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NorthLinkWA
Perth-Darwin National Highway

Condition Environmental Management Plan

Indirect Impacts and Threatened Flora and Communities

Perth–Darwin National Highway (Swan Valley Section)

JANUARY 2020

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Document *Control*

Revision	Date	Description	Prepared	Reviewed	Approved
A	29/07/2016	Draft (Coffey v1)	M. Holliday	E. Waterhouse	E. Waterhouse
B	10/08/2016	Draft (Coffey v2)	M. Holliday	D. Morley	D. Morley
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1	31/01/2017	Addressed OEPA comments (Coffey v5)	M. Holliday	B. Napier	D. Morley
2	17/02/2017	Addressed OEPA comments (Coffey v6)	M. Holliday	D. Morley	D. Morley
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1 SUMMARY

This Condition Environmental Management Plan (Condition EMP) (this plan) is submitted in accordance with Ministerial Statement No. 1036 condition 7-1 and Ministerial Statement No. 1116 condition 10-1 for the Perth–Darwin National Highway (Swan Valley Section) by Main Roads Western Australia. It is a revision of the previous version approved by the former Office of the Environmental Protection Authority (OEPA) on 1 March 2017 (reference NLWA-03-EN-RP-0052 / Rev 3).

This document sets out the environmental management actions to manage the potential indirect impacts of the proposal on Threatened flora and communities.

Table 1 details the environmental management targets to measure achievement of the environmental objectives that must be met through implementation of this Condition Environmental Management Plan (Condition EMP).

Table 1 Indirect Impacts and Threatened Flora and Communities Condition EMP summary

Item	Detail
Title of proposal	Perth–Darwin National Highway (Swan Valley Section)
Proponent name	Commissioner for Main Roads Western Australia
Ministerial Statement Nos.	1036 & 1116 (note that condition 10 of MS 1036 is deleted and replaced with condition 10 of MS 1116)
Purpose of this Condition EMP	The Flora and Vegetation - Indirect Impacts and Threatened Flora and Communities Condition EMP is submitted to fulfil the requirements of condition 7-1 of Ministerial Statement 1036 and condition 10-1 of Ministerial Statement 1116.
EPA's environmental objectives for the key environmental factors	To maintain representation, diversity, viability and ecological function at the species, population and community level.
Condition environmental objectives	To ensure that indirect impacts, including but not limited to weeds, unauthorised access, increased fire risk and litter, changes to surface water regimes, to flora and vegetation, including but not limited to *Caladenia huegelii* habitat, *Grevillea curviloba* subsp. *incurva*, *Darwinia foetida*, Conservation Category Wetlands and *Communities of Tumulus Springs (Organic Mound Springs, Swan Coastal Plain*) are minimised as far as practicable. To maintain or improve the condition of the remaining extent of SCP20a as shown in figure 4 of Ministerial Statement 1036, through implementation of the Flora and Vegetation – Indirect Impacts and Threatened Flora and Communities – Condition Environment Management Plan approved by the CEO.

Item	Detail
Management targets	Management target 1: Limit the extent of indirect impacts to no more than 10 m from the new edge of native vegetation adjacent to Communities of Tumulus Springs (Organic Mound Springs, Swan Coastal Plain) and Conservation Category Wetlands.
	Management target 2: Limit the extent of indirect impacts to no more than 10 m from the new edge of native vegetation in areas of *Caladenia huegelii* habitat.
	Management target 3: The number of individuals of *Grevillea curviloba* subsp. *incurva* in the Brand Highway road reserve at Muchea is maintained.
	Management target 4: The number of individuals of *Darwinia foetida* in the Great Northern Highway road reserve at Muchea is maintained.
	Management target 5: Maintain or improve the condition of remaining extent of SCP20a as shown in Figure 4 of Ministerial Statement 1036.

2 CONTEXT, SCOPE AND RATIONALE

2.1 Description of the Proposal

Main Roads Western Australia (MRWA) proposes to construct a new 38 km long section of the Perth–Darwin National Highway (PDNH) (Figure 1) between Malaga and Muchea, in Western Australia (the proposal). The proposal is a dual carriageway highway and will connect the intersection of Tonkin Highway and Reid Highway in the south with Great Northern Highway and Brand Highway in the north.

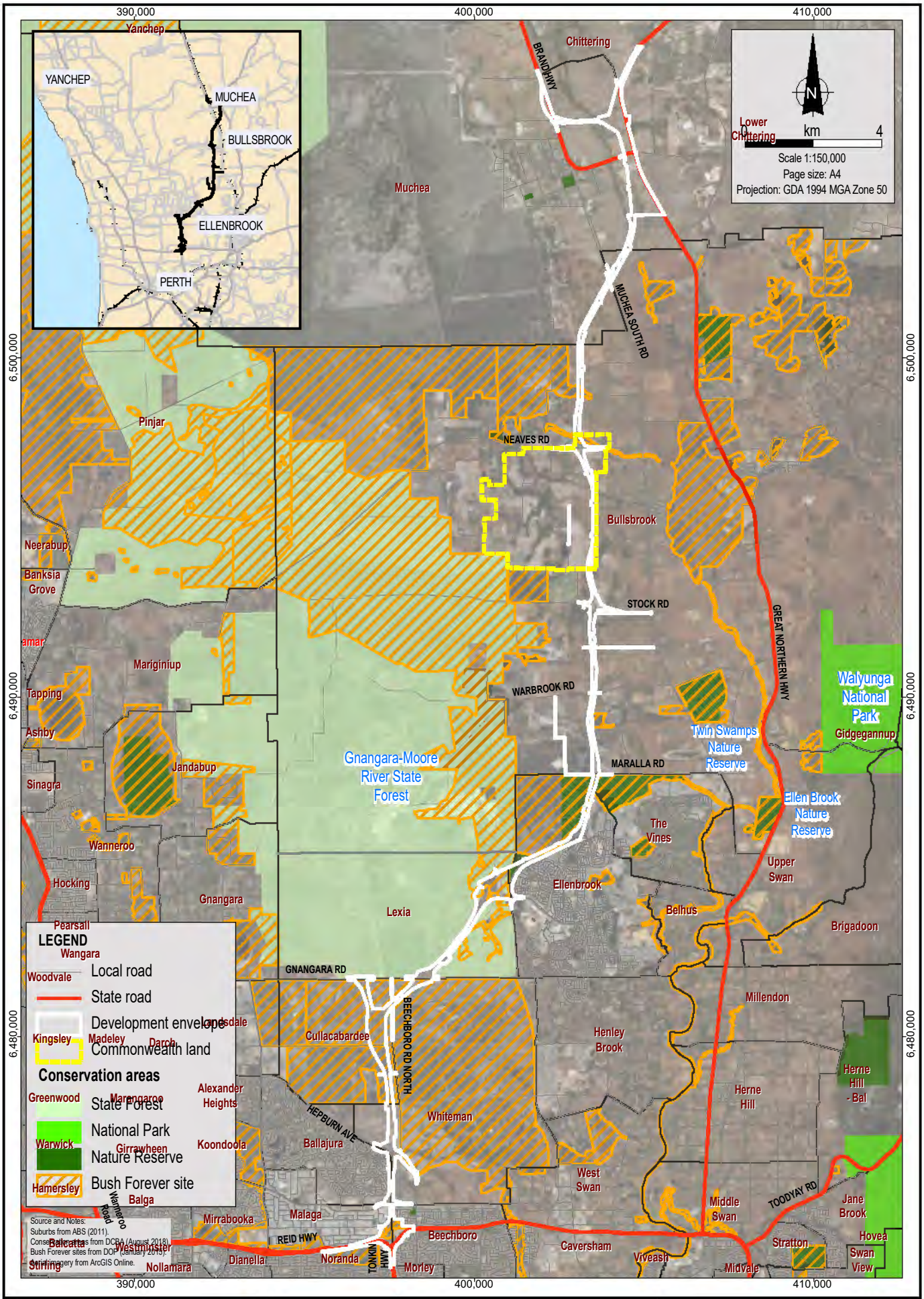
2.2 Key Environmental Factors

Indirect impacts are not a direct result of an activity and tend to occur away from the disturbance footprint of a project. These impacts can be the result of more complex impact pathways (compared to direct impacts). Indirect impacts to threatened flora and vegetation of the proposal therefore occur outside of the development envelope. In such areas, flora and vegetation could be degraded indirectly from the proposal through activities that encourage weed invasion, an increase in litter and the risk of fire, and changes to the water regime that disrupt, for example, natural water flows (Tsunokawa and Hoban, 1997).

This plan addresses the flora and vegetation environmental factor, which is part of the Land theme. The relevance of this environmental factor to the proposal is presented in Table 2.

Table 2 Environmental aspects of the proposal for indirect impacts and Threatened flora and communities

Environmental aspect of the proposal	Affected species, populations and communities	Indirect impact	Activity/Threatening process
Clearing of native vegetation Earthworks Traffic and access	• Threatened Ecological Communities and Priority Ecological Communities including: – Communities of Tumulus Springs (Organic Mound Springs, Swan Coastal Plain). – SCP20a (*Banksia attenuata* woodlands over species rich dense shrublands). • Threatened flora, including: – *Caladenia huegelii* habitat. – *Grevillea curviloba* subsp. *incurva*. – *Darwinia foetida.* • Conservation Category Wetlands.	Degradation of native flora and vegetation outside the development envelope.	Indirect impacts from: • Spread of weeds. • Increased occurrence of rubbish dumping and unauthorised access. • Increased fire risk and litter. • Changes to surface water regimes.



NorthLinkWA	coffey A TETRA TECH COMPANY	Date: 21.08.2018 MXD: 4483AA_59_GIS001_3 File Name: 4483AA_59_F001_GIS	Perth–Darwin National Highway Indirect Impacts and Threatened Flora and Communities Condition EMP	Proposal overview Figure No: 1

The threatening processes from indirect impacts have been identified in Table 2 and can cause the degradation of native flora and vegetation.

The following indirect impacts could occur as result of the proposal:

- The spread of weeds along the alignment and outside of the development envelope may occur due to vehicles carrying weeds and seeds along the road. Cleared areas along the road reserve will make it easier for weeds to establish. Changes to surface water regimes may be a vector for the spread of weeds.
- The presence of the proposal may make it easier for people to access adjacent bushland and dump rubbish.
- Fire risk could be increased with the potential for vehicles to cause fires, e.g. vehicle incidents resulting in fire, lit cigarettes discarded from passing vehicles. Litter may be thrown out of moving vehicles, or unsecured items could be blown into the road reserve.
- Surface water flows in vegetation immediately abutting the road reserve may be altered as a result of embankments, cuttings and drainage infrastructure. The hard surface of the road could create localised run-off that would otherwise infiltrate into the ground, particularly in areas with sandy soils.

Some external threatening processes that are not a result of the proposal could cause similar impacts, including:

- Climate change (i.e. drought, flooding and increased temperature) could preference some species over others through water availability, temperature and other climatic conditions.
- Indirect impacts from other developments in the area (i.e. impacts to *Grevillea curviloba* subsp. *incurva* caused by its proximity to existing Brand Highway and to *Caladenia huegelii* from the ongoing development and proximity of Ellenbrook housing estate).
- Impacts resulting from unauthorised access into areas of native vegetation (e.g. impacts from dumping of rubbish) could still continue if native vegetation is accessed from existing roads and properties other than the proposal. MRWA will be able to control access only from the road reserve.
- Change in surface water regimes due to an adverse weather event such as increased flooding in the area.

