4.6 Flora and Vegetation

4.6.1 EPA Objective

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

4.6.2 Policy and Guidance

The following guidance and policy documents are relevant to the Flora and Vegetation factor:

EPA Policy and Guidance

- Instructions on how to prepare an Environmental Review Document (EPA 2016i).
- Statement of Environmental Principles, Factors and Objectives (EPA 2016j).
- Environmental Factor Guideline: Flora and Vegetation (EPA 2013).
- Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016a).
- Environmental Protection Bulletin 20 - Protection of naturally vegetated areas through planning and development (EPA 2013).
- Guidance Statement 6 – Rehabilitation of Terrestrial Ecosystems (EPA 2006).
- EPA Instructions on how to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans (EPA 2018a).

Other Policy and Guidance

- Environmental, health, and safety guidelines for wind energy (World Bank Group 2015).
- WA Environmental Offsets Policy (Government of Western Australia 2011).
- WA Environmental Offsets Guidelines (Government of Western Australia 2014).
- Environmental Offsets Policy (Department of Sustainability, Environment, Water, Population and Communities 2012).

4.6.3 Receiving Environment

4.6.3.1 Conservation Reserves in the Locality

The nearest conservation reserves to the development envelope (Figure 4.6) comprise:

- Eighty Mile Beach Marine Park – a small section at the northern end of the transmission cable corridor part of the development envelope extends into the beach section of the Marine Park and continues offshore to the limit of State Waters (see Section 4.3.5 for a fuller discussion).
- Kujungurru-Warrarn Nature Reserve – a small section at the northern end of the transmission cable corridor crosses this Nature Reserve for a length of 261 m, representing a straight line crossing of <0.05% of the reserve by area (1.27 ha of temporary disturbance to the 2,552 ha extent of the reserve).
- Walyarta Conservation Park (Mandora Marsh) – the southwestern corner of this Conservation Park abuts the northern boundary of the main development envelope, but the proposal does not intrude into the Conservation Park; and
- Ex-Meentheena Station Conservation Reserve – 50 km to the southwest of the development envelope and unaffected by the proposal (Figure 4.6) (Biota 2018b).

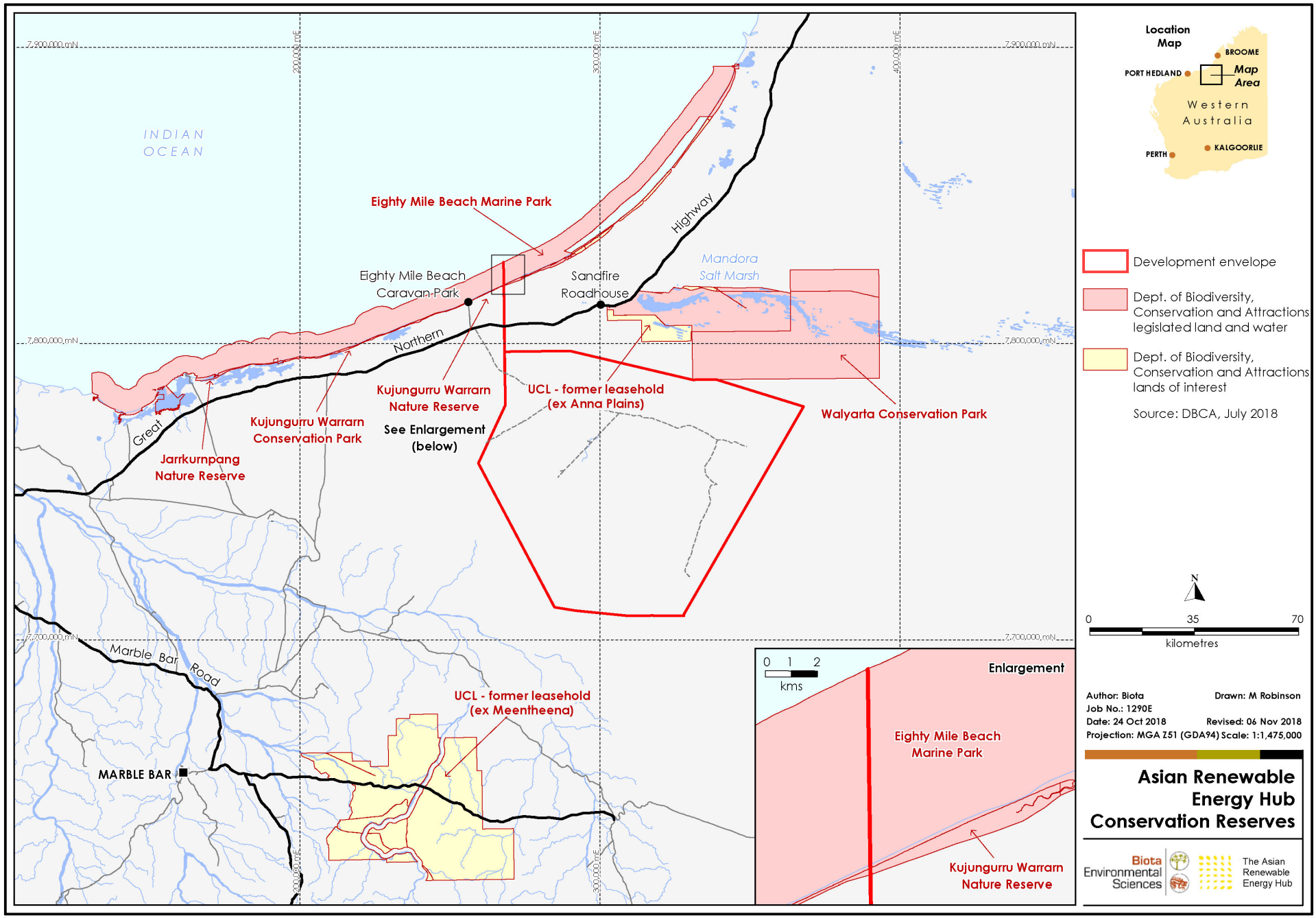

Figure 4.6: Conservation reserves in the locality.

4.6.3.2 Flora and Vegetation Survey

Biota (2018b) was commissioned to conduct a detailed terrestrial flora and vegetation survey (Appendix 5). After the completion of a desktop review of flora and vegetation values (Biota 2018b), the first phase of the survey was carried out from 24th August – 4th September 2017 (dry season), while the second phase was carried out from 13th – 22nd March 2018 (post-wet season). The Phase 2 survey followed high rainfall in the locality, and the surveys were appropriately timed to detect annual and cryptic perennial species.

The surveys were completed as far as practicable in accordance with relevant EPA policy, specifically:

- Environmental Factor Guideline: Terrestrial Flora and Vegetation (EPA 2016j); and
- Technical Guide - Terrestrial Flora and Vegetation Surveys (EPA 2016a).

A total of 99 flora sampling quadrats and seven relevés (unbounded flora sampling sites) were assessed within the development envelope, representatively sampling the range of vegetation types present (Figure 4.8).

Targeted foot traverses were also completed to search for rare flora and compile detailed vegetation mapping notes. The work was undertaken by a team of experienced botanists who have completed many past surveys in the Kimberley and Pilbara regions (Biota 2018b).

4.6.3.3 Land Systems

The then Department of Agriculture Western Australia mapped land systems for the Rangelands regions of WA, including much of the development envelope (van Vreeswyk et al. 2004). This classification divides the region into broad units (land systems), each consisting of a series of "land units" that occur on characteristic physiographic types within the land system. The development envelope intersects eight land systems: Anna, Buckshot, Callawa, Eighty Mile, Little Sandy, Mannerie, Nita and Robertson (Biota 2018b).

The development envelope is spatially dominated by just two of these land systems:

- Nita land system, *"Sandplains supporting shrubby spinifex grasslands with occasional trees",* which occupies the northwestern half of the development envelope (55% by area); and
- Little Sandy land system, *"Sandplains with linear and reticulate dunes supporting shrubby hard and soft spinifex grasslands",* which occupies most of the southeast of the development envelope (38%) (Figure 4.7).

These land systems both feature sandy substrates with vegetation dominated by hummock grasses, the most significant difference between the two being the conspicuous east-west dune systems dominating the Little Sandy land system (Biota 2018b).

The Nita and Little Sandy land systems combined account for 93% of the development envelope, with the remainder almost entirely accounted for by the Callawa (5.4%) and Buckshot (1.1%) land systems, which contain most of the low stony rise and rocky habitats in the development envelope and tend to occur in close geographic association (Figure 4.7). Most of the remaining land systems represents coastal or near-coastal habitats: the Anna, Eighty Mile and Mannerie land systems together comprise 0.06% of the development envelope and are only intersected by the transmission cable corridor portion of the development envelope (Biota 2018b) (Figure 4.7).

