Site Characteristics and Issues Matrix Site Name Perpendicular Head

Terrestrial Biophysical Attributes		Extent and Condition			Level of Confidence	Potential for Significant Risk / Hazard and Impact of Development at this Site
Rainfall: 769 mm (Cape Leveque)		**Extent** Extent in the local area and regional context. Coastal area extent may be described as either alongshore and cross-shore length. Non-coastal extent could include; highly restricted to landform or habitat, locally common but regionally restricted, or widespread	**Key Coastal and Ecological Processes** Key coastal processes are defined by NCCOE (2004) and should be interpreted in the context of coastal landform description. Ecological processes relate to terrestrial ecology	**Site Condition / Disturbance Factors** Includes factors such as weed cover, apparent erosion (on ground or visible in aerial photography), excessive fire frequency	**High**: from site visit /survey, good map based knowledge, **Medium**: inferred from other good information sets, **Low**: limited information.	
Geological Province	**Site Geology, Substrate Characteristics & Diversity**	**Extent in local area and region**	**Key Coastal / Ecological Processes**	**Site Condition / Disturbance Factors**		**Altered Drainage and Stormwater Management** **H**: Site area or substrate restricts effective on site management of storm water, erosion, potential pollution issues **M**: Site size and / or substrate allows for some retention of stormwater **L**: Site size and substrate allows for retention and managed discharge of stormwater.
Canning Basin Sandplains	Emeriau Sandstone (Exposed/soil covered) / Broome Sandstone / Melligo Sandstone	Present exposed as cliffs and soil covered– type location Emeriau Sandstone. Emeriau Sandstone has very limited extent largely confined regionally to this hub location. But appears to be very similar to / same as Broome Sandstone and Melligo Sandstone which are somewhat more widely exposed in near coastal locations.	Erosion of coastal headlands cliff. Represent regionally rare sandstone cliff/rock face environments and rock shelter/cave environments.	Some localised disturbance from vehicle access tracks to vantage points.	**H**	**L**: Relatively stable coastline and small scale, so limited physical constraint on development site management
	Pindan Red Earths	Widespread and dominant surface on the Dampier Peninsula,	Limited coastal exposure on site, but coastal areas showing evidence of major episodic erosion from cyclonic waves, storm surge and extreme meteorological events.	Localised coastal erosion, localised impact from vehicle road and track access, frequent extensive fire, some weed invasion.	**H**	**L**: Site size and substrate and gentle slopes allows for detention and managed discharge of stormwater.
	Alluvial and Lacustrine deposits	Limited area east of potential hub site. Larger areas regionally associated with drainage lines to Pender Bay and Beagle Bay, north and south of the site	Impeded by small barrier dune. Stormwater runoff from the site likely to drain towards the drainage line. Stormwater, erosion management required.	Generally intact	**H**	**L-M**: Site size and substrate allows for some detention of stormwater
Coastal Deposits	Holocene coastal dunes	Present Middle Lagoon and other small embayments	Cyclonic wind, waves and storm surge.	Vehicle access tracks have localised impact.	**M**	**M:** Stormwater management should avoid impacts on drainage flows to the back of the dune environments supporting Monsoon Vine Thicket vegetation.
	Bossut Formation (Exposed/soil covered)	Present exposed as cliffs and soil covered	Regionally restricted calcareous surface occurs south of Middle Lagoon. Karst collapse features.	Generally intact.	**H**	**M:** Stormwater management should avoid impact on karst environment.
	Tidal Flat and mangrove swamp	Limited area Middle Lagoon	Small scale example of these	Generally intact.	**H**	**M-H:** Drainage lines from the site flow to Middle Lagoon.

		west of the Site, Tappers Inlet more distant south of site.	environments in regional context			Stormwater management would need to avoid sediment, contaminant discharge to Middle Lagoon.
