PROPOSED SAND EXTRACTION
LOT 510 OLD LEDGE POINT ROAD, LANCELIN

ENVIRONMENTAL ASSESSMENT

Prepared for

[redacted]

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1.0 INTRODUCTION

Indian Coast Joint Venture (ICJV) proposes to develop 510 Old Ledge Point Road, Lancelin for a lime sand extraction operation.

Bayley Environmental Services was commissioned in September 2020 to carry out site investigations and prepare the necessary applications for approval of the extraction operation.

Lot 510 has an area of approximately 17.4 hectares and is located west of Old Ledge Point Road about 4.1km south of Lancelin. Figure 1 shows an aerial view of the site and surroundings.

This environmental assessment report has been prepared in support of applications by ICJV for a clearing permit, works approval, development approval and extractive industry licence.

2.0 SITE DESCRIPTION

2.1 Geology, Landforms and Soils

The site is located in the Quindalup Dunes system of the Swan Coastal Plain, about 200m to 600m from the ocean. The landform consists of irregular or parabolic calcareous sand dunes ranging in elevation from 1m to 16.5m AHD with slopes ranging from less than 2% to over 60%. Figure 2 shows topographic contours over the site.

The soil consists mostly of calcareous and/or siliceous sands. The sands are generally loose, free-draining and very low in organic content and nutrients. Cemented limestone occurs in places at elevations between -5m and 3m AHD. Previous sand extraction has left some areas of exposed limestone pavement at about 3m AHD in the north-east of the site.

Drilling at ten sites on the perimeter and within the site found a white to pale grey to pale yellow sandy soil profile to between 3.5m and 6m. Limestone was reported in one borehole at a depth of 9.5m (-5.6m AHD) during previous drilling. Figure 2 shows the locations of the drilling sites. Appendix A shows bore logs from the drilling.

2.2 Hydrology

There is no surface water expression within the site. Surface runoff may occur over the exposed limestone areas for short periods during intense rainfall events.

Groundwater occurs at levels of about 0.6m to 1.6m AHD (0.6-12m below ground) beneath the site, moving generally south-west towards the ocean. Measurements in six on-site bores in October 2020 showed groundwater depths of 0.75m to 4.28m in the bores.

Simultaneous measurements in a DWER monitoring bore (Salvado 1B) located 520 east-southeast of the site (Figure 1) enabled the average annual maximum groundwater levels (AAMGL) beneath the site to be calculated. Figure 2 shows the groundwater levels on 15 October 2020 and the AAMGL beneath the site, as contoured with the SURFER 6 surface mapping package.

Combining the calculated AAMGL with detailed spot height data provided by Harley Dykstra enabled depths to the AAMGL to be calculated and mapped as shown on Figure 2.

2.3 Vegetation and Flora

2.3.1 Vegetation Types

The vegetation of the site is mapped as Quindalup Complex by Heddle *et al*. (1980). The Quindalup Complex is associated with the Quindalup Dunes landform system and comprises two alliances: the Strand and Foredune Alliance and the Mobile and Stable Dune Alliance. The vegetation of Lot 510 belongs to the latter, which occurs on dunes slightly more inland and which has a higher diversity of vegetation than the Strand and Foredune Alliance.

Beard (1981) mapped the vegetation of the study area as Association 1007: Coastal heath and thicket on recent dunes.

Ecoscape (2007) surveyed the vegetation and flora of the site in October 2007. The survey found five vegetation communities on the site:

- *Spyridium globulosum* Closed Heath over *Templetonia retusa*, *Rhagodia baccata* and *Acanthocarpus preissii* Low Open Shrubland over *Lepidosperma gladiatum* Very Open Sedgeland;

- *Melaleuca lanceolata* Tall Shrubland over *Melaleuca huegelii* Open Shrubland over *Melaleuca systena* and *Rhagodia baccata* Low Open Shrubland over *Baumea juncea* and *Ficinia nodosa* Sedgeland;

- *Acacia rostellifera* Tall Open Scrub over *Spyridium globulosum, Acacia truncata* and *Rhagodia baccata* Shrubland over *Acanthocarpus preissii* Low Open Shrubland over **Bromus diandrus* Low Open Grassland and *Hardenbergia*; and

- *Melaleuca systena, Santalum acuminatum* and *Cryptandra mutila* Closed Low Heath over *Lomandra maritima* and *Conostylis pauciflora* subsp. *euryrhipis* Very Open Herbland.

Plantecology (2021) resurveyed the vegetation in October 2020, mapping the following associations on the site:

- *Melaleuca systena* Low Shrubland

Low shrubland of *Melaleuca systena, Olearia axillaris* and *Spyridium globulosum* with *Cryptandra mutila* over a herbland *of Conostylis candicans* subsp. *calcicola*, *Conostylis ?pauciflora* subsp. *euryrhipis* and *Hemiandra glabra* on grey-cream sand on dunes.

- *Acacia rostellifera* Tall Shrubland

Tall shrubland of *Acacia rostellifera, Spyridium globulosum* and *Santalum acuminatum* over a herbland of *Acanthocarpus preissii, Lomandra maritima* and *Rhagodia baccata* subsp. *baccata* on grey-cream sands of flats and swales.

- *Spyridium globulosum* Closed Shrubland

Closed shrubland of *Spyridium globulosum, Melaleuca huegelii* subsp. *huegelii* and *Templetonia retusa* over a herbland of *Lepidosperma gladiatum, Rhagodia baccata* subsp. *baccata* and *Acanthocarpus preissii* on grey-cream sands of swales.

- *Melaleuca lanceolata* Low Closed Forest

Closed low forest of *Melaleuca lanceolata* over Open Shrubland of *Melaleuca huegelii* subsp. *huegelii* over a sedgeland of *Ficinia nodosa* and *Lepidosperma pubisquameum* on grey-cream sands of swales.

Figure 3 shows the Plantecology (2021) vegetation mapping. The full Plantecology (2021) report is attached in Appendix B.

2.3.2 Vegetation Condition

Ecoscape (2007) assessed the vegetation condition of the site as ranging from Degraded in the previously quarried and cleared areas to Excellent in the uncleared areas. Weed invasion was minor, with no significant areas exceeding 5% weed cover.

The Plantecology (2021) survey found that the condition of the vegetation had improved in parts. Much of the *Acacia rostellifera* Tall Shrubland, previously mapped as Degraded, is now in Good or Very Good condition, and some of the previously quarried areas have regenerated enough to new be mapped as Good condition. A small blowout has developed at the northern end of the site and is in Completely Degraded condition.

Figure 4 shows the vegetation condition mapping by Plantecology (2021).

2.3.3 Flora

Ecoscape (2007) found a total of 41 native plant species from 23 families on the site. Plantecology (2021) found 70 native species, making a total of 76 native species across the two surveys.

The Ecoscape and Plantecology surveys also found eleven introduced species within the site. None of the introduced species is listed as a Declared Pest under the WA Biosecurity and Agriculture Management Act 2007.

Appendix C shows a consolidated flora species list from the two surveys.

2.3.4 Rare and Significant Flora

Ecoscape (2007) found two listed Priority Flora species, *Stylidium maritimum* (P3) and *Conostylis pauciflora* ssp. *euryrhipis* (P3) on the site. Priority species are not formally protected. No Declared Rare Flora (DRF) were found on the site.

Plantecology (2021) found 22 individual plants of *Stylidium maritimum* at six locations in the *Melaleuca systena* Low Shrubland, including in some locations not found by Ecoscape, but did not find it in the northern half of the site. Plantecology (2021) also found *Conostylis ?pauciflora* subsp. *euryrhipis* in numerous locations throughout the *Melaleuca systena* Low Shrubland as well as parts of the *Acacia rostellifera* Tall Shrubland.

2.3.5 Floristic Communities

Based on the floristic data, Ecoscape (2007) tentatively assigned the vegetation to one or both of two floristic community types (FCTs), as identified by Gibson *et al.* (1994):

- FCT 29a Coastal shrublands on shallow sands; and
- FCT 29b Acacia shrublands on taller dunes.

Plantecology (2021) analysed the current and previous floristic data for the site using hierarchical agglomerative clustering. The data for the Swan Coastal Plain regional survey (Gibson *et al.*, 1994) was downloaded from the NatureMap website and updated to reflect current nomenclature. The new data from the current survey were added to the matrix one plot at a time to remove any effect of spatial correlation between the new plots. Each new dataset was then analysed calculating the Bray-Curtis distance coefficient (or resemblance measure) and the flexible beta linkage method (beta = -0.1). Assignment of the Old Ledge Point Rd plots was to the nearest distinct group by inspection of the resulting dendrogram. The analyses were undertaken using R packages Cluster and Vegan.

The Plantecology (2021) analysis again indicated the vegetation units within the site are either FCT 29a ‘Coastal shrublands on shallow sands’ or FCT 29b ‘Acacia shrublands on taller dunes’. This result is consistent with the locality, soils and position relative to the coast on the Swan Coastal Plain.

2.3.6 Threatened and Priority Ecological Communities

Both FCT 29a and FCT 29b are listed as Priority 3 Ecological Communities under Western Australian State policy. Neither is listed as a Threatened Ecological Community (TEC), and the site vegetation did not match any of the 69 listed TECs at the time of the survey. A search of the DBCA Threatened Ecological Communities Database by Ecoscape in 2007 found no records of TECs within 10km of Lot 510.

Gibson *et al.* (1994) rated both FCT 29a and FCT 29b as Poorly Reserved (known from a single National Park or A-Class Nature Reserve) and Susceptible (liable to be modified or destroyed by human activities or vulnerable to new threatening processes). The Gibson *et al* (1994) study area extended only as far north as Seabird, and several large reserves in the Lancelin area including the Lancelin Defence Training Area, Nilgen Nature Reserve and other Crown lands are likely to also support these community types.

2.3.7 Local and Regional Representation

Table 2.1 summarises the status of the site vegetation types State-wide, in the Swan Coastal Plain Bioregion, the Shire of Gingin and within 15km of the site. The data in the table are sourced from the following:

- 2013 Native Vegetation extent by Vegetation complexes on the Swan Coastal Plain south of Moore River (Local Biodiversity Program, 2013).
- CAR Analysis Report 2009. WA Department of Environment & Conservation, Perth www2.landgate.wa.gov.au/slip/portal/services/files/carreserveanalysis2009.xls.
- Vegetation Extent-By-Type GIS database (Department of Agriculture, 2005).
- Swan Coastal Plain Vegetation Complexes GIS database (DPaW, 2016).
- CALM Estate GIS database (CALM, 2009).

Table 2.1 Remnant Vegetation Status

Vegetation Unit	*Pre-European Extent (km^2)*	*Current Extent (km^2)*	*% Remaining*	*% In Secure Reserves*
Remnant Vegetation				
Swan Coastal Plain Bioregion	1501	588	39	13
Shire of Gingin	320	177	55	23
15km Radius	370	155	42	19
Quindalup Complex (Heddle *et al.*, 1980)				
Swan Coastal Plain Bioregion	385	213	55	14
Shire of Gingin	164	122	74	1.6
15km Radius	96	81	84	2.7
Guilderton 1007 (Beard, 1981)				
Swan Coastal Plain Bioregion	30.1	21.6	72	8.5
Shire of Gingin	15	12.7	85	8.4
15km Radius	73	33.8	56	0.1

The table shows that the vegetation types present in Lot 510 and remnant vegetation overall are well represented both locally and regionally, but that their formal reservation

status is moderate to poor. Figure 5 shows the local and regional representation and reservation.

2.4 Fauna

A search of the Department of Environment and Conservation Threatened and Priority Fauna Database by Ecoscape (2007) identified two Schedule One Fauna Species (Fauna that is rare or likely to become extinct) (Western Australian Government 2006) as occurring within 10 km of Lot 510. They are:

- Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*); and
- Lancelin Island Skink (*Ctenotus lancelini*).

Carnaby's Black-Cockatoo is listed as Endangered under the 2007 IUCN Red List of Threatened Species (IUCN 2007), Threatened under the Western Australian Wildlife Conservation Act (Western Australian Government 2006) and Endangered under the EPBC Act (Australian Government 1999).

The Lancelin Island Skink is listed as Vulnerable under the 2007 IUCN Red List of Threatened Species (IUCN 2007), Vulnerable under the Western Australian Wildlife Conservation Act (Western Australian Government 2006) and Vulnerable under the EPBC Act (Australian Government 1999). Although the Lancelin Island Skink is recorded as occurring within 10 km of Lot 510, there is only one mainland sighting, directly opposite the island (Australian Government 1999).

Ecoscape (2007) carried out a reconnaissance fauna survey of Lot 510 searching for evidence of and habitats for listed Threatened Fauna, in particular the two most likely species, Carnaby's Black Cockatoo and the Lancelin island Skink.

The survey found no evidence of either species on the site, and no feeding, roosting or breeding habitat for Carnaby's Black Cockatoo. The report concluded that there was no realistic likelihood of either species being present.

2.5 Landscape

The site is elevated and the highest parts are visible from up to 10km away. The visibility will decrease substantially as the site levels are reduced by sand extraction.

The site is in an area that already hosts several sand quarries, including a large operation owned by Optima Lime immediately to the south. Therefore the proposed quarry on Lot 510 would be in keeping with existing activities in the surroundings.

2.6 Aboriginal Heritage

The Department of Planning Lands & Heritage (DPLH) online Aboriginal Sites Database shows one large non-registered Aboriginal heritage site, No. S00542:Ledge Point (Site ID 3237), covering a rectangular area of 100km^2 around the project site. Site S00542 is described as a "camp site and water source" and is listed in the database as "Stored Data". Appendix D shows the site report.

Non-registered sites are not formally protected and no permission under the Aboriginal Heritage Act 1972 is required to disturb them. The presence of other recent developments in the vicinity, including the extraction operation to the immediate south, suggests that the site is not considered significant.

3.0 PROPOSED SAND EXTRACTION

3.1 Available Sand Resource

The quantity of sand available for extraction depends largely upon the depth to which excavation can occur, which in turn is determined by the height of the water table. The Shire of Gingin's *Extractive Industries Local Law 2004* does not set a maximum depth of excavation or minimum clearance above the groundwater table for extractive industries, although it does give the Shire power to impose conditions on the depth of excavation.

A major consideration is the need to avoid creating open water bodies. For this reason, it is proposed to limit the depth of excavation to the level of the AAMGL. Following the replacement of topsoil, this will result in a minimum 0.3m clearance above the AAMGL and avoid the creation of surface water bodies.

The groundwater measurements and modelling carried out to date suggest that the AAMGL sits at between about 1m and 1.6m AHD across the site, meaning that the elevation of the quarry floor would be between about 1m AHD in the west and 1.6m AHD in the north-east.

Preliminary estimation with SURFER 6 using the mapped AAMGL contours and detailed spot heights suggest that the maximum sand resource available within Stage 1 (Figure 6) is about 244,000 cubic metres, while Stage 2 contains an estimated 114,000m^3. These volumes assume that all of the resource is of suitable grade except for 0.3m of topsoil.

Sample analysis at three sites within Lot 510 by LiquidlabsWA has shown that the lime sand on Lot 510 is of very high quality, with average calcium content across the three samples of 32.3%, particle size mostly (>60%) less than 0.25mm and weighted average acid neutralising value of 94.3%. Appendix E shows the test results.

3.2 Area and Depth of Excavation

The quarry will be excavated to a minimum level of between 1 m and 1.6m AHD, depending on the depth of the resource and the occurrence of limestone. This will result in an excavation depth of up to 12 metres. Because the sand resource is contained within sand dunes, the quarry will produce a final landform that is level with the surroundings to the east and west.

The extraction area will be set back at least 40m from Old Ledge Point Road and 20m from all other lot boundaries.

Figure 6 shows the existing and proposed final contours of the quarry.

3.3 Access Roads

Access to the site will be from Old Ledge Point Road via a private driveway. The turnoff from Old Ledge Point Road has clear lines of sight for about 550m to the north and 200m to the south.

3.4 Duration and Staging of Extraction

The extraction will be undertaken in two main stages, with the first stage covering about two thirds of the resource. The extraction will begin close to Old Ledge Point Road in the north-east of the site and proceed west. The second stage is likely to begin at the same general location and proceed south. Within each stage, extraction will proceed progressively, with rehabilitation taking place behind the extraction front. The active working area at any one time will be no more than 1ha. Figure 6 shows the proposed staging of the quarry.

Demand for lime sand is highly seasonal, with peak demand typically occurring between January and April. Operations at the quarry will vary according to demand, with output ranging from near-zero in winter up to 10,000-12,000 tonnes per week in summer.

The quarry will initially produce about 75,000 tonnes per annum, increasing according to demand up to a maximum of 100,000 tpa. The total lifetime of the quarry will be in the order of five years.

3.5 Method of Excavation

A wheeled loader will be used to strip the topsoil/overburden to a depth of up to 0.3m. The topsoil will be either windrowed (to a height of less than 2m) for later rehabilitation or placed directly onto previously quarried areas.

The loader will then be used to excavate the sand and load it directly into trucks. In busy periods two loaders may be used, with one excavating the sand and the other loading trucks.

3.6 Overburden Management

Up to 21,000m^3 of topsoil will be removed to a depth of up to 0.3m to expose the sand resource. Initially, the topsoil will be windrowed for later use in rehabilitation. Later, as the pit progresses, stripped topsoil will be placed directly onto newly completed areas of the pit.

3.7 Plant and Equipment

Two wheeled loaders (CAT 966H or similar) will be kept at the site and used to excavate and load the sand.

A diesel-powered mobile screening plant (Kleeman Mobiscreen MS952EVO or similar) will be used as required to screen coarse limestone fragments from the sand. The screening plant will have a capacity of approximately 500 tonnes per hour, although the actual throughput is expected to be less than 3,000 tonnes per day. Details of the Kleeman Mobiscreen MS952EVO are attached in Appendix F.

On-site refuelling of the loaders and screening plant will be carried out by a mobile tanker. On-site maintenance will be limited to routine oil changes. Major maintenance will be carried out off-site. No fuel or oils will be stored or discharged on site.

3.8 Hours of Operation

Sand extraction will occur between the hours of 6am - 6pm Monday to Friday and 6am - 12pm or 6pm Saturday, excluding public holidays. The intensity of the quarry operation will depend on sand demand. The busiest period is expected to be summer, when the demand for agricultural limesand is highest.

3.9 Water Demand and Supply

Water for dust suppression will be applied as necessary by a 30,000 litre water truck and sourced from another pit owned by the operator or from a public standpipe. Given the quarry's small size and distance from residences, little dust suppression watering is expected to be necessary.

3.10 Workforce

Up to three staff will be on site at any time, including two in the quarry and one in a transportable site office. Staff ablutions will be provided by a self-contained temporary facility that will be pumped out regularly by a licensed tanker operator. No on-site effluent disposal will occur.

3.11 Truck Movements

Sand will be transported from the quarry by pocket road trains in loads of up to 62 tonnes. Up to 180 truck movements per week (35 per day) will be required to export the sand. Old Ledge Point Road already carries heavy trucks from the adjacent quarry and is well able to handle the extra traffic.

3.12 Drainage Management

The highly porous sands of the site will generate little or no runoff under any but the most extreme rainfall conditions. Any runoff that does occur will be captured in the pit, where it will infiltrate to the groundwater within a few hours.

Runoff from the gravel access road will be allowed to drain to the roadside, where it will infiltrate.

3.13 Noise and Dust Management

The project area is more than 1.7km from the nearest residence and so noise and dust from the extraction operation are unlikely to be significant issues. This is supported by the previous approval of the extraction operations to the north-west and south-west.