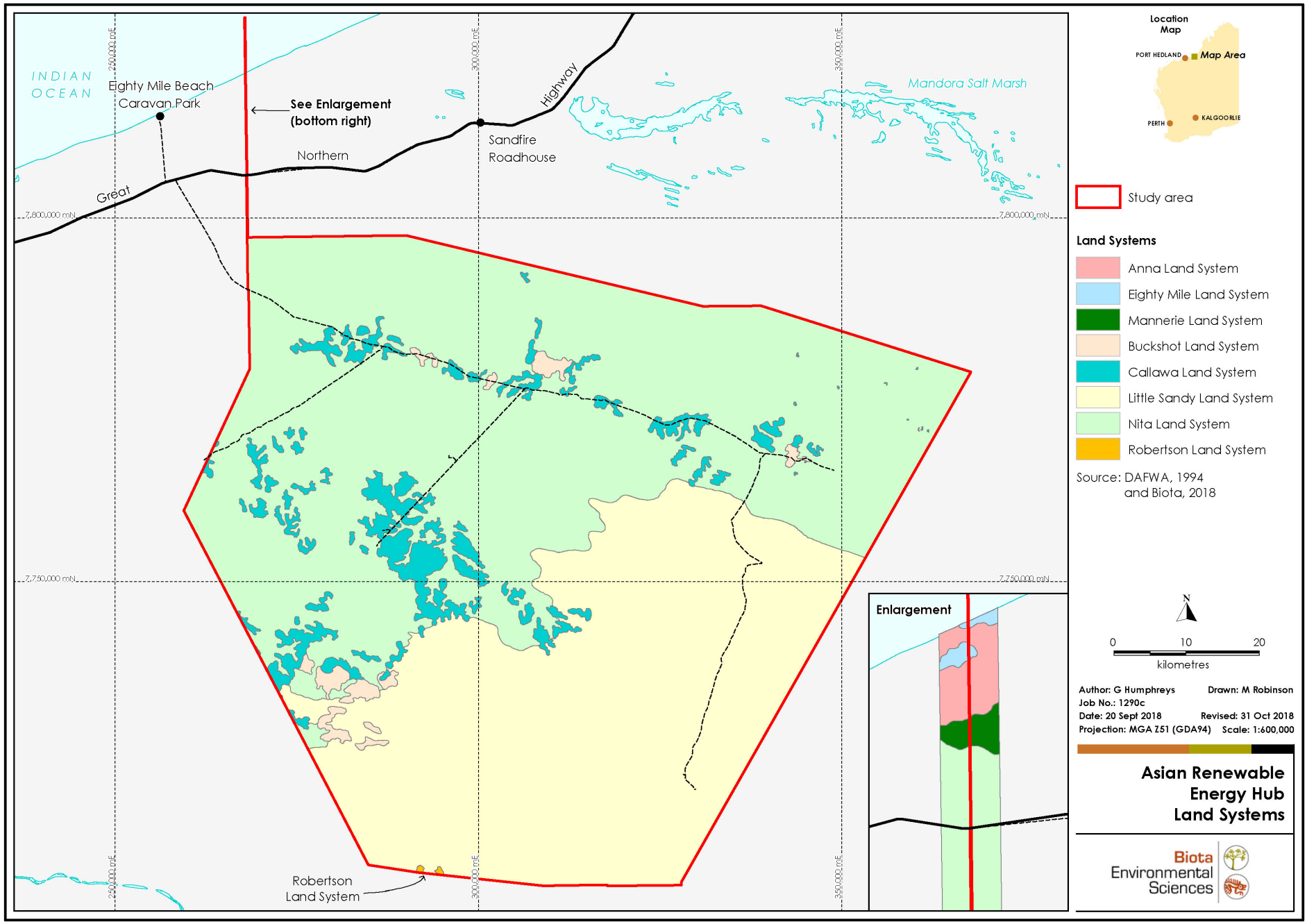

Figure 4.7: Land systems of the development envelope (Biota 2018b).

4.6.3.4 Vegetation

Nine vegetation types were identified for the development envelope, associated with five broad landforms and covering a mapped extent of 660,686 ha as detailed in Table 4.6 (Biota 2018b). These vegetation types were described by Biota (2018b) at the association level (Level V as per the National Vegetation Information System (NVIS)[3]). This level of detail would be considered fine-scale (intra-locality) delineation of vegetation types as required by relevant EPA technical guidance (2016a). In general, minor variations in the vegetation were not clearly defined on aerial photography, were confounded with differential fire history, or were not practical to accurately map in the field (e.g. minor drainage lines). These sub-types were still sampled and described separately (Table 4.6) and were incorporated into the surrounding 'parent' vegetation type in the mapping (Figure 4.8) (Biota 2018b). Examples of the vegetation types present in the overall development envelope are provided in Plate 4.5 to Plate 4.14.

Four of the nine vegetation types, S1, D1, P1 and P2, were only recorded from the cable corridor portion of the development envelope (Figure 4.8) and accounted for a very small proportion of the overall development envelope (0.01% for all four vegetation types combined; Table 4.6 (Biota 2018b)). One of these vegetation types, S1, is formally listed as being of elevated conservation significance, being representative of the Eighty Mile Land System Priority Ecological Community (PEC) (Biota 2018b) (see Section 4.6.3.5).

Virtually all of the development envelope was accounted for by the remaining five vegetation types, with the great majority of that comprising vegetation type P3 at over 91% of the development envelope (Table 4.6; Figure 4.8). None of the five vegetation types from the main development envelope represent Threatened Ecological Communities (TECs) or PECs (Biota 2018b). However, vegetation type R1 is of local conservation significance; this occurs on the scattered isolated rocky outcrops, which would act as refugia during fires and periods of drought, and contains species restricted to such habitats.

With the exception of the near-coastal areas within the cable corridor, the majority of the vegetation in the development envelope was in Excellent or Very Good condition, with little historical clearing (Biota 2018b). Clearing in the inland areas was largely limited to the roadway of the Nyangumarta Highway and three other vehicle tracks that are less frequently used. Other very old tracks traverse the area but have largely revegetated (Biota 2018b).

The cable corridor runs along the eastern edge of Wallal Downs Station, at its boundary with Mandora Station. There was heavy grazing and trampling by cattle in these pastoral areas near the coast. Although camel tracks and scats were recorded at most sites and a small number of individuals were sighted during the surveys, there were no obvious signs of vegetation grazing or trampling in the inland areas. Weeds were mainly recorded from the section of the cable corridor between the Great Northern Highway and the coast, with **Cenchrus* species (Buffel Grass and Birdwood Grass) being particularly abundant. There were few weed records from the main development envelope, reflected in the Excellent and Very Good vegetation condition ratings (Biota 2018b).

[3] http://www.environment.gov.au/land/publications/nvis-taxonomic-review/introduction#del

Plate 4.5: Drainage vegetation type D1.

Plate 4.6: Drainage vegetation type D2.

Plate 4.7: Sand dune vegetation type S2a.

Plate 4.8: Sand dune vegetation type S2b.

Plate 4.9: Plains vegetation type P3a.

Plate 4.10: Plains vegetation type P3d.

Plate 4.11: Low stony rise vegetation type H1.

Plate 4.12: Rocky outcrop vegetation type R1.

Table 4.6: Vegetation types recorded from the development envelope, including extent and proportion of the development envelope (vegetation types shaded grey were recorded only from the cable corridor).

Broad Landform	Vegetation		Description	Extent [1]	
	Type	Sub-Type		Ha	Proportion
Drainage areas	D1	-	*Melaleuca glomerata, M. lasiandra, M. alsophila, Acacia ampliceps* tall shrubland over *Trianthema turgidifolium, Solanum esuriale* low open shrubland	9.0	<0.01%
	D2	a	*Grevillea refracta, G. wickhamii, Acacia colei* var. *colei, A. monticola* tall shrubland to tall open scrub over *A. adoxa* var. *adoxa,* (*Indigofera monophylla*) low shrubland over *Triodia epactia* open hummock grassland with *Eulalia aurea,* (*Sorghum plumosum* var. *plumosum*) open tussock grassland	- [2]	- [2]
		b	*Acacia tumida* var. *kulparn,* (*Grevillea refracta*) tall shrubland to tall open scrub over *Indigofera monophylla* low open shrubland over *Triodia epactia* very open hummock grassland		
Sand dunes	S1	-	*Triodia epactia, Spinifex longifolius* open hummock grassland with *Whiteochloa airoides* open tussock grassland	0.7	<0.01%
	S2	a	*Grevillea stenobotrya, G. wickhamii, Acacia anaticeps* tall open shrubland over *A. tumida* var. *kulparn, Cyanostegia cyanocalyx, Sida* sp. Western sand dunes (P.K. Latz 11980) open shrubland over *Dicrastylis doranii,* (*Dampiera cinerea, A. stellaticeps, Gompholobium simplicifolium, Newcastelia cladotricha*) low open shrubland over *Triodia schinzii* very open hummock grassland and *Eriachne obtusa, Aristida holathera* var. *holathera* very open tussock grassland	23,577.5	3.57%
		b	*Grevillea wickhamii* tall open shrubland over *Acacia tumida* var. *kulparn, Cyanostegia cyanocalyx* open shrubland over *Gompholobium simplicifolium, Jacksonia aculeata,* (*Dicrastylis doranii, Dampiera cinerea*) low open shrubland over *Triodia schinzii* very open hummock grassland		
Plains	P1	-	*Sida fibulifera* scattered shrubs over **Cenchrus ciliaris, *C. setiger* tussock grassland	27.9	<0.01%
	P2	-	*Acacia colei* var. *colei, A. sericophylla,* tall open shrubland over *Corchorus incanus* subsp. *incanus* low open shrubland over *Triodia epactia* open hummock grassland	38.6	0.01%
	P3	a	*Owenia reticulata, Erythrophleum chlorostachys* scattered low trees over *Acacia eriopoda, A. sericophylla* scattered tall shrubs over *Acacia stellaticeps, Androcalva loxophylla* low open shrubland over *Triodia schinzii,* (*T. epactia*) open hummock grassland	605,656.4	91.67%
		b	*Erythrophleum chlorostachys* scattered low trees over *Acacia ancistrocarpa, A. monticola* tall open shrubland over *Triodia schinzii,* (*T. epactia*) open hummock grassland		
		c	*Corymbia zygophylla, Erythrophleum chlorostachys* scattered low trees over *Grevillea eriostachya, G. wickhamii* scattered tall shrubs over *Gompholobium simplicifolium, Jacksonia aculeata,* (*Dicrastylis doranii, Dampiera cinerea, Acacia stellaticeps*) low open shrubland over *Triodia schinzii* very open hummock grassland		
		d	*Erythrophleum chlorostachys* scattered low trees over *Grevillea refracta* scattered tall shrubs over *Acacia ancistrocarpa, A. monticola, A. tumida* var. *kulparn* open shrubland over *Triodia epactia* open hummock grassland		
		e	*Grevillea refracta, Acacia monticola, A. colei* var. *colei* tall open shrubland over *Acacia hilliana, A. adoxa* var. *adoxa* scattered low shrubs over *Triodia epactia* open hummock grassland		
Low stony rises	H1	-	*Acacia hilliana,* (*A. adoxa* var. *adoxa*) low open shrubland over *Triodia epactia* open hummock grassland	30,988.7	4.69%
Rocky outcrops and breakaways	R1	-	*Ficus brachypoda* low open woodland over *Acacia monticola, A. colei* var. *colei, Grevillea pyramidalis* tall open shrubland over *Triodia epactia* open hummock grassland	387.2	0.06%
			Total:	**660,686.0**	**100%**

[1] Figures given for mapped extent of NVIS Level V vegetation types (e.g. vegetation type S2 = 23,577.5 ha, totalling sub-types S2a and S2b).