	Supratidal flat	Limited area Middle Lagoon west of the site.	Small example of this environment type.	Localised impact from vehicle access tracks causing changes in drainage flows, erosion and compaction.	**M-H**	**M-H:** Stormwater management should avoid impact on supratidal flats and ephemeral freshwater wetland environments.
Site Diversity/ Extent	**Total** Seven geological units	High substrate diversity in study area. Substrate of Hub site regionally widespread surface.				
Coastal Geomorphology, Geomorphological Processes & Landform Stability		**Extent in local area and region**	**Key Coastal / Ecological Processes**	**Site Condition / Disturbance Factors**	**Level of Confidence**	**Potential for Coastal impacts from altered coastal wave / energy regime, or concentrated stormwater flows** **H**: Low lying topography; Proximity to tidal creeks; Cheniers, narrow barrier dunes & associated extensive wetlands; Extensive mudflats; considerable longshore sand drift regime with significant potential for impact **M**: Moderately elevated topography (to 10 m); Sandy & silty beaches limited longshore sand movement; Moderate to wide barrier dunes and wetlands; Erodable or eroding cliff. **L**: Elevated topography (>10m); rocky coast and landward landform with little evidence of recent erosion; low longshore sediment drift
Coastal Geomorphology, Geomorphological Processes & Landform Stability		**Extent in local area and region** Perpendicular Head is the larger of two rocky salients separating Beagle Bay and Pender Bay. It is approximately 8 km in alongshore width and extends approximately 9 km from the general trend of the shore. Distance to the 20m depth contour varies around the headland and is less than 2 km in the vicinity of Chimney Rocks – Mercedes Cove.	**Key Coastal / Ecological Processes** On its seaward margin the promontory is exposed to key processes identified by NCCOE (2004), including 1. Mean Sea Level changes 2. Ocean Currents 3. Wind Climate 4. Wave Climate 5. Rainfall & Runoff To landward the Pindan surface of the promontory is elevated, generally above 20m and undulating	**Site Condition / Disturbance Factors** Secondary processes are significant at a local scale due to variation in aspect and exposure of the coast around the headland. These processes are potentially disturbance factors and include: 1. Local sea level 2. Local currents 3. Local winds 4. Groundwater 5. Coastal flooding 6. Sediment transport 7. Tidal creek hydraulics The coastal geology is varied and controls the landform development between Tappers Inlet and Bell Point. Community settlements are located at Middle Lagoon and Mercedes Cove	**Level of Confidence** **M to H**: based interpretation of aerial photography, satellite imagery and reports.	Potential hazards and risks are very much dependent on the local conditions, ranging with the least environmental problems possibly encountered in Embalgun, away from cliffs separately developed in the sandstone and Pindan soils The geomorphology of Weedong lagoon is unusual in the region.
Inshore features (b) Sandy beaches & mudflats		The larger sandy beaches occur at Middle Lagoon, Embalgun and east of Bell Point in Pender Bay. Smaller beaches occur near Chimney Rocks, Mercedes Cove and around Perpendicular Head	Tides, local sea level, currents, waves and winds; beach profile responses to changes in the above; sediment transport.	Tidal currents; erosion in extreme storm events. Erosion of Pindan soil cliffs between Perpendicular Head and Bell Point where the beach abuts the Pindan and the frontal dune.		**M** to **H**
(d) Subtidal rock platforms & pavements		Local features in the vicinity of Perpendicular Head, where they are well developed, and west of Bell Point	Local variation in sea level and wave energy Extreme storm events, particularly tropical cyclones.	Overtopping of platforms during extreme storm events may exacerbate local erosion, particularly where the platforms underlie Pindan soils.		**L**

Rocky shores					
Rocky shores (d) Unstable cliffs - sandstone	Major structural feature of the site.	Tropical cyclones	Wave and storm surge erosion in extreme storm events. Karst solution along boundary of limestone and sandstone		**L to M**
(e) Unstable cliffs - limestone					**L to M**
(f) Unstable cliffs - other (Pindan)	Moderate extent	Tropical cyclones, extreme monsoonal rainfall	Wave and storm surge, extreme rainfall events. Potential for significant episodic erosion/ retreat in extreme storm events.		**M:** Uncontrolled stormwater runoff could lead to severe erosion
Rocky headlands					
(a) Localised outcrops & reefs	Small scale feature locally	Tropical cyclone	Storm surge – wave action		**M**
(b) Localised outcrops – talus / Storm deposits	Small scale feature locally	Tropical cyclone	Onshore surge events Along and across-shore movement of coarse sediments		**M**
Embayments					
Barrier dune ridge & vine thicket					
(b) Vegetated dunes	Middle Lagoon, Mercedes Cove	Tropical cyclone	Tourism numbers/ access related impacts, washover from cyclones.		**M**
Barrier dunes & freshwater wetlands					
(a) Mobile dunes	Weedong Lagoon	Extreme meteorological events	Storm surge on the lower, seaward faces of active dunes and aeolian processes Long-term migration of active dune and breaching by storm surge		**H**: The dune barrier impounds Weedong Lagoon, an unusual freshwater wetland close to the coast.
