

4.8 Social Surroundings

4.8.1 EPA Objective

The EPA objective for the Social Surroundings factor is to protect social surroundings from significant harm.

4.8.2 Policy and Guidance

The following guidance and policy documents are relevant to the Social Surroundings factor:

EPA Policy and Guidance

- Instructions on how to prepare an Environmental Review Document (EPA 2017);
- Statement of Environmental Principles, Factors and Objectives (EPA 2015);
- EPA Environmental Factor Guideline: Social Surroundings (EPA 2016I); and
- EPA Instructions on how to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans (EPA 2018a).

Other Policy and Guidance

- *Aboriginal Heritage Act 1972*;
- Visual Landscape Planning in Western Australia: a manual for evaluation, assessment, siting and design (WAPC 2007);
- Planning Bulletin 67 Guidelines for Wind Farm Development (WAPC 2004);
- Environmental, health, and safety guidelines for wind energy (World Bank Group 2015);
- National Wind Farm Commissioner website, <https://www.nwfc.gov.au/>, Australian Government;
- Aboriginal Heritage Due Diligence Guidelines (Department of Indigenous Affairs and Department of Premier and Cabinet 2013); and
- Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy (Department of Sustainability, Environment, Water, Population and Communities 2012).

4.8.3 Visual and Landscape

4.8.3.1 Policy and Guidance

The EPA objectives relevant to visual and landscape impact are those regarding the protection of social surroundings, and specifically the protection of social surroundings from harm. This includes protecting modifications to sensitive viewsheds and changes to landscape amenity.

Given that the visual and landscape considerations of wind turbines are more material than those of the solar PV and electrical infrastructure, the most relevant guidance available is contained in Section 6.1 of Planning Bulletin 67 of the Western Australian Planning Commission (WAPC 2004).

This states that:

“Visual impact is based on a number of factors which affect the perceived visual quality. The degree to which a wind farm development will impact on the landscape will depend upon:

- *Siting, layout and design of the turbines, infrastructure, signage and ancillary facilities, including provision for tourism.*
- *Number, colour, shape, height and surface reflectivity of the towers and blades.*
- *Visibility of the development, having regard to the location, distance from which the development is visible, skyline and view sheds.*
- *Significance and sensitivity of the landscape, having regard to topography, the extent and type of vegetation, natural features, land use patterns, built form character and community values.*

Methods to ameliorate visual impact include:

- *Ensuring all turbines look alike, have a clean, sleek appearance and that the blades rotate in the same direction.*
- *Minimising the number of turbines, as appropriate, by using the largest possible model (subject to the visual absorption capabilities and environmental considerations of the site) rather than numerous small ones.*
- *Siting the wind farm, ancillary buildings, access roads and transmission infrastructure to complement the natural landform contours and landform backdrop, including ridgelines.*
- *Ensuring the choice of materials and colour (e.g. off-white and grey for turbines, low contrast for roads) for the development complements the skyline and the backdrop of the view sheds.*
- *Minimising removal of vegetation and using advanced planting of vegetation screens as visual buffers where appropriate.*
- *Ensuring good quality vegetation and landform rehabilitation, on-site and off-site, where appropriate.*
- *Locating turbines to reflect landscape and topographical features (e.g. a random pattern may suit a rolling, varied landform and a linear pattern may suit a coastal edge, farm or industrial site).*
- *Avoiding clutter, such as advertisements and apparatus.”*

4.8.3.2 Receiving Environment

The development envelope is sited in a large-scale landscape setting in a remote part of the northeast Pilbara. This remoteness means that there are few public access locations near the site, and very few nearby residents. The nearest sealed public road is the Great Northern Highway, which is to the northwest of the site and 10 km away at its nearest point.

An unsealed track, referred to as the Nyangumarta Highway, runs through the development envelope from west to east. This track is managed by the Nyangumarta people and open to tourists who buy online permits.

Since it was inaugurated in 2015, the number of permits sold each year is the equivalent of about one vehicle a week, with the following numbers of permits having been issued in the past three years:

- 2015: 36;
- 2016: 48; and
- 2017: 53.

There are four residences within 30 km of the development envelope boundary, as highlighted in Figure 4.29. These are:

- Wallal Station, located 24 km from the nearest turbine;
- Mandora Station, located 18 km from the nearest turbine;
- Eighty Mile Beach Caravan Park, located 24 km from the nearest turbine; and
- Sandfire Roadhouse, located 18 km from the nearest turbine.

The proposal is situated to the east of the Great Northern Highway on the boundary between inland coastal plains and the beginning of the extensive sandy deserts of northwest Australia. The land is gently sloping, rising very gradually as it goes inland. However, due to the extensive vistas, that rise is not readily perceptible across the landscape. Generally, there is little variability in the extensiveness of viewsheds or the type of landform visible across the entire extent of the development envelope.

The development envelope encompasses three main groupings of landforms that are represented by the Nita, Little Sandy and Callawa land systems (Table 4.21 and Figure 4.30). These effectively correspond to visual landscape units for the purposes of this assessment.

Descriptions of these existing landscapes are provided in Table 4.21 below, and Plate 4.30 to Plate 4.32 show typical examples of each landscape type.

Table 4.21: Land systems of the development envelope and their landscape description.

Land System	Description of Landscape
Nita	Sandplains supporting shrubby spinifex grasslands with occasional trees. Generally, the landscape appears uniform and mildly undulating. Viewsheds are wide, especially at the top of small rises. The landform system is typical for areas near the coast in the region and is not unique.
Little Sandy	Sandplains with linear and reticulate dunes supporting shrubby hard and soft spinifex grasslands. Characterized by reduced viewsheds when between dunes, and wide vistas on top of dunes. The dunes average 5-30 m in height and carry on for several kilometres in a northwest to southeast alignment. The landform system is typical for the Little and Great Sandy Deserts and covers vast swaths of the northwest of Australia and is not unique.
Callawa	Highly dissected low hills, mesas and gravelly plains of sandstone and conglomerate with soft and hard spinifex grasslands. Characterised by very mildly undulating land, which can allow for wide vistas at the top of small rises. The landform system is found in areas across the region and is not unique.



Plate 4.30: Typical Nita land system landscape.



Plate 4.31: Typical Little Sandy land system landscape.



Plate 4.32: Typical Callawa land system landscape.

As can be seen from Plate 4.30 to Plate 4.32, although the landscapes have been categorised differently, in the context of the development envelope they are visually fairly similar and share much of the same vast vistas, are topographically low and with only gently undulating landforms, and have relatively uniform and structurally simple vegetation.

The above photographs effectively capture the nature of the viewsheds across virtually all of the 662,400 ha of the development envelope.

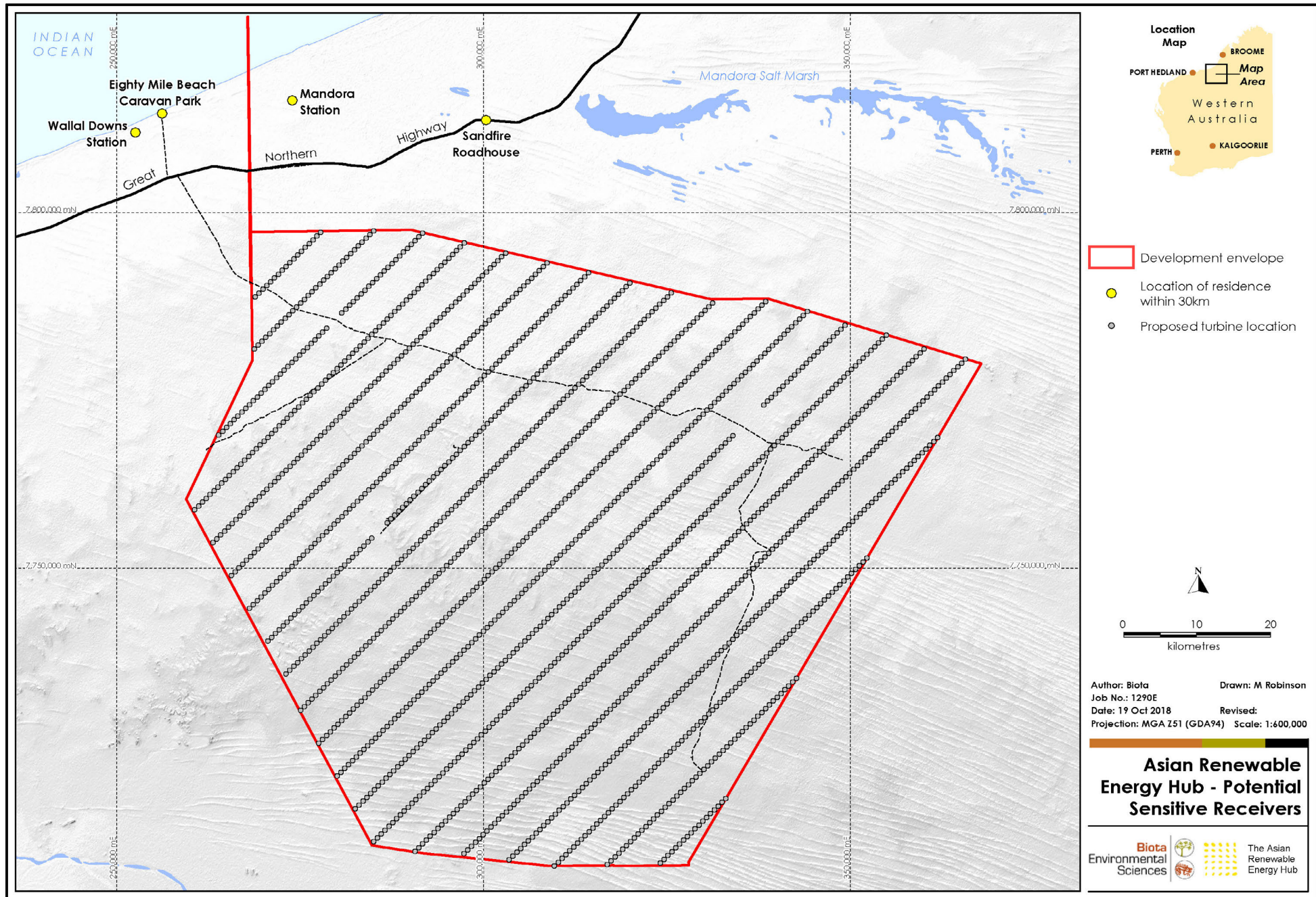


Figure 4.29: Potential sensitive receivers within 30 km of the development envelope.

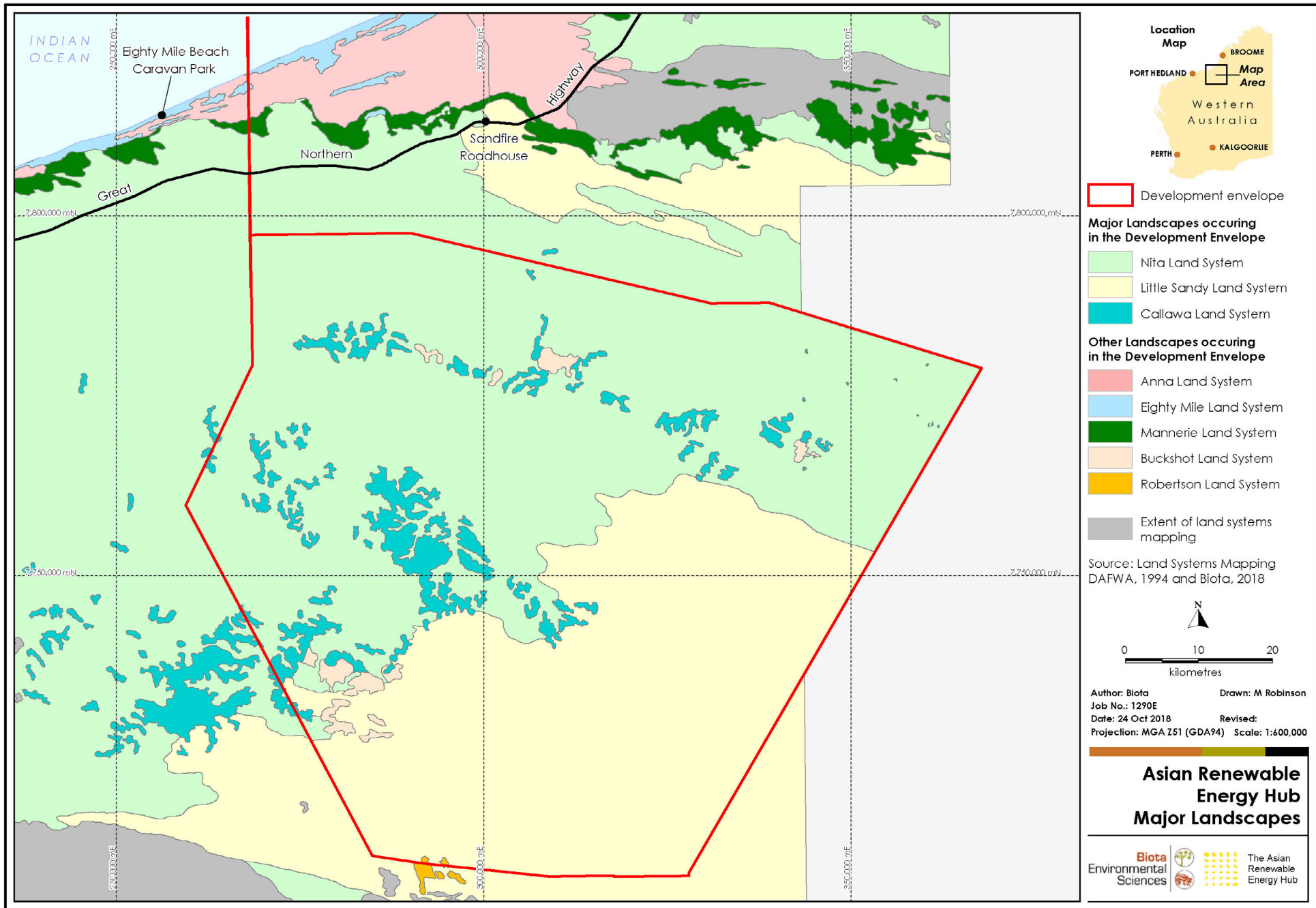


Figure 4.30: Distribution of the major landscapes of the development envelope (as mapped by land systems).

4.8.3.3 Potential Impacts

Construction and decommissioning activities could have a temporary impact on visual amenity through the movement of construction vehicles and busy activity at the site changing its character in an otherwise remote and natural landscape.

Operational solar PV arrays and wind turbines could also have potential impacts due to their man-made form in an otherwise uniformly natural landscape. Their impact on the visual amenity of an area can be beneficial or negative, depending on the scale and features of a landscape and, more importantly, the subjective perceptions of the viewer. Potential visual impacts are based on a number of factors that affect perceived visual quality.

The degree to which a wind or solar farm development will impact on the landscape will depend upon:

- siting, layout and design of the wind turbines, solar PV, infrastructure, signage and ancillary facilities, including provision for tourism;
- in the case of wind turbines, the number, colour, shape, height and surface reflectivity of the towers and blades;
- visibility of the development, having regard to the location, distance from which the development is visible, skyline and view sheds; and
- significance and sensitivity of the landscape, having regard to topography, the extent and type of vegetation, natural features, land use patterns, built form character and community values.

A visual effect that can occur in relation to operational wind turbines is shadow flicker. Shadow flicker occurs as a result of the wind turbine blades passing between the sun and a receptor point and is a potential concern when the receptor point is a dwelling. Shadow flicker may potentially occur under certain combinations of geographical position and time of day and year. Due to the movement of the sun across the sky, the effect can only occur for limited periods during a day and on limited days in a year. It is generally accepted that shadow flicker ceases to be a problem when the receptor point is greater than 10 blade diameters from the wind farm. In the case of the proposal, this equates to a separation distance of around 1,700 m.

A secondary visual effect that can occur at wind farms is glinting; the effect of light being reflected from turbine blades. This usually occurs when the blades are wet or rotating in strong sunshine. The likely incidence of glinting is impossible to predict, but past experience suggests that this is a relatively rare occurrence, especially with modern turbine blades, which have non-reflective coatings. Even in the event that glinting does occur with the current proposal, the effects are primarily limited to a distance of 1 km from a turbine.

Navigation lights are being proposed on the top of all the wind turbine towers, in line with best practice for aviation safety. These would be visible at night. The exact numbers and intensity of the lighting will be subject to further design work, but the lighting will be limited to between 4-10 km visibility.

4.8.3.4 Assessment of Impacts

Zone of Visual Influence

A critical aspect of assessing visual impact is to firstly determine from where the project will be seen or viewed from within the overall landscape by potential sensitive receivers. This is often referred to as a Zone of Visual Influence (ZVI) assessment and is undertaken using industry standard quantitative assessment techniques.

A ZVI is undertaken by preparing a three-dimensional software model which uses the proposed coordinates of the wind turbines, three-dimensional models representing the turbine size, and topographical data for the area in and around the development site. The software can then use these data to calculate geographical locations where turbines would be visible from and the number of turbines visible from each location.

Given the higher impact from wind turbines than solar PV arrays or electrical infrastructure in the visual assessment of the proposal, the calculations and assessment viewpoints were chosen using the wind turbine ZVI results to provide a worst-case scenario. The results are shown in Figure 4.31 and Figure 4.32.

These figures show the visibility of numbers of wind turbines in the surrounding landscape using a sliding scale illustrated graphically by a changing colour code. Two scenarios were modelled to provide a sensitivity analysis of the change in visibility of the turbines of the heights of two key components of the turbine infrastructure:

- Figure 4.31 shows the results up to the proposed turbine hub height at 175 m; and
- Figure 4.32 shows the results up to the proposed maximum tip height at 260 m.

The ZVIs allow the following broad conclusions to be reached:

- there is medium to high visibility of the total number of wind turbines within the development envelope itself;
- the topographic characteristics of the area are generally such that the visibility of the wind turbines will be primarily limited to seeing blade tips against a flat horizon at distances beyond 10 km; and
- the areas from which the project will be more visible are generally to the northwest of the development envelope.

These findings, however, must be considered in the context that:

- the calculations assume there is no vegetation cover that might obstruct visibility. On the ground, many areas that have theoretical visibility in the ZVI analysis would in reality not have any, due to the presence of low trees or high shrubs relatively close to the observer; and
- a turbine tower or blade is included in the count even if only the smallest part is visible in the model. Not all of the turbine tower hubs or blade tips would in reality be visible but have registered as being visible on the ZVI due to very small inclusions.

