapped beneath the turf farm located within Lots 303, 53, 214 and 213 Brentwood Road.

Local geology

The geology along the western and north-western boundary of the MRS amendment area is predominately sand over clayey sand and clay sediments associated with the Bassendean Sands and Guildford Formations. At the depth of the groundwater table these low permeable clayey sediments are shown as zones of high resistivity in the geophysical assessment (Figure 5-1).

Figure 5-11 provides a spatial summary of high resistivity (low conductivity) areas and the regional geological mapping within the amendment.

The areas of non-contiguous Guildford Formation clayey soil of low permeable forms hydraulic barrier(s) which locally directs groundwater flows as follows:

- Limits groundwater flow in a westerly direction.
- Groundwater following pathways of least resistance (and unable to readily flow through the low permeable clay layers), initially flowing radially through the higher permeability Yoganup Formation. Flow within the MRS amendment area was found to generally range from north-west to south-east through sand dominated geology and away from the GBSW area. Regional groundwater depth ranged from 4 m to 20 m below natural surface.

This conclusion is supported by:

- Soil permeability research and investigations within the MRS amendment area including:
    - PRAMS hydrogeology and groundwater modelling which defined the Guildford Formation hydraulic conductivity of 0.1 m/day (demonstrating low permeability of the clay geology) and the Yoganup Formation permeability rate at 8 - 10 m/day (Department of Water 2008).
    - Soil permeability assessment data within the MRS amendment area:
        - 29 to 12 m/day (Hyd2o 2024) – high permeability geology.
        - 34 to 1.4 m/day (Douglas Partners 2022) – high and low permeability geology.
- The geophysical assessment (GBG Group 2024) which identified:
    - Zones of high resistivity (low conductivity) material below the groundwater table along areas of Boundary Road (east) and Brentwood Road (east) approaching Tonkin Highway towards the western boundary of the MRS amendment area.

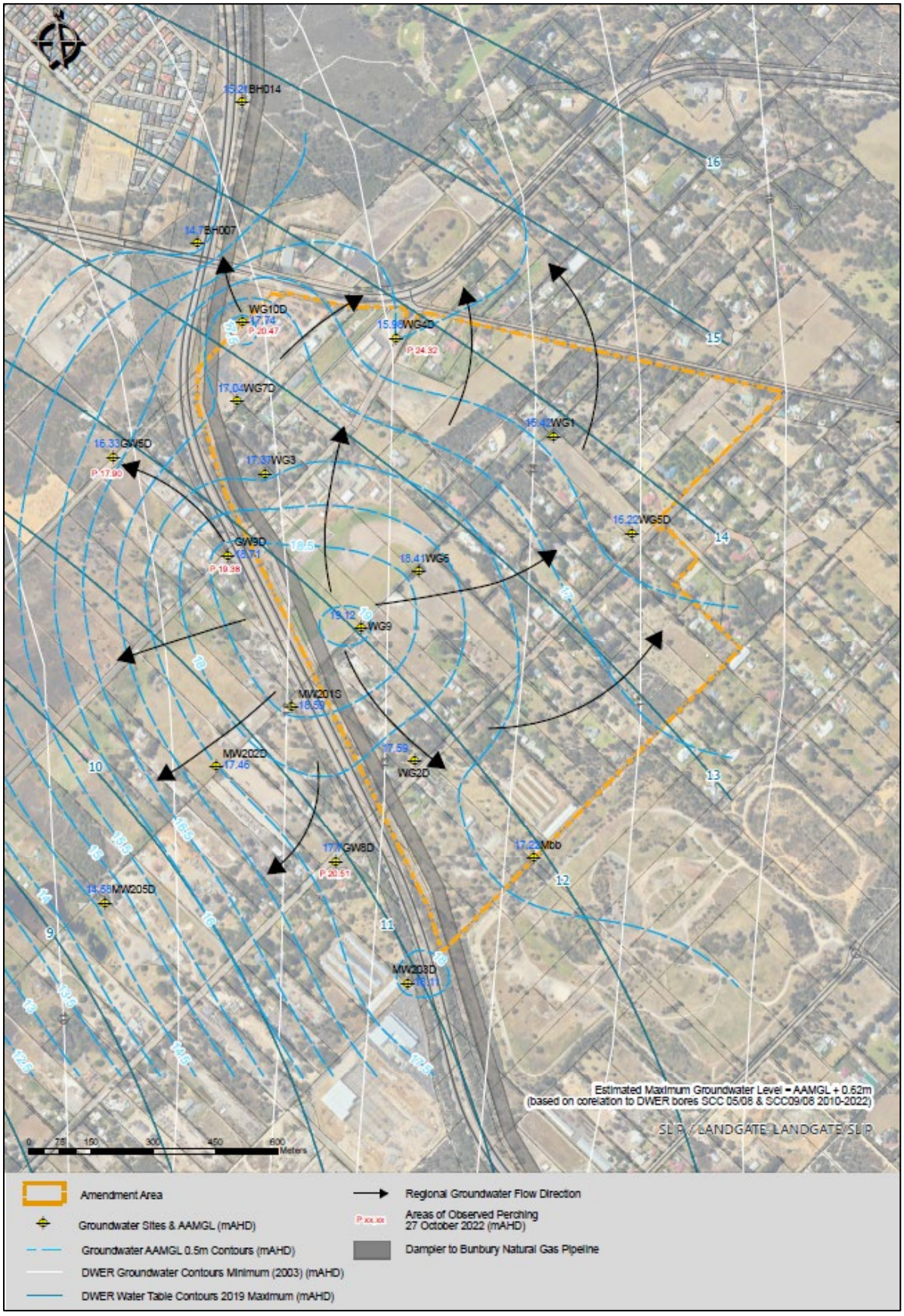

Figure 5-9: Groundwater plan local groundwater mapping (Hyd2o 2024)

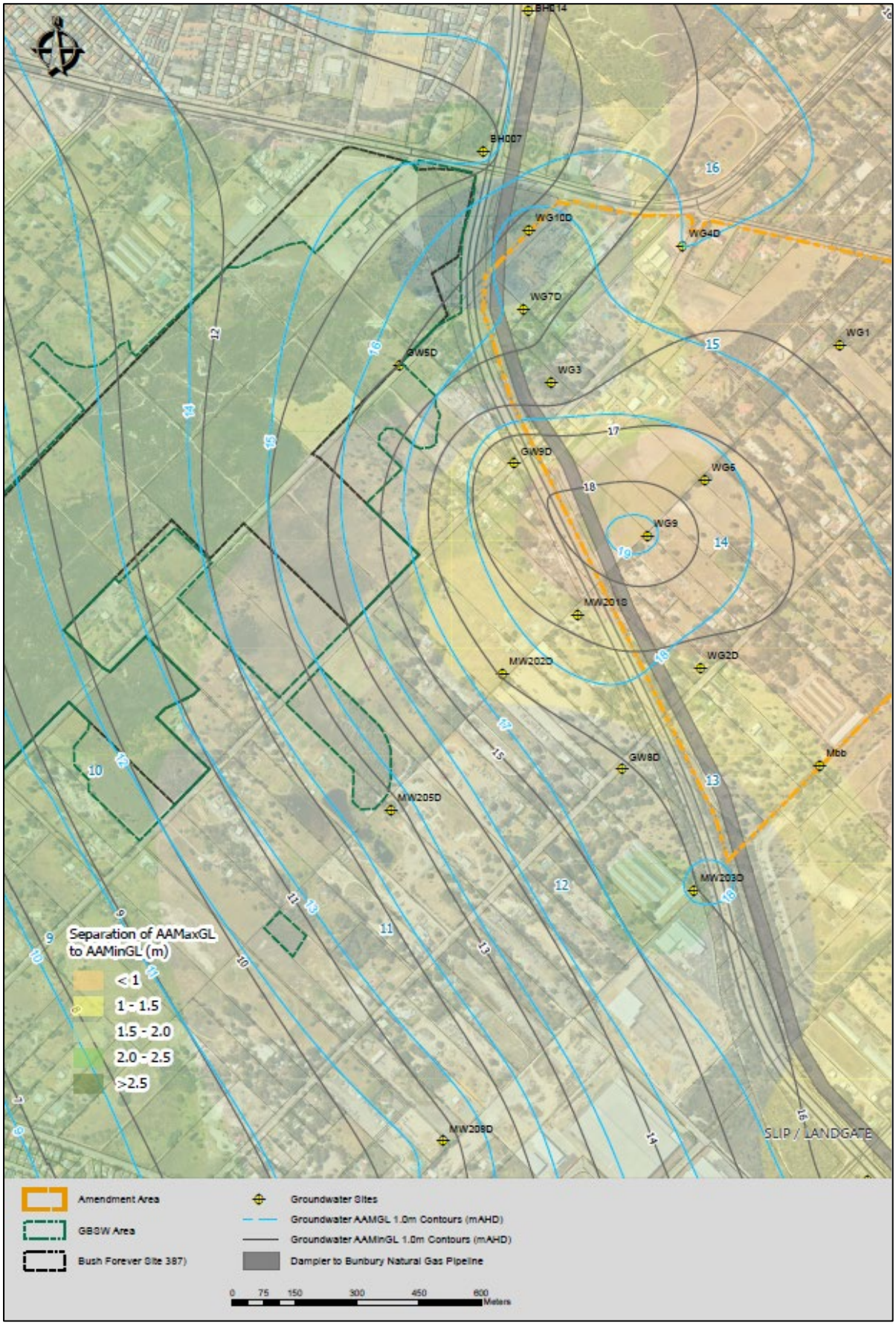

Figure 5-10: Seasonal groundwater variation (Hyd2o 2024)

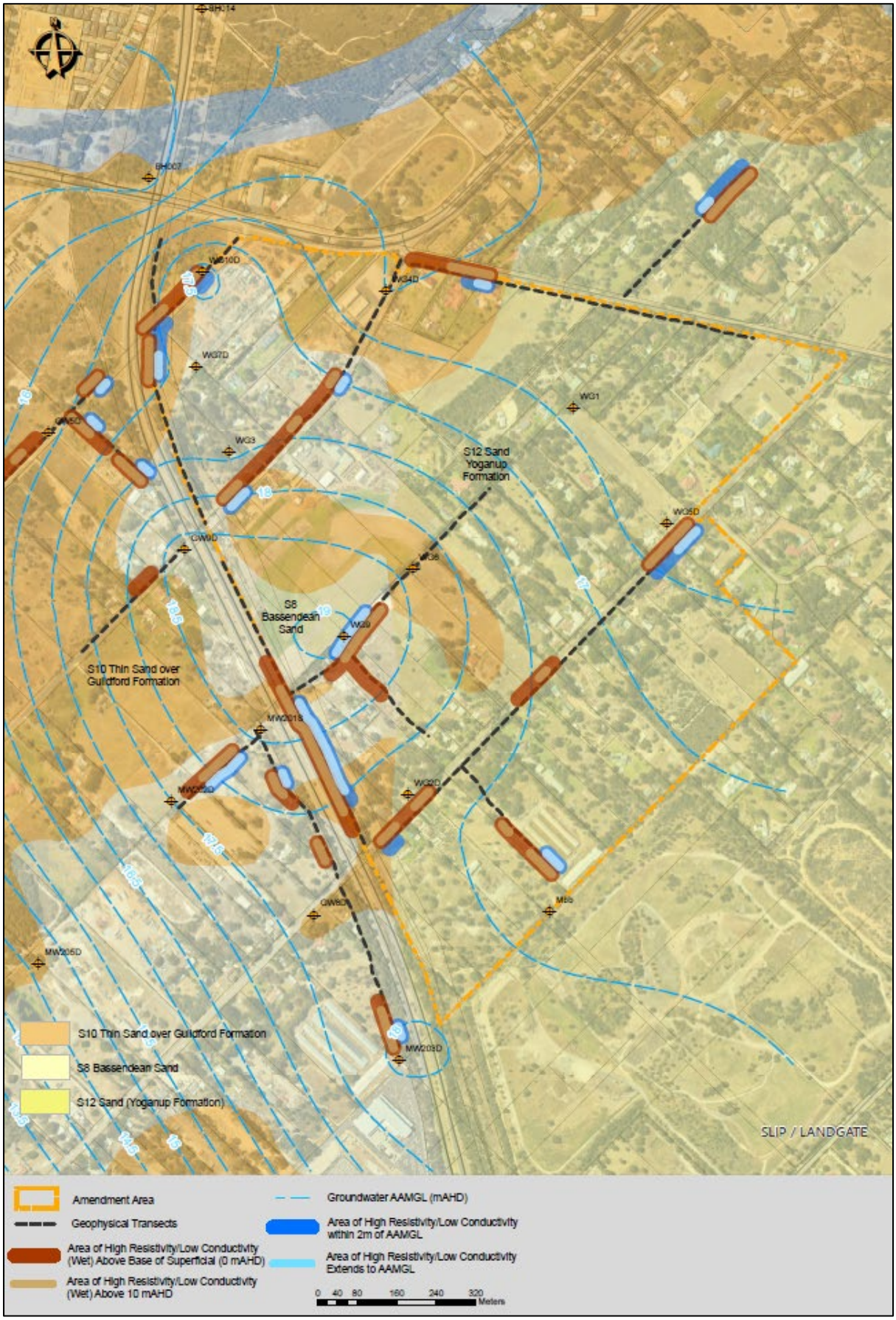

Figure 5-11: Groundwater contours and geological and geophysical interpretation (Hyd2o 2024)

Groundwater mound

The groundwater data confirmed the existence of a distinct groundwater mound centred over the former turf farm located on the south-western boundary (Figure 5-5). Monitoring of the Superficial Aquifer has however shown a considerable mound in the vicinity of the turf farm's 176,000 kL/year licence area rather than a reduction in levels locally (Hyd2o 2024). DWER's Water Information Reporting database indicates the turf farm operators drilled a bore to approximately -41 m AHD and screened from -30 m AHD to -40 m AHD which would be representative of the Leederville Aquifer.

The mound is relatively steep to the south-west where the permeability of the strata is lower (clayey Guildford Formation) and broader to the north-east where it is higher (Yoganup Formation). The mound is enhanced by higher rainfall recharge into the higher-permeability Yoganup Formation east of the turf farm.

The groundwater used to irrigate the turf was drawn predominantly from the Henley Sandstone (a member of the Leederville Aquifer). The Kardinya Shale present between the two aquifer systems, impedes downwards movement of infiltrated water, as well as the upward propagation of the drawdown (associated with the groundwater extraction from the Leederville Aquifer) to the Superficial Aquifer, resulting in groundwater mounding in Superficial Aquifer over the long-term.

The groundwater mounding is likely in part due to the comparatively high recharge from rainfall into the higher permeability Yoganup Formation. The shape of the mound within the MRS amendment area is broader to the east over the higher permeability Yoganup Formation. The western and north-western boundary of the MRS amendment area and extending along Boundary Road and Brentwood Road (east) is dominated by non-contiguous areas of lower permeability Guildford Formation geology resulting in a steeper hydraulic gradient towards the MRS amendment area's western boundary.

The mound has resulted in an artificial rise in the Superficial Aquifer groundwater table. The artificial groundwater rise associated with the mound extends west to north-west (to include the north-eastern portion of the GBSW) for approximately 1.5 km. This localised rise in the Superficial Aquifer groundwater table ranges from:

- a maximum of 5 m to 4 m (above the regional groundwater table) within 600 m west of the turf farm
- reducing to 3 m to 1 m (above the regional groundwater table) between 700 m and 1,500 m from the western boundary of the turf farm
- salinity of the Leederville Aquifer from the monitoring bore within the turf farm is fresh (657 mg/L TDS).

The groundwater level effect is lessened as spatial separation from this groundwater mound increases (Emerge Associates 2024). Figure 5-12 shows the existing groundwater mound contour in metres above the regional AAMGL groundwater levels.

The gradient and direction of groundwater flow across the MRS amendment area is influenced by the groundwater mound. The groundwater flow within the amendment area moves radially away from the groundwater mound which is located within the former turf farm and extends westwards to the Tonkin Highway.

The historical turf farm irrigation program and the associated establishment of the groundwater mound (within the Superficial Aquifer) represents the baseline environmental condition and represents the local hydrological conditions within the MRS amendment area and extending approximately 1.5 km west and north-west into the GBSW.

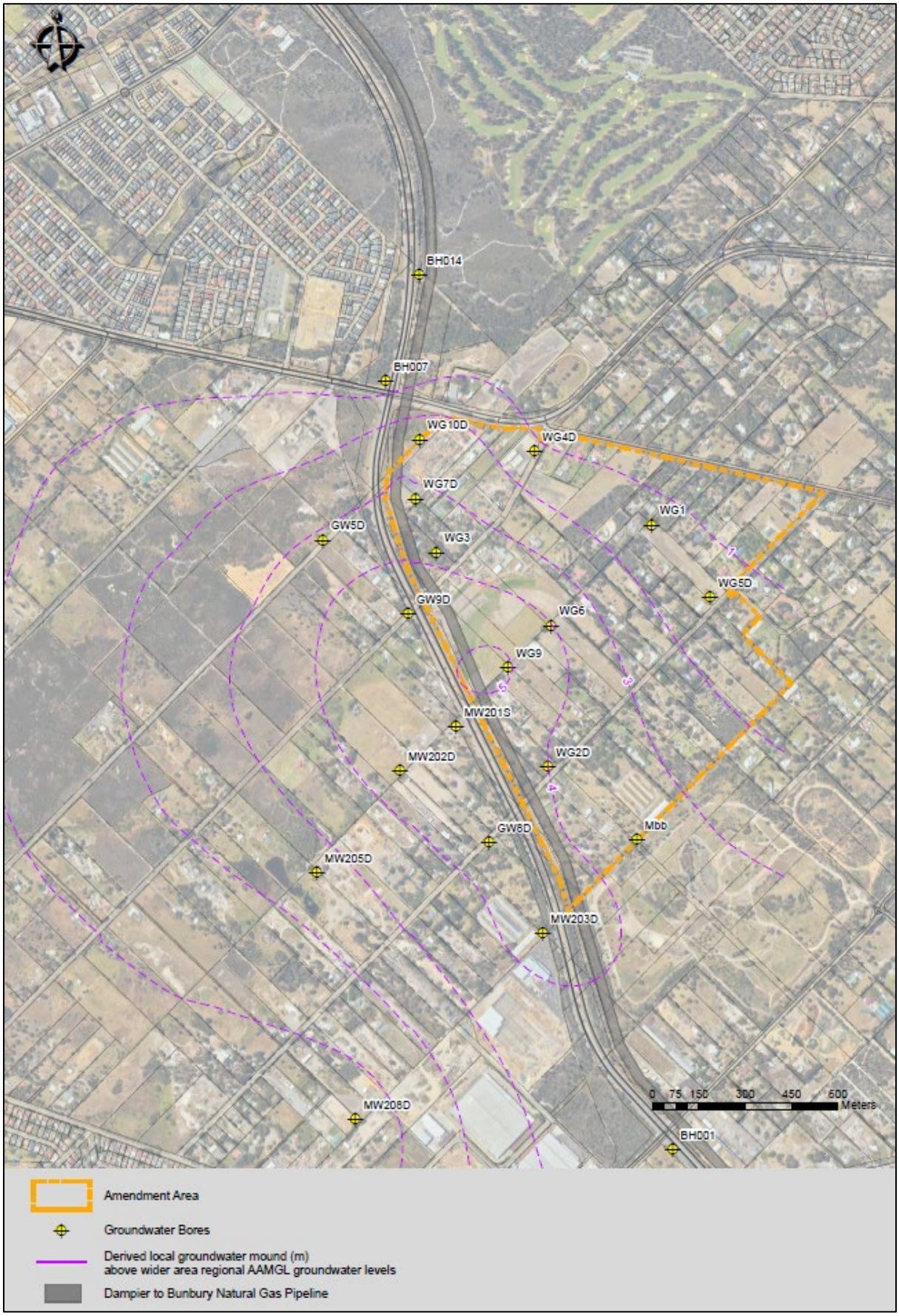

Figure 5-12: Localised groundwater mound (Hyd2o 2024)

The turf production and its irrigation appear to have ceased around April 2023. It is acknowledged the cessation of the turf farm's irrigation will likely affect groundwater levels locally. Groundwater monitoring in proximity of the mound between April 2023 to April 2024 confirms water levels in the Superficial Aquifer in the immediate vicinity of the turf farm have reduced with hydrographs based on the nearest bores to the turf farm showing (Hyd2o 2024):

- Bore WG9: Winter peak, pre ceasing of the irrigation ranged between 19.5 m AHD – 19.7 m AHD. Post ceasing of irrigation the winter peak water levels decreased to 17.8 m AHD in April 2024.
- Bore WG6: Winter peak, pre ceasing of the irrigation ranged between 18.5 m AHD – 18.0 m AHD. Post ceasing of irrigation the winter peak water levels decreased to 16.0 m AHD – 16.4 m AHD in April 2024.

The bore hydrographs in the area of the groundwater mound are provided in Figure 25 of the DWMS (Hyd2o 2024).

The operation and cessation of the turf farm irrigation practice is independent and not related to the proposed land use change. It is acknowledged the changes in water application and recharge (from the proposed future 'Urban' development) will affect groundwater levels locally i.e. reduce water levels (Hyd2o 2024). Accordingly, a key principle adopted within the DWMS is to locate stormwater management areas in the vicinity of the existing groundwater mound to maintain the annual pre-development groundwater recharge and flow directions at that location (Hyd2o 2024).

Alignment with the regional groundwater mapping

The confluence of the localised groundwater mound and the low permeable Guildford Formation geology along portions of the western and north-western boundary of the MRS amendment area has resulted in a deviation of local groundwater flow directions, within and immediately adjacent to the MRS amendment area when compared with DWER's regional groundwater contours. However, at a larger scale, (i.e. within 2 km south-west of the MRS amendment area), the groundwater flow direction is in a west to south-west direction, which broadly agrees with DWER's regional mapping.

To provide a comparative analysis of the regional groundwater contour mapping and the local groundwater contour mapping the following figures have been prepared:

- Figure 5-13**:** Local groundwater contours at a larger scale overlaid by DWER's 2023 minimum contours (Hyd2o 2024).
- Figure 5-14**:** Local groundwater contours at a larger scale overlaid by DWER's 2019 maximum contours (Hyd2o 2024).

In summary, the key difference in the local groundwater flow direction when compared with the DWER regional groundwater contours is the local flows were found to be radial from the groundwater mound which originates within the former turf farm which is located centrally along the western boundary. Flow within the MRS amendment area generally ranged from north-west to south-east and away from the GBSW (or westerly direction). The DWER regional mapping indicates a uniform groundwater flow direction to the west and south-west (Hyd2o 2024).

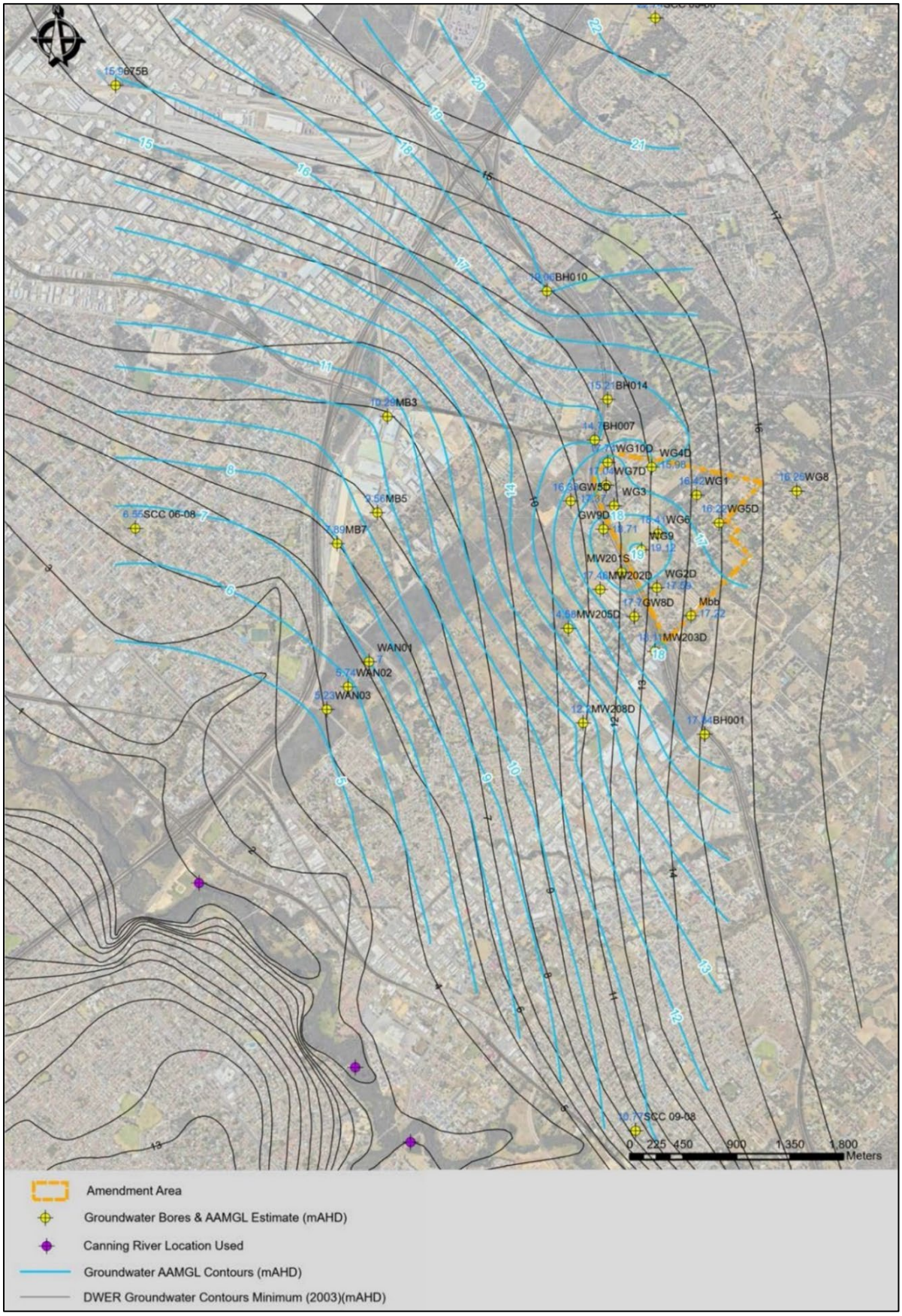

Figure 5-13: Local groundwater contours and DWER regional 2023 minimum contours (Hyd2o 2024)

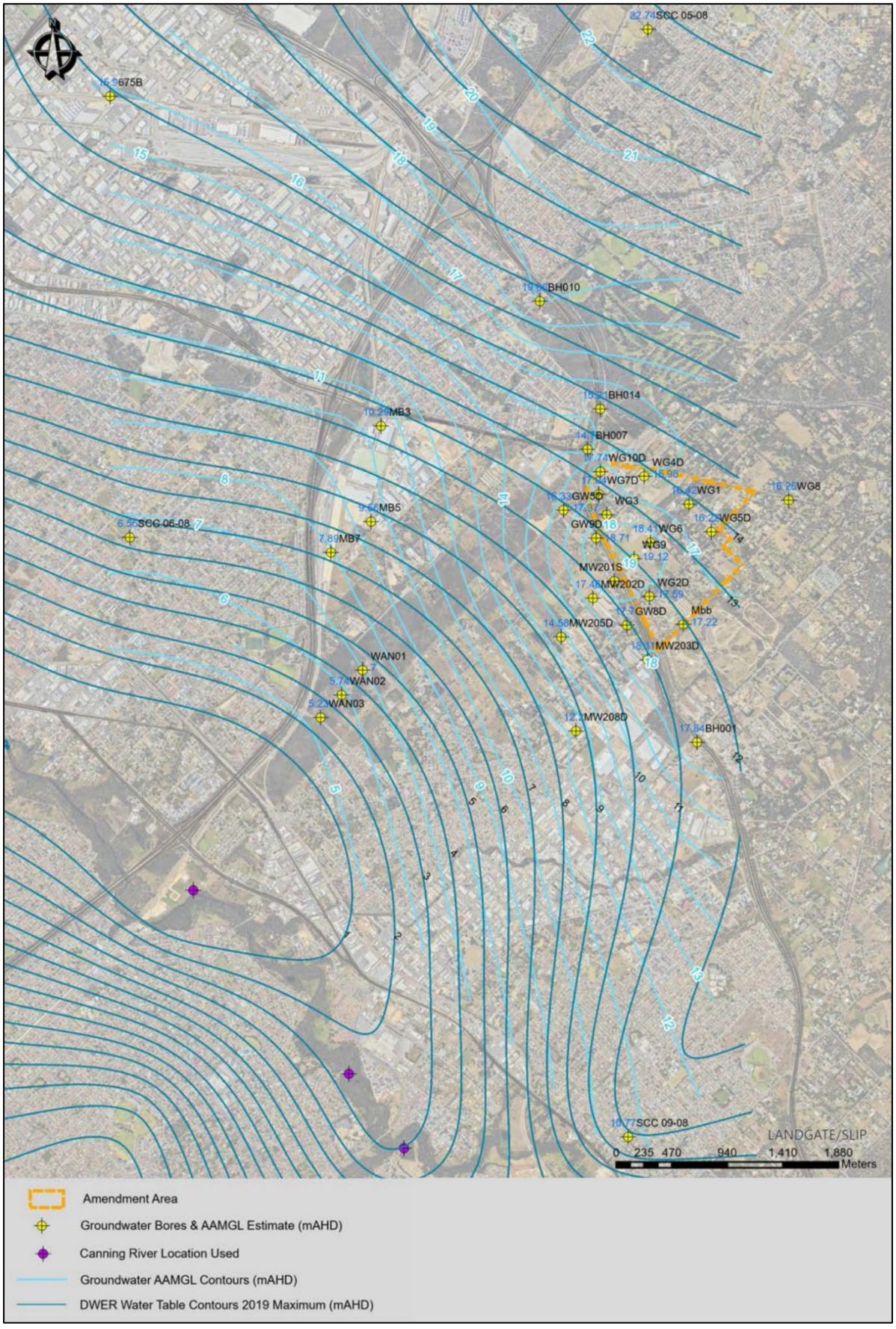

Figure 5-14: Local groundwater contours and DWER regional 2019 maximum contours (Hyd2o 2024)

5.4.3.6 Groundwater flow towards the GBSW area

Groundwater flow in a westerly direction (i.e. towards the GBSW) represents an extremely small contribution of the total groundwater flows from the MRS amendment area due to:

- Local geology:
  - The Guildford Formation geology occurring as clayey dominated soils along portions of the western and north-western boundary of the MRS amendment area and extend eastward i.e. along Boundary Road (east) and Brentwood Road (east) into the Yoganup Formation form areas of low permeable hydraulic barrier(s) which limits westerly groundwater flows (Figure 5-11).
  - Groundwater flow at a local scale follows a pathway of least resistance and tends to be eastward through the more permeable Yoganup Formation before moving predominantly towards the north-west and south-east through sand dominated geology.
- Groundwater mound:
  - The groundwater mound has artificially increased water levels along the north-western periphery of the MRS amendment area including a portion of the GBSW area (Figure 5-12). This is an artificial dynamic and is a direct result of the historical turf farm irrigation practice.

Perched (shallow) groundwater

Six bores were installed to assess the potential for perched groundwater within the MRS amendment area (Figure 5-7). Perching was evident in groundwater levels in the north-western corner of the MRS amendment area near Tonkin Highway which is associated with low permeable geology (Figure 5-11). Perched water was not recorded at most bores within the MRS amendment area.

The perched water within the MRS amendment area flows through the following modes:

- Unlined open drains along Boundary Road and Brentwood Road intercept the perched water table. These roadside drains direct the perched water in a westerly direction toward the culvert(s) under Tonkin Highway.
- The perched water moves laterally north or north-west into areas where the geology transitions from clay soils to a deeper sand dominated geology. The change in the geology allows for infiltration of the perched water into the Superficial Aquifer.

Tonkin Highway acts as an impermeable flow boundary, excluding shallow perched groundwater flows in a westerly direction (given likely removal of the shallow soil profile during construction). The presence of the DBNGP (which required the trenching and backfilling along the gas pipeline alignment) is also expected to facilitate downward infiltration of shallow perched groundwater to the deeper sandy layer (Emerge Associates 2024). A figure of the perched water assessment is presented in Figure 5-33 and in Figure 26 of the DWMS (Hyd2o 2024).

5.4.3.7 Independent review of groundwater levels and flow direction

Rockwater (a hydrogeological specialist consultant) undertook an independent review of the local and regional groundwater data and flow directions. Following their review, Rockwater provided advice on the post development groundwater flow dynamics.

The primary objective of this independent review was to:

- Confirm the assessment of the groundwater flow direction investigations and groundwater contour mapping locally and regionally.

- Review and address any differences between the regional DWER groundwater contour mapping and the local groundwater contour mapping, based on localised data collected from bores within the MRS amendment area and the surrounding locality.

The Rockwater assessment confirmed, in agreement with the local groundwater contour and flow direction (Hyd2o 2024) and the presence of:

- Low permeable geology associated with alluvial clays of the Guildford Formation geology
- A distinct mound beneath the turf farm, on the western boundary of the MRS amendment area.

Post assessment of the regional geology setting, bore hole lithologies and the geophysical assessments the following conclusions were made:

- The Yoganup Formation geology is consistent with the higher permeability areas defined in the geophysical mapping (GBG Group 2024) and areas of Guildford Formation geology are associated with the lower permeability areas.
- Along the western and north-western boundary of the MRS amendment area the geology is predominately sand over clayey sediments associated with the Bassendean Sands and Guildford Formations. At the depth of the groundwater table the sediments are predominantly clayey and hence have low permeability. This geology would limit the potential for westerly groundwater flows from the MRS amendment area.

In relation to the groundwater mound, the following conclusions were made:

- Irrigation from the turf farm bore, which is screened over the upper part of the Leederville Aquifer is the primary reason for the localised mounding.
- The groundwater mound may be exaggerated in part from the comparatively high recharge from rainfall into the higher permeability Yoganup Formation.
- The shape of the mound is broader to the east over the higher permeability Yoganup Formation. To the west, the shape of the mound is influenced by the lower permeability of the Guildford Formation, resulting in a steeper hydraulic gradient on this side of the mound.
- This groundwater mound is a key driver for the deviation of groundwater flow direction.

Review of the local and regional groundwater flows

Key conclusions from assessment of the local and regional groundwater flow direction were:

- The hydrogeological conditions together with the turf farm's historical irrigation activities, has resulted in a localised deviation in the groundwater contours from DWER's regional groundwater contour mapping.
- The lower permeability of sediment west of the MRS amendment area impedes groundwater flow.
- Groundwater flows preferentially through higher permeability areas, in particular the sandy Yoganup Formation which makes up the eastern portion of the MRS amendment area.
- Accordingly, the overall groundwater flow contribution in a westerly direction, towards the GBSW, is relatively small.
- The groundwater mound beneath the former turf farm has artificially elevated water levels at the north-western periphery of the GBSW area.
- Other than reduced irrigation all other water balance aspects related to the flow of groundwater from the MRS amendment area to the GBSW are expected to remain the same.

5.4.3.8 Groundwater quality

Groundwater quality was monitored within shallow (perched) and deep (Superficial Aquifer) bores within the MRS amendment area and west of Tonkin Highway in proximity to the GBSW. The groundwater data was supplemented with historical data including Endemic's (2012) data which was collected from 2009 to 2011.

The groundwater quality results compared to the ANZECC (2000) guidelines for wetland ecosystems in south-west Australia and freshwater ecosystems is summarised as follows (Hyd2o 2024):

- Median EC values at both shallow and deep bores within the MRS amendment area are higher than the respective medians of shallow and deep bores west of Tonkin Highway. Only the median for shallow bores within the MRS amendment area (2.25 mS/cm) fell outside the ANZECC guideline range (0.3 – 1.5 mS/cm).
- Median pH values for all bore groups except for shallow bores west of Tonkin Highway (7.20) have indicated some acidity and fall outside the ANZECC guideline range (7.0 – 8.5).
- Median TN values at deep bores within the MRS amendment area (3.35 mg/L) and shallow bores west of Tonkin Highway (2.80 mg/L) exceeded the ANZECC guideline (1.50 mg/L). Within their aggregations, bores WG9 and GW12 reported high exceedances of 52.0 mg/L and 8.4 mg/L respectively during the monitoring period. Bore GW5D reported the highest reading across the deep bores west of Tonkin Highway (5.50 mg/L).
- The median NOx-N values for shallow (0.96 mg/L) and deep (1.60 mg/L) bores within the MRS amendment area exceeded the ANZECC guideline (0.1 mg/L). Within their aggregations, bores WG9 and GW3 reported high exceedances of 44.0 mg/L and 7.55 mg/L respectively during the monitoring period. Medians for all aggregations fell within the ANZECC guideline for NH3-N (0.9 mg/L).
- Medians for all aggregations fell within the ANZECC guideline for TP (0.06 mg/L), apart from the shallow bores west of Tonkin Highway (0.15 mg/L). Within their aggregations bores WG9, GW12 and GW5D all reported the highest readings of 3.70 mg/L, 1.50 mg/L and 0.42 mg/L respectively.
- Medians for all aggregations fell within the ANZECC guideline for Filterable Reactive Phosphorus (FRP) (0.03 mg/L). Within their aggregations bores WG9, GW12 and GW9D all reported the highest readings of 2.9 mg/L, 0.68 mg/L and 0.06 mg/L respectively.
- Generally, medians for heavy metals across the bore sets fell within the 95% protection trigger value for freshwater ecosystems. The exceptions were median values for As, Cr, Cu and Zn for shallow bores west of Tonkin Highway.
- Metal readings across the aggregations were generally higher across the bores west of Tonkin Highway with notably high readings taken at bores GW5S, GW8S and GW12. The highest metal readings across the deep bores west of Tonkin Highway were generally reported at GW9D.

Nutrient levels in the Superficial Aquifer appear highest around the mounding associated with the former turf farm located at the western boundary of the MRS amendment area (at bores WG9 and GW9D). Nutrient levels were also generally highest at bore GW5D (located within Boundary Road reserve east of the MRS amendment area) and adjacent to the GBSW area.

Generally metal levels within the Superficial Aquifer fall within ANZECC trigger values, however higher concentrations are apparent at bore GW9D. Bore GW9D is located at the Brentwood Road cul-de-sac adjacent to Tonkin Highway.

Perched groundwater nutrient levels within the GBSW area were generally highest at bores GW3 and GW12. These bores are located over 2 km west of the MRS amendment area. Bore GW3 is in the Bickley Road reserve and bore GW12 is located within a rural property on Brook Road.

Figure 5-7 illustrates the location of the groundwater and surface water monitoring locations.

Table 5-9 summarises the groundwater quality monitoring results.

Table 5-9: Groundwater quality summary (Hyd2o 2024)

Parameters	ANZECC Guidelines (2000)	MRS amendment area bores				Bores west of Tonkin Highway			
		Shallow		Deep		Shallow		Deep	
		Median	Max	Median	Max	Median	Max	Medium	Max
EC (mS/cm)	1.50 - 0.300	2.251	3.622 (WG4S)	1.273	9.532 (WG3)	0.835	26.60 (GW12)	0.633	1.496 GW9D)
pH	7.0 - 8.5	5.94	6.95 (WG4S)	5.89	6.75 (Mbb)	7.15	8.18 (GW12)	6.22	6.54 (GW9D)
TN (mg/L)	1.50	1.50	14. 0 (WG4S)	3.35	52.0 (WG9)	2.80	8.40 (GW12)	0.84	5.50 (GW9D)
NOx-N (mg/L)	0.1	0.96	1.30 (WG4S)	1.60	44.0 (WG9)	0.23	7.55 (GW3)	0.01	
NH3-N (mg/L)	0.900	0.03	0.32 (WG4S)	0.01	3.40 (Mbb)	0.06	0.18 (GW3)	0.08	0.18 (GW5D)
TP (mg/L)	0.06	0.05	0.25 (WG4S)	0.05	3.70 (WG9)	0.15	1.50 (GW12)	0.05	0.42 (GW5D)
FRP (mg/L)	0.03	0.01		0.01	2.90 (WG9)	0.01	0.68 (GW12)	0.01	0.06 (GW9D)
As (mg/L)	0.024	0.001		0.001	0.002 (WG3)	0.0027	0.019 (GW12)	0.001	0.0062 (GW9D)
Cd (mg/L)	0.0002	0.0001		0.0001		0.0001	0.0034 (GW8S)	0.0001	
Cr (mg/L)	0.001	0.001		0.001	0.009 (WG4D)	0.0018	1.70 (GW12)	0.001	0.0023 (GW9D)
Cu (mg/L)	0.0014	0.001		0.001	0.019 (WG9)	0.004	0.48 (GW12)	0.001	0.0064 (GW9D)
Pb (mg/L)	0.0034	0.001		0.001	0.03 (WG6)	0.001	0.19 (GW5S)	0.001	0.0021 (GW5D)
Ni (mg/L)	0.011	0.0021	0.0027 (WG4S)	0.004	0.019 (WG3)	0.0095	0.98 (GW8S)	0.008	0.035 (GW9D)
Hg (mg/L)	0.0006	0.00005		0.00005	0.00031 (WG9)	0.0001	0.0006 (GW8S)	0.00005	
Zn (mg/L)	0.008	0.0038	0.016 (WG4S)	0.008	0.0610 (Mbb)	0.011	1.90 (GW12)	0.004	0.023 (GW9D)

5.4.3.9 Groundwater nutrient assessment

Hyd2o (2024) completed a pre-development nutrient assessment using DWER's Urban Nutrient Decision Outcomes (UNDO) model. The UNDO model is a conceptual decision support tool which evaluates nutrient reduction decisions for urban developments on the Swan Coastal Plain.

The UNDO assessment considered current land uses within and adjacent to the MRS amendment area that have the potential to export nutrients, including the former turf farm, septic tanks, and livestock. The nutrient application rate for bowling greens was used as a surrogate for the existing turf farm, as a specific rate is not provided in the model for this land use.

Table 5-10 summarises the nutrient input and export results for the MRS amendment area (Hyd2o 2024).

Table 5-10: UNDO assessment – Nutrient inputs and exports for existing land uses (Hyd2o 2024)

Nutrient	Annual Input (kg/yr)	Annual Export (kg/yr)
Total Nitrogen (TN)	13,772	392.2
Total Phosphorous (TP)	1,405	18.8

The model considers soil types, groundwater gradients and depth to groundwater. The model predicts the pre-development nutrient inputs into the environment are 13,772 kilogram (kg)/year of TN and 1,405 kg/year of TP. The nutrient export from the MRS amendment area is 329.2 kg/year and 18.8 kg/year of TN and TP, respectively.

A key conclusion drawn from this UNDO assessment is the proposed 'Urban' land use change provides the opportunity to significantly reduce nutrient application within the MRS amendment area and export of nutrients towards the west, which includes the GBSW and MKSEA areas. This conclusion is consistent with DBCA's 2021 advice specific to the wetlands and the GBSW area within the MRS amendment area outlined within the MRS Amendment Request, which stated:

'The proposed development will reduce impacts on the wetlands within the GBSW (located to the west Tonkin Highway) by improving water quality and reducing the nutrient levels exported from the amendment area' (WAPC 2021).

5.4.4 Surface water

5.4.4.1 Regional surface water

The MRS amendment area is situated within the Yule Brook sub-catchment which forms the northern most section of the larger Swan Avon Canning River Catchment (Figure 5-15). The Yule Brook and its major tributaries (Woodlupine Brook and Crystal Brook) has a total catchment area of 56 km^2, most of which is highly modified and includes industrial and urban uses, such as light to medium industry and residential, as well as agricultural uses.

The MRS amendment area represents approximately 2% of the total Yule Brook catchment area and 15% of the GBSW sub-catchment. The MRS amendment area surface water contribution to the GBSW however is much less than 15%, because the Yoganup Formation (the dominant geology unit) within the MRS amendment area facilitates the infiltration of surface water into the deeper Superficial Aquifer, reducing the surface water flows towards the GBSW.

Yule Brook

Yule Brook is a natural watercourse particularly in the upper catchment, however its lower reaches, in proximity to Tonkin Highway and the MKSEA area, has been modified to function as a 'Main Drain' and is managed by the Water Corporation.

Yule Brook is located outside MRS amendment area's sub catchment boundary which at its closest point is approximately 700 m north of the MRS amendment area boundary (Figure 5-15). The regional road network (Welshpool Road and Tonkin Highway) has created a physical barrier between the MRS amendment area and the Yule Brook. The closest surface water flow path from the MRS amendment area is the Boundary Road culvert located approximately 700 m south of Yule Brook. The surface water flow from the Boundary Road culvert and the former Crystal Brook tributary is detailed in the following section.

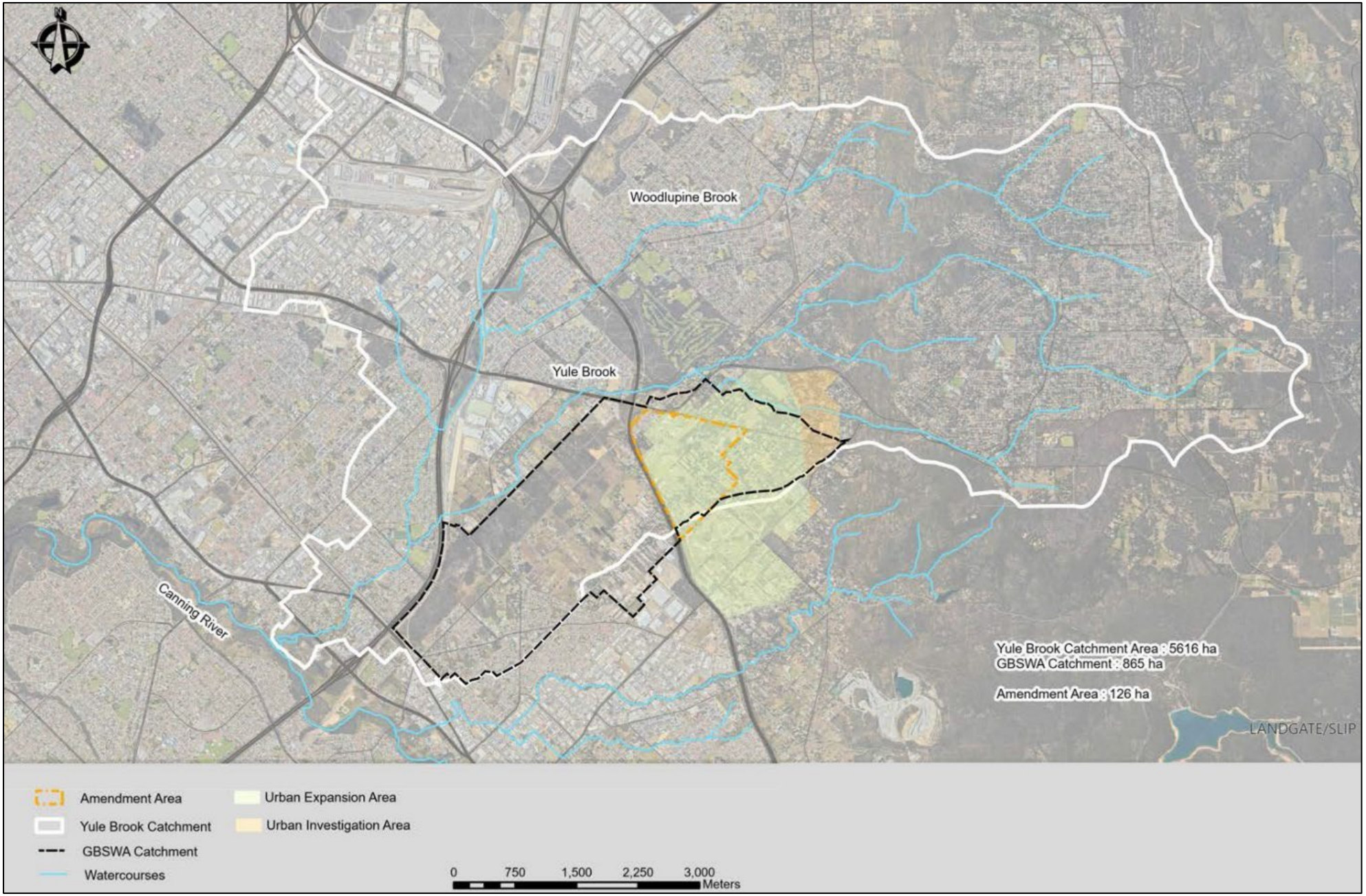

Figure 5-15: Yule Brook Sub-Catchment (Hyd2o 2024)

Yule Brook annual flow assessment undertaken for the City of Gosnells TPS No. 6 Amendments 166 and 169 concluded flows have declined in recent years. The comparison of the short-term average with longer-term average flow trend showed a decline of annual surface water runoff in Yule Brook of approximately 15% (Emerge Associates 2023b). Water quality within Yule Brook varies both seasonally and annually. Between 2006 and 2016, TN median concentration levels annually ranged between 0.66 mg/L and 1.10 mg/L, while median TP ranged from 0.07 mg/L and 0.16 mg/L. DWER and DBCA (2016) reported the catchment was generally meeting its long-term TN and TP targets of 1.0 mg/L and 0.1 mg/L respectively (Hyd2o 2024).

The Swan Canning Water Quality Improvement Plan (SCWQIP) seeks to reduce nutrient inputs within the Yule Brook catchment by an additional 25%. (DBCA 2009).

Former Crystal Brook tributary

Tauss et al (2019) in 'A Jewel in the Crown of a Global Biodiversity Hotspot' (Lambers 2019) provides a comprehensive assessment of the Crystal Brook tributary and the historical alterations in the surface water flow paths.

Originally, pre-1950's and the clearing of vegetation to establish rural land uses, the former Crystal Brook tributary provided a natural surface water flow path from the northern portion of the MRS amendment area into the GBSW. In the early 1950s the brook was diverted, via an excavated drain, north of the MRS amendment area into the Yule Brook. Subsequently, areas of the former Crystal Brook tributary within the MRS amendment area were historically cleared and infilled to facilitate the following land uses and infrastructure developments:

- Semi-rural and commercial land uses
- Construction of Boundary Road
- Construction of Tonkin Highway

Within the GBSW, the former Crystal Brook tributary was impacted from historical land clearing and semi-rural land uses. Figure 5-16 illustrates the approximate original Crystal Brook tributary flow path on a 1953 aerial photograph and the location of the roadside open drains.

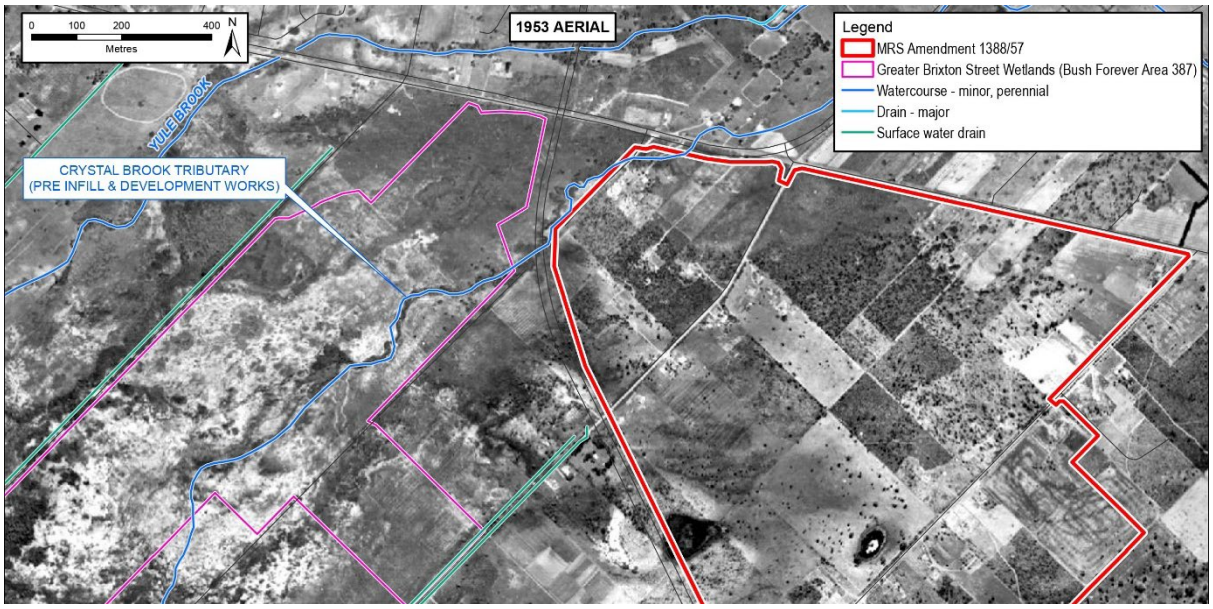

Figure 5-16: Wattle Grove MRS amendment area and the original Crystral Brook tributary flow path (1953 aerial photograph)

5.4.4.2 Surface water flows

Within the MRS amendment area, post seasonal rain events, overland water flows in a north-westerly direction following the topographical gradient. The surface water flow (if it is not infiltrated in the Yoganup Formation sandy soil profile) is intercepted by open roadside drains located along Boundary Road, Brentwood Road and Victoria Road and piped drains within private landholdings.

The roadside drains are located above the groundwater table (Hyd2o 2024). Theses drains direct the surface water in a westerly to south-westerly direction towards three culvert outlets, positioned under Tonkin Highway, located at the western ends of the following roads:

- Brentwood Road (culverts: 2 x 350 mm diameter)
- Victoria Road (culvert:1 x 300 mm diameter)
- Boundary Road (culverts: 2 x 900 mm diameter)

Figure 5-17 details key topographic catchment boundaries, sub catchment areas, and the location of the culverts linking surface water flows to the GBSW area.

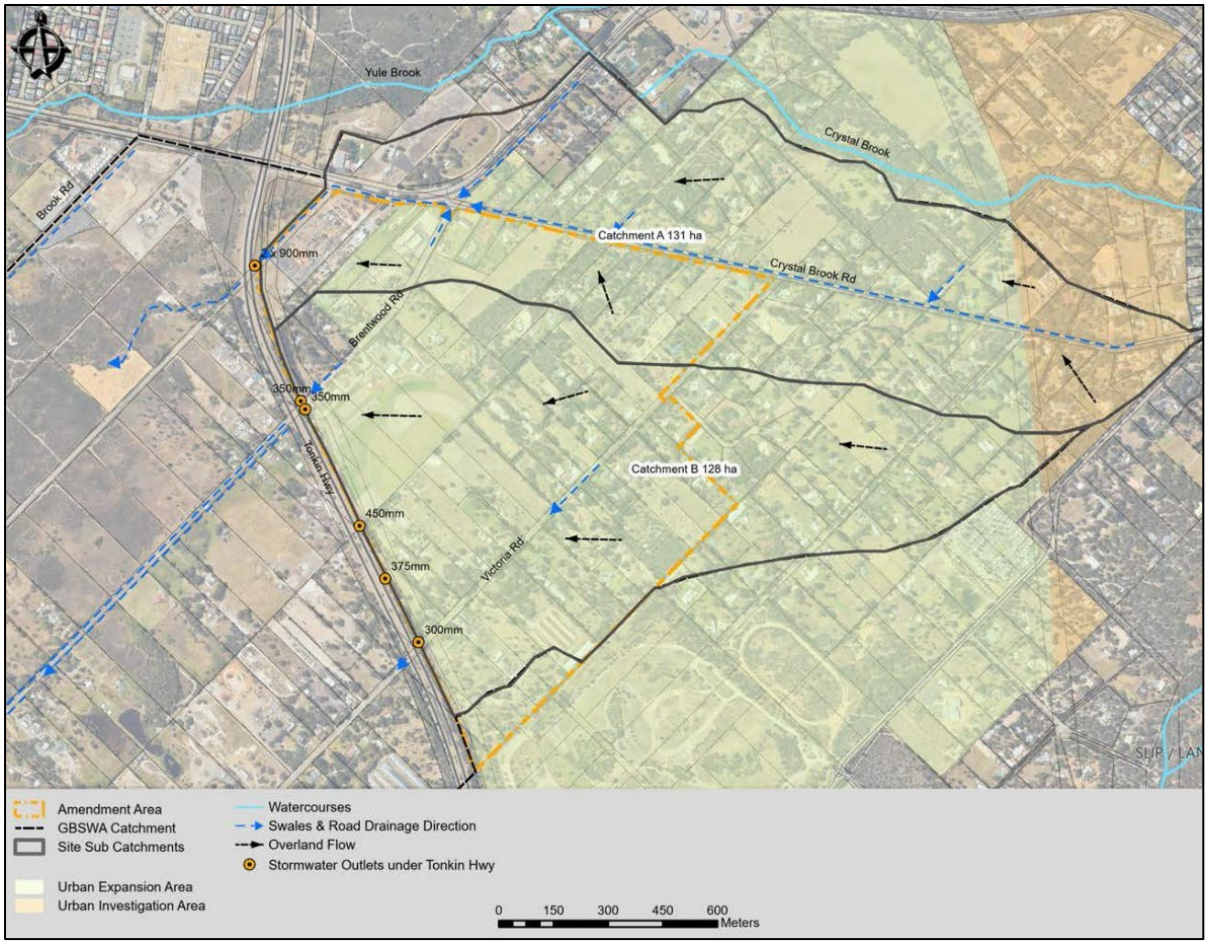

Figure 5-17: Surface Water Flow Pathways and the MRS amendment area Sub Catchments (Hyd2o 2024)

Victoria Road culvert

The Victoria Road culvert is a single 300 mm culvert. Surface water from this culvert flows westerly along Victoria Road, via the road reserve and the roadside open drain. This flow path is located at the boundary of the proposed MKSEA Precinct 2 area and the approved MKSEA Precinct 1 area.

The existing land use adjacent to Victoria Road (within the MKSEA Precinct 2 area) are mostly semi-rural properties, poultry farm, and truck and machinery lay down areas. Industrial lots within the MKSEA Precinct 1 area are under construction.

The Victoria Road culvert and surface water flow path is shown in Figure 5-18.

Figure 5-18: Surface water flow path conveyed via the Victoria Road culvert.

The flow paths along unlined roadside drains (located within existing road reserves and between rural residential lots), notably within the existing drain which flows from Victoria Road towards Brentwood Road before entering the GBSW.

Brentwood Road culverts

The Brentwood Road outlet conveys surface water runoff from the MRS amendment area via 2 x 900 mm culverts beneath Tonkin Highway into an open roadside drain on the western side of Tonkin Highway. This roadside drain is within the proposed MKSEA Precinct 2 area.

The existing land uses along Brentwood Road include dog kennels, small-scale livestock properties and semi-rural properties.

Figure 5-19 illustrates the location of the Brentwood Road culverts and the open roadside drain on the west side of Tonkin Highway.

Figure 5-19: Surface water flow path conveyed via the Brentwood Road culverts.

Boundary Road culverts

Surface water flows from the north-western portion of the MRS amendment area (including from Crystal Brook Road and its associated roadside drain) are directed towards the Boundary Road culverts beneath Tonkin Highway via:

- The remnant portion of the former Crystal Brook tributary located within Lot 501 adjacent to the MRS amendment area and Boundary Road
- Overland flows along Boundary Road.

The remnant portion of the former Crystal Brook tributary consists of an approximately 0.5 m deep creek line that commences near the Welshpool Road and Boundary Road intersection within Lot 501. This portion of the former Crystal Brook tributary has been historically disturbed from the construction of the adjacent roads (Welshpool Road, Tonkin Highway and Boundary Road) and the installation (via trenching and backfilling along the alignment) of the Water Corporation pipeline and the DBNGP.

The mapped vegetation within this portion of the tributary consists of:

- Mid open woodland of *Corymbia calophylla* over low woodland of mixed species dominated by *Eucalyptus rudis*, *Melaleuca rhaphiophylla* and *Melaleuca preissiana* over tall sparse shrubland of mixed species dominated by Acacia saligna over mid sparse shrubland of *Acacia pulchella* over mid tussock grassland of mixed species dominated by **Avena barbata*, * *Eragrostis curvula* and **Ehrharta calycina over* **Watsonia meriana* on grey and brown sandy loam and clay loam on plains, flats, and drainage lines.

Plate 5-1 illustrates the degraded nature of the former Crystal Brook tributary within Lot 501 adjacent to Boundary Road.

Plate 5-1: Crystal Brook tributary alignment within Lot 501 adjacent to the MRS amendment area

Figure 5-20 summarises the surface flow pathway, at a local scale, from the MRS amendment area via the Boundary Road culvert into the open roadside drain and the former Crystal Brook tributary.

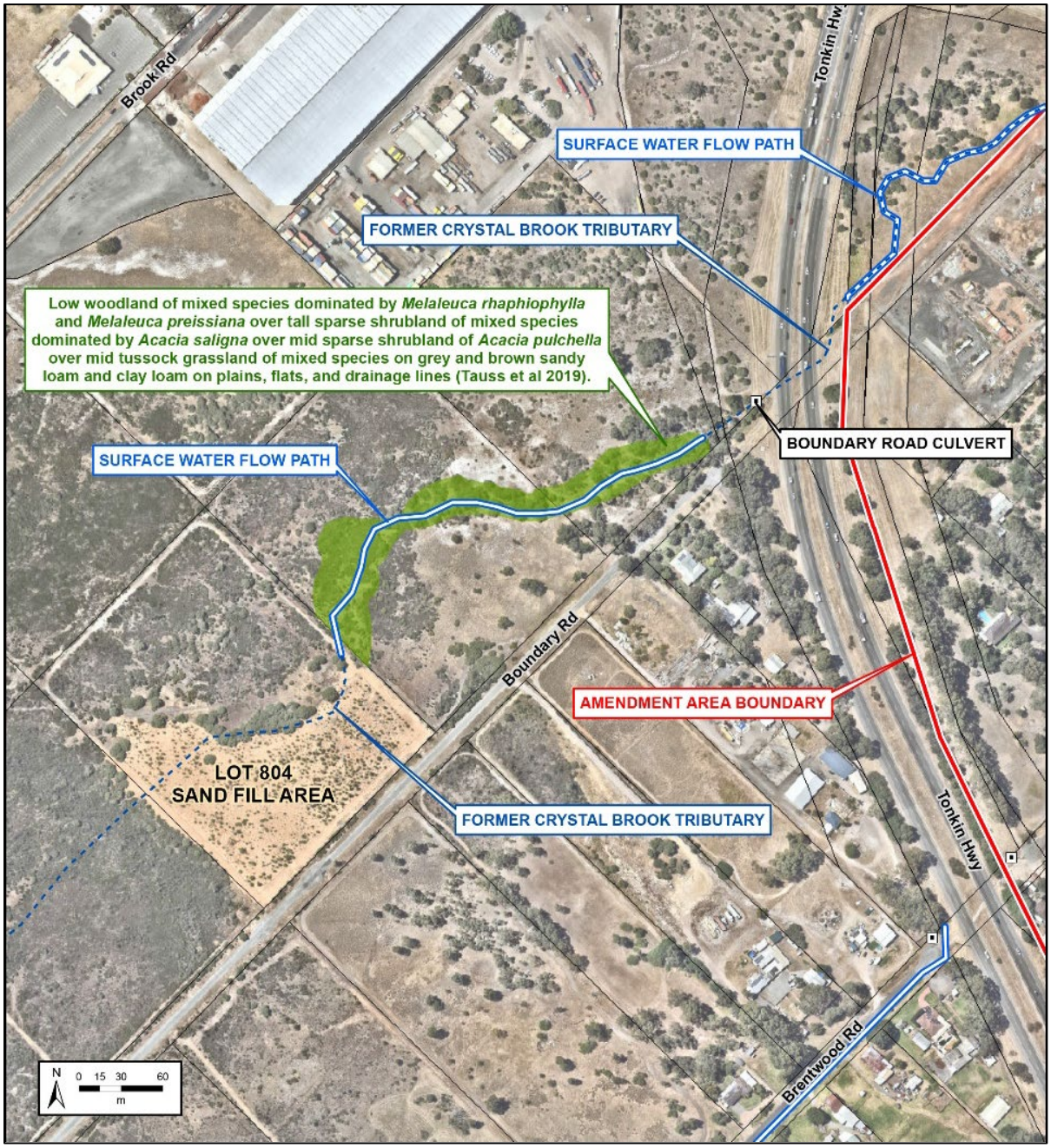

Figure 5-20: Surface water path flow via the former Crystal Brook tributary

On the western side of Tonkin Highway, the surface water flows are directed initially along the southern side of Boundary Road for approximately 20 m before being directed north-west within the former Crystal Brook tributary and the GBSW area for approximately 500 m.

The mapped vegetation within the tributary within the GBSW area consists of:

- Low woodland of mixed species dominated by *Melaleuca rhaphiophylla* and *Melaleuca preissiana* over tall sparse shrubland of mixed species dominated by *Acacia saligna* over mid sparse shrubland of *Acacia pulchella* over mid tussock grassland of mixed species dominated by **Avena barbata*, * *Eragrostis curvula* and **Ehrharta calycina* over **Watsonia meriana* on grey and brown sandy loam and clay loam on plains, flats, and drainage lines (Tauss et al 2019).

Plate 5-2 illustrates where surface water flows into the former Crystal Brook tributary along Boundary Road.

Plate 5-2: Crystal Brook tributary alignment along Boundary Road within the GBSW area

The landholdings south of Boundary Road (west of Tonkin Highway) are within the proposed MKSEA Precinct 2 area. The existing land uses adjacent to Boundary Road include, the GBSW on the northern boundary and semi-rural properties, and truck and material storage yard.

5.4.4.3 Surface water monitoring

Commenced in 2020, the surface water monitoring program incorporated sampling upstream and downstream of the MRS amendment area. This surface water monitoring program is defined in Table 5-11.

Table 5-11: Surface water monitoring program (Hyd2o 2024)

Monitoring	Parameter	Location	Frequency and timing
Surface Water Quality	Flow rate(s) Physical parameters Nutrients and heavy metals	3 site outlets 1 site inflow 5 downstream locations	Up to 4 occasions in winter

5.4.4.4 Surface water quality

Surface water sampling occurred at nine locations, post rain events when surface water was flowing (Figure 5-7). Surface water data is summarised in Table 5-12. This table aggregates surface water data to reflect:

- Surface water quality upstream, leaving, or downstream of the MRS amendment area (west of Tonkin Highway) near the GBSW.
- Historical Endemic (collected 2009 to 2010) and Urbaqua (collected 2019 to 2020) data sets.

Table 5-12: Surface water quality summary (Hyd2o 2024)

Parameters	ANZECC Guidelines (2000)	Surface water sampling sites					
		Upstream (SW1)		Outlets (SW2, SW3, SW4)		Downstream (SW5, SW6, SW7, SW8 and SW9)	
		Median	Max.	Median	Max.	Median	Max.
EC (mS/cm)	**0.120 – 0.300**	0.260	0.352	1.058	1.812 (SW2)	0.648	5.200 (SW7)
pH	**6.5 – 8.0**	7.90	8.19	7.55	9.01 (SW2)	7.35	7.90 (SW7)
TN (mg/L)	**1.20**	0.60	0.90	2.20	18.00 (SW2)	1.90	3.60 (SW7)
NOx-N (mg/L)	**0.15**	0.02		0.87	5.40(SW2)	0.12	1.30 (SW7)
NH3-N (mg/L)	**0.900**	0.01	0.02	0.03	0.77 (SW3)	0.02	2.70 (SW7)
TP (mg/L)	**0.065**	0.05		0.15	5.60 (SW3)	0.15	0.32 (SW9)
FRP (mg/L)	**0.04**	0.01	0.01	0.02	0.51 (SW2)	0.07	0.32 (SW9)
As (mg/L)	**0.024**	0.0015	0.002	0.001	0.003 (SW2)	0.001	0.004 (SW7)
Cd (mg/L)	**0.0002**	0.0001		0.0001		0.0001	0.0003 (SW7)
Cr (mg/L)	**0.001**	0.001		0.001	0.002 (SW2)	0.001	0.002 (SW7)
Cu (mg/L)	**0.0014**	0.0035		0.005	0.100 (SW4)	0.002	0.013 (SW7)
Pb (mg/L)	**0.0034**	0.001		0.001	0.005 (SW2)	0.001	
Ni (mg/L)	**0.011**	0.001		0.001	0.006 (SW4)	0.002	0.019 (SW7)
Hg (mg/L)	**0.0006**	0.00005		0.00005	0.0001 (SW2)	0.00005	0.0001 (SW7)
Zn (mg/L)	**0.008**	0.0135	0.017	0.019	0.078 (SW4)	0.013	0.360 (SW7)

The surface water quality results compared to the ANZECC (2000) guidelines for wetland ecosystems in south-west Australia and freshwater ecosystems is summarised as follows (Hyd2o 2024):

- Median EC values at upstream sampling sites fell within the ANZECC guideline range (0.12 – 0.3 mS/cm). Median EC across locations downstream was next highest with a value of 0.648 mS/cm and site outlets recorded the highest median with a value of 1.812 mS/cm.
- Median pH across all sampling groups fell within the ANZECC guideline range (pH 6.5 – 8).
- Median TN values for both the site outlets (2.2 mg/L) and the locations west of Tonkin Highway (1.90) exceeded the ANZECC guideline (1.2 mg/L). Outlet SW2 had a high exceedance value of 18 mg/L, while SW7 recorded the highest reading for a downstream location (3.6 mg/L) located approximately 1.5 km west of the MRS amendment area.
- The median value for Nox-N across outlets (0.87 mg/L) within the MRS amendment area exceeded the ANZECC guideline (0.15 mg/L), with the highest reading recorded at SW2 (5.4 mg/L). The highest reading downstream was 1.30 mg/L at SW7.
- Median NH3-N values across all sampling groups fell within the ANZECC guideline (0.9 mg/L). The highest site outlet recording was at SW3 (0.77 mg/L) while the highest downstream reading was at SW7 (2.70 mg/L).
- Median TP values across the site outlets and downstream locations were both reported as 0.15 mg/L, which exceed the ANZECC guideline (0.065 mg/L). The highest reading across the outlets was taken at SW3 (5.6 mg/L), while the highest reading downstream was taken at SW9 (0.32 mg/L) located approximately 1.5 km west of the MRS amendment area.
- Median FRP values across locations downstream of the site (0.07 mg/L) marginally exceeded the ANZECC guideline (0.04 mg/L). The highest value was recorded across the site outlets at SW2 (0.51 mg/L), while the highest value across the downstream locations occurred at SW9 (0.32 mg/L) located approximately 1.5 km west of the MRS amendment area.

- Medians for heavy metals across all sampling groups fell within the 95% trigger value for freshwater species except for Cu and Zn.
- The highest heavy metal readings were most common at SW2 for site outlets, while SW7 recorded the highest readings for all metals across locations downstream.
- Surface water flow upstream of the MRS amendment area (represented by sampling site SW1) generally had the best quality with the least ANZECC guideline exceedances.
- Downstream, nearest to the GBSW and prior to discharge into Yule Brook, the highest nutrient and metal concentrations were at sampling site SW7 located approximately 1.5 km west of the MRS amendment area.

The proposed 'Urban' land use provides an opportunity to improve surface water quality and reduce impacts (i.e. from nutrients) on the GBSW through the implementation of the Better urban water management guideline (WAPC 2008) requirements and the Stormwater management manual for WA (DWER 2022). This includes the establishment of biofiltration basins and swales for treatment and infiltration, and maintenance of pre-development surface water flows.

5.4.5 Geomorphic wetlands

Wetlands within the Swan Coastal Plain are protected and managed in accordance with the management categories assigned by DBCA (DBCA 2017). These management categories and their objectives are outlined in Table 5-13.

Table 5-13: Wetland management categories, description and management objectives (EPA 2008)

Management category	General description	Management objective
Conservation Wetlands (CCW)	Wetlands which support a high level of attributes and functions	To preserve wetland (natural) attributes and functions.
Resource Enhancement Wetlands (REW)	Wetlands which may have been partially modified but sill support substantial ecological attributes and functions	To restore wetlands through maintenance and enhancement of wetland functions and attributes.
Multiple Use wetlands (MUW)	Wetlands with few remaining important attributes and functions	To use, develop and manage wetlands in the context of water, town, and environmental planning.

Table 5-14 summaries the wetlands subject to this wetland assessment report inclusive of the numerous mapped wetlands within the GBSW area.

Table 5-14: DBCA mapped geomorphic wetlands within and adjacent to the MRS amendment area.

Unique Feature Identifier (UFI)	Management category	Geomorphic classification	Land tenure details	Total area (ha)
Within the MRS amendment area				
8037	REW	Sumpland	• Lot 301 – zoned Primary Regional Road. • Lot 302 – zoned 'Rural' (Water Corporation easement). • Lot 303 - zoned 'Rural' (turf farm). • Dampier to Bunbury Natural Gas Pipeline (DBNGP) easement (D207286). • Lot 107 – zone 'rural' predominantly cleared small rural landholding. • Lot 106 – zone 'rural' predominantly cleared small rural landholding.	0.86
Portion of 15257	REW	Palusplain	• Lots 146, 12 - zoned 'Rural' predominantly cleared small rural landholdings. • Lot 302 – zoned 'Rural' (Water Corporation easement). • DBNGP easement.	30.33 (2.06 is within the MRS amendment area)
North of the MRS amendment area (located within Lot 501 located - 30 m north of the MRS amendment area)				
8026	CCW	Palusplain	• Lot 501 - zoned 'Parks and Recreation' and includes Water Corporation and DBNGP easement.	0.38
8027	CCW	Palusplain		0.32
Portion of 15257	REW	Palusplain		30.33 (0.52 ha is within Lot 501).
GBSW area (within 150 m of the MRS amendment area west of Tonkin Highway)				
8025	CCW	Palusplain	Lot 51 - reserved 'Parks and Recreation' and Bush Forever Site No 387	2.78
8028	CCW	Sumpland	Lot 340 - reserved 'Parks and Recreation' and Bush Forever Site No 387	1.48
8030	MUW	Palusplain	Lot 342 - reserved 'Parks and Recreation' and Bush Forever Site No 387	1.29
14962	CCW	Palusplain	Lot 342 - reserved 'Parks and Recreation' and Bush Forever Site No 387	62.68
Balance of 15257	REW	Palusplain	Lot 51 - reserved 'Parks and Recreation' and Bush Forever Site No 387	27.75 (being the balance of 30.33 ha)

The wetlands within and adjacent to the MRS amendment area is shown in Figure 5-21.

Groundwater dependent ecosystems (GDEs) are those that require access to groundwater at some stage in their life cycle order to maintain community structure and function (Eamus et al. 2006). GDEs can be grouped into three broad classification types:

- Terrestrial GDEs: ecosystems that rely on the sub-surface presence of groundwater which includes all vegetation communities.
- Aquatic GDEs: rely on the surface expression of GDEs and include riverine base flow systems, wetlands, and springs.
- Subterranean GDEs: includes aquifer and karst systems.

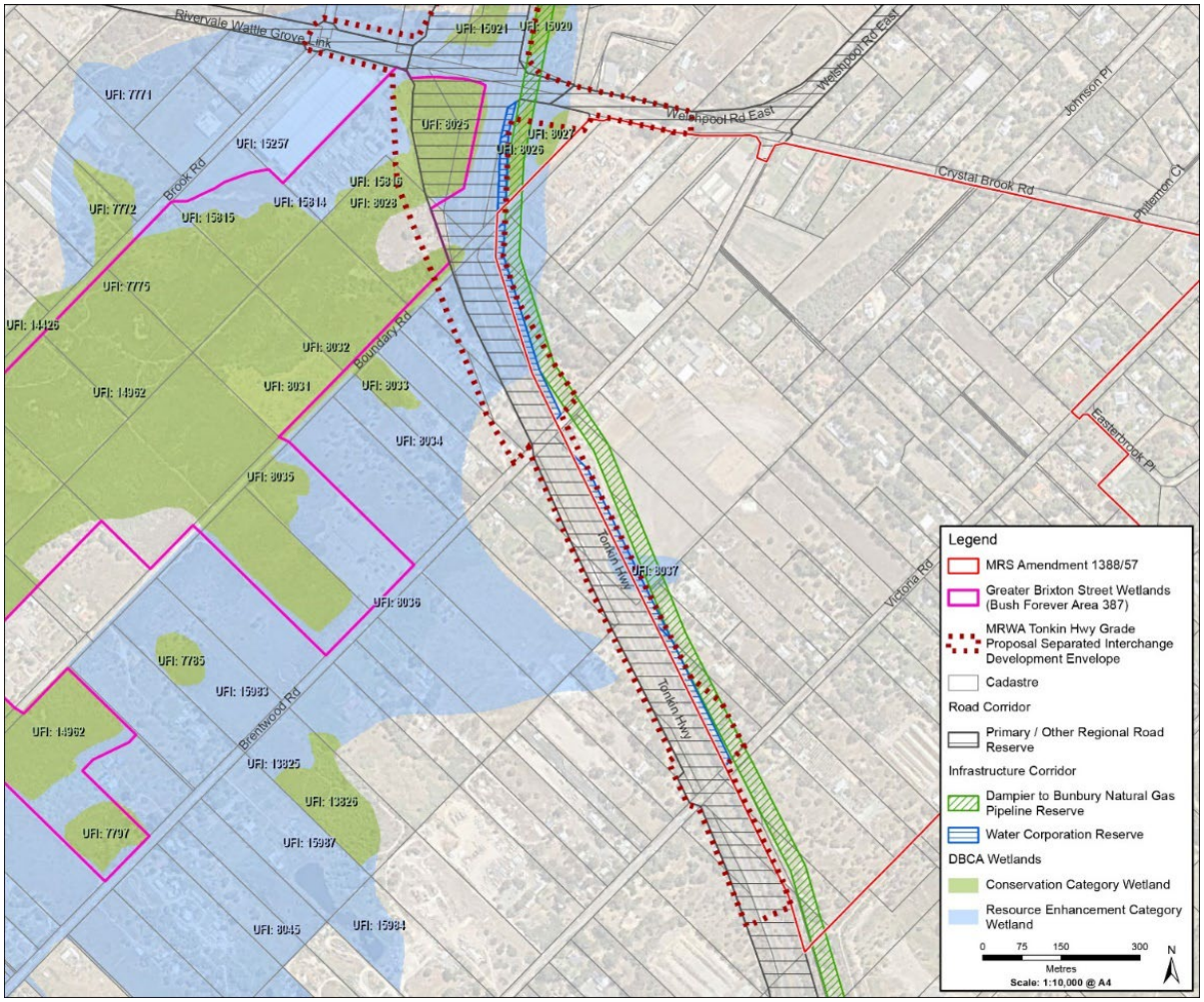

Figure 5-21: Wetlands within and adjacent to the MRS amendment area

5.4.5.1 Assessment of geomorphic wetlands environmental values

Evaluation of the two REWs (UFI 8037 and portion of UFI 15257) within the MRS amendment area

The evaluation of two REWs (UFI 8037 and portion of UFI 15257) within the MRS amendment area was premised on:

- *A methodology for the evaluation of wetlands on the Swan Coastal Plain, Western Australia* (DBCA 2017).
- Site survey which identified the obvious anthropogenic impacts within the mapped wetland areas from:
    - Historical clearing and infilling activities associated with the construction of Tonkin Highway, the Water Corporation pipeline and DBNGP (and maintaining a cleared easement)
    - 'Rural' open paddock land uses.
- The site survey confirmed the two REWs (UFI 8037 and portion of UFI 15257) within the MRS amendment area are in Completely Degraded condition or in the case of REW UFI 8037 within Tonkin Highway reserve, DBNGP easement and the former turf farm has been completed infilled and cleared of all native vegetation (Figure 5-22).

- DBCA's preliminary advice on the proposed Wattle Grove MRS amendment. DBCA's preliminary advice specific to the two REWs within the MRS amendment area is summarised below (WAPC 2021):
    - The portion of REW (UFI 15257) has been significantly modified from the construction of Tonkin Highway, the Water Corporation pipeline and DBNGP easements.
    - REW (UFI 8037) has been cleared and filled (from the turf farm land use) and no longer exists.
    - The environmental values of the two REWs (UFI 8037 and UFI 15257), using available regional scale data are commensurate with a MUW.

Buffer assessment of the wetlands located within Lot 501 adjacent to the MRS amendment area and the GBSW area.

The purpose of this assessment is focused on evaluating separation buffers to the two CCWs (UFI 8026 and UFI 8027) and portion of REW UFI 15257 within Lot 501 and the numerous mapped wetlands within the GBSW area located inside 150 m of the MRS amendment area.

The wetland separation buffer assessment was undertaken in accordance with Draft Guideline for the Determination of Wetland Buffer Requirements (WAPC 2005).

Wetlands subject to the buffer assessment are:

- East of Tonkin Highway:
    - Within Lot 501 there are two CCWs (UFI 8026 and UFI 8027) and a portion of REW UFI 15257. Lot 501 is a 1.6 ha triangular landholding bounded by Tonkin Highway to the west, Welshpool Road to the north and Boundary Road to the south.
- West of Tonkin Highway:
    - The GBSW area which incorporates numerous DBCA mapped CCW and REW features. The mapped wetlands within 150 m of the MRS amendment area include, three CCW UFI 8025, UFI 8028, UFI 14962, one REW UFI 5257 and a MUW UFI 8030.

The Wattle Grove South MRS amendment 1388/57 does not alter:

- Lot 501 existing 'Parks and Recreation' land use
- the GBSW area 'Parks and Recreation' and Bush Forever Site No 387 boundary or land use.

The proposed 'Urban' land use within the MRS amendment area (and proposed future residential development) does not intrude into the two CCWs (UFI 8026 and UFI 8027) or the GBSW area. Instead, the two CCWs (UFI 8026 and UFI 8027) and the numerous wetlands with the GBSW area are physically separated from the MRS amendment area by key regional infrastructure corridors including:

- Boundary Road reserve
- Tonkin Highway reserve and Welshpool Road reserve
- Water Corporation water pipeline easement
- DBNGP easement.

Wetland Assessment Report for Wattle Grove South MRS Amendment 1388/57

The detailed assessment of the wetlands within the MRS amendment area (REWs UFI 8037 and portion of UFI 15257) and the separation buffer assessment of CCWs UFI 8026 and UFI 8027 and portion of REW UFI 15257 within Lot 501 is provided in the Wetland Assessment Report prepared by Pentium Water (2024). This Wetland Assessment Report can be found at Appendix C.

MRS amendment area - Wetland review

REW - UFI 8037

The wetland vegetation within REW UFI 8037 was historically cleared and infilled in the early 1980s to accommodate the construction of Tonkin Highway, the Water Corporation water pipeline and the DBNGP (Figure 5-22). In the early 2000s the landowner extended the turf farm across the mapped REW area.

There is no native vegetation within the former turf farm (Lot 303), the Water Corporation water pipeline and DBNGP easements (Lot 302) and the Tonkin Highway road reserve (Lot 301). The vegetation within Lots 107 and Lot 106 adjacent to the turf farm totals 0.08 ha in area and consists of scattered trees in a cleared rural paddock. The open seasonal wetland area was infilled between 1970 – 2003 to facilitate the construction of Tonkin Highway and the commercial turf farm.

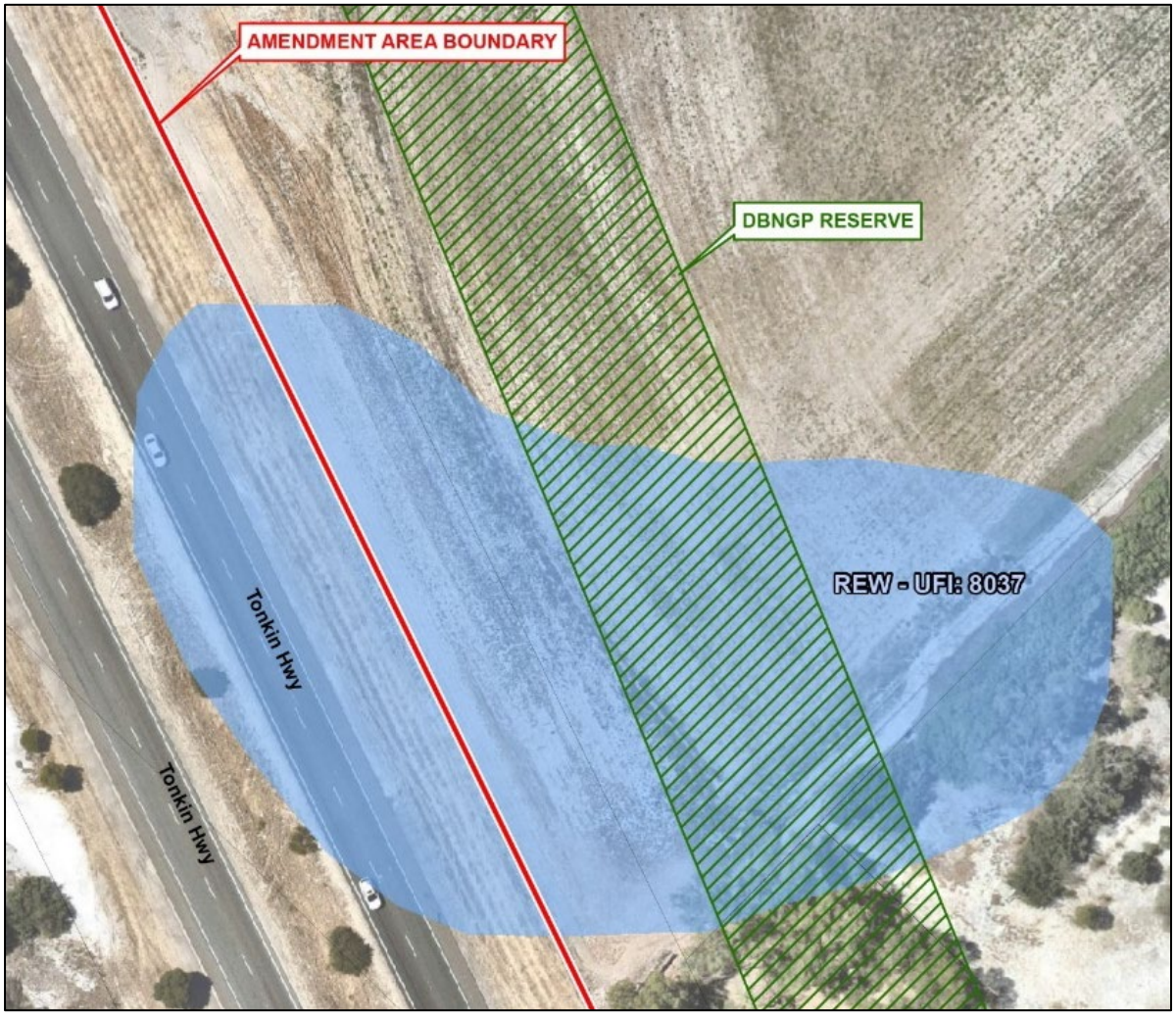

Figure 5-22: REW 8037 aerial photograph from 2023 with the DBNGP easement

Figure 5-22 clearly demonstrates that the wetland has been historically cleared of native vegetation, infilled and subsequently contains:

- no surface water
- no wetland/riparian native vegetation
- no fauna habitat for aquatic dependent fauna species.

Portion of REW UFI 15257

By 1985 approximately 90% of the remnant native vegetation within portion of REW UFI 15257 in the MRS amendment area had been cleared of native vegetation and infilled in areas to establish rural livestock paddocks, residential dwellings, and the construction of Tonkin Highway and the Water Corporation and the DBNGP pipeline easement.

Between 1985 and 1995 the landowner(s) planted eucalyptus trees along fence lines adjacent to the cleared Water Corporation pipeline and the DBNGP easement. The easement is maintained as cleared open paddock areas.

Currently within the mapped portion of REW (UFI 15257) in the MRS amendment area are the following land uses:

- Tonkin Highway reserve
- Boundary Road reserve
- Water Corporation pipeline and DBNGP easements
- semi-rural paddocks
- commercial landscape supply business.

The REW (UFI 15257) wetland area has been subject to historical infrastructure construction works and infilling to support the above land uses and infrastructure.

Within and adjacent to the Tonkin Highway reserve, the following vegetation was surveyed and mapped:

- Planted stands of *Corymbia calophylla* (Marri) and non-native eucalypt *Eucalyptus camaldulensis* (River Red Gum) over non-native eucalypt *Casuarina cunninghamiana* subsp. cunninghamiana, *Melaleuca preissiana*, *Jacksonia sternbergiana* and **Schinus terebinthifolia* over introduced species on various soils and topographical positions (Woodman Environmental 2021).

Along the boundary of the Water Corporation / DBNGP easement (maintained as an open paddock area):

- Planted E*ucalyptus camaldulensis* (River Red Gum).

There is no seasonal surface water present within REW UFI 15257 (within the MRS amendment area) or fauna habitat for aquatic dependent fauna species.

Figure 5-23 illustrates the status of the mapped REW UFI 15257 which is located across the following cleared and infilled areas:

- open paddocks
- commercial landscape supply yard
- Water Corporation and DBNGP easements
- Tonkin Highway reserve within and immediately adjacent to the MRS amendment area.

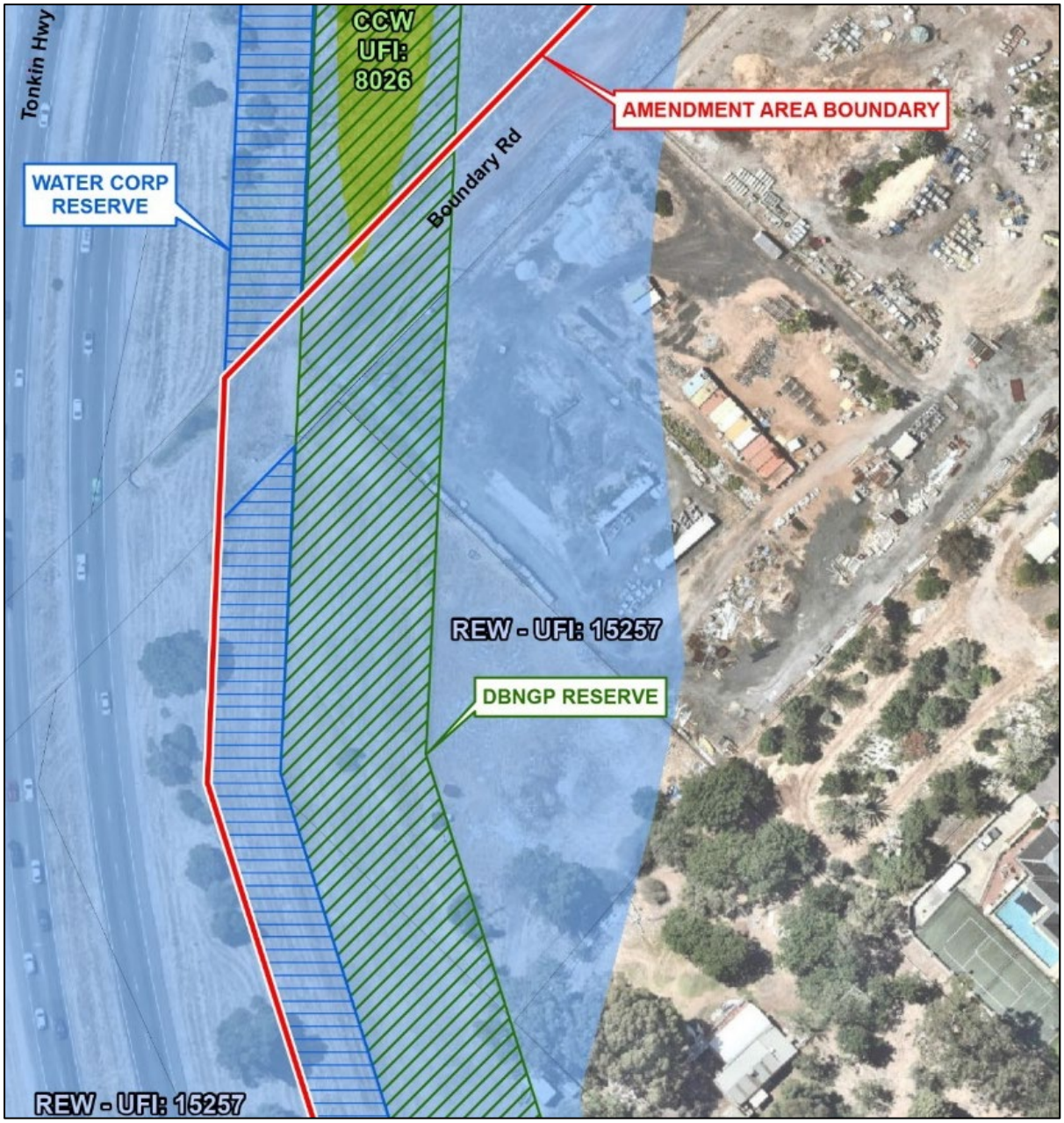

Figure 5-23: Portion of REW 15257 aerial photograph from 2023 with the DBNGP easement

Lot 501 - Wetland review

Two CCWs (UFI 8026 and UFI 8027) are located are within Lot 501, which is external and adjacent to the MRS amendment area. Lot 501 is a 1.6 ha triangular landholding bounded by Tonkin Highway to the west, Welshpool Road to the north and Boundary Road to the south. The landholding also contains a portion of REW UFI 15257. Lot 501 is zoned 'Parks and Recreation' under the MRS and is owned and managed by the WAPC.

Within Lot 501 and 50 m of the two CCWs (UFI 8026 and UFI 8027) are the following key land uses:

- Welshpool Road and Tonkin Highway reserves
- DBNGP and Water Corporation easements
- Boundary Road reserve
- landscape supply commercial business
- semi-rural lots.

These land uses have resulted in the historical clearing of significant portions of the two CCWs and native vegetation within Lot 501. The construction of Welshpool Road, Tonkin Highway, Boundary Road and DBNGP resulted in clearing of native vegetation and infilling of the mapped wetland areas. Approximately 80% of Lot 501 has been cleared of native vegetation. Within Lot 501 the existing land management practices maintains the Tonkin Highway reserve, Welshpool Road reserve and the DBNGP easement as cleared open areas.

Figure 5-24 overviews the status of the two CCWs (UFI 8026 and UFI 8027) and portion of REW UFI 15257 within Lot 501 and the adjacent Tonkin Highway (west), Welshpool Road (north), Boundary Road (south) and the commercial landscape business (south).

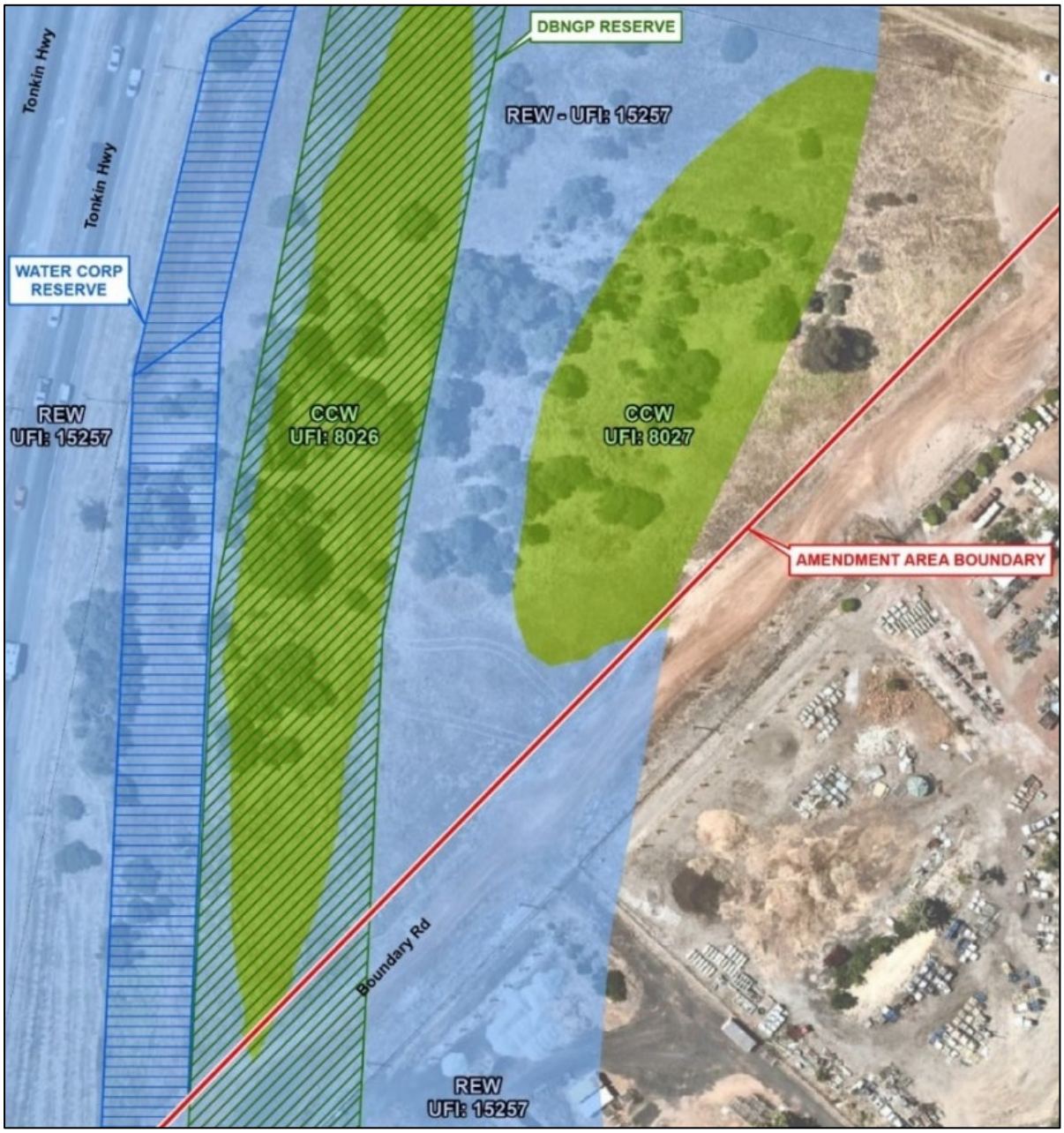

Figure 5-24: CCWs (UFI 8026 and UFI 8027) and portion of REW UFI 15257 within Lot 501.

Figure 5-25 illustrates the proximity of the Boundary Road reserve to the mapped CCWs (UFI 8026 and UFI 8027). Boundary Road is a City of Kalamunda local road asset and is used to access the commercial landscape supply business and Lot 501.

Importantly, the MRS amendment area does not include Lot 501, and therefore the MRS amendment will not alter:

- the Boundary Road reservation and/or its current location or alignment
- Lot 501 'Parks and Recreation' reservation
- the landowner's (WAPC) existing land management practices within Lot 501.

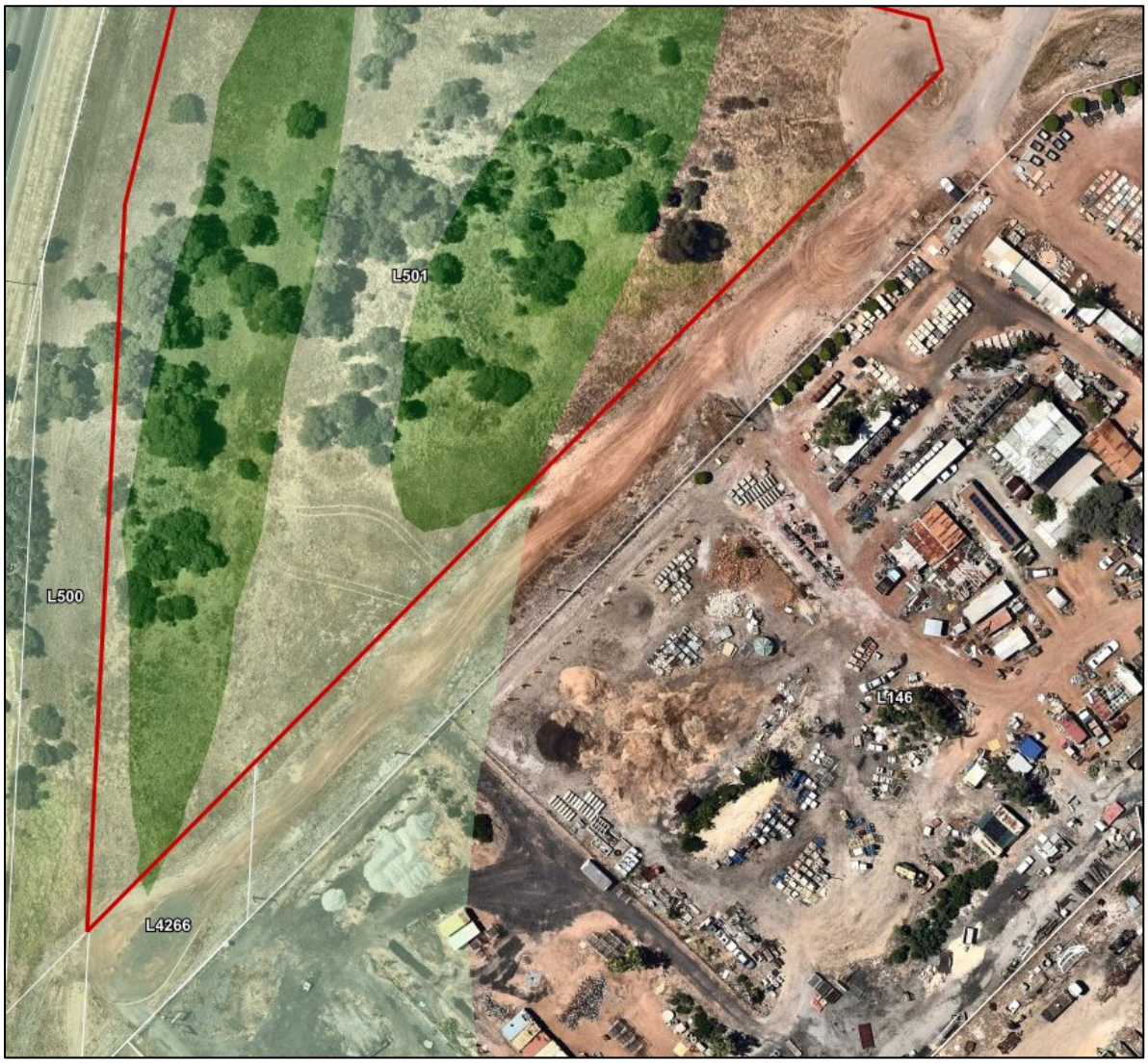

Figure 5-25: CCWs (UFI 8026 and UFI 8027) and portion of REW UFI 15257 and the adjacent Boundary Road reserve.

Wetland value summary

The values of each wetland feature documented as part of the wetland assessment are summarised in Table 5-15.

Table 5-15: Summary of significant wetland features and their attributes

Wetland Attribute	Wetlands within the MRS amendment area		Wetlands within Lot 501		
Wetland	**REW UFI 8037**	**REW UFI 15257**	**CCW UFI 8026**	**CCW UFI 8027**	**REW UFI 15257**
Area	0.86 ha.	30.33 ha (approximately 2.06 ha is within the MRS amendment area).	0.38 ha.	0.32 ha.	30.33 ha (0.52 ha is within Lot 501).
Geomorphology	Bassendean Sand over sandy clay to clayey sand of the Guildford Formation.		Bassendean Sand over sandy clay to clayey sand of the Guildford Formation.		
Hydrology	Sumpland	Palusplain	Palusplain	Palusplain	Palusplain
Vegetation unit	Over 90% of the mapped REW has no native vegetation. Native vegetation was historically cleared, and the wetland infilled to establish the rural land uses and then subsequently, for the establishment of a turf farm, construction of Tonkin Highway and Water Corporation and DBNGP easements. The vegetation present is scattered trees approximately 0.08 ha at the periphery of the REW in Lots 106 and 107.	Within the Tonkin Highway reserve and Water Corporation easement: • Stands of *Corymbia calophylla* (Marri) and non-native eucalypt *Eucalyptus camaldulensis* (River Red Gum) over non-native eucalypt *Casuarina cunninghamiana* subsp. *cunninghamiana*, *Melaleuca preissiana*, *Jacksonia sternbergiana* and **Schinus terebinthifolia* over introduced species (AECOM 2020 and Woodman Environmental 2021). • Cleared paddocks with *Eucalyptus camaldulensis* (River Red Gum).	80% of Lot 501 has been historically cleared of native vegetation. The remnant vegetation community consists of non-continuous patches of: • Mid open woodland of *Corymbia calophylla* over low woodland of mixed species dominated by *Eucalyptus rudis*, *Melaleuca rhaphiophylla* and *Melaleuca preissiana* over tall sparse shrubland of mixed species dominated by *Acacia saligna* over mid sparse shrubland of *Acacia pulchella* over mid tussock grassland of mixed species dominated by **Avena barbata*, * *Eragrostis curvula* and **Ehrharta calycina* over **Watsonia meriana* on grey and brown sandy loam and clay loam on plains, flats, and drainage lines (Woodman Environmental 2021). • Individual or stands of *Corymbia calophylla* over introduced species including **Avena barbata*, **Bromus diandrus* and **Ehrharta calycina* on various soils and topographical positions (mostly with REW UFI 15257) (Woodman Environmental 2021).		
Vegetation condition	Completely Degraded condition (AECOM 2020 and Woodman Environmental 2021).	Completely Degraded condition (Woodman Environmental 2021).	Degraded condition (Woodman Environmental 2021).		
TEC	No State and Commonwealth listed TECs were surveyed/ observed.	No State and Commonwealth listed TECs were surveyed/observed.	No State and Commonwealth listed TECs were surveyed/observed.		
Conservation Significant flora	No conservation significant flora present.		No conservation significant flora present.		

Wetland Attribute	Wetlands within the MRS amendment area		Wetlands within Lot 501
Conservation Significant fauna	Lack of dense understorey for Quenda. Limited foraging/roosting/breeding trees for the threatened black cockatoo species within the planted stands of *Eucalyptus camaldulensis* (River Red Gum).		• The limited native vegetation, in particular the *Corymbia calophylla* (Marri) trees within the two CCWs (UFI 8026 and UFI 8027) has the potential to provide foraging and roosting habitat to the threatened Carnaby's cockatoo and Forest red-tailed black cockatoo species. • Former Crystal Brook tributary and two CCW wetland areas provides habitat for frogs and reptiles.
Heritage sites	The wetland is located within one heritage site: Brentwood Road Swamp (Site ID 4343). This heritage site has historically been high disturbed from the construction of Tonkin Highway, Water Corporation pipeline, DBNGP and the former turf farm.	The wetland is not within an identified as an Aboriginal Heritage Place.	The CCWs (UFI 8026 and UFI 8027) and portion of REW UFI are not within an identified as an Aboriginal Heritage Place.

5.4.5.2 Wetland assessment recommendations

Evaluation of REW UFI 8037 and portion of REW UFI 15257 (within the MRS amendment area)

The MRS Amendment Request - Wattle Grove South (WAPC 2021) incorporates the following DBCA preliminary assessment advice specific to the wetlands within the MRS amendment area:

- The REW (UFI 15257) partially intersects the site, but that this area has been significantly modified during the construction of Tonkin Highway and the DBNGP. The original wetland area was historically cleared pre-1950 (initially to establish rural landholdings) and contains no surface water body and no fauna habitat for aquatic dependent fauna species.
- REW (UFI 8037) has been cleared and filled and no longer exists. The wetland has been historically infilled and contains no surface water body and no fauna habitat for aquatic dependent fauna species.
- The DBCA and DWER provided advice on the environmental values of the wetlands currently mapped in the GWSCP dataset within the MRS amendment area using available regional scale data. The review concluded that the two REW within the MRS amendment area (portion of UFI 15257 and UFI 8037) have values commensurate with a MUW.

