Appendix X Threatened Ecological Communities Management Plan

Public Transport Authority

Malaga to Ellenbrook Rail Works
TEC Management Plan

July 2020

Assessment Number 2238

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Contents

Abbreviations and Definitions **1**

Summary **3**

1. Introduction **4**

1.1. Proposal overview 4

1.2. Purpose of this plan 4

1.3. Scope of this plan 4

2. Context, scope and rationale **7**

2.1. Relevant Environmental Factors 7

2.2. Relevant Environmental Values 7

2.2.1. Summary of Key Environmental Surveys 7

2.2.2. Significant Environmental Values 8

2.3. Key Construction Activities and Impacts 10

2.3.1. Vegetation clearing 10

2.3.2. Temporary Construction Dewatering 10

2.3.3. Construction Water Supply 15

2.3.4. Introduction and spread of weeds and *Phytophthora* dieback 15

2.4. Management approach 20

2.5. Key assumptions and uncertainties 21

3. Provisions – Management and Response Framework **22**

3.1. Management Objective 22

3.2. Management Measures 22

3.3. Environmental Criteria 29

3.3.1. Threshold criterion 29

3.3.2. Trigger criteria 29

3.4. Monitoring 30

3.4.1. Vegetation monitoring 30

3.4.2. Groundwater level monitoring 32

3.4.3. Incursion into TEC areas 32

3.5. Implementation of Trigger Level Actions 33

3.6. Implementation of Threshold Contingency Action 34

4. Reporting **39**

4.1. Reporting on exceedances of trigger or threshold criteria 39

4.1.1. Construction Contractor reporting to PTA 39

4.1.2. PTA reporting to DWER 39

Tables

Table 1: Summary of environmental investigations commissioned by PTA relevant to Banksia Woodlands TEC 7
Table 2: Summary of environmental investigations relevant to Inland Waters 8
Table 3: Predicted drawdown from dewatering the Tonkin Highway dive structure 12
Table 4: Management Measures 23
Table 5: Environmental criteria 29
Table 6: Management and response framework 35
Table 7: Management and response framework reporting 39

Figures

Figure 1: Overview of Proposal 5
Figure 2: Patch 1 Malaga and Patch 5 Gnangara TECs 6
Figure 3: Predicted water table drawdown at the Tonkin Highway dive structure 13
Figure 4: Predicted water table drawdown at Gnangara Road 14
Figure 5: Dieback Occurrence 17
Figure 6: Environmental risk matrix 20

Abbreviations and Definitions

Item	Details
ASS	Acid sulfate soils
AHD	Australian height datum
ASSMP	Acid sulfate soils management plan
BAM Act	*Biosecurity and Agriculture Management Act 2007*
BC Act	*Biodiversity Conservation Act 2016*
bgl	below ground level
CCW	Conservation Category Wetland
CEMP	Construction Environmental Management Plan
DBCA	The Department of Biodiversity, Conservation and Attractions, or the State Government agency responsible for the administration of the *Conservation and Land Management Act 1985*. The former Department of Parks and Wildlife (DPaW).
Development Envelope	The area within which activities associated with the construction and operation of the Proposal can occur
DMP	Dewatering Management Plan
DPIRD	Department of Primary Industries and Regional Development
DWER	The Department of Water and Environmental Regulation. The State Government agency responsible for the administration of the *Environmental Protection Act 1986*.
EAG 17	Environmental Assessment Guideline 17
EP Act	*Environmental Protection Act 1986*
EPA	Environmental Protection Authority. The Authority responsible for assessing the environmental impacts of development proposals.
EPASU	Environmental Protection Authority Services Unit
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
FCT	Floristic Community Type
Footprint	The area within which rail infrastructure will be located and construction activities will occur.
GDE	Groundwater dependent ecosystem
GL	Gigalitre
ha	Hectare
IBSA	Index of Biodiversity Surveys for Assessments
kL/d	kilolitre per day
km	Kilometre
m	metre(s)

Item	Details
m AHD	metres above Australian height datum
m bgl	metres below ground level
MEL	Morley Ellenbrook Line
NVRA	Native Vegetation Retention Area
PATN	Program which undertakes pattern analysis
PDWSA	Public drinking water source area
PEC	Priority ecological community
PER	Public Environmental Review
Proposal	The Malaga to Ellenbrook Rail Works Proposal, the subject of this Threatened Ecological Community Management Plan.
PTA	Public Transport Authority of Western Australia
Q1, Q2, Q3, Q4	Quarter one, quarter two, quarter three, quarter four
REW	Resource Enhancement Wetland
RIWI Act	*Rights in Water and Irrigation Act 1914*
SCP	Swan Coastal Plain
TEC	Threatened Ecological Community
TECMP	Threatened Ecological Community Management Plan
TSSC	Threatened Species Scientific Committee
UFI	Unique Feature Identifier
WA	Western Australia
WAPC	The Western Australian Planning Commission; or statutory authority of the Government of Western Australia with functions and authority to undertake and regulate land use planning and development established under the *Planning and Development Act 2005.*
WONS	Weeds of National Significance

Summary

Item	Detail
Title of Proposal	METRONET Malaga to Ellenbrook Rail Works.
Short Description	The Proposal is to construct and operate a 13 km new dual railway track, which connects to the Bayswater to Malaga Rail Works. The Proposal includes the construction and operation of three new stations at Malaga, Whiteman Park and Ellenbrook, with provision for a future Bennett Springs East Station.
Proponent	Public Transport Authority of Western Australia.
Ministerial Statement No.	Proposal is under assessment.
Purpose of this Plan	To ensure that the construction of the Proposal is undertaken in a manner that meets the EPA Objective relating to Flora and Vegetation by avoiding direct or indirect impacts to Patch 1 Malaga and Patch 5 Gnangara TEC.
Threshold criteria	A measurable decline in the condition or extent of Patch 1 Malaga or Patch 5 Gnangara TEC, which occurs outside of the Proposal's Footprint as a result of construction of the Proposal.
Triggers	Trigger 1: Incursions into Patch 1 Malaga or Patch 5 Gnangara TEC beyond the Proposal's Footprint. Trigger 2: Regional groundwater levels are reduced below the lowest recorded summer groundwater level within or adjacent to the areas of Patch 1 Malaga or Patch 5 Gnangara TEC beyond the Proposal's Footprint as a result of dewatering during construction of the Proposal.

Signature of duly authorised proponent representative (i.e. PTA's Representative):

1.Introduction

1.1. Proposal overview

The Public Transport Authority of Western Australia (PTA) is proposing to develop the Malaga to Ellenbrook Rail Works (the Proposal) in the north-eastern suburbs of Perth as part of the new Morley-Ellenbrook Rail line. The Proposal is one of several METRONET projects, which aim to improve and integrate the public transport network and align with the State Government's vision for future land use planning in Western Australia. The rail line will be constructed from the new Malaga train station and terminate at the new Ellenbrook train station.

The Proposal is to construct and operate a 13 kilometre (km) new dual railway track, which spurs off the proposed Bayswater to Malaga Rail Works line, and includes the construction and operation of three new stations at Malaga, Whiteman Park and Ellenbrook with intermodal rail, bus, carpark, and active mode (cycling and walking) facilities at each station. A potential future station is also proposed at Bennett Springs. An overview of the Proposal is given in Figure 1.

Two Banksia Woodlands of the Swan Coastal Plain Threatened Ecological Community (TEC) patches have been mapped within and adjacent to the Development Envelope (RPS 2020). This includes Patch 1 which is located at the proposed Malaga Station (Patch 1 Malaga TEC) and Patch 5 which is located in the vicinity of Gnangara Road (Patch 5 Gnangara TEC) (Figure 2). These two TECs have the potential to be impacted by construction activities if these activities are not appropriately managed.

1.2. Purpose of this plan

The objective of this TEC Management Plan (TECMP) is to outline the proposed approach for management and mitigation of potential direct and indirect impacts on the Patch 1 Malaga and Patch 5 Gnangara TECs during construction of the Proposal.

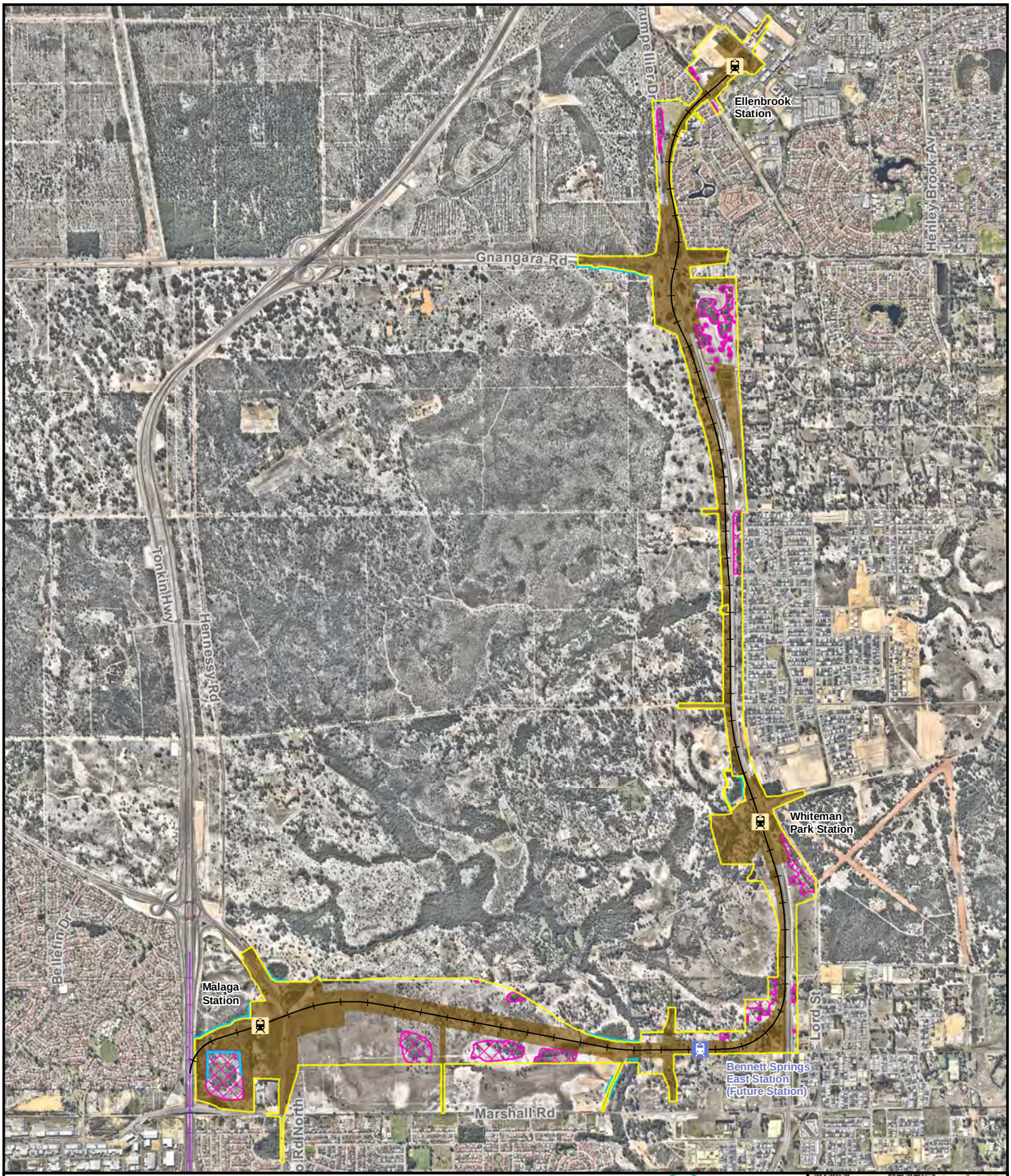
This plan has been developed with consideration of the Environmental Protection Authority (EPA) Instructions on how to prepare *Environmental Protection Act 1986* Part IV Environmental Management Plans (EPA 2020).

1.3. Scope of this plan

This TECMP has been prepared by PTA to specifically address the Proposal's construction phase activities having the potential to impact the Patch 1 Malaga and Patch 5 Gnangara TECs. Such activities and impacts comprise:

- Direct impacts due to clearing of vegetation outside approved areas.
- Indirect impacts from clearing and construction activities including movement of personnel and machinery spreading weeds and *Phytophthora* dieback, dust deposition and drainage.
- Indirect impacts from temporary dewatering during the construction of the Tonkin Highway dive structure and Gnangara Road grade separation.

The management of construction phase Proposal activities and associated direct and indirect impacts to areas of flora, vegetation and wetlands other than Patch 1 Malaga and Patch 5 Gnangara TECs is addressed in the CEMP.