The ZVI modelling is therefore a conservative and precautionary predictor, and the actual visibility to an observer at any point outside of the development envelope will be less than indicated in Figure 4.31 and Figure 4.32.

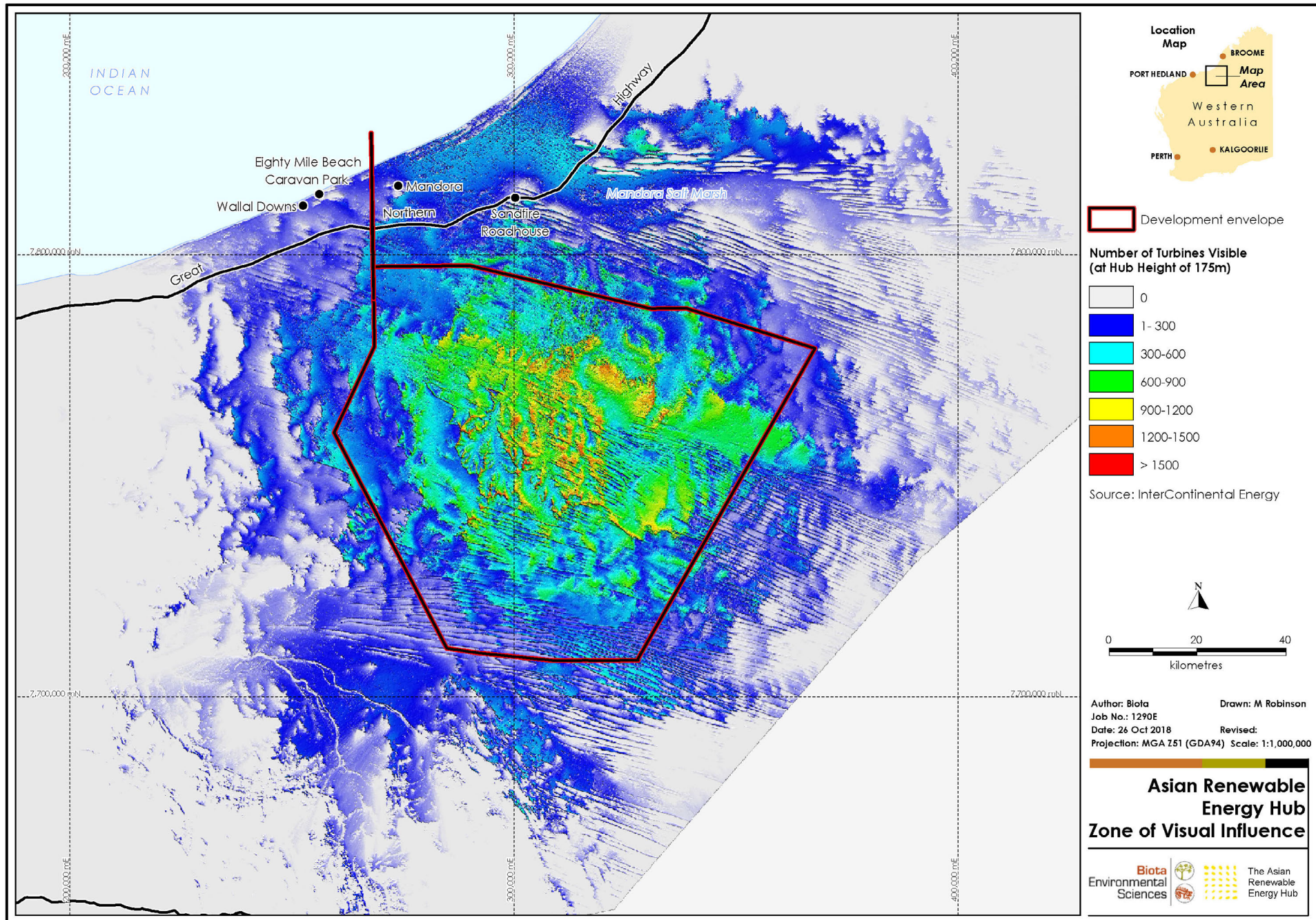


Figure 4.31: ZVI to hub height of 175 m.

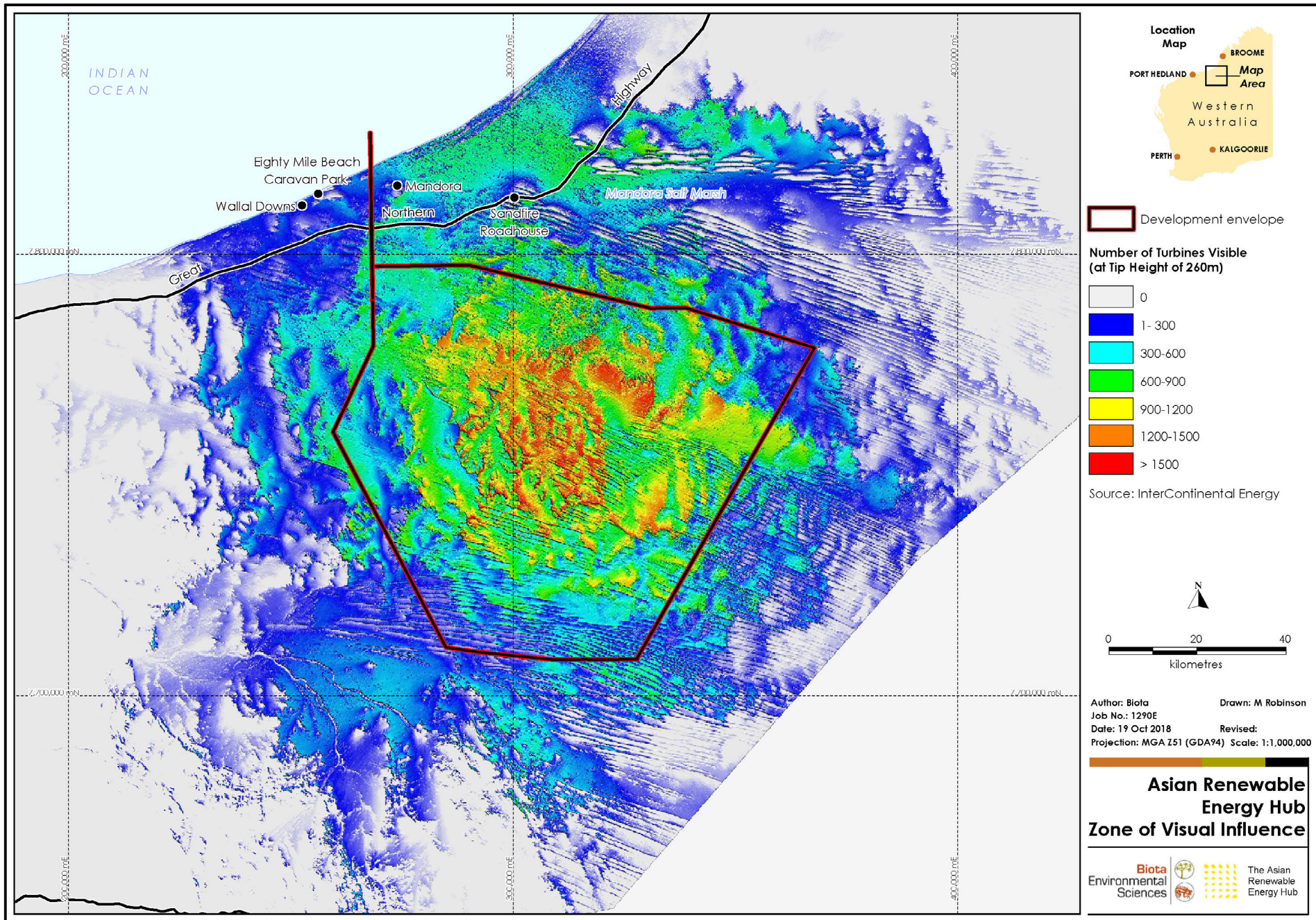


Figure 4.32: ZVI to tip height of 260 m.

Sensitive Receivers and Photomontage Locations

When considering how the project might be perceived, the focus has been on considering areas within 30 km of the nearest turbines. Viewsheds beyond this distance are unlikely to be significantly impacted by the proposal as the turbines would become increasingly invisible to the naked eye beyond 30 km.

People are not uniformly distributed throughout the landscape near the development envelope. Because of the inaccessibility of most of the area to the south and east of the development envelope, observers would primarily be limited to the areas to the west and north of the site. Within this area, the proposal might be observed from either fixed or static points (e.g. residences and roadside stops), or linear corridors (e.g. roads). The proposal is unlikely to be observed from other points as there are no hiking or cycling trails nearby, and people do not venture far from driveable tracks in such a remote location.

Table 4.22 shows the potential sensitive receivers identified within 30 km of the project and Figure 4.33 shows the viewpoint locations.

Table 4.22: Sensitive receivers within 25 km of the development envelope.

Photomontage Location	Description
1 – Highway Ramsar View across marshlands driving south on the Great Northern Highway	Given the extensive flat area of the marshlands to the north of the project, it would be possible for drivers to see the project. This viewpoint also has the most extensive views of the project from the Great Northern Highway in terms of the number of turbines visible.
2 – Highway Stop Great Northern Highway tourist rest stop	The project will not be visible from Sandfire Roadhouse or Mandora due to topography and vegetation coverage. A representative location was therefore selected along the Great Northern Highway with less vegetation.
3 – Nyangumarta Highway Turn-off onto the Nyangumarta Highway from Great Northern Highway	Given the vegetation coverage along the Great Northern Highway, it was necessary to drive down the Nyangumarta Highway a few hundred meters to obtain a viewpoint that might represent a tourist approaching the project, or what might be seen from a moving car along the Great Northern Highway where vegetation allowed.
4 – Eighty Mile Beach Residents to the northwest	Wallal Station, Mandora Station and Eighty Mile Beach Caravan Park are all located relatively near to each other to the northwest of the project. A photomontage was generated on high ground to represent a worst-case scenario for this area. All three dwellings would not be able to directly see the project due to tree coverage.
5A, B, C and D – Site North, South, East, West Within the development envelope	These viewpoints are representative of what a driver on the Nyangumarta Highway would observe driving through the project, rather than a receiver external to the development envelope. The location selected is a potential site for the tourist visitor centre and viewing platform.

A representative photomontage was produced using digital modelling software for each potential sensitive receiver location (see Plate 4.33 to Plate 4.40). These demonstrate the effect that the geographic separation of the site from key viewing points along the Great Northern Highway will have, whereby the turbines will be barely visible on the horizon from most locations.

The photomontages are also provided in high-resolution format in Appendix 9 should the reader wish to enlarge the images to improve turbine visibility.

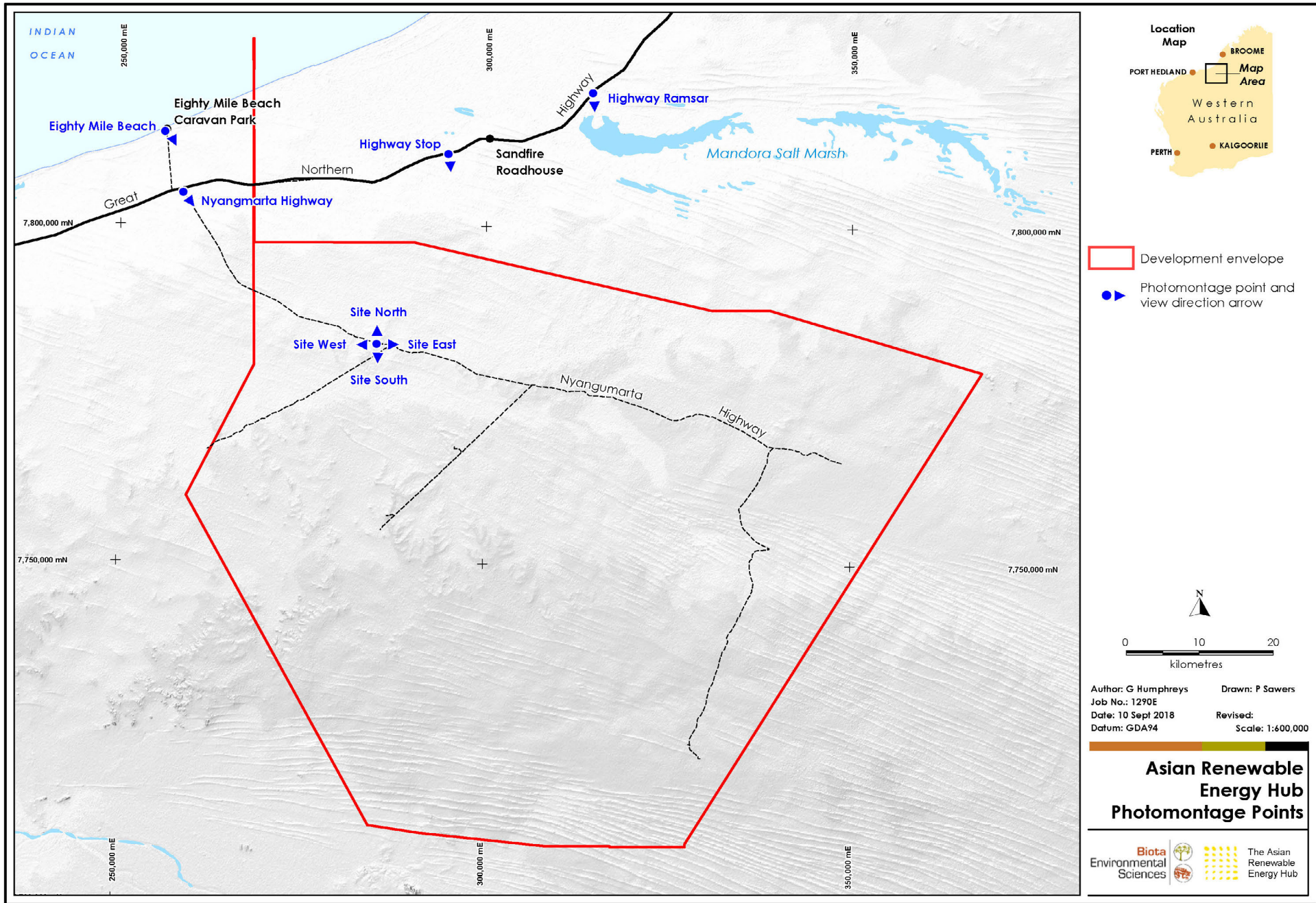


Figure 4.33: Sensitive receiver photomontage locations.

PREDICTED VIEW - PHOTOMONTAGE



Plate 4.33: Photomontage of predicted viewshed from the Great Northern Highway crossing of the Mandora Marsh Ramsar site (Walyarta) after the implementation of the proposal (see Appendix 9 for high resolution version).

PREDICTED VIEW - PHOTOMONTAGE



Plate 4.34: Photomontage of predicted viewshed from the tourist travel stop on the Great Northern Highway after the implementation of the proposal (see Appendix 9 for high resolution version).

PREDICTED VIEW - PHOTOMONTAGE



Plate 4.35: Photomontage of predicted viewshed from Eighty Mile Beach caravan park after the implementation of the proposal (see Appendix 9 for high resolution version).

PREDICTED VIEW - PHOTOMONTAGE



Plate 4.36: Photomontage of predicted viewshed from the intersection of the Nyangumarta Highway and the Great Northern Highway after the implementation of the proposal (see Appendix 9 for high resolution version).



Plate 4.37: Photomontage of predicted viewshed within the development envelope (Site North; Figure 4.33) after the implementation of the proposal (see Appendix 9 for high resolution version).



Plate 4.38: Photomontage of predicted viewshed within the development envelope (Site East; Figure 4.33) after the implementation of the proposal (see Appendix 9 for high resolution version).

PREDICTED VIEW - PHOTOMONTAGE

Plate 4.39: Photomontage of predicted viewshed within the development envelope (Site South; Figure 4.33) after the implementation of the proposal (see Appendix 9 for high resolution version).

PREDICTED VIEW - PHOTOMONTAGE

Plate 4.40: Photomontage of predicted viewshed within the development envelope (Site West; Figure 4.33) after the implementation of the proposal (see Appendix 9 for high resolution version).

Potential Impacts

Given the temporary nature of construction activities and the development envelope's distance from the identified sensitive receivers, these activities are not considered further. The same is true of potential shadow flicker and glinting impacts since their effects are very localised and none of the local dwellings are close enough for those effects to be a significant consideration. In the medium to long-term timeframe, the project may eventually be decommissioned, at which time residual visual impacts may remain from areas of ground disturbance. These too would only be visible within the development envelope itself, and will be mitigated through the development and implementation of an appropriate closure plan (Section 4.8.3.5).

The primary potential visual and landscape impact from the proposal therefore relates to the operational phase of the project, and the presence and operation of the wind turbines in particular.

Viewpoints from Public Roads and Nearby Dwellings

Viewpoints 1, 2, 3 and 4 represent viewsheds from the nearest public road and dwellings (Table 4.22 and Figure 4.33). They are all 15 km or more from the nearest turbine. To observers at these viewpoints, or viewpoints of a similar distance, visible elements of the turbines will appear as small, indistinct, pin-like elements and will be less readily recognisable as human or man-made structures than in closer views (see Plate 4.33 to Plate 4.36). Navigation lights will not be visible at these distances and the turbines will tend to appear less like new artificial features in the landscape. For this reason, their contrast with the natural characteristics of the surrounding landscape will be significantly less than in closer views.

The scale of the turbine structures is unlikely to be readily evident due to the absence of human scale features in close proximity to them in these views, and the fact that complete turbines will not be visible due to blocking from landform and vegetation, and as a function of separation distance. In these distant views, observers will tend to experience the horizontality of the wind farm elements that are visible, as opposed to the verticality of the turbine structures. In this sense, the turbines will tend to correspond to the overwhelmingly horizontal characteristics of the existing landscape and vistas. In many views, turbines will be seen as part of much wider panoramas of the desert landscape and their significance will therefore diminish in the wider setting. They will typically be seen along the skyline behind large scale and vast panoramas, which are of a similar scale and will thus tend to provide an appropriate scalar setting for the turbines. Again, Plate 4.33 to Plate 4.36 illustrate this in representative examples.