[2] Minor flowlines off low stony rises, not mapped separately; included within the extent of vegetation type H1.

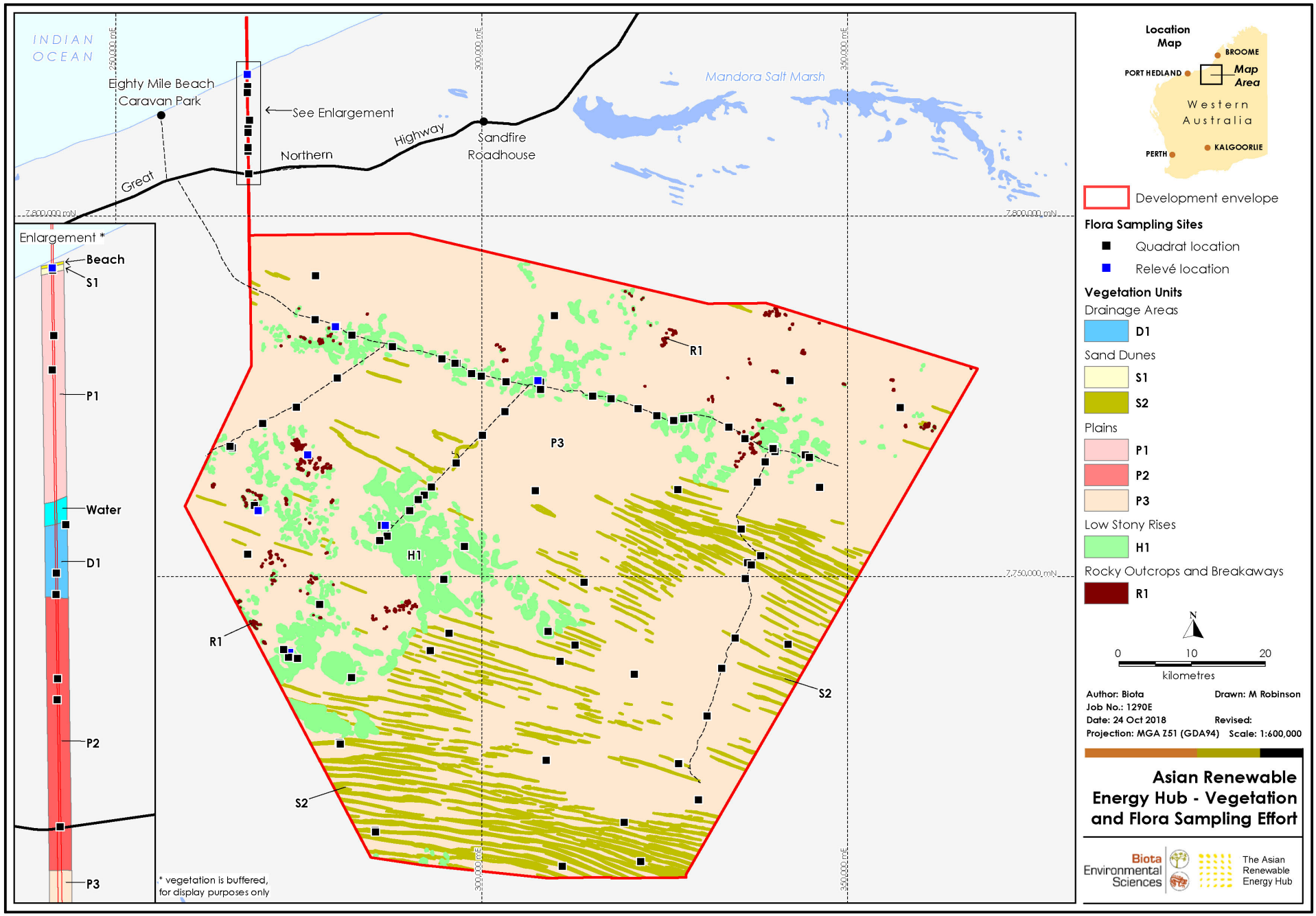

Figure 4.8: Flora and vegetation sampling effort and distribution of vegetation types (Biota 2018b).

4.6.3.5 Vegetation of Conservation Significance

None of the vegetation types represent TECs at either State or Commonwealth levels. One of the vegetation types recorded from the cable corridor portion of the development envelope, S1 (*Triodia epactia, Spinifex longifolius* open hummock grassland with *Whiteochloa airoides* open tussock grassland), is representative of a State PEC (Biota 2018b):

> **Eighty Mile Land System PEC:** This Priority 3(iii) PEC is described as *"Beach foredunes, longitudinal coastal dunes and sandy plains with tussock grasslands and spinifex grasslands", which are under threat from "extensive threatening processes acting at landscape scales, namely altered fire regimes, over grazing, erosion, and weed invasion (Buffel Grass)"* (DBCA 2019).

Vegetation type S1 was sampled by Biota (2018b) on a substrate of white sand on the primary dunes and swales close to the coast at the northernmost end of the cable corridor (Figure 4.8). *Spinifex longifolius* was the dominant grass on the dunes (Plate 4.13), with *Triodia epactia* and *Whiteochloa airoides* becoming dominant in the swales (Plate 4.14).

Plate 4.13: Vegetation type S1 on foredune.

Plate 4.14: Vegetation type S1 in swale.

The vegetation type covered a minute proportion of the development envelope with only 0.7 ha mapped by Biota (2018b) (<0.01% of the development envelope; Table 4.6). Areas of Eighty Mile land system are also mapped to the south within the cable corridor (Figure 4.7), but only the coastal dunes at the far northern end of the corridor where vegetation type S1 was mapped remain in good condition (Biota 2018b).

4.6.3.6 Flora

A total of 315 native vascular flora taxa from 138 genera and 48 families were recorded from the development envelope during the survey, and four additional taxa have previously been recorded from the area. This is a relatively high number of species, given the limited range of habitats present (Biota 2018b). Nine of the species confirmed are listed as conservation significant taxa (see Section 4.6.3.7).

The development envelope is located mainly in the Great Sandy Desert bioregion, with the cable corridor crossing into the southern end of the Dampierland bioregion. The northeastern edge of the Pilbara bioregion is also relatively close (approximately 3 km from the southern boundary of the development envelope).

As such, the development envelope contains elements of both the Northern and Eremaean floristic provinces and of all three bioregions (Biota 2018b). The dominant native plant families and genera recorded from the development envelope were consistent with this biogeographic setting Table 4.7.

Table 4.7: Dominant native families and genera recorded from the development envelope (Biota 2018b).

Family	No. of Species	Genus	No. of Species
Fabaceae (peas, cassias and wattles)	67	*Acacia* (wattles)	21
Poaceae (grasses)	44	*Tephrosia* (a pea)	11
Malvaceae (hibiscus, sida etc)	28	*Ptilotus* (mulla-mullas)	10
Goodeniaceae (fan-flowers etc)	16	*Grevillea*	9

4.6.3.7 Flora of Conservation Significance

Threatened Flora

One Threatened flora species, *Seringia exastia* (Plate 4.30 and Plate 4.16), was recorded from the development envelope, with a total of 334 individuals recorded from six locations (Biota 2018b) (Figure 4.9). This species is listed as Threatened under both the State Biodiversity Conservation Act and the Commonwealth EPBC Act (Critically Endangered).

In addition, approximately 146 additional individuals of a sterile *Seringia* were recorded from 15 other locations (Figure 4.9). These may represent *S. exastia, S. katatona* (a Priority 3 species; see below), or one of two *Seringia* species that are not listed as being of conservation significance (*S. elliptica* or *S. nephrosperma*) (Biota 2018b). As a precaution, all sterile individuals recorded from the development envelope have been considered to represent *S. exastia*.

Plate 4.15: *Seringia exastia* overall growth form.

Plate 4.16: Enlargement of *Seringia exastia* flowers.

When originally described (as *Keraudrenia exastia*), the species was only known from a single locality, comprising pindan dune swale on the Dampier Peninsula near Broome (Wilkins 1999); as a consequence, it was listed as Declared Rare Flora (now 'Threatened') for WA in 2006 (Biota 2018b). This species was also subsequently listed in 2009 as a Threatened species under the Commonwealth EPBC Act, in the category of Critically Endangered; this was due to its (then) very restricted geographic distribution, and the perceived susceptibility of the population to threats including weed

invasion and clearing for infrastructure (DEWHA 2009b). *Seringia exastia* was subsequently recorded from a small number of additional locations approximately 140 km south of the Broome populations, and has also recently been recorded from two locations on Shelamar Station, which are within this range but closer to the coast (Emerge Associates 2017).