Dust may be generated by excavation, sand screening, truck loading and wind action on exposed surfaces. The main potential for dust generation will occur during the stripping of topsoil, which contains fine sand and particulate organic matter. The potential for dust generation during excavation, screening and loading of sand, which has much more evenly sized particles, will be much lower.

No topsoil stripping will occur when the wind speed is greater than 20km/hr. No excavation, screening or truck loading will occur in winds of greater than 40km/hr. Progressive rehabilitation of quarried areas will mean that no more than 1ha of sand is exposed at any one time, thus reducing the potential for dust generation.

Mechanical equipment used at the quarry will include front-end loaders, a mobile screening plant and trucks carrying the sand. These will be fitted with standard noise attenuation equipment. No blasting or rock-breaking will be required.

The quarry is remote from noise-sensitive premises. The nearest neighbouring residence is more than 1.7km to the north and screened from the quarry by terrain and vegetation. Therefore, noise nuisance is not expected to be an issue.

3.14 Dieback and Weed Management

Dieback caused by *Phytophthora cinnamomi* generally does not occur in calcareous sands due to the high alkalinity of the soils (e.g. WA Govt, 2010). Dieback hygiene measures are not required of other lime sand quarries in the vicinity, such as the Optima Lime operation to the immediate south and the Cooljarloo limesand quarry in Indian Ocean Drive.

Weed introduction and spread is a risk with any undertaking involving the movement of topsoil in native vegetation areas. In this case the risk is low as a result of the limited area of operation and the absence of any importation of soil.

To minimise the risk of importation of plant diseases or weeds into the site, all machinery (including loaders, graders, screening plant, trailers etc.) will be cleaned down using water jets or compressed air and inspected prior to entry to the site. Trucks transporting sand will be restricted to designated areas of the site and will not access areas where topsoil is stored or in situ. No soil or plant material (other than seed from dieback-free sources, if required) will be imported to the site.

3.15 Rehabilitation and Final Land Use

Rehabilitation will consist of terrain reshaping and the re-establishment of native vegetation. Rehabilitation will be progressive and will take place immediately behind the extractive front of each extraction block. The topsoil from each extraction block will be saved and re-spread over the surfaces of restored landforms to allow for the regrowth of native vegetation from the seed bank in the topsoil.

The landform at the end of extraction will be a flat or gently sloping pit floor with a sandy soil texture. The pit floor will be left smooth and even to prevent ponding of surface water and erosion. The rear and sides of the pit will be battered where necessary to a slope of less than 1:3. Figure 7 shows a conceptual profile of the completed land surface.

Rehabilitation will comprise battering (if necessary) to a slope of less than 1:3, followed by spreading of topsoil and vegetation debris. Topsoil will be applied to the completed pit surface using a wheeled loader and spread using a grader.

Stockpiled vegetation debris will be spread over the soil surface to provide a seed source. Some debris may be burned *in situ* to break seed dormancy and create ash beds for germination.

These rehabilitation activities will be completed within one month of the completion of quarrying in each extraction block.

Regrowth of native vegetation in the rehabilitated area will be monitored visually once each year for two years after the completion of the initial rehabilitation works. Records of the monitoring, including photographs of the rehabilitated area, will be made available to the Shire of Gingin.

If at the end of two years the regrowth is not seen to be progressing satisfactorily, direct seeding with local native species (selected from the species list in Appendix C) may be undertaken.

3.16 Public Safety

The excavation area will be fenced with ringlock wire to discourage unauthorised access. Warning signs will be fixed to the fence at no more than 200m spacing in accordance with the Shire of Gingin Extractive Industries Local Law 2004. Due to the absence of any deep excavation, the site will not pose a high risk to the public except in the immediate vicinity of operating machinery.

No explosives or other hazardous materials will be stored or used on the site.

4.0 ENVIRONMENTAL ASSESSMENT

4.1 Vegetation Clearing

The full quarrying programme will require the clearing of about 11.2 hectares of native vegetation in degraded to excellent condition. About 6.9ha will be cleared in Stage 1, with another 4.3ha to be cleared in Stage 2. The owner will initially apply for a clearing permit for Stage 1.

4.2 Assessment Against the Clearing Principles

a) Native vegetation should not be cleared if it comprises a high level of biological diversity.

Summary: Proposal is not likely to be at variance to this principle.

The wording of this principle suggests that, to be regarded as having a "high level" of biological diversity, then the diversity of the vegetation should be relatively high compared to other vegetation, either of the same type or of different types.

Ecoscape (2007) and Plantecology (2021) together found 76 native flora species on the site. Ecoscape surveyed four 100m^2 plots, while Plantecology (2021) surveyed five plots. The number of native species per plot ranged from 10 to 28, with an average of 19.3 species per 100m^2.

Other surveys in the general area have recorded species richness as follows:

- One Tree Botanical (2020) surveyed fifteen 100m^2 plots in Beard Association 1007 and Quindalup Complex at Two Rocks, for an average species richness of 29.4 species per 100m^2. The 12ha site yielded a total of 99 native species.

- Emerge Associates (2015) surveyed 26 plots in Beard Association 1007 and 19 in Quindalup Complex at Seabird with the following results:

  - Total native species: 179 (363ha)

  - Association 1007: Range 15 – 44 species per 100m^2
    Average 24

  - Quindalup Complex Range 15 – 32 species per 100^2
    Average 21.5

These results suggest that the vegetation of Lot 510 has relatively low diversity compared with the other examples. This is likely due at least in part to the previous sand quarrying activity over part of the site and its previous inferred use as unimproved grazing land.

The Quindalup Complex has been previously noted (e.g. Cresswell & Bridgewater, 1984) as having the lowest species diversity and structural complexity of the vegetation systems on the Swan Coastal Plain, due to factors including the salt content of the air and the young age and higher fertility of the soils.

Ecoscape (2007) and Plantecology (2021) found two Priority 3 flora taxa, *Stylidium maritimum* and *Conostylis pauciflora* subsp. *euryrhipis*, on Lot 510 but no listed threatened flora species.

b) Native vegetation should not be cleared if it comprises the whole or part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia.

Summary: Proposal is not likely to be at variance to this principle.

Despite an intensive site survey by Ecoscape (2007) there was no indication of the presence of the two potential threatened fauna species, Carnaby's Black-Cockatoo and the Lancelin Island Skink.

Carnaby's Black-Cockatoo occurs in woodland, shrubland or Kwongan heath, feeding on Hakea, Dryandra or Banksia species (Department of Environment and Conservation 2007), none of which were found on Lot 510. It is therefore unlikely that Lot 510 could be considered as habitat for this species.

The Lancelin Island Skink is known to occur on Lancelin Island and has been reported from one specimen on the mainland directly opposite the island. Despite intensive trapping, no further animals have been captured on the mainland (Australian Government 1999).

Few animals were recorded as being present during the surveys. A Western Grey Kangaroo (*Macropus fuliginosus*) was disturbed during the survey, and Emu (*Dromaius novaehollandiae*) scats were observed. Reptiles, probably snakes, were heard in dense sedgeland, however no positive identifications could be made. There were few bird calls heard, and bird species observed during the daylight survey were limited to common species including Singing Honeyeater and Willie Wagtail.

c) Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, rare flora.

Summary: Proposal is not likely to be at variance to this principle.

No Declared Rare Flora or Threatened Flora listed under the Western Australian Wildlife Conservation Act 2006 or the Commonwealth EPBC Act 1999 were found by either the Ecoscape (2007) or Plantecology (2021) surveys, and none are considered likely to be present.

d) Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of, a threatened ecological community.

Summary: Proposal is not likely to be at variance to this principle.

No Threatened Ecological Communities were found in Lot 510 by the Ecoscape (2007) or Plantecology (2021) surveys, although the two Floristic Community Types (FCTs) assessed as being present are both listed as Priority 3 Ecological Communities by the DBCA.

e) Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared.

Summary: Proposal is not likely to be at variance to this principle.

Table 2.1 shows that the vegetation types present in the application area, and remnant vegetation overall, are generally well represented in the Swan Coastal Plan Bioregion, the Shire of Gingin and within a 15km radius of the site. All have more than 39% of their pre-European extent remaining locally and regionally. The level of secure reservation in some cases is low, with the Quindalup complex being poorly reserved in the Shire of Gingin, and both it and Beard Association 1007 very poorly reserved within 15km of the site. Nonetheless, the level of representation shows that ample opportunities for further reservation exist, both in the Shire of Gingin and within 15km of the site.

f) Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.

Summary: Proposal is not likely to be at variance to this principle.

The application area is located on elevated dry land. The nearest mapped wetland in the DBCA Geomorphic Wetland Database is Karakin Lake, located 10.3km to the east. The application area contains no wetland-dependent or riparian vegetation.

g) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.

Summary: Proposal is not likely to be at variance to this principle.

Land degradation may be taken to mean erosion, salinisation, nutrient leaching or other events that reduce the capability of the land or other areas downgradient to support biological production.

The application area is situated on elevated soils with no significant risk of salinisation. After quarrying, the site will be rehabilitated to native vegetation.

The proposed sand extraction operation will begin with clearing vegetation and stripping topsoil to a depth (nominally) of 300mm. The vegetation debris and topsoil will be windrowed for use in rehabilitation. The windrows will be watered as necessary to minimise dust generation and erosion. The underlying sands are coarser with low organic content and are much less susceptible to erosion.

h) Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.

Summary: Proposal is not likely to be at variance to this principle.

There are no conservation areas near the application area. The closest DBCA-managed reserves are the Lancelin and Edwards Islands Nature Reserve, located 4.6km north-west of the site, and the Nilgen Nature Reserve, 7km to the north-east. The proposed clearing will have no effect on either of these reserves.

i) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.

Summary: Proposal is not likely to be at variance to this principle.

The proposed sand extraction operation will be limited to above the average annual maximum groundwater level. The operation will not involve the use of any chemicals, fertilisers or other potentially contaminating materials.

Refuelling of machinery on site will be carried out by a mobile tanker. No fuel, oils or other environmentally hazardous materials (e.g. pesticides) will be stored on site.

Machinery used on the site will be properly maintained to prevent leakage of oils, fuel and hydraulic fluid. In the unlikely event of a spill or significant leak, the spilled fluid and

any spill-affected soil will be cleaned up and placed in a sealed container or removed from the site within 24 hours.

j) Native vegetation should not be cleared if clearing the vegetation is likely to cause or exacerbate the incidence or intensity of flooding.

Summary: Proposal is not likely to be at variance to this principle.

The application area is situated on elevated ground which is not at risk of flooding.

5.0 REFERENCES

Beard J.S. (1981). *Vegetation Survey of Western Australia, Swan 1:1,000,000 Vegetation Series*. University of Western Australia Press.

Ecoscape (Australia) Pty Ltd (2007). *Lot 510 Old Ledge Point Road, Lancelin*. Draft report prepared for Gray & Lewis Land Use Planners, Perth.

Emerge Associates (2015). *Environmental Assessment and Justification Report: Lot 2 on Plan 10531 Scheme Amendment*. Prepared for Golden beach (WA) Pty Ltd, Perth.

Gibson N., Keighery B.J., Keighery G.J., Burbidge A.H. & Lyons M.N. (1994). *A Floristic survey of the southern Swan Coastal Plain*. Unpublished Report for the Australian Heritage Commission prepared by Department of Conservation and Land Management and the Conservation Council of Western Australia (Inc.).

Heddle E.M., Loneragan O.W. & Havel J.J. (1980). Vegetation Complexes of the Darling System, Western Australia. In: *Atlas of Natural Resources Darling System, Western Australia*. Department of Conservation and Environment, Perth.

Local Biodiversity Program (2013). *Native Vegetation extent by Vegetation complexes on the Swan Coastal Plain south of Moore River.* Western Australian Local Government Association, Perth.

One Tree Botanical (2020). *Two Rocks beach Access Way: Flora and Vegetation Survey – Detailed and Targeted.* Prepared for the City of Wanneroo.

WA Govt (2010). *Performance Assessment of Phytophthora Dieback Management on Lands Vested in the Conservation Commission of Western Australia*. Conservation Commission of WA, Crawley.

