Mr I Yujnovich

Local Water Management Strategy – Lot 123 Mortimer Road Casuarina

V1 – 08 October 2019

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Contents

1.0 Introduction

Natural Area Holdings Pty Ltd T/A Natural Area Consulting Management Services was engaged by Mr I. Yujnovich to prepare this Local Water Management Strategy (LWMS) to support the structure planning approvals process to subdivide Lot 123 Mortimer Road Casuarina in the City of Kwinana into two Lots (Figure 1) in the first instance, with subdivision to residential expected at some future stage.

The Lot has been in the ownership of Mr Yujnovich for more than 60 years and represents a legacy site in terms of the environmental values that are present, and which need to be considered from an approvals process today, in contrast to when the Lot was purchased. In time, when further consideration of subdividing the Lot for residential purposes occurs, additional consideration of local water impacts will take place.

The objective of this LWMS is to ensure consideration of water management issues are addressed at an early stage of the planning process. Present within Lot 123 is a conservation category wetland to the north, along with portions of three resource enhancement wetlands along the western boundary. A Tumulus Mound Spring threatened ecological community is present approximately 3 km to the south east of the site. Each of these features needs to be considered during the planning process for the site.

This report details the following:

- the current planning context
- details of the proposed development
- indicative design criteria
- current site characteristics, including soils, wetlands, and other environmental assets
- indicative water sustainability initiatives
- stormwater management strategy
- groundwater management strategy
- probable future investigations
- implementation.

It is understood that there is no district water management strategy for the site. This document will support the early stages of the planning approvals process, with additional studies and amendments to occur as planning and other approvals progress over the site.

1.1 Planning Context

Lot 123 Mortimer Road is located in Casuarina, within the City of Kwinana. It is a 45 ha in area, located to the east of the Kwinana Freeway, and is bounded by existing rural residential properties to the north, south, east and west (Figure 1). It is zoned Residential Development, as per the *City of Kwinana Town Planning Scheme No. 2* (City of Kwinana, 2019) and *Local Planning Policy 6 – Guidelines for Structure Planning in the Casuarina Cell* (City of Kwinana, 2018). This zoning is consistent with the Metropolitan Regional Scheme, which indicates that Lot 123 is zoned Urban (Department of Planning, Lands, and Heritage, 2019).

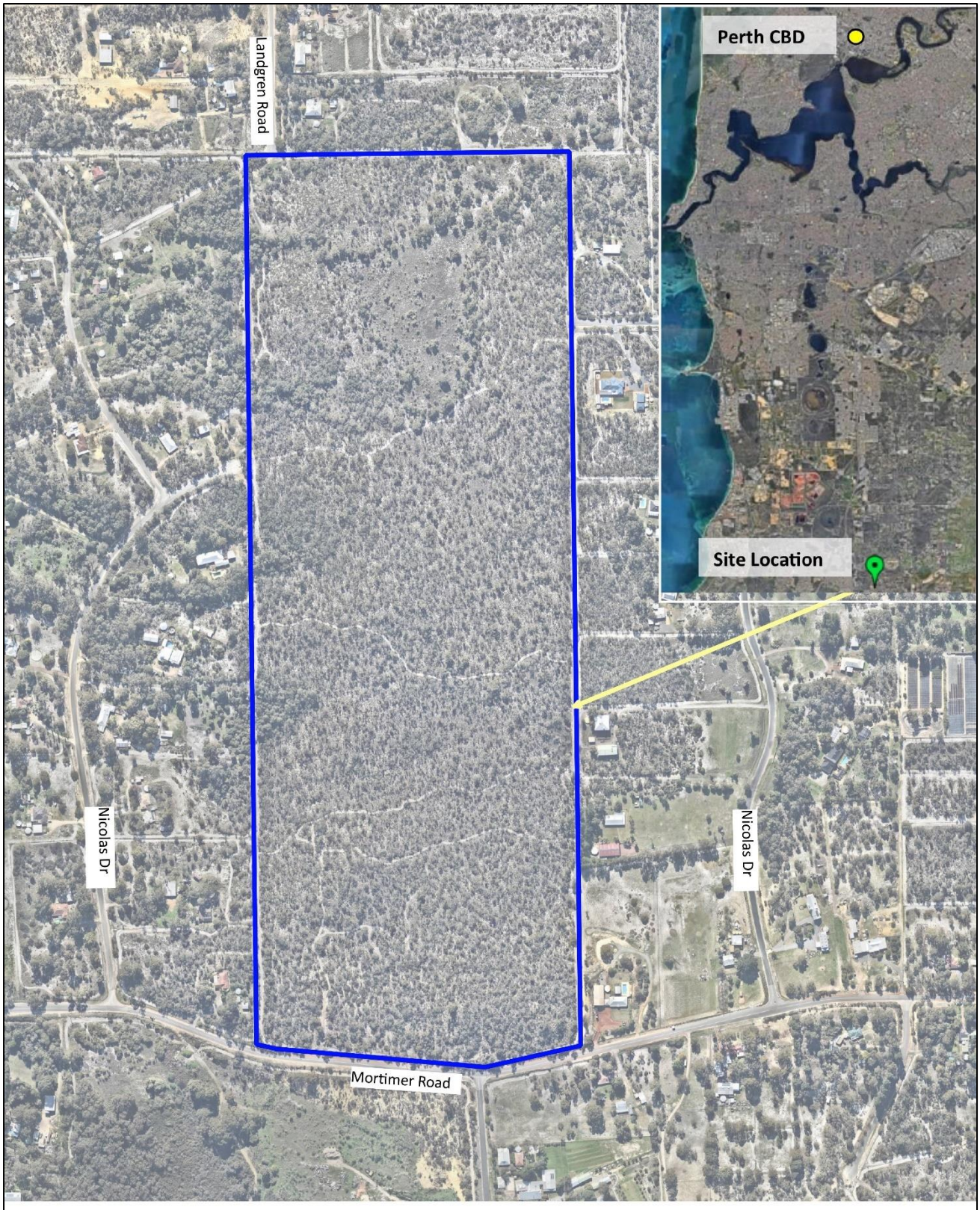

Figure 1:
Location,
Lot 123 Mortimer Rd, Casuarina

1.2 Supporting Documents

This LWMS has drawn on the following documents to support its preparation, including defining its principles, criteria, objectives, and implementation requirements:

- *Better Urban Water Management* (WAPC, DEWHA and WALGA, 2008)
- *Interim: Developing a Local Water Management Strategy* (DoW, 2008)
- *Jandakot Drainage and Water management Plan – Peel Main Drain Catchment* (Department of Water, 2009)
- *Local Planning Policy 6 – Guidelines for Structure Planning in the Casuarina Cell* (City of Kwinana, 2018)
- *Stormwater Management Manual for WA* (DoW, 2004 – 2007)
- *Town Planning Scheme No. 2* (City of Kwinana, 2019a).

2.0 Proposed Development

The Local Water Management Strategy for Lot 123 is based on the initial plan to undertake a super lot subdivision from one Lot into two (Figure 2), with additional subdivision activities occurring at a future point in time; Figure 3 provides an indicative future Lot layout that is conceptual only, with additional detailed design required.

Figure 2: Subdivision Plan

Figure 3: Indicative concept plan, Lot 123

3.0 Design Criteria

In the first instance, design criteria will not apply to the subdivision of Lot 123 as it will be a super Lot subdivision from one Lot into two, with the only change being the location of boundary lines for the Lots. There will be no installation of drainage, roads, or other infrastructure in the short term.

As further detailed design work occurs, the design criteria that the subdivision will be comply will be reviewed and confirmed with the City of Kwinana and the Department of Water. At present, the principle design criteria that it is expected the subdivision will comply with is summarised in Table 1.