The assessment of the REWs UFI 8037 and portion of UFI 15257 values concluded:

- The wetland values are representative of MUW category, in alignment with the wetland advice provided by DBCA i.e. the wetlands are in Completely Degraded condition or have been completely infilled.
- REW 8037 has been subject to historical impacts including clearing of native vegetation and infilling works to facilitate the construction of Tonkin Highway, the Water Corporation pipeline, DBNGP and an operational turf farm.
- The wetland's ecological values (or GDEs) are no longer present. There are no groundwater dependent riparian communities present or habitat (or habitat diversity) for aquatic dependent fauna. The mapped wetland contains a commercial turf area and the cleared Water Corporation and DBNGP easements.
- The portion of REW UFI 15257 within the amendment area has been historically cleared of native vegetation and infilled during the construction of Tonkin Highway, the installation of Water Corporation and DBNGP pipelines and the establishment of rural livestock paddocks and commercial landscape supply business. There are no GDEs present with only scattered *Melaleuca preissiana* trees located within the Tonkin Highway reserve and the Water Corporation easement or habitat for aquatic dependent fauna. The existing vegetation outside of the Tonkin Highway reserve consists predominantly of River Red Gums planted in the late 1980s along the DBNGP easement and livestock paddock boundaries. The vegetation was surveyed as being in Completely Degraded condition.

In summary, the detailed wetland assessment (Appendix C) recommends the two REWs (UFI 8037 and portion of UFI 15257) within the MRS amendment area are removed from the GWSCP dataset.

Portions of the former mapped REWs (UFI 8037 and portion of UFI 15257) will be incorporated into POS areas and stormwater bioretention basins adjacent to the Water Corporation and DBNGP pipeline easement. The DWMS identifies the future Local Structure Plan and subdivision plans will formally integrate the Water Corporation and DBNGP easement into open space, ensuring the pipeline is protected whilst also providing a valuable community asset that provides local amenity.

In large storm events (for example a 100-year storm event) stormwater contained in stormwater basins will overtop and infiltrate across POS area including the Water Corporation/DBNGP easement in alignment with the existing (or pre-development) stormwater flow patterns.

DBCA is the custodian of the GWSCP dataset. An application to DBCA to amend GWSCP dataset for the two REWs (UFI 8037 and portion of UFI 15257) removing these two wetlands from the GWSCP dataset will occur concurrently with the finalisation of a future Local Structure Plan and LWMS.

The DPLH Aboriginal Heritage Places mapping tool (DPLH 2024a) identified the MRS amendment area intersects one registered heritage site:

- Brentwood Road Swamp (Site ID 4343). REW (UFI 8037) intersects a portion of this heritage site.

A cultural heritage survey completed with the Traditional Owner elders in 2021 concluded (Horizon Heritage 2021):

- The Brentwood Road Swamp (Site ID 4343) is a heavily disturbed and altered environment.
- No cultural material was observed/recorded within the MRS amendment area.

This section of the MRS amendment area is adjacent or within the Water Corporation/DBNGP easement. Activities within the DBNGP easement is restricted and generally prohibits any construction works. Accordingly, the Water Corporation and DBNGP easement will form POS areas. Stormwater bioretention basin will be located adjacent (but outside of) to the POS / easement areas. All future works within proximity of Brentwood Road Swamp (Site ID 4343) will be undertaken in consultation with the Traditional Owner group.

Wetland Buffer Assessment - CCWs (UFI 8026 and UFI 8027) and portion of REW (UFI 15257) within Lot 501

The wetland assessment identified there is currently no separation buffer from the two CCWs (UFI 8026 & UFI 8027) and portion of REW UFI 15257 within Lot 501. The mapped wetland and associated buffer area has been subject to historical anthropogenic impacts, specifically the existing infrastructure corridors, which both frame and intrude into the mapped wetlands areas and immediate surrounds within Lot 501. Key infrastructure located immediately adjacent to or within the mapped wetland areas in Lot 501 include:

- Boundary Road reserve
- Tonkin Highway reserve and Welshpool Road reserve
- Water Corporation water pipeline easement
- DBNGP easement.

The existing infrastructure corridors are fixed and operational. These structures essentially frame and contain the limited wetland environmental and ecological values to entirely within Lot 501 without the application of any additional buffers to surrounding land uses i.e. landscape supply yard, Welshpool Road and Tonkin Highway. Importantly, the wetland buffer assessment identified:

- The wetland/ecological values associated with the mapped CCWs (UFI 8026 and UFI 8027) and REW UFI 15257 do not extend outside of Lot 501.
- The MRS amendment does not alter the existing WAPC land management practices including regular mowing and slashing of the wetland areas to maintain the road reserves/Water Corporation pipeline and DBNGP easement as cleared areas.

In this context, the existing Boundary Road provides an approximate 20 m permanent infrastructure barrier between the two CCWs (UFI 8026 and UFI 8027) within Lot 501 and the commercial landscape supply yard and the semi-rural paddocks within the MRS amendment area.

The wetland assessment concluded the 20 m Boundary Road reserves provides physical separation from the two CCWs (UFI 8026 and UFI 8027) and the portion of REW UFI 15257. The road reserve is managed by the City of Kalamunda and will be maintained in the future.

The conclusion drawn on the status of and the road separation distance is supported by:

- The wetland assessment demonstrating the ecological values for the two CCWs (UFI 8026 and UFI 8027) and portion of REW UFI 15257 are more aligned with the management categories for REW and/or MUW. This conclusion was underpinned by the following assessment:
    - Approximately 80% of Lot 501 has been historically cleared of native vegetation and subject to infilling.
    - The historical and current land uses resulting in the establishment of open cleared areas within the mapped wetland areas include:
        - Welshpool Road and Tonkin Highway reserves
        - DBNGP and Water Corporation easements
        - Boundary Road reserve.
    - Lot 501 is owned and managed by the WAPC and regularly maintained via slashing and mowing of the open grass and weed areas to uphold the road reserves, Water Corporation and DBNGP easements as cleared open areas.
    - The understorey of the two CCWs (UFI 8026 and UFI 8027) and portion of REW UFI 15257 within Lot 501 is significantly dominated by weed species including *Avena barbata* (wild oats), *Eragrostis curvula* (African lovegrass), *Ehrharta calycina* (perennial veldt grass) and *Watsonia meriana*.
    - The two CCWs (UFI 8026 and UFI 8027) and REW UFI 15257 within Lot 501 are in a Degraded to Completely Degraded condition.
    - The Boundary Road reserve adjacent to Lot 501 is a fixed City of Kalamunda road asset.
    - The MRS amendment does not alter:
        - the location or the road reserve land use
        - the Lot 501 Parks and Recreation land use.
- Immediately south of Boundary Road (i.e. approximately 20 m from the mapped wetlands) are private landholdings including a commercial landscape supply yard and cleared semi-rural property and the DBNGP easement. Portions of these landholdings have been extensively filled and cleared of native vegetation. These land uses (i.e. the privately owned commercial and rural land uses) and the DBNGP easement have been in place for over 20 years.

5.4.6 Greater Brixton Street Wetlands

The significant environmental feature in proximity to the MRS amendment area is the GBSW, located on the western side of Tonkin Highway. The GBSW comprises a complex of significant wetlands, including areas of seasonally waterlogged flats (palusplain) and seasonally inundated basins (sumplands). Table 5-16 outlines the DBCA mapped geomorphic wetland features within the GBSW area.

Table 5-16: Summary of significant wetland features and their attributes

Wetland category	UFI No.	Total Area
CCW	7637, 7646, 7653, 7747, 7748, 7775, 7797, 8025, 8028, 8031, 8032, 8035, 13129, 13131, 13365, 14962, 15255, 15815, 15816.	Approximately 150.1 ha
REW	8036, 15257, 15814, 15983	Approximately 10 ha
MUW	7740, 7744, 7746, 8030, 14964, 15254, 15724	Approximately 6.5 ha

The GBSW, which comprises Bush Forever Site No.387, covers an area of approximately 215 ha as illustrated in Figure 5-26.

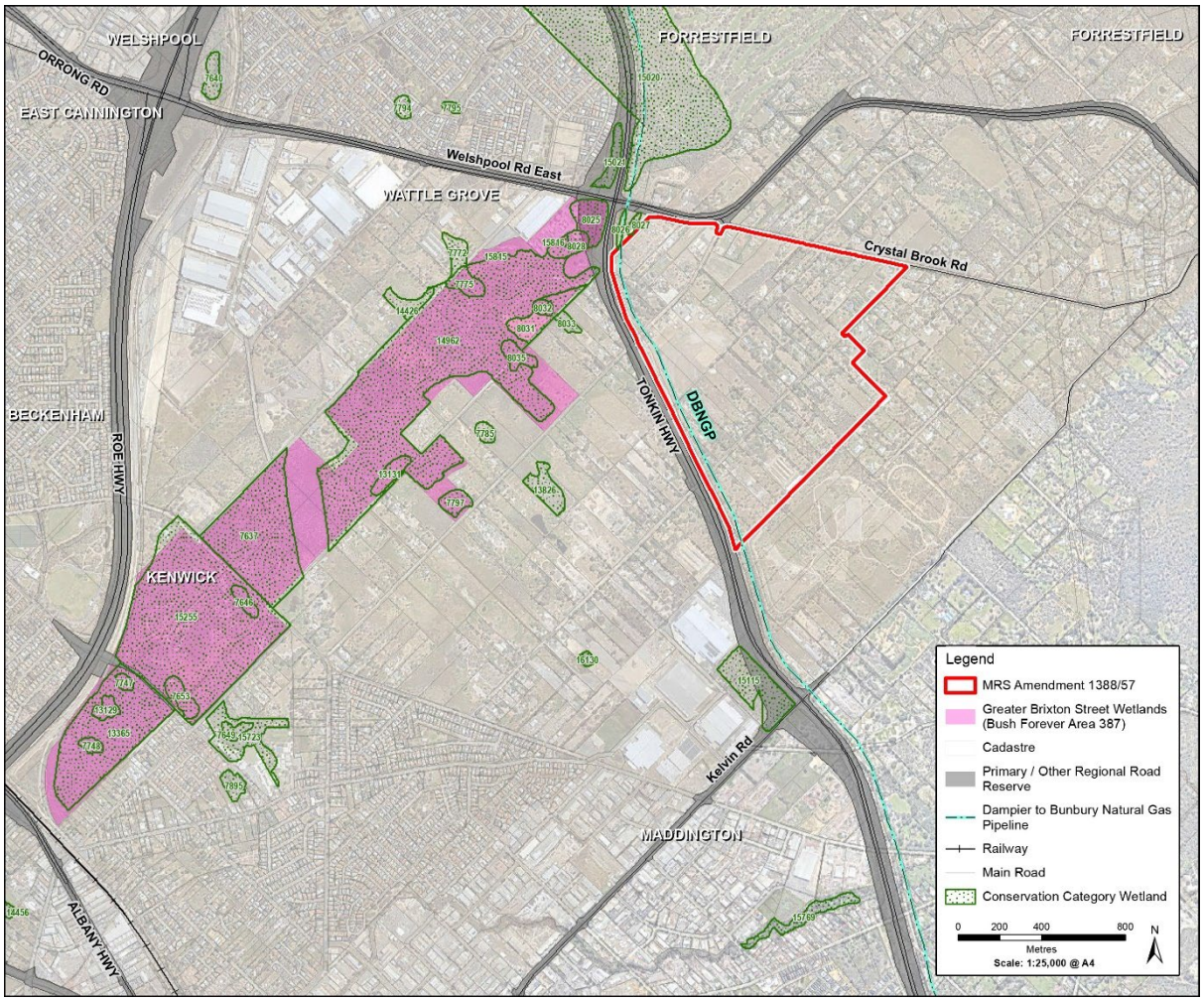

Figure 5-26: Greater Brixton Street Wetlands

The nearest DBCA mapped geomorphic wetland features within the GBSW area to the MRS amendment area outlined in Table 5-17.

Table 5-17: Mapped wetland features within 150 m of the MRS amendment area.

UFI No.	Geomorphic classification	Management category	Land tenure details	Total area (ha)
GBSW area (within 75 m to 150 m of the MRS amendment area)				
8025	CCW	Palusplain	Lot 51 Zoned 'Parks and Recreation'	2.78
8028	CCW	Sumpland	Lot 340 Zoned 'Parks and Recreation'	1.48
8030	Multiple Use	Palusplain	Lot 342 Zoned 'Parks and Recreation'	1.29
14962	CCW	Palusplain	Lot 342 Zoned 'Parks and Recreation'	62.68
15257	REW	Palusplain	Lot 51 Zoned 'Parks and Recreation'	30.33

5.4.6.1 GBSW tenure and land management

The management of the GBSW is not uniform. It incorporates a non-continuous A Class Reserve, Bush Forever Sites No.387, State Government (such as the WAPC and DBCA) and private landholdings. Table 5-18 summarises the management areas, land managers and environmental assets across the GBSW area.

Table 5-18: GBSW management reserves and tenure

Reserve / Management areas	Summary of environmental values	Land manager	Distance to MRS amendment area
Within Bush Forever Site No. 387			

A Class Reserve / GBSW	• Non-contiguous reserve consisting of Brixton Block, Wanaping Block and separate landholdings, Alison Baird Reserve, private and government owned landholdings.
	• TECs identified include:
	  ○ FCT 3a - Corymbia calophylla - Kingia australis woodlands on heavy soils of the Swan Coastal Plain
	  ○ FCT 7, FCT 8, FCT 9, FCT 10a - Clay pans of the Swan Coastal Plain
	  ○ FCT 21c - Low lying Banksia attenuata woodlands or shrublands
	  ○ FCT 23a - Banksia Woodlands of the Swan Coastal Plain IBRA Region
	• Guildford Vegetation Complex is the dominant vegetation complex (Heddle et al. 1990). Only 5.1% of Guildford complex remains on the SCP.
	• DBCA's Threatened and Priority Fauna and Atlas of Living Australia databases identified 319 vertebrate species have the potential to occur in the GBSW area (EPA 2022).
		DBCA	100 m – 200 m

State Government owned	• Multiple mapped CCWs and REWs. • Historical clearing and intact vegetation areas.	WAPC	400 m – 1,000 m
Private landholdings	• Private landholdings (not including UWA landholding). • Industrial land use and rural lifestyle.	Various private landowners	200 m

Alison Baird Reserve - 35 ha area	• CCW areas – including Clay pans of the Swan Coastal Plain which are listed as Wetlands of National Significance.
	• Over 650 native taxa from 80 families and characterised 13 vegetation communities (Tauss et al. 2019).
	• Alison Baird Reserve is recognised as the most floristically biodiverse area with an extensive number of endemic species including Spider net grevillea, Swamp starflower and the Pyramid mulla mulla (Tauss et al. 2019; Tauss and Weston 2010).
	• EPBC Act listed:
	  ○ FCT 3a - Corymbia calophylla - Kingia australis woodlands on heavy soils of the Swan Coastal Plain
	  ○ FCT 7, FCT 8, FCT 9, FCT 10a - Clay pans of the Swan Coastal Plain
	  ○ FCT 21c - Low lying Banksia attenuata woodlands or shrublands
		UWA	1,500 m

Wanaping Block - 38 ha area		DBCA	2,200 m
Brixton Block - 21 ha area		DBCA / Friends of Brixton Street Wetland	2,900 m

Reserve / Management areas	Summary of environmental values	Land manager	Distance to MRS amendment area
	○ FCT 23a - Banksia Woodlands of the Swan Coastal Plain IBRA Region • Sumpland CCW areas with areas of Melaleuca woodlands over shrubland heath. • Endangered Ecological Community Corymbia calophylla — Kingia australis woodlands on heavy soils of the Swan Coastal Plain). • Threatened or priority fauna habitat including: ○ Carnaby's black cockatoo ○ Forest red-tailed black cockatoo ○ Chuditch ○ Southern brown bandicoot		
GBSW Areas outside of Bush Forever Site No. 387			
Private landholdings / High School	• Mix of wetland types (CCWs, REWs, MUW) and areas with intact native vegetation and cleared areas. • Semi-rural properties within the western portion of the GBSW area. • Industrial development within the western portion of the GBSW area adjacent to Roe Highway. • High school area.	• Rehoboth Christian College • Various private landowners	600 m - 2,900 m

Land use review

Existing land uses adjacent to the GBSW include:

- Regional roads including Roe Highway, Welshpool Road, Tonkin Highway and Bickley Road.
- A freight rail line to the west (adjacent to Roe Highway).
- Residential homes and a high school located adjacent to the Brixton and Wanaping Blocks.
- Semi-rural lots.
- Existing light industrial and commercial land uses including:
  - Truck and machinery lay down areas
  - Waste and recycled material storage and stockpiling
  - Wrecked-car storage.
- Commercial and industrial development within MKSEA Precinct 3A and MKSEA Precinct 1.

Proposals within or adjacent to the GBSW and key hydrological assumptions

<u>City of Gosnells TPS No. 6 Amendments 166 and 169</u>

MKSEA Precinct 2 and Precinct 3B adjacent to the GBSW area are proposed to be re-zoned under the City of Gosnells TPS No. 6 Amendment Nos. 166 and 169, from 'General Rural' to 'Business Development'. These scheme amendments are subject to a formal environmental impact assessment (Environmental Review) by the EPA.

Figure 5-27 shows the MKSEA Precinct areas. Precincts 3B and 2 are subject to the Scheme Amendment Nos. 166 and 169.

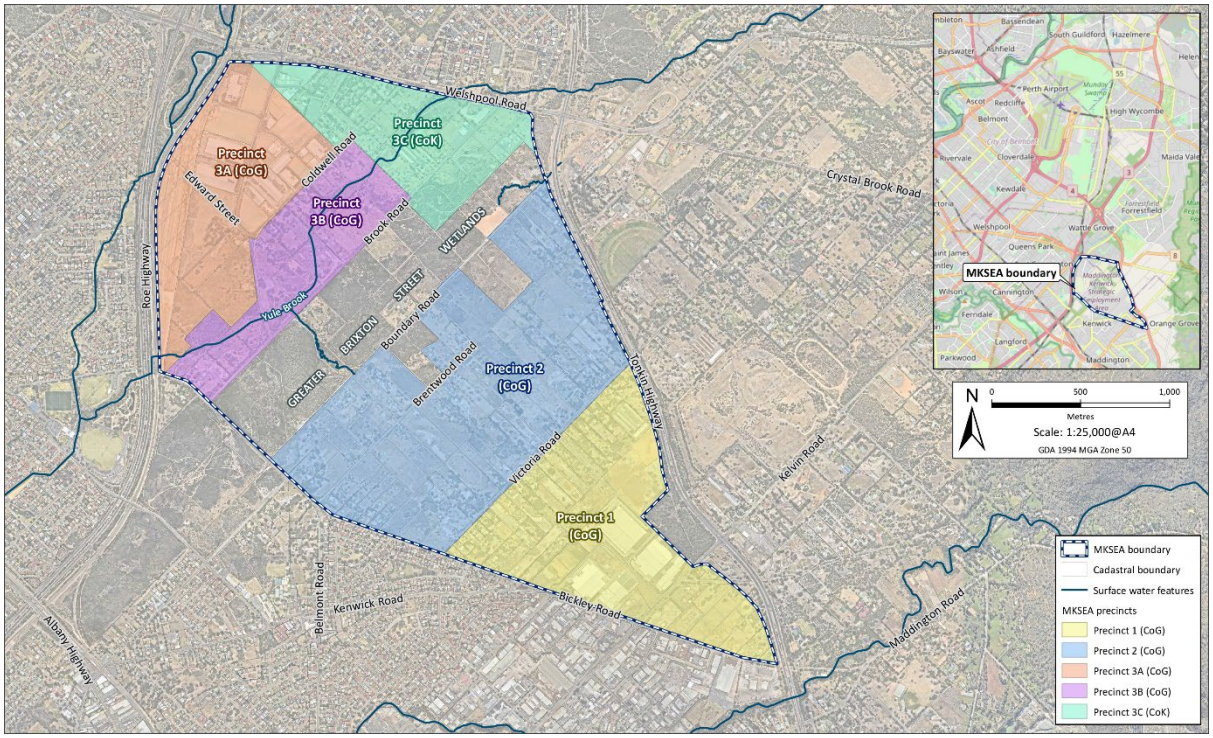

Figure 5-27: MKSEA precinct boundaries (Emerge Associates 2023b)

Tonkin Highway Grade Separated Interchange Proposal - Main Roads Western Australia (MRWA)

MRWA is proposing to construct a single fly-over and grade separated interchange at the existing intersections of Tonkin Highway and Hale Road in Forrestfield and Tonkin Highway and Welshpool Road in Wattle Grove. The road widening proposal intersects an area totalling 4.10 ha in the north-eastern part of the GBSW (or Bush Forever Site no. 387).

The portion of the proposed Tonkin Highway Grade Separated Interchange within the GBSW area is shown in Figure 5-28.

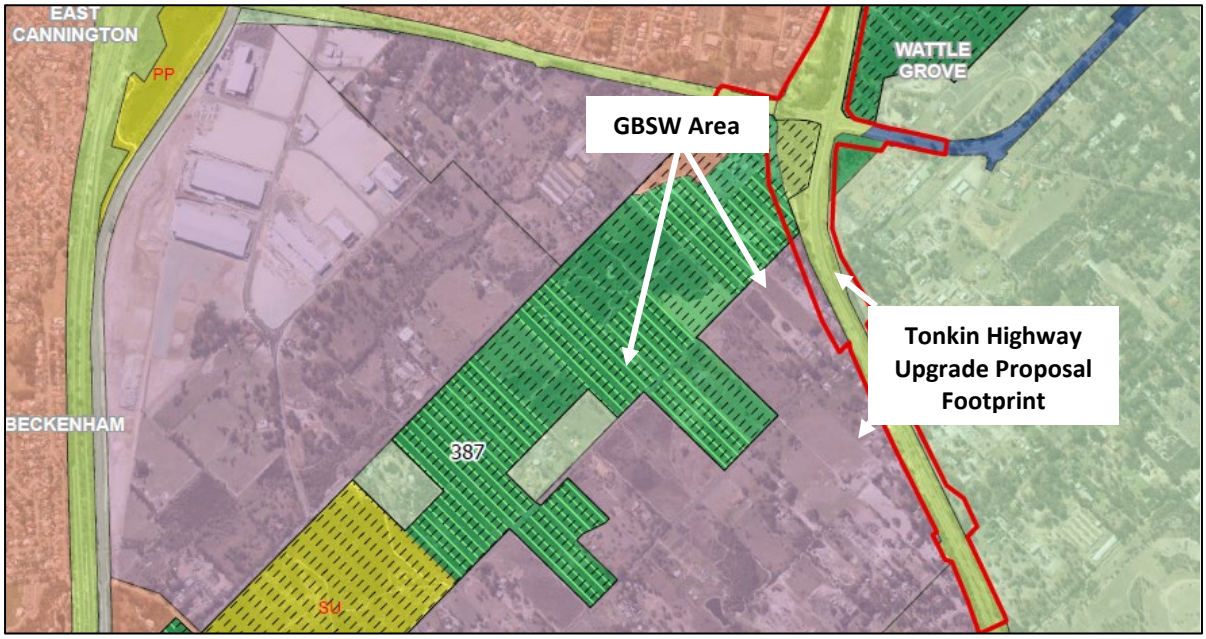

Figure 5-28: Tonkin Highway Grade Separated Interchange within the GBSW area (Bush Forever Site no. 387)

The MKSEA totals approximately 585 ha and directly fronts the GBSW area and a 2.5 km length of Yule Brook. The hydrological assumptions adopted in the assessments of LPS No. 6 Amendments 166 and 169 and Tonkin Highway Grade Separated Interchange Proposal relevant to the amendment are outlined in Table 5-19.

Table 5-19: Relevant hydrological assumptions

Proposal	Hydrological assumptions	Water management assumptions

LPS No. 6 Amendments 166 and 169	• Mapped wetlands represent 77% of the MKSEA.
	• The regional groundwater depth ranges from natural surface, compared with 0 – 0.5 m over most of the MKSEA.
	• The WBA (Emerge Associates 2024) and surface water model incorporate surface water flows from the Yule Brook catchment inclusive of the MRS amendment area.
	• The stormwater runoff from the MRS amendment area via the Boundary Road, Brentwood Road, and Victoria Road culverts flows towards the MKSEA Precinct 2 area with a small portion directed into the GBSW area via the former Crystal Brook tributary.
	• Stormwater runoff is conveyed via a combination of overland flow, unlined open drains both within road reserves and between lots towards Boundary Road or Bickley Road.
	• Hydrological and hydraulic models were undertaken to characterise the existing environment (using XPSWMM). The model accounts for (Emerge Associates 2023b):
	  ○ Inflows from upstream catchments based on topographic contours generated from LiDAR data.
	  ○ Existing pit and pipe networks and culvert survey.
	  ○ The variable depth of sand across the site determined by geotechnical test pitting.
	  ○ Depth to maximum groundwater level (MGL) across the site determined by onsite monitoring.
	  ○ Existing flood storage.
	  ○ Any tailwater influence from Yule Brook or downstream culverts and catchments.
	• Local groundwater contours including depth to maximum groundwater level.
	• Groundwater is typically perched on the low permeability soil layer beneath topsoil and the shallow Bassendean Sand dunes.
		• Maintain flow regime to wetlands and sensitive environments within the site so that the hydrology feeding these is maintained.
		• Avoid changes to existing groundwater controls so that groundwater conditions are maintained.
		• Avoid the need for significant imported fill that could potentially alter catchment hydrology.
		• Treatment of road reserve runoff at source via extended detention/infiltration in swales.
		• Treatment of lot runoff (i.e. the small event) runoff at source and provide at-source detention for some of the major rainfall event.
		• Conveyance of minor and major event runoff from lots and road reserves via swales and overland flow within road reserves.
		• Major event flood storage within multiple use corridor (MUC) that integrates with surrounding levels and avoids the need to undertake earthworks within proposed buffers.
		• Minor and major event flows will be detained within swales and detention areas to ensure that pre-development peak flows are maintained.

Tonkin Highway Grade Separated Interchange Proposal	• Surface water hydrology in the locality is characterised by channels carrying water and sediments from the Darling Scarp to the fans and plains at the foot of the ranges and into the Canning River. • Potential 3.61 ha impact on native vegetation in degraded condition from within 4.27 ha of the GBSW. • The natural drainage channel (former Crystal Brook tributary) is connected via a culvert beneath Tonkin Highway.	• Stormwater drainage will be designed to maintain existing hydrology through the implementation of best practice consistent with Better urban water management (WAPC 2008) and the *Stormwater Management Manual for WA* (DWER 2022). • The drainage design adopted maintains the current water volume of water passing under Tonkin Highway. However, some of the existing culvert configurations will be amended to

Proposal	Hydrological assumptions	Water management assumptions
	• The groundwater table occurs approximately 4 m - 5 m below the ground surface.	address potential flood risks. The Boundary Road culverts is proposed to be upgraded from 2x900 mm to 4 x 900 mm. This will reduce flow velocities and mitigate the adverse impacts of high velocity flows. • Construction of basins and/or swales to capture, retain and/or infiltrate runoff from a 1 in 100-year Average Recurrence Interval (ARI) rainfall event, to prevent stormwater runoff into adjacent areas of native vegetation.

5.4.6.2 Assessment of the GBSW environmental values

GBSW geology

The unique wetlands and associated ecology of the GBSW are situated atop of the alluvial Pinjarra Plain which is characterised by soils of the Guildford Formation. These include a combination of sand, mud, clay, and mixtures of these soils (Semeniuk 2001). Within areas of the GBSW, the Guildford Formation clay form layers a complex sequence of clay lenses that are laterally and vertically varied.

The Geological Survey of Western Australia (Jordan 1986), indicates the GBSW area is underlain by Guildford Formation and is comprised of:

- Sand (S8): white to pale grey at surface, yellow at depth, fine to medium-grained, moderately sorted, subangular to subrounded, minor heavy minerals, of eolian origin.
- Clayey sand (SC): silty in part, pale grey-brown, medium to coarse, poorly sorted, sub-angular to rounded, frequent heavy minerals, rare feldspar, of alluvial origin.
- Sand (S10): white to pale grey at surface, yellow at depth, fine to medium-grained, moderately well sorted, subangular to subrounded quartz, of eolian origin, over other units.
- Sand (S12): structureless, yellow, fine-grained, subangular, and medium to coarse-grained subrounded to rounded quartz, feldspar and heavy minerals common, minor silt and clay, of colluvial origin.
- Sandy silt (Ms4): cream to pale brown alluvium, clayey in part, fine to medium-grained sand, of alluvial origin.
- Sandy clay (Cs): white-grey to brown, fine to coarse-grained, subangular to rounded sand, clay of moderate plasticity gravel and silt layers near scarp.

Figure 5-29 shows the GBSW (and MKSEA Precincts) mapped geological units.

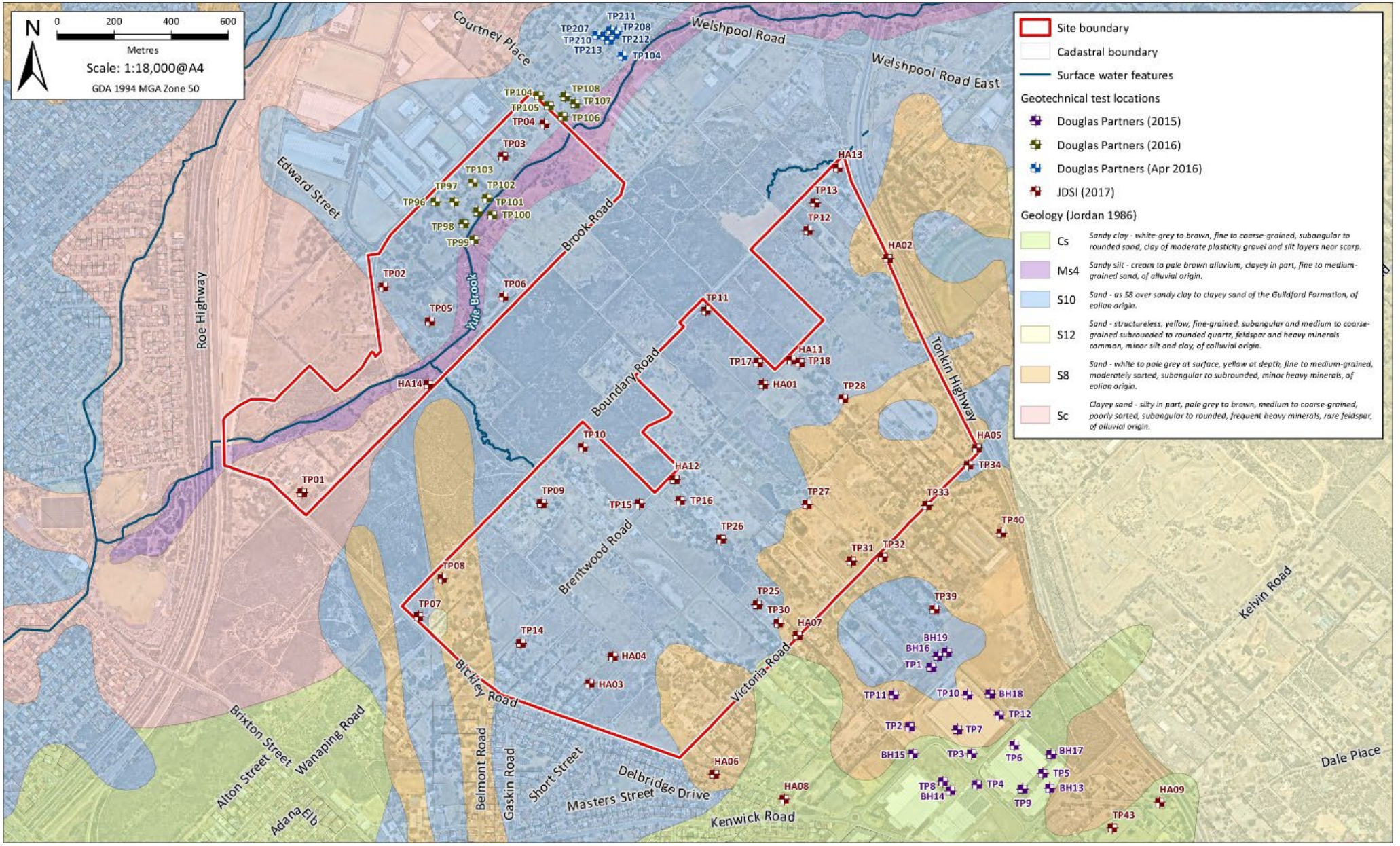

Figure 5-29: Regional geological mapping (Emerge Associates 2023b)

Geophysical assessment

Geophysical resistivity assessment undertaken within the Wanaping block and Brixton Street block demonstrated the presence of near surface low permeability (or high resistivity) clay layers. Cemented clay layers are common within a few metres of the surface of the GBSW. It is these clay layers that underpin the base of the mapped claypan areas within the GBSW (Lane and Evans 2019).

This description of the GBSW geology is supported in the conceptual diagram of the stratigraphy and hydrogeology of the Brixton Block and Wanaping Block (Bourke 2017) (Figure 5-30) and the ERT assessment within Alison Baird Reserve (Figure 5-31). Both assessments identified the presence of near surface perched groundwater table over a clay lens.

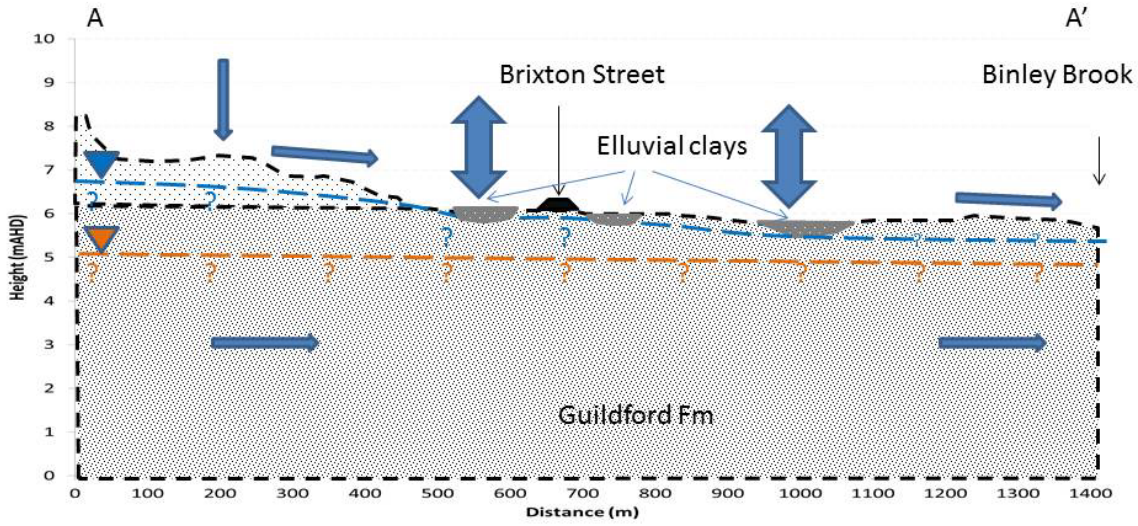

Figure 5-30: Conceptual Hydrogeology of Brixton Block Located in GBSW (Bourke 2017)

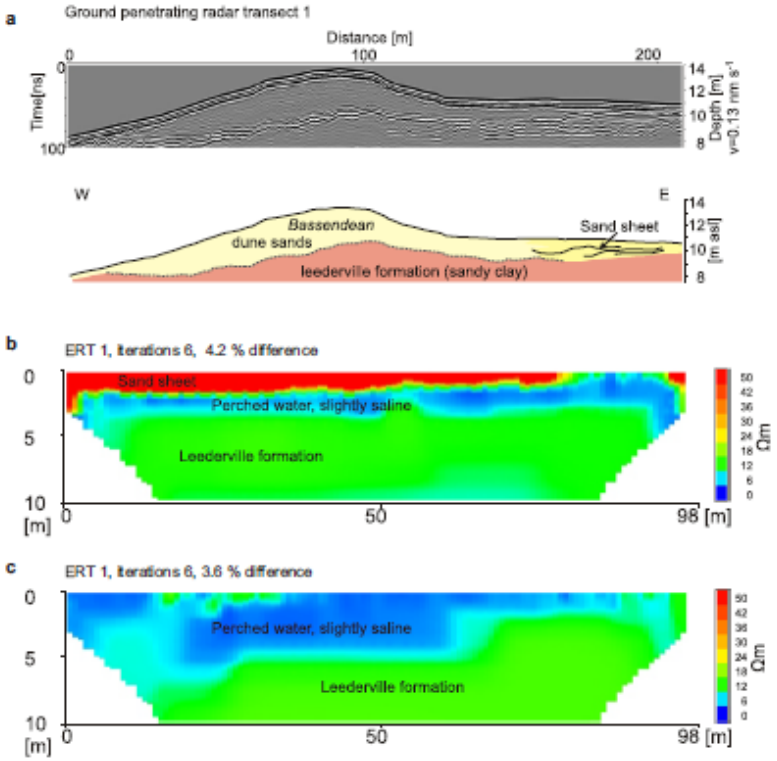

Figure 5-31: ERT Transect Within Alison Baird Reserve, East of the Sand Dune (E. Smith et al 2023)

Geotechnical investigations and permeability studies

The geotechnical investigations undertaken within the MKSEA Precinct 2 and 3B and portions of the GBSW conclude (JDSi 2017):

- Soils generally comprises of topsoil or fill to depths ranging from 0.1 m to 1.2 m, overlying sand, clayey, silty, or gravelly materials.
- The depth of higher permeable sand overlying the less permeable geological material ranges from 0 m to over 2 m.
- The clayey and sandy materials encountered include stiff to hard clay or clayey sand/sandy clay.

The soil permeability tests conducted in MKSEA Precincts 3b and 2 confirmed (Emerge Associates 2023b):

- Soil hydraulic conductivity rates ranged between 0.1 to 1.6 m/day at the interface of sand fill and clayey sand.
- Soil hydraulic conductivity rates was measured at >10 m/day rate within Bassendean sand which overlies the alluvial clays.

GBSW surface water

The GBSW is located within the western portion of the Yule Brook catchment. Two main surface watercourses dissect the catchment Woodlupine Brook and Yule Brook. The Yule Brook catchment has been highly altered by a range of industrial and urban uses, such as light to medium industry and residential, as well as agricultural production (DWER 2019). Both the Woodlupine Brook and Yule Brook watercourses ultimately discharge to the Canning River south-west of the GBSW.

The main hydrological features within and adjacent to the GBSW area are:

- Central channel (referred as the 'central drain') linking Boundary Road and Brook Road.
- Roadside drains (0.5 m to 1 m in depth) present along Brook Road and portions of Boundary Road adjacent to the GBSW.

This drainage infrastructure has resulted in surface water runoff and intercepted perched groundwater being diverted into open drains. Investigations undertaken by V and C Semeniuk Research Group 2001, Tauss et al. 2019 and Emerge Associates 2023b all drew the conclusion that the open drain infrastructure has substantially altered the original surface water flow patterns into the GBSW. The drains are responsible for reducing surface water runoff volumes accessible to traverse the GBSW and fill wetland areas.

The main contributor of water inflows into the GBSW is direct rainfall. Generally, seasonal surface water entering the GBSW are retained as perched groundwater due to the low permeable clay layers, rather than infiltrating downwards into the underlying Superficial or Leederville Aquifers (Emerge Associates 2023b). The slow movement of water through the clay layers causes the perched water table during the winter months.

Surface water from the MRS amendment area flows via the Boundary Road, Brentwood Road, and Victoria Road culverts towards the proposed MKSEA Precinct 2 landholdings (which currently consists of semi-rural properties, poultry farm, and truck and machinery lay down land uses) adjacent to the GBSW.

Surface water modelling

Surface water runoff and flow(s) was modelled for the formal ER of the City of Gosnells TPS No.6 Amendment Nos. 166 and 169 (Emerge Associates 2023b). The modelled surface water runoff during a major rainfall event (i.e. the 1% annual exceedance probability (AEP) event) demonstrates the following flow patterns:

- The Victoria Road and Brentwood Road culverts water flows are conveyed into the MKSEA Precinct 2 landholdings (consisting of semi-rural, light industrial and commercial land uses). The surface water from the culverts is mixed/combined with the water runoff (via roadside drains/overland flows) within the MKSEA Precinct 2 landholdings. This water moves primarily in a westerly direction through a combination of overland flow, unlined open drains both within road reserves and between lots towards Bickley Road. Only a portion of the total surface water flows (within the MKSEA Precinct 2 landholdings) is intercepted and directed in a north-west direction. This portion of water runoff is directed towards a central channel linking Boundary Road and Brook Road and ultimately discharging into the Yule Brook (Emerge Associates 2023d).
- The Boundary Road culvert flows is the primary pathway and source of water runoff from the MRS amendment area into the GBSW area. In large storm events water from the Boundary Road culvert is directed towards the Yule Brook through the following pathways:
    - Initially water is directed north-west within the former Crystal Brook tributary and the GBSW area for approximately 500 m.
    - Surface water exits the tributary with no dominant flow pathway either in a north-west direction towards Brook Road or in a westerly direction where it is intercepted by a central channel linking Boundary Road and Brook Road.
    - During large storm events, in both scenarios, water that is not infiltrated, moves towards constructed drains or a central channel which conveys the water towards the Yule Brook.
- The drains along road reserves and the central drainage channel within the GBSW efficiently captures and directs the water runoff (as well as intersected perched groundwater flows) towards the Yule Brook.

Figure 5-32 shows the modelled surface water flow movement, within the MKSEA Precincts and the eastern portion of the GBSW (Emerge Associates 2023d).

GBSW groundwater

A review of publicly available data to assess the thickness of the superficial formation across the GBSW found:

- The base of the superficial is reported between 0 m AHD (east) and -5 m AHD (west) across the study area.
- LiDAR shows the elevation ranges from 8 m AHD (west) to 25 m AHD (east) across the site.
- DWER historical maximum groundwater level contours indicate maximum water levels between 5 m AHD (west) and 18 m AHD (east), equivalent to 3 - 12 m below ground level.
- ER City of Gosnells TPS No. 6 Amendments 166 and 169 (MKSEA Precinct 2 and 3B) indicated maximum water levels range between 8 m AHD and 22 m AHD, equivalent to 0 m - 5 m below ground level (Emerge Associates 2023b)

Groundwater flows (Superficial Aquifer and indicatively the perched water table) are in a westerly to south-westerly direction towards the Canning River.

Figure 5-33 illustrates the GBSW regional groundwater contours and indicative perched groundwater flow directions.

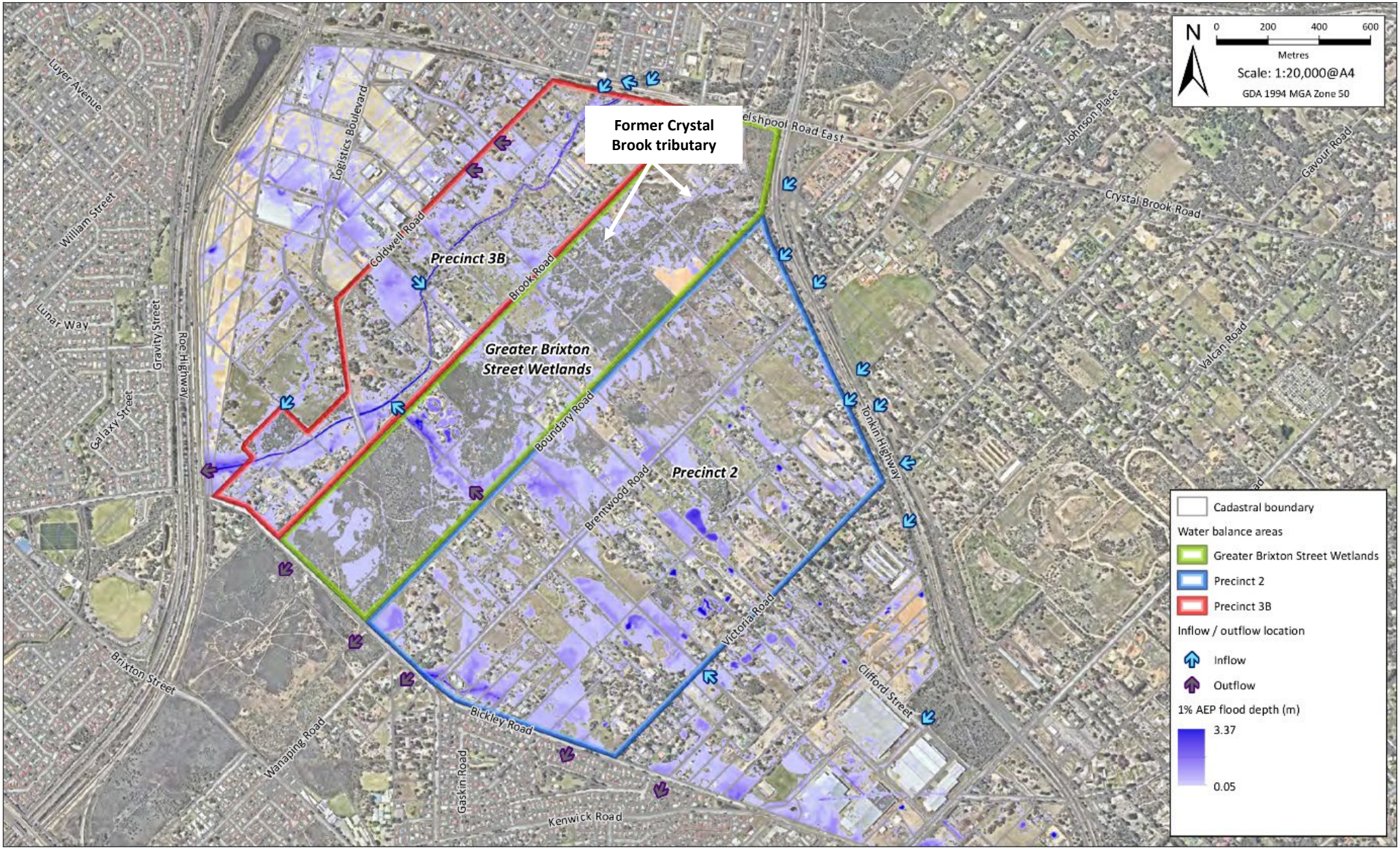

Figure 5-32: Inundation during the major rainfall event within the MKSEA Precinct and the GBSW (Emerge Associates 2023g)

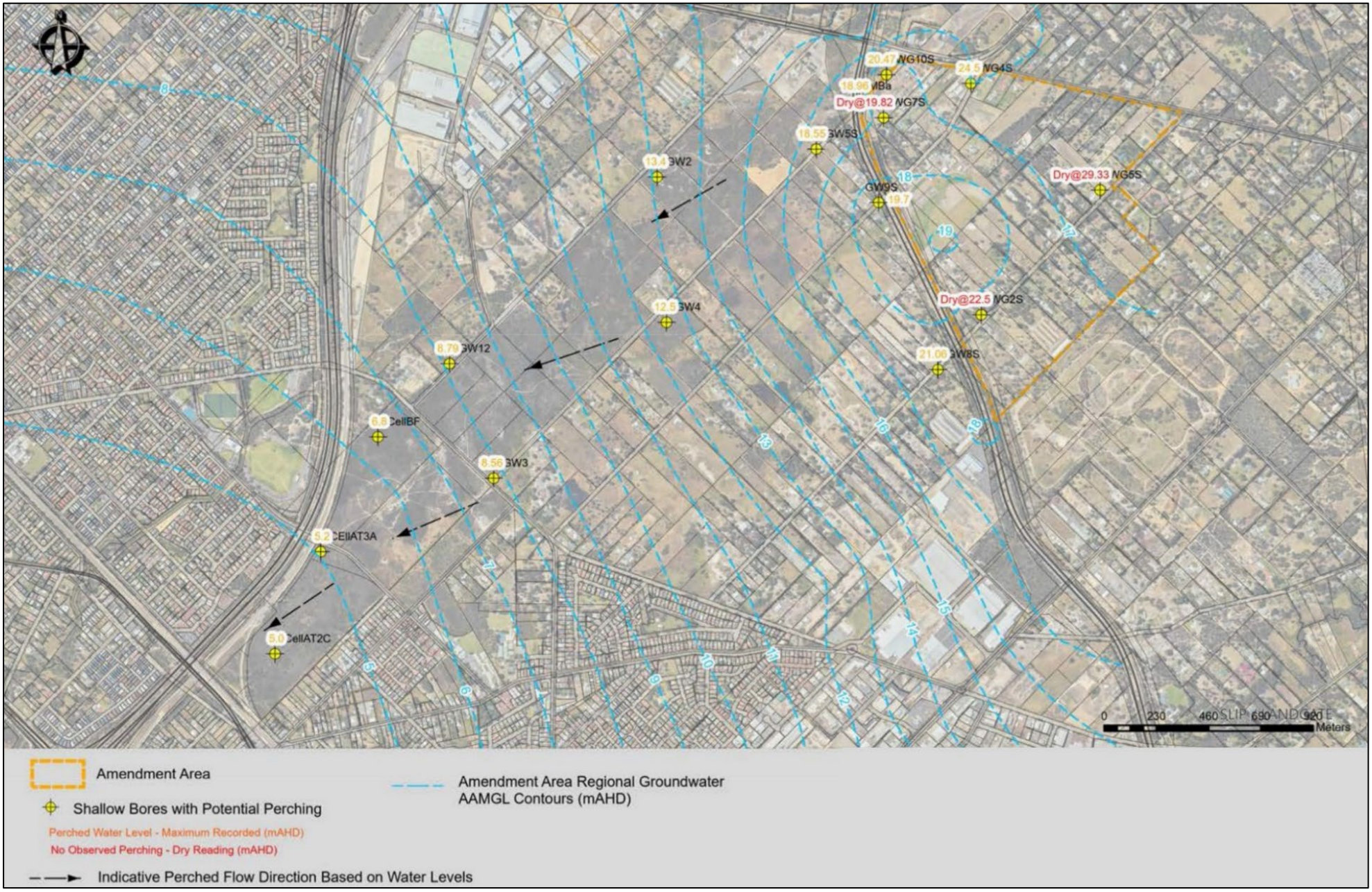

Figure 5-33: GBSW regional groundwater mapping and perched water flow direction (Hyd2o 2024)

Figure 5-33 highlights the differences in groundwater depth and perched/Superficial Aquifer interactions at the MRS amendment area, in comparison to the lower lying areas of the GBSW area south of Tonkin Highway, where the Superficial Aquifer is in much closer proximity to the natural surface (Hyd2o 2024).

GBSW and groundwater connectivity

Regional geology mapping and hydrogeological assessments of the GBSW by Emerge Associates (2023b), V and C Semeniuk Research Group (2001) and Lane and Evans (2019) confirm:

- A hard pan clay layers extends across most of the GBSW. These low permeable clay layers can limit the hydrological connections between the surface, perched water table and the underlying groundwater of the Superficial Aquifer. The perched water table beneath wetland sediments and topsoils is weakly confined with water flowing upwards and evaporating during summer.
- Areas of low permeable clay geology underpin the perched water table and clay pan wetlands and its associated groundwater dependent vegetation. Seasonally, the clay pan wetlands flood in winter and become dry in summer.
- The modelled 100-year storm event illustrates the preferred flow pathways for surface water runoff flows (Figure 5-32) and specifically the influence of the constructed drains conveying flows towards the Yule Brook and away from the GBSW. The existing drainage infrastructure has resulted in less surface water being available to traverse wetlands within the GBSW area (Tauss et al. 2019 and Emerge Associates 2023b).
- Surface and rain water which infiltrates below the surface is likely to be maintained as perched groundwater rather than infiltrating further into the underlying Superficial Aquifer primarily due to the presence of low permeable clay substrate layers. The perched groundwater moves laterally through the catchment, until either intercepted by an open drain or it reaches more permeable soil layers enabling recharge to the Superficial Aquifer.

However, the connectivity between surface water, perched water, Superficial Aquifer and Leederville Aquifer beneath the GBSW area are not fully understood. Connectivity between wetlands, perched water, and the Superficial Aquifer was subject to investigation(s) by V and C Semeniuk Research Group (2001) and Bourke (2017). These investigations drew the following theories on the GBSW and groundwater connections (EPA 2022):

- Surface water infiltrates below the surface (until saturation) forming a perched groundwater layer. The alluvial clay geology underpinning the wetlands, and the perched groundwater layer generally acts as barriers between the perched aquifer and the deeper Superficial Aquifer. However, slow downward leakage (due to low permeability of the clay geology) into the Superficial Aquifer could occur from the clay-based wetland areas.
- There are potentially localised areas of higher permeable geology within the GBSW area due to the heterogeneous geology of the Guildford Formation. This would facilitate the upward flow of groundwater from the Superficial Aquifer into the perched groundwater system and discharge into wetland(s), forming a hydrologically connected aquifer.

In both scenarios, the potential interaction between the surface/perched water and the Superficial Aquifer would be dependent on water levels in the Superficial Aquifer at peak levels post winter rainfall events and/or if the perched water layer is saturated.

Figure 5-34 conceptually illustrates the potential interaction between surface/perched water with the Superficial Aquifer within the GBSW area (EPA 2022).

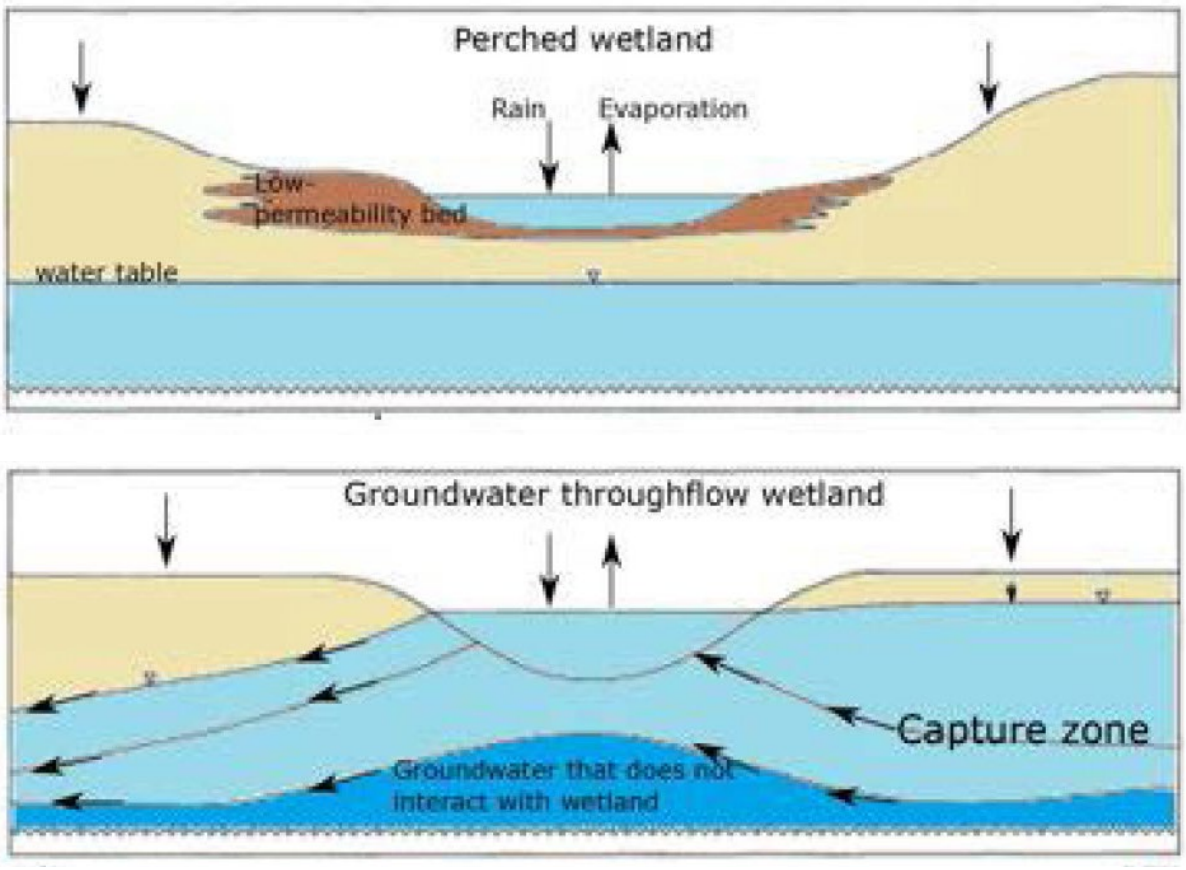

Figure 5-34: Potential interaction between surface/perched water with the Superficial Aquifer within the GBSW area (Davidson 1995)

Hydrogeological conceptual model - Summary

Geology

Geotechnical testing indicates the GBSW area geology is a thin layer of Bassendean Sand (0 m - 3 m) over Guildford Formation. Within the surface sands there is shallow, perched groundwater which variably shows surface expression in low lying areas and drainage channels.

Hydrology

Rainfall generally only infiltrates the topsoil/sand geology where there is capacity in the surface sands, forming a perched water table with limited recharge into the Superficial Aquifer due to the low hydraulic conductivity (associated with the Guildford heavier alluvial clay layers which overlies the Superficial Aquifer) and high groundwater levels.

Perched water is intercepted by the natural and man-made drainage lines to control the rising groundwater levels associated with the historical clearing and rural land uses.

Connectivity

There is limited information on the spatial and temporal nature of the perched groundwater. It may be only present seasonally and spatially across the GBSW as there may be areas and/or seasonal times where it connects with the underlying Superficial Aquifer. Limited data suggests any groundwater flow is likely to be downward from the perched groundwater to the Superficial Aquifer (i.e. slow leakage

through low permeable clays), however it is possible that upwards flow occurs in localised areas where clay layer(s) are limited or not present.

Figure 5-35 presents an east to west conceptual hydrogeological cross section extending from the eastern portion of the MRS amendment area to the GBSW. This conceptual hydrogeological cross section provides a spatial understanding of the geological formations and the hydrological systems including the perched and Superficial Aquifer.

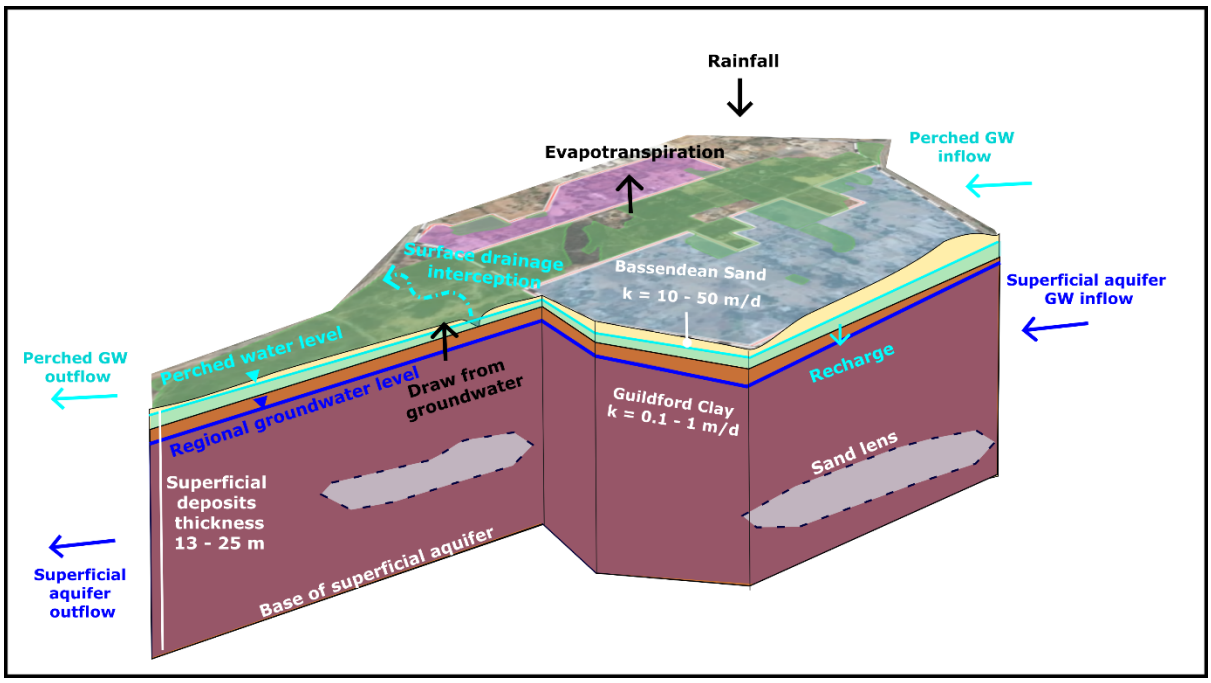

Figure 5-35: Hydrogeological conceptual model of the GBSW

Salinity and sodicity

Soil salinity refers to soluble salts (often associated with near surface groundwater interactions), concentrating within the shallow soil profile. The ions in salt that are responsible for causing salinity in soils are sodium (Na+), potassium (K+), calcium (Ca2+), magnesium (Mg2+) and chlorine (Cl-) (Emerge Associates 2024).

Connection with the Superficial Aquifer beneath the GBSW is spatially limited due to the presence of a hardpan clays associated with the Guilford Formation which underline wetland areas. However, localised connections with the Superficial Aquifer have been potentially identified within the Wanaping Block (EPA 2022). The Superficial Aquifer may seasonally impact the perched water table, wetlands, and the root zone from upgradient loading of salinity/sodicity and local variations of the water table. Salts can accumulate from slow rates of recharge in winter and evaporation due to capillary action when the water table is close to the surface in summer (EPA 2022).

Accordingly, a salinity and sodicity (conservative mixing/evaporation) solute composition assessment was undertaken for the MRS amendment's three water balance scenarios i.e. pre-development, post-development, and post-development with climate change (MBS Environmental 2024).

5.4.6.3 Assessment of salinity

Leederville Aquifer:

- Groundwater composition from the Leederville Aquifer (located approximately 3 km north of the MRS amendment area) show salinity is fresh (657 mg/L TDS) but higher than reference bores from the Superficial Aquifer.
- Salinity is dominated by moderate concentrations of sodium (156 mg/L) and chloride (276 mg/L in Table 2 mg/L) and sodicity (7.0) is low.

Superficial Aquifer:

- The average composition of the aquifer within the MRS amendment area (monitoring bore WG5D) and average inflow composition measured salinity as fresh (537 mg/L TDS) to slightly brackish (1,445 mg/L TDS).

GBSW:

- Salinity ranged from 183 to 13,266 mg/L TDS (average of 2,882 mg/L) at monitoring bores GW3/GW12 and from 1,370 to 17,556 mg/L TDS (average of 8,675 mg/L TDS).

The salinity risks and SAR values from rainfall, Leederville Aquifer and Superficial Aquifer upgradient from the GBSW is low.

MBS Environmental (2024) detailed a technical assessment of the potential impacts of salinity and soil sodicity for the MRS amendment area and its immediate surrounds based on the development of surface water and groundwater solute mass balances. A copy of the report is included as Appendix S of the Wattle Grove South DWMS (Hyd2o 2024) which is provided in Appendix B of this Environmental Review. Potential salinity and sodicity impacts assessment were included in the evaluation of predevelopment and post development scenarios (MBS Environmental 2024).

GBSW groundwater dependent ecosystems

The GBSW is located within the Mungala consanguineous wetland suite as identified by Hill et al. (1996). The Mungala consanguineous suite is characterised by its location in the transition between the Bassendean Dunes and Pinjarra Plain and contains approximately 25,979 ha of wetlands, of which approximately 12.6% comprises CCWs (Emerge Associates 2023f).

GBSW flora and vegetation

The regional vegetation complex mapping (Heddle et al. 1980) illustrates the GBSW occurs within the Guildford complex. The Guildford complex has been subject to significant historical land clearing since European settlement, resulting in approximately 5.1% of its original extent currently remaining on the Swan Coastal Plain.

A range of vegetation and flora surveys and reporting has been completed across the GBSW including:

- Vegetation, Flora and Conservation Values of Lot 106 Wanaping Road, Kenwick in the Greater Brixton St Wetlands (Keighery and Tauss 2008).
- Flora, Vegetation and Wetlands of MKSEA (Tauss and Weston 2010).
- Environmental Review City of Gosnells TPS No.6 Amendments 166 and 169 (Emerge Associates 2023b).
- The Greater Brixton Street Wetlands Management Guidelines, Natural History and Research (Marshall 2000).

The GBSW flora and vegetation surveys have recorded 611 native plant taxa. Approximately 51% of these taxa are wetland species, with the remainder occurring outside of wetland areas on low ridges and dunes (Emerge Associates 2023f).

The recorded conservation significant flora species within the GBSW are outlined in Table 5-20.

Table 5-20: Conservation significant flora species within GBSW (Tauss et al. 2019)

Species	Conservation status	
	BC Act	EPBC Act
Grevillea thelemanniana	Threatened	Critically Endangered
Ptilotus pyramidatus	Threatened	Critically Endangered
Synaphea sp. Fairbridge Farm (D. Papenfus 696)	Threatened	Critically Endangered
Andersonia gracilis	Threatened	Endangered
Austrostipa bronwenae	Threatened	Endangered
Calytrix breviseta subsp. Breviseta	Threatened	Endangered
Diuris purdiei	Threatened	Endangered
Eremophila glabra subsp. Chlorella	Threatened	Endangered
Lepidosperma rostratum	Threatened	Endangered
Conospermum undulatum	Threatened	Endangered
Eleocharis keigheryi	Threatened	Endangered
Calandrinia sp. Piawaning (A.C. Beauglehole 12257)	Priority 1	
Schoenus sp. Beaufort (G.J. Keighery 6291)	Priority 1	
Comesperma griffinii	Priority 2	
Comesperma rhadinocarpum	Priority 2	
Diuris brevis	Priority 2	
Isotropis cuneifolia subsp. glabra	Priority 2	
Lepyrodia curvescens	Priority 2	
Schoenus loliaceus	Priority 2	
Byblis gigantea	Priority 3	
Chamaescilla gibsonii	Priority 3	
Cyathochaeta teretifolia	Priority 3	
Eryngium pinnatifidum subsp. palustre (G.J. Keighery 13459)	Priority 3	
Eryngium subdecumbens (G.J. Keighery 5390)	Priority 3	
Isopogon drummondii	Priority 3	
Myriophyllum echinatum	Priority 3	
Schoenus benthamii	Priority 3	
Schoenus capillifolius	Priority 3	
Schoenus pennisetis	Priority 3	
Schoenus sp. Waroona (G.J. Keighery 12235)	Priority 3	
Stylidium aceratum	Priority 3	
Stylidium longitubum	Priority 3	
Aponogeton hexatepalus	Priority 4	

Species	Conservation status	
	BC Act	EPBC Act
Drosera occidentalis	Priority 4	
Hydrocotyle lemnoides	Priority 4	
Ornduffia submersa	Priority 4	
Schoenus natans	Priority 4	
Verticordia lindleyi subsp. lindleyi	Priority 4	

The floristic community types (FCTs) and associated threatened and priority ecological communities which occur within the GBSW and are considered groundwater dependent are defined in Table 5-21.

Table 5-21: Threatened and priority FCTs recorded within GBSW (Keighery et al. 2019)

FCT	Dominant water balance process	Ecological water requirements
FCT 3a – *Corymbia calophylla - Kingia australis* woodlands on heavy soils of the Swan Coastal Plain	• The community requires a relatively shallow (approximately 0.5 m to 3 m) depth to groundwater, and occurrences can become inundated in the wetter months due to rainfall and surface flows (DotEE 2017a).	• The *Corymbia calophylla – Kingia australis* woodlands on heavy soils of the Swan Coastal Plain TEC occurs on flat landforms which are saturated due to an underlying impervious soil layer (such as a claypan associated with the Guildford Formation), which acts as a barrier to drainage of water through the soil, causing waterlogging.
FCT 7, FCT 8, FCT 9 and FCT 10a – Clay pans of the Swan Coastal Plain	• The TEC is reliant on the local catchment sustaining poorly drained flats, i.e. fresh surface water pooling over a confining layer (Emerge Associates 2022f).	• The Clay Pans of the Swan Coastal Plain TEC occurs within low permeable clay layers located close to the ground surface. The clay layer impedes water movement vertically, enabling water to collect on the surface. The TEC relies on rainfall and/or local surface flow to fill the clay pan landform and is less likely to be influenced by groundwater (DSEWPaC 2012a).

FCT 21c – Low lying *Banksia attenuata* woodlands or shrublands
 	
FCT 21c and FCT 23a – Banksia Woodlands of the Swan Coastal Plain IBRA Region
	• This community is largely restricted to:
	  ○ The uplands on the Bassendean system, consisting of low dunes and interwoven wetlands.
	  ○ Muchea limestone and other palusplain vegetation types that access water at depth, albeit potential shallow depth (Emerge Associates 2022f).
		• The community occurs within wetland and/or heavy soils associated with the eastern side of the Swan Coastal Plain (DotEE 2017b).
		• The Shrublands and woodlands on Muchea limestone TEC occurs on palusplain soils locally mapped as Muchea Limestone comprising limestone, clay, and sand. The community can occur as a wetland or terrestrial environment that accesses groundwater at depth with sustained saturation which allows plants to access stored water.

Groundwater dependent ecosystems

Generally, the GDE communities within the GBSW are classified as 'aquatic' (i.e. driven from rainfall and surface water flows) with high ecological values due to the large and highly connected vegetation communities with a range of integrated fauna habitat used by a diversity of fauna species including threatened species.

Clay pan vegetation and the GBSW hydrological cycle

The Brixton Street Field Herbarium (DBCA 2018) describes the following complex sequence of different flora species which occur across different seasons within the claypan habitats that dominate the GBSW:

- when the claypans are inundated with winter rains and are full, they support a range of native aquatic plants
- as water levels begin to drop, a series of annual and perennial herbs grow and flower
- once the claypans dry out in early summer, different species then emerge, such as sundews and trigger plants
- flat areas surrounding the claypans also support various native herbs, sedges, and rushes, whilst upland areas and sandy rises are characterised by marri and Banksia woodlands with native understoreys.

The GBSW vegetation and flora communities depend significantly on the seasonal rainfall and associated surface water flows, which seasonally fills and waterlogs the low permeable clay layers forming a perched groundwater layer (DBCA 2018).

Variation in depth and duration of inundation is a factor in determining the suite of plant species that occur in a particular clay pan, explaining some of the variation in flora across the extent of the ecological community (Gibson et al. 2005). There is a positive correlation between flora species richness and rainfall with significantly higher species richness in clay pans on flats compared to basins. This is likely a result of a shorter period of inundation and potentially longer wet terrestrial phase (Gibson et al. 1994).

The botanical investigations (i.e. Tauss et al. 2019; Tauss and Weston 2010; and Emerge Associates 2022f) within the GBSW demonstrate the resilience of the flora and vegetation (inclusive of threatened flora species and clay pan communities) to the historical hydrological changes, including alterations in surface water flows from open drains (within and adjacent to the GBSW) and changes in water quality from upgradient land clearing and rural land uses.

GBSW - Wetland buffer assessment

<u>Existing infrastructure</u>

The following existing infrastructure corridors form a physical barrier between the GBSW area (inclusive of the GBSW numerous mapped wetlands) and the MRS amendment area. The infrastructure corridors include:

- Tonkin Highway reserve (proposed to be increased to six lane highway)
- Water Corporation water pipeline easement
- DBNGP easement

The closest wetland (CCW UFI 14962) within the GBSW area (and the Tonkin Highway reserve) is situated approximately 75 m to the west of the MRS amendment area, separated by the four-lane Tonkin Highway.

Figure 5-36 illustrates mapped CCW (UFI 14962) extends into the Tonkin Highway reserve, which is currently subject to grade separated upgrade assessment. The measurement was taken from the CCW (UFI 14962) within the highway reserve. If the upgrade of Tonkin Highway is approved (i.e. increased to six lanes) the separation distance to the MRS amendment area would be further extended by an approximate 30 m.

Within the MRS amendment area, immediately adjacent to Tonkin Highway is the Water Corporation pipeline and DBNGP easements. The *Dampier to Bunbury Pipeline Act 1997*, draft Development Control Policy 4.3 – Planning for High Pressure Gas Pipelines (DPLH 2016), and the Land Use Guidelines Dampier to Bunbury Gas Pipeline Corridor (Department of Lands 2016) generally excludes construction and residential/commercial or industrial development within the easement. These easements further extend the separation distance, from the proposed future residential development, within the MRS amendment area to the closest wetland within the GBSW area, to approximately 105 m. The rest of the MRS amendment area is located significantly further than 100 m from the GBSW area east of Tonkin Highway.

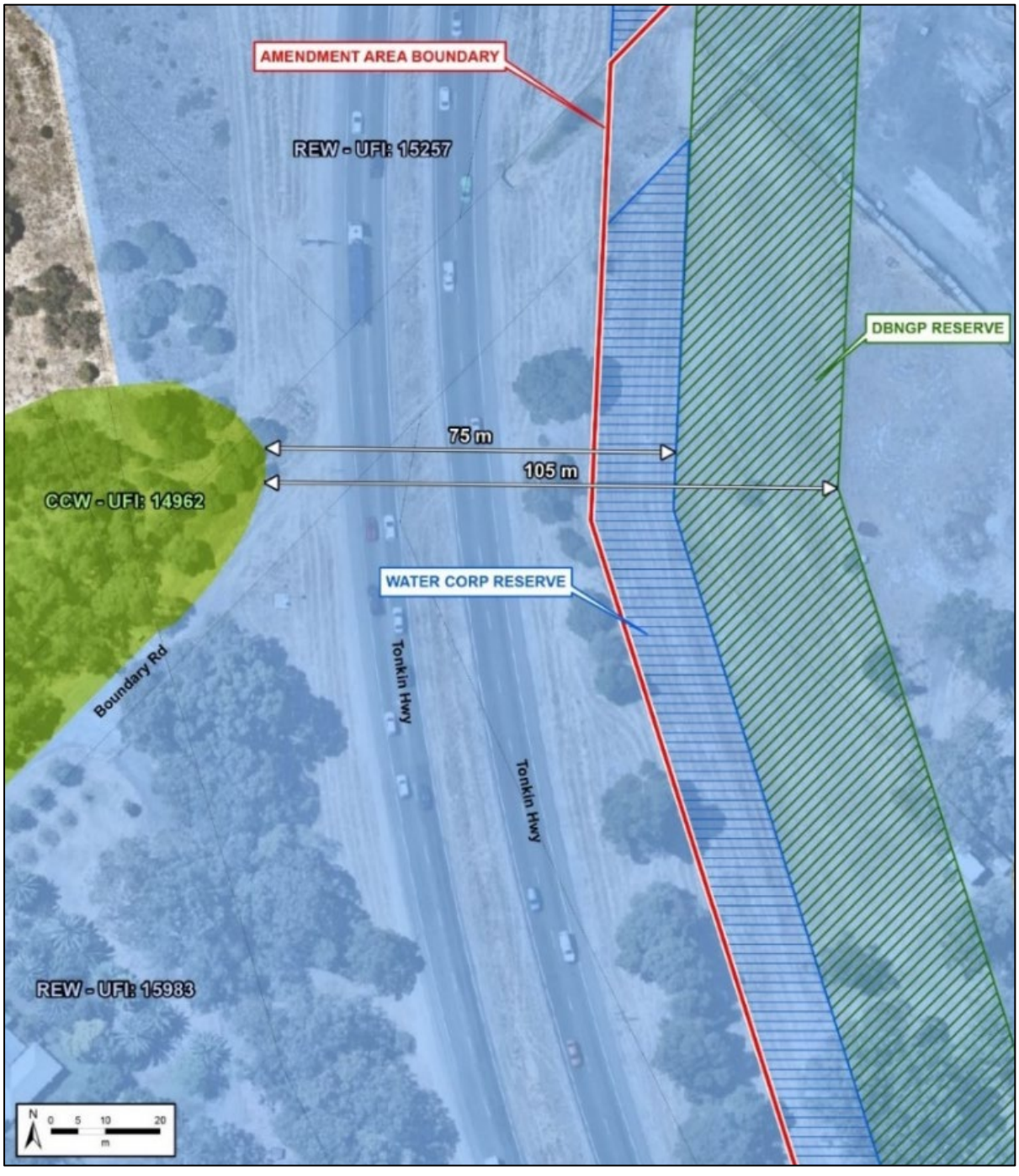

Figure 5-36: Physical Infrastructure separating CCW UFI 14962 and the MRS amendment area

5.4.6.4 Threating processes – Access to the GBSW

Existing pedestrian access from the MRS amendment area into the GBSW is either via:

- Footpath adjacent to Crystral Brook Road, Welshpool Road and then Brook Road for approximately 1.3 km.
- At Brentwood Road there is an at level pedestrian crossing of the four lane Tonkin Highway. The distance to the mapped GBSW boundary from the MRS amendment area along Brentwood Road is approximately 700 m. This pedestrian access would be formally closed either as part of MRWA's proposed Tonkin Highway Grade Separated Interchange (which extends the highway from four to six lanes) or through a future subdivision approval.

Figure 5-37 illustrates the pedestrian access towards the GBSW area.

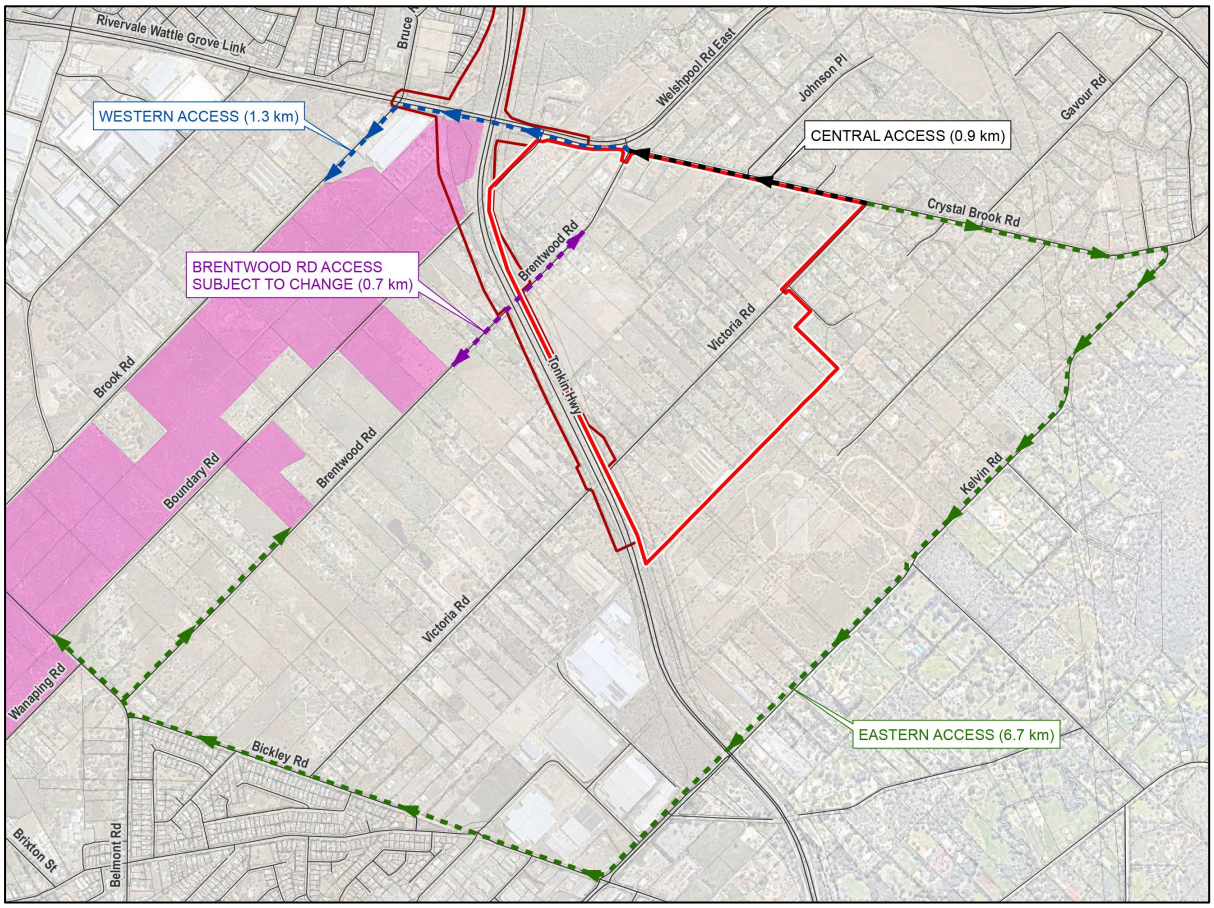

Figure 5-37: Access Pathways towards the GBSW

5.4.7 Water balance assessment

The Wattle Grove South Water Balance Assessment (WBA) (Emerge Associates 2024) completed for the MRS amendment area has been informed by regional scale geological, surface water, wetland and groundwater mapping and assessments, along with local scale hydrological and geotechnical assessments. A detailed description of all water balance parameters, assumptions and methodology is presented in Appendix A, the Water Balance Assessment: Wattle Grove South MRS Amendment (Emerge Associates 2024) of this Environmental Review.

The WBA considers the hydrological regime and total water cycle of the MRS amendment area and its interrelationship with the GBSW. It quantifies and provides a linked assessment of the following key hydrological components (Emerge Associates 2024):

- Rainfall
- Irrigation
- Surface water runoff and drainage
- Upstream catchment inflows
- Groundwater throughflow
- Seasonal perched groundwater
- Evapotranspiration
- Recharge

The WBA covers an annual scale, and the data and results are presented as annual figures, however the modelling for the individual components of the assessment was completed at variable timescales, typically daily but some as small as hourly intervals (Emerge Associates 2024).

Figure 5-38 illustrates how the key hydrological components of the total water cycle conceptually link to one another in the existing (pre-development) environment.

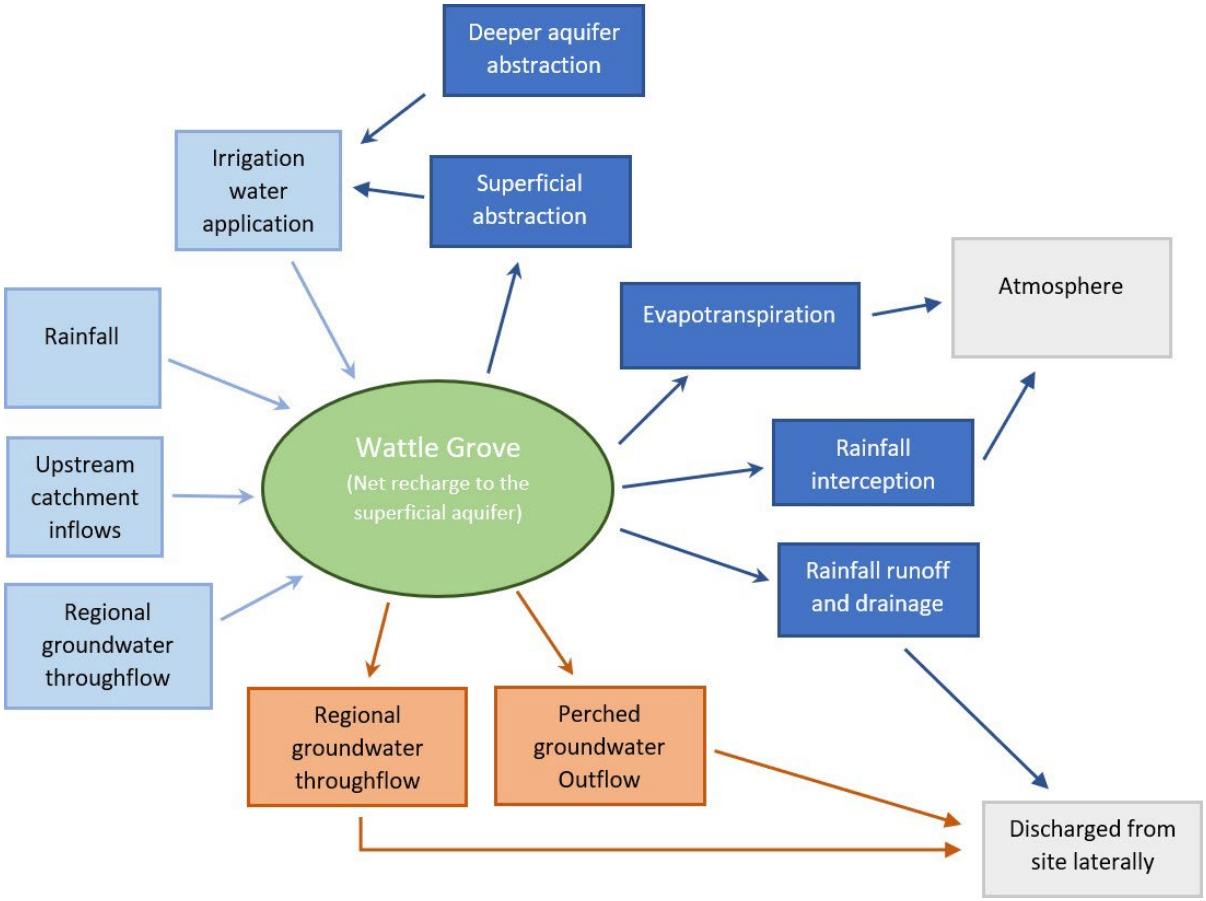

Figure 5-38: Conceptual water balance showing key hydrological components (pre-development) (Emerge Associates 2024)

The WBA includes an assessment of the pre-development (existing environment) and post-development ('Urban' zoning) environments. The post development model compares the expected changes to the existing hydrological regime following urbanisation of the MRS amendment area (Emerge Associates 2024).

5.4.7.1 MRS amendment area – Pre development environment

In summary, the following lists the key hydrological drivers within the MRS amendment area:

- Seasonal rainfall events and subsequent infiltration of surface water into the Superficial Aquifer.
- Locally, groundwater flow direction within the Superficial Aquifer is influenced by:
    - The Guildford Formation geology occurring as clayey dominated Guildford Formation soils along portions of the western and north-western boundary of the MRS amendment area and extend eastward into the Yoganup Formation forming areas of low permeable hydraulic barrier(s) and limiting westerly groundwater flows.
    - The groundwater mound. The effect of this mound causes the groundwater to flow radially away from the mound.
- Tonkin Highway acts as an impermeable flow boundary, excluding shallow perched groundwater flows in a westerly direction (given likely removal of the shallow soil profile during construction). The presence of the DBNGP at this boundary is also expected to facilitate downward infiltration of shallow perched groundwater to the deeper sandy layer.
- Surface water runoff flows generally towards Tonkin Highway through open roadside drains, where the water is discharged under the highway into predominantly semi-rural landholdings within the MKSEA Precinct 2 area. The main outlet locations are Boundary Road, Brentwood Road, and Victoria Street. In large storm events water runoff discharged to the MKSEA Precinct 2 area are conveyed by overland flows and a system of drains and swales through the GBSW to the Yule Brook.

The existing (or pre-development) environment water balance for the MRS amendment area is summarised in Table 5-22.

Table 5-22: MRS amendment area - Pre-development water balance (Emerge Associates 2024)

Water balance component	Pre-development (kL) (% of total)
Inflows	
Rainfall	928,888 (72.1%)
Upstream catchment inflows	34,536 (2.7%)
Irrigation water application (of Superficial Aquifer origin)	84,655 (6.6%)
Irrigation water application (of Leederville aquifer origin)	176,000 (13.7%)
Irrigation water application sourced from Water Corporation's Integrated Water Supply System (IWSS)	32,500 (2.5%)
Groundwater throughflow (Superficial Aquifer)	32,212 (2.5%)
Total Inflows	**1,288,791**
Outflows	
Rainfall interception	95,346 (7.4%)
Irrigation water interception	29,316 (2.3%)
Groundwater abstraction (from the Superficial Aquifer)	84,655 (6.6%)
Surface water runoff and drainage outflow (inclusive of upstream flows)	100,337 (7.8%)
Groundwater throughflow (Superficial Aquifer)	346,081 (26.9%)
Groundwater throughflow (perched)	7,280 (0.6%)
Evapotranspiration (of rainfall)	420,566 (32.6%)

Water balance component	Pre-development (kL) (% of total)
Evapotranspiration (of irrigation water/scheme water - IWSS)	205,209 (15.9%)
Total Outflow	**1,288,791**

Pre-development the hydrological flows within the MRS amendment area are primarily sourced from rainfall which provides 72.1% of the total inflow.

Outside of rainfall events the next significant inflow is from the turf farm irrigation (sourced from the Leederville Aquifer) which contributes 13.6% towards the total inflows.

Other minor water inflow contributions include:

- Inputs from upstream catchments (~2.6% of total inflows)
- Irrigation water application sourced from IWSS (~2.5% of total inflows).
- Groundwater throughflow (via the Superficial Aquifer) from adjacent catchment (2.5% of the total inflows).

The key hydrological outflows are:

- Evapotranspiration (~48.5% of total outflows) in areas of vegetated rural land (dominated by non-native pasture area, but containing areas of remnant native vegetation)
- The second largest outflow is groundwater throughflow which is 27.5%, inclusive of perched shallow groundwater. Most of this throughflow is away from the GBSW area.
- The total surface water runoff volume (100,337 kL/year) is minor representing 7.8% of the total outflow volume.

5.4.7.2 Greater Brixton Street Wetland - Pre-development

MRS amendment area flows towards the GBSW - Pre-development.

Pre-development the estimated total outflow of 158,567 kL/year from the MRS amendment area toward the GBSW area consists of:

- Surface water runoff:
  - Boundary Road culvert: 31,674 kL/year
  - Brentwood Road and Victoria Road culverts: 66,472 kL/year. Stormwater modelling of MKSEA Precinct 2 (Emerge Associates 2023f) illustrates only a portion of this surface water flow, pre-development, is intercepted and directed in a north-west direction towards the GBSW (Figure 5-32).
- Groundwater flow within the Superficial Aquifer is estimated at 60,421 kL/year.

This inflow contribution is minor. By comparison, direct rainfall on the surface of the GBSW area contributes 1,629,700 kL/year. The combined surface water (assuming all the estimated 66,472 kL/year surface water entering the MKSEA Precinct 2 landholdings enters the GBSW) and groundwater flows is less than 10% of the GBSW annual rainfall volume.

GBSW - Pre-development

The GBSW hydrological regime is primarily driven by surface water factors (i.e. rainfall and surface water runoff) rather than groundwater flows. Most of the surface and rain water which infiltrates below the surface is retained in the perched water table rather than infiltrating further into the

Superficial Aquifer. This is primarily due to the presence of low permeable clay substrate layers across the GBSW area. The deposition of the alluvial clayey-sands layers associated with the Guilford Formation is spatially heterogeneous across the GBSW. Spatially, in localised areas, there is the potential for higher permeable geology (i.e. higher sand content) to allow for possible limited hydrological connection between the perched water table and the Superficial Aquifer.

A summary of GBSWs current hydrological regime is presented below (Emerge Associates 2023d):

- The hydrological inflows totalled 1,669,215 kL/year. The inflows were dominated by rainfall (~48%) and surface water inflows from upstream catchments (~35%).
- Upstream catchments inflows incorporate:
    - The surface water runoff outflow volume from the MRS amendment area which enters the GBSW either via:
        - overland flows and drains from the landholdings within the MKSEA Precinct 2 area, or
        - the Boundary Road culvert which diverts stormwater towards the former Crystral Brook tributary for approximately 500 m.
- Other notable inflows include:
    - groundwater throughflow is minor at less than ~0.1% of the total inflows
    - the perched water intercepted in shallow drains (or groundwater baseflow) makes less than ~2% of the total inflows.
- Hydrological outflows are dominated by:
    - evapotranspiration (~50% of the totalled outflows), due to the heavily vegetated nature of the GBSW
    - surface water runoff contributes ~41% of the totalled outflows via the Yule Brook tributary that traverses the northern side of GBSW.

5.4.7.3 Post development assessment

The WBA (Emerge Associates 2024) applied the identical pre-development model assessment to the proposed post-development (or 'Urban' land use) across the MRS amendment area. In addition, the model assessed the following two development scenarios for the UE and UI areas abutting the MRS amendment area:

- The MRS amendment area is developed for an 'Urban' land use, but no 'Urban' development occurs in the UE and UI areas (i.e. the existing rural-residential land uses remain). This scenario has been titled 'UE, UI areas not developed'.
- The MRS amendment area and the UE and UI are 'fully developed' consistent with an 'Urban' land use. This scenario has been titled 'UE, UI areas are fully developed'.

Modelling assessed the impacts from the key changes within the MRS amendment area occurring in a post development environment including:

- the impact of the introduction of greater impervious surfaces with the MRS amendment area and their impact of evapotranspiration
- changes to stormwater management within the MRS amendment area with the proposed 'Urban' development land use and the introduction of a formalised drainage system
- changes in irrigation water use and aquifer abstractions (Hyd2o 2024).

The post development water balance scenarios are summarised in Table 5-23.

Table 5-23: Post-development water balance scenarios (Emerge Associates 2024)

Water balance component	Pre-development (% of total)	Post-development (kL) - UE, UI areas not developed (% of total)	Change to water balance component (%)	Post-development (kL) - UE, UI areas fully developed (% of total)	Change to water balance component (%)
Inflows					
Rainfall	928,888 (72.1%)	928,888 (79.7%)	0.0%	928,888 (78.8%)	0.0%
Upstream catchment inflows	34,536 (2.7%)	34,536 (3.0%)	0.0%	48,210 (4.1%)	+39.6%
Irrigation water application (of Superficial Aquifer origin)	84,655 (6.6%)	123,694 (10.6%)	+46.1%	123,694 (10.5%)	+46.1%
Irrigation water application (of Leederville aquifer origin)	176,000 (13.7%)	0 (0%)	-100.0%	0 (0%)	-100.0%
Irrigation water application (sourced from IWSS)	32,500 (2.5%)	46,000 (3.9%)	+41.5%	46,000 (3.9%)	+41.5%
Groundwater throughflow (Superficial Aquifer)	32,212 (2.5%)	32,212 (2.7%)	0.0%	32,212 (2.7%)	0.0%
Total Inflows	**1,288,791**	**1,165,330**	**-9.6%**	**1,179,004**	**-8.5%**
Outflows					
Rainfall interception	95,346 (7.4%)	63,529 (5.5%)	-33.4%	63,529 (5.4%)	-33.4%
Irrigation water interception	29,316 (2.3%)	18,206 (1.6%)	-37.9%	18,206 (1.5%)	-37.9%
Groundwater abstraction (from the Superficial Aquifer)	84,655 (6.6%)	123,694 (10.6%)	+46.1%	123,694 (10.5%)	+46.1%
Surface water runoff and drainage outflow (inclusive of upstream flows)	100,337 (7.8%)	111,422 (9.6%)	+11.0%	125,096 (10.6%)	+24.7%
Groundwater throughflow (Superficial Aquifer)	346,081 (26.9%)	411,223 (35.3%)	+18.8%	411,223 (34.9%)	+18.8%
Groundwater throughflow (perched)	7,280 (0.6%)	7,280 (0.6%)	0.0%	7,280 (0.6%)	0.0%
Evapotranspiration (of rainfall)	420,566 (32.6%)	312,427 (26.8%)	-25.7%	312,427 (26.5%)	-25.7%
Evapotranspiration (of irrigation water and IWSS)	205,209 (15.9%)	117,549 (10.1%)	-42.7%	117,549 (10.0%)	-42.7%
Total Outflow	**1,288,791**	**1,165,330**	**-9.6%**	**1,179,004**	**-8.5%**

The water balance draws the following conclusions from the urbanisation of the MRS amendment area and the UI and UI area compared to pre-development conditions (Emerge Associates 2024):

- Small increase in groundwater abstraction from the Superficial Aquifer beneath the MRS amendment area (due to irrigation of POS and primary school site).
- Decreased groundwater abstraction from the deeper Leederville Aquifer beneath the MRS amendment area (due to cessation of irrigation from the deeper aquifer).
- Reduction in rainfall and irrigation water interception (due to less vegetation and irrigation).
- Increase in surface water runoff and drainage (due to more impervious surfaces).
- Increase in groundwater recharge and through flow within the Superficial Aquifer beneath the MRS amendment area and UE and UI areas (a direct result of less vegetation and more impermeable surfaces).

5.4.7.4 MRS amendment area and GBSW – Post development

Table 5-24 presents the changes from the pre-development (or existing environment) and post development ('urban' land use) with the UE, UI areas being fully developed (i.e. representing the extreme residential development scenario). The post development scenario was also considered in the context of the potential impacts to GBSW.

Table 5-24: Water balance scenario changes pre- and post-development (Emerge Associates 2024).

Water balance component	Pre-development	Post-development (kL) - UE, UI areas fully developed	Change (kL and %) to the west
Inflows			
Rainfall	928,888 (72.1%)	0%	0%
Upstream catchment inflows	34,536 (2.7%)	+39.6%	0%
Irrigation water application (of Superficial Aquifer origin)	84,655 (6.6%)	+46.1%	0%
Irrigation water application (of Leederville aquifer origin)	176,000 (13.7%)	-100%	0%
Irrigation water application (sourced from IWSS)	32,500 (2.5%)	+41.5%	0%
Groundwater throughflow (Superficial Aquifer)	32,212 (2.5%)	+51.7%	0%
Outflows			
Rainfall interception	95,346 (7.4%)	-33.4%	0%
Irrigation water interception	29,316 (2.3%)	-37.9%	0%
Groundwater abstraction (from the Superficial Aquifer)	84,655 (6.6%)	+46.1%	0%
Surface water runoff and drainage outflow (inclusive of upstream flows)	100,337 (7.8%)	+24.7%	+16.4%
Groundwater throughflow (Superficial Aquifer)	346,081 (26.9%)	+18.8%	+4.7%
Groundwater throughflow (perched)	7,280 (0.6%)	0%	0%
Evapotranspiration (of rainfall)	420,566 (32.6%)	-25.7%	0%
Evapotranspiration (of irrigation water and IWSS)	205,209 (15.9%)	-42.7%	0%
Groundwater throughflow (perched)	7,280 (0.6%)	0%	0%
Evapotranspiration (of rainfall)	420,566 (32.6%)	-25.7%	0%
Evapotranspiration (of irrigation water and IWSS)	205,209 (15.9%)	-42.7%	0%

The key pre-development and post development (which assumes the MRS amendment area and UE, UI areas are fully developed) hydrological changes are:

- The total surface water and groundwater flow towards the GBSW is 169,412 kL/year which is a 10,845 kL/year increase compared with the total pre-development flows.
- Surface water outflows, increase by 13,674 kL/year (18.8% increase from pre-development surface flows). This surface water increase consists of:
    - 5,830 kL/year increase toward the GBSW area via the Boundary Road culvert and the former Crystral Brook tributary
    - 7,844 kL/year increase towards the MKSEA Precinct 2 open drains via Brentwood Road and Victoria Road culverts.
- This surface flow represents approximately 40% increase in inflow to the MRS amendment area from the upstream catchments. This represents a minor component of the overall water balance representing 5.8% of the total MRS amendment area inflow. This estimated predicted outflow increases (including peak flows) can be readily retained within the MRS amendment area (and in the UE and UI areas) to match pre-development flows.
- Groundwater throughflow increases in the post-development environment this can be attributed to the increase in available water (from surface water runoff and drainage) infiltrating into the Superficial Aquifer. This increase in available water (which represents approximately 5% of the overall water balance) will be recharging into a Superficial Aquifer which is already being altered by a reduction in groundwater flows (estimated 1 m to 1.5 m within the turf farm area monitoring bores) since April 2023 when the turf farm ceased irrigation.
- Cessation in the turf farm's abstraction from the Leederville Aquifer results in 176,000 kL/year water saving. However, this also results in a reduction in groundwater levels extending into the north-west portion of the GBSW area. The existing groundwater mound along Tonkin Highway is recognised to represent the baseline condition for considering historical hydrological conditions of the MRS amendment area in proximity to GBSW.
- The increase in recharge will assist, alongside the proposed stormwater management approach for the development, in maintaining the existing groundwater mound beneath the former turf farm within the MRS amendment area. With the retention of the mound, post development groundwater flows to the west will be maintained broadly comparable with pre-development flows.
- The abstraction from the Superficial Aquifer will increase by an estimated 39,039 kL/year (or a 46% increase from the existing environment groundwater abstraction) for use in POS areas and school oval(s).
- There are no drivers that will trigger a change to the conditions supporting shallow perched groundwater levels and flow along the northern boundary of the MRS amendment area that is upstream of the GBSW.

5.4.7.5 Climate change assessment

The palusplain, floodplain and sumpland wetlands, and the associated vegetation communities and ecology within the GBSW area are dependent on the seasonal rainfall and surface water flows. Bourke (2017) and Semeniuk (2001) both identified climate change and specifically the reduction in rainfall in the last 30 years as a significant contributor to changes in the hydrological cycle within the GBSW area.

The predicted rainfall reduction from climate change would affect the following water balance components:

- Rainfall

- Upstream catchment flows
- Rainfall interception
- Surface water runoff from the MRS amendment area
- Evapotranspiration

The WBA accounted for the anticipated future impacts of climate change, by including a sensitivity analysis on the post-development scenario using DWER's future climate change projections. The projections are based on data used by the Intergovernmental Panel on Climate Change (IPCC) (Emerge Associates 2024).

The DWER dataset(s) provides predicted future climate data in daily intervals for three climate scenarios at time horizons of 2050 and 2100. Modelling was performed for the 'dry' scenario for both 2050- and 2100-time horizons. Future climate change predictions are summarised in Table 5-25.

Table 5-25: Climate change factors (Emerge Associates 2024).

Climate change factor baseline	Baseline average (2010-2020)	Future climate prediction (DWER 2021) % change from 2010 - 2020 baseline	
		Dry 2050	Dry 2100
Annual rainfall (mm) (Gosnells)	656	627 (-4.4%)	430 (-34.5%)
Annual rainfall used in the surface water balance (mm) (Jandakot hourly dataset)	735	702 (-4.4%)	481 (-34.5%)

The assessment of climate change factors on the following two post-development environments was considered for the two climate change scenarios:

- The UI and UE are not developed (remaining semi-rural residential lots).
- The UI and UE are fully developed (urbanised).

The water balance incorporating climate change scenarios is summarised in Table 5-26 and Table 5-27.

Table 5-26: Water balance with climate change factors with UI and UE Areas not developed (Emerge Associates 2024)

Water balance component	Post-development (kL)	Post-development (kL) Dry 2050	Post-development (kL) Dry 2100
Inflows			
Rainfall	928,888	887,738	608,422
Upstream catchment inflows	34,536	33,214	21,269
Irrigation water application (of Superficial Aquifer origin)	123,694	123,694	123,694
Irrigation water application (of Leederville aquifer origin)	0	0	0
Irrigation water application (sourced from IWSS)	46,000	46,000	46,000
Groundwater throughflow (Superficial Aquifer)	32,212	32,212	32,212
Total Inflows	**1,165,330**	**1,122,858**	**831,597**
Outflows			
Rainfall interception	63,529	60,684	41,580
Irrigation water interception	18,206	18,206	18,206
Groundwater abstraction (from the Superficial Aquifer)	123,694	123,694	123,694
Surface water runoff and drainage outflow (inclusive of upstream flows)	111,422	102,641	49,549

Water balance component	Post-development (kL)	Post-development (kL) Dry 2050	Post-development (kL) Dry 2100
Groundwater throughflow (Superficial Aquifer)	411,223	390,321	247,222
Groundwater throughflow (perched)	7,280	7,280	7,280
Evapotranspiration (of rainfall)	312,427	302,483	226,517
Evapotranspiration (of irrigation water and IWSS)	117,549	117,549	117,549
Total Outflow	**1,165,330**	**1,122,858**	**831,597**

Table 5-27: Water Balance with Climate Change Factors with UI and UE Areas Developed (Emerge Associates 2024)

Water balance component	Post-c	Post-development (kL) Dry 2050	Post-development (kL) Dry 2100
Inflows			
Rainfall	928,888	887,738	608,422
Upstream catchment inflows	48,210	43,523	17,700
Irrigation water application (of Superficial Aquifer origin)	123,694	123,694	123,694
Irrigation water application (of Leederville aquifer origin)	0	0	0
Irrigation water application (sourced from IWSS)	46,000	46,000	46,000
Groundwater throughflow (Superficial Aquifer)	32,212	32,212	32,212
Total Inflows	**1,179,004**	**1,133,167**	**828,028**
Outflows			
Rainfall interception	63,529	60,684	41,580
Irrigation water interception	18,206	18,206	18,206
Groundwater abstraction (from the Superficial Aquifer)	123,694	123,694	123,694
Surface water runoff and drainage outflow (inclusive of upstream flows)	125,096	112,950	45,979
Groundwater throughflow (Superficial Aquifer)	411,223	390,357	247,216
Groundwater throughflow (perched)	7,280	7,280	7,280
Evapotranspiration (of rainfall)	312,427	302,447	226,524
Evapotranspiration (of irrigation water and IWSS)	117,549	117,549	117,549
Total Outflow	**1,179,004**	**1,133,167**	**828,028**

The modelling results for both development of the site only and site and UE and UI area scenarios are summarised below (Emerge Associates 2024):

- In the MRS amendment area being developed scenario the upstream catchment recharge decreases to the Superficial Aquifer by 20,866 kL/year (or 5% reduction) in the Dry 2050 scenario, in comparison to the post development environment without climate change factors. The Dry 2100 scenario shows groundwater recharge further decreasing to 247,222 kL/year (a 39% reduction).
- For the Dry 2100 scenario under the fully urbanised UI and UE scenario, the upstream catchments the surface water runoff exported from the MRS amendment area reduces by 63.2%. It reduces by 55.5% under the UI and UE not being developed scenario.

- The key influence of urbanisation is a decrease in evapotranspiration resulting in an increase in groundwater recharge. With the inclusion of climate change, rainfall reduces which significantly reduces surface water runoff leaving the MRS amendment area towards the GBSW.
- Overall, the impact of climate change on the water balance is relatively minor for the Dry 2050 scenario but more significant for the Dry 2100 scenario. The most significant impact is seen in the surface water inflows and outflows for the MRS amendment area, which are both reduced by approximately 10% in the Dry 2050 scenario and 63% in the Dry 2100 scenario.

5.5 Potential environmental impacts

The EPA's Instruction for Environmental Review No. 2335 for MRS Amendment 1388/57 identified four potential impacts (direct, indirect, and cumulative) on the environmental values for the inland waters factor. The key potential impacts identified by the EPA include:

- Impacts to current surface and groundwater cycles (alteration of hydrological regimes) resulting in impacts to significant wetlands and waterways within and nearby to the MRS amendment area, including the Yule Brook and the GBSW.
- Impacts to water quantity and quality of significant wetlands and waterways within and nearby to the MRS amendment area.
- Impact to the hydrology and biodiversity of the GBSW.
- Loss of foreshore functions and groundwater and/or surface water dependent vegetation and impacts to other water dependent ecosystems.