Mud Flats & Tidal Creeks					
(a) Tidal creek - vegetated distributary fan	Small creeks in Tappers Inlet and Middle Lagoon	Tides Local sea levels Local wind and waves Coastal flooding (Tappers Inlet and Middle Lagoon)	Tidal regime, water level set-up associated with monsoonal NW winds and storm surge during tropical cyclones. Particular effects depend on coastal aspect. Inundation during extreme meteorological events. The environments are subject to short term variability		**H:** Low lying site subject to high inter-decadal variability as well as inundation during extreme storm events.
(c) Tidal creek – vegetated tributaries	Small	Tidal regime	Storm surge	**H**	**M**:
Stream Mouths					
Intermittently Open (a) Drains vegetated uplands	Small streams are located at Embalgun and flow into Weedong Lagoon	High rainfall events	Disruption of surface run-off and/or groundwater flow		**M**: Uncontrolled stormwater runoff could lead to severe erosion
Site Diversity Eight coastal landform types near site location	High diversity with some units regionally uncommon				**M-L**: Relatively stable Stormwater runoff management and discharge across the coast.' Cliff coastline unstable - development setback needed.
Diversity of Vegetation Communities - on site and regional context	**Extent in local area and region**	**Key Coastal / Ecological Processes**	**Site Condition / Disturbance Factors**	**Level of Confidence**	**Potential for Significant Impacts from Site Clearing** **H**: Conservation Significant communities, high physical / biological diversity, or restricted community/s. **M**: Moderate physical / biological diversity. **L**: Low diversity, communities widespread regionally
Coastal Vegetation Communities					
Foredune vegetation	Present but limited scale adjacent to the site, larger areas	Dune stability, habitat			

	regionally				
Supratidal Flats					
(a) Samphire (b) Saltwater couch (c) Bare surface-algal crust	Present at Tappers Inlet. Locally common.	Cyclonic winds and storm surge, tidal processes.	Localised disturbance associated with vehicle access.	**M-H**	**M**
Mangrove –					
(a) closed forest,	Present – small area Middle Lagoon, larger more complex examples present regionally				
(b) scattered plants					
Rocky coast community	Rocky shorelines and headland vegetation present. Regionally restricted environment best represented at this site.	One of the most extensive representations of communities associated with sandstone headlands on west coast of the Dampier Peninsula. Also representation of distinctive community associated with limestone Bossut Formation low cliffs. This environment is more extensive at North Head.	Generally excellent condition with limited areas of severe localised disturbance associated with vehicle tracks		
Wetland Vegetation Communities					
Wetland vegetation					
(b) Permanent	Lagoons uncommon regionally	Drainage line ponded behind coastal dunes, rare freshwater wetland habitat.	Apparently intact condition, significant.	**M**	**H:** Rare semipermanent freshwater wetland habitat in the region.
Stream Riparian vegetation					
(a) Seasonal Stream	Minor drainage depression to east of site	Local drainage catchment after heavy rain.			