2.3 Requirements of the Conditions

This plan is submitted in accordance with Ministerial Statement No. 1036 condition 7-1, and Ministerial Statement 1116 conditions 10-1 and 10-2 for the proposal.

As required under condition 5-1 of Ministerial Statement 1036, this plan will be made publicly available for the life of the proposal.

The requirement of these conditions and where they are addressed in this plan are described in Table 3.

The former OEPA was replaced by the Department of Water and Environmental Regulation (DWER) EPA Services Division on 1 July 2017. References to OEPA in this plan have been changed to DWER except for historical usage and direct quotations of the condition text from Ministerial Statement No. 1036.

The former of Department of Parks and Wildlife (DPAW) was replaced by the Department of Biodiversity, Conservation and Attractions (DBCA) on 1 July 2017. All references to DPAW in this plan are historical and have been retained.

Table 3 Summary of conditions

Condition No.	Condition	Section in this plan
Ministerial Statement 1036		
7-1	Prior to the commencement of ground disturbing activities, or as otherwise agreed in writing by the CEO, the proponent shall prepare and submit Condition Environmental Management Plans to satisfaction of the CEO to demonstrate that the environmental objectives in condition 10-1 of Ministerial Statement 1116 will be met.	This plan
7-2	The Condition Environmental Management Plans shall: 1. Prioritise risk-based management actions that will be implemented to meet the environmental objectives in condition 10-1 of Ministerial Statement 1116.	Section 3.2
	2. Specify measurable management targets for determining the efficacy of the risk-based management actions.	Sections 1 and 3.3
	3. Specify monitoring to be conducted to measure the efficacy of management actions against management targets.	Section 3.4
	4. Specify, in the event that the management targets are not achieved a procedure for revision of management actions and changes to proposal activities. The procedure shall include an investigation to determine the cause of the management targets being exceeded.	Section 3.5
	5. Provide the format and timing for annual reporting required by condition 4-6 of Ministerial Statement 1036 for: a) Verification of the implementation of management actions to demonstrate that condition 10-1 of Ministerial Statement 1116 has been met for the reporting period. b) Reporting on the efficacy of management actions against management targets.	Section 3.6.1
	6. Provide for reporting when management actions are not implemented.	Section 3.6.2
7-3	After receiving notice in writing from the CEO that the Condition Environmental Management Plan(s) satisfies the requirements of condition 7-2 for conditions 9- 1, 10-1 [of Ministerial Statement 1116], 11-1, 12-1 and 15-1, the proponent shall prior to the commencement of ground disturbing activities: 1. Implement the provisions of the Condition Environmental Management Plan. 2. Continue to implement the approved Condition Environmental Management Plan until the CEO has confirmed by notice in writing that the proponent has met the relevant objectives specified in the approved Condition Environmental Management Plan and no longer needs to implement that particular Condition Environmental Management Plan.	Section 3
7-4	In the event that monitoring, tests, surveys or investigations indicate that management actions specified in the Condition Environmental Management Plan are not implemented or that management targets specified in the Condition Environmental Management Plans are exceeded, the proponent shall: 1. Report the exceedance or failure to implement management actions in writing within 7 days of identification.	Section 3.6.2

Condition No.	Condition	Section in this plan
	2. Investigate to determine the cause of the management actions not being implemented and/or management targets being exceeded.	Section 3.5
	3. Investigate to provide information for the determination by the CEO of potential environmental harm or alteration of the environment that occurred due to the failure to implement management actions.	Section 3.5
	4. Provide a report to the CEO within 60 days of the reporting required by condition 7-4(1) of Ministerial Statement 1036. The report shall include: a) Cause for failure to implement management actions and/or management targets exceeded. b) The findings of the investigation required by conditions 7-4(2) and 7-4(3). c) Details of revised and/or additional management actions to be implemented to prevent exceedance of the management targets and/or ensure implementation of management actions. d) Relevant changes to proposal activities. e) Measures to prevent, control or abate the environmental harm which may have occurred.	Section 3.6.2
7-5	The proponent may review and revise the Condition Environmental Management Plans, or as otherwise specified by the CEO.	Sections 3.5 and 4.2
7-6	The proponent shall implement the latest revision of the Condition Environmental Management Plan, which the CEO has confirmed by notice in writing, satisfies the requirements of condition 7-2 of Ministerial Statement 1036.	Section 4.2
Ministerial Statement 1116		
10-1	The proponent shall manage the implementation of the proposal to meet the following environmental objectives: 1. to ensure that indirect impacts, including but not limited to weeds, unauthorised access, increased fire risk and litter, changes to surface water regimes, to flora and vegetation, including but not limited to *Caladenia huegelii* habitat, *Grevillea curviloba* subsp. *incurva, Darwinia foetida,* Conservation Category Wetlands and *Communities of Tumulus Springs (Organic Mound Springs, Swan Coastal Plain)* are minimised as far as practicable; and 2. to maintain or improve the condition of the remaining extent of SCP20a as shown in figure 4 of Ministerial Statement 1036, through implementation of the Flora and Vegetation – Indirect Impacts and Threatened Flora and Communities – Condition Environmental Management Plan approved by the CEO.	Sections 1 and 3.3
10-2	The proponent shall prepare the Flora and Vegetation – Indirect Impacts and Threatened Flora and Communities – Conditional Environmental Management Plan required by condition 7-1 of Ministerial Statement 1036 on advice of the Department of Biodiversity, Conservation and Attractions.	Section 5

2.4 Rationale and Approach in Meeting the Environmental Objective

Results of baseline surveys and a number of assumptions and uncertainties inform the management approach for meeting the condition environmental objective stated in Section 1. The identified management

actions, management targets and proposed review and revision of management actions are aligned with the overall management approach.

2.4.1 Results of Flora and Vegetation Surveys Conducted

A Level 2 flora and vegetation survey was conducted in September and November 2014 of the development envelope and surrounding areas in accordance with relevant guidelines and policies (Coffey, 2015a). The survey built on previous surveys carried out in 2012 (GHD, 2013) and 2013 (360 Environmental, 2014).

The study area for the Level 2 spring flora and vegetation survey included the whole development envelope and extended to the surrounding area to provide local and regional context. A total of 120 flora sampling sites were established and sampled (Coffey, 2015a). The survey included re-sampling 29 quadrats previously established in 2013 by 360 Environmental.

Conservation Significant Flora

The Threatened flora recorded from the flora study area include (Coffey, 2015a):

- *Caladenia huegelii* (Critically Endangered (CR) – State and Endangered (EN) – Commonwealth).
- *Darwinia foetida* (EN – State and CR – Commonwealth).
- *Grevillea curviloba* subsp. *incurva* (EN – State and Commonwealth).

Vegetation

Five vegetation complexes of the Swan Coastal Plain (SCP) occur within the development envelope:

- Bassendean Complex – Central and South.
- Bassendean Complex – North Transition.
- Bassendean Complex – North.
- Southern River Complex.
- Yanga Complex.

The Bassendean Complex – Central and North, Southern River Complex and Yanga Complex are all below the EPA's 30% retention target of pre-European extent remaining (EPA, 2015). However, Bassendean Complex – Central and North and Southern River Complex occur within a "constrained area" and are above the 10% threshold of pre-European extent remaining in a constrained area (EPA, 2015). Only the Yanga Complex is considered to be under-represented. This complex is also below the 10% Bush Forever protection target (DOP, 2015).

Conservation Significant Vegetation

A total of 18 Threatened Ecological Communities (TECs) and Priority Ecological Communities (PECs) were mapped or were considered likely to occur within the flora study area. Three TECs and five PECs were recorded within the development envelope (Coffey, 2015a) as follows:

- Claypans of the Swan Coastal Plain (SCP) TEC (P1 – State and CR – Commonwealth).
- Tumulus Springs (Organic Mound Springs SCP) TEC (EN – State and CR – Commonwealth).
- SCP20a – *Banksia attenuata* woodlands over species rich dense shrublands TEC (EN – State).
- SCP21c – Low lying *Banksia attenuata* woodlands or shrublands PEC (P3 – State).
- SCP22 – *Banksia ilicifolia* woodlands PEC (P2 – State).
- SCP23b – Northern *Banksia attenuata* – *Banksia menziesii* woodlands PEC (P3 – State).

- SCP24 – Northern Spearwood shrublands and woodlands PEC (P3 – State).
- *Banksia* dominated woodlands on the Swan Coastal Plain PEC (P3 – State).

Claypans of the SCP TEC is no longer considered at risk of direct or indirect impacts as a result of proposal activities. Emerge Associates conducted further vegetation survey at the site mapped as Claypans of the SCP TEC in the original Ministerial Statement No. 1036 and found that the vegetation was not representative of the TEC (Emerge Associates, 2017). This conclusion was supported by DPAW (V. English, pers. com., 2016).

2.4.2 Results of the Wetland Assessment

A wetland assessment of the development envelope and surrounding areas was undertaken in conjunction with the Level 2 flora and vegetation survey in September 2014, in accordance with relevant guidelines and polices (Coffey, 2015b).

A total of 56 samples sites within the 120 flora and vegetation sampling sites were located in wetlands. These sites were located randomly within structural communities.

The wetland assessment involved a desktop assessment, site visit and a wetland review.

Seven conservation category wetlands (CCWs) will be directly and indirectly impacted by the proposal. A further two CCWs are within 10 m of the proposal and may be indirectly impacted by the proposal. The CCWs have intact native vegetation in good or better condition (Coffey, 2015b).

Table 4 indicates the CCWs that will be directly and indirectly impacted by the proposal.

Table 4 Conservation category wetlands impacted by the proposal

Wetland unique feature identifier	Directly impacted	Indirectly impacted
8416	Yes	Yes
8773	Yes	Yes
8792	Yes	Yes
8802	No	Yes
8909	Yes	Yes
8926	No	Yes
15028	Yes	Yes
15033	Yes	Yes
15260	Yes	Yes

2.4.3 Key Assumptions and Uncertainties

The key assumption and uncertainties within this plan include:

- The flora and vegetation surveys were sufficient to identify the presence of conservation significant flora and communities adjacent to the proposal footprint.
- Indirect impacts to Threatened flora and communities are primarily due to edge effects such as the spread of weeds, increased occurrence of rubbish dumping and unauthorised access, increased fire risk and litter and changes to surface water regimes.
- Vegetated buffers and access controls are effective in minimising indirect impacts on Threatened flora and communities.

- The proposed parameters (used to monitor indirect impacts) are sufficient to determine whether the condition of the vegetated buffers, and therefore habitat, is being maintained.
- Installation of culverts will minimise changes to surface water regimes in order to maintain existing regimes and minimise indirect impacts caused by the alteration of surface flows.
- Installation of bio-retention swales and basins will also minimise changes to surface water regimes.
- Variation in climate or weather patterns may influence the monitoring results and cannot be controlled by management actions.
- *Caladenia huegelii* may not flower every season and therefore failure to detect the species during one monitoring period is not necessarily an indication that a management target has not been met.
- Any rubbish dumping and unauthorised access observed to be from areas other than the proposal (i.e. areas not in MRWA's control) will be recorded during monitoring.
- Threatened flora may be impacted by disturbance from other effects due to the close proximity to Ellenbrook housing estate and Brand Highway.