5.5.1 Assessment of impacts

The MRS Amendment 1388/57 (which assesses the proposed land use change i.e. from 'rural to 'urban') is not the approval trigger for any construction works within the MRS amendment area. Construction works within the MRS amendment area will only commence post the future adoption of a Local Structure Plan by the City of Kalamunda and the WAPC, followed by a WAPC subdivision approval. Importantly, future proposed construction activities within the MRS amendment area will occur east of Tonkin Highway, approximately 100 m (at the closest) from the mapped GBSW and Yule Brook waterway.

Impacts to current surface and groundwater cycles (alteration of hydrological regimes) resulting in impacts to significant wetlands and waterways within and nearby to the MRS amendment area, including the Yule Brook and the GBSW.

5.5.1.1 Significant wetlands and waterways

The identified significant wetlands and waterways within and nearby the MRS amendment area include:

- MRS amendment area (Figures 5-21,5-22 and 5-23)
  - REWs (UFI 8037 and portion of UFI 15257).
- Lot 501 (Figures 5-21 and 5-24) – adjacent to the MRS amendment area
  - CCWs UFI 8026 and UFI 8027 and portion of REW UFI 15257.
- GBSW area (Figures 5-21 and 5-26) – west of Tonkin Highway

    - GBSW comprises a complex of significant wetlands, including areas of seasonally waterlogged flats (palusplain) and seasonally inundated basins (sumplands).
- Yule Brook (Figures 5-21 and 5-26) – north and north-west of the MRS amendment area

Key hydrological change

The WBA (Emerge Associates 2024) accounts for key aspects of the proposed urbanisation which will directly influence the local hydrology within and adjacent to the MRS amendment area. These include:

- Introduction of hard (impervious) surfaces (roofs, roads, and pavements) and control of water runoff to the subsurface
- Groundwater recharge
- Removal or establishment of deep-rooted vegetation
- POS irrigation
- Climate change scenarios

The inland waters hydrological assessment is premised on the MRS amendment area and UE, UI areas being 'fully developed'. However, any 'Urban' land use within the UI and UE areas will require a separate MRS amendment, independent of this Wattle Grove South MRS Amendment. These MRS amendments, should they proceed in the future, will need to be supported site specific (and regional):

- Hydrological and geological assessments.
- Assessment of surface water and groundwater flows
- Water management framework in accordance with Better urban water management (WAPC 2008) and the *Stormwater Management Manuel for WA* (DWER 2022).

Table 5-28 summarises in context of the above the hydrological regime pre and post the 'Urban' land use zoning.

Table 5-28: Summary of the hydrological regime pre and post the 'Urban' land use zoning (Emerge Associates 2024).

Summary of hydrological flows	Flows (kL)	Explanation
Pre-development MRS amendment area – Total flows and outflows towards the GBSW		
Total inflow/outflows	1,288,791 kL/year	• Pre-development the hydrological flows within the MRS amendment area are primarily sourced from rainfall which provides 72.1% of the total inflow. • Outside of rainfall events the next significant inflow is from the turf farm irrigation (sourced from the Leederville Aquifer) which contributes 13.7% towards the total inflows.

Surface water	100,337 kL/year	• 98,146 kL/year of this surface water is directed west and south-west via:
		  ○ Boundary Road culvert (~32%).
		  ○ Brentwood Road and Victoria Road culverts (~67.7%).
		• The remaining 2,191 kL/year discharges southwards in a roadside swale on the eastern side of Tonkin Highway.

Groundwater	346,081 kL/year	• Groundwater flow was found to be radial with a mound evident along the central western boundary adjacent to Tonkin Highway. Flow within the MRS amendment area was found to generally range from north-west to south-east and away from the GBSW area.
Pre-development GBSW estimated total flows and surface and groundwater flows from the MRS amendment area		
Surface water (from the MRS amendment area catchment)	98,146 kL/year	• This represents a minor component of the overall water balance representing 7.6% of the total MRS amendment area inflow. • Boundary Road culvert: 31,674 kL/year. • Brentwood Road and Victoria Road culverts: 66,472 kL/year.

Groundwater (Superficial Aquifer)	60,421 kL/year	• Groundwater flow in a westerly direction (i.e. towards the GBSW) represents a small contribution of the total groundwater flows from the MRS amendment area due to:
		  ○ Local geology (Figure 5-11):
		  ▪ The Guildford Formation geology occurring as clayey dominated soils along portions of the western and north-western boundary of the MRS amendment area and extend eastward i.e. along Boundary Road (east) and Brentwood Road (east) into the Yoganup Formation form areas of low permeable hydraulic barrier(s) which limits westerly groundwater flows.
		  ▪ Groundwater flow at a local scale follows a pathway of least resistance (i.e. more permeable soil pathway) tending eastward through the Yoganup Formation before moving predominantly towards the north-west and south-east through sand dominated geology.
		  ○ Groundwater mound (Figure 5-12):
		  ▪ The groundwater mound has artificially increased water levels north-western periphery of the amendment including a portion of the GBSW area.
		  ▪ This is an artificial dynamic is a direct result from the turf farm irrigation practice.

Summary of hydrological flows	Flows (kL)	Explanation
Post development - MRS amendment area and UE and UI area developed ('full developed' scenario)		
Total inflow/outflows	1,179,004 kL/year (109,787 kL/year in total flows (-8.5%) decease)	• Aquifer irrigation water use is reduced by 52.5% post development, which is largely influenced by the removal of the existing turf farm. • Evapotranspiration is reduced by 48.5% of the total outflow for the pre-development land use and 36.5% decrease post development.
Surface water (from the MRS amendment area catchment)	125,096 kL/year (24,759 kL/year (or 24.7%) increase)	• The predicted increase in surface water volume exported from the MRS amendment area toward the GBSW is 24,524 kL/year. This consists of: o 5,192 kL/year increase toward the GBSW area via the Boundary Road culvert and the former Crystral Brook tributary from the Boundary Road culvert o 19,332 kL/year towards the MKSEA Precinct 2 open drains via Brentwood Road and Victoria Road culverts.
Groundwater (Superficial Aquifer)	411,223 kL/year	• Groundwater throughflow in the Superficial Aquifer is increased from 26.9% pre-development to 34.9% post development of total outflow. This increase in available water will be recharging into a Superficial Aquifer which is already being altered from a reduction in groundwater mound levels and flows (estimated 1 m to 1.5 m within the turf farm area monitoring bores) since April 2023 when the turf farm ceased irrigation. • Post development through maintaining the groundwater mound, it is predicted groundwater flows will remain consistent with predevelopment flow towards the GBSW. • The predicted increase in groundwater flows will assist (along with stormwater management measures) to offset the hydrological impacts from ceasing of the turf farm irrigation (from the Leederville Aquifer) which reduces groundwater levels across an area of approximately 1.5 km west of the turf farm into the north-western portion of the GBSW.

Hydrological changes summary

MRS amendment area only

Modelling assessed the impacts of the following key changes within the MRS amendment area which would occur in a post development environment (Hyd2o 2024):

- The impact from the introduction of greater impervious surfaces with the MRS amendment area and their impact to evapotranspiration. Quantification of this change was based on values presented in DWER's PRAMS documentation.
- Changes to stormwater management within the MRS amendment area with 'Urban' land uses and introduction of a formalised drainage system.
- Changes in irrigation water use and aquifer abstractions. Currently the total abstraction allocation from the MRS amendment area is 260,655 kL/year annually.

Water balance modelling results show the balance of all inflows and outflows for the MRS amendment area post development in comparison to the water balance results under existing land use.

Post-development, evapotranspiration in the MRS amendment area is reduced, and a minor increase in surface water outflow was modelled. Given the predominately permeable surface soils and infiltration-based water management strategy, the increase in water volume infiltrated results in an increase in groundwater recharge to the Superficial Aquifer. Groundwater outflow from the Superficial Aquifer is predicted to leave the MRS amendment area consistent with existing groundwater flow directions.

Modelling results are summarised compared to the predevelopment condition as follows (Hyd2o 2024):

- Overall, there is an 9.6% reduction in total inflow and outflows for the MRS amendment area post development. Rainfall remains the predominant source of inflow for the MRS amendment area, representing approximately 79.7% of the total inflow. Irrigation is the second largest component at 10.6%.
- Groundwater throughflow and upstream catchment inflows are relatively minor contributions at 2.8% and 3% respectively.
- Aquifer irrigation water use is reduced by 52.5% post development, reduced via the removal of the turf farm.
- In relation to outflows, evapotranspiration is the largest volumetric reduction representing 48.5% of the total outflow for existing land use and 36.9% post development. Groundwater throughflow in the superficial aquifer is increased from 26.9% to 35.3% of total outflow.
- Groundwater throughflow in the superficial aquifer is increased from 26.9% to 35.3% of total outflow.
- Surface water from the MRS amendment area was marginally increased from 7.8% to 9.6% of total outflow.

Overall, the water balance indicates a combined total outflow (groundwater and surface water) of 169,412 kL/year from the MRS amendment area toward the GBSW area, a 10,845 kL/year increase.

Surface water flow changes for flows directly to the GBSW area from the MRS amendment area are negligible (-638 kL/year), with the majority of flow change occurring where the site discharges to the MKSEA Precinct 2 landholdings and open drains (11,489 kL/year) (Emerge Associates 2024).

In the context of the GBSW area, these increases are minor. By comparison, direct rainfall (annual average 758 mm/year) on the surface of the GBSW area (215 ha) contributes 1,629,700 kL/year.

Overall, most of the minor combined outflow increase is due to a modelled increase in groundwater throughflow. It is important to note however that the direction of the modelled flow increase is north-west and toward the far eastern extent of GBSW, and an area where regional groundwater is well below natural surface (Hyd2o 2024).

The minor increases to the GSBW area can be readily amended to the pre-development levels through refinement of stormwater storage designs and adaptive management.

In relation to the Yule Brook's total annual flow of approximately 7.9 GL/year (7,900,000 kL/year). The water balance flow increased estimate of 10,845 kL/year to GBSW and MKSEA represents only 0.14% of the Yule Brook annual flow and is therefore, considered negligible in the context of interannual flow variability.

MRS amendment area, UE and UI areas 'fully developed'

Changes within the UE and UI area affecting the water balance were consistent with those affecting the MRS amendment area post development, including the introduction of greater impervious surfaces and its impact to evapotranspiration, changes to stormwater management within the UE and UI area, and changes in irrigation water use (Hyd2o 2024).

Regarding the total inflows and outflows for the MRS amendment area post development, the WBA draws the following conclusions (Hyd2o 2024):

- The water balance predicts post development a combined total outflow (groundwater and surface water) of 183,091 kL/year from the MRS amendment area toward the GBSW area.
- MRS amendment area inflows: the water balance is only marginally changed compared with the MRS amendment area only development condition with an increase in surface water inflow to the MRS amendment area of 13,674 kl/year. This represents approximately a 40% increase in inflow to the MRS amendment area from the contributing upstream catchments (UE and UI area). This increase in upstream catchment inflow represents a minor component of the overall water balance being 4% of the total MRS amendment area inflow.
- MRS amendment area outflows: most elements of the water balance remained consistent with the MRS amendment area only development scenario. The development of the UE and UI area resulted in an increase in the overall MRS amendment area surface water outflow. Modelling indicates surface water outflows would increase by 24,759 kL/year compared to the existing condition and 13,674 kL/year compared to the MRS amendment area only development scenario. Of the additional 13,674 kL/year because of the UE and UI development:
    - 5,830 kL/year is toward the GBSW area (via the Boundary Road culvert)
    - 7,844 kL/year (via the Brentwood Road and Victoria Road culverts) to the MKSEA Precinct 2 landholdings and open drains.

Based on these modelling results, the development of the UE and UI area only minimally changes the overall water balance of the MRS amendment area (Hyd2o 2024).

Predicted changes to the key hydrological elements

Groundwater and groundwater mound

Groundwater contours at the MRS amendment area (in the existing pre-development environment), range from approximately 16 m AHD in the north-eastern region to approximately 19 m AHD on the western boundary, with a regional groundwater depth ranging from 4 m to 20 m below natural surface.

Assuming a 'fully developed scenario', modelling of the post development environment has predicted that reduced evapotranspiration and increased infiltration will increase groundwater recharge to the Superficial Aquifer through flow by 65,976 kL/year. Whereas groundwater recharge under the 'amendment area developed only scenario' is estimated at 60,421 kL/year. This increase in groundwater recharge is not as large as would normally be expected due to:

- a reduction in groundwater elevation and flows in the Superficial Aquifer from the predicted lowering in groundwater mound from cessation of the turf farm irrigation
- the additional groundwater offsetting the reduction in the groundwater mounds levels (as a result of ceasing irrigation from the Leederville Aquifer at the turf farm).

The former turf farm has a groundwater abstraction licence for up to 176,000 kL/year and was abstracting groundwater (for irrigation purposes) from the deeper Leederville Aquifer. Following application of irrigation water from the Leederville Aquifer, it infiltrated downwards through the Yoganup sand dominated geology into the Superficial Aquifer where it is retained. The mound beneath the turf farm and along the western boundary ranges up to 5 m in height and the influence of the mound extends approximately 1.5 km west and north-west into the GBSW (Figure 5-12).

The extent to which the ceased irrigation at the turf farm from the deeper aquifer will impact groundwater levels locally is difficult to quantify, given the non-uniform geology particularly along the MRS amendment area's western boundary. Monitoring bores WG6 and WG9 (adjacent to the turf farm) have shown downward trends i.e. approximate 1 m to 1.5 m level reduction. Groundwater levels within nearby bores GW9D and WG3 have not significantly change. Bore hydrographs within the area of the local groundwater mound is presented in the Figure 25 of the DWMS (Appendix B).

The cessation of the turf farm irrigation (from the Leederville Aquifer) has the unintentional hydrological outcomes of reducing groundwater levels (or mound) which have been kept at an elevated level for the past 20 years. Therefore, the predicted additional recharge due to urbanisation is not expected to result in a significant change in groundwater levels within the Superficial Aquifer. Specifically, in proximity to the former turf farm, post development stormwater runoff will be managed via stormwater detention basins for the purpose of maintaining the influence of the mound. Along with the additional recharge, this will maintain the influence of the mound and retain groundwater flows and direction toward the GBSW, consistent with pre-development flows.

Perched water table

The Tonkin Highway acts as an impermeable flow boundary, excluding shallow perched groundwater flows in a westerly direction (given likely removal of the shallow soil profile during construction). The presence of the DBNGP at this boundary is also expected to facilitate downward infiltration of shallow perched groundwater to the deeper sandy layer (Emerge Associates 2024).

Surface water

The impacts to GBSW from the development of the MRS amendment area and UI and UE are minimal with the only noted change being an increase in surface water runoff being exported from the MRS amendment area. The volume of surface water runoff exported from the MRS amendment area toward the GBSW is noted as increasing by 16.4%, however this only represents 0.4% of the overall water balance (Emerge Associates 2024). Under the 'fully developed scenario' the UE and UI areas contributes an additional 13,674 kL/year of surface water to the MRS amendment area (Emerge Associates 2024).

If the MRS amendment area was only developed, the surface water changes for flows directly to the GBSW area from the MRS amendment area is negligible (-638 kL/year), with the majority of flow

change occurring where the site discharges to the MKSEA Precinct 2 landholdings and open drains (11,488 kL/year) (Hyd2o 2024).

The MRS amendment area under the existing 'Rural' land use, currently has no water sensitive measures or controls to improve and manage water prior to its discharge to receiving environments.

Further, surface water exported from the MRS amendment area via the Brentwood Road and Victoria Road culverts is assumed to be directed towards the GBSW. However, surface water modelling of the MKSEA Precinct 2 landholdings and the GBSW identified:

- The Boundary Road culvert flows is the primary pathway and source of water runoff from the MRS amendment area into the GBSW area.
- Victoria Road and Brentwood Road culverts water flows are conveyed into the MKSEA Precinct 2 landholdings (consisting of semi-rural, light industrial and commercial land uses). This surface water moves primarily in a westerly direction through a combination of overland flow, unlined open drains both within road reserves and between lots towards Bickley Road. Only a portion of the total surface water flows (within the MKSEA Precinct 2 landholdings) is intercepted and directed in a north-west direction towards the GBSW (Emerge Associates 2023g).

Figure 5-32 shows the modelled surface water flow movement within the MKSEA Precinct and the GBSW (Emerge Associates 2023g).

Climate change

Declining rainfall in Western Australia's south-west over the last 30 years has likely already resulted in changes to the hydrological cycle of the GBSW area and will continue to do so in future. No strategies currently exist for managing the impacts of future reduced inflow to the GBSW.

In the scenario where the MRS amendment area is developed, only the impact of climate change on the water balance is relatively small for the Cdry 2050 horizon modelling but more significant for the 2100 horizon. The most significant impact is from the reduction of surface water inflows and outflows from the MRS amendment area (i.e. 7.9% reduction) in the 2050 horizon and a 58.7% reduction by 2100.

In the scenario where the MRS amendment area, UE and UI areas are developed, the results show surface water flows reducing by 9.7% for the 2050 horizon, and 60.4% by 2100 compared to the scenario without climate change. Groundwater throughflow as outflow from the MRS amendment area was found to reduce by 5% in the dry 2050 horizon modelling and by 40% to 2100 under both development scenarios.

Assessment of impacts - MRS amendment area wetlands (REWs UFI 8037 and portion of UFI 15257)

The assessment of the REWs (UFI 8037 and UFI 15257) values within the MRS amendment concluded (Pentium Water 2024):

- REW 8037 has been subject to anthropogenic impacts including historical clearing of native vegetation and infilling of the wetland areas to facilitate:
    - construction of Tonkin Highway, the Water Corporation and DBNGP pipelines
    - commercial turf farm
    - open rural paddock areas.

- The wetland's ecological values are no longer present. REW (UFI 8037) has been subject to clearing of native vegetation and infilled. The mapped wetland area no longer contains a surface water body or habitat for aquatic dependent fauna species.
- The detailed wetland assessment (Appendix C) recommends formally removing the REW category classification for UFI 8037 and portion of UFI 15257 within the MRS amendment area from the GWSCP dataset.
- Portions of the REWs (UFI 8037 and the portion of UFI 15257 within the MRS amendment area) recommended for removal from the DBCA GWSCP dataset will be integrated into POS and stormwater bio-retention basin/swale areas.
- DBCA is the custodian of GWSCP dataset. An application to DBCA to amend GWSCP dataset for these two REWs (UFI 8037 and portion of UFI 15257 within the MRS amendment) will be undertaken concurrently with the finalising of a future Local Structure Plan and the LWMS.
- The DPLH Aboriginal Heritage Places mapping tool (DPLH 2024a) concluded REW UFI 8037 intersects a portion of the Brentwood Road Swamp (Site ID 4343). The cultural heritage survey completed with the Traditional Owner elders in 2021 concluded the Brentwood Road Swamp (Site ID 4343) is a heavily disturbed and altered environment and no cultural material within the MRS amendment area was identified (Horizon Heritage 2021). The majority of the Brentwood Road Swamp (Site ID 4343) area will be integrated into POS areas and/or retained within the existing Water Corporation and DBNGP easement. Future works in proximity to the Brentwood Road Swamp (Site ID 4343) will be undertaken in consultation with the Traditional Owner group.
- The portion of REW UFI 15257 within the MRS amendment area has been historically cleared of native vegetation and infilled to establish the construction of Tonkin Highway, the Water Corporation pipeline and DBNGP (and associated easement), and the rural open paddocks. Previous survey of the existing vegetation confirmed:
    - Within and adjacent to the Tonkin Highway reserve:
        - Planted stands of *Corymbia calophylla* (Marri) and non-native eucalypt Eucalyptus camaldulensis (River Red Gum) over non-native eucalypt *Casuarina cunninghamiana* subsp. *cunninghamiana, Melaleuca preissiana, Jacksonia sternbergiana* and **Schinus terebinthifolia* over introduced species on various soils and topographical positions (Woodman Environmental 2021).
    - Along the boundary of the Water Corporation/ DBNGP easement (maintained as open paddock area):
        - Planted *Eucalyptus camaldulensis* (River Red Gum).
- There is no seasonal surface water present within REW UFI 15257 (within the MRS amendment area) or fauna habitat for aquatic dependent fauna species.
- The vegetation present which consists predominately of River Red Gums were planted in the late 1980's. The vegetation was surveyed as Completely Degraded condition. The mapped wetland area contains no surface water body and no fauna habitat for aquatic dependent fauna species.

Table 5-29 assesses the predicted impacts to the two REWs (UFI 8037 and portion of UFI 15257) located on the western boundary of the MRS amendment area.

Table 5-29: REWs (UFI 8037 and portion of UFI 15257) groundwater and surface water assessment

Wetland values	Assessment and predicted outcomes	Figures / Appendix
• **REWs UFI 8037 and portion of UFI 15257 have both been subject to construction works and engineering fill.** • **No GDE / riparian vegetation or open water areas exist.** • **No fauna habitat for aquatic dependent fauna species**	**Groundwater**	

	• Urbanisation will not result to a significant rise in groundwater levels.
	• The groundwater flow direction post development will remain consistent with pre-development flow.
	• The predicted increase in groundwater recharge from 'Urban' land use is within the Superficial Aquifer which is several metres below natural surface (i.e. 4 m plus).
	• The existing groundwater mound along Tonkin Highway is recognised to represent the baseline condition for considering historical hydrological conditions of the MRS amendment area in proximity to GBSW.
	• The cessation of the turf farm irrigation reduces the spatial influence of the groundwater mound particularly within the north-western portion of the GBSW area. The mound has created a 3 m to 1 m rise in the regional groundwater table 700 m and 1,500 m from the western boundary of the turf farm.
	• The implementation of a targeted stormwater management approach applied to the area of the existing mound can result in similar annual recharge pre and post development in the groundwater mound area. The strategy modelled to achieve this outcome was based on:
	  ○ Stormwater biofiltration and flood management areas to be focussed to the area of the mound adjacent to Tonkin Highway.
	  ○ Lot soakwells to be adopted for almost all lots within the wider 50.5 ha contributing stormwater catchment for this area, with a small area of lot connections
		• Figure 5-39 illustrates the separation distance from the natural surface to AAMGL.
		• The depth to groundwater in proximity to REWs (UFI 8037 and UFI 15257) is approximately 4 m.
		• Figure 5-12 shows the groundwater mound area of influence.

	Surface water	
	• REW UFI 8037 is located within a former commercial turf farm, Tonkin Highway reserve and a cleared Water Corporation pipeline/DBNGP easements. The mapped wetland area has been completely infilled, and the native vegetation removed. Surface water to this mapped wetland area is primarily from overland surface flows during large water events. • REW UFI 15257 within the MRS amendment area consists of following land uses, Tonkin Highway reserve, cleared Water Corporation pipeline and DBNGP easements and open paddocks. All these land uses contributed towards the clearing of native vegetation and infilling of the mapped wetland. Surface water flows into this wetland from overland flows. • The wetland assessment (Appendix C recommended the removal of the two REWs (UFI 8037 and portion of UFI 15257) from DBCA's GWSCP dataset. • An application to DBCA to amend GWSCP dataset for the two REWs (UFI 8037 and portion of UFI 15257) will be undertaken concurrently with the finalising of a future Local Structure Plan and the LWMS. • Portions of the former wetland areas will be integrated into POS and stormwater bio-retention basin areas.	• The Wattle Grove South DWMS (Hyd2o 2024) incorporates Water Sensitive Urban Design principles including: ○ Post development stormwater flows are maintained consistent with existing conditions.
	Predicted Outcomes	

Wetland values	Assessment and predicted outcomes	Figures / Appendix

	• REW (UFI 8037) totals 0.86 ha in area and has been completely infilled. REW UFI 8037 is proposed to be remove from the DBCA geomorphic dataset.
	• The portion of REW (UFI 15257) totals approximately 2.06 ha (within the MRS amendment area). The portion of REW (UFI 15257) within the MRS amendment area is proposed to be removed from the GWSCP dataset.
	• The removal of the two wetlands from the GWSCP dataset is reflective of the ecological condition (i.e. Completely Degraded) of the two wetlands. Specifically, historical anthropogenic impacts including the construction of the Tonkin Highway, Water Corporation and DBNGP pipelines and adjacent land uses including commercial turf farm and rural lots resulted in the clearing of native vegetation and the infilling of the wetlands.
	• Further, the removal of the two REWs (UFI 8037 and portion of UFI 15257) from the GWSCP dataset is consistent with DBCA's preliminary assessment which advised the environmental values of the two REWs (UFI 8037 and portion of UFI 15257) within the MRS amendment area are commensurate with an MUW.
	• It is not expected there will be any measurable impacts to the historically cleared and infilled and Completely Degraded REWs UFI 8037 and portion of UFI 15257 within the MRS amendment area as a result of the proposed increase in groundwater recharge of the Superficial Aquifer. This is due to:
	  ○ the depth (4 m) from the natural ground surface to the Superficial Aquifer
	  ○ substantial portions of the mapped REWs areas have been infilled.
	• This section of Aboriginal Heritage site Brentwood Road Swamp (Site ID 4343) will predominately be in areas of POS and/or the existing Water Corporation pipeline / DBNGP easement areas. Future works undertaken in proximity to the Brentwood Road Swamp (Site ID 4343) will be undertaken in consultation with the Traditional Owner group.
	• Maintaining groundwater recharge and groundwater flow direction is a key principle informing the water management framework. The DBNGP easement will be utilised for open space with bio-retention basins/swales located adjacent (i.e. outside) to the easement.
	• The proposed POS and drainage basin areas will be defined and managed in accordance with the following sequential planning stages in accordance with the Better urban water management guidelines (WAPC 2008):
	  ○ Wattle Grove South LSP – will incorporate an LWMS (and surface water modelling) and landscape concept plan.
	  ○ Subdivision approval – which will require the following as conditions of approval:
	  ▪ UWMP (which includes detailed engineering designs of the drainage basin/swales).
	  ▪ Detailed landscape plan which incorporates the existing mature trees, streetscapes, POS areas and drainage basins/swales.	

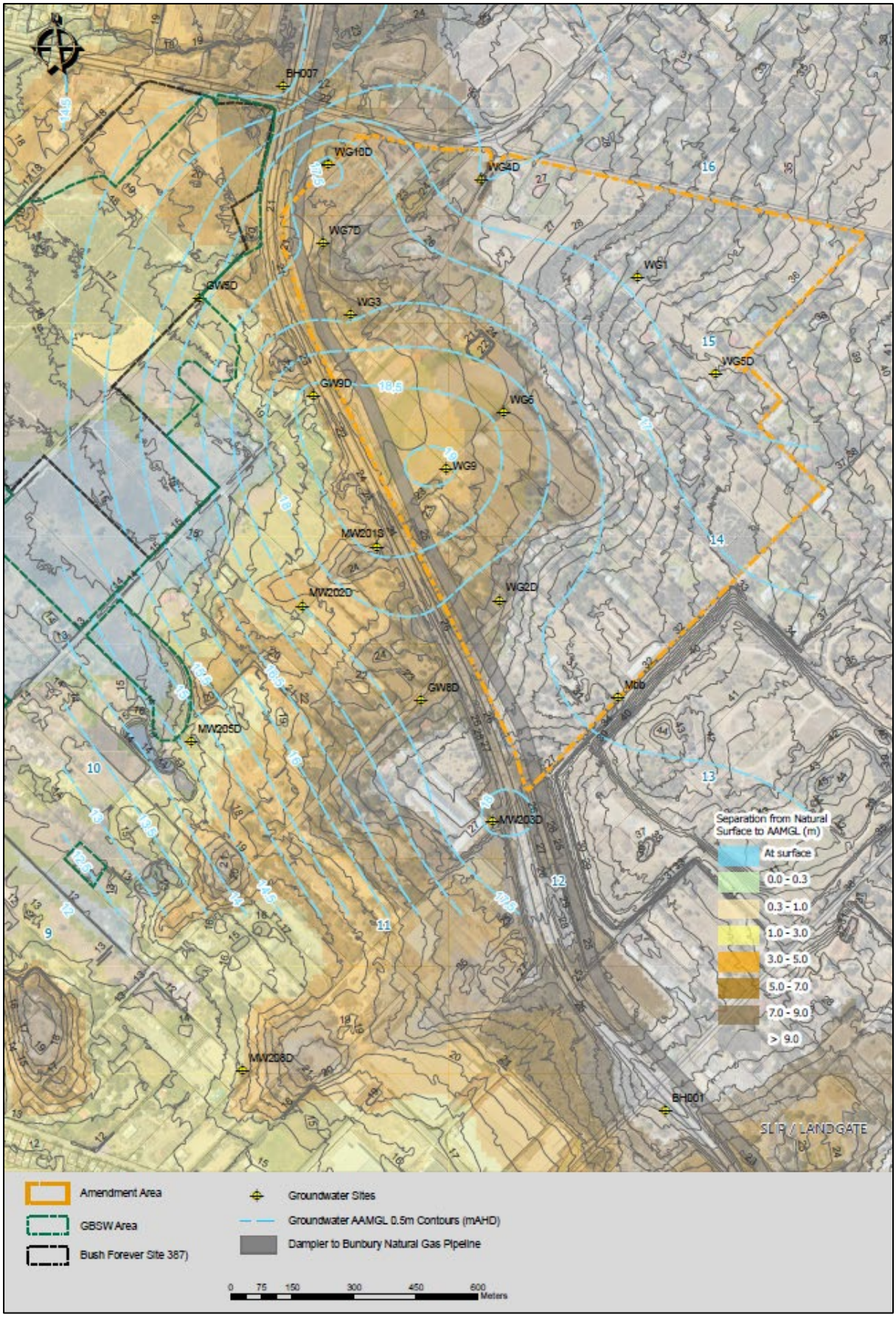

Figure 5-39: Separation Distance from the Natural Surface to AAMGL (Hyd2o 2024)

5.5.1.2 Assessment of impacts - Lot 501: CCWs (UFI 8026 and UFI 8027) and portion of REW UFI 15257 within the MRS amendment area

The wetland assessment identified there is currently no separation buffer from the two CCWs (UFI 8026 & UFI 8027) and portion of REW UFI 15257 within Lot 501. The mapped wetland and associated buffer area has been subject to historical anthropogenic impacts, specifically, the existing infrastructure corridors, which both frame and intrude into the mapped wetlands areas and immediate surrounds within Lot 501. Key infrastructure located immediately adjacent to or within the mapped wetland areas within Lot 501 include:

- Boundary Road reserve
- Tonkin Highway reserve and Welshpool Road reserve
- Water Corporation water pipeline easement
- DBNGP easement.

The existing infrastructure corridors are fixed and operational. These structures essentially frame and contain the limited wetland environmental and ecological values to entirely within Lot 501 without the application of any additional buffers to surrounding land uses i.e. landscape supply yard, Welshpool Road and Tonkin Highway. Importantly, the wetland assessment identified:

- The wetland/ecological values associated with the mapped CCWs (UFI 8026 and UFI 8027) and REW UFI 15257 do not extend outside of Lot 501.
- The MRS amendment does not alter the existing WAPC land management practices including regular mowing and slashing of the wetland areas to maintain the road reserves, Water Corporation pipeline and DBNGP easements as cleared areas.

In this context, the wetland assessment concluded the 20 m Boundary Road reserve provides an existing physical separation from the two CCWs (UFI 8026 and UFI 8027) and the portion of REW UFI 15257, and that the proposed 'Urban' land use zoning south of Lot 501 and Boundary Road reserve will not alter the hydrology, the existing ecological condition of the wetlands or the WAPC's existing land maintenance practices. This conclusion is supported by:

- The assessment of the two CCWs (UFI 8026 and UFI 8027) and portion of REW UFI 15257 within the MRS amendment area demonstrates the ecological values of these wetlands are more aligned with REW category and/or MUW category wetlands. This conclusion was underpinned by the following assessment:
    - Approximately 80% of Lot 501 has been historically cleared.
    - The historical and current land uses have created open cleared areas within the mapped wetland areas including:
        - Welshpool Road and Tonkin Highway reserves
        - DBNGP and Water Corporation easements
        - Boundary Road reserve.
    - Lot 501 is owned and managed by the WAPC and regularly maintained via slashing and mowing of the open grass and weed areas to uphold the road reserves, Water Corporation pipeline and DBNGP easements as cleared open areas.
    - Significant weed understory dominated by *Avena barbata* (wild oats), *Eragrostis curvula* (African lovegrass), *Ehrharta calycina* (perennial veldt grass) and *Watsonia meriana*.
- The separation distance to the Superficial Aquifer across Lot 501 (Figure 5-39).

The site review and wetland assessment concluded the existing ecological attributes and values of the two CCWs (UFI 8026 and UFI 8027) and the portion of REW (UFI 15257) within Lot 501 are aligned with REW and/or MUW categories.

Boundary Road provides an approximate 20 m permanent infrastructure barrier between the two CCWs within Lot 501 and the commercial landscape supply yard and semi-rural paddocks within the MRS amendment area.

Lot 501 is owned and managed by the WAPC as a 'Parks and Recreation' reserve. Lot 501 is located outside of the MRS amendment area. The MRS amendment does not propose to alter:

- the existing 'Parks and Recreation' land use zoning within Lot 501
- the WAPC's (the landowner) existing land management practices within Lot 501.

The WAPC as the landowner of Lot 501 (or MRWA as the proponent for the Tonkin Highway Grade Separated Interchanges proposal which intersections a portion of Lot 501) may seek to formally engage with DBCA for the purpose of amending the GWSCP dataset (specifically the category status of the two CCWs (UFI 8026 and UFI 8027) and the portion of REW (UFI 15257)) within Lot 501.

Hydrological impact assessment

No proposed physical disturbance to the wetlands, or the portion of the former Crystal Brook tributary located within Lot 501 is proposed as a result of the 'Urban' land use re-zoning. The wetlands are separated from the existing land uses within the MRS amendment area, (which includes commercial landscape supply yard and open semi-rural paddocks) by the 20 m Boundary Road reserve. The Boundary Road reserve and constructed road is managed by the City of Kalamunda.

Table 5-30 assesses the predicted surface and groundwater impacts to the two CCWs (UFI 8026 and UFI 8027) and the portion of REW UFI 15257 within Lot 501, located adjacent to the north-western boundary of the MRS amendment area. Figure 5-25 illustrates the proximity of the Boundary Road reserve and surrounding land uses to the two mapped CCWs (UFI 8026 and UFI 8027).

Table 5-30: CCWs (UFI 8026 and UFI 8027) and the portion of REW UFI 15257 within Lot 501 Groundwater and Surface Water Assessment

Wetland values	Assessment and predicted outcomes	Figures / Appendix
• **The two CCWs (UFI 8026 and UFI 8027) and the portion of REW UFI 15257 have both been subject to construction works and engineering fill.**	**Groundwater**	
	• The predicted 65,976 kL/year increase in groundwater recharge from 'Urban' land use (within the MRS amendment area and the UI and UE areas) is within the Superficial Aquifer which is several metres below natural surface (i.e. 4 m plus). • Groundwater flow was found to be radial with a mound evident along the central western boundary adjacent to Tonkin Highway. Flow within the MRS amendment area was found to generally range from north-west to south-east and away from the GBSW area. • Regional groundwater depth ranges from 4 m to 20 m below natural surface. • Groundwater flow direction in proximity to Lot 501 is predominately in an easterly and then north-westerly direction noting Guildford Formation clays intersect portions of Boundary Road. These clays form a hydrological barrier (i.e. lower permeability) to Superficial Aquifer flows.	• Figure 5-39 illustrates the separation distance from the natural surface to AAMGL. • The depth to groundwater in proximity to two CCWs (UFI 8026 and UFI 8027) and the portion of REW UFI 15257 is approximately 3 m - 4 m. • Figure 5-9 illustrates the local groundwater flow direction. • Figure 5-11 illustrates the groundwater contours and geological and geophysical interpretation
	Surface water	
	• The implementation of stormwater management including biofiltration and flood management areas will improve water quality and maintain the pre-development surface water flows towards the former Crystal Brook tributary, wetlands (within Lot 501) and the Boundary Road culvert.	• The Wattle Grove South DWMS (Hyd2o 2024) (Appendix B) incorporates Water Sensitive Urban Design principles including: ○ Post development stormwater flows are maintained consistent with existing conditions. • Figure 5-39 illustrates the Separation Distance from the Natural Surface to AAMGL (Hyd2o 2024).
	Predicted Outcomes	

	• It is not expected there will be any impacts to the Degraded CCWs (UFI 8026 and UFI 8027) and the portion of REW UFI 15257 due to the proposed increase in groundwater recharge of the Superficial Aquifer due to the depth (3 m – 4 m) from the natural ground surface to the Superficial Aquifer.
	• The stormwater basins located within the MRS amendment area will maintain the pre-development surface flow.
	• The proposed drainage basin areas will be defined and managed in accordance with the following sequential planning stages:
	  ○ Wattle Grove South LSP – will incorporate an LWMS (and surface water modelling) and landscape concept plan.
	  ○ Subdivision approval – which will require the following as conditions of approval:
	  ▪ UWMP (which includes detailed engineering designs of the drainage basin/swales).
	  ▪ Detailed landscape plan which incorporates the existing mature trees, streetscapes, POS areas and drainage basins/swales.	

Assessment of impacts - GBSW and Yule Brook: surface water flows

The MRS amendment area represents approximately 2% of the total Yule Brook catchment area and 15% of the GBSW area sub catchment. The MRS amendment area surface water contribution to the GBSW however is much less than 15%, because the Yoganup Formation (the dominant geology unit) within the MRS amendment area facilitates the infiltration of surface water into the Superficial Aquifer, reducing the surface water flows towards the GBSW.

Surface water flows within the MRS amendment area and downgradient within the MKSEA Precinct 2 landholding and the GBSW was subject to the following assessments:

- Wattle Grove South MRS Amendment: WBA (Emerge Associates 2024)
- Wattle Gove South DWMS (Hyd2o 2024)
- City of Gosnells TPS No. 6 Amendments 166 and 169: WBA (inclusive of surface water runoff and drainage modelling) (Emerge Associates 2023g)

The key conclusions from these assessments were:

- Surface water flows post-development from the MRS amendment area towards the GBSW area is predicted to increase by 24,524 kL/year assuming a 'fully developed scenario'. This predicted increase consists of:
    - 5,192 kL/year increase from the Boundary Road culvert
    - 19,332 kL/year increase from the Brentwood Road and Victoria Road culverts.

This represents a marginal increase from 7.8% pre-development to 9.6% post development of total outflow volumes. Noting, the surface water outflows from the UE and UI areas (under the 'fully developed' scenario) contributes 13,674 kL/year of surface water flows to the MRS amendment area.

This predicted post development flow increase (24,524 kL/year) is minor, particularly when it is compared against:

- **Total water balance:** The flow increase represents approximately 2% of the total water balance outflows.
- **GBSW rainfall:** Direct rainfall (annual average 758 mm/year) on the surface of the 215 ha GBSW area contributes 1,629,700 kL/year. The flow increase represents approximately 1.5% of annual rainfall volumes.
- **Yule Brook:** The Yule Brook has an estimated annual flow of 7,900,000 kL (SRT 2011). The flow increase represents only 0.3% of the Yule Brook estimated annual flow and is therefore considered negligible in comparison to interannual flow variability (Hyd2o 2024).
- If the MRS amendment area only was developed, the surface water changes for flows directly to the GBSW area from the MRS amendment area is negligible (-638 kL/year), with most flow change occurring where the site discharges to the MKSEA Precinct 2 landholdings and open drains (11,488 kL/year) (Emerge Associates 2024).

The predicted surface water flow increase post development:

- assumes the entire surface water volume (i.e. the 19,332 kL/year increase) from the Brentwood Road and Victoria Road culverts is directed to the GBSW.

The surface water modelling of the MKSEA Precinct 2 landholdings and GBSW identified (Emerge Associates 2023g):

- The Boundary Road culvert flows is the primary pathway and source of water runoff from the MRS amendment area into the GBSW area.
- Victoria Road and Brentwood Road culverts water flows conveyed into the MKSEA Precinct 2 landholdings (consisting of semi-rural, light industrial and commercial land uses). The surface water from the culverts is mixed/combined with the water runoff (via roadside drains/overland flows) within the MKSEA Precinct 2 landholdings. This water moves primarily in a westerly direction through a combination of overland flow, unlined open drains both within road reserves and between lots towards Bickley Road.
- In summary, only a portion of the total surface water flows (within the MKSEA Precinct 2 landholdings) is intercepted and directed in a north-west direction. This portion of water runoff is directed towards a central channel linking Boundary Road and Brook Road and ultimately discharging into the Yule Brook (Emerge Associates 2023g).
- The drains along road reserves and the central drainage channel within the GBSW efficiently captures and directs the water runoff (as well as intersected perched groundwater flows) towards the Yule Brook (Emerge Associates 2023g).

Figure 5-40 illustrates the surface water flow pathways into the GBSW and the proposed MKSEA Precinct 2 landholdings area.

The assessment of the surface water flows should be considered in the context of the potential impacts from climate change. Climate change is a pertinent consideration as monitoring of the Yule Brook annual flows have declined in recent years. The longer term (35 year) average annual flow is > 9,700,000 kL, whereas the shorter term (10 year) average annual flow is 8,200,000 kL, which shows a 15% decline of surface water runoff into the Yule Brook (Emerge Associates 2023g).

The modelling assessment of the climate scenarios concluded the most significant impact from the climate change scenarios is on surface water inflows and outflows from the MRS amendment area. The impacts from climate change impacts are defined in Section 5.5.1.4.

Predicted outcome

The MRS amendment area contributes a relatively small component of surface water inflow to the GBSW area compared to its other sources, surface flows are recognised as a key component of the wetlands hydrological water balance and the principle of maintaining pre and post development flow rates and volumes to the GBSW area has been used to inform the water management strategy and design.

The proposed 'Urban' land use within the MRS amendment area is an opportunity to improve the hydrological outcomes for the GBSW and Yule Brook in terms of both water quality and quantity. Best practice urban water management approaches will be adopted in alignment with:

- Environmental values and pressures for the Greater Brixton Street Wetlands on the Swan Coastal Plain (EPA 2022a)
- A Vision for Conservation and Public Enjoyment of the Greater Brixton Street Wetlands and eventual Yule Brook Regional Park (Beeliar Group 2018)

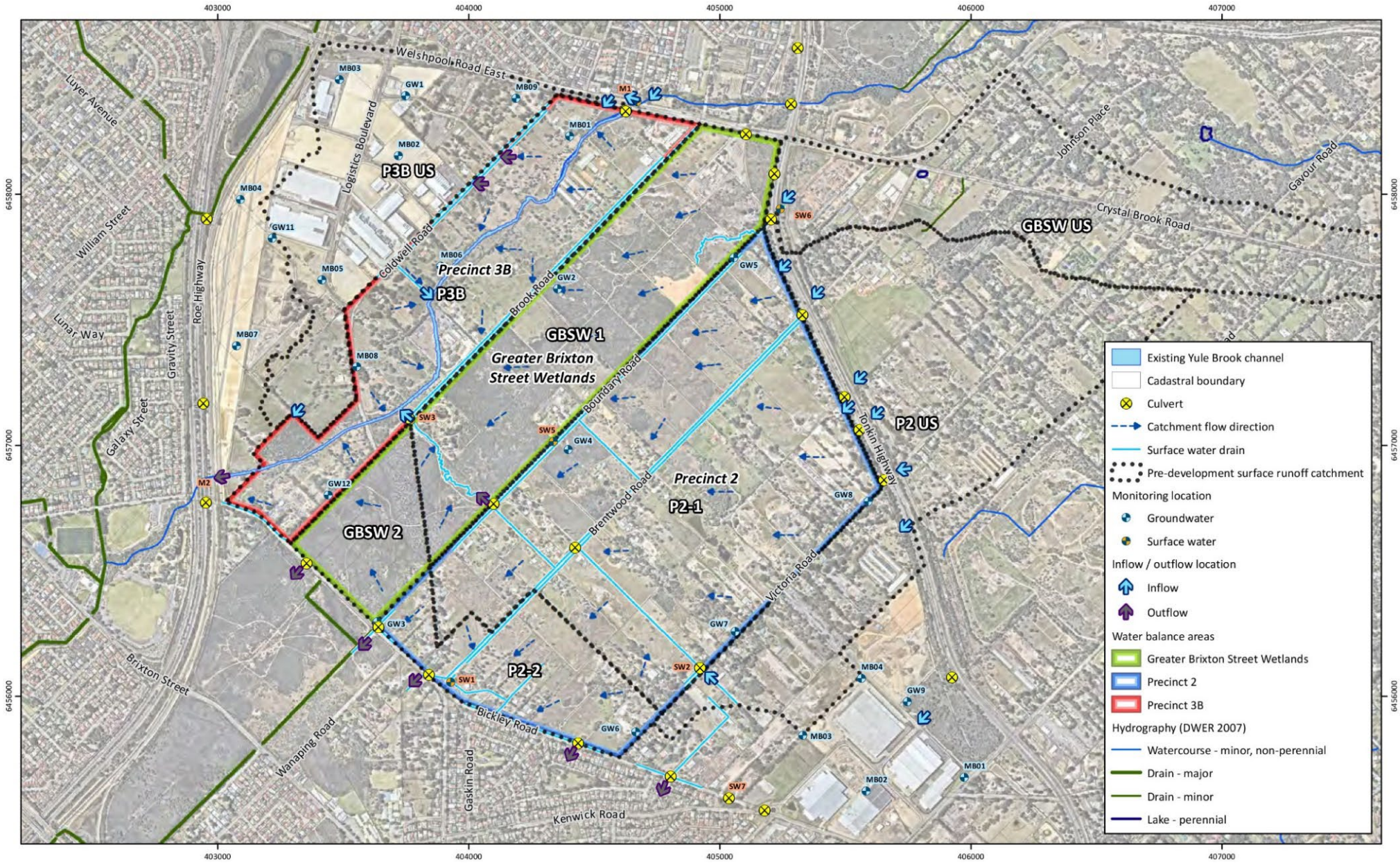

Figure 5-40: Surface Water Flow Pathways into the GBSW and the adjacent areas (Emerge Associates 2023g)

Key stormwater and water sensitive urban design management measures include (Hyd2o 2024):

- Implementation of stormwater management measures which includes maximising infiltration at source and mimicking natural flow paths and providing overland flow across vegetated surfaces to help to maintain water flows and improve water quality in accordance with Better urban water management (WAPC 2008) and the Stormwater management manual for WA (DWER 2022).
- Adoption of water quality treatment areas (i.e. biofiltration swales) to reduce nutrient application and output and improve water quality (relative to current conditions) and the downgradient ecological systems within the GBSW.
- The proposed 'Urban' land use will not alter the GBSW or Yule Brook surface water quantity flows through the adoption of the following measures:
    - Post development stormwater volumes and flows to be managed relative to existing conditions particularly in relation to the GBSW area i.e. no significant increase surface flow volumes post development.
    - The current seasonal hydroperiod for wetlands within the GBSW will not be altered.
    - Providing adaptive outlet structure for stormwater areas post development to combat the potential impacts from climate change and provide flexibility to adjust future stormwater outflow volumes from the MRS amendment area for the benefit of GBSW hydrology and groundwater dependent ecology.
    - Any future 'Urban' development within the UE and UI areas would be subject to:
        - WAPC initiated MRS Amendment which automatically triggers an EPA assessment
        - site specific hydrological (surface water and groundwater) and geological assessments
        - preparation of a DWMS in accordance with Better urban water management (WAPC 2008) which defines the stormwater management framework.

Application of the Better urban water management (WAPC 2008) requirements and the Stormwater management manual for WA (DWER 2022) to the proposed 'Urban' land use within the MRS amendment area would improve:

- surface water quality
- reduce water quality impacts on the GBSW and the Yule Brook, while maintain existing flow volumes.

No significant impacts to surface water cycles and significant downgradient wetlands and waterways (including the Yule Brook and the GBSW) are expected are predicted, because even under the 'fully developed scenario' the UE and UI areas contribute a predicted 13,674 kL/year of additional surface water which is considered minor.

Assessment of impacts - GBSW and Yule Brook: groundwater

<u>Perched groundwater</u>

Six bores were installed within the MRS amendment area to assess the potential of perched groundwater. Data recorded from these locations typically represent a perched groundwater level which temporarily forms for several months above the Guilford Clay Formation alluvial geology, rather than the regional, Superficial Aquifer groundwater table.

Some perching is evident in groundwater levels in the north-western corner of the MRS amendment area near Tonkin Highway, no perching was evident at most bores. There are a small number of unlined drains in the MRS amendment area, near Brentwood Road and Crystal Brook Road, which are located below the perched water table and drain toward the culvert under Tonkin Highway and the

GBSW area. Development within this portion of the MRS amendment area will provide an opportunity for treatment and improved management of any flows.

Figure 5-33 highlights the differences in groundwater depth and perched/regional interactions at the MRS amendment area in comparison to the lower lying areas of the GBSW area south of Tonkin Highway, where the Superficial Aquifer is much closer to the natural surface (Hyd2o 2024). In areas along the western side of Tonkin Highway (i.e. in the GBSW) perching was found to occur 1 m to 3 m above the Superficial Aquifer.

Within the MRS amendment area, the seasonal perched system is limited to small areas along the western and north-western portions of the MRS amendment area. The Tonkin Highway acts as an impermeable flow boundary, excluding shallow perched groundwater flows in a westerly direction (given likely removal of the shallow soil profile during construction). The presence of the DBNGP at this boundary is also expected to facilitate downward infiltration of shallow perched groundwater to the deeper sandy layer (Emerge Associates 2024).

Groundwater mound

The groundwater monitoring program observed the presence of a groundwater mound within the vicinity of the former turf farm. The mound has resulted in a rise in the Superficial Aquifer groundwater table. The groundwater rise associated with the mound extends west to north-west (to include the north-eastern portion of the GBSW) for approximately 1.5 km. This localised rise in the Superficial Aquifer groundwater table ranges from:

- a maximum of 5 m to 4 m (above the regional groundwater table) within 600 m west of the turf farm.
- reducing to 3 m to 1 m (above the regional groundwater table) between 700 m and 1,500 m from the western boundary of the turf farm.

Figure 5-12 shows the existing groundwater mound contour in metres above the regional AAMGL.

The mound is a result of the historical irrigation of the turf farm (i.e. sourcing groundwater from the deeper Leederville Aquifer) and the local geology (i.e. non-contiguous Guildford Formation clay layers) (Hyd2o 2024).

Typically, abstraction of Superficial Aquifer groundwater (i.e. for watering of POS and school ovals) and subsequent evapotranspiration losses associated with the 'Urban' land use is expected to result in reducing local groundwater levels. However, the groundwater mound beneath the former turf farm provided an additional source of water (i.e. lower permeability clay dominated geology from the deeper Leederville Aquifer) to the Superficial Aquifer that exceeded the additional losses to evapotranspiration from irrigation (which is expected to be around 80% of irrigated water). Based on the observed groundwater mounding, it is assumed that the 176,000 kL/year allocation was being abstracted from the underlying Leederville Aquifer.

Both the gradient and direction of groundwater flow across the MRS amendment area is influenced by the groundwater mound underlying the former turf farm, however the effect is lessened as spatial separation from this groundwater mound increases i.e. approximately 1.5 km to the west.

The turf production and its irrigation appear to have ceased around April 2023. The cessation of the turf farm's irrigation will affect the Superficial Aquifer levels locally i.e. reduction in the water table. Groundwater monitoring post April 2023 confirms groundwater levels in the Superficial Aquifer immediate vicinity of the turf farm have reduced with hydrographs based on the nearest bores to the turf farm showing:

- Bore WG6: Winter peak, pre ceasing of the irrigation ranged between 19.5 m AHD – 19.7 m AHD. Post ceasing of irrigation the winter peak water levels decreased to 18.5 m AHD.
- Bore WG9: Winter peak, pre ceasing of the irrigation ranged between 18.5 m AHD – 18.3 m AHD. Post ceasing of irrigation the winter peak water levels decreased by 1.5 m to 16.8 m AHD at the 2023 winter peak.

The cessation of the turf farm irrigation (from the Leederville Aquifer) has the following unintentional hydrological outcomes for the groundwater mound within the Superficial Aquifer:

- Reduction of the groundwater levels which have been kept at an elevated level (i.e. between 1 m to 5 m for the past 20 years).
- This reduction in groundwater level elevation will extend approximately 1.5 km west and north-west into the GBSW. The extent to which the ceased irrigation at the turf farm from the Leederville Aquifer will impact groundwater levels locally is difficult to quantify given the variable geology (i.e. Guildford Formation soils) in the local area of the mound.

A key principle adopted within the Wattle Grove South DWMS (Hyd2o 2024) is to maintain pre-development conditions by locating stormwater management areas in the vicinity of the existing groundwater mound to maintain the annual pre-development groundwater recharge and flow directions at that location. To assess the ability to achieve this outcome, the DWMS (Hyd2o 2024) assessed the groundwater recharge to the Superficial Aquifer, based on the information presented in the WBA, under the following three scenarios:

- across the entire MRS amendment area
- within a 29 ha area that encompassed the groundwater mound
- localised 14 ha area associated with the existing turf farm.

Figure 5-41 spatially illustrates the location of the recharge scenarios.

The results of the groundwater recharge assessment for each of the three scenarios are presented in Figure 5-42, Figure 5-43 and Figure 5-44.

Results from the Superficial Aquifer recharge assessment indicate there is an overall minor increase in annual groundwater recharge across the MRS amendment area post development (assuming a 'fully developed scenario'). This assessment demonstrates post development the combination of recharge and targeted stormwater management can maintain the influence of the mound comparable with pre-development hydrological conditions (Hyd2o 2024).

The strategy modelled to achieve this outcome was based on:

- stormwater biofiltration and flood management areas to be focussed to the area of the groundwater mound on the eastern side of Tonkin Highway in the vicinity of the former turf farm
- lot soakwells to be adopted for almost all lots within the wider 50.5 ha contributing stormwater catchment for this area, with a small area of lot connections.

Alternative approaches include supplementary Leederville Aquifer recharge via irrigation to:

- strategically located POS areas.
- local primary school oval (located within the turf farm area).

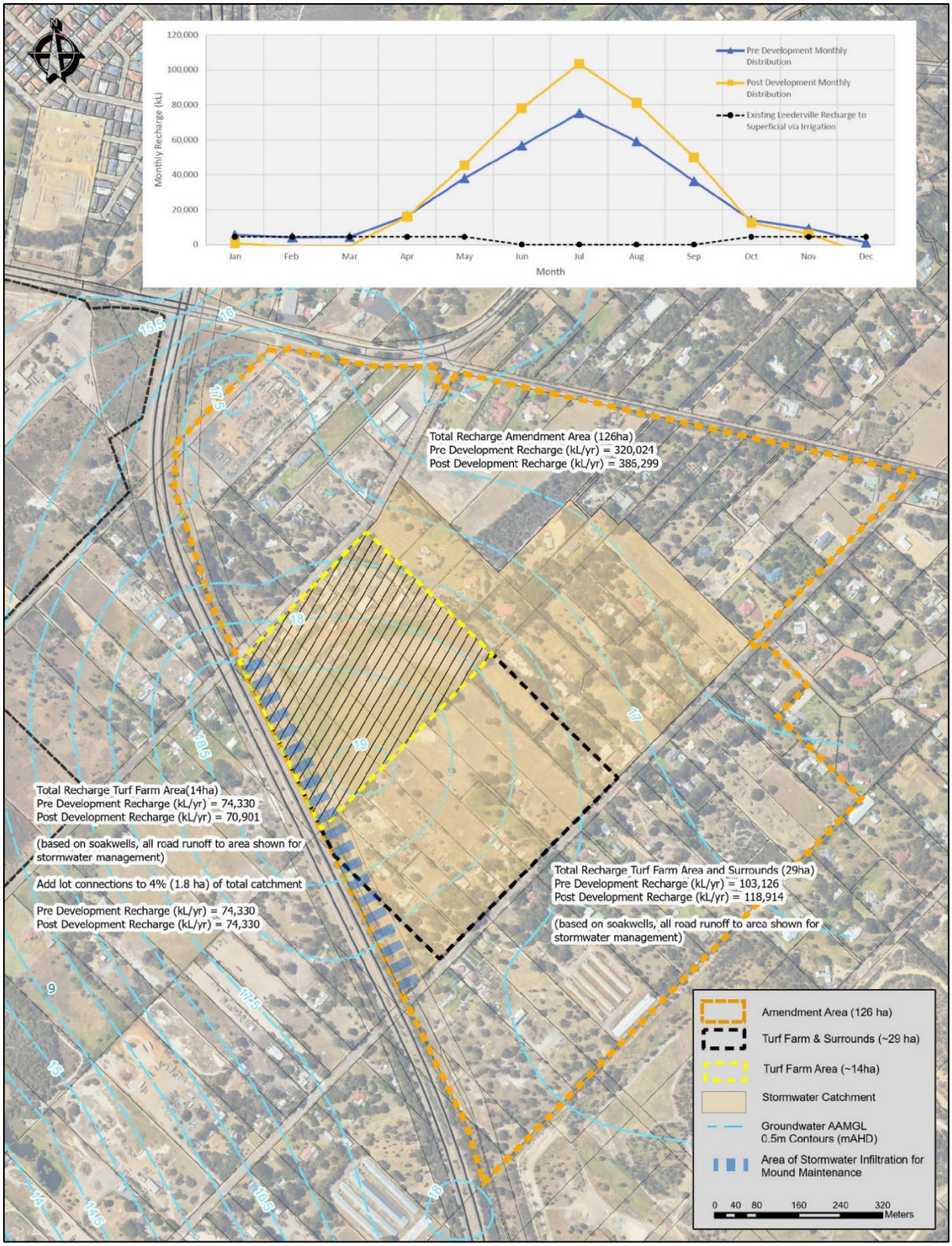

Figure 5-41: Superficial Aquifer recharge option assessment (pre and post development) to the groundwater mound (Hyd2o 2024).

Pre Development & Post Development Recharge Comparison

Assessment Scale : Amendment Area (126 ha)

		Pre Dev		Post Dev
Irrigation via Groundwater Leederville (kL/yr)		176,000		0
RECHARGE	20%	35,200	20%	0
Irrigation via Domestic Supply (IWS) (kL/yr)		32,500		46,000
RECHARGE	20%	6,500	20%	9,200
Irrigation via Groundwater Superficial (kL/yr)		84,655		123,694
RECHARGE	20%	16,931	20%	24,739
Recharge Total Above (kL/yr)		58,631		33,939
Including Local Superficial Use (kL/yr)		-26,024		-89,755
Rainfall Recharge (kL/yr) - via Emerge (2024)		346,048		476,054
Total Recharge Within Amendment Area (kL/yr)		**320,024**		**386,299**

Pre Development Monthly Distribution

	Rainfall	Leederville	IWSS	Superficial	TOTAL
Jan	8,413	4,400	1,083	-8,466	5,431
Feb	7,047	4,400	1,083	-8,466	4,065
Mar	7,322	4,400	1,083	-8,466	4,340
Apr	19,494	4,400	1,083	-8,466	16,512
May	42,080	4,400	0	-8,466	38,014
Jun	56,715	0	0	0	56,715
Jul	75,272	0	0	0	75,272
Aug	59,015	0	0	0	59,015
Sep	36,328	0	0	0	36,328
Oct	18,065	4,400	0	-8,466	13,999
Nov	12,231	4,400	1,083	-8,466	9,249
Dec	4,065	4,400	1,083	-8,466	1,083
	346,048	35,200	6,500	-67,724	**320,024**

Post Development Monthly Distribution

Rainfall	Leederville	IWSS	Superficial	TOTAL
11,574	0	1,533	-12,369	738
9,695	0	1,533	-12,369	-1,141
10,073	0	1,533	-12,369	-763
26,818	0	1,533	-12,369	15,981
57,888	0	0	-12,369	45,519
78,022	0	0	0	78,022
103,551	0	0	0	103,551
81,187	0	0	0	81,187
49,976	0	0	0	49,976
24,851	0	0	-12,369	12,482
16,827	0	1,533	-12,369	5,991
5,592	0	1,533	-12,369	-5,244
476,054	0	9,200	-98,955	**386,299**

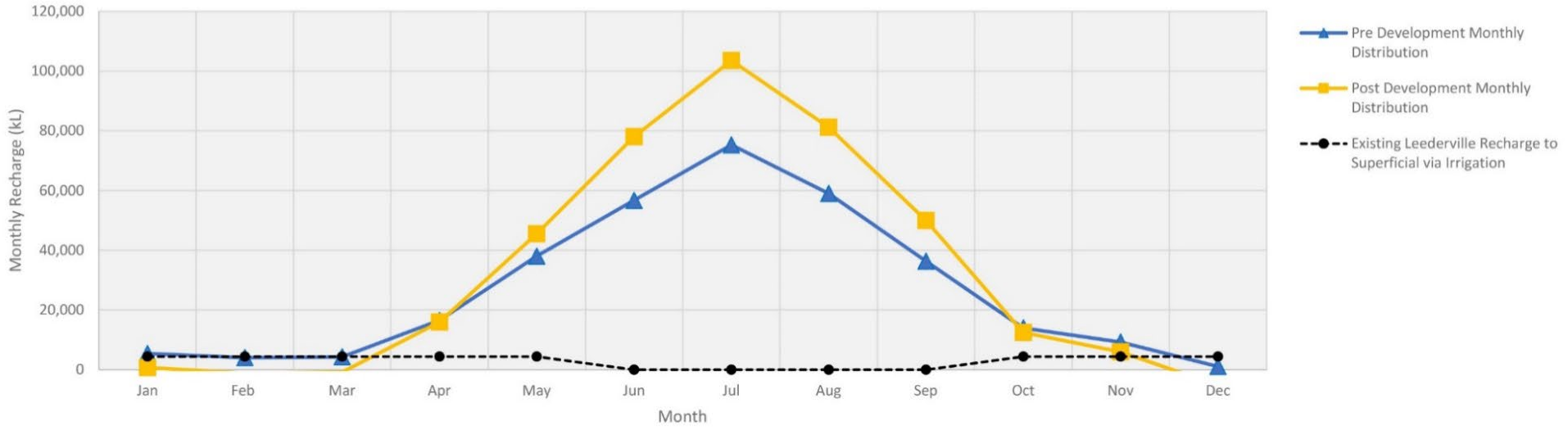

Figure 5-42: Recharge across the entire MRS amendment area (Hyd2o 2024)

Pre Development & Post Development Recharge Comparison

Assessment Scale : Turf Farm Area and Surrounds (29 ha)

	Pre Dev	Post Dev
Area Considered for Analysis (ha)	29.3	29.3
Extenal Stormwater Catchment to be Managed in Area (ha)	0.0	21.2
Annual Rainfall (mm)	758	
Rainfall Recharge (via Emerge 2024) (%)	37%	51%
Volume of Rainfall Recharge (kL/yr)	82,175	113,268
Irrigation via Leederville Aquifer (kL/yr)	176,000	0
Irrigation Recharge (via Emerge 2024) (%)	20%	20%
Volume of Recharge via Leederville Irrigation (kL/yr)	35,200	0
Superficial Area Abstraction in Area (kL/yr) (via Water Register, & post dev pro rata)	19,700	10,697
Net Abstraction Following Recharge Consideration (%)	80%	80%
Volume Abstracted from Superficial (kL/yr)	15,760	8,557
Irrigation via IWSS		
Total for Amendment Area (via Emerge, 2024) (kL/yr)	32,500	46,000
Local Mound Area as % of total Amendment Area	23%	23%
Irrigation Recharge (via Emerge 2024) (%)	20%	20%
Volume of Recharge via IWSS Irrigation (kL/yr)	1,512	2,139
Post Development Infiltration in Area of Current Mound via External Catchment		
Road Area providing minor event runoff (25% of area assumed) (ha)		5.3
% Rainfall managed/retained in 15mm Areas, via Emerge (2024) 8% annual runoff		92%
% Runoff via road reserves in minor events (via stormwater modelling, Appendix P)		64%
Recharge (via Emerge 2024) (%)		51%
Volume of Stormwater Recharge (kL/yr)		12,064
Total Recharge Within Amendment Area (kL/yr)	**103,126**	**118,914**

Pre Development Monthly Distribution

	Rainfall	Leederville	IWSS	Superficial	TOTAL
Jan	1,998	4,400	252	-1,970	4,680
Feb	1,674	4,400	252	-1,970	4,355
Mar	1,739	4,400	252	-1,970	4,421
Apr	4,629	4,400	252	-1,970	7,311
May	9,992	4,400	0	-1,970	12,422
Jun	13,468	0	0	0	13,468
Jul	17,875	0	0	0	17,875
Aug	14,014	0	0	0	14,014
Sep	8,627	0	0	0	8,627
Oct	4,290	4,400	0	-1,970	6,720
Nov	2,905	4,400	252	-1,970	5,586
Dec	965	4,400	252	-1,970	3,647
	82,175	35,200	1,512	-15,760	**103,126**

Post Development Monthly Distribution

	Rainfall	Leederville	IWSS	Superficial	Stormwater	TOTAL
Jan	2,754	0	357	-1,070	293	2,334
Feb	2,307	0	357	-1,070	246	1,839
Mar	2,397	0	357	-1,070	255	1,939
Apr	6,381	0	357	-1,070	680	6,347
May	13,773	0	0	-1,070	1,467	14,171
Jun	18,564	0	0	0	1,977	20,541
Jul	24,638	0	0	0	2,624	27,262
Aug	19,317	0	0	0	2,057	21,374
Sep	11,891	0	0	0	1,266	13,157
Oct	5,913	0	0	-1,070	630	5,473
Nov	4,004	0	357	-1,070	426	3,717
Dec	1,331	0	357	-1,070	142	759
	113,268	0	2,139	-8,557	12,064	**118,914**

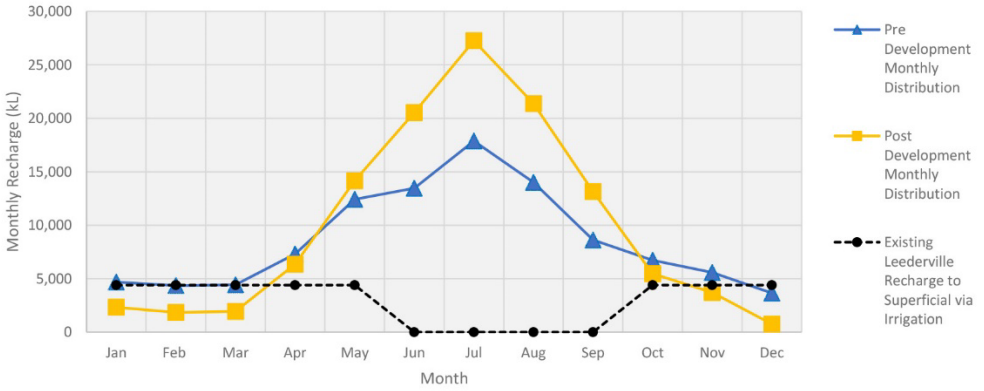

Figure 5-43: Recharge across the turf farm and surrounds (29 ha) within the MRS amendment area (Hyd2o 2024).

Pre Development & Post Development Recharge Comparison

Assessment Scale : Turf Farm Area (14 ha)

	Pre Dev	Post Dev
Area Considered for Analysis (ha)	13.7	13.7
Extenal Stormwater Catchment to be Managed in Area (ha)	0.0	36.8
Annual Rainfall (mm)	758	
Rainfall Recharge (via Emerge 2024) (%)	37%	51%
Volume of Rainfall Recharge (kL/yr)	38,423	52,961
Irrigation via Leederville Aquifer (kL/yr)	176,000	0
Irrigation Recharge (via Emerge 2024) (%)	20%	20%
Volume of Recharge via Leederville Irrigation (kL/yr)	35,200	0
Superficial Area Abstraction in Area (kL/yr) (via Water Register, & post dev pro rata)	0	5,002
Net Abstraction Following Recharge Consideration (%)	80%	80%
Volume Abstracted from Superficial (kL/yr)	0	4,002
Irrigation via IWSS		
Total for Amendment Area (via Emerge, 2024) (kL/yr)	32,500	46,000
Local Mound Area as % of total Amendment Area	11%	11%
Irrigation Recharge (via Emerge 2024) (%)	20%	20%
Volume of Recharge via IWSS Irrigation (kL/yr)	707	1,000
Post Development Infiltration in Area of Current Mound via External Catchment		
Road Area providing minor event runoff (25% of area assumed) (ha)		9.2
% Rainfall managed/retained in 15mm Areas, via Emerge (2024) 8% annual runoff		92%
% Runoff via road reserves in minor events (via stormwater modelling, Appendix P)		64%
Recharge (via Emerge 2024) (%)		51%
Volume of Stormwater Recharge (kL/yr)		20,941
Total Recharge Within Amendment Area (kL/yr)	**74,330**	**70,901**
Area of Lot Connections Required to Provide Annual Recharge Balance		
Overall Recharge Change Pre to Post Dev Above (kL/yr)		-3429
External Stormwater Catchment Area (ha)		50.5
Lot Area in Stormwater Catchment (25% roads, 10% POS) (ha)		65%
Lot Connection Runoff (assumed via impervious area of lot)		75%
Total Additional Stormwater Runoff Volume from all lots (kL/yr)		186610
Recharge (via Emerge 2024) (%)		51%
Volume of Recharge for Lot Connections Across Whole Catchment		95171
% of Lots Required to have Lot Connections to Balance Recharge		4%
Area of Lot Connection (ha)		1.8
Total Recharge Within Amendment Area (kL/yr)	**74,330**	**74,330**

Pre Development Monthly Distribution

	Rainfall	Leederville	IWSS	Superficial	TOTAL
Jan	934	4,400	118	0	5,452
Feb	783	4,400	118	0	5,300
Mar	813	4,400	118	0	5,331
Apr	2,164	4,400	118	0	6,682
May	4,672	4,400		0	9,072
Jun	6,297				6,297
Jul	8,358				8,358
Aug	6,553				6,553
Sep	4,034				4,034
Oct	2,006	4,400		0	6,406
Nov	1,358	4,400	118	0	5,876
Dec	451	4,400	118	0	4,969
	38,423	35,200	707	0	**74,330**

Post Development Monthly Distribution

	Rainfall	Leederville	IWSS	Superficial	Stormwater	TOTAL	Lot X	TOTAL
Jan	1,288	0	167	-500	509	1,463	83	1,547
Feb	1,079	0	167	-500	426	1,172	70	1,241
Mar	1,121	0	167	-500	443	1,230	73	1,303
Apr	2,983	0	167	-500	1,180	3,830	193	4,023
May	6,440	0		-500	2,546	8,486	417	8,903
Jun	8,680				3,432	12,112	562	12,674
Jul	11,520				4,555	16,075	746	16,821
Aug	9,032				3,571	12,603	585	13,188
Sep	5,560				2,198	7,758	360	8,118
Oct	2,765	0		-500	1,093	3,358	179	3,537
Nov	1,872	0	167	-500	740	2,279	121	2,400
Dec	622	0	167	-500	246	535	40	575
	52,961	0	1,000	-4,002	20,941	**70,901**	3,429	**74,330**

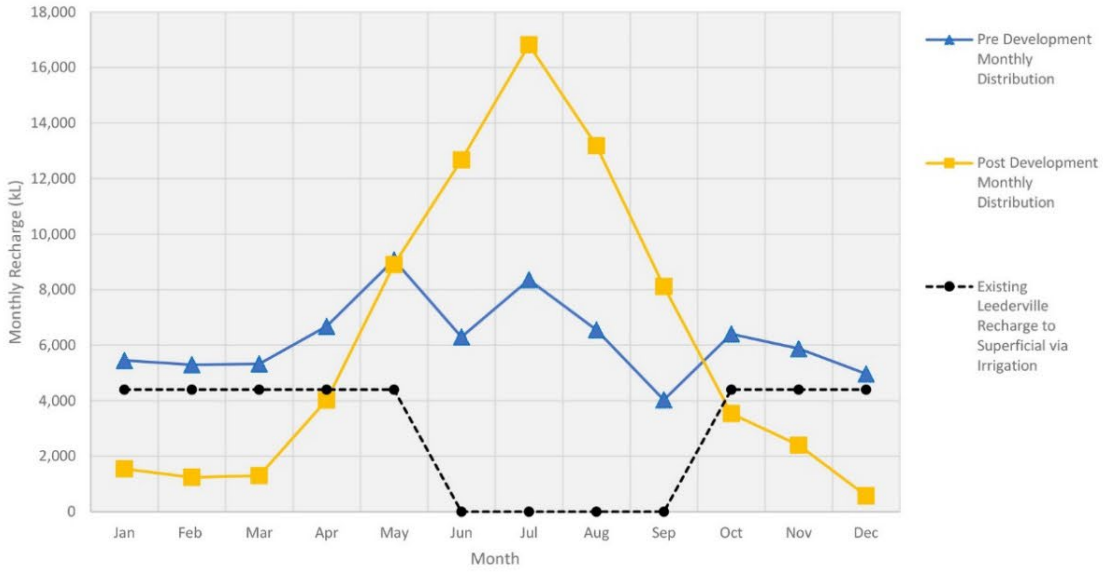

Figure 5-44: Recharge within the turf farm only (14 ha) within the MRS amendment area (Hyd2o 2024).

Superficial Aquifer

Pre-development, the groundwater contours for the Superficial Aquifer across the MRS amendment area range from approximately 16 m AHD in the north-eastern region to approximately 19 m AHD on the western boundary, with a groundwater depth ranging from 4 m to 20 m below natural surface.

Post development assuming a 'fully developed scenario' the increase in the Superficial Aquifer from surface water recharge is 65,976 kL/year. The proposed 'Urban' land use will therefore increase groundwater levels due to reduced evapotranspiration and greater infiltration and recharge of the superficial aquifer, via runoff from roads, roofs, and other hard surfaces.

Site specific data has defined the local geology and groundwater contour mapping and groundwater flow direction, specifically:

- Groundwater flow was found to be radial with a mound evident along the central western boundary adjacent to Tonkin Highway. Flow within the MRS amendment area was found to generally range from north-west to south-east and away from the GBSW area. Regional groundwater depth ranged from 4 m to 20 m below natural surface (Figure 5-9).
- The MRS amendment area has good clearance to the Superficial Aquifer from permeable Yoganup Formation soils in contrast with the Guildford Formation geology and associated shallow perched groundwater within the GBSW area.
- There are no unlined open drains within the MRS amendment area which intercepts the Superficial Aquifer (Hyd2o 2024).
- The ceasing of the turf farm irrigation (from the Leederville Aquifer) will alter the groundwater mound which will result in a reduction of the groundwater levels from the turf farm extending approximately 1.5 km west and north-west into the GBSW.

Importantly, the increase in groundwater recharge in combination with locating stormwater management areas in the vicinity of the existing groundwater mound underpin the key hydrological objective of:

- Maintaining the groundwater mound consistent with pre-development environment.

Maintaining post development recharge around the groundwater mound is a key principle for the proposed stormwater management system within the MRS amendment area, in order to meet the EPA's objective for Inland Waters, which is to maintain the existing hydrological regime and existing groundwater flows at this location post development.

By maintaining the groundwater mound (consistent with pre-development conditions), via groundwater recharge and focused surface water infiltration (in drainage basins/swales in the vicinity of the mound) post-development groundwater flows and elevation are expected to be broadly comparable with pre-development conditions. Groundwater flow within the Superficial Aquifer will continue to flow radially away from the mound. Groundwater that flows towards the west will remain comparable to pre-development flows.

The assessment concludes there will be no impact(s) to Superficial Aquifer groundwater flows towards the GBSW or the Yule Brook from the proposed 'Urban' land use. The groundwater assessment was premised on the 'fully developed scenario'.

The Superficial Aquifer is several metres (4 m plus) below the shallow perched conditions experienced along the western boundary of the MRS amendment area and the portion of GBSW on the western side of Tonkin Highway. Accordingly, the minor change in groundwater recharge will not affect localised perched water conditions beneath GBSW (Figure 5-39).

The historical research and investigations on the hydrogeological drivers draw the following conclusions on the interaction between the Superficial Aquifer and the perched water table and wetlands within the GBSW:

- The GBSW geological contains heterogeneous sands, clays, and muds sediment layers associated with the Guildford Formation. Hydro geologically this has created:
    - thin layer of seasonally saturated clayey-sand and sand forming a perched water table which sits above lower permeable heavier clays layers which in turn overlies the Superficial Aquifer
    - potential localised lens of sand dominated geology with higher permeable soils.
- Any hydrological connectivity between the Superficial Aquifer and the perched water table, and wetland(s) would generally occur when:
    - Superficial Aquifer is at its seasonal winter peak and/or the perched water table is saturated
    - rainfall and the surface runoff exceed the soils saturated hydraulic conductivity.
- Accordingly, any connections between the Superficial Aquifer, the perched water table and wetlands would not be spatially uniform across the entirety of the GBSW area, or the interaction is possibly limited to minor leakage through heavy clay layers.

Figure 5-45 presents a conceptual hydrogeological cross section of the eastern portion of the MRS amendment area through to the GBSW and provides a spatial understanding of the geological formations and the hydrological systems, including the perched water table and Superficial Aquifer.

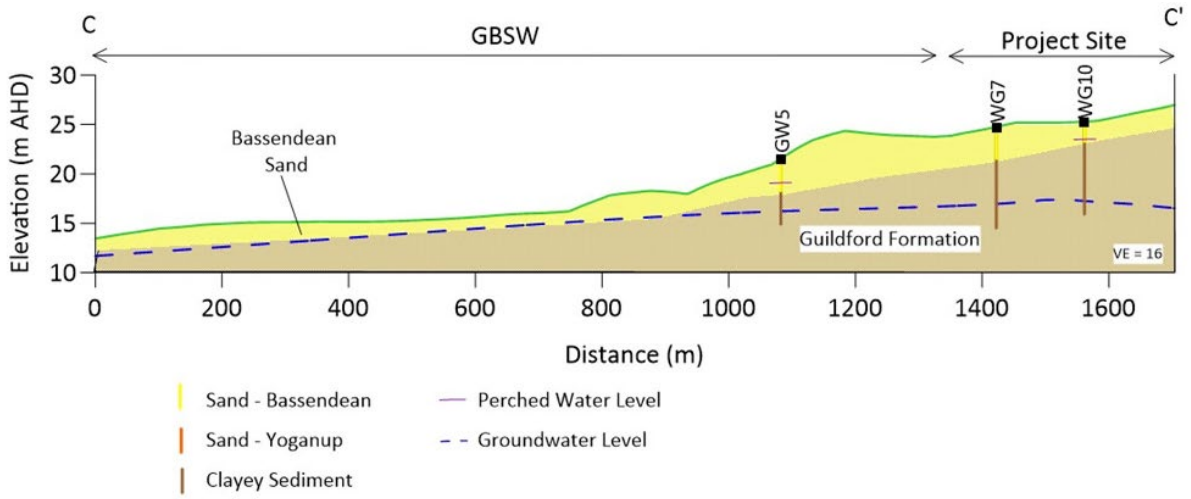

Figure 5-45: Shallow hydrogeological cross-section within the GBSW (Rockwater 2023)

Predicted outcome

The key predicted outcomes are:

- maintenance of the groundwater mound
- minor increase in the groundwater through flow through within the Superficial Aquifer.

Groundwater mound

The predicted post development increase in groundwater recharge into the Superficial Aquifer from soakwells, stormwater biofiltration and flood management areas focussed in the area of the existing mound adjacent to Tonkin Highway balances the reduction in the groundwater mound levels as a

result of ceasing irrigation from the Leederville Aquifer beneath the turf farm (Hyd2o 2024). The irrigation has recently ceased irrespective of the proposed 'Urban' land use change.

The result of the WBA (Emerge Associates 2024) shows that there is a net increase in available water, attributable to the increased areas of impermeable surface and removal of pasture and vegetated areas that will likely occur as a result of urbanisation within the MRS amendment area and UE and UI areas. These land use changes affect evapotranspiration, surface runoff and drainage which in turn result in an overall increase in available water within the MRS amendment area. The permeability of soils within the MRS amendment area (specifically the Yoganup Formation and Bassendean Sands), and the ability for stormwater management infrastructure to be located within permeable areas, increases the water available to recharge into the Superficial Aquifer.

This increase in recharge will assist, in combination with the DWMS stormwater management approach to maintain the pre-development conditions i.e. the presence of existing groundwater mound. Accordingly, post-development:

- groundwater flows are expected to be comparable with pre-development conditions and will continue to flow radially away from the mound
- groundwater flows towards the west will remain comparable with the pre-development flows and is not expected to impact GBSW (Emerge Associates 2024).

Groundwater through flow

A minor increase in Superficial Aquifer through flows (65,976 kL) is predicted under a 'fully developed scenario'. The risk(s) of this minor change to groundwater flow within the Superficial Aquifer is not considered significant due to:

- The recharge flow being within the deeper Superficial Aquifer (i.e. not the shallow perched water table).
- The groundwater through flow will be consistent with the pre-development flow directions, which is predominantly in a north-west to south-east and away from the GBSW area.
- The GBSW is situated atop of the alluvial Pinjarra Plain which is characterised by soils of the Guildford Formation. Within areas of the GBSW, the Guildford Formation clay form layers a complex sequence of clay lenses that are laterally and vertically varied which form a low permeable barrier between the perched water table, wetlands and the Superficial Aquifer.
- Key conclusions from hydrological assessment within the GBSW area confirm rainfall and ground water perching are the dominant hydrological process, for example:
    - Semeniuk (2001) reported the wetlands within the GBSW area were maintained by surface and near surface perching of direct precipitation and by infiltration. During periods of below average rainfall groundwater in the Superficial Aquifer was considered likely to play only a minor part on the maintenance of the wetlands, with the major recharge mechanism for the wetlands identified as being direct precipitation, perching, infiltration, and sub surface perching.
    - Bourke (2017) concluded in agreement with previous investigations that the GBSW area was predominately a surface water feature and reliant largely on rainfall and surface water inflow.
- The interaction between the Superficial Aquifer and the perched groundwater table within the GBSW is unlikely to be spatially uniform across the GBSW (or the interaction is possibly limited to minor leakage through heavy clay layers).

The Wattle Grove South DWMS (Hyd2o 2024) promotes an adaptive management approach for the MRS amendment area which is underpinned by the continued implementation of the current

groundwater and surface water monitoring program as defined in Table 5-8 and Table 5-11. Figure 5-7 shows the local groundwater monitoring locations.

The monitoring program and reporting framework encapsulates monitoring of the Superficial Aquifer groundwater levels (both near the turf farm and in the GBSW). This will enable:

- a comparative review of seasonal groundwater contours and flow direction pre-and post-development
- the influence of the groundwater mound post development.

By assessing the monitoring data, adaptive management approaches should be applied to mitigate (i.e. maintain the groundwater mound) any potential impacts as development precedes (Hyd2o 2024). Adaptive management measures, if required, to maintain the mound could include:

- Supplementary Leederville Aquifer recharge via irrigation to:
    - strategically located POS areas
    - local primary school oval (located within the turf farm area).

5.5.1.3 Impacts to water quantity and quality of significant wetlands and waterways within and nearby to the MRS amendment area.

Significant wetlands and waterways

The identified significant wetlands and waterways within and nearby the MRS amendment area include:

- MRS amendment area (Figure 5-21,Figure 5-22 and Figure 5-23)
    - REWs (UFI 8037 and portion of UFI 15257).
- Lot 501 (Figure 5-21 and Figure 5-24)
    - CCWs UFI 8026 and UFI 8027 and portion of REW UFI 15257.
- GBSW area (Figure 5-21 and Figure 5-26)
    - GBSW comprises a complex of significant wetlands, including areas of seasonally waterlogged flats (palusplain) and seasonally inundated basins (sumplands).
- Yule Brook (Figure 5-21 and Figure 5-26)

Assessment of impacts - Water quality assessment

Impacts to water quantity of significant wetlands and waterways was addressed in the previous assessment on potential alterations to current surface and ground water cycles.

This impact assessment addresses the potential impacts to water quality on significant wetlands and waterways within and nearby to the MRS amendment area.

A nutrient input and export rate assessment using DWER's UNDO model was undertaken for the pre-development and the proposed post development 'Urban' land use. The UNDO modelling of the post development scenario compared with the current land uses is shown in Table 5-31.

Table 5-31: Nutrient inputs and outputs from the proposed 'Urban' land use (Hyd2o 2024)

Nutrient	Annual input (kg)	Annual export (kg)
Total Nitrogen (TN) (kg/yr)	5,148	130.0
% Change (compared to existing land use)	-63%	-61%
Total Phosphorous (TP) (kg/yr)	891	7.5
% Change (compared to existing land use)	-37%	-60%

The post development UNDO modelling shows a positive impact from the proposed land use change with respect to nutrient application and export. The predicted reductions in nutrients exported from the MRS amendment area will significantly benefit the wetlands within the GBSW area and Yule Brook (Hyd2o 2024). Particularly as it is acknowledged the unique vegetation communities associated with the GBSW landscape have evolved to survive in nutrient-poor soils (Lambers 2019).

Compared to the status-quo of continued semi-rural and commercial land uses, the proposed future 'Urban' land use will result in the introduction of contemporary nutrient management controls for existing nutrient loads. The key controls will be the establishment of drainage swales to provide at source treatment structures, including biofiltration treatment swales/basins, which meet contemporary water sensitive urban design with respect to nutrient management and bio-retention.

Predicted outcome

The existing 'Rural' land use currently has no water sensitive measures or controls to improve and manage water prior to its discharge to receiving environments. Should the proposed future residential development proceed, in accordance with appropriate stormwater mitigation measures, the following benefits are anticipated:

- A reduction in nutrients (61% total nitrogen reduction and 60% total phosphorus reduction) exported from the MRS amendment area.
- Implementation of future residential subdivision will be developed with contemporary stormwater management infrastructure that provides treatment of surface water runoff, to remove nutrient loadings through native vegetation biofilters and/or nutrient retaining soils.
- The existing surface water peak flow rates will not exceed pre-development flows. This approach will be subject to agency advice on establishing opportunities for future increased flows to mitigate climate change impacts on declining inflows towards the GBSW area, if required.

The UNDO and water quality assessment predict there will be an overall improvement in water quality of water exiting the MRS amendment area as a result of implementing best practice stormwater management (i.e. stormwater biofiltration basin). This management action reduces water quality risks to significant wetlands and waterways downgradient to the MRS amendment area.

Assessment of impacts - Water quality: construction phase

This assessment specifically addresses the potential impacts to water quality (surface and groundwater) from the following:

- Construction – potential for sedimentation, erosion, spread of weed/ Phytophthora dieback and accidental chemical spills
- Acid sulfate soils (ASS)
- Contamination (i.e. from historical land uses)

Construction

Construction activities under the PD Act are only possible post assessment and approval of the following sequential statutory planning stages:

- MRS Amendment 1388/57 and Environmental Review (Assessment No. 2335)
- Future Wattle Grove South LSP
- Subdivision and/or development application(s)

Activities associated with the construction of the civil construction works (e.g. earthworks) and the installation of civil infrastructure (e.g. drainage basins, sewer and water lines) have the potential to influence and/or alter existing hydrological processes and water quality within the MRS amendment area and in the downgradient catchment i.e. the GBSW and MKSEA.

Potential impacts to hydrological processes may occur due to:

- sediment runoff during bulk earthworks
- spread of weeds and Phytophthora dieback
- contamination of surface and/or groundwater water sources from accidental spills during construction and/or maintenance activities.

The potential environmental risks from construction activities are well established and accordingly, are addressed through the application of subdivision conditions (and associated advice notes).

Impacts from proposed construction activities are typically managed through a condition of subdivision. A CEMP will be prepared and implemented to ensure that EPA's objective for the inland waters factor can be met during the construction phase. The CEMP defines objectives for maintaining hydrological regimes and quality of groundwater and surface water so that environmental values are protected.

The CEMP will address (specific to inland waters):

- Hygiene management (weeds and *Phytophthora* dieback)
- Hydrocarbon spill management
- Sediment and erosion control actions
- Dust management
- Monitoring program (parameters to be monitored, methodology and frequency)
- Reporting

Table 5-35 (within Section 5.7 Inland Waters – Mitigation) details the objectives and outcomes of the CEMP in alignment with EPA's Environmental outcomes and outcomes-based conditions Interim Guidance (EPA 2021b).

Acid sulfate soils

The acid sulfate soil (ASS) risk mapping for the MRS amendment area (DWER 2017) indicates the potential for 'moderate to low risk' of ASS occurring within 3 m of natural soil surface.

The environmental consequences that may result include:

- soil and water acidification (lowering of pH)
- adverse changes to the quality of soil and water (groundwater, surface water, wetlands, watercourses, and estuaries)

- degradation of downgradient wetlands, water-dependent ecosystems, and ecosystem services
- loss of habitat ecosystem complexity and biodiversity
- reduction of soil stability and fertility.

Contaminated sites

DWER are the responsible authority for administering the CS Act and its associated procedures. DWER maintain the Contaminated Sites Database which holds information on known contaminated sites that have been classified by DWER as 'contaminated – remediation required', 'contaminated – restricted use' or 'remediated for restricted use'.

There are no known or registered contaminated sites within the MRS amendment area. The risk of contamination within the MRS amendment area is considered generally low. However, within the MRS amendment area there are an array of rural land uses including turf farm, small scale tree orchards, open paddocks and former poultry farm sheds.

Predicted outcomes

The sequential planning framework has demonstrated its ability to comprehensively address the risks from construction works, such as ASS. The model subdivision conditions (DPLH 2024b) have standard conditions addressing:

- Construction management plans
- ASS/contamination investigations and management

In this context, all future construction works can be implemented in accordance with approved management plans which mitigates impacts to surface water quality resulting from construction works within the MRS amendment area.

No impacts to surface water (quantity and quality) and downgradient significant wetlands and waterways within and nearby to the MRS amendment area because of construction activities within the MRS amendment area is expected.

Additional ASS specific soil and groundwater investigation will be undertaken in accordance with DWER guidelines to determine if there is the presence (and any likelihood of disturbance) of ASS.

The proposed ASS investigations will be in accordance with the Acid Sulfate Soils Planning Guidelines (WAPC 2008), specifically, completing desktop ASS risk assessment in support of this planning scheme amendments, and completing (as required) detailed ASS investigations in support of a future structure plan. The WAPC post ASS investigation, if required, can impose a condition requiring the preparation of an Acid Sulfate Soils Management Plan (ASSMP) as a condition of approval at the subdivision stage. This ASSMP would be prepared and implemented to the satisfaction of DWER.

The assessment and management of potential for ASS exposure will be consistent with the following guidelines:

- Identification and investigation of acid sulfate soils and acidic landscapes (DWER 2015)
- Treatment and management of soils and water in acid sulfate soil landscapes (DWER 2015)

The implementation of ASS investigation (and if required ASS management) is embedded in the model subdivision conditions schedule (DPLH 2024b).

No impacts to water (quantity and quality), downgradient significant wetlands and waterways from ASS exposure is expected.

Former land uses in the amendment area such as the former poultry farm sheds will be subject to future preliminary site investigations in accordance with the CS Act and the Contaminated Sites Guidelines (DWER 2021) undertaken either at the Local Structure Plan or at the subdivision approval stage (as a condition of approval). A contamination subdivision condition defines the investigation, assessment, remediation and management of contaminated sites and the DWER reporting requirements under the CS Act and the Contaminated Sites Guidelines (DWER 2021).

No impacts to water (quantity and quality), downgradient significant wetlands and waterways from contamination exposure is expected.

5.5.1.4 Impact to the hydrology and biodiversity of the GBSW.

Flora and vegetation studies of the GBSW area have recorded 611 native plant taxa. Approximately 51% of these taxa are wetland species, with the remainder occurring outside of wetland areas on low ridges and dunes (Emerge Associates 2023e). The GBSW area environmental values contain TECs and endangered FCTs including:

- FCT 3a - *Corymbia calophylla* - *Kingia australis* woodlands on heavy soils of the Swan Coastal Plain
- FCT 7, FCT 8, FCT 9, FCT 10a - Clay pans of the Swan Coastal Plain
- FCT 21c - Low lying *Banksia attenuata* woodlands or shrublands
- FCT 23a - Banksia Woodlands of the Swan Coastal Plain IBRA Region

The surveyed and mapped vegetation units across the GBSW area are all considered groundwater-dependent (Tauss et al. 2019).

The ecology of the Clay Pans of the Swan Coastal Plain is entirely dependent on the hydrological function of the clay pan (whether clay basin or clay flat). The clay pans fill during the winter rains and slowly dry over spring and early summer to a hard, almost impermeable surface. Variation in depth and duration of inundation is a factor in determining the suite of plant species that occur in a particular clay pan, explaining some of the variation in flora across the extent of the ecological community (Gibson et al. 2005).

The hydroperiod is a fundamental metric of relevance to ecological processes for clay pan ecosystems. This is important particularly in the context of climate change where a decrease in annual rainfall is expected (IPCC 2007).

Assessment of impacts - Surface water

Surface water flows post-development from the MRS amendment area towards the GBSW assuming a ‘fully developed scenario’. This predicted increase consists of:

- 5,192 kL/year increase from the Boundary Road culvert
- 19,332 kL/year increase from the Brentwood Road and Victoria Road culverts.

Noting, the surface water outflows from the UE and UI areas (under the ‘fully developed’ scenario) contributes 13,674 kL/year of surface water flow increases to the MRS amendment area.

This predicted flow increase is minor, particularly when it is compared against:

- **Total water balance:** The flow increase represents approximately 2% of the total water balance outflows.

- **GBSW rainfall:** Direct rainfall (annual average 758 mm/year) on the surface of the 215 ha GBSW area contributes 1,629,700 kL/year. The flow increase represents approximately 1.5% of annual rainfall volumes.
- **Yule Brook:** The Yule Brook has an estimated annual flow of 7,900,000 kL (SRT 2011). The flow increase represents only 0.3% of the Yule Brook estimated annual flow and is therefore considered negligible in comparison to interannual flow variability (Hyd2o 2024).
- The assessment assumed 13,674 kL/year (of the 24,524 kL/year) surface water flow is from the UE and UI area.

This predicted surface water flow increase has assumed post development:

- the entire surface water volume from the Brentwood Road and Victoria Road culverts is directed to the GBSW.

Assessment of impacts - Groundwater

The cessation of the turf farm irrigation (from the Leederville Aquifer) has the following unintentional hydrological outcomes for the groundwater mound within the Superficial Aquifer:

- Reduction of the groundwater levels which have been kept at an elevated level (i.e. between 1 m to 5 m for the past 20 years).
- This reduction in groundwater level elevation will extend approximately 1.5 km west and north-west into the GBSW. The extent to which the ceased irrigation at the turf farm from the Leederville Aquifer will impact groundwater levels locally is difficult to quantify given the variable geology of the local area.

The DWMS assessment of the groundwater mound specific to maintaining the annual pre-development groundwater recharge and flow directions (Figure 5-42, Figure 5-43 and Figure 5-44) demonstrates post development the combination of recharge and targeted stormwater management can maintain the influence of the mound comparable with pre-development hydrological conditions (Hyd2o 2024).

The predicted minor increase in the post development groundwater throughflow in combination with locating stormwater management areas in the vicinity of the existing groundwater mound underpins the key hydrological objective of:

- Maintaining the groundwater mound consistent with the pre-development environment.

By maintaining the influence of the groundwater mound, the post-development groundwater flows will be maintained and will continue to flow radially away from the mound, with flows towards the west remaining consistent with the pre-development hydrological conditions. Accordingly, the minor change from the increase in groundwater recharge balanced by the reduction in the groundwater mound is not expected to impact the GBSW or the Yule Brook.

Noting, the groundwater assessment was premised on the ‘fully developed scenario’.

The implementation of a targeted stormwater management approach applied to the existing groundwater mound area can result in similar annual pre and post development recharge i.e. retain the influence of the mound (Hyd2o 2024).

The strategy modelled to achieve this outcome was based on:

- stormwater biofiltration and flood management areas to be focussed to the area of the mound adjacent to Tonkin Highway

- lot soakwells to be adopted for almost all lots within the wider 50.5 ha contributing stormwater catchment for this area, with a small area of lot connections.

Predicted outcomes

The proposed 'Urban' land use within the MRS amendment area provides an opportunity to improve the hydrological outcomes for the GBSW and Yule Brook in terms of both water quality and quantity.

The proposed 'Urban' land use will not alter the GBSW or the Yule Brook surface water quantity flows through the adoption of the following measures:

- Post development stormwater volumes and flows will be managed relative to existing conditions particularly in relation to the GBSW area.
- The current seasonal hydroperiod for wetlands within the GBSW will not be altered.
- Providing adaptive outlet structure for stormwater areas post development to combat the potential impacts from climate change and provide flexibility to adjust future stormwater outflow volumes from the MRS amendment area for the benefit of the GBSW hydrology and GDEs.
- The proposed 'Urban' land use would likely improve surface water quality and reduce water quality impacts on the GBSW and the Yule Brook, while maintain existing flow volumes, through application of the Better urban water management (WAPC 2008) requirements and the Stormwater management manual for WA (DWER 2022).

Groundwater mound

The post-development contours for the Superficial Aquifer are expected to be consistent with the pre-development environment due to:

- The increase recharge to the Superficial Aquifer, from soakwells, stormwater biofiltration and flood management areas focussed in the area of the existing mound adjacent to Tonkin Highway. This action balances the reduction in the groundwater mound levels as a result of ceasing irrigation from the turf farm (Hyd2o 2024)
- The proposed stormwater management approach maintains the influence of the groundwater mound i.e. maintains pre-development levels.

The Wattle Grove South DWMS (Hyd2o 2024) promotes an adaptive management approach for the MRS amendment area which is underpinned by the continued implementation of the current groundwater and surface water monitoring program (as defined in Table 5-8 and Table 5-11). The monitoring program and reporting framework encapsulates the monitoring and assessment of the surface water recharge into the Superficial Aquifer (around the turf farm) to maintain the groundwater mound.

The monitoring program and reporting framework encapsulates monitoring of the Superficial Aquifer groundwater levels (both near the turf farm and in the GBSW). This will enable:

- A comparative review of seasonal groundwater contours and flow direction pre- and post-development
- The influence of the groundwater mound post development.

By assessing the monitoring data, adaptive management approaches should be applied to mitigate (i.e. maintain the groundwater mound) any potential impacts as development precedes (Hyd2o 2024). Adaptive management measures, if required, to maintain the mound could include:

- Supplementary Leederville Aquifer recharge via irrigation to:

- strategically located POS areas
- local primary school oval (located within the turf farm area).

Groundwater through flow

The WBA (Emerge Associates 2024) predicts a minor increase in Superficial Aquifer through flows (65,976 kL) assuming a 'fully developed scenario'. The risk(s) from this minor change to groundwater flow within the Superficial Aquifer is not considered significant due to:

- The recharge flow being within the deeper superficial aquifer (i.e. not the shallow perched water table).
- The groundwater through flow will be consistent with the pre-development flow directions, which is predominantly in a north-west to south-east and away from the GBSW area.
- The GBSW is situated atop of the alluvial Pinjarra Plain which is characterised by soils of the Guildford Formation. Within areas of the GBSW, the Guildford Formation clay form layers a complex sequence of clay lenses that are laterally and vertically varied which form a low permeable barrier between the perched water table, wetlands and the Superficial Aquifer.
- Key conclusions from hydrological assessment within the GBSW area confirm rainfall and ground water perching are the dominant hydrological process, for example:
  - Semeniuk (2001) reported the wetlands within the GBSW area were maintained by surface and near surface perching of direct precipitation and by infiltration. During periods of below average rainfall groundwater in the Superficial Aquifer was considered likely to play only a minor part on the maintenance of the wetlands, with the major recharge mechanism for the wetlands identified as being direct precipitation, perching, infiltration, and sub surface perching.
  - Bourke (2017) agreed that the GBSW area was predominately a surface water feature and reliant largely on rainfall and surface water inflow.
- The interaction between the Superficial Aquifer and the perched groundwater table within the GBSW is unlikely to be spatially uniform across the GBSW (or the interaction is possibly limited to minor leakage through heavy clay layers).

Assessment of impacts - Climate change

Climate change represents the most influential threat to the GBSW hydrology and ecology. The historical and ongoing climate change resulting in a long-term drying trend is an important consideration, given the significant water dependent ecosystems within the GBSW are primarily dependent on direct rainfall, surface water runoff or expressions of perched groundwater.

In the scenario where the MRS amendment area is only developed, the impact of climate change on the water balance is relatively small for the dry 2050 horizon modelling but more significant for the 2100 horizon. The most significant impact is from:

- Reduction of surface water inflows and outflows from the MRS amendment area (i.e. 7.9% reduction) in the 2050 horizon and a 58.7% reduction by 2100.
- Where the MRS amendment area, UE and UI areas are developed, the results show surface water flows reducing by 9.7% for the 2050 horizon, and 60.4% by 2100 compared to the scenario without climate change.
- Groundwater throughflow as outflow from the MRS amendment area was found to reduce by 5% in the dry 2050 horizon modelling and by 40% to 2100 under both development scenarios.

The assessment exposes the risks to wetlands and the ecology of the GBSW from climate change, including higher temperatures, increased evaporation and reduced rainfall, all of which combine to reduce water flows and hydroperiod within the GBSW. Climate change predictions will alter the hydrological regimes affecting water flux and hydroperiod in wetlands and clay pan systems in the GBSW.

The hydrological assessments and research conducted by Emerge Associates (2023b), Bourke (2017) and V and C Semeniuk Research Group (2011) within the GBSW draw the conclusion that the wetlands and clay pans (and associated groundwater dependent communities) are predominantly dependent on overland surface, and perched water table flows. Specifically, under a drying climate scenario, the wetlands and clay pans within the GBSW area will become further dependent on overland surface flows and change the wetland vegetation dynamics particularly for shallow rooted flora species.

In terms of reduced rainfall directly on the GBSW area, a reduction in rainfall is predicted by 2050 (33 mm) across the GBSW area (215 ha), and by 2100 (254 mm). These predicted changes in rainfall volumes are irrespective of development (Hyd2o 2024a).

Predicted outcomes

To counteract the long-term drying trend (as a direct result of climate change), additional surface water flows towards the GBSW (and its seasonally water dependent ecosystems i.e. Clay pans of the Swan Coastal Plain) could form part of the management response. Accordingly, the DMWS outlines:

- The continuation of the hydrological monitoring program (which informs adaptive management), this monitoring program encapsulates:
    - The continuation of pre-development groundwater and surface water program within the MRS amendment area and the GBSW.
    - Analytes used to measure groundwater and surface water quality include:
        - Analytes listed in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality for slightly to moderately disturbed fresh water aquatic ecosystems (ANZECC and ARMCANZ 2000).
        - Contaminants that have the potential to be introduced to groundwater and/or surface water from future development activities (e.g. earthworks resulting in erosion) or incidents (e.g. accidental chemical/hydrocarbon spills).
- The monitoring program would be subject to an annual review and assessment of performance. Reporting will also review climate change in the context of climate projections and its impact on GBSW hydrology for the purpose of informing an adaptive management approach. This includes installing adaptive structures within stormwater drainage basins/swales for the purpose of providing flexibility to adjust stormwater outflows for the benefit of the GBSW area.

Assessment of impacts - Salinity and sodicity

A summary of the salinity and sodicity assessment of post-development scenarios is presented below (MBS Environmental 2024).

Surface Water

Salinity was brackish for both scenarios with a predicted value of 2,230 mg/L TDS for pre-development and 1,590 mg/L TDS for post-development. Sodicity was low with SAR values of 8.5 and 7.12

respectively. The difference between both scenarios was attributed to higher evapotranspiration and lower rainfall runoff rates to the GBSW in the pre-development scenario.

Results for the post-development climate change scenario were identical to the post-development for the period 2024-2050. After year 2050 salinity was predicted to become marginally fresh by dropping significantly to 1,158 - 1,027 mg/L TDS for the period 2050-2100. Sodicity followed the same trend and decreased to SAR values of 6.14 - 5.83 over the same period.

After year 2100 surface water salinity and sodicity were anticipated to slightly increase to 1,070 mg/L TDS and a median SAR of 6.0.