The confirmed records from the current surveys extend the known range of *S. exastia* by 290 km, from near Broome to the eastern section of the development envelope. This range encompasses a very large area of suitable pindan plain habitat, and it is likely that this species is considerably more abundant than the current records indicate (Biota 2018b). Its apparent rarity may be more a function of limited survey effort relative to the extensive extent of suitable habitat and that the species may have gone unidentified in some past cases where survey has occurred but only sterile *Seringia* specimens have been collected.

Priority Flora

Eight species listed by DBCA as Priority species were also recorded from the development envelope (Table 4.8 and Figure 4.9). *Bonamia oblongifolia* and *Tribulopis marliesiae* were recorded from the cable corridor as well as the main development envelope, while all remaining species were only recorded from the main development envelope (Figure 4.9).

Table 4.8: Summary of Priority flora recorded from the development envelope (Biota 2018b).

Species	Status	No. of Individuals / % Cover and No. of Locations (Broad Distribution)
Tephrosia rosea var. Port Hedland (A.S. George 1114)	Priority 1	4% cover at 1 location (southwestern section of main development envelope)
Bonamia oblongifolia	Priority 3	0.1-1% cover at 13 locations (throughout development envelope)
Croton aridus	Priority 3	0.1-3% cover at 5 locations (southern section of main development envelope)
Indigofera ammobia	Priority 3	0.1% cover at 7 locations (southern section of main development envelope)
Polymeria ? sp. Broome (K.F. Kenneally 9759)	Priority 3	0.1% cover at 2 locations (northwestern section of main development envelope)
Seringia katatona	Priority 3	150 individuals at 1 location (in southeast of main development envelope)
Terminalia kumpaja	Priority 3	68 individuals at 36 locations (throughout main development envelope)
Tribulopis marliesiae	Priority 3	176+ individuals at 45 locations (throughout development envelope)

While all of these species have broad ranges and appear to be more common than previously thought, the specimen of *Tephrosia rosea* var. Port Hedland (A.S. George 1114) is atypical and matches one other specimen attributed to this taxon; these may potentially represent a new species.

Another entity recorded during the Biota (2018b) survey, *Portulaca* aff. *australis*, may also represent a new species, however additional collections would be required to further investigate this (Biota 2018b).

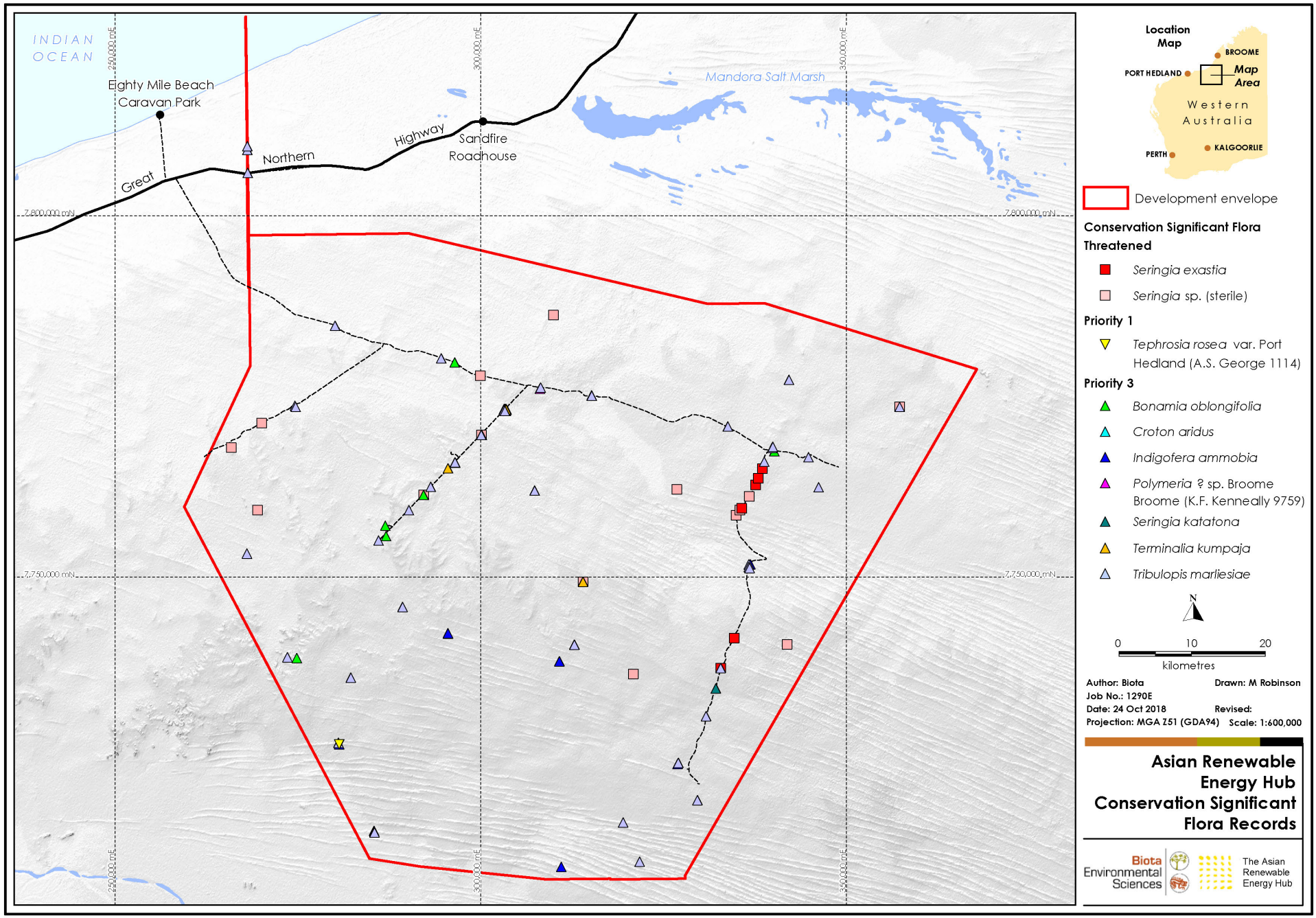

Figure 4.9: Flora of conservation significance within the development envelope (Biota 2018b).

The desktop assessment completed by Biota (2018b) (including searches of public and private databases, as well as previous botanical surveys in the vicinity of the development envelope) indicated that 11 additional Priority flora species have previously been recorded from the locality. While not recorded during the detailed flora survey, two of these species are considered likely to occur in the development envelope:

- *Goodenia hartiana* (Priority 3) has been recorded from a red sand dune 3.9 km southwest of the southwestern corner of the development envelope, and could occur on the sand dunes supporting vegetation type S2 (Figure 4.8); and
- *Corynotheca asperata* (Priority 3) has been recorded from sand plain 9.6 km south of the development envelope, and could occur on the pindan plains supporting vegetation type P3 (Figure 4.8) (Biota 2018b).

If either species does occur within the development envelope, they are unlikely to be restricted in distribution, given the very extensive nature of the two vegetation types they are likely to occur within (Table 4.6).

4.6.3.8 Fire History

The proposal area is dominated by *Triodia* hummock grasslands, which are very flammable, and even open or discontinuous vegetation can support high levels of fire behaviour under high wind conditions.

Fire regimes in the western deserts were actively managed by Aboriginal people for tens of thousands of years, ending abruptly in the mid 1900s (Burrows and Christensen 1991). Desert people used fire continuously but with a high level of control, resulting in high-density time-since-fire vegetation mosaics. While large fires could still spread under extreme conditions, the mosaic patchwork of vegetation ages since fire ensured that the size and intensity of large fires was reduced (Appendix 6). This situation has changed in the last century with the change in land management, and the locality in which the development envelope is situated is now generally subject to more frequent and widespread fires, which typically act to reduce diversity in the landscape.

The size and intensity of a fire determines the long-term outcome, which can range from insignificant (little or no impact from a small local fire) to catastrophic, where large, intense fires burn vast areas of country (sometimes on a scale of millions of hectares) in single events. While fire is required for some plants and vegetation communities to regenerate, and recently burned areas are favoured by some species, large fires remove time-since-fire heterogeneity in the landscape. Large areas of similar-aged vegetation will then have a similar vulnerability to burning in the future. Lack of vegetation diversity reduces flora and fauna diversity and the resilience of the system to respond to future disturbance (Appendix 6).

Fire history for the vegetation of the development envelope was assessed as part of preparing the proposal's Fire Management Strategy (Appendix 6). This was described on the basis of remote-sensed historical fire scar data sourced from the Northern Australian Fire Information (NAFI) project[4]. This enabled the compilation of a ten-year fire history for the development envelope showing data on pre-development bushfire environments (Figure 4.10). This recent fire history shows a pattern of episodic large fires occurring, with very little of the development envelope being longer than 10 years since it was last burnt (Figure 4.10 A). Parts of the development area have also burnt twice or three times in the past decade (Figure 4.10 B). These events currently occur in a completely unplanned and uncontrolled manner, with bushfires ignited by lightning strikes and accidentally through human activity.