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Figures

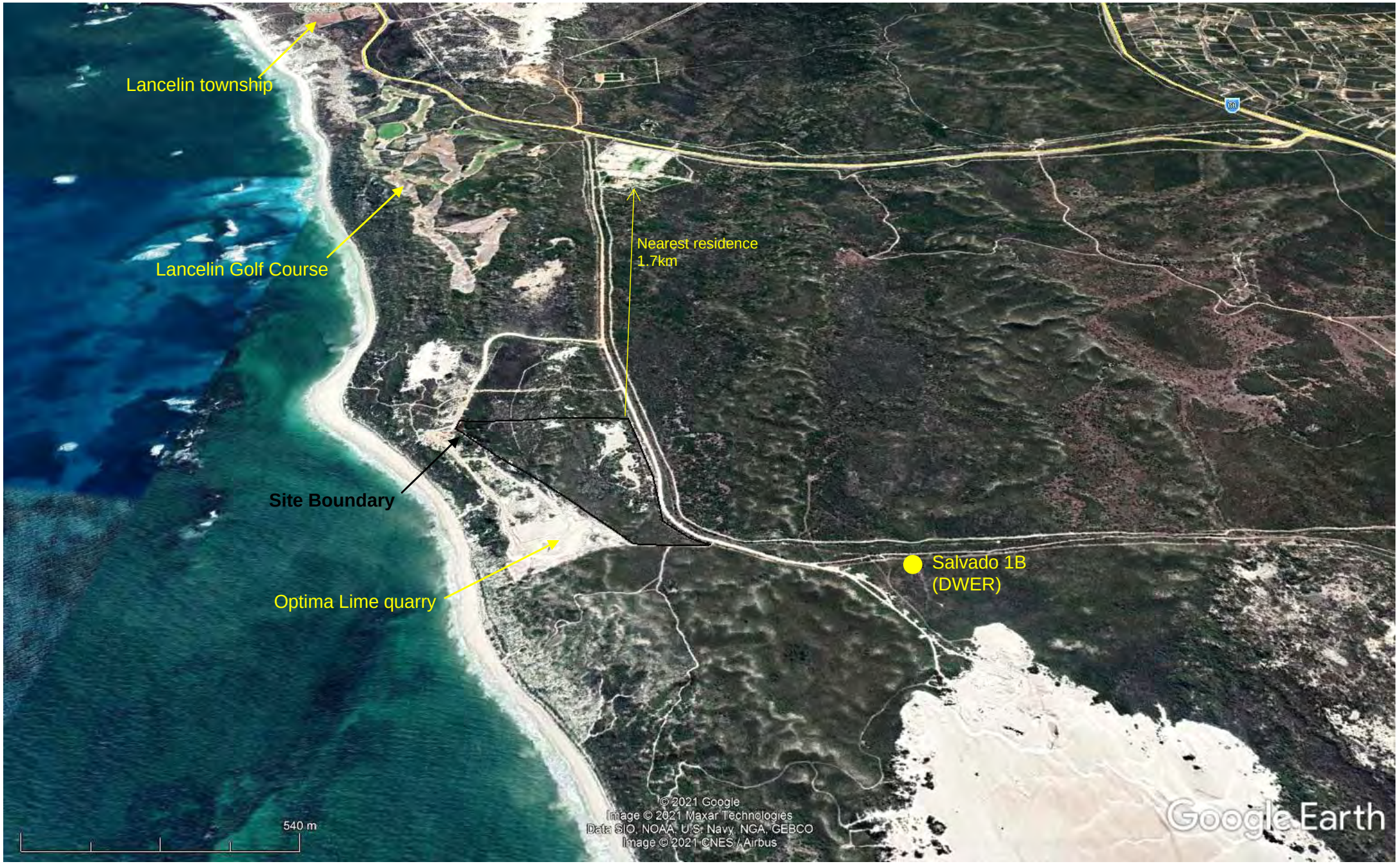

Figure 1

THE SITE AND SURROUNDINGS

bayley environmental services

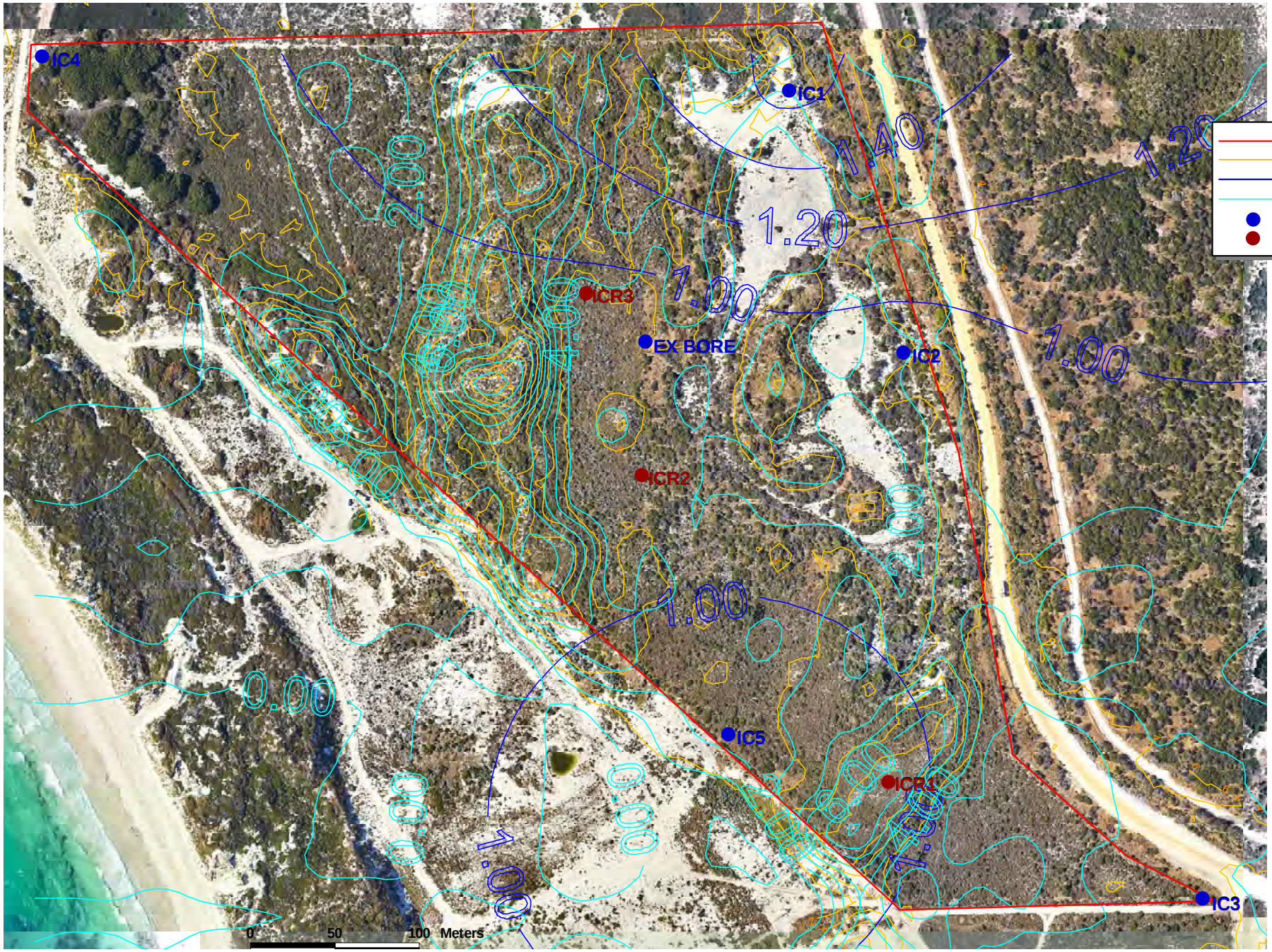

Figure 2

TOPOGRAPHY AND HYDROLOGY

bayley environmental services

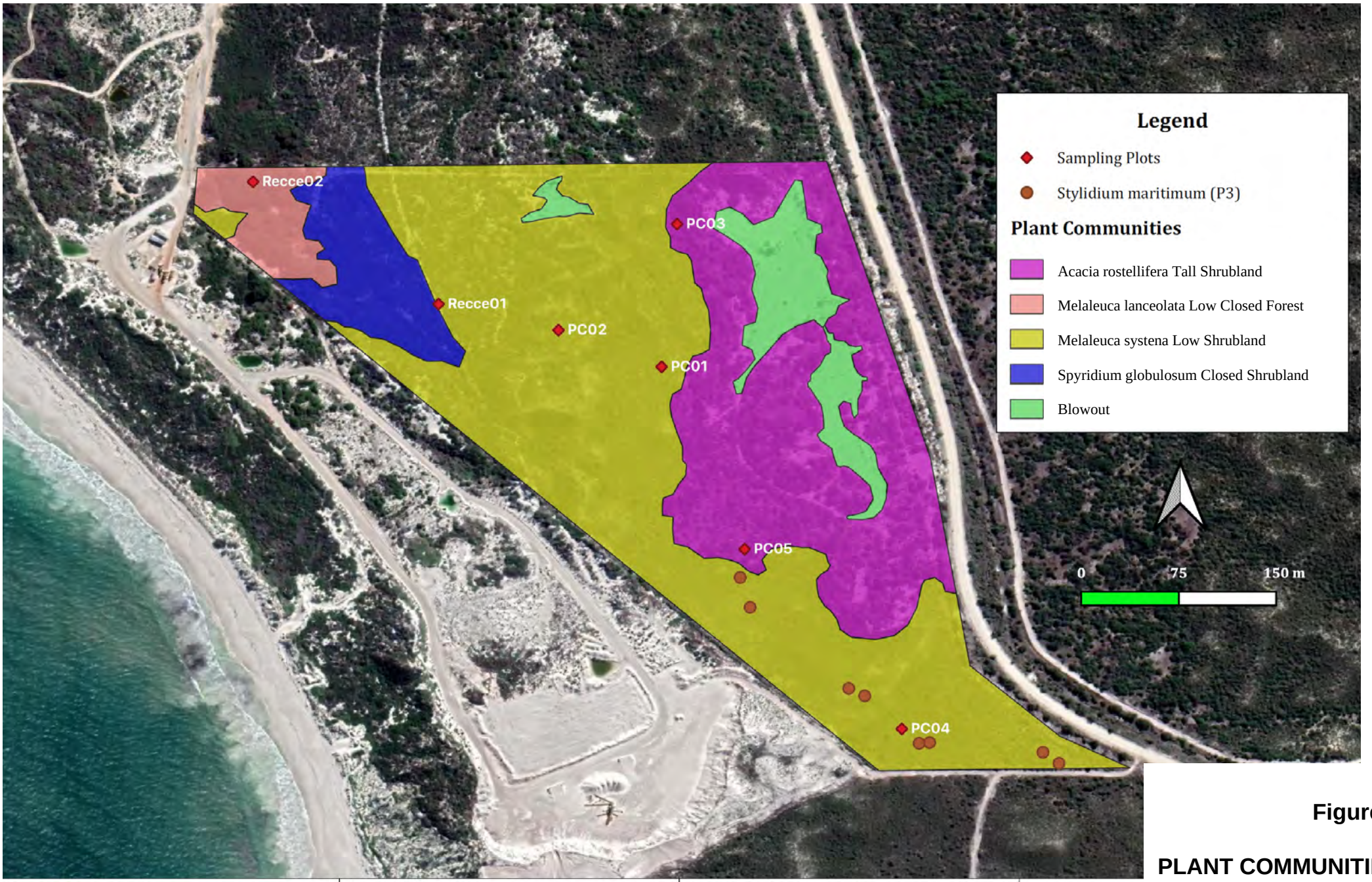

Figure 3

PLANT COMMUNITIES

Plantecology CONSULTING

50 New Cross Rd
Kingsley WA 6026

Scale: 1:3 750
Original Size: A4
Basemap Source: Google Satellite
Datum: GDA94
Projection: EPSG4283

Client: Bayley Environmental Services
Project: Old Ledge Point Rd Vegetation Survey
Location: Lot 510 Old Ledge Point Rd, Lancelin
Author: S. Chalwell
Drawn: S. Chalwell

bayley environmental services

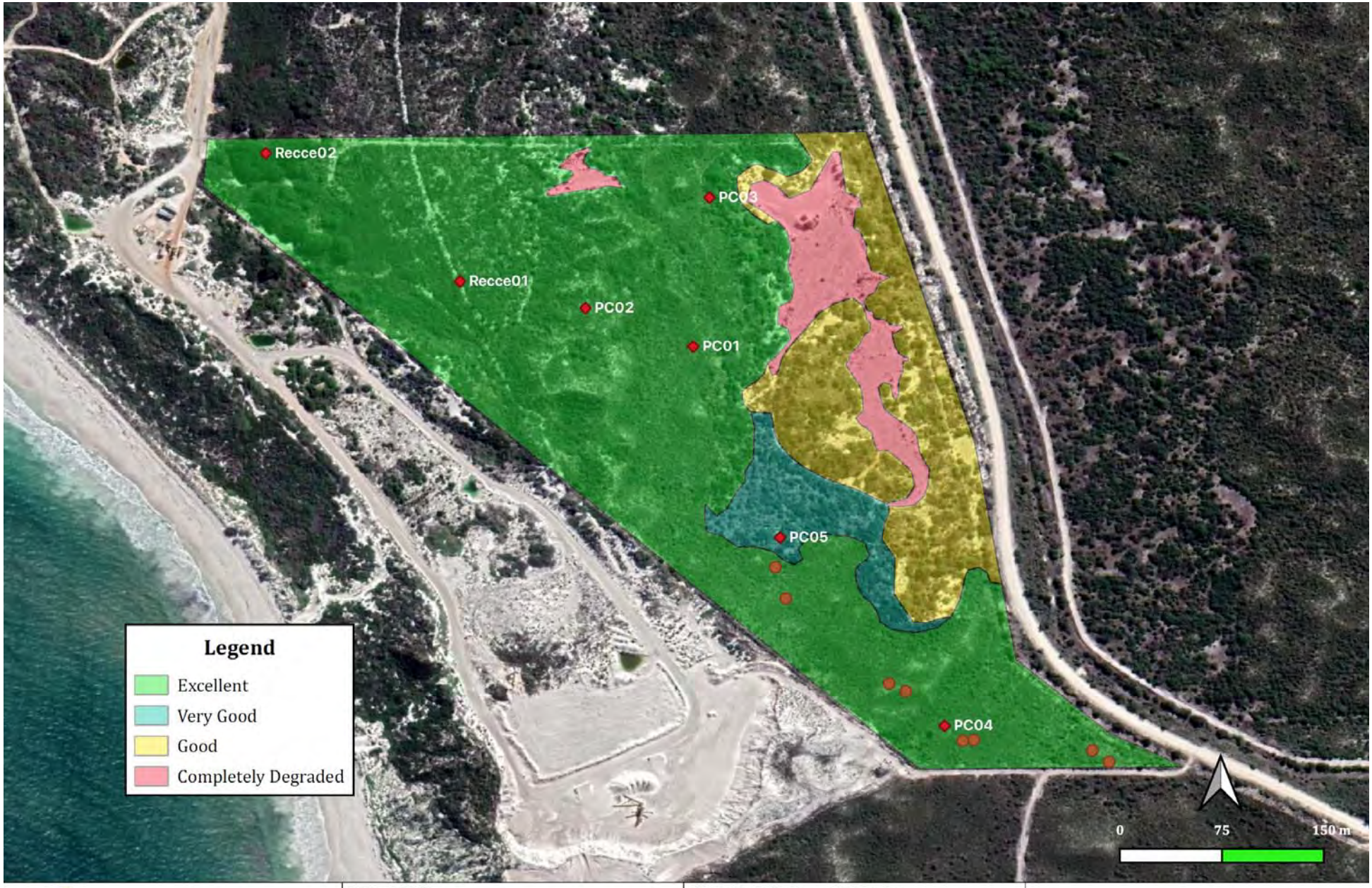

Figure 4

VEGETATION CONDITION

Plantecology CONSULTING

50 New Cross Rd
Kingsley WA 6026

Scale: 1:3 750
Original Size: A4
Basemap Source: Google Satellite
Datum: GDA94
Projection: EPSG4283

Client: Bayley Environmental Services
Project: Old Ledge Point Rd Vegetation Survey
Location: Lot 510 Old Ledge Point Rd, Lancelin
Author: S. Chalwell
Drawn: S. Chalwell

bayley environmental services

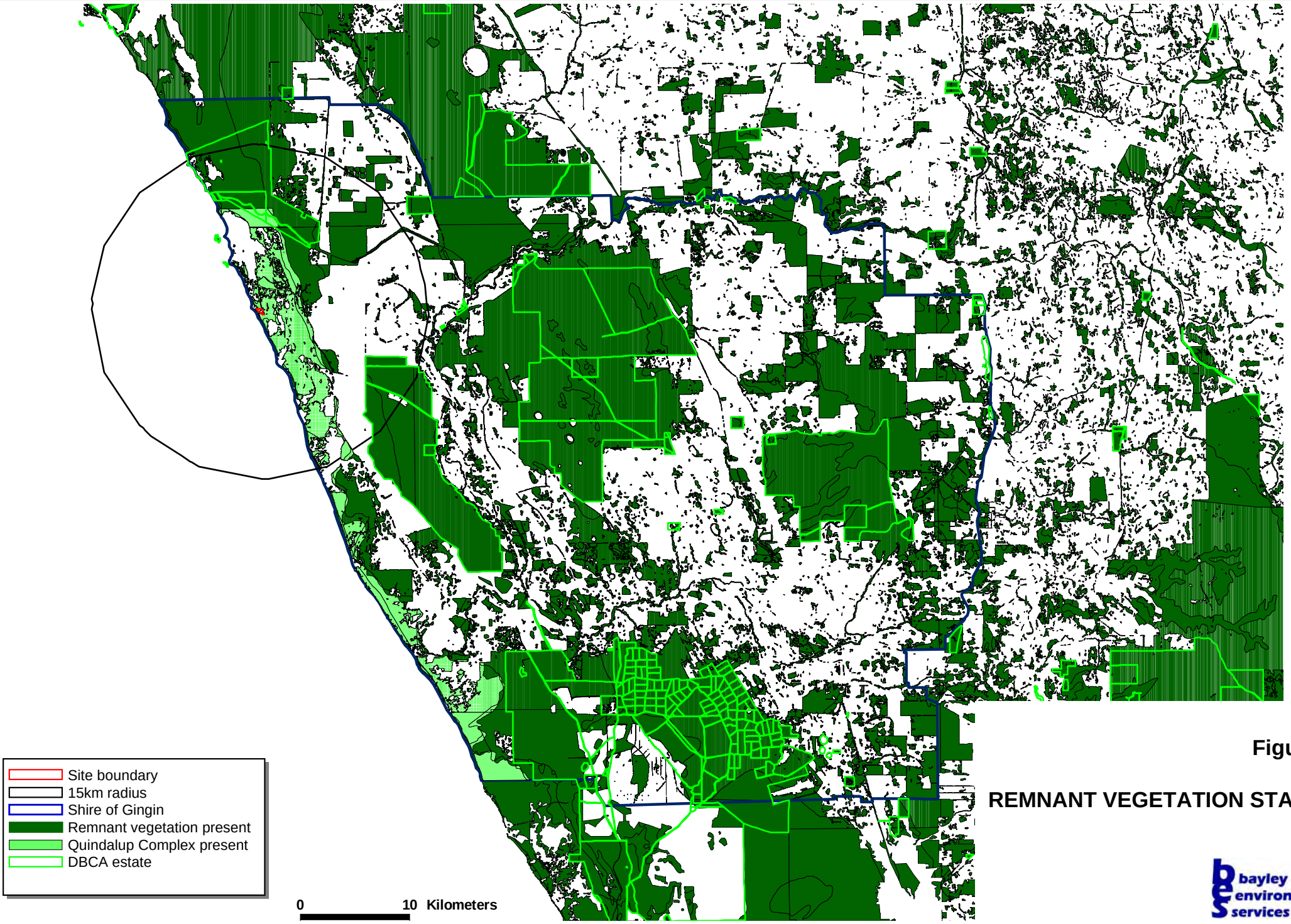

Figure 5

REMNANT VEGETATION STATUS

bayley environmental services

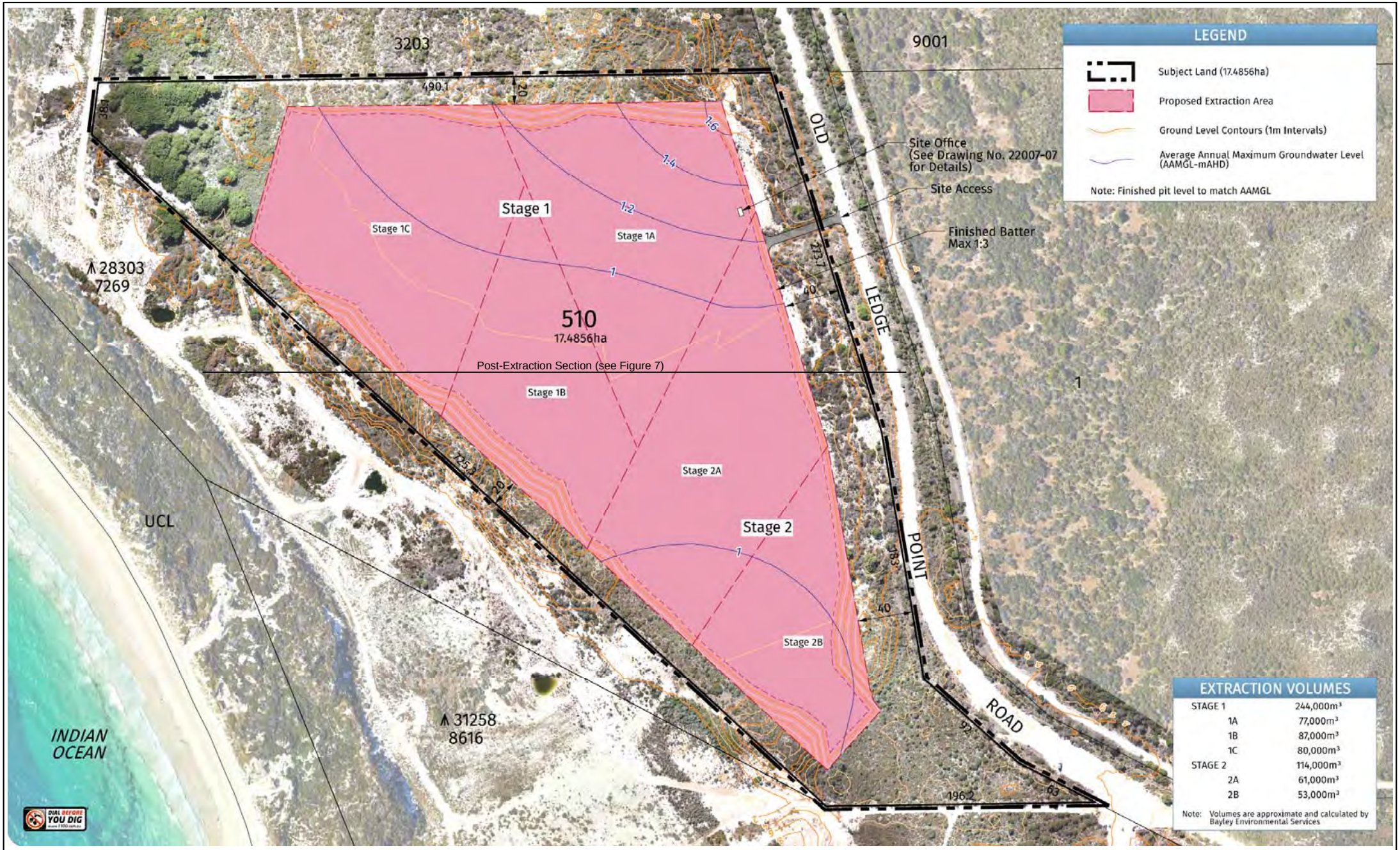

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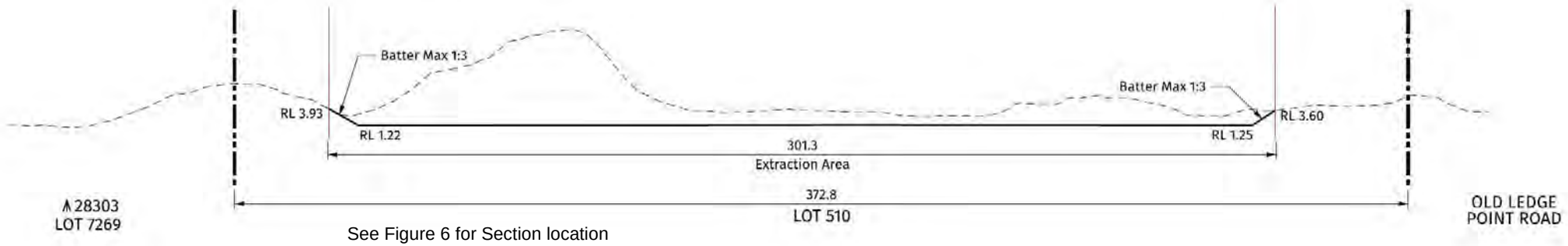
Figure 6

STAGING PLAN

bayley environmental services



See Figure 6 for Section location

Site Cross Section 1

Horizontal Scale 1 : 2000

0 20m 40m 60m

Vertical Scale 1 : 1000

0 10m 20m 30m

LEGEND

- Natural Ground Level
- Post Extraction Ground Level
- Lot Boundary
- Extraction Boundary

Figure 7

POST-EXTRACTION SECTION

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Appendix A

Bore Logs

SOIL PROFILE LOG

PROJECT NUMBER:	J20013
SITE ID:	IC1
EASTING:	343228
NORTHING:	6562018
METHOD:	Auger Rig
TOTAL DEPTH (mbgl):	6.0
REFUSAL (Y/N):	N
DATE:	18/02/2020
DEPTH TO WATER (mbgl)	

SOIL PROFILE		SAMPLE DATA	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 6	Grey-white sand		

SOIL PROFILE LOG

PROJECT NUMBER:	J20013
SITE ID:	IC2
EASTING:	343298
NORTHING:	6561858
METHOD:	Auger Rig
TOTAL DEPTH (mbgl):	6.0
REFUSAL (Y/N):	N
DATE:	18/02/2020
DEPTH TO WATER (mbgl)	

SOIL PROFILE		SAMPLE DATA	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 1	V pale grey - white sand		
1 - 1.5	Pale grey-brown sand		
1.5.- 6	Very pale yellow-brown sand		

SOIL PROFILE LOG

PROJECT NUMBER:	J20013
SITE ID:	IC3
EASTING:	343482
NORTHING:	6561522
METHOD:	Auger Rig
TOTAL DEPTH (mbgl):	5.0
REFUSAL (Y/N):	N
DATE:	18/02/2020
DEPTH TO WATER (mbgl)	

SOIL PROFILE		SAMPLE DATA	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 0.5	Grey-brown sand		
0.5 - 5	Pale yellow-brown sand		