METRONET | Malaga to Ellenbrook Rail Works

Figure 1 **The Proposal**

Public Transport Authority

Legend

- Development Envelope
- Indicative Footprint
- Native Vegetation Retention Area
- Potential indirect impacts outside Footprint
- Proposed Railway Station
- Proposed Railway Station (Future)
- Indicative Railway Alignment

Date Printed: 20/07/2020
Created By: D.Whiteley
Approved by: C.Baxter

Scale: 1:40,000 @ A4
Coordinate System: GDA 1994 MGA Zone 50

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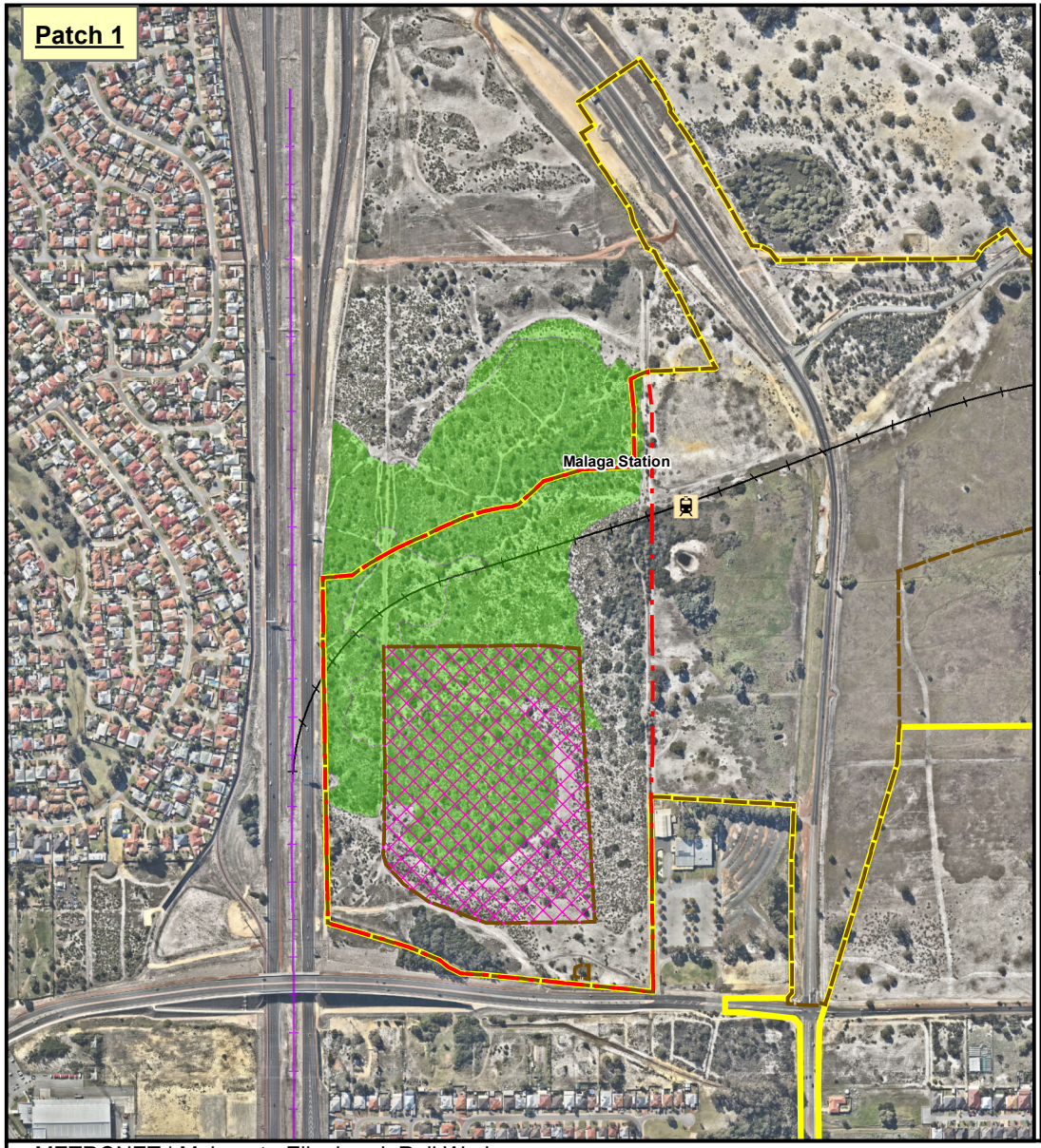
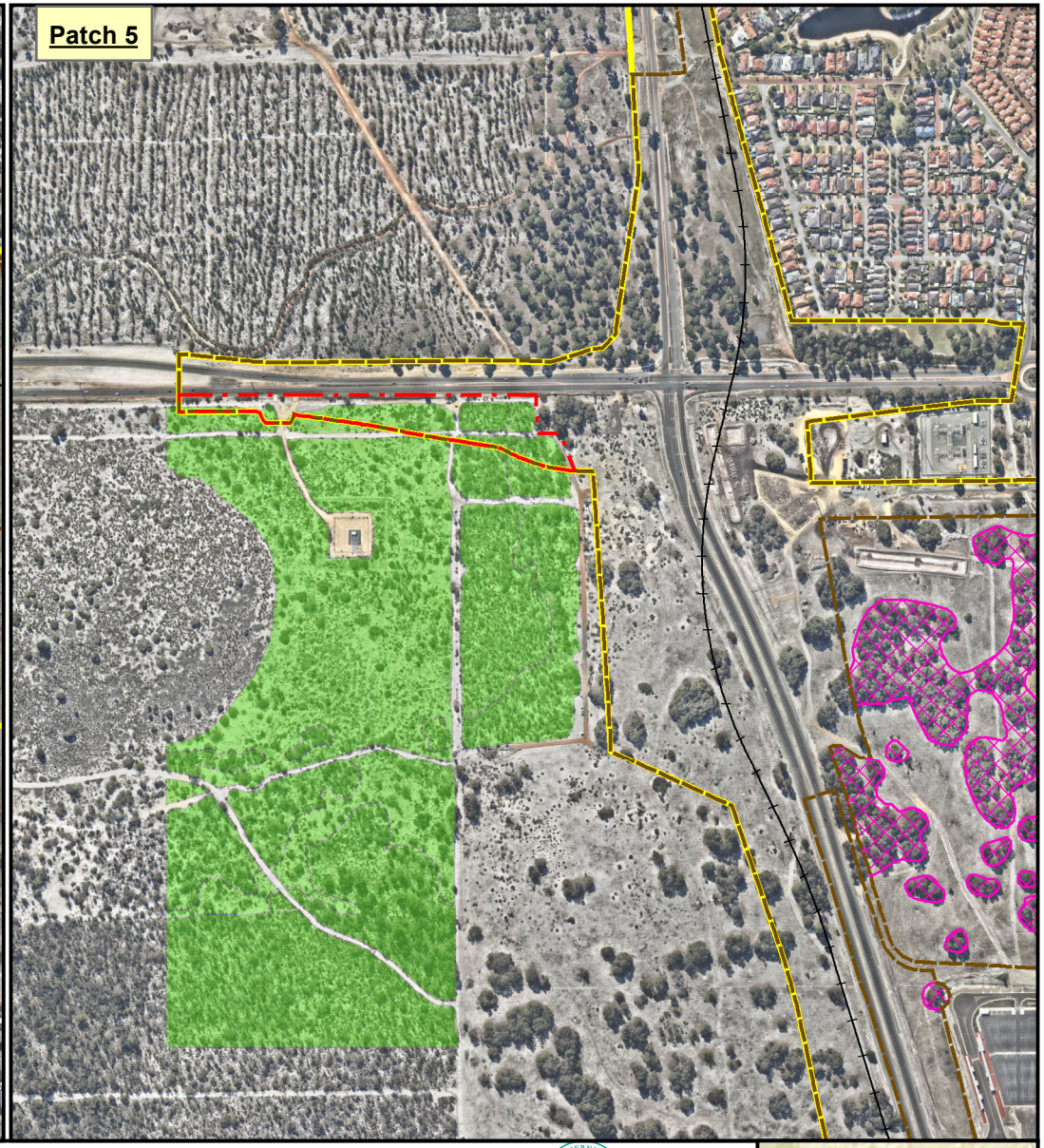
Base Data: Nearmap 2019, Landgate 2019, Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community





METRONET | Malaga to Ellenbrook Rail Works

Figure 2 **Threatened Ecological Community Management Plan**

Legend

- Development Envelope
- Indicative Footprint
- Native Vegetation Retention Area
- Proposed Railway Station
- Indicative Railway Alignment
- TEC/PEC Banksia Woodlands of the Swan Coastal Plain Ecological Community

Management Plan

- TECMP

Public Transport Authority

Date Printed: 20/07/2020
Created By: R.McGregor
Approved by: M.Erskine

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2. Context, scope and rationale

2.1. Relevant Environmental Factors

The ERD identifies five preliminary key environmental factors that are relevant to the construction phase of the Proposal, as follows:

- Flora and Vegetation.
- Terrestrial Fauna.
- Terrestrial Environmental Quality.
- Inland Waters.
- Social Surroundings.

The ERD also identifies Matters of National Environmental Significance (MNES) relating to Commonwealth listed species and TECs.

This TECMP addresses the Flora and Vegetation key environmental factor and MNES relating to potential impacts of the Proposal's construction phase activities (as outlined in Section 1.3) on the Banksia Woodlands TECs.

2.2. Relevant Environmental Values

2.2.1. Summary of Key Environmental Surveys

Flora and vegetation surveys and groundwater investigations have been undertaken within or adjacent to the Proposal Development Envelope. Key studies that have been used to inform this TECMP are summarised in Table 1 and Table 2.

Table 1: Summary of environmental investigations commissioned by PTA relevant to Banksia Woodlands TEC

Investigation	Details of investigation
Consolidated detailed flora and vegetation assessment: Morley-Ellenbrook Line	**Scope:** Detailed flora and vegetation survey of Development Envelope with a buffer to provide local context. Total survey extent was 1,358.61 ha, within which 32 quadrats and 16 relevés have been sampled, including 19 that have been scored twice. This report presents a consolidation of survey effort for the Project and includes targeted Priority flora surveys. An IBSA data package was produced as part of this works. Assessments and surveys were undertaken in accordance with the EPA (2016) Flora Survey Technical Guide. **Consultant**: RPS **Survey date/s**: Spring 2017, Spring 2018, Autumn 2019 and Spring 2019. Total 38 personnel days. **Report date:** April 2020 **Commissioned by:** PTA
Targeted Banksia Woodlands TEC Assessment at Malaga Station	**Scope:** Verification of Patch 1 Banksia Woodlands TEC identified in RPS (2020). Included field verification, mapping and statistical analysis of quadrat data to justify changes proposed to the Patch mapping. **Consultant:** Woodman Environmental **Survey date/s**: 11 May 2020 **Report date:** May 2020 **Commissioned by:** PTA

Investigation	Details of investigation
Targeted Banksia Woodlands TEC Assessment for Patch 5	**Scope:** Verification of Patch 5 Banksia Woodlands TEC identified in RPS (2020) and AECOM (2019) projects. Included field verification, mapping and statistical analysis of quadrat data to justify changes proposed to the Patch 5 boundary. **Consultant:** Woodman Environmental **Survey date/s:** 6 July 2020 **Report date:** 10 July 2020 **Commissioned by:** PTA
Phytophthora Dieback occurrence assessment – Version 1.1	**Scope:** Phytophthora Dieback detection, diagnosis and mapping of the Development Envelope in accordance with standards and procedures defined in FEM047 Chapter 6 (DPAW 2015). **Consultant:** Glevan Consulting (Glevan) **Survey date/s:** 5 and 6 May 2020 **Report date:** June 2020 **Commissioned by:** PTA

Table 2: Summary of environmental investigations relevant to Inland Waters

Investigation	Details of investigation
METRONET - Morley to Ellenbrook Line (MEL) - Strategic Level Hydrogeological Assessment	**Scope:** Assessment of potential environmental impact risks from temporary groundwater abstraction (water supply and dewatering) during construction. The report provides a preliminary assessment based on currently available information to allow regulators to gain a timely understanding of the hydrogeological conditions and potential issues along the proposed alignment so appropriate management and contingency measures can be implemented if required. **Consultant:** Golder **Survey date/s:** Not Applicable **Report date:** 29 April 2020 **Commissioned by:** PTA
Golder Preliminary Dewatering Assessment	**Scope:** Assessment of the vertical and lateral extend of groundwater level drawdown during construction of the Tonkin Highway Dive structure, Bennett Brook bridge and Gnangara Road grade separation. **Consultant:** Golder **Survey date/s:** Not Applicable **Report date:** 5 June 2020 **Commissioned by:** PTA

2.2.2. Significant Environmental Values

An ecological community is a naturally occurring group of plants, animals and other organisms interacting in a unique habitat. The complex range of interactions between the component species provides an important level of biological diversity in addition to genetics and species (DBCA 2018a). Threatened Ecological Communities (TECs) are formally protected under the Western Australian *Biodiversity Conservation Act 2016* (BC Act) and/or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

A Banksia Woodlands TEC is described as an ecological community woodland associated with the Swan Coastal Plain. It is characterised by a prominent Banksia tree layer with scattered Eucalypts and other tree species present within or above the Banksia canopy. Species richness is high within this ecological community and is characterised by high endemism and considerable localised variation in species composition across its range (TSSC 2016).