[4] http://www.firenorth.org.au/nafi3/

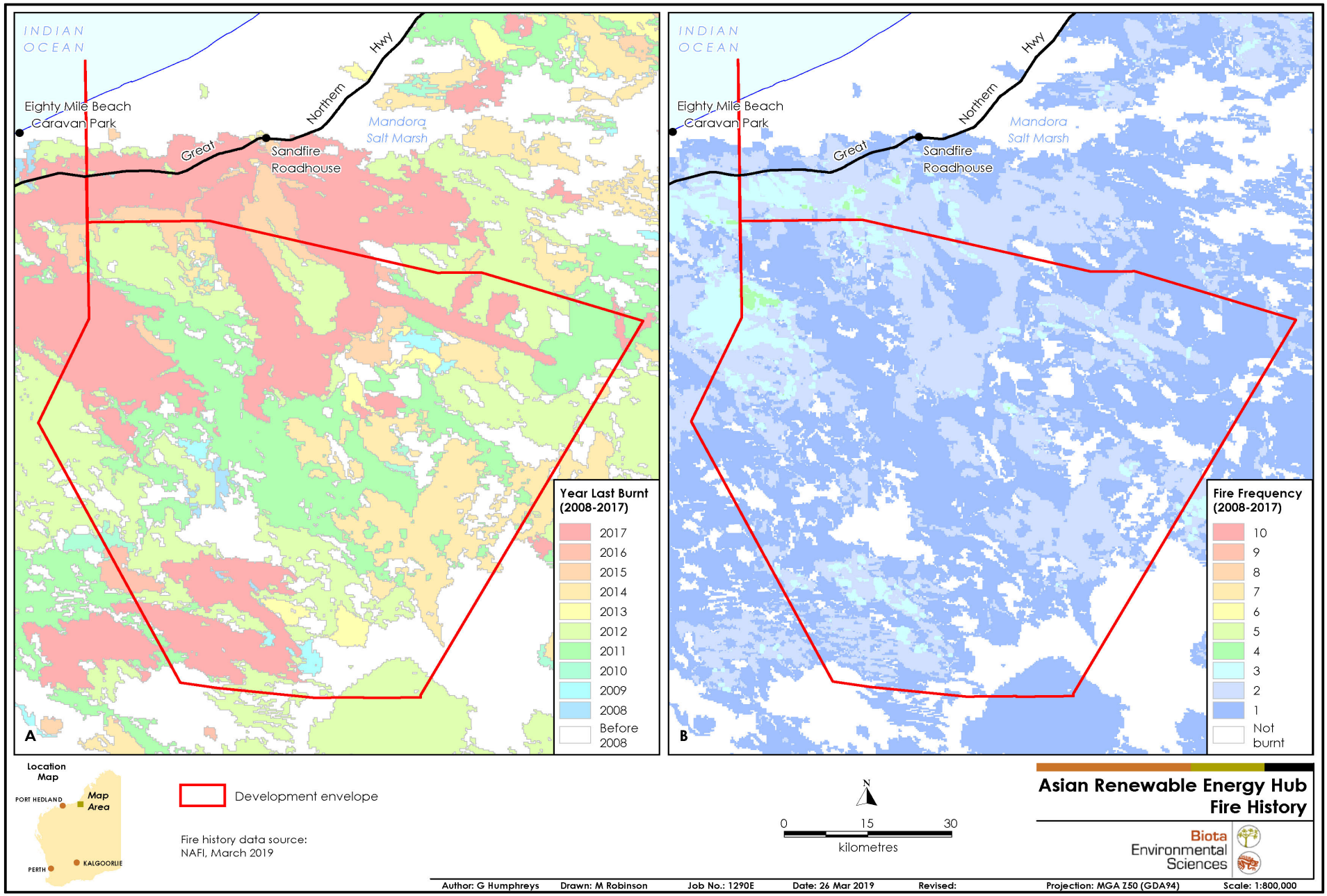

Figure 4.10: Fire history of the development envelope, showing A) year in which areas last burnt, and B) the number of years in the last decade in which areas burned (data source: http://www.firenorth.org.au/nafi3/).

Based on fire scar data, and from observations of fires that have occurred during 2017 and 2018, these events can occur with relatively high frequency and currently affect very large areas within the development envelope (e.g. the extent of the 2017 and 2011 fire scars on Figure 4.10 A). The existing Nyangumarta Highway is one of the few features in the landscape of the development envelope to halt the progress of fires, though fire scar data indicate that this does not always act as a firebreak (see Figure 4.10 A), presumably when the fire is late in the season, and therefore more intense, or under high wind conditions.

All vegetation types found in non-rock pile environments within the development envelope are adapted to periodic burning, and the vegetation structure and species composition of any particular area may be determined by the time since fire (Appendix 6). A variety of different fire ages will increase the diversity of vegetation seral states and structural complexity in the area, and floristic composition of these communities will also change with time since fire. Understanding the existing fire regimes within the development envelope, and developing and implementing a Fire Management Strategy in the context of the landscape-scale changes the project will bring to fire patterns, is therefore essential to both informed impact assessment (Section 4.6.5.7) and management for vegetation and individual species (Section 4.6.6).

4.6.4 Potential Impacts

The aspects of the proposal that may impact on flora and vegetation include:

- Clearing of vegetation in the construction footprint to accommodate the proposal infrastructure, including access roads, turbine pads, solar panel arrays, substations and transmission lines;
- Deployment of plant and equipment into the development envelope from other locations where introduced flora or soil pathogens may be present;
- Construction and maintenance activities that have the potential to ignite bushfires; and
- The long-term (approximately 50 years) presence of finished access roads in linear corridors within the landscape of the development envelope.

The potential impacts on flora and vegetation arising from these aspects of the proposal include:

- The permanent clearing of a total of 11,962 ha of native vegetation within the 660,686 ha of vegetation present within the development envelope (1.81% by area) to accommodate the proposal infrastructure (Figure 4.11);
- Temporary clearing of 612.4 ha during construction for short-term use as laydown areas and the burial of transmission cables in the coastal portion of the development envelope;
- Potential direct clearing impacts on the Eighty Mile Land System PEC;
- Temporary clearing within the Kujungurru-Warrarn Nature Reserve;
- Potential direct clearing impacts on populations of *Seringia exastia* (State: Threatened; EPBC Act: Threatened (Critically Endangered));
- Potential direct clearing impacts on populations of one Priority 1 species and seven other Priority listed species;
- A risk of weed introduction and spread during earthworks and construction activities;
- Other impacts typically associated with construction and operations impacts, such as risk of project-induced bushfires and off-road driving impacts on vegetation; and
- The long-term presence of the site access tracks, partitioning vegetation into blocks and thereby altering fire regimes within the development envelope, leading to consequent changes in vegetation structure and floristic composition.

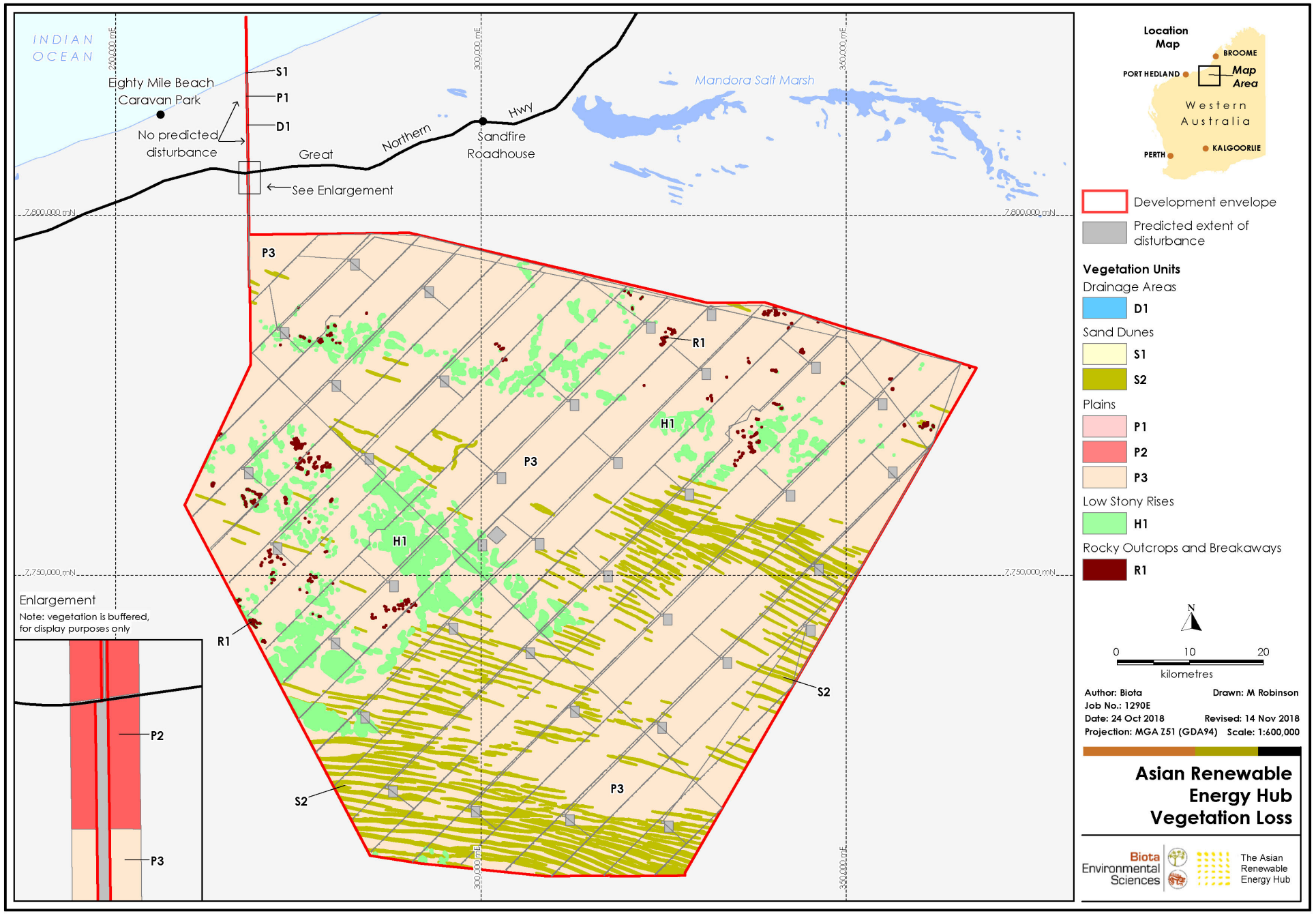

Figure 4.11: Conceptual vegetation clearing footprint within the development envelope.