At these distances, the effects of humidity, haze and clouds may mean that there will be days in the year when turbine visibility will be very low, while in clearer air conditions their off-white colour will complement the colours of the sky. The effects of motion will not be obvious at these distances and should offer no significant contrast with the overwhelmingly static qualities of the existing landscape.

In these more distant views, to the extent that the project is visible at all because of landform and vegetation, the turbines should be perceived to subtly interface with the horizon component of the landscape and should not result in any dramatic change to the overall physical texture and structure of the viewshed. The magnitude of change in view experienced by these viewpoints in the operation phase will therefore be low to negligible, especially when considering the mitigation measures discussed in Section 4.8.3.5.

Viewpoints Along the Nyangumarta Highway

Plate 4.37 to Plate 4.40 are representative of the viewsheds of an observer travelling along the Nyangumarta Highway within the development envelope itself (Table 4.22 and Figure 4.33). From this close range, the observer will be able to fully grasp and appreciate the scale, form, and details of the wind turbines. The verticality of the turbines will be very obvious and will contrast with the overwhelmingly horizontal characteristics of the landscape at closer viewing range. The observer will also occasionally be able to see solar PV arrays at various points along the track. The artificial character of these elements will be very evident and will provide a contrast with the natural characteristics and views of the landscape.

Aviation navigation lights would generally be visible between 4-10 km away, depending on the final arrangements. These features will represent a significant new source of artificial lighting in a landscape where night-time lighting is completely absent. Set against this though, is the fact that tourists using the Nyangumarta Highway would not be likely to be driving at night, and so will be largely unaffected by the effects of lights.

The turbines, spaced in rows over 4 km apart, with 800 m between turbines in each row, will be visually permeable, allowing views through them across the landscape. The simple repetition of the turbines in a clear grid will provide a fundamental coherence that will respond in a sense to the simplicity and uniformity of the natural landscape. The turbines are clean, simple and elegant structures with a form intimately related to their function. To this extent, many observers often find there is a certain aesthetic pleasure that can be derived from the elegant, slender form of a turbine, particularly given they are a physical embodiment of the positive concept of clean renewable power generation. In close view they will be a striking, harmonious landscape element maintaining a complementary landscape relationship with the surrounding vistas in terms of their scale and relative simplicity of form.

In close views, the movement of the turbines will be readily visible in a landscape where movement is limited. However, in terms of perceptual psychology, it is probable that the wind farm will evoke a positive connotation with sustainability and clean energy in the minds of observers who have driven this far into the development envelope, knowing the project is there, and this will enhance their visual acceptability.

Although the magnitude of change in views close to the turbines and solar PV panels is considered large, the overall significance of the residual impacts upon observers during the operation phase of the proposal is low. This is because the number of observers using the Nyangumarta Highway are so few, and because their presence within close proximity to the project will be for relatively short periods only, and because of the other visual perception factors assessed above. The visual impact will be further reduced by the implementation of the mitigation measures described in Section 4.8.3.5.

Light Impacts on the Conservation Estate

While the ZVI and photomontage studies were conducted primarily to assess visual impact during daylight hours, the findings of those investigations are also informative when considering any potential light impacts from the main development envelope on amenity within Walyarta Conservation Park, Kujungurru-Warrarn Nature Reserve and the Eighty Mile Beach Marine Park.

Plate 4.33 above illustrates the separation distance between Walyarta (Mandora Marsh) and the main development envelope: as the separation distance is so great, there will be no significant impact from light spill during construction, operation or maintenance of the

project. The situation is similar for the Kujungurru-Warrarn Nature Reserve and Eighty Mile Beach Marine Park in respect of the main development envelope and the great majority of the project infrastructure. Plate 4.35 provides the predicted view from basically the same spatial location as these coastal reserves, again illustrating the very large separation distance from the main development envelope. This distance will attenuate any light spill from construction, operation or maintenance within the main development envelope to insignificant levels. Operational lighting on wind turbines would not be visible beyond a 4-10 km distance (Section 4.8.3.3) and would not result in any light spill amenity impacts on the conservation estate.

There may be very short duration light spill impacts on the amenity of Kujungurru-Warrarn Nature Reserve and Eighty Mile Beach Marine Park during the cable installation component of the construction works. As described in Section 2.6.11.3, it is expected that the installation of each of the cables will take approximately one week. Works will be preferentially conducted during daylight hours to minimise light spill during this brief period, though some night work may also be required. Given that this will only occur for a short period of time, and the cable will then be buried with no artificial lighting for the project operational life, light impacts arising from the cable corridor portion of the development envelope would also not be significant. Any maintenance that may be required for the cables would also be brief in duration and preferentially conducted during daylight hours.

4.8.3.5 Mitigation

In the initial site selection and design the proponent has already incorporated a range of mitigation measures to avoid and reduce the potential adverse impacts on landscape and visual amenity, including:

- Site selection and siting considerations:
 - avoiding significant landscapes and National Parks;
 - setting the project well back from dwellings; and
 - setting the project well back from well know tourist destinations.
- Other site design criteria used to minimise any potential impacts include:
 - using similar types of turbine to keep uniformity of design;
 - using similar types of solar PV panel arrangement to keep uniformity in design;
 - adopting a minimum 15 km buffer distance to neighbouring residences;
 - adopting a 10 km buffer from the Great Northern Highway;
 - using modern turbine designs with three blades that spin slowly; and
 - using matt finish paint and appropriate colouring for the wind turbines.
- Commitment to develop and implement 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.

4.8.3.6 Predicted Outcome

The assessment undertaken shows that there will be negligible negative visual effect on the regional or local landscape quality.

As the largest wind / solar hybrid renewable energy project proposed in the world, the proposal should become a tourist attraction along a stretch of road that currently has few tourist attractions. A tourist centre and viewing platform will be established, and the section of the Nyangumarta Highway leading to the centre will be sealed to make it easier for non-4WD vehicles to visit.

4.8.4 Noise

4.8.4.1 Policy and Guidance

The solar PV and electrical infrastructure aspects of the project have no notable noise impacts to consider beyond typical construction and decommissioning works. Therefore, the primary operational noise considerations that require consideration are in relation to the wind turbines.

The best guidelines for considering potential operational noise impacts from wind farms are contained in Planning Bulletin 67 of the Western Australian Planning Commission (WAPC 2004). These state that:

“A wind energy facility can create noise from the turbine gearbox (if used) or generator (mechanical noise), movement of the blades (aerodynamic noise) and during construction. Mechanical noise has been analysed and reduced in modern machines and usually is similar to, or less than, aerodynamic noise. Aerodynamic noise generally is unobtrusive, broadband in nature and similar to the noise of wind in trees. The noise characteristics of machines vary according to the make and model. Turbines with dual wind speed blades reduce noise emission when wind speeds are lower, however this may not be less than that generated by fixed speed machines. Some turbines have the ability to reduce their sound output at night.

To avoid adverse noise impacts on the amenity of the surrounding community, wind farm developments should include sufficient buffers or setbacks to noise sensitive premises. As a guide, the distance between the nearest turbine and a noise-sensitive building not associated with the wind farm, is likely to be 1km. The ultimate distance between sensitive users and the wind turbine, may be determined on the basis of acoustical studies. It is expected that the proponent will undertake noise monitoring and acoustical modelling against the relevant criteria, to enable the relevant planning authority to determine the acceptability of the development and the merits of a lesser separation distance. Until such time as a formal policy is adopted in Western Australia, the Department of Environment (DoE) endorses the criteria and approach of assessing wind farms based on background noise levels, as described in the South Australian guidelines Environmental Protection Authority – Wind Farms Environmental Noise Guidelines. These guidelines provide that wind farm developments should be constructed and designed to ensure that noise generated will not exceed 5dB(A) above the background sound level or 35dB(A) using a 10-minute LA eq, whichever is the greater, at surrounding noise-sensitive premises.”

4.8.4.2 Receiving Environment

Based on the above guidelines, and taking into account the local social surroundings context, the sensitive receivers of potential concern with regard to noise are the nearest dwellings to the project.

There are four dwellings within 30 km of the development envelope. Figure 4.34 shows the location of these, with 15 km buffers applied to each dwelling. These dwellings are:

1. Wallal Station, located 24 km from the nearest turbine;
2. Mandora Station, located 18 km from the nearest turbine;
3. Eighty Mile Beach Caravan Park, located 24 km from the nearest turbine; and
4. Sandfire Roadhouse, located 18 km from the nearest turbine.

In addition, the proponent will give due consideration to the siting of the project workforce control centre and accommodation buildings to ensure the amenity of personnel living onsite is appropriately managed.

4.8.4.3 Potential Impacts

Potential Impacts from noise can arise during operational activities and during construction, major maintenance and decommissioning. However, noise from during these project phases will be localised and temporary, and all activities will comply with the *Environmental Protection (Noise) Regulations 1997*.

The solar PV and electrical infrastructure aspects of the project have no notable operational noise impacts to assess. Therefore, the only operational noise considerations are in relation to the wind turbines. Wind turbines can create noise from the turbine gearbox or generator (mechanical noise), and movement of the blades (aerodynamic noise). Mechanical noise has been eliminated as a concern in modern wind turbines, which are well insulated, leaving aerodynamic noise as the only concern when considering potential impacts on sensitive receivers. As WAPC (2004) suggest, aerodynamic noise is generally unobtrusive, broadband in nature and similar to the noise of wind in trees. Best practice is to separate wind turbines by at least 1 km from homes to reduce the potential for significant noise impacts (WAPC 2004).

Concrete batching will also be required during the construction period (Section 2.6.3), but the potential for noise and odour arising from this to impact social surroundings will be very localised on the scale of the development envelope, and consideration of this potential impact is therefore limited to the project workforce control centre and accommodation buildings.

4.8.4.4 Assessment of Impacts

Wind turbine noise can be an issue when turbines are located close to sensitive receivers. In the case of the current proposal there are no sensitive receivers located close to the development envelope, so noise is not expected to be an issue. Detailed noise modelling using industry standard software confirmed this prediction as shown in Figure 4.35. Details on the methodology employed for the noise modelling are provided in Appendix 10.

The modelling shows that the expected noise generated by the wind turbines would be below 35dB at a range of approximately 2 km from a row of turbines. This is the level established in the planning guidelines as best practice for proximity to homes in a quiet rural environment (WAPC 2004). Given the separation distance from the turbines to the nearest sensitive receiver is well in excess of this, noise is not considered a significant potential impact on social surroundings.

This finding also applies to the on-site control centre and accommodation for the operational workforce, with the location of this building adjusted such that it will sit outside of the <40dB contour (Figure 4.35). That already low level of noise will be the ambient noise outside of the buildings, which will be suitably constructed to ensure noise within the buildings will remain below 35dB.

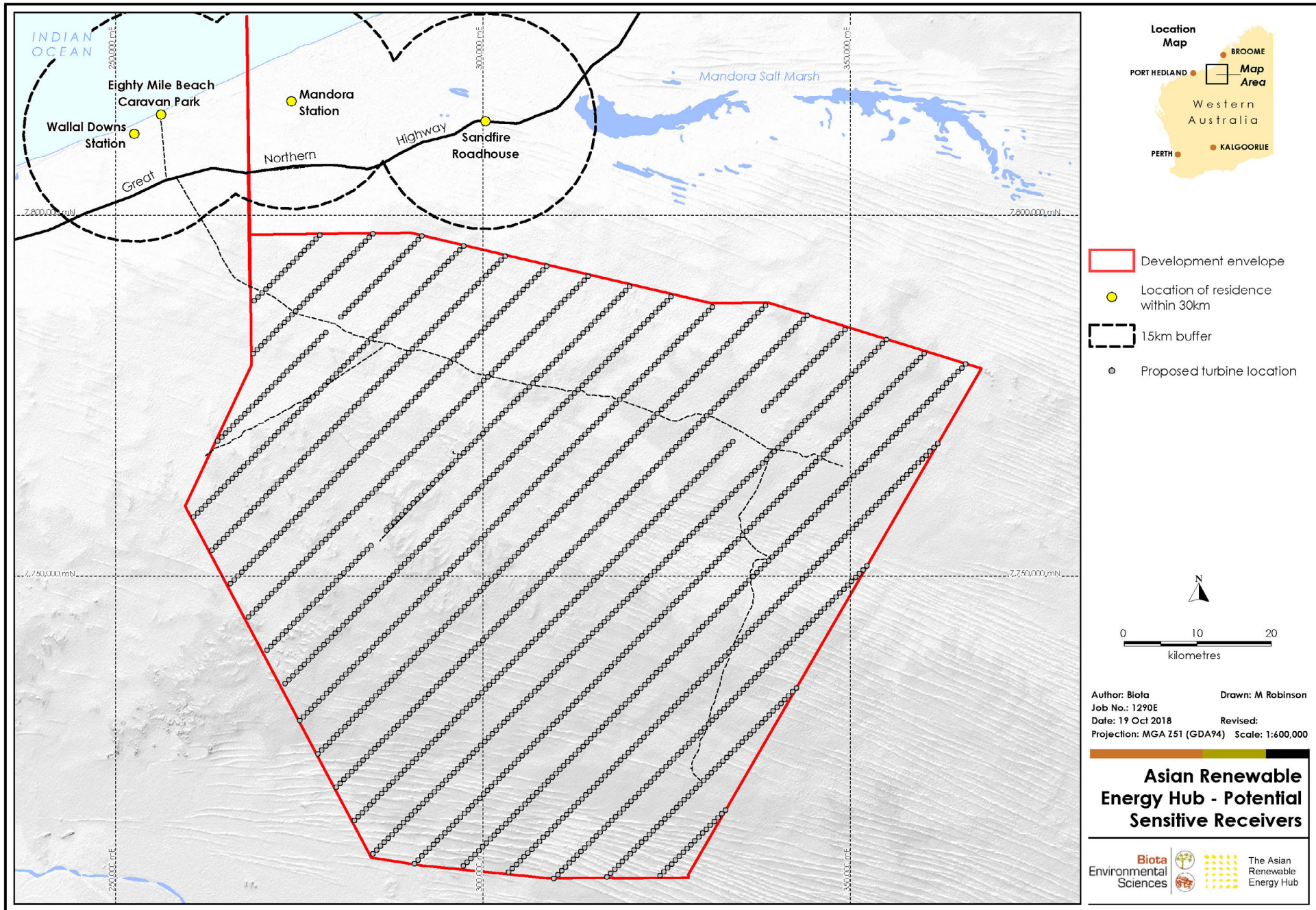


Figure 4.34: Potential sensitive receivers within 30 km of the development envelope and 15 km buffer.

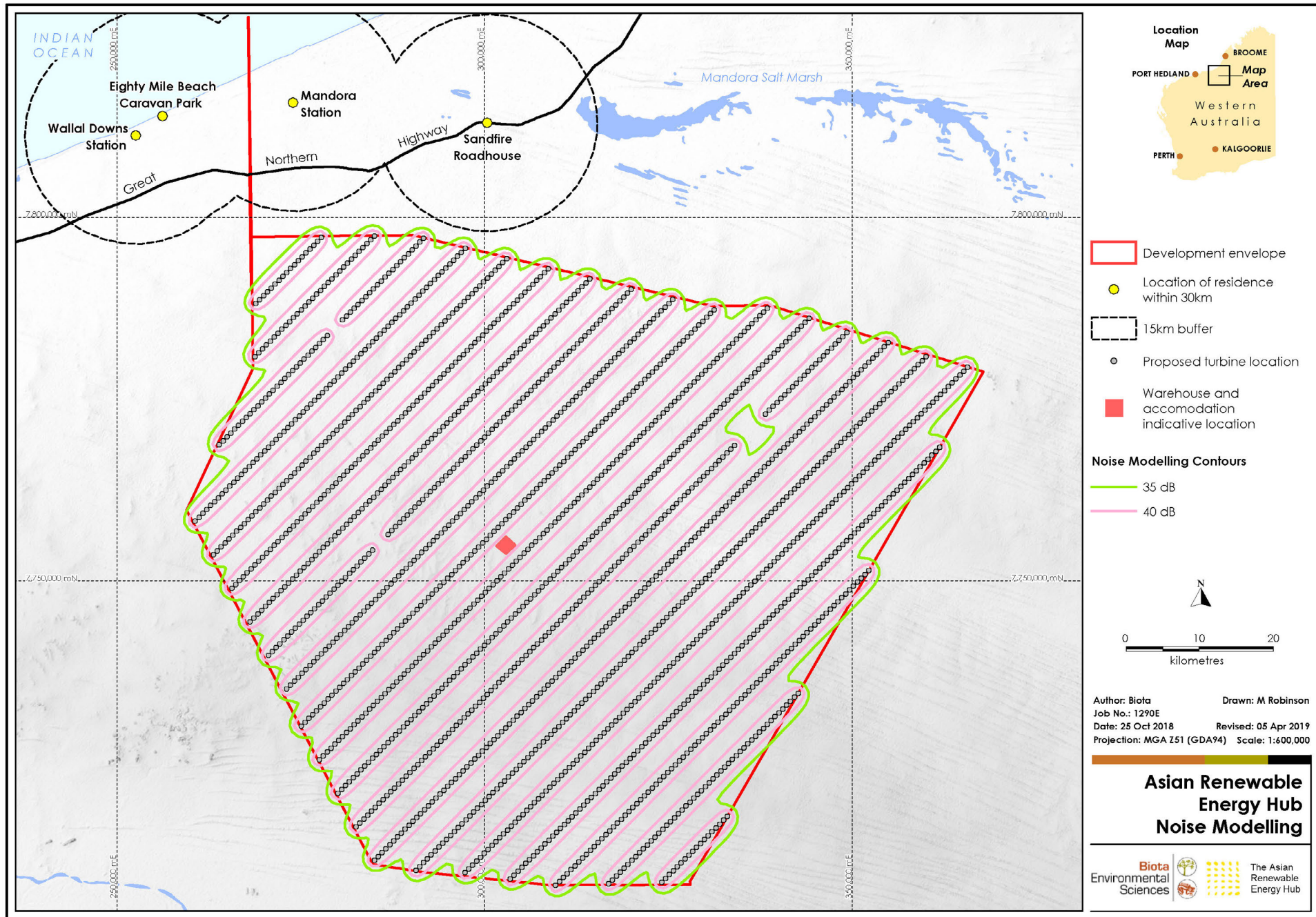


Figure 4.35: Noise modelling for the wind turbine component of the project.