SOIL PROFILE LOG

PROJECT NUMBER:	J20013
SITE ID:	IC4
EASTING:	342765
NORTHING:	6562043
METHOD:	Auger Rig
TOTAL DEPTH (mbgl):	3.5
REFUSAL (Y/N):	N
DATE:	18/02/2020
DEPTH TO WATER (mbgl)	

SOIL PROFILE		SAMPLE DATA	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 0.5	Pale brown sand		
0.5 - 3.5	Very pale grey sand, wet from 1m		

SOIL PROFILE LOG

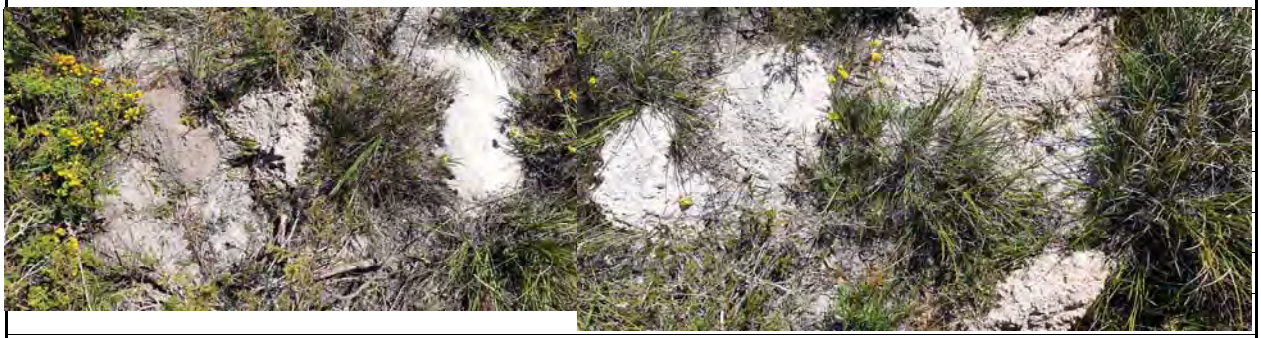
PROJECT NUMBER:	J20013
SITE ID:	IC5
EASTING:	343191
NORTHING:	6561624
METHOD:	Auger Rig
TOTAL DEPTH (mbgl):	6.0
REFUSAL (Y/N):	N
DATE:	18/02/2020
DEPTH TO WATER (mbgl)	

SOIL PROFILE		SAMPLE DATA	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 1	Pale grey sand		
1 - 6	Very pale yellow sand		

SOIL PROFILE LOG

PROJECT NUMBER:	J20013
SITE ID:	ICR1
EASTING:	343288
NORTHING:	6561595
METHOD:	Auger Rig
TOTAL DEPTH (mbgl):	7.5
REFUSAL (Y/N):	N
DATE:	18/02/2020
DEPTH TO WATER (mbgl)	

SOIL PROFILE		SAMPLE DATA	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 0.5	Pale grey sand		
0.5 - 1	Pale grey-brown sand		
1 - 2	Very pale yellow-white sand		
3 - 7.5	Pale grey sand		



SOIL PROFILE LOG

PROJECT NUMBER:	J20013
SITE ID:	ICR2
EASTING:	343136
NORTHING:	6561782
METHOD:	Auger Rig
TOTAL DEPTH (mbgl):	4.0
REFUSAL (Y/N):	N
DATE:	18/02/2020
DEPTH TO WATER (mbgl)	

SOIL PROFILE		SAMPLE DATA	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 1	Pale grey-brown sand		
1 - 2	Pale yellow-brown sand		
2 - 4	Pale grey sand, wet at 4m		

SOIL PROFILE LOG

PROJECT NUMBER:	J20013
SITE ID:	ICR3
EASTING:	343101
NORTHING:	6561894
METHOD:	Auger Rig
TOTAL DEPTH (mbgl):	4.0
REFUSAL (Y/N):	N
DATE:	18/02/2020
DEPTH TO WATER (mbgl)	

SOIL PROFILE		SAMPLE DATA	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 1	Grey-brown sand		
1 - 4	Pale yellow-brown sand		

SOIL PROFILE LOG

PROJECT NUMBER:	J20013
SITE ID:	Existing Bore
EASTING:	343112
NORTHING:	6561857
METHOD:	Unknown
TOTAL DEPTH (mbgl):	10.0
REFUSAL (Y/N):	N
DATE:	16/06/2010
DEPTH TO WATER (mbgl)	

SOIL PROFILE		SAMPLE DATA	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 9.5	White sand		
9.5 - 10	Limestone		

Information obtained from DWER SWRIS Database

Appendix B

Botanical Survey Report (Plantecology, 2021)

Lot 510 Old Ledge Point Rd Lancelin
Flora and Vegetation Survey

Prepared for Bayley Environmental Services

Plantecology CONSULTING

FEBRUARY 2021

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Kingsley WA 6026
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shane@plantecology.com.au

Executive Summary

Plantecology Consulting was commissioned by Bayley Environmental Services to undertake a detailed flora and vegetation survey of Lot 510 Old Ledge Point Rd, Lancelin, in the Shire of Gingin. The site is approximately 17.6 ha in area and currently mostly supports native vegetation.

A field survey of the site was undertaken by two botanists from Plantecology Consulting on the 15th October 2020. A detailed survey of the vegetation was undertaken at five 100 m^2 sampling plots (10m x 10m quadrats), selected to adequately sample the flora within a stand. Plots were positioned to sample a representative and homogeneous area (i.e. not located in transitional areas between communities) and also to not overlap with the plots used by Ecoscape (2007) so as to provide a wider sampling coverage of the site. A relevé as defined by the EPA (2016) rather than a detailed plot was located in each of the *Spyridium globulosum* Closed Heath and the *Melaleuca lanceolata* Tall Shrubland mapped by Ecoscape (2007). The stands of these communities are small and as they had been surveyed with quadrats previously, the data gathered by Ecoscape (2007) was used to evaluate any changes in the interim. The location of each corner of a plot was recorded with a hand-held GPS unit and a photograph of the plot taken looking inward to the quadrat. All vascular plant species were recorded and an estimate of the Foliage Projective Cover (FPC) percentage was made for each species.

A total of 70 native and 8 non-native (exotic) taxa were recorded within the site, representing 37 families and 65 genera. The dominant families containing mostly native taxa were Fabaceae (7 native taxa), Asteraceae (6 native taxa), and Myrtaceae (5 native taxa).

No Threatened Flora pursuant to the Biodiversity Conservation Act (2016) nor the EPBC Act (1999) were recorded during the survey.

Two species listed as Priority Flora by the PWS were recorded during the survey. *Stylidium maritimum* (P3) and *Conostylis ?pauciflora* var. *euryrhipis* (P4) occur across the dunes and swales in the central and southern parts of the site.

The survey identified four plant communities within the site:

Melaleuca systena Low Shrubland

Low shrubland of *Melaleuca systena, Olearia axillaris* and *Spyridium globulosum* with *Cryptandra mutila* over a herbland of *Conostylis candicans* subsp. *calcicola, Conostylis ?pauciflora* subsp. *euryrhipis* and *Hemiandra glabra* on grey-cream sand on dunes.

Acacia rostellifera Tall Shrubland

Tall shrubland of *Acacia rostellifera, Spyridium globulosum* and *Santalum acuminatum* over a herbland of *Acanthocarpus preissii, Lomandra maritima* and *Rhagodia baccata* subsp. *baccata* on grey-cream sands of flats and swales.

Spyridium globulosum Closed Shrubland

Closed shrubland of *Spyridium globulosum, Melaleuca huegelii* subsp. *huegelii* and *Templetonia retusa* over a herbland of *Lepidosperma gladiatum, Rhagodia baccata* subsp. *baccata* and *Acanthocarpus preissii* on grey-cream sands of swales.

Melaleuca lanceolata Low Closed Forest

Closed low forest of *Melaleuca lanceolata* over Open shrubland of *Melaleuca huegelii* subsp. *huegelii* over a sedgeland of *Ficinia nodosa* and *Lepidosperma pubisquameum* on grey-cream sands of swales.

Hierarchical clustering assignments indicated that the communities within the site are either FCT 29a – 'Coastal shrublands on shallow sands' or FCT 29b 'Acacia shrublands on taller dunes' , both of which are ranked as Priority 3 communities under Western Australian state policy.

The vegetation for most of the site including the *Melaleuca lanceolata* Low Closed Forest, *Spyridium globulosum* Closed Shrubland and *Melaleuca systena* Low Shrubland remains in an 'Excellent' condition and retains most of its original botanical value (Figure 3). A small blowout has developed adjacent to the northern boundary and is in a 'Completely Degraded' condition. Much of the *Acacia rostellifera* Tall Shrubland has improved to a 'Very Good' rating and some of the sand mined area has regenerated enough to now be considered in 'Good' condition with the bare areas rated as 'Completely Degraded'.

Eight of the taxa recorded during the survey are exotics (weeds). None is a Declared Pest under the Biosecurity and Agriculture Management Act 2007.

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Introduction

Plantecology Consulting was commissioned by Bayley Environmental Services to undertake a detailed flora and vegetation survey of Lot 510 Old Ledge Point Rd, Lancelin, in the Shire of Gingin (Figure 1). The site is approximately 17.6 ha in area and currently mostly supports native vegetation.

1.1 Previous Surveys

The site was surveyed by Ecoscape (Australia) Pty Ltd (Ecoscape) (2007). That survey identified four plant communities: a *Melaleuca lanceolata* Tall Shrubland was located in the north-western corner of the site; a *Spyridium globulosum* Closed Heath was mapped adjacent to the southern boundary of the *Melaleuca lanceolata* Tall Shrubland; a *Melaleuca systena, Santalum acuminatum* and *Cryptandra mutila* Closed Low Heath was mapped through the central and southern areas of the site; and an *acacia rostellifera* Tall Open Scrub was mapped on the western part of the site adjacent to a large blowout.

Vegetation condition was described as ranging from 'Good' for the *Acacia rostellifera* scrub to 'Excellent' across the remainder of the site apart from the large blowout, which was rated as 'Completely Degraded'. No Threatened Flora were recorded during the previous survey but two taxa of Priority Flora were recorded in the *Melaleuca systena, Santalum acuminatum* and *Cryptandra mutila* Closed Low Heath.

1.2 Existing Environment

The site is currently vegetated apart from firebreaks around the perimeter and the remnants of sand extraction in the north-eastern sector. The vegetation condition and structure is largely intact, with some evidence of historical access tracks, much of which is regenerating. Inspection of historical aerial photography indicates a small area of sand blowout has formed adjacent to the northern boundary since the time of the Ecoscape (2007) survey.

1.3 Climate

The Lancelin area experiences a dry Mediterranean climate of hot dry summers and cool wet winters. Long-term climatic averages indicate the site is located in an area of moderate to high rainfall, receiving 600 mm on average annually (data for Lancelin, station number 9114, the nearest currently reporting station) (Bureau of Meteorology 2021) with the majority of rainfall received between May and August. The area experiences rainfall on an average of 80 days per year. Mean maximum temperatures range from 19.3 °C in July to 29.9 °C in February. Mean minimum temperatures range from 9.9 °C in July and August, to 18.1 °C in February.

1.4 Soils

The Atlas of Australian Soils maps the soils for the site as Map Unit A13, which is a coastal dune formation backed by low-lying deposits of inlets and estuaries. The chief soils of the dunes are calcareous sands (Uc1.11) with smaller areas of acid peat in the swales (Natural Resource Information Centre 1991).

1.5 Conservation Significant Flora

Under the Biodiversity Conservation Act 2016 ('BC Act'), the Minister for the Environment produces a gazetted list of Threatened Flora under three categories: Critically Endangered, Endangered and Vulnerable. The Parks and Wildlife Service (PWS) also produces a list of Priority Flora that have not been assigned statutory protection under the BC Act but may be under some degree of threat (PWS 2019a). The PWS recognises four Priority Flora levels. The definitions for each category of Threatened and Priority Flora are shown in Appendix E.

As well as protection under State legislation, selected flora are also afforded statutory protection at a Federal level pursuant to the Environment Protection and Biodiversity Conservation Act 1999 (EPBC

Act). The EPBC Act provides for the protection of Threatened species, pursuant to Schedule 1 of the Act, and are defined as "Critically Endangered", "Endangered", "Vulnerable" or "Conservation Dependent" under Section 179. Definitions of these categories are shown in Appendix E. Any action likely to have a significant impact on a species listed under the EPBC Act requires approval from the Commonwealth Minister for the Environment.

Searches of the State databases identified 66 taxa with the potential to occur within the site (Table 1). Of these taxa, nine are listed as Threatened under the BC Act, of which one is an orchid. *Drakaea elastica* occurs in sands of low-lying areas adjacent to damp sites. This species are unlikely to occur within the site.

1.6 Conservation Significant Communities

The PWS defines an ecological community as "a naturally occurring assemblage that occurs in a particular type of habitat" (PWS 2019b). A Threatened Ecological Community (TEC) is one that has declined in area or was originally limited in distribution. Uncommon ecological communities that do not strictly meet TEC defined criteria, or are inadequately defined, are listed by the PWS as a Priority Ecological Community (PEC). Definitions of the categories of Threatened and Priority Ecological Communities are given in Appendix E.

As well as protection under State legislation, selected ecological communities are also afforded statutory protection at a Federal level pursuant to the EPBC Act. The EPBC Act provides for the protection of TECs, which are listed under section 181 of the Act, and are defined as "Critically Endangered", "Endangered" or "Vulnerable" under Section 182. Similar to flora listed under the EPBC Act, any action likely to have a significant impact on a TEC listed under the EPBC Act requires Commonwealth approval.

One terrestrial TEC endorsed under State legislation is recorded as occurring within 10 km of the site:

- Floristic Community Type (FCT) 19a -'Sedgelands in Holocene dune swales of the southern Swan Coastal Plain'.

Two other terrestrial FCTs listed as PECs are recorded as occurring within 10 km of the site:

- 'Tuart (Eucalyptus gomphocephala) woodlands and forests of the Swan Coastal Plain' (Priority 3); and
- 'Banksia dominated woodlands of the Swan Coastal Plain IBRA Region' (Priority 3).

The 'Tuart (Eucalyptus gomphocephala) Woodlands and Forests of the Swan Coastal Plain ecological community' is also categorised as 'Critically Endangered' by the Commonwealth, and the 'Banksia-dominated woodlands of the Swan Coastal Plain IBRA Region' and the 'Sedgelands in Holocene dune swales of the southern Swan Coastal Plain' are both listed as 'Endangered' TECs by the Commonwealth.

None of the communities listed above are mapped as occurring within the site.

1.7 Vegetation Complexes

Vegetation complexes are a series of plant communities forming a regularly repeating pattern associated with a particular soil unit (Government of Western Australia 2000). The vegetation complex mapped as occurring within the site is the Quindalup Complex, which has approximately 60% of its original 55 570 ha pre-European extent remaining and 8.4% of its current extent has some level of protection (Government of Western Australia 2017).

Table 1: Threatened and Priority Flora potentially occurring within the survey area based on database searches. (VU = Vulnerable; EN = Endangered; CR = Critically Endangered; T = Threatened; 1 – 4 = Priority Flora Category)

Taxon	PWS Ranking	EPBC Act Category	Flowering Period
Allocasuarina grevilleoides	3		Sep-Nov
Andersonia gracilis	T	EN	Oct-Nov
Anigozanthos humilis subsp. Badgingarra (S.D. Hopper 7114)	2		Sep-Oct
Anigozanthos humilis subsp. *chrysanthus*	4		Jul-Sep
Anigozanthos viridis subsp. *terraspectans*	T	VU	Oct-Nov
Arnocrinum drummondii	3		Mar-Sep-Dec
Babingtonia delicata	1		
Babingtonia urbana	3		Jan-Mar
Baeckea sp. Limestone (N. Gibson & M.N. Lyons 1425)	1		
Banksia dallanneyi subsp. *pollosta*	3		Aug
Banksia fraseri var. *crebra*	3		Jul-Aug
Beyeria cinerea subsp. *cinerea*	3		Nov
Caladenia speciosa	4		Sep-Oct
Calothamnus accedens	4		Feb
Calothamnus pachystachyus	4		Aug-Oct
Calytrix ecalycata subsp. *brevis*	3		Aug-Oct
Chamaescilla gibsonii	3		Sep
Chorizema varium	T		Jun, Sep-Oct
Conostylis bracteata	3		Aug-Sep
Conostylis pauciflora subsp. *euryrhipis*	4		Aug-Oct
Dampiera tephrea	2		Aug
Darwinia acerosa	T	EN	Sep-Nov
Darwinia carnea	T	EN	Oct-Dec
Desmocladus nodatus	3		
Dillwynia dillwynioides	3		Aug-Dec
Dodonaea hackettiana	4		Jul-Oct
Drakaea elastica	T	EN	Oct-Nov
Eleocharis keigheryi	T	VU	
Eucalyptus argutifolia	T	VU	Mar-Apr
Eucalyptus macrocarpa subsp. *elachantha*	4		Apr-Sep
Gratiola pedunculata	2		Jan-May
Grevillea evanescens			
Grevillea rudis	4		Jul-Feb
Grevillea thyrsoides subsp. *thyrsoides*	3		All
Gyrostemon sp. Mogumber (T.J. Hawkeswood 250)	1		
Haemodorum loratum	3		Sep-Nov
Hakea oligoneura	4		Aug-Oct
Hensmania stoniella	3		Sep-Nov
Hibbertia leptotheca	3		
Hypocalymma sp. Cataby (G.J. Keighery 5151)	2		Aug-Sep

Taxon	PWS Ranking	EPBC Act Category	Flowering Period
Isotropis cuneifolia subsp. *glabra*	3		Sep
Lepidosperma rostratum	T		
Leucopogon sp. Yanchep (M. Hislop 1986)	3		Apr-Jun, Sep
Leucopogon squarrosus subsp. *trigynus*	2		
Macarthuria keigheryi	T	EN	Sep-Dec, Feb-Mar
Marianthus paralius	T		Sep-Nov
Persoonia rudis	3		Sep-Nov
Petrophile biternata	3		Sep
Phlebocarya pilosissima subsp. *pilosissima*	3		Aug-Sep
Pimelea calcicola	3		Sep-Nov
Platysace ramosissima	3		
Ptychosema pusillum	T	VU	Oct-Nov
Rumex drummondii	4		
Sarcozona bicarinata	3		Aug
Schoenus pennisetis	3		Aug-Sep
Scholtzia laciniata	2		
Stylidium aceratum	3		Oct-Nov
Stylidium hymenocraspedum	3		Oct
Stylidium maritimum	3		Sep-Nov
Stylidium sp. Moora (J.A. Wege 713)	2		Oct
Thelymitra apiculata	4		Jun-Jul
Thryptomene sp. Lancelin (M.E. Trudgen 14000)	3		Sep
Trithuria australis	4		Oct
Trithuria australis	4		Oct
Verticordia lindleyi subsp. *lindleyi*	4		Nov-Jan

1.8 Purpose

The purpose of the survey was to assess the botanical values within the site by:

- Undertaking a detailed flora and vegetation survey in accordance with the Environmental Protection Authority's (EPA) *Technical Guidance: Flora and Vegetation Survey for Environmental Impact Assessment* (2016).
- Identifying the presence of any Threatened Ecological Communities (TECs) and Priority Ecological Communities (PECs);
- Undertaking a systematic search for all vascular plant taxa present; and
- Recording the locations and numbers present of any Threatened Flora and Priority Flora.