4.6.5 Assessment of Impacts

4.6.5.1 Vegetation Clearing

An overall total of 11,962 ha of vegetation will be permanently cleared for the proposal, representing 1.81% of the development envelope by area (Table 4.9 and Figure 4.11).

Table 4.9: Permanent clearing of vegetation types for the conceptual design of the proposal (vegetation types shaded grey occur only in the transmission cable corridor).

			Impact Quantification		
Landform	**Vegetation Type**	**Mapped Extent (ha)** [1]	**Permanent Clearing (ha)**	**Mapped Proportion Lost**	**Mapped Proportion Remaining**
Drainage areas	D1	9.0	0.0	0.00%	100.00%
Sand dunes	S1	0.7	0.0	0.00%	100.00%
	S2	23,577.5	404.3	1.71%	98.29%
Plains	P1	27.9	0.0	0.00%	100.00%
	P2	38.6	10.3	26.62%	73.38%
	P3	605,656.4	11,137.0	1.84%	98.16%
Low stony rises	H1	30,988.7	407.0	1.31%	98.69%
Rocky outcrops	R1	387.2	3.4	0.87%	99.13%
	Totals:	**660,686.0**	**11,962.0**	**1.81%**	**98.19%**

[1] Vegetation type D2 mapped as part of H1 (see Section 4.6.3.4) and proportional loss can assumed to be equivalent to H1.

Almost all of the permanent clearing for the proposal will occur in the main development envelope (Table 4.9 and Figure 4.11). The great majority of this will affect the P3 vegetation type at 11,137.0 ha of clearing (Table 4.9), but this vegetation type is also the most widespread in the development envelope at 605,656.4 ha, and the implementation of the proposal will leave well over half a million hectares of the same vegetation unit undisturbed within the development envelope (over 98% of its current extent; Table 4.9). The situation is similar with the next most affected vegetation type, H1, where the proposed clearing would remove less than 2% of the extent mapped within the development envelope (Table 4.9).

All of the vegetation types within the main development envelope have in excess of 98% of their current mapped extent retained with the implementation of the proposal. While the permanent vegetation clearing, at 11,962 ha in the overall development envelope in total (Table 4.9), is extensive, it will occur in a well-separated footprint that is distributed within a very large development envelope, most of which is pindan sandplain that has limited variability in vegetation type over its extent (Biota 2018b) (Figure 4.11).

Some additional short-term and temporary clearing of vegetation will also occur as part of the proposal, to allow for lay down of turbine components prior to construction (Section 2.6.3) and for trenching for the underground section of the transmission corridor north of the Great Northern Highway (Section 2.6.11.2). Overall, this will total 612.4 ha (Table 4.10), all of which will be immediately rehabilitated in an ongoing fashion during the course of the construction phase. All of the vegetation types within the main development envelope will have approximately 0.1% or less of their current extent within the development envelope temporarily disturbed during construction (Table 4.10).

Table 4.10: Temporary clearing of vegetation types for the conceptual design of the proposal (vegetation types shaded grey occur only in the transmission cable corridor).

			Impact Quantification		
Landform	**Vegetation Type**	**Mapped Extent (ha)** [1]	**Temporary Clearing (ha)**	**Mapped Proportion Cleared**	**Mapped Proportion Left Intact**
Drainage areas	D1	9.0	2.7	30.16%	69.84%
Sand dunes	S1	0.7	0.2	30.63%	69.37%
	S2	23,577.5	25.6	0.11%	99.89%
Plains	P1	27.9	8.5	30.32%	69.68%
	P2	38.6	8.5	22.00%	78.00%
	P3	605,656.4	538.7	0.09%	99.91%
Low stony rises	H1	30,988.7	27.9	0.09%	99.91%
Rocky outcrops	R1	387.2	0.3	0.09%	99.91%
Totals:		**660,686.0**	**612.4**	**0.09%**	**99.91%**

[1] Vegetation type D2 mapped as part of H1 (see Section 4.6.3.4) and proportional loss can assumed to be equivalent to H1.

It is important to note that the percentage figures in Table 4.9 and Table 4.10 for the disturbance of the vegetation within the transmission cable corridor are calculated based on the limited extent of each vegetation type that was mapped by Biota (2018b) within the survey boundary. All of the coastal vegetation types are distributed considerably more widely and are broadly arranged in bands parallel to the coast, with the corridor crossing them at perpendicular, meaning that the proportional impact at local and regional scales are orders of magnitudes less than the percentages in Table 4.9 and Table 4.10, which provide a very localised framework. Vegetation type S1 of Table 4.10 is an illustrative example: it is representative of the Eighty Mile Land System PEC and, as set out in Section 4.6.5.2, when this is considered at a more appropriate locality scale, the regional loss of vegetation type S1 is less than 0.01% rather than the approximately 30% local scale loss presented in Table 4.9.

Observations of rapid revegetation of access tracks onsite, and the reliable rainfall patterns of the locality, provide a high degree of confidence that the short-term clearing for cable burial will rehabilitate rapidly. Table 4.9 therefore represents the effective impact on vegetation types from the proposal, noting again that vegetation type P2 is far more widespread in the locality than the extent mapped within the development envelope.

4.6.5.2 Clearing of Eighty Mile Land System PEC

The Eighty Mile Land System PEC is represented within the cable corridor portion of the development envelope as mapped by vegetation type S1 (Section 4.6.3.5).

Trenching for the cable installation will result in the clearing of a very small area of the PEC at 0.2 ha (Table 4.9). This will be a short-term disturbance during cable installation that will be rehabilitated on completion of the cable works (Section 4.6.6). Figure 4.12 shows the potential impact of the construction clearing in context with the wider distribution of the PEC in the locality (as represented by the Eighty Mile Beach land system). The clearing of 0.2 ha represents less than 0.01% of the total extent of the Eighty Mile Land System (42,259 ha; van Vreeswyk et al. 2004). Given this, and that the disturbance to the PEC will be a narrow corridor that will be rehabilitated on completion (Section 4.6.6), the impacts to the PEC are not considered significant.

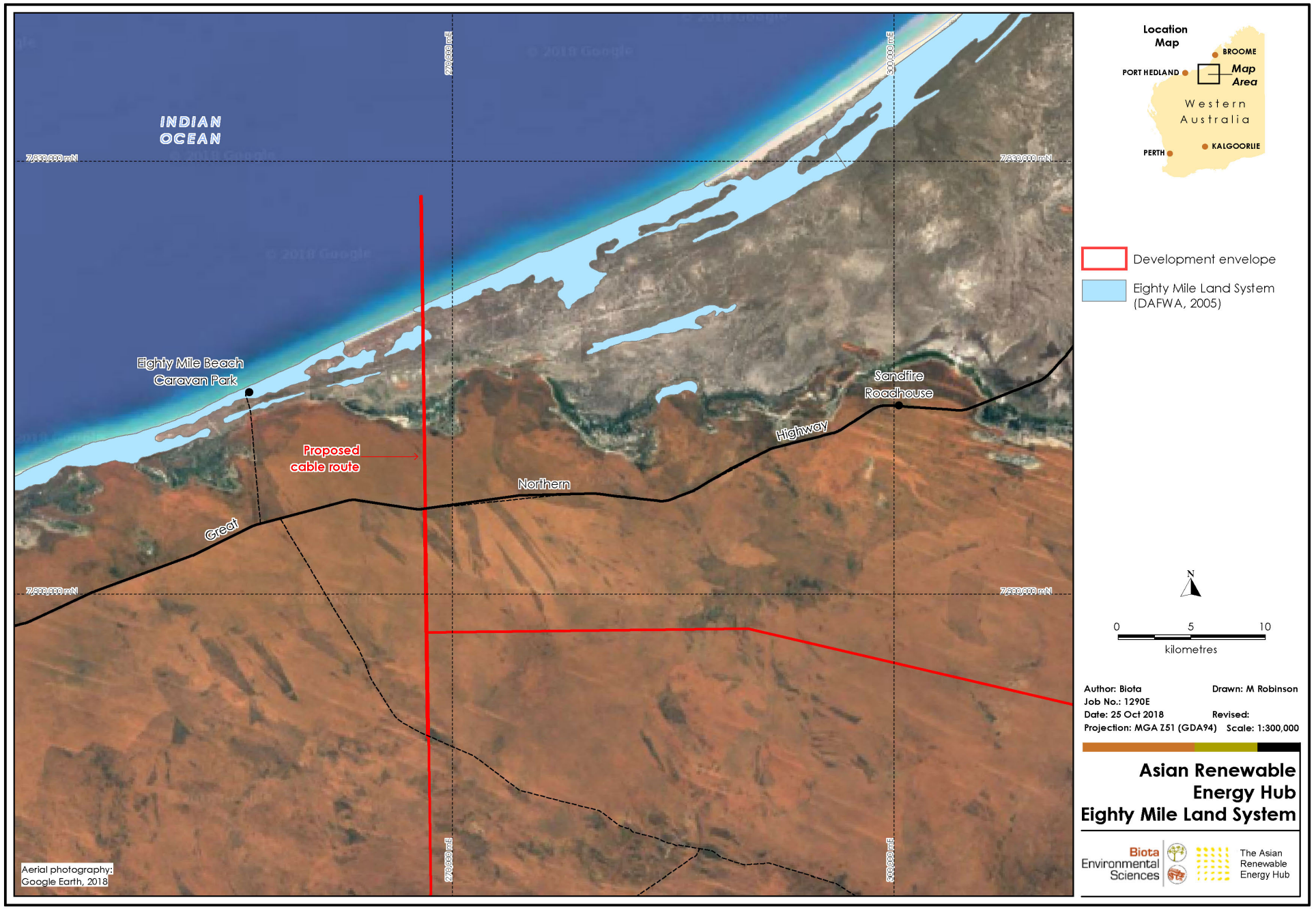

Figure 4.12: Potential impacts on the Eighty Mile Land System PEC in context with its wider distribution in the locality.