Table 1: Expected Water Management Design Criteria

Strategy Element	Method and Approach
Stormwater	
Ecological values	▪ Use of soak wells on Lots to infiltrate the rainfall ▪ Bioretention basins or similar to retain initial rainfall runoff from roads to ensure water quality within any wetland areas is not compromised ▪ The hydrological regime of any significant water-dependent ecosystems is to be maintained ▪ Establishment of storage invert levels above seasonal maximum groundwater levels
Flood protection	▪ Flood storage to be integrated within POS area(s), sufficient on-site storage to retain and treat runoff from a 1-year ARI, 1-hour duration storm event ▪ Establish minimum habitable floor levels 0.5 m above the 100-year ARI flood levels ▪ Stormwater drainage system shall be designed to collect and absorb or transmit a 1-in-5-year ARI storm ▪ Overland flow paths within road reserves determined to enable the safe movement of 1-in-100-year ARI storm events
Nuisance insect management	▪ Retention and detention of surface water designed to ensure the infiltration of static water within 96 hours
Serviceability	▪ Ensure roads will be passable during a 1 in 5-year rainfall event, with design explored during future civil design phases of the project in consultation with the City of Kwinana and other organisations as appropriate
Groundwater	
Acid sulphate soils	▪ If acid sulphate soils are present and likely to be disturbed, they will be managed in accordance with current DWER guidelines; it is anticipated that a site-specific acid sulphate soil management plan would be prepared
Fill and subsoil drainage	▪ Where necessary, import fill to ensure habitable floor levels 0.5 m above the 100-year ARI flood levels are established ▪ Where necessary, subsoil drainage to manage groundwater post development is designed during later civil design processes

Strategy Element	Method and Approach
Sustainability	
Water efficiency	▪ Where possible, groundwater is used for the reticulation of turfed areas, such as for playing fields and POS ▪ Retention of native vegetation will occur where possible to minimise the need for irrigating landscaped areas ▪ Use of water fixtures and fittings with a minimum 4-star water efficiency labelling and standards (WELS) rating ▪ Encourage future landowners to landscape their Lots with local native plants to reduce water use on gardens
Water supply	▪ Water supply will be via the Water Corporation reticulated water supply system
Wastewater	▪ Wastewater will be via the Water Corporation reticulated wastewater sewerage system

4.0 Pre-Development Environment

4.1 Location

Lot 123 Mortimer Road is located approximately 32 km south of the Perth Central Business District (Figure 1). The site is a single, large Lot zoned urban and which is currently surrounded by rural residential Lots to the south, west, north and east.

4.2 Current Land Use

The current land use within Lot 123 is a 45-ha area of remnant bushland (Figure 4) dominated by Banksia Woodland. A review of aerial imagery held by Landgate (2019) indicates that a house constructed on the south-west portion of the site during the 1960's was demolished sometime between 1985 and 1989.

Current landuse | Remains of dwelling demolished in mid-late 1980s

Figure 4: Current and previous land use

4.3 Topography

Lot 123 is located on the Bassendean Dune System within the Swan Coastal Plain. This system is characterised by undulating land associated with sand dunes, interdunal swales and sandplains with pale, deep sand, semi-wet and wet soils (Department of Primary Industries and Regional Development, 2019).

The site ranges in height from 18 m AHD in the north to 38 m AHD in the south-east, with some higher areas around the centre of the site (Figure 5). Accordingly, slope across the site is currently variable, and will be modified when development progresses and engineering works are carried out.

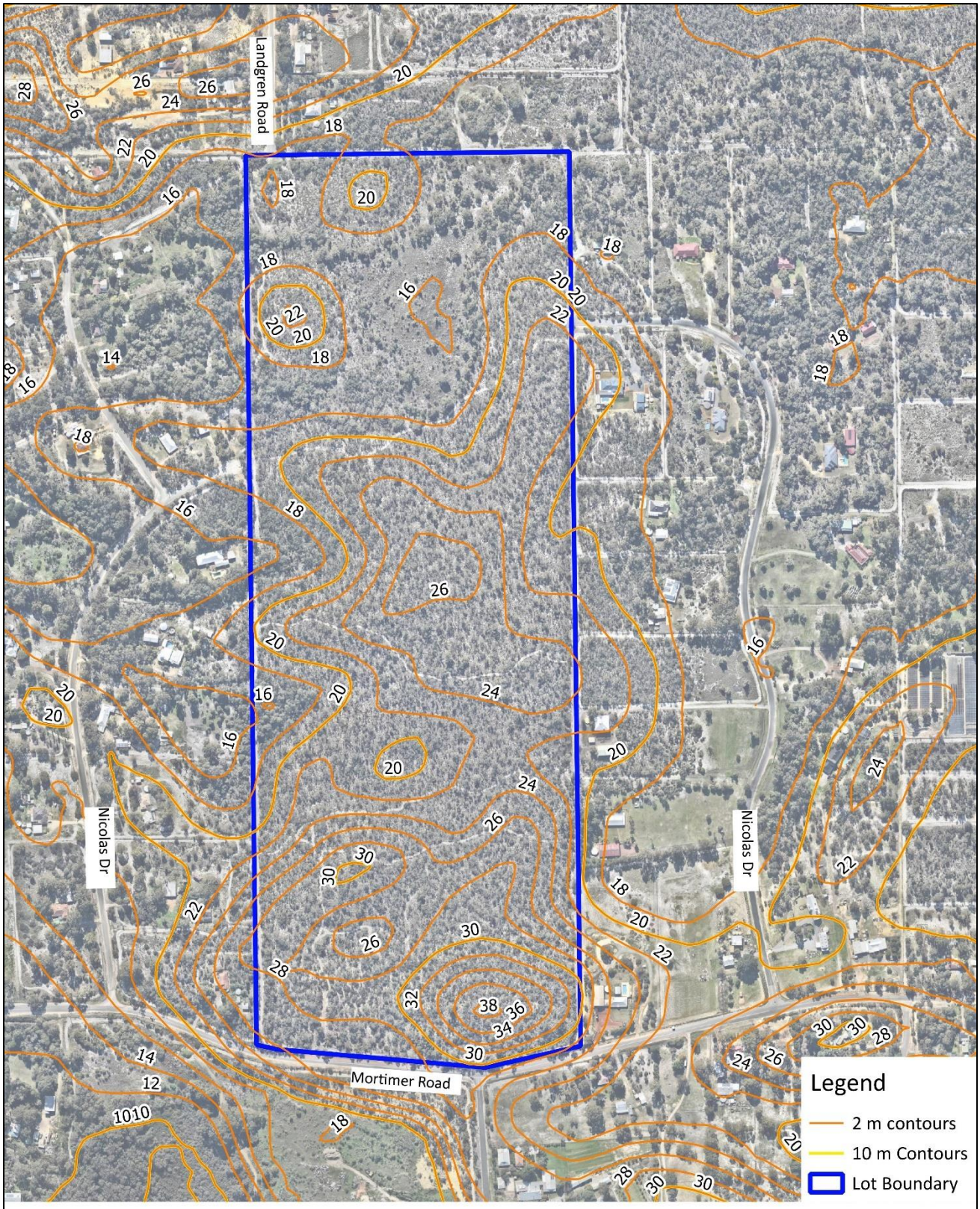

Figure 5:
Site Contours
Lot 123 Mortimer Rd, Casuarina

4.4 Soils

According to NRInfo (Department of Primary Industries and Regional Development, 2019), two soil types are present within Lot 123 (Figure 6):

- Bassendean B1 Phase (212Bs_B1) – Extremely low to very low relief dunes, undulating sandplain and discrete sand rises with deep bleached grey sands sometimes with a pale-yellow B horizon or a weak iron-organic hardpan at depths generally greater than 2m; Banksia dominant
- Bassendean B3 Phase (212Bs_B3) – Closed depressions and poorly defined stream channels with moderately deep, poorly to very poorly drained bleached sands with iron-organic hardpan 1-2 m or clay subsoils. Surface soils are dark grey sand or sandy loam.

4.4.1 Geotechnical Investigations

Due to the current works being completed during a very early stage of the planning process, geotechnical investigations for the site have not yet been carried out. However, it is recognised that Bassendean Sands are permeable and that on-site stormwater disposal and treatment will be feasible. Geotechnical investigations will be carried out as the planning process advances at some future stage.