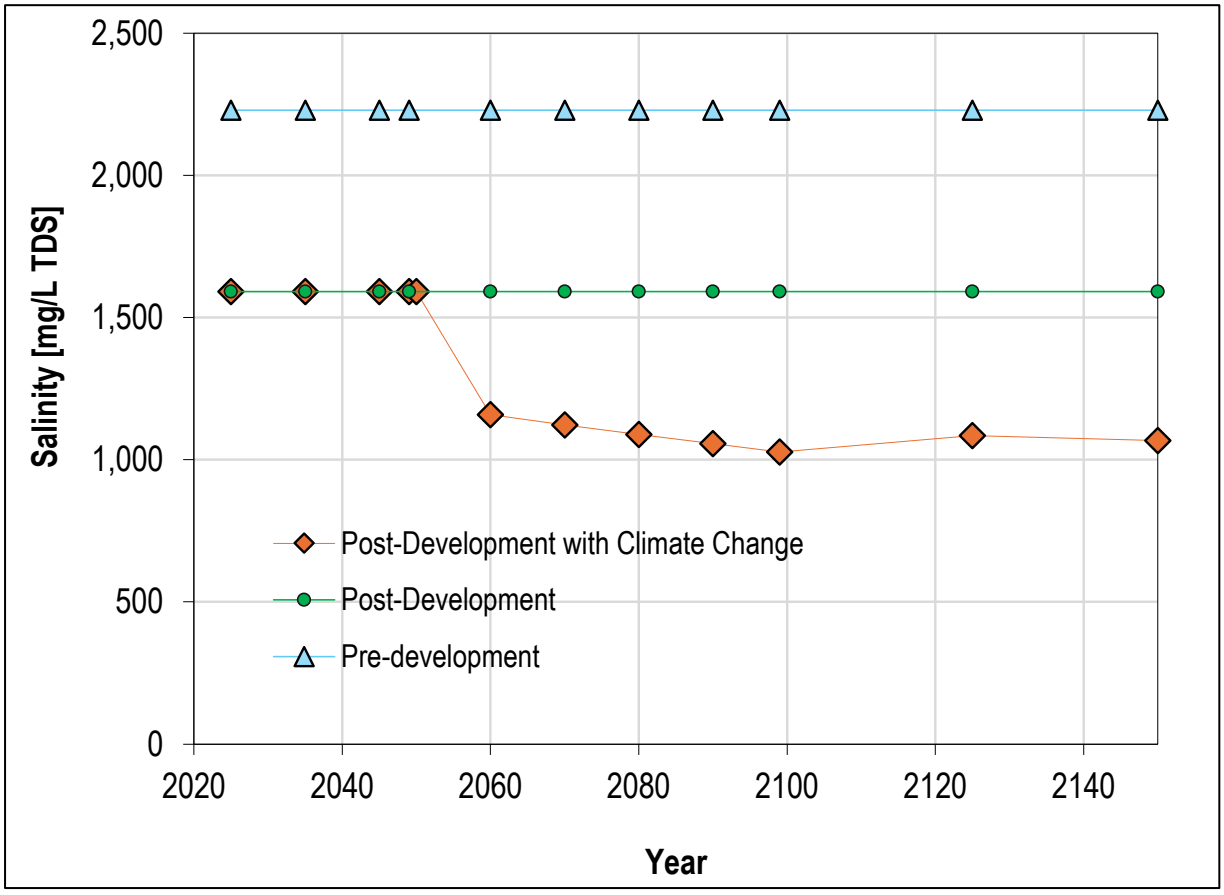

Chart 5-1: Predicted surface water salinity discharging to the GBSW (MBS Environmental 2024)

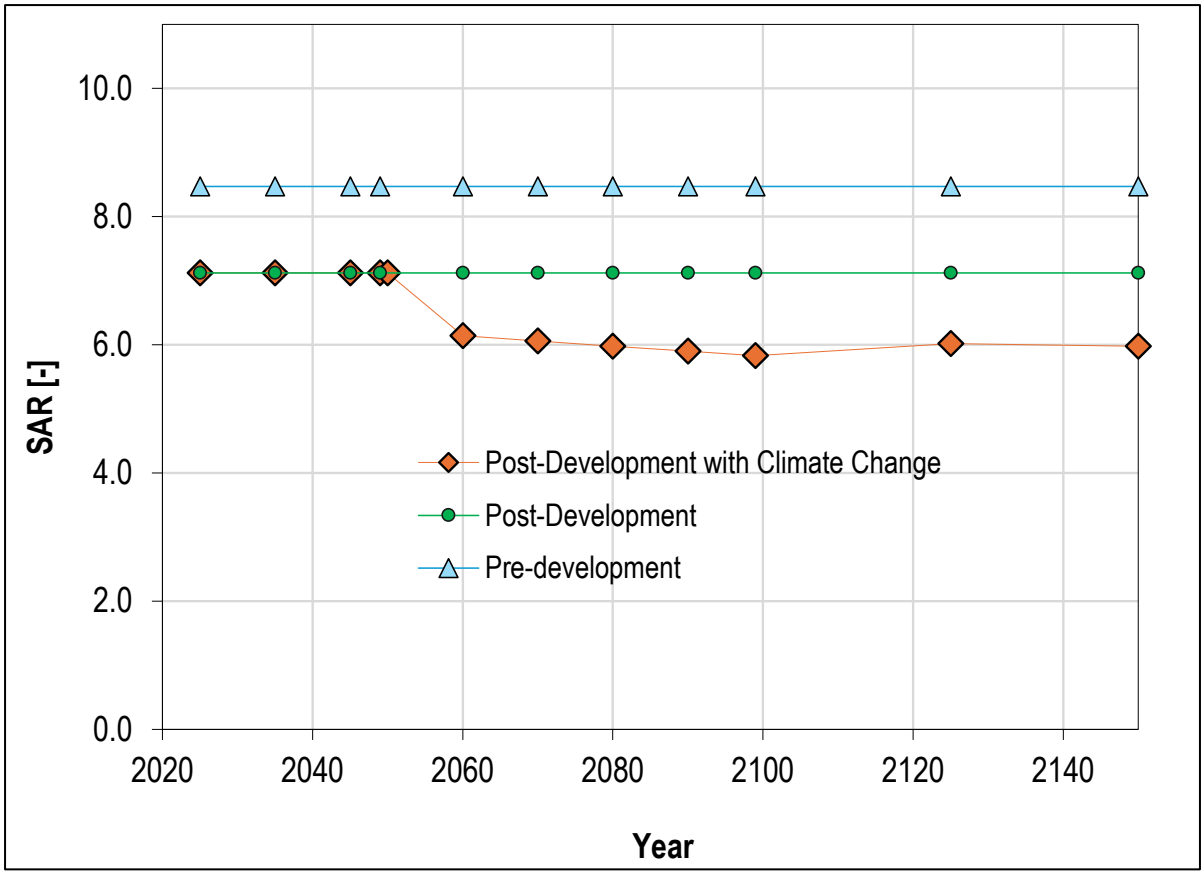

Chart 5-2: Predicted surface water SAR (sodicity) discharging to the GBSW (MBS Environmental 2024)

Groundwater

Consistent with surface water, salinity and sodicity of the pre and post development scenarios were predicted to remain steady for the total duration of the projection. Both scenarios showed close results with marginally fresh predicted groundwater salinities of 1,560 and 1,530 mg/L TDS, and SAR values of 7.31 and 7.21.

Salinity decreased significantly after 2050 for the post-development scenario with climate change conditions. Values were anticipated to drop to 1,284 mg/L TDS in 2060 and steadily decrease to 1,058 in 2150. Sodicity followed the same trend and decreased slightly from a SAR value of 6.47 in 2060 to reach 5.95 in 2150. These depletions of salinity and SAR are attributed to a reduction of rainfall infiltration.

These results indicated that the groundwater salinities in the Superficial Aquifer flowing from the MRS towards the GBSW were expected to be similar between the pre- and post-development scenarios and remained marginally brackish and within the lower end of the range recorded at downgradient bore GW3 (183 to 13,266 mg/L TDS) for the period 2009-2022.

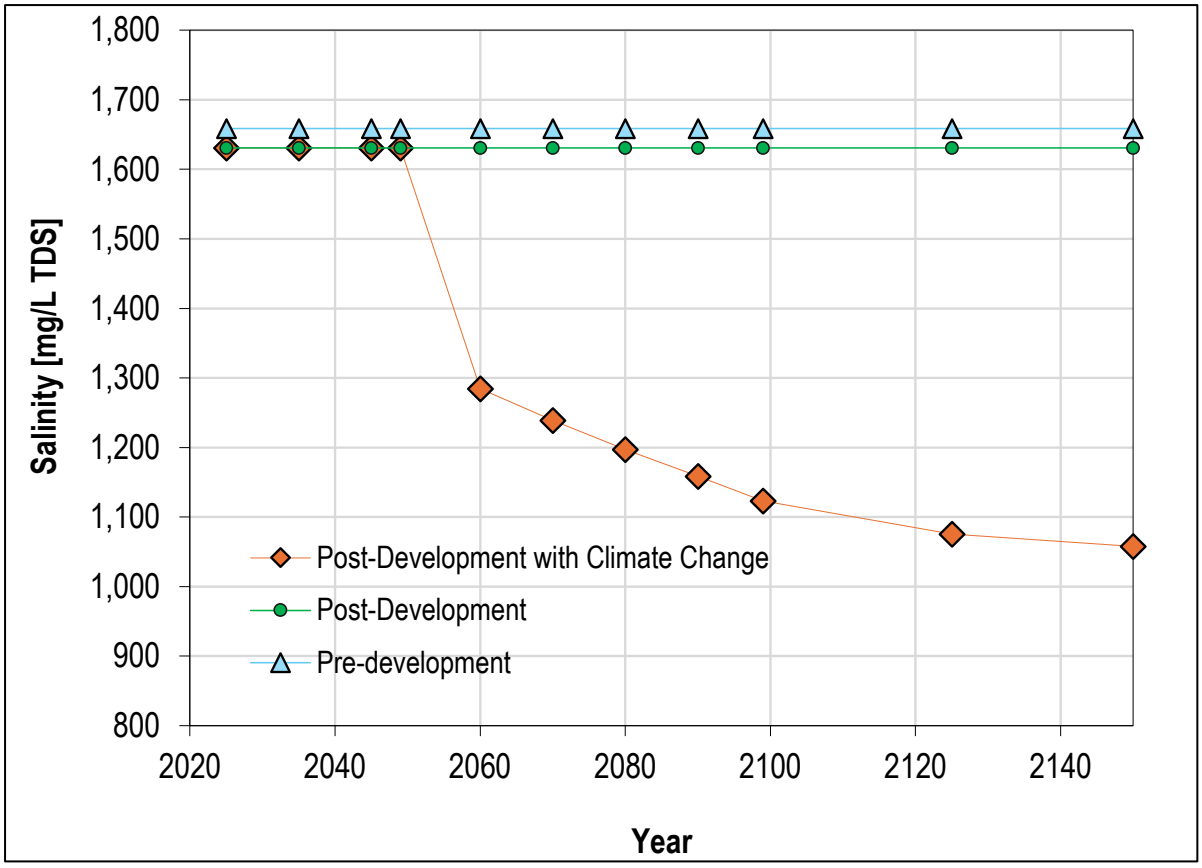

Chart 5-3: Predicted salinity - Superficial Aquifer (MBS Environmental 2024)

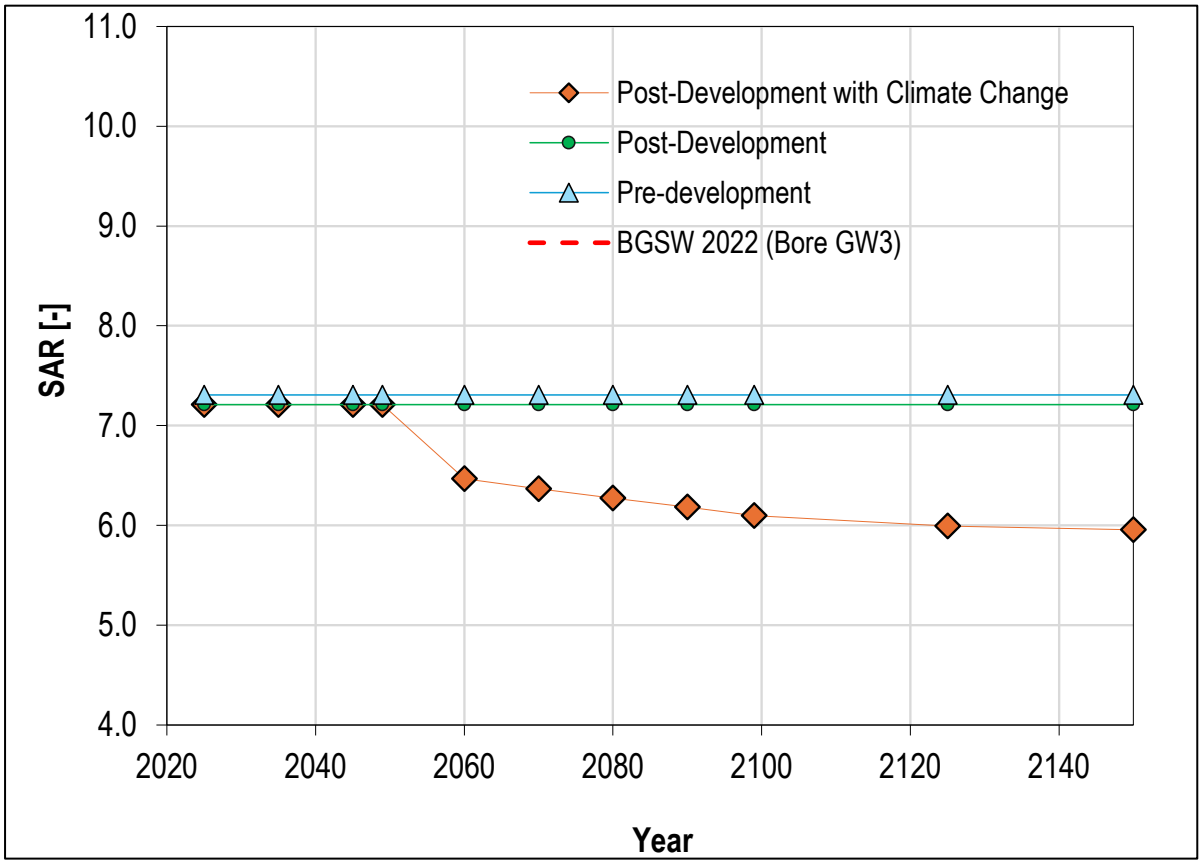

Chart 5-4: Predicted SAR - Superficial Aquifer MBS Environmental 2024)

Predicted outcomes

The key conclusions from the assessment of the potential salinity and sodicity impacts on the GBSW include (MBS Environmental 2024):

- Salinity and sodicity of the post-development scenarios for surface water discharge were both predicted to be less than the pre-development scenario for the entire 2024 - 2150 projection period. This represents a net reduction in risk to the GBSW.
- Post-development salinity of the surface water discharging to the north of the GBSW was predicted to be slightly brackish, and values decreasing to marginally fresh after 2050 under the climate change scenario. Surface water sodicity followed the same trend and was always low to moderate.
- The general trend of both salinity and sodicity in the superficial aquifer flowing to the GBSW area was constant and close to the pre-development scenario. Salinity was marginally brackish at all times. Predicted salinity and sodicity of the post development climate change scenario showed groundwater changing steadily from marginally brackish to fresh with low SAR values.
- There is a 'low to moderate' risk to the vegetation along the former Crystal Brook tributary drainage line from surface water discharge.
- No salinity/sodicity guideline values were available for comparison for aquatic and terrestrial fauna. However, all the predicted salinities for all scenarios remained well below the livestock drinking water guideline trigger value of 4,000 mg/L TDS (ANZECC 2000/ANZG 2018) and were predicted to fall with development.

The assessment concluded there is a low risk of increasing salinity and sodicity in the GBSW and the associated groundwater dependent ecosystems from future surface and groundwater discharge existing the MRS amendment area post development. The modelling assessment predicted a decrease in salinity and sodicity in both surface water and groundwater.

The continuation of the hydrological monitoring program (which informs adaptive management), will encapsulate the following analytes used to measure groundwater and surface water quality:

- Analytes listed in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality for slightly to moderately disturbed fresh water aquatic ecosystems (ANZECC and ARMCANZ 2000).
- Contaminants that have the potential to be introduced to groundwater and/or surface water from future development activities (e.g. earthworks resulting in erosion) or incidents (e.g. accidental chemical/hydrocarbon spills).

No impacts to hydrology and biodiversity of the GBSW as a result of increasing salinity and sodicity is expected.

The assessment noted the proximity of the Hartfield Park irrigated golf course and playing fields to the north of the MRS amendment area as likely to have a much larger influence on salinity/sodicity within the GBSW area (MBS Environmental 2024).

Other considerations

The sequential planning framework has demonstrated its ability to comprehensively address the risks from construction works, and ASS/contamination risks. The WAPC model subdivision schedule (DPLH 2024b) has standard conditions which address the following requirements:

- Construction management plans
- ASS/contamination investigations and management.

In this context, all future construction works can be implemented in accordance with approved management plans which mitigates impacts to surface water quality resulting from construction works within the MRS amendment area.

No impacts to hydrology and biodiversity of the GBSW from construction activities and ASS or exposure is expected.

Loss of foreshore functions and groundwater and/or surface water dependent vegetation and impacts to other water dependent ecosystems.

Significant wetlands and waterways

The identified significant wetlands and waterways within and nearby the MRS amendment area include:

- MRS amendment area (Figure 5-21, Figure 5-22 and Figure 5-23)
  - REWs (UFI 8037 and portion of UFI 15257).
- Lot 501 (Figure 5-21 and Figure 5-24)
  - CCWs (UFI 8026 and UFI 8027) and portion of REW UFI 15257.
- GBSW area (Figure 5-21 and Figure 5-26)
  - GBSW comprises a complex of significant wetlands, including areas of seasonally waterlogged flats (palusplain) and seasonally inundated basins (sumplands).
- Yule Brook (Figure 5-21 and Figure 5-26)

Assessment of impacts - MRS amendment area: REWs (UFI 8037 and portion of UFI 15257)

The assessment of the wetlands within the MRS amendment area can be reviewed in Table 5-29.

In summary, the assessment of the REWs UFI 8037 and portion of UFI 15257 values concluded:

- Removal of REW (UFI 8037) which totals 0.86 ha from the DBCA GWSCP dataset.
- Removal of the portion of REW (UFI 15257) which totals approximately 2.06 ha (within the MRS amendment area) from the DBCA GWSCP dataset.
- The removal of UFI 8037 and portion of UFI 15257 within the MRS amendment area from the GWSCP dataset is reflective of the historical land uses and the Completely Degraded ecological condition of the two wetlands. Specifically, the historical anthropogenic impacts including the construction of the Tonkin Highway, Water Corporation pipeline, DBNGP and adjacent land uses including commercial turf farm and rural lots resulted in the clearing and infilling of the wetlands.
- An application to DBCA to amend the GWSCP dataset for the two REWs (UFI 8037 and portion of UFI 15257) will be undertaken concurrently with finalisation of the Local Structure Plan and the LWMS.
- Portions of the two former wetland areas will be incorporated into POS areas and stormwater bioretention basins.
- It is not expected there will be any measurable impacts to the Completely Degraded REWs UFI 8037 and portion of UFI 15257 within the MRS amendment area. The existing trees planted within the portion of UFI 15257 located in the MRS amendment area (and mostly within the Water Corporation pipeline / DBBGP easement boundary) will be retained and integrated in POS areas and stormwater bioretention basins.

Assessment of impacts Lot 501: Wetland Buffer: CCWs (UFI 8026 and UFI 8027) and portion of REW UFI 15257

The assessment of the wetlands within the MRS amendment area can be reviewed in Table 5-30.

Wetland buffer review

The wetland assessment identified there is currently no separation buffer from the two CCWs (UFI 8026 & UFI 8027) and portion of REW UFI 15257 within Lot 501. The mapped wetland and associated buffer area has been subject to historical anthropogenic impacts, specifically, the existing infrastructure corridors, which both frame and intrude into the mapped wetlands areas and immediate surrounds within Lot 501. Key infrastructure located immediately adjacent to or within the mapped wetland areas within Lot 501 include:

- Boundary Road reserve
- Tonkin Highway reserve and Welshpool Road reserve
- Water Corporation water pipeline easement
- DBNGP easement.

The existing infrastructure corridors are fixed and operational. These structures essentially frame and contain the limited wetland environmental and ecological values to entirely within Lot 501 without the application of any additional buffers to surrounding land uses i.e. landscape supply yard, Welshpool Road and Tonkin Highway. Importantly, the wetland assessment identified:

- The wetland/ecological values associated with the mapped CCWs (UFI 8026 & UFI 8027) and REW UFI 15257 do not extend outside of Lot 501.
- The MRS amendment does not alter the landowner's (WAPC) existing land management practices including regular mowing and slashing of the wetland areas to maintain the road reserves/Water Corporation pipeline and DBNGP easements as cleared areas.

The wetland assessment concluded the existing 20 m Boundary Road reserve provides an existing physical separation from the two CCWs (UFI 8026 and UFI 8027) and the portion of REW UFI 15257.

Predicted outcome

The two CCWs (UFI 8026 & UFI 8027) and portion of REW UFI 15257 have limited ecological attributes which are entirely contained within Lot 501 and do not extend into the Boundary Road reserve or the MRS amendment area.

The MRS amendment does not propose to alter:

- Lot 501 existing 'Parks and Recreation' land use
- the landowner's (the WAPC) existing land management practice
- the City of Kalamunda's Boundary Road reserve land use and management of the existing road.

In this context, the management of the two CCWs (UFI 8026 and UFI 8027) and portion of REW UFI 15257) within Lot 501 will incorporate the following:

- Formal Boundary Road as a hard infrastructure barrier to the wetlands from future 'Urban' land uses.
- Formalising a footpath on the southern side of Boundary Road (i.e. adjacent to the proposed future 'Urban' land uses area or the current commercial landscaping yard).

- Install contemporary drainage basins adjacent to Boundary Road (within the MRS amendment area) with the objective of improving surface water quality and maintaining existing flow rates from the MRS amendment area via the Boundary Road culvert.
- The proposed formalising of Boundary Road, footpath, and drainage basin areas (within the MRS amendment area) will be defined and managed in accordance with the following sequential planning stages:
    - Wattle Grove South Local Structure Plan – which will incorporate LWMS and landscape masterplan.
    - Subdivision approval – which will require the following as conditions of approval:
        - UWMP
        - Detailed landscape plan which incorporates the drainage basins/swales
        - Detailed engineering drainage design
- No impacts or loss of the wetland's foreshore functions, vegetation or other water dependent ecosystems are expected to the wetlands within Lot 501. Lot 501 is not subject to MRS Amendment 1388/57 and will be managed in accordance with the landowner's (WAPC) existing land management practices.
- The WAPC as the landowner of Lot 501 (or MRWA as the proponent for the Tonkin Highway Grade Separated Interchanges proposal which intersections a portion of Lot 501) may seek to formally engage with DBCA for the purpose of amending the GWSCP dataset (specifically the category status of the two CCWs (UFI 8026 and UFI 8027) and the portion of REW (UFI 15257)) within Lot 501.

Assessment of impacts - GBSW and Yule Brook

Separation buffer

There are no existing streamlines within the MRS amendment area. The only remnant stream is a portion of the former Crystal Brook tributary which is in Lot 501 adjacent to the MRS amendment area and extends for approximately 500 m on the western side of Tonkin Highway (Figure 5-32).

The MRS amendment area is physically separated from the Yule Brook watercourse and wetlands within the GBSW area by (Figure 5-36):

- Welshpool Road and Tonkin Highway road reserves and intersection
- Water Corporation pipeline and the DBNGP easements.

The Yule Brook is located approximately 250 m from the MRS amendment area at the closest point. Downgradient, west of Tonkin Highway, the Yule Brook is located over 700 m to the north-west from the MRS amendment area.

The GBSW is separated from the amendment area by the 75 m Tonkin Highway reserve (at the closest point). This separation distance is extended by a further 25 m due to the Water Corporation pipeline and DBNGP easements, located along the length of the MRS amendment area's western boundary.

At Brentwood Road there is an at level pedestrian crossing of the four lane Tonkin Highway (Figure 5-37). The distance to the mapped GBSW boundary from the MRS amendment area along Brentwood Road is approximately 700 m. This pedestrian access would be formally closed either as part of MRWA's proposed Tonkin Highway Grade Separated Interchange (which extends the highway from four to six lanes) or through a future subdivision approval.

The separation distance review of the GBSW and the MRS amendment area identified:

- The existing transport infrastructure (Tonkin Highway) and Water Corporation pipeline and DBNGP easements which provides a physical separation boundary to the MRS amendment area.
- The Tonkin Highway Grade Separated Interchange Proposal, specifically, if the upgrade of Tonkin Highway is approved (i.e. increased to six lanes) the minimum separation distance to the MRS amendment area would be extended by an additional 30 m.
- The MRS amendment area and any proposed future development works do not intrude into the GBSW area and remain on the eastern side of Tonkin Highway.

Predicted outcome

The proposed wetland buffer distance to the GBSW area is:

- A minimum 100 m buffer from the GBSW (at the closest point) will be maintained. The Tonkin Highway reserve in combination with the Water Corporation pipeline and DBNGP easements has already established a minimum 100 m physical boundary between the GBSW wetlands and the MRS amendment area at the closest point. If the MRWA Tonkin Highway Grade Separated Interchange Proposal is approved and constructed (creating a six-lane highway) the minimum buffer would extend to approximately 130 m. Noting the vast majority of the proposed future 'Urban' land uses will be located significantly further (i.e. 500 m plus) from the GBSW.
- No impacts or loss of the wetland's foreshore functions, vegetation or other water dependent ecosystems within the GBSW or the Yule Brook is expected.

Other considerations – Hydrological

The assessment of loss of foreshore functions and groundwater and/or surface water dependent vegetation and impacts to other water dependent ecosystems as a result of altered groundwater or surface water regime has been addressed in the assessment of:

- Impact to the hydrology and biodiversity of the GBSW.
- Impacts to water quantity and quality of significant wetlands and waterways within and nearby to the MRS amendment area.
- Impacts to current surface and groundwater cycles (alteration of hydrological regimes) resulting in impacts to significant wetlands and waterways within and nearby to the MRS amendment area, including the Yule Brook and the GBSW

5.6 Cumulative environmental impacts

A summary of the impacts from other proposals in proximity to the MRS amendment area are provided in Table 5-32.

Table 5-32: Cumulative impacts to inland waters values (MRWA 2022)

Aspect	Wattle Grove MRS Amendment	Wattle Grove UI Area	Wattle Grove UE Area	Tonkin Highway Grade Separated Interchanges (Hale Road to Welshpool Road) Current Proposal	Tonkin Highway Grade Separated Interchange (Kelvin Road)	Tonkin Highway, Guildford Road to Great Eastern Highway Upgrade (Tonkin Gap)	Byford Rail Extension (BRE)	Tonkin Highway Extension from Thomas Road, to South Western Highway, Mundijong	MKSEA Precincts	Roe Highway and Great Eastern Highway (GEH) Bypass	Cumulative environmental impacts
Proponent	WAPC	TBD	TBD	MRWA	MRWA	MRWA	Public Transport Authority	MRWA	City of Gosnells	MRWA	N/A
Proposed project commencement	2025	Unknown	Unknown	2024	Construction commenced in 2020	2022/23	2022/23	2022/23	2021	2022	
Description	Rezoning approximately 126 ha of 'Rural' zoned land for 'Urban' land use within Wattle Grove.	Identified in the WAPC's North-East sub-regional planning framework. Noting the North-East sub-regional planning framework (WAPC 2018) states: *'land classified Urban Expansion/ Investigation may contain significant environmental attributes and these classifications should not be construed as support for the development'.*		Upgrade of Tonkin Highway including additional traffic lanes, a fly-over at the intersection with Hale Road and a grade separated interchange at the intersection with Welshpool Road.	Upgrade and widening a 2 km section of Tonkin Highway from four lanes to six lanes and grade separated interchange at the intersection with Kelvin Road.	Upgrade of Tonkin Highway including additional traffic lanes, two additional bridges in the Swan River, and modification of Great Eastern Highway interchange.	Extension the passenger rail network by 8 km from Armadale Station to a proposed new station at Byford.	Extension of Tonkin Highway an additional 14 km to South Western Highway.	Development of an industrial area. The MKSEA has been divided into Precincts, 1, 2, 3A and 3B. Precincts 2 and 3B are subject to assessment by the EPA.	Construction of a grade separation at the intersection of Roe Highway and GEH Bypass and upgrade of Roe Highway between Kalamunda Road and Clayton Street.	N/A
Location	City of Kalamunda, bound by Welshpool Road East and Crystal Brook Road to the north, and Tonkin Highway to the west.	City of Kalamunda, bound by Welshpool Road East and Crystal Brook Road.		City of Kalamunda along Tonkin Highway from south of Roe Highway to approximately 1 km north of Kelvin Road	City of Gosnells along Tonkin Highway from approximately 1 km north of Kelvin Road extending south to Maddington Road	City of Bayswater and City of Belmont along Tonkin Highway, between Guildford Road and Great Eastern Highway.	City of Armadale and Shire of Serpentine Jarrahdale. Armadale to Byford, along the existing Australind rail corridor.	Shire of Serpentine Jarrahdale Thomas Road, Oakford to South Western Highway, south-east of Mundijong.	City of Gosnells Bounded by Roe Highway, Welshpool Road, Tonkin Highway and Bickley Road	City of Swan, City of Kalamunda and Shire of Mundaring along Roe Highway, between GEH and just south of Adelaide Street West.	N/A
Surface water values affected	Woodlupine and Yule Brooks	Woodlupine and Yule Brooks		Woodlupine and Yule Brooks	Bickley Brook	Swan River	Neerigen, Wungong and Beenyup Brooks.	Canning River and Southern River. Wright Lake.	Yule Brook.	Bibra and North lakes, Horse Paddock, and Roe and Melaleuca swamps.	N/A
Consanguineous wetland suite	Mungala	Mungala		Mungala	Mungala	Jandakot, Swan Estuary	Keysbrook	Keysbrook, Little Dardanup	Mungala, Keysbrook	Jandakot Mound	Impact to Mungala Consanguineous wetland suite.
Wetlands affected	Two REWs which have been significantly modified and exhibit as MUWs, to be retained within vegetated drainage swales and POS in the MRS amendment area – no direct impacts.	N/A		GBSW CCW, MUW and REW, including 9.34 ha of CCW.	CCW and MUW, including 1.87 ha of vegetation associated with CCW.	Impact to 0.74 ha CCWs (Swan River and Claughton Reserve).	CCW, MUW and REW including 3.5 ha of CCW.	CCW, MUW and REW, including up to 15.13 ha of CCW.	GBSW area, CCW, and REW.	CCW and MUW including up to 2.47 ha of CCW and 1.98 ha of MUW.	The MRWA's Tonkin Grade Separated Interchange (Kelvin Road) will clear: Up to 11.41 ha of CCW native vegetation, which equates to 0.67% of the CCW remnant vegetation present within the Mungala consanguineous wetland suite.

5.6.1 Cumulative impact assessment

Numerous existing and reasonably foreseeable projects within 2 km of MRS Amendment 1388/57 have potentially a cumulative impact on the environmental values within the MRS amendment area and/or the GBSW. The relevant projects used to assess the cumulative impacts to inland waters factor are listed in Table 5-33.

Table 5-33: Inland waters cumulative impact assessment

Proposal	Project Summary	Location	Potentially Impacted Wetlands	Potentially Impacts GDEs
Wattle Grove South MRS Amendment 1388/57 (WAPC).	• MRS Amendment 1388/57 proposes to re-zone approximately 126 ha of 'Rural' zoned land to 'Urban' within Wattle Grove.	Figure 5-21	• REW (UFI 8037) totals 0.86 ha in area and has been completely infilled. REW UFI 8037 will be remove from the DBCA geomorphic dataset. • The portion of REW (UFI 15257) totals approximately 2.06 ha (within the MRS amendment area). The portion of REW (UFI 15257) within the MRS amendment will be removed from the GWSCP dataset. • The removal of the two wetlands from the GWSCP dataset is reflective of the ecological condition of the two wetlands. Specifically, historical anthropogenic impacts including the construction of the Tonkin Highway, Water Corporation and DBNGP pipelines and adjacent land uses including commercial turf farm and rural lots resulted in the clearing of native vegetation and the infilling of the wetlands.	• No GDEs associated REWs (UFI 8037 and portion of UFI 15257) are present within the MRS amendment area.
TPS No. 6 Amendments 166 and 169 (City of Gosnells).	• Amendments 166 and 169 to TPS No. 6 proposes to re-zone MKSEA Precincts 2 and 3B to 'Industrial' (consistent with the MRS zoning) under the City's Local Planning Scheme.	Figure 5-27	• Loss of up to 0.7 of CCW values (road widening).	• Loss of up to 1.1 ha of Guildford complex vegetation in Good or better condition.
Tonkin Highway Grade Separated Interchange Proposal (MRWA).	• Construct a single fly-over and grade separated interchange at the existing intersections of Tonkin Highway and Hale Road in Forrestfield and Tonkin Highway and Welshpool Road in Wattle Grove, respectively. In addition, Tonkin Highway will be widened to a six-lane dual carriageway	Figure 5-28	• Loss of wetland areas and values through infill, ground disturbance and vegetation clearing including: o 16.74 ha of mapped CCW. o 10.62 ha of mapped REWs. o 5.91 ha of MUW. o 4.27 ha of the GBSW.	• 9.54 ha of the native vegetation is associated with CCWs.

5.6.1.1 Hydrological cumulative impact assessment

MRS amendment area plus UE and UI areas

The water balance (based on this 'full developed' scenario) predicts post development a combined total outflow (groundwater and surface water) of 183,091 kL from the MRS amendment area toward the GBSW area.

Surface water

The predicted increased in surface water volume exported from the MRS amendment area toward the GBSW is 24,524 kL/year assuming a 'fully developed scenario'. (Emerge Associates 2024). This predicted surface water volume would reduce by 13,674 kL/year if the UE and UI area remains undeveloped. The 24,524 kL/year volume consists of:

- 5,192 kL/year increase toward the GBSW area via the Boundary Road culvert and the former Crystral Brook tributary from the Boundary Road culvert
- 19,332 kL/year towards the MKSEA Precinct 2 open drains via Brentwood Road and Victoria Road culverts.

If the MRS amendment area only was developed, the surface water changes for flows directly to the GBSW area from the MRS amendment area is negligible (-638 kL/year), with the majority of flow change occurring where the site discharges to the MKSEA Precinct 2 landholdings and open drains (11,488 kL/year) (Emerge Associates 2024).

Groundwater through flow

The WBA (Emerge Associates 2024) predicts a minor increase in Superficial Aquifer through flows (65,141 kL) assuming a 'fully developed scenario'. This recharge flow is within the deeper superficial aquifer (i.e. not the shallow perched water table). In terms of the GBSW area:

- The groundwater through flow will be consistent with the pre-development flow directions, which is predominantly north-west to south-east and away from the GBSW area.
- The GBSW is situated atop of the alluvial Pinjarra Plain which is characterised by soils of the Guildford Formation. Within areas of the GBSW, the Guildford Formation clay form layers a complex sequence of lay lenses that are laterally and vertically varied which form a low permeable barrier between the perched water table, wetlands and the Superficial Aquifer.
- Key conclusions from hydrological assessment within the GBSW area confirm rainfall and groundwater perching are the dominant hydrological process, for example:
    - Semeniuk (2001) reported the wetlands within the GBSW area were maintained by surface and near surface perching of direct precipitation and by infiltration. During periods of below average rainfall groundwater in the Superficial Aquifer was considered likely to play only a minor part on the maintenance of the wetlands, with the major recharge mechanism for the wetlands identified as being direct precipitation, perching, infiltration and sub surface perching.
    - Bourke (2017) agreed that the GBSW area was predominantly a surface water feature and reliant largely on rainfall and surface water inflow.
- The interaction between the Superficial Aquifer and the perched groundwater table within the GBSW is unlikely to be spatially uniform across the GBSW (or the interaction is possibly limited to minor leakage through heavy clay layers).

Groundwater mound

The predicted post development increase in groundwater recharge into the Superficial Aquifer from soakwells, stormwater biofiltration and flood management areas focussed in the area of the existing mound adjacent to Tonkin Highway (within the area of the former turf farm) balances the reduction in the groundwater mound levels as a result of ceasing irrigation from the Leederville Aquifer.

This increase in recharge will assist, in combination with the DWMS stormwater management approach to maintain the pre-development conditions i.e. the presence of existing groundwater mound. Accordingly, post development:

- groundwater flows are expected to be comparable with pre-development conditions and will continue to flow radially away from the mound
- groundwater flows towards the west will remain comparable with the pre-development flows and is not expected to impact GBSW (Emerge Associates 2024).

MKSEA Precinct 2 and 3B

The hydrological and environmental impact assessment addressed in the Environmental Review of City of Gosnells TPS No. 6 Amendments 166 and 169 (Emerge Associates 2023b) was inclusive of pre-development surface water runoff volumes into MKSEA Precinct 2 landholdings from the MRS amendment area via the Boundary Road, Brentwood Road, and Victoria Road culverts.

Stormwater runoff within Precinct 2 is conveyed via a combination of overland flow, unlined open drains both within road reserves and between lots towards either the culvert beneath Boundary Road (and which discharges to the GBSW central drain) or Bickley Road (Emerge Associates 2023d). The GBSW is located hydrologically downstream of MKSEA Precinct 2.

The most prominent feature of Precinct 3B is Yule Brook, which flows to the south-west. Flows enter Precinct 3B at Welshpool Road. Precinct 3B is hydrologically downstream of the GBSW. Yule Brook conveys flows from the WBA areas as well as upstream catchments towards the Roe Highway culverts to the west and ultimately to the Canning River (Figure 5-32).

The recharge to the underlying groundwater aquifer is expected to be relatively minor due to the measured low permeable shallow clay/sandy clay layers across MKSEA Precincts 2 and 3B (Emerge Associates 2023b), given the following:

- The total additional surface water volume from MKSEA Precinct 2 towards the GBSW is 682,912 kL/year.
- The additional recharge into the perched water table within the GBSW area is 2,860 kL/year.

The MKSEA assessment was based on a scenario of no additional development within the MRS amendment area. The entire 24,524 kL/year (assuming a 'fully developed scenario') surface water increase exiting the MRS amendment area via the Boundary Road culvert (5,192 kL/year), Brentwood Road and Victoria Road culverts (19,332 kL/year) into either the GBSW and/or the MKSEA Precinct 2 landholdings and open drains.

Hydrologically, the potential connection(s) between the Superficial Aquifer and the perched water table and wetlands within the GBSW and any hydrological connection is unlikely to be spatially uniform across the GBSW or the interaction is possibly limited to minor leakage through heavy clay layers. Only a minor portion of the Superficial Aquifer would potentially interact with the perched water table and/or wetlands.

The cumulative assessment primarily addresses the additional surface water flows towards the GBSW.

The direct impacts (assuming a 'fully developed scenario') from the MRS amendment area would be:

- The additional 5,192 kL/year flows from the Boundary Road culvert which would flow directly into the GBSW via the former Crystal Brook tributary.
- The additional 19,332 kL/year flows from Brentwood Road and Victoria Road culverts into the MKSEA Precinct 2 landholdings.

Assuming the MKSEA Precinct 2 industrial development is 'fully developed'. Accordingly, the 19,332 kL/year surface water flow volumes would be intercepted by the proposed multiple use corridor. This multiple use corridor purpose is to ensure post-development peak flow rates towards the GBSW from minor and major rainfall events are consistent with the existing environment.

In this 'worst case' cumulative impact assessment, the surface water outflows from the MRS amendment area would contribute:

- An additional 4% towards the total outflows leaving MKSEA Precinct 2 into GBSW.

Figure 5-46 illustrates the proposed stormwater management structures within MKSEA Precinct 2.

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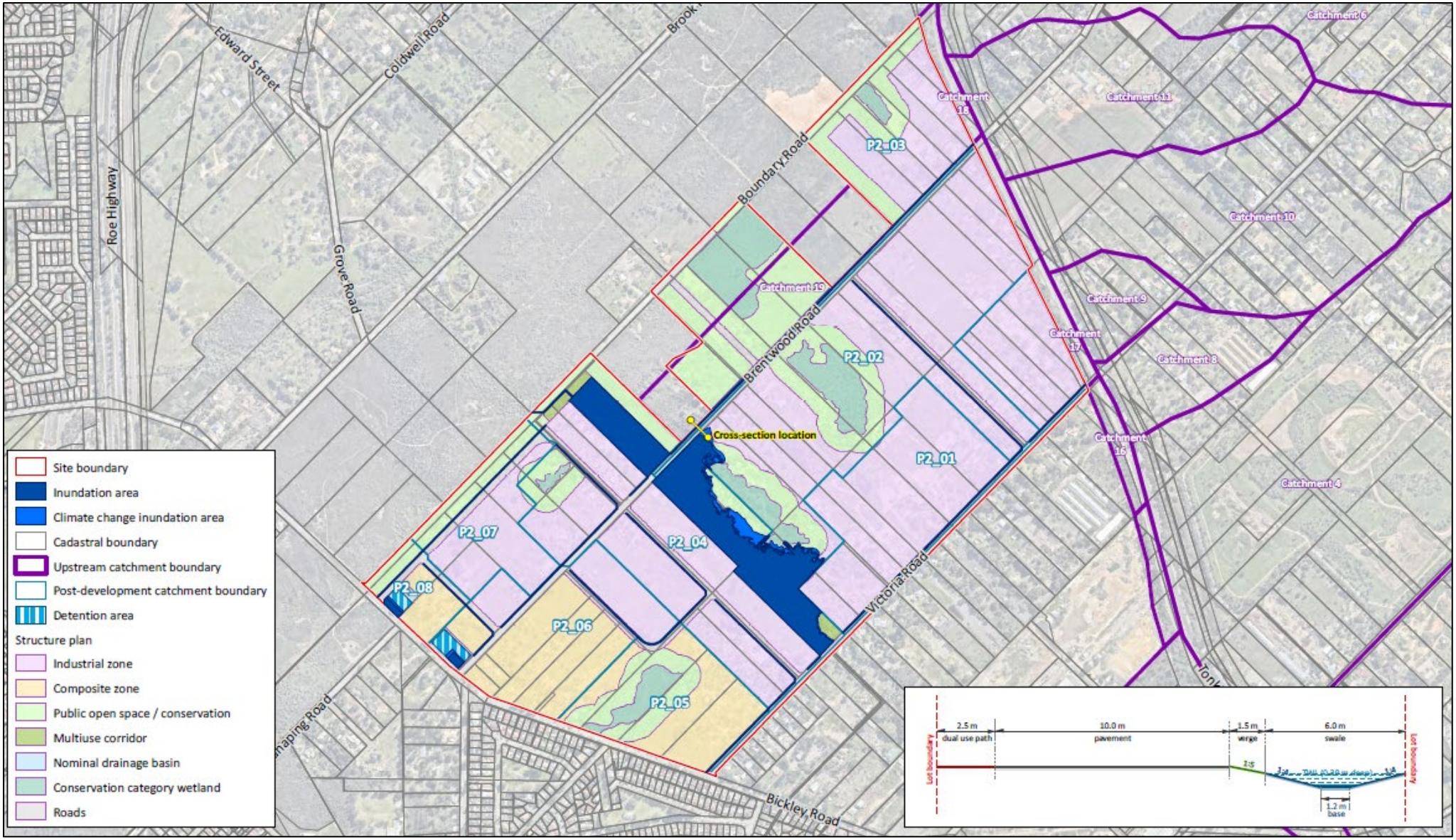

Figure 5-46: MKSEA Precinct 2 concept stormwater management strategy (Emerge Associates 2022h)

Proposed hydrological management.

The cumulative assessment of the MRS amendment area and the MKSEA Precincts 2 and 3b should acknowledge the proposed hydrological mitigation measures embedded in the MRS amendment area DWMS and MKSEA Precinct 2 LWMS (Emerge Associates 2022h). Specifically:

MKSEA Precinct 2 and 3b:

The key elements of the water management approach are (Emerge Associates 2023b):

- Maintain the peak flow regime to wetlands and sensitive environments within the amendment areas so that the hydrology feeding these is maintained.
- Maintain existing key discharge locations and configurations of these to assist in maintaining the existing hydrological regime.
- Avoid the need for significant imported fill that could potentially alter catchment hydrology.
- Treatment of road reserve runoff at source via extended detention/infiltration in vegetated swales.
- Treatment of lot runoff (i.e. the small event runoff) at source and provide at source detention for some of the major rainfall event.
- Conveyance of minor and major event runoff from lots and road reserves via vegetated swales and overland flow within road reserves.
- Major event flood storage within a multiple use corridor (MKSEA Precinct 2) that integrates with surrounding levels and avoids the need to undertake earthworks within proposed/adjacent buffers.
- Minor and major event flows will be detained within swales and detention areas to ensure that pre-development peak flows discharging from Precinct 2 are maintained.
- Utilise reticulated scheme water and wastewater.
- Water efficiency measures (e.g. waterwise gardening) to be implemented to reduce water requirements.

MRS amendment area:

- Stormwater management improvement via the use of water sensitive urban design techniques in accordance with Better urban water management (WAPC 2008) and the Stormwater management manual for WA (DWER 2022), including the approach of managing small events and maximising infiltration at source. This will also include mimicking natural flow paths and providing overland flow across vegetated surfaces to help to maintain water flows and improve water quality.
- Post development stormwater volumes and flows to be managed relative to existing conditions particularly in relation to the GBSW area.
- The post development UNDO modelling shows a positive impact from the proposed 'Urban' land use with an approximate 60% reductions in nutrients exported from the MRS amendment area (Hyd2o 2024).

Mitigation

Table 5-34 outlines the relevant Inland Waters mitigation measures to be prepared and implemented in accordance with the corresponding planning decision stages under the PD Act.

Table 5-34: Inland waters mitigation measures and alignment with the PD Act process

Planning stage/instrument	Proponent	Management actions	Approval responsibility
Water management			

MRS amendment and City of Kalamunda LPS amendment.	WAPC / City of Kalamunda.	Preparation of the Wattle Grove South DWMS inclusive of:
		• Identification of specific water management objectives, outcomes and design criteria to be achieved in relation to:
		  ○ Protection of GBSW and other important environments
		  ○ Stormwater and groundwater management
		  ○ Water efficiency and fit-for-purpose use
		  ○ Adaptive management framework.
		• Pre and post development water balance to inform the determination of hydrological regimes of water dependant ecosystems to be protected.
		• Initiation of the surface water and groundwater monitoring program (as defined in Table 5-8 and Table 5-11).
			WAPC (with endorsement from DWER in consultation with DBCA and the City of Kalamunda)

Local Structure Plan.	Developer / City of Kalamunda.	Preparation of the Wattle Grove South LWMS inclusive of:
		• Identification of relevant site-specific water value triggers and management objectives based on:
		  ○ Surface water and groundwater monitoring program data set
		  ○ Geotechnical data
		  ○ Surface water modelling
		  ○ UNDO modelling
		  ○ Preliminary earthworks strategy
		  ○ Consultation with DBCA/DWER and the City of Kalamunda.
		• Continuation of the surface water and groundwater monitoring program.
		• Refinement of groundwater mapping if required based on additional monitoring data.
		• Concept design of stormwater management bioretention basins for both small and large rainfall events.
		• Engineering and landscape concept designs for the stormwater management bioretention basins, POS areas and streetscapes.
		• Preliminary earthworks strategy and refinement of post development catchments.
		• Identification of proposed POS areas, water source bore(s) and water requirements.
			WAPC (with endorsement from DWER in consultation with DBCA and the City of Kalamunda)

Subdivision/development application.	Developer / City of Kalamunda.	Preparation and implementation of UWMP(s) inclusive of:
		• Subdivision plan.
		• Identification of relevant site-specific water management objectives and outcomes to be achieved based on:
		  ○ Surface water and groundwater monitoring program data set.
		  ○ Geotechnical data.
		  ○ Surface water modelling.
		  ○ Consultation with DBCA/DWER and the City of Kalamunda.
		• Continuation of the surface water and groundwater monitoring program (as defined in Tables 5-8 and 5-11).
			WAPC (with endorsement from DWER in consultation with DBCA and the City of Kalamunda)

Planning stage/instrument	Proponent	Management actions	Approval responsibility
		• Detailed surface water management drainage design drawings addressing small, minor and major rainfall events. • Adaptive/flexible outlet structures on stormwater infrastructure to enable changed performance based on monitoring outcomes. • Reporting and compliance audit.	
Construction management			
Subdivision/development application.	Developer	• CEMP • Table 5-35 details the management actions, management targets, monitoring actions relating to earthworks and civil infrastructure construction associated with future approved subdivision/development applications.	City of Kalamunda
Acid Sulfate Soils			
Subdivision/development application.	Developer	• Addressed in the Model Subdivision Conditions Schedule (DPLH 2024b) if required/applicable. • An ASS self-assessment form • If required as a result of the self-assessment, an ASS report and an Acid Sulphate Soils Management Plan (ASSMP) will be submitted to and approved by DWER before any subdivision works or development are commenced. Note: Assessment and ASS management will be undertaken in accordance with the Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes Guideline (Department of Environment Regulation 2015).	DWER
Contamination			
Subdivision/development application.	Developer	• Addressed in the Model Subdivision Conditions Schedule (DPLH 2024b). • Prior to commencement of subdivision works, investigation for soil and groundwater contamination will be undertaken to determine if remediation is required. If required, remediation, including validation of remediation, of any contamination identified shall be completed prior to the issuing of titles on advice from DWER. Note: Contamination assessment will be undertaken in accordance with the CS Act, the Contaminated Sites Regulations 2006 and Contaminated Sites Guidelines (Department of Environment Regulation 2006 - 2017).	DWER.

Table 5-34 demonstrates through the PD Act process:

- The implementation of the water management framework in accordance with:
  - Better urban water management (WAPC 2008)
  - State Planning Policy 2.9 Planning for Water (WAPC 2021)
  - Environmental Guidance for Planning and Development – Guidance Statement 33 (EPA 2008)

- The implementation of the ASS and contamination mitigation framework aligns with the WAPC's existing Model Subdivision Conditions (DPLH 2024b).
- Former land uses in the amendment area such as the former poultry farm sheds will be subject to future preliminary site investigations in accordance with the CS Act and the Contaminated Sites Guidelines (DWER 2021) undertaken either at the Local Structure Plan or at the subdivision approval stage (as a condition of subdivision). A contamination subdivision condition defines the investigation, assessment, remediation and management of contaminated sites and the DWER reporting requirements under the CS Act and the Contaminated Sites Guidelines (DWER 2021).
- The preparation and implementation of a CEMP is activated at the subdivision or development application approval stage under the PD Act. The subdivision or development application approval provides the planning authority to undertake civil infrastructure works and earthworks associated with the establishment of residential lots, roads and installation of drainage basins, power, sewer and water infrastructure.

Table 5-35 provides additional evidence of the application of the CEMP by setting out the Management Target, Management Actions, Monitoring Timing/Frequency of Monitoring, and Reporting criteria in alignment with *Instructions on how to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans* (EPA 2021).

The management criteria (outlined in Table 5-35) will be reviewed in consultation with the City of Kalamunda prior to the lodgement of the stage 1 subdivision application and/or development application. Noting the subdivision or development application will be the trigger under the PD Act for the preparation and implementation of the CEMP

Table 5-35: Inland Waters CEMP

Management Target	Management Actions	Monitoring	Timing/Frequency of Monitoring	Reporting
• **EPA Objective:** To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected. • **Key Risks:** o Alteration of hydrological regimes resulting in impacts to significant wetlands and waterways within and nearby to the MRS amendment area. o Impacts to water quantity and quality of significant wetlands and waterways within and nearby to the MRS amendment area. o Impact to the hydrology and biodiversity. o Potential erosion and sedimentation due to discharge of water for the purpose of dust suppression where and when required. o Potential contamination of surface and/or groundwater due to accidental fuel/chemical spills and contaminated stormwater runoff.				
• The CEMP will define management targets. For example: o No damage to CCWs outside of the approved future subdivision boundaries. o Weed and pathogen management measures.	• The CEMP will include specific: o Erosion, Sediment and Drainage control measures for the construction work phase. o Control stormwater run-off management measures to minimise potential downgradient environmental impacts. o Dust control management actions. o Specific weed and pathogen management measures.	• The CEMP will define specific monitoring protocols. For example: o Visual inspection. o Monitoring of weather. o Site inspections to ensure if any fuel, oil, and chemical materials are stored and used correctly within dedicated storage areas. o Inspection of vehicles and machinery entering the approved earthwork area. o Visual inspection of the earthwork/subdivision area to ensure that clearing boundaries have been clearly marked.	• The CEMP will define the timing for the monitoring program. For example: o Prior to clearing activities and fortnightly during clearing activities. o Daily weather observations. • Weekly (or after a large storm event). • Visual site inspection prior to clearing activities and fortnightly during clearing activities.	• The CEMP will define the reporting requirements. For example: o Confirm all site personnel have completed a site induction addressing CEMP management targets and actions. o Providing evidence that earthwork/subdivision boundaries have been clearly marked prior to clearing. o Recording and reporting of any spill incidents. o The application of weed treatments.

In summary, the Inland Waters mitigation and management framework will be implemented in accordance with:

- The environmental protection and application of mitigation measures administered under the PD Act
- State Planning Policy 2.9 Planning for Water (WAPC 2021)
- Environmental Guidance for Planning and Development – Guidance Statement 33 (EPA 2008)
- Better urban water management (WAPC 2008)
- Model Subdivision Conditions (DPLH 2024b)

5.6.1.2 Avoid

Future 'Urban' land use and associated construction activities will avoid clearing impacts to:

- **GBSW:** The MRS amendment does not change the existing 'Parks and Recreation' and 'Bush Forever' land use within the GBSW area located east of Tonkin Highway. All future approved development works (i.e. civil infrastructure works and earthworks associated with the creation of residential lots, roads, the installation of drainage basins, power, sewer and water infrastructure) will occur within the approved subdivision and/or development application boundary (located entirely within the MRS amendment area) and outside of the GBSW area. The Tonkin Highway reserve in combination with the Water Corporation pipeline and DBNGP easements establishes a minimum 100 m physical boundary between the GBSW wetlands and the MRS amendment area at the closest point.
- **Yule Brook:** The waterway, inclusive of the brook's foreshore area is located outside of the MRS amendment area. Future construction activities within the MRS amendment area will occur east of Tonkin Highway, located over 200 m from the Yule Brook waterway.
- **CCWs:** The two CCWs (UFI 8026 and UFI 8027) and the portion of REW (UFI 15257) within Lot 501 will be retained along with the Boundary Road reserve.

5.6.1.3 Minimise

The Wattle Grove South DWMS (Appendix B) defines the best practice urban water management approaches (which will be employed in the future LWMS and UWMP(s)). The best practice urban water management approaches include (Hyd2o 2024):

- The implementation of water sensitive urban design in accordance with:
    - Better urban water management guidelines (WAPC 2008).
    - Stormwater management manual for WA (DWER 2022).
- The installation of stormwater bioretention basins (which are currently not employed within the MRS amendment area) will improve water quality relative to the current conditions (i.e. existing open rural paddocks/turf farm land uses) and improve downstream ecological conditions.
- Integrating the surface water and groundwater monitoring program dataset into the future LWMS and UWMP(s), surface water and groundwater trigger values and the adaptive management framework.
- The surface water and groundwater monitoring program (as defined in Table 5-8 and Table 5-11 and illustrated in Figure 5-7) will be continued for the purpose of informing the future water planning and assessment stages, specifically, LWMS and UWMP.

- The surface water and groundwater dataset include groundwater levels and quality and surface water quality and flows parameters both within the MRS amendment and the GBSW areas (refer to Figure 5-7). Currently, there is over three years of seasonal surface water and groundwater data. The dataset underpins:
    - The application of specific surface water and groundwater trigger values which will be adopted in future water planning stage (i.e. LWMS and UWMP(s)) on advice from regulatory authorities (i.e. DBCA, DWER and the City of Kalamunda).
    - Provides evidence on the performance of the management measures.
    - Agreed triggers for the implementation of adaptive management measures in agreement with the regulatory authorities (i.e. DBCA, DWER and the City of Kalamunda).
    - Reporting to regulatory authorities (i.e. DWER, DBCA and the City of Kalamunda).
- Advice/feedback from regulatory authorities (i.e. DWER, DBCA and the City of Kalamunda) into the LWMS, UWMP(s) inclusive of the following elements:
    - Surface and groundwater monitoring data and monitoring program
    - Geotechnical dataset
    - Water values triggers
    - Surface water modelling (completed as a component of the LWMS)
    - Nutrient modelling (UNDO model)
    - Climate change assessment
    - Biofiltration basin location
    - Adaptive management framework
- Locating stormwater bioretention basins and swales in areas the vicinity of the existing groundwater mound to maintain the pre-development groundwater recharge and groundwater flow direction.
- Attenuation of stormwater flow events (in accordance with stormwater modelling) and DWER stormwater management objectives) in bioretention basins designed to align with pre-development flows, facilitate infiltration into the Superficial Aquifer and protect downstream infrastructure (Figure 5-47).
- Adopting flexible infrastructure arrangements within stormwater bioretention basins with the objective of enabling water flow adjustments to downstream environmental needs (i.e. the GBSW area) if required to address the impacts from climate change. The bioretention drainage basin design will be subject to review from DWER in consultation with DBCA and City of Kalamunda at the LWMS and UWMP stages.
- Avoid significant imported of fill that could potentially alter catchment hydrology.
- Utilisation of reticulated scheme water and wastewater.
- Other corresponding management plans which would be triggered at subdivision include:
    - CEMP (refer to Table 5-35).
    - ASS/contamination investigation and management, if applicable.

The DWMS spatially summarises the water management framework across the MRS amendment area. This water management framework is presented spatially in Figure 5-47. The DWMS water management framework will be refined at each sequential planning stage in accordance with the Better urban water management guidelines (WAPC 2008).

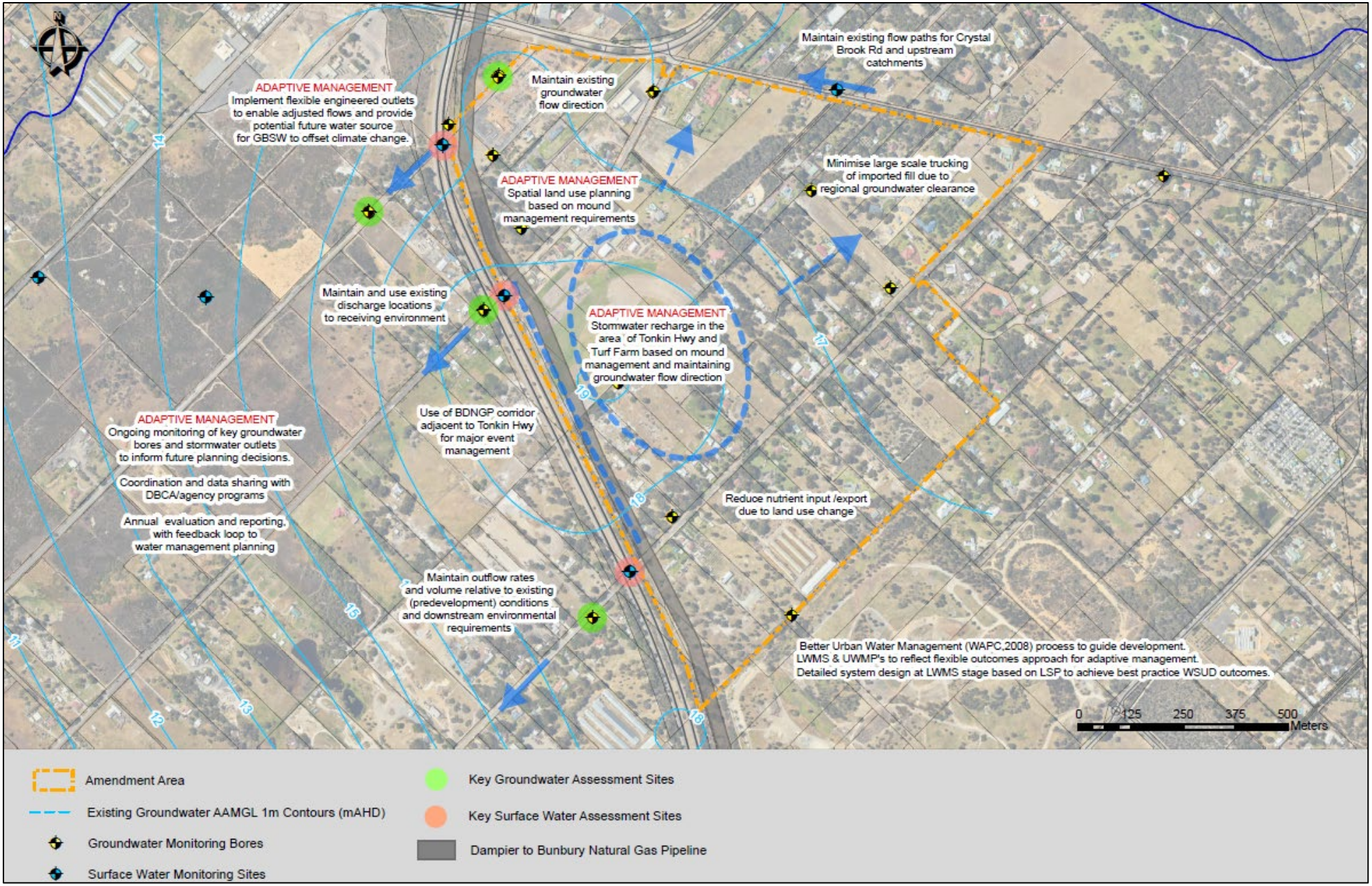

Figure 5-47: Hydrological management framework (Hyd2o 2024)

5.6.1.4 Water monitoring program

The groundwater and surface water monitoring program were commenced by Hyd2o in November 2020. The monitoring program which forms a central element of the mitigation and minimise framework is embedded in the DWMS (Appendix B).

The monitoring program (as defined in Table 5-8 and Table 5-11 and illustrated in Figure 5-7) includes:

- Sampling groundwater quality and levels within, upstream, and downstream of the amendment area, with the selection of sites to enable a review of data in the context of groundwater quality closer to the GBSW area.
- Surface water quality upstream and downstream of the amendment area, and within the GBSW area where stormwater inflow and outflows occur.

The water monitoring program currently captures over three years of monitoring data.

The location(s) of the surface water (9 monitoring sites) and groundwater (26 monitoring bores) monitoring program is detailed in Figure 5-7. The strategic monitoring locations for adaptive hydrological management, with a focus on the groundwater mound levels is provided in the DWMS - Figure 33 (Hyd2o 2024).

The monitoring program will be maintained through the sequential planning stage/instrument and will guide the management of stormwater and groundwater within the following water management planning reports in accordance with Better urban water management guidelines (WAPC 2008):

- LWMS
- UWMP(s)

The surface water and groundwater monitoring program and parameters are outlined in Table 5-36. Further analysis suite testing will be undertaken during winter 2024 in consultation with government agencies.

Table 5-36: Summary of proposed monitoring program

Monitoring task	Summary
Parameters to be measured as part of monitoring	• Groundwater levels (including groundwater contour assessments pre and post development). • Groundwater quality (physical parameters, nutrients and heavy metals) • Surface water quality (physical parameters, nutrients and heavy metals) • Surface water flow rates. • Assessing groundwater levels and quality trends within monitoring bores MW205D, GW5D and BH007 (in the GBSW area).
Location of monitoring sites	The groundwater and surface water monitoring locations remain in accordance with the pre-development monitoring sites as shown in Figure 5-7.
Frequency of monitoring	• Groundwater and surface water monitoring frequency proposed as follows: o Post-development monitoring and reporting. o Groundwater levels monthly o Groundwater quality quarterly (physical parameters, nutrients, metals as per above) o Full analysis suite - periodic.
Responsibilities	Land Developer(s)
Review and application (Hyd2o 2024)	• The future LWMS and UWMP(s) will be informed by the surface water and groundwater monitoring outcomes and key principles of DWMS. • The surface water and groundwater monitoring program (defined in Table 5-8 and Table 5-11) will underpin the following:

Monitoring task	Summary
	○ Water values/targets: Water values will be established and refined in consultation with key regulatory authorities (i.e. City of Kalamunda, DWER and DBCA) at each water planning stage. ○ Annual Assessment: Performance evaluation against agreed water values/parameters in annual reports. The annual reports will be used in consultation with the regulatory authorities and inform the adaptive management framework. ○ The application of adaptive management measures.

5.6.1.5 Interim water quality targets

The interim water quality targets for the key post development assessment sites are premised upon the 2021-2023 pre-development monitoring data are shown in Table 5-37 (Hyd2o 2024).

Table 5-37: Indicative water trigger values

Monitoring element	Sites	pH	EC (mS/cm)	TN (mg/L)	TP (mg/L)
ANZECC (2000) default trigger values for lowland river ecosystems in south-west Australia		6.5 - 8.0	0.12 - 0.30	1.20	0.065
Surface Water	SW2	7.34	0.98	2.90	0.15
	SW3	7.38	0.23	1.80	2.90
	SW4	7.62	0.17	0.45	0.08
ANZECC (2000) default trigger values for wetland ecosystems in south-west Australia		7.0 - 8.5	0.30 - 1.50	1.50	0.06
Groundwater	GW5D	4.55	0.67	1.30	0.05
	GW9D	6.52	0.63	1.75	0.05
	WG8D	5.33	0.85	1.50	0.28
	WG10D	6.30	0.33	2.90	0.05

The nutrient targets at some monitoring locations currently exceed the Swan Canning catchment Nutrient report (DWER & DBCA 2016) targets for the Yule Brook catchment specifically for long term TN (1.0 mg/L) and TP (0.1 mg/L). A summary of the water quality monitoring program for groundwater and surface water is provided in Tables 5-9 and 5-12. The proposed interim targets reflect the amendment area's historical and existing 'rural' land use condition. Improvement in water quality is expected with land use change as development progresses as result of the implementation best practice water sensitive urban design and the Better Urban Management guidelines (Hyd2o 2024).

A key conclusion drawn from this UNDO assessment is the proposed 'Urban' land use change provides the opportunity to significantly reduce nutrient application within the MRS amendment area and export of nutrients towards the west, which includes the GBSW and MKSEA areas. This conclusion is consistent with DBCA's 2021 advice specific to the wetlands and the GBSW area within the MRS amendment area outlined within the MRS Amendment Request, which stated (WAPC 2021):

'The proposed development will reduce impacts on the wetlands within the GBSW (located to the west Tonkin Highway) by improving water quality and reducing the nutrient levels exported from the amendment area'.

The key post development monitoring sites are shown in the DWMS - Figure 33 (Hyd2o 2024). The monitoring site captures:

- Surface water data within the amendment area in proximity to the Tonkin Highway culvert outlets (i.e. prior to flowing west).
- Groundwater bores within (or adjacent to) the GBSW area. In addition to water quality, a focus of monitoring these bores is capture the short- and long-term groundwater level changes from the existing groundwater mound.

The interim water quality targets will be reviewed and refined in consultation with regulatory authorities (i.e. DBCA and DWER) at the sequential planning stages. The review of the water quality targets will incorporate the additional surface water and groundwater data from the ongoing monitoring program. Water level targets for groundwater level mound management will be appropriately established at LWMS stage based on consultation with agencies (i.e. DBCA and DWER).

The water quality (and possible groundwater level) targets (inclusive of any refinements) will be embedded within the following water management reports:

1) LWMS – subject to endorsement from DWER (in consultation with DBCA and the City of Kalamunda).
2) UWMP(s) – subject to endorsement from the City of Kalamunda (in consultation with DWER and DBCA).

5.6.1.6 Inland waters management framework

Table 5-34 overviews the application of the Inland Waters mitigation measures through the PD Act process. The Inland Waters Management Framework addresses the following elements:

1) Water management in accordance with the Better urban water management guidelines (WAPC 2008).
2) Construction management and ASS/contamination investigation and management in accordance with the WAPC's Model Subdivision Conditions (DPLH 2024b).

Inland Waters Management and Integration with the PD Act Process

Water management

The water management framework embedded in the DWMS (Appendix B) will be implemented throughout the sequential (or tiered) planning framework, specifically:

1) Local Structure Plan stage:

a) Preparation of the LWMS
b) Refinement of the indicative water trigger values and adaptive water management measures in liaison with DBCA, DWER and the City of Kalamunda.
c) Detailed stormwater modelling to refine volumes, locations, areas and levels and ensure water releases from the MRS amendment area are consistent with downstream requirements to maintain the downstream water balance of the wetlands.
d) Engineering and landscape design for bioretention drainage basins and swales.
e) Refinement of UNDO nutrient modelling based on the Local Structure Plan.

2) Subdivision stage:

a) Preparation of UWMP(s)
b) Detailed engineering and landscape designs.

c) Establishment of trigger values and adaptive management actions in liaison with DBCA, DWER and the City of Kalamunda.
d) Application of adaptive management measures.

The Better urban water management guidelines (WAPC 2008) provide the framework for the management of water resources at each planning stage by identifying specific actions and/or investigations required to support the planning decision. It also identifies the regulatory authorities (I.e., DWER and local governments) responsible for assessing and providing advice on water management. The water management principles embedded within the Wattle Grove South DWMS will be carried through to inform the subsequent planning stage(s).

Construction Management

The Wattle Grove South MRS amendment changes the existing 'Rural' land use to 'Urban'. The amendment does not authorise construction activities. Post the land use rezoning under the sequential planning stage a Local Structure Plan is required to be prepared and approved by the WAPC. Only post the public advertisement and approval of a future Local Structure Plan that a subdivision application and/or development application can be lodged with the WAPC and/or the City of Kalamunda.

The approval of a future subdivision application and/or development application provides the authority for the implementation of specific construction actions associated with the delivering of a residential subdivision such as earthworks and the installation of civil infrastructure. However, the approved subdivision will be subject to specific implementation conditions. Subdivision conditions and associated advice notes are used by the WAPC to ensure compliance with its statutory and policy responsibilities. These conditions incorporate (refer to Table 5-34):

1) The preparation and implementation of a CEMP.
2) ASS investigation and management, if applicable.
3) Contamination investigations, as applicable.

Table 5-38 demonstrates how the EPA's mitigation hierarchy (avoid, minimise, and rehabilitate) has been applied for inland waters in alignment with the PD Act statutory process. The table details specific management actions addressing the key potential impacts on inland waters (inclusive of the environmental values in the GBSW area) which would be undertaken at the subdivision construction phase (i.e. the implementation of the subdivision conditions).

The construction phase of the Wattle Grove South residential development would be underpinned by the following management framework:

1) Approved DWMS and LWMS (in accordance with the Better urban water management guidelines (WAPC 2008)) prepared at the MRS amendment and the subsequent local structure plan approval stage.
2) Approved UWMP and the surface water and groundwater monitoring program (subdivision condition).
3) Preparation and implementation of a CEMP (subdivision condition).
4) ASS/contamination investigation and management, if applicable (subdivision condition).

Table 5-38: Inland waters management framework

EPA factor: Inland Waters **EPA objective: To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.** **Proposal objective: To minimise as far as practicable the direct and indirect impacts to inland waters from the future 'urban' land use.** **Key environmental values: Watercourses and wetlands within the MRS amendment area and downgradient, including wetlands within the GBSW area.** **Key risks: Disruption of surface water flows, degradation of surface water and groundwater quality.**								
Management targets or indicators	**Hierarchy**	**Management or response actions**	**Monitoring**	**Timing/Frequency**	**Reporting**	**Corrective action trigger**	**Corrective actions**	**Corrective action responsibility**
Planning Stage: Subdivision Approval								

Prevent impacts to water quality during civil construction / earthworks.	**Minimise**	• Preparation and implementation of a UWMP in accordance with subdivision condition.
		• Preparation and implementation of a CEMP in accordance with subdivision condition.
			• Site inspections with civil engineer /City of Kalamunda to confirm:
			  ○ The implementation of the CEMP inclusive of erosion, sediment, dust and drainage control measures.
			  ○ Failure(s) with in erosion/sediment control measures.
			  ○ Dust events.
			• Inspect any temporary drainage sumps and review against the approved civil design.
			• Environmental incident reporting.
				• CEMP and UWMP approval prior to the commencement of site construction works.
				• The civil stormwater and erosion/sediment controlling infrastructure will be inspected:
				  ○ Monthly inspection.
				  ○ Within 24 hours of major storm.
				• The continuation of the surface and groundwater monitoring program as defined in Tables 5-8 and 5-11.
					• Site inspections/audits of the CEMP erosion, sediment, dust and drainage control measures.
					• Annual report on the surface and groundwater monitoring program.
					•
						• Site inspection.
						• Surface water management measures are not in place or not effective i.e. evidence of erosion, sedimentation.
						•
							• Review/amend the relevant management actions within the CEMP to the satisfaction of the City of Kalamunda including:
							  ○ Sediment/erosion management practices.
							  ○ Sizing of temporary drainage sumps.
							  ○ Monitoring of surface water (during / post rain events).
								• Civil Engineer Contractor.
								• Environmental/Hydrologist Consultant(s).
								• Land developer.

Prevent contamination from accidental hydrocarbon and chemical spills	**Avoid**	• Preparation and implementation of a CEMP.	• Environmental audit.
			• Environmental incident reporting.
				• Prior to staff/contractors commencing on site.
				• During construction.
				• Clean up following any spill incident.
					• Environmental audit report.
					• Environmental incident reporting.
						• Spill not remediated and reported.	• Review/amend the relevant management actions within the CEMP to the satisfaction of the City of Kalamunda including:
							  ○ Spill response.
							  ○ Corrective training.
							  ○ Remediation of spills.
							  ○ Reporting.
								• Civil Engineer Contractor.
								• Land developer.

Avoid impacts within the MRS amendment area and downgradient from exposure to ASS and contaminating material.	**Avoid**	• Minimise ASS risk through undertaking soil and groundwater investigations in accordance with the following DWER guidelines:
		  ○ Identification and investigation of acid sulfate soils and acidic landscapes (DWER 2015).
		  ○ Treatment and management of soils and water in acid sulfate soil landscapes (DWER 2015).
		  ○ *Contaminated Sites Act 2003*.
		  ○ Contaminated Sites Regulations 2006.
			• Preliminary ASS investigations (soil/groundwater) and reporting to define risk.
			•
				• Pre-construction works.	• Laboratory soil and groundwater results and preliminary ASS assessment.	• Site soil / groundwater investigations confirm ASS risk through investigations and management in accordance with the 'Identification and investigation of acid sulfate soils and acidic landscapes guidelines' (DWER 2015).	• Prepare and submit ASS management plan for approval by DWER – if required.
							• Implement ASS management plan inclusive of close out plan in accordance with DWER requirements – if required.
								• Environmental consultant.
								• Land developer.

EPA factor: Inland Waters
EPA objective: To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.
Proposal objective: To minimise as far as practicable the direct and indirect impacts to inland waters from the future 'urban' land use.
Key environmental values: Watercourses and wetlands within the MRS amendment area and downgradient, including wetlands within the GBSW area.
Key risks: Disruption of surface water flows, degradation of surface water and groundwater quality.

Management targets or indicators	Hierarchy	Management or response actions	Monitoring	Timing/Frequency	Reporting	Corrective action trigger	Corrective actions	Corrective action responsibility
Impacts to current surface and groundwater cycles (alteration of hydrological regimes) resulting in impacts to significant wetlands and waterways within and nearby to the MRS amendment area, including the Yule Brook and the GBSW.	Minimise	• Preparation and implementation of an UWMP. The UWMP contains: ○ Agreed water value targets in consultation with key regulatory authorities (i.e. City of Kalamunda, DWER and DBCA) based on the surface water and groundwater monitoring outcomes. ○ Annual reporting requirements ○ Adaptive water management actions. ○ Stormwater drainage design. • Continue the surface water and groundwater monitoring program. The monitoring program will: ○ Confirm that surface water management infrastructure is functioning to the design criteria. ○ Assess pre and post development surface water quality to confirm the earthworks and residential development (or 'urban' land use) is not adversely affecting water quality downgradient (i.e. within the GBSW area). ○ Assess pre and post development groundwater quality and depth to confirm the earthworks and residential development (or 'urban' land use) is not adversely affecting groundwater quality downgradient (i.e. within the GBSW area).	• The construction of surface water drainage infrastructure in accordance with: ○ The approved detailed civil engineering and landscape designs which treats the surface water and maintains the pre development surface water outflow. ○ Detailed civil engineering design drawings. ○ Detailed landscape design including biofiltration planting within stormwater basins. • Implement surface water/groundwater monitoring program (as defined in Tables 5-8 and 5-11): ○ Groundwater levels ○ Groundwater quality (physical parameters, nutrients and heavy metals) ○ Surface water quality (physical parameters, nutrients and heavy metals) ○ Surface water flow rates.	• Detailed civil stormwater and landscape designs are embedded in the UWMP and will be assessed by DWER/City of Kalamunda in consultation with DBCA. • Groundwater and surface water monitoring as defined in the approved UWMP.	• Record UWMP approval(s). • Record of the detailed civil stormwater bio-retention drainage infrastructure and detailed landscape plan approvals from City of Kalamunda (potentially on advice from DWER). • The groundwater and surface water monitoring program will be reported annually to key regulatory authorities including City of Kalamunda, DBCA and DWER.	• Confirm in liaison with the City of Kalamunda the approved stormwater bioretention basins/swales have constructed in accordance with the approved engineering and landscape design. • The approved UWMP will confirm the specific groundwater and surface water values triggers. • Identify the source of elevated nutrient or suspended solids through additional site-specific investigations.	• Comparison of upstream water quality levels to downstream water quality levels. • Complete re-sampling event. • If water quality nutrients levels are greater than 20% higher downstream, then a review of nutrient application practices and surveillance of the area will be undertaken to identify the source, which would be removed if possible (for example fertiliser input). • If upstream and downstream levels are similar, then conduct a site-specific review of background data to determine if trigger values require modification, in consultation with DWER. • Consult the regulatory authorities (i.e. DWER, DBCA and the City of Kalamunda) on the monitoring data and the performance of the specific water management actions in context of the established targets. and providing recommendations for future monitoring, planning and development implications, and any further corrective actions. •	• Civil Engineer Contractor. • Environmental / Hydrologist Consultant(s). • Land developer.

5.6.2 Assessment and Significance of residual impacts

If the Wattle Grove South scheme amendment proceeds in accordance with the mitigation measures, the following residual impacts and benefits are anticipated. This assessment based on the MRS amendment area, UE and UI areas being 'fully developed'.

5.6.2.1 Changes to hydrological regimes of adjacent GBSW area

No significant residual direct impacts or changes to the current surface and groundwater cycles resulting in impacts to the nearby GBSW area are predicted for the following reasons:

- The water balance (based on this 'full developed' scenario) predicts post development a combined total outflow (groundwater and surface water) of 183,091 kL/year from the MRS amendment area toward the GBSW area.
- The predicted increased in surface water volume exported from the MRS amendment area toward the GBSW is 24,524 kL/year assuming a 'fully developed scenario' noting this predicted surface water volume would reduce by 13,674 kL/year if the UE and UI area remain undeveloped (Emerge Associates 2024). This consists of:
    - 5,192 kL/year increase toward the GBSW area via the Boundary Road culvert and the former Crystral Brook tributary from the Boundary Road culvert
    - 19,332 kL/year towards the MKSEA Precinct 2 open drains via Brentwood Road and Victoria Road culverts.
- If the MRS amendment area only was developed, the surface water changes for flows directly to the GBSW area from the MRS amendment area is negligible (-638 kL/year), with the majority of flow change occurring where the site discharges to the MKSEA Precinct 2 landholdings and open drains (11,488 kL/year) (Emerge Associates 2024).
- Groundwater throughflow increases in the post-development environment, attributed to the increase in available water (from recharge) to the Superficial Aquifer. This increase recharge will assist in maintaining the groundwater mound, alongside the proposed stormwater management approach detailed in the DWMS, and so changes to groundwater flow towards GBSW are unlikely to occur (Emerge Associates 2024). Maintaining the groundwater mound (consistent with pre-development conditions), via the groundwater recharge and focused surface water infiltration (in drainage basins/swales in the vicinity of the mound) consistent post-development groundwater flows are expected to be maintained comparable with pre-development conditions. Groundwater flow within the Superficial Aquifer will continue to flow radially away from the mound towards the north-west and south-east.
- The hydrological features within GBSW area are largely driven by surface water inputs and perched groundwater expressions, rather than interactions with groundwater from the underlying Superficial (or Leederville Aquifer), due to the prevalence of near surface impermeable alluvial clay layers across the GBSW area. Any connections between the Superficial Aquifer, the perched water table, and wetlands would not be spatially unform across the GBSW or the interaction is possibly limited to minor leakage through heavy clay layers.
- The ceasing of the turf farm irrigation source (i.e. from the Leederville Aquifer) has the following unintentional hydrological outcomes for the groundwater mound:
    - Reduction of the groundwater levels which have been kept at an elevated level (i.e. between 1 m to 5 m for the past 20 years).
    - This groundwater level elevation extends approximately 1.5 km west and north-west into the GBSW. The extent to which the ceased irrigation at the turf farm from the Leederville Aquifer will impact groundwater levels locally is difficult to quantify given the variable geology of the local area.

- A key principle adopted within the Wattle Grove South DWMS (Hyd2o 2024) is to maintain pre-development groundwater elevations (i.e. the existing mound). The predicted increase in groundwater recharge into the Superficial Aquifer (typically recorded within urban developments) is offset in the MRS amendment area by the reduction in the groundwater mound occurring beneath the turf farm. The post-development contours for the Superficial Aquifer are expected to be consistent with the pre-development environment due to:
    - The increase recharge to the Superficial Aquifer.
    - The proposed stormwater management approach which maintains the groundwater mound via locating stormwater basins in the vicinity pf the turf farm (or the source of the mound).
- The Wattle Grove South DWMS (Hyd2o 2024) promotes an adaptive management approach for the MRS amendment area which is underpinned by the continued implementation of the current groundwater and surface water monitoring program as defined in Table 5-8 and Table 5-11. The monitoring program and reporting framework encapsulates the monitoring and assessment of the surface water recharge into the Superficial Aquifer (around the turf farm) to maintain the groundwater mound. The monitoring program and reporting framework encapsulates monitoring of the Superficial Aquifer groundwater levels (both near the turf farm and in the GBSW). This will enable:
    - A comparative review of seasonal groundwater contours and flow direction pre-and post-development
    - The influence of the groundwater mound post development.
- By assessing the monitoring data, adaptive management approaches should be applied to mitigate (i.e. maintain the groundwater mound) any potential impacts as development precedes (Hyd2o 2024). Adaptive management measures, if required, to maintain the mound could include:
    - Supplementary Leederville Aquifer recharge via irrigation to:
        - Strategically located POS areas.
        - Local primary school oval (located within the turf farm area).
- The adaptive management program, in addition to the monitoring of the groundwater mound, will:
    - Continue the current comprehensive surface and groundwater monitoring program (as defined in Table 5-8 and Table 5-11.
    - Applying agreed targets in consultation with agencies (City of Kalamunda, DWER and DBCA) based on pre-development monitoring outputs for the following aspects:
        - Surface water quality and flows.
        - Groundwater quality and levels (including contour assessments pre and post development).
        - Climate change.
    - Undertake annual assessment including performance evaluation against the targets, annual reporting, with outcomes and recommendations to influence water management.
- The proposed stormwater management infrastructure will be developed to mimic pre-development peak flow volumes. The implementation of a stormwater management framework in alignment with Better urban water management (WAPC 2008) requirements and the Stormwater management manual for WA (DWER 2022) is expected to significantly improve water quality existing the MRS amendment area post development towards the GBSW i.e. predicted 61% total nitrogen reduction and 60% total phosphorus export reduction from the MRS amendment area (Hyd2o 2024).

- The implementation of adaptive outlet structures on stormwater infrastructure presents an opportunity to partially mitigate climate change impacts on declining inflows and water levels within the GBSW area downgradient if required (Hyd2o 2024a).
- The Tonkin Highway acts as an impermeable flow boundary, excluding shallow perched groundwater flows in a westerly direction (given likely removal of the shallow soil profile during construction). The presence of the DBNGP at this boundary is also expected to facilitate downward infiltration of shallow perched groundwater to the deeper sandy layer (Emerge Associates 2024).

5.6.2.2 Construction activities

The sequential planning framework has demonstrated its ability to comprehensively address the risks from construction works and ASS. The model subdivision conditions (DPLH 2024b) have standard conditions addressing:

- construction management
- ASS/contamination investigations and management.

No impacts to water (quantity and quality), downgradient significant wetlands and waterways from construction and ASS exposure is expected.

5.6.3 Other statutory decision-making processes

Table 5-39 summarises whether another statutory decision-making process can mitigate the potential environmental impacts of the MRS amendment on Inland Waters.

Table 5-39: Inland Waters - Other statutory decision-making processes

Potential impact	Statutory decision-making process that can mitigate impacts	Reason
Alteration to groundwater regimes (drawdown) from groundwater abstraction.	Yes	***Rights in Water and Irrigation Act 1914 (RiWI) 5C licence*** • Opportunity for public comment on the proposed licence/licence amendment. • Licence specifies location of groundwater abstraction, maximum abstraction rate and compliance requirements. • Operating Strategy (licence condition) specifies abstraction, monitoring, and reporting details. • Licence contains outcome-based conditions (including operating strategy) that can maintain the hydrological regimes of surface water to protect environmental values, to meet the EPA's objective for Inland Waters.

Alteration to surface water and wetlands.	Yes	**State Planning Policy prepared under Part Three of the PD Act: State Planning Policy 2.9 (SPP 2.9) Planning for Water (WAPC 2021)**
		• This policy outlines the integration of water resource management into planning processes. This policy applies to proposals prepared and assessed under the PD Act i.e. scheme amendments, LSP and subdivisions.
		• Proposals in accordance with the SPP 2.9 require the following actions:
		  ○ Identify wetlands and their buffers and waterways and their foreshore areas and/or reserves.
		  ○ Ensure waterways and wetlands have adequate foreshore areas and wetland buffers to protect, manage and conserve water quality and quantity, native vegetation, aquatic and riparian habitats, ecological linkages, and associated biodiversity values.

Potential impact	Statutory decision-making process that can mitigate impacts	Reason
		○ Ensure the maintenance of natural flows in waterways, groundwater levels and inundation of wetlands to sustain aquatic and terrestrial habitats through the delivery of appropriate stormwater and groundwater management systems. • Water management plans including DWMS and LWMS are available for public and agency/local government review and comment. • DWMS, LWMS and UWMP includes key hydrological assessments/ data and water management framework including groundwater/surface monitoring program(s). • Specific conditions may be required to address, wetlands/waterways. **Better urban water management provides guidance on implementing State planning policy 2.9: Water resources (WAPC 2008)** • Better urban water management was designed to guide water management at the regional, district, local and subdivision stages of the planning process by ensuring consideration is given to the total water cycle at each stage of planning and development. • A DWMS is a high-level water management report which is a requirement of Better urban water management. • The report accompanies a district structure plan or region planning scheme amendment and is prepared by the initiator of the planning proposal. • The purpose of a DWMS, as outlined in Better urban water management, is to demonstrate that the land can support the change in land use and is able to achieve appropriate urban water management outcomes. The DWMS informs the decision-making process associated with the proposed land use change. This involves demonstrating that the development: ○ will not detrimentally impact water resources and associated environmental values ○ can manage surface water and groundwater ○ can be serviced with water and wastewater.
Acid sulfate soils	Yes	**Acid Sulfate Soils Planning Guidelines (WAPC 2008)** • Acid Sulfate Soils Planning Guidelines outline a range of matters that need to be addressed at various stages of the planning process to ensure that the subdivision and development of land containing acid sulfate soils is planned and managed to avoid potential adverse effects on the natural and built environment. **Identification and investigation of acid sulfate soils and acidic landscapes (DER 2015)** • The purpose of the Identification and investigation of acid sulfate soils and acidic landscapes guideline is to provide guidance on the minimum level of investigation required to identify the presence or the absence of ASS in areas likely to be disturbed by a proposed development or other project. **Treatment and management of soils and water in acid sulfate soil landscapes (DER 2015)** • If ASS is present, define the nature and extent of ASS and the amount of existing and potential acidity it contains to determine appropriate management measures. This document provides information on the treatment and management of ASS. ○

5.7 Environmental Outcomes

Proposed environmental outcomes to inland waters are outlined in Table 5-40.

Table 5-40: Summary of environmental outcomes

Factor	Summary of proposed environmental outcomes

Inland Waters	• All 'urban' land uses to be confined to the MRS amendment area.
	• The Inland Waters mitigation and management framework will be implemented in accordance with the environmental protection and application of mitigation measures administered under the PD Act and the following key policies and guidance:
	  ○ State Planning Policy 2.9 Planning for Water (WAPC 2021)
	  ○ Environmental Guidance for Planning and Development – Guidance Statement 33 (EPA 2008)
	  ○ Better urban water management (WAPC 2008)
	  ○ Model Subdivision Conditions (DPLH 2024b)
	Wetlands
	• The assessment of the REWs UFI 8037 and UFI 15257 values within the amendment area (Figure 5-21, Figure 5-22 and Figure 5-23) concluded:
	  ○ REW (UFI 8037) environmental/ecological values are in a Completely Degraded state.
	  ○ REW (UFI 15257) environmental/ecological values are in a Completely Degraded state.
	• The wetland assessment (Appendix C) recommends the removal of the two REWs (UFI 8037 and portion of UFI 15257) from DBCA's GWSCP dataset.
	  ○ The conclusion to remove the two REWs (UFI 8037 and 15257) from the GWSCP dataset is underpinned by:
	  ▪ The ecological condition (i.e. Completely Degraded) of the two wetlands.
	  ▪ The anthropogenic historical impacts which resulted in the clearing of native vegetation and infilling of the mapped wetland areas because of the following land uses:
	  1. Turf farm
	  2. Rural paddocks
	  3. Construction and operation of Tonkin Highway, Water Corporation pipeline and the DBNGP/Water Corporation pipeline easement.
	  ○ There will not be any measurable impacts to the existing Completely Degraded REWs (UFI 8037 and UFI 15257).
	• An application to DBCA to amend GWSCP dataset for the two REWs (UFI 8037 and portion of UFI 15257) will be undertaken concurrently with the finalising of a future Local Structure Plan and the LWMS.
	• Portions of the former wetland areas will be integrated into POS and stormwater bioretention basin areas.
	Hydrological Regime Management
	• There will be no change to hydrological regime resulting in impacts to groundwater dependent vegetation either within the MRS amendment area or the GBSW area, specifically:
	  ○ There will be no significant change to the seasonal surface water flows downgradient towards the GBSW area.
	  ○ The proposed management measures detailed in the Wattle Grove South DWMS (Hyd2o 2024) including the implementation of:
	  ▪ Stormwater bioretention basins/swales. This would immediately benefit surface water quality, noting the existing landholdings does not currently have any water quality management control measures.
	  ▪ Integrating the surface water and groundwater monitoring program (which commenced in late 2020) into the future LWMS and UWMP(s), surface water and groundwater trigger values and the adaptive management framework.

Factor	Summary of proposed environmental outcomes
	▪ The surface water and groundwater monitoring program (as defined in Table 5-8 and Table 5-11) will be continued for the purpose of informing the future water planning and assessment stages, specifically, LWMS and UWMP. ▪ The application of specific surface water and groundwater trigger values which will be adopted in future water planning stage (i.e. LWMS and UWMP(s)) on advice from regulatory authorities (i.e. DBCA, DWER and the City of Kalamunda). ▪ Triggers for the adaptive management measures. ▪ Reporting to regulatory authorities (i.e. DWER, DBCA and the City of Kalamunda). ▪ Adaptive management framework. ▪ Locating stormwater bio-retention basins and swales in the vicinity of the existing groundwater mound to maintain the pre-development groundwater recharge and groundwater flow direction. ▪ Attenuation of stormwater flow events (in accordance with stormwater modelling) and DWER stormwater management objectives) in bio-retention basins designed to align with pre-development flows, facilitate infiltration into the Superficial Aquifer and protect downstream infrastructure. ▪ Adopting flexible infrastructure arrangements within stormwater bio-retention basins with the objective of enabling water flow adjustments to downstream environmental needs (i.e. the GBSW area) if required to address the impacts from climate change. The bio-retention drainage basin design will be subject to review from DWER in consultation with DBCA and City of Kalamunda at the LWMS and UWMP stages. **Construction Phase Management** • The implementation of the ASS and contamination mitigation framework aligns with the WAPC's existing Model Subdivision Conditions (DPLH 2024b). • Former land uses in the amendment area such as the former poultry farm sheds will be subject to future preliminary site investigations in accordance with the CS Act and the Contaminated Sites Guidelines (DWER 2021) undertaken either at the Local Structure Plan or at the subdivision approval stage (as a condition of subdivision). • The preparation and implementation of a CEMP is activated at the subdivision or development application approval stage under the PD Act. The subdivision or development application approval provides the planning authority to undertake civil infrastructure works and earthworks associated with the establishment of residential lots, roads and installation of drainage basins, power, sewer and water infrastructure.

The EPA's environmental assessment expectations as it relates to the Wattle Grove South MRS Amendment 1388/57 (and specifically the inland waters section) are outlined in Table 5-38.

Table 5-41: EPA's defined GBSW environmental values and Environmental Review response

EPA's Identified GBSW Environmental Values	Inland Waters Section Response
Undertake appropriate and site-specific hydrological and hydrogeological investigations to inform the environmental impact assessment. Site specific studies must consider: • **regional hydrogeological** • **hydrological context**	The ER inland waters section addresses this requirement in Section 5.
Address potential impacts on the local water balance, hydrological regime, and water-dependent environmental values, as well as potential changes in surface and groundwater flow and quality, in a local and regional context.	The inland waters section has addressed this requirement in Section 5. This requirement has also been addressed in the following technical documents: • Water Balance Assessment: Wattle Grove South MRS Amendment (Emerge Associates 2024) - Appendix A. • Wattle Grove South DWMS (Hyd2o 2024) – Appendix B.
Demonstrate any water abstraction will not adversely impact the environmental values of the GBSW area directly or indirectly.	The inland waters section has addressed this requirement in Section 5.
Demonstrate that changes to hydrological regimes will not adversely affect the flora and vegetation of the GBSW area.	The inland waters section has addressed this requirement in Section 5.
Direct, indirect, and cumulative impacts to the GBSW area must be considered, including in connected aquifers and ecosystems.	The inland waters section has addressed this requirement in Section 5.
Demonstrate best practice environmental management with adaptability in design and approach to protect the environmental values and supporting ecological and hydrological processes of the GBSW area.	The inland waters section has addressed this requirement in Section 5. This requirement has also been addressed in the following technical documents: Wattle Grove South DWMS (Hyd2o 2024) – Appendix B.
Incorporate best practice stormwater and drainage management to ensure that changes to the hydrology of the GBSW area are minimised.	The inland waters section has addressed this requirement in Section 5. This requirement has also been addressed in the following technical documents: • Wattle Grove Soutth DWMS (Hyd2o 2024) – Appendix B.
Demonstrate that any potential changes to the water balance, hydrological regime, or water quality will not adversely impact the environmental values of the GBSW area.	The inland waters section has addressed this requirement in Section 5. This requirement has also been addressed in the following technical documents: • Water Balance Assessment: Wattle Grove South MRS Amendment (Emerge Associates 2024) - Appendix A.

6. Key environmental factor - Flora and vegetation

6.1 EPA objective

The EPA's objective for Flora and Vegetation is:

To protect Flora and Vegetation so that biological diversity and ecological integrity are maintained.

In the context of this objective:

Ecological integrity is the composition, structure, function and processes of ecosystems, and the natural range of variation of these elements.

6.2 Instruction for Environmental Review (Assessment No. 2335) for Amendment 1388/57 – Flora and vegetation

The EPA's Instruction for Environmental Review (Assessment No. 2335) for Amendment 1388/57 (15th August 2022) identified 12 specific scopes of works for the Flora and Vegetation environmental factor. Table 6-1 outlines the required work for Flora and Vegetation.

Table 6-1: Flora and vegetation – EPA requirements for Environmental Review

Task	Required work
1.	Identify and characterise the flora and vegetation present and likely to be present within the amendment area, in accordance with EPA Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment, December 2016. For existing flora and vegetation surveys completed for the amendment area, demonstrate (provide justification) how surveys are relevant, representative and demonstrate consistency with current EPA policy and guidance set out below. Include a summary of survey findings for the amendment area and an analysis of the significance of flora and vegetation in local and regional context in accordance with relevant EPA guidelines. Note: Ensure species database searches and taxonomic identifications are current. IBSA data packages should be provided in accordance with EPA guidance.
2.	For lots within the amendment which are accessible, TEC identification and analysis to be undertaken in accordance with the most current version of Methods for survey and identification of Western Australian threatened ecological communities. Draft for consultation, currently Version 3: 14 April 2022. Individual quadrat data should be analysed to determine the FCT present using single site insertions against the Gibson et al. 1994) and Keighery et al. (2012 - Bush Forever) datasets, to minimise disruption. A combination of methods including cluster, nearest neighbours and similarity indices are also advised. Critical analysis of the logic of the outcomes of analysis is then required. The typical broad habitat features such as soil and landform, and hydrological status of quadrats established for Gibson et al. (1994) should also be explicitly discussed and compared in reporting.
3.	Provide maps depicting the survey effort (for existing and any future surveys) in relation to the amendment area, recorded locations of significant flora, ecological communities, and vegetation in relation to the amendment area in accordance with the relevant guidelines set out below. Clearly show any areas unable to be surveyed and indicate likelihood of occurrence of TECs and threatened and priority flora within these areas. Ensure species database searches and taxonomic identifications are up to date. Provide vegetation condition mapping.
4.	Identify and assess the potential direct, indirect and cumulative impacts of future development on the identified environmental values. Include a quantitative assessment of levels of impact on significant flora, listed ecological communities and all vegetation units. Describe and assess the extent of any cumulative impacts within local and regional contexts as appropriate. Provide a map(s) depicting areas of flora and vegetation detailing communities

Task	Required work
	(including Floristic Community Type), units, and quality, to be retained and protected. Determine the ecological water requirements of; and identify buffers to significant vegetation.

5.	Provide a quantitative assessment of impact:
	• For significant flora, this includes:
	  ○ Number of individuals and populations in a local and regional context;
	  ○ Numbers and proportions of individuals and populations directly or potentially indirectly impacted, and
	  ○ Numbers/proportions/populations currently protected within the conservation estate (where known).
	• For all vegetation units (noting threatened and priority ecological communities and significant vegetation) this includes:
	  ○ Area (in hectares) and proportions directly or potentially indirectly impacted, and
	  ○ Proportions/hectares of the vegetation unit currently protected within conservation estate (where known).

6.	Describe the planning or other mechanisms that will ensure vegetation identified for retention will be protected.
7.	Describe the ongoing management requirements to ensure retained areas of vegetation within the amendment area are managed appropriately and identify which planning or other mechanisms are required to ensure this management is implemented.
8.	Describe the ongoing management requirements for the amendment area, and broader urban expansion and investigation area, which would ensure the hydrological requirements of vegetation within the amendment and nearby (including GBSW) is maintained, and what planning or other mechanisms are required to ensure this management.
9.	Describe any proposed avoidance, mitigation and management measures that demonstrate the EPA's objectives can be met.
10.	Identify, describe, and quantify the potential residual impacts (direct, indirect and cumulative) that may occur after considering and applying the mitigation hierarchy.
11.	Based on the components of the amendment, determine and quantify any significant residual impacts by applying the Residual Impact Significance Model (page 11) and WA Offset Template (Appendix 1) in the WA Environmental Offsets Guidelines (2014). Where significant residual impacts remain, propose an appropriate offsets strategy. Spatial data defining the area of significant residual impacts for each environmental value should be provided (e.g. vegetation type, vegetation condition, specific fauna species habitat).
12	Describe the planning mechanisms that are to be applied to ensure impacts are managed to meet the EPA's objectives.

6.3 Relevant policy and guidance

The relevant policy and guidance for Flora and Vegetation is summarised in Table 6-2.

Table 6-2: Policy and guidance relevant to flora and vegetation

Policy and guidance	Key aspects

Environmental Factor Guideline: Flora and Vegetation (EPA 2016a)	This guideline provides an outline of how flora and vegetation is considered by the EPA in EIA process. Relevant matters discussed in the guideline include:
	• A description of EIA considerations, including:
	  ○ Application of the mitigation hierarchy.
	  ○ The flora and vegetation affected by the proposal or scheme.
	  ○ The potential impacts and the activities that will cause them.
	  ○ Surveys and analyses required.
	  ○ The significance of the flora and vegetation.
	  ○ The risk to the flora and vegetation.
	  ○ The current state of knowledge of flora and vegetation and the level of confidence underpinning the predicted residual impacts.
	• The issues commonly encountered by the EPA during EIA of this factor.
	• A summary of the type of information that may be required by the EPA to undertake EIA related to this factor.

Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2020a)	This guidance is intended to ensure adequate flora and vegetation data of an appropriate standard is obtained and used in EIA, specifically providing advice on: • Survey preparation and desktop study. • Determining the type of survey required. • Sampling techniques and survey design. • Data analysis and reporting.

6.4 Studies and investigations

To date, 360 Environmental (2018) and AECOM (2020) have previously undertaken desktop assessments of the MRS amendment area as part of a consideration of the broader Wattle Grove (South) locality. AECOM (2020) also conducted site surveys and assessment for flora, vegetation and fauna.

The AECOM survey did not survey every allotment within the MRS amendment area and as a result, JBS&G undertook the following supplementary surveys of the MRS amendment area during 2021 and 2022:

- Tree survey (February 2021): Habitat tree survey of various lots and the Victoria Road reserve.
- Targeted flora survey (August 2021): *Drakaea elastica* on Lot 254 Victoria Road
- Supplementary vegetation and flora assessment (October 2021): Various lots
- Reconnaissance vegetation and flora assessment (January 2022): Various lots, including from lot boundaries
- Further reconnaissance vegetation and flora assessment of targeted lots (October 2022)

Figure 6-1 presents the combined survey effort by AECOM and JBS&G within the MRS amendment area, which were done in accordance with EPA (2016) Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment.

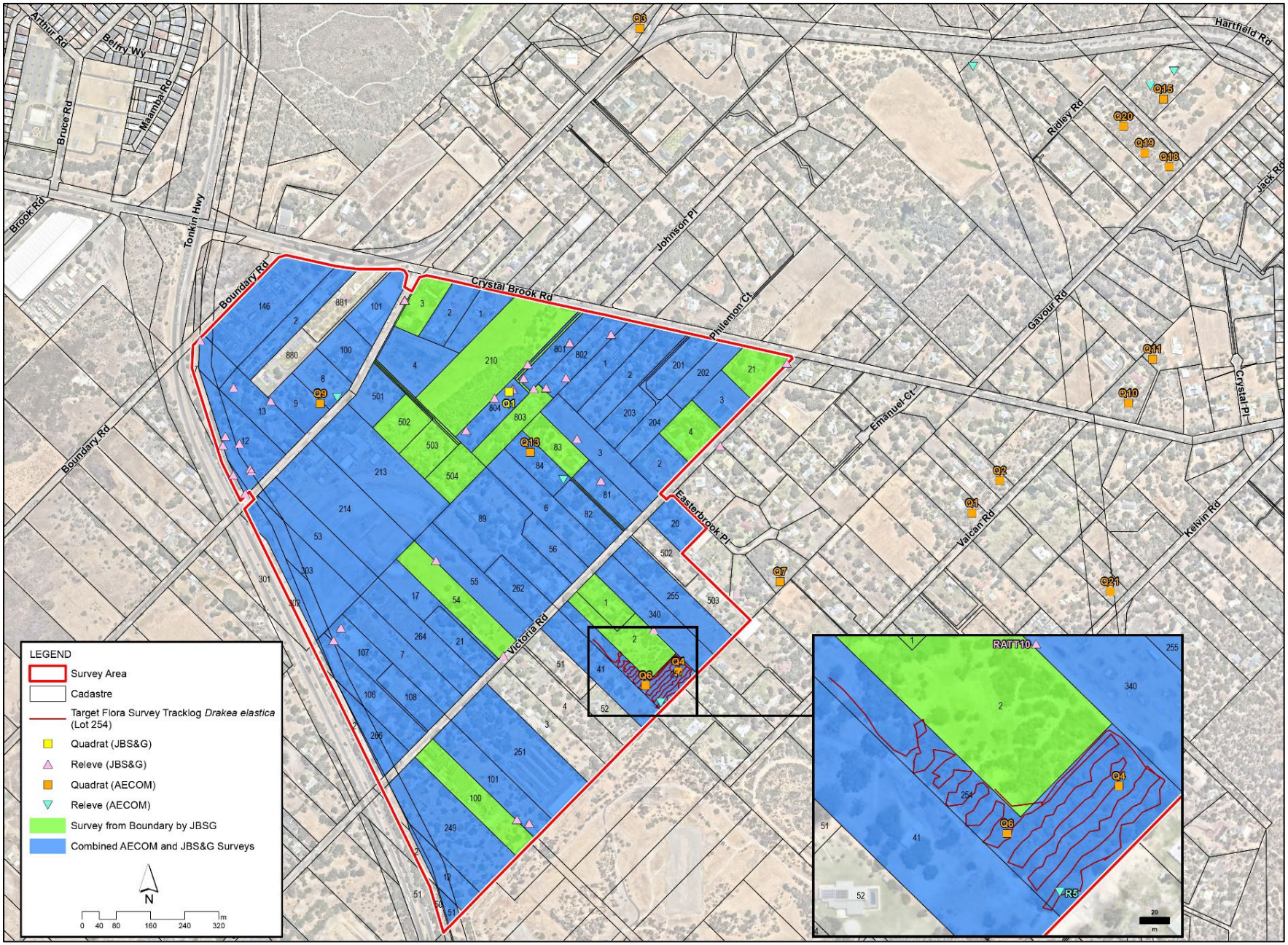

Figure 6-1: Lots surveyed within MRS amendment area

JBS&G (2024) have drafted an ecological memo which provides an overview of the above flora, vegetation and fauna surveys and assessment that have been undertaken within the MRS amendment area (Appendix D). Plantecology Consulting (2024) (Appendix E) have undertaken the numerical analysis and assignment of AECOM (2020) and JBS&G (2024) plot data to existing Floristic Community Types (FCT) of the Swan Coast Plain and assigned the probable FCTs within the MRS amendment area. This FCT analysis was done in accordance with the methods outlined in Methods for Survey and Identification in Western Australian Threatened Ecological Communities (DBCA 2024). The 360 Environmental (2018) and AECOM (2020) reports are included in Appendices A and B of the JBS&G (2024) ecological memo.

A total of eight lots within the MRS amendment area were unable to be surveyed and 13 lots were surveyed based on observations made from the fence line of adjacent lots and road reserve, so there may be some limitations with the survey data that has been collected for these lots. Where any limitations in the survey data collected requires consideration or further attention, this has been addressed in this ER.

To ensure that any limitations in the flora and vegetation survey data collected to date does not compromise future planning decisions, the Environmental Management Framework requires that any subdivision and development application within the MRS amendment area for a lot that has not already been subject to survey, be accompanied by a suitable flora and vegetation survey undertaken in accordance with current EPA policy and guidelines. The requirement for this flora and vegetation survey will also be highlighted as a provision in all future local structure plan(s) within the MRS amendment area.

Undertaking the required flora and vegetation surveys will ensure that if for any reason there is any conservation significant flora and/or vegetation within these currently unsurveyed lots, it will be identified and appropriately avoided, mitigated and/or offset as part of the assessment and determination of all future subdivision and development proposals for the unsurveyed lots and managed through conditions of approval.

Notwithstanding the above, the majority of the MRS amendment area (~92%) has been subject to some form of an ecological assessment, and consequently, the ecological values of the area are well understood. The survey efforts have found that vegetation within the MRS amendment area is predominantly cleared, and now consists primarily of lawns/paddocks, planted trees, garden beds and fragmented areas of scattered native trees, with some small discrete areas of remnant native vegetation ranging from Degraded to Excellent condition.

6.5 Receiving environment

6.5.1 Bioregion

The Interim Biogeographic Regionalisation for Australia (IBRA) defines 89 regions based on climate, geology, landforms and characteristic vegetation and fauna (DCCEEW 2022). The MRS amendment area is located within the Perth sub-region (SW02) of the Swan Coastal Plain, under the Interim Biogeographic Regionalisation of Australia (IBRA7).

6.5.2 Vegetation association

Vegetation occurring within the region was initially mapped at a broad scale (1:1000 000) by Beard during the 1970s. This dataset formed the basis of several regional mapping systems, including the biogeographic region dataset (IBRA7) for Western Australia (available via data.gov.au) and the physiographic regions defined by Beard (1975). The vegetation for the MRS amendment area has been identified as belonging to two sub-associations of the Pinjarra vegetation system (Beard et al. 2013), as shown in Figure 6-2 and Table 6-3.