2.4.4 Management Approach

The management approach has been informed by best practice and recent experience on similar road projects in Western Australia. The hierarchical approach taken focuses on management aims to minimise indirect impacts to flora and vegetation and maintain the condition of the remaining extent of SCP20a.

2.4.5 Rationale for Choice of Management Target

The rationale for the choice of management targets is described below.

Management target 1: Limit the extent of indirect impacts to no more than 10 m from the new edge of native vegetation adjacent to Communities of Tumulus Springs (Organic Mound Springs, Swan Coastal Plain) and Conservation Category Wetlands.

Clearing native vegetation will create a new vegetation edge where increased light, dust, wind, weeds, litter and unauthorised access and changes to surface water flows and quality could degrade vegetation. The edge-affected area will be a modified ecosystem or ecotone. The condition of this ecosystem will be a gradient that reflects the extent and severity of the processes contributing to indirect impacts.

The average width of indirect impacts on other major MRWA road projects has been demonstrated to be less than 10 m and in some cases almost zero where road fill batters are present (South Metro Connect, 2011). Van Etten (2014) concluded that with management in place, the maximum indirect impacts on damplands including waterlogged and flooded areas after 10 years could be around 3 m.

The area exposed to indirect impacts will include fringing vegetation of CCWs.

Management target 2: Limit the extent of indirect impacts to no more than 10 m from the new edge of native vegetation in areas of *Caladenia huegelii* habitat.

This management target focuses on minimising indirect impacts on the Threatened species *Caladenia huegelii* by limiting the extent of indirect impacts to within 10 m of the new edge of native vegetation. The persistence of the *Caladenia huegelii* individual depends on the maintenance of habitat immediately surrounding it.

Management target 3: The number of individuals of *Grevillea curviloba* subsp. *incurva* in the Brand Highway road reserve at Muchea is maintained.

This management target focuses on minimising indirect impacts on the Threatened species *Grevillea curviloba* subsp. *incurva* by limiting indirect impacts to the 10 m vegetation buffer around two individuals of

Grevillea curviloba subsp. *incurva* in the Brand Highway road reserve at Muchea. The persistence of the *Grevillea curviloba* subsp. *incurva* individuals can be monitored directly, but it also depends on the maintenance of habitat immediately surrounding them.

Management target 4: The number of individuals of *Darwinia foetida* in the Great Northern Highway road reserve at Muchea is maintained.

This management target focuses on minimising indirect impacts on this population by limiting indirect impacts within the 10 m vegetation buffer around the plants. The persistence of the *Darwinia foetida* individuals can be monitored directly, but it also depends on the maintenance of habitat immediately surrounding them and ensuring no project or ground disturbance activities are conducted within the local catchment to maintain the existing surface water regime.

Management target 5: Maintain or improve the condition of remaining extent of SCP20a as shown in Figure 4 of Ministerial Statement 1036.

This management target focuses on maintaining the condition of the three remnants of SCP20a that are located outside, but adjacent to the development envelope, through limiting the extent of indirect impacts as a result of the proposal.

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3 CONDITION EMP PROVISIONS

3.1 Condition Environmental Objective

Condition 10-1 of Ministerial Statement 1116 sets out the environmental objectives to be met, namely:

- To ensure that indirect impacts, including but not limited to weeds, unauthorised access, increased fire risk and litter, changes to surface water regimes, to flora and vegetation, including but not limited to *Caladenia huegelii* habitat, *Grevillea curviloba* subsp. *incurva*, *Darwinia foetida*, Conservation Category Wetlands and Communities of Tumulus Springs (Organic Mound Springs, SCP) are minimised as far as practicable.
- To maintain or improve the condition of the remaining extent of SCP20a outside the development envelope as shown in figure 4 of Ministerial Statement 1036.

3.2 Management Actions to be Implemented

Risk-based management actions have been identified and prioritised to achieve the condition environmental objective (Table 5). These management actions focus the greatest management effort on reducing vegetation degradation from indirect impacts beyond the development envelope and loss of Threatened flora species and ecological communities. These management actions were specifically developed to ensure that impacts to conservation significant flora, CCWs, Communities of Tumulus Springs and SCP20a are minimised as far as practicable and will be implemented by MRWA for the Perth–Darwin National Highway (Swan Valley Section) Project.

Management actions listed in Table 5 will commence during construction (unless otherwise stated) and will continue to be implemented in line with condition 7-3(2) of Ministerial Statement 1036.

Table 5 Management actions to be implemented to achieve the environmental objectives

Risk and key impacts	Management actions	Risk-based priority
Vegetation loss and degradation through indirect impacts	Weeds and disease will be managed in accordance with the Flora and Vegetation – Construction – Condition Environmental Management Plan to minimise the possibility of their introduction and establishment. Newly identified declared weeds within the development envelope will be managed in accordance with the *Biosecurity and Agriculture Management Act 2007* and subsidiary regulations. Periodic weed spraying will be undertaken to control weeds where required. Establish landscaping and/or revegetation on roadside batters as quickly as practicable post-construction to reduce the risk of weed establishment on the batters and invasion of adjacent native vegetation.	High
	The road reserve will be fenced adjacent to native vegetation to reduce the spread of litter. Regular maintenance activities during operation will include litter removal.	
	To reduce the fire risk:	

Risk and key impacts	Management actions	Risk-based priority
	• Mulch at intersections will not contain fines that may be ignited by cigarettes. • Control grassy weeds within the road reserve. • Close side tracks (except at designated intersections and emergency vehicle access points) to prevent illegal or inappropriate access to adjacent native vegetation. This will reduce the possibility of an arsonist easily accessing remote bushland.	
	Revegetation will be conducted progressively where practicable.	
SCP20a	Map full extent of SCP20a within Whiteman Park west of Beechboro Road.	Medium
	Monthly inspections will be undertaken for weeds and litter in the remaining extent of SCP20a as shown in Figure 4 of Ministerial Statement 1036.	
	Implement weed control (see actions in Vegetation loss and degradation through indirect impacts) outside and inside the remaining extent of SCP20a (subject to approval from Whiteman Park).	
	Remove any litter found within the vicinity of the remaining extent of SCP20a (subject to approval from Whiteman Park).	
	Fence area of road adjacent to the remaining extent of SCP20a to reduce the spread of litter.	
Changes in surface water regime	Culverts will be designed and installed to maintain surface water flows in accordance with the drainage strategy.	Medium
	Maintain culverts to prevent backwater or ponding of water.	
	Maintain bio-retention swales and infiltration basins to prevent backwater or ponding of water.	
	Install appropriate controls such as temporary pipes to prevent backwater or ponding of water during construction.	

Other management actions that address potential impacts to surface water regimes are contained in the Infrastructure Plan (Terrestrial Fauna, Hydrological Processes, Inland Waters Environmental Quality, Amenity (Noise)) and the Flora and Vegetation – Inland Waters Environmental Quality – Hydrological Processes Condition Environmental Management Plan.

3.3 Management Target

Management targets will be used to measure and report against achievement of the environmental objectives (Table 6).

Table 6 Management targets to measure the efficacy of management actions relative to the environmental objective

Item	Detail
Condition environmental objective	To ensure that indirect impacts, including but not limited to weeds, unauthorised access, increased fire risk and litter, changes to surface water regimes, to flora and vegetation, including but not limited to *Caladenia huegelii* habitat, *Grevillea curviloba* subsp. *incurva*, *Darwinia foetida*, Conservation Category Wetlands and *Communities of Tumulus Springs (Organic Mound Springs, Swan Coastal Plain)* are minimised as far as practicable. To maintain or improve the condition of the remaining extent of SCP20a as shown in Figure 4 of Ministerial Statement 1036.
Management targets	**Management target 1:** Limit the extent of indirect impacts to no more than 10 m from the new edge of native vegetation adjacent to Communities of Tumulus Springs (Organic Mound Springs, Swan Coastal Plain) and Conservation Category Wetlands.
	Management target 2: Limit the extent of indirect impacts to no more than 10 m from the new edge of native vegetation in areas of *Caladenia huegelii* habitat.
	Management target 3: The number of individuals of *Grevillea curviloba* subsp. *incurva* in the Brand Highway road reserve at Muchea is maintained.
	Management target 4: The number of individuals of *Darwinia foetida* in the Great Northern Highway road reserve at Muchea is maintained.
	Management target 5: Maintain or improve the condition of remaining extent of SCP20a as shown in Figure 4 of Ministerial Statement 1036.

3.4 Monitoring

The purpose of monitoring is to inform, through the management targets, if the condition environmental objectives are being achieved or whether management actions need to be reviewed and revised.

Monitoring will be undertaken for each management target as detailed in Table 7. The method, location, parameters and frequency of monitoring is specified. Early warning indicators provide advance warning that a management target may not be met. The results of monitoring will be compared against early warning indicators to enable actions to be put in place to control the contributing processes so that the management objective can be met.

Note that potential changes to surface water regimes will be monitored in accordance with the Flora and Vegetation – Inland Waters Environmental Quality – Hydrological Processes Condition Environmental Management Plan.

3.4.1 Monitoring Site Selection

Monitoring sites have been selected in locations relevant to measuring the efficacy of management actions. Monitoring sites are listed in Appendix A and shown in Figure 2.

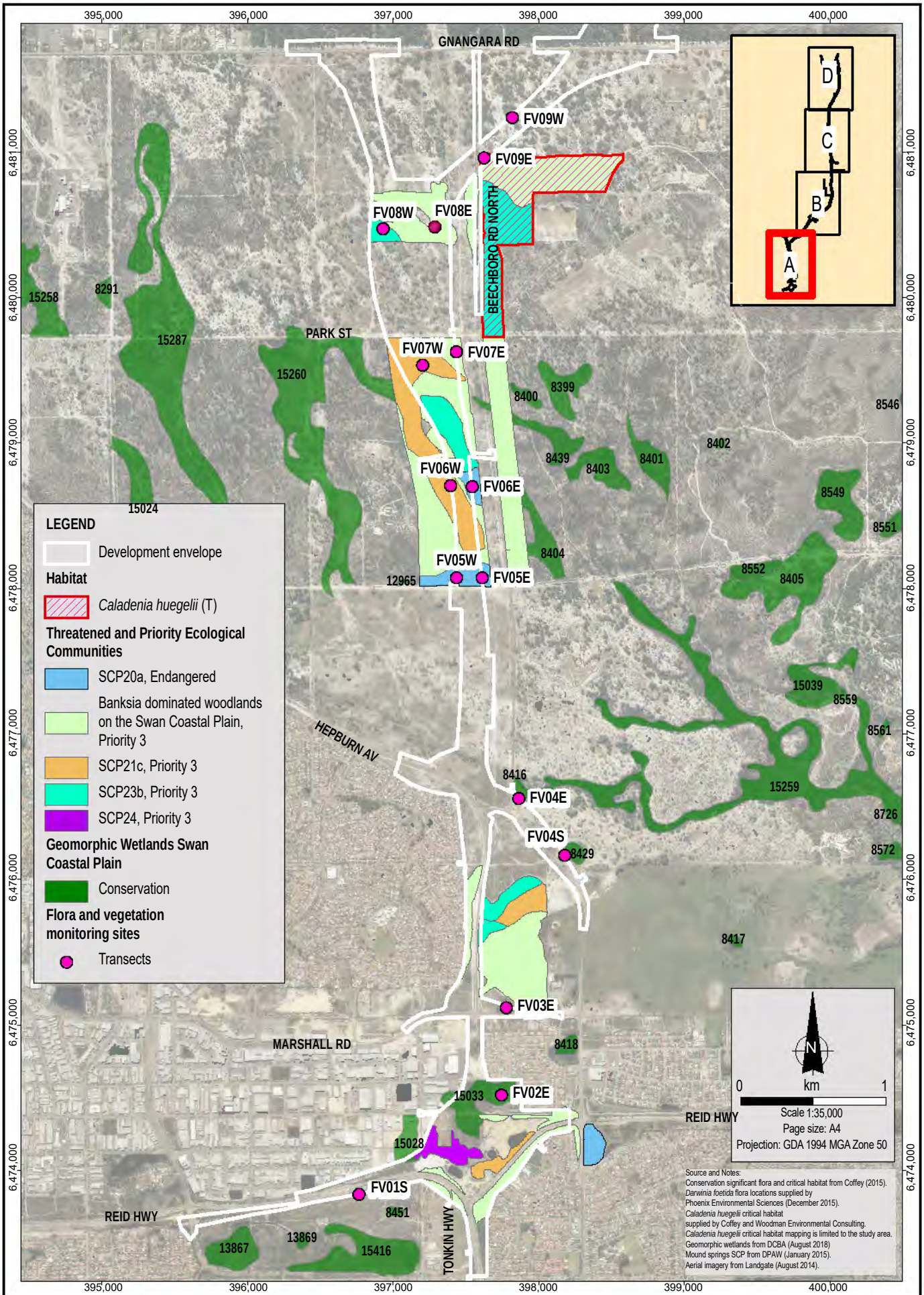
Table 7 Monitoring to measure the efficacy of management actions against the management targets