The assessment of potential noise and odour impacts from temporary concrete batching plants on workforce personnel is similar: these will be sited such that external noise levels at on-site accommodation are attenuated by distance to <40dB, which will also serve to mitigate any potential odour impacts.

4.8.4.5 Mitigation

The primary mitigation adopted by the proponent was to eliminate the risk of noise impacts from the outset by selecting a site that was far from existing sensitive receivers. This is consistent with the mitigation hierarchy, which favours avoidance of potential impacts through site selection and design (Government of Western Australia 2014).

In the event that construction needs dictate that noise levels from concrete batching may significantly affect workforce amenity, and adequate attenuation by distance cannot be achieved, then engineering solutions to enhance noise-proofing of accommodation buildings will be developed and implemented.

4.8.4.6 Predicted Outcome

The predicted outcome is that there will not be any impact from noise on any of the four sensitive receivers identified.

4.8.5 Cultural Heritage

4.8.5.1 Policy and Guidance

Under the *Aboriginal Heritage Act 1972* all Aboriginal places and objects are protected, while all places that have significance to the cultural heritage of the State are also protected under the *Heritage of Western Australia Act 1990*.

4.8.5.2 Receiving Environment

A review of existing publicly available information was carried out by the proponent to identify known Aboriginal sites and places, and any non-Aboriginal archaeological sites and heritage places, within and bordering the development envelope.

The project is very remote and the terrain can be inhospitable. As a result, the site is not a tourist destination, nor does it have any other regular land use activities taking place on it, including pastoral or mining activities. No sites of non-Aboriginal heritage importance were identified within the development envelope. However, a limited number of sites of known Aboriginal heritage value are known to exist within the development envelope (Figure 4.36). These sites are related to rock art and areas of cultural importance around watering holes.

The proposal is entirely located on land that is part of the Nyangumarta People's determined native title claim (Figure 4.37). Nyangumarta country extends from desert to sea, covering vast areas of the Great Sandy Desert west through to Eighty Mile Beach, including Pardoo Station, Wallal Downs Station and Anna Plains Station by the coast.

Most Nyangumarta people now live in Broome, Bidadanga and Port Hedland, though there are members scattered around smaller settlements in the Pilbara. The Nyangumarta have a strong link to the land and regularly visit country, running an active ranger program.

The proponent has been in regular contact with the Nyangumarta people over the last four years. This has included:

- attending regularly scheduled Directors meetings every six months to provide regular updates on project progress;
- working with Nyangumarta representatives to carry out clearance surveys prior to disturbing any ground for installing resource monitoring equipment (Plate 4.41);
- working with the Nyangumarta Rangers during biological surveys (Plate 4.42); and
- more recently, commencing negotiations for an ILUA to formalise a long-term partnership between the proponent and the Nyangumarta people.



Plate 4.41: Aboriginal heritage clearance survey.



Plate 4.42: Nyangumarta rangers participating in fauna survey work.

As well as the existing known areas of Aboriginal heritage significance, some new rock art and archaeological finds were identified in the northern part of the development envelope during the extensive surveys that were carried out in completing this ERD (Figure 4.38).

4.8.5.3 Potential Impacts

The potential impact to cultural heritage from the proposal relates to the risk of disturbance or destruction of known or unknown Aboriginal sites or objects during construction and operation activities.

4.8.5.4 Assessment of Impacts

The current conceptual design for the proposal has been refined to avoid the previously known or newly discovered sites. As such, these sites will be avoided by all construction and operation activities, resulting in negligible risk of impacts to cultural heritage.

4.8.5.5 Mitigation

The primary form of mitigation adopted by the proponent is to eliminate the risk of impacts on cultural heritage by avoiding areas that are known to, or subsequently discovered to, contain sites of importance. As well as designing infrastructure to avoid known areas of importance, exclusion zones will be established to avoid the risk of damage in the future.

In addition to the desktop study and preliminary site visits already undertaken, a further heritage study prior to construction will be conducted together with representatives from the Nyangumarta in consultation with YMAC and the Department of Planning, Lands and Heritage to identify any further Aboriginal sites or objects that require protection under the Act. This will require a walkover survey of areas that are earmarked for disturbance during construction of the project infrastructure. Such a survey would be carried out by Nyangumarta representatives together with a qualified archaeologist/anthropologist(s).

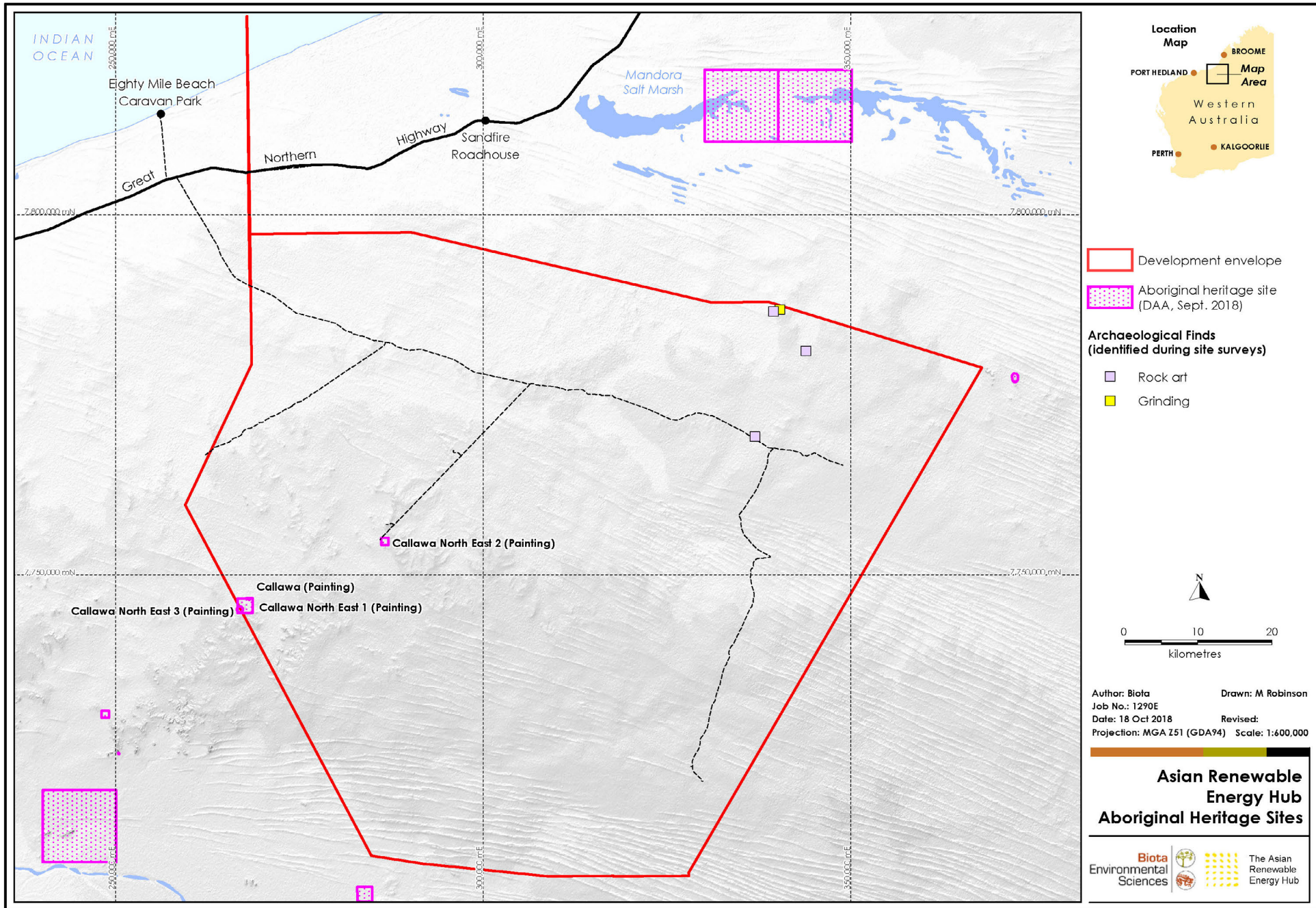


Figure 4.36: Department of Aboriginal Affairs Aboriginal heritage sites and newly identified archaeological finds.

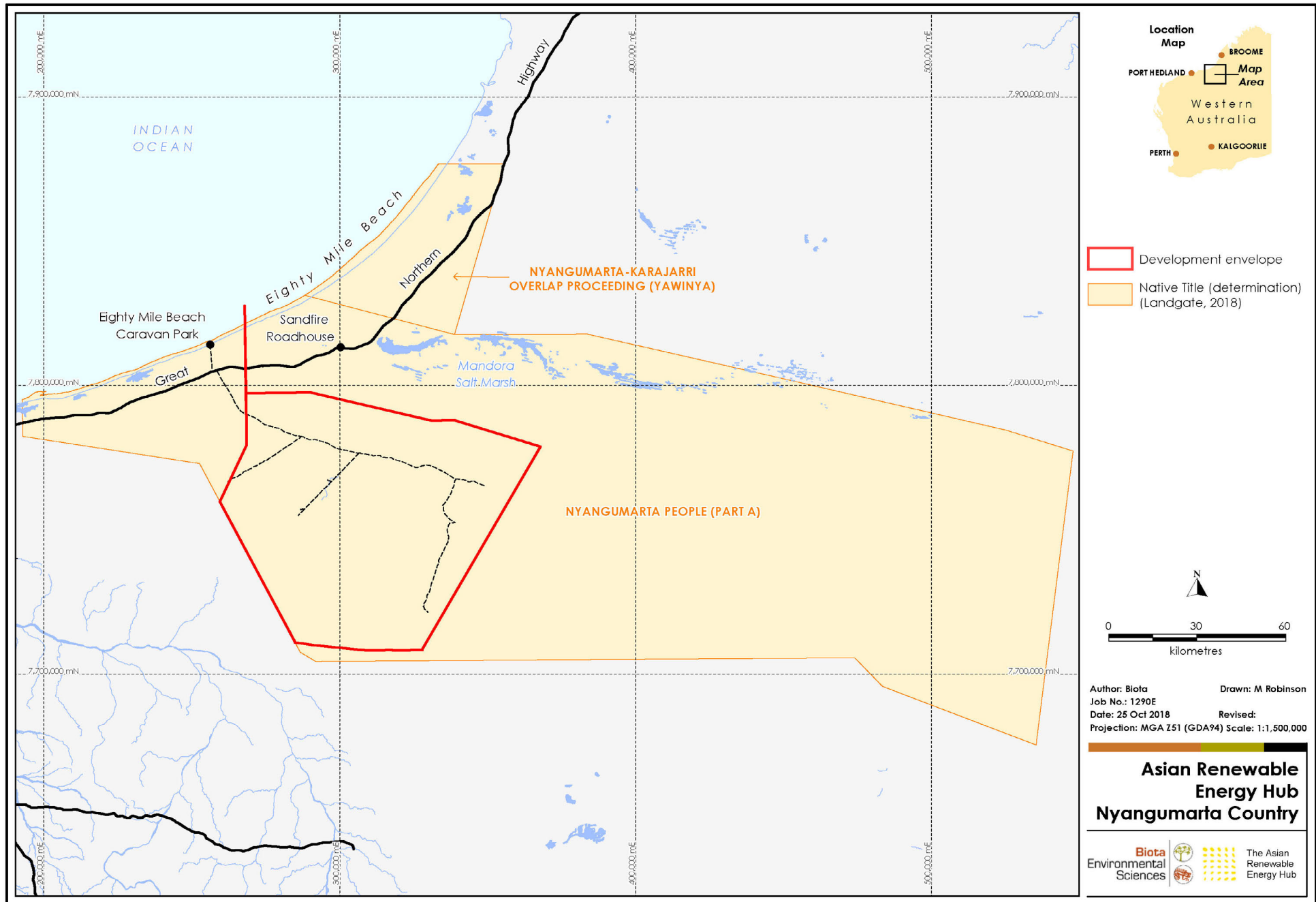


Figure 4.37: Development envelope in relation to Nyangumarta Country.

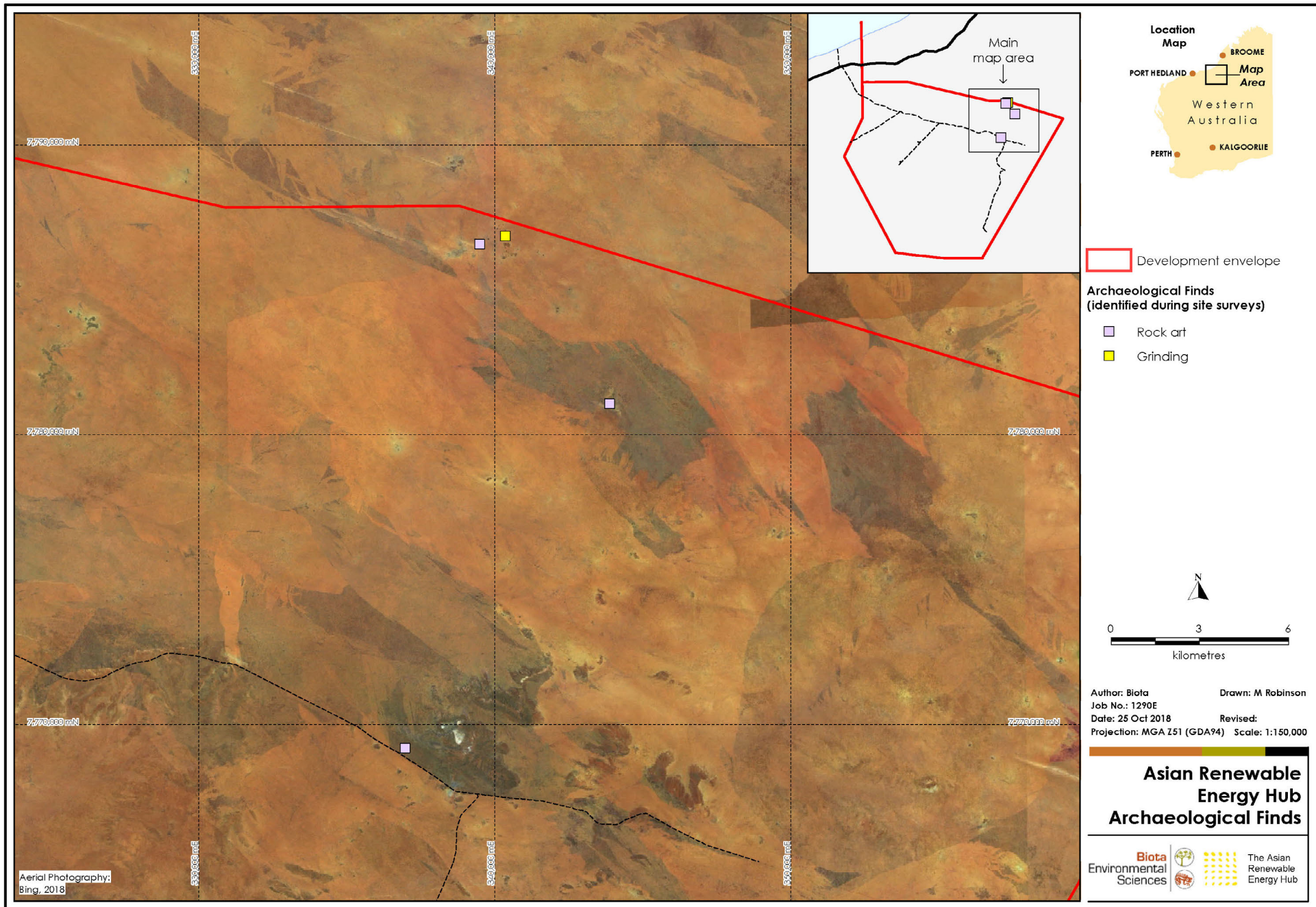


Figure 4.38: Newly identified archaeological finds.

If it is determined as a result of the survey that proposed infrastructure overlaps an area of newly discovered archaeological and/or cultural heritage significance, the infrastructure layout will be altered accordingly, if required, to avoid such areas. The revised layout or routing would then be surveyed to ensure it is cleared. Given the flexibility of site infrastructure to be adjusted within the large development envelope, it is well within the project design limits to move proposed site tracks, turbine foundations and solar array locations. Any newly discovered sites will be recorded and all site personnel will be informed of such areas and instructed that they are prohibited from entry.

Appropriate management actions for responding to inadvertent disturbance to Aboriginal heritage sites, and for new site discoveries, during construction will be included in the CEMP for the project. Such actions will be in line with legislative requirements. Cultural training courses approved and/or delivered by Nyangumarta representatives will also be required by all staff working on site during the construction and operation phases.

4.8.5.6 Predicted Outcome

Given the nature of the potential impacts and the mitigation strategies proposed, there is a high degree of confidence that there will not be any significant impacts on cultural heritage from the proposal.

4.8.6 Social Surroundings Factor Predicted Outcome

Given the outcomes of the assessment is that potential impacts relating to visual and landscape values (Section 4.8.3.6), noise (Section 4.8.4.6), and cultural heritage (Section 4.8.5.6) are all not significant, the EPA's objective for the Social Surroundings factor can be met.

5.0 Other Environmental Factors or Matters

5.1 Coastal Processes

The only element of the proposal with any potential to affect coastal processes is the offshore portion of the transmission cable corridor at the northernmost end of the development envelope, where it extends offshore to the limit of State waters. The method proposed for burial of the cables is trenching on-shore and hydro-plough (or low-impact equivalent) for offshore (see Section 2.6.11.3).

With the relatively narrow disturbance corridor, and given that the original topography and bathymetry will be rapidly restored after installation, potential impacts on coastal processes would not be significant (BMT 2018a) (Appendix 3).

Disturbance to coastal processes will be negligible since sediment disturbance during cable lay/pull-up will be temporary, and complete burial of the cable during operation will ensure no impediment to regional sediment movement processes (BMT 2018a) (Appendix 3).

5.2 Inland Waters

5.2.1 Surface Water

The development envelope is essentially a very large-scale sandplain system with occasional low relief rises and laterite exposures. Run-off during major rain events is limited to low velocity surface sheet flows and localised drainage into minor drainage lines, with rapid infiltration through transmissive, sand-dominated stratigraphy, and recharge to underlying regional aquifers.