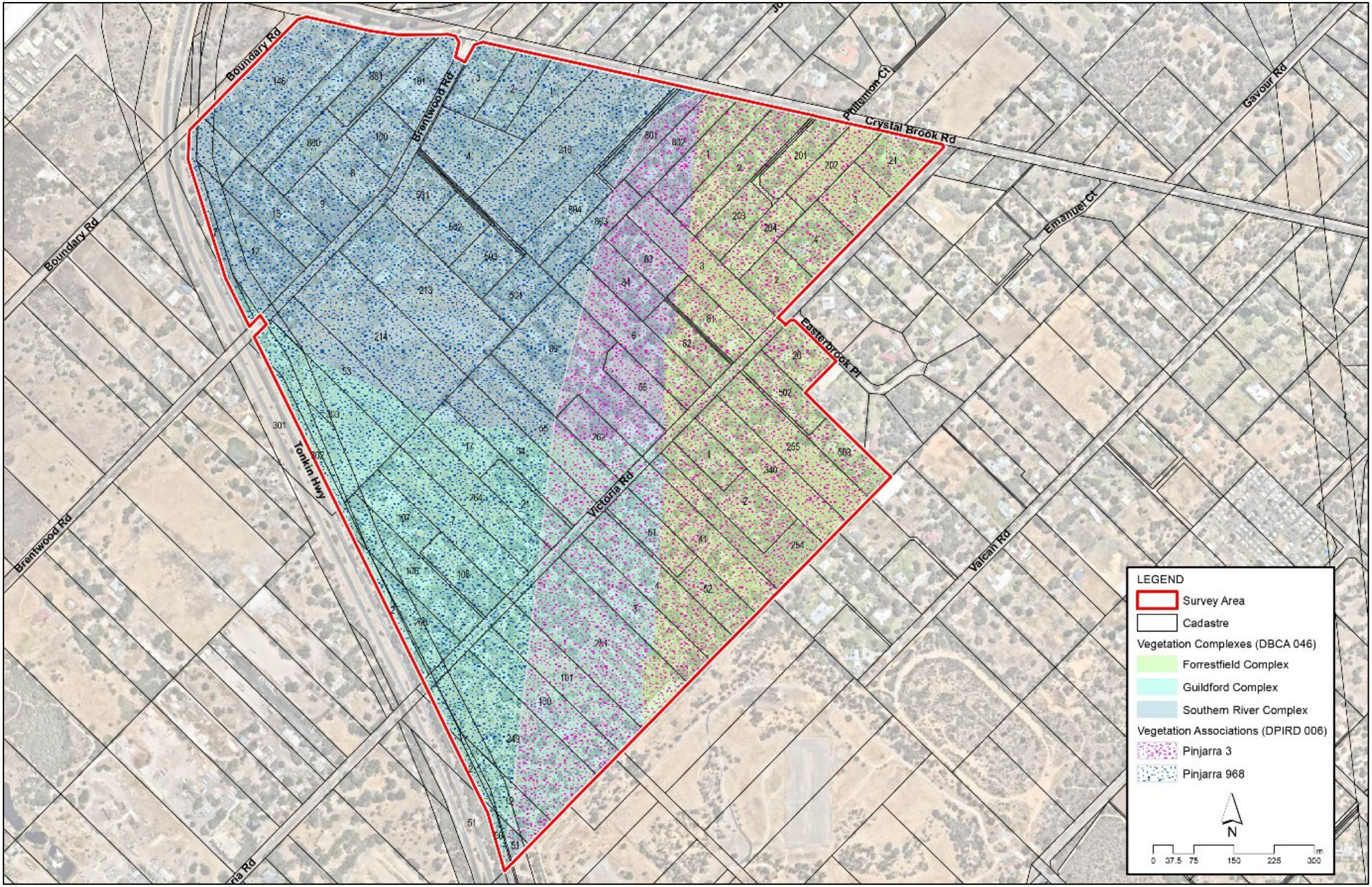

Figure 6-2: Vegetation associations and complexes

Most of the Pinjarra vegetation system on the Swan Coastal Plain has been historically cleared. Table 6-3 shows that of the two sub-associations of the Pinjarra system that are representative of the MRS amendment area, there is only 10,583 ha in total remaining on the Swan Coastal Plain. This accounts for only 7% of the pre-European extent of these two sub-associations, in aggregate.

This is largely consistent with the extent of pre-European vegetation clearing that has historically occurred within the MRS amendment area. The area has been significantly cleared and now consists primarily of lawns/paddocks, planted trees and garden beds, with intact remnant native vegetation (in Good or better condition) making up approximately 2.9% of the MRS amendment area.

Table 6-3: Vegetation system associations and extents (GoWA 2019a)

Region	Vegetation system association	Pre-European extent	Current extent	Current extent in all DBCA management land
Western Australia (Report 1b)	Pinjarra 3.2	15,738.25 ha	1,844.72 ha (11.72%)	271.60 ha (1.73%)
	Pinjarra 968.3	137,184.58 ha	9,172.10 ha (6.69%)	2,009.62 ha (1.46%)
Swan Coastal Plain (IBRA Region) (Report 2b)	Pinjarra 3.2	13,738.98 ha	1,586.73 ha (11.55%)	262.92 ha (1.91%)
	Pinjarra 968.3	135,999.02 ha	8,996.33 ha (6.61%)	1,948.40 (1.43%)
Perth (IBRA Subregion) (Report 3b)	Pinjarra 3.2	13,738.98 ha	1,586.73 ha (11.55%)	262.92 ha (1.91%)
	Pinjarra 968.3	135,999.02 ha	8,996.33 ha (6.61%)	1,948.40 ha (1.43%)
City of Kalamunda (Report 4b)	Pinjarra 3.2	265.40 ha	36.09 ha (13.60%)	-
	Pinjarra 968.3	487.50 ha	74.76 ha (15.33%)	1.19 ha (0.24%)

6.5.3 Vegetation complex

Vegetation complex mapping of the Swan Coastal Plain was completed by Heddle et al. (1980) and considers soils, landforms and floristics. The MRS amendment area straddles the Forrestfield, Guildford, and Southern River Complexes on the Ridge Hill Shelf, fluviatile deposits (deposited by watercourses) and aeolian deposits (wind-driven deposits) as shown on Figure 6-2**.**

The Forrestfield Complex is dominated by open forest or woodland of Marri (*Corymbia calophylla*), Wandoo (*Eucalyptus wandoo*) and Jarrah (*Eucalyptus marginata*) on heavier, gravelly soils, as well as Jarrah, Marri, and Sheoak (*Allocasuarina spp.*) on sandier soils. The Guildford Complex is dominated by open forest to woodland of Marri, Wandoo, and Jarrah, with areas of just Wandoo. The Southern River Complex is an open woodland of Marri, Jarrah, and Banksia. Woodlands of flooded gum (*Eucalyptus rudis*) and Swamp Paperbark *(Melaleuca raphiophylla*) occur in wet areas in all three complexes (Heddle et al. 1980).

Most of the Guildford Complex has been historically cleared with less than 10% remaining (Table 6-4) on the Swan Coastal Plain and within the Perth Metropolitan Region, which again is largely consistent with the pre-European vegetation clearing that has taken place within the MRS amendment area. However, it is worthwhile to note that there is no intact remnant vegetation within the area mapped as Guildford Complex.

Table 6-4: Vegetation complexes and extents (GoWA 2019b)

Region	Vegetation complex	Pre-European extent	Current extent	Current extent protected for conservation
Swan Coastal Plain (IBRA Region)	Forrestfield	22,812.92 ha	2,803.36 ha (12.29)	359.71 ha (1.58%)
	Guildford	90,513.13 ha	4,607.91 ha (5.09)	297.86 (0.33%)
	Southern River	58,781.49 ha	10,832.18 ha (18.43)	480.48 ha (2.42%)
Perth Metropolitan Region (IBRA Subregion)	Forrestfield	13,332.94 ha	1,396.26 ha (10.47)	226.23 ha (1.70%)
	Guildford	24,300.38 ha	1,219.79 ha (5.02)	230.66 ha (0.95%)
	Southern River	31,146.06 ha	4,359.94 ha (14.00)	21.98 ha (0.49%)
City of Kalamunda	Forrestfield	1,924.36 ha	209.26 ha (10.87)	-
	Guildford	77.51 ha	8.47 ha (10.93)	-
	Southern River	2,317.00 ha	224.15 ha (9.67)	-

The National Objectives and Targets for Biodiversity Conservation 2001-2005 recognises that retention of 30% or more of the pre-clearing extent of each ecological community is necessary if Australia's biological diversity is to be protected (ANECC 2000). However, State Planning Policy 2.8 – Bushland policy for the Perth Metropolitan Region (WAPC 2010) and EPA Guidance Statement 33 (EPA 2008) recognises the Perth Metropolitan Region as a 'constrained area' and establishes a target of 10% retention for vegetation complexes.

As can be seen from the remaining extents presented above for the vegetation associations and complexes within the MRS amendment area, all of them are well below the national target of 30% retention for vegetation. In relation to the modified objective to achieve a 10% target within constrained areas, there are those that exceed the 10% target and some that fall below the 10% depending on the IBRA region, IBRA subregion and local government locality (Table 6-3 and Table 6-4). It is apparent that all of the above vegetation associations and complexes are poorly represented in existing conservation reserves across the IBRA region, IBRA subregion and local government locality.

Again, this is largely consistent with the extent of pre-European vegetation clearing that has historically occurred within the MRS amendment area, which is now highly modified and consists primarily of lawns/paddocks, planted trees and garden beds. The small areas of remnant native vegetation (in Good or better condition) make up approximately 2.9% of the total MRS amendment area.

6.5.4 Database searches – Flora

Desktop assessments were undertaken in September 2023 by JBS&G (Appendix D), with database requests submitted to DBCA for both the Threatened and Priority Flora Database and the Western Australian Herbarium Database. A total of 83 flora taxa of conservation significance were identified by the searches, with 60 potentially occurring within a 5 km buffer of the MRS amendment area. A 10 km buffer was requested; however, DBCA determined that a 5 km buffer was appropriate for the MRS amendment area, based on the number of records available in the general area and the range of local species, and that this flexibility caters for complexity, ensuring meaningful results.

The potential for these plants to occur within the site was assessed and based on general habitat requirements and distribution. Twenty Threatened and 61 Priority flora species were considered to have the potential to occur within the site (Table 6-5).

Of these, two conservation significant flora taxa have been recorded within the MRS amendment area:

- *Conospermum undulatum* (T) – listed as Vulnerable under the EPBC Act and the BC Act.
- *Isopogon autumnalis* (P3), previously named *Isopogon drummondii* – listed under the DBCAs Priority flora lists.

Table 6-5: Threatened and priority flora potentially occurring within MRS amendment area

Species Common name (if applicable)	Conservation listing		Potential to occur (based on desktop assessment)	Comments
	EPBC Act	BC Act		
Grevillea thelemanniana **(Spider Net Grevillea)**	Critically Endangered	Critically Endangered	Possible	Occurs on sand, sandy clay and winter-wet low-lying flats. Known occurrence from the Canning and Gosnells localities (DBCA 2024).
Ptilotus pyramidatus **(Pyramid Mulla-mulla)**	Critically Endangered	Critically Endangered	Unknown	Occurs in seasonally inundated flats over pale grey, muddy-sand to sandy-mud on the Pinjarra plain (DCCEEW 2024) The site is outside of the currently mapped distribution range of the species, however there is a record in the Gosnells locality (DBCA 2024).
Synaphea sp. Fairbridge Farm (D. Papenfus 696)	Critically Endangered	Critically Endangered	Likely	Occurs on sandy soils with lateritic pebbles, near winter-wet flats in low woodland with weedy grasses. Known occurrences in the Canning and Gosnells localities (Florabase).
Caladenia huegelii **(Grand Spider Orchid)**	Endangered	Critically Endangered	Unknown	Grows in well-drained, deep sandy soils. Occurs in areas with dense undergrowth, on deep grey-white sand within 20 km of the coast. Commonly found in Jarrah/Banksia woodland on Bassendean Sands (DCCEEW 2024).
Drakaea elastica **(Glossy-leaved Hammer Orchid)**	Endangered	Critically Endangered	Likely	Grows in bare patches of sand within otherwise dense vegetation in low-lying areas alongside winter-wet swamps (DCCEEW2 2024).
Calytrix breviseta subsp. Breviseta **(Swamp Starflower)**	Endangered	Critically Endangered	Likely	Species are restricted to winter-wet clay flats with low shrubs or jarrah forest (DCCEEW 2024). Known extant populations of the species are within the vicinity of the MRS Amendment area.
Thelymitra magnifica **(Crystal Brook Star Orchid)**	-	Critically Endangered	Likely	Known occurrence further east of MRS amendment area and on boundary of wider Wattle Grove South (360 Environmental 2018).
Andersonia gracilis **(Slender Andersonia)**	Endangered	Vulnerable	Possible	Suitable habitat may be present. Found on seasonally damp, black sandy clay flats near or on the margins of swamps. Known to occur in proximity to the MRS amendment area (Kenwick locality) (DCCEEW 2024).

Species Common name (if applicable)	Conservation listing		Potential to occur (based on desktop assessment)	Comments
	EPBC Act	BC Act		
Austrostipa bronweniae	Endangered	Endangered	Likely	Known occurrence in the Kenwick locality and associated with Muchea Limestone TEC (TSSC 2018a),
Banksia mimica **(Summer Honeypot)**	Endangered	Vulnerable	Possible	Occurs in three distinct populations (Mogumber, Darling Range and Whicher Range) and is not thought to occur elsewhere. MRS amendment area is in proximity to the Darling Range population (DCCEEW 2024).
Darwinia apiculata **(Scarp Darwinia)**	Endangered	Endangered	Possible	The species is endemic to the Darling Range, where three populations occur. It has not been recorded within the MRS amendment area, but has been recorded in proximity (DCCEEW 2024)
Diuris purdiei **(Purdie's Donkey Orchid)**	Endangered	Endangered	Unknown	The species is confined to low-lying depressions in peaty and sandy clay swamps, however much of its biology is unknown and therefore occurrence is difficult to predict (DCCEEW 2024).
Eremophila glabra subsp. Chlorella **(Emu bush)**	Endangered	Endangered	Likely	The species exists in five subpopulations in four locations, with several occurrences recorded in the Kenwick/Cannington locality. Habitat preference is winter-wet depressions, grey-brown sand over clay based sub-soils (DCCEEW 2024).
Macarthuria keigheryi	Endangered	Endangered	Possible	Five known populations occur within a 5 km radius of Welshpool/Kewdale in the Perth region. Preferred habitat is low-lying winter-wet damp, grey/white sands, where it grows in open patches with low tree canopy cover among heathland, jarrah and Allocasuarina/banksia woodland in the Welshpool/Kewdale population (DCCEW 2024
Lepidosperma rostratum **(Beaked Lepidosperma)**	Endangered	Endangered	Likely	Occurs in association with Marsh Banksia (Banksia telmatiaea) and Hairy Claw flower (*Calothamnus hirsutus*) in winter wet swamp. Known population in proximity to the MRS amendment area (Kenwick) (DCCEEW 2024)
Thelymitra stellata **(Star Orchid)**	Endangered	Endangered	Likely	Habitat preference includes low heath and scrub in Jarrah and Wandoo woodland, both on ridges and slopes, flats and on riverbanks and breakaways (DCCEEW 2024).
Acacia anomala **(Grass Wattle)**	Vulnerable	Vulnerable	Possible	Grows on lateritic soils on slopes, in shallow sand, loam. Clay or gravel (DBCA 2024). Known occurrences of the species on the western slopes of the Darling Range, including the Kalamunda locality. Suitable habitat for the species may be present (DCCEEW 2024).

Species Common name (if applicable)	Conservation listing		Potential to occur (based on desktop assessment)	Comments
	EPBC Act	BC Act		
Acacia aphylla **(Leafless Rock Wattle)**	Vulnerable	Vulnerable	Possible	Know to occur in two distinct populations, including one in the Darling Range in proximity to the MRS amendment area (DCCEEW 2-24).
Anthocercis gracilis **(Slender Tailflower)**	Vulnerable	Vulnerable	Possible	Nine populations are currently known from the Darling Scarp area and known to occur on steep granite slopes, in shallow, hummus-rich sandy or loamy soils (DCCEEW 2024).
Conospermum undulatum	Vulnerable	Vulnerable	Confirmed	-
Eleocharis keigheryi **(Keighery's Eleocharis)**	Vulnerable	Vulnerable	Possible	Known occurrence in the vicinity (Wanaping Road) Known to occur in drainage lines and claypans (DCCEEW 2024).
Morelotia australiensis **(Southern Tetraria)**		Vulnerable	Unlikely	Species occurs in the Swan and South West Natural Resource Management Regions, with the northernmost occurrence being Serpentine (DCCEEW 2024).
Goodenia arthrotricha	Endangered	Endangered	Possible	Known to occur in Gosnells locality along the Darling Scarp. Found in areas where granite outcropping/granite close to surface (DCCEEW 2024).
Grevillea curviloba McGill **(Narrow Curved-Leaf Grevillea)**	Endangered	Endangered	Possible	Occurs in grey sand, sandy loam, winter-wet heath. Known occurrences in Carnamah, Chittering, Gingin, Swan and Serpentine-Jarrahdale (DBCA 2024)
Diuris drummondii **(Tall Donkey Orchid)**	Vulnerable	Threatened	Unlikely	Occurs in mud and winter-wet claypans. Found in low lying depressions in peaty and sandy clay swamps. Known occurrence in the Gosnells locality (DBCA 2024; DCCEEW 2024).
Schoenus sp. Beaufort (G.J. Keighery 6291)	-	P1	Possible	Occurs in mud/ winter-wet claypans. Known occurrence in Gosnells locality (DBCA 2024).
Boronia humifusa	-	P1	Possible	Occurs on gravelly clay loam over laterite. Jarrah marri open forest (360 Environmental, 2018). All known occurrences. Nearby records are confined to the Darling Scarp (360 Environmental, 2023).
Lepyrodia curvescens	-	P2	Possible	Known to occur in seasonally inundated swampland with one record within proximity to the MRS amendment area (DBCA 2024).

Species Common name (if applicable)	Conservation listing		Potential to occur (based on desktop assessment)	Comments
	EPBC Act	BC Act		
Schoenus loliaceus	-	P2	Possible	Occurs in winter-wet depressions. Known occurrence in the Gosnells locality (DBCA 2024).
Comesperma griffinii	-	P2	Likely	Occurs in yellow or grey sand plains. Known occurrence in the Gosnells locality (DBCA 2024).
Platysace ramosissima	-	P3	Possible	Occurs in sandy soils. Known occurrence in the Kalamunda location (DBCA 2024).
Schoenus benthamii	-	P3	Possible	Occurs on winter-wet flats and swamps. Known occurrence in Gosnells locality (DBCA 2024).
Schoenus capillifolius	-	P3	Possible	Occurs on brown mud and claypans. Known occurrence in Gosnells locality (DBCA 2024).
Schoenus pennisetis	-	P3	Possible	Occurs on grey or peaty sand, sandy clay in swamps and winter-wet depressions. Known occurrence in the Gosnells and Kalamunda localities (DBCA 2024).
Schoenus sp. Waroona (G.J. Keighery 12235)	-	P3	Possible	Occurs on clay or sandy clay in winter wet flats. Known occurrence in the Gosnells locality (DBCA 2024).
Stylidium aceratum	-	P3	Possible	Occurs on sandy soils in swamp heathland. Known occurrence in the Gosnells locality (DBCA 2024).
Styphelia filifolia	-	P3	Unknown	Species ecology is poorly known. Known occurrence in Gosnells and Kalamunda localities (DBCA 2024).
Thysanotus anceps	-	P3	Possible	Occurs on white or grey sand, lateritic gravel or laterite. Known occurrences in the Gosnells and Kalamunda localities (DBCA 2024).
Isopogon autumnalis **(Previously *Isopogon drummondii*)**	-	P3	Confirmed	-
Isotropis cuneifolia subsp. Glabra	-	P3	Possible	Occurs on sand, clay loam on winter-wet flats. Known occurrence in the Gosnells locality (DBCA 2024).
Allocasuarina grevilleoides	-	P3	Possible	Occurs on sand over laterite/gravel. Known occurrence in the Gosnells locality (DBCA 2024).
Jacksonia gracillima	-	P3	Possible	Known occurrence in the Gosnells locality. Species habitat is poorly known (DBCA 2024).
Lasiopetalum glutinosum subsp. Glutinosum	-	P3	Unlikely	Species ecology has not been recorded. Known occurrence in Gosnells and Kalamunda localities (DBCA 2024).

Species Common name (if applicable)	Conservation listing		Potential to occur (based on desktop assessment)	Comments
	EPBC Act	BC Act		
Meionectes tenuifolia	-	P3	Possible	Can occur on seasonally wet inundated areas on grey sand (360 Environmental). Known occurrence in Gosnells locality (DBCA 2024).
Myriophyllum echinatum	-	P3	Possible	Occurs on winter-wet flats. Known occurrence in the Gosnells locality (DBCA 2024).
Babingtonia urbana **(Coastal Plain Babingtonia)**	-	P3	Unlikely	Occurs in association with wetlands on the Swan Coastal Plain (360 Environmental, 2023). Known occurrence in Canning and Gosnells localities (DBCA 2024).
Banksia pteridifolia subsp. Vernalis	-	P3	Unlikely	Occurs on white/grey sand over laterite. Known occurrence in the Kalamunda locality, north of the MRS amendment area (DBCA 2024).
Byblis gigantea **(Rainbow Plant)**	-	P3	Unlikely	Occurs in sandy-peat swamps, seasonally wet areas. Known occurrence in the Canning, Gosnells and Kalamunda localities (DBCA 2024).
Chamaescilla gibsonii	-	P3	Possible	Occurs on clay to sandy clay on winter-wet flats on shallow water-filled claypans. Known occurrence in Gosnells locality (DBCA 2024).
Comesperma rhadinocarpum **(Slender-fruited Comesperma)**	-	P3	Unknown	Occurs on sandy soils. Species ecology has been poorly recorded. Known occurrence in Gosnells locality (DBCA 2024).
Asteridea gracilis	-	P3	Possible	Occurs on sand, clay and gravelly soils. Known occurrence in the Gosnells and Kalamunda localities (DBCA 2024).
Beaufortia purpurea **(Purple Beaufortia)**	-	P3	Possible	Occurs on lateritic or granite soils/ rocky slopes. Known occurrences in the Gosnells and Kalamunda facilities (DBCA 2024).
Eryngium pinnatifidum subsp. Palustre (G.J. Keighery 13459)	-	P3	Likely	Occurs on seasonally wet inundated areas, on grey clay (360 Environmental, 2023). Known occurrence to the north of the MRS amendment area (DBCA 2024).
Carex tereticaulis	-	P3	Possible	Occurs on black peaty sand. Known occurrence in the Gosnells locality (DBCA 2024).
Eryngium sp. Subdecumbens (G.J. Keighery 5390)	-	P3	Likely	Occurs on seasonally wet inundated areas on grey-brown clay (360 Environmental, 2023). Known occurrence in the Gosnells locality (DBCA 2024).
Haemodorum loratum	-	P3	Likely	Occurs on grey or yellow sand, gravel. Known occurrence in Kalamunda locality (DBCA 2024).

Species Common name (if applicable)	Conservation listing		Potential to occur (based on desktop assessment)	Comments
	EPBC Act	BC Act		
Halgania corymbosa	-	P3	Possible	Occurs in gravelly soils/soils over granite. Known occurrence in the Gosnells and Kalamunda localities (DBCA 2024).
Acacia horridula	-	P3	Likely	Occurs on gravelly soils over granite and sand, rocky hillsides. Known occurrence in the Gosnells and Kalamunda localities (DBCA 2024).
Schoenus natans **(Floating Bog-rush)**	-	P4	Possible	Occurs on winter-wet depressions. Known occurrences in the Canning and Gosnells localities (DBCA 2024).
Lasiopetalum bracteatum	-	P4	Likely	Occurs on sandy clay, clay, lateritic gravel, along drainage lines, creeks, gullies, granite outcrops. Known occurrences in the Kalamunda locality (DBCA 2024).
Cyanicula ixioides subsp. Ixioides	-	P4	Unknown	Occurs on sand, laterite or gravel. No known occurrences in the vicinity of the MRS amendment area (DBCA 2024).
Senecio leucoglossus	-	P4	Possible	Occurs on gravelly lateritic or granite soils, on granite outcrops or slopes. Known occurrences in the Kalamunda locality (DBCA 2024).
Stylidium longitubum **(Jumping Jacks)**	-	P4	Possible	Occurs on sandy clay, clay in seasonal wetlands. Known occurrences in the Gosnells locality (DBCA 2024).
Stylidium striatum **(Fan-leaved Triggerplant)**	-	P4	Possible	Occurs on brown clay loam over laterite on hillslopes in Jarrah/Marri forest or Wandoo woodland. Known occurrence in the Kalamunda locality (DBCA 2024).
Verticordia lindleyi subsp. Lindleyi	-	P4	Likely	Occurs on sand, sandy clay in winter-wet depressions. Known occurrence in Gosnells and Kalamunda localities (DBCA 2024).
Ornduffia submersa	-	P4	Unknown	Occurs on dry, seasonally inundated grey soil (360 Environmental, 2023). Known occurrence in Gosnells and Kalamunda localities (DBCA 2024).
Acacia oncinophylla subsp. Patulifolia	-	P4	Likely	Occurs on granitic soils, occasionally on laterite. Known occurrences in the Gosnells and Kalamunda localities (DBCA 2024).
Drosera occidentalis **(Western Sundew)**	-	P4	Unknown	Known occurrence in Gosnells locality. Species ecology is largely unknown (DBCA 2024).

Species Common name (if applicable)	Conservation listing		Potential to occur (based on desktop assessment)	Comments
	EPBC Act	BC Act		
Calothamnus accedens	-	P4	Possible	Occurs in sandy soils over laterite, road verges. Known occurrence in Gosnells locality (DBCA 2024).
Aponogeton hexatepalus **(Stalked Water Ribbons)**	-	P4	Possible	Occurs in freshwater ponds, rivers and claypans. Known occurrences in Canning and Gosnells localities (DBCA 2024).
Bolboschoenus fluviatilis	-	P1	Unlikely	Occurs in winter-wet areas (360 Environmental, 2023). Known occurrence in the Gosnells locality (DBCA 2024).
Calandrinia uncinella	-	P1	Possible	Occurs on seasonally wet swamps or on saline river flats on ground or embankments just above water, growing in soils described as grey-brown sandy or silty loams or white to creamy sands over clays usually with poor drainage (360 Environmental, 2023). Known occurrence in the Gosnells locality (DBCA 2024).
Calectasia grandiflora	-	P2	Possible	Occurs on white, grey or yellow sand, sandy clay, gravel, laterite, granite. Swamy areas, rock outcrops, flats, slopes, ridges. Known occurrence in Gosnells locality (DBCA 2024).
Commersonia sp. Lesmurdie (A.A. Mitchell 11429)	-	P2	Unlikely	Species ecology has not been recorded. Known occurrence in the Kalamunda locality (DBCA 2024).
Cyanothamnus tenuis **(Blue Boronia)**	-	P4	Unlikely	Occurs on granite slopes, yellow, brown clay, loam (360 Environmental, 2023). Known occurrence in Gosnells and Kalamunda localities (DBCA 2024).
Diuris brevis **(Short-nosed Donkey Orchid)**	-	P2	Possible	Occurs on flat areas, grey soils. Known occurrence in the Gosnells locality (Greater Brixton Street Wetlands) (360 Environmental, 2023).
Hydrocotyle lemnoides **(Aquatic Pennywort)**	-	P4	Possible	Occurs in swamps. Known occurrence in Gosnells locality (DBCA 2024).
Johnsonia pubescens subsp. Cygnorum	-	P2	Possible	Occurs on grey/white/yellow sand on flats, seasonally wet sites. Known occurrence in Kalamunda (DBCA 2024).
Pimelea rara	-	P4	Unlikely	Occurs on lateritic soils. Known occurrence in Gosnells and Kalamunda localities (DBCA 2024).

Species Common name (if applicable)	Conservation listing		Potential to occur (based on desktop assessment)	Comments
	EPBC Act	BC Act		
Pithocarpa corymbulosa **(Corymbose Pithocarpa)**	-	P3	Unlikely	Occurs on gravelly or sandy loam amongst granite outcrops. Known occurrence in Kalamunda locality.
Rytidosperma racemosum var. racemosum	-	P2	Possible	Species ecology is largely unknow. Known occurrence in Gosnells locality (DBCA 2024).
Thysanotus cymosus	-	P3	Unlikely	Occurs on clay, granitic or lateritic sand. Known occurrences in Kalamunda locality (DBCA 2024).

Conservation Codes	State (WA)	Federal
Endangered	EN	E
Critically Endangered	CR	CE
Vulnerable	VU	V
Priority (rated in order of significance from 1 to 4)	P	

6.5.5 Database searches – Ecological communities

JBS&G's 2024 desktop assessment identified 6 Threatened Ecological Communities (TECs) listed under the EPBC Act and 11 TECs listed under the State BC Act and 3 Priority Ecological Communities (PECs) listed by the DBCA as having a likely or greater chance of occurrence in the MRS amendment area (See Table 6-6). Of these, the federally listed Banksia Woodlands of the Swan Coastal Plain (which is listed as Priority 3 by the DBCA) and 2 state-listed TECs have been identified as occurring within the MRS amendment area (Plantecology 2024).

The BC Act defines an ecological community as naturally occurring assemblage of organisms that occurs in a particular habitat. The classification of TECs and PECs at a Federal and State level can be briefly explained as follows:

- An ecological community becomes threatened (i.e. a TEC) when it is at risk of extinction. TECs are recognised and protected under the EPBC Act (Federal), the BC Act (State) as well as the EP Act (State).
- PECs are ecological communities with insufficient information to be considered a TEC or are rare but are not currently threatened. The 'Priority' conservation status of PECs is only recognised within Western Australia and not at a Federal level. PECs are not protected under the BC Act.
- Under the BC Act, some TECs on the Swan Coastal Plain are determined by their individual Floristic Community Type (FCTs), as originally described in Gibson et al. (1994).
- Similarly, some PECs are determined by their individual FCTs, but not always.
- Some of the EPBC Act listed TECs include several sub-communities (i.e. FCTs) that have been combined into a single nationally significant ecological community because of their similarity.

- Therefore, some TECs under the EPBC Act can represent multiple TECs under the BC Act, and/or PECs listed by DBCA. Banksia Woodlands of the Swan Coastal Plain and Clay Pans of the Swan Coastal Plain are two such examples, as evidenced in Table 6-6 below.

Of the various TECs and PECs that were identified in the database searches as potentially occurring within the MRS amendment area, and based on the various field surveys completed by AECOM and JBS&G from 2019 to 2022, the FCT analysis undertaken by Plantecology (2024) shows that there are probably two FCTs present, one of which is associated with *Banksia Woodlands of the Swan Coastal Plain* (Table 6-6).

Table 6-6: Conservation significant ecological communities identified by database searches

Community	Conservation Listing		Confirmed Presence in MRS amendment area (Based on 2019 to 2022 Field Surveys and FCT Analysis by Plantecology (2024))
	State	Federal	
Banksia Woodlands of the Swan Coastal Plain ecological community Incorporating the State listed TECs and PECs:	P3	E	Present (See section 6.5.6.4)
• *Banksia attenuata* woodlands over species rich dense shrublands (FCT 20a)	CR		• Probably present (See section 6.5.6.3)
• *Banksia attenuata* and/or *Eucalyptus marginata* woodlands of the Eastern Swan Coastal Plain (FCT 20b)	CR		• Absent
• Low lying *Banksia attenuata* woodlands or shrublands (FCT 21c)	P3		• Absent
Shrublands and Woodlands of the Eastern Swan Coastal Plain (FCT 20c)	CR	E	Probably present (See section 6.5.6.3)
Clay Pans of the Swan Coastal Plain Incorporating the State listed TECs:		CE	Absent
• Herb rich saline shrublands in clay pans (FCT 07)	EN		Absent
• Herb rich shrublands in clay pans (FCT 08)	EN		Absent
• Shrublands on dry clay flats (FCT 10a)	EN		Absent
Corymbia calophylla – Kingia australis Woodlands on Heavy Soils of the Swan Coastal Plain (FCT 3a)	CR	E	Absent
Corymbia calophylla – Eucalyptus marginata Woodlands on Sandy Clay Soils of the southern Swan Coastal Plain (FCT 3b)	EN	-	Absent
Corymbia calophylla – Xanthorrhoea preissii Woodlands and Shrublands, Swan Coastal Plain (FCT 3c)	EN	E	Absent
Central Northern Darling Scarp Granite Shrubland Community	P4	-	Absent
Southern Wet Shrublands, Swan Coastal Plain (FCT 02)	CR	-	Absent
Muchea Limestone – Shrublands and Woodlands on Muchea Limestone of the Swan Coastal Plain	EN	E	Absent

Conservation Codes	State (WA)	Federal
Endangered	EN	E
Critically Endangered	CR	CE
Vulnerable	VU	V
Priority (rated in order of significance from 1 to 4)	P	

6.5.6 Field surveys

The results of the field surveys undertaken within the MRS amendment area over a three-year period from 2019 to 2022, by AECOM and JBS&G are presented and analysed in this section. Figure 6-1 graphically illustrates the survey effort completed to date.

6.5.6.1 Vegetation communities

Six native vegetation communities were described and mapped by AECOM (2020) for the broader Wattle Grove South area. Of these, three occur within the MRS amendment area. These communities fall into the broad category of Banksia Woodlands and *Eucalyptus marginata* Woodlands (AECOM 2020). Vegetation descriptions for those communities present in the MRS amendment area are provided in Table 6-7 and shown in Figure 6-3. The vegetation communities within the MRS amendment area are mapped in Figure 6-3 and presented in Table 6-8.

The delineation of vegetation communities was supported by cluster analysis of floristic data. The cluster outcomes, as identified using the three quadrats undertaken by AECOM (2020) and the single quadrat undertaken by JBS&G (2024), the locations of these quadrats are provided in Figure 6-1.

Five vegetation communities (representing three native vegetation and two highly modified or planted) have been mapped consistent with those identified in the AECOM (2020) survey. Areas not subject to a site survey have been extrapolated by JBS&G (2024) based on adjacent ecological values, review of aerial imagery and where possible visual assessment from adjoining lots and road reserves.

Table 6-7: Vegetation community descriptions

Description (ACEOM 2020)	Additional details	Photograph (AECOM 2020)
BaEpPf Banksia Woodland *Banksia attenuata*, *Banksia menziesii* and *Eucalyptus todtiana* low open woodland over *Eremaea pauciflora var. pauciflora*, *Hibbertia hypericoides* and *Allocasuarina humilis* low shrubland over *Phlebocarya filifo*lia, *Mesomelaena pseudostygia* and *Lepidosperma leptostachyum* low sedgeland. Supports the Threatened *Conospermum undulatum* and Priority 3 *Isopogon drummondii*.	Survey effort: Q6 (AECOM quadrat) Q13 (AECOM quadrat) S01 (JBS&G relevé) Species richness: 88 native and 7 weed species.	
BmXpEc Banksia Woodland *Banksia menziesii*, *Allocasuarina fraseriana* and *Eucalyptus todtiana* low open woodland over *Xanthorrhoea preissii*, *Eremaea pauciflora var. pauciflora* and *Stirlingia latifolia* low open shrubland over *Ehrharta calycina**, *Dasypogon bromeliifolius* and *Anigozanthos manglesii subsp. manglesii* mixed grass and forbland.	Survey effort: Q09 (AECOM quadrat) – vegetation recently cleared R12 (AECOM relevé) R14 (AECOM relevé) Species richness: 80 native and 12 weed species (AECOM 2020).	

EmMpLp Eucalyptus marginata Woodland *Eucalyptus marginata subsp. marginata* and *Allocasuarina fraseriana* mid open forest over *Mesomelaena pseudostygia* and *Tetraria octandra* low sedgeland with *Lomandra preissii*, *Tricoryne elatior* and *Dampiera linearis* low open forbland. Larger patch of this community surveyed in wider Wattle Grove South survey area (but outside of MRS amendment area) (Q20 – AECOM quadrat).	Survey effort: R05 (AECOM relevé)	
Significantly Altered Includes planted, gardens, scattered trees (both native and introduced). Condition considered Completely Degraded.	N/A	N/A

Review of recent aerial imagery revealed that vegetation located on Lots 8 and 9 Brentwood Road has been cleared since AECOM and JBS&G undertook their site surveys. Plate 6-1 presents aerial imagery from 30 April 2023 when the lots were vegetated. Plate 6-2 presents the latest aerial imagery which demonstrates the full extent of vegetation clearing that has recently taken place.

Plate 6-1: Aerial imagery (30/04/23) of Lots 9 and 8

Plate 6-2: Latest aerial imagery of Lots 9 and 8

The vegetation on Lots 8 and 9 was previously mapped by AECOM (2020) and JBS&G (2024) as BmXpEc vegetation and ranged from Degraded to Very Good condition.

Figure 6-3 reflects the recent clearing and illustrates the current extent of BmXpEc. Table 6-8 reflects the updated vegetation community areas and percentages for BmXpEc and Cleared Land as a result of this clearing and revision to the vegetation mapping. Similarly, the vegetation condition mapping (Figure 6-4) has been amended to reflect the areas cleared within Lots 8 and 9. Table 6-9 reflects the revised areas and percentages for vegetation condition.

JBS&G (2024) also mapped two discrete areas located along the north-eastern boundary of Lot 2 (42) Victoria Road as vegetation community EmMpLp; however, upon closer inspection of the vegetation mapping it was noted that the JBS&G (2024) vegetation mapping differed to the AECOM (2020) mapping, which originally categorised these two areas as 'Trees' due to the vegetation (non-native and native trees) being significantly altered with an absence of understorey and the vegetation

condition being Completely Degraded. Plate 6-3 provides a ground view photo of the north-eastern boundary of Lot 2 which provides clear evidence that the understorey is absent. Given the absence of an understorey, the vegetation condition being mapped as Completely Degraded, the vegetation mapping for these two areas more appropriately reflects AECOMs (2020) original vegetation community of 'Trees' (Figure 6-3) and has been mapped as such.

Plate 6-3: Ground view of north-east**ern boundary of Lot 2 (42) Victoria Road**

The vegetation community extents within the MRS amendment, which include the three native vegetation communities, as well as two other highly modified vegetation communities described as 'Trees' and 'Planted and Maintained Gardens', are provided in Table 6-8. Areas that have been subject to clearing or development have been mapped as 'Cleared' and include the recent clearing on Lots 8 and 9. As a result, the areas provided in the table below will have a minor variation to the areas presented in JBS&G (2024) ecological memo.

Table 6-8: Vegetation communities and extents

Vegetation community	Area	Percentage of total
Remnant native vegetation		
BaEpPf	4.23 ha	3.37%
BmXpEc	0.28 ha	0.22%
EmMpLp	0.05 ha	0.04%
Total Remnant Native Vegetation	4.56 ha	3.63%
Highly modified vegetation		
Planted and Maintained Gardens	2.59 ha	2.06%
Scattered Trees	26.94 ha	21.45%
Other		
Cleared Land	91.49 ha	72.85%
Total	125.58 ha	100%

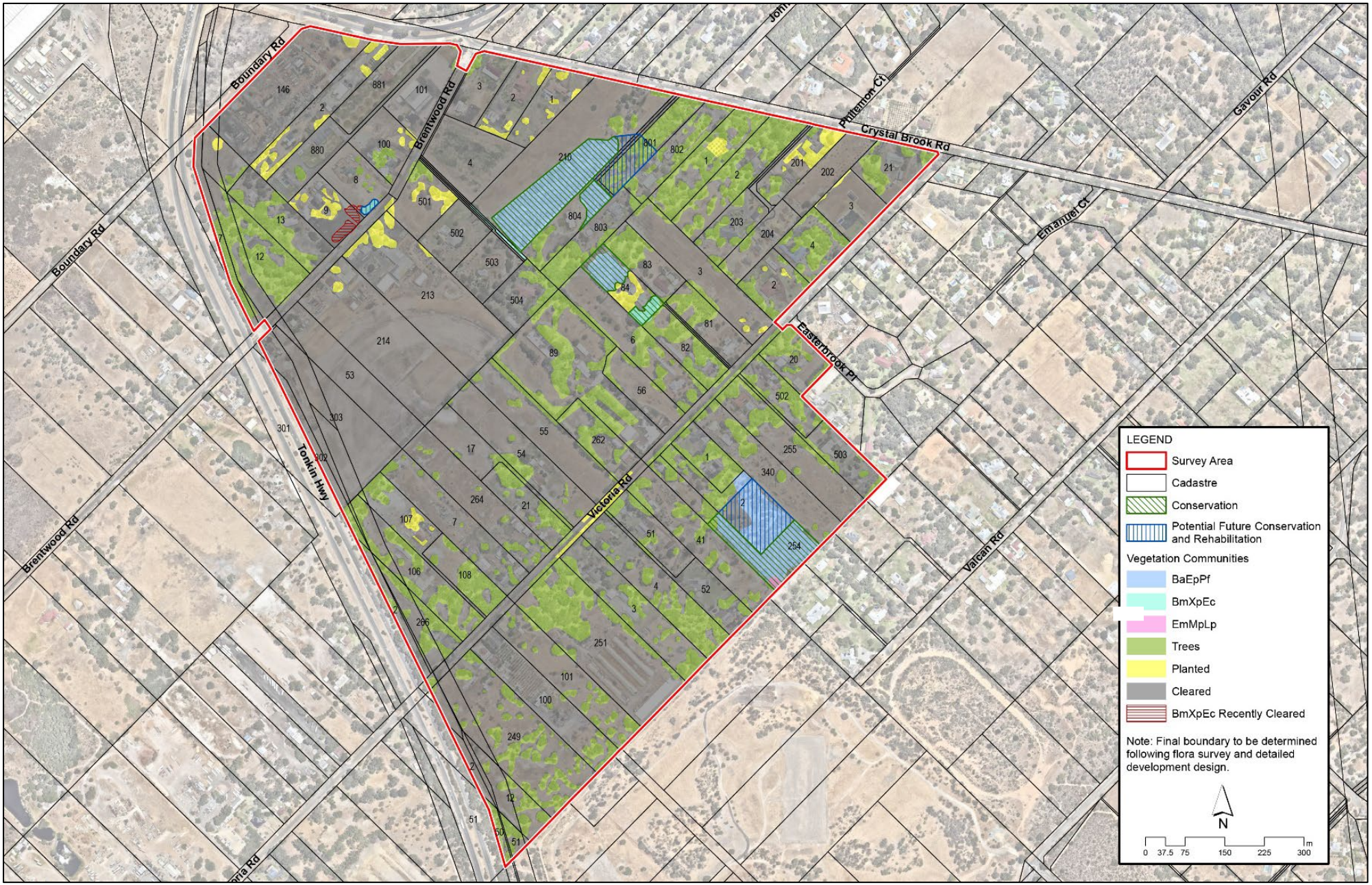

Figure 6-3: Vegetation communities

6.5.6.2 Vegetation condition

Vegetation condition within the MRS amendment area varies from Excellent to Completely Degraded as shown in Table 6-9 and mapped in Figure 6-4. As previously advised, the areas provided in the table below will have a minor variation to the areas presented in JBS&G (2024) ecological memo.

Table 6-9: Vegetation condition and extents

Vegetation Condition	Area	Percentage of total
Remnant native vegetation		
Excellent	3.41 ha	2.72%
Very Good	0.05 ha	0.04%
Good	0.15 ha	0.12%
Degraded	0.13 ha	0.11%
Completely Degraded	0.82 ha	0.65%
Highly modified vegetation		
Completely Degraded	23.93 ha	19.05%
Other		
Cleared	97.09 ha	77.31%
Total	125.58 ha	100.00%

The vegetation condition within the MRS amendment area is predominantly Completely Degraded and Cleared, which is characteristic of the highly modified environment and current land uses within the area, comprising a mixture of residential and semi-rural living, composite business along Welshpool Road and horticulture. A former turf farm was located on Lots 303, 53, 213 and 214 Brentwood Road. There is also a former poultry farm located at Lot 251 within the south-east portion of the area, which ceased operations over a decade ago. The DBNGP also runs along the western edge of the area, adjacent to Tonkin Highway. The majority of semi-rural residences comprise cleared grasslands/paddocks, lawn and maintained gardens.

Due to the historical and current land use, only 2.72% of the area comprises vegetation in Excellent condition, and 0.16% of the area contains vegetation in Good or Very Good condition.

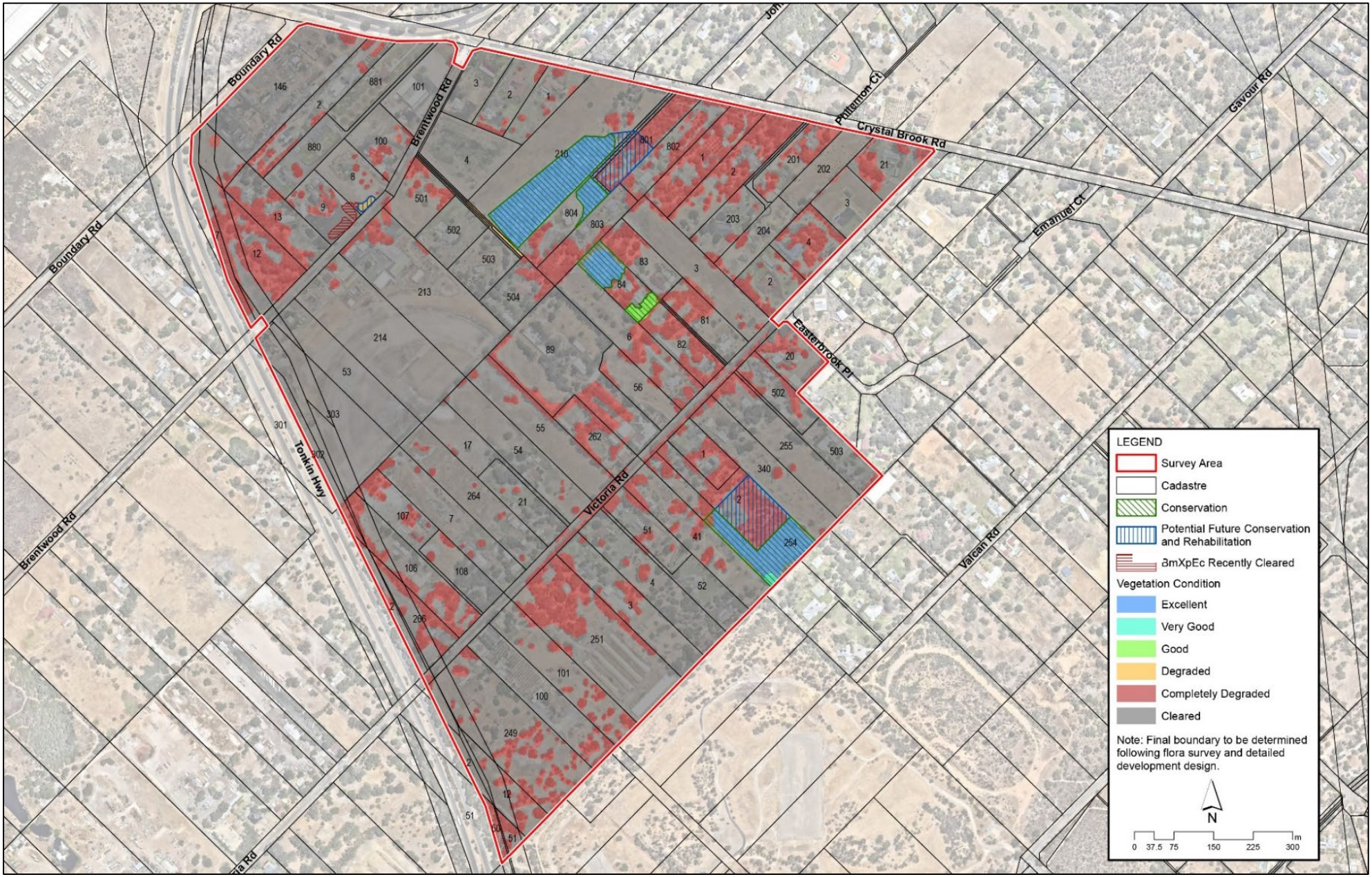

Figure 6-4: Vegetation condition

6.5.6.3 Floristic community type analysis

The FCT analysis undertaken by AECOM (2020) used the Keighery et al. (2012) dataset to assign likely FCTs, whereas JBS&G (2024) used the Keighery et al, (2020) to infer likely FCTs. However, neither analysed the quadrat species data against the original Gibson et al. (1994) dataset which is a key component of the DBCA (2024) Methods for Survey and Identification of Western Australian Threatened Ecological Communities.

Subsequently, an FCT analysis was undertaken by Plantecology (2024) (Appendix E) in accordance with DBCA (2024). The FCT assignment used the Gibson et al. (1994) and Keighery et al. (2012) datasets, and assignment was done by minimum dissimilarity between the AECOM and JBS&G plot data and plots from two regional datasets (nearest neighbour) (Plantecology 2024).

The FCT analysis incorporated relevant quadrats from the broader AECOM (2020) study area. Although some of the quadrats themselves were outside of the MRS amendment area (Figure 6-1), using these quadrats enabled a better and more robust analysis of FCT. All but one of these quadrats were surveyed by AECOM (2020), with the other quadrat surveyed by JBS&G (2024).

Table 6-10 presents the summary results of the FCT analysis and shades in grey the following quadrats, which are located within the MRS amendment area (Figure 6-1):

- AECOM Quadrat 4 (Q4) – located within Lot 254 Victoria Road
- AECOM Quadrat 6 (Q6) – located within Lot 254 Victoria Road
- AECOM Quadrat 9 (Q9) – previously located in Lot 9 Brentwood Road but vegetation has now been cleared
- AECOM Quadrat 13 (Q13) – located within Lot 84 Victoria Road
- JBS&G Quadrat 1 (S01) – located within Lot 804 Crystal Brood Road and represents part of a larger patch of vegetation located on Lot 210 that could not be directly accessed for survey purposes.

Table 6-10: Floristic community type assignment summary (Plantecology 2024)

Quadrat / Plot	Assignment to Gibson et al. (1994)	Assignment to Keighery et al. (2012)	Nearest neighbour	Probable FCT
AECOM Q1 (outside)	3b	3b	20b	3b
AECOM Q4	20a	20a	20a	20a
AECOM Q6	20a	20a	20c	20a
AECOM Q7 (outside)	3b	3 / 20	3b	3b
AECOM Q9 (vegetation cleared)	20c	Undetermined	20c	20c
AECOM Q10 (outside)	3b	3b	3b	3b
AECOM Q11 (outside)	3b	3b	3b	3b
AECOM Q13	20a	20a	20a	20a
AECOM Q15 (outside)	3b	S09 / S16	20c	3b
AECOM Q18 (outside)	20c	20b	20b	20c
AECOM Q19 (outside)	20c	20c	20b	20c
AECOM Q20 (outside)	20c	Undetermined	20b	20c
JBSG_S01	20a	20a	20a	20a

To determine the probable FCTs and produce clearer and more consistent results, most weight was given assignment to the original Gibson et al. (1994) dataset (Plantecology 2024) (Table 6-10). Whereas comparison to the Keighery et al. (2012) dataset was mostly similar there was more disruption to the original classification and therefore, a reduction in confidence of the results (Table 6-10). It should be noted that the least weight was given to the nearest neighbour assignments as these were less consistent with the analyses against the Gibson et al. (1994) and Keighery et al. (2012) datasets.

Within the MRS amendment area, the probable FCTs assigned from the analysis undertaken by Plantecology (2024) include:

- FCT 20a *Banksia attenuata* woodlands over species rich dense shrublands WA TEC – Critically Endangered (BC Act)
- FCT 20c Shrublands and woodlands of the eastern side of the Swan Coastal Plain WA TEC – Critically Endangered (BC Act) and Federal TEC – Endangered (EPBC Act)

However, as previously stated the quadrat (AECOM Q9) located within Lot 9 has recently been cleared and all that remains of this patch of vegetation (BmXpEc) is mapped within Lot 8 and is now 0.05 ha in extent and is in Degraded condition. Given the results of the FCT analysis for AECOM Q9, it is recommended a targeted survey and FCT analysis of the flora and vegetation within this patch is undertaken in accordance with DBCA (2024) Methods for Survey and Identification of Western Australian Threatened Ecological Communities, prior to local structure plan or subdivision to verify if it represents FCT 20c.

6.5.6.4 Threatened and priority ecological communities

Native vegetation was mapped over 4.56 ha within the MRS amendment area. The FCT analysis undertaken by Plantecology (2024) (Appendix E) and the Banksia Woodlands Assessment undertaken by JBS&G (2024) (Appendix D) was used to determine the presence of any conservation-significant ecological communities within the four major vegetation patches (Figure 6-5) occurring within the MRS amendment area. Three of these include TECs (Patches 1, 2 and 4), and another one (Patch 3) use to include TEC vegetation that has been recently cleared. The four patches are:

- **Patch 1**: Contains 1.8 ha of Banksia Woodland – BaEpPf across Lots 254 and Lot 2 Victoria Road.
    - Located on Lot 254 Victoria Road is 0.99 ha of BaEpPf which is mapped as being in Excellent condition (AECOM quadrats 6 and 4). Subsequently, this vegetation has been assigned as probably being FCT 20a - *Banksia attenuata* woodlands over species rich dense shrublands (refer to Table 6-10), which is a State-listed TEC (Critically Endangered), and whilst, FCT 20a is not a Federally-listed TEC, this area of BaEpPf on Lot 254 does meet the condition threshold requirement for the Federally-listed Banksia Woodlands of the Swan Coastal Plain TEC. Located in the southernmost corner of Lot 254 is a small (0.05 ha) area of EmMpLp (AECOM relevé 5) in very good condition.
    - Located adjacent on Lot 2 is 0.82 ha of BaEpPf which is mapped as Completely Degraded and was not considered to be part of the Federal-listed Banksia Woodlands of the Swan Coastal Plain TEC.
    - Patch 1 also supports occurrences of threatened flora species *Conospermum undulatum* (Vulnerable) and priority flora *Isopogon autumnalis* (Priority 3).

- **Patch 2:** Contains 0.35 ha of Banksia Woodland – BaEpPf (AECOM quadrat 13), which is assigned as probably being State-listed TEC FCT 20a (refer to Table 6-10), and located within the northern half of Lot 84 Victoria Road and 0.14 ha of Banksia Woodland – BmXpEc, which is located within the southern portion of the same lot.
    - FCT 20a is a State-listed TEC (Critically Endangered) and whilst this patch represents two discreet areas that are different vegetation communities they are broadly defined as Banksia Woodland. Furthermore, due to the connection of canopies of trees these two areas are considered representative of the same patch.
    - Whilst the area falls outside the required 0.5 ha by a minute amount of 0.01 ha the precautionary principle has been applied and therefore, the patch meets the threshold requirements for the Federally listed Banksia Woodlands of the Swan Coastal Plain TEC.
    - Patch 2 also supports occurrences of threatened flora species *Conospermum undulatum* (Vulnerable) and priority flora *Isopogon autumnalis* (Priority 3).
- **Patch 3**: Located on Lots 8 and 9 Brentwood Road this patch used to comprise approximately 0.3 ha of BmXpEc which was assigned as probably being FCT 20c by Plantecology (2024) (refer to Table 6-10)
    - FCT 20c is a State-listed TEC (Critically Endangered) and Federal-listed TEC (Endangered); however, due to the recent clearing on Lots 8 and 9 (previously contained AECOM quadrat 9), the remaining area of BmXpEc on Lot 8 has now been reduced to 0.05 ha which is mapped as being in Degraded condition and now may be considered too small and degraded to be assigned an FCT. However, it is recommended a targeted survey and FCT analysis of the flora and vegetation within this remaining patch of vegetation is undertaken in accordance with DBCA (2024) Methods for Survey and Identification of Western Australian Threatened Ecological Communities, prior to local structure plan or subdivision to confirm if this remaining patch represents FCT 20c.
- **Patch 4**: Contains 2.07 ha of BaEpPf which is assigned as probably being FCT 20a by Plantecology (2024) (refer to Table 6-10) and is located on Lots 210 and 804 Crystal Brook Road.
    - FCT 20a is a State-listed TEC, and given it is in excellent condition it meets the condition threshold requirement for the Federally listed Banksia Woodlands of the Swan Coastal Plain TEC (JBS&G quadrat S01).
    - Supports occurrences of threatened flora species *Conospermum undulatum* (Vulnerable) and priority flora *Isopogon autumnalis* (Priority 3).

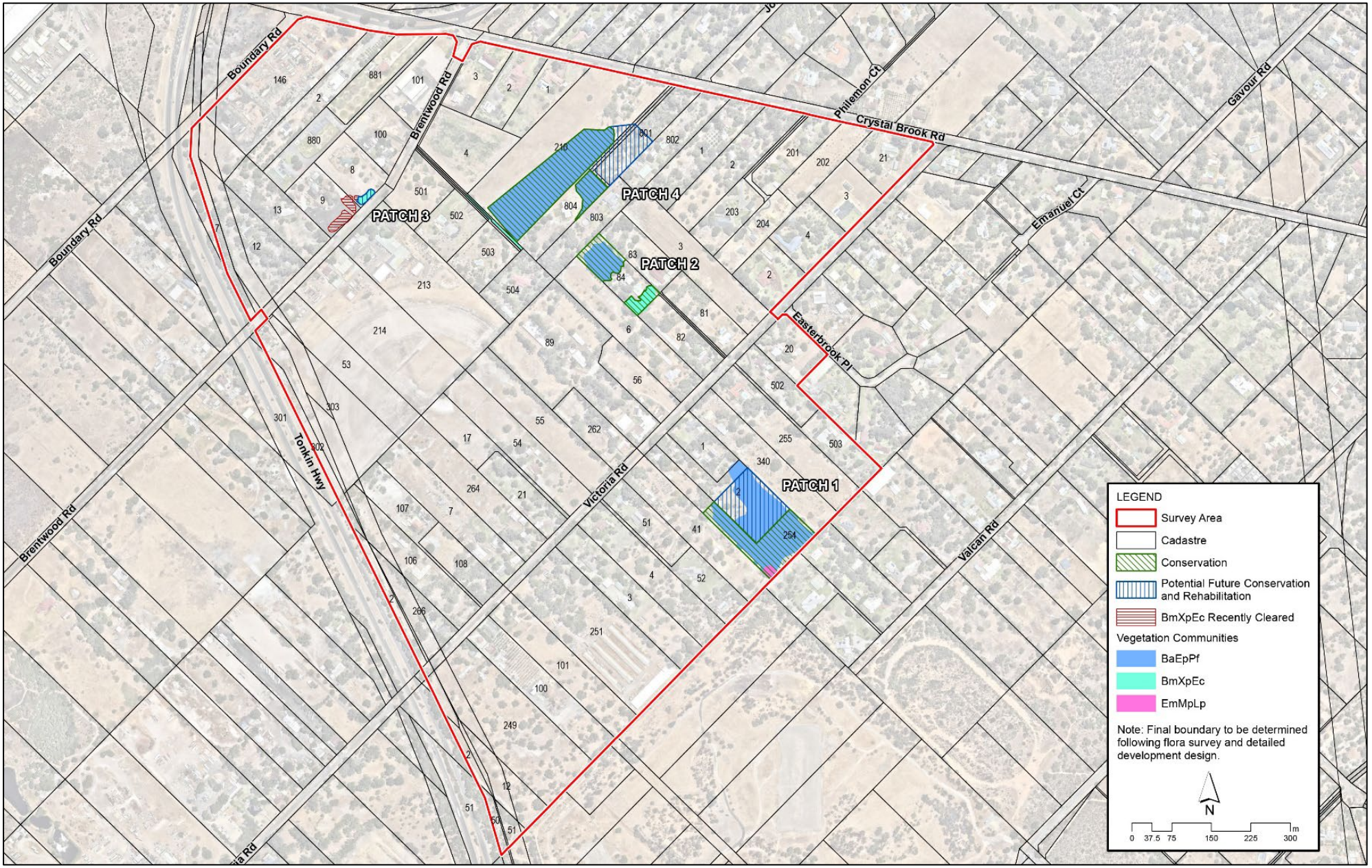

Figure 6-5: Conservation significant ecological communities

6.5.6.5 Conservation significant flora

AECOM undertook an ecological spring survey, incorporating flora and vegetation in October 2019 (AECOM 2020). The survey recorded data from twelve quadrats and eight relevés, covering a broader area of the Wattle Grove locality than the MRS amendment area. The result of this survey has been augmented by the further survey work undertaken by JBS&G.

AECOM (2020) recorded 165 native vascular flora taxa from the broader survey area and 21 introduced flora taxa, many of which are not expected to occur within the MRS amendment area. This also included two conservation significant flora taxa, concentrated in two localised areas, within the MRS amendment area:

- *Conospermum undulatum* (T)
- *Isopogon autumnalis* (P3), previously named *Isopogon drummondii*.

The AECOM field survey was undertaken at an appropriate time to identify conservation significant orchid species if present, however, the survey only gained access to approximately 50% of lots and recognised that there is potential for conservation significant flora taxa to have been missed if present. JBS&G conducted flora and vegetation surveys in October 2021, incorporating both previously surveyed and unsurveyed lots within the MRS amendment area. Therefore, the MRS amendment area has been adequately surveyed and values appropriately assessed.

In addition, flora surveys conducted by JBS&G in January 2022 recorded observations of conservation significant flora from the boundary of Lots 210 and 801. Observations of Lot 210 and Lot 801 noted the presence of *Conospermum undulatum* (T) and *Isopogon autumnalis* (P3).

Conospermum undulatum (waxy-leaved smokebush) is an erect shrub which grows to 1.5 m height and is characterised by its fibrous, longitudinally fissured stems and wide leaves with wavy margins. It is listed as Vulnerable under the BC Act and EPBC Act and is ranked as Vulnerable (VU) under World Conservation Union (IUCN 1994) Red List criterion B1+2c, with its main threats being listed as further land clearing, poor habitat quality, road and firebreak maintenance, inappropriate fire regimes, weeds, recreational activities and rabbit grazing (DEC 2009). *Conospermum undulatum* is recorded from 25 historical populations, comprising 83 subpopulations. However, only 20 populations currently contain extant plants (DEC 2009). It occurs on sand and sandy clay soils, often over laterite, on flat or gently sloping sites between the Swan and Canning Rivers. A few records are from slightly swampy habitat. Habitat critical to the survival of *Conospermum undulatum* includes the area of occupancy of important populations and areas of similar habitat surrounding important populations (DEC 2009). Important populations of *Conospermum undulatum* are listed in the species' recovery plan.

Isopogon autumnalis is an erect shrub growing to 1 m height with cream-yellow flowers and mostly terete leaves (Rye and MacFarlane 2019). It is listed as a Priority 3 taxon by DBCA. It is known from a large range extending from the southern Lesueur Sandplains through the Swan Coastal Plain and Dandaragan Plateau to the Northern Jarrah Forrest. It prefers white, grey or yellow sand, often over laterite. It was previously known as *Isopogon drummondii* but was renamed in 2019 due to lack of a type specimen and descriptions being based on cultivated specimens (Rye and MacFarlane 2019). Variants of the taxon with larger leaves were transferred to *Isopogon sphaerocephalus*.

Two additional conservation significant flora species, *Banksia mimica* and *Lasiopetalum glutinosum* subsp. *glutinosum,* were identified in the 2018 desktop assessment through DBCA records (360 Environmental 2018). *Banksia mimica* was previously recorded south-east of the Crystal Brook Road and Brentwood Road junction. All properties in this vicinity have since been cleared for residential development, and no native vegetation remains. *Banksia mimica* was not recorded during the field survey (AECOM 2020) or by JBS&G during subsequent site surveys.

Naturemap records of *Lasiopetalum glutinosum* within the site are associated with Paganoni Swamp, approximately 60 km south-west of the site. The occurrence of *Lasiopetalum glutinosum* within the site is therefore considered a result of mapping inaccuracies. AECOM determined that the species is unlikely to occur within the site, given it is associated with lateritic outcrops on the Darling Scarp. AECOM (2020) did not identify *Lasiopetalum glutinosum* during the survey or JBS&G during subsequent site surveys.

6.5.6.6 Targeted *Drakaea elastica* survey

Drakaea elastica is a small, tuberous orchid, whose distinctive leaves appear at ground level in late winter. It is a Threatened orchid species and is known to grow within areas of Banksia Woodlands.

On 25 August 2021 an experienced JBS&G ecologist undertook a targeted survey for *Drakaea elastica* on Lot 254 Victoria Road, where the Banksia Woodlands community BaEpPf is known to be present. Whilst Banksia Woodlands communities have been recorded on other landholdings within the MRS amendment area, at the time of the *Drakaea elastica* survey, Lot 254 Victoria Road was the only landholding containing Banksia Woodlands that was able to be accessed.

During the survey, remnant native vegetation within Lot 254 was traversed at 10 m intervals and the ground was observed for *Drakaea elastica* leaves. The survey tracks were recorded on a Garmin™ GPS (Figure 6-1). No *Drakaea elastica* was identified by this survey.

The remnant native vegetation present within Lot 254 is an open to sparse Banksia Woodlands over closed, medium-low shrubland. AECOM (2020) undertook multivariate analysis of quadrat data from the lot and determined that the vegetation present was consistent with FCT 20a *Banksia attenuata woodland* over species rich dense shrublands.

Vegetation within the remnant vegetation within Lot 254 is in Very Good to Excellent condition, but with significant invasive weed species at the edges. Significant weed taxa observed during the *Drakaea elastica* survey included **Acacia iteaphylla* (Flinders Range wattle), **Leptospermum laevigatum* (Victorian tea tree), **Cytisus proliferus* (tree lucerne), **Eragrostis curvula* (African love grass), **Ehrharta longifolia* (annual veldt grass) and **Asparagus asparagoides* (bridal creeper).

Understory vegetation within Lot 254 was dense and leaf litter had built up to around 20cm depth, mostly obscuring the ground, and resulting in high fuel loadings that may present a fire hazard. This also resulted in a low level of detectability for *Drakaea elastica*, though in such circumstances, it is unlikely to be present as any individuals would not receive sufficient light.

Although no *Drakaea elastica* was identified during the survey of Lot 254 Victoria Road, one other conservation significant taxa, *Conospermum undulatum*, previously identified within Lot 254, was observed in abundance. *Isopogon autumnalis*, previously named *Isopogon drummondii*, was also seen in abundance. *Conospermum undulatum* was also visible and flowering in the adjacent Lot 2.

6.5.6.7 Potential survey limitations for conservation significant flora

To date a total of 104 individuals of conservation significant flora have been identified during surveys of the MRS amendment area, including (Figure 6-6):

- 84 *Conospermum undulatum* (T).
- 20 *Isopogon autumnalis* (P3).

Both species are known to occur within fragmented remnant bushland; however, on review of recent aerial imagery, it is evident that:

- of the eight lots that have not been surveyed to date, seven of them (Lots 3, 51, 52, 502 and 503 Victoria Road and Lots 880 and 881 Welshpool Road East) are predominantly cleared with little to no extant trees or vegetation. It is therefore considered highly unlikely that conservation significant flora will be present on these landholdings.
- due to the recent clearing that took place on Lots 8 and 9 Brentwood Road, it is considered unlikely that the two occurrences of *Conospermum undulatum* located on these lots remain.
- within Lots 802, 803 and 804 there are 3 occurrences of *Conospermum undulatum* and 3 occurrences of *Isopogon drummondii* that are located either adjacent to the boundary of the proposed Conservation area or may have been historically cleared.

The one remaining unsurveyed lot (Lot 4 (No.95) Victoria Road) is situated in the vicinity of recorded locations for conservation significant flora, however the scattered trees present on Lot 4 have been noticeably disturbed so it is also considered unlikely there will be conservation significant flora on this lot.

Of the 13 lots that have been subject to a survey from the fence line, six lots (Lots 3 and 21 Crystal Brook Road, 502 and 503 Brentwood Road and 54 and 100 Victoria Road) have been predominantly cleared and contain little to no extant trees or vegetation. The presence of conservation significant flora on these lots is also considered to be highly unlikely.

Five other lots that were surveyed from the fence line (Lot 803 Crystal Brook Road, Lots 1, 4 (No.36) and 83 Victoria Road and 504 Brentwood Road) are within the vicinity of recorded locations for conservation significant flora, however the scattered trees present on these lots have also been noticeably disturbed so the presence of conservation significant flora on these lots is considered unlikely.

The remaining two lots that were surveyed from the boundary are Lot 210 Crystal Brook Road and Lot 2 (No.75) Victoria Road. During these surveys, *Conospermum undulatum* was visible and flowering in both lots and *Isopogon autumnalis* was also observed flowering in Lot 210. It is therefore possible that further individuals of these conservation significant flora may be identified when these lots are subject to a full site survey.

Notwithstanding, the remnant Banksia Woodlands on both Lot 210 Crystal Brook Road and Lot 2 (No.75) Victoria Road will be retained for Conservation. This in turn will ensure that any unidentified individuals of *Conospermum undulatum* or *Isopogon autumnalis* that may be present within the remnant vegetation on these lots will in any event be protected.

Similarly, because Lot 254 Victoria Road is the only landholding containing Banksia Woodlands that has been surveyed for *Drakaea elastica* to date, the presence of this threatened orchid species on other landholdings containing Banksia Woodlands remains unconfirmed. In the event any unidentified *Drakaea elastica* is present within the MRS amendment area, it will be automatically protected through the retention and conservation of all areas of its known habitat (i.e. areas of remnant Banksia Woodlands) as per the requirements of the Environmental Management Framework.

To ensure that the presence of any significant flora or vegetation within lots which have not be subject to adequate survey is appropriately identified and considered in the determination of future subdivision or development proposals and managed through conditions of approval, the Environmental Management Framework requires that any future subdivision and development application for these lots be accompanied by a suitable flora and vegetation field survey.

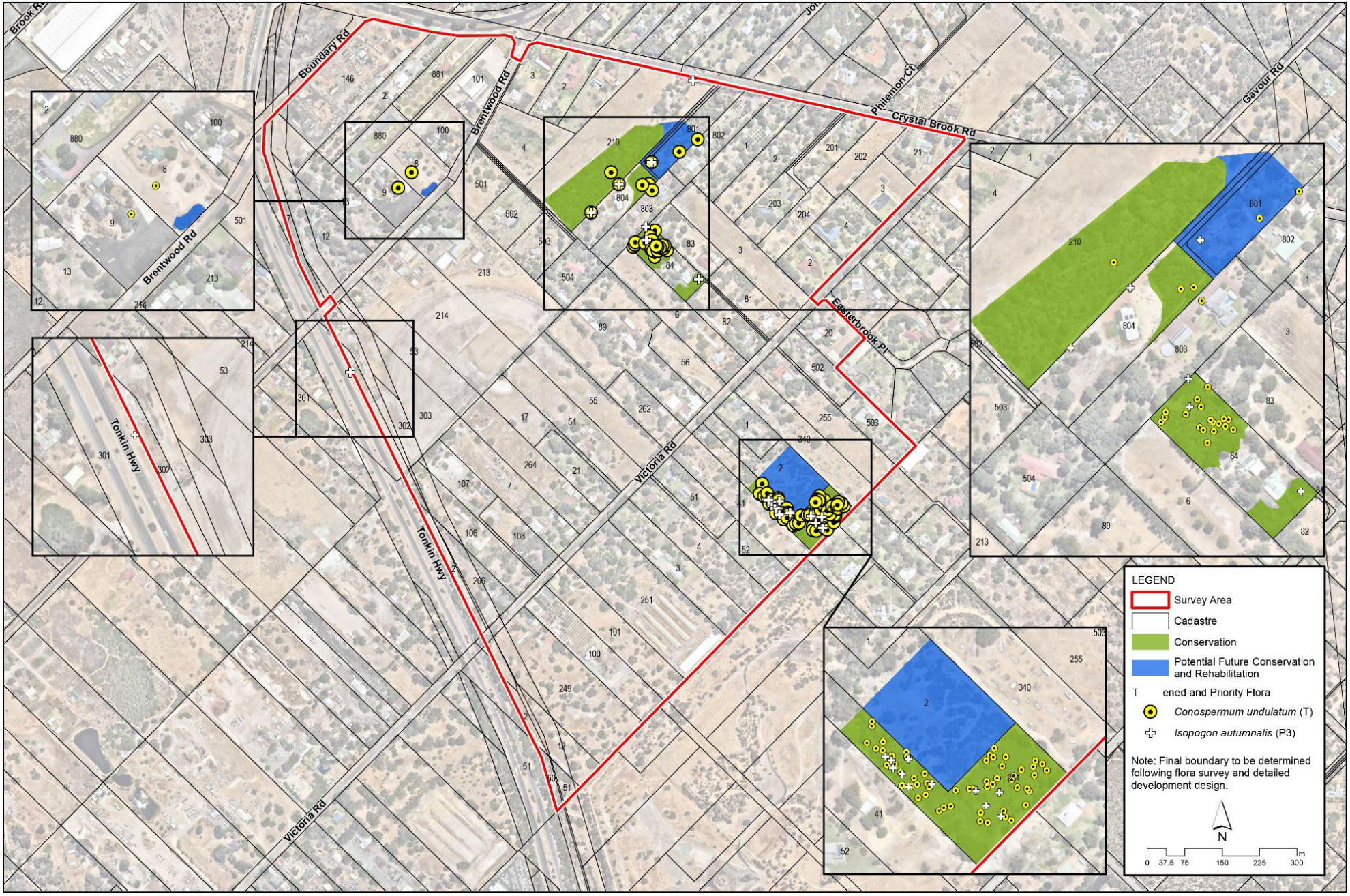

Figure 6-6: Conservation significant flora

6.5.6.8 Weeds

Two Declared Pest plants were identified by AECOM (2020) as occurring within the broader survey area, **Asparagus asparagoides* (bridal creeper) and **Rubus ulmifolius* (blackberry). AECOM (2020) did not include a location for these weed species, so it is not known whether AECOM identified them as occurring within the MRS amendment area. However, during the Strategen-JBS&G targeted survey for *Drakaea elastica*, **Asparagus asparagoides* (bridal creeper) was recorded on Lot 254 Victoria Road. Strategen-JBS&G (2024) also noted during their January 2022 survey that Lot 801 is a significant source of weeds invading remnant vegetation on Lot 210, including but not limited to **Leptospermum laevigatum*.

6.6 Potential environmental impacts

Future urban development as well as the provision of associated infrastructure, within the MRS amendment area has the potential to directly and indirectly impact flora and vegetation. As outlined in the ER Instructions, potential impacts (direct and indirect loss of significant flora and vegetation, including threatened and priority ecological communities, threatened and priority flora, and vegetation complexes poorly represented in existing conservation reserves (Guildford Complex and Forrestfield and Southern River Complex) include:

- Direct loss through clearing
- Loss of fauna habitat (vegetation loss) short and long term
- Impacts to wetland and riparian vegetation and ground water dependant ecosystems within and nearby to the MRS amendment area (including GBSW) through changes to hydrology
- Spread or intensification of weeds and Phytophthora dieback
- Fragmentation.

Direct impacts are predominantly limited to clearing activities during development. Indirect impacts may also occur as a result of construction activities during the development phase, or as a result of increased population and human activity in the post development phase.

The potential impacts to flora and vegetation are presented below.

6.6.1 Direct impacts

6.6.1.1 Clearing of remnant vegetation and conservation significant flora

Clearing activities for future urban development may decrease connectivity between nearby areas of intact native vegetation, as well as reduce available fauna habitat, and impact regional scale vegetation retention.

Surveys of the MRS amendment area have shown there is 4.56 ha of remnant native vegetation that could be impacted by clearing activities associated with the proposed change in land use. The extent of these vegetation communities within the MRS amendment area and to be retained in Conservation areas are presented in Table 6-11 and illustrated in Figure 6-3.

Table 6-11: Vegetation communities within conservation

Vegetation community	Extent within MRS amendment area	Conservation	Potential Future Conservation and Rehabilitation	Total area and percentage (Conservation and Potential Future Conservation and Rehabilitation)
BaEpPf	4.23 ha	3.41 ha	0.74 ha	4.15 ha (98% of BaEpPf area)
BmXpEx	0.28 ha	0.15 ha	0.05 ha	0.20 ha (71% of BmXpEx area)
EmMpLp	0.05 ha	0.05 ha	0.0 ha	0.05 ha (100% of EmMpLp area)
Total	4.56 ha	3.61 ha	0.79 ha	4.40 ha (96% of total remnant vegetation area)

Subsequently, future urban development will result in 0.08 ha of Banksia Woodland - BmXpEx in Degraded condition (which is located along the battle axe for Lot 504 and 0.08 ha of Banksia Woodland - BaEpPf in Completely Degraded condition being cleared. Due to the degraded condition of these two areas of Banksia Woodland, neither are considered to be a TEC.

At a regional level, clearing 0.16 ha of Degraded and Completely Degraded native vegetation represents the following:

- 0.009% (1,875 ha) of native vegetation within 5 km of the MRS amendment area
- 0.002% (9,169 ha) of native vegetation within 10 km of the MRS amendment area
- 0.001% (22,828 ha) of native vegetation within 15 km of the MRS amendment area

Given the above, the proposed clearing is not considered to be significant at a local and regional level.

Conversely, the addition of 4.40 ha of native vegetation to conservation represents the following:

- 0.27% increase in the current extent of native vegetation in conservation (1,609 ha) within 5 km of the MRS amendment area
- 0.03% increase in the current extent of native vegetation in conservation (13,328 ha) within 10 km of the MRS amendment area
- 0.03% increase in the current extent of native vegetation in conservation (16,768 ha) within 15 km of the MRS amendment area

In relation to vegetation complexes, clearing of 0.08 ha of Banksia Woodland - BmXpEx in Degraded condition vegetation represents approximately 0.001% of the current extent of the Southern River vegetation complex remaining on the Swan Coastal Plain. For the portion of 0.08 ha of Banksia Woodland - BaEpPf in Completely Degraded condition vegetation, clearing this area represents approximately 0.003% of the current extent of Forrestfield vegetation complex remaining on the Swan Coastal Plain.

Therefore, the proposed clearing will not reduce the extent of these vegetation complexes below the modified objective to retain at least 10% of the current extents within defined constrained areas including the Perth metropolitan region.

Vegetation condition, and accounting for the area of remnant vegetation recently cleared on Lots 8 and 9, mapped within the MRS amendment area as being in Good or better condition is 3.61 ha. Table 6-12 and Figure 6-4 demonstrates that all vegetation in Good or better condition will be retained in Conservation area. Of the remnant native vegetation that has been mapped, 0.16 ha is proposed to be cleared, and which comprise of 0.08 ha of vegetation in Degraded condition and 0.08 ha of vegetation in Completely Degraded.

Table 6-12: Vegetation condition within conservation

Vegetation condition	Extent within MRS amendment area	Conservation	Potential Future Conservation and Rehabilitation	Total area (Conservation and Potential Future Conservation and Rehabilitation)
Remnant Native Vegetation				
Excellent	3.41 ha	3.41 ha	0.00 ha	3.41 ha
Very Good	0.05 ha	0.05 ha	0.00 ha	0.05 ha
Good	0.15 ha	0.15 ha	0.00 ha	0.15 ha
Degraded	0.13 ha	0.00 ha	0.05 ha	0.05 ha
Completely Degraded	0.82 ha	0.00 ha	0.74 ha	0.74 ha
Total	4.56 ha	3.61 ha	0.79 ha	4.40 ha

These Banksia Woodlands communities are largely restricted to the Perth (SWA02) and Dandaragan (SWA01) subregions of the Swan Coastal Plain IBRA bioregion. An estimate of the extent of Banksia Woodlands that remain within these subregions (including within reserves) is provided in the *Approved Conservation Advice for Banksia Woodlands of the Swan Coastal Plain* (TSSC 2016). An assessment of the extent of Banksia Woodlands (in Good or better condition) that remain within the MRS amendment area, as a proportion of these estimates for the Perth subregion, is presented in Table 6-13.

Table 6-13: Extent of Banksia Woodlands TEC remaining and protected in reserves (TSSC 2016)

Subregion	Current Extent (ha)	Proportion Within MRS amendment area (ha)	Proportion Retained in MRS amendment area (%)	Proportion Remaining in Reserves (ha)	Proportion Remaining in Reserves (%)
Perth (SWA02)	253,540.6 ha	3.61 ha	<0.002%	57,054.9 ha	22.5%

Retention of all areas of remnant native vegetation in Good or better condition will ensure the following TECs are avoided and conserved for the long-term:

- Banksia Woodlands of the Swan Coastal Plain ecological community - Endangered (EPBC Act) and Priority 3 (DBCA listing)
- Probable FCT 20a *Banksia attenuata* woodlands over species rich dense shrublands WA TEC – Critically Endangered (BC Act)

With regard to the remaining Degraded 0.05 ha patch of vegetation (BmXpEc) within Lot 8, and given the results of the FCT analysis for Q9 which was previously located on Lot 9, this area has been identified as Potential Future Conservation and Rehabilitation, which will require a flora and vegetation survey and FCT analysis to confirm if this remaining patch represents FCT 20c *Shrublands and woodlands of the eastern side of the Swan Coastal Plain* WA TEC – Critically Endangered (BC Act) and Federal TEC – Endangered (EPBC Act), prior to local structure plan or subdivision.

Two conservation significant flora taxa are also present within the MRS amendment area:

- *Conospermum undulatum* (T)
- *Isopogon autumnalis* (P3)

Surveys to date have identified the presence of 84 individuals of *Conospermum undulatum* and 20 individuals of *Isopogon autumnalis.* Of these (Figure 6-6):

- 76 *Conospermum undulatum* (T) and 14 *Isopogon autumnalis* (P3) are located within Conservation
- 3 *Conospermum undulatum* (T) and 1 *Isopogon autumnalis* (P3) are located within Potential Future Conservation
- 2 *Conospermum undulatum* (T) and 2 *Isopogon autumnalis* (P3) located on Lot 803 and 804 Crystal Brook Road are mapped as being adjacent to Conservation but may have been potentially cleared
- 1 *Conospermum undulatum* (T) and 1 *Isopogon autumnalis* (P3) located on Lot 804 Crystal Brook Road are mapped as being adjacent to Conservation
- 2 *Conospermum undulatum* (T) located within Lots 8 and 9 Brentwood Road are presumed to be cleared given the extent of recent clearing that has taken place
- 1 *Isopogon autumnalis* (P3) located along the northern boundary of Lot 201 Crystal Brook Road and is adjacent to the road reserve.
- 1 *Isopogon autumnalis* (P3) located outside the MRS amendment area eastern boundary and is within a narrow strip of land between Tonkin Highway and the DBNGP corridor, which is owned by the Water Corporation and houses a water main. As such it will not be developed for urban uses.

The Conservation and Potential Future Conservation and Rehabilitation boundaries have potential to be extended following detailed design and further flora and vegetation surveys being undertaken (where site access has been limited). Given the number of individuals that occur within close proximity of the Conservation and Potential Future Conservation areas (Figure 6-6) there will be opportunities through the Environmental Management Framework to extend the final design and boundary of the Conservation areas to retain the adjacent *Conospermum undulatum* (T) and *Isopogon autumnalis* (P3) located on Lot 804 as part of future local structure planning, subdivision and/or development.

6.6.1.2 Types of Clearing Activities

When assessing the potential direct impacts of clearing activities on flora and vegetation, consideration should be given to the different types of clearing that may occur. These include:

- Land clearing to facilitate new urban development.
- Incidental clearing associated with construction activities – e.g. to facilitate the construction of a temporary haul road for construction vehicles and machinery.
- Accidental clearing during construction activities – e.g. flora or vegetation that is earmarked for retention can be inadvertently cleared during construction if the appropriate construction management measures are not in place.

The impacts of land clearing to facilitate future urban development will be mitigated through the Environmental Management Framework during early stages of the planning process, by requiring:

- the identification and retention of conservation significant flora and vegetation within Conservation areas
- the preparation of a Conservation Area Management Strategy (CAMS) to inform local structure planning and then preparation, approval and implementation of Conservation Area Management Plan (CAMP) at subdivision and development to ensure the long-term protection and management of these conservation reserves.

Incidental and accidental clearing of vegetation during construction will be avoided through the Environmental Management Framework and the sequential planning framework as the well as the WAPC model subdivision schedule (DPLH 2024b) which has standard conditions requiring the

preparation and approval of a Construction Environmental Management Plan (CEMP) post subdivision approval, and then implemented during construction works.

6.6.2 Indirect impacts

The inhabitants of new urban communities have the potential to indirectly impact on areas of retained native vegetation through uncontrolled access (by vehicles and pedestrians), littering, dumping and through the spread of weeds or disease and fire risk.

All of these impacts may also occur as a result of construction activities during the development phase. Construction activities can also indirectly impact on flora and vegetation through dust deposition.

Other potential indirect impacts of urbanisation of the MRS amendment area include fragmentation, degradation of ecological linkages, hydrological changes and erosion. Consideration of these potential indirect impacts is provided below.

It should be noted that all indirect impacts as a result of urbanisation of the MRS amendment area can be managed through the preparation and approval of CEMP(s) post subdivision approval, and then implemented during construction works.

6.6.2.1 Fragmentation

The MRS amendment area predominantly comprises significantly altered areas, including 91.23 ha of cleared land and another 29.7 ha of land characterised by highly modified vegetation in the form of planted gardens and scattered trees. These cleared and modified areas account for ~96.4% of the total MRS amendment area. Surviving areas of remnant native vegetation are already highly fragmented by historical clearing and development. These areas are very small and make up approximately 3.6% of the MRS amendment area.

As previously advised, the Environmental Management Framework and subsequent environmental conditions will ensure the remaining areas of intact native vegetation (in Good or better condition) be placed within Conservation areas along with the preparation, approval and implementation of CAMP(s) which will ensure that no further fragmentation of the surviving areas of intact remnant native vegetation occurs within the MRS amendment area.

6.6.2.2 Hydrological changes

Urbanisation could result in an increase in groundwater levels due to reduced evapotranspiration and greater infiltration and recharge of the superficial aquifer, via runoff from roads, roofs and other hard surfaces. The level of groundwater rise is dependent upon a range of factors, but as a maximum it can sometimes be in the order of meters.

Groundwater contours at the MRS amendment area (in the existing pre-development environment), range from approximately 16 m AHD in the north-eastern region to approximately 19 m AHD on the western boundary, with a regional groundwater depth ranging from 4 m to 20 m below natural surface. Due to this significant separation distance that exists between groundwater and vegetation, it is very unlikely that vegetation within the MRS amendment area is groundwater dependent.

Modelling of the post development environment has predicted that reduced evapotranspiration and increased infiltration as a result of urbanisation will increase groundwater recharge to the superficial aquifer by 66,275 kL/year. This increase in recharge due to the physical changes associated with urbanisation is not as large as would normally be expected with urbanisation as it is offset by a reduction in recharge to the superficial aquifer that had been occurring at the turf farm on Brentwood Road.

The currently disused turf farm has a groundwater abstraction licence for up to 176,000 kL/year and was abstracting groundwater (for irrigation purposes) from the deeper Leederville aquifer. Following application of irrigation water from the Leederville aquifer, it infiltrated downwards into the superficial aquifer and was being retained there. This is due to the presence of a layer of Kardinya Shale between the two aquifer systems, which impedes the downward movement of irrigation water from the superficial aquifer to the deeper Leederville aquifer, resulting in groundwater mounding in the superficial aquifer over the long term.

This artificial recharge of the superficial aquifer that is taking place in the pre-existing environment will cease to occur when the MRS amendment area is urbanised and now that operations at the turf farm have ceased. Therefore, any new artificial recharge that occurs following urbanisation is not expected to result in a significant increase in groundwater levels within the superficial aquifer. In the vicinity of the former turf farm, post development stormwater runoff can be managed to maintain the existing annual recharge in the area of the mound to retain groundwater flows and direction toward GBSW.

Given that the depth to groundwater within the MRS amendment area is already several metres below natural surface and it has been predicted that the physical process of urbanisation will not lead to a significant rise in groundwater levels, it is therefore not expected there will be any hydrological impacts on flora and vegetation within the MRS amendment area due to the proposed change in land use from Rural to Urban.

Furthermore, no significant residual impacts to wetlands and riparian vegetation, and groundwater dependent ecosystems within and nearby to the MRS amendment area (such as within the GBSW where there is shallow depth to groundwater that is associated with localised perched groundwater systems) because of changes to the current surface water and groundwater cycles are anticipated. The reasons for this are outlined in Section 5.5 of this ER.

6.6.2.3 Erosion and sedimentation

The MRS amendment area is relatively flat to gently undulating with elevation ranging from approximately 22 m AHD in the west to 36 m AHD in the east. Therefore, there is unlikely to be a significant reduction in surface level during construction associated with future potential urban development. Erosion impacts (such as sheet erosion) on flora and vegetation are therefore considered unlikely.

Notwithstanding this, appropriate actions to mitigate any potential impacts due to erosion will be addressed through the preparation, approval and implementation of CEMP(s) at subsequent phases of the planning process (i.e. subdivision and/or development) and during construction works for each stage of the development.

6.6.2.4 Dust deposition

Construction activities associated with the urbanisation of the MRS amendment area may generate fugitive dust emissions, which in turn may result in dust deposition impacts to native vegetation, including:

- Leaf damage through abrasion
- Blocking the stoma of plants
- Dust accumulation on leaves, limiting photosynthesis capability

Management measures to mitigate dust impacts can be addressed through the Environmental Management Framework which will require the preparation, approval and implementation of CEMP(s) at subsequent stages of the planning process (i.e. subdivision and/or development) and implemented during construction works (refer to Section 6.7).

6.6.2.5 Weeds and pathogens

Urbanisation can lead to the introduction and spread of weeds and pathogens, such as Dieback (*Phytophthora cinnamomi*), which can indirectly impact vegetation in the MRS amendment area.

The application of standard dieback management actions will minimise the potential introduction and/or spread of weeds and pathogens within the MRS amendment area. Implementation of these management measures will be done through the Environmental Management Framework which will require the preparation, approval and implementation of CEMP(s) at later phases of the planning process (i.e. subdivision and/or development) and during construction works for each stage of development.

Furthermore, the preparation and implementation of CAMP(s) during the development and post development phases of urbanisation, will minimise the potential introduction and/or spread of weeds and pathogens within the Conservation areas.

6.6.2.6 Uncontrolled vehicle and pedestrian access, littering, dumping and fire risk

With urbanisation comes an increase in population and in turn an increased risk of human activity, which can indirectly impact on areas containing conservation significant flora and vegetation.

The most common impacts of increased human activity include degradation to flora and vegetation as a result of uncontrolled vehicle and pedestrian access, as well as littering, dumping and increased fire risk. These same impacts can also be caused by construction personnel, vehicles, plant and equipment during construction activities associated with urban development.

Management measures to appropriately control and minimise the impacts of increased human activity, both during the development and post development phases, can be addressed through the CEMP(s) during the construction phase for each stage of development. Furthermore, the preparation and implementation of CAMP(s) during the development and post development phases of urbanisation will minimise the potential impacts of increased human activities within the Conservation areas (refer to Section 6.7).

6.6.3 Cumulative impacts

An assessment of cumulative impacts requires an understanding of the potential impacts from other present and reasonably foreseeable future actions, including related development projects and planning schemes that have been recently approved, or are subject to current proposals. A summary of the potential impacts from other proposals and planning scheme amendments in proximity to the MRS amendment area is provided in Table 6-14 and discussed below.

91.23 ha (72.6%) of the MRS amendment area has been historically cleared and the majority of remaining land has been significantly altered, comprising mostly of scattered native trees, planted trees, lawns and gardens. As a result, 97% of the MRS amendment area is in a Completely Degraded or 'Cleared' condition.

All remnant native vegetation (in Good or better condition), inclusive of all remnant patches of Banksia Woodlands TEC and probable FCT 20a, which makes up approximately 2.9% of the MRS amendment area, will be retained in Conservation areas.

Furthermore, all intact Southern River Complex and Forrestfield complex vegetation in good or better condition will be avoided, protected and managed.

The retention of these remaining patches of native vegetation will also facilitate the protection of two conservation significant flora taxa that are known to be present within the remnant vegetation – *Conospermum undulatum* (T) and *Isopogon autumnalis* (P3).

Of the 104-conservation significant flora identified within the MRS amendment area, there are:

- 76 *Conospermum undulatum* and 14 *Isopogon autumnalis* are located within Conservation
- 3 *Conospermum undulatum* and 1 *Isopogon autumnalis* are located within Potential Future Conservation
- 2 *Conospermum undulatum* and 2 *Isopogon autumnalis* located on Lot 803 and 804 Crystal Brook Road are mapped as being adjacent to Conservation but may have been potentially cleared
- 1 *Conospermum undulatum* and 1 *Isopogon autumnalis* located on Lot 804 Crystal Brook Road are mapped as being adjacent to Conservation
- 2 *Conospermum undulatum* located within Lots 8 and 9 Brentwood Road are presumed to be cleared given the extent of recent clearing that has taken place
- 1 *Isopogon autumnalis* located along the northern boundary of Lot 201 Crystal Brook Road and is adjacent to the road reserve.
- 1 *Isopogon autumnalis* located outside the MRS amendment area eastern boundary and is within a narrow strip of land between Tonkin Highway and the DBNGP corridor, which is owned by the Water Corporation and houses a water main. As such it will not be developed for urban uses.

As previously advised, the Conservation and Potential Future Conservation boundaries have potential to be extended following detailed design and further flora and vegetation surveys being undertaken (where site access has been limited). Given the number of individuals that occur within close proximity of the Conservation and Potential Future Conservation areas there will be opportunities through the Environmental Management Framework to ensure the final design and boundary of the Conservation areas will retain all remaining *Conospermum undulatum* (T) and *Isopogon autumnalis* (P3) within the MRS amendment area as part of future local structure planning, subdivision and/or development.

In light of the above, there will not be any cumulative impacts of significance to conservation significant flora and vegetation, as a result of the proposed change in land use from Rural to Urban.

Table 6-14: Cumulative impacts to flora and vegetation

Aspect	Wattle Grove Urban Expansion and Urban Investigation Areas	Tonkin Highway Grade Separated Interchanges (Hale Road to Welshpool Road)	Tonkin Highway Grade Separated Interchange (Kelvin Road)	Tonkin Highway, Guildford Road to Great Eastern Highway Upgrade (Tonkin Gap)	Maddington Kenwick Strategic Employment Area (MKSEA)	Roe Highway and Great Eastern Highway Bypass
Proponent	WAPC	MRWA	MRWA	MRWA	City of Gosnells	MRWA
Description	Urban expansion and investigation areas, identified in the WAPC's *North-East Sub-regional Planning Framework* (2018).	Upgrade of Tonkin Highway including additional traffic lanes, a fly-over at the intersection with Hale Road and a grade separated interchange at the intersection with Welshpool Road.	Upgrade and widening a 2 km section of Tonkin Highway from four lanes to six lanes and grade separated interchange at the intersection with Kelvin Road.	Upgrade of Tonkin Highway including additional traffic lanes, two additional bridges over the Swan River, and modification of Great Eastern Highway interchange.	Development of an industrial area. The MKSEA has been divided into Precincts 1, 2, 3A and 3B. The Local Planning Scheme amendments for Precincts 2 and 3B are subject to assessment by the EPA.	Construction of a grade separation at the intersection of Roe Highway and Great Eastern Highway Bypass and upgrade of Roe Highway between Kalamunda Road and Clayton Street, including a duplication of the bridge over Helena River.
Location	City of Kalamunda, to the east and south of the Wattle Grove South MRS amendment area.	City of Kalamunda along Tonkin Highway, from south of Roe Highway to approximately 1 km north of Kelvin Road.	City of Gosnells along Tonkin Highway, from approximately 1 km north of Kelvin Road extending south to Maddington Road.	City of Bayswater and City of Belmont along Tonkin Highway, between Guildford Road and Great Eastern Highway.	City of Gosnells bounded by Roe Highway, Welshpool Road, Tonkin Highway and Bickley Road.	City of Swan, City of Kalamunda and Shire of Mundaring along Roe Highway, between Great Eastern Highway and just south of Adelaide Street West.
Development Commencement	Yet to be initiated / seriously entertained	To be confirmed, subject to approvals	To be confirmed, subject to approvals	To be confirmed	To be confirmed, subject to approvals	Project on hold
EPA/EPBC Referral Decision	N/A	EPA – Assess EPBC – Controlled action (EPBC 2019/8529)	EPA – Assess EPBC – Controlled action (EPBC 2022/09325)	EPA – Assessment not required EPBC – Not a controlled action (EPBC 2019/8545)	EPA – Assess LPS Amendments Nos. 166 and 169 to City of Gosnells Local Planning Scheme No.6.	DWER – Clearing Permit CPS9448-1 EPBC – Controlled action (EPBC 2020/8784)
EPA/EPBC Assessment Status	N/A	Active EPA assessment Approved (EPBC)	Active EPA assessment Pending (EPBC)	EPA – N/A Approved (EPBC)	EPA active assessment	Project on hold
Potential Impacts to Conservation Significant Flora and Vegetation Relevant to the Wattle Grove MRS amendment area	The urban potential of these areas is subject to further detailed investigation prior to any MRS rezoning proposals being seriously entertained by the WAPC. The *North-East Sub-regional Planning Framework* advises that: *'Land classified Urban Expansion/ Investigation may contain significant environmental attributes and these classifications should not be construed as support for the development.'* To date the urban potential of these areas has not been seriously entertained by the WAPC.	Clearing of up to 14.8 ha of remnant native vegetation and 5.42 ha of highly modified native vegetation (20.22 ha). Clearing of up to 4.69 ha of Banksia Woodlands TEC. Clearing of up to 1.61 ha of FCT 20a - *Banksia attenuata* woodlands over species rich dense shrublands (WA TEC). Clearing of up to 62 individuals of *Conospermum undula*tum (T). Clearing of up to 7 individuals of *Isopogon autumn*alis (P3). Indirect impacts including the introduction and spread of dieback and weeds and alteration of fire regimes. Source: Environmental Review Document, Tonkin Highway Grade Separated Interchanges Hales Road and Welshpool Road (Main Roads WA, September 2022).	Clearing of 10.62 ha of native vegetation including up to 2.33 ha in Good or better condition, up to 1.13 ha in Degraded condition and up to 7.16 ha in a Completely Degraded condition. Clearing of up to 1.72 ha of FCT 20a - *Banksia attenuata* woodlands over species rich dense shrublands (WA TEC). Clearing of up to 210 individuals of *Conospermum undulatum* (T). Clearing of up to 5 individuals of *Isopogon autumnali*s (P3). Indirect impacts including the introduction and spread of dieback and weeds and alteration of fire regimes. Source: Section 38 EP Act Referral Supporting Document, Tonkin Highway Grade Separated Interchanges Kelvin Road (Main Roads WA, February 2022).	Clearing of up to 0.7 ha of native vegetation. Source: Section 38 EP Act Referral Supporting Document, Tonkin Highway Upgrade Guildford Road to Great Eastern Highway (Main Roads WA, September 2019).	Clearing of up to 9.56 ha of native vegetation including 1.1 ha in Good or better condition. Clearing of up to 0.07 ha of Banksia Woodlands TEC. Source: Environmental Review Document, City of Gosnells Town Planning Scheme No.6 Amendments 166 and 169 (Emerge, May 2023).	Clearing of up to 18.9 ha of Banksia Woodlands TEC. Clearing of approximately 9.49 ha of FCT20a - *Banksia attenuata woodland over species rich dense shrublands* (WA TEC). Clearing of up to 3 individuals of *Conospermum undulatum* (T). Clearing of up to 112 individuals of *Isopogon autumnalis* (Priority 3). Sources: Environmental Review Document, Tonkin Highway Grade Separated Interchanges Hales Road and Welshpool Road (Main Roads WA, September 2022). EPBC Act Referral 2020/8774 – Roe Highway and Great Eastern Highway Bypass Grade Separation Interchange, Hazelmere WA (Main Roads, Sep 2020).

6.7 Mitigation

With reference to the EPA mitigation hierarchy, it is considered that the potential direct impacts to remnant native vegetation and conservation significant flora within the MRS amendment area, because of the proposed change in land use (i.e. clearing), can be predominantly avoided through retention of any remaining areas of intact native vegetation in Good or better condition to be placed within Conservation areas. The Environmental Management Framework and the sequential planning framework will require future local structure planning and subdivision applications set aside these areas for conservation, as well require the preparation, approval and implementation of CAMP(s) and thereby ensuring that potential direct impacts and clearing of these remaining areas of intact native vegetation is avoided.

The further potential for incidental or accidental clearing during construction activities as well as any potential indirect impacts of the proposed change in land use will also be avoided and minimised through the Environmental Management Framework and the sequential planning framework as the well as the WAPC model subdivision schedule (DPLH 2024b) which has standard conditions requiring the preparation and approval of CEMP(s) post subdivision approval, and then implemented during construction works.

These proposed management measures are described in the following sections.

6.7.1 Retention of remnant native vegetation and conservation significant flora

Areas of remnant native vegetation within the MRS amendment area are physically separated from other areas of native vegetation within the surrounding region by existing development and infrastructure, including Tonkin Highway and Welshpool Road, which act as significant physical barriers.

Furthermore, the remaining small areas of native vegetation within the MRS amendment area have also been subject to localised fragmentation, due to the historical clearing and development that has occurred within the MRS amendment area itself. Local ecological and habitat connectivity has already been significantly compromised by this existing fragmentation.

To avoid further impacts occurring as a result of the proposed change in land use, all remnant native vegetation (in Good or better condition) within the MRS amendment area will be retained in Conservation areas. It is worthwhile to note that most of the degraded BaEpPf patch located on Lot 2 Victoria Road is proposed to be included in conservation, as it has not been subject to detailed ecological survey to discount its conservation significance, given its connectivity to the area of Excellent condition BaEpPf vegetation located on Lot 254 and that *Conospermum undulatum* was visible and flowering within Lot 2 close to the common boundary of the two lots.

Subsequently, this area has been identified as Potential Future Conservation and Rehabilitation, with the final boundary to be defined following detailed surveys and development design to ensure all conservation significant flora and vegetation is retained, conserved, rehabilitated and managed for the long term.

The remaining patch of degraded BmXpEc (Banksia Woodlands) mapped on Lot 8 Brentwood Road occupies a very small area (0.05 ha). Whilst it is degraded given the assignment of the adjacent vegetation within the former AECOM quadrat (Q9) on Lot 9 (which has now been cleared) as probably being FCT 20c, this remaining patch has also been identified as Potential Future Conservation requiring further detailed flora and vegetation survey to determine the probable FCT.

Table 6-15 sets out the vegetation communities that will be retained in Conservation.

Table 6-15: Vegetation communities to be retained in conservation

Vegetation community	Extent within MRS amendment area	Conservation	Potential Future Conservation and Rehabilitation	Total area and percentage (Conservation and Potential Future Conservation and Rehabilitation)
BaEpPf	4.23 ha	3.41 ha	0.74 ha	4.15 ha (98% of BaEpPf area)
BmXpEx	0.28 ha	0.15 ha	0.05 ha	0.20 ha (71% of BmXpEx area)
EmMpLp	0.05 ha	0.05 ha	0.0 ha	0.05 ha (100% of EmMpLp area)
Total	4.56 ha	3.61 ha	0.79 ha	4.40 ha (96% of total remnant vegetation area)

The retention of these native vegetation communities within conservation and road reserves under the care and management of the City of Kalamunda will provide a higher level of management and protection than the current situation whereby they are located within private and unmanaged rural residential allotments.

The retention of all remnant vegetation will in turn also facilitate the retention of *Conospermum undulatum* (T) and *Isopogon autumnalis* (P3) that are located within (or immediately adjacent to) the remnant vegetation patches that have been earmarked for retention within Conservation areas.

One further individual of *Isopogon autumnalis* (P3) is located on a narrow strip of land between Tonkin Highway and the DBNGP corridor, which is owned by the Water Corporation and houses a water main and is not at risk of being cleared for urban uses.

Furthermore, the Environmental Management Framework will require that any subdivision or development proposals for the eight unsurveyed lots or the 13 lots surveyed from the boundary of adjacent lots be accompanied by a suitable flora and vegetation field survey at the time of application. This will ensure that the presence of any significant flora or vegetation within these lots is appropriately identified and is retained within Conservation areas.

6.7.1.1 Conservation area design and shape in an urban setting

Table 6-16 sets out the EPA (2021d) *Guidance for planning and development: Protection of naturally vegetated areas in urban and peri-urban areas* and demonstrates:

- how the current configuration for the Conservation and Potential Future Conservation and Rehabilitation areas integrates EPA (2021d) design guidelines in order to avoid, minimise and rehabilitate impacts on the naturally vegetated areas within the MRS amendment area
- the mechanisms that will be implemented through the Environmental Management Framework and the subsequent levels of planning to ensure the Conservation and Potential Future Conservation and Rehabilitation areas will be established and managed for the long term as part of future local structure planning, subdivision and/or development of the MRS amendment area.

Table 6-16: Design guidelines on retaining naturally vegetated areas in an urban environment (EPA 2021)

Design guidance	Urban development response	Implementation mechanisms
Avoiding impacts to naturally vegetated areas		

Locate development on existing cleared land	• Urban development will be located on existing cleared land as approximately 96% of the MRS amendment area is highly modified and/or cleared due to historical clearing and development that has already taken place.	As per the Environmental Management Framework and the sequential planning framework, the following is required to be undertaken to ensure naturally vegetated areas within the MRS amendment area are set aside for conservation:
		• Retention of all remnant patches of vegetation communities BaEpPf, BmXpEc and EmMpLp (in Good or better condition), containing conservation significant flora and/or high-quality foraging habitat for all three black cockatoos in areas.
		• Retention and rehabilitation of vegetation and conservation significant flora in areas identified as Potential Future Conservation and Rehabilitation, with the final boundary to be determined following detailed flora surveys and development design.
		• Any applications to subdivide or develop land that was not previously the subject of onsite surveys for flora, vegetation and fauna at the date of the Minister for Environment's decision on Assessment No. 2335 must include an onsite survey of flora, vegetation and fauna (in accordance with EPA guidance) to be submitted:
		  ○ As the time of the subdivision or development application, or
		  ○ As part of a Local Structure Plan preceding the application.
		
		As per the Environmental Management Framework and the sequential planning framework, the following management strategies are required to be undertaken at Local Structure Plan stage:
		• An LSP map that designates the retention of all remnant patches of vegetation communities BaEpPf, BmXpEc and EmMpLp (in Good or better condition), containing conservation significant flora and/or high-quality foraging habitat for all three black cockatoos, for Conservation purposes.
		• CAMS
		• TCRLMS

Protect large blocks of naturally vegetated areas	• All areas of remnant native vegetation (in Good or better condition) within the MRS amendment area will be retained. These areas reflect the largest areas of remnant vegetation within the MRS Amendment area and have been selected on the basis that they provide the greatest habitat value within the site and will be subjected to the least amount of degradation/loss of condition if proposed for retention compared to lower condition/smaller patches. • Where possible, the Conservation area boundaries have been rationalised to reduce the edge to area ratio. • Conservation areas will be buffered by hardstand areas/roads. These hard-edge buffers will serve to deter edge effects by reducing weed introduction and maintaining the integrity of the good condition vegetation as it currently stands. Further, the addition of public roads/pathways around the conservation areas serves to reduce potential impacts from unwanted human activity within the conservation areas.	
Infrastructure should not be within retained naturally vegetated areas	• No services and infrastructure (including roads and transport corridors) are proposed within or through the Conservation areas.	
Retain naturally vegetated areas in locations prone to degradation	• The MRS amendment area is relatively flat to gently undulating with elevation ranging from approximately 22 m AHD in the west to 36 m AHD in the east. Initial feasibility studies done on future earthwork requirements to facilitate urban development indicate there will be minimal cut and fill requirements and there is unlikely to be a significant reduction in surface level during construction associated with future potential urban development. Erosion impacts (such as sheet erosion) on flora and vegetation are therefore considered unlikely. • Additionally, all areas of intact remnant vegetation (in Good or better condition) will be conserved and managed for the long term, thereby reducing the risk of land degradation.	