4.4.2 Phosphorous Retention Index

Phosphorus (P) is a key plant nutrient that is often a growth limiting factor in Australian soils without the addition of fertilisers or other forms of treatment. The sandy soils of the Swan Coastal Plain, and particularly those of the Bassendean Dune System on which Lot 123 is located, have a poor ability to adsorb nutrients, thus the excess application of soluble forms of fertiliser containing phosphorus have the potential to result in eutrophication of the groundwater and downstream surface water features.

The phosphorus retention index of a soil provides information on a particular soils ability to adsorb phosphorus and thus its availability to plants. Phosphorus fixation properties are described according the PRI (mg/L) values provided in Table 2. At present, testing of the phosphorous retention index of soils on Lot 123 has not occurred, but results are expected to be in the 0 – 2 mg/L range due to their being those associated with the Bassendean Dune System with their ability to rapidly leach phosphorous.

Table 2: Phosphorus fixation properties

PRI	Soil Phosphorous Absorbing Capacity	Example Soil
0 – 2	Weak	Bassendean
2 – 20	Moderate	Karrakatta, Cottesloe
20 – 100	Strong	Limestone
> 100	Very strong	Clays

(After Department of Water, 2004 – 2007)

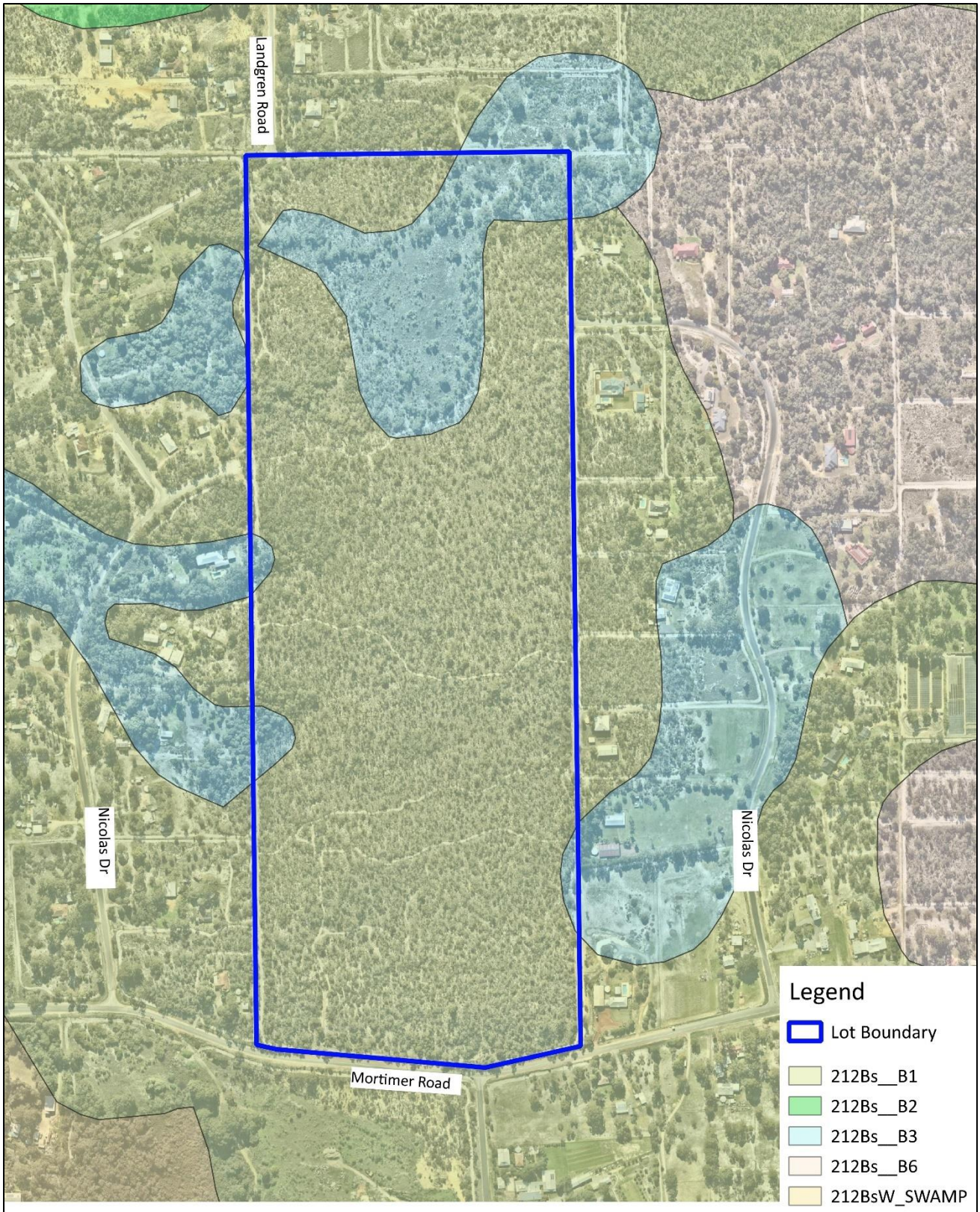

Figure 6:
Soils
Lot 123 Mortimer Rd, Casuarina

4.4.3 Acid Sulfate Soils (ASS)

A review of acid sulfate soil (ASS) mapping held by the Department of Water and Environmental Regulation (DWER) (Data WA, 2019), the majority of the site is shown as having a moderate - low risk of ASS occurring within 3 m of the natural soil surface, with a high – moderate risk of ASS at depths below 3 m. Portions of the site that are in locations designated as wetlands are shown as having a high to moderate risk of ASS within 3 m of the natural soil surface. (Figure 7)

Field testing of pH and pH after oxidation was carried out by Bioscience to support an application to modify the classification of the conservation category wetland in the northern portion of the Lot, with no evidence of ASS noted (Bioscience 2011).