The reliance on groundwater is location and species-specific, however studies have shown that *Banksia attenuata* have deep roots that penetrate down to the moist soil just above the groundwater level. Research conducted on Banksia species on the Gnangara Mound groundwater system north of Perth and elsewhere in the South-west of Western Australia (Froend and Loomes 2004; 2006) proposed three main categories of phreatophytic (groundwater dependent) vegetation: 0–3 m, 3–6 m and 6–10 m depth to groundwater, all of which are assumed to utilise groundwater to some extent. This suggests that where groundwater is less than 10 m below the surface within a confirmed Banksia Woodland TEC, it is likely to be a terrestrial groundwater dependent ecosystem (GDE).

GDEs are natural areas that rely on access to groundwater for some portion of time to maintain their flora and fauna community composition, ecological processes and ecosystem services. Groundwater dependent terrestrial vegetation is composed of phreatophytic species, i.e. those that use groundwater to meet some or all their water requirements (Land and Water Australia 2007a). For these species, groundwater is usually relied upon during seasonal or episodically dry periods.

Impacts from an increase in temporary groundwater abstraction, patterns in water regulation, and decreased rainfall and subsequent recharge to the groundwater system are identified as a significant threat to the Banksia Woodlands TEC (TSSC 2016). The level of risk to Banksia Woodlands depends on the floristic community type present and its corresponding dependence on groundwater resources in the region (TSSC 2016).

Whilst some research exists on response of vegetation to drawdown on the Swan Coastal Plain, this research is generally based on response to prolonged or permanent water table decline rather than short term drawdown from temporary dewatering and water supply abstraction. Professor Ray Froend identifies a maximum rate of drawdown of 0.1 m per year to avoid mortality of individual plants (no measurable change) (Froend and Loomes 2005). However, vegetation response to drawdown is influenced by a variety of factors including historical groundwater fluctuations, site specific conditions, species present and other influences such as disturbance (Froend and Loomes 2005).

Two Banksia Woodlands of the Swan Coastal Plain Threatened Ecological Community (TEC) patches have been mapped within and adjacent to the Development Envelope (RPS 2020). This includes Patch 1 Malaga TEC and Patch 5 Gnangara TEC (Figure 2). Four other Banksia Woodlands TEC patches were identified by RPS (2020). These are more than 200 m from the Development Envelope and as such will not be impacted by the Proposal. Analysis and verification of Patch 1 Malaga (Woodman 2020a) and Patch 5 Gnangara Rd (Woodman 2020b) has been completed to clarify their extent and condition.

Patch 1 Malaga TEC is located at the proposed Malaga Station, between Tonkin Highway (west), Marshall Road (south) and paddocks (east and north). It is partially fragmented from adjacent vegetation by road infrastructure (Beechboro Rd North and Tonkin Hwy) and paddocks. The patch is 23.23 ha and includes vegetation that ranges from Good to Excellent condition, with the majority in Very Good condition. Of the total extent, 15.49 ha is within the Development Envelope, of which 8.54 ha is within the Proposal's Footprint. The area of this TEC within the Development Envelope and outside of the Proposal's Footprint is designated as a Native Vegetation Retention Area (NVRA) for the purposes of the Proposal. The total extent of the designated NVRA within this TEC is 6.95 ha. The purpose of these NVRAs is to retain patches of native vegetation within the Development Envelope. This TEC Patch also extends beyond the Development Envelope. For the purpose of this plan, Patch 1 Malaga TEC is considered to be a GDE.

Patch 5 Gnangara TEC is located in the northeast corner of Whiteman Park, bounded by Gnangara Road (north), Whiteman Park (south and west) and Drumpellier Drive (east). This patch extends south beyond the Development Envelope. The extent of the patch mapped in flora and vegetation surveys is 36.75 ha and is in Very Good condition. Of this, 1.51 ha occurs within the Proposal's Footprint. For the purpose of this plan, Patch 5 Gnangara TEC is considered to be a GDE.

2.3. Key Construction Activities and Impacts

2.3.1. Vegetation clearing

Despite the implementation of avoidance and minimisation measures the Proposal will result in the permanent loss of 10.05 ha of Banksia Woodlands of the Swan Coastal Plain TEC, comprising:

- 8.54 ha from Patch 1 Malaga TEC.
- 1.51 ha from Patch 5 Gnangara TEC.

The loss of 10.05 ha of Banksia Woodlands TEC and fragmentation of Patch 1 Malaga into two patches is considered a significant residual impact which will be counterbalanced by measures contained in an Offsets Strategy.

This TECMP provides management measures to ensure that the Proposal does not result in unauthorised clearing of the Patch 1 Malaga or Patch 5 Gnangara TECs which occur outside of the Proposal's Footprint during construction of the Proposal.

2.3.2. Temporary Construction Dewatering

Construction dewatering will temporarily lower the water table to support proposed construction activities that unavoidably extend below the groundwater table. Temporary dewatering will be required in the vicinity of Patch 1 Malaga TEC to provide a dry and safe working environment during construction of the dive structure which passes beneath the south-bound carriageway of Tonkin Highway. Temporary dewatering will also be required in the vicinity of Patch 5 Gnangara TEC to grade separate Gnangara Road and the MEL railway.

Dewatering activities are expected to vary in scale (pumping rate, depth and extent) and duration, consequently potential dewatering impacts and environmental risks may also vary. The dewatering rates, volumes of groundwater which will be abstracted and the vertical and lateral extent of water table lowering (drawdown) is dependent on a number of factors including the design of the structures, the construction methodology, the depth of the water table and the sub-surface soil conditions.

The largest temporary dewatering activity for the Proposal is for construction of the dive structure to allow the railway to pass eastwards from the middle of Tonkin highway to the proposed Malaga Station. Final designs are yet to be completed for the Proposal, however typical dive structures, such as the one proposed at Tonkin Highway, are constructed by means of diaphragm walls, buttress top beams and reinforced concrete bottom slabs. A key objective in dive construction design is to minimise the impact on groundwater levels during dewatering activities.

The dewatering durations have not yet been finalised, however, based on other similar projects, dewatering at the Tonkin Highway dive structure is anticipated to be required for up to 12 months and for one month at Gnangara Road.

To minimise the vertical and lateral extent of drawdown and to avoid discharge of groundwater abstracted from dewatering activities to drains and surface water features, dewatering effluent will be reinjected back to the water table. This will be achieved using recharge bores and/or infiltration trenches. This technique will be adopted to limit the effect of groundwater drawdown during dewatering to inside the walls of the dive structure as far as is practicable.

An analysis of the potential drawdown from dewatering of the Tonkin Highway dive structure and Gnangara Road grade separation was undertaken by Golder (2020b). These analyses considered two scenarios (models):

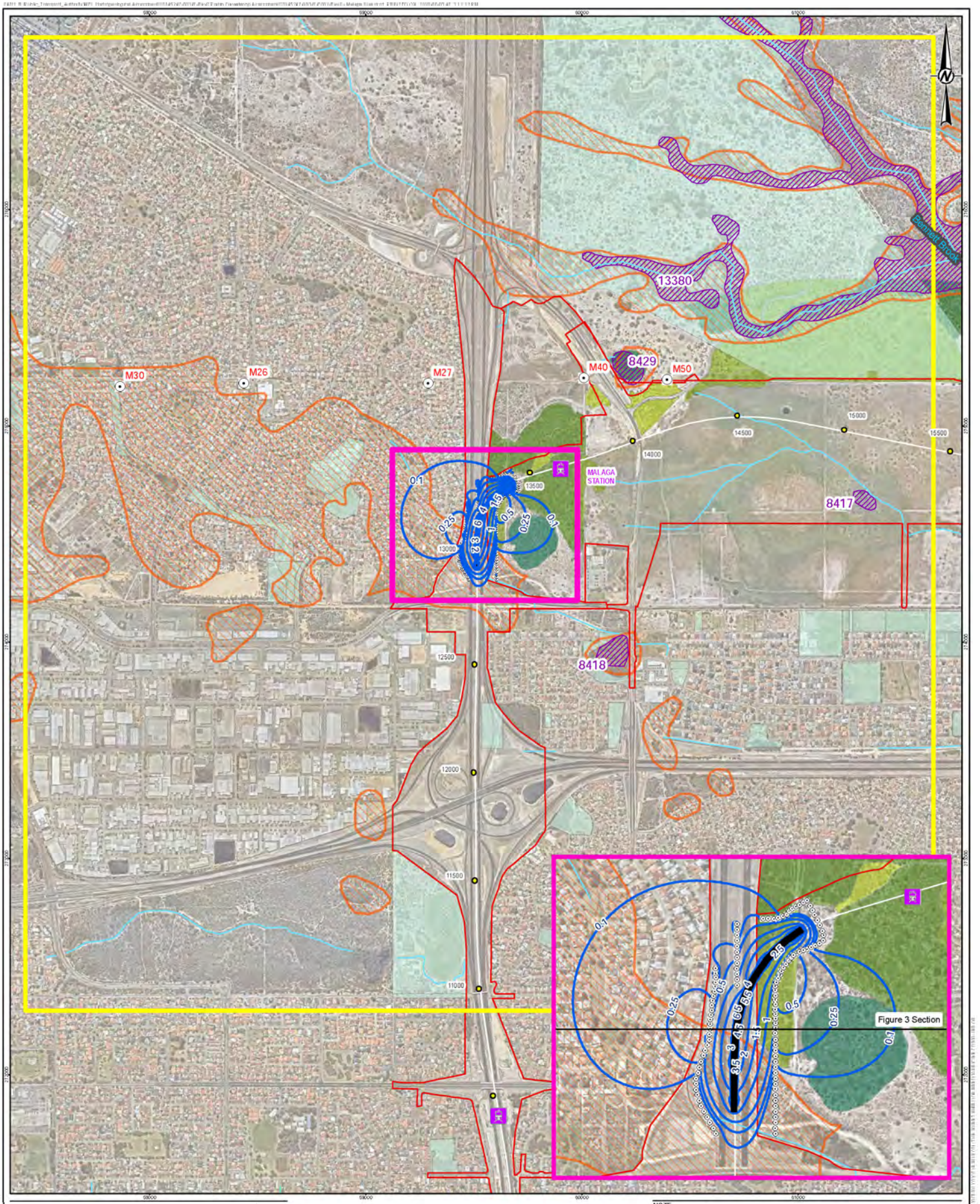
- Dewatering without any return of the abstracted groundwater i.e. a do-nothing scenario.
- Reinjection of abstracted groundwater back to the water table.

The results of the model 2 (reinjection) simulations for the Tonkin Highway dive structure are shown on Figure 3, while the results from Gnangara Road are shown on Figure 4

Potential drawdown depths and extents resulting from the modelling are summarised in Table 3.

Table 3: Predicted drawdown from dewatering the Tonkin Highway dive structure

Scenario	Result
Tonkin Highway dive structure	
1	If the abstracted groundwater is not reinjected back into the water table, drawdown is predicted to extend radially outwards by over 1.5km including lowering of the water table below parts of the Patch 1 Malaga TEC by up to 3m.
2	If the abstracted groundwater is reinjected back into the water table, the lateral extent of drawdown is significantly reduced. Lowering of the water table below parts of the Patch 1 Malaga TEC is reduced to less than 0.25m.
Gnangara Road	
1	If the abstracted groundwater is not reinjected back into the water table, drawdown is predicted to extend radially outwards by up to 300m including lowering of the water table below parts of the Patch 5 Gnangara TEC by up to 0.25m.
2	If the abstracted groundwater is reinjected back into the water table, the lateral extent of drawdown is significantly reduced. In this scenario, there will be no lowering of the water table below the Patch 5 Gnangara TEC.