Indicator	Method	Location	Parameters	Frequency	Early warning indicator
Indirect impacts	Visual observations of selected parameters at 5 m intervals, along a 30 m long transect at each monitoring site. Record observations within a plot at each 5 m interval. Photographic record of transect. Refer to Appendix B for detailed method including transect and plot design and placement.	At monitoring sites (transects) as shown in Figure 2 and listed in Appendix A, specifically: **Remnant vegetation:** FV01S, FV03E, FV07W, FV07E, FV08W, FV08E, FV09E, FV09W, FV11E, FV13S, FV13E, FV14N, FV15N, FV15S, FV16E, FV17W, FV17S, FV17E, FV19W, FV22E, FV23W, FV26E, FV26W, FV29E, FV33W, FV33E, FV34W, FV34E, FV35W, FVB1N, FVB1S. **CCWs:** FV02E, FV04S, FV04E, FV06W, FV16W, FV16N, FV18W, FV19E, FV24E, FV28E. **Communities of Tumulus Springs (Organic Mound Springs, SCP):** FV29W.	• Perennial native vegetation cover (%) and species diversity (richness and abundance). • Introduced vegetation (weed) cover (%) and species diversity (richness and abundance). • Level of dust. • Plant deaths. • Presence of wind throw. • Litter (rubbish) presence. • Vegetation condition (Keighery, 1994). • Evidence of unauthorised access (from the road reserve). • Evidence of fire caused by construction or maintenance activities. • Broad vegetation structure. • Presence of conservation significant flora. • Backwater/ponding (during construction only).	Baseline in spring prior to construction. Quarterly during construction. In spring annually post-construction. Quarterly post-construction for weeds.	Indirect impacts extend into remnant vegetation further than: • 6 m; or • 3 m in one year.

Indicator	Method	Location	Parameters	Frequency	Early warning indicator
		***Caladenia huegelii* habitat:** FV15N, FV15S, FV16E, FV16N, FV17S, FV17W, FV17E. **SCP20a:** FV05W, FV05E, FV06E.			
	Visual observations by an experienced botanist. Recording of locations of weeds by GPS and photographs.	In remaining extent of SCP20a as shown on Figure 4 of the Ministerial Statement.	• Number, species and location of weeds. • Litter (rubbish) presence.	Monthly during construction. Quarterly post-construction.	Increase in weed numbers, species or locations. Increase in litter.

Indicator	Method	Location	Parameters	Frequency	Early warning indicator
Loss of Threatened flora	Visual observations of selected parameters within buffer monitoring sites. Photographic record of buffer.	In vegetated buffers established around known Threatened flora (as shown in Figure 2D and listed in Appendix A), specifically: • FVB2B – *Grevillea curviloba* subsp. *incurva* 10 m buffer. • FV37B – *Darwinia foetida* 10 m buffer.	• Indirect impact parameters (refer to Appendix B and first row of this table). • Number and condition of *Grevillea curviloba* subsp. *incurva* individuals (FVB2B only). • Number and condition of *Darwinia foetida* individuals (FV37B only).	Baseline in spring prior to construction. Quarterly during construction. Quarterly post-construction.	Indirect impacts extend into a buffer further than: • 3 m of the buffer radius in total; or • 2 m of the buffer radius in one year. Decrease in plant condition of *Grevillea curviloba* subsp. *incurva* or *Darwinia foetida*.
Changes in surface water regime	Visual observation and measurement of backwater or ponding of water. Photographic record.	During construction, edge of the development envelope once area has been cleared. Once after construction is complete, drainage infrastructure, specifically: • On PDNH: – Culverts (upstream and downstream). – Bio-retention swales. – Infiltration basins.	• Backwater or ponding of water.	Immediately after significant rainfall events (over 15 mm rainfall in 24 hours), and then daily for three days during construction Once annually post construction (in August) immediately after significant rainfall event (over 15 mm rainfall in 24 hours), and then daily for three days.	Presence of backwater or ponding of water over a period of two consecutive days at distances further than 6 m from the edge of the development envelope.

Indicator	Method	Location	Parameters	Frequency	Early warning indicator
Changes in surface water regime	Visual observation for evidence of unauthorised project activity or ground disturbance. Photographic record.	• Local catchment for *Darwinia foetida*; i.e. on Great Northern Highway; i.e. road train assembly area. • Local catchment for *Grevillea curviloba* subsp. *incurva*; i.e. existing road reserve between Brand Highway and the railway adjacent to the known *Grevillea curviloba* subsp. *incurva* population.	• Evidence of unauthorised project activity or ground disturbance.	Weekly during construction.	Not applicable.



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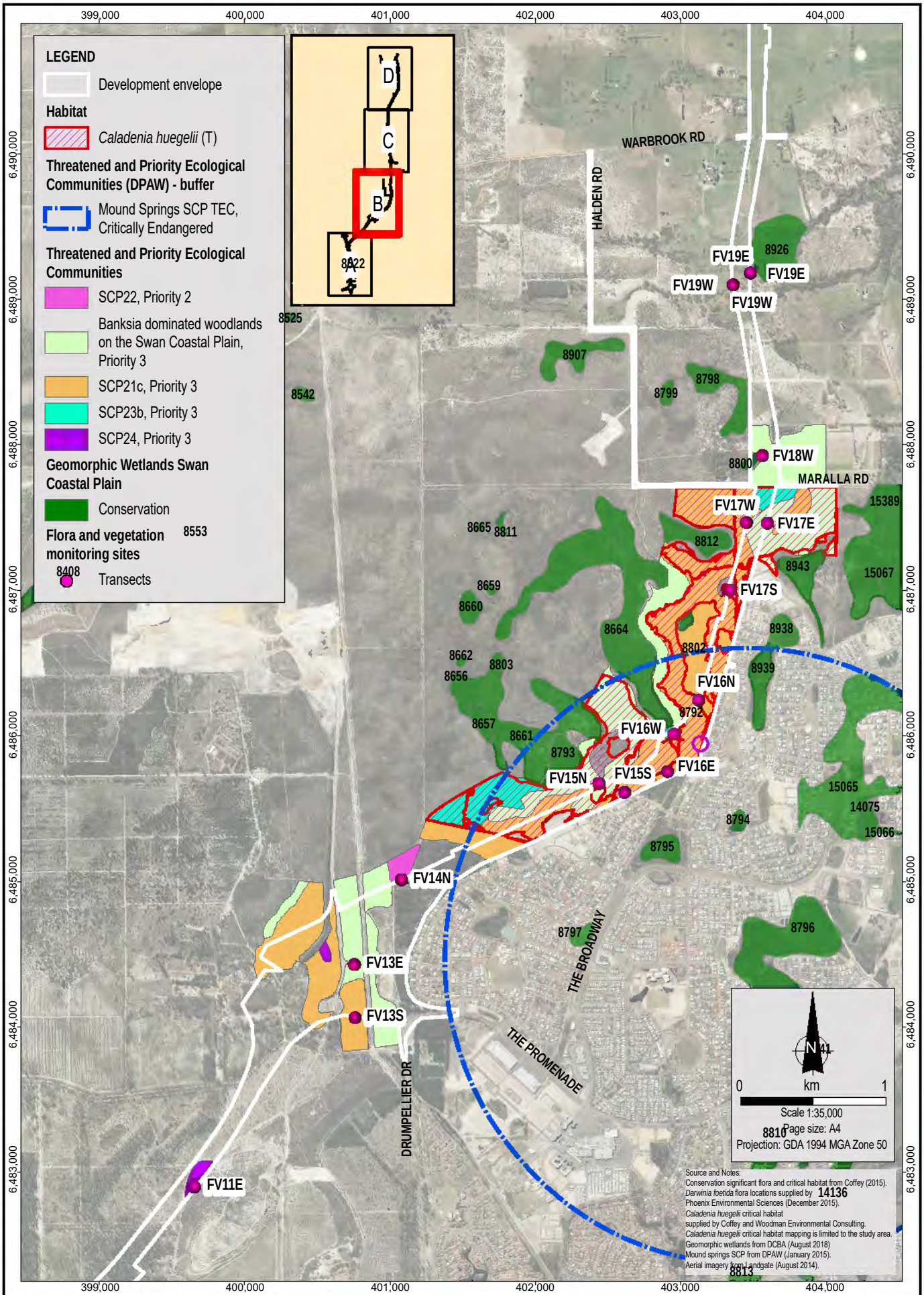
Date: 21.08.2018
MXD: 4483AA_59_GIS002_8
File Name: 4483AA_59_F002A_GIS

Perth-Darwin National Highway

Indirect Impacts and Threatened Flora and Communities Condition EMP

Locations of transects/buffers in relation to Threatened flora and vegetation communities - Map 1 of 4