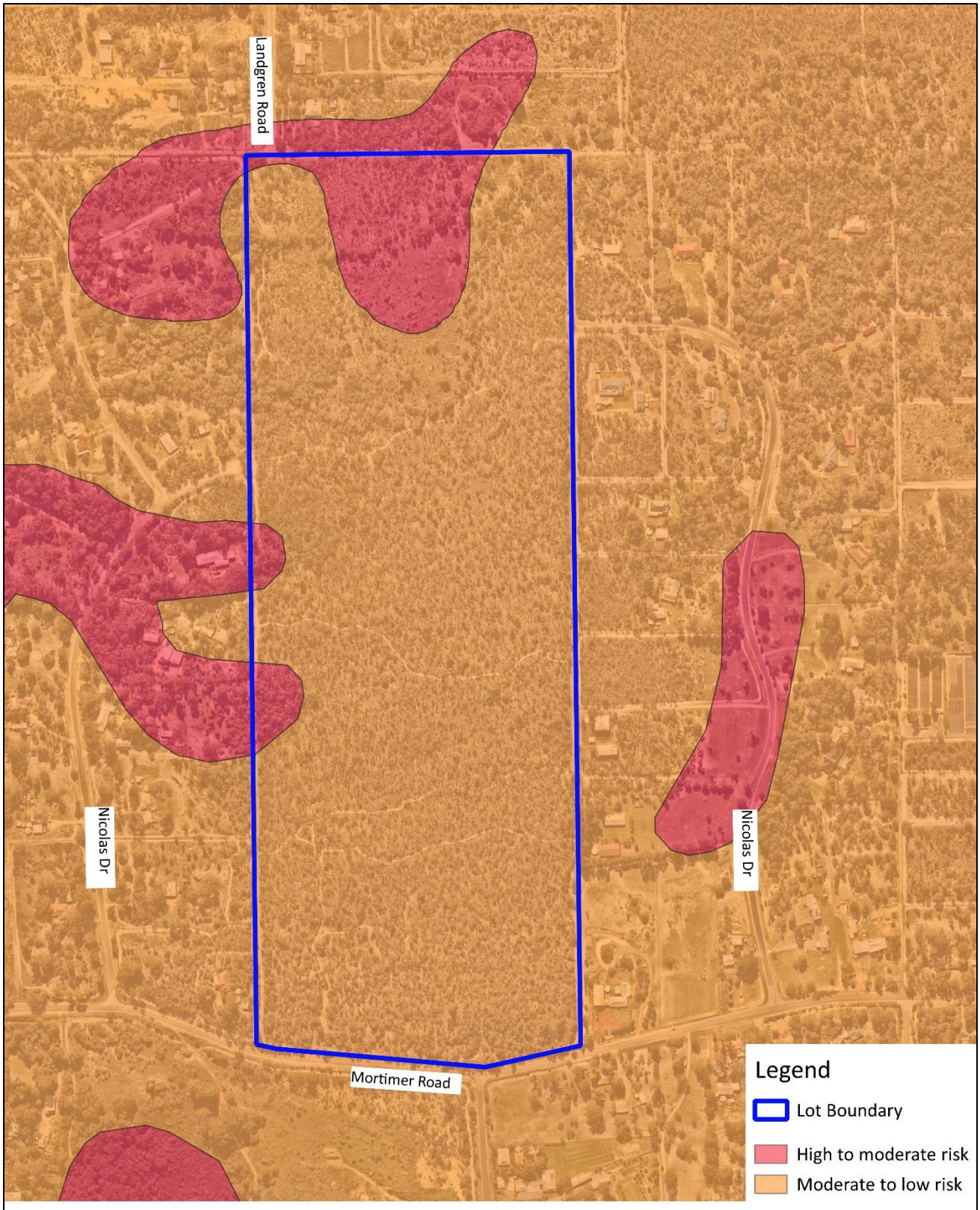

Figure 7:
Acid Sulphate Soil Risk Mapping
Lot 123 Mortimer Rd, Casuarina

4.5 Environmental Assets

4.5.1 Wetlands

Wetlands on the Swan Coastal Plain were identified, mapped, classified and assessed over several years, with outcomes of that process becoming the basis of the Geomorphic Wetlands of the Swan Coastal Plain Dataset maintained by the Department of Biodiversity, Conservation and Attractions. The identification and assessment process included desktop review activities of aerial imagery that included the presence of vegetation typically associated with wetland areas (Hill, Semeniuk, Semeniuk and Del Marco, 1996).

This process defined the wetlands on Lot 123 as damplands, which are seasonally waterlogged areas, meaning that groundwater levels rise and become close to the natural surface level during wetter months (winter) (Department of Biodiversity, Conservation and Attractions, 2019a). These wetter areas can be diverse in terms of the flora and fauna they support. While it is understood that some site visits were made to ground truth the assessment activities, it is unlikely any visits were made to those on Lot 123 due to the land being in private ownership.

One wetland is currently recognised by the Department of Biodiversity Conservation and Attractions as being present within Lot 123, with portions of two others extending a short distance into the Lot along the western boundary; these are summarised in Table 3 and shown in Figure 8. The landowner has indicated that no standing water has ever been observed on site since he purchased the property more than 60 years ago. The wetland areas present in Lot 123 are not considered locally, regionally, nationally or internationally significant.

Table 3: Wetlands within Lot 123

Unique Feature ID (UFI)	Landform	Wetland Type	Management Category	Area (ha)	Approx. Extent within Lot (ha)
6690	Basin	Dampland	Resource Enhancement	4.22145	0.34638
13969	Basin	Dampland	Resource Enhancement	7.596212	0.53837
6679	Basin	Dampland	Conservation	2.566374	2.566374
15862	Not a wetland	Not a wetland	N/A	0.894903	0.89475

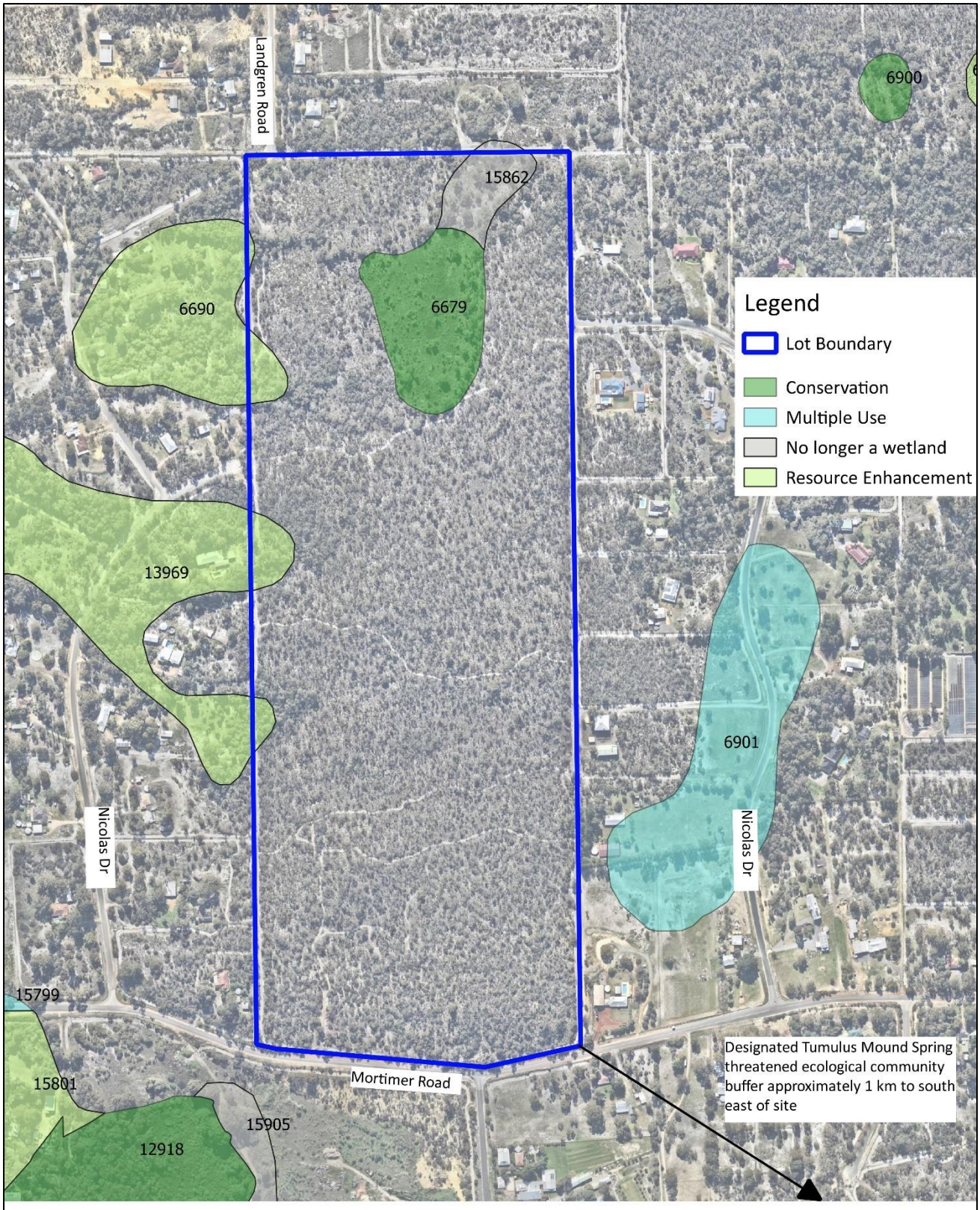

Figure 8:
Designated Wetland Areas as per the Geomorphic Wetlands Dataset
Lot 123 Mortimer Rd, Casuarina

Conservation Category Wetland

Requests to modify the extent and classification of the conservation category wetland (UFI 6679) on Lot 123 was undertaken by Bioscience after completing detailed reviews of the vegetation within the designated conservation category wetland, along with a drilling program to investigate the soil profile, depth to groundwater, and other hydrological features (2006 and 2011; copies of reports provided in Appendix 1 and 2). The maximum depth to groundwater was determined to be 1.5 m below the natural surface level. Department of Water long term monitoring bores maintained by the then Department of Environment indicated a trend of increasing depth to groundwater over time. This data, along with the vegetation assessment included in the Bioscience reports, suggests that designating the northern portion of Lot 123 as a wetland of any description was questionable. The assessment process carried out by Bioscience resulted in a modification to the accepted boundary of the conservation category wetland, reducing its extent, with the area no longer considered to be a wetland designated UFI 15862 (Table 3).