Methods

1.9 Field Survey

A field survey of the site was undertaken by two botanists from Plantecology Consulting on the 15th October 2020. A detailed survey of the vegetation was undertaken at five 100 m^2 sampling plots (10m x 10m quadrats), selected to adequately sample the flora within a stand (Figure 2). Plots were positioned to sample a representative and homogeneous area (i.e. not located in transitional areas between communities) and also to not overlap with the plots used by Ecoscape (2007) so as to provide a wider sampling coverage of the site. A relevé as defined by the EPA (2016) rather than a detailed plot was located in each of the *Spyridium globulosum* Closed Heath and the *Melaleuca lanceolata* Tall Shrubland mapped by Ecoscape (2007). The stands of these communities are small and as they had been surveyed with quadrats previously, the data gathered by Ecoscape (2007) was used to evaluate any changes in the interim. The location of each corner of a plot was recorded with a hand-held GPS unit and a photograph of the plot taken looking inward to the quadrat. All vascular plant species were recorded and an estimate of the Foliage Projective Cover (FPC) percentage was made for each species.

Environmental data recorded included topographic position, aspect, slope, soil colour and texture class, rock outcropping, litter cover as well as the degree of disturbance and an estimate of the time since the last fire event. The condition of the vegetation of the site was assessed to assist in determining the conservation values of the site. The vegetation condition was rated according to Keighery (1994), a vegetation condition scale commonly used in the metropolitan and southwest regions. The categories are listed and defined in Table 2. Data on the vegetation structure was also recorded and included the height of the three main strata and the dominant species within each stratum. The vegetation structural description follows that of the National Vegetation Information System (Thackway et al. 2006).

Table 2: Vegetation Condition Scale (Keighery 1994)

Vegetation Condition	Definition
Pristine (1)	Pristine or nearly so, no obvious signs of disturbance.
Excellent (2)	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
Very Good	Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs.

All plant specimens collected during the field survey were dried, pressed and then sorted in accordance with requirements of the Western Australian Herbarium. Identification of specimens occurred through comparison with named material and through the use of taxonomic keys. Taxonomic determinations were made using reference material at the Western Australian State Herbarium. Taxa names utilise the current terminologies from FloraBase (2020). Family names utilise the revised phylogeny of the Angiosperm Phylogeny Group - APGIII (FloraBase 2020).

1.10 Survey Limitations

Various factors can limit the effectiveness of a vegetation survey. Pursuant to EPA Technical Guidance: Flora and Vegetation Survey for Environmental Impact Assessment (EPA 2016), these factors have been identified and their potential impact on the effectiveness of the survey has been assessed (Table 3).

The initial survey was undertaken October 2020 and would likely have intercepted the flowering period of annuals of conservation concern with the potential to occur within the site. However, the preceding three months were drier than normal (mainly in August), which may have affected the flowering of some species.

Table 3: Potential limitations affecting the vegetation survey

Potential limitations	Constraint	Comment
Availability of contextual information	No	Sufficient regional and local information was available to place the survey site in its environmental context.
Competency and experience of the botanists	No	The survey was undertaken by botanists with a comprehensive knowledge of Swan Coastal Plain vegetation, with at least 15 years experience in vegetation surveys in Western Australia.
Seasonality	Minor	The survey was undertaken in spring 2020. The rainfall in the three months prior to the survey was near average for the area. Maximum and minimum temperatures in September and October were approximately 1-2^0 higher than the mean.
Adequate coverage and intensity of survey	No	The survey area was traversed on foot. It is considered the survey quadrats and mapping points provided adequate coverage given the degraded nature of most of the site.
Proportion of Flora identified	No	The survey recorded an estimated 90% of the plant taxa present (Chao2 estimator).
Disturbance	Minor	The vegetation was mostly intact, with a large blowout and bare areas from past resource extraction. A small blowout has formed since the previous survey in 2007.
Resources	No	Adequate resources were available to conduct the survey.
Access restrictions	No	All parts of the site were accessible

1.11 Data Analysis

The remnant vegetation of the southern Swan Coastal Plain (SCP) was surveyed by Gibson et al. (1994) to provide an understanding of the major floristic gradients across the region. The major plant

communities (or FCTs) were defined by classifying the data according to the similarities in species composition between plots. When determining the FCT of a new record, a floristic analysis of species composition provides the most robust method that is consistent with the original classification, although presently a single consistent method for the determination of FCTs for vegetation data in the Swan Coastal Plain is not available.

Hierarchical agglomerative clustering is the usual first stage in classifying vegetation data into community types. This involves calculating the similarity (or more often, the dissimilarity) between plots within the dataset and then sequentially fusing the plots into groups according to their similarity. This type of method was used in the analysis of the original Swan Coastal Plain dataset (Gibson et al. 1994), but its use as the basis for assigning new plot data to the regional classification has some drawbacks. Firstly, a hierarchical clustering only applies to the relationships between plots, and the relative distances between them, within that particular dataset. The addition of new data often alters the relative distances and disrupts the clustering output. Secondly, as an unsupervised method, hierarchical clustering does not define rules for the membership of the defined groups, and so the addition of new plots requires the rebuilding of the entire hierarchy (De Cáceres and Wiser 2012).

The data for the Swan Coastal Plain regional survey (Gibson et al. 1994) was downloaded from the NatureMap website. This is largely similar to the original survey except for one site (OATES-1), which has now been excluded. The species nomenclature of the original dataset was updated to be consistent with current usage. Where original names could not be matched clearly to the updated usage, those taxa were removed from the analysis. The new data from the Old Ledge Point Rd survey was added to the matrix one plot at a time to remove any effect of spatial correlation between the new plots. Each new dataset was then analysed calculating the Bray-Curtis distance coefficient (or resemblance measure) and the flexible beta linkage method (beta = -0.1). Assignment of the Old Ledge Point Rd plots was to the nearest distinct group by inspection of the resulting dendrogram. The analyses were undertaken using R packages Cluster and Vegan.

Results

1.12 Flora

1.12.1 Floristic Summary

A total of 70 native and 8 non-native (exotic) taxa were recorded within the site, representing 37 families and 65 genera. The dominant families containing mostly native taxa were Fabaceae (7 native taxa), Asteraceae (6 native taxa), and Myrtaceae (5 native taxa). For a complete species list and the individual site data refer to Appendix A and Appendix B, respectively.

1.12.2 Threatened and Priority Flora

No Threatened Flora pursuant to the Biodiversity Conservation Act (2016) nor the EPBC Act (1999) were recorded during the survey.

Two species listed as Priority Flora by the PWS were recorded during the survey. *Stylidium maritimum* (P3) is a perennial herb growing to around 0.7 m in height and was recorded from eight occurrences (Table 4) in the *Melaleuca systena* Low Shrubland community (see below). *Conostylis ?pauciflora* var. *euryrhipis* (P4) was also common in the *Melaleuca systena* Low Shrubland community, as well as being recorded in the *Acacia rostellifera* Tall Shrubland. Three specimens of *Conostylis ?pauciflora* var. *euryrhipis* were collected and none could be identified to subspecies rank with complete confidence. However, it is the most likely identification and it should also be noted that the taxon was recorded by Ecoscape (2007) as being common on the site.

Table 4: Recorded locations of *Stylidium maritimum* (P3) within the surveyed area.

Taxon Name	Rank	Abundance	Latitude	Longitude
Stylidium maritimum	P3	1	115.35632	-31.06813
Stylidium maritimum	P3	4	115.3564	-31.06837
Stylidium maritimum	P3	1	115.3572	-31.06903
Stylidium maritimum	P3	5	115.35733	-31.06909
Stylidium maritimum	P3	2	115.35785	-31.06946
Stylidium maritimum	P3	1	115.35777	-31.06947
Stylidium maritimum	P3	2	115.35877	-31.06954
Stylidium maritimum	P3	6	115.3589	-31.06963

1.13 Vegetation

1.13.1 Plant Associations

The survey identified four plant communities within the site (Figure 2):

Melaleuca systena Low Shrubland (Plates 1, 2 & 4)

Low shrubland of *Melaleuca systena, Olearia axillaris* and *Spyridium globulosum* with *Cryptandra mutila* over a herbland of *Conostylis candicans* subsp. *calcicola, Conostylis ?pauciflora* subsp. *euryrhipis* and *Hemiandra glabra* on grey-cream sand on dunes.

Acacia rostellifera Tall Shrubland (Plates 3 & 5)

Tall shrubland of *Acacia rostellifera, Spyridium globulosum* and *Santalum acuminatum* over a herbland of *Acanthocarpus preissii, Lomandra maritima* and *Rhagodia baccata* subsp. *baccata* on grey-cream sands of flats and swales.

Spyridium globulosum Closed Shrubland (Plate 6)

Closed shrubland of *Spyridium globulosum, Melaleuca huegelii* subsp. *huegelii* and *Templetonia retusa* over a herbland of *Lepidosperma gladiatum, Rhagodia baccata* subsp. *baccata* and *Acanthocarpus preissii* on grey-cream sands of swales.

Melaleuca lanceolata Low Closed Forest

Closed low forest of *Melaleuca lanceolata* over Open shrubland of *Melaleuca huegelii* subsp. *huegelii* over a sedgeland of *Ficinia nodosa* and *Lepidosperma pubisquameum* on grey-cream sands of swales.

1.13.2 Vegetation Condition

Ecoscape (2007) previously reported most of the vegetation to be in 'Excellent' condition with the *Acacia rostellifera* Tall Shrubland mainly in 'Good' condition and the sand mining and blowout areas in 'Degraded' condition. The vegetation for most of the site including the *Melaleuca lanceolata* Low Closed Forest, *Spyridium globulosum* Closed Shrubland and *Melaleuca systena* Low Shrubland remains in an 'Excellent' condition and retains most of its original botanical value (Figure 3). A small blowout has developed adjacent to the northern boundary and is in a 'Completely Degraded' condition. Much of the *Acacia rostellifera* Tall Shrubland has improved to a 'Very Good' rating and some of the sand mined area has regenerated enough to now be considered in 'Good' condition with the bare areas rated as 'Completely Degraded'.

1.13.3 Conservation Significance

The hierarchical clustering assignments indicated that both of the vegetation units within the site are either FCT 29a – 'Coastal shrublands on shallow sands' or FCT 29b 'Acacia shrublands on taller dunes' (Appendix D). This result would be consistent with the locality, soils and position adjacent to the coast on the Swan Coastal Plain. Both FCT 29a and 29b are ranked as Priority 3 communities under Western Australian state policy.

Plot PC01 showed some similarity to the FCT 30a2 sub-type of the *'Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands'. This assignment is likely unreliable as FCT 30a is a woodland dominated by either *Callitris preissii* or *Melaleuca lanceolata*. To check the conservation status of the *Melaleuca lanceolata* woodland and ascertain if it is part of FCT 30a, the plot data for Plot Q2 from Ecoscape (2007) was also analysed. The results indicated an affinity to Swan Coastal Plain 19a, 'Sedgelands in Holocene dune swales', which is listed as a 'Critically Endangered' TEC under Western Australian criteria and as an 'Endangered' TEC under the EPBC Act. This result is also likely unreliable as FCT 19a is structurally a sedgeland and the assignment is likely due to the presence of species such as *Ficinia nodosa*, *Poa porphyroclados, *Crassula glomerata* and **Bromus diandrus,* which are common in FCT 19a. The immediately adjacent vegetation of the neighbouring property to the north of the *Melaleuca lanceolata* woodland was observed to support sedges in a dampland and this may be influencing the assignment of Ecoscape Plot Q2.

1.13.4 Weeds

Eight of the taxa recorded during the survey are exotics (weeds). None is a Declared Pest under the Biosecurity and Agriculture Management Act 2007.

Discussion

The site has retained its botanical values since the previous survey and in some places the extent of native vegetation has increased.

1.14 Flora

No species of Threatened Flora were recorded during the survey.

Two species of Priority Flora were recorded within the site. Twenty-two plants of *Stylidium maritimum* (P3) were recorded at six locations within the *Melaleuca systena* Low Shrubland. An inspection of recorded occurrences by Ecoscape (2007) found no plants in the northern part of that community and additional occurrences in the southern part. This is not unusual as some plants will have senesced and new plants established in the interim. The number of individuals observed is similar indicating a relatively stable population size within the site.

Conostylis ?pauciflora subsp. *euryrhipis* was common throughout the *Melaleuca systena* Low Shrubland along with the congeneric *Conostylis candicans* subsp. *calcicola,* as well as parts of the *Acacia rostellifera* Tall Shrubland, but was too numerous to count accurately. This result also agrees with the observation of Ecoscape (2007). Three specimens were collected to confirm the identity of the taxon and it is the most likely result and consistent with the previous survey, but none of the identifications were definitive.

1.15 Plant Communities

The results of the FCT analysis indicate that the vegetation units identified within the site are either of FCT 29a 'Coastal shrublands on shallow sands' or FCT 29b '*Acacia* shrublands on taller dunes'. Although the regional survey of Gibson *et al.* (1994) did not include the Lancelin area, the south-western and southern coastlines of Western Australia share similar environments and similar vegetation types and so an assignment to FCT using the Swan Coastal Plain dataset is considered appropriate. Both FCT 29a and 29b are listed as Priority 3 communities under state policy.

Similarity to other FCTs in the classification are likely due to misclassifications. Misclassifications occur because hierarchical clustering uses relative similarities between plots to form groups, which can be affected by the addition of new data. This can be common with the Swan Coastal Plain dataset as it is based on presence/absence of species rather than dominance (abundance). Plot PC01 was assigned to FCT 30a2, but this FCT is a woodland dominated by either *Callitris preissii* or *Melaleuca lanceolata* and the vegetation at PC01 is a *Melaleuca systena* shrubland as at the PC02 and PC04 plots. The FCT for the Ecoscape (2007) plot Q2 was assessed before the field survey as it is dominated by *Melaleuca lanceolata* and therefore was potentially part of FCT 30a, which listed as a TEC. The nearest assignment for the plot was to FCT 19a 'Sedgelands in Holocene dune swales', which is also a TEC, and secondarily to a FCT 29a/29b cluster. Again, the vegetation at this site is structurally incorrect for this assignment and is likely due to the presence in the understorey of sedge species such *Ficinia nodosa.* Sedge species were observed to be dominant in areas within the adjacent property to the north and FCT 19a may be present there and is influencing the understorey of the *Melaleuca lanceolata* woodland.

The Quindalup vegetation complex mapped as occurring within the site has more than 30% of its original extent remaining.

1.16 Vegetation Condition

Vegetation condition across the site has not altered significantly since the 2007 survey and has even improved in parts of the old sand mining area. A new blowout has formed in the north of the site, likely in the last ten years from inspection of historical aerial photography.

1.17 Weeds

None of the weeds recorded within the site is a Declared Pest under the Biosecurity and Agriculture Management Act 2007.

Summary

Lot 510 Old Ledge Point Rd, Lancelin has retained its botanical values since the previous survey and s the extent of native vegetation has increased. in the intervening 13 years. Two Priority 3 communities have been identified within the site as well as two Priority Flora: *Stylidium maritimum* (P3) and *Conostylis ?pauciflora* subsp. *euryrhipis* (P4). The major habitat for the Priority Flora is the *Melaleuca systena* Low Shrubland, which occurs across the dunes and swales in the central and southern parts of the site and is the most extensive community within the site.

References

Bureau of Meteorology (2021) Climate Statistics Lancelin meteorological station 9114. Bureau of Meteorology. http://www.bom.gov.au/climate/data/

De Cáceres, M and Wiser, S.K. (2012) Towards consistency in vegetation classification, Journal of Vegetation Science, 23: 387-393

Ecoscape (Australia) Pty Ltd (2007) Lot 510 Old Ledge Point Rd, Lancelin. Unpublished report for Gray & Lewis Land Use Planners, North Fremantle

Environmental Protection Authority (2016) Technical Guidance: Flora and Vegetation Survey for Environmental Impact Assessment, Perth.

FloraBase (2021). FloraBase the Western Australian Flora. Parks and Wildlife Service, Como, Western Australia. http://florabase.dpaw.wa.gov.au/

Gibson, N, Keighery, BJ, Keighery, GJ, Burbidge, AH and Lyons, MN (1994), A floristic survey of the southern Swan Coastal Plain, Unpublished Report for the Australian Heritage Commission prepared by the Department of Conservation and Land Management and the Conservation Council of Western Australia (Inc), Perth.

Government of Western Australia (2017) 2016 South West Vegetation Complex Statistics. Current as of December 2016. WA Department of Parks and Wildlife, Perth

Keighery, BJ (1994), Bushland plant survey: A Guide to Plant Community Survey for the Community, Wildflower Society of WA (inc), Nedlands, Western Australia.

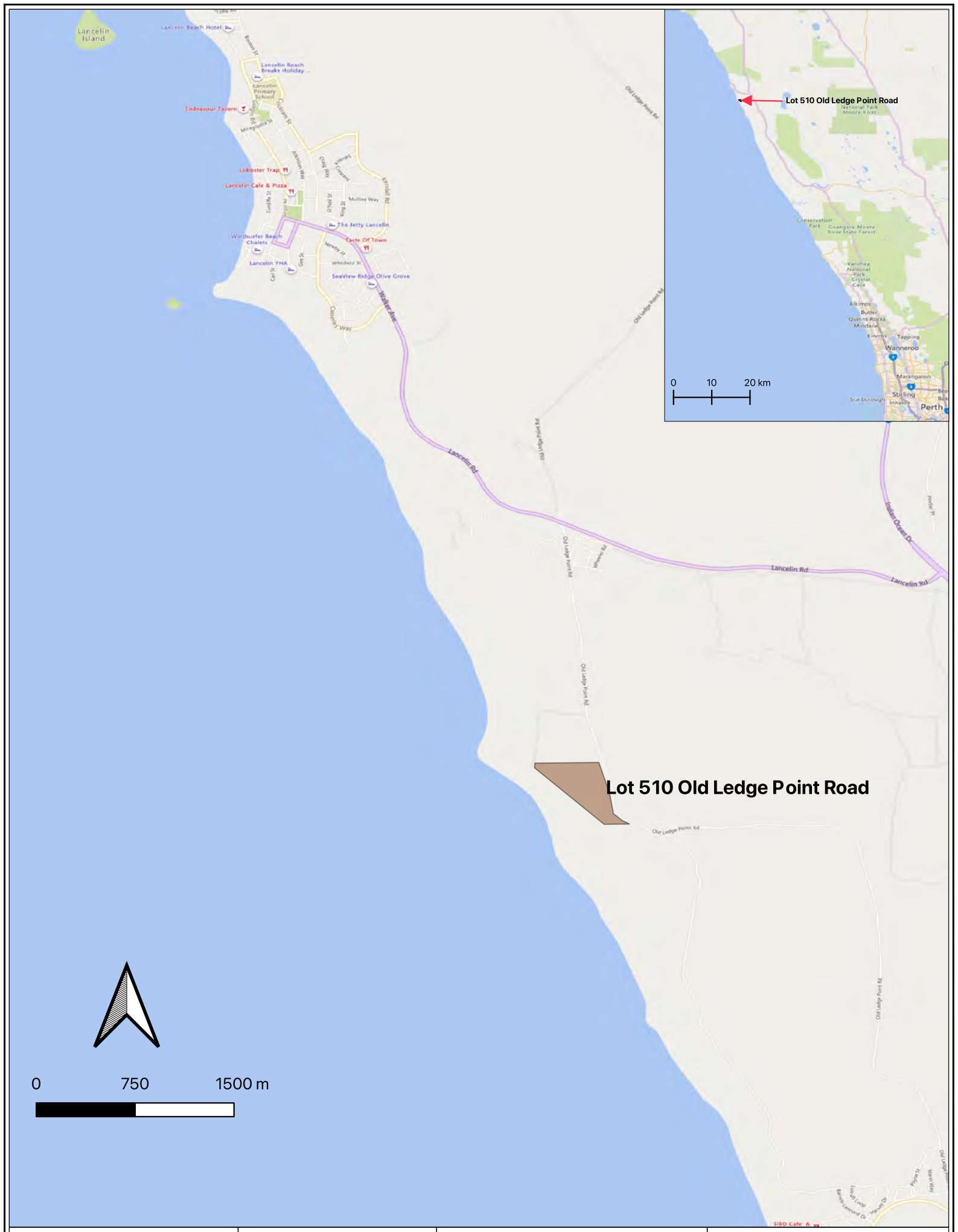
Natural Resource Information Centre (1991) Digital Atlas of Australian Soils, Bureau of Rural Sciences, Canberra.