Design guidance	Urban development response	Implementation mechanisms
Avoid inappropriate development in bushfire-prone areas	• The MRS amendment area is in a bushfire prone area, consistent with SPP 3.7 and associated guidelines future development will ensure that all necessary bushfire protection measures are accommodated within the development area and will not place reliance or impositions on the management of the Conservation areas.	As per the requirements of SPP 3.7 and associated guidelines a Bushfire Management Plan will be required to support the Local Structure Plan.
Minimising impacts to naturally vegetated areas		
Locate and manage land uses and development around retained naturally vegetated areas to avoid or minimise adverse impacts	• The area surrounding the remaining naturally vegetated areas within the MRS amendment area is already highly modified. Retention of these naturally vegetated areas within Conservation and implementation of interface management (i.e. fencing, weed control, etc) and hard-edge buffers such as hardstands/roads will provide a higher level of management and protection than what is currently provided. • During construction, all machinery and vehicles will be clean prior to entering the MRS Amendment area, reducing the potential spread of dieback, weeds or other contaminants. • Future development design (through LSP, subdivision and/or development) and long-term management of these Conservation areas (through implementation of a CAMP) will ensure potential impacts are avoided and/or minimised.	The following is to be submitted and approved with all applications for the subdivision of land: • A plan of subdivision that designates any remnant patches of vegetation communities BaEpPf, BmXpEc and EmMpLp (in Good or better condition) on the land for Conservation purposes. • A CAMP for any Conservation areas and Potential Future Conservation and Rehabilitation within the subdivision area. The plan will address: o Rehabilitation and weed control. o Fencing and any other measures required to limit public access. o TECs or conservation significant flora requirements. o Terrestrial fauna habitat requirements. o Erection of educational signage o Requirements for ongoing environmental management and maintenance. • A TCRLMP that confirms: o The location of existing trees to be removed. o The location, species, size and structural health of trees to be retained. o The location of new trees and planting schedule, including species, number of trees planted, planting size, mature height and spread. o The percentage of canopy coverage achieved. • Prepare and implement a CEMP for all subdivision works within 100 m of remnant patches of vegetation communities BaEpPf, BmXpEc and EmMpLp (in Good or better condition), conservation
Consider the impact of bushfire protection requirements on biodiversity	• Future development design will ensure that all necessary bushfire protection measures are accommodated within the adjacent development area and will not place reliance or impositions on the management of the Conservation areas. • Hard-edge buffers around retained bushland areas will increase hazard separation. • Bushfire mitigation measures will be implemented through the CAMP to reduce the risk of fire within the Conservation areas.	
Minimises impacts to naturally vegetated areas through site responsive design	• All areas of intact remnant vegetation (in Good or better condition) will be retained in Conservation areas. The MRS amendment area is relatively flat to gently undulating. • Initial feasibility studies done on future earthwork requirements to facilitate urban development indicate there will be minimal cut and fill requirements, and highly likely that substantial areas of remnant trees will be retained within the MRS amendment area	
Ensure retained naturally vegetated areas are connected to	• One regionally mapped ecological linkage is located at the north-westernmost extent of the MRS Amendment area (Link ID: 40), connecting the GSW and the Hartfield Road Bushland. The small extent of the regional ecological linkage that is within the MRS Amendment area (over portions of Lot 146 Welshpool Road East	

Design guidance	Urban development response	Implementation mechanisms
other naturally vegetated areas via ecological linkages	and Lot 12 Brentwood Road) has been mostly cleared and is therefore no longer functioning as an ecological linkage. • Surviving areas of naturally vegetated areas are already highly fragmented by historical clearing and development. These areas are small and make up approximately 3.6% of the MRS amendment area. The retention of all areas of intact remnant vegetation (in Good or better condition) within Conservation along with the implementation of the CAMP will ensure that no further fragmentation of the surviving areas of intact remnant native vegetation occurs within the MRS amendment area. • A Tree Canopy Retention and Landscaping Management Strategy and subsequent Management Plan will be implemented and will include locations for replanting that provide for an even distribution of trees across the MRS amendment area, thereby creating a local ecological linkage between the Conservation areas and retained Black cockatoo habitat. • Therefore, the urbanisation of the MRS Amendment area will not impact the regionally mapped ecological linkages within the amendment area, and ultimately implementation of the Tree Canopy Retention and Landscape Management Strategy will likely enhance the ecological linkage characteristics throughout the MRS amendment area.	significant flora and black cockatoo habitat identified for retention. The plan will address: ○ Weeds and pathogen management. ○ Fauna management. ○ Access management (preventing access during construction). ○ Dust management. Applications for the subdivision of land (and the endorsement of subsequent plans and diagrams of survey) and/or Development Applications will be conditional upon: • The designation of all remnant patches of vegetation communities BaEpPf, BmXpEc and EmMpLp (in Good or better condition) for Conservation purposes. • The preparation, approval and implementation of CAMP(s), TCRLMP(s) and CEMP(s). As per the requirements of SPP 3.7 and associated guidelines a Bushfire Management Plan will be required to support the applications for the subdivision and/or development of land.
Ensure clear and ongoing management responsibilities in retained naturally vegetated areas	• Implementation of the CAMP as condition of subdivision and/or development will ensure the long-term conservation and management of the naturally vegetated areas as well provide clear and ongoing management roles and responsibilities. • Furthermore, placing these vegetated areas in Conservation and under the care and management of the City of Kalamunda will provide a higher level of management and protection than the current situation whereby they are located within private and unmanaged rural residential allotments	
Rehabilitation of naturally vegetated areas		
Restore the ecological function of impacted naturally vegetated areas	• Future rehabilitation is proposed within disturbed areas that are known and/or suspected to contain conservation significant flora and are adjacent to intact areas of vegetation that are being set aside and retained for Conservation and Potential Future Conservation and Rehabilitation (Figure 6-3, Figure 6-5 and Figure 6-6). The primary purpose of restoring the ecological function of these areas is to assist with the long-term conservation of the intact native vegetation within Conservation and conservation significant flora. • Rehabilitation will include weed control, feral pest management, unwanted access restrictions, buffer implementation and revegetation.	• A CAMP for any Conservation areas and Potential Future Conservation and Rehabilitation within the subdivision area. The plan will address: ○ Weed and pathogen control. ○ Rehabilitation program ○ Fencing and any other measures required to limit public access. ○ TECs or conservation significant flora requirements. ○ Terrestrial fauna habitat requirements.

Design guidance	Urban development response	Implementation mechanisms
	• Rehabilitation will also seek to maintain TEC vegetation in Good or better condition. Should further survey with the areas identified Potential Future Conservation and Rehabilitation confirm the presence of TEC vegetation in degraded condition, then Rehabilitation will seek to retain and restore TEC vegetation so that vegetation condition rating of Good or better is achieved. • Extensive surveys have been undertaken of the proposed conservation areas, where restoration efforts will be focussed. This will track progress towards completion targets and ensure that ecological function of an area is being increased.	○ Erection of educational signage ○ Requirements for ongoing environmental management and maintenance.
Maximise ecosystem services	As part of the preparation and implementation of a CAMP, a rehabilitation program will be included that maximises ecosystem services by: • selecting locally native species where appropriate • using structurally diverse plantings • selecting species with a variety of flowering and fruiting times • planting known food plants for native fauna species	
Enlarge or connect existing naturally vegetated areas	Adjacent to the northern and southern Conservation areas, additional areas for Potential Future Conservation and Rehabilitation have been identified that will potentially extend the Conservation areas to ensure the long-term conservation and management of TECs, fauna habitat and conservation significant flora.	

With respect to the provision of site-specific buffers to retained vegetation and conservation significant flora, given the areas adjacent to the intact native vegetation have been highly modified and is either cleared or in completely degraded condition, the high-level design response for the Conservation and Potential Future Conservation and Rehabilitation areas has been influenced by the following factors:

Bushfire management

Consistent with SPP 3.7 and associated guidelines, future development will be required to ensure that all necessary bushfire protection measures are accommodated within the development area and will not place reliance or impositions on the management of the Conservation areas.

Adjoining land use

Most of the land adjacent to the retained vegetation is highly modified and subject to the existing land uses which is primarily semi-rural in nature and therefore, is not proposed to be included within a buffer which would extend around the entire Conservation area(s) containing vegetation (in Good or better condition) and/or conservation significant flora. That is, with exception to areas that are adjacent to the northern and southern Conservation areas and contain some isolated conservation significant flora and degraded vegetation communities. These have been included as Potential Future Conservation and Rehabilitation with the final boundary to be defined following detailed flora surveys and development design to ensure the final Conservation area boundary being appropriately defined to ensure the long-term conservation and management of TECs and conservation significant flora.

Interface management

Future development design will utilise hard edges (such as roads and/or conservation fencing) to act as a buffer between the Conservation areas and adjacent proposed residential land uses. Given the remaining vegetation has maintained a Good or better vegetation condition rating, the provision of hard edges, instead of a vegetated buffer that will require intensive revegetation and weed control over many years due to its current highly modified state, is considered appropriate and will reduce the risk of introducing weeds into the Conservation area and potentially causing significant impacts on the TEC vegetation and conservation significant flora.

6.7.2 Management strategy and plans

It is further recommended that the environmental values of the remnant native vegetation and conservation significant flora identified for retention be enhanced through the preparation, approval and implementation of the following strategies and management plans during later stages of the planning process, and during and after development has occurred.

6.7.2.1 Conservation area management

The CAMS will establish at the local structure plan stage the objectives and information that each CAMP will be required to address and implement the following during the subdivision or development within the MRS amendment area:

- Physical delineation of areas of remnant native vegetation to be retained (e.g. fencing)
- Limiting access to and within the areas of retained remnant native vegetation
- Weed and pathogen control
- Rehabilitation program to:
    - manage TEC vegetation in Good or better condition
    - restore TEC vegetation in degraded condition so that the vegetation condition rating of Good or better is achieved (should further survey with the areas identified Potential Future Conservation and Rehabilitation confirm the presence of TEC vegetation).
- Bushfire prevention
- Fauna and pest management
- Waste management, including uncontrolled littering and dumping
- An assessment of the potential risks to environmental values and the effectiveness of the proposed management measures
- An environmental monitoring program to assess the success of the management measures
- Trigger criteria for the implementation of contingency actions
- Roles and responsibilities
- Indicative timeframes for the implementation of the above management measures

The overarching objective of the CAMS and subsequent CAMP(s) will be to provide a framework and on ground mechanism to protect and enhance the biodiversity values of the conservation area.

Table 6-17 provides a broad outline of the framework that will be used to inform the preparation of the CAMS and subsequent CAMP(s).

Table 6-17: Framework for Conservation Area Management Strategy and Plan

Parameter	Management actions		Target	Monitoring	Reporting	Environmental Outcome
	CAMS	CAMP				
Delineation and access management	Define conservation area boundary during detailed design at LSP stage	Physical delineation of areas of remnant native vegetation to be retained (e.g. fencing)	To ensure no clearing of vegetation within conservation area.	• Pre clearing site inspection • Monthly site inspections (during construction) • Quarterly site inspection (post construction) and for remainder of Management Plan implementation	Annual audit reporting.	Will ensure the long-term protection and management of the conservation area and prevent its significant ecological attributes being degraded as a result of unapproved clearing and unmitigated vehicle and pedestrian access.
	Define location and type of fencing, gates and signage to be installed around conservation area.	Install and maintain appropriate fencing around the periphery of the conservation area and lockable gates at appropriate locations to enable vehicle access when required.	To prevent unauthorised vehicle and pedestrian access to the conservation area.	• Pre clearing site inspection • Monthly site inspections (during construction) • Quarterly site inspection (post construction) and for remaining duration of Management Plan implementation	Annual audit reporting.	
		Install and maintain signage on periphery fencing detailing access and presence of conservation area.	Increase awareness that conservation area is a restricted access reserve containing significant vegetation and discourage unauthorised access	• Quarterly site inspection (post construction) and for remainder of Management Plan implementation	Annual audit reporting.	
Threatened Ecological Communities	Establish recovery actions to be implemented to ensure the overall maintenance or improvement of TECs within the conservation area	Verify and monitor occurrences of TECs	To ensure known occurrences are maintained or improved within conservation areas.	• Pre clearing site inspection • Monthly site inspections (during construction) • Annual monitoring and site inspection (post construction) and for remaining duration of Management Plan implementation	Annual audit reporting.	Will ensure the long-term protection, management and restoration (if required) of TECs and prevent decline as a result of threatening process such as weed and/or pest invasion, unapproved clearing, unmitigated vehicle and pedestrian access.
		Restore occurrences of TECs in Degraded condition to achieve condition rating of Good or better.	To ensure known degraded occurrences are restored within conservation areas (see below revegetation management actions, targets, etc.)	• Pre clearing site inspection • Monthly site inspections (during construction) • Annual monitoring and site inspection (post construction) and for remaining duration of Management Plan implementation	Annual audit reporting.	
		Install and maintain signage on periphery fencing detailing access and presence of TEC in conservation area	Increase awareness that conservation area is a restricted access reserve containing TECs and discourage unauthorised access	• Quarterly site inspection (post construction and for remainder of Management Plan implementation	Annual audit reporting.	
Conservation significant flora • ***Conospermum undulatum* (T)** • ***Isopogon autumnalis* (P3)**	Establish recovery actions to be implemented to ensure the total number of conservation significant flora is maintained or increased within the conservation area	Monitor populations of conservation significant flora	To ensure populations of conservation significant flora are maintained or increased within conservation area	• Pre clearing site inspection • Monthly site inspections (during construction) • Annual monitoring and site inspection (post construction) and for remaining duration of Management Plan implementation	Annual audit reporting.	Will ensure the long-term protection and management of conservation significant flora and prevent species decline as a result of threatening process such as weed and/or pest invasion, unapproved clearing, unmitigated vehicle and pedestrian access.
		Install and maintain signage on periphery fencing detailing access and presence of conservation significant flora in conservation area.	Increase awareness that conservation area is a restricted access reserve containing conservation significant flora and discourage unauthorised access	• Quarterly site inspection (post construction and for remainder of Management Plan implementation	Annual audit reporting.	
Weed and pathogen control	Establish weed and pathogen management measures to be implemented to minimise potential introduction and spread of new weeds and pathogens within the conservation area.	Prior to entering the conservation area, all vehicles and machinery are to be free of mud and soil that may have been brought onto site from outside the MRS amendment area.	Prevent the introduction of new weed species and pathogens into the conservation area.	• Inspection of vehicles and machinery entering the conservation area	Records of clean machinery will be presented in annual audit reports, where machinery has accessed the MRS Amendment area during the previous year.	Implementation of weed and dieback measures will ensure significant ecological attributes within conservation area are protected in the long term by:

Parameter	Management actions		Target	Monitoring	Reporting	Environmental Outcome
	CAMS	CAMP				
		Develop weed control and monitoring program.	Ensure effective weed control is undertaken and that weed densities do not increase above established % cover.	• Annual assessment of distribution, species and density/cover of weed species for duration of Management Plan	Reports will be available after each weed control event and will be summarised and compiled during annual audit reporting.	• reducing weeds within conservation area • preventing any new weeds and pathogens being introduced into the conservation area.
		Establish and implement hygiene procedures.	Ensure adequate hygiene conditions to prevent introduction of new weed species and pathogens within the conservation area.	• Annual assessment of distribution, species and density/cover of weed species for duration of Management Plan	Annual audit reporting.	
Fauna and pest management	Establish fauna and pest management measures to increase habitat quality and availability within the conservation area.	Undertake pest fauna control / removal (if required)	To mitigate impacts of herbivory on conservation significant flora and revegetation activities. No pest species present within conservation areas.	• Annual assessment of revegetation success will record incidence of herbivory.	Annual audit reporting.	Increasing the overall fauna habitat available within the MRS Amendment area. Reducing the impacts of feral species on endemic fauna survival. Providing fauna habitat that is secured and maintained as a conservation area.
		Translocation of hollow bearing logs into the conservation area.	To increase the availability and quality of native fauna habitat.	• No active monitoring of hollow bearing logs is proposed at this stage.	-	
	Establish black cockatoo management measures to enhance their habitat within the conservation area.	Revegetation and landscaping within the conservation area with suitable endemic native species will be undertaken to provide foraging habitat for black cockatoos.	Increase available foraging habitat for black cockatoos.	• Annual monitoring will be undertaken for revegetation sites	Annual audit reporting,	
		Install educational signage regarding black cockatoo species ecology and habitat within conservation areas.	To reduce impacts of increased human activity within the MRS amendment area on black cockatoos.	• Annual monitoring will check the condition of signage and confirm condition/ replacement requirements		
	Reduce access for pest species to conservation areas.	Install and maintain conservation fencing to protect vegetation from herbivory and endemic fauna from feral animals.	To reduce the potential harm of feral animals within conservation areas to native flora and fauna.	• Fencing condition assessment will be undertaken annually	Annual audit reporting.	
Revegetation (if required in degraded TEC vegetation within Potential Future Conservation and Rehabilitation; see Conservation Concept Plan - Figure 13-2)	Establish revegetation measures to be undertaken	Undertake seed collection from adjacent intact TEC vegetation within conservation areas	Seed collection of revegetation species to be undertaken at appropriate time.	• Annual revegetation success monitoring.	Annual audit reporting.	Increasing biodiversity, without loss of genetic diversity.
		Identify boundaries to be implemented.	Prior to revegetation, confirm revegetation location is suitable to reduce risk of stock not establishing or causing disruption to currently present ecosystem.			
	Establish revegetation completion criteria	Implement planting and monitoring schedule to align with completion criteria objectives	Completion criteria are achieved within desired timeframe.	• Annual revegetation success monitoring, with corrective strategies implemented when required.	Annual audit reporting.	Ensuring establishment of appropriate revegetation species, therefore increasing biodiversity and ecological value.
Bushfire	Establish bushfire mitigation measures to reduce the risk of fire within the conservation area.	Store all flammable materials as specified by manufacturer's instruction at minimum 50 m from boundary of conservation area.	No incidental bushfires are caused.	• Annually, as development stages progress	Nil, unless a bushfire occurs.	Ensures maintenance of natural bushfire cycles, promoting species natural regeneration cycles and

Parameter	Management actions		Target	Monitoring	Reporting	Environmental Outcome
	CAMS	CAMP				
	Undertake bushfire management controls at appropriate times.	Prohibit vehicle movements within the conservation area during increased fire risk or total bans.				limiting the destruction of species beyond levels where establishment can occur.
	Reduce risk of bushfires occurring during clearing works.	Vegetation stockpiles to be stored at minimum 50 m from boundary of conservation area.				
	Maintain fire access tracks and footpaths.	Undertake vegetation clearing in line with requirements under the City of Kalamunda Fire Hazard reduction Notice.	Bushfire risk is not exacerbated with increased housing density requirements.	• Annual monitoring in line with DFES recommended vegetation clearing schedule for bushfire management	Nil.	Reduces potential risk of bushfire frequency occurring beyond natural cycles.

6.7.2.2 Tree canopy retention and landscaping

The City of Kalamunda has developed an Urban Forest Strategy (UFS) which provides guidance on the protection, management and growth of the urban forest across the City.

Broadly the UFS goals are to (City of Kalamunda 2023):

- Protect the City's urban forest on public and private land
- Grow the urban forest on public and private land through new tree plantings to maximise the social, economic and environmental benefits of trees and urban greening.
- Engage with community, research institutions, schools, government and private sector to care for the urban forest and broaden the understanding of the benefits it provides.
- Investigate new resourcing and research opportunities to enable further investment in on-ground actions using best practice science to manage and grow the urban forest.

The above goals provide a holistic and strategic approach to achieving our target, to protect and plant enough trees to grow the City's urban canopy cover to an aspirational goal of 30% (at maturity) by 2043 across the City (City of Kalamunda 2023).

With regard to new Urban development, the UFS identifies the Wattle Grove MRS amendment area as a case study and has set a UFS target of 20% canopy cover (at maturity).

The Tree Canopy Retention and Landscaping Management Strategy (TCRLMS) will establish at the local structure plan stage the objectives and information that each Tree Canopy Retention and Landscaping Management Plan (TCRLMP) will be required to address the following and be implemented as part of subdivision and/or development within the MRS amendment area:

- City of Kalamunda UFS
- Achieve a minimum canopy target of 20%, which will be contingent on:
    - water availability
    - bushfire management
    - local government support and incentives
    - land developer incentives (garden packages including trees)
    - resident engagement and education
- Ensure tree canopy analysis identifies existing canopy values, and includes a survey of all existing trees on the relevant lot(s)
- Identify which trees will be retained and removed as a result of the subdivision or development proposal, prioritising the retention and revegetation of Black cockatoo habitat trees
- Demonstrate how development design has avoided impacts on trees suitable for retention (through the location of public open space, road reserves, pedestrian access ways and drainage design) to ensure their viability within an urban landscape
- Demonstrate how the impact of any required clearing will be mitigated based on pre and post development canopy values
- Demonstrate how the minimum tree canopy coverage post subdivision or development will be achieved
- Identify measures that will be used to protect trees identified for retention during development and subdivision works (i.e. tree protection zones, tree labelling, physical barriers being erected and maintained through construction, etc)
- Establish tree and landscape maintenance requirements post planting.

6.7.2.3 Construction management

The CEMP(s) will address the following during the construction phase of future development:

- Clear demarcation and fencing of all remnant vegetation, individual trees and conservation significant flora identified for retention, prior to the commencement of construction works
- Erosion and sediment control
- Dust control
- Weed and pathogen control
- Bushfire prevention
- Waste management, including uncontrolled littering and dumping
- Inductions to educate construction personnel on the above management measures.

6.7.3 Approved conservation advice for the Banksia Woodlands of the Swan Coastal Plain

The conservation objective of this advice is to '*mitigate the risk of extinction of the Banksia Woodlands of the Swan Coastal Plain ecological community and help recover its biodiversity and function'* (TSSC 2016).

The advice outlines three key actions to achieve this conservation objective being:

- Protect the ecological community to prevent further loss of extent and condition.
- Restore the ecological community within its original range by active abatement of threats, revegetation and other conservation initiatives.
- Communicate with and support researchers, land use planners, landholders, land managers, community members, including the Indigenous community, and others to increase understanding of the value and function of the ecological community and encourage their efforts in its protection and recovery.

The recommended management measures for remnant native vegetation in the MRS amendment area will achieve these key actions and in turn contribute to the conservation of the Banksia Woodlands of the Swan Coastal Plain TEC through:

- Retention of all remnant patches of this TEC within Conservation areas
- Management of the potential indirect impacts of urbanisation on the TEC through the implementation of CAMP(s) and CEMP(s).

6.7.4 Recovery Plan for Banksia attenuata woodlands over species rich dense shrublands (FCT 20a)

The objective of the interim recovery plan is '*to maintain and maintain or improve the overall condition of the Banksia attenuata woodlands over species rich dense shrublands in the known locations*' (DPaW 2016).

Table 6-18 addresses the relevant recovery actions for FCT 20a and demonstrates that implementation of the MRS amendment and the conservation measures proposed will achieve the overall objective of the Recovery Plan and contribute towards the increasing the occurrences of FCT 20a within the conservation estate.

Table 6-18: Relevance to the interim recovery plan for FCT 20a

Recovery action (DPaW 2016)	Relevance to MRS amendment and future conservation
Liaise with stakeholders to implement recovery	As part of the CAMS (to be prepared at LSP stage) and subsequent CAMP (to be prepared and implemented at subdivision/development stage), liaison will be undertaken with DBCA and the City of Kalamunda to ensure the management actions will ensure FCT 20a is adequately protected within the conservation areas.
Seek to minimise further clearing of the community	Implementation of the MRS amendment will result in all occurrences of FCT 20a being retained and protected within the conservation areas. Thereby, minimising the further clearing of the community.
Verify occurrences as required	All 3 remaining areas of intact remnant vegetation (in Good or better condition) within the MRS amendment area have been surveyed and the probable FCT 20a has been assigned using DBCA (2024) Methods for survey and identification of Western Australian threatened ecological communities.
Continue to monitor the extent and boundaries of occurrences	Where occurrences of FCT 20a within the MRS amendment are retained, regular monitoring and annual reporting via the CAMP. Annual reporting will include annual monitoring of condition to ensure the occurrences are being maintained and not declining in condition.
Implement weed control and rehabilitation as required	The CAMP will include and implement weed control measures within the conservation area, and in line with the following protocol: 1) Determine which weeds are present and develop a prioritised weed control program 2) Select appropriate herbicides 3) Control invasive weeds by hand removal or spot spraying as the herb layer is an integral part of this plant community and care will be taken to minimise disturbance of native herbs The CAMP will also include a rehabilitation program that will be tailored to increase the extent as well as improve the overall condition of the FCT 20a within the conservation areas.
Develop and implement a fire management strategy	The CAMP will include appropriate bushfire management measures to be implemented within the conservation areas. Furthermore, site specific Bushfire Management Plans will be required as part of local structure planning, subdivision and/or development.
Implement disease hygiene procedures	The CAMP will establish and implement hygiene procedures to prevent introduction of pathogens within the conservation area.
Seek long term protection of the community for conservation	Implementation of the MRS amendment will result in all occurrences of FCT 20a being retained and protected within the conservation areas. Further, implementation of the CAMP will facilitate their on-ground management and thereby, ensure their conservation for the long term.

6.7.5 Recovery plan for *Conospermum undulatum*

The objective of the recovery plan is to maintain or improve the conservation status of *Conospermum undulatum* during the term of this plan by abating identified threats to populations (DEC 2009).

Table 6-19 addresses the relevant recovery actions for *Conospermum undulatum* and demonstrates that implementation of the MRS amendment and the conservation management measures proposed will achieve the overall objective of the Recovery Plan and contribute towards improving its conservation status.

Table 6-19: Relevance to the Recovery Plan for *Conospermum undulatum*

Recovery action (DEC 2009)	Relevance to MRS amendment and future conservation
Monitor populations	Where populations of *Conospermum undulatum* within the MRS amendment are retained, regular monitoring and annual reporting via the CAMP will record occurrences of the species and whether they are being maintained / improved and are not declining.
Liaise with relevant land managers regarding management of bushland containing *Conospermum undulatum*	As part of the CAMS (to be prepared at LSP stage) and subsequent CAMP (to be prepared and implemented at subdivision/development stage), liaison will be undertaken with DBCA and the City of Kalamunda to ensure the management actions will ensure the populations of *Conospermum undulatum* are adequately protected within the conservation areas.
Fence subpopulations	Fencing the conservation area or populations of *Conospermum undulatum* will be included as part of the on-ground management for each conservation area, where required.
Undertake weed control	The CAMP will include and implement weed control measures within the conservation area, and in line with the following protocol: 4) Determine which weeds are present and develop a prioritised weed control program 5) Select appropriate herbicides 6) Control invasive weeds by hand removal or spot spraying around *Conospermum undulatum* plants when weeds first emerge
Develop and implement a rabbit control strategy	The CAMP will include and implement pest control measures, including rabbit control within the conservation area.
Assess development applications for lands containing *Conospermum undulatum*	The Environmental Management Framework sets out the future requirements for Local Structure Plan, subdivision and development applications which will ensure DBCA continue to assess future proposals for lands for lands containing *Conospermum undulatum* and participate in environmental impact assessment and statutory planning processes.
Increase area of Conospermum undulatum in the conservation estate	Implementation of the MRS amendment will result in occurrences of *Conospermum undulatum* being retained and protected within the conservation areas. Thereby, leading to the area of *Conospermum undulatum* in the conservation estate being increased.
Conduct further surveys	Past surveys undertaken by AECOM (2020) and JBS&G (2024) have recorded several populations of *Conospermum undulatum* within the MRS amendment area. The Environmental Management Framework requires additional flora studies to be undertaken over areas that have not be previously surveyed.
Develop and implement a fire management strategy	The CAMP will include appropriate bushfire management measures to be implemented within the conservation areas. Furthermore, site specific Bushfire Management Plans will be required as part of local structure planning, subdivision and/or development.
Promote awareness	The CAMP will include the requirement for educational signage to be installed providing information on the species and the importance of its conservation, in consultation with DBCA

6.8 Assessment and significance of residual impacts

The following residual impacts are anticipated as a result of the proposed change in land use, once mitigation measures have been applied:

- The potential loss of up to 4 individuals of conservation significant flora, of which 1 individual is *Conospermum undulatum* (T) (located on Lot 804 and adjacent to Conservation) and 3 individuals are *Isopogon autumnalis* (P3) (2 are located on Lot 804 and adjacent to the Conservation and 1 is located along the northern boundary of Crystal Brook Road and adjacent to the road reserve).

However, there will be opportunities at later and more detailed stages of the planning process and through the Environmental Management Framework to extend the final design and boundary of Conservation areas to retain the adjacent the adjacent *Conospermum undulatum* (T) and *Isopogon autumnalis* (P3) located on Lot 804 as part of future local structure planning, subdivision and development.

In relation to the remaining 0.05 ha of BmXpEc located on Lot 8 and mapped as Future Potential Conservation and Rehabilitation, further flora and vegetation survey and FCT analysis will be undertaken to confirm if this area of vegetation is TEC FCT 20c and therefore, warrant conservation and rehabilitation.

Accordingly, the no significant residual impacts are anticipated for conservation significant flora and vegetation once mitigation measures have been applied as part of the Environmental Management Framework and during the subsequent stages of the planning and development process.

6.9 Environmental outcomes

The MRS amendment area is mostly comprised of significantly altered areas, namely cleared or handstand areas. Approximately 91 ha (~73%) of the land has been historically cleared and ~97% of the total MRS amendment area is in a Completely Degraded condition.

Following implementation of the proposed mitigation measures, the predicted environmental outcomes for flora and vegetation associated with urbanisation of the MRS amendment area are:

- Retention of all vegetation in Good to Excellent condition.
- Retention of all remnant patches of Banksia Woodlands in Good or better condition, representing the following threatened and priority ecological communities:
    - Banksia Woodlands of the Swan Coastal Plain TEC - Endangered (EPBC Act) and Priority 3 (DBCA listing).
    - Probable FCT 20a *Banksia attenuata* woodlands over species rich dense shrublands WA TEC – Critically Endangered (BC Act).
- Possible retention and rehabilitation of degraded vegetation (BmXpEc) located on Lot 8 pending further survey and FCT analysis to confirm if remaining patch is TEC FCT 20c (Figure 6-3).
- Possible retention and rehabilitation of degraded vegetation (BaEpPf) located on Lot 2 Victoria Road pending further survey and FCT analysis to confirm conservation status of vegetation and flora (Figure 6-3)
- Higher order protection for all remnant native vegetation, by virtue of its retention within Conservation areas and road reserves under the care and management of the City of Kalamunda. In particular, all patches of remnant Banksia Woodlands in Good or better condition representing TECs and/or PECs will be retained in Conservation POS.

- Retention of conservation significant flora taxa within conservation including at least:
    - 79 individuals of *Conospermum undulatum* (T).
    - 15 individuals of *Isopogon autumnalis* (P3).
- No impact to one individual of *Isopogon autumnalis* (P3) located on Water Corporation land (adjacent to Tonkin Highway) that will not be developed for urban uses.
- The retention of up to another 3 individuals of conservation significant flora representing the two flora taxa above, during later and more detailed stages of the planning process and through the Environmental Management Framework to ensure the final design and boundary of the Conservation and Potential Future Conservation areas will retain all conservation significant flora.
- All Southern River Complex and Forrestfield complex vegetation in good or better condition will be avoided, protected and managed. Note: there are no areas of intact remnant vegetation within the area mapped as Guildford complex.
- Given that the depth to groundwater within the MRS amendment area is already several metres below natural surface and it has been predicted that the physical process of urbanisation will not lead to a significant rise in groundwater levels, it is expected there will not be any hydrological impacts on flora and vegetation within the MRS amendment area due to the proposed change in land use from Rural to Urban.
- As there will be no significant hydrological changes, there will be no significant impacts to wetland and riparian vegetation and groundwater dependant ecosystems in proximity to the MRS amendment area (including the GBSW).

7. Key environmental factor - Terrestrial fauna

7.1 EPA objective

The EPA's objective for Terrestrial Fauna is:

To protect Terrestrial Fauna so that biological diversity and ecological integrity are maintained.

In the context of this objective:

Ecological integrity is the composition, structure, function and processes of ecosystems, and the natural range of variation of these elements (EPA 2016a).

7.2 Instruction for Environmental Review (Assessment No. 2335) for Amendment 1388/57 – Terrestrial Fauna

The EPA's Instruction for Environmental Review (Assessment No. 2335) for Amendment 1388/57 (15th August 2022) identified 11 specific scopes of works for the Terrestrial environmental factor. Table 7-1 outlines the required work for Terrestrial Fauna.

Table 7-1: Terrestrial Fauna – EPA Requirements for Environmental Review

Task	Required work
1.	In accordance with the requirements of EPA guidance conduct a desktop study to identify and characterise the fauna and fauna habitats for the amendment area to inform local and regional context. Based on the results of the desktop study undertake the appropriate level survey and habitat assessment. This should include survey/assessment within the amendment area and consideration of cumulative impacts. For identified significant (Threatened and Priority) fauna, this must include information on: a) The abundance, distribution, ecology, and habitat preferences, together with baseline information and mapping of local and regional occurrences. b) Population size and importance of the population from a local and regional perspective; and c) Information on conservation value of each habitat type (e.g. breeding, migration, feeding, roosting etc.) from a local and regional perspective, including the percentage representation of each habitat site in relation to its local and regional extent. Note: Surveys should include both Terrestrial Vertebrate Fauna and Short-range Endemic (and/or other significant) Invertebrate Fauna. Survey design should ensure that adequate local and regional contextual data are collected and should consider cumulative impacts. If multiple surveys have been undertaken to support the assessment, a consolidated report should be provided including the integrated results of the surveys. Where surveys were undertaken at the referral stage, survey results and a demonstration of how the guidance has been followed are to be included in the Environmental Review. Ensure species database searches and taxonomic identifications are current. IBSA data packages should be provided in accordance with EPA guidance. Ensure species database searches and taxonomic identifications are up to date.
2.	Provide a map of the survey effort applied in relation the fauna habitat, the study area and amendment area illustrating the known recorded locations of conservation significant species, other significant fauna and fauna habitat in relation to the amendment area. Clearly show any areas/lots unable to be surveyed. Mapping should also identify the direct and indirect impact areas.
3.	Identify and describe the characteristics of the fauna and fauna habitat that may be impacted directly and indirectly by the amendment, development and provision of associated infrastructure and describe the significance of these values in a local and regional context. Describe significant habitats, including but not limited to: refugia, breeding areas, key foraging habitat, movement corridors and linkages. Habitats that are important to significant species, and the reasons for their importance, should be identified. Discussions of habitats should quantify the absolute and relative areas of the habitats in question, and

Task	Required work
	that these discussions should be supported by tables and figures that illustrate the extents of habitats.
4.	Identify significant fauna and describe in detail their known ecology, likelihood of occurrence, habitats, and known threats. Map the locations of significant fauna records in relation to the fauna habitats, the study area, the scheme amendment area, and potential direct, indirect, and cumulative impact areas.
5.	Provide a map depicting areas of fauna habitat to be retained and protected from future subdivision, development and provision of associated infrastructure.
6.	Detail, map and quantify areas of fauna habitat not proposed to be retained.
7.	Describe and assess the extent of direct and indirect impacts as a result of the proposed change in land use associated with the amendment to terrestrial fauna taking into consideration cumulative impacts and the significance of fauna and fauna habitat. This should include an assessment of the risk posed to any significant species as a result of future development and associated infrastructure. For significant species, this should be done on a species-by-species basis. Significant species discussed should include short-range endemic and other significant invertebrates. Note: The likelihood of SRE fauna occurring within a given development area should be considered early in the environmental scoping stage. Preliminary SRE fauna risk assessments can then be used to set the context for a given assessment and as a reasoned basis to identify the extent of any surveys required.
8.	Apply the mitigation hierarchy and describe any proposed avoidance, mitigation and management measures that demonstrate the EPA's objectives can be met.
9.	Identify, describe and quantify the potential residual impacts (direct, indirect and cumulative) to fauna assemblages, habitats and significant species, that may occur following implementation of the amendment after considering and applying avoidance and minimisation measures, in a local and regional context.
10.	Based on the components of the amendment, determine and quantify any significant residual impacts by applying the Residual Impact Significance Model (page 11) and WA Offset Template (Appendix 1) in the WA Environmental Offsets Guidelines (2014). Where significant residual impacts remain, propose an appropriate offsets strategy.
11.	Describe the planning mechanisms that are to be applied to ensure impacts are managed to meet the EPA's objectives.

7.3 Relevant policy and guidance

The relevant policy and guidance for Terrestrial Fauna is summarised in Table 7-2.

Table 7-2: Policy and guidance relevant to terrestrial fauna

Policy and guidance	Key aspects

Environmental Factor Guideline: Terrestrial Fauna (EPA 2016d)	This guideline provides an outline of how Terrestrial Fauna is considered by the EPA in the EIA process. Relevant matters discussed in the guideline include the following:
	
	• Description of EIA considerations, including:
	
	  ○ Application of the mitigation hierarchy.
	  ○ The terrestrial fauna affected by the proposal.
	  ○ The potential impacts and the activities that will cause them.
	  ○ Surveys and analyses required.
	  ○ The significance of and risks to the fauna.

Policy and guidance	Key aspects
	○ The current state of knowledge of terrestrial fauna and the level of confidence underpinning the predicted residual impacts. ○ Issues commonly encountered by the EPA during EIA of this factor. ○ A summary of the type of information that may be required by the EPA to undertake EIA related to this factor.
Technical Guidance – Sampling of Short Range Endemic Invertebrate Fauna (EPA 2016e)	This technical guidance provides information on the standards and methods of survey required to assist in collecting appropriate data on short range endemic species (SREs) for EIA. SREs are defined as terrestrial and freshwater invertebrates that have naturally small distributions of less than 10,000 km2. Within this distribution, the actual areas occupied may be small, discontinuous or fragmented. Within the context of EIA in Western Australia, the term SRE has effectively been used in this Guidance Statement to refer only to surface dwelling invertebrates.
Technical Guidance: Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA 2020)	The purpose of this technical guidance is to ensure that terrestrial vertebrate fauna data of an appropriate standard is obtained and used for EIA. This guidance is applicable to terrestrial vertebrate fauna only and should be applied in conjunction with the EPA's *Environmental Factor Guideline: Terrestrial Fauna*. The technical guidance provides advice on: • Desktop studies. • Survey preparation and determining survey type and design. • Habitat assessment, survey techniques and specimen handling. • Data analysis, mapping and reporting.

7.4 Studies and investigations

To date, 360 Environmental (2018) and AECOM (2020) have previously undertaken desktop assessments of the MRS amendment area as part of a consideration of the broader Wattle Grove (South) locality. AECOM (2020) also conducted site surveys and assessment for flora, vegetation and fauna.

The AECOM survey did not survey every allotment within the MRS amendment area and as a result, JBS&G undertook the following supplementary surveys of the MRS amendment area from 2021 through to 2022:

- Supplementary fauna surveys in 2021 and 2022, which corroborated the findings of the AECOM surveys within the MRS amendment area and provided additional data on some areas previously not surveyed by AECOM.
- Targeted black cockatoo survey (August 2021): Various lots
- Significant tree and black cockatoo habitat assessment (February 2021): Various lots
- Reconnaissance black cockatoo habitat survey (January 2022): Various lots, including from lot boundaries

Figure 7-1 presents the combined survey effort by AECOM and JBS&G within the MRS amendment area, which were done in accordance with EPAs *Technical Guidance – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA 2016b and EPA 2020).

JBS&G (2024) have drafted an ecological memo which provides an overview of the above flora, vegetation and fauna surveys and assessment that have been undertaken within the MRS amendment area (Appendix D). The 360 Environmental (2018) and AECOM (2020) reports are included in Appendices A and B of the JBS&G Ecological Memo, which can be found at Appendix D of this ER.

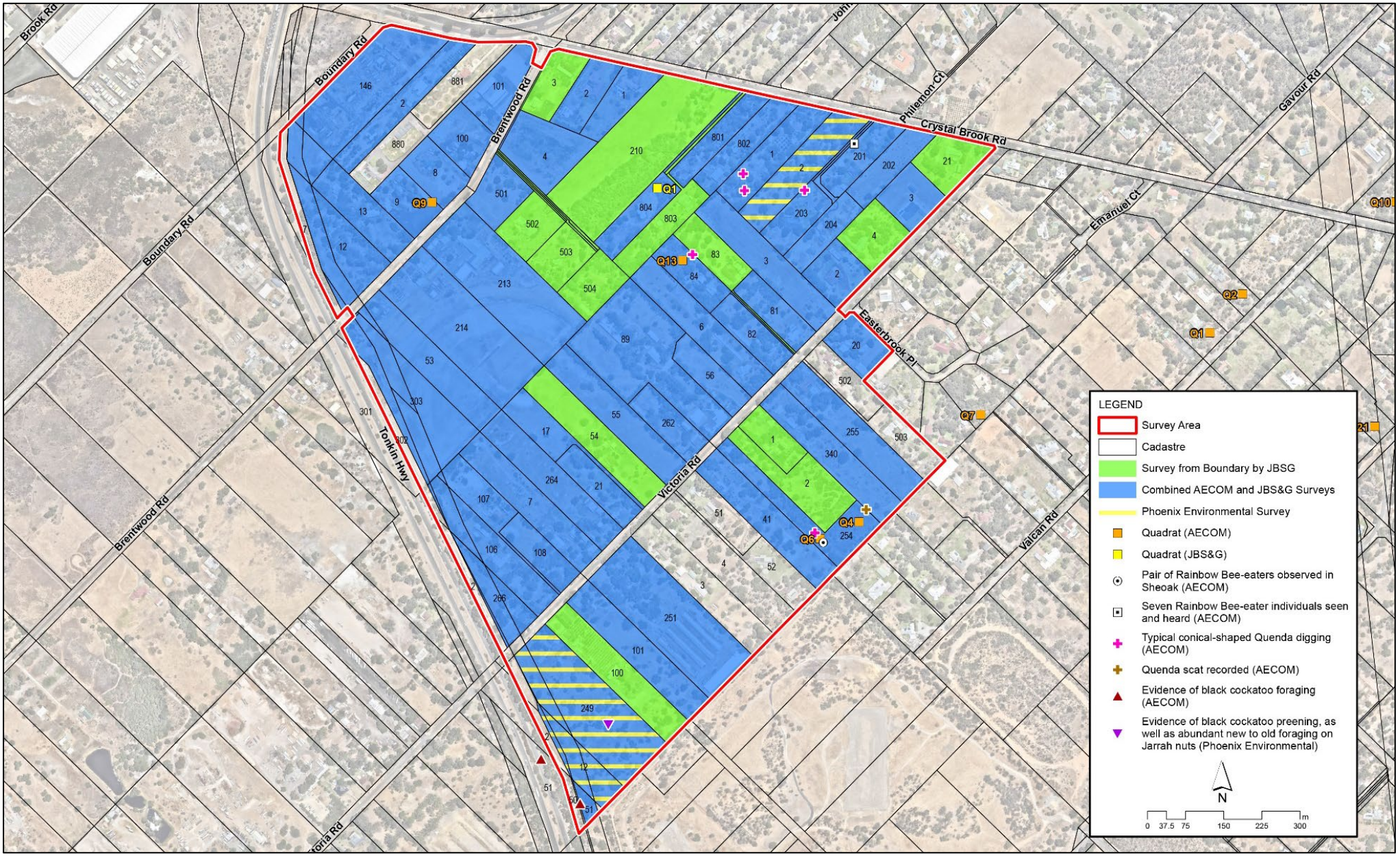

Figure 7-1: Lots surveyed within MRS amendment area

In addition to the above, the following supplementary assessments have also been undertaken:

- Phoenix Environmental Services (Phoenix Environmental) (2024) undertook a black cockatoo habitat assessment (Appendix F), which included the following:
    - review habitat mapping with respect to consistency with the vegetation type and condition mapping and black cockatoo species foraging habitat
    - review the potential nesting tree dataset
    - hollow inspection
    - undertake black cockatoo species foraging habitat quality scoring per the 'Bamford Method' (BCE 2021).
- Bennelongia Environmental Consultants (Bennelongia) (2024) - Wattle Grove South SRE Invertebrate Fauna Desktop Assessment (Appendix G).

As previously advised, a total of eight lots were unable to be surveyed and 13 lots were surveyed based on observations made from road reserves and the fence line of adjacent lots, so there may be some limitations with the survey data that has been collected for these lots. Where any limitations in the survey data collected requires consideration or further attention, this has been addressed in this ER. To ensure that any limitations in the survey data collected to date does not compromise future planning decisions, the Environmental Management Framework will require that any future subdivision or development application of lots not subject to survey within the MRS amendment area be accompanied by a suitable fauna survey undertaken in accordance with current EPA policy and guidelines. This requirement for fauna survey will also be highlighted as a provision in all future structure plans within the MRS amendment area.

- Undertaking the required fauna surveys will ensure that any significant fauna values and habitats within these lots will be identified and appropriately avoided, mitigated and/or offset as part of the determination of all future subdivision or development proposals and managed through conditions of approval.
- Notwithstanding the above, the majority of the MRS amendment area (~92%) has been subject to some form of an ecological assessment, and consequently, the ecological values of the area are well understood.
- The survey efforts have found that vegetation within the MRS amendment area is predominantly cleared, and now consists primarily of lawns, planted trees, garden beds and fragmented areas of scattered native trees, with some small discrete areas of remnant native vegetation ranging from Degraded to Excellent condition.

7.4.1 AECOM level 1 Wattle Grove fauna surveys

AECOM (2020) conducted a Level 1 fauna survey in conjunction with the detailed flora and vegetation surveys that they also completed during spring 2019. Conducting the two surveys concurrently enabled consistent and clear mapping of fauna habitats and vegetation communities.

A targeted black cockatoo survey was also conducted in conjunction with the Level 1 fauna survey and detailed flora and vegetation survey by AECOM ecologists and botanist. This survey was conducted over multiple mobilisations due to site accessibility, including 9 and 10 September 2019, 1 to 4 and 8 October 2019 and 18 and 21 November 2019.

7.4.2 Significant tree and black cockatoo habitat assessments

A targeted black cockatoo survey was undertaken by JBS&G (previously Strategen-JBS&G) in August 2021 involving Lots 12 and 13 Brentwood Road, 81, 106 and 107 Victoria Road and 804 Crystal Brook Road. The targeted black cockatoo survey was conducted to identify potential breeding, roosting and foraging habitat for the three threatened black cockatoo species that occur in WA, as all three species have the potential to utilise the habitats present in the MRS amendment area.

The three species are Carnaby's cockatoo *Zanda latirostris* (Endangered under the EPBC Act and the BC Act), Baudin's cockatoo *Zanda baudinii* (Endangered under the EPBC Act and the BC Act) and the Forest Red-tailed black cockatoo *Calyptorhynchus banksii naso* (Vulnerable under the EPBC Act and the BC Act).

The survey was undertaken by two ecologists from JBS&G with relevant experience in accordance with the guidance current at the time – *EPBC Act Referral guidelines for three threatened black cockatoo species* (DSEWPaC 2012). The (then) draft DotEE (2017) referral guidelines were also utilised.

JBS&G also undertook a significant tree and black cockatoo habitat assessment in February 2021, incorporating additional areas of the MRS amendment area to result in a combined survey area covering 116 ha. The survey also provided further context to support habitat mapping over the balance of the MRS amendment area. This assessment was undertaken by two ecologists from JBS&G with relevant experience as specified by the DSEWPaC (2012) guidance and also utilising the draft DotEE (2017) Referral Guidelines.

In January 2022, JBS&G also undertook reconnaissance flora and vegetation surveys from the boundaries of previously unsurveyed lots within the MRS amendment area, noting the quality and extent of black cockatoo habitat observed therein.

Phoenix Environmental (2024) undertook hollow inspections on 19 January 2024 of seven potential nesting trees within the MRS amendment area (Figure 7-1) (Appendix F). The purpose of this inspection was to confirm the location and suitability of hollows as nests for black cockatoos, which was based on previous biological surveys undertaken by AECOM (2020) and JBS&G (2024); however, it should be noted that no targeted investigations of these trees had been undertaken during the time of these surveys. In summary, none of the trees inspected were considered suitable for black cockatoo nesting (Phoenix Environmental 2024). Further discussion of the results is provided in Section 7.5.5.10.

Phoenix Environmental (2024) also undertook a black cockatoo habitat assessment for the MRS amendment area with consideration of the following guidelines and guidance:

- Referral guideline for 3 WA threatened black cockatoo species Carnaby's cockatoo (*Zanda latirostris*), Baudin's cockatoo (*Zanda baudinii*) and the FRTBC (*Calyptorhynchus banksii naso*) (DAWE 2022a).
- Black cockatoos and development in South-West Western Australia (DAWE 2022b).
- Scoring System for the Assessment of Foraging Value of Vegetation for Black-Cockatoos (Bamford 2021).

Further discussion of the results is provided in Section 7.5.5.9 and Appendix F.

7.5 Receiving environment

7.5.1 Desktop assessments

Desktop assessments were undertaken in addition to field surveys for vertebrate fauna and short-range endemic invertebrates. Results of the desktop assessments are detailed in the below sections.

7.5.1.1 Vertebrate fauna

Conservation significant fauna database searches were conducted using a 10 km buffer surrounding the MRS amendment area using the EPBC Act Protected Matters Search Tool (PMST) and the Threatened, Specially Protected, and priority fauna database (DBCA) by AECOM in 2020 and JBS&G in 2022. An additional database search was conducted in September 2023 by JBS&G (2024) to verify the validity of the previous searches (Appendix D).

An assessment of the likelihood for each species to occur within the MRS amendment area was undertaken based on the habitat types within the MRS amendment area. As the area is predominantly cleared of native vegetation and used for a range of semi-rural, composite business and horticultural purposes, the area is not considered to offer large areas of intact habitat.

The surrounding environment is also representative of cleared land and semi-rural land uses containing limited vegetation to the north, west and south of the MRS amendment area. Large areas of intact vegetation located further east of the MRS amendment area may provide higher quality fauna habitat (360 Environmental 2018).

The 2023 desktop assessments identified a total of 34 fauna taxa of conservation significance as potentially occurring within a 10 km buffer of the MRS amendment area, and of these 16 species were considered to have potential to occur based on presence of suitable habitat, including 9 species (including 5 migratory species) listed under both the BC and EPBC Act (Appendix D).

As the site is predominantly cleared of native vegetation and used for rural purposes, the site does not provide large areas of intact or connected habitat. The surrounding environment is also predominantly cleared and consists of rural land uses containing limited native vegetation. Large areas of intact vegetation are located east of the site, within the Lesmurdie Falls National Park, may provide higher quality fauna habitat. The Greater Brixton Street Wetlands, located to the west of the site and physically separated by Tonkin Highway, also provides higher quality fauna habitat. An assessment of the likelihood for each species to occur was undertaken, based on the habitat types within the site. The likelihood for each species to occur within the site is provided in Table 7-3.

AECOM (2020) recorded habitat of varying quality that may be suitable for Carnaby's, Baudin's and Forest Red-tailed black cockatoos, as well as for Quenda, within the site boundary. AECOM (2020) recorded Quenda sightings at seven locations (Lots 1, 203,254 and 84) and Rainbow Bee-eater at two locations (Lot 254 and Lot 204) within the areas of remnant vegetation.

Table 7-3: Threatened and Priority Fauna potentially occurring within 10 km of the MRS amendment area

Scientific name	Common name	Conservation status		Likelihood of occurrence	Comments
		State (WA)	Federal		
Leioproctus douglasiellus	a short-tongued bee	EN	CR	Unlikely	Known to occur in association with Goodenia *Filiformis* and *Anthotium junciforme*, both of which are not present. No DBCA records or plant association occur in the survey area (AECOM, 2020)
Neopasiphae simplicior	a short-tongued bee	EN	CR	Unlikely	Known only from a single location within the Forrestdale Lake Nature Reserve, however, is likely to occur in Banksia Woodland SCP ecological communities (Bennelongia, 2024).
Glossurocolletes bilobatus	a short-tongued bee (south-west)	P2		Possible	The species has been recorded from one location in proximity to the MRS amendment area, approximately 2.5 km south-west. Is likely to occur in association with the Banksia Woodlands of the Swan Coastal Plain TEC (Bennelongia, 2024).
Zanda baudinii	Baudin's cockatoo	EN	EN	Possible	May occur based on DBCA records in proximity to the MRS amendment area (AECOM, 2020). The survey area provides some areas of good quality foraging habitat as well as roosting and breeding habitat, however no evidence of the species was recorded within or around the survey area.
Neelaps calonotos	black-striped snake, black-striped burrowing snake	P3		Unlikely	No recent records within or adjacent to the survey area (AECOM, 2020).
Oxyura australis	blue-billed duck	P4		Unlikely	The species is almost wholly aquatic and rarely seen on land (Australian Museum, 2020). The species prefers deep and freshwater swamps that contain dense vegetation (360 Environmental, 2023)
Zanda latirostris	Carnaby's cockatoo	EN	EN	Likely	Abundant recent observations of the species and suitable habitat present indicate the species is likely present (AECOM, 2020).
Westralunio carteri	Carter's freshwater mussel	VU	VU	Unlikely	There are no DBCA records within or in close proximity to the MRS amendment area (AECOM, 2020) and a lack of suitable habitat present.
Hydroprogne caspia	Caspian tern	MI	MI	Unlikely	There is a lack of suitable habitat present (harbours, lagoons, inlets, bays, estuaries and river deltas) (DCCEEW 2024).
Australotomurus morbidus	cemetery springtail, Guildford springtail	P3		Unlikely	Occurs in coastal heath remnants on the Swan Coastal Plain. Closest known extant occurrence located at the Perth airport (Greenslade, et. al 2014).
Dasyurus geoffroii	chuditch, western quoll	VU	VU	Unlikely	Limited habitat within the MRS amendment area. No known records within the last 25 years within MRS amendment area (AECOM 2020).
Tringa nebularia	common greenshank	MI	MI	Unlikely	Occurs in sheltered coastal habitat, typically with large mudflats and saltmarsh, mangroves or seagrass (DCCEEW 2024).

Scientific name	Common name	Conservation status		Likelihood of occurrence	Comments
		State (WA)	Federal		
Actitis hypoleucos	common sandpiper	MI	MI	Unlikely	No recent records and no preferred habitat likely to be present (AECOM 2020).
Thalasseus bergii	crested tern	MI	MI	Unlikely	The MRS amendment area does not contain suitable habitat (coastal, beaches, bays, lagoons, salt ponds and lakes, estuaries, tidal creeks) (360 Environmental 2023).
Calyptorhynchus banksii naso	forest red-tailed black cockatoo	VU	VU	Likely	Abundant recent observations and suitable habitat is present (AECOM 2020).
Plegadis falcinellus	glossy ibis	MI	MI	Unlikely	No suitable habitat present (shallow, fresh water, and estuarine waters, dry grasslands) (360 Environmental 2023).
Kawanaphila pachomai	grey vernal katydid (south-west)	P1		Unlikely	No suitable habitat present (prefers moist, shaded, uncleared forest and gullies, mostly the Tingle forests along the south coast of Western Australia (Harewood, 2018).
Tringa stagnatilis	marsh sandpiper, Little greenshank	MI	MI	Unlikely	Occurs in permanent or ephemeral wetlands of varying salinity, with a preference for freshwater environments in Western Australia. Occurs in Australia during the boreal winter but is not considered to utilise or be dependent on the MRS amendment area (DCCEEW 2024).
Myrmecobius fasciatus	numbat, walpurti	EN	EN	Unlikely	Only known extant populations are at Dryandra and Perup in Western Australia. No suitable habitat present (AECOM 2020).
Pandion haliaetus	osprey	MI	MI	Unlikely	No recent records within MRS amendment area or preferred habitat present (AECOM 2020).
Falco peregrinus	peregrine falcon	OS		Unlikely	The species utilises ledges, cliff faces and large hollow/broken spouts of trees for nesting (Harewood 2018). The species may utilise some parts of the MRS amendment area as part of a larger home range.
Lerista lineata	Perth slider, lined skink	P3		Unlikely	The MRS amendment area is outside of the known range for this species. The species is usually not present in degraded habitat (Harewood 2018).
Isoodon fusciventer	quenda, south-western brown bandicoot	P4		Likely	Abundant recent observations and suitable habitat are present within the MRS amendment area (AECOM 2020).
Setonix brachyurus	quokka	VU	VU	Unlikely	Species is considered to be extinct from the Swan Coastal Plain (AECOM 2020).
Acanthophis antarcticus	southern death adder	P3		Unlikely	Species range is the Darling Range between Mt Helena and Jarrahdale. The MRS amendment area is outside of the known distribution range (Harewood 2018).
Phascogale tapoatafa wambenger	south-western brush-tailed phascogale, wambenger	CD		Unknown	The survey area may contain suitable habitat including mature trees, dead logs and stags. However, the fragmented nature of vegetation remnants suggests the species is likely not to occur.

Scientific name	Common name	Conservation status		Likelihood of occurrence	Comments
		State (WA)	Federal		
Idiosoma sigillatum	Swan Coastal Plain shield-backed trapdoor spider	P3		Possible	The species has been recorded in close vicinity to the survey area (Bennelongia 2024).
Hydromys chrysogaster	water-rat, rakali	P4		Unlikely	The species thrives in areas with year-round water supply, intact riparian vegetation and bank stability (DWER, 2024).
Notamacropus irma	western brush wallaby	P4		Unlikely	No recent records in or adjacent to the survey area.
Platycercus icterotis xanthogenys	western rosella (inland)	P4		Possible	Survey area does not contain primary habitat suitable to the species (salmon gum and wandoo woodlands, farmlands, less common in heavy wet Karri and Jarrah) (360 Environmental 2023), but the species is widely distributed across the state.
Pseudemydura umbrina	western swamp tortoise	CR	CR	Unlikely	The species is restricted to two wild populations, neither of which are in the MRS amendment area (WA Museum 2023).
Tringa glareola	wood sandpiper	MI	MI	Unlikely	Suitable habitat is not present in the MRS amendment Area (freshwater wetlands with emergent sedges and taller fringing vegetation) (360 Environmental 2023).
Bettongia penicillata ogilbyi	woylie, brush-tailed bettong	CR	EN	Unlikely	Current extent of this species is restricted to the wheatbelt. There are no records of and no preferred habitat likely to be present in the MRS amendment area (AECOM 2020).

Conservation Codes	State (WA)	Federal
Endangered	EN	E
Critically Endangered	CR	CE
Vulnerable	VU	V
Migratory	MI	MI
Species of conservation interest (Conservation Dependent)	CD	Not applicable
Species otherwise in need of special protection (other specially protected)	OS	Not applicable
Priority (rated in order of significance from 1 to 4)	P	Not applicable

7.5.1.2 Short-range endemic invertebrates

Short-range endemic (SRE) invertebrates have naturally small distribution, which can be influenced by several factors including life history, physiology, habitat requirements, dispersal capabilities, biotic and abiotic interactions, and historical conditions. These not only influence their distribution but also the tendency for differentiation and speciation (Ponder and Colgan 2002).

The SRE status of each species within the MRS amendment area was determined by Bennelongia in 2024 (Appendix G) using a modified version of the Western Australian Museum's (WAMs) SRE classification system. The modifications used by Bennelongia aim to account for the fact that many recorded species have limited available data on their taxonomy, range, habitat preferences, and/or natural history.

As a first step in classification, SRE species were assigned to the following categories (Bennelongia 2024):

- **Confirmed SREs** have a known range <10,000 km^2. The taxonomy is well known, and the group well represented in collection and/or via comprehensive sampling.
- **Potential SREs** are species for which there are gaps in knowledge, either because they are not well represented in collections, taxonomic knowledge is incomplete, or the distribution is poorly understood due to insufficient sampling.
- **Widespread (not an SRE)** species have a known distribution range >10,000 km^2. The taxonomy is well known, and the group well represented in collections via comprehensive sampling.

Potential SREs were then assigned as *likely* or *unlikely potential SREs* based on the following information (if available) (Bennelongia 2024):

- Habitat indicators and degree of specialisation (e.g. occur only in habitat typical of SREs; occur in one or multiple habitats).
- Research and expertise (assigned by expert; use expert information of the biology and ecology of related species); and/or
- Molecular evidence regarding the genetic variability within sampling areas.

If species are data deficient in all these areas, the precautionary approach was taken of assigning them as data deficient *likely potential SREs*; although these species were highlighted in the results, noting the lack of available data (Bennelongia 2024).

The desktop search over an area of the Swan Coastal Plain extending 50 km north and south of the site returned 2 confirmed SRE species, 135 likely potential SRE species (with 37 of these due to data deficiency), 17 unlikely SRE species and 425 widespread species. The list of species with some possibility of being SREs includes 52 species of araneomorph spider, 37 species of mygalomorph spider, 20 species of millipede, 18 species of slater, seven species of pseudoscorpion, six species each of scorpion, centipede and land snail, and two species of harvestman (Bennelongia 2024).

Additionally, eight listed Threatened or Priority species have been recorded within the 100 km search area, including two trapdoor spiders and six species of bees; however, only limited (or no) occurrences of most of these species have been found in close proximity of the MRS amendment area.

Vegetation assessment undertaken in the MRS amendment area identified some remnants of *Banksia attenuata* woodlands and a small remnant of *Eucalyptus marginata* woodland, in Good and better condition, which are likely to provide the most suitable habitat for SRE fauna. However, these habitats exist as small discrete fragments occupying less than 4% of the MRS amendment area. Most of the vegetation within the MRS amendment is in Degraded and Completely Degraded condition represented by scattered native and planted trees, planted gardens, and cleared areas, which provide more limited value habitat for SRE invertebrate. For that reason, although a diverse community of potentially restricted species occurs within the extended desktop search area, the small areas of residual habitat appropriate for SRE species in the MRS amendment area are considered to be less suitable for maintaining a large diverse structured SRE community within the MRS amendment area. Moreover, larger areas of SRE suitable habitat are more diverse and abundant outside the MRS amendment area than within it. Notwithstanding, as the remnant areas of *Banksia attenuata* and *Eucalyptus marginata* identified as being in Good or better condition are proposed to be retained and managed in Conservation areas, they will continue to function to provide residual SRE suitable habitat and will not contribute to further fragmentation of SRE suitable habitat on the Swan Coastal Plain. (Bennelongia 2024)

For these reasons, overall, the proposal to rezone the MRS amendment area from rural to urban is not expected to have significant impacts on the conservation values of SREs or other significant terrestrial invertebrates. It is acknowledged that access to remnant areas of the *Banksia attenuata* and *Eucalyptus marginata* is currently limited; however, through the Environmental Management Framework, SRE surveys will be undertaken within the conservation areas to ensure that the management measures within the CAMP(s) are suitable and respond to the SRE that may be present.

7.5.2 Terrestrial fauna habitat

The AECOM (2020) terrestrial fauna survey primarily focused on mapping of fauna habitat and assessing this habitat for their potential to be used by conservation significant fauna species within the wider Wattle Grove area. Fauna habitats were assessed for specific habitat components, including consideration of structural diversity and refuge opportunities for fauna.

Records of all observed fauna species, identified from distinctive calls and details of indirect evidence such as scats, tracks and diggings, were documented. Particular attention was given to searching for conservation significant species that had been identified in desktop assessments as having potential to occur in the area. All observations were made between daylight hours of 0700 and 1700.

The AECOM survey broadly defined and mapped six fauna habitats within the wider area of Wattle Grove South area. Of these, only four of these habitats were mapped within the MRS amendment area, including:

- Banksia Woodlands
- Eucalypt Woodlands
- Scattered Trees
- Planted and Maintained Gardens

Fauna habitat within the MRS amendment area has been highly modified through historical and ongoing land uses, which have resulted in the clearing of the majority of native vegetation. The small areas of remnant vegetation that remain within the MRS amendment area provide the greatest significant fauna habitat. The remnant vegetation comprises mostly Banksia Woodlands, which exists in four distinct patches, as well as one very small patch of Eucalyptus Woodland in Very Good condition (Figure 6-5).

The habitat types of 'Planted and Maintained Gardens' and 'Scattered Trees' are both highly disturbed and completely degraded. These habitat types contain a mixture of native and non-native Eucalyptus trees, as well as other introduced species such as Cape Lilac and Jacaranda. The main distinction between the two habitat types is the understorey; understorey is not present in the 'Scattered Trees' habitat and is variable in the 'Planted and Maintained Gardens' habitat. These habitat types have limited value for species of conservation significance.

Based on the results of the AECOM (2020) terrestrial fauna survey, the majority of the MRS amendment area is lacking in natural attributes and is now predominantly used by generally common and widespread fauna species with non-specific requirements, which allow them to persist in disturbed to highly disturbed habitats.

As a result, the fauna diversity is well below levels that would have been present prior to historical clearing and disturbance having occurred. Due to these factors, most of the MRS amendment area has very little conservation significance to fauna in general.

These survey results were further confirmed by JBS&Gs surveys undertaken in 2021 and 2022 (JBS&G 2024). The fauna habitat types that have been recorded within the MRS amendment area are presented in Table 7-4.

Table 7-4: Fauna habitats descriptions (AECOM 2020)

Fauna habitat	Description
Banksia Woodlands	This habitat generally comprises a low open woodland of Banksia and Eucalyptus over a low open shrubland on loamy, sandy brown soil. The habitat is generally considered high quality due to the presence of Banksia, its complexity and limited disturbance levels. Habitat quality is reduced where areas are significantly degraded due to impacts from clearing and edge effects.  Fauna habitat characteristics include: • Dense understorey common • Logs of various sizes are common. • Fine and course leaf litter common to abundant • Bare ground occasionally present • Absence of stones and boulders ○ Large mature trees in occasional abundance (hollows absent).
	Conservation Significant Species with Potential to Utilise Habitat: Generally good quality foraging habitat for Carnaby's cockatoo and Baudin's cockatoo • Low to moderate quality foraging habitat for the Forest Red-tailed black cockatoo • Contains occasional breeding tree for black cockatoos • Habitat for Quenda
Eucalypt Woodlands	This habitat typically contains a Eucalypt woodland / open forest over a low shrubland over sandy brown soils. This habitat is variable throughout the survey area though generally contains a Eucalyptus woodland / open forest over a low shrubland over sandy brown soils. This habitat is considered high to moderate (depending on degree of degradation) quality due to the structural complexity and disturbance levels.  Significant habitat characteristics include: • presence of large mature eucalypts • dense understorey occasionally present • logs of various sizes in variable abundance • fine and course leaf litter common • bare ground occasionally present • absence of stones and boulders • large hollows occasionally present, small hollows common • soils of areas at base of Darling scarp contained pea-gravel

	Conservation Significant Species with Potential to Utilise Habitat:
	
	• Potential foraging, breeding and roosting habitat for:
	  ○ Forest Red-tailed black cockatoo
	  ○ Carnaby's cockatoo

Fauna habitat	Description
	○ Baudin's cockatoo • Habitat for Quenda
Planted and Maintained Gardens	Highly variable habitat including areas of planted and maintained native and introduced vegetation. The habitat is considered low to moderate quality due to disturbance levels and limited habitat complexity. Significant habitat characteristics include: • mature trees rare • variability of understorey, with areas of dense understorey generally absent • general lack of hollows • bare sandy ground abundant • absence of stones, boulders and rock crevices. 
	Conservation Significant Species with Potential to Utilise Habitat: • Predominantly foraging habitat, but also occasionally potential breeding and roosting habitat for: ○ Forest Red-tailed black cockatoo ○ Carnaby's cockatoo ○ Baudin's cockatoo • Habitat for Quenda.
Scattered Trees	This habitat is varied and contains large mature native and non-native eucalypt trees, as well as other introduced species such as Cape Lilac and Jacaranda. Trees were generally recorded over cleared areas. The significant fauna habitat characteristics include: • presence of large mature trees • absence of dense understorey • small hollows are common, large hollows are rare • logs of all sizes are rare to occasionally present • course and fine litter are present but generally only under trees. • bare sandy ground abundant • absence of stones, boulders and rock crevices. 
	Conservation Significant Species with Potential to Utilise Habitat: • Potential foraging, breeding and roosting habitat for: ○ Forest Red-tailed black cockatoo ○ Carnaby's cockatoo ○ Baudin's cockatoo • Marginal habitat for Quenda.

Fauna habitat	Description
Cleared	• Generally, consists of areas which have been cleared (e.g. paddocks) and now comprise bare soil and / or weeds (may contain the occasional shrub/ tree), or hardstand areas (e.g. roads). • Habitat is considered very low quality. **Conservation Significant Species with Potential to Utilise Habitat**: • This habitat may contain the occasional individual foraging tree/ shrub for black cockatoos. 

In relation to the clearing that has taken place on Lots 8 and 9 Brentwood Road and the mapping discrepancy identified on Lot 2 Victoria Road, Table 7-5 and Figure 7-1 reflects the updated fauna habitat areas for Banksia Woodland, Eucalyptus Woodland and Cleared land as a result of this clearing and revision to the mapping.

Table 7-5: Fauna habitats within MRS amendment area

Vegetation community	Area	Percentage of MRS amendment area
Remnant Native Vegetation		
Banksia Woodlands	4.51 ha	3.59%
Eucalyptus Woodland	0.05 ha	0.04%
Total Remnant Native Vegetation	**4.5**6 ha	**3.63%**
Highly Modified Vegetation		
Planted and Maintained Gardens	2.59 ha	2.06%
Scattered Trees	26.94 ha	21.45%
Other		
Cleared Land	91.49 ha	72.85%
Total	**125.5**8 ha	**100%**

7.5.3 Fauna habitat linkages

Habitat linkages are typically areas or corridors of vegetation that link (larger) areas of fauna habitat. Linkages are important as they enable fauna to move freely between remnant bushland patches, therefore increasing gene-flow between populations. A study conducted by Gilbert et al. (1998) found that corridors and/or linkages do maintain species richness in fragmented landscapes.

The MRS amendment area is located on the edge of the Perth metropolitan area and comprises significant amounts of cleared and highly modified land. AECOM (2020) found that the MRS amendment area is unlikely to contain any significant habitat linkages, predominantly due to clearing, habitat fragmentation and arterial roads bisecting the area, but it does contain degraded roadside drainage lines that may enable some fauna taxa to move through the area.

The MRS amendment area is located near the GBSW and habitat within Bush Forever Site 320, associated with the Hartfield Golf Club, however the linkage is broken by the major arterial roads of Tonkin Highway and Welshpool Road, which provide a physical separation between the MRS amendment area and the GBSW and Hartfield Golf Club.

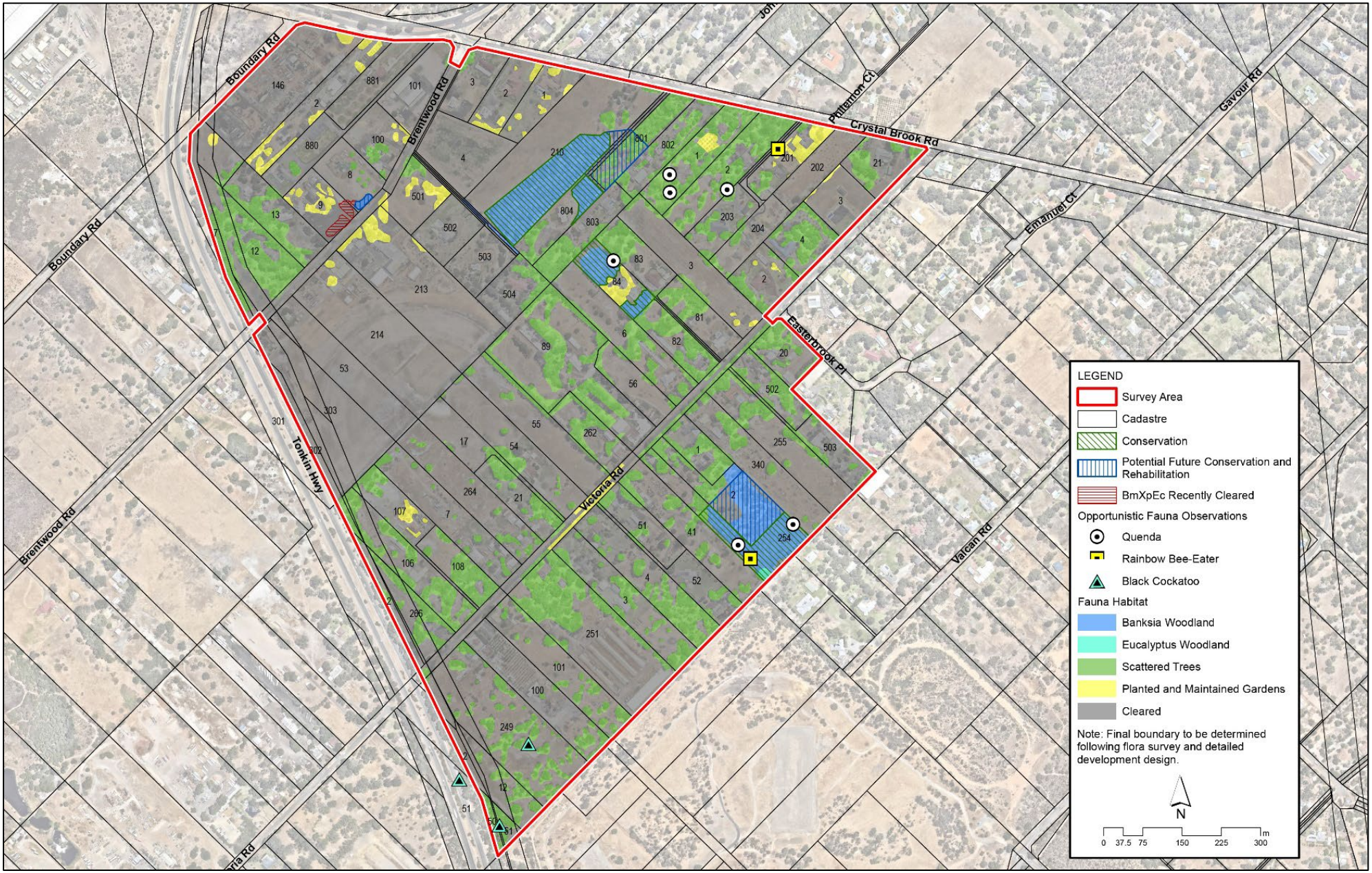

Figure 7-2: Fauna Habitats

7.5.4 Vertebrate fauna occurrence

Fifty-one vertebrate fauna species were recorded within the MRS amendment area or in adjacent areas during the AECOM (2020) field survey. This comprised 36 bird, 11 mammal, one amphibian and three reptile species. The species observed during the field survey for the wider Wattle Grove are presented in Table 7-6.

Table 7-6: Fauna species observed during field surveys (AECOM 2020)

Species	Common Name	Status	Observations
Birds			
Anas superciliosa	Pacific Black Duck	Native	Observed in artificial ponds
Anthochaera carunculata	Red Wattlebird	Native	Commonly seen and heard throughout survey area
Cacatua roseicapilla	Galah	Native	Observed multiple times during survey
Cacatua sanguinea	Western Corella	Native	Small flock observed in trees
Cacomantis flabelliformis	Fan-tailed Cuckoo	Native	Heard in trees in paddock
Calyptorhynchus banksii	Forest Red-tailed black cockatoo	Native	Two birds observed foraging in Marri tree, multiple birds seen flying over area, multiple observations of foraging evidence
Chenonetta jubata	Australia Wood Duck	Native	Observed multiple times during survey
Chalcites (formerly Chrysococcyx) basalis	Horsfield's Bronze Cuckoo	Native	Heard multiple times
Colluricincla harmonica	Grey Shrike thrush	Native	Heard in Flooded Gums adjacent drainage line
Corvus coronoides	Australian Raven	Native	Commonly seen and heard throughout survey
Gymnorhina tibicen	Australian Magpie	Native	Commonly seen and heard throughout survey
Cracticus torquatus	Grey Butcherbird	Native	Observed flying through maintained gardens
Dacelo novaeguineae	Laughing Kookaburra	Naturalised exotic	Commonly seen and heard throughout survey area
Dromaius novaehollandiae	Emu	Native	Individual observed in an enclosure
Petrochelidon nigricans	Tree Martin	Native	Flock of 10 birds observed flying in survey area
Gerygone fusca	Western Gerygone	Native	Seen in survey area
Grallina cyanoleuca	Magpie Lark	Native	Commonly seen and heard throughout Survey
Gavicalis virescens	Singing Honeyeater	Native	Common throughout survey area
Malurus splendens	Splendid Fairywren	Native	Seen and heard twice in survey area
Merops ornatus	Rainbow Bee-Eater	Native	Multiple observations recorded throughout survey area
Ocyphaps lophotes	Crested Pigeon	Native	Observed several times
Pardalotus striatus	Striated Pardalote	Native	Commonly seen and heard throughout survey area
Pavo cristatus	Common Peafowl	Introduced	Heard several times

Species	Common Name	Status	Observations
Phaps chalcoptera	Common Bronzewing	Native	Observed several times in survey area
Phylidonyris niger	White-cheeked Honeyeater	Native	Observed multiple times in survey area
Phylidonyris novaehollandiae	New Holland Honeyeater	Native	Commonly seen and heard throughout survey
Purpureicephalus spurius	Red-capped Parrot	Native	Observed individuals and foraging evidence multiple times
Barnardius zonarius	Australian Ringneck	Native	Commonly seen and heard throughout survey area
Rhipidura leucophrys	Willie Wagtail	Native	Commonly seen and heard throughout survey area
Spilopelia senegalensis	Laughing Turtle Dove	Introduced	Seen and heard multiple times in trees and flying over survey area
Taeniopygia guttata	Zebra Finch	Native	Two finches observed in Jarrah tree
Threskiornis moluccus	Australian White Ibis	Native	Observed multiple times during survey
Todiramphus sanctus	Sacred Kingfisher	Native	Individual in tree in maintained garden
Zanda latirostris	Carnaby's cockatoo	Native	Foraging evidence observed
Zosterops lateralis	Silver-eye	Native	Observed twice in survey area, flying through trees and in banksia woodland
Mammals			
Canis familiaris	Dog	Introduced	Common throughout survey area
Capra hircus	Goat	Introduced	Observed in paddock
Equus asinus	Donkey	Introduced	Observed in field
Equus caballus	Horse	Introduced	Horses observed in multiple paddocks in survey area
Felis catus	Cat	Introduced	Seen once during survey
Isoodon fusciventer	Quenda	Native	Observed directly and indirectly (conical digging and scat) several times in survey area
Lama glama	Llama	Introduced	Observed in field
Macropus fuliginosus	Western Grey Kangaroo	Native	Observed directly and indirectly several times in survey area
Oryctolagus cuniculus	Rabbit	Introduced	Observed directly and indirectly several times in survey area
Ovis aries	Sheep	Introduced	Observed in paddock
Vulpes vulpes	Red Fox	Introduced	Multiple scats recorded
Amphibians			
Crinia glauerti	Clicking Froglet	Native	Multiple
Reptiles			
Cryptoblepharus buchananii	Buchanan's Snake- Eyed Skink	Native	Seen multiple times on trees throughout survey area
Pogona minor minor	Dwarf Bearded Dragon	Native	Observed in survey area
Tiliqua rugosa	Bobtail	Native	Observed twice during survey

7.5.5 Conservation significant fauna species

Four of the 51 recorded vertebrate fauna species are identified as having some conservation significance, including three birds and one mammal, summarised as follows:

- Forest Red-Tailed black cockatoo *Calyptorhynchus banksii* (listed as Vulnerable under the EPBC Act and the BC Act).
- Carnaby's cockatoo *Zandi latirostris* (listed as Endangered under the EPBC Act and the BC Act).
- Quenda *Isoodon fusciventer* (listed as Priority 4 by DBCA) (refer to Figure 7-2 for locations of Quenda diggings and scat recorded within the MRS amendment area).
- Rainbow Bee-Eater *Merops ornatus* (listed as Marine under the EPBC Act).

Based on the desktop assessment and the field survey, an additional conservation significant fauna species is also considered to have the potential to utilise the habitats within the survey area:

- Baudin's cockatoo *Zandi baudinii* - listed as Endangered under the BC Act and the EPBC Act.

7.5.5.1 Rainbow Bee-eater

Whilst the Rainbow Bee-eater has historically been listed as a migratory species of conservation significance, it has since been removed from the EPBC Act migratory species list. Currently the Rainbow Bee-eater is only listed under the EPBC Act as 'Marine', and therefore is only considered conservation significant in Commonwealth marine environments. In addition, the Rainbow Bee-eater is currently considered to be a low priority for management – although population size and trends have not been quantified, the population size is assumed to be reasonably large and there is little documented evidence of population declines (DAWE 2021).

Subsequently, this species is not considered to be conservation significant in the context of the MRS amendment area. Two sightings of the Rainbow Bee-eater bird were recorded within the MRS amendment area during the AECOM (2020) survey, one of which was on Lot 254 Victoria Road and another near the boundary of Lots 2 and 201 Crystal Brook Road.

7.5.5.2 Quenda

The quenda (*Isoodon obesulus*) is a medium-sized ground dwelling marsupial of the bandicoot and bilby family (Marsupialia: Peramelemorphia) and is endemic to the south-west of Western Australia. The species is found in forest, woodland, heath and shrub communities, and its preferred habitat usually consists of a combination of sandy soils and dense heathy vegetation.

This species is listed as a 'Priority 4' species at a state level by DBCA, however it is not listed as threatened or endangered under either the BC Act (State) or EPBC Act (Federal). Like many small to medium sized Australian marsupials, quenda have suffered a population decline post European settlement and it is estimated that their historical range distribution has contracted by approximately 40% (Abbott 2008). The Priority 4 listing means that this species is categorised as 'rare, near threatened and other species in need of monitoring'.

Quenda are known to inhabit urban backyards, urban parklands, bush fragments and conservation reserves, even where no predator control programs occur (Bryant, Kobryn, Hardy, and Fleming 2017; Howard *et al. 20*14; Valentine *et al.* 2013). However, they prefer dense, understory vegetation and are found in both open forest and dense vegetation near swamps and watercourses (Valentine *et al.* 2013). They are currently found in an arc along the Swan Coastal Plain, with some sightings near Geraldton in the north, extending past Cape Naturaliste and Cape Leeuwin to the south, through to Albany and Esperance in the south-east.

The habitat types of 'Cleared' and 'Scattered Trees' within the MRS amendment area does not provide favourable habitat for quenda, as they lack the dense understorey vegetation and cover that the species prefers. The preferred quenda habitat within the MRS amendment area is Banksia Woodlands (4.51 ha), with 'Planted and Maintained Gardens' (2.59 ha) also offering some habitat value. Six observations of the presence of quenda were recorded during the AECOM (2020) survey, including two observations on Lot 1 Crystal Brook Road, two observations on Lot 254 Victoria Road, one observation at the boundary of Lots 2 and 203 Crystal Brook Road and one observation on Lot 84 Victoria Road.

7.5.5.3 Black cockatoos

7.5.5.4 Carnaby's cockatoo

Carnaby's cockatoo (*Zanda latirostris*) is listed as Endangered under the EPBC Act (Federal) and Endangered under the BC Act (State). The species is endemic to the south-west of Western Australia, extending from the Murchison River to Esperance, and inland to Coorow, Kellerberrin and Lake Cronin. This black cockatoo has a white patch on its cheek, white bands on its tail and a strong curved bill. Carnaby's cockatoo is a seasonal visitor to the Swan Coastal Plain, which provides important foraging and roosting habitat during the non-breeding season.

Carnaby's cockatoo feeds on seeds, nuts and flowers of a variety of native and exotic plants. Feed plants include the various proteaceous species (e.g. *Banksia, Grevillea* and *Hakea*), Marri (*Corymbia calophylla*), Jarrah (*Eucalyptus marginata*), and seeds from the cones of Pine (*Pinus sp*.) trees. Cockatoo flocks follow vegetation corridors and actively avoid cleared and open areas when moving between roosting, water and food resources. Habitat fragmentation increases the distances cockatoos need to travel between resources. Proximity of foraging habitat and water has been demonstrated to be critical to support roosting and breeding sites (Le Roux 2017).

Carnaby's cockatoo displays strong pair bonds and nest in the hollows of live or dead mature Eucalypts including Salmon Gum (*Eucalyptus salmonophloia*), York Gum *(Eucalyptus loxophleba* subsp. *Loxophleba*), Flooded Gum (*Eucalyptus rudis*), Karri (*Eucalyptus diversicolor*), Wandoo (*Eucalyptus wandoo*), Tuart (*Eucalyptus gomphocephala*) and Marri (*Corymbia calophylla*), (DSEWPaC 2012). Nest hollows generally range from 2.5-12 m above ground, size of entrance from 23-30 cm and depth of hollows from 1-2.5 m (Johnstone and Storr 1998).

Carnaby's cockatoo has undergone a dramatic decline of approximately 50 percent in the past 45 years, with the main contributing factors the clearing of core breeding habitat in the Wheatbelt, the deterioration of nesting hollows and clearing of foraging habitat.

Breeding habitat for this species occurs in the Wheatbelt, Jarrah Forest and South Coast regions, and the species is expanding its current breeding range with small patches of breeding habitat now being utilised across the Swan Coastal Plain. After breeding, Carnaby's cockatoo disperse to the higher rainfall coastal areas of the south-west of Western Australia to feed in late December to July. Breeding has been recorded from early July to mid-December.

Carnaby's cockatoos were not directly observed during the AECOM (2020) field survey, however probable foraging evidence was recorded at three locations, one of which was located within the south-western corner of the MRS amendment area. Whilst undertaking a hollow inspection of several trees within the MRS amendment area in January 2024, Phoenix Environmental also found evidence of old and new foraging evidence on Jarrah nuts and at least 4 preened black cockatoo feathers under a tree (ID 491) within the south-western corner of the MRS amendment area (Phoenix Environmental 2024).

7.5.5.5 Forest Red-tailed black cockatoo

The Forest Red-tailed black cockatoo (*Calyptorhynchus banksii naso*) is listed as Vulnerable under the EPBC Act (Federal) and Vulnerable under the BC Act (State). The species is endemic to the south-west humid and semi-humid zones of Western Australia, where it inhabits dense Jarrah, Karri and Marri forests which receive more than 600 mm average annual rainfall (DSEWPaC 2012). It has a pair of black central tail feathers and a bright red, orange or yellow barring on the tail.

This species predominantly feeds in eucalypt forests, preferring Marri (*Corymbia calophylla*) and Jarrah (*Eucalyptus marginata*) seeds, but also feeding on Blackbutt (*Eucalyptus patens*), Albany Blackbutt (*Eucalyptus staeri*), Karri (*Eucalyptus diversicolor*), Sheoak (*Allocasuarina* sp.) and Snottygobble (*Persoonia longifolia*) (Johnstone 2016 pers. comm).

Forest Red-tailed black cockatoo are monogamous and pairs nest in tree hollows from 6.5 to 33 m above ground. Most nests are in very large and very old, mature Marri (Johnstone, Kirkby and Sarti 2013), though they will nest in other Eucalypts such as Tuart (Johnstone 2016 pers. comm.). Breeding habitat for this species occurs in the eastern margins of the Jarrah forests of the Wheatbelt, and within the Jarrah Forest regions. The Forest Red-tailed black cockatoo is also expanding its current breeding range with small patches of breeding habitat now being utilised across the Swan Coastal Plain.

During the AECOM field survey, two individuals of the Forest Red-tailed black cockatoo were observed foraging in a Marri tree outside of the MRS amendment area and multiple birds were seen and heard flying over the wider survey area. Multiple observations of old and recent foraging evidence were also recorded, including at two locations within the MRS amendment area (adjacent to Crystal Brook Road and in the south-western corner adjacent to Tonkin Highway) (AECOM 2020). As previously advised, Phoenix Environmental also found evidence of old and new foraging evidence on Jarrah nuts and at least 4 preened black cockatoo feathers under a tree (ID 491) within the south-western corner of the MRS amendment area (Phoenix Environmental 2024).

7.5.5.6 Baudin's cockatoo

Baudin's cockatoo (*Zanda baudinii*) is listed as Endangered under the EPBC Act (Federal) and the BC Act (State). The species is distributed throughout the south-western humid and subhumid zones of Western Australia, from the northern Darling Range and adjacent far east of the Swan Coastal Plain (south of the Swan River), south to Bunbury and across to Albany (Johnstone and Storr 1998). It is a large black cockatoo with rectangular white patches in the tail. Males have a pink eye ring, the female a dark eye ring.

Baudin's cockatoo forages primarily in Eucalypt forest, where it feeds on seeds, flowers, nectar and buds from Marri (*Corymbia calophylla*), and seeds of Eucalyptus and proteaceous species (e.g. *Banksia* and *Hakea*), as well as orchard fruits and Pines (*Pinus sp*). It also takes insect larvae and insects (including beetle, wasp and moth larvae) from under bark and in wood of live and dead trees, from galls and from flower spikes of *Xanthorrhoea* and the pith of *Anigozanthos flavidus* (Johnstone and Kirkby 2008).

This black cockatoo primarily nests in tree hollows in live or dead Karri (*Eucalyptus diversicolor*), Marri (*Corymbia calophylla*), Wandoo (*Eucalyptus wandoo*) and Tuart (*Eucalyptus gomphocephala*) (DSEWPaC 2012b). Baudin's cockatoo nests in spring in the deep south-west of Western Australia.

No Baudin's cockatoo or foraging evidence of this species has been observed in or adjacent to the MRS amendment area. Baudin's cockatoo is considered far less likely to occur within the MRS amendment area and instead, may occur occasionally as vagrants from the Perth foothills where there are records further west on the Swan Coastal Plain (BCE 2019 as cited in Phoenix Environmental 2024).

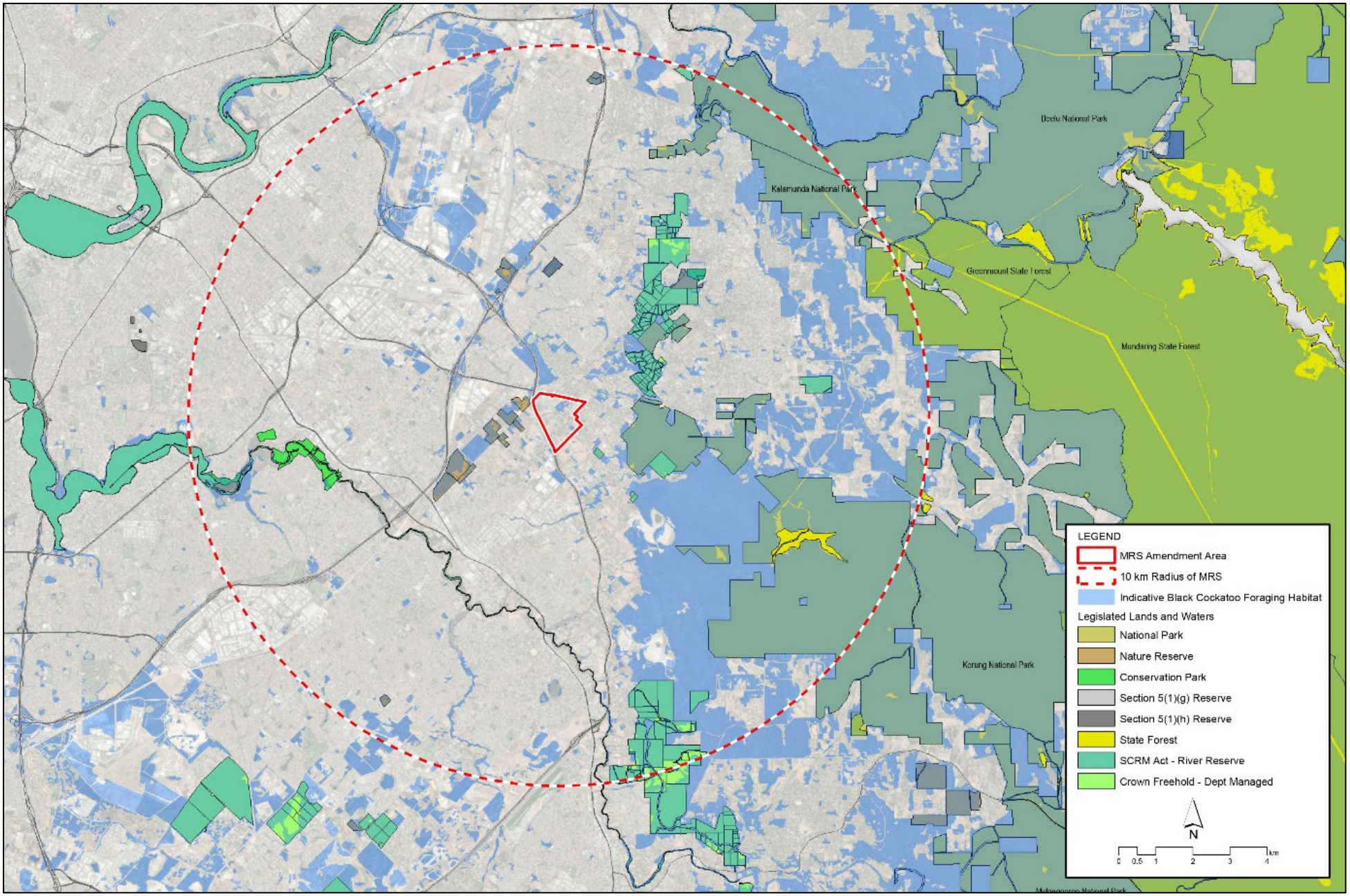

Figure 7-3: Regional black cockatoo Foraging Habitat

7.5.5.7 Regional context of black cockatoo foraging habitat

Figure 7-2 shows the regional context of black cockatoo foraging habitat. A total of 14,251 ha of potential black cockatoo foraging habitat has been identified within 12 km of the MRS amendment area extent, with 43% of this within the following DBCA managed reserves:

- Korung National Park (4,101.46 ha)
- Beelu National Park (1,016.77 ha)
- Greenmount State Forest (883.55 ha)
- Kalamunda National Park (375.60 ha)
- Greenmount National Park (70.44 ha)

The MRS amendment area comprises 0.03% of the potential foraging habitat within this extent, which is not considered significant in a regional context.

7.5.5.8 Black cockatoo foraging habitat in MRS amendment area

The MRS amendment area contains both native and introduced vegetation, of varying quality, some of which may be suitable for foraging for all three black cockatoo species, as described in Table 7.4. The suitability of this habitat for foraging varies, depending on the type of habitat and its condition.

AECOM (2020) previously assessed the black cockatoo foraging habitat for wider Wattle Grove area using the (then) DAWE (2017) draft referral guideline scoring tool. The factors applied to this scoring tool include foraging potential, connectivity, proximity to known breeding and roosting sites and plant disease and because all of these factors favour the site and therefore, within the MRS amendment area a larger area was considered to have Very High and High foraging habitat value for all 3 species of black cockatoo (Phoenix Environmental 2024). However, in reality the abundance of forage species is minimal for both high quality forage species such as *Banksia*, Marri and Pine (predominantly <10% foliage cover), as well as lower quality forage species such as small fruited eucalypts and introduced fruit trees (Phoenix Environmental 2024).

AECOM (2020) also recorded the presence of trees with potentially suitable nest hollows (in the south-west corner and along the eastern boundary of the MRS amendment area), which contributed towards a higher foraging habitat value score (as the DAWE (2017) scoring tool requires a factor of 3 to be added to the overall score if there are any trees with suitable nest hollows); however, upon closer inspection of the hollows by Phoenix Environmental during their site visit in January 2024 it was discovered that the trees did not contain any suitable hollows (see Section 7.5.5.10 for further discussion on the results of the hollow inspection).

As part of the further black cockatoo habitat assessment undertaken by Phoenix Environmental (2024) for the MRS amendment, area, the Bamford Consulting Ecologists (BCE) (2021) scoring system was used instead of the DAWE (2022) scoring tool.

Whilst the BCE (2021) scoring may derive a lower score than those presented in AECOM (2020), it is considered a more accurate depiction of the foraging habitat value and the predicted distribution (Phoenix Environmental 2024). Further, it takes into consideration the condition of the foraging habitat, whereas the former DAWE (2017) and current DAWE (2022) scoring tools do not include this as a factor. The presence of weeds and introduced forage species does provide an indication of low value forage habitat due to their sparse coverage and/or poor-quality food source and poor accessibility, especially when compared to native forage species found in remnant native patches which are generally higher in quality and abundance (Phoenix Environmental 2024).

Phoenix Environmental has used the data collected by AECOM (2020) and JBS&G (2024), which included site surveys undertaken by AECOM in 2019 and JBS&G in 2021 and 2022 and determined the foraging habitat value using the BCE (2021) scoring system for all three black cockatoos within the MRS amendment area.

At the time of the surveys undertaken by AECOM (2020) and JBS&G (2024), there were no records of fire and therefore, is unlikely to have impacted forage species coverage scores (Phoenix Environmental 2024).

The BCE (2021) scoring system provides a foraging value score that reflects the significance of vegetation as foraging habitat for black cockatoos and a numerical value that is designed to assess potential impact significance and offset requirements. The foraging value of the vegetation is dependent on the following components:

- Site condition – a score out of six is determined based on the vegetation composition, condition and structure.
- Site context – a score out of three is determined for the context of the site, which is a function of site size, availability of nearby habitat and breeding area, as well as consideration of connectivity to access foraging sites.
- Species stocking rate – a score out of one is determined based on upon the black cockatoo species being either abundant or not-abundant (i.e. a score of 1 is used when the species is reported regularly and/or there is abundant foraging evidence and a score of 0 is used when the species is recorded or reported very infrequently, and there is little or no foraging evidence).
- Determining the total score out of 10, which may require moderation for context and species density with respect to the site condition (vegetation) score. Moderation also includes consideration of pine plantations as a special case for foraging value

Site condition is scored out of 6 and is the biggest factor in the overall score. Site condition varied between species of black cockatoo and vegetation communities, with higher scores being attributed to those vegetation communities/habitats with a higher density of foraging species (Phoenix Environmental 2024).

The site context was assigned by Phoenix Environmental (2024) as 3 to all polygons, given:

- Carnaby's cockatoo: local breeding is also known and 32.9% of native vegetation remains within 15 km of the MRS amendment area.
- Baudin's cockatoo: no local breeding is known or likely, but 32.9% of native vegetation remains within 15 km of the MRS amendment area
- Forest Red-tailed black cockatoo: no local breeding is known or likely, but 32.9% of native vegetation remains within 15 km of the MRS amendment area.

The following stocking rates were calculated by Phoenix Environmental as:

- Carnaby's cockatoo: stocking rate = 1 as observed feeding and multiple recent and historic evidence of feeding activity were recorded (i.e. AECOM 2020; DBCA 2023; JBS&G 2024 and here).
- Baudin's cockatoo: stocking rate = 0 as no feeding was directly observed, nor was recent or historical evidence found and desktop records are also absent within 15 km of the MRS amendment area
- Forest Red-tailed black cockatoo: stocking rate = 1 as observed feeding and multiple recent and historic evidence of feeding activity were recorded (i.e. AECOM 2020; DBCA 2023; JBS&G 2024 and here).

The moderation values were applied to parts of the habitat polygons that did not record a known forages species (native or introduced) (Phoenix Environmental 2024).

The resultant site scores and how they were derived according to the vegetation community (Figure 6-3) for each black cockatoo species is provided in Table 7-7 for Carnaby's cockatoo, Table 7-8 for Baudin's cockatoo and Table 7-9 for Forest Red-tailed black cockatoo. The resultant foraging habitat scores for all three black cockatoos area according to the vegetation communities is presented in Table 7-10 and summarised in Table 7-11.

The spatial distribution of the foraging habitat value is show in Figure 7-3 (Carnaby's cockatoo), Figure 7-4 (Baudin's cockatoo) and Figure 7-5 (Forest Red-tailed black cockatoo).

Table 7-7: Site score for Carnaby's cockatoo (Phoenix Environmental 2024)

Vegetation community / site score with justification	2 (ha)	3 (ha)	5 (ha)	6 (ha)	8 (ha)	Total (ha)
BaEpPf				**0.82**	**3.41**	4.23
32.9% native veg. remaining (within 15 km). Local breeding confirmed (within 12 km).					3.41	3.41
32.9% native veg. remaining (within 15 km). Some foraging species present but moderated down due to degraded condition.				0.82		0.82
BmXpEc					**0.15**	**0.15**
32.9% native veg. remaining (within 15 km). Local breeding confirmed (within 12 km).					0.15 (pre clearing 0.29)	0.15
Cleared	**91.37**					**91.37**
32.9% native veg. remaining (within 15 km). But no foraging species present.	91.37 (pre clearing 91.23)					91.23
EmMpLp	**0.08**				**0.05**	**0.13**
32.9% native veg. remaining (within 15 km). But no foraging species present.	0.08					0.89
32.9% native veg. remaining (within 15 km). Local breeding confirmed (within 12 km).					0.05	0.05
Planted	**2.80**					**2.80**
32.9% native veg. remaining (within 15 km). But no foraging species present.	2.80					2.80
Trees	**20.43**	**5.84**	**0.59**	**0.05**		**26.91**
32.9% native veg. remaining (within 15 km). But no foraging species present.	20.43					20.43
32.9% native veg. remaining (within 15 km). Local breeding confirmed (within 12 km).			0.59			0.59
32.9% native veg. remaining (within 15 km). Some foraging species present but moderated down due to degraded condition.		5.84		0.05		5.89
Total (ha)	**114.68**	**5.84**	**0.59**	**0.87**	**3.61**	**125.59**

Table 7-8: Site score for Baudin's cockatoo (Phoenix Environmental 2024)

Vegetation community / site score with justification	2 (ha)	3 (ha)	4 (ha)	5 (ha)	7 (ha)	Total (ha)
BaEpPf	**0.82**			**1.34**	**2.07**	**4.23**
32.9% native veg. remaining (within 15 km). Foraging species present.				1.34		1.34
32.9% native veg. remaining (within 15 km). Foraging species present. Moderated down due to degraded condition.	0.82					0.82
32.9% native veg. remaining (within 15 km). Multiple foraging species present, veg in good or better condition.					2.07	2.08
BmXpEc					**0.15**	**0.15**
32.9% native veg. remaining (within 15 km). Multiple foraging species present, veg in good or better condition.					0.15 (pre clearing 0.29)	0.15
Cleared	**91.37**					**91.37**
32.9% native veg. remaining (within 15 km). Foraging species present. Moderated down due to degraded condition.	91.37 (pre clearing 91.23)					91.37
EmMpLp		**0.08**			**0.05**	**0.13**
32.9% native veg. remaining (within 15 km). Foraging species present. Moderated down due to degraded condition.		0.08				0.08
32.9% native veg. remaining (within 15 km). Multiple foraging species present, veg in good or better condition.					0.05	0.05
Planted		**2.80**				**2.80**
32.9% native veg. remaining (within 15 km).		2.80				2.80
Trees	**21.62**	**4.48**		**0.81**		**26.91**
32.9% native veg. remaining (within 15 km).		4.48				4.48
32.9% native veg. remaining (within 15 km). Foraging species present. Moderated down due to degraded condition.	21.62			0.81		22.44
Total (ha)	**113.81**	**7.36**	**0**	**2.15**	**2.27**	**125.59**

Table 7-9: Site score for Forest Red-tailed black cockatoo (Phoenix Environmental 2024)

Vegetation community / site score with justification	2 (ha)	3 (ha)	7 (ha)	8 (ha)	Total (ha)
BaEpPf		**0.82**		**3.41**	**4.23**
32.9% native veg. remaining				2.42	2.42
32.9% native veg. remaining (within 15 km). But Moderated down due to clearing, despite foraging species present.		0.82			0.82
32.9% native veg. remaining (within 15 km). No foraging species present.				0.99	0.99
BmXpEc			**0**	**0.15**	**0.15**
32.9% native veg. remaining (within 15 km)			0 (pre clearing 0.05)	0.15 (pre clearing 0.24)	0.15
Cleared	**91.37**				**91.37**
32.9% native veg. remaining (within 15 km). No foraging species present. Moderated down due to condition.	91.37 (pre clearing 91.23)				91.37
EmMpLp		**0.08**		**0.05**	**0.13**
32.9% native veg. remaining (within 15 km)				0.05	0.05
32.9% native veg. remaining (within 15 km). But Moderated down due to clearing, despite foraging species present.		0.08			0.08
Planted	**2.80**				**2.80**
32.9% native veg. remaining (within 15 km). No foraging species present. Moderated down due to condition.	2.80				2.80
Trees	**20.61**	**6.30**			**26.91**
32.9% native veg. remaining (within 15 km). But Moderated down due to clearing, despite foraging species present.		6.30			6.30
32.9% native veg. remaining (within 15 km). No foraging species present. Moderated down due to condition.	20.61				20.61
Total	**114.78**	**7.20**	**0.05**	**3.61**	**125.59**

Based on the density of suitable foraging species, most of the MRS amendment area (ranging from 95.96% for Carnaby's cockatoo to 97.01% for Forest Red-tailed black cockatoo) is comprised of low foraging habitat value for all three Black cockatoos (Table 7-11). The Banksia Woodland (BaEpPf and BmXpEc) and Eucalyptus Woodland (EmMpLp) scored the highest at either 7 or 8 out of 10. There were some discrete areas that were of medium foraging habitat value for Carnaby's cockatoo (located on Lot 801 and Lot 2) and Baudin's cockatoo (located on Lots 84, 504, 803 and 804).

Given the results of the habitat assessment, Phoenix Environmental (2024) recommended that all of the high-quality TEC remnant vegetation present within the MRS amendment area is retained to support local breeding, roosting and foraging for Carnaby's cockatoo and Forest Red-tailed black cockatoo as the remaining areas offer little value to those species.

Areas that have been subject to clearing or development have been mapped as 'Cleared', and include the recent clearing on Lots 8 and 9. As a result, the areas provided in the table below will have a minor variation to the areas presented in Phoenix Environmental's (2024) black cockatoo habitat assessment memo (Appendix F).