LEGEND

- Groundwater Model Boundaries
- Modelled Recharge Wells
- Dive Structure
- Modelled Groundwater Level Drawdown (m)
- Project Envelopes
- Surface Water
- Ecological Significant Wetlands*
- Operational Water Corporation Bore
- High Risk ASS
- Lots with 5C License

Banksia Woodland Conditions

- Good
- Good - Degraded
- Very Good
- Excellent
- Very Good - Good

0 500 1,000

1:16,000 METRES

CLIENT
PUBLIC TRANSPORT AUTHORITY

CONSULTANT
GOLDER

YYYY-MM-DD	2020-06-05
DESIGNED	HT
PREPARED	AL
REVIEWED	KM
APPROVED	KM

NOTE:
1. COORDINATE SYSTEM: PERTH COASTAL GRID (PCG94)

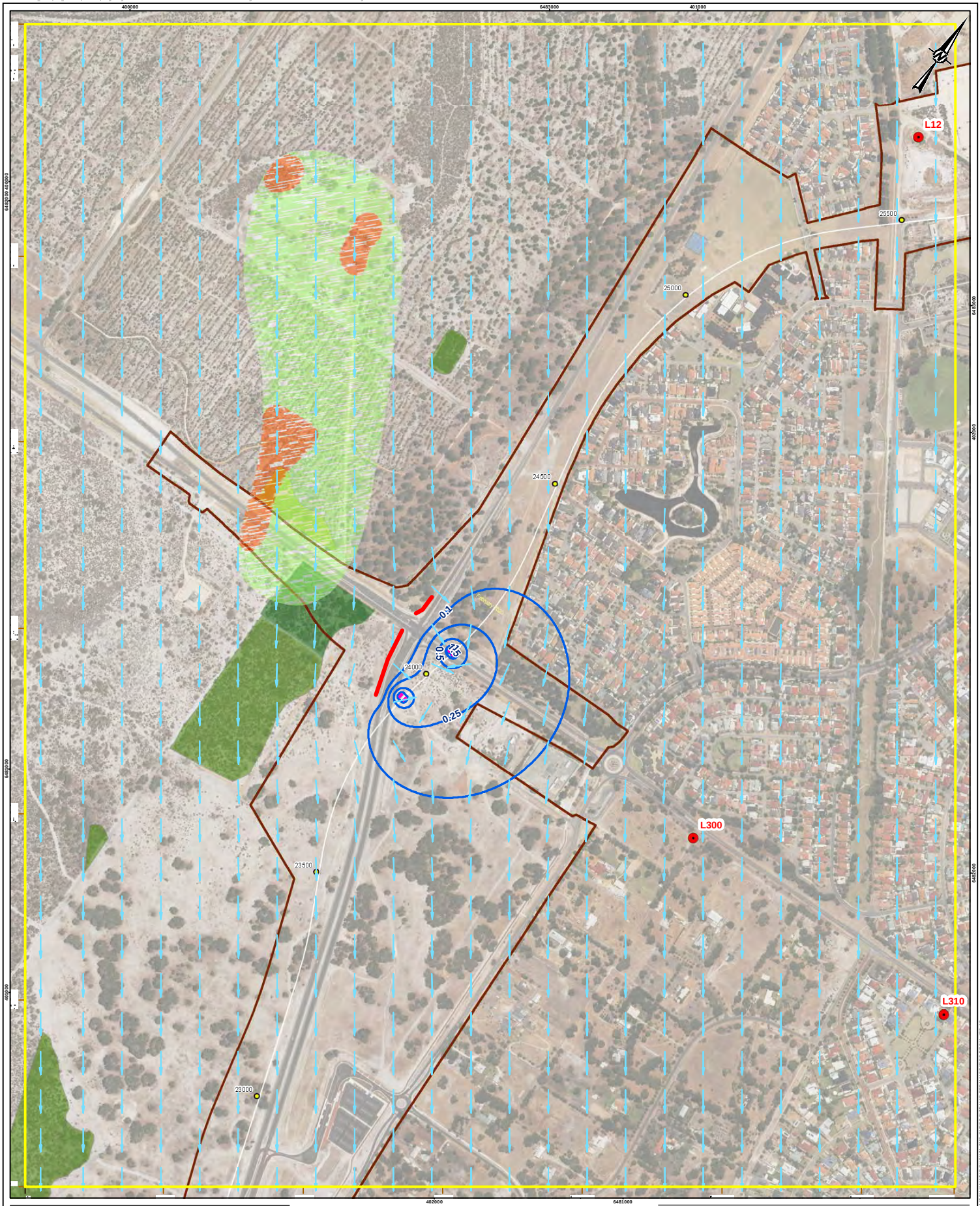
REFERENCES:
INSET BASE DATA SOURCED FROM STREET PRO DATA 2009.
AERIAL IMAGE SOURCED FROM NEARMAP (DECEMBER 2019)
*ECOLOGICAL SIGNIFICANT WETLANDS FROM ECO LOGICAL 2020

PROJECT
MORLEY ELLENBROOK LINE
MALAGA TO ELLENBROOK RAIL WORKS

TITLE
MALAGA DIVE STRUCTURE -
MODEL 2 - GROUNDWATER LEVEL DRAWDOWN
AFTER 1 YEAR

PROJECT NO	CONTROL	REV
20145247	003	0

FIGURE 3



LEGEND

- Project Envelope
- Groundwater Model Boundary

Lexia Facility Groundwater Plume

- Nutrient Plume
- Organic Contaminant Plume
- Surface Water
- Operational Water Corporation Bore
- Footings
- Modelled Infiltration Trench
- Modelled Groundwater Level Drawdown (m)

Banksia Woodland Conditions

- Good
- Good - Degraded
- Very Good
- Excellent
- Very Good - Good

Groundwater Flow Direction

0 250 500

METRES

NOTE:

REFERENCES:

CLIENT
PUBLIC TRANSPORT AUTHORITY

CONSULTANT
GOLDER

YYYY-MM-DD	2020-06-[illegible]
DESIGNED	AL
PREPARED	AL
REVIEWED	KM
APPROVED	KM

PROJECT
MORLEY ELLENBROOK LINE
MALAGA TO ELLENBROOK RAIL WORKS

TITLE
GNANGARA/DRUMPELLIER CROSSING - MODEL 2 - GROUNDWATER LEVEL DRAWDOWN AFTER 1 MONTH

PROJECT NO.	CONTROL	REV.
20145247	003	a

Figure 4

The results show that dewatering-related drawdown impacts can be successfully minimised. This will require careful planning to ensure abstracted groundwater is returned to the water table using reinjection bores and/or infiltration trenches to minimise drawdown effects. It will also require frequent monitoring to identify whether the reinjection borefield needs to be modified. Once dewatering ceases, it is expected the water table will fully recover within one wet season of recharge.

This TECMP provides management measures to ensure that the proposed dewatering activities do not result in measurable decline in the condition or extent of Patch 1 Malaga or Patch 5 Gnangara TEC.

The PTA is confident that dewatering can be successfully managed to meet the EPA Objective relating to Flora and Vegetation by avoiding indirect impacts to Patch 1 Malaga and Patch 5 Gnangara TECs from temporary construction dewatering.

2.3.3. Construction Water Supply

Groundwater abstraction for construction water supply will be required for moisture conditioning during placement and compaction of fill, foundation preparation, sub-ballast capping and dust suppression. It is expected the water supply will be required during the construction period for about 4-years but would vary depending on the construction activities and season.

It is expected that the water supply bores will be located within the Development Envelope and are likely to be located close to major structures such as bridges and stations, laydown areas and stockpiles where the water will be required for construction activities. Groundwater supply bores are likely to be distributed along the alignment to minimise water transport requirements. All groundwater abstraction will be subject to approvals under the *Rights in Water and Irrigation Act 1914* (RIWI Act).

To understand the site-specific potential drawdown impact of proposed abstraction wells, an assessment of groundwater level drawdown (radius of influence) was completed by Golder (2020a). Based on the anticipated pumping rate of 3 L/sec for a period of up to 18 months, the average extent of 0.3 m drawdown is within 50 m from the pumping well. Golder's analysis considered the results to be conservative because bores typically only operate for 18 hours per day and their use is controlled by automatic on/off switches within the storage tank or basin. The water table is expected to recover shortly after abstraction ceases and/or after one winter season of recharge.

This TECMP provides management measures to ensure that construction water supply activities do not result in measurable decline in the condition or extent of Patch 1 Malaga or Patch 5 Gnangara TEC.

Potential drawdown-related impacts from construction water supply abstraction can be successfully managed to meet the EPA Objective relating to Flora and Vegetation by locating and operating bores 50 m from the Patch 1 Malaga and Patch 5 Gnangara TECs.

2.3.4. Introduction and spread of weeds and *Phytophthora* dieback

Construction and landscaping activities including movement of personnel, vehicles, plant and machinery have the potential to introduce or spread weeds and *Phytophthora* dieback into the Patch 1 Malaga and Patch 5 Gnangara TECs if these activities are not managed appropriately during construction. Dieback can also be introduced via imported fill material extracted from a dieback infested area.

***Phytophthora* Dieback**

A *Phytophthora* Dieback Assessment undertaken by Glevan Consulting (Glevan 2020) identified three areas in the Development Envelope as uninfested - protectable (dieback free), as shown in Figure 5. This includes two areas within Patch 1 Malaga TEC, each characterised by a sandy rise supporting vegetation in Very Good or Excellent condition. The third area is Patch 5 Gnangara TEC which is mapped as uninfested – protectable in its entirety within the Development Envelope. The remainder of the Development Envelope is mapped as infested or uninterpretable/ unprotectable.

Weeds

A total of 84 weed species were recorded in the wider survey area, representing 22.5% of the total flora taxa recorded.

Two Declared Pest species listed under Section 22(2) of the *Biosecurity and Agriculture Management Act 2007* (BAM Act) were recorded: *Zantedeschia aethiopica* (Arum Lily); and *Moraea flaccida* (Cape Tulip). None of the weeds recorded were listed as Weeds of National Significance (WONS). Both species are in the C3 category, which is described as “Organisms that should have some form of management applied that will alleviate the harmful impact of the organism, reduce the numbers or distribution of the organism or prevent or contain the spread of the organism”.

**Zantedeschia aethiopica* (Arum Lily) is a tall fleshy herb with big, dark green, arrowhead-shaped leaves and large white funnel-shaped 'arum-type' flower structures with a central yellow spike. It is a common ornamental garden plant that has escaped from cultivation. Arum lily has become a widespread weed, invading mainly damp habitats in pastures, wetlands and forest. All parts of the plant are toxic to humans, stock and pets (DPIRD 2019). The species was recorded along the banks of Bennett Brook and within REW UFI 8678. This species prefers moist and winter-wet areas associated with wetlands. It is unlikely that this species would spread into Patch 1 Malaga or Patch 5 Gnangara TEC during construction of the Proposal.

**Moraea flaccida* (Cape Tulip) is a perennial weed introduced from South Africa. This species is a garden escapee which has now become a significant weed throughout southern Australia. Cape tulip is difficult to control chemically due to the dormancy of corms below the ground. It is highly toxic to stock and may invade pastures (DPIRD 2019). Cape tulip was widespread and recorded at low densities opportunistically throughout much of the Degraded and Completely Degraded previously cleared low-lying (palusplain) portions of the survey area, including in the Whiteman Park paddocks close to the TECs. There is the potential for machinery and personnel movement within the Development Envelope to result in the spread of **Moraea flaccida,* however given this species prefers low-lying areas it is unlikely that this species would spread into Patch 1 Malaga or Patch 5 Gnangara TEC during construction of the Proposal.

This TECMP provides management measures to prevent the spread of weeds and *Phytophthora* dieback into Patch 1 Malaga and Patch 5 Gnangara TECs during construction. The PTA is confident that construction activities can be successfully managed to meet the EPA Objective relating to Flora and Vegetation by avoiding indirect impacts to Patch 1 Malaga and Patch 5 Gnangara TECs from the spread of weeds and *Phytophthora* dieback.