4.6.5.3 Clearing Within Kujungurru-Warrarn Nature Reserve

A small section at the northern end of the transmission cable corridor will make a straight line crossing of the Nature Reserve for a length of 261 m (Figure 4.6). This will equate to 1.27 ha of temporary disturbance to the 2,552 ha extent of the reserve, or <0.05% by area. The impacts associated with this work are short-term and minor and comprise:

Vegetation clearing – which will be short-term trenching only to install the cables; topsoil will be reinstated via direct return protocols immediately following completion of the works, bringing a high degree of confidence in successful rehabilitation;

Weed introduction or spread – which will be managed through the development of a comprehensive weed hygiene and topsoil management programme (Section 4.6.6 and Appendix 1);

Fragmentation of the Nature Reserve – which, considering the works will only affect <0.05% of the extent of the reserve, are temporary in nature, and will be immediately rehabilitated such that no barriers or divisions are created within the reserve, is very unlikely to be a significant impact.

Considering the above, the proposal is unlikely to present any significant risks to the values of the Kujungurru-Warrarn Nature Reserve.

4.6.5.4 Clearing of *Seringia exastia*

The State and Commonwealth listed Threatened flora species, *Seringia exastia,* was recorded from six locations within the eastern portion of the development envelope (Section 4.6.3.5), but none of these fall within the clearing footprint of the current conceptual design.

In addition, records of a sterile *Seringia* that could not be confirmed to species level were recorded from 15 other locations, and a precautionary approach has been adopted in regard to these, assuming that they may also represent *S. exastia* (Section 4.6.3.5). On the basis of the current conceptual design, all of these 15 undetermined *Seringia* records also fall outside the proposal clearing footprint and they would therefore not be impacted.

Figure 4.13 shows the closest known records of *S. exastia* to the clearing footprint for the conceptual design: these are separated by 303 m and 543 m from the predicted extent of the disturbance. It is possible that there are other currently undocumented populations of the species within the development envelope, and the proponent will undertake targeted surveys at the detailed design stage of the project, with modifications to the final design to avoid direct impacts (Section 4.6.6).

The broader status of *Seringia exastia* also has some bearing on the assessment of impacts: evidence from recent surveys suggests the species may be considerably more widely distributed than thought at the time of its listing (Biota 2018b) (Section 4.6.3.5). The records from the current assessment alone have extended its known distribution by 290 km, with much of the intervening area comprising very similar and suitable habitat (Biota 2018b). This suggests that the species' true distribution is probably underestimated and that inadequate data have contributed to its current conservation status, rather than true rarity.

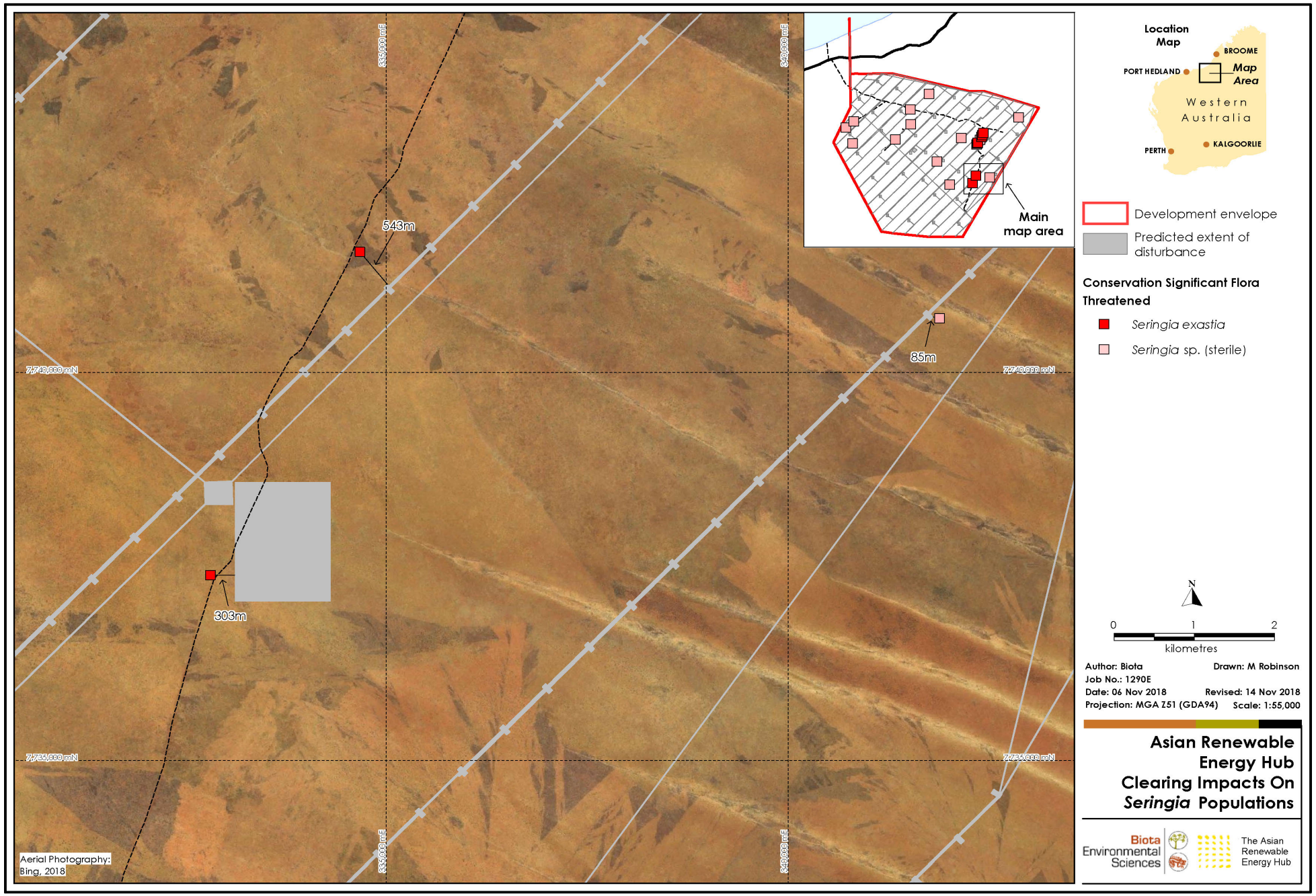

Figure 4.13: Potential impacts on *Seringia exastia*.

Considering that:

1. the current conceptual design already avoids impacts on all new records of *S. exastia* and undetermined *Seringia* populations from the Biota (2018b) survey;
2. the potential impacts will be further mitigated by targeted surveys for the species at the detailed design stage of the project, with refinement of the final design to avoid impacting any currently undocumented *S. exastia* populations (Section 4.6.6); and
3. it appears that the species may be more widely distributed than originally thought,

the potential impacts of the proposal on *Seringia exastia* are not considered significant.

4.6.5.5 Clearing of Priority Flora

Eight Priority flora species were recorded from the development envelope (Section 4.6.3.7), including one Priority 1 species *Tephrosia rosea* var. Port Hedland (A.S. George 1114). In addition to being listed as a Priority 1 species, the latter record from the development envelope may represent a new species (Biota 2018b).

However, similar to *Seringia exastia* (Section 4.6.5.2), spatial analysis of the location of the Priority 1 flora and the conceptual design shows that it is more than a kilometre outside of the clearing footprint for the proposal and would not be impacted (see Figure 4.14).