Table 7-10: Black cockatoo foraging habitat value per BCE 2021 scoring method

Vegetation community	Rating*	Carnaby's cockatoo		Baudin's cockatoo		Forest Red-tailed black cockatoo	
		Score	Sum area (ha)	Score	Sum area (ha)	Score	Sum area (ha)
BaEpPf	Low	-	0	2	0.82	3	0.82
	Medium	6	0.82	5	1.34	-	0
	High	8	3.41	7	2.07	8	3.41
BmXpEc	High	-	0	7	0.15 (pre clearing 0.29)	7	0 (pre clearing 0.05)
		8	0.15 (pre clearing 0.29)	-	0	8	0.15 (pre clearing 0.24)
EmMpLp	Low	2	0.08	3	0.08	3	0.08
	High	8	0.05	7	0.05	8	0.05
Trees	Low	2	20.43	2	21.62	2	20.61
		3	5.84	3	4.48	3	6.30
	Medium	5	0.59	5	0.81	-	0
		6	0.05	-	0	-	0
Planted	Low	2	2.80	3	2.80	2	2.80
Cleared	Low	2	91.37 (pre clearing 91.23)	2	91.37 (pre clearing 91.23)	2	91.37 (pre clearing 91.23)
Total area (ha)		125.59		125.59		125.59	

*** Relative Rating**

- Low value habitat (red) is 1 to 3 out of 10
- Medium value habitat (yellow) is 4 to 6 out of 10
- High value habitat (green) is 7 to 10 out of 10

Table 7-11: Summary of foraging habitat scores per black cockatoo species

Score		Carnaby's cockatoo		Baudin's cockatoo		Forest Red-tailed black cockatoo	
		Area (ha)	%	Area (ha)	%	Area (ha)	%
Low	2	114.68	91.32	113.81	90.63	114.78	91.39
	3	5.84	4.65	7.36	5.79	7.20	5.73
Subtotal		120.52	95.97	121.17	96.49	121.97	97.13
Medium	5	0.59	0.47	2.15	1.70	-	-
	6	0.87	0.69	-	-	-	-
Subtotal		1.46	1.16	2.15	1.70	-	-
High	7	-	-	2.27	1.81	0.00	-
	8	3.61	2.87	-		3.61	2.87
Subtotal		3.61	2.87	2.27	1.81	3.61	2.87
Total area (ha)		125.59	100.00	125.59	100.00	125.59	100.00

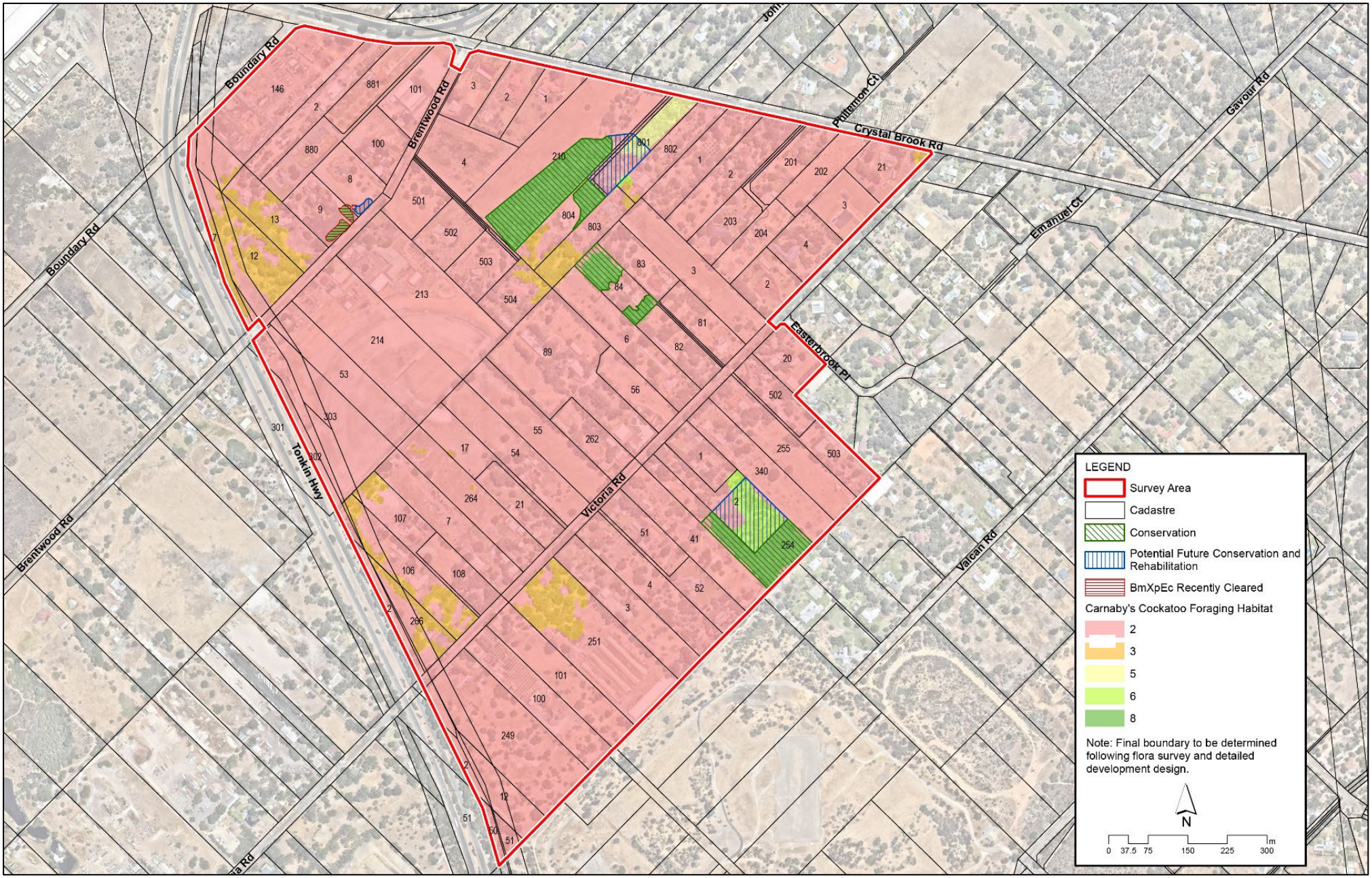

Figure 7-4: Carnaby's cockatoo foraging habitat

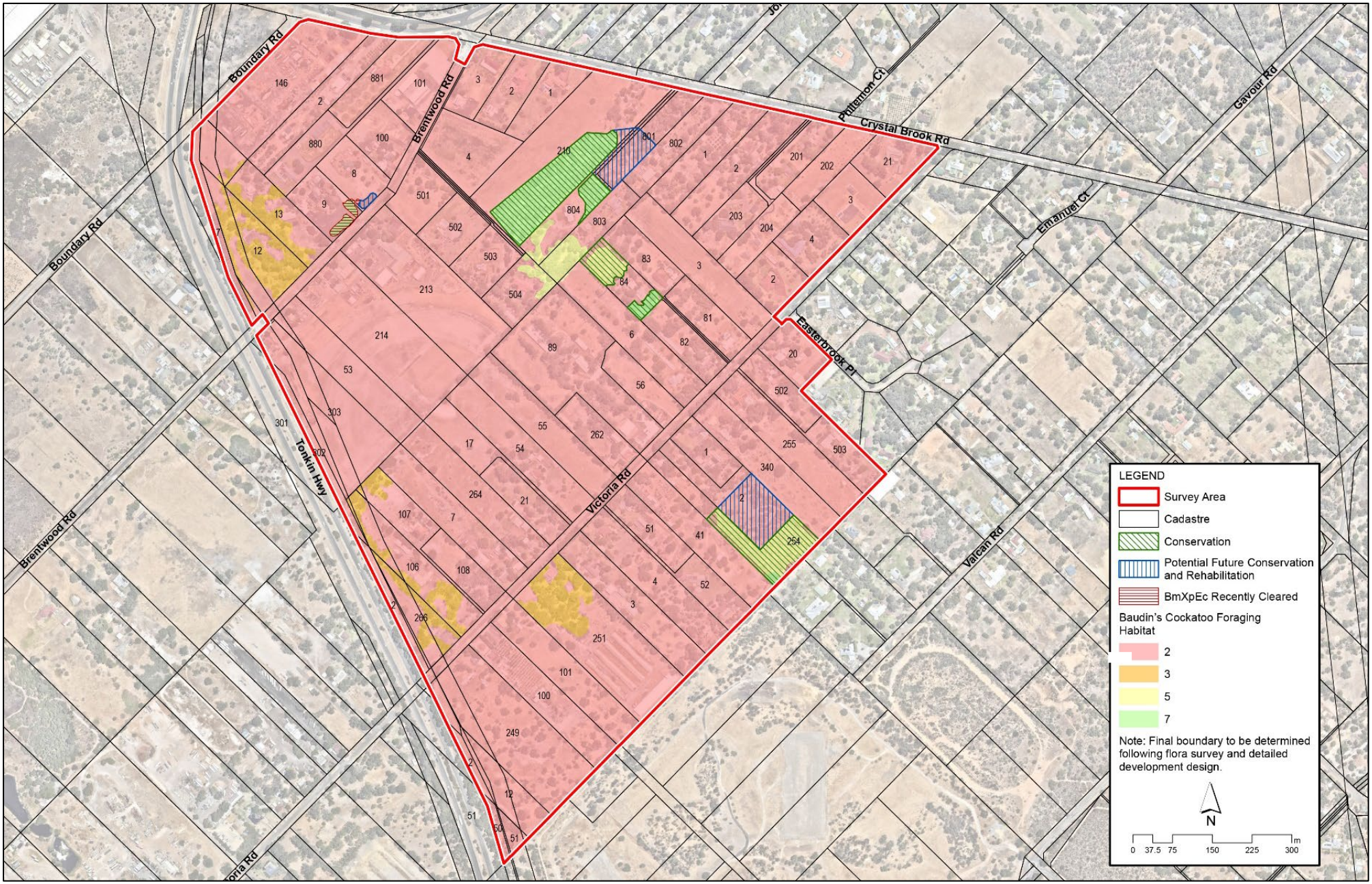

Figure 7-5: Baudin's cockatoo foraging habitat

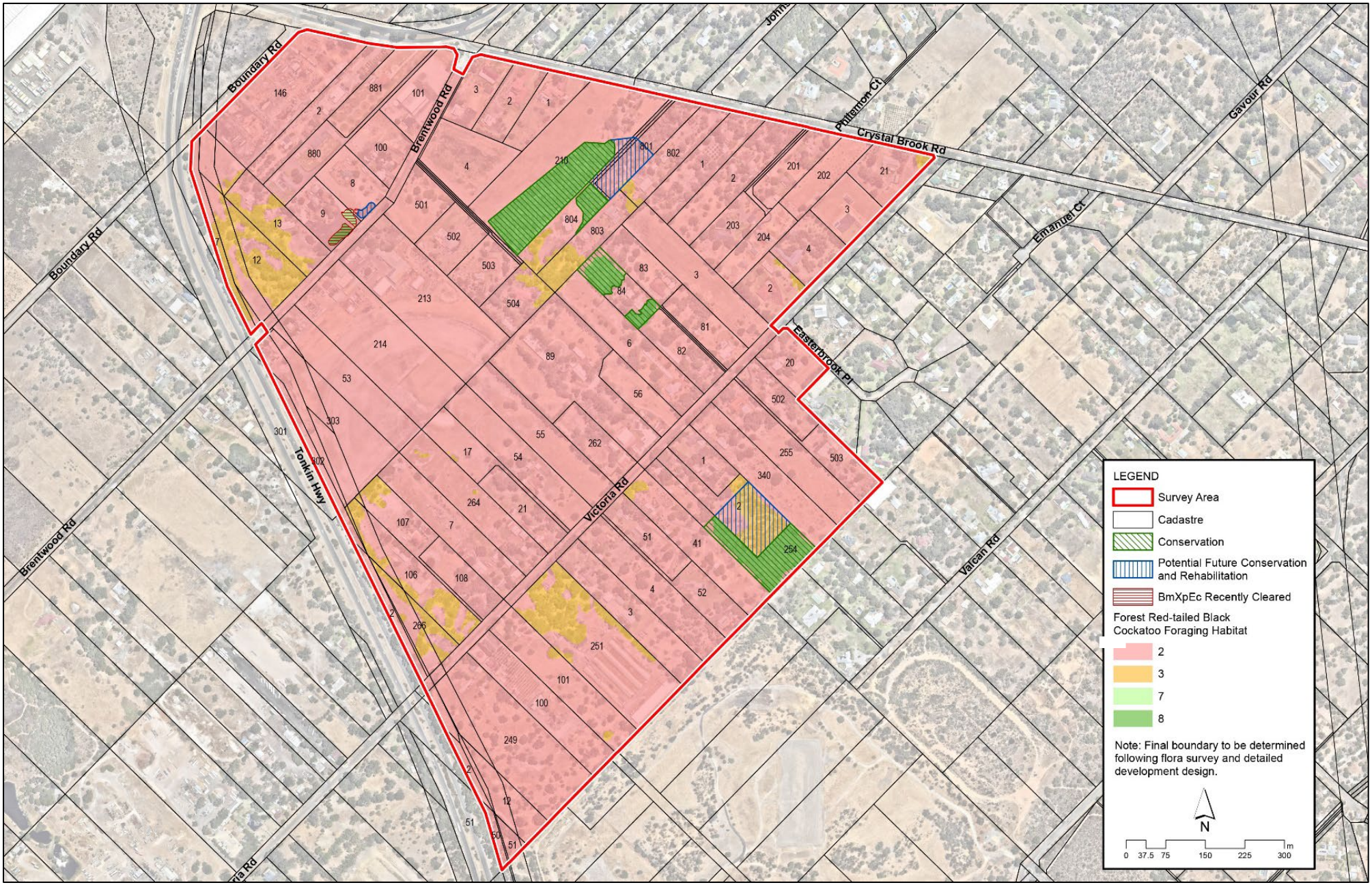

Figure 7-6: Forest Red-tailed black cockatoo foraging habitat

7.5.5.9 Black cockatoo breeding habitat

Potential nesting trees, in the context of black cockatoos, are defined by DAWE (2022) as trees of suitable species with a diameter at breast height (DBH) greater than 500 mm (or >300 mm for Salmon Gum and Wandoo). Trees with a DBH greater than 500 mm (or >300 mm for Salmon Gum and Wandoo) are large enough to potentially contain hollows suitable for nesting black cockatoos or have the potential to develop suitable hollows over the next 50 years.

Table 7-12 lists the potential nesting trees species for black cockatoos and those that have been recorded within the MRS amendment area. A total of 153 potential nesting trees occur within the MRS amendment area (Phoenix Environmental 2024) (Figure 7-6 and Appendix F).

The majority of potential nesting trees are scattered in areas of degraded habitat or cleared land/paddocks and consist of native trees known to support breeding such as Jarrah, Marri, Tuart and Flooded Gums (Phoenix Environmental 2024).

Table 7-12: Black cockatoo potential nesting tree species recorded in MRS amendment area

Scientific name	Common name	Recorded in MRS amendment area
Corymbia calophylla	Marri	24
Eucalyptus accedens	Powderbark	-
Eucalyptus diversicolor	Karri	-
Eucalyptus gomphocephala	Tuart	24
Eucalyptus longicornis	Red Morrell	-
Eucalyptus loxophleba	York Gum	-
Eucalyptus marginata	Jarrah	93
Eucalyptus megacarpa	Bullich	-
Eucalyptus occidentalis	Swamp Yate	-
Eucalyptus patens	Blackbutt	3
Eucalyptus rudis	Flooded Gum	6
Eucalyptus salmonophloia	Salmon Gum	-
Eucalyptus salubris	Gimlet	-
Eucalyptus wandoo	Wandoo	-
	Introduced species	2
	Stag	1

Source: Groom 2011, DSEWPaC 2012

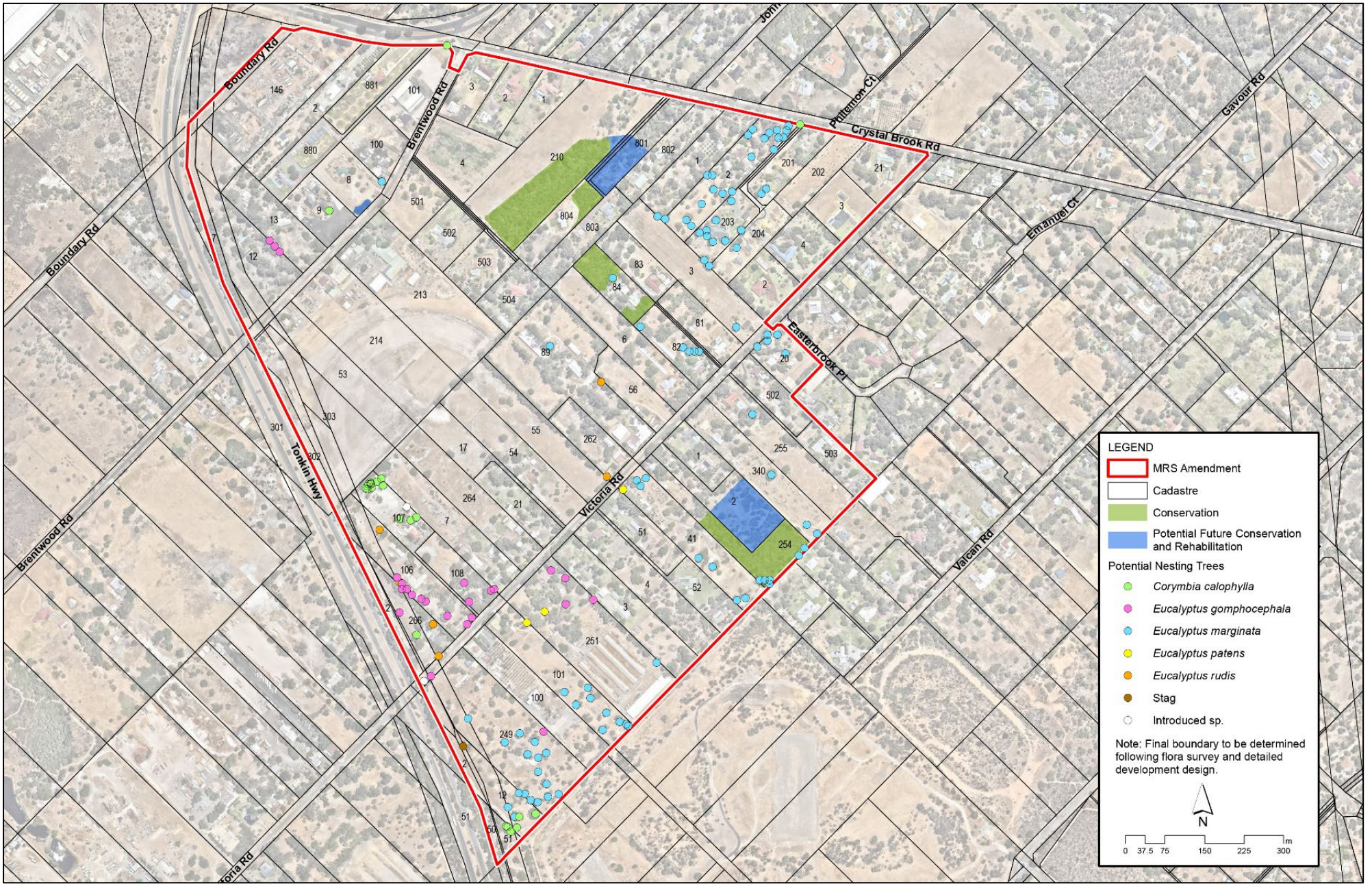

Figure 7-7: Black cockatoo potential nesting trees

Tree hollow inspection

As part of Phoenix Environmental (2024) analysis of the black cockatoo data collected from the site surveys by AECOM (2020) and JBS&G (2020), seven potential nesting trees were identified as requiring re-inspection to confirm location and suitability of hollows as nests for black cockatoos (Appendix F). Subsequently, Phoenix Environmental (2024) inspected the seven potential nesting trees on 19 January 2024 (Figure 7-8). The hollows considered potentially suitable were inspected with a GoPro pole camera and the following details were recorded (Phoenix Environmental 2024):

- tree species
- DBH
- number of hollows present
- hollow height and orientation
- hollow suitability (e.g. size of entrance, condition of outside of the hollow)
- evidence of use.

In summary, none of the inspected trees are suitable for black cockatoo nesting, and of the seven trees visited (Phoenix Environmental 2024) (Appendix F):

- two are considered to be erroneous and should be removed from the dataset (NewID = 0)
- habitat tree 417 is no longer present; given its age and comments, it is assumed that this tree had deteriorated
- habitat tree 482 was in poor condition and no longer contained suitable hollows
- the remaining three trees (438, 491, 561) contained unsuitable hollows (too small and/or inhabited by bees). It is worthwhile to note that abundant forging evidence was seen under habitat tree 491.

In order to be suitable for black cockatoos, hollow entrances need to be at least 100 mm in diameter. Hollows in Jarrah tend to be smaller than those found in Marri, consequently black cockatoos, particularly Forest Red-tailed black cockatoos, breed predominantly in Marri, in the Jarrah-Marri forest of the south-west (Whitford 2002; Johnstone *et al* 2013). On the Swan Coastal Plain most black cockatoo breeding records, particularly for Carnaby's cockatoo, are in Tuart (Johnstone and Kirkby 2011).

Given the semi-urban nature of the local environment and the outcome of the hollow inspection undertaken by Phoenix Environmental (2024), it is unlikely that the MRS amendment area represents breeding habitat for any of the 3 black cockatoo species especially in the absence of confirmed or historic breeding observations and the absence of any trees with suitable hollows.

The MRS amendment area does contain small areas of high-quality foraging habitat, as well as water sources and roosting site in close proximity, and so whilst the MRS amendment area could be considered high quality future breeding habitat, the MRS amendment area comprises semi-rural residential land that has been heavily developed and highly modified (Phoenix Environmental 2024). Subsequently, numerous potential nesting trees have been lost over the past few years due to age and condition and therefore, in the consideration of the current land use, it is considered highly unlikely that the current crop of trees will still be standing in 50 to 100 years, which is when they may begin to develop larger hollows suitable for breeding (Phoenix Environmental 2024).

Figure 7-8: Potential nesting trees inspected (Phoenix Environmental 2024)

7.5.5.10 Black cockatoo roosting habitat

Carnaby's and Baudin's cockatoos roost in or near riparian environments or near other permanent water sources, generally within any tall trees, but particularly Flat-topped Yate, Salmon Gum, Wandoo, Marri, Karri, Blackbutt, Tuart, introduced Eucalypts and introduced Pines. The Forest Red-tailed black cockatoo prefers the edges of forests for roosting, within any tall trees, but particularly tall Jarrah, Marri, Blackbutt, Tuart and introduced Eucalypt trees (DotEE 2017).

Within 12 km of the MRS amendment area, there are 50 confirmed roosting sites (23 Forest Red-tailed black cockatoo roosting sites, 7 White tailed black cockatoo roosting sites and 20 White-tailed and Forest Red-tailed roosting sites) and 10 unconfirmed roosting sites (Figure 7-8) (Birdlife 2024, as cited in Phoenix Environmental 2024)).

Located 250 m east from the MRS amendment area is an unconfirmed roosting site (KALWATR001), which means roosting black cockatoos have been provided but there has been no positive count recorded during any of the Great Cocky Count census (Birdlife 2024, as cited in Phoenix Environmental 2024). The following 2 roosting sites occur to the east and are within 1 km of the MRS amendment area (Figure 7-8) (Phoenix Environmental 2024):

- Confirmed site (KALWATR002) is located 850 m east of the MRS amendment area and is known to support FRTBC roosting of up to 150 individuals (Great Cocky Count Census 2016, 2018) (DBCA 2023), with lower numbers recorded in subsequent years (2019 – 23, 2021 – 87, 2022 – 0 and 2023 – 35).
- Unconfirmed site (KALWATR001) is located 250 m east of the MRS amendment area. An unconfirmed black cockatoo roosting site is where roosting has been reported but there has been no positive count recorded during any of the Great Cocky Count census (Birdlife 2024, as cited in Phoenix Environmental 2024).

The habitat assessment undertaken by AECOM (2020) determined that 29.8 ha of suitable roosting habitat was present, consisting of remnant native vegetation, planted gardens and scattered trees; however, these have been found to be of largely low value (Phoenix Environmental 2024).

Numerous surveys have been undertaken within the MRS amendment area since 2019, as well as numerous sites in close proximity are part of annual black cockatoo monitoring, and to date no roosting sites for black cockatoo species have been identified within the MRS amendment area (Figure 7-8). So, while there may be suitable roosting habitat, it does not appear to be used as such, at least not for the last decade (Phoenix Environmental 2024).

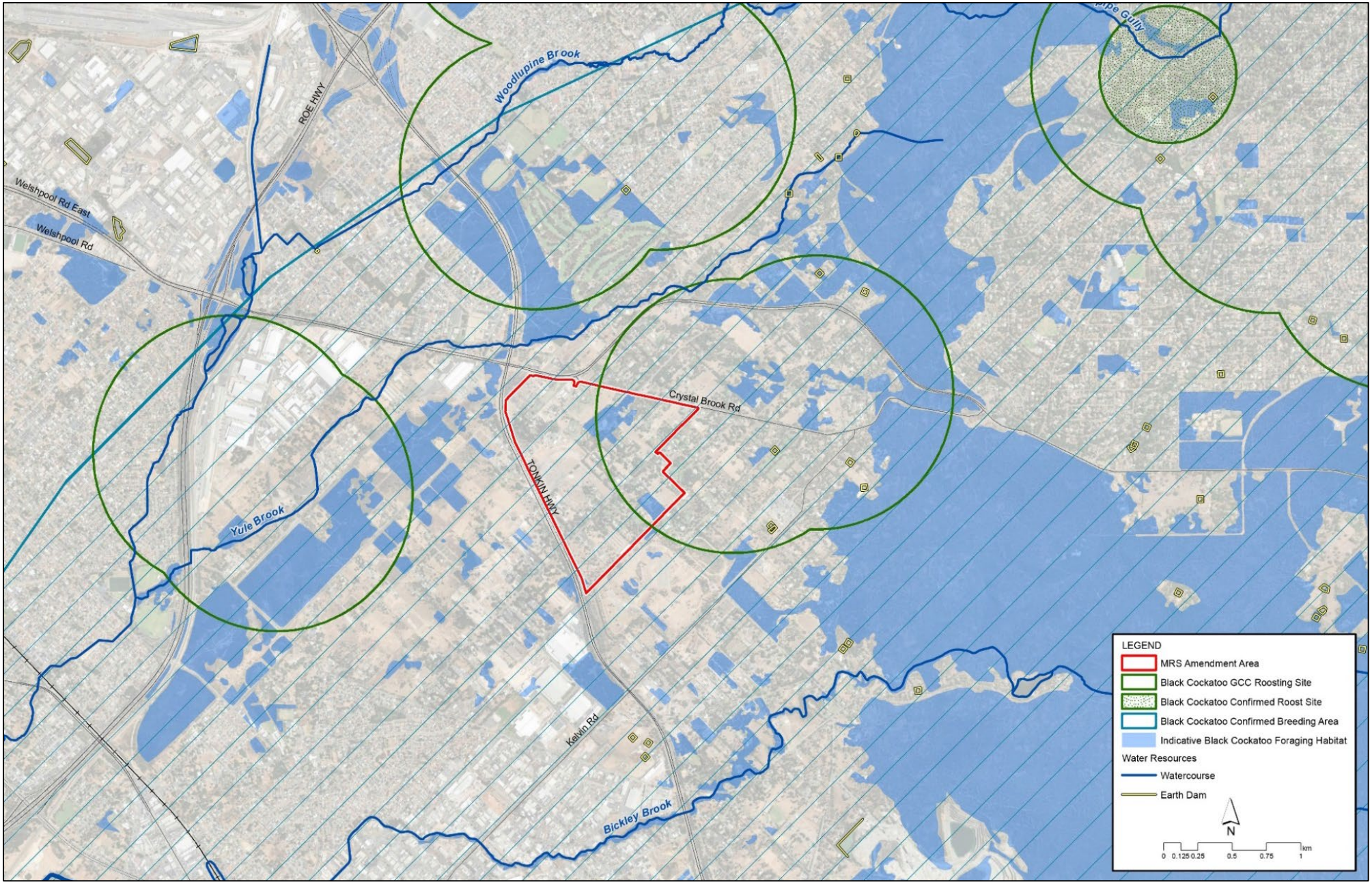

Figure 7-9: Black cockatoo roosting sites and water resources

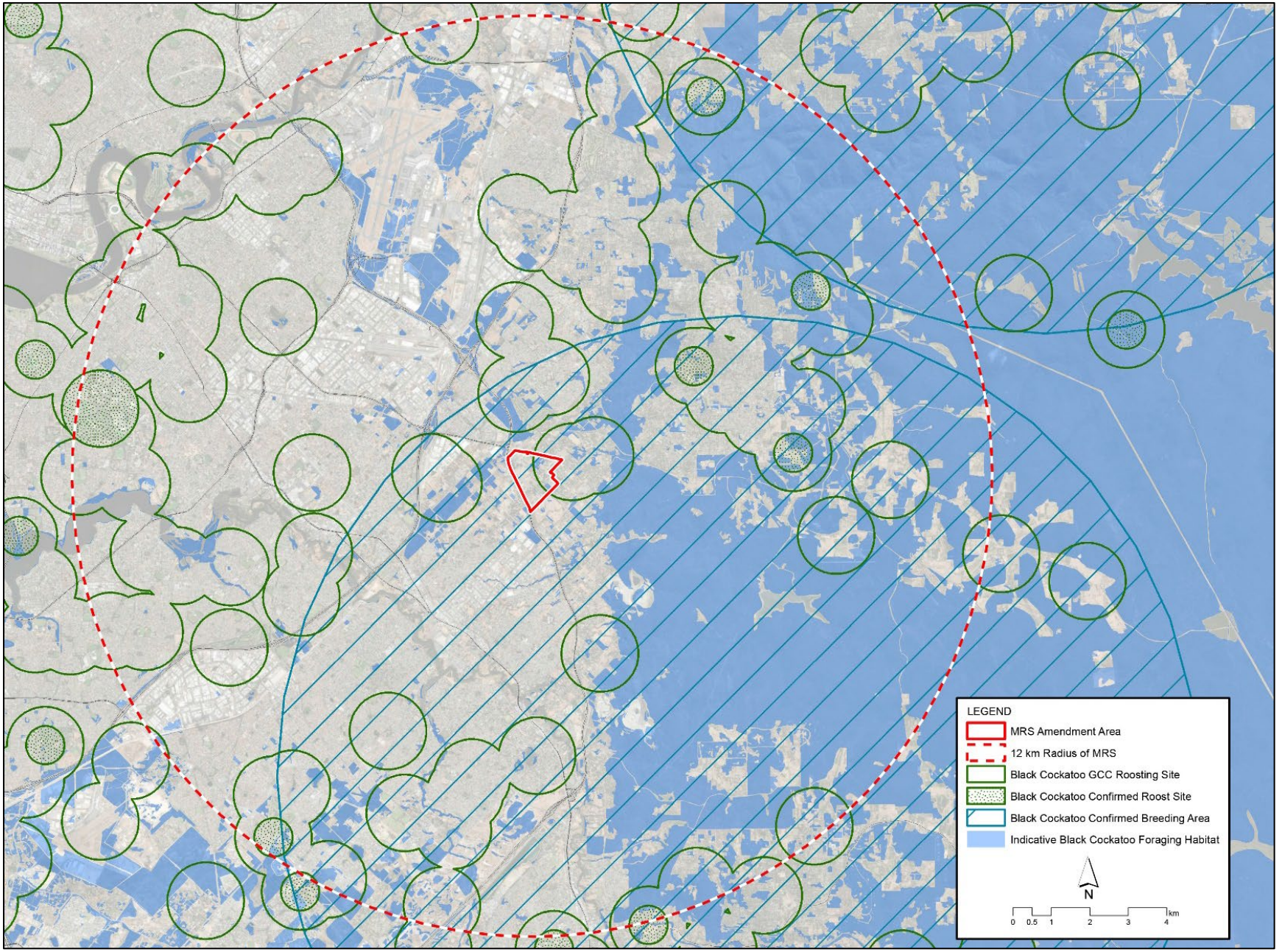

Figure 7-10: Black cockatoo roosting and breeding sites (within 12 km)

7.6 Potential environmental impacts

Future urban development as well as the provision of associated infrastructure, within the MRS amendment area has the potential to directly and indirectly impact conservation significant fauna that may utilise habitat within the area, namely back cockatoos and quenda. As outlined in the ER Instructions, potential impacts include:

- Loss of significant fauna habitat including black cockatoo breeding, roosting and foraging habitat.
- Direct or indirect impacts or loss of other significant fauna and fauna habitat found to be present during survey.
- Fragmentation of fauna habitat and loss of ecological connectivity.
- Degradation of fauna habitat and habitat modification from introduction and increased spread of weeds and/or disease, altered surface water flows, altered groundwater and edge effects.
- Fauna mortality as a result of construction activities.
- Disturbance to waterbirds (including migratory species) from impacts to wetlands.
- Altered fauna behaviour due to noise, lighting and human presence.
- Change in feral animal abundance and/or movement.

Direct impacts are predominantly limited to clearing activities during development. Indirect impacts may also occur as a result of construction activities during the development phase, or as a result of increased population and human activity in the post development phase.

The potential impacts to conservation significant fauna are presented below.

7.6.1 Direct Impacts

7.6.1.1 Clearing of Fauna Habitat

The clearing of native and non-native vegetation within the MRS amendment area has the potential to directly impact conservation significant fauna, through the loss and/or dispersal of breeding and foraging habitat.

The exact extent of vegetation clearing that may occur to facilitate future urban development is not known at this stage. Therefore, direct impacts to conservation significant fauna and fauna habitat have been considered in the context of the most conservative scenario of vegetation clearing, to inform future stages of the planning process.

The most conservative scenario assumes that the areas of remnant native vegetation that have already been identified for retention in this ER will not be cleared (including 4.16 ha of Banksia Woodlands and 0.05 ha of Eucalyptus Woodland containing Good or better condition vegetation) and that all other existing vegetation within the MRS amendment area will be cleared.

In relation to black cockatoo foraging habitat, Table 7-10 lists the foraging habitat score for each black cockatoo species and those that will be retained in Conservation areas. The areas provided also accounts for the clearing that recently took place on Lots 8 and 9 Brentwood Road and the mapping discrepancy on Lot 2 Victoria Road. The table demonstrates that all areas containing high quality foraging habitat for all three black cockatoos will be retained for conservation.

Table 7-13: Foraging habitat value per black cockatoo species in Conservation

Score		Carnaby's cockatoo			Baudin's cockatoo			Forest Red-tailed black cockatoo		
		MRS amendment area	Conservation	Potential Future Conservation and Rehab.	MRS amendment area	Conservation	Potential Future Conservation and Rehab.	Extent in MRS amendment area	Conservation	Potential Future Conservation and Rehab.
Low	2	114.68 ha (91.32%)	-	0.05 ha (0.04%)	113.81 ha (90.63%)		0.79 ha (0.63%)	114.78 ha (91.39%)	-	0.05 ha (0.04%)
	3	5.84 ha (4.65%)	-		7.36 ha (5.79%)	-		7.20 ha (5.73%)		0.74 ha (0.59%)
Subtotal		120.52 ha (95.97%)	-		121.17 ha (96.48%)			121.97 ha (97.12%)	0.60 ha (0.48%)	
Medium	5	0.59 ha (0.47%)	-		2.15 ha (1.71%)	1.34 ha (1.06%)		-	-	
	6	0.87 ha (0.69%)		0.74 ha (0.59%)	-	-		-	-	
Subtotal		1.46 ha (1.16%)			2.15 ha (1.71%)	1.34 ha (1.06%)		-	-	
High	7	-	-		2.27 ha (1.81%)	2.27 ha (1.81%)		-	-	
	8	3.61 ha (2.88%)	3.61 ha (2.87%)		-			3.61 ha (2.87%)	3.61 ha (2.87%)	
Subtotal		3.61 ha (2.88%)	3.61 ha (2.87%)		2.27 ha (1.81%)	2.27 ha (1.81%)		3.61 ha (2.87%)	3.61 ha (2.87%)	
Total		125.59 ha (100%)	3.61 ha (2.87%)	0.79 ha (0.63%)	125.59 ha (100%)	3.61 ha (2.87%)	0.79 ha (0.63%)	125.58 ha (100%)	3.61 ha (2.87%)	0.79 ha (0.63%)

The results of the most conservative clearing scenario are presented in Table 7-14 and are summarised as follows:

- Clearing 0.72 ha and 0.80 ha of medium quality foraging habitat for Carnaby's cockatoo and Baudin's cockatoo, respectively, represents 0.006% of black cockatoo foraging habitat within 12 km of the MRS amendment area, this. Whereas, clearing of low-quality foraging habitat for Carnaby's cockatoo (29.28 ha), Baudin's cockatoo (29.93 ha) and Forest Red-tailed black cockatoo (30.74 ha) represents approximately 0.2% of the existing black cockatoo foraging habitats within 12 kms of the MRS amendment area.
- Most areas to be developed comprise of Cleared or highly modified land that has to be categorised as low-quality foraging habitat with 120.51 ha (95.97%) for Carnaby's cockatoo, 121.16 ha (96.48%) for Baudin's cockatoo and 121.97 ha (97.12%) for Forest Red-tailed black cockatoo.
- Clearing of 0.16 ha of Degraded to Completely Degraded condition Banksia Woodlands, representing habitat for quenda.
- Clearing of individual scattered trees dispersed across 26.9 ha of disturbed land, representing low quality habitat for quenda due to the predominant absence of dense understorey.
- Clearing of individual trees and plants dispersed within 2.8 ha of planted and maintained gardens, with low quality foraging habitat for all three black cockatoo species but offering some potential habitat for quenda.
- Of the individual trees that are proposed to be cleared, 146 trees are potential nesting trees of which none have suitable breeding hollows.

Mitigation measures for this most conservative clearing scenario are presented in Section 7.7.

Table 7-14: Fauna habitat retained within conservation areas and potential maximum clearing impact (most conservative clearing scenario)

Habitat	Habitat values	Area	Retained within Conservation and Potential Future Conservation and Rehabilitation	Potential maximum clearing impact
Banksia Woodlands	• Low, medium and high-quality foraging habitat for Carnaby's cockatoo and Baudin's cockatoo. • Low- and high-quality foraging habitat for the Forest Red-tailed black cockatoo. • 3 potential nesting trees for black cockatoos. • Habitat for quenda.	4.51 ha	4.35 ha (96% of all remnant native vegetation) of which includes: • 3.56 ha of Good to Excellent condition vegetation • Medium to high quality foraging habitat for Carnaby's cockatoo and Baudin's cockatoo • Low- and high-quality foraging habitat for Forest Red-tailed black cockatoo • 3 potential nesting trees for black cockatoos • Habitat for quenda	0.16 ha (4% of all remnant native vegetation) of: • Degraded to Completely Degraded condition vegetation • Low quality foraging habitat Baudin's and Forest Red-tailed black cockatoo • Low and medium quality foraging habitat for Carnaby's • 0 potential nesting trees for black cockatoos • Habitat for quenda
Eucalyptus Woodlands	• High quality foraging habitat for all three black cockatoo species. • 4 potential nesting trees for black cockatoos. • Habitat for quenda.	0.05 ha	0.05 ha of which includes: • High quality foraging habitat for all three black cockatoo species. • 4 potential nesting trees for black cockatoos. • Habitat for quenda	0 ha
Scattered Trees	• Low quality foraging habitat for all 3 black cockatoo species. • 0.72 ha and 0.80 ha of medium quality foraging habitat for Carnaby's cockatoo and Baudin's cockatoo, respectively • Comprising 140 potential nesting trees for black cockatoos. • Low quality habitat for quenda due to the absence of dense understorey.	26.90 ha	0.32 ha of which includes: • Medium to low quality foraging habitat for Carnaby's cockatoo • Low quality foraging habitat for Baudin's cockatoo and Forest Red-tailed black cockatoo	26.58 ha of individual trees (both native and introduced species) scattered across the MRS amendment area, which comprise: • mostly low-quality foraging habitat for all three black cockatoos • 0.72 ha and 0.80 ha of medium quality foraging habitat for Carnaby's and Baudin's cockatoo, respectively • 140 potential nesting trees for black cockatoos • Low quality habitat for quenda due to the absence of dense understorey.
Planted and Maintained Gardens	• Low quality foraging habitat for all 3 black cockatoo species. • 6 potential nesting trees for black cockatoos. • Potential habitat for quenda.	2.80 ha	0 ha	2.8 ha of trees and plants (both native and introduced species) dispersed across planted gardens in the MRS amendment area, which comprise: • low quality foraging habitat for all three black cockatoos • 6 potential nesting trees for black cockatoos • Potential habitat for quenda
Cleared Ground	• Low quality foraging habitat for all 3 black cockatoo species. • Nil to negligible quality habitat for quenda.	91.32 ha	N/A	N/A
Total			4.72 ha	29.54 ha

7.6.1.2 Accidental and incidental clearing during construction

Construction activities associated with urban development typically include temporary site works, such as the construction of limestone haul roads for construction vehicles and machinery, which at times can necessitate incidental clearing of fauna habitat. At other times, areas of habitat that are earmarked for retention in a new development can be accidentally cleared during construction if the appropriate management measures are not in place.

Incidental and accidental clearing of vegetation during construction can be avoided and through the Environmental Management Framework which will require the preparation, approval and implementation of CEMP(s), at subsequent stages of the planning process (i.e. subdivision and/or development) and during construction works.

7.6.1.3 Fauna injury or mortality

Activities associated with the clearing of vegetation also have the potential to directly impact fauna through injury or mortality, as a result of vehicle and machinery movements during clearing. This can also be avoided through the Environmental Management Framework which will require preparation, approval and implementation of CEMP(s) at subsequent stages of the planning process (i.e. subdivision and/or development) and during construction works.

7.6.2 Indirect impacts

The inhabitants of new urban communities have the potential to indirectly impact on fauna and fauna habitat through uncontrolled access (by vehicles and pedestrians), littering, dumping, the introduction of feral and predatorial animals and through the spread of weeds or disease and increased fire risk. Many of these impacts may also occur during construction activities during the development phase.

Other potential indirect impacts of urbanisation of the MRS amendment area include fragmentation of fauna habitat, dust deposition and erosion. Consideration of these potential indirect impacts is provided below.

It should be noted that all indirect impacts as a result of urbanisation of the MRS amendment area can be managed through the Environmental Management Framework which will require the preparation, approval and implementation of CEMP(s), at subsequent stages of the planning process (i.e. subdivision and/or development) and during construction works.

7.6.2.1 Fragmentation of fauna habitat and edge effects

Fragmentation is the process by which contiguous areas of habitat are interrupted or separated into two or more smaller areas. The outcome from fragmentation is changes to fauna movement patterns and the impact it has on their ability to disperse. Fragmentation can result in genetic isolation and increased pressure for limited resources. Ultimately, fragmentation leads to a reduction in ecological integrity and a species resilience.

The MRS amendment area comprises significantly altered areas, including cleared, planted and handstand areas, with approximately 91.23 ha (73%) of land already cleared. Areas of remnant native vegetation with moderate to high fauna habitat value within the MRS amendment area are small, comprising approximately 3.6% of the total area. All other vegetation types within the MRS amendment area are highly disturbed and have low fauna habitat value.

Therefore, new urban development from the proposed change in land use will not cause fragmentation of the remaining areas of native vegetation with moderate to high fauna habitat value,

as they are proposed to be retained in their entirety within future Conservation areas, thereby ensuring no further fragmentation will occur.

In relation to edge effects, given the high level of fragmentation that has already occurred around the remaining areas of remnant vegetation and associated fauna habitat within the MRS amendment area there is potential for additional edge effects as future urban development proceeds.

As previously advised, the Environmental Management Framework will ensure the remaining areas of native vegetation with high fauna habitat value be placed within Conservation areas along with the preparation, approval and implementation of CAMP(s) which will ensure that no further fragmentation of the surviving areas of intact remnant native vegetation occurs and that edge effects are adequately managed within the MRS amendment area (refer to Section 7.7).

7.6.2.2 Ecological linkages

Ecological corridors have been identified in the Perth metropolitan region to limit the effects of fragmentation across areas of remnant bushland. As previously identified, there is one Regional Ecological Linkage at the north-westernmost extent of the MRS amendment area (Link ID: 40), which connects the GBSW and the Hartfield Road Bushland (WALGA 2008) **(**Figure 1-3**)**; however, the small portion of this Regional Ecological Linkage which falls within the MRS amendment area (over portions of Lot 146 Welshpool Road East and Lot 12 Brentwood Road) has been predominantly cleared.

Notwithstanding the above, the Environmental Management Framework will require the preparation of a Tree Canopy Retention and Landscape Management Strategy to inform local structure planning, and then preparation, approval and implementation of Tree Canopy Retention and Landscape Management Plan(s) at subdivision and development to ensure the as many trees are retained within the urban landscape, as well as prioritising the retention and revegetation of black cockatoo habitat trees (refer to Section 7.7).

Therefore, urbanisation of the MRS amendment area will not impact the ecological linkage, and any functions currently facilitated by the linkage will still be maintained and could be enhanced.

7.6.2.3 Hydrological changes

As previously discussed, urbanisation could result in an increase groundwater levels due to reduced evapotranspiration and greater infiltration and recharge of the superficial aquifer, via runoff from roads, roofs and other hard surfaces. The level of groundwater rise is dependent upon a range of factors.

Groundwater contours at the MRS amendment area (in the existing pre-development environment), range from approximately 16 m AHD in the north-eastern region to approximately 19 m AHD on the western boundary, with a regional groundwater depth ranging from 4 m to 20 m below natural surface. Due to this significant separation distance that exists between groundwater and vegetation, it is very unlikely that vegetation within the MRS amendment area is groundwater dependent.

Modelling of the post development environment has predicted that reduced evapotranspiration and increased infiltration as a result of urbanisation will increase groundwater recharge to the superficial aquifer by 66,275 kL/year. This increase in recharge due to the physical changes associated with urbanisation is not as large as would normally be expected with urbanisation as it is offset by a reduction in recharge to the superficial aquifer that had been occurring at the turf farm on Brentwood Road.

The currently disused turf farm has a groundwater abstraction licence for up to 176,000 kL/year and was abstracting groundwater (for irrigation purposes) from the deeper Leederville aquifer. Following

application of irrigation water from the Leederville aquifer, it infiltrated downwards into the superficial aquifer and was being retained there. This is due to the presence of a layer of Kardinya Shale between the two aquifer systems, which impedes the downward movement of irrigation water from the superficial aquifer to the deeper Leederville aquifer, resulting in groundwater mounding in the superficial aquifer over the long term.

This artificial recharge of the superficial aquifer that is taking place in the pre-existing environment will cease to occur when the MRS amendment area is urbanised and now that operations at the turf farm have ceased. Therefore, any new artificial recharge that occurs following urbanisation is not expected to result in a significant increase in groundwater levels within the superficial aquifer. In the vicinity of the former turf farm, post development stormwater runoff can be managed to maintain the existing annual recharge in the area of the mound to retain groundwater flows and direction toward GBSW.

Given that the depth to groundwater within the MRS amendment area is already several metres below natural surface and it has been predicted that the physical process of urbanisation will not lead to a significant rise in groundwater levels, it is therefore not expected there will be any hydrological impacts on remnant vegetation and associated fauna habitats within the MRS amendment area due to the proposed change in land use from Rural to Urban.

Furthermore, the findings of this ER and the extensive studies that have been undertaken demonstrate there will be no significant impacts to current surface and groundwater cycles (see Section 5.5) and therefore, no significant impacts to fauna habitats associated with wetlands and riparian vegetation, and groundwater dependent ecosystems within and nearby to the MRS amendment area (including the GBSW) are anticipated.

7.6.2.4 Disturbance to waterbirds (including migratory species) from impacts to wetlands

Within the MRS amendment area, the wetland assessment of the two REWs (UFI 8037 and portion of UFI 15257) drew the following conclusions based on the historical anthropogenic impacts and land uses:

- No wetland/groundwater dependent riparian communities or habitat for aquatic dependent fauna are present within the two REWs.
- The dominant land uses within the mapped wetland (UFI 8037 and portion of UFI 15257) which contributed towards the clearing of remnant native vegetation and the infilling of these wetland areas include:
    - Disused commercial turf area. The turf farm land use was responsible for infilling a portion of REW UFI 8037.
    - Open rural paddocks which contributed to the clearing of native vegetation and infilling of REW UFI 15257.
    - Cleared Water Corporation and DBNGP easements which contributed to the clearing of native vegetation and infilling of REW UFI 15257 (within the MRS amendment area) and REW UFI 8037.
    - Construction and operation of the Tonkin Highway contributed to the clearing of native vegetation and infilling of REW UFI 15257 and REW UFI 8037.
- The ecological values of these wetlands are no longer present and therefore, no migratory or wetland bird species are considered to occur within or utilise these wetlands.

Within Lot 501, located north of the MRA amendment area, the wetland assessment of the two CCWs (UFI 8026 and UFI 8027) drew the following conclusions (Pentium Water 2024):

- The two CCW's due to historical anthropogenic impacts exhibit limited ecological values. The assessment identified the existing ecological and wetland values of the two mapped CCWs areas are aligned with REW or MUW category wetlands. The degraded state of the mapped CCW areas is inflated by the current land management practices which focuses on maintaining the following infrastructure reserves and corridors (which traverse the mapped CCW areas) as cleared spaces:
    - Welshpool Road reserve
    - Tonkin Highway reserve
    - Boundary Road reserves
    - Portions of the DBGNP easement.
- Accordingly, the environmental values within the two CCWs is limited to isolated stands of *Corymbia calophylla*, *Eucalyptus rudis*, *Melaleuca rhaphiophylla* and *Melaleuca preissiana* over a weed dominated understorey. In the context of the small areas of remnant vegetation, the degraded state of the mapped wetland areas in combination with the land management practices, it is concluded that migratory or wetland bird species would only be considered a transient visitor to this wetland and would not be reliant on limited habitat within these two small CCW areas. Further, there is significant intact wetland habitat suitable for waterbirds available within the GBSW area.

The key conclusions drawn from the wetland assessment (Appendix C) and the extensive hydrological, geotechnical and water balance technical studies (Appendix A and Appendix B) demonstrate there will be no significant impacts to current surface and groundwater cycles resulting in impacts to significant wetlands waterways within and nearby to the MRS amendment area (including Yule Brook and the GBSW) (see Section 5.5). Appropriately, it is concluded there will not be disturbances to waterbirds as a result of impacts to wetlands located within the MRS amendment area, the adjacent 501 or the GBSW area.

7.6.2.5 Dust Deposition

Construction activities associated with the urbanisation of the MRS amendment area may generate fugitive dust emissions, which in turn may result in dust deposition impacts to native vegetation and fauna habitat, including:

- Leaf damage through abrasion.
- Blocking the stoma of plants.
- Dust accumulation on leaves, limiting photosynthesis capability.

Management measures to mitigate dust impacts can be addressed through the Environmental Management Framework and the sequential planning framework as the well as the WAPC model subdivision schedule (DPLH 2024b) which has standard conditions requiring the preparation and approval of CEMP(s) post subdivision approval, and then implemented during construction works (refer to Section 7.7).

7.6.2.6 Weeds and Pathogens

Urbanisation can lead to the introduction and spread of weeds and pathogens, such as Dieback (*Phytophthora cinnamomi*), which can indirectly impact vegetation in the MRS amendment area.

The application of standard dieback management actions will minimise the potential introduction and/or spread of weeds and pathogens within the MRS amendment area. Implementation of these management measures will be achieved through the preparation, approval and implementation of

CEMP(s) at later phases of the planning process (i.e. subdivision and/or development) and during construction works for each stage of development.

Furthermore, the preparation of a CAMP(s) (activated as a condition of subdivision) will minimise the potential introduction and/or spread of weeds and pathogens within the Conservation areas (refer to Section 7.7).

7.6.2.7 Altered fauna behaviour due to noise, lighting and human presence

With urbanisation comes an increase in population and in turn an increased risk of human activity, which can indirectly impact on Conservation areas containing fauna habitats.

The proposed change in land use will result in increased levels of noise and light emissions, which potentially may impact fauna species by affecting their foraging and reproductive behaviours', reducing animal fitness, increasing the risk of predation and reducing reproductive success (Newport et al. 2014).

Rich and Longcore (2013) examine a number of studies which demonstrate the impact of artificial night lighting on fauna and identifies that lighting has the potential affect fauna behaviour more than noise.

Newport et al. (2014) recommends implementing measures that:

- strategically plan the types of development and associated activities next to protected areas
- use shields and barriers (i.e. covers for lights) or using dense native vegetation screens that still allow movement of animals.

In relation to human presence, other human activities that have the potential alter fauna behaviour is degradation to vegetation and associated fauna habitats as a result of uncontrolled vehicle and pedestrian access, as well as littering, dumping and increased fire risk. These same impacts can also be caused by construction personnel, vehicles, plant and equipment during construction activities associated with urban development.

Management measures to appropriately control and minimise the impacts of increased noise and light emissions and human presence, both during the development and post development phases, can be addressed through the CEMP which will be implemented as a condition of subdivision throughout the construction phase of each stage of the development. The preparation and implementation of the CAMP during the development and post development phase will minimise the potential impacts of increased human activities within the dedicated conservation areas (refer to Section 7.7).

7.6.2.8 Change in feral animal abundance and/or movement

Introduced fauna, such as those recorded within the MRS amendment area (Table 7-6), often thrive in disturbed or modified habitats and may compete with local species for food and habitat resources. Increased predation by feral cats and foxes can result in changes to species assemblage, resulting in the loss of conservation significant fauna native species such as Quenda, which is known to occur within the site and are the most susceptible to predation by feral cats.

The City of Kalamunda's *Keeping and Control of Cats Local Law 2023* lists conservation reserves within the City as being ‘cat prohibited areas’. It is anticipated that once the conservation areas within the MRS amendment area are established that these will be listed within Schedule 3 of the City’s local law, which would then provide the City with powers to target control of domestic and feral cats in the MRS amendment area, as well as penalise any cat owners if their cats are found within the Conservation areas. Furthermore, the City’s local law places limits on the number of cats allowed on each residential

premise and is intended to prevent the harmful nuisance of cats and thereby, reduce their impacts on local native fauna.

Inappropriate management of waste, particularly putrescible waste, generated within new urban communities may provide additional food source for scavengers, including feral cats, vermin house mice and rats, which are all likely to occur within the MRS amendment area.

These potential impacts can be addressed through the preparation, approval and implementation of the CAMP(s) and CEMP(s) (see Section 7.7.3) during the subdivision and/or development within the MRS amendment area.

The preparation of these management plans would be implemented as specific subdivision conditions. Typically, the implementation of the management plans would be to the satisfaction of the City of Kalamunda potentially on advice from specific agencies i.e. DBCA or DWER.

7.6.3 Cumulative Impacts

An assessment of cumulative impacts requires an understanding of the potential impacts from other present and reasonably foreseeable future actions, including related development projects and planning schemes that have been recently approved, or are subject to current proposals. A summary of the potential impacts from other proposals and planning scheme amendments in proximity to the MRS amendment area is provided in Table 7-12.

91.23 ha (72.6%) of the MRS amendment area has been historically cleared and therefore is of no value to conservation significant fauna. The majority of remaining land has been significantly altered, comprising mostly of scattered native trees with an absence of any understorey, planted trees, lawns and gardens. These highly modified and disturbed areas cover 29.7 ha (23.7%) of land within the MRS amendment area and have low to negligible value as fauna habitat.

All remnant native vegetation (in Good or better condition), which makes up approximately 2.9% of the MRS amendment area will be retained in any future urban development proposals. This includes 4.16 ha of Banksia Woodland and 0.05 ha of Eucalyptus Woodland containing medium to high quality foraging habitat for black cockatoos, seven potential nesting trees for black cockatoos and habitat for quenda.

A landscape-led approach, through implementation of a TCRLMS be taken to inform the future design of local structure plans for future urban development. This will facilitate the retention of as many existing scattered and planted trees as possible, in particular trees with a DBH of >500 mm and/or that are foraging species for black cockatoos. Where it is not possible to retain such trees, it is recommended that they be replaced with suitable habitat species.

Whilst there will be a time lag associated with the growing period for the replanted trees, their increased numbers, prominence and more even distribution within the landscape will facilitate the proliferation of better-quality habitat across the entire MRS amendment area, as compared to the existing mosaic of fragmented and scattered habitat, with low habitat value for black cockatoos, that currently exists.

The MRS amendment area contains very little habitat for quenda outside of the areas of Banksia Woodlands that will be retained. Any potential quenda habitat is predominantly limited to existing planted gardens that only occupy 2.8 ha of land in total. Not all gardens will contain habitat for quenda, particularly areas of lawn and where there is an absence of dense understorey.

Notwithstanding this, urbanisation of the MRS amendment area can facilitate mitigation of this minor habitat loss through by retaining and rehabilitating vegetation in Conservation areas and the re-

establishment of garden beds containing dense understorey favoured by quenda, within local public open space, road reserves and new residential lots. This will be considered in the preparation of the TCRLMS and subsequent TCRLMP(s) to determine implementation requirements for subdivision and development.

In light of the above, there will not be any cumulative impacts of significance to terrestrial fauna or fauna habitat, as a result of the proposed change in land use from Rural to Urban.

Table 7-15: Cumulative Impacts to Terrestrial Fauna and Fauna Habitat

Aspect	Wattle Grove Urban Expansion and Urban Investigation Areas	Tonkin Highway Grade Separated Interchanges (Hale Road to Welshpool Road)	Tonkin Highway Grade Separated Interchange (Kelvin Road)	Tonkin Highway, Guildford Road to Great Eastern Highway Upgrade (Tonkin Gap)	Maddington Kenwick Strategic Employment Area (MKSEA)	Roe Highway and Great Eastern Highway Bypass
Proponent	WAPC	MRWA	MRWA	MRWA	City of Gosnells	MRWA
Description	Urban expansion and investigation areas, identified in the WAPC's *North-East Sub-regional Planning Framework* (2018).	Upgrade of Tonkin Highway including additional traffic lanes, a fly-over at the intersection with Hale Road and a grade separated interchange at the intersection with Welshpool Road.	Upgrade and widening a 2 km section of Tonkin Highway from four lanes to six lanes and grade separated interchange at the intersection with Kelvin Road.	Upgrade of Tonkin Highway including additional traffic lanes, two additional bridges over the Swan River, and modification of Great Eastern Highway interchange.	Development of an industrial area. The MKSEA has been divided into Precincts 1, 2, 3A and 3B. The Local Planning Scheme amendments for Precincts 2 and 3B are subject to assessment by the EPA.	Construction of a grade separation at the intersection of Roe Highway and Great Eastern Highway Bypass and upgrade of Roe Highway between Kalamunda Road and Clayton Street, including a duplication of the bridge over Helena River.
Location	City of Kalamunda, to the east and south of the Wattle Grove South MRS amendment area.	City of Kalamunda along Tonkin Highway, from south of Roe Highway to approximately 1 km north of Kelvin Road.	City of Gosnells along Tonkin Highway, from approximately 1 km north of Kelvin Road extending south to Maddington Road.	City of Bayswater and City of Belmont along Tonkin Highway, between Guildford Road and Great Eastern Highway.	City of Gosnells bounded by Roe Highway, Welshpool Road, Tonkin Highway and Bickley Road.	City of Swan, City of Kalamunda and Shire of Mundaring along Roe Highway, between Great Eastern Highway and just south of Adelaide Street West.
Development Commencement	Yet to be initiated / seriously entertained	To be confirmed, subject to approvals	To be confirmed, subject to approvals	To be confirmed	To be confirmed, subject to approvals	Project on hold
EPA/EPBC Referral Decision	N/A	EPA – Assess EPBC – Controlled action (EPBC 2019/8529)	EPA – Assess EPBC – Controlled action (EPBC 2022/09325)	EPA – Assessment not required EPBC – Not a controlled action (EPBC 2019/8545)	EPA – Assess LPS Amendments Nos. 166 and 169 to City of Gosnells Local Planning Scheme No.6.	DWER – Clearing Permit CPS9448-1 EPBC – Controlled action (EPBC 2020/8784)
EPA/EPBC Assessment Status	N/A	Active EPA assessment Approved (EPBC)	Active EPA assessment Pending (EPBC)	EPA – N/A Approved (EPBC)	EPA active assessment	Project on hold
Potential Impacts to Terrestrial Fauna and Fauna Habitat Relevant to the Wattle Grove MRS amendment area	The urban potential of these areas is subject to further detailed investigation prior to any MRS rezoning proposals being seriously entertained by the WAPC. The *North-East Sub-regional Planning Framework* advises that: *'Land classified Urban Expansion/ Investigation may contain significant environmental attributes and these classifications should not be construed as support for the development.'* To date the urban potential of these areas has not been investigated or seriously entertained. Therefore, the extent of fauna impacts (if any) is unknown.	Clearing of 20.22 ha of suitable habitat for quenda. Loss of black cockatoo habitat including: • Clearing of 141 potential breeding trees, none with nesting hollows. • Clearing of 7.9 ha of medium to high value foraging habitat and 11.3 ha of low to medium foraging habitat for Baudin's cockatoo and Forest Red-tailed black cockatoo. • Clearing of 18.54 ha of low to medium foraging habitat for Carnaby's cockatoo. • Indirect impact such as fauna injury/mortality, habitat degradation from edge effects, Dieback, rubbish and vehicle tracks, disturbance of fauna due to dust and vibration. Source: Environmental Review Document, Tonkin Highway Grade Separated Interchanges Hales Road and Welshpool Road (Main Roads WA, September 2022).	Clearing of 11.36 ha of suitable habitat for quenda. Loss of black cockatoo habitat including: • Clearing up to 125 potential breeding trees none with nesting hollows. • Clearing of 10.13 ha of low to high value foraging habitat for Forest Red-tailed black cockatoo. • Clearing of 10.12 ha of low to high value foraging habitat for Baudin's cockatoo. • Clearing of 10.12 ha medium to low value foraging habitat for Carnaby's cockatoo. • Indirect impact such as fauna injury/mortality, habitat degradation from edge effects, Dieback, rubbish and vehicle tracks, disturbance of fauna due to dust and vibration. Source: Section 38 EP Act Referral Supporting Document, Tonkin Highway Grade Separated Interchanges Kelvin Road (Main Roads WA, February 2022).	No significant impacts due to very limited clearing of vegetation within the project area. Source: Section 38 EP Act Referral Supporting Document, Tonkin Highway Upgrade Guildford Road to Great Eastern Highway (Main Roads WA, September 2019).	Clearing of 9.6 ha of suitable habitat for quenda. Loss of black cockatoo habitat including: • Clearing of 49 potential breeding trees, none with nesting hollows. • Clearing of 2.75 ha of foraging habitat suitable for Carnaby's cockatoo, Baudin's cockatoo and Forest Red-tailed black cockatoo. Source: Environmental Review Document, City of Gosnells Town Planning Scheme No.6 Amendments 166 and 169 (Emerge, May 2023).	Loss of black cockatoo habitat including: • Clearing of 35.12 ha of foraging habitat of Corymbia calophylla (Marri), Eucalyptus marginata (Jarrah), Eucalyptus rudis (Flooded gum), Banksia attenuata, Banksia menziesii and Xanthorrhoea preissii. • Clearing of 222 trees with DBH size suitable for hollow formation. Seven trees were recorded to contain at least one hollow, however, not all hollows were deemed suitable for breeding based on their size, location and/or presence of bees. Sources: Environmental Review Document, Tonkin Highway Grade Separated Interchanges Hales Road and Welshpool Road (Main Roads WA, September 2022). EPBC Act Referral 2020/8774 – Roe Highway and Great Eastern Highway Bypass Grade Separation Interchange, Hazelmere WA (Main Roads, Sep 2020).

7.7 Mitigation

With reference to the EPA mitigation hierarchy, it is considered that the potential direct impacts to fauna and fauna habitat within the MRS amendment area, as a result of the proposed change in land use, can be avoided and rehabilitated through a combination of habitat retention within Conservation areas and a replanting program. The Environmental Management Framework and the sequential planning framework will require future local structure planning and subdivision applications set aside these areas for conservation, as well require the preparation, approval and implementation of CAMP(s) and thereby ensure that potential direct impacts and clearing of these remaining areas of intact native vegetation is avoided.

Furthermore, it is considered that the potential indirect impacts of the proposed change in land use on fauna and fauna habitat can be avoided and minimised through the Environmental Management Framework and the sequential planning framework as the well as the WAPC model subdivision schedule (DPLH 2024b) which has standard conditions requiring the preparation and approval of CEMP(s) post subdivision approval, and then implemented during construction works.

These proposed management measures are described in the following sections.

7.7.1 Retention of fauna habitat

Areas of fauna habitat within the MRS amendment area are physically separated from other areas of fauna habitat within the surrounding region by existing development and infrastructure, including Tonkin Highway and Welshpool Road, which act as significant physical barriers.

Furthermore, the remaining fauna habitat within the MRS amendment area has also been subject to localised fragmentation, due to the historical clearing and development that has occurred within the MRS amendment area itself. Local ecological and habitat connectivity has already been significantly compromised by this existing fragmentation.

To avoid further impacts to fauna habitat as a result of the proposed change in land use from Rural to Urban, all remnant native vegetation (in Good or better condition) within the MRS amendment area will be retained in any future urban development proposals. This includes the fauna habitat and vegetation communities set out in Table 7-13.

Table 7-16: Fauna habitat and vegetation communities to be retained in conservation areas

Fauna habitat (Vegetation communities)	Extent within MRS amendment area	Conservation	Potential Future Conservation and Rehabilitation	Total area and percentage (Conservation and Potential Future Conservation and Rehabilitation)
Banksia Woodlands (BaEpPf)	4.23 ha	3.41 ha	0.74 ha	4.15 ha (98%)
Banksia Woodlands (BmXpEc)	0.28 ha	0.15 ha	0.05 ha	0.20 ha (71%)
Eucalypt Woodlands (EmMpLp)	0.05 ha	0.05 ha	0.0 ha	0.05 ha (100%)
Total	4.56 ha	3.61 ha	0.79 ha	4.40 ha (96%)

The areas of remnant Banksia Woodland and Eucalyptus Woodland offer medium to high quality foraging habitat for Carnaby's cockatoo and Baudin's cockatoo species, as well as habitat for quenda.

Within the areas of remnant Banksia Woodland and Eucalyptus Woodland there are also seven significant trees, which are large enough to potentially contain breeding hollows suitable for black cockatoos or have the potential to develop suitable hollows over the next 50 years.

The 4.23 ha of BaEpPf (Banksia Woodlands) and the small patch of BmXpEc (Banksia Woodlands) on Lot 84 Victoria Road will be retained within Conservation and Potential Future Conservation and Rehabilitation.

All other vegetation within the MRS amendment area, consisting of scattered trees and planted and maintained gardens, exist within a highly disturbed and fragmented landscape and their value in terms of fauna habitat is mostly considered low quality; with the exception of some discrete areas that were of medium foraging habitat value for Carnaby's cockatoo (located on Lot 801 and Lot 2) and Baudin's cockatoo (located on Lots 84, 504, 803 and 804). It is therefore considered that any impacts to conservation significant fauna associated with further modification of this disturbed and fragmented environment (as a result of the proposed change in land use to Urban) can be mitigated through the Environmental Management Framework by:

- Requiring the preparation of a TCRLMS at local structure plan stage to ensure a landscape-led approach is taken when designing local structure plans for future urban development within the MRS amendment area, and will require:
    - a tree survey to reconfirm the DBH, species and health of each individual tree within the local structure plan area
    - retention of as many existing trees as possible within local public open space, road reserves, pedestrian access ways, and any other areas where tree retention is possible
    - where possible, prioritising the retention of existing trees with a DBH of >500 mm and/or that are foraging species for black cockatoos.
- Requiring the preparation of a TCRLMP(s) with every subdivision and development application for land containing trees that have been identified for retention in a local structure plan (and accompanying TCRLMS)
- Requiring that a suitable vegetation and fauna habitat survey undertaken and submitted with any subdivision or development application on land that has not been surveyed to date. Such applications may be approved, refused or subject to conditions of approval based on the results of the survey.

7.7.2 Revegetation

It should be noted that the extent of individual tree clearing that actually occurs is expected to be less than the maximum assumed within the most conservative clearing scenario. Based on initial feasibility studies done on future earthwork requirements to facilitate urban development, it appears that there will be minimal cut and fill requirements. Therefore, it is highly likely that substantial areas of remnant scattered trees will be retained within the MRS amendment area. Furthermore, this has become typical of standard industry practice for new urban development in Perth over the past two decades.

Notwithstanding the above, it may not be practical or feasible to retain all existing trees with a DBH of >500 mm and/or that are foraging species for black cockatoos. It is recommended that the clearing of such trees can be mitigated through revegetation, in the form of a replanting program, that is established in the TCRLMS and implemented in the associated TCRLMP(s). To support and enhance these replanting measures the TTCRLMS will require new trees be replanted in locations that facilitate an even distribution of trees within road reserves, pedestrian access ways and public open spaces.

Whilst there will be a time lag associated with the growing period for the replanted trees, their increased numbers, prominence and more even distribution within the landscape will facilitate the proliferation of better-quality habitat across the entire MRS amendment area, as compared to the existing mosaic of fragmented and scattered habitat, with low value, that exists.

With respect to the loss of potential quenda habitat, the worst case clearing scenario outlined in Section 7.6.1.1 includes the loss of 2.8 ha of existing planted gardens that may provide some potential habitat for quenda, noting however that there will be portions of these planted gardens that offer no

habitat value for quenda, particularly areas of lawn and where there is an absence of dense under-storey.

Notwithstanding this, urbanisation of the MRS amendment area will facilitate mitigation of this minor habitat loss through the retention of habitat in Conservation areas and the re-establishment of planted garden areas within local public open space, road reserves and new residential lots. The re-establishment of potential quenda habitat can be facilitated through the selective planting of species that will grow into a dense understorey of habitat favoured by quenda. This can be implemented through the management plans described below.

7.7.3 Management strategy and plans

The environmental values of the remnant native vegetation and conservation significant flora identified for retention will be enhanced through the preparation, approval and implementation of the following strategies and management plans during later stages of the planning process, and during and after development has occurred:

7.7.3.1 Conservation area management

The CAMS will establish at the local structure plan stage the objectives and information that each CAMP(s) will be required to address and implement the following during the subdivision or development within the MRS amendment area:

- Physical delineation of areas of remnant native vegetation to be retained (e.g. fencing)
- Nature of access to and within the areas of retained remnant native vegetation
- Rehabilitation program
- Weed and pathogen control
- Bushfire prevention
- Predatorial fauna and pest management
- Avoidance and minimisation of fauna injury and mortality in the new urban environment
- Waste management, including uncontrolled littering and dumping
- An assessment of the potential risks to environmental values and the effectiveness of the proposed management measures
- An environmental monitoring program to assess the success of the management measures
- Trigger criteria for the implementation of contingency actions
- Roles and responsibilities
- Indicative timeframes for the implementation of the above management measures

The overarching objective of the CAMS and subsequent CAMP(s) will be to provide a framework and on ground mechanism to protect and enhance the biodiversity values of the conservation area.

Table 6-17 provides a broad outline of the framework that will be used to inform the preparation of the CAMS and subsequent CAMP(s).

7.7.3.2 Tree canopy retention and landscaping management

The City of Kalamunda has developed an Urban Forest Strategy (UFS) which provides guidance on the protection, management and growth of the urban forest across the City.

Broadly the UFS goals are to (City of Kalamunda 2023):

- Protect the City's urban forest on public and private land
- Grow the urban forest on public and private land through new tree plantings to maximise the social, economic and environmental benefits of trees and urban greening.

- Engage with community, research institutions, schools, government and private sector to care for the urban forest and broaden the understanding of the benefits it provides.
- Investigate new resourcing and research opportunities to enable further investment in on-ground actions using best practice science to manage and grow the urban forest.

The above goals provide a holistic and strategic approach to achieving our target, to protect and plant enough trees to grow the City's urban canopy cover to an aspirational goal of 30% (at maturity) by 2043 across the City (City of Kalamunda 2023).

With regard to new Urban development, the UFS identifies the Wattle Grove MRS amendment area as a case study and has set a UFS target of 20% canopy cover (at maturity).

The TCRLMS will establish at the local structure plan stage the objectives and information that each TCRLMP(s) will be required to address the following and be implemented as part of subdivision and/or development within the MRS amendment area:

- City of Kalamunda UFS
- Achieve a minimum canopy target of 20%, which will be contingent on:
    - water availability
    - bushfire management
    - local government support and incentives
    - land developer incentives (garden packages including trees)
    - resident engagement and education
- Ensure tree canopy analysis identifies existing canopy values, and includes a survey of all existing trees on the relevant lot(s)
- Identify which trees will be retained and removed as a result of the subdivision or development proposal, prioritising the retention and revegetation of black cockatoo habitat trees
- Implementation of a black cockatoo habitat replanting program that provides for the replacement of any individual trees that are cleared
    - Specifies locations for replanting that provide for an even distribution of trees across the MRS amendment area and create local ecological linkages between areas of retained black cockatoo habitat (i.e. Banksia Woodlands)
- Establishes a detailed methodology for landscape work, including consideration of species and planting densities to facilitate the growth of a dense understorey of habitat favoured by quenda in appropriate locations
- Demonstrate how development design has avoided impacts on trees suitable for retention (through the location of public open space, road reserves, pedestrian access ways and drainage design) to ensure their viability within an urban landscape
- Demonstrate how the impact of any required clearing will be mitigated based on pre and post development canopy values
- Demonstrate how the minimum tree canopy coverage post subdivision or development will be achieved
- Identify measures that will be used to protect trees identified for retention during development and subdivision works (i.e. tree protection zones, tree labelling, physical barriers being erected and maintained through construction, etc)
- Establish tree and landscape maintenance requirements post planting.

7.7.3.3 Construction management

The CEMP(s) will address the following during the construction phase of future development:

- Clear demarcation and fencing of all fauna habitat, including individual trees, identified for retention.
- Avoidance and minimisation of fauna injury and mortality.
- Erosion and sediment control
- Dust control
- Weed and pathogen control
- Bushfire prevention
- Waste management, including uncontrolled littering and dumping
- Inductions to educate construction personnel on the above management measures.

7.7.4 Recovery plan for Carnaby's cockatoo

The objective of the recovery plan is to stop further decline in the distribution and abundance of Carnaby's cockatoo by protecting the birds throughout their life stages and enhancing habitat critical for survival throughout their breeding and non-breeding range, ensuring that the reproductive capacity of the species remains stable or increases (DPaW 2013).

Table 7-17 addresses the relevant recovery actions for Carnaby's cockatoo and demonstrates that implementation of the MRS amendment and the conservation measures proposed will assist with achieving the overall objective of the Recovery Plan and contribute towards protecting and enhancing habitat critical for their survival.

Table 7-17: Relevance to the recovery plan for Carnaby's cockatoo

Recovery action (DPaW 2013)	Relevance to MRS amendment and future Conservation and tree retention / replanting
Protect and management important habitat	Implementation of the MRS amendment will result in: • all occurrences of intact remnant vegetation (that is also mapped as being high quality foraging habitat) being retained and protected within the conservation areas via the CAMP. • potential nesting trees being retained (wherever possible) or replaced at 2:1 ratio via the Tree Canopy Retention and Landscape Management Plan Thereby, minimising the further clearing of the important foraging habitat and ensuring future protection and management of their habitat within the MRS amendment area.
Undertake regular monitoring	Where intact remnant vegetation (that is also mapped as being high quality foraging habitat) and potential nesting trees are being retained and/or rehabilitated, regular monitoring and annual reporting via the CAMP and the Tree Canopy Retention and Landscape Management Plan. Annual reporting will include annual monitoring of condition and tree survival rates to ensure the occurrences are being maintained and not declining in condition.
Manage other impacts	The CAMP will address, monitor and implement management measures to reduce the following potential impacts on black cockatoo habitat within the Conservation areas: • Fauna and pest management • Weed and pathogen control • Bushfire management • Fencing and access control
Engage with broader community	The CAMP will include the requirement for educational signage to be installed providing information on the species and the importance of its conservation, in consultation with DBCA.

7.7.5 Conservation advice for Baudin's cockatoo

The reason for the conservation assessment and advice was *'to change the listing status of Baudin's cockatoo to Endangered'* (TSSC 2018b).

The relevant conservation and management priorities are identified to be (TSSC 2018b):

- Ensure land managers are aware of the species' occurrence and provide appropriate mitigation measures against habitat clearing
- Undertake habitat restoration by revegetating suitable areas with key tree species
- Fire must be managed to ensure that prevailing fire regimes do not disrupt the life cycle of Baudin's cockatoo, that they support rather than degrade the species habitat, and that they do not promote invasion of exotic species
- Implement best practice and adaptive management actions to reduce the spread of phytopathogens, manage and contain infested areas, and protect non-infested areas across the Baudin's cockatoo distribution
- Monitor the progress of conservation actions, including the effectiveness of management actions and adapt them if necessary to contribute to the species' recovery

The recommended management measures for remnant native vegetation and potential nesting tree retention and replating in the MRS amendment area will assist with achieving these key priorities and in turn contribute to the conservation of black cockatoo habitat through:

- Retention of all intact remnant patches within Conservation areas
- Management of the potential indirect impacts of urbanisation on black cockatoo habitat through the implementation of CAMP(s), Tree Canopy Retention and Landscaping Management Plan(s) and CEMP(s).

It is worthwhile to note that the Recovery Plan for Baudin's cockatoo and Forest Red-tailed black cockatoo has been revoked and is no longer in effect.

7.7.6 Conservation advice for Forest Red-tailed black cockatoo

The Approved Conservation Advice for Forest Red-tailed black cockatoo identifies various research priorities, regional priority and threat abatement actions to support the recovery of Forest Red-tailed black cockatoo (DEWHA 2009).

The following relevant regional priority actions were identified to be:

- Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary
- Determine and implement ways to manage forests for the conservation of the subspecies

The recommended management measures for remnant native vegetation and potential nesting tree retention and replating in the MRS amendment area will assist with achieving these key priorities and in turn contribute to the conservation of black cockatoo habitat through:

- Retention of all intact remnant patches within Conservation areas
- Management of the potential indirect impacts of urbanisation on black cockatoo habitat through the implementation of CAMP(s), Tree Canopy Retention and Landscaping Management Plan(s) and CEMP(s).

It is worthwhile to note that the Recovery Plan for Baudin's cockatoo and Forest Red-tailed black cockatoo has been revoked and is no longer in effect.

7.8 Assessment and significance of residual impacts

Once mitigation measures have been applied, the following residual impacts to conservation significant fauna and fauna habitat is not considered to be significant:

- The loss of individual native and non-native trees scattered across 26.9 ha of disturbed land, representing:
    - mostly low-quality foraging habitat for all three black cockatoos
    - 0.72 ha and 0.80 ha of medium quality foraging habitat for Carnaby's cockatoo (located on Lot 801 and Lot 2) and Baudin's cockatoo (located on Lots 84, 504, 803 and 804), respectively
    - negligible to low quality habitat for quenda due to the absence of dense understorey.

The loss of individual trees and plants dispersed within 2.8 ha of planted and maintained gardens, with low quality foraging habitat for all three black cockatoo species, but potentially containing isolated areas of habitat for quenda; however, any small and isolated pockets of potential quenda habitat that may currently exist within planted gardens will be re-established within new public open spaces and gardens.

In relation to the clearing of 146 potential nesting trees (with no hollows or no suitable hollows) for black cockatoos, the *WA Environmental Offsets calculator* (DWER 2021a) was used to estimate the significant residual impact feature for all 3 black cockatoos, once mitigation and rehabilitation measures (i.e. establishment of the Conservation areas and tree replanting within the MRS amendment area) were considered.

Table 7-17 and Table 7-18 presents the offset calculation values for all 3 black cockatoos, including the scores and rationale that was applied to derive the significant residual impact and guided by DWERs (2021b) Environmental offsets metric: Quantifying environmental offsets in Western Australia The offset calculation has used the 'significant impact calculation feature' and assumes a worst case scenario that all of the 146 potential nesting trees (with no hollows or no suitable hollows) located outside the Conservation areas will be cleared.

It is worthwhile to note that the worst-case scenario is considered unlikely for the following reasons:

- The Environmental Management Framework requiring the preparation and implementation of a TCRLMS and TCRLMP(s) to ensure future development design will facilitate the retention of as many existing scattered and planted trees as possible, in particular trees with a DBH of >500 mm and/or that are foraging species for black cockatoos. Where it is not possible to retain such trees, they will be replaced with suitable potential nesting tree species at a ratio of 2:1.
- Whilst there will be a time lag associated with the growing period for the replanted black cockatoo potential nesting trees, the increased numbers, prominence and more even distribution within the landscape will facilitate the proliferation of better-quality habitat across the entire MRS amendment area, as compared to the existing mosaic of fragmented and scattered habitat, with low value, that exists.
- It is also expected that the extent of individual tree clearing that actually occurs will be less than the maximum assumed in the worst-case clearing scenario, as it is highly likely that substantial areas of scattered trees will be retained in future public open spaces and road reserves, in line with typical contemporary urban development practices and minimum cut and fill earthworks being proposed.
- Furthermore, as it is typical of contemporary urban development practices for retained or newly planted trees to be sited predominantly within public open spaces or road reserves under the care and management of the City of Kalamunda, this will provide the trees with a higher level of management and protection than what currently exists.

Table 7-18:Residual impact calculation for Carnaby's and Baudin's cockatoo potential nesting trees

	Attribute	Score (Feature)	Rationale
Step 1: Determining conservation significance	**Conservation significance determination for environmental value**		
	Description of Environmental Value	Carnaby's / Baudin's cockatoo potential nesting trees	Proposed clearing will impact on Carnaby's cockatoo potential nesting trees
	Type of environmental value	Species (flora/fauna)	Environmental value based on fauna species
	Conservation significance of environmental value	Rare/threatened species - Endangered	BC Act listing
	Conservation significance score is **1.2%**		
Step 2: Calculating significant residual impact	**Part A; Significant impact calculation – Feature**		
	Potential nesting tree (with no hollows or no suitable hollows)	146	153 potential nesting trees (with no hollows or no suitable hollows) recorded within MRS amendment area, of which 7 occur within Conservation and 146 occur within the development area.
	Total quantum of impact is **146**		
	Part B: Rehabilitation credit calculation – Feature (onsite)		
	Start number (potential nesting tree)	0	Assumes worst case scenario and the development area will be fully cleared and no potential nesting trees remain.
	Future number (potential nesting tree) WITHOUT rehabilitation	0	Assumes worst case scenario and no potential nesting trees will be present at the site in the foreseeable future (15 years), after project is complete and no rehabilitation occurs.
	Future number (potential nesting tree) WITH rehabilitation	292	Assumes ratio of 2:1 tree revegetation for each potential nesting tree that is cleared, and after proposed onsite rehabilitation is complete (15 years).
	Time until ecological benefit (years)	15	Assumes trees will be established and mature within 15 years and any loss in trees will be observed within this timeframe.
	Confidence in rehabilitation result	80%	80% confidence given rehabilitation will be undertaken by suitably qualified personnel and in accordance with detailed tree revegetation program.
	Rehabilitation credit is **195.33**		
	Part C: Significant residual impact calculation – Feature		
	Total quantum of impact	146	
	Rehabilitation credit	195.33	
	Significant residual impact is **- 49.33**		

Table 7-19: Residual impact calculation for Forest Red-tailed black cockatoo potential nesting trees

	Attribute	Score (Feature)	Rationale
Step 1: Determining conservation significance	**Conservation significance determination for environmental value**		
	Description of Environmental Value	Forest Red-tailed black cockatoo potential nesting trees	Proposed clearing will impact on Carnaby's cockatoo potential nesting trees
	Type of environmental value	Species (flora/fauna)	Environmental value based on fauna species
	Conservation significance of environmental value	Rare/threatened species - Vulnerable	BC Act listing
	Conservation significance score is 0**.2%**		
Step 2: Calculating significant residual impact	**Part A; Significant impact calculation – Feature**		
	Potential nesting tree (with no hollows or no suitable hollows)	146	153 potential nesting trees (with no hollows or no suitable hollows) recorded within MRS amendment area, of which 7 occur within Conservation and 146 occur within the development area.
	Total quantum of impact is **146**		
	Part B: Rehabilitation credit calculation – Feature (onsite)		
	Start number (potential nesting tree)	0	Assumes worst case scenario and the development area will be fully cleared and no potential nesting trees remain.
	Future number (potential nesting tree) WITHOUT rehabilitation	0	Assumes worst case scenario and no potential nesting trees will be present at the site in the foreseeable future (15 years), after project is complete and no rehabilitation occurs.
	Future number (potential nesting tree) WITH rehabilitation	292	Assumes ratio of 2:1 tree revegetation for each potential nesting tree that is cleared, and after proposed onsite rehabilitation is complete (15 years).
	Time until ecological benefit (years)	15	Assumes trees will be established and mature within 15 years and any loss in trees will be observed within this timeframe.
	Confidence in rehabilitation result	80%	80% confidence given rehabilitation will be undertaken by suitably qualified personnel and in accordance with detailed tree revegetation program.
	Rehabilitation credit is **226.70**		
	Part C: Significant residual impact calculation – Feature		
	Total quantum of impact	**146**	
	Rehabilitation credit	**226.70**	
	Significant residual impact is **- 80.70**		

Based on the above parameters and the final calculation of the residual impacts, there is no significant residual impact for all 3 black cockatoos and therefore, no offset is required when taking into consideration the avoidance, minimisation and rehabilitation measures that will be implemented.

Accordingly, no significant residual impacts are anticipated for terrestrial fauna or fauna habitat once mitigation measures have been applied as part of the Environmental Management Framework and during the subsequent stages of the planning and development process.

7.9 Environmental Outcomes

Following implementation of the proposed mitigation measures, the predicted environmental outcomes for terrestrial fauna and fauna habitat associated with urbanisation of the MRS amendment area are:

- Retention of all remnant native vegetation (in Good and better condition), including 4.16 ha of Banksia Woodland and 0.05 ha of Eucalyptus Woodland containing medium and high quality foraging habitat for Carnaby's black cockatoo and Baudin's black cockatoo, seven potential nesting trees for black cockatoos and habitat for quenda, within Conservation areas, which will be guided by the preparation and implementation of CAMS and CAMP(s) at the local structure plan and subdivision and development stages, respectively.
- Likely retention of further individual scattered native trees, providing medium and low-quality foraging habitat for black cockatoos, in future public open spaces and road reserves, through the preparation and implementation of a TCRLMS and TCRLMP(s) at the local structure plan and subdivision and development stages, respectively.
- Whilst there will be a time lag associated with the growing period for the replanted black cockatoo foraging trees, the increased numbers, prominence and more even distribution within the landscape will facilitate the proliferation of better-quality habitat across the entire MRS amendment area, as compared to the existing mosaic of fragmented and scattered habitat, with low value, that exists.
- Higher order protection for remnant native vegetation, retained and replanted trees, by virtue of their location within future public open spaces and road reserves under the care and management of the City of Kalamunda.
- Re-establishment of potential quenda habitat (i.e. garden beds with dense understorey) across areas of local public open space, road reserves and new residential lots.

8. Key environmental factor - Social surroundings

8.1 EPA objective

The EPA's objective for Social Surroundings is:

To protect Social Surroundings from significant harm.

The objective recognises the importance of ensuring that social surroundings are not significantly affected as a result of the proposed change in land use.

8.2 Instruction for Environmental Review (Assessment No. 2335) for Amendment 1388/57 – Social Surroundings

The EPA's Instruction for Environmental Review (Assessment No. 2335) for Amendment 1388/57 (15th August 2022) identified 8 specific scopes of works for the Social Surroundings environmental factor. The required work is set out in Table 8-1.

Table 8-1: Social Surroundings – EPA Requirements for Environmental Review

Task	Required work
1.	Characterise the heritage and cultural values within the amendment area to identify sites of significance and their relevance within a wider regional context.
2.	Conduct appropriate consultation with Traditional Owners to identify areas of significance and any concerns in regard to environmental impacts as they affect heritage and cultural matters.
3.	Provide a description and figure(s) of the heritage and cultural values and proposed direct and indirect impacts within and adjacent to the amendment area (including the GBSW).
4.	Assess the direct and indirect impacts on known heritage sites, values and/or cultural associations, associated with the changes in land use which may impact on cultural and heritage significance (including the GBSW).
5.	Predict the residual impacts on heritage sites, values and/or cultural associations, for direct, indirect and cumulative impacts after consideration of the mitigation hierarchy.
6.	Outline the mitigation and management measures to ensure impacts to heritage sites, values and /or cultural association (direct and indirect) are minimised, and not greater than predicted.
7.	Identify and discuss the potential visual amenity impact from the change in land use on residents within and adjacent to the amendment area, and broader area.
8.	Describe the planning mechanisms that are to be applied to ensure impacts are managed to meet EPA's objectives.

8.3 Relevant policy and guidance

The relevant policy and guidance for Social Surroundings is summarised in Table 8-2.

Table 8-2: Policy and guidance relevant to social surroundings

Policy and guidance	Key aspects
Statement of Environmental Principles, Factors, Objectives and Aims and EIA (EPA 2021)	The purpose of this EPA statement is to communicate how, for the purposes of EIA, the EPA: • Considers the object and principles of the EP Act. • Considers what the aims of EIA should be. • Uses environmental factors and objectives to organise and systemise EIA and reporting. • Considers significance throughout the EIA process. • Takes a holistic view of the environment and a proposal or scheme's potential impact on the environment. • Considers cumulative effects when assessing a proposal or scheme's potential impact on the environment.
Environmental Factor Guideline – Social Surroundings (EPA June 2023)	The purpose of this guideline is to communicate how the factor Social Surroundings is considered by the EPA in the EIA process. Specifically, the guideline: • Defines the factor Social Surroundings and explains the associated objective. • Describes EIA considerations for this factor. • Describes issues commonly encountered by the EPA during EIA of this factor. • Identifies activities that can impact social surroundings. • Provides a summary of the type of information required by the EPA to undertake EIA related to this factor.
Due Diligence Guidelines, Version 3.0 (Department of Aboriginal Affairs and Department of Premier and Cabinet 2013)	The purpose of these Guidelines is to assist land users to be more aware of how their activities could adversely impact Aboriginal heritage sites, with the intent of protecting of reducing harm to Aboriginal heritage sites in WA.
Visual Landscape Planning in Western Australia – A manual for evaluation, assessment, siting and design (Western Australian Planning Commission 2007)	This manual is the key guiding document utilised by the WAPC, EPA, other state government agencies and local government in the evaluation, protection and management of visual amenity and landscape values in Western Australia. The manual provides guidance and tools to use at each stage of the planning process to evaluate, protect and manage visual amenity and landscape values.

8.4 Studies and investigations

8.4.1 Cultural heritage values of the GBSW and Aboriginal cultural heritage

Element Advisory (Element) was engaged to undertake an evaluation of Aboriginal cultural heritage within the MRS amendment area and the surrounding region, as well as the natural, social and historic cultural heritage values of the GBSW (Element 2024) (Appendix H).

The following research and consultation methods were used to characterise Aboriginal heritage sites, values and cultural associations relevant to the proposed MRS amendment, as well as the cultural heritage values of the GBSW:

- Review of Aboriginal heritage sites registered under the *Aboriginal Heritage Act 1972*.
- Review of heritage registers and inventories administered under the *Heritage Act 2018*.

- Review of documentary evidence, including publications, research papers, government policy documents, archaeological surveys, historical maps and plans and social media.
- Consultation and site visit with a group of Whadjuk Traditional Owners, who hold the kaartdijin (knowledge) about the MRS amendment area and the surrounding region.

The study was completed in accordance with the relevant EPA guidance (set out in Table 8.2 above) and the Traditional Owner group consulted during the study was established under the guidance of consultant Brendan Moore, acting as the Noongar Group Facilitator. The consultation took place on 5 December 2022.

8.4.2 Visual amenity of the MRS amendment area

EPCAD was engaged to undertake an evaluation of the visual amenity values (hereafter referred to as 'landscape values') of the natural and semi-rural character of the MRS amendment area (Element 2024) (Appendix H). The study was undertaken in accordance with the WAPC's *Visual Landscape Planning in Western Australia* (VLPWA) manual (November 2007).

The VPLWA manual is the key guiding document utilised by the WAPC, EPA, other state agencies and local government in the evaluation, protection and management of landscape character values in Western Australia. It provides guidance and tools to use at each stage of the planning process to evaluate, protect and manage landscape character values. It recommends that visual landscape evaluation be used in the preparation and amendment of planning schemes by state and local planning authorities.

The VPLWA manual also provides guidance on the appropriate scope and level of detail that should be included in visual landscape evaluations at three different levels – regional, local or site, which represent the primary levels of the planning system in Western Australia. In accordance with the VLPWA manual, the applicable level of evaluation for an MRS amendment is regional, which entails the following level of detail and scope:

- Broad inventory and assessment of regional scale patterns and landscape characteristics.
- Understanding of visual landscape character, community perceptions, values and issues.
- Recommendations to address broad-scale landscape issues and generalised community attitudes and values.

The VPLWA manual advises that the required level of detail for visual landscape evaluation increases as the planning for an area or site moves through subsequent stages of the planning process.

At the local level, including the preparation of local structure plans, visual landscape evaluation is no longer limited to just broad, regional scale visual landscape patterns. At the local level, the landscape character of local places, as experienced and valued by discrete local populations, also needs to be evaluated. Subdivision and development proposals at an individual site level must respond to regional and local landscape matters, as well as any site-specific considerations.

8.5 Receiving environment

8.5.1 Aboriginal cultural heritage

Through the documentary research, site visit and consultation with Traditional Owners that was undertaken, a range of Aboriginal heritage sites, values and cultural associations in and around the MRS amendment area were identified. They are summarised in Table 8-3 and illustrated in Figure 8-1.

Table 8-3: Aboriginal heritage sites, values and cultural associations

Place name or description	Heritage listings	Heritage sites, values and cultural associations
Within the MRS amendment area		
Brentwood Road Swamp	Registered Aboriginal Heritage Site (#4343)	Artefacts scatter (archaeological significance)
External to the MRS amendment area		
Brentwood Road Quarry	Registered Aboriginal Heritage Site (#4342)	Artefacts scatter and quarry (archaeological significance)
Boundary Road, Wattle Grove	Registered Aboriginal Heritage Site (#3824)	Artefacts scatter (archaeological significance)
Maamba Reserve, Forrestfield (now known as Hartfield Park)	Registered Aboriginal Heritage Site (#3773)	Former camp site of significance to the Whadjuk Noongar people of the region, attributed upon the basis of tradition, historical association and sentiment
Yule Brook / Mandoorn	Registered Aboriginal Heritage Site (#36929)	Mythological site renowned for its association with the mythological water serpent, the Waugyl
Trees endemic to the GBSW and surrounding region	N/A	Endemic trees are valued by the Whadjuk Noongar people of the region for a variety of cultural associations

Brentwood Road Swamp

Brentwood Road Swamp is a registered Aboriginal heritage site (#4343), thought to be an artefacts scatter of archaeological significance. No archaeological evidence was found at the site during an archaeological survey undertaken by Archae-aus and Ethnosciences in 2019. Similarly, no artefacts were identified during the visit to the site with Traditional Owners on 5 December 2022.

However, during the site visit, the Traditional Owners discussed that the site was closely related to the Brentwood Road Quarry site (#4342), on the western side of Tonkin Highway. The two sites are situated within only 200 m of one another, albeit they are now physically separated by Tonkin Highway. Archaeological evidence was found at the Brentwood Road Quarry site on the western side of Tonkin Highway during the 2019 Archae-aus and Ethnosciences survey.

Brentwood Road Quarry

Brentwood Road Quarry is a registered Aboriginal heritage site (#4342), known to be an artefacts scatter and quarry of archaeological significance. Archaeological evidence was found at the site during an archaeological survey undertaken by Archae-aus and Ethnosciences in 2019. Although it is closely associated with the Brentwood Road Swamp heritage site, it is physically severed from this site by Tonkin Highway and is external to the MRS amendment area.

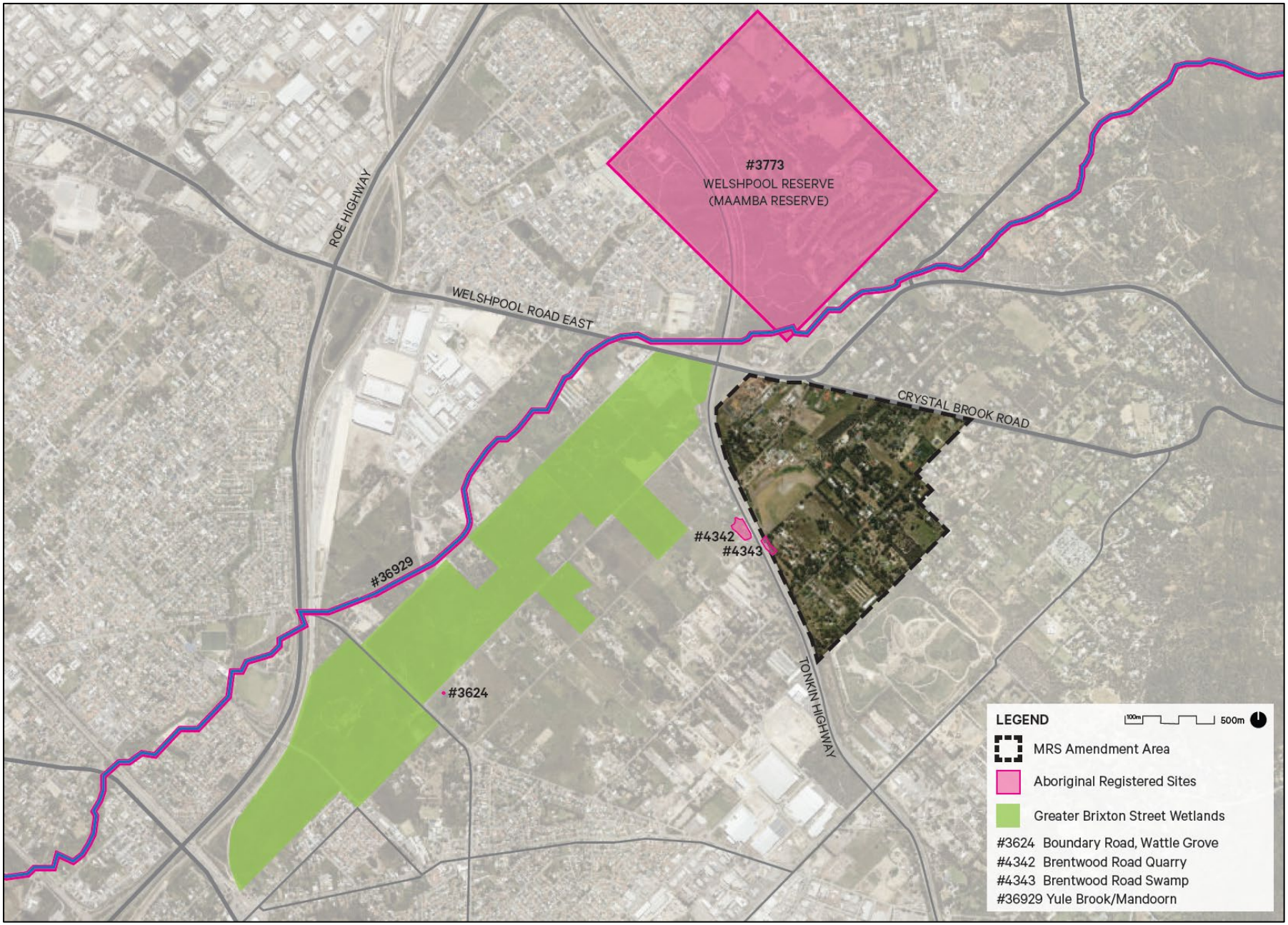

Figure 8-1: Location of Aboriginal heritage sites in context of MRS amendment area

Boundary Road, Wattle Grove

Boundary Road, Wattle Grove is a registered Aboriginal heritage site (#4343), thought to be an artefacts scatter of archaeological significance. A 2011 archaeological survey reported that earlier recorded artefacts could not be found due to ground disturbance. The site is situated near the corner of Boundary and Bickley Roads, immediately south of the GBSW. It is situated approximately 2 km west of the MRS amendment area, on the opposite (western) side of Tonkin Highway.

Mamba Reserve (now Hartfield Park), Forrestfield

Maamba Reserve (now Hartfield Park) in Forrestfield is a registered Aboriginal heritage site (#3773), recognised for its significance as a former camp site with special meaning to the Whadjuk Noongar people of the region, for its historical associations and sentimental value.

In the mid to late 1800s, the Aboriginal people who had survived the first few decades of introduced disease or violence, were displaced and forced to live on the fringes of towns, away from their traditional lands. Maamba Reserve was set aside in the late 1800s as a 'native reserve' or 'retreat for the surviving Perth Nyungars' as it was known at the time. It became a camping ground for the Aboriginal people of the region, where they lived until 1928, when the reserve was declared as a 'recreation reserve' and they were subsequently forced to leave.

Today Maamba Reserve is known as Hartfield Park and is predominantly occupied by a public golf course, however the place continues to hold strong family connections, historical associations and sentiment for the Whadjuk Noongar people of the region. Yule Brook traverses the south-western corner of the Reserve – it was a water source for the population who camped there.

Yule Brook / Mandoorn

Yule Brook / Mandoorn is a registered Aboriginal heritage site, known for its association with the mythological water serpent, the Waugyl. Waterways such as Mandoorn were particularly important to the Noongar people as abundant sources of seasonal food from animal and plant life, and for their mythological and spiritual association with the Waugyl, a powerful figure in the form of a rainbow serpent that formed the landscape and waterways.

The Waugyl is recognised today as the power that creates and maintains the fresh flow of drinking water for humans in all watercourses and springs. During the site visit and consultation with Traditional Owners on 5 December 2022, it was identified that the water flows of Yule Brook / Mandoorn have cultural heritage value and are to be protected and respected.

Trees Endemic to the GBSW and Surrounding Region

Endemic trees of the GBSW and surrounding region are valued by the Whadjuk Noongar people for a variety of cultural associations. Below are a few examples (that are not intended as an exhaustive list) identified through documentary research and consultation with Traditional Owners:

- The use of the branches of the Spearwood tree in spear making.
- The Christmas tree as a sacred resting place for the spirits of ancestors.
- Paperbark trees as a sign of underground water.

8.5.2 Cultural heritage values of the GBSW

Through the documentary research, site visit and consultation with Traditional Owners that was undertaken came an understanding of the natural, social and historical heritage values of the GBSW. These values are summarised in Table 8-4 below.

Table 8-4: Cultural Heritage Values of the GBSW

Place Name or Description	Heritage Listings	Heritage Values
Greater Brixton Street Wetlands	City of Gosnells Local Heritage List (Lot 808 of Reserve 49200 only)	The GBSW is a place of special meaning for a cross section of groups and individuals in the community. The cultural heritage values of the wetlands include the following: • Educational values for researchers and scientists. • Social and historical values held by individuals and community groups, who have come together for over three decades, to conserve and enhance the wetlands for future generations. • Social value for its aesthetic natural beauty. • Its natural water flows, which have been identified as having cultural heritage value to the Whadjuk Noongar people of the region.

The GBSW cover an area of approximately 215 ha, a portion of which (20 ha) is included in the City of Gosnells Local Heritage List. It is a place of special meaning for a cross section of groups and individuals in the community, who recognise its exceptional biodiversity within the context of the Swan Coastal Plain. The Whadjuk Noongar people value the GBSW and its natural water flows.

8.5.3 Visual amenity of the MRS amendment area

As outlined in Section 8.3.2, a regional level visual landscape evaluation was completed for the MRS amendment area. Accordingly, the focus of the evaluation was on landscape values at a state and regional level – i.e. what aspects of the visual landscape within the MRS amendment area contribute to the overall value of the regional landscape and/or the Western Australian landscape?

Utilising the methodology in the VLPWA for characterising the level of significance of viewing experiences, three viewing experiences of the MRS amendment area were categorised as being of state or regional significance:

- Views experienced from vehicles on Tonkin Highway.
- Views experienced from vehicles on Welshpool Road East and Crystal Brook Road.
- Views experienced by visitors to Lions Lookout in the Korung National Park.

These three viewing experiences were evaluated in detail to determine if there were any visual features or views of the MRS amendment area that contributed to the overall value of the regional landscape and/or the Western Australian landscape.

The landscape character values of state and regional significance that were identified for the MRS amendment area are summarised in Table 8-5 and described in more detail below.

Tonkin Highway interface

Tonkin Highway is a high speed (100 km/h) arterial road designed to move vehicles and people efficiently across the Perth metropolitan area. It is also a major truck route utilised by road trains. A vegetative corridor along the interface of Tonkin Highway and the MRS amendment area acts as a

screen and obscures views into the majority of the MRS amendment area. The views of this vegetative corridor are typical of the views experienced along most major highways and freeways in Perth.

Views into the MRS amendment area from Tonkin Highway are experienced obliquely and at high speeds. The entire 1.9 km length of the MRS amendment area is passed in just over one minute, significantly limiting the opportunity for meaningful views into the area. There is also an absence of any notable features within the landscape that draw the viewer's eye to it.

Views into the MRS amendment area from Tonkin Highway vary depending on whether they are experienced as a passenger or as a driver. The quality of views experienced as a driver are low, as their line of sight is predominantly on the road with only peripheral views of the MRS amendment area. A passenger of a vehicle may have more viewing opportunity, however due to the high speed of travel, lack of notable features in the landscape and typical appearance of the vegetation dominating the landscape, it is questionable that any views of this stretch of Tonkin Highway are uniquely memorable or valued by the majority of its users.

The remnant vegetation within the MRS amendment area that is visible from Tonkin Highway would however likely have some value, not as an isolated or individual view, but as part of an overall viewing experience when travelling along Tonkin Highway.

Table 8-5: State and regional landscape character values

Viewing location	How the landscape is experienced	Typical view	Landscape character values
Tonkin Highway Interface	As a passenger or driver of a vehicle travelling at 100 km/h		Natural Woodland Views
Welshpool Road East Interface	As a passenger or driver of a vehicle travelling at 80 km/h		Natural Woodland Views
Crystal Brook Road Interface	As a passenger or driver of a vehicle travelling at 70 km/h		Natural Woodland Views

Viewing location	How the landscape is experienced	Typical view	Landscape character values
Crystal Brook Road Interface	As a passenger or driver of a vehicle travelling at 70 km/h		Rural look and feel of the landscape, dominated by views of mature tree canopy and rural style boundary fencing
Lions Lookout, Korung National Park	From public lookout and walking trails – the MRS amendment area is barely distinguishable int		Vast horizontal scale and expansiveness of views of the Perth metropolitan area and CBD skyline

Welshpool Road East interface

The natural woodland views along the Welshpool Road interface are limited to the junction of Welshpool Road East, Crystal Brook Road and Brentwood Avenue. Views into the MRS amendment area from vehicles travelling along Welshpool Road East are otherwise dominated by a large landscape salvage yard, industrial sheds, cleared areas and hard stand areas. These views are of little to no value.

Crystal Brook Road interface

Views into the MRS amendment area from vehicles travelling along Crystal Brook Road are dominated by vegetation and rural style boundary fences, including post and rail and post and wire fences. Intermittent views into the MRS amendment area become available when there are breaks in the vegetation – these views include homestead style houses, sheds and open paddocks.

The visual characteristics that contribute to the landscape value of Crystal Brook Road include the aesthetic of the road itself (e.g. un-engineered, no kerbing, gravel shoulders) and the rural aesthetic of built form and boundary fencing visible from the road. However, it is the mature tree canopy and areas of remnant woodland that dominate views of the MRS amendment area from vehicles travelling along Crystal Brook Road. This is considered of most value.

Lions Lookout, Korung National Park

Lions Lookout is a formalised lookout in Korung National Park, in the Darling Range, located approximately 2 km to the east of the MRS amendment area. The lookout marks the beginning of a bush walking trail and is equipped with carparking, benches and picnic facilities.

Lions Lookout offers expansive panoramic views of the city at an unusually vast horizontal scale, which are rare in the context of metropolitan Perth. The Perth CBD skyline is visible in the distance and the metropolitan area is viewed as a heterogenous patchwork of human settlement, in which areas of dense urban settlement and untouched native bushland provide a distinct visual contrast, which is not unpleasing to the eye. With the exception of the Perth CBD skyline, the areas of urban settlement within the panoramic views are relatively consistent in scale and height (i.e. 1-3 storeys), which contributes significantly to the expansiveness and horizontal scale of the views.