Figure No: 2A



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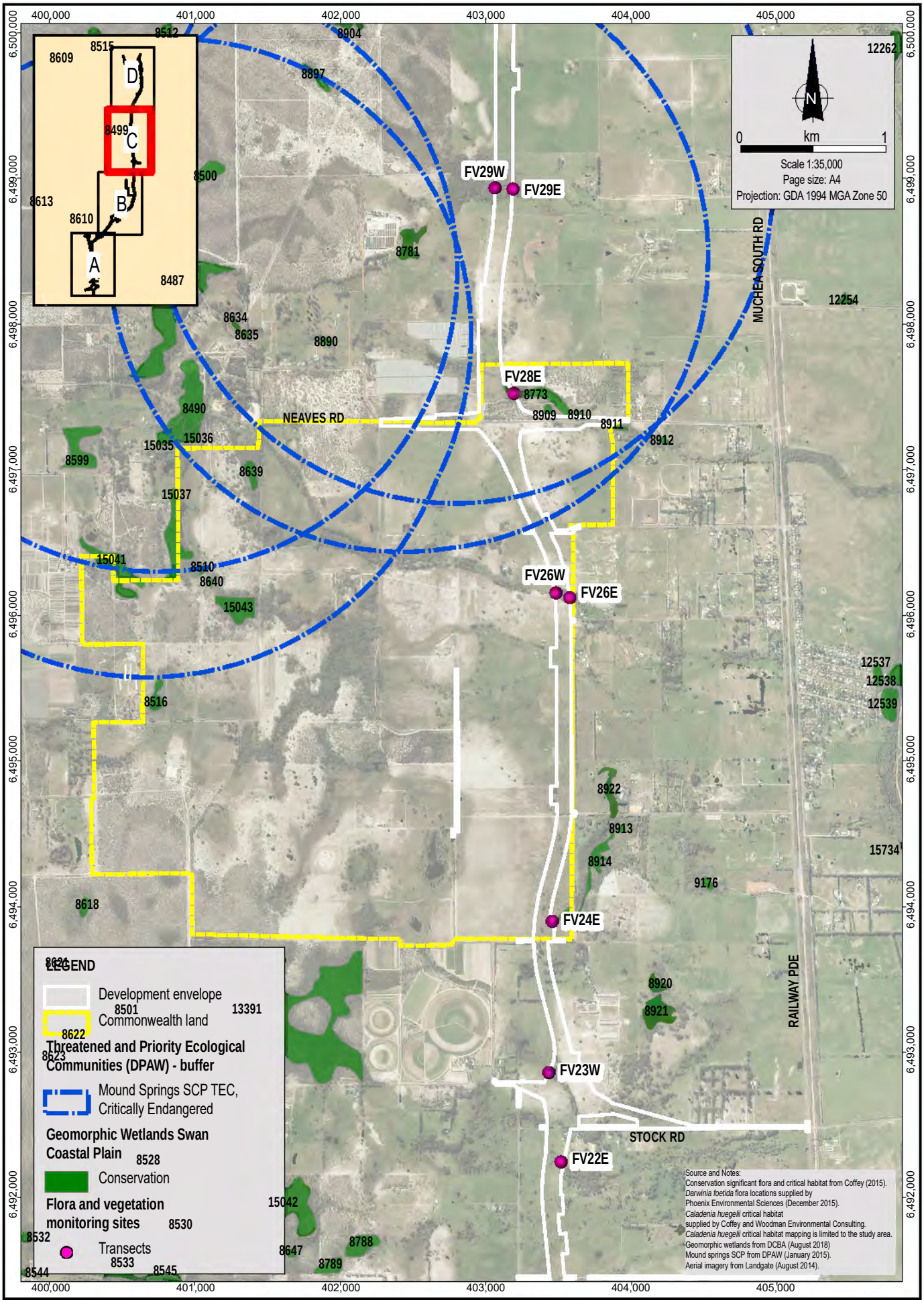
Date: 21.08.2018
MXD: 4483AA_59_GIS002_8
File Name: 4483AA_59_F002B_GIS

Perth-Darwin National Highway

Indirect Impacts and Threatened Flora and Communities Condition EMP

Locations of transects/buffers in relation to Threatened flora and vegetation communities - Map 2 of 4

Figure No: 2B



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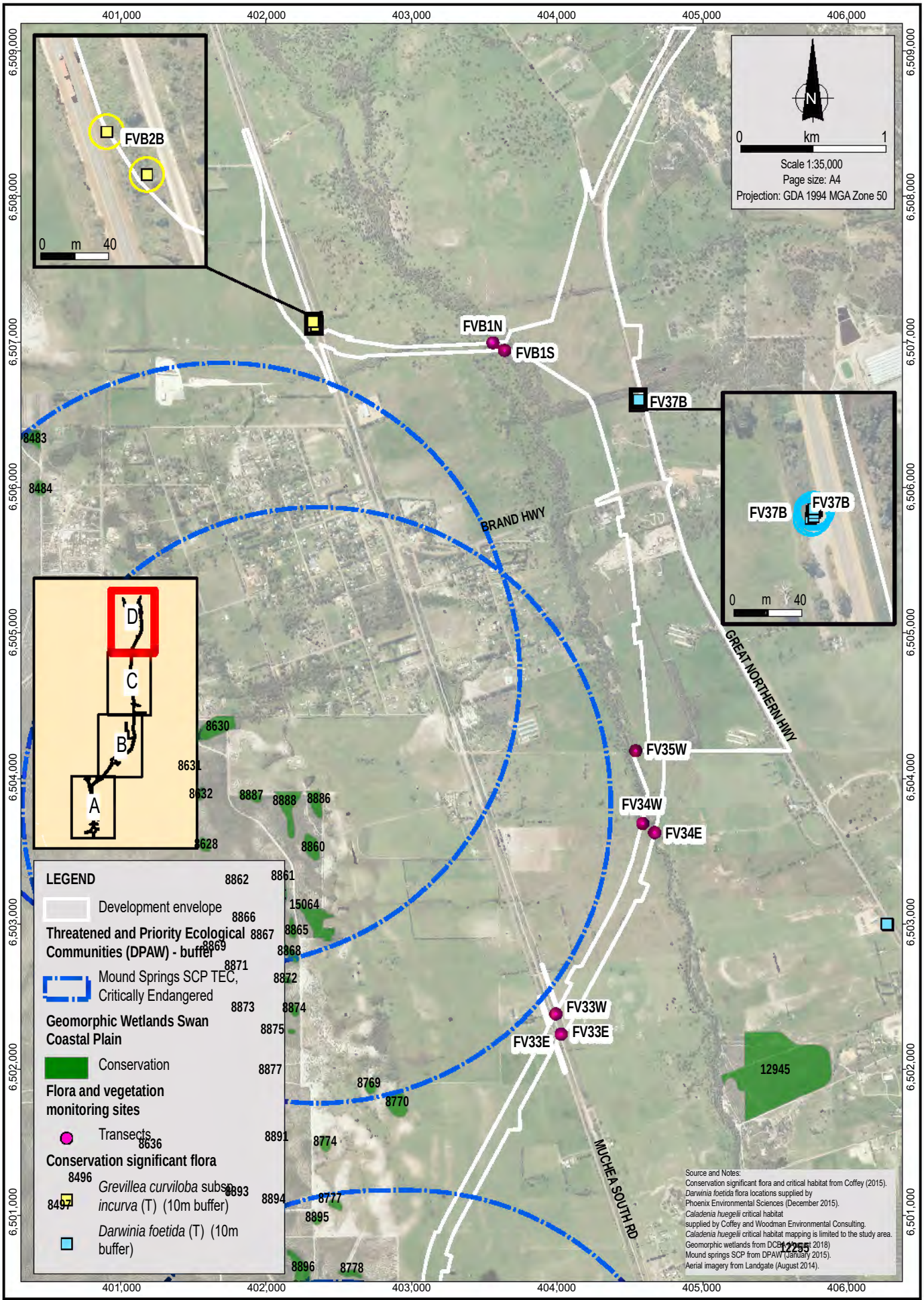
Date: 21.08.2018
MXD: 4483AA_59_GIS002_8
File Name: 4483AA_59_F002C_GIS

Perth-Darwin National Highway

Indirect Impacts and Threatened Flora and Communities Condition EMP

Locations of transects/buffers in relation to Threatened flora and vegetation communities - Map 3 of 4

Figure No: 2C



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Date: 21.08.2018
MXD: 4483AA_59_GIS002_8
File Name: 4483AA_59_F002D_GIS

Perth-Darwin National Highway

Indirect Impacts and Threatened Flora and Communities Condition EMP

Locations of transects/buffers in relation to Threatened flora and vegetation communities - Map 4 of 4

Figure No: 2D

Justification for chosen monitoring site locations for each management action indicator are provided below.

Indirect Impacts

Transect monitoring sites for indirect impacts (shown in Figure 2) have been selected in remnant vegetation along the development envelope within (or within the vicinity of) CCWs, Communities of Tumulus Springs (Organic Mound Springs, SCP), *Caladenia huegelii* habitat and SCP20a.

The conservation significant values targeted and/or present at each monitoring site are set out in Appendix A.

Parts of the development envelope are located on land that is Completely Degraded due to existing clearing or farming activities. Transect monitoring sites have not been located in these areas.

Loss of Threatened Flora

Monitoring sites for loss of Threatened flora have been selected in buffers established around known locations of Threatened flora, specifically *Grevillea curviloba* subsp. *incurva* and *Darwinia foetida* (Figure 2).

Changes in Surface Water Regime

After significant rainfall events (over 15 mm in 24 hours), the edge of the development envelope (during construction) will be inspected for ponding to determine if the drainage system is functioning to maintain the surface water regime as far as is practicable. Following construction, culverts, bio-retention swales and infiltration basins will be inspected annually in August for three years', or until the CEO has confirmed by notice in writing that the proponent has met the relevant objectives.

To monitor any disturbance that may lead to changes in surface water regimes that will impact on *Darwinia foetida* and *Grevillea curviloba* subsp. *incurva*, upstream monitoring sites have been selected in:

- The local catchment area overlapping the development envelope for *Darwinia foetida*; i.e. Great Northern Highway's road train assembly area adjacent to the known *Darwinia foetida* population.
- The local catchment area overlapping the development envelope for *Grevillea curviloba* subsp. *incurva*; i.e. existing road reserve between Brand Highway and the railway adjacent to the known *Grevillea curviloba* subsp. *incurva* population.

3.4.2 Monitoring Method

A flora and vegetation survey method (transect-based monitoring for indirect impacts and walk-overs for monitoring Threatened flora buffers) has been developed (Appendix B) to detect changes in vegetation within the area potentially exposed to indirect impacts. The survey will provide information on the health of the flora and vegetation prior to, during and post-construction. Results from the ongoing monitoring program will be compared against the pre-construction survey. The results of the pre-construction survey will be provided to the Department of Water and Environmental Regulation (DWER).

The impact quadrats (located within the initial 10 m of the transect) will be compared against the control quadrats (located beyond the 10 m mark of the transect) along each transect. The results of monitoring will be graphically represented to show variation along the length of each transect over time. If any indirect impacts are occurring, they would be expected to be observed as a change over time in one or more parameters in the impact quadrats without a corresponding change being recorded in control quadrats. Over time, the comparison will also allow determination of whether indirect impacts, if any are occurring, are extending beyond the predicted 10 m from the new vegetation edge and into the control quadrats. Each transect will be tested independently from the remaining transects as the prevailing environment (i.e. vegetation structure, condition, environmental receptor) at each location will be different.

Monitoring will occur within remnant native vegetation as shown in Figure 2 and listed in Appendix A. These locations have been chosen as they are close to CCWs, Communities of Tumulus Springs (Organic Mound

Springs, SCP), *Caladenia huegelii* habitat and SCP20a and in vegetated buffers established around known locations of *Grevillea curviloba* subsp. *incurva* and *Darwinia foetida*. Completely degraded and non-native vegetation has been excluded from the monitoring program.