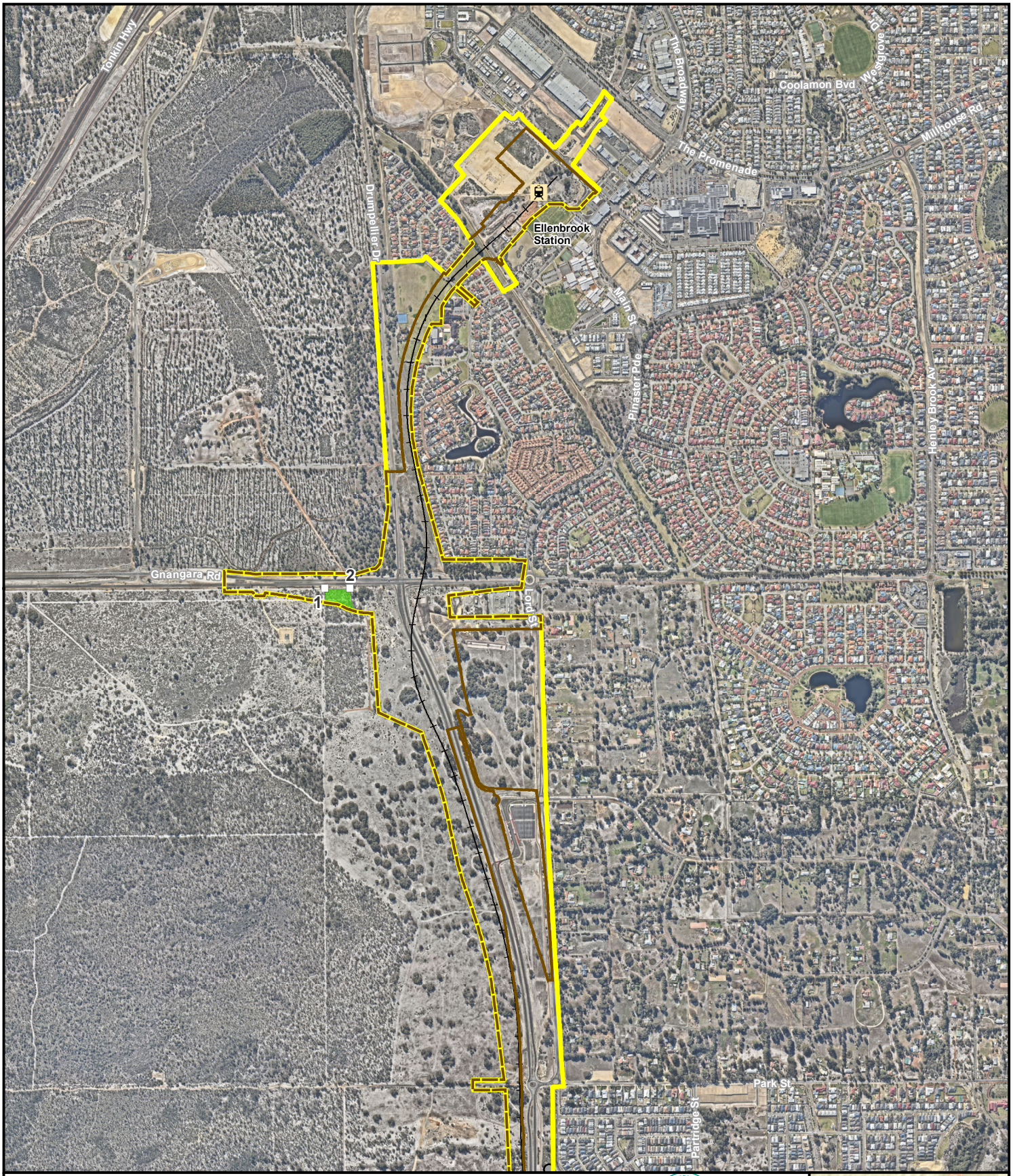


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Figure 5A **Dieback Occurrence**

Public Transport Authority

Legend

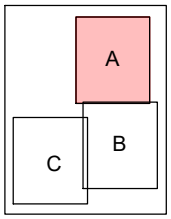
- Development Envelope
- Indicative Footprint
- Proposed Railway Station
- Indicative Railway Alignment

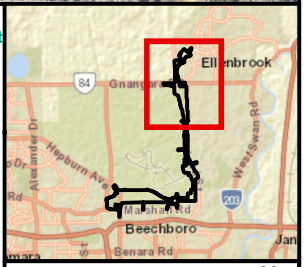
Occurance

- Uninfested
- COE Points

Sample Sites

- Negative





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Approved by: C.Baxter

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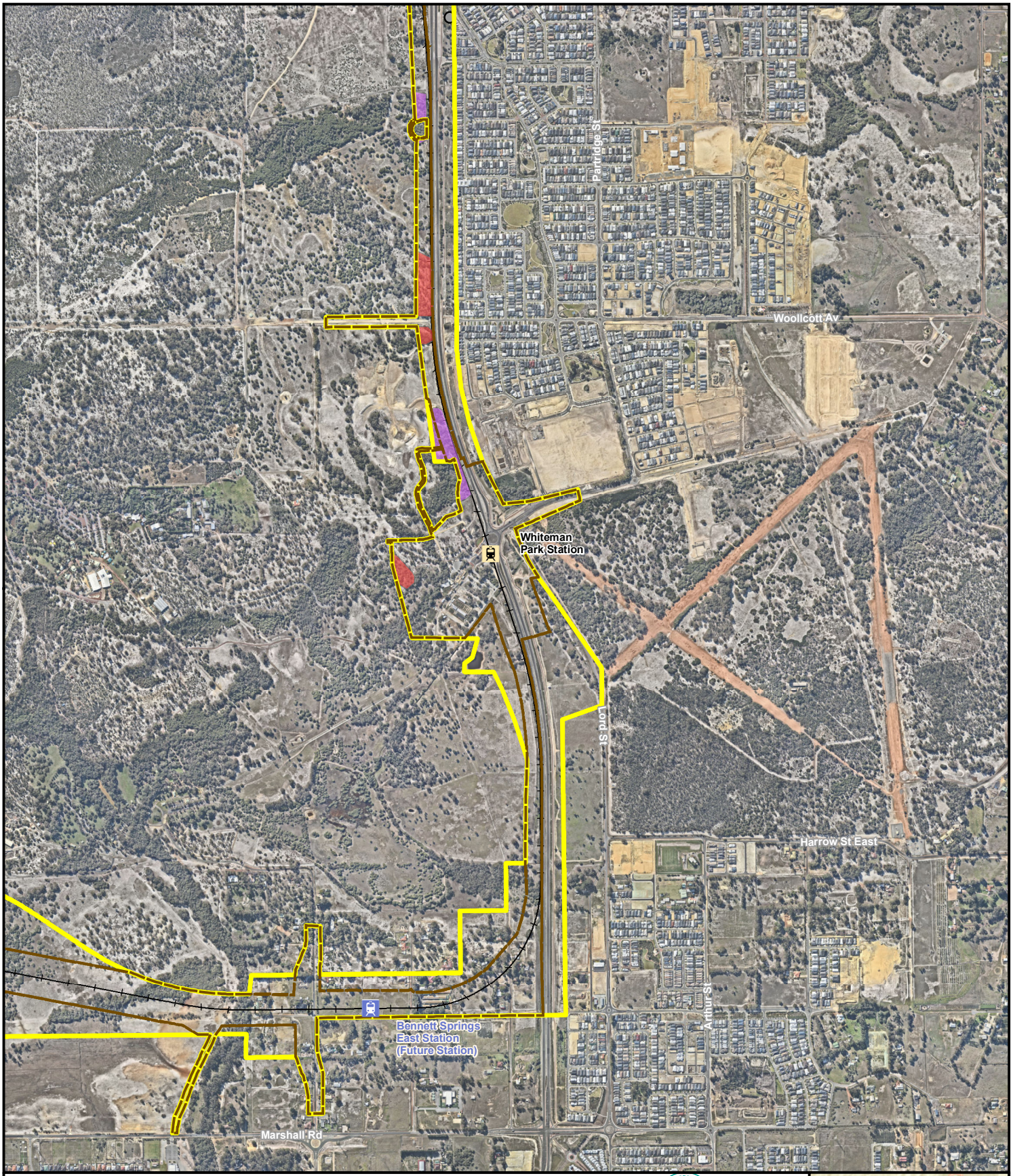


METRONET | Malaga to Ellenbrook Rail Works
Figure 5B **Dieback Occurrence**

Public Transport Authority

Legend

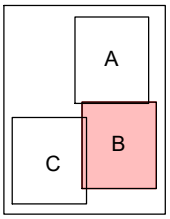
- Development Envelope
- Indicative Footprint
- Proposed Railway Station
- Proposed Railway Station (Future)
- Indicative Railway Alignment

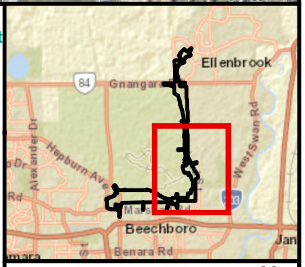
Occurance

- Infested
- Uninterpretable

Sample Sites

- Negative





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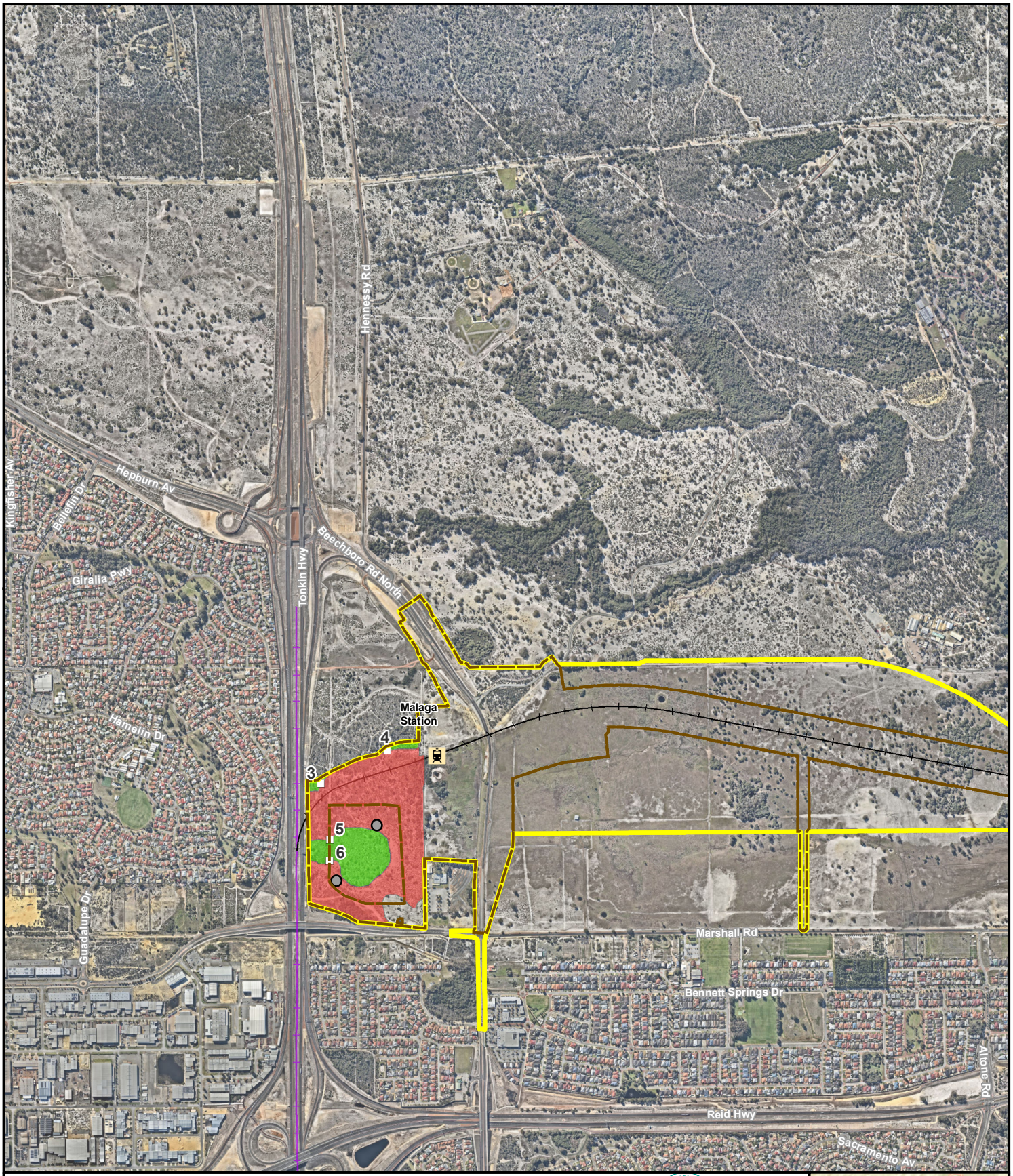


METRONET | Malaga to Ellenbrook Rail Works

Figure 5C **Dieback Occurrence**

Public Transport Authority

Legend

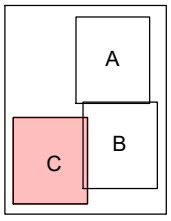
- Development Envelope
- Indicative Footprint
- Proposed Railway Station
- Indicative Railway

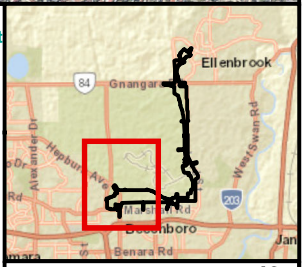
Occurance

- Infested
- Uninfested
- COE Points

Sample Sites

- Negative





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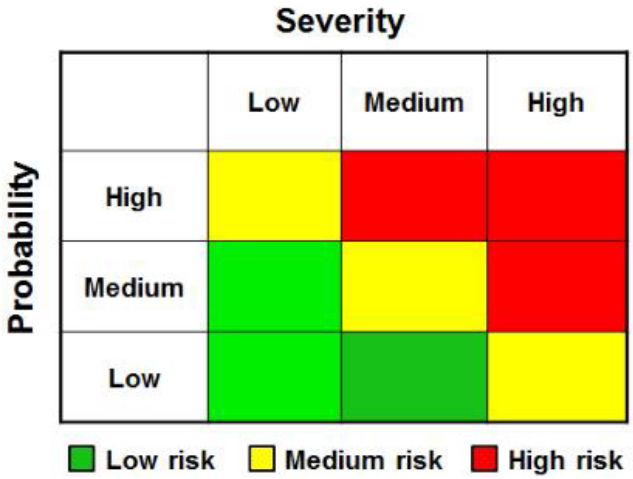
2.4. Management approach

In accordance with the EPA mitigation hierarchy (avoid, minimise, rehabilitate, offset), avoidance of key values has been undertaken in the scoping and design phase and has included the management of construction activities in such a way as to avoid impacts on Banksia Woodlands TECs within and adjacent to the Development Envelope wherever practicable.