Resource Enhancement Wetlands

Resource enhancement wetlands are described as those that may have been partially modified but still support substantial ecological attributes and functions (Department of Biodiversity, Conservation and Attractions, 2019b). The Geomorphic Wetlands of the Swan Coastal Plain Dataset indicates that the eastern extremities of two wetlands identified by Hill *et al* (1996) are present along the western boundary of Lot 123. The resource enhancement designation indicates that the wetlands have been modified, but 'substantial' ecological attributes and functions are present. For those portions of UFIs 6690 and 13969 located within Lot 123, there has been significant modification to these wetland areas due to the requirement to comply with the requirements of the *Bushfires Act 1954* (WA) to have a cleared firebreak of at least 3 m around the perimeter of the Lot; modifications to the wetland values have also occurred on neighbouring properties to the west through clearing to support rural residential development (Figure 9).

Figure 9: Modifications to resource enhancement wetland, Lot 123 and neighbour to the west

Observations during site assessment activities carried out by Natural Area suggest that the resource enhancement category assigned to the wetlands considered to extend into Lot 123 along the western boundary are no longer applicable due to the extent of modifications that have occurred through clearing and other development activities. The vegetation within Lot 123 is Marri, which can tolerate moist but not wet conditions, suggesting a transition area between wetland and dryland conditions. No formal assessment of the extent of the resource enhancement wetland areas (UFI 6690 and 13969) has been undertaken, thus there has been no formal request to modify their extent and/or classification.

Tumulus Mound Springs

Tumulus Mound Springs are a threatened ecological community that is characterised by a continuous discharge of groundwater in locations with areas of raised peat that provide a range of microhabitats that are permanently moist (Department of Environment and Conservation, 2005). A DBCA database search of threatened and priority listed ecological communities for the area surrounding Lot 123 indicated that a Tumulus Mound Spring area is located approximately 3 km to the south-east (Figure 8, off map to the south east). As groundwater generally flows to the west, impacts to this community are unlikely (Walker, 2019, personal communication).

4.5.2 Public Drinking Water Source Protection Areas

Lot 123 is located approximately 400 m to the south east of priority 1 and priority 2 (P1 and P2) Drinking Water Source Protection Areas associated with the Jandakot Land Use and Water Management Strategy 1995) (Figure 10). As groundwater flow is approximately to the west, development of Lot 123 is unlikely to impact on this area.

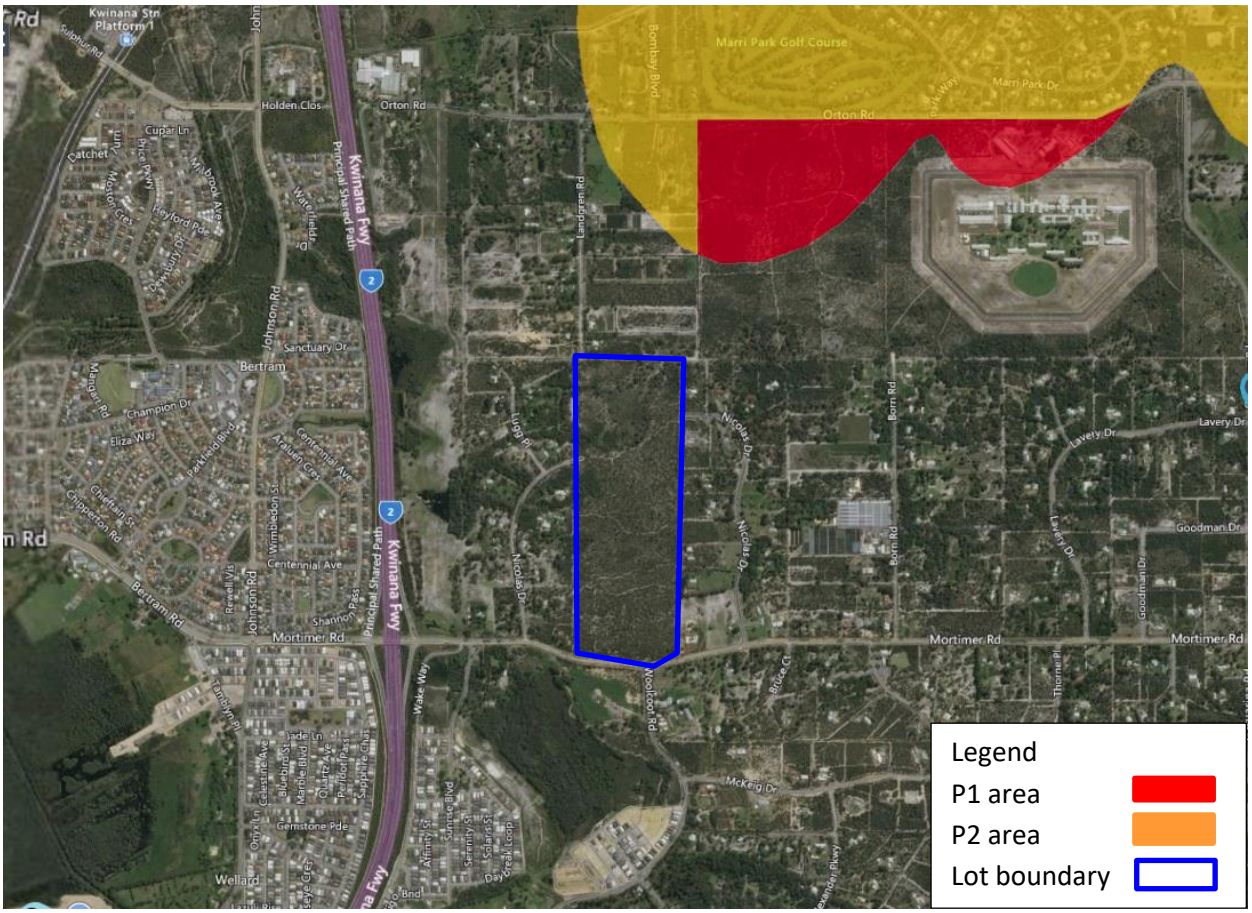

Figure 10: Drinking Water Source Protection Areas
(Source: National Map, 2019b)

4.5.3 Bush Forever

While Lot 123 is not a designated Bush Forever Site, it is located with 5 km of ten Bush Forever sites (Figure 11):

- Bush Forever Site 67 – Parmelia Ave Bushland, Parmelia, 6.8 ha
- Bush Forever Site 68 – Jackson Road Bushland, 19.3 ha
- Bush Forever Site 70 – Duckpond Bushland, 8.8 ha,
- Bush Forever Site 269 – The Spectacles, 349.7 ha (including lake)
- Bush Forever Site 270 – Sandy Lake and Adjacent Bushland, Anketell, 181.3 ha
- Bush Forever Site 272 – Sicklemore Road Bushland, Parmelia/Casuarina, 84.6 ha
- Bush Forever Site 273 – Casuarina Prison Bushland, Casuarina, 116.9 ha
- Bush Forever Site 348 – Modong Nature Reserve and Adjacent Bushland, Oakford, 242.0 ha
- Bush Forever Site 349 – Leda and adjacent bushland, Leda, 959.8 ha
- Bush Forever Site 353 – Banksia Road Nature Reserve, Wellard, 32.3 ha.

The closest is Site 273, which is approximately 1.5 km to the north-east. All except Site 68 contain some portion of the *Bassendean Complex – Central and South* vegetation complex that is located on Lot 123 (Government of Western Australia, 2000; National Map, 2019).