(b) Permanent Stream					
Ephemeral seep	Ephemeral wetland environment supporting narrow linear stands of *Melaleuca alsophila* associated with wet season seeps, where pindan soils adjoin the supratidal flats around Tappers Inlet.	Dependent of groundwater recharge and discharge. Potentially impacted by cyclonic storm surge.	Generally intact.	**H**	**L-M:** Restricted wetland environment potentially impacted by changes to groundwater recharge and stormwater discharge associated with hub development. Management required.
Upland Vegetation Communities					
(c) Upland on Pindan surfaces					
High rainfall Pindan Open Eucalyptus dominated woodland / forest	The dominant vegetation on site away from coastal communities		Frequent fire, defoliation of *Eucalyptus miniata* (Darwin Woollybutt), apparently by insect attack and the presence of some weeds		
Vine Thicket/Rainforest TEC in Dune Swale	Small patches in scattered locations behind coastal dunes	Essential habitat for a range of flora and fauna species confined to these vegetation communities	Fire		**H**: Soil moisture conditions need to be maintained to sustain the community.
Communities on Cliff / outcrop, or exposed rock surfaces	Present and restricted on site to localised areas in near clifftop skeletal soils and salt wind exposure. Regionally restricted community type	Distinctive shrub heath community on sandstone cliffs and Spinifex Grassland associated with calcareous surfaces of the Bossut Formation.	Generally excellent condition with areas of severe localised disturbance associated with vehicle access tracks		
Site Diversity	Seven vegetation communities. Moderate-high diversity in vicinity of hub site. Some environmentally sensitive environments				**M-H**
Threatened, Priority, Significant Flora (Population)	**Extent in local area and region**	**Key Coastal / Ecological Processes**	**Site Condition / Disturbance Factors**	**Level of Confidence**	**Potential for Significant Impacts from Site Clearing** **H**: Threatened species recorded, High quality/extensive suitable

(Species/status)					habitat for threatened species, high physical / biological diversity, or restricted community. **M**: Limited representation of restricted habitat type/s, or habitats suitable for priority/significant species, moderate physical / biological diversity. **L**: Low habitat diversity, Habitats widespread regionally, limited potential to support threatened/priority or other significant species.
DRF (Wildlife Conservation Act) / Endangered (EN)/Vulnerable (VU) EPBC Act Species/Habitat	No species recorded			**M**	**L**
Priority flora	*Glycine pindanica* P1 was identified in survey and is widely distributed on Pindan soils in study area. The WA Herbarium has records of a further 2 species in the vicinity- *Aphyllodium glossocarpum* P3- Pindan sands on Dampier Peninsular, and *Nymphoides beaglensis* P2- Edges of permanent waterholes or in seasonally inundated claypans & depressions in both Dampierland and North Kimberley Bioregions (Weedong Lagoon)			**M**	**M**
Other significant flora. (eg Unnamed species, Range end/outlying populations)	10 recorded species that represent range extensions or possible range extensions and a further 2 species that have unusual characteristics for the species.		Frequent fire and some widespread weeds.	**M**	**M**
Habitat specialist restricted taxa, restricted habits	None recorded			**M**	**L**
Threatened, Priority, Significant Fauna Population or Habitat (Species / status)	**Extent in local area and region**	**Key Coastal / Ecological Processes**	**Site Condition / Disturbance Factors**	**Level of Confidence**	**Potential for Significant Impacts from Site Clearing** **H**: Threatened (Rare) species recorded, High quality/extensive suitable habitat for Threatened species, high physical / biological diversity, or restricted community. **M**: Limited representation of restricted habitat type/s, or habitats suitable for threatened/priority species, moderate physical / biological diversity. **L**: Low habitat diversity, Habitats widespread regionally, limited value as habitat for threatened/priority or other significant species.