Parks and Wildlife Service (2019a) Conservation Codes for Western Australian Flora and Fauna, Department of Environment and Conservation, Perth.

Parks and Wildlife Service (2019b) Definitions, Categories and Criteria for Threatened and Priority Ecological Communities, Parks and Wildlife Service, Perth.

Thackway, R., Neldner, J. and Bolton, M. (2006) Chapter 8: Vegetation, in: The Blue Book: Australian Soil and Land Survey Handbook Guidelines for Conducting Surveys, CSIRO, Canberra.

Figures



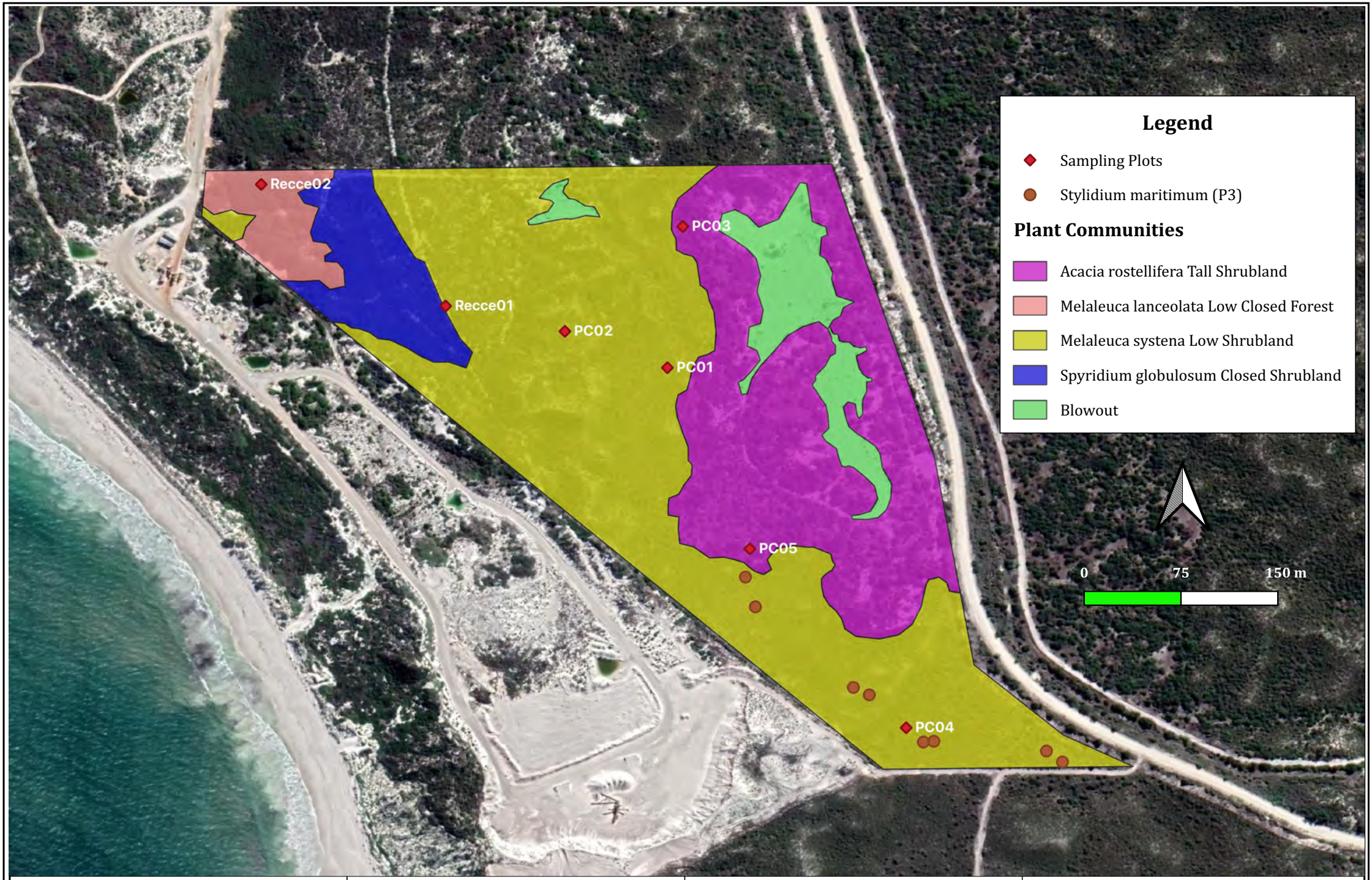
Plantecology CONSULTING

50 New Cross Rd Kingsley WA 6026

Scale: 1:37 500
Basemap Source: Bing Map
Datum: GDA94
Projection: EPSG4283

Client: Bayley Environmental Services
Project: Old Ledge Point Rd Vegetation Survey
Location: Lot 510 Old Ledge Point Rd, Lancelin
Author: S. Chalwell
Drawn: S. Chalwell

Figure 1: Locality Plan



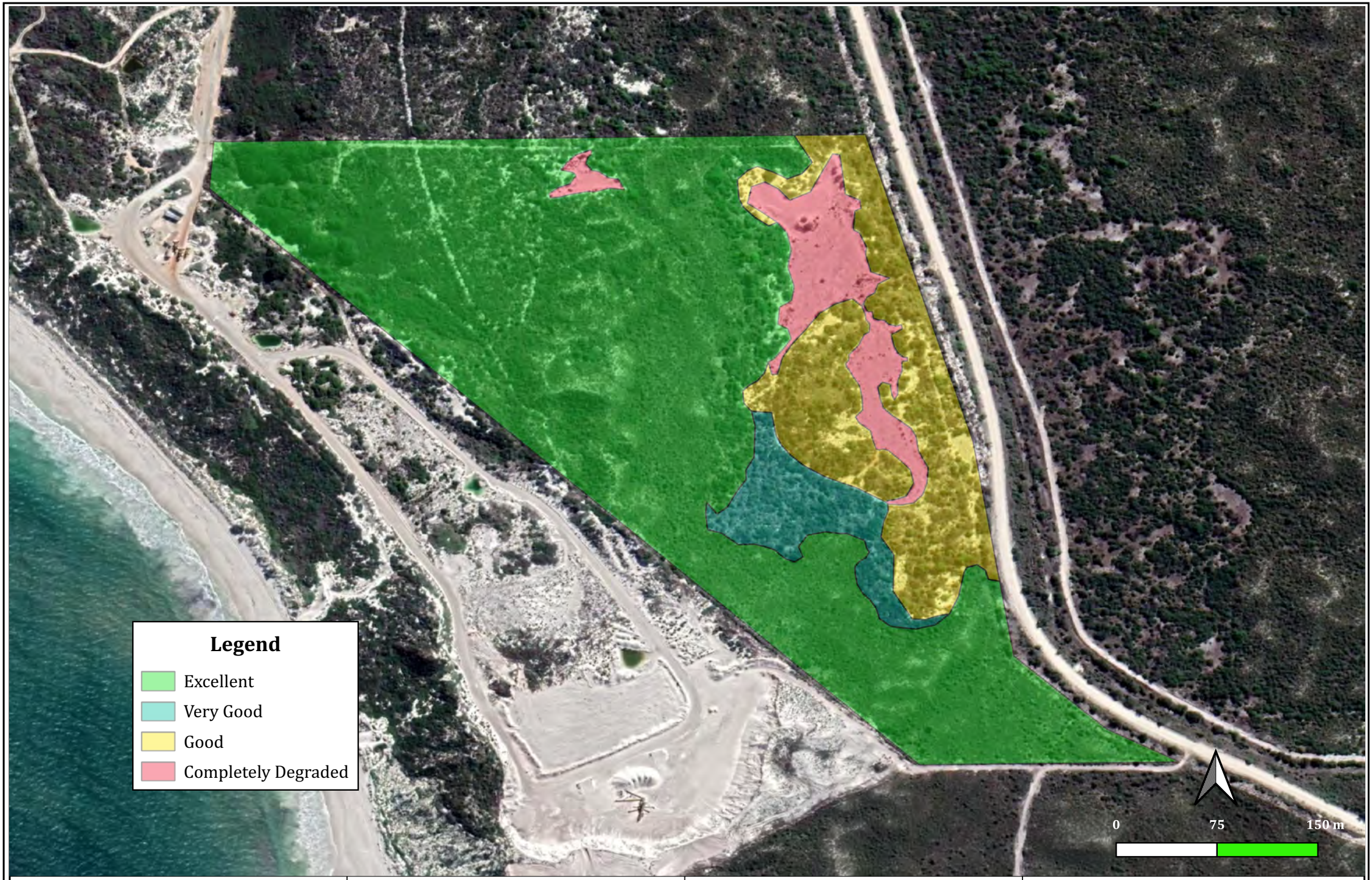
Plantecology CONSULTING

50 New Cross Rd
Kingsley WA 6026

Scale: 1:3 750
Original Size: A4
Basemap Source: Google Satellite
Datum: GDA94
Projection: EPSG4283

Client: Bayley Environmental Services
Project: Old Ledge Point Rd Vegetation Survey
Location: Lot 510 Old Ledge Point Rd, Lancelin
Author: S. Chalwell
Drawn: S. Chalwell

Figure 2: Plant Communities



Plantecology CONSULTING

50 New Cross Rd
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Scale: 1:3 750
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Client: Bayley Environmental Services
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Location: Lot 510 Old Ledge Point Rd, Lancelin
Author: S. Chalwell
Drawn: S. Chalwell

Figure 3: Vegetation Condition

Plates

Plate 1: View of sampling plot PC01: *Melaleuca systena* Low Shrubland

Plate 2: View of sampling plot PC02: *Melaleuca systena* Low Shrubland

Plate 3: View of sampling plot PC03: *Acacia rostellifera* Tall Shrubland

Plate 4: View of sampling plot PC04: *Melaleuca systena* Low Shrubland

Plate 5: View of sampling plot PC05: *Acacia rostellifera* Tall Shrubland

Plate 6: View of sampling plot Recce01: *Spyridium globulosum* Closed Shrubland

Appendix A

List of flora recorded within the survey area

NB: * indicates introduced flora

Family	Taxon
Lauraceae	*Cassytha aurea* var. *aurea*
	Cassytha racemosa
Asparagaceae	*Acanthocarpus preissii*
	Lomandra maritima
	Thysanotus arenarius
Asphodelaceae	*Trachyandra divaricata*
Hemerocallidaceae	*Dianella revoluta* var. *divaricata*
Haemodoraceae	*Conostylis ?pauciflora* subsp. *euryrhipis*
	Conostylis candicans subsp. *calcicola*
Cyperaceae	*Ficinia nodosa*
	Lepidosperma gladiatum
	Lepidosperma pubisquameum
	Lepidosperma tetraquetrum
Restionaceae	*Desmocladus flexuosus*
Poaceae	* *Austrostipa flavescens*
	* *Avena barbata*
	* *Bromus diandrus*
	* *Lolium rigidum*
	Poa porphyroclados
	Rytidosperma occidentale
	Spinifex longifolius
Ranunculaceae	*Clematis linearifolia*
Dilleniaceae	*Hibbertia racemosa*
Crassulaceae	*Crassula glomerata*
Fabaceae	*Acacia cyclops*
	Acacia lasiocarpa var. *lasiocarpa*
	Acacia rostellifera
	Acacia truncata
	Gastrolobium nervosum
	Hardenbergia comptoniana
	Templetonia retusa
Polygalaceae	*Comesperma confertum*
Rhamnaceae	*Cryptandra mutila*
	Spyridium globulosum
	Trymalium ledifolium var. *ledifolium*
Casuarinaceae	*Allocasuarina lehmanniana* subsp. *lehmanniana*

Family		Taxon
Celastraceae		*Stackhousia pubescens*
Euphorbiaceae	*	*Euphorbia terracina*
Phyllanthaceae		*Phyllanthus calycinus*
Geraniaceae	*	*Pelargonium capitatum*
Myrtaceae		*Calothamnus quadrifidus* subsp. *quadrifidus* *Melaleuca cardiophylla* *Melaleuca huegelii* subsp. *huegelii* *Melaleuca lanceolata* *Melaleuca systena*
Thymeleaceae		*Pimelea ferruginea*
Brassicaceae	*	*Heliophila pusilla*
Santalaceae		*Exocarpos sparteus* *Leptomeria cunninghamii* *Santalum acuminatum*
Chenopodiaceae		*Rhagodia baccata* subsp. *baccata* *Rhagodia preissii* subsp. *preissii* *Threlkeldia diffusa*
Aizoaceae		*Carpobrotus virescens* *Tetragonia decumbens*
Montiaceae		*Calandrinia tholiformis*
Ericaceae		*Acrotriche cordata* *Leucopogon parviflorus* *Lysinema pentapetalum* *Styphelia insularis*
Rubiaceae		*Opercularia vaginata*
Scrophulariaceae	*	*Dischisma arenarium* *Eremophila glabra* subsp. *albicans* *Myoporum insulare*
Lamiaceae		*Hemiandra glabra*
Campanulaceae		*Isotoma hypocrateriformis*
Stylidiaceae		*Stylidium scariosum*
Goodeniaceae		*Scaevola crassifolia* *Scaevola nitida*

Family	Taxon
Goodeniaceae	*Scaevola thesioides* subsp. *thesioides*
Asteraceae	*Asteridea pulverulenta* *Brachyscome bellidioides* *Olearia axillaris* *Rhodanthe citrina* *Senecio pinnatifolius* var. *latilobus* *Waitzia acuminata* var. *acuminata*
Araliaceae	*Trachymene cyanopetala*
Apiaceae	*Daucus glochidiatus*

Appendix B

Site x species matrix of flora recorded within plots in the survey area.

Taxon	PC01	PC02	PC03	PC04	PC05	Recce01	Recce02
Acacia cyclops	0.5						
Acacia lasiocarpa var. *lasiocarpa*	0.5	0.3	0.3	0.3	0.3		
Acacia rostellifera			10		15		
Acacia truncata		0.5					
Acanthocarpus preissii	2	10	3		2		
Allocasuarina lehmanniana subsp. *lehmanniana*						0.3	
Asteridea pulverulenta					0.1		
Austrostipa flavescens	0.1	0.2		0.1	0.2		
Avena barbata			0.2				
Brachyscome bellidioides				0.2			
Bromus diandrus	2	2	2		4		
Calothamnus quadrifidus subsp. *quadrifidus*						0.3	
Carpobrotus virescens		1	0.3				
Cassytha aurea var.aurea	0.1	0.2		0.1			
Cassytha racemosa		0.2	0.1	0.2			
Clematis linearifolia	0.2	0.2	0.1		2		
Comesperma confertum	23			0.2			
Conostylis ?pauciflora subsp. *euryrhipis*				0.1			
Conostylis candicans subsp. *calcicola*	0.2	0.2	0.1		0.2		
Crassula glomerata		0.1	0.1		0.1		
Cryptandra mutila				4			
Daucus glochidiatus		0.1	0.1				
Dischisma arenarium		0.1					
Eremophila glabra subsp. *albicans*	0.3			0.3			
Euphorbia terracina							
Exocarpos sparteus	0.3						
Gastrolobium nervosum		0.3					
Hardenbergia comptoniana					0.5		
Heliophila pusilla	0.5						
Hemiandra glabra	0.3	0.3		0.3	0.3		
Hibbertia racemosa		0.2					
Isotoma hypocrateriformis				0.1			
Lepidosperma gladiatum		1					
Lepidosperma pubisquameum	0.3		0.3	0.2			
Leptomeria cunninghamii				0.3			
Leucopogon parviflorus	2						
Lolium rigidum	10	0.2	1	0.5	0.3		
Lomandra maritima	3		0.5	2	0.5		
Melaleuca cardiophylla						0.3	
Melaleuca huegelii subsp. *huegelii*						35	
Melaleuca lanceolata							60
Melaleuca systena	9	1	1	20			
Myoporum insulare		3			7		
Olearia axillaris	0.3	1		0.4	0.3		
Opercularia vaginata		0.1					
Poa porphyroclados	0.5	0.2		0.5	0.2		
Rhagodia baccata subsp. *baccata*	1	1	1	0.3	1		
Rhodanthe citrina				0.1	0.1		
Rytidosperma occidentale				0.1			
Santalum acuminatum		0.3	25				
Scaevola thesioides subsp. *thesioides*			0.2	0.2			
Senecio pinnatifolius var. *latibolus*	0.1	0.1					
Spinifex longifolius		0.2					
Spyridium globulosum	1	6	15	2	5	35	
Styphelia insularis		0.3			0.4		
Threlkeldia diffusa		0.1					
Trachyandra divaricata	0.3		0.2				
Trachymene cyanopetala			0.1				
Trymalium ledifolium var. *ledifolium*	0.3	0.3					