Monitoring sites (see Appendix A) will be established and marked by recording locations with a Global Positioning System (GPS). Monitoring will consist of observations and recording of the parameters set out in Table 7 for each monitoring site location.

Transects will extend perpendicular from the new vegetation edge into remnant vegetation for at least 30 m, where possible. Appendix B shows the general arrangement of a transect.

Monitoring of vegetated buffers established around known locations of *Grevillea curviloba* subsp*. incurva* and *Darwinia foetida* will be conducted by observation. Buffer radii relevant to each species are:

- Habitat within 10 m of *Grevillea curviloba* subsp*. incurva* individuals in the Brand Highway road reserve at Muchea.
- Habitat within 10 m of *Darwinia foetida* individuals in the Great Northern Highway road reserve at Muchea.

Monitoring for backwater or ponding of water will be conducted by observation along the boundary of the development envelope during construction and at culverts, bio-retention swales and infiltration basins post-construction. If backwater or ponding of water is present, the extent will be measured.

Monitoring for unauthorised project activity or ground disturbance will be conducted by observation within the local catchments overlapping the development envelope for *Darwinia foetida* and *Grevillea curviloba* subsp. *incurva*.

Evidence of fire will be readily determined during the monitoring of transects. Possible sources of the fire should be noted where possible to do so, e.g. a grass fire started by machinery operating in the development envelope versus a fire that is under management of Department of Fire and Emergency Services and has a known or approximated ignition point away from the development envelope.

3.4.3 Monitoring Program Review

The monitoring program will initially be reviewed post-construction. Subsequent reviews will occur every three years post-construction. The plan will be reviewed and revised (if required) ahead of any future construction relating to the ultimate design.

The monitoring program will also be reviewed in the event that there is an exceedance of the management targets or failure to implement a management action.

Details of the distance into the vegetated buffer around Threatened flora and communities that would trigger the early warning indicator are set out in Table 8 for each environmental value.

Table 8 Early warning indicators

Environmental value	Predicted impact / protection	Early warning distance/indicator	
		Total	In one year
Remnant vegetation (CCWs, Communities of Tumulus Springs (Organic Mound Springs, SCP), *Caladenia huegelii* habitat and SCP20a)	10 m indirect impacts	6 m	3 m
Grevillea curviloba subsp. *incurva*	10 m buffer	3 m	2 m
Darwinia foetida	10 m buffer	3 m	2 m

3.5 Review and Revision of Management Actions

Where an early warning indicator is triggered, management actions are not implemented and/or a management target is not met, MRWA will:

- Investigate the cause of the management actions not being implemented and/or management targets being exceeded. If an early warning indicator is triggered, investigate whether it was project-attributable.
- Investigate to determine potential environmental harm or alteration of the environment that occurred due to failure to implement management actions and identify any required changes to existing management actions.
- Review the management actions (see Table 5) and revise if required.
- Develop additional management actions where necessary.

Potential adaptive management actions are listed in Section 4.

3.6 Reporting Provisions

3.6.1 Annual Compliance Assessment Report

The annual compliance assessment report (CAR) will include a summary of compliance against the management actions detailed in Table 5. The results of monitoring undertaken in Table 7 will be included in appendices of the CAR including the following information:

- Documentation of monitoring undertaken.
- Comparison of monitoring results against the management targets and early warning indicators.
- Management actions undertaken, including revised or additional actions.

The CAR will also include information on the achievement or not of the condition environmental objectives (Table 9). If the environmental objectives have not been achieved during the reporting period, the CAR will include a description of the revised and/or additional management actions to be implemented to achieve the targets, and an analysis of monitoring data to discern trends.

The CAR will be submitted in accordance with condition 4-6 of Ministerial Statement 1036.

Table 9 Environmental management plan reporting table

Key environmental factor: Flora (Ministerial Statement 1116, conditions 10-1 and 10-2)		
Condition environmental objective and management targets set in the Condition EMP	**Reporting on the management objectives and management targets annually, commencing 12 months from the date of issue**	**Status[1]**
Condition environmental objective 1: To ensure that indirect impacts, including but not limited to weeds, unauthorised access, increased fire risk and litter, changes to surface water regimes, to flora and vegetation, including but not limited to *Caladenia huegelii* habitat, *Grevillea curviloba* subsp. *incurva*, *Darwinia foetida*, Conservation Category Wetlands and *Communities of Tumulus Springs (Organic Mound Springs, Swan Coastal Plain*) are minimised as far as practicable.	Indirect impacts to Threatened flora and communities were minimised as far as practicable. Management targets 1 to 4 have been met.	Yes / No
Condition environmental objective 2: To maintain or improve the condition of the remaining extent of SCP20a as shown in Figure 4 of Ministerial Statement 1036, through implementation of the Flora and Vegetation – Indirect Impacts and Threatened Flora and Communities – Condition Environmental Management Plan approved by the CEO.	The remaining extent of SCP20a along Beechboro Road North was maintained or improved. Management target 5 has been met.	Yes / No

Notes:
1. The status of achievement of the condition environmental objectives is indicated as follows:
Yes - condition environmental objective achieved.
No - condition environmental objective not achieved.

3.6.2 Reporting on Management Actions not Implemented or Exceedance of the Management Targets

In the event that the management target is exceeded (or not met), the CEO of DWER will be advised in writing within seven days of identification of the exceedance.

A report will be provided to the CEO of DWER within 60 days of a management target not being met including details on:

- The cause for failure to implement management actions and/or management targets to be exceeded.
- Findings of the investigation to determine potential environmental harm or alteration of the environment that occurred due to failure to implement management actions.
- Details of revised and/or additional management actions to be implemented to prevent exceedance of the management targets and/or ensure the implementation of management actions.
- Relevant changes to the proposal activities.
- Measures implemented to prevent, control or abate environmental harm which may have occurred.

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4 ADAPTIVE MANAGEMENT AND REVIEW OF THE CONDITION EMP

4.1 Adaptive Management

MWRA will implement adaptive management to respond to any issues identified in the implementation of management measures, monitoring and evaluation against the management targets, to more effectively meet the environmental objectives.

Potential adaptive management actions include:

- Introduction and/or spread of new weed species:
  - Determine/investigate cause/source (see Section 3.5).
  - Quarantine affected areas.
  - Restrict access to quarantined areas.
  - Eradicate (spraying or removal).
- Unauthorised access, and fire risk and littering:
  - Determine/investigate cause/source (see Section 3.5).
  - Review effectiveness of measures relating to unauthorised access, fire risk and litter control.
  - Reiterate to the workforce the importance of maintaining vegetated buffers, restricting access and good waste management.
- Changes to surface water regimes:
  - Determine/investigate cause/source (see Section 3.5).
  - Confirm validity of results.
  - Halt causal construction activities and/or consider changes to construction methods and controls.
- Reduction in condition of remaining extent of SCP20a:
  - Determine/investigate cause/source (see Section 3.5).
  - Confirm validity of results.
  - Review effectiveness of management actions.
  - Undertake further flora and vegetation surveys.
  - Revegetate areas of reduced vegetation condition within remaining extent of SCP20a (as shown in Figure 4 of Ministerial Statement 1036).

4.2 Review

This plan will be reviewed as required to determine if management actions require revision. Potential reasons or triggers for revising management actions include:

- Changes to construction methods and timing and operations.
- Trigger of early warning indicators specified in Table 8.
- New or revised information becoming available about Threatened flora and communities.
- Changes to action plans for Threatened flora and communities developed under state or federal legislation.

In accordance with condition 7-5 of Ministerial Statement 1036, MRWA may review and revise this plan or as otherwise specified by the CEO of DWER.

The implementation of this plan will be audited.

The latest version of this plan shall be implemented once the CEO of DWER has confirmed in writing that it satisfies the requirements of condition 7-2 of Ministerial Statement 1036.

This plan will continue to be implemented until directed otherwise by the CEO in accordance with condition 7-3(2) of Ministerial Statement 1036.

5 STAKEHOLDER CONSULTATION

MRWA consulted with stakeholders while developing this plan. This section provides a summary of consultation that occurred. The comments raised during consultation with stakeholders were considered in preparing this plan.

DPAW was consulted in accordance with condition 10-2 of Ministerial Statement 1036. It should be noted that condition 10-2 of Ministerial Statement 1036 has since been deleted and replaced with condition 10-2 of Ministerial Statement 1116 which refers to DPAW under its current name: the Department of Biodiversity, Conservation and Attractions (DBCA).

Table 10 presents a summary of consultation and MRWA's response.

Table 10 Stakeholders consulted, comments and responses

Date	Organisation	Summary of consultation	MRWA response to comment/concern
13 September 2016	DPAW – Swan Region and Environmental Management Branch	DPAW provided comments on this plan.	MRWA took into account DPAW's comments and revised the plan where appropriate.
25 October 2016	DPAW – Swan Region and Environmental Management Branch	Workshop to discuss other Condition Environmental Management Plans, some of which have overlapping themes with this Condition Environmental Management Plan.	MRWA has taken into account DPAW's comments and revised the plan where appropriate.

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6 GLOSSARY

6.1 Abbreviations

Abbreviation	Definition
CAR	Compliance Assessment Report
CCW	Conservation Category Wetlands
CR	Critically Endangered
DBCA	Department of Biodiversity, Conservation and Attractions
DPAW	Department of Parks and Wildlife
DWER	Department of Water and Environmental Regulation
EMP	Environmental Management Plan
EN	Endangered
GPS	Global Positioning System
MRWA	Main Roads Western Australia
OEPA	Office of the Environmental Protection Authority
PDNH	Perth–Darwin National Highway
PEC	Priority Ecological Community
SCP	Swan Coastal Plain
TEC	Threatened Ecological Community

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APPENDIX A

Transect and Buffer Monitoring Sites

FLORA AND VEGETATION MONITORING SITES

Nominal flora and vegetation monitoring sites are presented in the Condition EMP. Monitoring sites are:

- Spaced at approximately 1 km intervals to represent entire length of alignment.
- Located adjacent to proposal footprint but only where native vegetation exists outside proposal footprint (i.e. not in paddocks).
- Preferentially located where the following conservation significant values exist adjacent to the proposal footprint:
  - Threatened flora *Grevillea curviloba* subsp. *incurva* and *Darwinia foetida.*
  - Habitat for Threatened flora *Caladenia huegelii*.
  - Threatened Ecological Communities (TECs) including SCP20a and Communities of Tumulus Springs (Organic Mound Springs, SCP).
  - Conservation Category Wetlands (CCWs).
  - Bush Forever, Nature Reserves and State Forest (collectively 'reserves').
- Attempt to represent as wide a range of vegetation associations as possible.

Monitoring site locations will attempt to satisfy the above criteria as far as practicable.

The naming of monitoring sites follows the following convention FV00A, where:

- **FV** is a fixed prefix denoting flora and vegetation sites.
- **00** is chainage rounded to nearest kilometre. Chainages on Brand Highway are B1, B2, B3, etc.
- **A** is a letter representing compass direction of site relative to proposal footprint (e.g. N/S/E/W) or B, if denoting buffer monitoring around Threatened flora.

For example, monitoring site 'FV06E' would be located on the east side of the proposal footprint at approximate chainage 6 km. Chainages are referenced back to those shown on Figure 4.1 in the PER.

Table 1 presents the rationale for each monitoring site location.