Threatened (Rare) Wildlife Conservation Act / Endangered (EN), or Vulnerable (VU) EPBC Act Species / Habitat (ie Turtle nesting beach)	Limited number of beaches suitable for turtle nesting.			**H**	**L**
Priority listed sp / habitat	Three species of priority birds- *Numenius madagascariensis* (Eastern Curlew) P4 is a wader species utilising intertidal habitat. *Burhinus grallarius* (Bush Stonecurlew) P4 wide ranging in a variety of habitats. Phaps histrionica (Flock Bronzewing) P4	Wide ranging species in suitable habitat.	Fire frequency and some widespread weed invasion.	**H**	**M**

Ramsar/JAMBA/CAMBA, ROKAMBA Migratory sp / habitat	55 species of Migratory Birds listed under international treaty. Provides significant but small scale habitat in the region			**H**	**M**
Other significant fauna. (eg Unnamed species, Range end/outlying populations, species with declining range	The schedule 4 species, Saltwater Crocodile (*Crocodylus porosus),* is known from Weedong Lagoon. *Diporiphora pindan* (Pindan Dragon) is considered of local conservation significance due to uncertainty of northern extent of its range.			**H**	**L**
Potential habitat for Short Range Endemic inc subterranean fauna	**Extent in local area and region**	**Key Coastal / Ecological Processes**	**Site Condition / Disturbance Factors**	**Level of Confidence**	**Potential for Significant Impacts from Site Clearing** **H**: Restricted habitat with high potential for short range endemic species, or restricted community/s or restricted environment with substrate characteristics (high porosity, connectivity and high humidity/moisture) favourable for subterranean fauna **M**: Moderately restricted habitat with some potential for short range endemic species, or environment with substrate characteristics (high porosity, connectivity and high humidity/moisture) potentially favourable for subterranean fauna. **L**: Common substrates and communities regionally widespread, without substrate characteristics normally favourable for subterranean fauna
Site environment likely to support restricted habit specialist fauna, SRE fauna Substrate/habitat potential suitability for subterranean fauna, (ie fractured rock, karst environment, springs etc)	Some potential associated with the restricted sandstone cliff environments of Perpendicular Head and Emeriau Head, and the calcareous coastal environment south of Middle Lagoon, and limited patches of Vine Thicket vegetation present. Pindan substrate low risk.			**M**	**M:** associated with disturbance to restricted sandstone and calcareous rock substrates and vine thickets.
Visual Landscape Significance	**Visual landscape Significance Assessment**			**Level of Confidence**	**Potential significance of Landscape impacts from development of the site**
Landscape character of hub site and broader context	***Landscape Region****:* The Kimberley ***Character type***: Dampier Tableland ***Landscape context***: The Perpendicular Head node is located within a broad-scale landscape with a landform of gently undulating sand plains with closely spaced linear dunes and dramatic coastal features. Vegetation cover is open woodland with pindan thickets and hummock grass understorey common to the Dampier Peninsula. Numerous creeks dissect the peninsula and mangroves, bays, mud-flats, swamps and sandy beaches occur along the coastline. Grazing has occurred on pastoral leases with evident signs of pastoral/residential infrastructure – roads, fences, out-camps and yards. There are small residential communities, out-camps, localised evidence of mining and exploration and public recreation use in this sub-type. ***View character of this development node***: The landscape is characterised by dramatic coastal dune ridges, rock outcroppings between Perpendicular Head and Emeriau Point, a dramatic beach strand between the headland and Bell Point and diverse vegetation patterns in the coastal influence zone; inland plain horizontal character with largely uniform woodland with few patterns. Tappers Inlet is a coastal feature south of the headland with diverse water/vegetation forms, colours and textures. ***Landscape character significance rating***: *High* coastal and *moderate* inland. ***Comments***: There are several landscapes of cultural significance, Aboriginal settlements and established and potential recreation use areas that limit the suitability of the Perpendicular Head node.			**H**	High ***Suitability rating:*** Low ***Absorption Capability*:** Low to Moderate ***Analysis (+ positive and - negative):*** - high level of visual landscape significance - proximity to marine tour boat routes - proximity to dispersed coastal campsites - established user patterns - low to moderate visual absorption capability - cultural landscape of significance