The MRS amendment area is barely visible from the lookout and is almost insignificant in the context of the entire viewshed, which takes in the 20 km distance leading to the CBD skyline. The various natural and built form components that make up the landscape of the MRS amendment area are not separately distinguishable in the context of the overall panoramic views, nor are there any features within the area that catch the viewer's eye.

Notwithstanding this, the low-rise nature of existing built form within the MRS amendment area sits comfortably within the vast and relatively consistent horizontal scale of the panoramic views from Lions Lookout. It is this vast horizontal scale that makes the views from the lookout unique and sought after.

8.5.4 The Local Landscape of the MRS amendment area

Whilst the VLPWA manual only requires detailed consideration of regional scale patterns and landscape values in visual landscape evaluations undertaken at the regional level (such as this one), it does however also require that generalised community attitudes, perceptions and values be addressed, which is not necessarily limited to those at a regional level.

This is of relevance in the context of this visual landscape evaluation, which has been prepared to inform the EPA's environmental impact assessment of the proposed MRS amendment, which includes *'potential visual amenity impacts on* residents within and adjacent *to the MRS amendment area.'*

Within the MRS amendment area there are only three internal roads providing access – Boundary, Brentwood and Victoria Roads. Views along these internal roads are obtained from vehicles and also at a pedestrian level, by people using the roads for walking activities.

Due to the disconnected nature of these internal roads, terminating at Tonkin Highway, they are only accessible from Crystal Brook Road and do not facilitate through traffic. Accordingly, these roads experience low levels of usage by only local residents, workers and visitors to the area. Views from these internal roads have therefore categorised as being of local significance, in accordance with the VPLWA manual.

Similarly, the views into the MRS amendment area from the rural residential properties on the opposite sides of Crystal Brook and Victoria Roads (that are orientated towards the area), as well as a small number of properties on Easterbrook Place and Valcan Roads (which back onto the MRS amendment area) have also been categorised as being of local significance, as they are only experienced by a small number of local residents.

The local landscape is experienced very differently from within the MRS amendment area to that of the external viewing locations of state and regional significance. Views from within the MRS amendment area itself are local and immediate. They are site-specific experiences and include views from the internal roads and the few open areas. The viewing experiences of local residents will also be of the landscape character that is created on their properties and others surrounding them.

The way in which the local landscape within the MRS amendment area is viewed and valued by its residents will depend on various factors, such as the extent to which local residents utilise the internal streets for car travel and walking, the siting and street setback distances of residential dwellings, and the presence of vegetation on individual properties that may create enclosed canopied views, thus obstructing longer views out to surrounding properties.

These same principles apply to the viewing experiences of the MRS amendment area from those residents residing immediately opposite the MRS amendment area (on Crystal Brook and Victoria Roads) or backing onto the MRS amendment area (from Easterbrook Place and Valcan Roads).

Overall, there is not one overarching view or specific class of features within the local landscape that is commonly experienced by all users. Therefore views, viewing experiences and attitudes towards what is of value within the local landscape will be highly personal and unique to each individual.

It is further recognised that attitudes towards the potential changes that will occur to the local landscape as a result of the proposed change in land use to Urban will be influenced by the intentions of local residents to either remain in or leave the area, if the rezoning proceeds.

The MRS amendment area has been earmarked for urban development since the release of the WAPC's North East Sub-regional Planning Framework in 2018. In the five years that have ensued, a number of residents have come to accept this proposed change to their local environment and have made the decision to sell and move out of the area if the MRS rezoning proceeds. Accordingly, these residents will not be impacted by any changes to the visual landscape of the area as a result of the rezoning.

The extent to which other residents within and adjacent to the MRS amendment area are impacted by the changing landscape will depend on the location of their properties, their viewing experiences (for example properties with views orientated towards Crystal Brook Road won't experience any change in their outlook of the rural-residential properties on the opposite side of the road that are not subject to the proposed rezoning), and the extent to which any existing vegetative buffers provide separation from and screen future urban development.

The impacts of the changing visual landscape on existing residents who remain in the area will also depend on the rate of urbanisation, which typically occurs over a timescale of 15 to 25 years in an area the size of the MRS amendment area.

It is conceivable that during this time, a number of these residents will have moved on or out of the area for a variety of reasons (lifestyle, relocation for work or family reasons, illness or death, or to realise the improved commercial value of their land) before they experience any significant impacts to their visual amenity and experience of the local landscape.

Their properties will either be purchased for development, or by new owners who are accepting of the urban zoning and the changes in the landscape that this will bring.

Any potential changes to the local landscape can be addressed at the local level, through structure plans and conditions of subdivision approval. Structure plans for land within the MRS amendment area can be required to incorporate a Visual Amenity Management Strategy, to identify and mitigate any impacts on locally significant landscape values. The identification of values should be informed by the community aspirations, attitudes and perceptions of local visual amenity current at that time.

8.6 Potential environmental impacts

In accordance with the *EPA Environmental Factor Guideline - Social Surroundings,* an assessment of potential impacts on social surroundings requires a clear link to be established between:

Any impacts of the proposed change in land use on the physical or biological surroundings it relates to; and Any subsequent impacts flowing on from these physical and biological changes to the aesthetic, cultural, economic or social surroundings of individuals or groups of people.

There are four key changes to physical and biological surroundings that are reasonably foreseeable as a result of the proposed change in land use. These are set out in Table 8-6 below.

Table 8-6: Potential changes to physical and biological surroundings

Physical surroundings	Biological surroundings
• Physical modification of the landscape as a result of urban development, including clearing of vegetation, development of housing, retail and commercial centres, roads, services and public open spaces. • Modification of the landscape during construction, such as incidental clearing of vegetation (e.g. construction of vehicle haul roads), or littering and unauthorised dumping by construction personnel. • Increased human activity both during and after development, increasing the potential for human intervention with heritage sites and the risk of physical disturbance from impacts such as uncontrolled access and unauthorised dumping.	• Changes to the hydrological regime within the MRS amendment area and the surrounding locality, due to changes in surface water and groundwater flows, groundwater abstraction rates and application of irrigation water, as a result of urban development.

These changes to physical and biological surroundings have the potential to directly and indirectly impact social surroundings within the MRS amendment area and the surrounding locality.

Direct impacts are predominantly the result of physical modifications to the landscape of the MRS amendment area, such as clearing and development of housing and infrastructure, as well as changes to the hydrological regime within the MRS amendment area and the surrounding locality.

Indirect impacts may also occur as a result of construction activities during the development phase, or as a result of an increase in population and human activity within the future urban community.

These potential impacts on social surroundings are presented in the following sections.

8.6.1 Direct impacts (physical surroundings)

8.6.1.1 Physical modification of the landscape

Only the physical landscape of the MRS amendment area has the potential to be modified by the proposed change in land use. Therefore, the direct impacts associated with this are limited to:

Potential alteration of one registered Aboriginal heritage site within the MRS amendment area – the artefacts scatter known as Brentwood Road Swamp (#4343).

Clearing of endemic trees within the MRS amendment area that may hold important cultural associations for the Whadjuk Noongar people of the region.

Change in landscape character from the existing semi-rural setting to an urban setting.

All other Aboriginal heritage sites within the locality and the GBSW are located outside of the MRS amendment area and are separated from it by Tonkin Highway and Welshpool Road East, which act as significant physical barriers. Therefore, there is no risk that the cultural heritage values of these sites will be impacted by physical modifications to the landscape as a result of the proposed change in land use.

8.6.1.2 Brentwood Road Swamp artefacts scatter

The Brentwood Road Swamp registered heritage site is an artefacts scatter situated within the MRS amendment area, where the change in land use to Urban has been proposed. Therefore, there is the risk that this heritage site could be impacted by new urban development.

The likelihood of such impacts occurring at the Brentwood Road Swamp heritage site is negligible to low given that no artefacts were found at the site during the archaeological survey by Archae-aus and Ethnosciences in 2019, or again during the visit to the site with Traditional Owners on 5 December 2022.

Furthermore, the risk of impact to the heritage site is also considered to be negligible to low, due to it being situated within the easement for the Dampier to Bunbury Natural Gas Pipeline (DBNGP). The pipeline is protected by the *Dampier to Bunbury Pipeline Act 1997* (DBP Act) and the easement exists as a development exclusion zone.

8.6.1.3 Endemic trees that may hold important cultural associations

There is the potential for endemic trees that hold important cultural associations for the Whadjuk Noongar people to exist within the MRS amendment area, albeit none were identified during the site visit and consultation with Traditional Owners on 5 December 2022. If they do exist, there is the potential for the special meaning of these cultural associations to be inadvertently impacted through the clearing of vegetation for urban development.

8.6.1.4 Change in visual amenity from semi-rural to urban setting

A change in landscape character within the MRS amendment area, from a semi-rural setting to an urban setting, has the potential to impact on the landscape character values of state and regional significance that have been identified in the following ways:

Clearing of remnant vegetation and new urban development may impact the overall viewing experiences for travellers in vehicles along Tonkin Highway, Welshpool Road East and Crystal Brook Road.

The rural look and feel of Crystal Brook Road evolving into a more urban aesthetic, as a result of new urban development.

The panoramic views from Lions Lookout in Korung National Park being negatively impacted by future development within the MRS amendment area that is noticeably inconsistent with the predominant scale and height of existing urban settlement visible within those views (i.e. 1 to 3 storeys).

The extent to which these impacts are likely to occur, or will be significant, is discussed below.

Tonkin Highway interface

Views of remnant vegetation within the MRS amendment area form part of an overall viewing experience when travelling along Tonkin Highway. Vegetative corridor views along Tonkin Highway are typical of one type of viewing experience along major highways and freeways in Perth.

Views of the MRS amendment area from Tonkin Highway after urban development has occurred will likely incorporate some retained vegetation (including within the Tonkin Highway road reserve, which is not subject to the proposed change in land use), residential, school and commercial buildings. These views represent another typical viewing experience along major highways and freeways in Perth, including Tonkin Highway.

Therefore, it is unlikely that the change in landscape character from a semi-rural to an urban setting within the MRS amendment area will have a significant impact on the viewing experience from Tonkin Highway.

Welshpool Road East interface

Views into the MRS amendment area from vehicles travelling along Welshpool Road East are dominated by a large landscape salvage yard, industrial sheds, cleared areas and hard stand areas. These views are considered to be of little to no value. The very small patch of trees at the junction of Welshpool Road East, Crystal Brook Road and Brentwood Avenue is considered insignificant in the overall viewing experience of the MRS amendment area from vehicles along Welshpool Road East.

Therefore, it is not considered that the change in landscape character from a semi-rural to an urban setting will impact the viewing experience from Welshpool Road East. To the contrary, urban redevelopment along Welshpool Road East is likely to result in an enhanced visual amenity outcome and improve the overall viewing experience from vehicles travelling along this road.

Crystal Brook Road interface

Urban development is highly adaptive and can take many forms, both visually and spatially. It is therefore possible to retain the integrity of the existing 'rural look and feel' and viewing experience (dominated by the mature tree canopy) of Crystal Brook Road in any future urban development proposals within the MRS amendment area. This can be appropriately managed at future stages of the planning process through structure plan controls and conditions of subdivision and development.

Lions Lookout, Korung National Park

The MRS amendment area is barely visible from Lions Lookout and is almost insignificant in the context of the vast panoramic views from this location. It is highly unlikely that any future urban development within the MRS amendment area will be of a scale and height that is greater than 1 to 3 storeys. It is therefore anticipated that any new urban development will be visually consistent with, and sit comfortably within, the existing pattern of urban development within the viewshed from the lookout.

It is therefore unlikely than the proposed change in land use within the MRS amendment area will negatively impact the significantly vast horizontal scale of the views from this lookout. Notwithstanding, appropriate mechanisms for managing the height and scale of future development can be implemented at later stages of the planning process if required.

8.6.2 Direct impacts (biological surroundings)

The hydrological changes associated with urban development include altered surface water and groundwater flows and variations in rates of groundwater abstraction and application of irrigation water. Unmanaged surface water or groundwater impacts as a result of new urban development can adversely alter the hydrological regime of wetlands and waterways in the surrounding region.

This can lead to a deterioration in the quality and quantity of plant life and fauna within the wetlands and waterways, which in turn has the potential to impact on social surroundings including:

- The cultural heritage values of the GBSW, in particular its social and educational values.
- Endemic trees of the GBSW that hold important cultural associations for the Whadjuk Noongar people of the region.
- The registered Aboriginal heritage site, Yule Brook / Mandoorn (#36929), due to its mythological association with the Waugyl, that formed the landscape and waterways, and nowadays is recognised as the power that creates and maintains the fresh flow of drinking water in all watercourses and springs.
- To a lesser extent, the registered Aboriginal heritage site, Maamba Reserve (#4342). Yule Brook traverses the south-western corner of the reserve and was an important source of water for people who once camped at the reserve.

8.6.3 Indirect impacts (physical surroundings)

The inhabitants of new urban communities have the potential to indirectly impact on social surroundings through activities typically associated with an increase in human activity in an area.

This includes uncontrolled access by vehicles and pedestrians, littering, unauthorised dumping, fire risk and intentional or accidental interference with heritage sites. Many of these impacts may also occur during construction activities associated with urban development.

These potential indirect impacts as a result of the proposed change in land use can be managed through the implementation of environmental management plans, at subsequent stages of the planning process and during and after development.

No indirect impacts to social surroundings as a result of changes to biological surroundings have been identified.

8.6.4 Cumulative impacts

Cumulative impacts result from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions.

In Section 8.7 below, it is demonstrated, with reference to the EPA's mitigation hierarchy, that potential impacts to social surroundings as a result of the proposed change in land use to Urban, can be appropriately mitigated, predominantly through **avoidance** measures. It is therefore predicted that the extent of impacts associated with the proposed change in land use will be nil or negligible.

It therefore follows that there will be no cumulative impacts of significance to social surroundings associated with the proposed urbanisation of the MRS amendment area.

8.7 Mitigation

8.7.1 Direct impacts (physical surroundings)

It has been identified that changes to physical surroundings as a result of the proposed change in land use may have the potential to directly impact:

- Brentwood Road Swamp artefacts scatter (registered Aboriginal heritage site #4343).
- Any endemic trees within the MRS amendment area with important cultural associations.
- The integrity of the 'rural look and feel' and existing viewing experience (dominated by the mature tree canopy) of Crystal Brook Road.
- The expansive panoramic views from Lions Lookout in Korung National Park.

The recommended management measures for mitigating these potential impacts are set out below.

8.7.1.1 Brentwood Road Swamp artefacts scatter

With reference to the EPA mitigation hierarchy, the potential direct impacts to the Brentwood Road Swamp artefacts scatter and registered Aboriginal heritage site can be mitigated through avoidance and minimisation.

The Brentwood Road Swamp artefacts scatter and registered heritage site is situated within the easement for the Dampier to Bunbury Natural Gas Pipeline (DBNGP). The DBNGP is Australia's longest gas pipeline and one of Western Australia's most critical pieces of energy infrastructure. The pipeline is governed by the *Dampier to Bunbury Pipeline Act 1997* (DBP Act) and the easement exists to always guarantee essential access to the pipeline.

The DBP Act effectively requires the easement to be a 'development free' zone. There are also associated land use guidelines for the DBNGP easement (WA Government 2016), which restrict any activities or modifications to land within the easement that may compromise essential access to the pipeline, or the physical integrity of the pipeline itself. In particular the excavation of land within the easement is highly regulated and largely prohibited.

Essentially modifications to land within the DBNGP easement are restricted to low impact landscaping treatments, such as shrubs and plants with shallow roots not exceeding 300 mm in depth, unsealed pathways and no reticulation. Officer level advice received from the City of Kalamunda in November 2022 has confirmed these land use management requirements for the DBNGP easement.

These significant statutory limitations that apply to development and excavation of land within the DBNGP corridor will largely protect the Brentwood Road Swamp heritage site from risk of physical disturbance.

It is also noted that no archaeological evidence was found at the heritage site during a recent archaeological survey by Archae-aus and Ethnosciences in 2019. However as there is the potential for archaeological evidence to be present in the land surrounding the site (particularly in any undisturbed sandy areas), it is recommended that subdivision or development within the vicinity of the Brentwood Road heritage site be subject to an application for Section 18 approval, pursuant to the Aboriginal Heritage Act 1972.

Engagement with Traditional Owners typically forms part of a Section 18 application. It is also recommended that an Archaeological Site Survey (and Archaeological Management Strategy in the event artefacts are uncovered) also be submitted with the application.

Through the Section 18 process, conditions can be placed on any subdivision or development proposals to avoid or minimise potential impacts on the Brentwood Road Swamp heritage site.

8.7.1.2 Endemic trees with important cultural associations

With reference to the EPA mitigation hierarchy, it is considered that potential direct impacts to any endemic trees within the MRS amendment area that may hold important cultural heritage associations for the Whadjuk Noongar people can be mitigated through a combination of avoidance and rehabilitation.

It is proposed that any existing trees within the area that may have important cultural associations for the Whadjuk Noongar people be identified, and if possible, retained within future public open spaces and road reserves.

In instances where retention is not possible or practical, it is proposed that this be ameliorated through the relevant tree species being afforded recognition and respect in the:

- Tree Canopy Retention and Landscape Management Strategy at local structure plan stage.
- Tree Canopy Retention and Landscape Management Plan at subdivision stage.

At the local structure plan stage, Traditional Owners should be consulted to identify if there are any trees with important cultural associations within the MRS amendment area, to inform the Tree Canopy Retention and Landscape Management Strategy.

Then at subdivision stage, the Tree Canopy Retention and Landscape Management Plan will document if any trees have been identified for retention and/or if the replanting program will include the targeted replanting of certain tree species that hold special cultural associations for the Whadjuk Noongar people of the region.

Additionally, it is recommended that these measures be supplemented by:

- An Interpretation Plan – to provide opportunities for educating the wider community about the special meaning that any endemic trees retained and planted within the MRS amendment area hold for the Whadjuk Noongar people.

8.7.1.3 Landscape character of Crystal Brook Road

As outlined in section 8.6.1.3 above, the integrity of the existing 'rural look and feel' and viewing experience (dominated by the mature tree canopy) of Crystal Brook Road can be retained in any future urban development proposals within the MRS amendment area. This can be appropriately managed at future stages of the planning process through structure plan controls and conditions of subdivision and development.

The most effective and recommended management measure is the designation of an 'Interface Transition Zone' along the boundary of Crystal Brook Road within all future structure plans prepared for the MRS amendment area. This zone will facilitate an appropriate graduation and transition in visual landscape character from the existing rural residential properties on the north-eastern side of Crystal Brook Road to future urban development within the MRS amendment area.

To achieve this, structure plans should also include appropriate provisions and controls for the 'Interface Transition Zone', including:

- Where possible, the retention of existing remnant and open woodland areas along the edge of Crystal Brook Road.
- Requirement for subdivision and development within the 'interface transition zone' to reflect a contemporary rural aesthetic that is responsive to its surrounds.

8.7.1.4 Viewing experience along Tonkin Highway

Notwithstanding that urbanisation of the MRS amendment area is unlikely to have a significant impact on the existing viewing experience from Tonkin Highway, the Visual Landscape Evaluation (EPCAD 2024) recommends that views of remnant and open woodland areas from Tonkin Highway should be retained where possible. This can be appropriately managed at future stages of the planning process through structure plans and conditions of subdivision and development.

8.7.1.5 Panoramic views of Lions Lookout from Korung National Park

As outlined in section 8.6.1.3 above, it is highly unlikely that any future urban development within the MRS amendment area will be of a scale and height that is greater than 1 to 3 storeys. As such any modification to the landscape within the MRS amendment area as a result of urban development will be barely noticeable from Lions Lookout and therefore will not impact the panoramic views from this location, characterised by their significantly vast horizontal scale.

However, should management of the height and scale of urban development within the MRS amendment area be desired in the future, there are appropriate mechanisms at later stages of the planning process that are equipped to address this.

Most notably, in the event that a structure plan for land in the MRS amendment area proposes residential density coding that would permit or contemplate development over three storeys in height, it can be required to be accompanied by a visual impact assessment, to demonstrate that the height and scale of future development will not interrupt or impact on the integrity of the panoramic views from Lions Lookout in Korung National Park.

8.7.2 Direct impacts (biological surroundings)

It is considered that through the implementation of the best practice urban water management measures recommended in Section 5.7 of this ER (for the environmental factor Inland Waters), potential impacts to the hydrological regime, plant life and fauna of wetlands and waterways in the surrounding region can be appropriately mitigated and managed.

Through the appropriate management of these biological surroundings, any subsequent impacts to social surroundings can also be mitigated. This includes protection of the following values:

- The cultural heritage values of the GBSW, in particular its social and educational values.
- Endemic trees of the GBSW that hold important cultural associations for the Whadjuk Noongar people of the region.
- The registered Aboriginal heritage site, Yule Brook / Mandoorn (#36929) and its mythological association with the Waugyl.
- The registered Aboriginal heritage site, Maamba Reserve (#4342) and its association with Yule Brook, an important source of water for people who once camped at the reserve.

8.7.3 Indirect impacts (physical surroundings)

Any potential indirect impacts on social surroundings will be the result of changes to physical surroundings only. They are limited to the Brentwood Road Swamp Aboriginal heritage site and endemic trees with important cultural associations for the Whadjuk Noongar people within the MRS amendment area. With reference to the EPA mitigation hierarchy, it is considered that any indirect impacts can be avoided and minimised.

Potential indirect impacts to the Brentwood Road Swamp heritage site include:

- Uncontrolled access by people and vehicles.
- Littering and unauthorised dumping.
- Risk of fire during construction.
- Intentional or accidental interference with the heritage site.

All of these potential indirect impacts are a risk to the Brentwood Road Swamp heritage site during the construction phase of urbanisation. They can be appropriately managed through CEMP(s) at the subdivision approval stage of the planning process.

The protection of the heritage site from indirect impacts after urbanisation has occurred can be appropriately mitigated through an Archaeological Management Strategy and conditions of a Section 18 approval, should this be required.

The risk of fire and incidental or accidental clearing of vegetation during construction are potential indirect impacts to endemic trees that may be culturally significant to the Whadjuk Noongar people. Similarly, these indirect impacts during construction can be appropriately managed through CEMP(s) at the subdivision approval stage of the planning process.

8.7.4 Assessment and significance of residual impact

No residual impacts are anticipated as a result of the proposed change in land use and future urban development once mitigation measures have been applied.

8.8 Environmental outcomes

Following the implementation of the proposed mitigation measures, the predicted environmental outcomes for social surroundings associated with urbanisation of the MRS amendment area are:

- Protection and conservation of the Brentwood Road Swamp artefacts scatter (registered Aboriginal heritage site #4343) located within the MRS amendment area (if it still exists).
- No impacts to other registered Aboriginal heritage sites in the region surrounding the MRS amendment area.
- Retention and/or replanting of any endemic trees within the MRS amendment area that may hold important cultural associations for the Whadjuk Noongar people of the region.
- Protection and conservation of the natural, social and historical cultural heritage values of the GBSW.
- Appropriate management of potential impacts to visual amenity / landscape values during later stages of the planning process, including:

Measures to retain the integrity of the existing 'rural look and feel' and viewing experience (dominated by the mature tree canopy) along Crystal Brook Road.

Measures to retain natural woodland views from Tonkin Highway where possible.

Measures to ensure the height and scale of future urban development does not interrupt or impact on the integrity of the panoramic views from Lions Lookout in Korung National Park (albeit that this is very unlikely to be a consequence of future urban development).

9. Key environmental factor – Greenhouse gas

9.1 EPA objective

The EPA's objective for Greenhouse Gas is:

To minimise the risk of environmental harm associated with climate change by reducing greenhouse emissions as far as practicable.

9.2 Instruction for Environmental Review (Assessment No. 2335) for Amendment 1388/57 – Greenhouse Gas

The EPA's Instruction for Environmental Review (Assessment No. 2335) for Amendment 1388/57 (15th August 2022) identified 3 specific scopes of works for the Greenhouse Gas environmental factor. The required work for Greenhouse Gas, is outlined in Table 9-1.

Table 9-1: Greenhouse Gas – EPA Requirements for Environmental Review

Task	Required work
1.	Estimate the expected Scope 1 (direct) and Scope 2 (indirect) net greenhouse gas emissions (i.e. quantity of carbon dioxide equivalent (CO2-e)) on an annual basis and over the life of the scheme amendment inclusive of changes to land use (clearing of vegetation). Breakdown estimated emissions by source (e.g. changes to land use, clearing of vegetation). Detail the methods used to estimate the net greenhouse gas emissions.
2.	Describe the considered and proposed mitigations that demonstrate all reasonable and practicable measures have been applied at each step of the mitigation hierarchy to avoid, reduce and/or offset greenhouse gas emissions over the life of the scheme amendment.
3.	Where Scope 1 emissions are estimated to exceed 100,000 tonnes per equivalent per annum, develop a Greenhouse Gas Management Plan in accordance with the EPA's Environmental Factor Guideline: Greenhouse Gas Emissions and demonstrate how the EPA's objective for this factor can be met.

9.3 Relevant policy and guidance

The relevant policy and guidance for Greenhouse Gas is summarised in Table 9-2.

Table 9-2: Policy and guidance relevant to greenhouse gas

Policy and guidance	Key aspects
Environmental Factor Guideline: Greenhouse Gas Emissions (EPA 2023c)	The purpose of this guideline is to outline how and when the Greenhouse Gas Emissions factor is considered by the EPA in the EIA process. Specifically, the guideline: • Describes why the EPA has published the guideline and how it is applied. • Defines greenhouse gases and the different scope of emissions. • Outlines the international and national frameworks. • Describes how this factor links with other environmental factors. • Outlines when the EPA may apply this guideline. • Describes EIA considerations for this factor. • Provides a summary of the information required by the EPA to undertake EIA related to this factor (including consideration of Scope 1, 2 and 3 emissions). • Provides the expected content for Greenhouse Gas Management Plans. • Outlines periodic public reporting requirements. • Identifies issues commonly encountered by the EPA during EIA of this factor.

9.4 Receiving environment

The receiving environment for Greenhouse Gas (GHG) emissions associated with the proposed MRS amendment is the atmosphere on a global scale. Western Australia is experiencing changing climate, including warming trends and extreme weather events (GoWA 2021). Specifically, the impacts of climate change already experienced in Western Australia include:

- An increase in the average temperature of 1.3°C since 1910.
- A decline in rainfall since 1900 in the far west and south-west regions, while an increase has been recorded generally over most of Western Australia.
- An increase in the number of days with dangerous weather conditions for bushfires in nearly all regions.
- A decline in the number of tropical cyclones over the period 1981/82 to 2017/18.

Future climate change projections predicted for Western Australia by mid-century (GoWA 2021), include:

- A continued rise in temperatures (exact projections depend on the global GHG emissions scenario utilised).
- A projected increase in the number of very hot days (>40°C) in Perth from 1.5 to 5 a year.
- A more extended fire season with 40% more 'very high' fire danger days.
- A rise in sea level of 24 cm.
- Increased intensity of extreme rainfall events.
- The State is likely to become drier – rainfall change is unclear in the monsoonal north, but ongoing significant declines in the south-west are likely.
- A projected 12% decrease in tropical cyclones.

9.4.1 Scope of emissions

GHG emissions, expressed in tonnes of carbon dioxide equivalent (tCO_2-e), is an aggregate of individual GHGs, including carbon dioxide, methane, nitrous oxide (N_2O), sulphur hexafluoride (SF_6), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and nitrogen trifluoride (NF_3), calculated as an equivalent CO_2 emission by factoring in the global warming potential (GWP) of each gas.

National and international GHG reporting standards define a set of distinct classes (scopes) of GHG emissions that delineate sources and associated responsibilities. The scopes of GHG emission classes are defined (CER 2023) as:

- Scope 1 emissions are the GHG emissions released to the atmosphere as a direct result of an activity or a series of activities at a facility level.
- Scope 2 emissions are GHG emissions released to the atmosphere from indirect consumption of energy commodities (electricity, heat or steam) from third party suppliers.
- Scope 3 emissions are indirect GHG emissions, other than Scope 2 emissions, which are generated in the wider economy, which occur because of the activities of a facility, but from sources not owned or controlled by that facility's business.

9.5 Potential environmental impacts

The Environmental Review instructions issued by the EPA specify clearing of vegetation as the relevant activity associated with the proposed change in land use that has the potential to generate GHG emissions.

The future change in land use proposed by the MRS amendment has the potential to result in clearing of some vegetation leading to loss of bio-sequestration capacity. Degradation of the removed vegetation will lead to stored carbon being released to the atmosphere, largely as carbon dioxide (CO_2) and methane (CH_4).

In addition to the carbon sequestered in vegetation, emissions associated with fuel consumption by mobile plant and equipment used for any land clearing activities will also occur. These have not been accounted for in this GHG assessment, as they are considered to be negligible in the overall context of the assessment, due to the small size of the MRS amendment area, the low density of the existing vegetation, the environmental objective of retaining as many existing trees as possible within the future urban development, and in light of any land clearing being a finite (one-off) occurrence that will not be ongoing once the area is fully developed.

Carbon sequestration loss due to biomass disturbance has been calculated using the methodology from the Intergovernmental Panel on Climate Change (IPCC 2003).

No Scope 1 GHG emissions from other sources will occur directly due to the potential clearing of vegetation associated with future urban development. There are also no Scope 2 emissions associated with the potential clearing activities.

9.5.1 Estimated emissions

The 'Maximum Above Ground Biomass' of vegetation (also known as the 'M value') is one of the key inputs utilised to calculate carbon sequestration loss due to biomass disturbance. The M value spatial layer developed for the Full Carbon Accounting Model (CSIRO 2017) is based on the forest productivity index at a specific location and is constant – i.e. it is not influenced by site specific variances in land use or vegetation condition.

Ecological surveys of the MRS amendment area (JBS&G 2024) have shown that the majority of the area (~73%) has already been cleared of vegetation. Areas of remnant vegetation, where the maximum biomass is most likely to occur, only account for less than 4% of the MRS amendment area. The balance of remaining land, representing ~23% of the MRS amendment area, is highly modified and while it includes planted vegetation and scattered trees, it likely supports a lower biomass than the M value data predicts. This is supported by the vegetation condition mapping for the MRS amendment area, which shows that existing vegetation is largely degraded, with only 3.6 ha (~3%) in 'Good to Excellent' condition (JBS&G 2024).

In light of this known extent of vegetation modification and noting that within the MRS amendment area there is a range of existing land uses (such as composite business, semi-rural residential and semi-rural commercial properties including a turf farm), it is considered that applying the M value across the entire MRS amendment area will not provide an accurate representation of actual GHG emissions.

Therefore, to develop a more representative GHG emissions estimate while retaining some conservatism, the following assumptions have been applied to the MRS amendment area:

- A minimum of ~3.6 ha of remnant native vegetation in Good or better condition will be retained.
- All other existing vegetation within the MRS amendment area will be fully cleared, including:
  - ~31.0 ha of land containing modified vegetation, including scattered trees and planted gardens (noting that that this clearing assumption does not account for the environmental objective of retaining as many existing trees as possible within the future urban development).
  - ~91.1 ha of cleared land, which has been conservatively assumed to all be grassland (noting that this area also incorporates, houses, sheds, driveways, hardstand and roads with no existing biomass).
- All modified vegetation has been assigned the maximum potential Above Ground Biomass of 159 tonnes of dry matter per hectare derived from the M value spatial data, notwithstanding that the actual Above Ground Biomass for modified vegetation is expected to be less.
- To estimate the Below Ground Biomass for the areas of modified vegetation, a root-to-shoot ratio of 0.257 has been applied, as this is representative of natural Eucalyptus trees (IPCC 2003). Given that ~90% of modified vegetation in the MRS amendment area consists of scattered trees comprising mostly Eucalyptus species, this assumption is considered reasonable.
- With respect to the remaining ~91.1 ha of cleared land, an estimated maximum Above Ground Biomass of 2.7 tonnes of dry matter per hectare and a root-to-shoot ratio of 4.0 have been assumed, which is representative of grassland in a warm temperate wet climate (IPCC 2006, Tables 6.4 and 6.1).
- The default IPCC (2006) value for carbon fraction of biomass dry matter (i.e. 0.5) has been utilised, as it is representative in this instance.
- It is assumed that all carbon in the cleared biomass is released as CO_2.
- Soil that will remain in situ is expected to primarily be covered with an impervious surface (e.g. bitumen or concrete) or gardens – therefore soil carbon will largely be retained and has not been accounted for.

The carbon sequestration loss from potential vegetation clearing ($\boldsymbol{\Sigma E_v t\ CO_2 - e}$) was estimated using the following formula (IPCC 2006 equation 2.14):

$$\boldsymbol{\Sigma E_v t\ CO_2 - e = A \times AGB\ x\ (1 + R)\ x\ CF\ x\ CD}$$

Where:

Parameter	Description	Measurement	Modified Vegetation	Cleared Land (Grassland)
A	Area to be cleared	Ha	**31.0**	**91.1**
AGB	Above Ground Biomass	Tonnes Dry Matter / Ha	**158.87**	**2.7**
R	Below Ground Biomass	Root-to-Shoot Ratio	**0.257**	**4.0**
CF	Carbon Fraction of Biomass	IPCC Default	**0.5**	**0.5**
CD	Ratio of Molecular Weight of Carbon Dioxide to Carbon	CO2 (44) / C (14)	**3.67**	**3.67**

Using the above values, the potential maximum GHG emissions from clearing of vegetation and loss of bio-sequestration capacity, as a result of future urban development would be **11,360 tCO2-e.**

9.6 Mitigation

The potential maximum GHG emissions of 11,360 tCO_2-e are expected to be generated over a period of 15 to 20 years, which is the typical timeframe it would take to fully urbanise an area of land the size of the MRS amendment area. This equates to average annual emissions in the order of up to 757 tCO_2-e per year, as staged development of the area progresses.

However, the actual GHG emissions from urbanisation of the MRS amendment area are expected to be less than the maximum predicted, for a few reasons:

- It is highly likely that areas of remnant scattered trees will be retained in future public open spaces and road reserves, as this has become typical of standard industry practice for new urban development in Perth over the past two decades.
- The Above Ground Biomass of 159 tonnes of dry matter per hectare that has been assumed for the potential clearing of scattered trees and planted gardens is conservative.
- The assumption that all cleared areas are vegetated (i.e. grassland) is conservative.

Furthermore, the retention of a minimum of ~3.6 ha of remnant native vegetation within the MRS amendment area (as recommended in this ER) in addition to the retention of existing mature trees will provide an offset to the annual GHG emissions that do occur.

In addition, as the staged development of the MRS amendment area progresses, new trees will also be planted in public open spaces and road reserves. Whilst there will be a time lag associated with the growing period for the replanted trees, their increased numbers and prominence within the local landscape will over time assist in offsetting the minor GHG emissions that occur as a result of any clearing activities required to facilitate future urban development.

Notwithstanding the above vegetation retention and rehabilitation activities that have been recommended for the mitigation of other environmental impacts identified in this ER, no formal offsets are proposed for potential GHG emissions given their minor and once-off nature.

9.7 Assessment and significance of residual impact

The estimated Scope 1 emissions associated with potential vegetation clearing for future urban development are predicted to be minor, in the order of up to 757 tCO_2-e per year over a 15-to-20-year development horizon.

Actual Scope 1 emissions from clearing activities are expected to be less than the maximum predicted, as they have been informed by conservative biomass assumptions, and it is highly likely that areas of scattered trees that have been assumed to be cleared, will in fact be retained in future public open spaces and road reserves, in line with typical contemporary urban development practices.

The recommended retention of a minimum 3.6 ha of remnant native vegetation together with existing mature trees within the MRS amendment area will also provide a minor offset to the emissions that do occur as a result of any future clearing activities.

Further mitigation of GHG emissions will also occur over time through the tree retention and replanting programs established in the Tree Canopy Retention and Landscape Management Strategy and associated Plan(s) prepared to support local structure planning and implemented as a requirement of subdivision or development. The resultant urban tree canopy that matures over time will contribute to the ongoing absorption and reduction of GHG emissions in the longer term.

As such, any residual impacts of GHG emissions from the clearing of vegetation for future urban development are not considered to be significant.

9.8 Environmental outcomes

The GHG emissions generated by vegetation clearing activities for future urban development will be minor in nature and are expected to be less than the maximum 11,360 tCO_2-e predicted.

Clearing activities will take place in a staged manner over an anticipated development horizon of 15 to 20 years, resulting in average annual maximum emissions of around 757 tCO_2-e per year.

These predicted annual maximum emissions are well below the 100,000 tCO_2-e per year threshold defined by the EPA as requiring detailed environmental impact assessment and a Greenhouse Gas Management Plan (EPA 2023c). The predicted level of emissions is considered insignificant in the context of annual emissions reported for Western Australia.

No significant environmental impacts associated with GHG emissions are anticipated as a result of the proposed change in land use within the MRS amendment area. It is therefore considered that the EPA's objective for Greenhouse Gas can be met.

10. Other environmental factors

The following environmental factors, which are not considered by the Proponent to be key environmental factors are summarised in Table 10.1. No direct impacts are anticipated for these factors as a result of the Amendment and the indirect impacts associated with future development are not considered to be significant and can be managed by future planning controls.

Table 10-1: Assessment of Other Environmental Factors

Environmental Factor	EPA Objective	Relevant Surveys/ Investigations	Potential Impacts	Management of Impacts
Air Quality	To maintain air quality and minimise emissions so that environmental values are protected	• Baseline air quality monitoring or emissions modelling was not undertaken given the small scale of disturbance that may generate dust, and temporary duration of dust generating activities.	• There is no direct impact associated with the Amendment • Indirect impacts from airborne dust may arise from future activities arising as a result of the MRS amendment • Airborne dust may be generated during construction activities (such as clearing vegetation) and is considered to be temporary, with limited direct impact on surrounding vegetation or local air quality. • Demolition activities may also result in localised dust emissions.	• Land clearing, demolition and other potentially dust generating activities can be controlled through water-based dust suppression measures, such as sprinklers and water carts to minimise dust emissions. • Sealed paths, access ways and roads will be constructed as part of future urban development, with remaining cleared areas to be landscaped which will minimise dust generation from these areas once operational. • Dust emissions associated with future activities resulting from urban development are expected to be localised, temporary and of short duration. • A CEMP will be prepared for the site. This will contain, amongst other items, unexpected finds protocol, dust management requirements to prevent loss of surface soils and soil stabilisation requirements.
Terrestrial Environmental Quality	To maintain the quality of land and soils so that environmental values are preserved.	• Desktop assessment for acid sulfate soil risk • Geotechnical assessment (Douglas Partners 2020 and 2022)	• Generally, the soils within the MRS amendment area (as described in Section 5.4.2.2) are highly permeable Bassendean Sands (topsoil through to 2.5 m depth) overlaying Yoganup Formation medium dense to dense light brown and yellow-brown sand to sand/clayey sand with lower permeabilities. • No direct impacts to soils will occur as a result of the MRS amendment, however future activities within the MRS amendment area may cause soil and water	• Retention of areas of native vegetation as well as landscaping and streetscaping will be undertaken as part of urban development. • Refer also to 5.7.1.3 which provides details of proposed inland waters management framework. Water management (which will include measures to prevent erosion from surface drainage) will be undertaken in accordance with a required district water management strategy (Appendix B). • Additional ASS specific soil and groundwater investigation will be

Environmental Factor	EPA Objective	Relevant Surveys/ Investigations	Potential Impacts	Management of Impacts
			erosion as a result of clearing and urban development and construction activities. • The acid sulfate soils (ASS) risk mapping for the amendment area (WAPC 2003) indicates there is the potential for moderate to low risk of acid sulfate soils occurring within 3 m of natural soil surface. • Intercepting areas of potential contamination within MRS amendment area	undertaken in accordance with DWER guidelines to determine if there is the presence (and any likelihood of disturbance) of ASS and if so, an appropriate management plan will be prepared to the satisfaction of DWER and the subsequently implemented. • No impacts to the receiving environment within the amendment area or downgradient from ASS exposure is anticipated. • An unexpected finds procedure will be provided to site contractors in the case of potential contamination being identified • Should any signs of potential contamination be detected onsite a Potential Contamination Investigation will be undertaken in accordance with the DWER Contaminated Sites Guideline for 'Assessment and management of contaminated sites'

11. Offsets

The Western Australian Government's Environmental Offsets Policy (Offsets Policy) (GoWA 2011) seeks to protect and conserve environmental and biodiversity values for present and future generations while supporting long term environmental and conservation values. The WA Environmental Offset Guidelines (Offset Guidelines) (GoWA 2104) complement the Offsets Policy by clarifying the determination and application of environmental offsets in Western Australia.

The Offset Guidelines define environmental offsets as actions that provide environmental benefits which counterbalance the potential significant residual environmental impacts or risks of a Proposal or activity. Environmental offsets are only be applied where the residual impacts of a Proposal are determined to be significant. That is, after avoidance, minimisation and rehabilitation measures have been pursued. Unlike mitigation actions which would occur on-site during implementation of the MRS amendment to reduce the direct impact of the Proposal, offsets would be undertaken outside of the MRS amendment area to counterbalance potential significant residual impacts.

To ensure consistency and transparency on whether offsets should be applied to a Proposal, the significance of residual impacts is determined through application of the residual impact significance model (RISM), which is in accordance with the Offset Guidelines. This model identifies the four levels of significance for residual impacts and when an offset is required, may be required, or not required at all in relation to the relevant EPA environmental factors and relevant clearing principles in Schedule 5 of the EP Act (GoWA 2014).

In general, potential significant residual impacts include those that affect rare and endangered plants and animals (such as threatened flora and fauna that are protected by statute), areas within the formal conservation reserve system, important environmental systems and species that are protected under international agreements (such as Ramsar listed wetlands) and areas that are already defined as being critically impacted in a cumulative context. Impacts may also be significant if, for example, they could cause plants or animals to become rare or endangered, or they affect vegetation which provides important ecological functions (GoWA 2014).

The formulated Environmental Management Framework provides a robust statutory mechanism to ensure that any potential impacts resulting from future subdivision and development will be adequately mitigated through the application of appropriate avoidance, minimisation and rehabilitation measures (see Section 13) and thereby, prevent significant residual impacts on conservation significant flora, vegetation and fauna values within and adjacent to the MRS amendment area. This ER document and its assessment herein, demonstrates that implementation of the Environmental Management Framework will ensure there is in no significant residual impacts for each relevant EPA environmental factor. In accordance with the RISM template provided in the Offset Guidelines, Table 11-1 demonstrates the proposal will not result in significant residual impacts and as such, no offsets are required or are proposed for the MRS amendment.

Notwithstanding, given site access has been limited within some lots within the MRS amendment area, should any future site surveys of the 13 lots that have not yet been subject to detailed survey (required to be undertaken prior to subdivision or development) identify any conservation significant values previously not identified (i.e. threatened species, black cockatoo significant trees with suitable hollows, threatened ecological community, etc) and where the proposed subdivision and/or development would result in significant residual impacts by proposing to clear these values, then environmental offsets will be required. The Environmental Offset Framework (Figure 11-1) sets out the steps required to be applied at the time of subdivision or development to determine if the residual impacts will be significant, and if so, that an environmental offset is required.

Table 11-1: Residual impact significance model for the MRS Amendment

Part IV Environmental Factors	Vegetation and Flora							
				Terrestrial Fauna				
	Rare flora	Threatened ecological communities	Remnant vegetation	Wetlands and waterways	Conservation areas	High biological diversity	Habitat for fauna	Other
Residual impact that is environmentally unacceptable or cannot be offset	No significant residual impacts that are environmentally unacceptable							
Significant residual impacts that will require an offset – **All significant residual impacts to species and ecosystems protected by statute or where the cumulative impact is already at a critical level**	No significant residual impacts that will require an offset							
Significant residual impacts that may require an offset – **Any significant residual impact to potentially threatened species and ecosystems, areas of high environmental value or where the cumulative impact may reach critical levels if not managed**	No significant residual impacts that may require an offset							
Residual impacts that are not significant	Potential loss of up to 4 individuals of conservation significant flora, of which 1 individual is (*Conospermum undulatum* (Wavy-leaved Smokebush VU (EPBC Act and BC Act) (located on Lot 804 and adjacent to Conservation) and 3 individuals are *Isopogon autumnalis* (P3) (2 are located on Lot 804 and adjacent to the Conservation and 1 is located along the northern boundary of Crystal Brook Road and adjacent to the road reserve). Will be opportunities to retain within conservation areas and legally secured through future planning stages. **Residual impacts are not significant and will not trigger offset.**	As all TECs will be retained within conservation areas, there will be no loss of the following TECs/PECs within the MRS amendment area: • Banksia Woodlands of the Swan Coastal Plain ecological community - Endangered (EPBC Act) and Priority 3 (DBCA listing). • Probable FCT 20a *Banksia attenuata* woodlands over species rich dense shrublands WA TEC – Critically Endangered (BC Act). • Probable FCT 20c Shrublands and Woodlands of the Eastern Swan Coastal Plain WA TEC – Critically Endangered (BC Act) and Federal TEC – Endangered (EPBC Act). **Residual impacts are not significant and will not trigger offset.**	Of the 4.56 ha remnant native vegetation within the MRS amendment area, 0.08 ha (Degraded condition) and 0. 08 ha (Completely Degraded condition) will be cleared. Remnant native vegetation (in Good or better condition) (4.21 ha) will be retained within conservation areas. At a regional level, clearing 0.16 ha of Degraded and Completely Degraded condition native vegetation represents 0.009% of native vegetation within 5 km, 0.002% within 10 km and 0.001% within 15 km of the MRS amendment area All Southern River Complex and Forrestfield complex vegetation in good or better condition will be avoided, protected and managed. Note: there are no areas of intact remnant vegetation within the area mapped as Guildford complex. **Residual impacts are not significant and will not trigger offset.**	The Amendment will not directly or indirectly impact on the nearby GBSW as no significant changes to the hydrological regime or downgradient surface flows are predicted based on modelling undertaken to support this assessment. Ongoing monitoring of surface and groundwater will be undertaken. **Residual impacts are not significant and will not trigger offset**.	There are no DBCA managed lands or Bush Forever site within the MRS amendment area.	The 4.56 ha of remnant vegetation within the MRS amendment area varied from Excellent to Completely Degraded. Of which, 4.21 ha of native vegetation (in Good or Better condition) will be retained (85%) within conservation areas, 3.41 ha of vegetation is in Excellent condition and 0.05 ha of vegetation is in Very Good condition and 0.15 ha is in Good condition. The retained vegetation provides habitat for two identified conservation significant flora taxa (*Conospermum undulatum* (VU; T); *Isopogon autumnalis* (P3). It also provides for the protection of all high-quality fauna habitat and all high-quality foraging habitat for all three black cockatoos within the MRS amendment area. **Residual impacts are not significant and will not trigger offset.**	Clearing of: low quality foraging habitat for Carnaby's cockatoo (29.1 ha), Baudin's cockatoo (29.02 ha and Forest Red-tailed black cockatoo (29.82 ha), 0.72 ha and 0.80 ha of medium quality foraging habitat for Carnaby's cockatoo and Baudin's cockatoo, respectively. This represents approximately 0.006% of the existing black cockatoo foraging habitats within the local area 12 km radius. 146 potential nesting trees for black cockatoos (of which have either no hollows or no suitable hollows). 0.16 ha of habitat (Degraded to Completely Degraded Banksia Woodland) for quenda and 2.8 ha of potential habitat (planted gardens) p for quenda. Given the retention of all high-quality fauna habitats, high quality black cockatoo foraging habitat and native vegetation (in Good or better condition) conservation areas, the overall impact on fauna habitat is not considered significant at either a regional or local level. It is highly likely there will be retention of the individual scattered native trees in future POS and road reserves, along with revegetation of black cockatoo trees to replace those that cannot be practically retained. Thereby, reducing the residual impacts on black cockatoo further. **Residual impacts are not significant and will not trigger offset.**	NA

Should future site surveys identify conservation significant values previously not identified (i.e. threatened species, black cockatoo significant trees with suitable hollows, threatened ecological community, etc), as part of any future local structure plan, subdivision and/or development within the MRS amendment area, the landowner or land developer will be required to undertake the following steps to demonstrate the mitigation hierarchy has been applied. If the residual impacts are still significant, then environmental offset(s) will be required

Undertake site-specific environmental studies to identify flora, vegetation and fauna values within site

Identify conservation significant flora, vegetation and fauna values within the Local Structure Plan / Subdivision / Development area

Mitigation Hierarchy

Avoid

Minimise

Rehabilitate

Offset

Prepare and implement Tree Canopy Retention and Landscape Management Strategy and Plan(s) to:

- identify and characterise how flora, vegetation and fauna (particularly black cockatoos) values will be retained within the urban development footprint (i.e. road reserves, pedestrian access ways and POS)
- facilitate revegetation of black cockatoo habitat trees within road reserve, pedestrian access ways and POS

Spatially define and establish Conservation areas to protect and conserve the following significant environmental values:

- Remnant vegetation in Good or better condition
- Threatened and/or Priority Ecological Communities)
- Conservation significant flora
- High quality fauna habitats (incl black cockatoo foraging habitat)

Prepare and implement Conservation Area Management Strategy and Plan(s) for Conservation areas to ensure the significant environmental values are protected, enhanced and managed for the long-term.

Assess residual impacts on conservation significant flora, vegetation and fauna values within the Local Structure Plan / Subdivision / Development area

Significant residual impacts on conservation significant flora, vegetation and/or fauna values

Environmental offset(s) required

Prepare **Environmental Offset Strategy / Management Plan**

Determine **type of environmental offset**, which can be a combination of the following:

- On-ground revegetation and/or offsite rehabilitation
- Land acquisition
- Research

Security of offset –will this offset persist in the long-term?

Likely success of achieving offset - can environmental values be recreated? Does operator have adequate experience to undertake actions?

Time lag in achieving the offset - initial benefit (land acquisition) vs ongoing benefit (e.g. revegetation)?

Consultation with DBCA, DWER and/or City of Kalamunda - depending on offset package, the components and their likely role

Finalise **Environmental Offset Strategy / Management Plan** and submit with DWER, DBCA and/or City of Kalamunda for review and approval

Implement **Environmental Offset Strategy / Management Plan,** following approval

No significant residual impacts on conservation significant flora, vegetation and/or fauna values

Environmental offset/s not required

RELEVANT POLICIES AND GUIDELINES

WA Environmental Offsets Policy (2011)

WA Environmental Offsets Guidelines (April, 2014)

DWER Environmental offsets metric - Quantifying environmental offsets in WA (October, 2021)

DWER WA Environmental offsets calculator (November, 2021)

Quantify environmental offsets using:

- DWER Environmental offsets metric
- WA Environmental Offsets Calculator

ACRONYMS

DBCA – Department of Biodiversity, Conservation and Attractions

DWER – Department of Water and Environmental Regulation

Figure 11-1: Environmental Offset Framework

12. Holistic impact assessment

The environmental impact assessment process also considers the connections and interactions between parts of the environment to inform a holistic view of impacts to the whole environment. The holistic impact assessment considers the combination of the environmental effect of two or more environmental factors where there is the potential to result in a significant impact.

The MRS amendment itself does not have a direct environmental impact, however, this has the potential to occur through future subdivision and development in accordance with an approved local structure plan. That is, future subdivision and development enabled by the MRS amendment and subsequent planning processes, has the potential to have direct, indirect and cumulative impacts on a number of environmental factors, including Inland Waters, Flora and Vegetation, Terrestrial Fauna, Social Surroundings and Greenhouse Gas. An assessment of the potential impacts (direct, indirect and cumulative) of the MRS amendment on these factors is provided in Sections 5 to 9. Potential impacts of other factors, Air Quality and Terrestrial Environmental Quality have also been considered in Section 10.

Table 11-1 provides an outline of the interactions between environmental factors and values associated with future activities arising from the MRS amendment, and Figure 11-1 illustrates the connections and interactions between the key environmental factors to inform the holistic assessment.

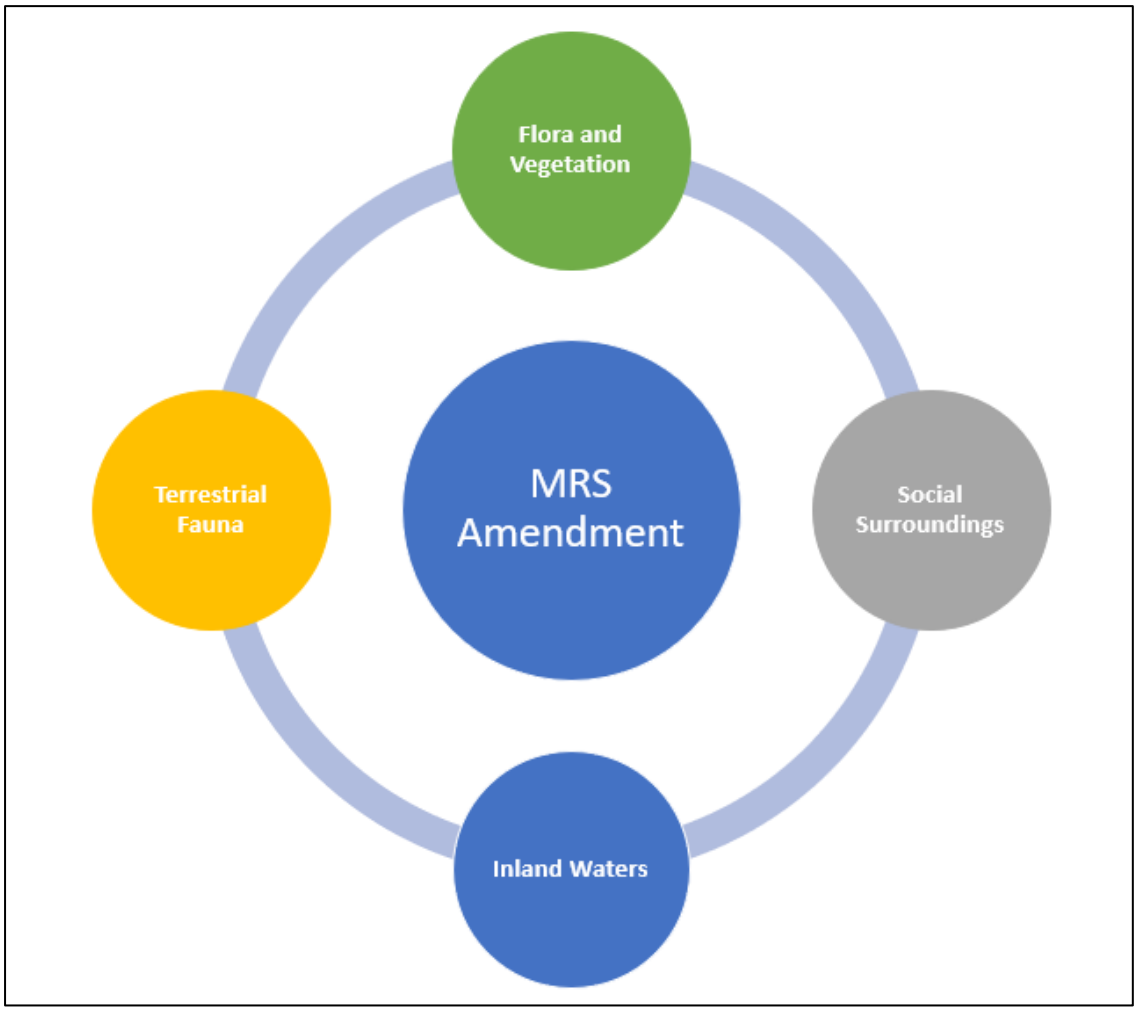

Figure 12-1: Intrinsic Interactions with Environmental Factors

Flora/Vegetation – Terrestrial Fauna – Social Surrounds – Inland Waters Interactions

The MRS amendment area is currently comprised of a number of semi-rural land holdings, maintaining a 'rural' visual and social amenity. Future subdivision will result in changes to the landscape, including loss of Degraded or Completely Degraded native vegetation (0.35 ha in Degraded and Completely Degraded condition) and current planted trees and gardens (2.8 ha) during a transition towards an urban landscape. This change will alter amenity values associated with increased human habitation and activity, such as artificial light and noise.

The MRS amendment however provides for the retention of most (92%) of the native vegetation present (4.56 ha) in Conservation areas, supplemented by future street scaping and landscaping. This remnant vegetation will provide habitat for known conservation significant flora and fauna, and ecological community values (Banksia Woodlands of the Swan Coastal Plain (Federal TEC and WA PEC), probable FCT 20a (WA TEC) and probable FCT 20c (Federal and WA TEC), and high quality foraging habitat for all three black cockatoos) as well as maintaining current linkages with nearby areas, in particular the GBSW (limited to an extent by the separation by Tonkin Highway).

Future site works may alter surface flows, drainage and infiltration, and have the potential to impact on the ecological values of the GBSW, particularly as it supports groundwater dependant vegetation. The GBSW and inland waters (such as Yule Brook) have intrinsic cultural heritage associations and values of significance to local Traditional Owners. Ensuring the protection of these areas for future generations is an important aspect of future planning controls, particularly those relating to water management (drainage, stormwater, etc). Site investigations and water balance modelling (Appendices A and B) inform the development of appropriate mitigation and ongoing monitoring measures through the Environmental Management Framework.

Furthermore, future urban development will require approval and implementation of water management strategies and plans, with specific consideration to GBSW and other relevant inland waters (such as Yule Brook) to ensure ongoing conservation of their values.

In summary, the combined potential impacts associated with future activities arising from the MRS amendment, when implemented in accordance with the proposed mitigation measures to be reflected in future planning controls, ensure that the urban development of the MRS amendment area can be undertaken such that the EPA objectives for the relevant environmental factors can be met.

Table 12-1: Interaction of Key Environmental Factors

Proposed activities	Key environmental factors – Potential impacts				
	Inland waters	Flora and vegetation	Terrestrial fauna	Social surroundings	Greenhouse gas
Clearing of vegetation (native and non-native)	• Potential for erosion and sedimentation in the event of rainfall after clearing and prior to construction.	• Up to 0.16 ha of remnant native vegetation within the MRS amendment area may be impacted by the proposed clearing, which comprise of: ○ 0.08 ha of Banksia Woodland - BmXpEx in Degraded condition ○ 0.08 ha of Banksia Woodland - BaEpPf in Completely Degraded condition. Note: Due to the degraded condition of these two areas of Banksia Woodland, neither were considered to be a TEC.	• 0.16 ha (3.5% of all remnant native vegetation) of fauna habitat, including potential breeding, foraging and dispersal habitat at risk from clearing, which comprise of: ○ degraded to completely degraded condition vegetation ○ low quality foraging habitat Baudin's and Forest Red-tailed black cockatoo ○ low and medium quality foraging habitat for Carnaby's ○ 0 potential nesting trees for black cockatoos ○ habitat for quenda • 26.58 ha of individual trees (both native and introduced species) scattered across the MRS amendment area that may be used for fauna breeding, foraging and dispersal habitat at risk from clearing, which comprise: ○ mostly low-quality foraging habitat for all three black cockatoos ○ 0.72 ha and 0.80 ha of medium quality foraging habitat for Carnaby's cockatoo and Baudin's cockatoo, respectively ○ 140 potential nesting trees for black cockatoos ○ low quality habitat for quenda due to the absence of dense understorey. • 2.8 ha of trees and plants (both native and introduced species) dispersed across planted gardens in the MRS amendment area may be used for fauna breeding, foraging and dispersal habitat at risk from clearing, which comprise:	• Potential clearing of native vegetation to make way for new urban development may inadvertently devalue the cultural associations that certain endemic trees have for the Whadjuk Noongar people. Opportunities for connecting with those cultural associations would also be lost.	• Future change of land use facilitated by MRS amendment has the potential to result in clearing of vegetation leading to loss of bio-sequestration capacity.

Proposed activities	Key environmental factors – Potential impacts				
	Inland waters	Flora and vegetation	Terrestrial fauna	Social surroundings	Greenhouse gas
			○ low quality foraging habitat for all three black cockatoos ○ 6 potential nesting trees for black cockatoos ○ potential habitat for quenda • Potential vehicular strike during clearing activities		
Construction activities	• Potential for contaminated surface runoff to infiltrate groundwater.	• Potential spread or intensification of weeds	• Potential for fauna trapping and relocation to be required. • Potential vehicular strike.	• Potential landscaping and rehabilitation within Aboriginal heritage site may generate dust.	• Not applicable
Alteration of natural drainage regimes for future development and associated infrastructure	• Post-development, potential for increased surface water and groundwater recharge in proximity to GBSW. • Potential to alter soil salinity and sodicity within the GBSW.	• Potential impacts to wetland and riparian vegetation and ground water dependent ecosystems within and nearby to the MRS amendment area	• No direct or indirect impact.	• Potential impacts to the natural, social and historical heritage values of the GBSW	• Not applicable
Physical presence of future development and associated infrastructure	• Potential urbanisation will result in increased impermeable surfaces, reduction in evapotranspiration and increased infiltration within stormwater management. Potential to alter water quantity and quality.	• Potential spread or intensification of weeds • Further fragmentation	• Potential fragmentation of fauna habitat.	• Potential impacts to the visual amenity associated with the natural and semi-rural character of the area • Potential impacts to State and Regional Landscape Values. • Changes to environment which may impact on Aboriginal heritage places.	• Not applicable

12.1 Controlling provision

The potential EPBC Act controlling provisions that may be applicable to subsequent proposals arising from the MRS amendment, as identified in flora and fauna assessments (Sections 6 and 7), include:

- Listed Threatened species and ecological communities (sections 18 and 18A)
  - Listed Threatened flora species, including but not limited to:
    - *Conospermum undulatum* (Vulnerable)
  - Listed Threatened Ecological Communities, including:
    - Banksia Woodlands of the Swan Coastal Plain ecological community, listed as Endangered TEC
  - Listed Threatened fauna species, including:
    - *Zanda baudinii* (Baudin's cockatoo)
    - *Calyptorhynchus banksia naso* (Forest Red-tailed black cockatoo)
    - *Zanda latirostris* Carnaby's cockatoo)

12.2 Controlled actions

Controlled actions are those actions that the Commonwealth Minister for the Environment decides to have, will have or are likely to have a significant impact on one or more protected matters and therefore require assessment and approval under the EPBC Act.

In general, planning scheme amendments are not considered 'actions' under the EPBC Act (section 523) and are not subject to assessment by the Commonwealth. Notwithstanding, individual proposals will still have to have regard to Matters of National Environmental Significance (MNES).

13. Mitigation of environmental impacts through MRS Schedule 1 conditions and statutory planning processes - An Environmental Management Framework

The preceding sections have identified that the MRS amendment will facilitate planning processes that will ultimately result in subdivision and development, which will contribute to changes to physical and biological surroundings and in turn could potentially have direct and indirect impacts on the environment.

The proposed mitigation of these potential direct and indirect impacts through the planning and development processes will now be discussed, along with the environmental outcomes that will be achieved as a result of the recommended mitigation measures. The discussion will also include the statutory mechanisms and approval processes that will be applied to ensure that all impacts (direct and indirect) are successfully mitigated.

13.1 Recommended statutory planning mechanisms and approvals

Traditionally, Ministerial conditions relating to the implementation of assessed schemes under Part IV of the EP Act have required that specific environmental provisions be incorporated within schemes – local planning schemes in particular. However, in more recent years, Western Australian planning legislation has sought to standardise local planning schemes, to afford greater consistency and certainty across the planning system in Western Australia. This is evident in the *Planning and Development (Local Planning Schemes) Regulation 2015* (PD Regs), which includes a set of 'model provisions for local planning schemes' (refer Schedule 1 of the PD Regs).

The PD Regs require all local governments in Western Australia to follow the model provisions in the preparation of their local planning schemes. To ensure compliance with this legislation, the Minister for Planning will generally only approve deviations from the model scheme provisions in exceptional circumstances. Therefore, in recent years there has been a shift away from incorporating specific (and often widely varying) environmental conditions within local planning schemes, particularly in circumstances where concurrent MRS and LPS amendments are considered appropriate pursuant to Section 126(3) of the PD Act.

Similarly, there has been a growing recognition and acceptance that while the scheme amendment process is suitable to establish a framework for future planning and environmental management, it is the subsequent stages of planning which provide the context to require detailed consideration of environmental values and the mechanisms for ensuring appropriate mitigation measures are implemented.

In this regard, the MRS amendment process is an appropriate stage to develop environmental conditions that can be delivered through planning processes. This MRS amendment is one of the first MRS amendment to be subject to an EPA Environmental Review for more than a decade. Previous examples include the:

- Clarkson-Butler amendment (No. 992/33, EPA decision published July 2003)
- Port Catherine amendment in South Coogee (No. 1010/33, EPA decision published October 2003)
- Alkimos-Eglinton amendment (No. 1029/33, EPA decision published April 2006)
- Stakehill Swamp amendment in Baldivis (No. 1050/33, EPA decision published October 2007)

All four of these examples resulted in environmental conditions being added to the relevant Schedule in the MRS text, being Schedule 1 Environmental Conditions. These conditions are binding on all subsequent planning actions, including structure planning, subdivision and development.

There are robust statutory planning processes that ensure land can be subdivided for urban uses within the MRS amendment area in accordance with the relevant Ministerial conditions under Part IV of the EP Act. During the preparation and approval of a local structure plan, conditions of subdivision are required to be implemented, and cleared by the WAPC on the expert advice of the relevant agencies prior to the creation of new titles. A summary of the statutory planning processes that will apply to the MRS amendment area are summarised in Figure 13-1.

The way in which the above planning mechanisms can be utilised to mitigate any environmental impacts of the subject MRS amendment will now be discussed.

13.2 Local planning scheme zones requiring structure plans

In light of the above, structure plans have become the preferred and more appropriate planning instrument to give visibility to statutory Ministerial conditions placed on assessed Schemes under Part IV of the EP Act. Structure plans provide a framework for the coordinated provision and arrangement of future land use, subdivision and development. They assist landowners, developers, decision making authorities and advisory agencies to identify the specific issues and actions required to progress land through the subsequent planning and development processes, which are typically overseen through applications for land subdivision and development.

The model scheme provisions for local planning schemes contained in the PD Regs include three local land use zones that require the preparation of a structure plan as a prerequisite for any subdivision or development of land within that zone. Of relevance, is the 'Urban Development' zone.

In the event the Minister for Environment allows the subject MRS amendment to be implemented, it is proposed that the land within the MRS amendment area be concurrently zoned 'Urban Development' within the City of Kalamunda LPS 3. A concurrent amendment to LPS 3 in this case is appropriate because LPS 3 has an 'Urban Development' zone and no new planning provisions or related text changes are required, particularly as any MRS Schedule 1 environmental conditions will apply to subsequent planning processes.

The purpose of the 'Urban Development' zone is as follows:

- *'To provide orderly and proper planning through the preparation and adoption of a Structure Plan setting the overall design principles for the area.*
- *To permit the development of land for residential purposes and for commercial and other uses normally associated with residential development.'*

The 'Urban Development' zone will ensure that LPS 3 is consistent with the MRS and will give statutory effect to the requirement for structure plans to be prepared and approved prior to subdivision or development of the land for urban uses within the MRS amendment area and the applicable MRS Schedule 1 environmental conditions.

The MRS 'Urban' zone and the related 'Urban Development' zone under LPS 3 are similar in effect because neither authorises urban development; both require further planning (structure planning) before that can occur. Any Schedule 1 conditions imposed via the MRS amendment environmental assessment process, will be enforceable under the related entry in Schedule 1 of the MRS and will apply directly to the structure plan and subsequent subdivision and development processes. There is no need to duplicate them in LPS 3.

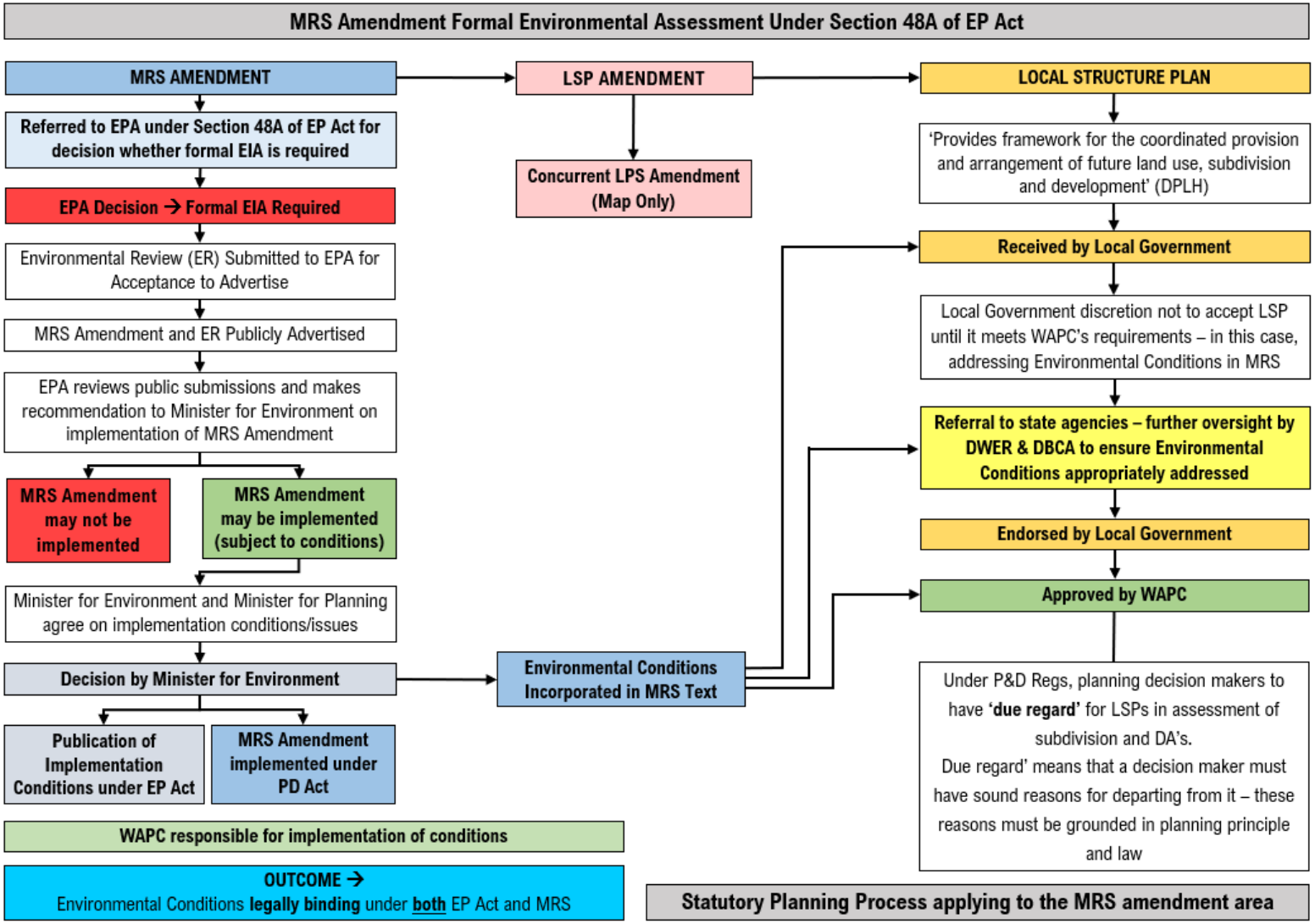

Figure 13-1: Summary of the planning mechanism to deliver environmental mitigation to the MRS amendment area

13.3 Structure plans as a mechanism for implementation of Ministerial conditions

The PD Regs include a set of 'deemed provisions' for local planning schemes (refer Schedule 2 of the PD Regs). The deemed provisions compliment the model provisions for local planning schemes and automatically apply to all local planning schemes. Part 4 of the deemed provisions includes a standard set of statutory provisions that govern the way in which structure plans are to be prepared, accepted, assessed, approved, amended and revoked.

Under Part 4 of the PD Regs, a proponent would prepare and submit structure plans for consideration by local governments and the WAPC. In the Perth metropolitan area, almost all structure plans are landowner and proponent driven in this manner. To provide appropriate oversight of structure plans submitted by proponents, section 16 of Part 4 of the deemed provisions provides that structure plans must be prepared to the WAPC's requirements and the WAPC can require any specific information, maps or other material to be included within a structure plan at its discretion.

To further reinforce this statutory requirement and provide further oversight of proponent driven structure plans, section 17 of Part 4 of the deemed provisions provide that a local government is not obliged to accept a structure plan submitted by a proponent until it is satisfied that the WAPC's requirements for what must be included in the structure plan have been met. This provides a robust statutory 'check point' to ensure that any requirements of Ministerial conditions placed on the subject MRS amendment under Part IV of the EP Act have been adequately addressed.

If any Ministerial conditions have not been adequately addressed, the City of Kalamunda would require that additional information be submitted by the proponent to address the conditions before the structure plan is accepted by the City of Kalamunda for assessment. This places the onus on the proponent to satisfactorily address the Ministerial conditions in order to advance the assessment of a structure plan.

Once a structure plan has been accepted for assessment, Part 4 of the PD Regs requires the local government to seek comments on the structure plan (and all associated technical appendices) from relevant state government advisory agencies, which will include DWER and DBCA for their expert advice on environmental matters. This will ensure further oversight that any Ministerial conditions placed on the MRS amendment under Part IV of the EP Act have been adequately addressed. Final approval of a structure plan by the WAPC provides a further and final 'check point' to ensure appropriate visibility has been given to any relevant Ministerial conditions within structure plans.

The local structure plan is therefore required to make provisions for the implementation of environmental conditions, regardless of their origin. Decision-makers must then apply these provisions when considering subdivision or development proposals pursuant to Section 27(1) of the Deemed Provisions in the Regulations. Decision makers must give cogent reasons for departing from the structure plan, and these reasons must be grounded in planning principle and law. The Guidance clarifies that any such departures must not (inter alia) 'alter the structure plan's design response or depart from the recommendations of the technical reports and studies', which includes environmental conditions.

Further to the above, it should be noted that the preparation of local structure plans involves decisions by two regulatory agencies, firstly the local government and ultimately the WAPC, and a mechanism by which the local government can request additional information or modifications up-front, shortly after lodgement, and/or before a structure plan is accepted for assessment. This enables any unjustified departures from the WAPC's requirements for structure plans, or any deficiencies in the information provided, to be identified and addressed. Upon lodgement, the City would review any local structure plan for the MRS amendment area to determine that the relevant environmental conditions imposed through the MRS amendment were included in Part 1 of that structure plan. The WAPC would not approve a structure plan without such conditions being addressed or included. The DBCA and DWER are both consulted during the assessment period and would also have an opportunity to identify any omissions or further investigations or management actions relating to the environmental conditions. The WAPC, as the Responsible Authority for the subject MRS amendment, on the advice of DWER and DBCA will need to ensure that any Ministerial conditions placed on the implementation of the MRS amendment under Part IV of the EPA Act are appropriately addressed within structure plans for the MRS amendment area.

Among other things, the local structure plan map and supporting plans will identify land uses within the MRS area for various purposes, including conservation, and any MRS Schedule 1 conditions are expected to require the protection of the identified good and better-quality vegetation condition, conservation significant flora, ecological communities and fauna habitat in conservation areas. The City of Kalamunda is committed to this outcome and noted this when it made its original recommendation to the WAPC on the MRS amendment in 2021, stating that 'the City's Local Structure Plan provisions will provide a statutory mechanism to ensure that these areas are identified and vested in the City for conservation management.' A Conservation Concept Plan has been prepared for context (refer Figure 12-2) to give spatial context to the protection of the identified conservation significant vegetation, flora and fauna habitats in conservation areas and in effect will serve as a baseline for the future preparation of the local structure plan.

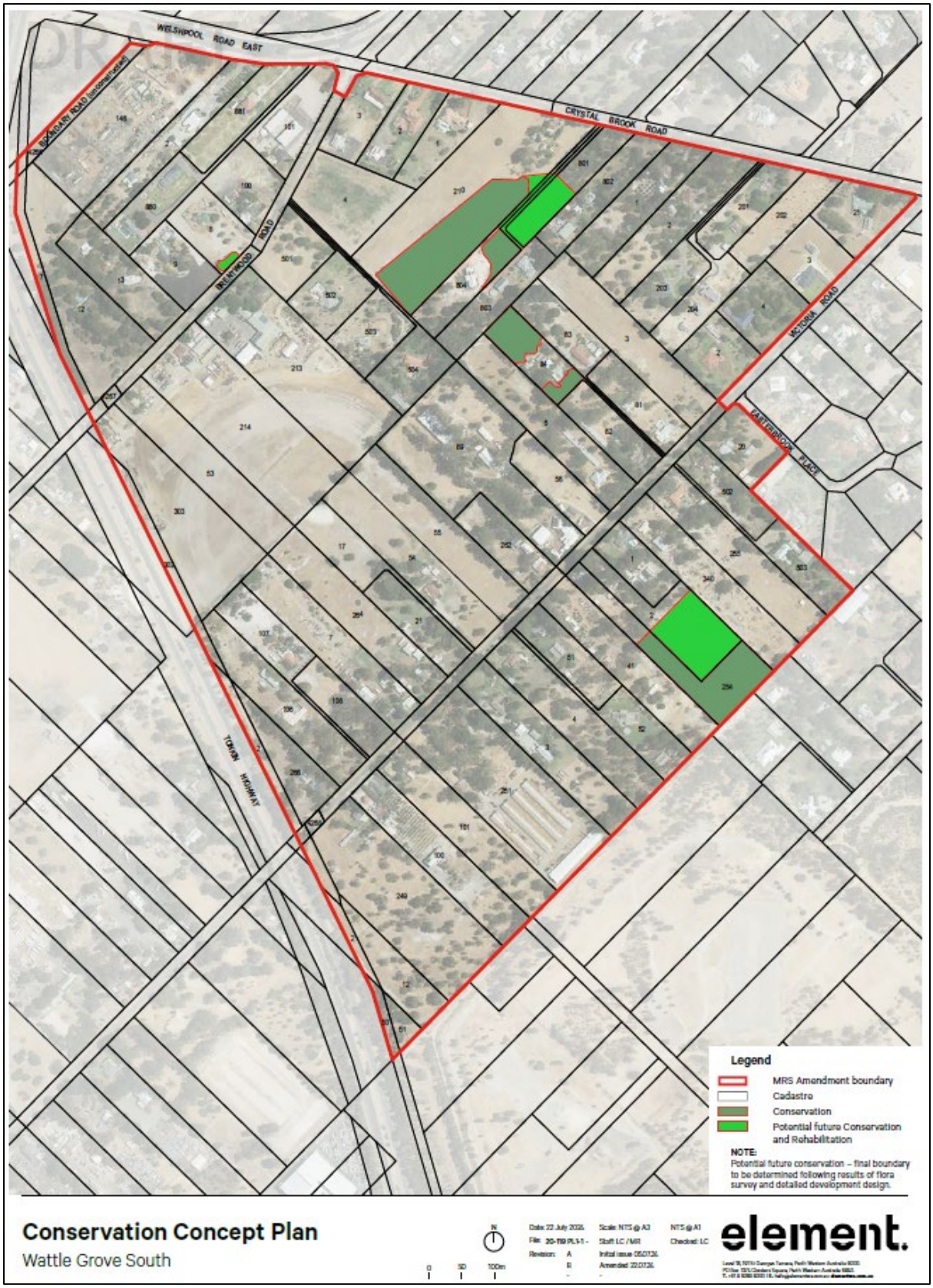

Figure 13-2: Conservation Concept Plan including Conservation and Potential Future Conservation and Rehabilitation

13.3.1 Subdivision and development as a mechanism for implementation of Ministerial conditions

None of the processes discussed above (including strategic plans, planning scheme amendments, concept planning or structure planning) authorise any actual works in the MRS amendment area and therefore cannot, in themselves, cause harm to environmental assets.

The first point at which an environmental condition would be implemented in a physical sense is the subdivision stage, which usually precedes development applications and building permits for private and public works. One of the purposes of structure planning is to inform the design of subdivision proposals and provide direction on the conditions of approval that might apply to a particular stage of development. In relation to the latter, the decision-maker will ensure compliance with the provisions of Part 1 of the structure plan, which will in this case include any environmental conditions listed in Schedule 1 of the MRS as an outcome of the environmental assessment and Ministerial approval of the MRS amendment. That is, assuming approval is granted.

The PD Act vests authority to assess and determine subdivision applications in the WAPC, which is resourced by the DPLH) The WAPC will apply the relevant approved structure plan to its assessment of applications for the subdivision of land within the MRS amendment area, as will the City of Kalamunda and advisory agencies consulted by the WAPC on all subdivision applications, which will include DWER and DBCA. The structure plan will alert the WAPC, City of Kalamunda and advisory agencies to the relevant Ministerial conditions that apply to the land as a result of this EIA under Part IV of the EP Act.

Conditions requiring implementation of environmental mitigation measures to address Ministerial conditions would be placed on subdivision approvals granted by the WAPC, pursuant to section 143(1)(c) of the PD Act. This section of the Act also requires the subdivider of the land to comply with such conditions before the diagram or plan of survey for the subdivision is endorsed by the WAPC.

For environment related subdivision conditions, the clearing authority would be the DBCA, DWER or the City and thus the system conducts another check on the implementation of the outcomes of the Environmental Review. The clearing authorities recommend to the decision-maker, being the WAPC, whether a condition has been satisfactorily fulfilled or requires further attention. Therefore, the City of Kalamunda and expert advisory agencies such as DWER and DBCA will be critically involved in ensuring that any relevant environmental mitigation measures required by Ministerial conditions under Part IV of the EP Act have been met before diagrams and plans of survey are endorsed by the WAPC.

Diagrams or plans of survey are the mechanism for the creation of certificates of title for new freehold lots, public reserves and other forms of land tenure shown on subdivision plans. This process is administered by Landgate under the *Land Administration Act 1997* and no diagrams or plans of survey are given effect by Landgate until the diagram or plan of survey has been endorsed by the WAPC. Only when all conditions (including environmental conditions) have been fulfilled will the WAPC offer its endorsement to a Deposited Plan.

At the development stage, any environmental conditions that still apply (i.e. have not already been implemented and actioned at the subdivision stage) would be imposed by the determining authority (in this case, the City of Kalamunda) as conditions of approval that must be cleared before building permits and/or occupancy permits are issued.

In conclusion, the planning system described above, and detailed in the Environmental Management Framework (Table 12-1), is a robust statutory process, containing numerous checks, which ensures land cannot be subdivided or developed within the MRS amendment area until any relevant

Ministerial conditions applied to the MRS amendment under Part IV of the EP Act have been met and endorsed by the WAPC on the expert advice of the relevant environmental and planning agencies.

It should also be noted that implementation conditions recommended by the EPA and imposed by the Minister for Environment, and in agreement with the Minister for Planning via the MRS amendment process are enforceable regardless of how they are referenced in the planning system, and any stakeholder that does not comply with a condition(s) also commits an offence under the EP Act.

Table 13-1: Environmental Management Framework

Planning mechanism	Legislation or agreement regulating the activity	Decision making authority	Stakeholder engagement in decision making	Environmental outcomes
Metropolitan Region Scheme (MRS)				
Binding statutory environmental conditions will be included in Schedule 1 of the MRS Text that require the following for each environmental factor:	***Environmental Protection Act 1986*** Ministerial conditions set pursuant to Part IV	**Minister for Environment**	**Minister for Planning:** Responsible for engaging with the Minister for Environment on the implementation of any conditions for the MRS amendment, pursuant to Part IV of EP Act. **EPA**: Responsible for advising Minister for Environment whether the MRS amendment can be implemented and if it should be subject to any conditions. **DWER and DBCA:** Responsible for providing expert advice to the EPA on any potential environmental impacts of the MRS amendment and their management.	**OVERARCHING** Conditions in Schedule 1 of the MRS Text will establish environmental management requirements for each stage of the planning process. The environmental conditions will ensure the significant environmental values are spatially identified and addressed prior to Local Structure Plan and/or subdivision/development, to ensure appropriate assessment and further environmental impact avoidance, minimisation, mitigation, protection and rehabilitation/offset (if required) measures are implemented. Future Local Structure Plans and/or applications for subdivision and development will be required to comply with the environmental conditions in Schedule 1 of the MRS Text and any associated Ministerial conditions set by the Minister for Environment in respect to Assessment No. 2335.
INLAND WATERS 1) A Local Water Management Strategy is to be submitted and approved at Local Structure Plan stage. 2) Urban Water Management Plan(s) are to be submitted and approved with all applications for the subdivision of land. 3) Local Water Management Strategy and Urban Water Management Plan(s) are to be prepared and approved in accordance with: a) The District Water Management Strategy endorsed as part of Assessment No. 2335 and any associated Ministerial conditions pursuant to Part IV of EP Act. b) All DWER and City of Kalamunda policies and guidance relating to urban water management. 4) Applications for the subdivision of land (and the endorsement of subsequent plans and diagrams of survey) will be conditional upon the preparation, approval and implementation of Urban Water Management Plan(s).				**INLAND WATERS** The requirement for future Local Water Management Strategy and Urban Water Management Plan(s) to be consistent with the District Water Management Strategy endorsed as part of Assessment No. 2335 will ensure that any specific requirements or objectives of the EPA will be satisfied in later stages of the planning process, including but not limited to: • Requirements for post development water monitoring. • Implementation of adaptive measures. This in turn will facilitate the protection of water quality, hydrology and environmental values of the Brixton Street Wetlands and Yule Brook.
FLORA and VEGETATION 1) Retention of all remnant patches of vegetation communities BaEpPf, BmXpEc and EmMpLp (in Good or better condition), containing conservation significant flora and/or high-quality foraging habitat for all three black cockatoos. 2) Any applications to subdivide or develop land that was not previously the subject of onsite surveys for flora, vegetation and fauna at the date of the Minister for Environment's decision on Assessment No. 2335 must include an onsite survey of flora, vegetation and fauna (in accordance with EPA guidance) to be submitted: a) As the time of the subdivision or development application, or b) As part of a Local Structure Plan preceding the application. 3) The following management strategies are to be submitted and approved at Local Structure Plan Stage: a) Environmental Offsets Strategy (if required). b) Conservation Area Management Strategy (CAMS). c) Tree Canopy Retention and Landscape Management Strategy. 4) The following is to be submitted and approved with all applications for the subdivision of land: a) A plan of subdivision that designates any remnant patches of vegetation communities BaEpPf, BmXpEc and EmMpLp (in Good or better condition) on the land for Conservation purposes. b) A Conservation Area Management Plan (CAMP) for any Conservation Areas within the subdivision area. c) A Tree Canopy Retention and Landscape Management Plan (TCRLMP). d) An Environmental Offset Management Plan (EOMP), if required by the Environmental Offset Management Strategy in the LSP.	***Planning and Development Act 2005*** **Part 4 – Region Planning Schemes** The MRS amendment (including the incorporation of environmental conditions in MRS Text) must be implemented in accordance with any Ministerial conditions set pursuant to Part IV of the EP Act.	**WAPC**	**EPA, DWER and DBCA:** Responsible for providing expert advice to the WAPC on the environmental conditions in Schedule 1 of the MRS Text. **Local Community:** Opportunity to provide written submissions during public advertising period for the MRS amendment and associated Environmental Review.	**FLORA AND VEGETATION** The environmental conditions included in Schedule 1 of the MRS Text will: • Ensure all patches of vegetation communities BaEpPf, BmXpEc and EmMpLp (in Good or better condition), (and conservation significant flora within the patches) are retained in the future subdivision and development of the land. • Provide for the identification and management of any additional ecological values on land that has not yet been subject to suitable onsite surveys for flora, vegetation and fauna. • If required, ensure that any potential significant loss to conservation significant vegetation in future subdivision and development proposals is appropriately offset in accordance with the Environmental Offset Framework endorsed as part of Assessment No. 2335.

Planning mechanism	Legislation or agreement regulating the activity	Decision making authority	Stakeholder engagement in decision making	Environmental outcomes
e) A Construction Environmental Management Plan (CEMP) for all subdivision works within 100 m of remnant patches of vegetation communities BaEpPf, BmXpEc and EmMpLp (in Good or better condition), conservation significant flora and black cockatoo habitat identified for retention. 5) All of the above management strategies and plans (at LSP and subdivision application stage) are to be prepared and approved in accordance with: a) The Environmental Offsets Framework endorsed as part of Assessment No. 2335. b) Any specific matters to be addressed within the management strategies and plans, as required by any Ministerial conditions set in respect of Assessment No. 2335. c) All other relevant EPA guidance. 6) Applications for the subdivision of land (and the endorsement of subsequent plans and diagrams of survey) will be conditional upon: a) The designation of all remnant patches of vegetation communities BaEpPf, BmXpEc and EmMpLp (in Good or better condition) for Conservation purposes. b) The preparation, approval and implementation of CAMP's, TCRLMP's, EOMP's and CEMP's.				
TERRESTRIAL FAUNA As above for Flora and Vegetation.				**TERRESTRIAL FAUNA** As above for Flora and Vegetation.
SOCIAL SURROUNDINGS 1) Nil. Potential impacts to biological surroundings are mitigated via implementation of the recommended measures and planning mechanisms for Inland Waters, while potential impacts to physical surroundings can be adequately mitigated at later stages of the planning process. 2) The Brentwood Road Swamp Aboriginal heritage site (if it still exists) is also afforded protection under other legislation i.e. the Dampier to Bunbury Pipeline Act 1997 (by virtue of its location in the DBNGP easement) and the Aboriginal Heritage Act 1972. 3) It is recommended that any development within the vicinity of the Brentwood Road Swamp heritage site be subject to an application for Section 18 approval under the Aboriginal Heritage Act 1972.				**SOCIAL SURROUNDINGS** Potential impacts will be adequately mitigated through the recommended measures and planning mechanisms for Inland Waters, at later stages of the planning process and through other legislation.
GREENHOUSE GAS Nil. No mitigation measures required.				**GREENHOUSE GAS** The MRS amendment meets the EPA's objective for Green House Gas.
Local Planning Scheme (LPS)				
Concurrent City of Kalamunda LPS No.3 amendment to 'Urban Development' zone.	***Planning and Development Act 2005*** **Section 123(3):** Provides for concurrent amendment of MRS and LPS maps, to rezone land for urban use. **City of Kalamunda LPS No.3** **Section 4.2.1:** The preparation and adoption of a structure plan is required for land zoned 'Urban Development'.	**Minister for Planning**	**WAPC**: Responsible for recommendation to Minister on concurrency of amending the MRS and LPS maps. **City of Kalamunda**: The WAPC is required to consult the relevant local government authority when amending the MRS and LPS maps concurrently before making its recommendation to the Minister.	• The 'Urban Development' zone in the City of Kalamunda LPS No.3 requires that a structure plan(s) be prepared for the subject land, to guide future subdivision and development. • The structure plan(s) will give visibility to the environmental conditions in Schedule 1 of the MRS Text and any Ministerial Conditions set in respect of Assessment No. 2335, ensuring they are appropriately implemented in later stages of the planning of process, through conditions of subdivision and development approval. • Conditions in Schedule 1 of the MRS Text will continue to have effect.

Planning mechanism	Legislation or agreement regulating the activity	Decision making authority	Stakeholder engagement in decision making	Environmental outcomes
Local Structure Plan (LSP)				
All LSP's for land within the MRS amendment area shall include the following at the time of lodgement with the City of Kalamunda:	***Planning and Development (Local Planning Schemes) Regulations 2015*** **Deemed Provisions (Part 4):** Provides that Local Structure Plans must be prepared and submitted in a manner and form approved by the WAPC. This enables the WAPC to ensure the environmental conditions in Schedule 1 of the MRS Text are implemented at LSP stage. **Planning and Development (Local Planning Schemes) Regulations 2015, WA Planning Manual – Guidance for Structure Plans (WAPC)** Provides additional guidance on the preparation of LSP's and the requirement to address environmental matters.	**WAPC**	**City of Kalamunda**: Responsible for accepting, and endorsing LSP's, before forwarding onto the WAPC for final approval. **DWER and DBCA**: Responsible for providing expert advice to the City of Kalamunda and the WAPC on LSP's and all associated environmental management strategies. **Local Community**: Opportunity to provide written submissions during the public advertising period for LSP's.	**OVERARCHING** Detailed environmental strategies prepared to support LSPs (and in accordance with environmental conditions in Schedule 1 of the MRS Text), will provide further detail and structure to environmental management and the protection of significant environmental values, to guide the next stages of subdivision and development.
INLAND WATERS 1) A Local Water Management Strategy prepared in accordance with the environmental conditions in Schedule 1 of the MRS Text.				**INLAND WATERS** Local Water Management Strategy will set the framework for ensuring future development is in accordance with the principles established in the Wattle Grove South DWMS, endorsed as part of Assessment No. 2335. This in turn will facilitate the protection of water quality, hydrology and environmental values of the Brixton Street Wetlands and Yule Brook.
FLORA and VEGETATION 1) An LSP map that designates the retention of all remnant patches of vegetation communities BaEpPf, BmXpEc and EmMpLp (in Good or better condition), containing conservation significant flora and/or high-quality foraging habitat for all three black cockatoos, for Conservation purposes. 2) The following management strategies prepared in accordance with the environmental conditions in Schedule 1 of the MRS Text: a) CAMS for all remnant patches of vegetation communities BaEpPf, BmXpEc and EmMpLp (in Good or better condition) identified on the LSP map to be retained for Conservation purposes. b) Tree Canopy Retention and Landscape Management Strategy. c) Environmental Offsets Strategy (if required). 3) A suitable onsite survey of flora, vegetation and fauna for any land within the LSP area that was previously not surveyed at the date of the Minister for Environment's decision on Assessment No. 2335.				**FLORA AND VEGETATION** The Tree Canopy Retention and Landscape Management Strategy will identify and characterise how the retention of all remnant patches of vegetation communities BaEpPf, BmXpEc and EmMpLp (in Good or better condition), containing conservation significant flora and/or high quality foraging habitat for all three black cockatoos within the LSP area, are to be retained and protected, as well as the principles to be applied during the subdivision and development phases, to avoid and minimise any impact. The CAMS will establish a framework for the protection, enhancement and management of Conservation Areas, including: • Weed management. • Rehabilitation/revegetation requirements. • Fencing and access restriction. • TECs and/or conservation significant flora requirements. • Terrestrial fauna habitat requirements. • City of Kalamunda long-term management actions. • Any further studies required to prepare site specific CAMP(s) for each conservation POS area. If required, the Environmental Offset Strategy will be informed by the Tree Canopy Retention and Landscape Management Strategy. It will consider the benefits of retention of existing habitat, offsets within the LSP area and potential offsets external to the LSP area (if required).
TERRESTRIAL FAUNA As above for Flora and Vegetation.				**TERRESTRIAL FAUNA** As above for Flora and Vegetation.
SOCIAL SURROUNDINGS 1) An LSP map that designates an 'Interface Transition Zone' along the boundary of Crystal Brook Road, to provide for a transition in visual landscape character from 'rural' to future 'urban' at this location. 2) Provisions in Part 1 of the LSP requiring future subdivision and development within the 'Interface Transition Zone' to: a) Reflect a contemporary rural aesthetic responsive to its surrounds. b) Provide for the retention of existing mature trees along Crystal Brook Road, where possible. 3) A Local Visual Amenity Management Strategy that provides for the identification and management of landscape values of local significance. 4) A Visual Impact Assessment (VIA) for any precincts with a proposed density coding that would permit development over three storeys in height. The VIA will need to demonstrate that the height and scale of				**SOCIAL SURROUNDINGS** • The implementation of an 'Interface Transition Zone' along Crystal Brook Road will enable the integrity of the 'rural look and feel' along this road to be retained. • The requirement for development over three storeys in height to be subject to a VIA will ensure that urbanisation does not interrupt the integrity of the panoramic views from Lions Lookout in Korung National Park. • The Local Visual Amenity Management Strategy will enable the integrity of any landscape values of local significance to be respected within the new urban environment.

Planning mechanism	Legislation or agreement regulating the activity	Decision making authority	Stakeholder engagement in decision making	Environmental outcomes
any development over three storeys will not interrupt the integrity of the panoramic views from Lions Lookout in Korung National Park. A strategy for the retention and/or replanting of any endemic trees that hold important cultural associations for the Whadjuk Noongar people of the region. The strategy is to be guided by engagement with the Traditional Owners of the land and incorporated into the TCRLMS.				Any endemic trees that hold important cultural associations for the Whadjuk Noongar people will be afforded recognition in the new urban environment (if any such trees are found to be present in the area).
GREENHOUSE GAS Nil. No mitigation measures required.				**GREENHOUSE GAS** The MRS amendment meets the EPA's objective for Green House Gas.
Subdivision (and Development)				
Any applications for the subdivision of land within the MRS amendment area shall include the following at the time of lodgement with the WAPC:	***Planning and Development Act 2005*** **Part 10** **Section 143(1)(c):** Provides that the WAPC can place binding statutory conditions on applications for the subdivision of land that: • Require preparation, approval and implementation of the environmental management plans in Schedule 1 of the MRS Text. • Addresses any ecological values identified in new site surveys submitted for previously unsurveyed land.	**WAPC**	**DWER, DBCA and City of Kalamunda:** Responsible for providing expert advice to the WAPC on: • Subdivision applications and recommended conditions of approval. • Compliance with subdivision conditions at the time of endorsing a diagram or plan of survey.	**OVERARCHING** Conditions imposed on applications for subdivision and development will require compliance with the environmental conditions in Schedule 1 of the MRS Text and any Ministerial conditions pursuant to Assessment No. 2335.
INLAND WATERS 1) An Urban Water Management Plan prepared in accordance with the environmental conditions in Schedule 1 of the MRS Text.				**INLAND WATERS** Implementation of approved Urban Water Management Plan(s) will ensure subdivision and development meets the principles and objectives established in the Wattle Grove South DWMS, endorsed as part of Assessment No. 2335. UWMP's will also facilitate ongoing surface and groundwater monitoring in the post development environment, to: • Ensure there is no adverse impact on the hydrological regime of the area or the GBSW and Yule Brook. • Inform the implementation of adaptive management measures (if required). Total water cycle management and water sensitive urban design principles will be implemented to ensure that subdivision and development is consistent with current best practice management and planning for the sustainable use of water resources, including water quality objectives to mitigate any impacts to the surrounding environment, including the GBSW and Yule Brook.
FLORA and VEGETATION 1) A plan of subdivision that designates the retention of all remnant patches of vegetation communities BaEpPf, BmXpEc and EmMpLp (in Good or better condition) containing conservation significant flora and/or high-quality foraging habitat for all three black cockatoos for Conservation purposes. 2) A CAMP for any Conservation Areas within the proposed subdivision. The plan will address: a) Rehabilitation and weed control. b) Fencing and any other measures required to limit public access. c) TECs or conservation significant flora requirements. d) Terrestrial fauna habitat requirements. e) Erection of educational signage f) Requirements for ongoing environmental management and maintenance. 3) A Tree Canopy Retention and Landscape Management Plan, which confirms: a) The location of existing trees to be removed. b) The location, species, size and structural health of trees to be retained. c) The location of new trees and planting schedule, including species, number of trees planted, planting size, mature height and spread.	**Part 10** **Section 145(4):** This section of the Act provides that the WAPC's endorsement of a diagram or plan of survey for the subdivision is subject to the WAPC being satisfied that all conditions of the subdivision approval have been complied with, including the implementation of			**FLORA AND VEGETATION** • All remnant patches of vegetation communities BaEpPf, BmXpEc and EmMpLp (in Good or better condition) containing conservation significant flora and/or high-quality foraging habitat for all three black cockatoos will be retained in Conservation Areas. • Implementation of the CAMP(s) will provide for the appropriate protection and management of vegetation communities BaEpPf, BmXpEc and EmMpLp (in Good or better condition) and conservation flora. • Implementation of the Tree Canopy Retention and Landscape Management Plan will achieve best practice sustainable outcomes, including: • Retention and enhancement of habitat, particularly black cockatoo habitat. • An urban tree canopy cover that reduces heat island effect and preserves and improves landscape amenity. • Implementation of CEMPs will ensure appropriate management of a number of environmental factors and mitigate the risk to the surrounding environment during subdivision and development works.

Planning mechanism	Legislation or agreement regulating the activity	Decision making authority	Stakeholder engagement in decision making	Environmental outcomes
d) The percentage of canopy coverage achieved. 4) An Environmental Offset Management Plan, if required by the Environmental Offset Management Strategy in the LSP. 5) A CEMP for any subdivision or development works within 100 m of remnant patches of vegetation communities BaEpPf, BmXpEc and EmMpLp (in Good or better condition), conservation significant flora and black cockatoo habitat identified for retention. The plan will address: a) Weeds and pathogen management. b) Fauna management. c) Access management (preventing access during construction). d) Dust management. An onsite site survey for flora, vegetation and fauna (in accordance with Schedule 1 of the MRS Text, for any land that that was not previously surveyed at the date of the Minister for Environment's decision on Assessment No. 2335.	environmental management plans.			
TERRESTRIAL FAUNA As above for Flora and Vegetation.				**TERRESTRIAL FAUNA** As above for Flora and Vegetation. Additionally, implementation of Environmental Offset Management Plan(s) (if required) will facilitate the retention of quality black cockatoo habitat and suitable revegetation / offsetting of any black cockatoo habitat that is removed.
SOCIAL SURROUNDINGS 1) A Visual Amenity Management Plan that provides for the implementation of the 'Interface Transition Zone', Local Visual Amenity Management Strategy and Visual Impact Assessment for development over three storeys (if required). 2) Provisions within the Tree Canopy Retention and Landscape Management Plan for the retention and/or replanting of endemic trees that hold important cultural associations for the Whadjuk Noongar people (if any are identified following engagement with Traditional Owners at LSP stage). 3) Subject to the above, an Interpretation Plan for educating the community about the special meaning that any such endemic trees retained and/or planted hold for the Whadjuk Noongar people. 4) A CEMP for any subdivision or development works within 100 m of the Brentwood Road Swamp Aboriginal heritage site (#4343), or any endemic trees that hold important cultural associations for the Whadjuk Noongar people and have been identified for retention.				**SOCIAL SURROUNDINGS** • Implementation of the Visual Amenity Management Plan will ensure that existing landscape values and significant viewing experiences are managed within the new urban environment. • Any endemic trees that hold important cultural associations for the Whadjuk Noongar people will be afforded recognition in the new urban environment (if any such trees are present in the area). • The significance of such trees will be further recognised through the implementation of an Interpretation Plan. CEMP(s) will provide for the protection of any endemic trees identified for retention, as well as the Brentwood Road Swamp Aboriginal heritage site (if it still exists), during subdivision and development works.
GREENHOUSE GAS Nil. No mitigation measures required.				GREENHOUSE GAS The MRS amendment meets the EPA's objective for Green House Gas.

14. Conclusion

This Environmental Review document has established the ecological values of the existing environment within and adjacent to the MRS amendment area and undertaken a robust assessment of the potential impacts of future actions resulting from the MRS amendment, in a local and regional context. The Environmental Review is supported by relevant technical environmental studies to inform the environmental impact assessment, and it is considered that the information provided addresses any potential environmental impacts relevant to the MRS amendment, individually and cumulatively with other existing and foreseeable actions in the region.

Whilst the MRS amendment in itself will not have any direct environmental impacts, if and when landowners and or developers choose to act on the change in land use, there will be the potential for impacts and changes to the physical and biological environment to occur.

The mitigation hierarchy (avoid, minimise and rehabilitate) has been applied and residual impacts and environmental outcomes predicted for each key preliminary environmental factor. In summary it is considered that with the application of appropriate mitigation and management measures at the various identified stages of future planning and development approvals subsequent to the MRS amendment, the EPA's objectives for the key environmental factors will be met. The Environmental Management Framework (Table 12-1) describes the stages at which mitigation measures will be implemented through future planning controls under the PD Act and associated regulatory statutory processes.

The predicted outcomes for the key environmental factors are summarised as follows:

Inland waters

- All 'urban' land uses to be confined to the MRS amendment area.
- No change to hydrological regime that will result in groundwater dependent vegetation to be impacted within the MRS amendment area or the GBSW as determined by a groundwater monitoring program.
- No significant change to surface water flows downgradient as determined by a surface water monitoring program

Flora and vegetation

- All remnant native vegetation in Good or better condition will be retained for conservation
- No threatened/priority ecological communities will be lost as a result of clearing of remnant native vegetation.
- 3.61 ha (92% of all remnant native vegetation) of remnant vegetation (in Good or better condition) will be retained for conservation as part of subsequent local structure planning, subdivision and development.
- No impacts to Eucalyptus Woodlands as part of the MRS amendment or subsequent subdivision.
- Retention of conservation significant flora (*Conospermum undulatum* and *Isopogon autumnalis*) within conservation areas as part of subsequent local structure planning, subdivision and development.

Terrestrial fauna

- All remnant native vegetation (in Good or better condition), which includes 4.16 ha of Banksia Woodland and 0.05 ha of Eucalyptus Woodland containing medium to high quality foraging habitat for black cockatoos, seven potential nesting trees for black cockatoos and habitat for quenda, will be retained for conservation.
- A potential loss of up to 29.54 ha of highly modified habitat types of compromising scattered trees (26.58 ha) and planted gardens (2.8 ha), as well as degraded to completely degraded Banksia Woodland (0.16 ha), which consist of predominantly of low-quality foraging habitat for black cockatoos, and 0.72 ha and 0.80 ha of medium quality foraging habitat for Carnaby's cockatoo and Baudin's cockatoo, respectively.
- Loss of up to 0.16 ha of native vegetation fauna habitat, including breeding, foraging and dispersal habitat, from clearing.
- Loss of up to of 29.54 ha of highly disturbed or altered non-native fauna habitat, which may be used for fauna breeding, foraging and dispersal habitat from clearing.

Social surroundings

- No direct impact to recorded and/or known Aboriginal Heritage Sites
- Ongoing engagement with Traditional Owners will occur as part of planning processes subsequent to the MRS amendment.

Greenhouse gas

- No direct impact. Scope 1 greenhouse gas emissions associated with future vegetation clearing (native and non-native) within the MRS amendment area, will not exceed 100,000 tCO2-e per annum (Scope 1).

15. Additional information

Index of Biodiversity Surveys for Assessments (IBSA)

Ecological Survey Data Package	IBSA Submission Number	IBSA Number
JBS&G 2024 Wattle Grove South MRS Amendment Area Ecological Survey Technical Memo IBSA data package	IBSASUB-20240318-C7D7DF68	IBSA-2024-0152

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Appendix A. Water Balance Assessment: Wattle Grove South MRS Amendment (Emerge Associates 2024)

Appendix B. Wattle Grove South District Water Management Strategy (Hyd2o 2024)

Appendix C. Wetland Assessment: Wattle Grove South MRS Amendment 1388/57 (Pentium Water 2024)

Appendix D. Wattle Grove South MRS Amendment Area Ecological Survey Effort – Technical Memo (JBS&G 2024)

Appendix E. Wattle Grove Floristic Community Type Analysis (Plantecology 2024)

Appendix F. Black Cockatoo Habitat Assessment for Wattle Grove (South) (Phoenix Environmental Services 2024)

Appendix G. Wattle Grove South SRE Invertebrate Fauna Desktop Assessment (Bennelongia Environmental Consultants 2024)

Appendix H. MRS Amendment 1388/57 (Wattle Grove South): Aboriginal and Cultural Heritage Evaluation (Element 2024)

Appendix I. Wattle Grove Visual Landscape Evaluation (EPCAD 2024)