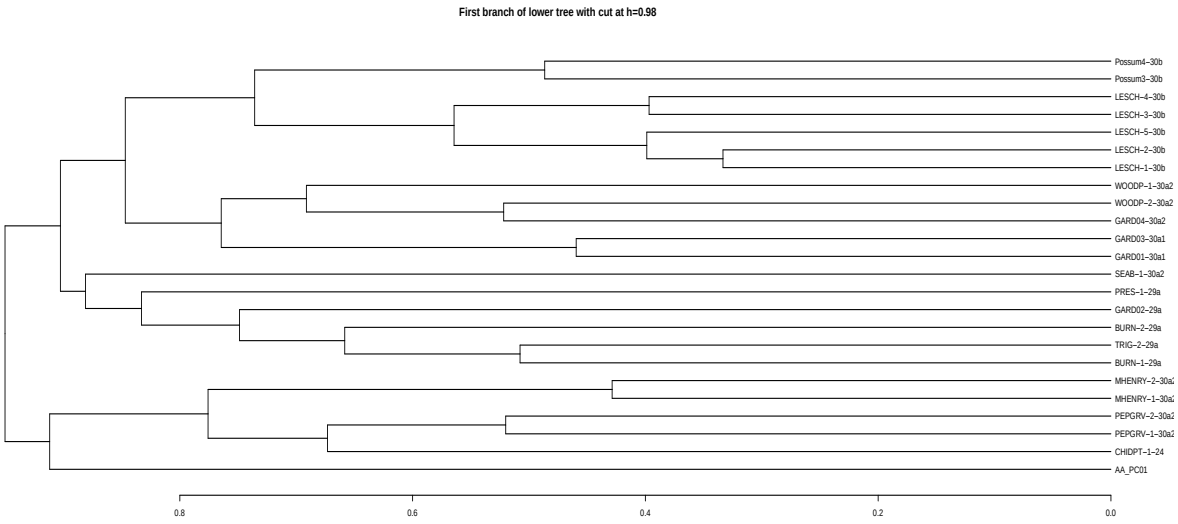
Appendix C

Sampling plot environmental data

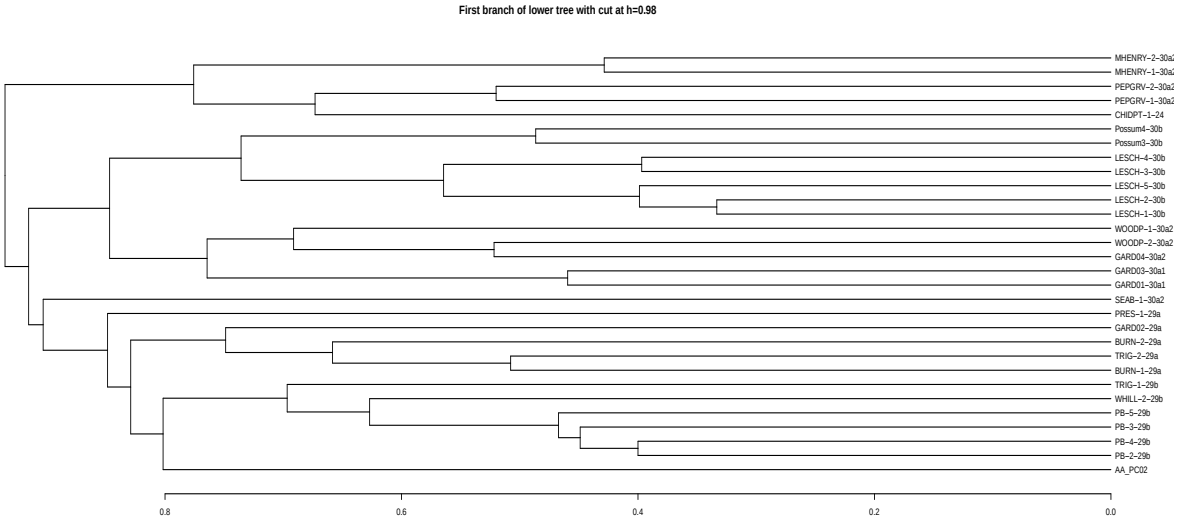
Plot	PC1	PC02	PC03	PC04	PC05	Recce01	Recce02
Latitude (°)	-31.066431	-31.066136	-31.065285	-31.069354	-31.067902	-31.06593	-31.064943
Longitude (°)	115.35569	115.354858	115.355815	115.357628	115.35636	115.35389	115.352393
Aspect (classes)	W	W	E	N/A	SW	N/A	N/A
Slope (°)	2	5	1	0	3	N/A	N/A
Plot Shape	Quadrat	Quadrat	Quadrat	Quadrat	Quadrat	Recce	Recce
Plot Size (m^2)	100	100	100	100	100	N/A	N/A
Plot Width (m)	10	10	10	10	10	N/A	N/A
Plot Length (m)	10	10	10	10	10	N/A	N/A
Placement strategy	Preferential	Preferential	Preferential	Preferential	Preferential	Preferential	Preferential
Date	15/10/2020	15/10/2020	15/10/2020	15/10/2020	15/10/2020	15/10/2020	15/10/2020
Time Since Fire	>5	>5	>5	>5	>5	>5	>5
Bare Ground (%)	10	40	10	15	5	5	20
Bare Rock (%)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Litter (%)	3	10	20	5	35	20	55
Landform	Swale	Crest	Swale	Flat	Swale	Swale	Flat
Soil Colour	Cream	cream	Cream	Cream	Cream	Cream	Cream
Soil Texture	Sand	sand	Sand	Sand	Sand	Sand	Sand
Rock Type	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vegetation Condition	Excellent	Excellent	Excellent	Excellent	Very good	Excellent	Very Good

Appendix D

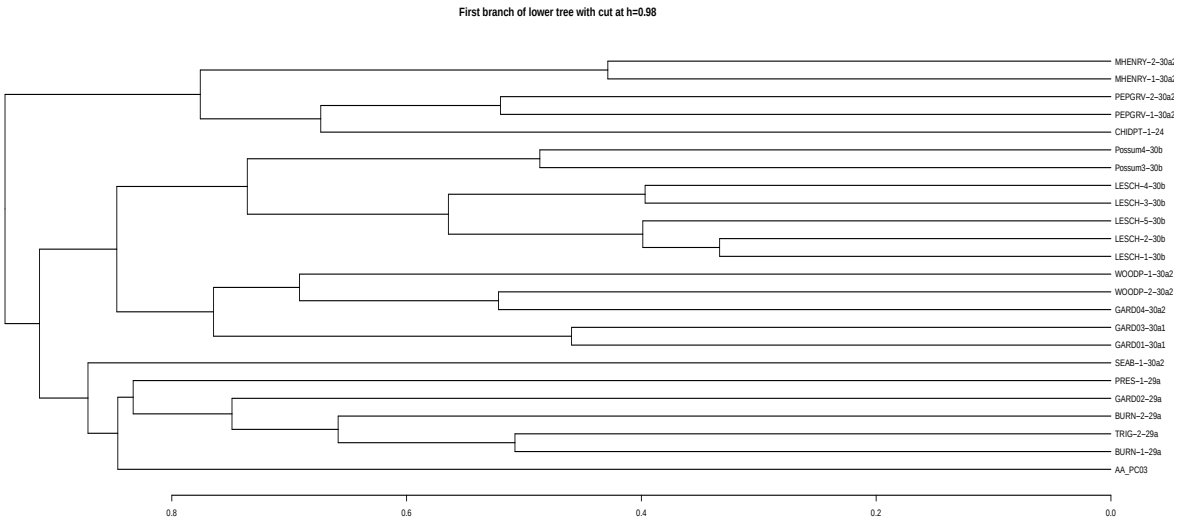
Partial dendrograms from hierarchical clustering assignment of plot floristics to the Swan Coastal Plain classification (Gibson et al. 1994)



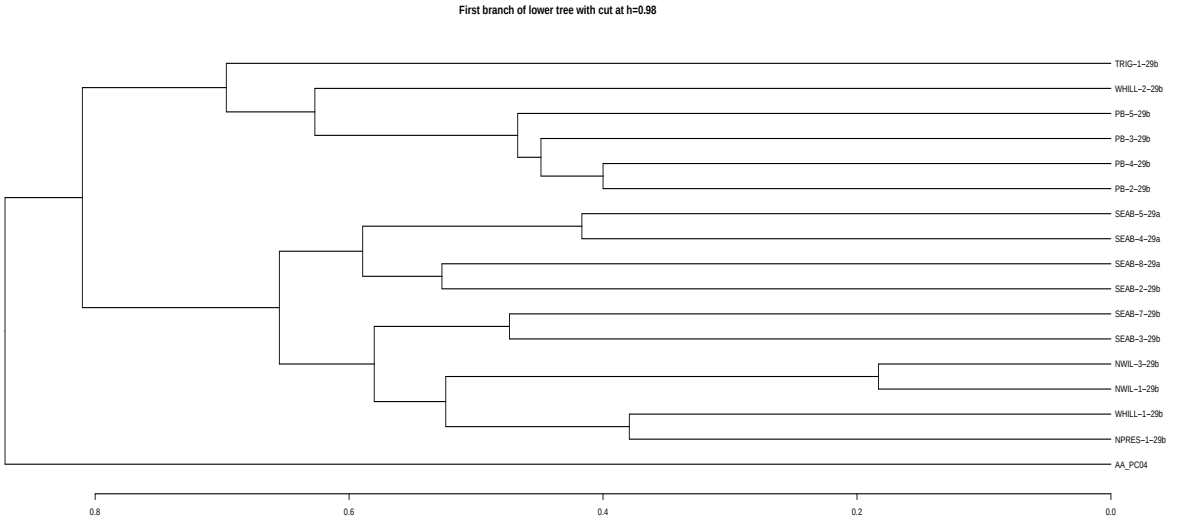
Partial Dendrogram for Plot PC01



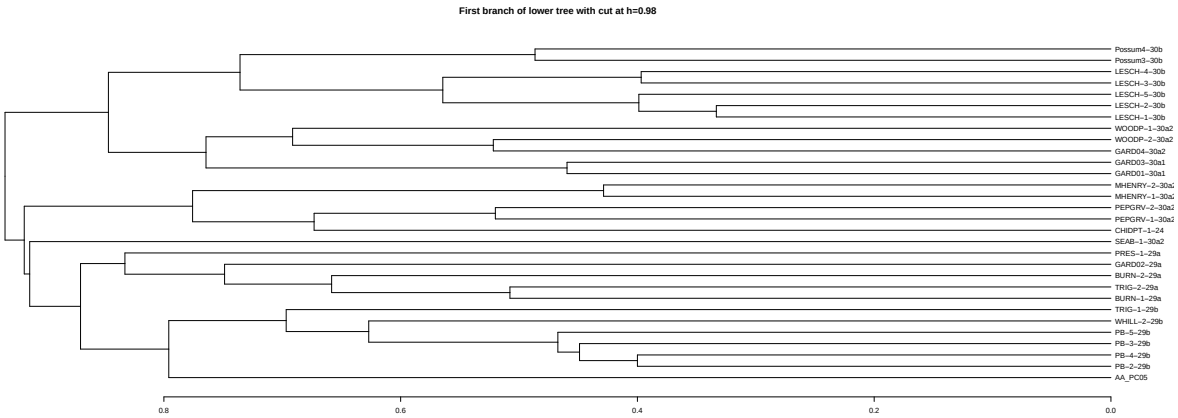
Partial Dendrogram for Plot PC02



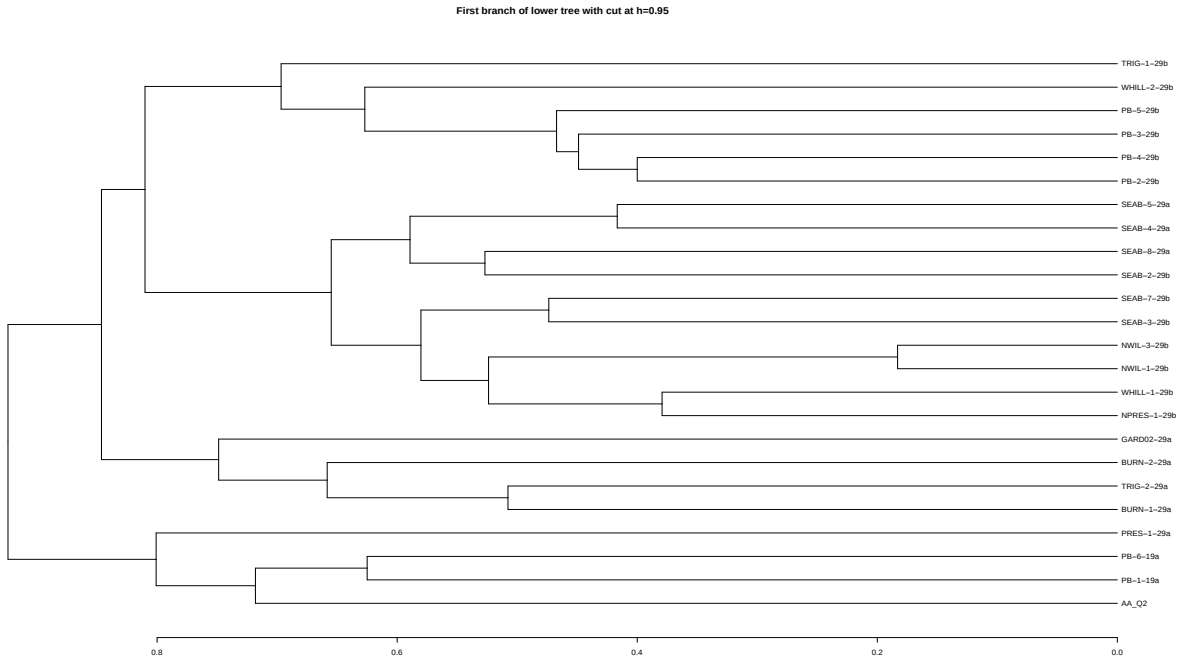
Partial Dendrogram for Plot PC03



Partial Dendrogram for Plot PC 04



Partial Dendrogram for Plot PC 05



Partial Dendrogram for Ecoscape Plot Q2

Appendix E

Definitions of Threatened and Priority Flora and Communities

Department of Parks and Wildlife

CONSERVATION CODES

For Western Australian Flora and Fauna

Specially protected fauna or flora[1] are species[2] which have been adequately searched for and are deemed to be, in the wild, either rare, at risk of extinction, or otherwise in need of special protection, and have been gazetted as such.

Categories of specially protected fauna and flora are:

T **Threatened species**

Published as Specially Protected under the *Wildlife Conservation Act 1950,* and listed under Schedules 1 to 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora (which may also be referred to as Declared Rare Flora).

Threatened fauna is that subset of 'Specially Protected Fauna' declared to be 'likely to become extinct' pursuant to section 14(4) of the Wildlife Conservation Act.

Threatened flora is flora that has been declared to be 'likely to become extinct or is rare, or otherwise in need of special protection', pursuant to section 23F(2) of the Wildlife Conservation Act.

The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as detailed below.

CR **Critically endangered species**

Threatened species considered to be facing an extremely high risk of extinction in the wild. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.

EN **Endangered species**

Threatened species considered to be facing a very high risk of extinction in the wild. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.

VU **Vulnerable species**

Threatened species considered to be facing a high risk of extinction in the wild. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.

EX **Presumed extinct species**

Species which have been adequately searched for and there is no reasonable doubt that the last individual has died. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Presumed Extinct Fauna and Wildlife Conservation (Rare Flora) Notice for Presumed Extinct Flora.

IA **Migratory birds protected under an international agreement**

Birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and the Bonn Convention, relating to the protection of migratory birds. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 5 of the Wildlife Conservation (Specially Protected Fauna) Notice.

CD Conservation dependent fauna

Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 6 of the Wildlife Conservation (Specially Protected Fauna) Notice.

OS Other specially protected fauna

Fauna otherwise in need of special protection to ensure their conservation. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 7 of the Wildlife Conservation (Specially Protected Fauna) Notice.

P Priority species

Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened flora or fauna.

Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring.

Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.

1 Priority 1: Poorly-known species

Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.

2 Priority 2: Poorly-known species

Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.

3 Priority 3: Poorly-known species

Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.

4 Priority 4: Rare, Near Threatened and other species in need of monitoring

(a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These species are usually represented on conservation lands.
(b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for Vulnerable, but are not listed as Conservation Dependent.
(c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

[1] The definition of flora includes algae, fungi and lichens
[2]Species includes all taxa (plural of taxon - a classificatory group of any taxonomic rank, e.g. a family, genus, species or any infraspecific category i.e. subspecies or variety, or a distinct population).

Categories of Threatened Species pursuant to the Environment Protection and Biodiversity Conservation Act 1999

EPBC Act Category	Department of Environment and Energy Definition
Extinct	A native species is eligible to be included in the extinct category at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.
Extinct in the wild	A native species is eligible to be included in the extinct in the wild category at a particular time if, at that time: (a) it is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or (b) it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
Critically endangered	A native species is eligible to be included in the critically endangered category at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
Endangered	A native species is eligible to be included in the endangered category at a particular time if, at that time (a) it is not critically endangered; and (b) it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
Vulnerable	A native species is eligible to be included in the vulnerable category at a particular time if, at that time: (a) it is not critically endangered or endangered; and (b) it is facing a high risk of extinction in the wild in the medium term future, as determined in accordance with the prescribed criteria.
Conservation dependent	A native species is eligible to be included in the conservation dependent category at a particular time if, at that time: (a) the species is the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered; or (b) the following subparagraphs are satisfied: (i) the species is a species of fish; (ii) the species is the focus of a plan of management that provides for management actions necessary to stop the decline of, and support the recovery of, the species so that its chances of long term survival in nature are maximised; (iii) the plan of management is in force under a law of the Commonwealth or of a State or Territory; (iv) cessation of the plan of management would adversely affect the conservation status of the species.

Categories of Threatened Communities pursuant to the Environment Protection and Biodiversity Conservation Act 1999

Category	Definition
Critically Endangered	(1) An ecological community is eligible to be included in the ***critically endangered*** category at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
Endangered	(2) An ecological community is eligible to be included in the ***endangered*** category at a particular time if, at that time: (a) it is not critically endangered; and (b) it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
Vulnerable	(3) An ecological community is eligible to be included in the ***vulnerable*** category at a particular time if, at that time: (a) it is not critically endangered nor endangered; and (b) it is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.

Department of Environment and Conservation
January 2013

DEFINITIONS, CATEGORIES AND CRITERIA FOR THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES

1. GENERAL DEFINITIONS

Ecological Community
A naturally occurring biological assemblage that occurs in a particular type of habitat.

Note: The scale at which ecological communities are defined will often depend on the level of detail in the information source, therefore no particular scale is specified.

A **threatened ecological community** (TEC) is one which is found to fit into one of the following categories; "presumed totally destroyed", "critically endangered", "endangered" or "vulnerable".

Possible threatened ecological communities that do not meet survey criteria are added to DEC's Priority Ecological Community Lists under Priorities 1, 2 and 3. Ecological Communities that are adequately known, are rare but not threatened, or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

An **assemblage** is a defined group of biological entities.

Habitat is defined as the areas in which an organism and/or assemblage of organisms lives. It includes the abiotic factors (eg. substrate and topography), and the biotic factors.

Occurrence: a discrete example of an ecological community, separated from other examples of the same community by more than 20 metres of a different ecological community, an artificial surface or a totally destroyed community.

By ensuring that every discrete occurrence is recognised and recorded future changes in status can be readily monitored.

Adequately Surveyed is defined as follows:
"An ecological community that has been searched for thoroughly in most likely habitats, by relevant experts."

Community structure is defined as follows:
"The spatial organisation, construction and arrangement of the biological elements comprising a biological assemblage" (eg. *Eucalyptus salmonophloia* woodland over scattered small shrubs over dense herbs; structure in a faunal assemblage could refer to trophic structure, eg. dominance by feeders on detritus as distinct from feeders on live plants).

Definitions of Modification and Destruction of an ecological community:

Modification: "changes to some or all of ecological processes (including abiotic processes such as hydrology), species composition and community structure as a

direct or indirect result of human activities. The level of damage involved could be ameliorated naturally or by human intervention."

Destruction: "modification such that reestablishment of ecological processes, species composition and community structure within the range of variability exhibited by the original community is unlikely within the foreseeable future even with positive human intervention."

Note: Modification and destruction are difficult concepts to quantify, and their application will be determined by scientific judgement. Examples of modification and total destruction are cited below:

Modification of ecological processes: The hydrology of Toolibin Lake has been altered by clearing of the catchment such that death of some of the original flora has occurred due to dependence on fresh water. The system may be bought back to a semblance of the original state by redirecting saline runoff and pumping waters of the rising watertable away to restore the hydrological balance. Total destruction of downstream lakes has occurred due to hydrology being altered to the point that few of the original flora or fauna species are able to tolerate the level of salinity and/or water logging.

Modification of structure: The understorey of a plant community may be altered by weed invasion due to nutrient enrichment by addition of fertiliser. Should the additional nutrients be removed from the system the balance may be restored, and the original plant species better able to compete. Total destruction may occur if additional nutrients continue to be added to the system causing the understorey to be completely replaced by weed species, and death of overstorey species due to inability to tolerate high nutrient levels.

Modification of species composition: Pollution may cause alteration of the invertebrate species present in a freshwater lake. Removal of pollutants may allow the return of the original inhabitant species. Addition of residual highly toxic substances may cause permanent changes to water quality, and total destruction of the community.