Degree of evident alteration or change from the 'naturally established' landscape character based on levels of 'naturalness'	***Degree of evident change from naturally established character***: Low on the coast, moderate inland; tracks, outcamps and coastal commercial campsites are evidence of human activity as viewed from some coastal observation positions, but none are seen from the beach strands; exploration roads on grids lines are present inland. ***Naturalness rating***: High		**H**	
Degree and sensitivity of views and seen areas from travel routes and use areas (duration, frequency, position in landscape, number of viewers, distance)	***Viewer positions***: Relatively small number of visitors on tour and cruise boats - often with a special focus on scenic assets and expert interpretation of bio-physical and landscape values and features. Several small outcamps, some with visitor facilities are located within the development node at Bell Point, Mercedes Cove, Middle Lagoon and Neem. The Cape Leveque Road is approximately 25km to the east while a number of local tracks provide access to Tapers Cove, Middle Lagoon, Bell Point, North Head as well as Perpendicular Head. Views are generally filtered by woodland vegetation until nearing the coastline. ***Distance zone****:* foreground, Middleground and background depending on viewer position. ***Duration of view***: Variable. ***Viewer position****:* Variable but generally 'level'. ***Sensitivity Level***: Level 1 – high level of concern from marine viewpoints and moderate concern from low use terrestrial travel routes and minor user nodes. ***Implications***: Development would severely impact on the landscape of distinctive significance due to its sense of remoteness, naturalness, ruggedness and natural diversity, most notably along the coastline. Development would be dominant as viewed by passing pleasure/tour craft and would potentially be seen in the foreground from the Bell Point access track. Development in this landscape would become visually dominant as viewed from a number of established marine and terrestrial use areas and travel routes. Height of the head ridge, coastal dunes and variation in vegetation patterns on the terrestrial plain, could help reduce but not eliminate negative visual impacts resulting from development. Should North Head be recommended for development, implications on the Perpendicular Head precinct would also be of primary consideration due to geographic proximity.		**H**	
Special features and focal points within view of the hub site	Tappers Inlet, Emeriau Point, Chimney Rocks, Embalgun Beach, Perpendicular Head, Pender Bay, Bell Point, Cape Borde, and Weedong Lagoon		**H**	
Remote Area - Quarantine Risks / Hazards from Construction / Operation of development Introducing new species	**Site Context**	**Site Condition and Disturbance Factors**	**Level of Confidence**	**Quarantine - Potential Hazard from Introduction of New Species** **H**: Island, or remote mainland area currently largely free of introduced species and distant from most human vectors **M**: Site has few weeds and limited vehicle access. **L**: Site some development / existing vehicle access / weeds are common and a stock grazing history
Relative quarantine risk from developing/operating Hub at the location	Site has scattered Aboriginal living areas and tourism infrastructure adjacent to it	vehicle access	**H**	**L**
Remote area – potential for future development of Land-based transport or Infrastructure links.			**Level of Confidence**	**Potential for major impacts from off site transport / infrastructure links** **H**: Remote mainland area currently distant from most human vectors **M**: Mainland area currently not serviced by main road access. **L**: Island with no potential for off site impacts. or mainland location close to major roads with existing vehicle access.
Degree of impact from potential future land-based transport or infrastructure links	Site has scattered Aboriginal living areas and tourism infrastructure adjacent to it	vehicle access		**L**
Existing or proposed conservation reserve (inc marine) or Indigenous Protected Area			**Level of Confidence**	**Conservation Reserve Status** **H**: Existing reserve **M**: Recommended Reserve **L**: No reserve proposed
Existing / Proposed Conservation reserve	No Terrestrial reserves proposed			**L**:
Existing / Proposed Marine Reserve	CALM 1994 report marine reserve proposed for Pender Bay			**M**:
Existing / Proposed Indigenous Protected Area				

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