Given the nature of both the hydrology of the area and the nature of project, surface hydrology is of very limited relevance to the assessment of the proposal. There are no defined permanent or semi-permanent watercourses that link the development envelope with Mandora Marsh, which is 18 km north of the development envelope. The development envelope is 26 km from Eighty Mile Beach itself, and is also completely separated from it by the alignment of the Great Northern Highway.

Considering that:

- most major rainfall events result in limited surface water within the development envelope;
- the surface water that does accumulate rapidly disappears through evaporation and infiltration;
- the proposal will only modify less than 2% of the landscape of the development envelope's existing surface hydrology; and
- the development envelope is 18 km away from Mandora Marsh at its closest point,

it is very unlikely that the hydrological processes which define Mandora Marsh and its associated ephemeral wetland habitat will be impacted by the proposal. There will be no impact on the hydrology of the Eighty Mile Beach component of the Ramsar site at a separation distance of 26 km.

5.2.2 Groundwater

The proposal is situated within a very extensive sandplain development envelope that has had limited hydrogeological characterisation. It is likely that the primary aquifer underlying the site is the Broome Sandstone aquifer identified in the La Grange Groundwater Allocation Plan (Department of Water 2010).

Both the referral document and the ESD for the proposal identified that abstraction of groundwater would be required for the proposal for construction requirements and operational accommodation purposes. However, the proponent has now identified that, given the volumes required are relatively low, water requirements for the proposal will be met on the basis of a commercial arrangement with a contract supplier. This ERD therefore does not consider any impacts on the groundwater systems of the development envelope, as abstraction is not proposed as part of the current proposal.

6.0 Offsets

6.1 Mitigation Measures and Significance of Residual Impacts

The policy requirements for development proposals to provide environmental offsets within Western Australia is set out in:

- WA Environmental Offsets Policy (Government of Western Australia 2011); and
- WA Environmental Offsets Guidelines (Government of Western Australia 2014).

The principles set out in this policy are illustrated in Figure 6.1 below. There are four steps in the mitigation hierarchy: Avoid, Minimise, Rehabilitate and Offset, and proponents are expected to follow this sequence in addressing potential proposal impacts (Government of Western Australia 2014). While environmental offsets may be appropriate for significant residual impacts or risks, they will not be required for minor environmental impacts; where the residual impact is not considered to be significant, no offset will be required (Government of Western Australia 2014).

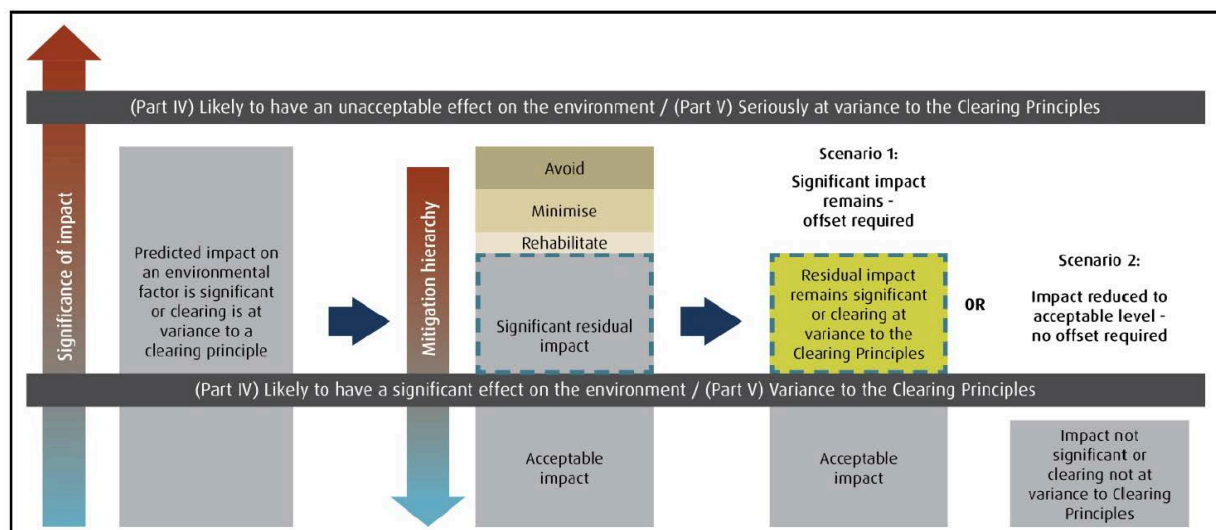


Figure 6.1: Mitigation hierarchy and requirement for offsets (Government of Western Australia 2014).

Unlike some other types of developments, the current proposal has the flexibility to enable the avoidance tier of the mitigation hierarchy to be very effectively implemented. Mining proposals, for example, are usually spatially fixed and direct impacts often cannot be avoided due to the location of the ore body. In the case of this proposal, the wind and solar resource is effectively equivalent across the landscape and varies little within the extent of the development envelope. The scale of the area in which the proposal is situated also assists with implementing the avoidance approach to impact mitigation: this has meant that there is plentiful space to combine with the flexibility in design that can be implemented without compromising wind and solar resource, and thereby the renewable energy output of the project. In summary; as the project is not spatially or resource constrained within the development envelope, the design has been, and can continue to be, refined at local scale to avoid impacts on key environmental attributes.

Mitigation measures for the proposal's potential impacts have been detailed earlier under each preliminary key factor. Table 6.1 below provides a summary of the key attributes this ERD has identified within each of the preliminary key factors, highlighting how the mitigation hierarchy has been observed to meet the EPA's objectives and ensure residual impacts are not significant.

Table 6.1: Summary of significance of residual impacts of the proposal with application of the mitigation hierarchy.

Factor	Key Attributes	Impact	Mitigation Hierarchy			Predicted Impact Outcome	Residual Impact Significance
			Avoid	Minimise	Rehabilitate		
Benthic Communities and Habitats	BCH	Direct removal	<ul style="list-style-type: none"> Cable route selection avoids any significant BCH 	<i>(Impact avoided; not needed)</i>	<i>(Impact avoided; not needed)</i>	Temporary disturbance of 15.3 ha of seabed, with no loss of significant BCH	Not significant (Section 4.3.7)
Marine Environmental Quality	Marine water quality	Generation of chlorine, EMF and heat	<ul style="list-style-type: none"> No cathode within Marine Park Pre-installation confirmation of cable specification Cable buried 5-10 m below the seabed 	<i>(Impact avoided; not needed)</i>	<i>(Impact avoided; not needed)</i>	No significant risk of impacts arising from cable installation and operation	Not significant (Section 4.3.7)
		Hydrocarbon and other waste spills	<ul style="list-style-type: none"> Risk of hydrocarbon and waste spills cannot be completely avoided 	<ul style="list-style-type: none"> Implementation of containment and management measures in CEMP 	<i>(Impact minimised; not needed)</i>	No significant risk of hydrocarbon and waste pollution of the marine environment	Not significant (Section 4.3.7)
		IMS	<ul style="list-style-type: none"> Risk of IMS introduction cannot be completely avoided 	<ul style="list-style-type: none"> IMS monitoring and management to State and Commonwealth requirements 	<i>(Impact minimised; not needed)</i>	No significant risk of IMS establishment	Not significant (Section 4.3.7)
	Marine sediment quality	Contaminants released from sediment disturbance and cable deterioration during operation	<ul style="list-style-type: none"> Cable installed in a setting with no history of urban or industrial development Cable buried 5-10 m below the seabed 	<i>(Impact avoided; not needed)</i>	<i>(Impact avoided; not needed)</i>	No significant increase in sediment contaminants	Not significant (Section 4.3.7)
Marine Fauna	Flatback Turtle	Trenching through beach nesting habitat	<ul style="list-style-type: none"> Cable installation to avoid peak turtle breeding period 	<i>(Impact avoided; not needed)</i>	<i>(Impact avoided; not needed)</i>	No significant impact on turtle nesting habitat on Eighty Mile Beach	Not significant (Section 4.3.7)
		Vessel collision or entanglement during cable burial	<ul style="list-style-type: none"> Risk of collision or entanglement cannot be completely avoided 	<ul style="list-style-type: none"> Implementation of monitoring and stop work protocols during cable installation 	<i>(Impact minimised; not needed)</i>	No significant risk of marine fauna collisions or cable entanglement	Not significant (Section 4.3.7)
		Behaviour modification from artificial lighting	<ul style="list-style-type: none"> Cable installation to avoid peak turtle breeding period Works preferentially scheduled for daylight 	<ul style="list-style-type: none"> Implementation of lighting controls in the event night work is required during cable installation 	<i>(Impact avoided and minimised; not needed)</i>	No significant impact on marine turtle behaviour	Not significant (Section 4.3.7)

Factor	Key Attributes	Impact	Mitigation Hierarchy			Predicted Impact Outcome	Residual Impact Significance
			Avoid	Minimise	Rehabilitate		
Marine Fauna (continued)	Sawfish	Trenching through nearshore areas during pupping	<ul style="list-style-type: none"> Cable installation to avoid peak sawfish pupping period 	<i>(Impact avoided; not needed)</i>	<i>(Impact avoided; not needed)</i>	No significant impact on sawfish pupping habitat on Eighty Mile Beach	Not significant (Section 4.3.7)
	General	Behaviour modification from EMF	<ul style="list-style-type: none"> No cathode within Marine Park Pre-installation confirmation of cable specification Cable buried 5-10 m below the seabed 	<i>(Impact avoided; not needed)</i>	<i>(Impact avoided; not needed)</i>	No significant impact on sawfish behaviour	Not significant (Section 4.3.7)
Flora and Vegetation	Vegetation associations	Clearing of vegetation	<ul style="list-style-type: none"> Clearing of vegetation cannot be completely avoided 	<ul style="list-style-type: none"> Clearing footprint kept to minimum possible 	<ul style="list-style-type: none"> Immediate rehabilitation of temporary construction areas Rehabilitation of all clearing at time of eventual project decommissioning 	Permanent clearing of 1.81% of development envelope vegetation extent, with all individual vegetation types cleared by <2% of their current extent within the development envelope	Not significant (Section 4.6.7)
		Changes to fire regime	<ul style="list-style-type: none"> Implementation of the project will unavoidably alter the fire regime of the development envelope 	<ul style="list-style-type: none"> Implementation of Fire Management Plan with biodiversity enhancement and infrastructure protection objectives 	<ul style="list-style-type: none"> Improvement of landscape heterogeneity and vegetation resilience through re-establishment of a mosaic of fire age vegetation units 	Improvements in landscape scale vegetation condition, heterogeneity and resilience compared to current unmanaged fire regime	Not significant (Section 4.6.7)
		Weed introduction and spread	<ul style="list-style-type: none"> Risk of weed introduction cannot be completely avoided 	<ul style="list-style-type: none"> Comprehensive weed hygiene and topsoil management plan 	<ul style="list-style-type: none"> Monitoring and control program to eliminate any weed recruits 	Low risk of novel weed introduction with provision for monitoring and control contingency response	Not significant (Section 4.6.7)
	Eighty Mile Beach PEC	Clearing of PEC vegetation	<ul style="list-style-type: none"> With its alignment parallel to the coast, clearing of PEC vegetation for the cable corridor cannot be completely avoided 	<ul style="list-style-type: none"> Alignment selection minimises temporary clearing of PEC relative to other crossing points Trenching width kept to minimum possible 	<ul style="list-style-type: none"> Immediate rehabilitation after cable burial 	Clearing of <0.1% of regional extent of the PEC	Not significant (Section 4.6.7)
	<i>Seringia exastia</i> (Threatened)	Clearing of individual plants	<ul style="list-style-type: none"> Conceptual design avoids clearing all known populations Targeted searches and design to avoid clearing any currently unknown populations 	<i>(Impact avoided; not needed)</i>	<i>(Impact avoided; not needed)</i>	No loss of individuals of <i>Seringia exastia</i>	Not significant (Section 4.6.7)

Factor	Key Attributes	Impact	Mitigation Hierarchy			Predicted Impact Outcome	Residual Impact Significance
			Avoid	Minimise	Rehabilitate		
Flora and vegetation (continued)	<i>Tephrosia rosea</i> var. Port Hedland (A.S. George 1114) (Priority 1)	Clearing of individual plants	<ul style="list-style-type: none"> Conceptual design avoids clearing the single known population Targeted searches and design refinement to avoid clearing any currently unknown populations 	<i>(Impact avoided; not needed)</i>	<i>(Impact avoided; not needed)</i>	No loss of individuals of <i>Tephrosia rosea</i> var. Port Hedland (A.S. George 1114)	Not significant (Section 4.6.7)
	Other Priority flora species	Clearing of individual plants	<ul style="list-style-type: none"> Conceptual design will be modified to avoid Priority flora where possible 	<i>(Impact avoided; not needed)</i>	<i>(Impact avoided; not needed)</i>	No changes to conservation status of any Priority flora species	Not significant (Section 4.6.7)
Terrestrial Fauna	Vertebrate and SRE fauna assemblage	Clearing of fauna habitat	<ul style="list-style-type: none"> Clearing of fauna habitat cannot be completely avoided but habitats of conservation significance have been avoided 	<ul style="list-style-type: none"> Clearing footprint kept to minimum possible 	<ul style="list-style-type: none"> Immediate rehabilitation of temporary construction areas Rehabilitation of all clearing at time of eventual project decommissioning 	Permanent clearing of 1.81% of development envelope habitats extent, with all individual habitat types cleared by <2% of their current extent within the development envelope	Not significant (Section 4.7.7)
		Feral fauna spread	<ul style="list-style-type: none"> Risk of further feral fauna spread is low but cannot be completely avoided 	<ul style="list-style-type: none"> Implementation of targeted fox monitoring and control at key risk locations 	<i>(Impact minimised; not needed)</i>	Negligible risk of increased feral fauna impacts on Black-footed Rock-wallaby attributable to the proposal	Not significant (Section 4.7.7)
		General construction impacts	<ul style="list-style-type: none"> General construction impacts cannot be completely avoided 	<ul style="list-style-type: none"> Implementation of CEMP 	<i>(Impact minimised; not needed)</i>	No significant impacts from general construction activities	Not significant (Section 4.7.7)
		Changes to fire regime	<ul style="list-style-type: none"> Implementation of the project will unavoidably alter the fire regime of the development envelope 	<ul style="list-style-type: none"> Implementation of Fire Management Plan with biodiversity enhancement and infrastructure protection objectives 	<ul style="list-style-type: none"> Improvement of landscape heterogeneity and resilience through re-establishment of a mosaic of fire age habitat units 	Improvements in landscape scale habitat quality, heterogeneity and resilience compared to current unmanaged fire regime	Not significant (Section 4.6.7)
	Black-footed Rock-wallaby	Clearing of habitat	<ul style="list-style-type: none"> Conceptual design avoids habitat removal for all known populations Targeted searches and design to avoid clearing of any other currently unknown populations 	<i>(Impact avoided; not needed)</i>	<i>(Impact avoided; not needed)</i>	No loss of newly discovered Black-footed Rock-wallaby colony	Not significant (Section 4.7.7)

Factor	Key Attributes	Impact	Mitigation Hierarchy			Predicted Impact Outcome	Residual Impact Significance
			Avoid	Minimise	Rehabilitate		
Terrestrial Fauna (continued)		Road kill and barriers to animal movement	<ul style="list-style-type: none"> Access road network conceptual design avoids creating barriers between rock piles and removes existing road kill risk 	<ul style="list-style-type: none"> Speed limits and environmental awareness inductions for all site personnel 	<i>(Impact avoided and minimised; not needed)</i>	Negligible risk of road kill impact on Black-footed Rock-wallaby	Not significant (Section 4.7.7)
		Feral fauna spread	<ul style="list-style-type: none"> Risk of further feral fauna spread is low but cannot be completely avoided 	<ul style="list-style-type: none"> Implementation of targeted fox monitoring and control at key risk locations 	<i>(Impact minimised; not needed)</i>	Negligible risk of increased feral fauna impacts on Black-footed Rock-wallaby attributable to the proposal	Not significant (Section 4.7.7)
	Bilby	Clearing of habitat	<ul style="list-style-type: none"> Clearing of potential Bilby habitat cannot be completely avoided 	<ul style="list-style-type: none"> Clearing of potential Bilby habitat kept to minimum possible, with over half a million hectares remaining within the development envelope 	<ul style="list-style-type: none"> Improvement of landscape heterogeneity and resilience through re-establishment of a mosaic of fire age habitat units to benefit the Bilby 	No significant reduction in potential Bilby habitat, and improvement to landscape heterogeneity and sustainability	Not significant (Section 4.7.7)
		Direct loss of individuals during construction	<ul style="list-style-type: none"> The risk that some individual Bilby may be impacted during construction cannot be completely avoided 	<ul style="list-style-type: none"> Implementation of prescribed burning to manage Bilby via behavioural ecology ahead of construction Pre-clearing targeted survey and contingency management to confirm effectiveness 	<i>(Impact minimised; not needed)</i>	No significant reduction in Bilby populations attributable to construction	Not significant (Section 4.7.7)
		Feral fauna spread	<ul style="list-style-type: none"> Risk of further feral fauna spread is low but cannot be completely avoided 	<ul style="list-style-type: none"> Implementation of targeted fox monitoring and control at key risk locations 	<i>(Impact minimised; not needed)</i>	Negligible risk of increased feral fauna impacts on Bilby attributable to the proposal	Not significant (Section 4.7.7)
	Migratory shorebirds and Waterbirds	Trenching through beach and intertidal habitat	<ul style="list-style-type: none"> Cable installation to avoid peak migratory shorebird activity periods 	<i>(Impact avoided; not needed)</i>	<i>(Impact avoided; not needed)</i>	No significant impact on migratory shorebird habitat at Eighty Mile Beach	Not significant (Section 4.7.7)
		Construction disturbance	<ul style="list-style-type: none"> Development envelope situated 13 km from Mandora Marsh and 26 km from Eighty Mile Beach 	<i>(Impact avoided; not needed)</i>	<i>(Impact avoided; not needed)</i>	No risk of construction disturbance on migratory shorebirds	Not significant (Section 4.7.7)

Factor	Key Attributes	Impact	Mitigation Hierarchy			Predicted Impact Outcome	Residual Impact Significance
			Avoid	Minimise	Rehabilitate		
Terrestrial Fauna (continued)		Wind turbine and power line collision risk	<ul style="list-style-type: none"> Development envelope situated 13 km from Mandora Marsh and 26 km from Eighty Mile Beach 	<ul style="list-style-type: none"> Wind turbine rows and turbine spacing best practice Wind turbine structures industry best practice Power lines fitted with visibility improvement Bird radar, high definition camera and contingency turbine shutdown protocols 	<i>(Impact minimised; not needed)</i>	Negligible residual risk of significant impacts on flyway populations of any migratory shorebird species	
Social Surroundings	Sensitive receivers	Visual impact	<ul style="list-style-type: none"> Development envelope more than 15 km from nearest sensitive receivers 	<ul style="list-style-type: none"> Wind turbine structures industry best practice to reduce visual impact 	<i>(Impact avoided and minimised; not needed)</i>	No significant change to the visual character of the landscape from nearest sensitive receiver locations	Not significant (Section 4.8.3.6)
	Sensitive receivers	Noise impacts	<ul style="list-style-type: none"> Development envelope more than 15 km from nearest sensitive receivers 	<i>(Impact avoided; not needed)</i>	<i>(Impact avoided; not needed)</i>	No significant contribution to noise levels at nearest sensitive receiver locations	Not significant (Section 4.8.4.6)
	Cultural heritage sites	Disturbance to cultural heritage sites	<ul style="list-style-type: none"> Conceptual design footprint avoids all known sites of significance Pre-clearance surveys with further design refinement to avoid impacts on any currently unknown sites 	<i>(Impact avoided; not needed)</i>	<i>(Impact avoided; not needed)</i>	No impact on sites of cultural heritage significance	Not significant (Section 4.8.5.6)

6.2 Requirement for Offsets

As this review concludes that there are no significant residual impacts on any of the preliminary key factors for the assessment (Section 6.2; Table 6.1), no environmental offsets are required at State level (Government of Western Australia 2014).