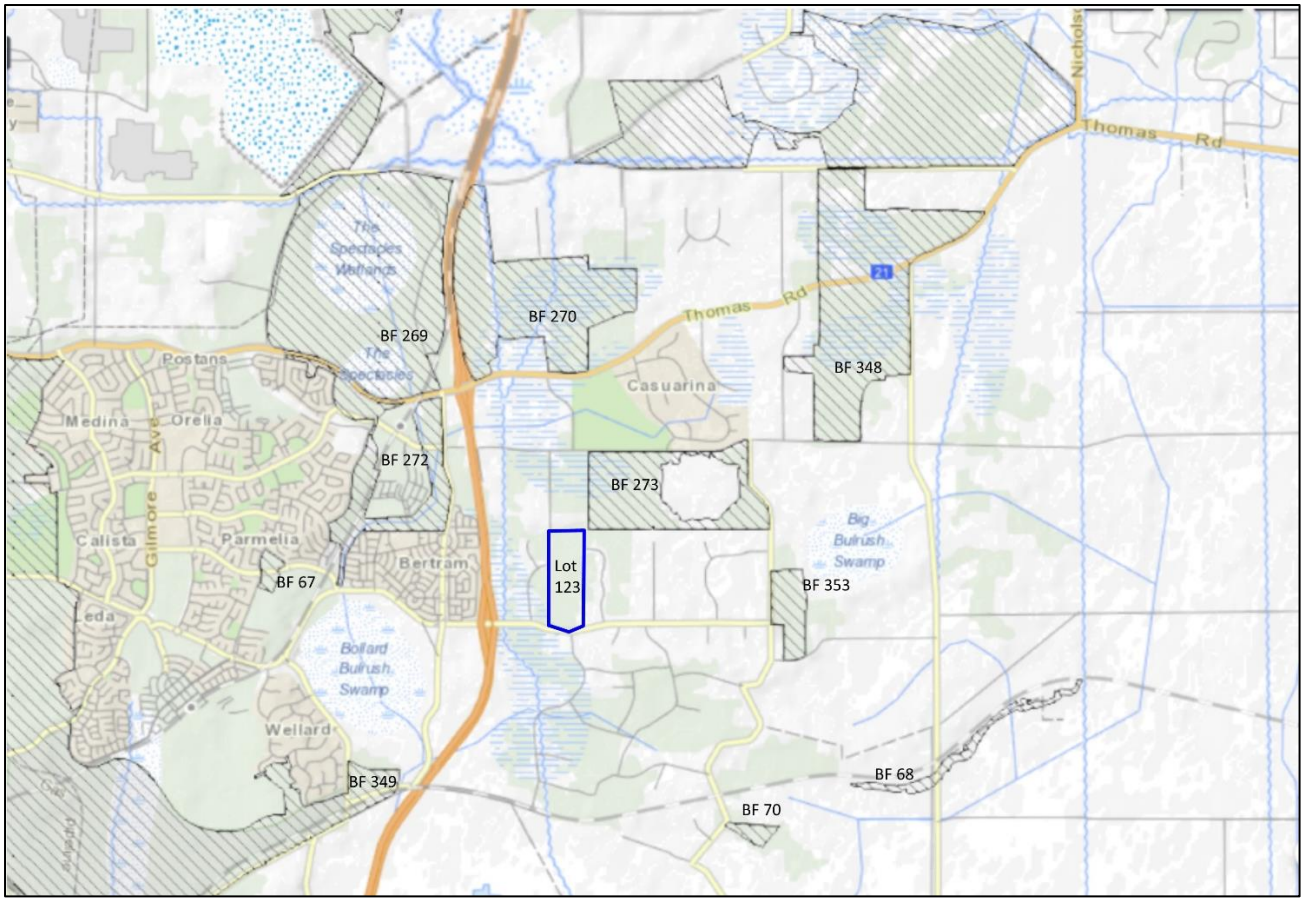

Figure 11: Bush Forever Sites in proximity to Lot 123
(Source: National Map, 2019a)

4.5.4 Flora and Vegetation

Natural Area undertook an updated flora and vegetation assessment of Lot 123 in during September 2018. That assessment confirmed:

- a total of 219 flora species present from 51 families
- a total of 41 weeds and 178 native flora species
- no priority or threatened flora species were found
- three vegetation types occur within the lot, with Banksia Woodland being the most dominant (Figure 12)
- vegetation across the site ranges from Degraded to Excellent with the majority of the site in Excellent condition (Figure 13)
- the presence of the endangered ecological community 'Banksia Woodlands of the Swan Coastal Plain', covering 37.9 ha (84%) of the site (Figure 12).

When combined with the Bioscience (2006, 2015) survey data, this results in a total of 248 species on site, of which 202 are native species and 46 are weeds. A copy of this report is provided in Appendix 3.