Threatening processes are defined as follows:
"Any process or activity that threatens to destroy or significantly modify the ecological community and/or affect the continuing evolutionary processes within any ecological community."

Examples of some of the continuing threatening processes in Western Australia include: general pollution; competition, predation and change induced in ecological communities as a result of introduced animals; competition and displacement of native plants by introduced species; hydrological changes; inappropriate fire regimes; diseases resulting from introduced microorganisms; direct human exploitation and disturbance of ecological communities.

Restoration is defined as returning an ecological community to its pre-disturbance or natural state in terms of abiotic conditions, community structure and species composition.

Rehabilitation is defined as the re-establishment of ecological attributes in a damaged ecological community although the community will remain modified.

2. DEFINITIONS AND CRITERIA FOR PRESUMED TOTALLY DESTROYED, CRITICALLY ENDANGERED, ENDANGERED AND VULNERABLE ECOLOGICAL COMMUNITIES

Presumed Totally Destroyed (PD)
An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future.

An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant **and either** of the following applies (A or B):

A) Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats **or**

B) All occurrences recorded within the last 50 years have since been destroyed

Critically Endangered (CR)
An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated.

An ecological community will be listed as **Critically Endangered** when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting **any one or more of** the following criteria (A, B or C):

A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% **and either or both** of the following apply (i or ii):

i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years);

ii) modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated.

B) Current distribution is limited, **and one or more** of the following apply (i, ii or iii):

i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 10 years);

ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes;

iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes.

C) The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 10 years).

Endangered (EN)
An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future.

An ecological community will be listed as **Endangered** when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information by it meeting **any one or more of** the following criteria (A, B, or C):

A) The geographic range, and/or total area occupied, and/or number of discrete occurrences have been reduced by at least 70% since European settlement **and either or both** of the following apply (i or ii):

i) the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term future (within approximately 20 years);

ii) modification throughout its range is continuing such that in the short term future (within approximately 20 years) the community is unlikely to be capable of being substantially restored or rehabilitated.

B) Current distribution is limited, **and one or more** of the following apply (i, ii or iii):

i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years);

ii) there are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes;

iii) there may be many occurrences but total area is small and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes.

C) The ecological community exists only as very modified occurrences that may be capable of being substantially restored or rehabilitated if such work begins in the short-term future (within approximately 20 years).

Vulnerable (VU)
An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range.

An ecological community will be listed as **Vulnerable** when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium (within approximately 50 years) to long-term future. This will be determined on the basis of the best available information by it meeting **any one or more of** the following criteria (A, B or C):

A) The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated.

B) The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations.

C) The ecological community may be still widespread but is believed likely to move into a category of higher threat in the medium to long-term future because of existing or impending threatening processes.

3. DEFINITIONS AND CRITERIA FOR PRIORITY ECOLOGICAL COMMUNITIES

Possible threatened ecological communities that do not meet survey criteria or that are not adequately defined are added to the Priority Ecological Community List under priorities 1, 2 and 3. These three categories are ranked in order of priority for survey and/or definition of the community. Ecological communities that are adequately known, and are rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

Priority One: Poorly-known ecological communities

Ecological communities that are known from very few occurrences with a very restricted distribution (generally ≤5 occurrences or a total area of ≤ 100ha). Occurrences are believed to be under threat either due to limited extent, or being on lands under immediate threat (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) or for which current threats exist. May include communities with occurrences on protected lands. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.

Priority Two: Poorly-known ecological communities

Communities that are known from few occurrences with a restricted distribution (generally ≤10 occurrences or a total area of ≤200ha). At least some occurrences are not believed to be under immediate threat (within approximately 10 years) of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.

Priority Three: Poorly known ecological communities

(i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or:

(ii) communities known from a few widespread occurrences, which are either large or with significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat (within approximately 10 years), or;

(iii) communities made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, inappropriate fire regimes, clearing, hydrological change etc.

Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.

Priority Four: Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring.

(i) Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands.

(ii) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for a higher threat category.

(iii) Ecological communities that have been removed from the list of threatened communities during the past five years.

Priority Five: Conservation Dependent ecological communities

Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Appendix C

Consolidated Flora Species List

Lot 510 Old Ledge Point Road, Lancelin
Consolidated Flora Species List

Sources: Ecoscape (2007)
Plantecology (2021)

Acacia cyclops
Acacia lasiocarpa var. lasiocarpa
Acacia rostellifera
Acacia truncata
Acanthocarpus preissii
Acrotriche cordata
Agonis flexuosa
Allocasuarina lehmanniana subsp. lehmanniana
Asteridea pulverulenta
Baumea juncea
Brachyscome bellidioides
Brachyscome iberidifolia
Calandrinia tholiformis
Calothamnus quadrifidus subsp. quadrifidus
Carpobrotus virescens
Cassytha aurea var.aurea
Cassytha racemosa
Clematis linearifolia
Comesperma confertum
Conostephium preissii
Conostylis ?pauciflora subsp. euryrhipis
Conostylis candicans subsp. calcicola
Crassula glomerata
Cryptandra mutila
Daucus glochidiatus
Desmocladus flexuosus
Dianella revoluta
Eremophila glabra subsp. albicans
Exocarpos sparteus
Ficinia nodosa
Gastrolobium nervosum
Hardenbergia comptoniana
Hemiandra glabra
Hibbertia racemosa
Isotoma hypocrateriformis
Lepidosperma gladiatum
Lepidosperma pubisquameum
Lepidosperma squamatum
Lepidosperma tetraquetrum
Leptomeria cunninghamii
Leucopogon parviflorus
Lomandra maritima
Lysinema pentapetalum
Melaleuca cardiophylla
Melaleuca huegelii subsp. huegelii
Melaleuca lanceolata
Melaleuca systena
Myoporum insulare
Olearia axillaris
Opercularia vaginata
Phyllanthus calycinus
Pimelea ferruginea
Poa porphyroclados
Rhagodia baccata subsp. baccata
Rhagodia preissii subsp. preissii
Rhodanthe citrina
Rytidosperma occidentale
Santalum acuminatum
Scaevola crassifolia
Scaevola nitida
Scaevola thesioides subsp. thesioides
Senecio pinnatifolius var. latibolus
Spinifex longifolius
Spyridium globulosum
Stackhousia pubescens
Stylidium scariosum
Styphelia insularis
Templetonia retusa
Tetragonia decumbens
Threlkeldia diffusa
Thysanotus arenarius
Trachyandra divaricata
Trachymene cyanopetala
Trachymene pilosa
Trymalium ledifolium var. ledifolium
Waitzia acuminata var. acuminata
*Asphodelus fistulosus
*Austrostipa flavescens
*Avena barbata
*Bromus diandrus
*Carpobrotus edulis
*Cuscuta epithymum
*Dischisma arenarium
*Euphorbia terracina
*Heliophila pusilla
*Lolium rigidum
*Pelargonium capitatum

Appendix D

Aboriginal Sites Report

Search Criteria

Site 3237

Disclaimer

Aboriginal sites exist that are not recorded on the Register of Aboriginal Sites, and some registered sites may no longer exist. Consultation with Aboriginal communities is on-going to identify additional sites. The AHA protects all Aboriginal sites in Western Australia whether or not they are registered.

Copyright

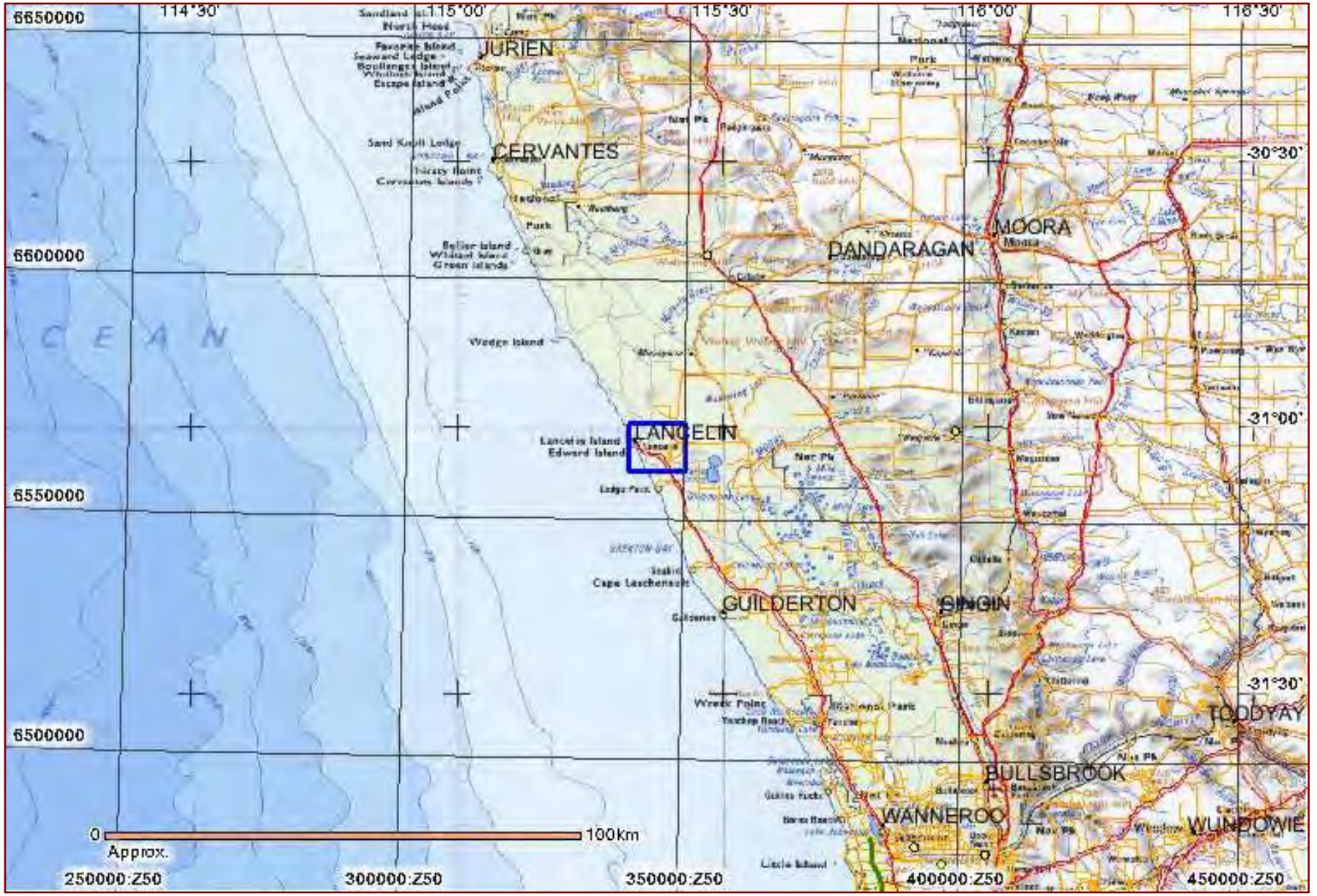
Legend

Restriction		Access		Status		Coordinate Accuracy	
N	No restriction	C	Closed	I	Interim register	Accuracy is shown as a code in brackets following the site coordinates.	
M	Male access only	O	Open	P	Permanent register	[Reliable]	The spatial information recorded in the site file is deemed to be reliable, due to methods of capture.
F	Female access	V	Vulnerable	S	Stored data	[Unreliable]	The spatial information recorded in the site file is deemed to be unreliable due to errors of spatial data capture and/or quality of spatial information reported.

Spatial Accuracy

Index coordinates are indicative locations and may not necessarily represent the centre of sites, especially for sites with an access code “closed” or “vulnerable”. Map coordinates (Lat/Long) and (Easting/Northing) are based on the GDA 94 datum. The Easting / Northing map grid can be across one or more zones. The zone is indicated for each Easting on the map, i.e. '5000000:Z50' means Easting=5000000, Zone=50.

Site ID	Status	Access	Restriction	Site Name	Site Type	Additional Info	Informants	Coordinates	Site No.
3237	S	O	N	Ledge Point.		Camp, Water Source		345136mE 6565151mN Zone 50 [Unreliable]	S00542



Legend

- Highlighted Area
- Town
- Map Area
- Search Area

Appendix E

Lime Sand Analysis Results

Liquid Labs WA
Unit 16b/81 Briggs Street
Carlisle, WA 6106
Perth Australia

NEUTRALISING VALUE TEST REPORT

BSEN1245:2014 Method A

Client	**Cooljarloo Limstone and Limesand**	Ticket No.	**M176**
Client Address	**10092 Indian Ocean Dr, Cooljarloo WA 6507**	Report No.	**LLM19/076_1_NV**
Project	**Material Assessment - Lime Sand**	Sample No	**LLM19/076**
Sampling Location	**Cooljarloo**	Date of Test	**14/02/2019**
Sample Identification	**20195LT - South Pit**	Sampled By	**Client**

LABORATORY RESULTS

Sieve Range (mm)	% Retained	Neutralising Value
0.000 - 0.125	2.2	84.4
0.125 - 0.250	60.1	92.0
0.250 - 0.500	36.5	96.9
0.500 - 1.000	1.2	91.1
>1.000	0.0	NT

Weighted Average Neutralising Value (%)	93.6	Calcium (%)	38.0
Bulk Neutralising Value (%)	93.0	Magnesium (%)	2.0
		Sodium (%)	0.2

Comments *NT = Not Tested*

Approved Signatory

Name Ryan Grieve

Function Technicial Manager

Date 18/02/2019

Liquid Labs WA
Unit 16b/81 Briggs Street
Carlisle, WA 6106
Perth Australia

NEUTRALISING VALUE TEST REPORT

BSEN1245:2014 Method A

Client	**Cooljarloo Limstone and Limesand**	Ticket No.	**M176**
Client Address	**10092 Indian Ocean Dr, Cooljarloo WA 6507**	Report No.	**LLM19/077_1_NV**
Project	**Material Assessment - Lime Sand**	Sample No	**LLM19/077**
Sampling Location	**Cooljarloo**	Date of Test	**14/02/2019**
Sample Identification	**20196B - South Pit**	Sampled By	**Client**

LABORATORY RESULTS

Sieve Range (mm)	% Retained	Neutralising Value
0.000 - 0.125	2.2	87.9
0.125 - 0.250	60.6	94.5
0.250 - 0.500	34.2	97.2
0.500 - 1.000	3.0	93.2
>1.000	0.0	NT

Weighted Average Neutralising Value (%)	**95.2**	**Calcium (%)**	**31.0**
Bulk Neutralising Value (%)	**92.6**	**Magnesium (%)**	**1.6**
		Sodium (%)	**0.2**

Comments *NT = Not Tested*

Approved Signatory

Name Ryan Grieve

Function Technicial Manager

Date 18/02/2019

Liquid Labs WA
Unit 16b/81 Briggs Street
Carlisle, WA 6106
Perth Australia

NEUTRALISING VALUE TEST REPORT

BSEN1245:2014 Method A

Client	**Cooljarloo Limstone and Limesand**	Ticket No.	**M176**
Client Address	**10092 Indian Ocean Dr, Cooljarloo WA 6507**	Report No.	**LLM19/078_1_NV**
Project	**Material Assessment - Lime Sand**	Sample No	**LLM19/078**
Sampling Location	**Cooljarloo**	Date of Test	**14/02/2019**
Sample Identification	**20196WB - South Pit**	Sampled By	**Client**

LABORATORY RESULTS

Sieve Range (mm)	% Retained	Neutralising Value
0.000 - 0.125	3.4	88.5
0.125 - 0.250	60.7	92.7
0.250 - 0.500	33.1	97.1
0.500 - 1.000	2.7	93.4
>1.000	0.0	NT

Weighted Average Neutralising Value (%)	**94.1**	**Calcium (%)**	**28.0**
Bulk Neutralising Value (%)	**93.1**	**Magnesium (%)**	**1.5**
		Sodium (%)	**0.1**

Comments *NT = Not Tested*

Approved Signatory

Name Ryan Grieve

Function Technicial Manager

Date 18/02/2019

Appendix F

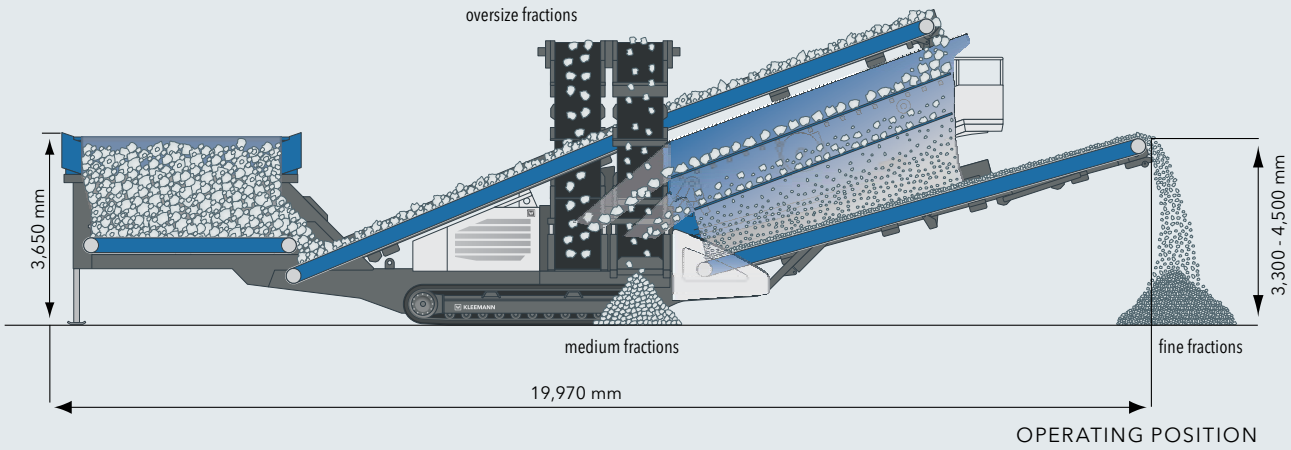
Kleeman Mobiscreen MS952EVO

A WIRTGEN GROUP COMPANY

KLEEMANN

TECHNICAL SPECIFICATIONS I TRACK-MOUNTED SCREENING PLANT

MOBISCREEN MS 952 EVO



TECHNICAL HIGHLIGHTS

- Double-deck screening unit
- Diesel-hydraulic drive
- Classifying screen
- Max. feed size: 150 mm

TECHNICAL SPECIFICATIONS MS 952 EVO

Feeding unit	
Feed capacity up to approx. (t/h)	500
Feed size max. (mm)	150 x 150
Feed height - foldable slotted grate (mm)	3,650
Hopper capacity (m³)	8
Hopper discharge conveyor	
Width x length (mm)	1,200 x 3,500
Feeding conveyor	
Width x length (mm)	1,200 x 12,000
Screening unit	
Type	double-deck vibration screen
Width x length (mm)	1,550 x 6,100
Main discharge conveyor	
Width x length (mm)	1,200 x 8,100
Discharge height approx. (mm)	3,300 - 4,500

Side conveyor right hand side	
Width x length (mm)	800 x 10,200
Discharge height approx. (mm)	5,000
Side conveyor left hand side	
Width x length (mm)	800 x 10,200
Discharge height approx. (mm)	5,000
Drive	
Drive concept	diesel-hydraulic
MS 952: Deutz (Tier 3/Stage IIIA) (kW)	90
MS 952i: Deutz (Tier 4f/Stage IV) (kW)	90
Transport	
Transport height approx. (mm)	3,400
Transport length approx. (mm)	18,600
Transport width approx. (mm)	3,000
Transport weight approx. (kg)	33,900