This TECMP provides an environmental objective, management actions, criteria and monitoring to manage potential direct and indirect impacts from construction activities on the Patch 1 Malaga and Patch 5 Gnangara TECs. Each of the management actions has been given a risk-based management priority. This risk-based management priority was determined using the matrix below (Figure 6), considering the likelihood (probability) of impacts to the Patch 1 Malaga and Patch 5 Gnangara TECs in the absence of the management measure, as well as the consequence (severity) of the impact to the Patch 1 Malaga and Patch 5 Gnangara TECs if it were to occur. The likelihood of occurrence takes into account the ability of other plans or procedures to manage the identified risk. Severity considers both potential extent of impacts (area potentially affected) as well as the duration (would the impact be temporary or permanent).



Probability:

- Low - unlikely with the implementation of other plans or procedures
- Medium - possible with the implementation of other plans or procedures
- High - likely with the implementation of other plans or procedures

Severity:

- Low - temporary duration of impacts affecting a small area
- Medium - temporary duration of impacts affecting a small area or long term/ permanent duration of impacts affecting a small area
- High - long term or permanent duration of impacts affecting a large area.

Figure 6: Environmental risk matrix

In order to determine the success of management actions in achieving the environmental objective, outcome-based trigger and threshold criteria have been developed for this TECMP, in accordance with EPA Instructions (EPA 2020). Trigger criteria are set at levels to forewarn of the approach of the threshold criteria and to trigger response actions to avoid the threshold criteria being reached. Trigger criteria are set at conservative levels to ensure trigger level actions are implemented well in advance of the threshold criteria. The threshold criterion has been framed to measure achievement of the environmental objective. A failure to meet the threshold criterion indicates the environmental objective is not being met.

Rationale for the choice of environmental criteria and response actions is provided in Sections 3.3, 3.5 and 3.6. The efficacy of management actions, based on these trigger and threshold criteria, will determined by the ability to achieve the environmental objective.

Due to the potential lead time in implementing appropriate groundwater contingency actions, an adaptive management approach has been adopted for groundwater drawdown impacts, in accordance with EPA Instructions (EPA 2020). This approach, discussed further in Section 3, will help to ensure the threshold criterion is not breached.

2.5. Key assumptions and uncertainties

The key assumptions within this plan are:

- This TECMP is an outcomes-based management plan and therefore does not include detailed instruction on standard day to day management of construction activities and the systems and processes in place to facilitate the overall management of environmental impacts. These will be addressed in the CEMP.
- In relation to timeframes for management actions or monitoring, the term ‘construction’ is used to refer to the period from which construction works and/or ground disturbance are substantially commenced (i.e. not including preliminary site investigative works, for example) until the substantial completion of such works. The term ‘substantial completion’ recognises that the change from construction to operations is a transition over a period of time and may occur at different times in different places within the Development Envelope, requiring interpretation on a case by case basis with respect to the provisions in this plan.

3. Provisions – Management and Response Framework

This section sets out the provisions that will be implemented as part of this plan. In accordance with EPA Instructions (EPA 2020), EMP 'provisions' are the key component of an EMP and are the legal requirements and/or commitments to be met by the proponent in implementing the EMP.

The provisions outlined below are outcome-based. In order to determine the success of management actions in achieving the environmental objective, trigger and threshold criteria have been defined.

3.1. Management Objective

The EPA Objective relating to the Flora and Vegetation factor is "to protect flora and vegetation so that biological diversity and ecological integrity are maintained".

The environmental objective for this TECMP is to ensure that the construction of the Proposal is undertaken in a manner that avoids direct or indirect impacts to the Patch 1 Malaga and Patch 5 Gnangara TEC.

3.2. Management Measures

The management measures detailed in Table 3 were identified to ensure that the environmental objective of the TECMP can be achieved.

Implementation of these management measures is intended to meet commitments made in the ERD and reflect the PTA's additional commitments to manage the Proposal's potential impacts to the Patch 1 Malaga and Patch 5 Gnangara TECs. A risk-based priority has been assigned to each of these actions indicating their relative importance in achieving the environmental objective for the TECMP.

Table 4: Management Measures

Aspect	Risk-based Management Priority	Management actions	Timing / Proposal Phase	Responsibility
General				
Unintentional impacts to TEC vegetation	Medium	All personnel, including sub-contractors, will be required to undergo a project environment and heritage induction prior to commencing work on-site. This will include an overview of the risks and obligations associated with protection of the TEC and appropriate management measures during construction activities (including no go areas, hygiene practices, etc).	On-going	Construction Contractor
Vegetation Clearing				
Vegetation clearing	High	Obtain appropriate authorisations, as required, in accordance with the WA Biodiversity Conservation Act 2016.	Prior to commencement of clearing	Construction Contractor
Vegetation clearing	High	Undertake clearing in accordance with the PTA Ground Disturbance Procedure (GDP) (7310-000-001) and the Construction Contractor CEMP.	Prior to and throughout clearing	Construction Contractor
Vegetation clearing	High	The Construction Contractor will provide the boundaries of the area to be cleared to the PTA for review as part of the GDP process. The Construction Contractor must provide the PTA with electronic shape files of the proposed clearing boundary in a format compatible with ArcGIS and Auto CAD DWG format in PCG 94.	Prior to, and as a prerequisite to obtaining a GDP	Construction Contractor
Vegetation clearing	High	The PTA must verify that the area to be cleared is compliant with the Proposal's State and Commonwealth environmental approval.	Prior to, and as a prerequisite to granting a GDP	PTA
Vegetation clearing	High	Proposed construction activities near the Patch 1 Malaga and Patch 5 Gnangara TEC shall be reviewed prior to the commencement of clearing and where possible, setbacks or adjustments to reduce the potential for unintentional impacts to TEC vegetation will be agreed in the field.	Prior to, and as a prerequisite to obtaining a GDP	Construction Contractor
Vegetation clearing	High	Protection boundaries of the Patch 1 Malaga and Patch 5 Gnangara TECs shall be clearly and effectively delineated using fencing and sign posted to ensure the construction workforce do not enter areas of the TECs prohibited to construction activities.	Prior to commencement of clearing	Construction Contractor

Aspect	Risk-based Management Priority	Management actions	Timing / Proposal Phase	Responsibility
Unintentional Vegetation clearing	High	The Patch 1 Malaga and Patch 5 Gnangara TECs must be marked on all construction plans as 'no go zones'.	On-going	Construction Contractor
Vegetation clearing	Medium	Movement of machinery and vehicles will be restricted to within the Footprint, with the exception of movement on existing tracks or designated accesses.	On-going	Construction Contractor
Disturbance to vegetation	Medium	All vegetation clearing activities will be confined to the approved clearing area. Where tall shrubs or trees need to be felled, this activity must be controlled so vegetative material (limbs, trunks etc.) falls entirely within the approved clearing area.	During clearing	Construction Contractor
Temporary Construction Dewatering				
Drawdown impacts to TEC vegetation	High	A Dewatering Management Plan (DMP) will be developed prior to commencing any dewatering activities that have the potential to indirectly impact the Patch 1 Malaga and Patch 5 Gnangara TEC. The DMP will include: • Details of the hydrogeological investigations undertaken. • Description of proposed dewatering and construction activities (including dewatering volumes, diaphragm wall construction, groundwater re-injection etc.). • Treatment requirements prior to disposal of abstracted groundwater (if required). • Contingency measures. • Reporting requirements. • Monitoring requirements associated with water quality of dewatering discharge. • Groundwater quality and level monitoring requirements (pre, during and post activities).	Prior to dewatering	Construction Contractor
Drawdown impacts to TEC vegetation	High	The DMP must include consideration of the following controls: • Minimising groundwater drawdown through established construction methods based on the dewatering requirements (i.e. depth and duration), such as re-injection of abstracted groundwater, use-of diaphragm walls and use of wet working techniques (as applicable). • Minimising groundwater drawdown at Malaga and Gnangara TECs through positioning of recharge wells. • Locating infiltration basins, trenches and/ or reinjection wells within the Development Envelope.	Prior to dewatering	Construction Contractor

Aspect	Risk-based Management Priority	Management actions	Timing / Proposal Phase	Responsibility
		• Re-use of excess abstracted dewater where possible to minimise offsite discharge.		
Drawdown impacts to TEC vegetation	High	Prior to undertaking any temporary dewatering activities that have the potential to indirectly impact the Patch 1 Malaga and Patch 5 Gnangara TEC, consideration must be given to the following guidance: • Assess the extent and duration of the temporary dewatering activity following the Water Quality Protection Note No. 13 - Dewatering of soils at construction sites (2012). • Completion of either a H1 - desktop assessment, H2 level desktop assessment including test pumping or H3 level desktop assessment including test pumping and modelling in accordance with Operational Policy 5.12 – Hydrogeological reporting associated with a groundwater well licence (2009), as required. • All dewatering wells to be installed in accordance with the Minimum Construction Requirements for Water Bores in Australia (2012). • All monitoring bores to be installed in accordance with Water Quality Protection note No. 30; Groundwater monitoring bores (2006). • Development of a Groundwater Licence Operating Strategy (GLOS) in accordance with Operational Policy 5.08 – Use of Operating Strategies in Water Licencing Process (2019) if required.	Prior to dewatering	Construction Contractor
Drawdown impacts to TEC vegetation	High	Prior to undertaking any temporary dewatering activities that have the potential to indirectly impact the Patch 1 Malaga and Patch 5 Gnangara TEC, apply for a 5C licence, issued under the provisions of the *Rights in Water and Irrigation Act 1914*.	Prior to dewatering	Construction Contractor
Drawdown impacts to TEC vegetation	High	A survey of baseline groundwater levels must be undertaken prior to commencement of dewatering at the Patch 1 Malaga and Patch 5 Gnangara TEC.	Prior to dewatering	Construction Contractor
Drawdown impacts to TEC vegetation	High	Daily groundwater level monitoring must be undertaken at the Patch 1 Malaga and Patch 5 Gnangara TEC during dewatering activities.	During dewatering	Construction Contractor
Drawdown impacts to TEC vegetation	High	Daily groundwater level monitoring must be undertaken at the Patch 1 Malaga and Patch 5 Gnangara TEC for two weeks following the cessation of dewatering.	Post dewatering	Construction Contractor

Aspect	Risk-based Management Priority	Management actions	Timing / Proposal Phase	Responsibility
Drawdown impacts to TEC vegetation	High	Monthly groundwater level monitoring must be undertaken at the Patch 1 Malaga and Patch 5 Gnangara TEC for 6 months following the cessation of dewatering.	Post dewatering	Construction Contractor
Drawdown impacts to TEC vegetation	High	Assess all groundwater level monitoring results obtained during and after dewatering activities against the Trigger Criteria described in Section 3.3.	During dewatering Post dewatering	Construction Contractor
Construction Water Supply				
Drawdown impacts to TEC vegetation	Medium	Groundwater abstraction bores used for construction water supply must be located at least 50m from the Patch 1 Malaga and Patch 5 Gnangara TECs.	On-going	Construction Contractor
Introduction and spread of weeds and *Phytophthora* dieback				
Unintentional vegetation clearing	Medium	Cleared areas will be utilised for laydown and temporary construction where practicable.	During construction	Construction Contractor
Introduction and/or spread of *Phytophthora* dieback)	Medium	Undertake the following hygiene measures: • Identify and demarcate areas uninfested with dieback and protectable within Patch 1 Malaga and Patch 5 Gnangara TECs on all relevant construction drawings • Control entry and exit to areas mapped as uninfested – protectable. • Restrict unauthorised access to and from protectable areas by installing temporary fencing, barriers or signage as required. • Ensure all vehicles and machinery observe appropriate hygiene measures • Require all personnel to complete a site induction that will include hygiene training with regards to dieback, the environmental implications of the introduction and spread of dieback and obligations • Movement of topsoil restricted to within the same *Phytophthora* dieback interpretation mapping unit. • All imported materials will be certified dieback free within protectable areas.	During construction	Construction Contractor