This outcome is a function of the proponent's fundamental observation of the mitigation hierarchy in the development and conceptual design of the proposal (Section 6.2).

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7.0 Matters of National Environmental Significance

7.1 Controlling Provisions

The proposal has been determined to be a controlled action under the EPBC Act and is being assessed as an accredited assessment (see Section 1.3).

The relevant MNES controlling provisions for the proposal are:

- Ramsar wetlands (sections 16 and 17B of the EPBC Act);
- Listed threatened species and communities (sections 18 and 18A);
- Listed migratory species (sections 20 and 20A); and
- Commonwealth marine areas (sections 23 and 24A).

Each controlling provision has been addressed individually in Section 7.2, though much of the substantive impact assessment is in common with the preliminary key factors identified for the State assessment and has been detailed previously in Section 4.0.

7.2 Existing Environmental Values

7.2.1 Ramsar Wetlands

The Eighty Mile Beach Ramsar site is situated within the wider locality of the proposal's development envelope. It is comprised of two areas: Eighty Mile Beach itself and Mandora Marsh (also known as Walyarta). The ecological values of the Ramsar site have been described earlier in this ERD, comprising:

- marine fauna – Sections 4.5.3.1, 4.5.3.2 and 4.5.3.3;
- migratory shorebirds – Section 4.7.3.5; and
- the ecological and cultural values for which Eighty Mile Beach is managed – Section 4.5.6.5.

7.2.2 Listed Threatened Species and Communities

Six fauna species listed as Threatened under the EPBC Act, and one flora species, are known to occur within the development envelope. Detailed accounts of these species have been provided in earlier sections of this ERD, which provide background on the abundance, distribution, ecology and habitat preferences of the listed species. The species in question comprise:

- Flatback turtle (Vulnerable) – Section 4.5.3.2;
- Dwarf sawfish (Vulnerable) – Section 4.5.3.3;
- Green sawfish (Vulnerable) – Section 4.5.3.3;
- Black-footed Rock-wallaby (Endangered) – Section 4.7.3.6;
- Bilby (Endangered) – Section 4.7.3.6;
- Northern Quoll (Vulnerable) – Section 4.7.3.6; and
- *Seringia exastia* (Critically Endangered) – Section 4.6.3.7.

7.2.3 Listed Migratory Species

Listed Migratory species relevant to this assessment fall into two categories: marine fauna species and migratory shorebirds. Both have been described in detail earlier in this ERD, comprising:

- marine fauna – Sections 4.5.3.1, 4.5.3.2 and 4.5.3.3; and
- migratory shorebirds – Section 4.7.3.5.

7.2.4 Commonwealth Marine Areas

The proposal as referred, and determined to be a controlled action, is limited to Western Australian State Waters. The current proposal does not extend into any Commonwealth marine areas.

7.3 Potential Impacts on MNES

7.3.1 Ramsar Wetlands

The only direct impact on the Eighty Mile Beach Ramsar site will be very minor and transitory, being limited to trenching of the transmission cables through Eighty Mile Beach (see Sections 4.3.5 and 4.4.5), with no impacts on the Mandora Marsh part of the Ramsar site.

7.3.2 Listed Threatened Species and Communities

There are no listed TECs within the development envelope and therefore no potential impact on listed communities. Potential impacts on the seven listed MNES species have previously been addressed in detail:

- Flatback turtle (Vulnerable) – Section 4.5.5.1, 4.5.5.2 and 4.5.5.3;
- Dwarf sawfish (Vulnerable) – Section 4.5.5.1, 4.5.5.4 and 4.5.5.4;
- Green sawfish (Vulnerable) – Section 4.5.5.1, 4.5.5.4 and 4.5.5.4;
- Black-footed Rock-wallaby (Endangered) – Section 4.7.5.2;
- Bilby (Endangered) – Section 4.7.5.2;
- Northern Quoll (Vulnerable) – Section 4.7.5.2; and
- *Seringia exastia* (Critically Endangered) – Section 4.6.5.3.

7.3.3 Listed Migratory Species

Potential impacts on marine migratory species are largely limited to the Flatback turtle and two sawfish species, which may potentially be impacted during cable installation (see Section 4.5.5 and 4.5.6 for a fuller discussion). This impact will be almost entirely mitigated by staging the offshore cable work such that it occurs outside of peak turtle breeding activity and sawfish pupping season (Section 4.5.6).

Potential impacts on migratory shorebirds utilising the Ramsar site have been assessed in significant detail earlier in this ERD (see Section 4.7.5.4), and are largely mitigated through avoidance, with the development envelope situated 13 km from Mandora Marsh and 26 km from Eighty Mile Beach itself at its closest point.

7.3.4 Commonwealth Marine Areas

The proposal as referred, and determined to be a controlled action, is limited to Western Australian State Waters. The current proposal does not extend into any Commonwealth marine areas.

Given that the predictions from the BMT marine environmental impact assessment are that there will be no significant impacts on benthic communities or marine environmental quality even locally within State Waters (Section 4.3.7 and 4.4.7; Appendix 3), there will be no impact from the proposal on Commonwealth marine areas further offshore.

7.4 Significance of Impacts on MNES

The significance of the impacts on three of the relevant MNES for this proposal have been effectively considered under preliminary key factors for the State assessment, with the relevant values of the Ramsar wetlands, Listed threatened species and communities, and Listed migratory species MNES effectively addressed under the key factors of Marine Environmental Quality, Marine Fauna, Flora and Vegetation and Terrestrial Fauna. The outcomes of those assessments, considering the mitigation hierarchy and the EPBC Act significant impacts guidelines, were that there was a low risk of significant residual impacts (see Sections 4.4.7, 4.5.7, 4.6.7 and 4.7.7).

7.5 Mitigation

A detailed account of the mitigation measures relevant to three of the MNES has already been provided earlier in this ERD, and in the interests of conciseness, the reader is directed to those sections. These comprise:

- Ramsar wetlands – Sections 4.3.6, 4.4.6, 4.5.6 and 4.7.6;
- Listed threatened species and communities – Sections 4.6.6 and 4.7.6; and
- Listed migratory species – Sections 4.5.6 and 4.7.6.

As no direct or indirect impacts on Commonwealth marine areas are predicted, no mitigation is required.

Section 6.1 also provides a detailed review of the adoption of the mitigation hierarchy in the proposal and how this has minimised the impacts on all aspects relevant to the MNES controlling provisions to a non-significant residual risk.

7.5.1 Offsets

An analysis of the significance of residual impacts is provided in Section 6.0. As this review concludes that there are no significant residual impacts on any of the controlling provisions for the assessment, no environmental offsets are required under the EPBC Act. This outcome is largely a function of the proponent's observation of the mitigation hierarchy.

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8.0 Holistic Impact Assessment

The body of this ERD has provided a detailed assessment of potential environmental impacts and planned mitigation measures for each of the preliminary key environmental factors.

An integrated assessment of the impacts of the proposal on the environment of the development envelope is provided in this closing section, by considering most significant aspects identified for each key preliminary factor, and any interactions between the preliminary key environmental factors, and viewing the proposal in a broader environmental context.

Table 3 provides a detailed summary of the potential impacts of the proposal, their mitigation and outcomes in regard to residual impact and the need for offsets, in the format required by EPA (2017).

The mitigation hierarchy (Government of Western Australia 2011) has been fundamental to the development of the proposal, from the initial stages of site and cable route selection, through to refinement of the development envelope and the conceptual design of the infrastructure layout. This has principally adopted the highest avoidance tier of the hierarchy, to effectively mitigate many potential impacts of the proposal that may otherwise have been significant.

This has resulted in a proposal that presents a minimised impact footprint and no residual impacts that are significant at species, ecological community, local or regional scales.

Benthic Communities and Habitats, Marine Environmental Quality

Trenching, ploughing or jetting activities to install the four transmission cables will result in the temporary disturbance to approximately 15.3 ha of seabed. This small-scale and localised disturbance of bioturbated sediments is not considered to be ecologically significant. While this will also be a temporary disturbance within the Eighty Mile Beach Marine Park, it represents <0.01% of the Marine Park by area and does not impact on any unique attributes or reduce any of the ecological character for which the Eighty Mile Beach Marine Park was established.

The risk of contaminant release arising from the seabed during cable installation is also considered negligible, given that the cable corridor traverses a Marine Park bordered on the landside by low density pastoral leases, with no history of urban or industrial development. Hydrocarbon and general waste may also be generated during cable installation, which can pollute the marine environment if not contained, but this will be completely mitigated by what are now standard environmental management measures.

Commissioning, decommissioning and maintenance works may result in the introduction of non-indigenous marine species (IMS) to the area. Mitigation measures will be employed for both biofouling and ballast water to minimise the risk of IMS associated with the proposal, in accordance with current State and Commonwealth regulatory requirements. Other potential impacts on marine environmental quality, including chlorine formation during monopole operation, and sediment contamination from cable deterioration, will be avoided or effectively minimised to non-significant levels in the implementation of the proposal.

The risk of significant impacts to marine environmental quality from contaminants is negligible. Other potential impact mechanisms will all be managed through well-established

and understood mitigation measures as part of the CEMP, such that the residual risk of any significant impacts is low. The EPA's objective for the Marine Environmental Quality factor can be met.

Marine Fauna

Marine fauna may potentially be impacted by collisions with vessels, or entanglement with equipment and anchor lines during installation. All international shipping to deliver turbine components for the project will be via existing commercial ports on the Pilbara coast, and components will then be trucked from the ports to the site. No international freight vessel movements will occur within the Eighty Mile Beach Marine Park as part of the proposal. As existing Pilbara commercial ports have numerous daily heavy shipping movements, including through international shipping lanes further offshore, the delivery of components for the project will represent only an incremental increase on existing vessel movements, with no impacts on marine fauna in the Eighty Mile Beach Marine Park.

Cable installation, maintenance and decommissioning will be a small-scale, temporary disturbance relative to the wider ranges of the marine fauna that may potentially occur, and is unlikely to significantly affect regional populations. There will be no risk of marine fauna entanglement with the cables once they are operational, as they will be buried 5-10 m below the seabed. The potential impacts of EMF or heat generation from the operational cables will also be effectively mitigated by this burial of the cable below the seabed, in addition to cable shielding specifications, pre-installation modeling of EMF, and post-installation monitoring to confirm effectiveness as part of the CEMP.

The primary mitigation of behavioural impacts on marine turtles will be through avoidance, both by staging cable works to avoid peak turtle nesting and hatchling emergence periods during the year, and by managing cable works such that they are preferentially conducted during daylight hours. Cable works will also be timed to avoid the peak season for sawfish pupping in the region.

Flora and Vegetation

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. The great majority of this will affect the P3 vegetation type (open shrublands over *Triodia* hummock grasslands on sandplain) at 11,137.0 ha of clearing, 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 over half a million hectares of the same vegetation unit undisturbed within the development envelope (over 98% of its current extent).

Trenching for the cable installation will result in the clearing of a very small area of the Eighty Mile Beach Land System Priority Ecological Community (PEC) at 0.2 ha, which will be rehabilitated on completion of the cable works. This represents less than 0.01% of the total extent of the Eighty Mile Land System and the impacts to the PEC are therefore not considered significant.

The State and Commonwealth listed Threatened flora species *Seringia exastia* was recorded from the six locations within the eastern portion of the development envelope, fall within the clearing footprint of the current conceptual design. The situation is similar for the Priority 1 species *Tephrosia rosea* var. Port Hedland (A.S. George 1114), with the only current development envelope record more than a kilometre outside of the clearing footprint for the proposal. Pre-clearance targeted surveys for these species will be undertaken during the detailed design process, with provision for further infrastructure amendments to avoid direct impacts on Threatened flora and Priority 1 flora. Locations

where other categories of Priority flora have been documented will be avoided during project design wherever practicable.

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 the maps in this ERD, 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. With construction of the proposal's access track network there is the opportunity to develop and implement a Fire Management Plan to determine when fires will occur, and the size and intensity of the burn. 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 unplanned bushfires, and offers strong possibilities in facilitating the development of collaborative partnerships with Traditional Owners and interested government agencies. In essence, implementing a mosaic fire control program would effectively represent a return to managing the land in the way similar to how Traditional Owners did for tens of thousands of years. The proposal will also include the design and implementation of a biodiversity monitoring programme to provide continuous feedback to fire management for long-term maintenance of biodiversity and infrastructure protection.

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 proponent will implement a CEMP for the proposal to minimise the risks of these potential impacts.

Terrestrial Fauna

In terms of ground fauna, the primary impact of the proposal will be the permanent clearing of 11,962 ha of fauna habitat. The great majority of this will affect the Shrub and spinifex on sandplain habitat at 11,147.3 ha of clearing, but this habitat type is also the most widespread in the development envelope at 605,695.0 ha, and the implementation of the proposal will leave well over half a million hectares of the same habitat undisturbed within the development envelope (over 98% of its current extent).

A new population of Black-footed Rock-wallaby (State: Schedule 2; EPBC Act: Endangered) was discovered as a result of the surveys conducted for the proposal, associated with rock pile and breakaway habitat isolates in the northeast of the development envelope; this habitat type accounts for a very small proportion of the site by area, but is critical to the survival of the species. The proponent has recognised the significance of the newly discovered population and the potential impacts of the proposal, and the most significant potential impacts on Black-footed Rock-wallaby have been avoided by applying a minimum 1 km no development buffer to the habitat isolates, with provision for connection between proximal rock piles within the buffers. The conceptual design for the project was also modified to avoid clearing impacts on both core rock pile habitat and surrounding foraging and local movement habitat, including a conceptual realignment of the existing Nyangumarta Highway, where it currently runs between several active rock piles that are separated by relatively short distances, to remove the risk posed by existing and future vehicle movements through core habitat. No significant impacts are therefore predicted for the Black-footed Rock-wallaby, and it is likely that with

realignment of existing roads, targeted feral fauna control and fire management, habitat quality for the species will in fact be improved.

The Bilby (State: Schedule 3; EPBC Act: Vulnerable) was recorded from multiple locations within the development envelope, mostly within the very extensive Nita land system, where it adjoins slightly higher elevation Callawa land system habitat. Unlike the Black-footed Rock-wallaby, which is strongly linked to particular fixed landscape features, the Bilby moves through areas of suitable habitat over time, mostly in response to fire history, vegetation recovery and rainfall. A large proportion of the development envelope represents potential habitat for the Bilby: the Shrub and spinifex on sandplain habitat, within the Nita land system, has suitable substrate for the species to construct burrows and supports the flora species known to be important in the species' diet. While the proportionate loss of potential habitat for the species as a result of clearing is not significant at the scale of the development envelope, with over half a million hectares to be retained, individual Bilby may still be impacted directly if they are actively utilising areas within the final design footprint at the commencement of construction earthworks.

The implementation of the proposal will result in the large-scale partitioning of the landscape into extensive blocks of habitat separated by access roads and other cleared areas. Not only will this provide a framework for ongoing operations phase management of habitats to create a significantly improved mosaic of varying fire age habitat, but the use of prescribed burns provides a means of management to move the Bilby population within the landscape, passively relocating them away from planned construction areas through means of their own behavioural ecology. As with the Black-footed Rock-wallaby, it is likely that the overall quality of habitat for the species will improve with the implementation of the proposal's mosaic fire management strategies.

Potential clearing impacts on the Black-footed Rock-wallaby population present in the development envelope have been, and will continue to be, completely mitigated through avoidance by modification of the proposal conceptual design. Potential direct impacts of construction on the Bilby will be mitigated via the application of fire management, supported by pre-clearance targeted surveys to validate the effectiveness of the approach and provisioning of additional contingency management actions if required. The implementation of the Fire Management Plan for the development envelope will benefit the populations of both species, providing for improved landscape heterogeneity, which will also serve to buffer the resilience of the overall vertebrate fauna assemblage in the >98% of the development envelope habitats that will remain intact. No significant impacts on fauna of conservation significance, or the assemblage generally, would therefore be predicted to arise from habitat removal, clearing activities or changed fire regimes.

Potential impacts on avifauna have been a fundamental focus of the proposal's development since the site selection stage, given the Eighty Mile Beach Ramsar site is present in the wider locality. The primary mitigation adopted for the proposal in this regard has been avoidance, with the siting of the development envelope providing a separation distance of 26 km between the coastal portion of the Ramsar site and the nearest turbine (and 13 km from the Mandora Salt Marsh), significantly reducing the risk of shorebird interaction with turbines. Cable installation works through the coastal zone will also be scheduled to avoid disturbance during seasonal activity peaks for migratory shorebirds at Eighty Mile Beach.