Table 1 Values of nominal flora and vegetation monitoring sites

Site[1]	Threatened flora[2]	TECs / PECs[3]	Vegetation associations[4]	Reserves[5]	CCWs[6]	GW/SW monitoring[7]	Other notes[8]
FV01S	–	–	Unknown	BFS 307	–	–	Lightning Swamp
FV02E	–	–	Mp[6]	BFS 480	CCW 15033	–	Victoria Road Swamp
FV03E	–	–	ErMp	–		–	
FV04E	–	–	Mp[4]	BFS 304	CCW 8416	MW10, SW-5	Whiteman Park
FV04S	–	–	Mp[4]	BFS 304	CCW 8429	SW-4	Whiteman Park
FV05W	–	SCP20a (EN)	BaBm[2]	BFS 198	–	–	Whiteman Park
FV05E	–	SCP20a (EN)	BaBm[2]	BFS 198	–	–	Whiteman Park
FV06E	–	SCP20a (EN)	BaBm[2]	BFS 198	–	–	Whiteman Park
FV06W	–	SCP21c (P3)	CcEm[2]	BFS 198	CCW 15260	SW-6	Whiteman Park, Cullacabardee
FV07W	–	SCP21c (P3)	CcEm[2]	BFS 304	–	–	
FV07E	–	Banksia (P3)	CcEm[2]	BFS 198	–	MW14	Thin strip between PDNH and Beechboro Rd
FV08W	–	SCP23b (P3)	CcEm[2]	BFS 304	–	–	
FV08E	–	Banksia (P3)	CcEm[2]	BFS 304	–	–	
FV09E	*Caladenia huegelii* habitat	Banksia (P3)	BaBm[2]	BFS 304	–	–	
FV09W	–	–	Cc[1]	BFS 304	–	–	Vegetation is highly altered
FV11E	–	SCP24 (P3)	BaBm[3]	BFS 192, F 65	–	–	
FV13S	–	SCP21c (P3)	Et[2]	BFS 399, F 65	–	–	
FV13E	–	Banksia (P3)	Et[2]	BFS 399, F65	–	–	

Site[1]	Threatened flora[2]	TECs / PECs[3]	Vegetation associations[4]	Reserves[5]	CCWs[6]	GW/SW monitoring[7]	Other notes[8]
FV14N	–	SCP22 (P3)	Mp[2]	BFS 399, F 65	–	–	
FV15N	*Caladenia huegelii* habitat	Banksia (P3)	Cc[3]	BFS 300	–	MW24	
FV15S	*Caladenia huegelii* habitat	SCP21c (P3)	BaBm[1]	–	–	(MW25)	
FV16W	–	SCP23b (P3)	BaBm[2]	– / BFS 300, R 46919	(CCW 8664)	SW-9	
FV16E	–	SCP21c (P3)	Et[2]	–	–	–	
FV16N	*Caladenia huegelii* habitat	SCP21c (P3)	BaBm[2]	BFS 300, R 46919	CCW 8802	SW-10	
FV17W	*Caladenia huegelii* habitat	SCP21c (P3)	BaBm[2]	BFS 300, R 46919	–	MW27	
FV17S	–	–	MpCc	BFS 300, R 46919	–	–	Tracks.
FV17E	*Caladenia huegelii* habitat	Banksia (P3)	Et[2]	R 46875	–	–	Maralla Rd Nature Reserve. Tracks.
FV18W	–	Banksia (P3)	Et[3] / Mp[4]	–	CCW 8800	MW29	
FV19W	–	–	Cc[5]	–	–	MW31	Upstream/downstream pair. Sawpit Gully.
FV19E	–	–	Cc[5]	BFS 13	CCW 8926	MW32, SW-14	Upstream/downstream pair. Sawpit Gully.
FV22E	–	–	Er[7]	–	–	MW33	Drainage line (downstream)
FV23W	–		CcEr[1]	–	–	MW35	Drainage line (upstream)

Site[1]	Threatened flora[2]	TECs / PECs[3]	Vegetation associations[4]	Reserves[5]	CCWs[6]	GW/SW monitoring[7]	Other notes[8]
FV24E	–	–	CcEr[3]	–	CCW 8914	SW-15	Vegetation is highly altered. Proposed retention basin adjacent. Leads to CCW 8914
FV26W	–	–	Er[8]	–	–	–	Upstream/downstream pair
FV26E	–	–	Er[8]	–	–	–	Upstream/downstream pair
FV28E	–	–	MpMr	BFS 100	CCW 8773	MW 39, SW-16	
FV29W	–	–	–	BFS 97	–	MW40	Mound Springs SCP TEC upstream
FV29E	–	–	Er[1]	BFS 97	–	MW41	
FV33W	*Grevillea curviloba* subsp. *incurva*.	–	Xp[1]	–	–	–	
FV33E	*Grevillea curviloba* subsp. *incurva*.	–	Xp[1]	–	–	–	
FV34W	–	–	–	–	–	MW46	Ellen Brook
FV34E	–	–	Er[6]	–	–	MW47, SW-18	Ellen Brook
FV35W	–	–	Er[6]	–	–	MW48	
FV37B	*Darwinia foetida*	–	–	–	–	–	Buffer monitoring for *Darwinia foetida.* Site covers 10 m buffer.
FVB1N	–	–	Er[6]	–	–	MW53	Ellen Brook (Brand Highway)
FVB1S	–	–	Er[6]	–	–	MW54	Ellen Brook (Brand Highway)

Site[1]	Threatened flora[2]	TECs / PECs[3]	Vegetation associations[4]	Reserves[5]	CCWs[6]	GW/SW monitoring[7]	Other notes[8]
FVB2B	*Grevillea curviloba* subsp. *incurva*	–	CcMpMr	–	–	–	Buffer monitoring for *Grevillea curviloba* subsp. *incurva*. Site covers 10 m buffer around both plants. Road reserve (Brand Highway).

Notes:

1. Sites are named using the 'FV' prefix to denote a flora and vegetation monitoring site; the nearest chainage rounded to a whole kilometre (B1, B2, B3 for sites on Brand Highway); and either a compass direction (N/S/E/W) representing position relative to proposal footprint or 'B' if denoting monitoring of a buffer around Threatened flora.
2. Shows selected Threatened flora or habitat present at site.
3. Shows Threatened Ecological Communities (TECs) and Priority Ecological Communities (PECs) present at site. Conservation status is shown in brackets.
4. Shows "Unknown" if mapping not available at proposed monitoring site. Shows vegetation association units defined by Coffey otherwise.
5. Shows reserve identifier. BFS = Bush Forever site. R = Nature Reserve. F = State Forest.
6. Shows wetland identifier. CCW = conservation category wetland.
7. Shows nearby and/or associated groundwater and surface water monitoring sites. Sites prefixed 'MW' are groundwater monitoring wells. Sites prefixed 'SW-' are surface water monitoring locations.
8. Vegetation that is highly altered is not included in the definition of intact native vegetation.

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APPENDIX B

Monitoring Method

FLORA AND VEGETATION MONITORING METHOD

The following monitoring method has considered the following standard and guidelines in the preparation of this documents:

- Guidance for the Assessment of Environmental Factors: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA, 2004).
- Technical Guide – Flora and Vegetation Surveys for Environmental Impact Assessment (EPA and DPAW, 2015).
- Standard Operating Procedure Establishing Vegetation Transects SOP No. 6.2 (DEC, 2009).

Transect Monitoring Method

Transect monitoring sites will be located in remnant vegetation along the development envelope and close to remnant vegetation, Conservation Category Wetlands (CCW), Communities of Tumulus Springs, *Caladenia huegelii* habitat and SCP20a. Transects will not be placed within Completed Degraded areas. All monitoring will be undertaken by an experienced botanist.

Transects with plots will be established to monitor indirect impact of the proposal (Figure 1), such that:

- Monitoring sites will be spaced at approximately 1 km intervals to represent the entire length of the alignment.
- Transects will start from the new vegetation edge (outside the road reserve) and the location will be recorded by GPS. A permanent marker will be used to mark the transect start point.
- At each monitoring site a transect line will be run perpendicular to the development envelope for 30 m.
- 2 x 2 m plots will be placed at 5 m intervals along the transect with the first plot at 0 m and the last at 30 m (Figure 3).
- The first plot will be established between 0 and 2 m along the transect. Each plot will placed alternately left and right of the transect line.

The transect monitoring method will be used to measure a gradient of indirect impact perpendicular to the new vegetation edge. Indirect impacts could occur up to 10 m from the new vegetation edge and any indirect impact beyond this distance would trigger non-compliance with management targets 1 and 2. The transects were designed to measure the extent of indirect impact to adjacent remnant vegetation.

The impact quadrats (located within the initial 10 m of the transect) will be compared against the control quadrats (located beyond the 10 m mark of the transect) along each transect (Figure 2). The results of monitoring will be graphically represented to show variation along the length of each transect over time. If any indirect impacts are occurring, they would be expected to be observed as a change over time in one or more parameters in the impact quadrats without a corresponding change being recorded in control quadrats. Over time, the comparison will also allow determination of whether indirect impacts, if any are occurring, are extending beyond the predicted 10 m from the new vegetation edge and into the control quadrats. Each transect will be tested independently from the remaining transects as the prevailing environment (i.e. vegetation structure, condition, environmental receptor) at each location will be different.

Within each plot the following parameters will be recorded:

- Perennial native vegetation cover (%).

- Perennial species diversity (richness and abundance).
- Introduced (weed) vegetation cover (%).
- Introduced (weed) species diversity (richness and abundance).
- Level of dust (0-4 scale) (refer to Table 1).
- Plant deaths.
- Presence of wind throw.
- Litter (rubbish) presence (0-4 scale) (refer to Table 1).
- Vegetation condition (Keighery, 1994).

Along each transect the following measures will be recorded:

- Evidence of unauthorised access (from the road reserve).
- Evidence of fire caused by construction or maintenance activities (e.g. fire known to have originated from adjacent remnant bushland versus a spark from machinery within the development envelope).
- Litter (rubbish) presence/absence.
- Broad vegetation structure.
- Vegetation condition (Keighery, 1994).
- Presence of conservation significant flora.
- Backwater or ponding of water.

A photo will be taken at the start and end point of each transect, facing towards the middle of the transect.

Two canopy cover photos will be taken along the transect for analysis (dependent on vegetation).

Dust Scale

Dust may be deposited on foliage from time to time due to natural processes, e.g. in windy and/or dry weather. Natural processes may also result in the removal of dust from foliage, e.g. during rainfall. It is assumed that these processes are typical, are not project attributable and do not indirectly impact vegetation.

Proposal activities have the potential to contribute to atypical dust deposition on foliage. Vegetation may be indirectly impacted by dust deposition if dust is observed and the vegetation is observed to be under stress (e.g., wilting/curling, discolouration of foliage).

A scale comprising five increments will be used to indicate the extent of dust that may be contributing to indirect impacts on vegetation. Table 1 lists the indicators to be used in assessing the level of dust present. To distinguish from typical dust deposition or dust deposition that is unlikely to be causing indirect impacts, the dust score also takes into account whether signs of plant stress are apparent. Criteria in both columns of Table 1 must be satisfied in order to assign a score. There are two possible sets of criteria for assigning a dust score of 0. The most suitable score will be assigned based on the criteria available and their applicability to the vegetation being assessed, e.g. for species where leaf colour is the appropriate indicator, the percentage of plants or foliage cover affected will be used to evaluate the plant stress criteria.