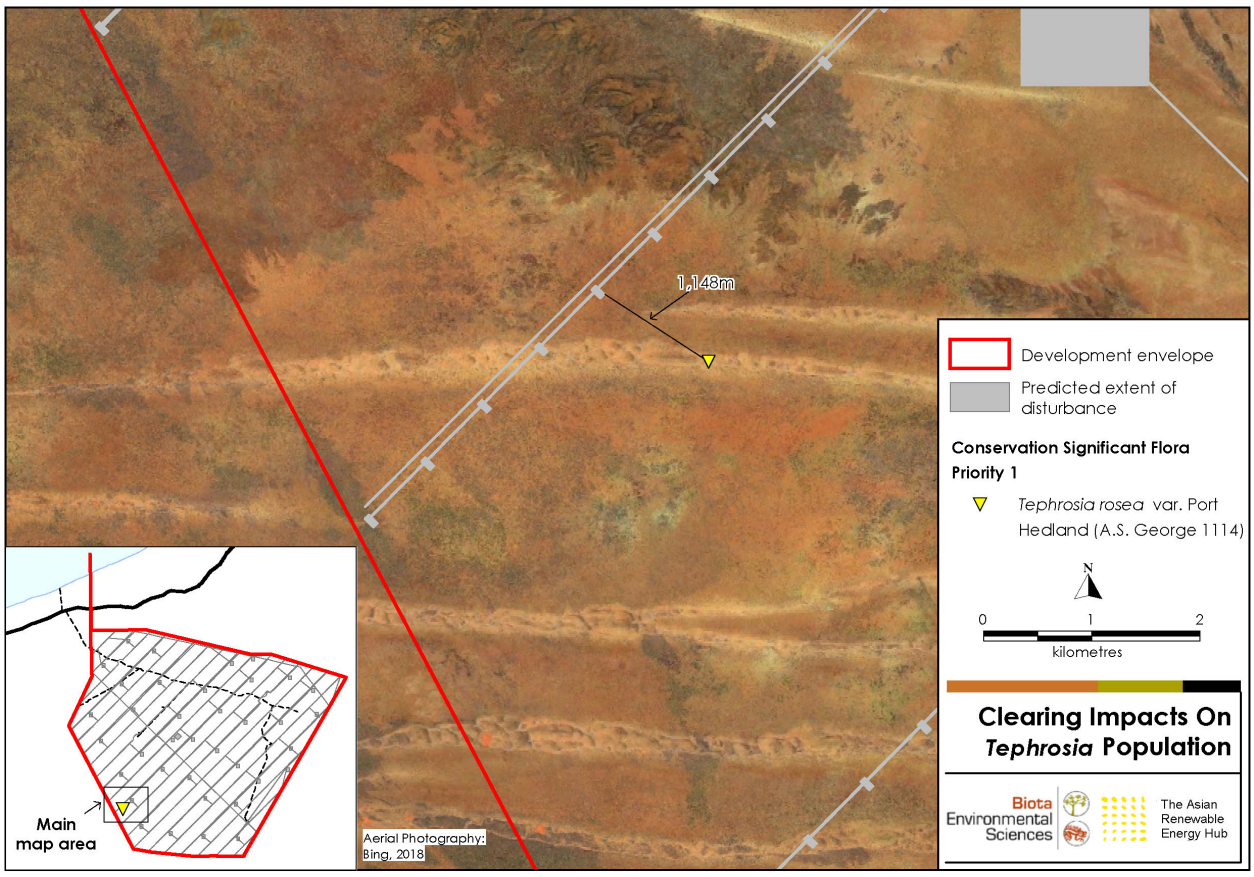

Figure 4.14: Potential impacts on *Tephrosia rosea* var. Port Hedland (A.S. George 1114).

The remaining seven Priority flora species are all listed as Priority 3 (Poorly-known species known from a number of locations and the species does not appear to be under imminent threat) (Biota 2018b). All seven of the Priority 3 species have broad ranges and appear to be more common than previously thought (Biota 2018b). The new records from the development envelope also represent additional, previously unknown populations of the species, meaning that any potential impacts on these new records would not change the conservation status of any of the species, as this was determined on the basis of

previously known populations and distributions. For Priority 3 species then, the proponent will avoid impacts where practicable through refinement of the conceptual design as a best practice approach, but this will not be treated as an overriding design constraint at the same level as Threatened or Priority 1 flora species (Section 4.6.6).

4.6.5.6 Weed Introduction and Spread

There were few weeds records from the main development envelope, and the vegetation was in Excellent and Very Good condition (Section 4.6.3.4). Weeds were mainly recorded from the section of the cable corridor between the Great Northern Highway and the coast, with **Cenchrus* species (Buffel Grass and Birdwood Grass) being particularly abundant (Biota 2018b).

Earthworks, disturbance to vegetation, movement of plant and equipment, and related activities have the potential to introduce new weeds to the development envelope and to spread existing populations of introduced flora; the latter primarily along the coastal portion of the cable corridor. With the Very Good to Excellent condition of the vegetation throughout the main development envelope, comprehensive weed hygiene will be an important management requirement for the project. Well-established management measures will be developed and implemented for all aspects of the construction and operation of the project to mitigate this risk of weed introduction and spread (see Section 4.6.6).

4.6.5.7 Vegetation Partitioning and Changes to Fire Regime

As outlined in Section 4.6.3.8, the landscape and vegetation of the development envelope is currently subject to relatively frequent and extensive fires. Large fires can be damaging to the environment, deadly to people and destructive to infrastructure. Not only will these events reduce vegetation diversity in the landscape, but the project workforce are at significant risk in any areas where flammable vegetation grows close to work areas. Bushfires do not respect tenure, and a fire originating on or passing through the project area could also seriously impact adjacent landholders (personnel, stock and property) and the public (Appendix 6).

Because of the nature of the vegetation throughout the development envelope, it is impossible to exclude fire from the area. The area will eventually burn. With construction of the proposal's access track network there is, however, the opportunity to develop and implement a Fire Management Plan to determine when fires will occur, and the size and intensity of the burn (Appendix 6). This dramatically reduces risk to personnel and infrastructure, as well as achieving good environmental outcomes. A prescribed burning program will also enable a dramatic reduction in risk from un-planned bushfires, and offers strong possibilities in facilitating the development of collaborative partnerships with Traditional Owners and interested government agencies (Appendix 6). In essence, implementing a mosaic fire control program would effectively represent a return to managing the land in the way that traditional owners did for tens of thousands of years.

The proposal will result in the large-scale partitioning of the landscape into 'blocks' of vegetation separated by significant distances as a result of access roads and other cleared areas acting as fire breaks. While these may appear to be somewhat isolated units on the scale of Figure 4.11, each area will in reality be a very extensive expanse of vegetation in its own right; on average approximately 5 km wide by 30 km in length (~15,000 ha). This will result in a change to the current fire regime, but rather than considering this a negative impact of the proposal, it is more appropriately viewed as a

positive opportunity to implement fire management for biodiversity objectives, in a currently unmanaged landscape where large-scale wildfires reduce vegetation diversity and overall resilience to other perturbations (Section 4.6.3.8; Appendix 6).

4.6.5.8 Other Construction and Operations Impacts

Additional impacts on flora and vegetation may also result from other project-related activities including off-road driving and increased risk of bushfires ignited by project works, particularly during construction. The *Triodia* spp. hummock grasslands that dominate the development envelope in particular are highly flammable and particularly susceptible to physical damage from vehicle movements and may take extended periods to recover.

4.6.5.9 Cumulative Impacts

EPA (2018c) requires the cumulative impact of the proposal on flora and vegetation to be considered in context with other existing or reasonably foreseeable activities, developments and land uses when considering the significance of impacts.

The proposal is set in a location where there has been virtually no land use development and no existing infrastructure or historical clearing beyond one or two access tracks (Section 2.4). This is reflected in the intact state of the vegetation and the very small extent of existing disturbed ground (Figure 4.8 and Table 4.6). In essence, this means there are effectively no cumulative impacts to be taken account of in respect to flora and vegetation, as there is no historical loss in the immediate locality to which the impacts of the current proposal can be incrementally added.

4.6.6 Mitigation

Mitigation measures that will be implemented to minimise impacts on flora and vegetation have followed the Western Australian mitigation hierarchy (Avoid, Minimise, Rehabilitate, Offset (Government of Western Australia 2011)) and will comprise:

- Avoidance of Threatened flora and Priority 1 flora locations during project design, with provision for pre-clearance targeted surveys of final design clearing limits.
- Avoidance of other Priority flora locations during project design wherever practicable, with provision for pre-clearance targeted surveys of final design clearing limits.
- Reduction of vegetation clearing footprint during the design stage to the minimum practicable, including utilisation of existing cleared tracks and co-location of infrastructure to the extent feasible.
- Development and implementation of a Construction Environmental Management Plan (CEMP) (Appendix 1) addressing:
    - Comprehensive weed hygiene management: all plant and equipment brought on to the site will be required to be free of vegetation and soil to ensure the risks of weed introduction are minimised. This will include the creation of formalised clean down points prior to plant and vehicles entering site. A weed monitoring and control programme will be developed to address all construction areas to promptly identify and control any new infestations which may still arise during construction.
    - Vegetation clearing control measures: definition of clearing limits on all design drawings and specifications, surveying in these limits in the field and erecting bunting or other clear boundary markers on-site. Vegetation clearing will constitute a hold point requiring written authorisation from the Site Superintendent prior to proceeding.

  - Topsoil management protocols: site-specific topsoil management protocols will be prepared to facilitate maximum use of topsoil in rehabilitation works. Rehabilitation of non-permanent disturbed areas will initially focus on recovery and recruitment from soil seedbanks and stockpiled vegetative material, with additional seeding using locally occurring native species in the event that monitoring shows slow rehabilitation success.
  - Additional rehabilitation protocols: including specific consideration of Priority flora where appropriate, erosion control and dune stabilisation where required.
  - Rehabilitation and weed monitoring and contingency measures.
  - Bushfire Risk Management: the risks of construction related fires will be minimised by measures such as controlled procedures for any welding and grinding activities, inspection of the exhausts of any clearing equipment and the use of spark suppressors on any generating equipment on site. A fire emergency response plan will be prepared to the satisfaction of the Shire of East Pilbara and FESA.
  - Other general construction site matters such as waste management, management and workforce environmental inductions.
- Design and implementation of a comprehensive landscape-scale fire management plan for the development envelope for the operational life of the proposal (see Appendix 6).
- Design and implementation of a biodiversity monitoring programme to provide continuous feedback to fire management for long-term maintenance of biodiversity and infrastructure protection.
- Development and implementation of a decommissioning and rehabilitation management plan a minimum of five years prior to eventual project closure. This is not expected for many decades and will be prepared with policy frameworks current at that time. It is likely to include:
  - protocols for decommissioning and removal of all infrastructure;
  - measures for earthworks and landscaping completion to maximise revegetation of cleared ground;
  - monitoring protocols to measure revegetation success and detect weed incursions; and
  - remedial protocols to address any revegetation or weed issues where objectives have not been adequately met.

These mitigation measures will all be embodied in the CEMP (Appendix 1) and required as contractual specifications for all works undertaken, with construction and post-construction environmental auditing, verification and corrective action where necessary.

4.6.7 Predicted Outcome

The principal impact of the proposal on flora and vegetation will be the permanent clearing of 11,962 ha that is required to construct the project infrastructure.

Almost all of the vegetation types to be cleared are not of elevated conservation significance, and the impact of the cable trenching on the Eighty Mile Land System PEC (vegetation type S1) is not significant at 0.2 ha of temporary clearing compared to its 42,259 ha overall extent. The two vegetation types that will be subject to the greatest clearing for the proposal, S2 and P3 (Section 4.6.5.1), are also the most extensive within