Specialist migratory shorebird studies were completed to inform this ERD, and the available data indicate that the risk of significant impact on migratory shorebirds from the wind turbines element of the proposal is acceptably low. The findings of the study

conducted for this assessment reconfirmed the ecological importance of both Eighty Mile Beach and Walyarta Conservation Park to avifauna, with an overall total of 95,609 migratory shorebird and waterbird individuals recorded across the two sites, including 32 bird species of conservation significance.

By comparison, just a single migratory shorebird species, the Oriental Pratincole, was recorded in the development envelope, with 35 individuals recorded (of the 2.88 million individuals of this species estimated in the East Asian Flyway population). This outcome is a function of the appropriate macro-scale siting of the proposal, whereby the development envelope has been set back from the coast during the site option evaluation process, mitigating the potential impact on migratory shorebirds through avoidance. The overall findings of this review are that virtually all of the migratory shorebird species, individuals, and avifauna values associated with Eighty Mile Beach Ramsar site are unlikely to be impacted by the proposal.

Although very few records were obtained from the development envelope, it is still possible that migratory shorebirds overfly the area when traveling to southern Australia. It is also possible that some waterbirds may cross the development envelope during the intermittent years that the Mandora Marsh fills, if other ephemeral water bodies south of the development envelope also fill during the same periods. If these bird movements do occur, the available data from both onsite observations and the literature suggest it is likely that they will be travelling at heights considerably above that of the wind turbine rotors' topmost swing.

This low risk of collision impacts is even further reduced by the best practice design of the wind farm itself: the turbines are separated by approximately 800 m and the rows of turbines have spacing provisioned for in excess of 4 km – considerably exceeding recommendations from past independent reviews of existing wind farms in regard to providing clear space for bird movement.

This already low risk profile for significant avifauna impacts will be further mitigated by the implementation of bird radar and real-time high definition video avifauna monitoring during operations, with protocols to shut down operation of individual turbines in advance if significant flocks of birds are detected on approach. Lastly, a comprehensive avifauna impacts monitoring programme will provide feedback to the operations to allow for continuous refinement and improvement of contingency protocols as required.

Social Surroundings

The Social Surroundings factor incorporates consideration of visual amenity, noise and heritage matters.

The initial site selection and design for the proposal has already incorporated a range of mitigation measures to avoid and reduce the potential adverse impacts on landscape and visual amenity. The assessment undertaken for this ERD shows that there will be negligible negative visual effect on the regional or local landscape quality, mainly as a function of the large separation distance of the wind turbines from the few nearby sensitive receivers.

The situation with potential noise impacts is similar. Modelling shows that the expected noise generated by the wind turbines would be below 35dB at a range of approximately 2 km from a row of turbines. Given that the 15 km separation distance from the turbines to the nearest sensitive receiver is well in excess of this, noise is not considered a significant potential impact on social surroundings.

The potential impact to cultural heritage from the proposal relates to the risk of disturbance or destruction of known or unknown Aboriginal sites or objects during construction and operation activities. The current conceptual design for the proposal has been refined to avoid all previously known or newly discovered sites. As such, these sites will be avoided by all construction and operation activities, resulting in negligible risk of impacts to cultural heritage. Additional mitigation will be implemented by the proponent in the event that any currently unknown sites are identified during future surveys, with further modifications to the infrastructure layout to avoid impacts during the detailed design stage.

Conclusion

The proposal will also deliver significant economic benefits to the State, underpinned by a project that is inherently sustainable in its nature. Approximately A\$21B of the project capital expenditure will be deployed in Western Australia, approximately A\$6.8B of which is expected to be spent directly on Australian company equipment and services during construction. During operation, approximately A\$300M will be spent every year in the State, resulting in A\$15B of spending during the project lifetime.

Beyond the economic business case for the proposal as a means to generate cheap and clean energy, it has the benefit of being completely renewable and CO₂ emissions free. This means that for every megawatt hour (MWh) of wind or solar energy produced, up to 0.84 tonnes of CO₂ would be displaced that would otherwise have been emitted into the atmosphere from fossil fuel power stations. Given the expected production of ~55 TWh of clean energy each year from the project, that would equate to annual emissions savings of ~46 million tonnes of CO₂. Over the 50-year life of the project this would be the equivalent of 2.3 billion tonnes of CO₂.

The proposal is therefore an excellent example of a renewable energy development that has the potential to provide significant environmental, social and economic benefits at state, national and global scales. The proposal will make a major and sustained contribution to Western Australia's economy, within a land setting that is currently unutilised for virtually any other economic land use.

These intergenerational benefits can be delivered with no significant impacts on either the Eighty Mile Beach Marine Park or Ramsar site, and the loss of less than 2% of the vegetation and fauna habitats within the development envelope; including avoidance or effective mitigation of impacts on species and communities of conservation significance.

After completion of this ERD, the proponent considers that the proposal is very clearly in accordance with the Environmental Principles of the *Environmental Protection Act 1986* (Section 4.1).

Based on the proposed avoidance of significant areas and proposed mitigation strategies, and the detailed content of this ERD, the proponent has concluded that the EPA objectives can be met for all preliminary key factors and that the proposal is environmentally acceptable.

9.0 References

- ACIL Allen (2018). Opportunities for Australia from Hydrogen Exports. Unpublished report prepared for the Australian Renewable Energy Agency, ACIL Allen Consulting Pty Ltd, Melbourne, Victoria.
- Alerstam, T., and G. A. Gudmundsson (1999). Migration Patterns of Tundra Birds: Tracking Radar Observations along the Northeast Passage. *Arctic* 52:346–371.
- Alerstam, T., G. A. Gudmundsson, M. Green, and A. Hedenström (2001). Migration along orthodromic sun compass routes by Arctic birds. *Science* 291:300–303.
- ANZECC (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality: Primary Industries — Rationale and Background Information (Irrigation and general water uses, stock drinking water, aquaculture and human consumers of aquatic foods). Australian and New Zealand Environment and Conservation Council, Canberra.
- APLIC, and U.S. Fish and Wildlife Service (2005). Avian Protection Plan (APP) Guidelines. Edison Electric Institute’s Avian Power Line Interaction Committee.
- Bacon, R., and M. Kojima (2011). Issues in estimating the employment generated by energy sector activities. World Bank Group.
- Bamford, M., D. Watkins, W. Bancroft, G. Tischler, and J. Wahl (2008). Migratory shorebirds of the East Asian - Australasian Flyway: Population estimates and internationally important sites. Wetlands International, Canberra.
- Baslev (2014). Electric power, HVDC from land to off-shore structures utilizing sea-electrodes for return current, concerns and precautions with regard to environment and corrosion. Unpublished report, Denmark.
- Battley, P. F., N. Warnock, T. L. Tibbitts, R. E. Gill, T. Piersma, C. J. Hassell, D. C. Douglas, D. M. Mulcahy, B. D. Gartrell, R. Schuckard, D. S. Melville, and A. C. Riegen (2012). Contrasting extreme long-distance migration patterns in bar-tailed godwits *Limosa lapponica*. *Journal of Avian Biology* 43:21–32.
- Bax, N. J., F. R. McEnulty, and K. L. Gowlett-Holmes (2003). Distribution and biology of the introduced gastropod *Maoricolpus roseus* in Australia. Commonwealth Scientific and Industrial Research Organisation and Department of Environment, Canberra, ACT.
- Bennelongia, DHI, and WRM (2009). Ecological Character Description for Roebuck Bay. Prepared for Department of Environment and Conservation, Western Australia.
- Biota (2008). Cape Lambert Port B Development Marine Turtle Management Plan. Unpublished report prepared for Pilbara Iron Pty Ltd, December 2008, Biota Environmental Sciences, Western Australia.
- Biota (2010). Yandicoogina Expansion Northern Quoll Position Paper. Unpublished report prepared for Rio Tinto Iron Ore, April 2010, Biota Environmental Sciences, Western Australia.

- Biota (2018a). Asian Renewable Energy Hub Fauna Survey. Unpublished report prepared for NW Interconnected Power, Biota Environmental Sciences, Western Australia.
- Biota (2018b). Asian Renewable Energy Hub Vegetation and Flora Survey. Unpublished report prepared for NW Interconnected Power, Biota Environmental Sciences, Western Australia.
- Biota (2018c). Asian Renewable Energy Hub Specialist Fauna Studies: Waterbirds and Migratory Shorebirds. Unpublished report prepared for NW Interconnected Power, Biota Environmental Sciences, Western Australia.
- Biota (2018d). Koodaideri Iron Ore Project Northern Quoll Baseline Long-Term Monitoring. Unpublished report prepared for Rio Tinto, Biota Environmental Sciences, Western Australia.
- BirdLife Australia (2018). Birddata [WWW Document]. Retrieved from <http://www.birddata.com.au>.
- BirdLife International (2013). The design and siting of wind turbines can reduce the risk of collision to birds of prey. BirdLife International. Retrieved from <http://datazone.birdlife.org/sowb/casestudy/the-design-and-siting-of-wind-turbines-can-reduce-the-risk-of-collision-to-birds-of-prey>.
- BMT (2018a). Asian Renewable Energy Hub: Marine State Waters Environmental Impact Assessment. BMT Western Australia, Osborne Park.
- BMT (2018b). Eighty Mile Beach Benthic Habitat Map Memorandum. BMT Western Australia, Osborne Park.
- BOEMRE (2011). Effects of EMFs from undersea power cables on elasmobranchs and other marine species. Unpublished report prepared for the United States Department of Interior, Bureau of Ocean Energy Management, Regulation and Enforcement, Bedford, USA.
- Bosse, E., R. M. Turner, and M. Lecours (1991). Tracking Swerling fluctuating targets at low altitude over the sea. *IEEE Transactions on Aerospace and Electronic Systems* 27:806–822.
- BP (2018). BP Statistical Review of World Energy. British Petroleum.
- Braithwaite, R. W., and A. D. Griffiths (1994). Demographic variation and range contraction in the northern quoll, *Dasyurus hallucatus* (Marsupialia: Dasyuridae). *Wildlife Research* 21(2):203–217.
- Brown, A. M., L. Bejder, K. H. Pollock, and S. J. Allen (2014). Abundance of coastal dolphins in Roebuck Bay, Western Australia. Report to World Wildlife Foundation Australia, Murdoch University Cetacean Research Unit, Western Australia.
- Bruce, S., M. Temminghoff, J. Hayward, E. Schmidt, C. Munnings, D. Palfreyman, and P. Hartley (2018). National Hydrogen Roadmap. CSIRO, Australia.
- Bureau of Meteorology (2018). Climate Data Online [WWW Document]. Retrieved from <http://www.bom.gov.au/climate/data/>.
- Burrows, N. D., and P. E. S. Christensen (1991). A survey of Aboriginal fire patterns in the Western Desert of Western Australia. Pages 297–305 in S. C. Nodvin and T.

- A. Waldrop, editors. *Fire and the environment: ecological and cultural perspectives*. USDA Forest Service, Southeastern Forest Experiment Station, Asheville, NC.
- CALM (1999). A land management assessment of Mandora Marsh and its immediate surrounds. Department of Conservation and Land Management, Western Australia.
- Castalanelli, M. A., R. Teale, M. G. Rix, J. Kennington, and M. S. Harvey (2014). Barcoding of mygalomorph spiders (Araneae: Mygalomorphae) in the Pilbara bioregion of Western Australia reveals highly diverse fauna. *Invertebrate Systematics* 28:375–385.
- Chalmers, C., and P. Woods (1987). Broome Coastal Management Plan. Environmental Protection Authority, Western Australia.
- Clean Energy Council (2018). Best Practice Guidelines for Implementation of Wind Energy Projects in Australia. Clean Energy Council.
- Commonwealth of Australia (2017). *Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species*. Department of the Environment and Energy, Commonwealth of Australia.
- Commonwealth of Australia (2018). Hydrogen for Australia’s Future. Unpublished report prepared by the Hydrogen Strategy Group, Commonwealth of Australia, Canberra, ACT.
- Condie, S., J. Andrewartha, J. Mansbridge, and J. Waring (2006). Modelling circulation and connectivity on Australia’s North West Shelf. Commonwealth Scientific and Industrial Research Organisation and Department of Environment, Perth, Western Australia.
- Cramer, V. A., M. A. Dziminski, R. Southgate, F. M. Carpenter, R. J. Ellis, and S. van Leeuwen (2016). A conceptual framework for habitat use and research priorities for the greater bilby (*Macrotis lagotis*) in the north of Western Australia. *Australian Mammalogy* 39(2):137–151.
- DBCA (2017a). Interim guideline for preliminary surveys of night parrot (*Pezoporus occidentalis*) in Western Australia. Department of Biodiversity, Conservation and Attractions.
- DBCA (2017b). Guidelines for Surveys to Detect the Presence of Bilbies, and Assess the Importance of Habitat in Western Australia. Department of Biodiversity, Conservation and Attractions.
- DBCA (2019). Priority Ecological Communities for Western Australia, Version 28. Species and Communities Branch, Department of Biodiversity, Conservation and Attractions, 17 January 2019.
- DEC (2012). A guide to managing and restoring wetlands in Western Australia. Department of Environment and Conservation, Perth, WA.
- Department of Agriculture and Water Resources (2009). National biofouling management guidelines for commercial vessels. Commonwealth of Australia, Canberra, ACT.

- Department of Climate Change and Energy Efficiency (2008). Australian National Greenhouse Accounts, National Inventory Report 2008. Commonwealth of Australia.
- Department of Conservation and Land Management, J. (2009). Information Sheet on Ramsar Wetlands (RIS): Eighty Mile Beach. Department of Conservation and Land Management, Western Australia.
- Department of Fisheries (2017). *Aquatic Biosecurity Policy 19 January 2017*. Government of Western Australia, Western Australia.
- Department of Indigenous Affairs and Department of Premier and Cabinet (2013). Aboriginal Heritage Due Diligence Guidelines. Perth WA.
- Department of Parks and Wildlife (2014). Eighty Mile Beach Marine Park Management Plan 80P 2014–2024.
- Department of Sustainability, Environment, Water, Population and Communities (2012). *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy*. Government of Western Australia, Canberra.
- Department of the Environment (2000). Directory of Important Wetlands in Australia - Information sheet [WWW Document]. Retrieved April 16, 2015, from <http://www.environment.gov.au/cgi-bin/wetlands/report.pl>.
- Department of the Environment and Energy (2017). Recovery Plan for Marine Turtles In Australia: 2017-2027. Department of the Environment and Energy, Canberra.
- Department of the Environment and Energy (2018). *Notorcytes caurinus* — Kakarratul, Karrkaratul, Northern Marsupial Mole SPRAT Profile [WWW Document]. Retrieved from http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=295.
- Department of the Environment and Heritage (2006). Wildlife Conservation Plan for Migratory Shorebirds. Department of the Environment and Heritage, Canberra.
- Department of Water (2010). La Grange Groundwater Allocation Plan. Department of Water.
- DEWHA (2009a). *Significant impact guidelines for 36 migratory shorebird species*. EPBC Act Policy Statement 3.21, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia.
- DEWHA (2009b). Approved Conservation Advice for *Keraudrenia exastia* (Fringed Keraudrenia). Approved Conservation Advice under s266B of the *Environment Protection and Biodiversity Conservation Act 1999*.
- DEWHA (2010a). Approved Conservation Advice for *Aipysurus apraefrontalis* (Short-nosed Sea Snake) - s266B of the Environment Protection and Biodiversity Conservation Act 1999. DEWHA.
- DEWHA (2010b). Survey Guidelines for Australia's Threatened Birds. Department of Sustainability, Environment, Water, Population and Communities.
- Dick, W. J. A., T. Piersma, and P. Prokosch (1987). Spring migration of the Siberian Knots *Calidris canutus canutus*: Results of a co-operative wader study group project. *Ornis Scandinavica* 18:5–16.

- Dickman, C. R. (1996). Overview of the Impacts of Feral Cats on Australian Native Fauna. Australian Nature Conservation Agency.
- Dickman, C. R., and R. W. Braithwaite (1992). Postmating mortality of males in the Dasyurid Marsupials, *Dasyurus* and *Parantechinus*. *Journal of Mammalogy* 73:143–147.
- DoEE (2009). EPBC Act Policy Statement 2.3: Wind Farm Industry. Commonwealth of Australia, Canberra.
- Doughty, P., J. K. Rolfe, A. H. Burbidge, D. J. Pearson, and P. G. Kendrick (2011). Herpetological assemblages of the Pilbara biogeographic region, Western Australia: ecological associations, biogeographic patterns and conservation. *Records of the Western Australian Museum* 78:315–341.
- Drewitt, A. L., and R. H. W. Langston (2008). Collision effects of wind-power generators and other obstacles on birds. *Annals of the New York Academy of Science* 1134:233–266.
- DSEWPaC (2011). Survey Guidelines for Australia's Threatened Mammals. Department of Sustainability, Environment, Water, Population and Communities, Canberra. Retrieved from <http://www.environment.gov.au/epbc/publications/threatened-mammals.html>.
- DSEWPaC (2012). Marine Bioregional Plan for the North Marine Region. Department of Sustainability, Environment, Water, Population and Communities, Canberra. Retrieved from <http://www.environment.gov.au/topics/land/national-reserve-system/science-maps-and-data/australias-bioregions-ibra>.
- DSEWPaC (2013). How to Use the Offsets Guide. Department of Sustainability, Environment, Water, Population and Communities, Canberra, Australia.
- Eastwood, E., and G. C. Rider (1965). Some radar measurements of the altitude of bird flight. *British Birds* 58:393–426.
- Emerge Associates (2017). Targeted Flora and Vegetation Assessment Shelamar Station, Project No. EP17-068(02). Emerge Associates.
- EPA (2006). *Guidance Statement 6 – Rehabilitation of Terrestrial Ecosystems*. Environmental Protection Authority, Western Australia.
- EPA (2010). *Environmental Assessment Guideline No. 5 - Environmental Assessment Guideline for Protecting Marine Turtles from Light Impacts*. Environmental Protection Authority.
- EPA (2013). *Environmental Protection Bulletin 20 - Protection of naturally vegetated areas through planning and development*. Environmental Protection Authority, Western Australia.
- EPA (2015). *Environmental Assessment Guideline No. 8: Environmental principles, factors and objectives*. Environmental Protection Authority, Western Australia.
- EPA (2016a). *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment*. Environmental Protection Authority, Western Australia.
- EPA (2016b). *Technical Guidance: Sampling Methods for Terrestrial Vertebrate Fauna*. Environmental Protection Authority, Western Australia.