Aspect	Risk-based Management Priority	Management actions	Timing / Proposal Phase	Responsibility
Introduction and/or spread of weeds	Low	Undertake the following management measures: • Identify weed management zones aligned with significant weed infestations • Identify and demarcate areas infested with declared weeds on all relevant construction drawings • Control access to areas mapped as infested • Restrict unauthorised access to and from the Development Envelope by installing temporary fencing, barriers or signage as required • Ensure all vehicles and machinery observe appropriate hygiene measures • Require all personnel to complete a site induction that will include hygiene training, including the environmental implications of the introduction and spread of weeds and associated obligations • Movement of topsoil restricted to within the same weed interpretation mapping	During construction	Construction Contractor
Deterioration of surface water quality and / or vegetation condition	Low	If necessary, drainage structures will be constructed to ensure minimal alteration to existing surface water drainage within the Development Envelope that may impact the Patch 1 Malaga and Patch 5 Gnangara TECs and will incorporate erosion protection measures where required.	During construction	Construction Contractor
Deterioration of vegetation condition	Low	Where applicable, silt traps will be installed between the Site and the Patch 1 Malaga and Patch 5 Gnangara TECs. This will be in the form of a silt fence or similar structure to prevent the movement of sediment into vegetation not approved to be cleared.	Prior to commencement of clearing	Construction Contractor
Deterioration of vegetation condition resulting from spills	Medium	• Project areas that will contain hazardous materials such as hydrocarbons shall be situated within bunded/enclosed containment systems away from the Patch 1 Malaga and Patch 5 Gnangara TECs. • Unless otherwise approved, all fuel or chemical supply lines shall be above ground, so leaks are detectable. • All chemicals to be bought to site shall be advised to the Construction Contractor Environment Manager and current Safety Data Sheets (SDS) provided prior to mobilisation on site. • Ensure all relevant employees and contractors are trained on safe handling procedures and incident response, including spill containment, clean-up and reporting procedures.	Prior to construction	Construction Contractor

Aspect	Risk-based Management Priority	Management actions	Timing / Proposal Phase	Responsibility
		• All hydrocarbon / chemical storage areas, vehicle maintenance and refuelling areas will be equipped with spill kits and emergency response kits to minimise contamination in the event of a spill. Spill management equipment is to be appropriate to the volume and type of hydrocarbons or chemicals being stored and shall be available, clearly labelled and highly visible at each chemical / hydrocarbon storage location at all times. • In the event of a spill, implement a spill response procedure, which may include groundwater or surface water monitoring or soil testing as required. Contaminated soil or surface water shall be removed immediately, contained in a designated area, removed from site and disposed of at an offsite licensed facility. • All spills of hydrocarbons or chemicals shall be reported as an incident.		
Deterioration of Vegetation condition - dust	Low	Dust will be minimised through the following actions: • Dust suppression measures will be utilised at locations of high dust risk including internal construction roads, cleared areas, batters and stockpiles. • Dust suppression measures will be implemented where dust generation has the potential to impact vegetation. • Vegetation clearing and exposed surfaces will be kept to a minimum wherever practicable. • Vehicle speeds on construction roads will be reduced where necessary to minimise dust emissions. • Vehicles will remain within designated roads and park only in allocated areas. • Vegetation clearing and earthworks will be avoided during high winds wherever practicable. • If stockpiles are left untouched for greater than 28 days and there is a risk of dust impacts, long-term stabilisation methods such as mulch or other stabilisers will be considered. • All vehicles carrying dusty loads will be covered with tarpaulins or similar. • If required and practicable, construction material will be dampened by spraying water prior to transportation, especially during dry and windy weather conditions.	During clearing of vegetation and construction	Construction Contractor

3.3. Environmental Criteria

Environmental criteria have been identified that will trigger the implementation of contingency actions to avoid direct or indirect impacts to the Patch 1 Malaga and Patch 5 Gnangara TEC which occur outside of the Proposal's Footprint. Trigger and threshold criteria are listed in Table 5 below.

Table 5: Environmental criteria

Type	Environmental Criteria
Threshold	A measurable decline in the condition or extent of Patch 1 Malaga or Patch 5 Gnangara TEC which occurs outside of the Proposal's Footprint as a result of construction of the Proposal.
Trigger 1	Incursions into Patch 1 Malaga or Patch 5 Gnangara TEC beyond the Proposal's Footprint.
Trigger 2	Regional groundwater levels are reduced below the lowest recorded summer groundwater level within or adjacent to the areas of Patch 1 Malaga or Patch 5 Gnangara TEC beyond the Proposal's Footprint as a result of dewatering during construction of the Proposal.

3.3.1. Threshold criterion

Exceedance of a threshold criterion indicates a non-compliance with the environmental objective. The threshold criterion for the Proposal has been defined as "A measurable decline in the condition or extent of Patch 1 Malaga or Patch 5 Gnangara TEC which occurs outside of the Proposal's Footprint as a result of construction of the Proposal".

3.3.2. Trigger criteria

The management measures described in Section 3.2 have been attributed a risk-based priority, as described in Section 2.4, which recognises their importance in achieving the environmental objective. This risk-based assessment has been used in determining those actions in highest need of monitoring and assessment against trigger criteria. This risk-based prioritisation was derived from an assessment of the following high-risk activities:

- Clearing and access, which have the highest likelihood of causing environmental impact; and
- Dewatering during construction of the Tonkin Highway dive structure and Gnangara Road overpass, where impacts are unlikely, but the consequence could be severe and irreversible.

The following trigger criteria have been developed to control these two activities.

Trigger 1 – Incursion into Patch 1 Malaga or Patch 5 Gnangara TEC

Trigger 1 will assess any incursion (including incursions by vehicle, unauthorised personnel or surface drainage) into Patch 1 Malaga or Patch 5 Gnangara TEC beyond the Proposal's Footprint, which may have the potential to result in direct or indirect impacts to the TEC vegetation.

Trigger 2 – Groundwater Level Drawdown

Trigger 2 has been developed to control drawdown of groundwater within the Patch 1 Malaga or Patch 5 Gnangara TEC beyond the Proposal's Footprint due to dewatering during construction of the Tonkin Highway dive structure and Gnangara Road grade separation. It is recognised that this trigger may require an adaptive management approach as more information becomes available throughout the course of the Proposal.

Whilst some research exists on response of vegetation to drawdown on the Swan Coastal Plain, this research is generally based on response to prolonged or permanent drawdown rather than short term dewatering, as discussed in Section 2.3.2. Professor Ray Froend identifies a maximum rate of drawdown of 0.1 m per year to avoid mortality of individual plants (no measurable change) (Froend and Loomes 2005). However, vegetation response to drawdown is influenced by a variety of factors including historical groundwater fluctuations, site specific conditions, species present and other influences such as disturbance (Froend and Loomes 2005). This makes setting of trigger values challenging and necessitates a precautionary approach.

The Proposal's predicted temporary dewatering drawdown impacts of up to 0.25 m beneath the Patch 1 Malaga TEC areas, are not considered significant in the context of seasonal regional water table fluctuations of up to 1.0m (Golder 2020b). This seasonal fluctuation suggests that, under natural conditions, the TECs are subjected to moderate changes in regional groundwater levels.

Based on findings (Froend and Loomes 2005) that a long term or permanent drawdown rate greater than 0.1 m per year would be required before a measurable change to vegetation health would be observed, projected values have been determined based on a short-term dewatering program. The limits that have been set also consider the historical fluctuations and provide conservative trigger levels for the implementation of management measures.

The PTA's approach is to manage the dewatering activities so that the groundwater level within and adjacent to Patch 1 Malaga and Patch 5 Gnangara TECs is not significantly lowered below the lowest recorded summer regional groundwater level as a result of dewatering activities.

The adopted criterion consider the range of observed natural seasonal groundwater level variation and the available groundwater level dataset. Trigger 2 contains three levels of indicators to act as an early response, providing information on changes before the onset of potential impacts to vegetation (Section 3.5). This aims to provide sufficient lead time to implement mitigation measures as required.

3.4. Monitoring

3.4.1. Vegetation monitoring

A baseline vegetation monitoring program will be implemented prior to the commencement of dewatering and construction works in the vicinity of the Patch 1 Malaga TEC and Patch 5 Gnangara TEC. Monitoring will be undertaken biannually during construction and biannually post construction for a period of one year.

Patch 1 Malaga TEC

For the Patch 1 Malaga TEC, a transect method will be used to monitor potential impacts from dewatering and construction works. The monitoring will be undertaken by an experienced botanist and will include establishing transects to enable evaluation of changes to vegetation quality. The monitoring will include:

- Three transects north of the Development Envelope. Transects will start at the edge of the vegetation adjacent to the Development Envelope.
- Four transects within the Patch 1 Malaga TEC NVRA. One transect will be established on each side of the NVRA. Transects will start at the edge of the vegetation on each side of the NVRA.
- One control transect in the centre of the Patch 1 Malaga TEC NVRA.
- The location of each transect will be recorded by GPS and permanent markers will be used to mark the starting point of each transect.

- Each transect will be 60 m in length and will be oriented to move away from the edge of the vegetation.
- 5 x 5 m plots will be placed at 20 m intervals along the transect with the first plot at 0 m and the last at 60 m.
- Each plot will be placed alternatively left or right of the transect line.
- Plots in the initial 20 m of the transect represent potential impact plots. The results from the 0 m and 20 m plots will be compared to the results of the 40 m and 60 m plots for each transect and the control transect in the centre of the Patch 1 Malaga TEC NVRA.

The results of monitoring will be graphically represented to show variation along the length of each transect over time. If indirect impacts are observed, they would be expected to be observed as a change over time in one or more parameter in the impact plots without a corresponding change being recorded in control plots.

Parameters recorded in each plot will include:

- Introduced vegetation cover (%)
- Introduced species diversity (richness and abundance)
- Vegetation condition (Keighery, 1994) including understorey species
- Canopy condition
- Plant deaths

Parameters recorded along the transect will include:

- Evidence of unauthorised access
- Vegetation condition (Keighery, 1994) including understorey species

A photo will be taken at the start and end point of each transect.

Patch 5 Gnangara TEC

For the Patch 5 Gnangara TEC, a transect method will be used to monitor potential impacts from dewatering and construction works. The monitoring will be undertaken by an experienced botanist and will include establishing permanent impact and control transects to enable evaluation of changes to vegetation quality. The monitoring will include:

- Two transects in the vegetation adjacent to the Development Envelope. Transects will start at the edge of the vegetation.
- The location of each transect will be recorded by GPS and permanent markers will be used to mark the starting point of each transect.
- Each transect will be 60 m in length and will be oriented to move away from the edge of the vegetation.
- 5 x 5 m plots will be placed at 20 m intervals along the transect with the first plot at 0 m and the last at 60 m.
- Each plot will be placed alternatively left or right of the transect line.
- Plots in the initial 20 m of the transect represent potential impact plots. The results from the 0 m and 20 m plots will be compared to the results of the 40 m and 60 m plots for each transect.

The results of monitoring will be graphically represented to show variation along the length of each transect over time. If indirect impacts are observed, they would be expected to be observed as a change over time in one or more parameter in the impact plots without a corresponding change being recorded in control plots.

Parameters recorded in each plot will include:

- Introduced vegetation cover (%)
- Introduced species diversity (richness and abundance)
- Vegetation condition (Keighery, 1994) including understorey species
- Canopy condition
- Plant deaths

Parameters recorded along the transect will include:

- Evidence of unauthorised access
- Vegetation condition (Keighery, 1994) including understorey species

A photo will be taken at the start and end point of each transect.

3.4.2. Groundwater level monitoring

A survey of baseline groundwater levels will be undertaken prior to commencement of dewatering at the Patch 1 Malaga and Patch 5 Gnangara TEC.

Groundwater level monitoring during dewatering will include:

- Patch 1 Malaga TEC: Daily groundwater level measurement at 3 locations within or adjacent to the Patch 1 Malaga TEC north of the Development Envelope and 3 locations within or adjacent to the Patch 1 Malaga TEC NVRA.
- Patch 5 Gnangara TEC: Daily groundwater level measurement at 3 locations within or adjacent to the Patch 5 Gnangara TEC.

Groundwater level monitoring following the cessation of dewatering will include:

- Patch 1 Malaga TEC: Daily groundwater level measurement at 3 locations within or adjacent to the Patch 1 Malaga TEC north of the Development Envelope and 3 locations within or adjacent to the Patch 1 Malaga TEC NVRA for two weeks.
- Patch 1 Malaga TEC: Monthly groundwater level measurement at 3 locations within or adjacent to the Patch 1 Malaga TEC north of the Development Envelope and 3 locations within or adjacent to the Patch 1 Malaga TEC NVRA for 6 months.
- Patch 5 Gnangara TEC: Daily groundwater level measurement at 3 locations within or adjacent to the Patch 5 Gnangara TEC for two weeks.
- Patch 5 Gnangara TEC: Monthly groundwater level measurement at 3 locations within or adjacent to the Patch 5 Gnangara TEC for 6 months.

Monitoring locations will be determined following completion of final Proposal designs. These wells will be surveyed to identify location, ground level and top of case.