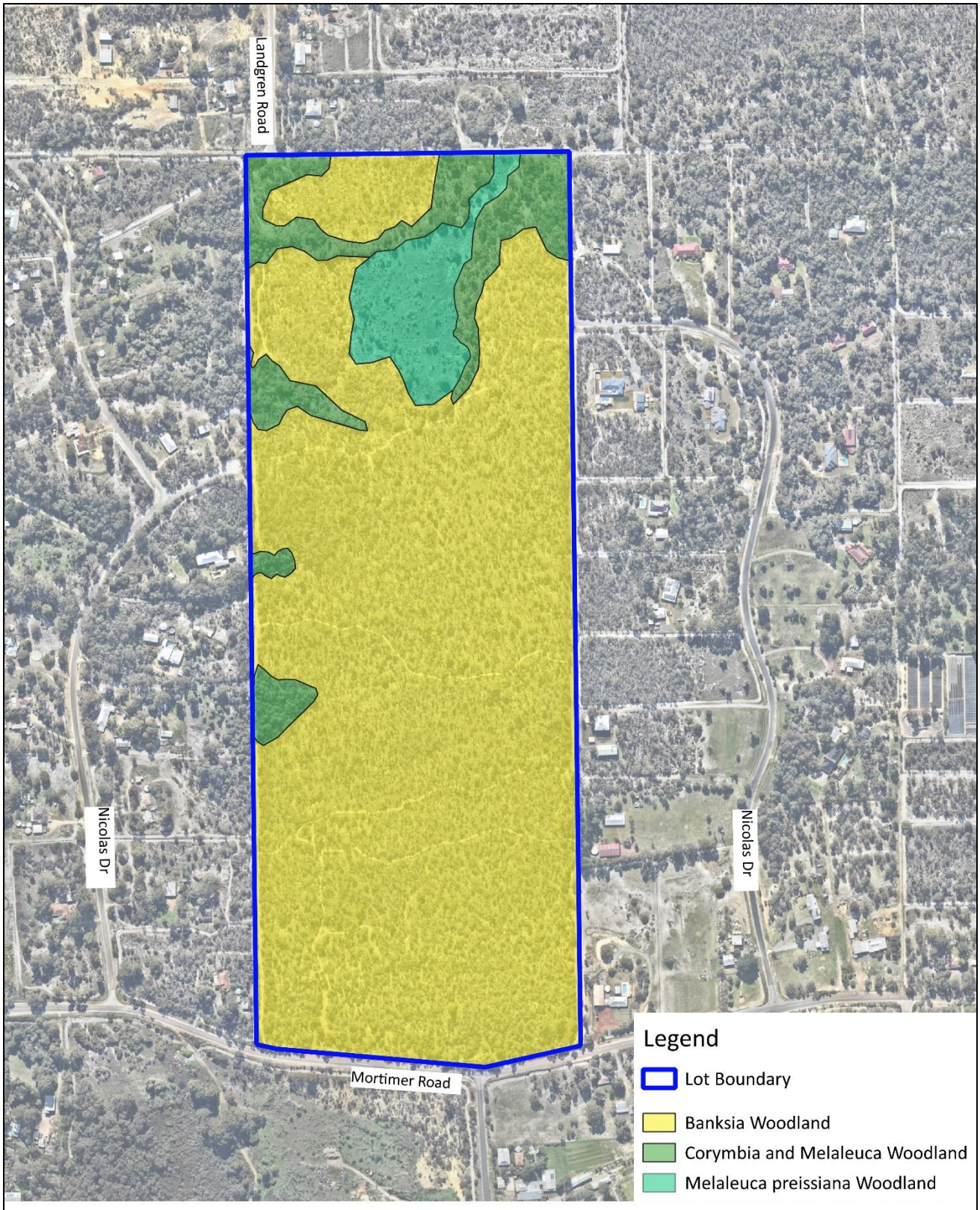

Figure 12:
Vegetation Type
Lot 123 Mortimer Rd, Casuarina

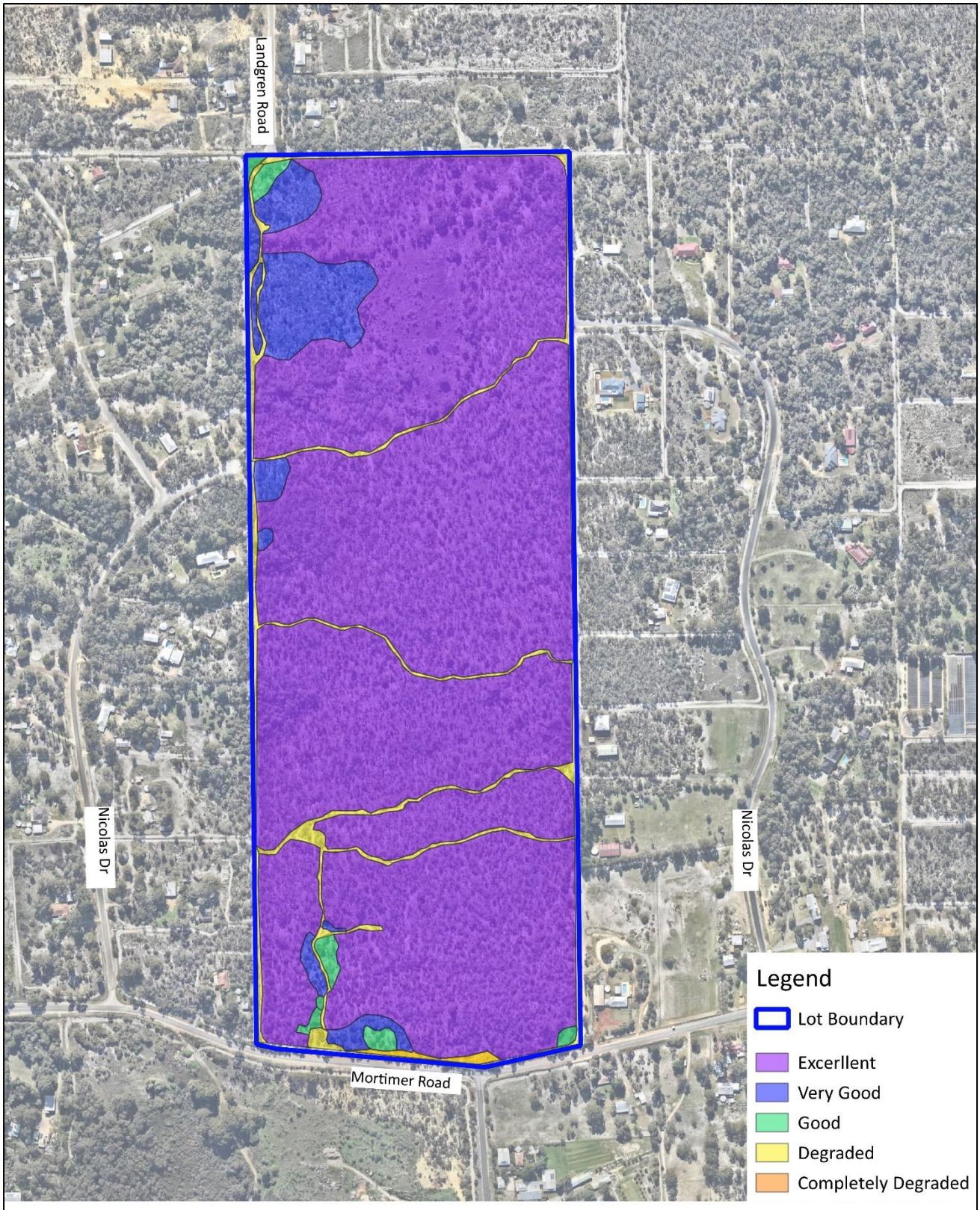

Figure 13:
Vegetation Condition
Lot 123 Mortimer Rd, Casuarina

4.5.5 Fauna

During the 2018 flora and vegetation assessment, Natural Area also undertook an assessment of habitat utilised by threatened black cockatoos, and recorded sightings of other vertebrate fauna species. The black cockatoo habitat assessment within Lot 123 Mortimer Rd, Casuarina confirmed:

- evidence of foraging by the threatened Carnaby's Cockatoo (*Calyptorhynchus latirostris*) (Endangered) and the Forest Red-tailed Black Cockatoos (*Calyptorhynchus banksii naso*) (Vulnerable)
- a total of 28 trees with hollows that are of a suitable size to be utilised for nesting and a further 12 trees that were suitable roosting trees for black cockatoos.

Opportunistic sightings of the Priority 4 Western Brush Wallaby (*Macropus irma*) and diggings of the Priority 4 Southern Brown Bandicoot (*Isoodon fusciventer*) were also recorded during the 2018 spring flora and habitat survey.

4.6 Drainage

As this LWMS is to support the subdivision of Lot 123 into two Lots in the first instance, a detailed assessment of the pre and post-development catchment areas has not been carried out. The known depth to groundwater of around 1.5 m below the natural surface level (Bioscience, 2011), and the anecdotal information provided by the owner indicating there has been no free-standing water on the site at any time during his 60+ years of ownership suggest that flooding has not occurred at the site.

A City of Kwinana drain commences in the northern portion of Lot 123, with water transported to the west (orange line, Figure 14) where it connects with the Water Corporation Peel Sub O Drain. Local stormwater channels are present to the north, east, south and west of Lot 123 (green lines, Figure 15) (City of Kwinana, 2019b). No additional drainage will be required on Lot 123 as result of the current subdivision process. As planning progresses at some future stage when development is planned, detailed drainage design will occur for the site.

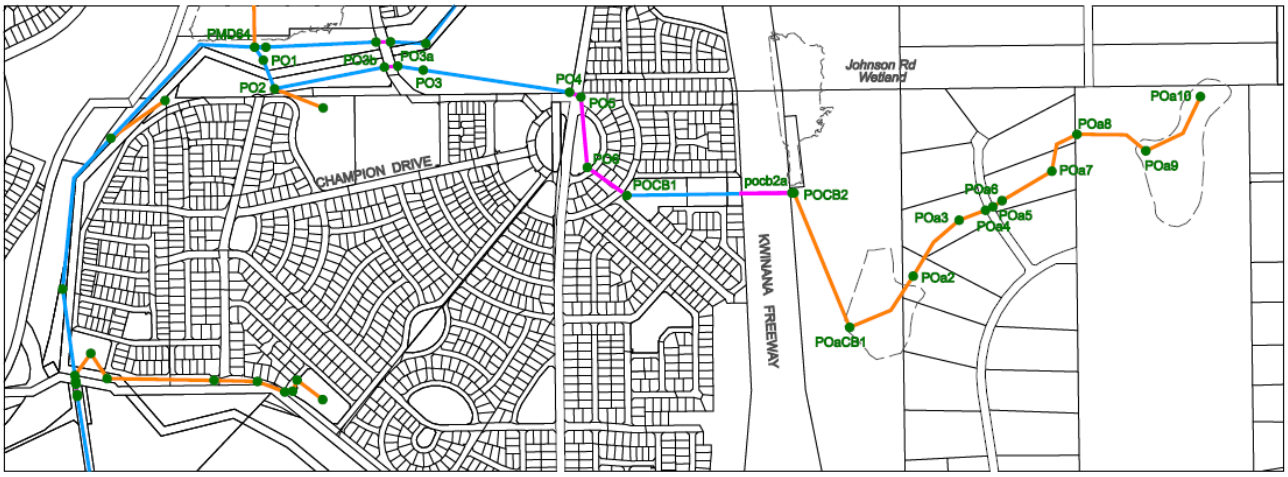

Figure 14: Peel Sub O Drain and Local Authority Drain (Department of Water, 2009)