Table 1 Level of dust scale

Scale	Criteria (both columns to be satisfied)	
	Dust	Stress
0	No evidence of dust deposition.	–
	Evidence of dust deposition.	No evidence of wilting. Foliage intact and healthy. Plants not stressed.
1	Minor evidence of dust deposition (minor discolouration indicating fine dust particles on surface of leaves).	Plant leaves show signs of wilting at periphery. Less than 10% of plants or foliage cover affected. Plants potentially stressed.
2	Minor evidence of dust deposition (minor dust build-up on surface of leaves).	Plant leaves wilting with noticeable curling of leaf periphery. 10% to 20% of plants or foliage cover affected. Plants exhibiting symptoms of stress.
3	Major evidence of dust deposition (moderate dust build-up visible on surface of leaves).	Plant leaves wilting with noticeable curling of leaf. 20% to 30% of plants or foliage cover affected. Plants exhibiting signs of stress.
4	Major evidence of dust deposition (heavy dust build-up visible on surface of leaves).	Plant leaves wilting with noticeable curling of leaf (approaching closure). More than 30% of plants or foliage cover affected. Plants clearly stressed.

Plants from various species will respond in different ways to dust deposition. Stress may be induced in some plants by minor build-up of dust, whereas other plants may tolerate heavier build-up with no adverse effects.

Litter Scale

A scale comprising five increments will be used to indicate evidence of litter. Table 2 lists the indicators to be used in assessing the level of litter present.

Table 2 Level of litter scale

Scale	Criteria
0	No evidence of litter present.
1	Evidence of litter (Less than 10 % coverage)
2	Evidence of litter (10 to 20% coverage)
3	Evidence of litter (20 to 30% coverage)
4	Evidence of litter (More than 30% coverage)

The presence of litter can indicate a number of issues, e.g. unauthorised access or smothering of plants.

Buffer Monitoring Method

The buffers for known populations of *Darwinia foetida* and *Grevillea curviloba* subsp. *incurva* will be monitored using the same transect monitoring parameters to detect indirect impacts extending into the buffer. No individual quadrats will be sampled for the buffer monitoring method given the buffers only have a 10 m radius. A photo-monitoring point will be established on the edge of the buffer with photos taken

looking towards the known populations. Additional monitoring parameters that will be recorded for the buffer monitoring method include:

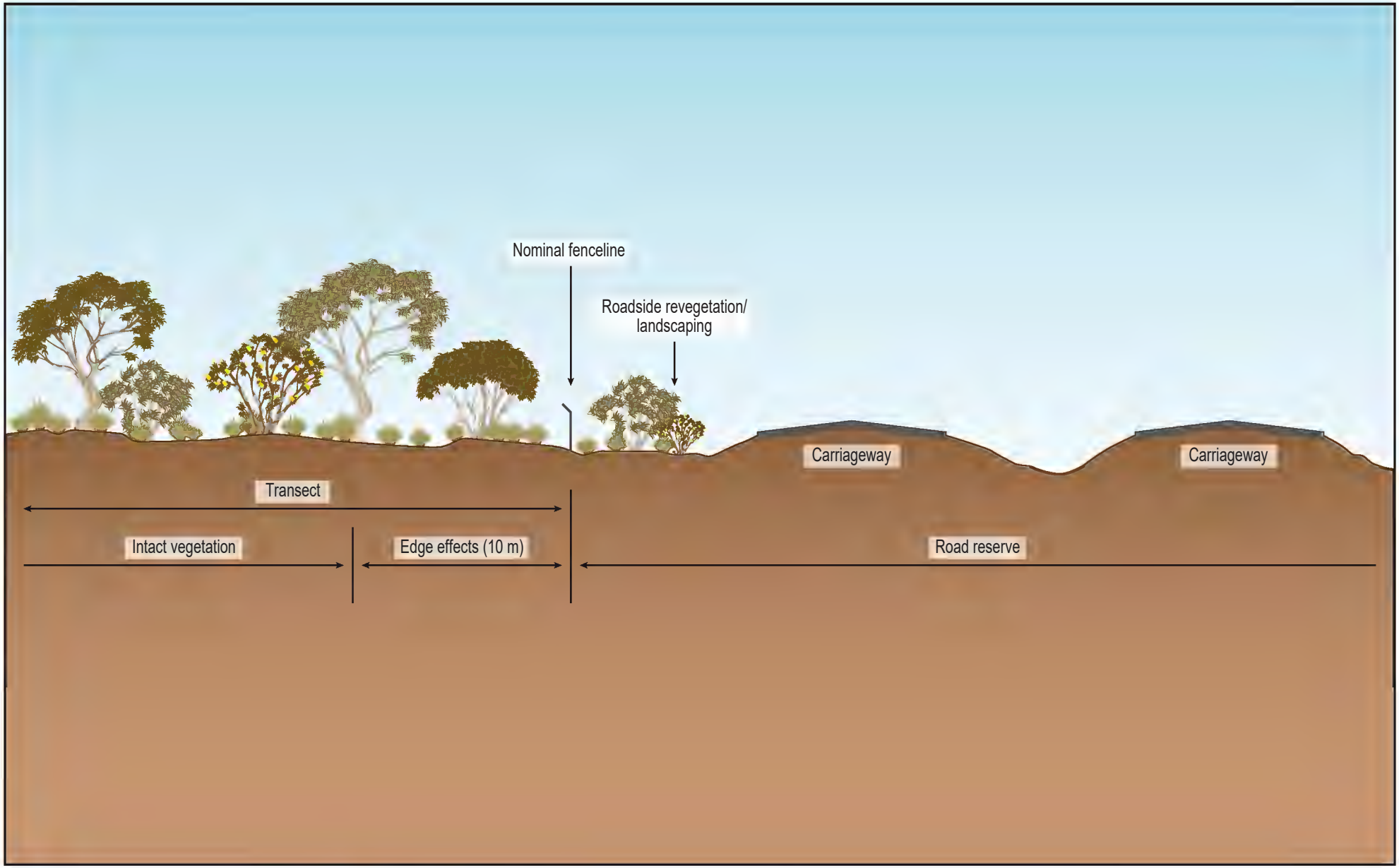
- The plant condition of the known individuals of *Grevillea curviloba* subsp. *incurva* and *Darwinia foetida.*
- The number of individuals of *Grevillea curviloba* subsp. *incurva* and *Darwinia foetida*.

References

DEC. 2009. Standard Operating Procedure: establishing Vegetation Transects. SOP No. 6.2. June. Department of Environment and Conservation, Kensington, Western Australia.

EPA. 2004. Guidance for the Assessment of Environmental Factors – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia No. 51. June. Environmental Protection Authority, Western Australia.

EPA and DPAW. 2015. Technical Guide – Flora and Vegetation Surveys for Environmental Impact Assessment. December. Environmental Protection Authority and Department of Parks and Wildlife, Perth, Western Australia.



Note:
Minimum length of transect ~30 m
Drawing is not to scale and is for illustrative purposes only.

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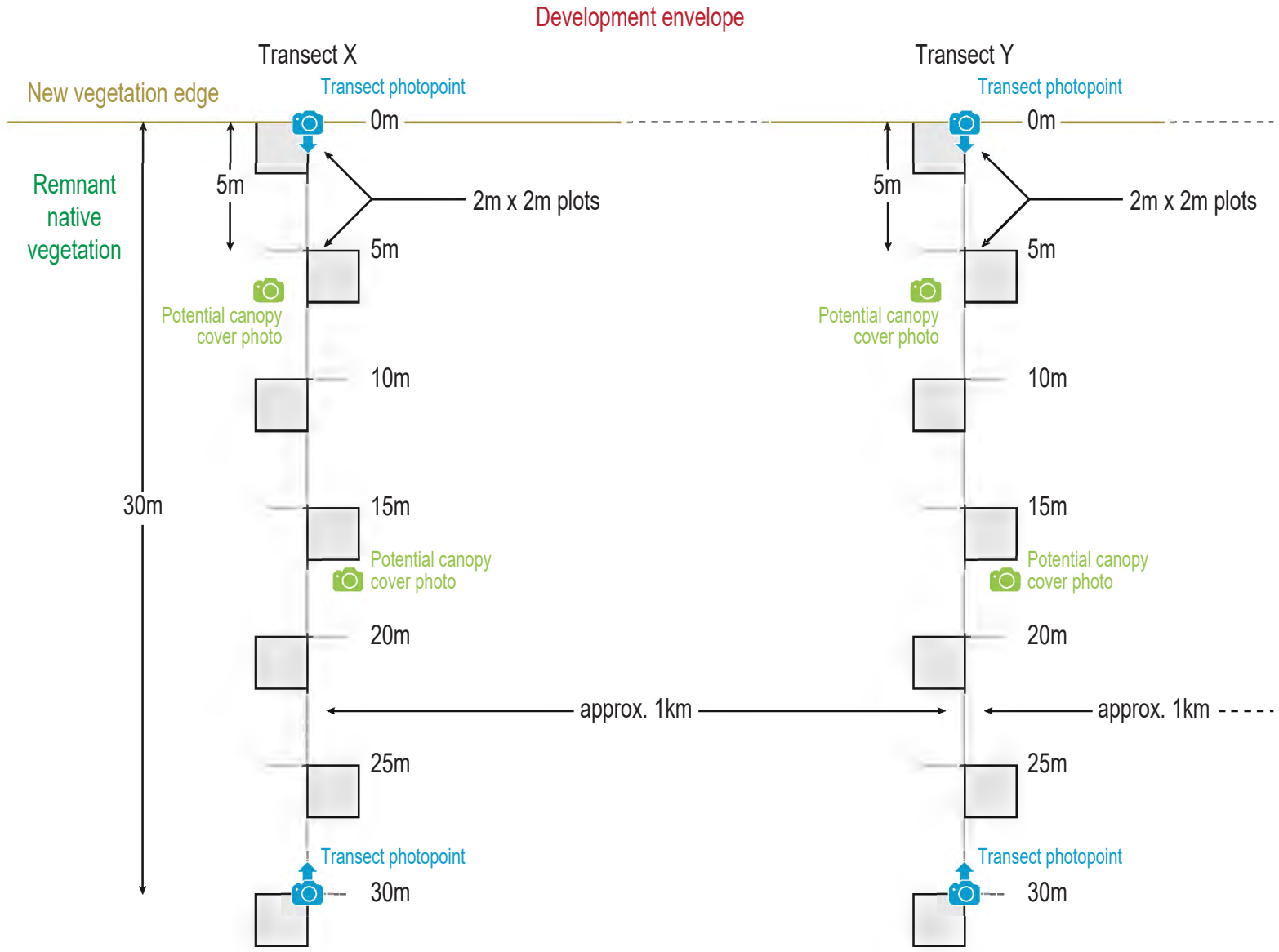
Perth–Darwin National Highway

Indirect Impacts and Threatened Flora and Communities Condition EMP

Monitoring Concept Illustration
(proposed arrangement of transect)

Figure No: 1

A1 Reference: 4483AA_59_GRA001_v2ai



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4483AA_59_F003_GRA

Perth–Darwin National Highway

Indirect Impacts and Threatened Flora and Communities Condition EMP

Typical transect line

Figure No:
2

AI Reference: 4483AA_59_GRA003_v2.ai_5

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