During dewatering, groundwater level data will be systematically evaluated and compared to the trigger groundwater levels (as discussed in Section 3.5). This will enable a process of adaptive management whereby drawdown predictions are verified. The results of this process may necessitate a revision of aspects of the TECMP.

3.4.3. Incursion into TEC areas

The purpose of monitoring is to inform, through the environmental criteria, if the environmental objective is being achieved and when trigger level actions or threshold contingency actions will be implemented.

In order to ensure a prompt response to exceedance of Trigger 1, weekly visual inspections will be undertaken by a qualified environmental professional over the duration of construction activities. The inspection will:

- Be undertaken at the boundary of the work area and areas adjacent to the Patch 1 Malaga and Patch 5 Gnangara TECs.
- Assess any evidence for unauthorised access, e.g. observations of vehicles or machinery, vehicle tracks, damage to vegetation or damage or absence of flagging or fencing specified in the TECMP.
- Assess evidence of surface water or silt movement in the direction of the TECs.
- Assess the performance of silt traps (if installed).

3.5. Implementation of Trigger Level Actions

PTA has developed trigger level actions that would be implemented if the associated trigger criterion signals the need for increased mitigation or protection (Table 6). These trigger level actions will be implemented to mitigate and manage impacts, so they meet trigger criteria and safeguard threshold criteria.

Trigger 1

An exceedance of Trigger 1 (indicating an incursion in the TEC areas) would indicate a temporary failure of management measures and potential for resulting impacts to vegetation. Where there has been a failure of any on-ground controls, these will be reinstated. If management controls are absent or inadequate to prevent further breaches of the trigger, controls will be reviewed and revised and if necessary, the TECMP will be updated to ensure the threshold criterion is not reached.

Where it is determined on visual inspection that the Patch 1 Malaga or Patch 5 Gnangara TEC which occurs outside of the Proposal's Footprint may have been impacted as a result of construction of the Proposal, vegetation monitoring will be undertaken. This will be undertaken by a qualified botanist and will vegetation monitoring. Results will be compared with baseline vegetation monitoring results.

Trigger 2

An exceedance of Trigger 2 will require review of the groundwater data collected. The review will assess the role of seasonal conditions in reaching the trigger and any other influences such as other groundwater users. This information will inform actions which may include maintenance or changes to the DMP, dewatering and infiltration system, increasing monitoring locations, reconsideration of trigger criteria or redesign of recharge well configuration.

Trigger values and associated action criteria for groundwater levels presented in this TECMP have been based on all available data (as summarised in Section 2.2.1). A summary of the trigger indicator levels and actions is presented below:

- Level 1: One (1) monitoring well exceeds the lowest recorded summer groundwater level.
- Level 2: Three (3) monitoring wells exceed the lowest recorded summer groundwater level.
- Level 3: Three (3) wells exceed 0.3 m drawdown below the lowest recorded summer groundwater level.

For Patch 1 Malaga the adopted lowest recorded summer groundwater level is 28.5 m AHD. For Patch 5 Gnangara the adopted lowest recorded summer groundwater level is 38.3 m AHD.

The adopted lowest recorded summer groundwater level may be amended as new information is obtained as part of PTA's adaptive management approach.

3.6. Implementation of Threshold Contingency Action

Where the threshold criterion has been exceeded, this constitutes a non-compliance with the environmental objective. Where a measurable decline in the condition or extent of TECs is reported and is attributable to the construction of the Proposal, a rehabilitation plan will be developed and agreed with DWER.

Any exceedance of the threshold criterion would indicate a non-compliance with the environmental objective and would require a redesign of the TECMP including management and monitoring measure contained in the TECMP.

Table 6: Management and response framework

Environmental criteria		Indicator	Method	Frequency	Actions	Responsibility	Timing
Threshold	Condition or extent of Patch 1 Malaga or Patch 5 Gnangara TEC which occurs outside of the Proposal's Footprint	Measurable decline in the condition or extent of Patch 1 Malaga or Patch 5 Gnangara TEC attributed to construction of the Proposal.	Groundwater level monitoring Vegetation monitoring Visual inspections	Monitoring frequency consistent with Section 3.4	Step 1 – Notification to PTA. Step 2 – Undertake a vegetation assessment. Step 3 – Develop a rehabilitation plan or equivalent, as agreed with DWER. Step 4 – Revise TECMP in consultation with DWER.	Step 1 – Construction Contractor Step 2 – Qualified botanist Step 3 – PTA Step 4 – PTA	Step 1 – Within 12 hrs Step 2 – Within two weeks. Step 3 – As agreed with DWER. Step 4 – As agreed with DWER.
Trigger 1	Disturbance of the vegetation within Patch 1 Malaga or Patch 5 Gnangara TEC which occurs outside of the Proposal's Footprint	Damage to protective fencing	Visual inspections as described in Section 3.4.3	Weekly	Step 1 – Notification to PTA. Step 2 – Implement temporary measures such as flagging. Step 3 – Reinstate fencing and upgrade as required. Step 4 – Produce an Environmental Alert and toolbox presentation regarding TECs and disturbance boundaries.	Construction Contractor for all	Step 1 – Within 24 hrs Step 2 – Within 24 hrs. Step 3 – Within 1 week. Step 4 – Within 2 weeks.
		Movement of silt or uncontrolled discharges into TECs	Visual inspections as described in Section 3.4.3	Weekly	Step 1 – Notification to PTA. Step 2 – Check silt traps and remove sediment build-up. Step 3 – Install or redesign erosion and sediment control measures.	Step 1 – Construction Contractor Step 2 – Construction Contractor Step 3 – Construction Contractor	Step 1 – Within 24 hrs Step 2 – Within 24 hrs. Step 3 – Within 1 week.

Environmental criteria		Indicator	Method	Frequency	Actions	Responsibility	Timing
		Evidence of machinery or personnel access to TECs	Visual inspections as described in Section 3.4.3	Weekly	Step 1 – Notification to PTA. Step 2 – Investigate cause of boundary incursion. Step 3 – Install additional fencing, flagging or signage if required. Step 4 – Produce an Environmental Alert and toolbox presentation regarding TECs and disturbance boundaries. Step 5 – Undertake a vegetation assessment.	Construction Contractor for all	Step 1 – Within 24 hrs Step 2 – Within 24 hrs. Step 3 – Within 1 week. Step 4 – Within 2 weeks. Step 5 – Within 2 weeks.
Trigger 2	Regional groundwater levels adjacent to or within Patch 1 Malaga or Patch 5 Gnangara TEC which occurs outside of the Proposal's Footprint	1. Groundwater levels in one (1) monitoring well is below the lowest recorded summer groundwater level	Groundwater monitoring described in Section 3.4	Daily during dewatering	Step 1 – Notification to PTA. Step 2 – Check pumping and reinjection rates to confirm dewatering works are being undertaken in accordance with the DMP. Step 3 – If dewatering works are not being undertaken in accordance with the DMP, correct the dewatering system to comply with the DMP. Step 4 – If the well does not return to a compliant groundwater level within 10 days, review the DMP and dewatering design including the location and number of reinjection bores and / or infiltration swales and consider modifications to the system.	Construction Contractor for all	Step 1 – Within 24 hrs Step 2 – Within 24 hrs. Step 3 – Within 2 days. Step 4 – Within 2 weeks.

Environmental criteria		Indicator	Method	Frequency	Actions	Responsibility	Timing
Trigger 2	Regional groundwater levels adjacent to or within Patch 1 Malaga or Patch 5 Gnangara TEC which occurs outside of the Proposal's Footprint	2. Groundwater levels in three (3) monitoring wells are below the lowest recorded summer groundwater level	Groundwater monitoring described in Section 3.4	Daily during dewatering	Step 1 – Notification to PTA. Step 2 – Check pumping and reinjection rates to confirm dewatering works are being undertaken in accordance with the DMP. Step 3 – If dewatering works are not being undertaken in accordance with the DMP, correct the dewatering system to comply with the DMP and increase groundwater level monitoring frequency to near-real time. Step 4 – If the wells do not return to a compliant groundwater level within 5 days, review the DMP and dewatering design including the location and number of reinjection bores and / or infiltration swales and consider modifications to the system. Step 5 – If the wells do not return to a compliant groundwater level within 5 days, commence contingency planning for additional reinjection wells, spears or sumps and / or infiltration swales, as well as additional groundwater control structures such as sub-surface polymer-based grout systems or cut-off walls to further restrict the inflow of groundwater to the excavation zone.	Construction Contractor for all	Step 1 – Within 24 hrs Step 2 – Within 24 hrs. Step 3 – Within 2 days. Step 4 – Within 1 week. Step 5 – Within 1 week.

Environmental criteria		Indicator	Method	Frequency	Actions	Responsibility	Timing
Trigger 2	Regional groundwater levels adjacent to or within Patch 1 Malaga or Patch 5 Gnangara TEC which occurs outside of the Proposal's Footprint	3. Groundwater levels in three (3) monitoring wells is more than 0.3 m below the lowest recorded summer groundwater level	Groundwater monitoring described in Section 3.4	Daily during dewatering	Step 1 – Notification to PTA. Step 2 – Check pumping and reinjection rates to confirm dewatering works are being undertaken in accordance with the DMP. Step 3 – If dewatering works are not being undertaken in accordance with the DMP, correct the dewatering system to comply with the DMP and increase groundwater level monitoring frequency to near-real time. Step 4 – If the wells do not return to a compliant groundwater level within 5 days, reduce pumping rate if practicable and review the DMP and dewatering design including the location and number of reinjection bores and / or infiltration swales and consider modifications to the system. Step 5 – If the wells do not return to a compliant groundwater level within 5 days, increase number of reinjection bores or infiltration swales in the vicinity of the TEC and commence contingency planning for additional groundwater control structures such as sub-surface polymer-based grout systems or cut-off walls to further restrict the inflow of groundwater to the excavation zone. Step 6 – Undertake a vegetation assessment.	Construction Contractor	Step 1 – Within 24 hrs Step 2 – Within 24 hrs. Step 3 – Within 2 days. Step 4 – Within 1 week. Step 5 – Within 1 week. Step 6 – Within 1 week.

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4. Reporting

4.1. Reporting on exceedances of trigger or threshold criteria

4.1.1. Construction Contractor reporting to PTA

Where trigger or threshold criteria specified in this Plan have been reached, the Construction Contractor will:

- Report this to the PTA within the timeframes specified in Table 7 below.
- Provide evidence to the PTA which allows for determination of the likely cause of the trigger or threshold criterion being reached and to identify any additional contingency actions required to prevent the trigger or threshold criterion being reached in the future.

Table 7: Management and response framework reporting

Criteria	Indicator	Notification Timeframes	
		PTA	DWER
Trigger 1 Incursion in Patch 1 Malaga or Patch 5 Gnangara TEC	Damage to protective fencing.	Within 24 hrs	Within 21 days
	Movement of silt or uncontrolled discharges into TECs.	Within 24 hrs	
	Evidence of machinery or personnel access to TECs	Within 24 hrs	
Trigger 2 Groundwater Level Drawdown	Level 1 - One (1) monitoring well exceeds the lowest recorded summer groundwater level.	Within 24 hrs	
	Level 2 - Groundwater levels in three (3) monitoring wells are below the lowest recorded summer groundwater level.	Within 24 hrs	
	Level 3 - Groundwater levels in three (3) monitoring wells is more than 0.3 m below the lowest recorded summer groundwater level.	Within 24 hrs	
Threshold	Measurable decline in the condition or extent of Patch 1 Malaga or Patch 5 Gnangara TEC attributed to construction of the Proposal.	Within 12 hrs	Within 7 days

4.1.2. PTA reporting to DWER

PTA will be responsible for any notifications to DWER. Where a trigger criterion specified in this TECMP has been reached, PTA will:

- Report any exceedance to the CEO of DWER within 21 days of the trigger criterion being reached.
- Provide evidence to the CEO of DWER that allows for determination of the likely cause of the trigger criterion being reached and to identify any additional contingency actions required to prevent the trigger criterion being reached in the future.
- If the reaching of trigger criterion is determined by the CEO of DWER to be a result of activities undertaken in implementing the Proposal, immediately implement the management and/or contingency actions specified in this Plan and continue implementation of those actions until the trigger criterion is being met, or until the CEO has confirmed by notice in writing that it has been demonstrated that the objective will continue to be met and implementation of the management and/or contingency actions is no longer required.

Where the threshold criterion is reached, the Construction Contractor will advise the PTA within 12 hours. PTA will advise the CEO of DWER within seven days of the threshold criterion being reached.

5. Review and Revision

This TECMP will be reviewed and revised by the PTA on an as needs basis. For example, if the threshold criterion is reached or if management controls included in this TECMP are inadequate to prevent further breaches of a trigger criterion, controls will be reviewed and revised and if necessary, the TECMP will be updated.

The PTA will update the TECMP if requested by the CEO of DWER.

6. Stakeholder Consultation

This TECMP will be refined as necessary in consultation with relevant stakeholders.

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