- EPA (2016c). *Technical Guidance: Sampling of Short Range Endemic Invertebrate Fauna*. Environmental Protection Authority, Western Australia.
- EPA (2016d). *Technical Guidance: Terrestrial Fauna Surveys*. Environmental Protection Authority, Western Australia.
- EPA (2016e). *Environmental Factor Guideline: Benthic Communities and Habitats*. Environmental Protection Authority, Western Australia.
- EPA (2016f). *Technical Guidance: Protection of Benthic Communities and Habitats*. Environmental Protection Authority, Western Australia.
- EPA (2016g). *Technical Guidance: Protecting the Quality of Western Australia's Marine Environment*. Environmental Protection Authority, Western Australia.
- EPA (2016h). *Environmental Factor Guideline: Marine Environmental Quality*. Environmental Protection Authority, Western Australia.
- EPA (2016i). *Environmental Factor Guideline: Marine Fauna*. Environmental Protection Authority, Western Australia.
- EPA (2016j). *Environmental Factor Guideline: Flora and Vegetation*. Environmental Protection Authority, Western Australia.
- EPA (2016k). *Environmental Factor Guideline: Terrestrial Fauna*. Environmental Protection Authority, Western Australia.
- EPA (2016l). *Environmental Factor Guideline: Social Surroundings*. Environmental Protection Authority, Western Australia.
- EPA (2016m). *Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2016*. Environmental Protection Authority, Western Australia.
- EPA (2017). *Instructions on how to prepare an Environmental Review Document*. Environmental Protection Authority, Western Australia.
- EPA (2018a). *Instructions on how to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans*. Environmental Protection Authority, Western Australia.
- EPA (2018b). *Environmental Impact Assessment (Part IV Divisions 1 and 2) Procedures Manual*. Environmental Protection Authority, Western Australia.
- EPA (2018c). *Statement of Environmental Principles, Factors and Objectives*. Environmental Protection Authority, Western Australia.
- Flannery, T., P. Kendall, and K. Wynn-Moylan (1990). *Australia's Vanishing Mammals Endangered and Extinct Native Species*. RD Press.
- Frith, H. J. (1959). The ecology of wild ducks in inland New South Wales. III. Food habits. *CSIRO Wildlife Research* 4:131–155.
- Geering, A., L. Agnew, and S. Harding (2007). *Shorebirds of Australia*. CSIRO Publishing, Melbourne.
- Gill, A. B. (2005). Offshore renewable energy: ecological implications of generating electricity in the coastal zone. *Journal of Applied Ecology* 42:605–615.

- Goosem, M. (2004). Linear infrastructure in the tropical rainforests of far north Queensland: mitigating impacts on fauna of roads and powerline clearings. Pages 418–434 in D. Lunney, editor. *Conservation of Australia's Forest Fauna*. Royal Zoological Society of New South Wales, New South Wales.
- Government of Western Australia (2011). *WA Environmental Offsets Policy*. Government of Western Australia, Western Australia.
- Government of Western Australia (2014). *WA Environmental Offsets Guidelines*. Environmental Protection Authority, Western Australia.
- Green, M. (2004). Flying with the wind - spring migration of Arctic-breeding waders and geese over south Sweden. *Ardea* 92:145–159.
- Gudmundsson, G. A., T. Alerstam, M. Green, and A. Hedenström (2002). Radar observations of the Arctic bird migration at the Northwest Passage, Canada. *Arctic* 55:21–43.
- GWEC (2018). *Global Wind Report 2017*. Global Wind Energy Council.
- Hale, J., and R. Butcher (2009). *Ecological Character Description of the Eighty-mile Beach Ramsar Site*. Department of Environment and Conservation, Perth, WA.
- Halse, S. A., G. B. Pearson, C. Hassell, P. Collins, M. D. Scanlan, and C. D. T. Minton (2005). Mandora Marsh, north-western Australia, an arid-zone wetland maintaining continental populations of waterbirds. *Emu* 105:115–125.
- Hamilton, Z. R. (2015). DNA barcoding reveals a contact zone in cryptic lineages of *Rhagada* land snails (Pulmonata: Camaenidae) in an ancient landscape. *in prep*.
- Helix (2018). Report on the molecular systematics of the targeted SRE invertebrates from the Asian RE Hub fauna survey. Unpublished letter report prepared for Biota Environmental Sciences, 9 August 2018, Helix Molecular Solutions.
- Hesp, P. A., and P. Curry (1984). *A Land Resource Survey of the Fall Point Coastline, Broome, WA – Resource Management*. Department of Fisheries and Wildlife, Perth, Western Australia.
- Hötker, H., K. Thomsen, and H. Jeromin (2006). Impacts on biodiversity of exploitation of renewable energy sources: the example of birds and bats - facts, gaps in knowledge, demands for further research, and ornithological guidelines for the development of renewable energy exploitation. NABU, Bonn, Germany.
- How, R. A., J. Dell, and N. K. Cooper (1991). Vertebrate fauna of the Abydos-Woodstock Reserve, northeast Pilbara. *Records of the Western Australian Museum Supplement* 37:78–125.
- IFAW (2011). *Australia's Last Great Whale Haven: cetacean distribution and conservation needs in the north-west marine region*. Unpublished report, International Fund for Animal Welfare, Western Australia.
- Ingleby, S. (1991). Distribution and status of the spectacled hare-wallaby, *Lagorchestes conspicillatus*. *Wildlife Research* 18:501–519.
- Johnson, K. A. (2008). Bilby. Pages 191–193 in S. van Dyck and R. Strahan, editors. *The Mammals of Australia*, 3rd edition. Reed New Holland, Sydney.

- Johnson, M. S., Z. R. Hamilton, C. E. Murphy, C. A. MacLeay, B. Roberts, and P. G. Kendrick (2004). Evolutionary genetics of island and mainland species of *Rhagada* (Gastropoda: Pulmonata) in the Pilbara Region, Western Australia. *Australian Journal of Zoology* 52:341–355.
- Johnstone, R. E., and G. M. Storr (1998). *Handbook of Western Australian Birds Volume 1 - Non-Passerines (Emu to Dollarbird)*. Western Australian Museum, Perth.
- Kahlert, J., I. Krag Petersen, A. D. Fox, M. Desholm, and I. Clausager (2003). Investigations of birds during construction and operation of Nysted offshore wind farm at Rødsand. Department of Wildlife Ecology and Biodiversity, Denmark.
- Kahlert, J., A. Leito, B. Laubek, L. Luigujõe, and A. Kuresoo (2012). Factors affecting the flight altitude of migrating waterbirds in western Estonia. *Ornis Fennica* 89:241–253.
- Kingsford, R. T., and F. I. Norman (2002). Australian waterbirds - products of the continent's ecology. *Emu* 102:47–69.
- Kingsford, R. T., D. A. Roshier, and J. L. Porter (2010). Australian waterbirds - time and space travellers in dynamic desert landscapes. *Marine and Freshwater Research* 61:875–884.
- Kinloch, M., R. Summerson, and D. Curran (2003). Domestic vessel movements and the spread of marine pests. Commonwealth Scientific and Industrial Research Organisation and Department of Environment, Canberra, ACT.
- Korner-Nievergel, F. K., O. Behr, R. Brinkmann, M. A. Etterson, M. P. Huso, D. Dalthorp, and P. Korner-Nievergelt (2015). Mortality estimation from carcass searches using the R-package carcass — a tutorial. *Wildlife Biology* 21:30–43.
- Langston, R. H. W., and J. D. Pullan (2003). Windfarms and Birds : An analysis of the effects of windfarms on birds, and guidance on environmental assessment criteria and site selection issues. Report by BirdLife International to the Council of Europe, Bern Convention on the Conservation of European Wildlife and Natural Habitats, .
- Lavaleye, M., P. J. C. Honkoop, L. Marsh, G. Pearson, T. Piersma, and P. De Goeij (2005). Atlas of the macrozoobenthotic fauna. Pages 73–150 *The Long Mud: Benthos and Shorebirds of the Foreshore of Eighty Mile Beach, Western Australia*. Netherlands Institute for Sea Research, Texel, Netherlands.
- Lazard (2017). Lazard's Levelized Cost of Energy Analysis Version 11.0. Lazard.
- de Lucas, M., M. Ferrer, M. J. Bechard, and A. R. Munoz (2012). Griffon vulture mortality at wind farms in southern Spain: Distribution of fatalities and active mitigation measures. *Biological Conservation* 147:184–189.
- Mack, R. N., D. Simberloff, W. M. Lonsdale, H. Evan, M. Clout, and F. A. Bazzaz (2000). Biotic invasions: causes, epidemiology, global consequences, and control. *Ecological Applications* 10(3):689–710.
- Marchant, S., and P. J. Higgins (1990). *Handbook of Australian, New Zealand and Antarctic Birds. Volume 1: Ratites to Ducks*. Oxford University Press, Melbourne.

- May, S. A., and T. W. Norton (1996). Influence of fragmentation and disturbance on the potential impact of feral predators on native fauna in Australian forest ecosystems. *Wildlife Research* 23:387–400.
- Meissner, K., H. Schabelon, J. Bellebaum, and H. Sordyl (2006). Impacts of submarine cables on the marine environment – a literature review. Technical report prepared for Federal Agency of Nature Conservation, Institute of Applied Ecology Ltd, Germany.
- Menkhorst, P., and F. Knight (2011). *A Field Guide to the Mammals of Australia*, 3rd edition. Oxford University Press, Australia.
- Minton, C., M. Connor, D. Price, R. Jessop, P. Collins, H. Sitters, C. Hassell, G. Pearson, and D. Rogers (2013). Wader numbers and distribution on Eighty Mile Beach, north-west Australia: baseline counts for the period 1981-2003. *Conservation Science Western Australia* 8:345–366.
- Minton, C., K. Gosbell, P. Johns, M. Christie, J. W. Fox, and V. Afanasyev (2010). Initial results from light level geolocator trials on Ruddy Turnstone *Arenaria interpres* reveal unexpected migration route. *Wader Study Group Bulletin* 117:9–14.
- Minton, C., J. Wahl, H. Gibbs, R. Jessop, C. Hassell, and A. Boyle (2011). Recoveries and flag sightings of waders which spend the non-breeding season in Australia. *Stilt* 59:17–43.
- Molnar, J. L., R. L. Gamboa, C. Revenga, and M. Spalding (2008). Assessing the global threat of invasive species to marine biodiversity. *Frontiers in Ecology and the Environment* 6:485–492.
- Newton, I. (2008). *The Migration Ecology of Birds*. Academic Press, London.
- NW Interconnected Power (2018). Asian Renewable Energy Hub Environmental Scoping Document. Biota Environmental Sciences, Western Australia.
- Oakwood, M. (2000). Reproduction and demography of the northern quoll, *Dasyurus hallucatus*, in the lowland savanna of northern Australia. *Australian Journal of Zoology* 48:519–539.
- Oakwood, M. (2008). Northern Quoll. Pages 57–59 in S. van Dyck and R. Strahan, editors. *The Mammals of Australia*, 3rd edition. Reed New Holland, Chatswood Australia.
- OSPAR Commission (2009). Assessment of the environmental impacts of cables. Convention for the Protection of the Marine Environment of the North-East Atlantic, the “OSPAR Convention”., Lauterbach, Germany.
- Pavey, C. R., C. E. M. Nano, J. B. Cooper, J. R. Cole, and P. J. McDonald (2011). Habitat use, population dynamics and species identification of mulgara, *Dasyercus blythi* and *D. cristicauda*, in a zone of sympatry in central Australia. *Australian Journal of Zoology* 59:156–169.
- Pearce-Higgin, J. W., L. Stephen, A. Douse, and R. H. W. Langston (2012). Greater impacts of wind farms on bird populations during construction than subsequent operation: results of a multi-site and multi-species analysis. *Journal of Applied Ecology* 49:386–394.

- Pearson, D. (2013). Recovery plan for five species of rock wallabies: Black-footed rock wallaby (*Petrogale lateralis*), Short-eared rock wallaby (*Petrogale brachyotis*), Monjon (*Petrogale burbidgei*), Nabarlek (*Petrogale concinna*), Rothschild rock wallaby (*Petrogale rothschildi*). Department of Parks and Wildlife.
- Pearson, G., R. Hickey, and P. J. C. Honkoop (2005). General description of the area. Pages 51–62 *The Long Mud: Benthos and Shorebirds of the Foreshore of Eighty Mile Beach, Western Australia*. Netherlands Institute for Sea Research, Texel, Netherlands.
- Pedler, R. D., F. H. Ribot, and A. T. D. Bennett (2014). Extreme nomadism in desert waterbirds: flights of the banded stilt. *Biology Letters* 10. doi: <http://dx.doi.org/10.1098/rsbl.2014.0547>.
- Peters, A., and K. J. F. Verhoeven (1994). Impact of Artificial Lighting on the Seaward Orientation of Hatchling Loggerhead Turtles. *Journal of Herpetology* 28(1):112–114.
- Piersma, T., and C. Hassell (2010). Record numbers of grasshopper-eating waders (Oriental Pratincole, Oriental Plover, Little Curlew) on coastal west-Kimberley grasslands of NW Australia in mid February 2010. *Wader Study Group Bulletin* 117:1–6.
- Powlesland, R. G. (2009). Impacts of wind farms on birds: a review. *Science for Conservation* 289.
- Richardson, W. J. (1979). Shorebird migration over Nova Scotia and New Brunswick in autumn: a radar study. *Canadian Journal of Zoology-Revue Canadienne de Zoologie* 57:107–124.
- Riley, J. R., and A. D. Smith (2002). Design considerations for an harmonic radar to investigate the flight of insects at low altitude. *Computers and Electronics in Agriculture* 35:151–169.
- Rogers, D. I., C. J. Hassell, A. Boyle, K. Gosbell, C. Minton, K. G. Rogers, and R. H. Clarke (2011). Shorebirds of the Kimberley coast - Populations, key sites, trends and threats. *Journal of the Royal Society of Western Australia* 94:377–391.
- Roshier, D. A., N. I. Klomp, and M. Asmus (2006). Movements of a nomadic waterfowl, Grey Teal *Anas gracilis*, across inland Australia - results from satellite telemetry spanning fifteen months. *Ardea* 94:461–475.
- Schmidt, G., B. Fiegl, and S. Kolbeck (1996). HVDC transmission and the environment. *Myriapodologica* 10:204–210.
- Sitters, H., C. Minton, P. Collins, B. Etheridge, C. Hassell, and F. O'Connor (2004). Extraordinary numbers of Oriental Pratincoles in NW Australia. *Wader Study Group Bulletin* 103:26–31.
- Stevens, J. D., R. B. Simpfendorfer, and R. D. Pillans (2008). Spatial distribution and habitat utilisation of sawfish (*Pristis* spp) in relation to fishing in northern Australia. Unpublished Report Prepared for Department of the Environment, Water, Heritage and the Arts, CSIRO and Western Australia Department of Fisheries.

- Sutton, S., S. Swingler, and P. Lewin (2016). HVDC Subsea Cable Electrical Return Path Schemes: Use of Sea Electrodes and Analysis of Environmental Impact. Unpublished report, Hubnet.
- Tulp, I., S. McChesney, and P. De Goeij (1994). Migratory departures of waders from north-western Australia: Behaviour, timing and possible migration routes. *Ardea* 82:201–221.
- van Dyck, S., and R. Strahan (Eds.) (2008). *The Mammals of Australia*, 3rd edition. Reed New Holland, Sydney.
- van Vreeswyk, A. M. E., A. L. Payne, K. A. Leighton, and P. Hennig (2004). *Technical Bulletin No. 92: An inventory and condition survey of the Pilbara region, Western Australia*. Department of Agriculture, South Perth WA.
- VWSG (2017). Grey Plover tracking in South Australia [WWW Document]. Retrieved July 18, 2018, from <http://www.vwsg.org.au/Grey-Plover-tracking.html>.
- WAPC (2004). Guidelines for Wind Farm Development. Planning Bulletin 67, Western Australian Planning Commission, Perth.
- WAPC (2007). Visual Landscape Planning in Western Australia: a manual for evaluation, assessment, siting and design. Western Australian Planning Commission, Perth, WA.
- Warburton, N. (2006). Functional morphology of marsupial moles (Marsupialia: Notoryctidae). *Verh. naturwissenschaftlicher Verlag Hamburg* NF (42):39–142.
- Wilkins, C. F. (1999). *Keraudrenia exastia* and *Keraudrenia katatona* (Malvaceae: Byttnerioideae), new species from the Kimberley region of Western Australia. *Nuytsia* 13(1):233–242.
- Williams, T. C. (1985). Autumnal bird migration over the Windward Caribbean Islands. *The Auk* 102:163–167.
- Wilson, S., and G. Swan (2017). *A Complete Guide to Reptiles of Australia*, 5th edition. New Holland.
- Woinarski, J. C. Z., A. A. Burbidge, and P. L. Harrison (2014). *The Action Plan for Australian Mammals 2012*. CSIRO Publishing, Victoria.
- Woolley, P. A. (2005). The species of *Dasycercus* Peters 1875 (Marsupialia: Dasyuridae). *Memoirs of Museum Victoria* 62:213–221.
- World Bank Group (2015). Environmental, Health and Safety Guidelines for Wind Energy. World Bank Group.
- Zwart, M. C., A. McKenzie, J. Minderman, and M. J. Whittingham (2016). Conflicts Between Birds and On-Shore Wind Farms. Page *Problematic Wildlife: A Cross-disciplinary Approach*. Springer International Publishing Switzerland.

Appendix 1: Draft Construction Environmental Management Plan

Appendix 2: Benthic Communities and Habitat Survey

Appendix 3: Marine Environmental Impact Assessment

Appendix 4: Representative Nearshore HDVC Cable Specifications

Appendix 5: Desktop Assessment and Detailed Flora and Vegetation Survey

Appendix 6: Fire Management and Monitoring Framework

Appendix 7: Desktop Assessment and Terrestrial Fauna Survey

Appendix 8: Migratory Shorebird and Water Bird Survey

Appendix 9: Visual Impact Assessment Figures

Appendix 10: Noise Modelling Report