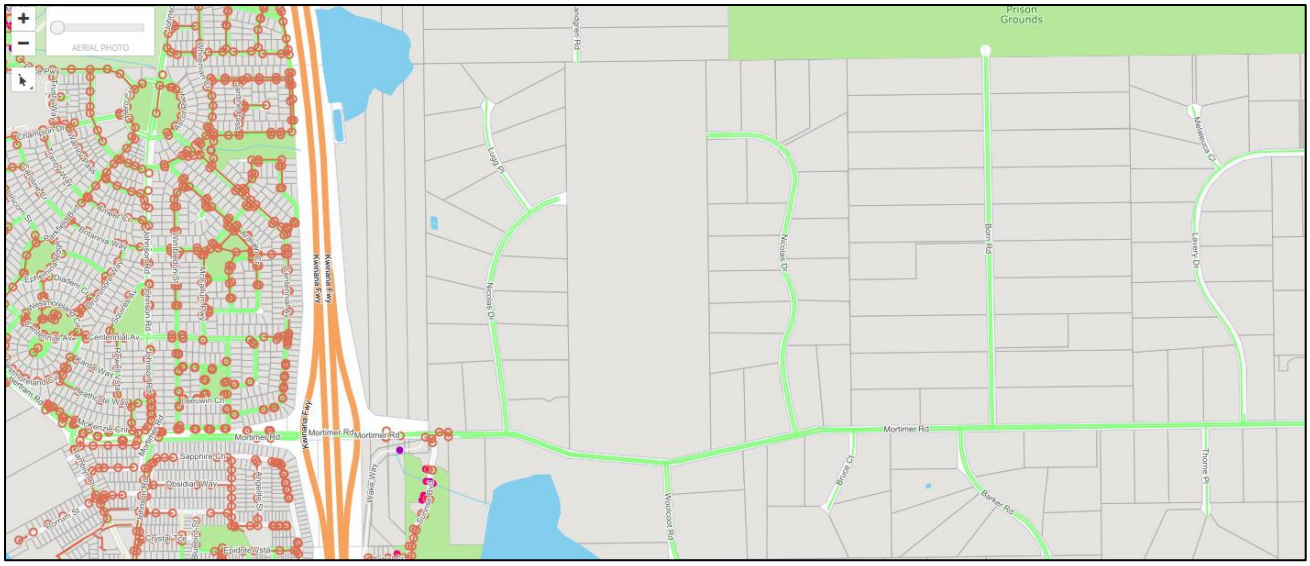

Figure 15: Local stormwater channels (City of Kwinana, 2019)

4.7 Groundwater

Hydrological investigations carried out by Bioscience (2011) to support the application to reclassify the conservation category wetland in the northern portion of Lot 123 indicated that minimum depth to groundwater is 1.5 m; investigations included a drilling program to determine the lithological profile and the depth to groundwater. Bioscience also undertook a review of depth to groundwater data in nearby monitoring bores maintained by the Department of Water indicated an increasing depth to groundwater below the natural surface level over time.

A series of water quality monitoring bores were installed by Bioscience across the site several years ago, with monitoring data collected for a range of parameters between 2010 and 2014, a summary of the results is provided in Table 4. Results indicate that the water is acidic and in the fresh-brackish range. Phosphate levels are variable but within guideline levels on average. Nitrogen levels, particularly nitrate, is more variable with most of the results being within the acceptable range; the exception is associated with one of the monitoring bores for unknown reasons. Iron readings are higher than guideline levels and are probably associated with the acidic nature of the water. Sulphate and chloride are both within the acceptable range.

Table 4: Summary of water quality sampling results

Parameter	Guideline Values[1,2]	Mean	Median	Std Dev	Max	Min	No. Samples
EC (mS/cm)	0.3 - 1.5	0.86	0.81	0.59	3.50	0.21	50
pH	6.5 - 8.5	4.65	4.40	0.67	5.99	3.83	50
Total P (mg/L)	0.2 mg/L	0.05	0.00	0.11	0.56	0.00	45
PO_4-P	0.03 mg/L	0.02	0.00	0.04	0.18	0.00	40
Total N (mg/L)	2.0 mg/L	0.31	0.02	0.26	1.06	0.01	40
NH_4-N (mg/L)	0.04 mg/L	0.33	0.17	0.35	1.34	0.00	40
NO_3-N (mg/L)	0.1 mg/L	0.48	0.02	1.44	7.00	0.00	40
Fe (mg/L)	0.2 mg/L (3)	8.42	2.23	12.01	47.26	0.01	40
SO_4 (mg/L)	5000 mg/L (5)	195.65	140.62	183.99	870.65	12.46	33
Cl (mg/L)	2500 mg/L (5)	98.73	70.73	93.16	380.84	0.00	33

Source: Bioscience, 2019 1: ANZECC guidelines, 2: Department of Health domestic non-potable groundwater use guides

When further subdivision of Lot 123 is planned, the location and maintenance status of the monitoring bores will be reviewed, with any repairs carried out and/or the installation of replacement bores. The water quality monitoring will also be reviewed and discussed with the City of Kwinana and Department of Water and implemented ahead of the development of an updated LWMS or Urban Water Management Plan, as appropriate. The acidic nature of the water mean that it is probably not suitable for use on gardens, lawns and landscaped areas.

4.8 Water Bore

A house was constructed in the southern portion of Lot 123 the 1960's was demolished sometime between 1985 and 1989. A bore was constructed in the vicinity of the house to provide water for the house. The Lot owner is currently investigating the re-instatement of this bore to provide a water source in the event there is a bushfire within the remnant vegetation on site.

5.0 Water Sustainability Initiatives

Water sustainability initiatives include those relating to potable use within the home and those potable and/or non-potable uses external to the home, such as uses for irrigation, gardening, and similar. As the initial subdivision is one Lot into 2, no water sustainability initiatives will apply at present. When further development is progressed at some future point in time, sustainability initiatives will be reviewed and assessed in greater detail. As a minimum, it is expected that they will consider:

- the use of WELS rated fittings and appliances within dwellings
- consideration of the soils and their ability to leach phosphorous when undertaking landscaping of residential Lots
- the development of management plans for areas of public open space that consider site conditions
- if appropriate, the use of sub-surface drip irrigation systems that delivers water to garden beds rather than broader areas.

6.0 Stormwater Management Strategy

At present, there is no stormwater drainage on site, and none will be required in the short term. When further development of the site is planned at some future point in time, detailed investigations will be carried out to inform the design, with the final design being in accordance with City of Kwinana engineering standards, as well as state and national guidelines for engineering design. As a minimum, it is expected that the following will be complied with:

- flood storage to be integrated within POS area(s), sufficient on-site storage to retain and treat runoff from a 1-year ARI, 1-hour duration storm event
- establish minimum habitable floor levels 0.5 m above the 100-year ARI flood levels
- stormwater drainage system shall be designed to collect and absorb or transmit a 1-in-5-year ARI storm
- overland flow paths within road reserves determined to enable the safe movement of 1-in-100-year ARI storm events.

7.0 Groundwater Management Strategy

One of the major aims of local and urban water management is to maintain ground water quality and quantity consistent with pre-development conditions. During the current process of subdividing Lot 123 into two Lots, there will be no impacts to groundwater. When development is planned in future, various investigations, monitoring and modelling will be undertaken to ensure groundwater values are maintained in the longer term.

8.0 Probable Future Investigations

Given that planning associated with Lot 123 is at a very early stage, with this LWMS supporting the subdivision of the site into two Lots, it is expected that further investigations, monitoring and modelling will be required to support future planning stages. Based on the current state of knowledge, it is probable that the following are likely to be required at some future point in time as a minimum:

- geotechnical investigations of the site
- current depth to groundwater data
- groundwater quality monitoring data of suitable parameters and at a suitable frequency
- site feature survey
- detailed engineering design of stormwater management catchment areas and associated infrastructure
- urban water management plan
- one or more management plans for natural areas.

9.0 Implementation

Implementation of this LWMS will be the responsibility of the developer, with no changes to current activities and/or practices until future planning activities are to be progressed.

10.0 References

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Appendix 1: Bioscience Report, 2006

Appendix 2: Bioscience Report, 2011

Appendix 3: Natural Area 2018 Report