

Table 1: Indirect threats/impacts associated with the proposal.

THREAT/IMPACTS	LITERATURE REVIEW	CURRENT THREAT STATUS	FUTURE THREAT STATUS
Direct Clearing	Littoral rainforest is listed as an EEC at the NSW and Federal level. ERM (1996) reviewed aerial photos of the area between Bonny Hills and Lake Cathie, documenting the contraction of native vegetation to the west. Sand mining is also known to have occurred north of Bonny Hills, and most of the vegetation east of the site indicates this, as well as the modified dune topography.	The SEPP 26 area falls within Crown land east of private landholdings. A current beach access exists.	The Part 3A proposals do not propose any clearing of the SEPP 26 vegetation. Existing beach access to be formalised as part of the property's future development. Route will follow existing track hence no new track created. No other clearing or intrusion into the Crown land proposed.
Weed Invasion	<p>Bitou Bush is the main weed threat to littoral rainforest due to its ability to penetrate closed canopies and overwhelm existing communities, as well as out compete native regrowth (Buchanan 1989, ERM 1996, NSWSC 1999, Hamilton <i>et al</i> 2008). Lantana is also a threat as it dominates the edges and suppresses establishment of native species (ERM 1996, Lamb 1982, NSWSC 2006a). Other weeds such as Winter Senna, also compete with native species especially at the edge.</p> <p>Disturbance of soil provides the opportunity for weed invasion. Weeds may also be transported into littoral rainforest via informal tracks made by people, and well as grazing stock eg cattle and horses. Dumping of green wastes may also introduce plant propagules, or introduce nutrients which advantage such species (ERM 1996, Buchanan 1989).</p> <p>Some ornamental plants also have the potential to escape and become weeds (Bennet <i>et al</i> 2000), though restrictions on the sale of such plants under the <i>Noxious Weeds Act 1993</i> reduce this threat.</p>	<p>Bitou Bush heavily infests the foredune, especially on the lee side (see later photos), but is not a threat to the rainforest north of the beach access due to the closed canopy. South of the beach access, it is hampering regeneration/succession in the Banksia woodland by rainforest species via smothering rainforest regeneration and development of protective shrubland to the east (see later photos). Bitou also occurs as scattered plants along the western fringe but is not a significant weed.</p> <p>Lantana dominates a large patch on the immediately southern side of the beach access (see later photo), and lines most of the beach access track. It only occurs as a few small plants along the western fringe north of the beach access, and south of the beach access thins out from the initial dense patch to a few scattered plants due to the well developed edge. Some pioneer plants are struggling to infest gaps in the southern end of the rainforest from the track infestations. Also occurs in patches just behind the foredune where it is hampering regeneration/succession.</p> <p>Winter Senna (<i>Senna pendula</i>) occurs sporadically along the western edge, in the canopy gaps in the rainforest (see later photo), along the beach access, and sporadically under the mosaic of rainforest, Banksia woodland and tall <i>Leptospermum</i> spp shrubland (latter dominates) which constitutes the dune vegetation south of the beach access.</p>	<p>No substantial soil disturbance is likely to occur during the rehabilitation of the walking track – sand will probably be imported to fill foundation for track, or will be sealed. Specific weed control will be undertaken to ensure weeds do not re-establish.</p> <p>Current weed infestations in the Crown land vegetation from the beach front to the site will be removed to encourage the continuation of ecological processes and re-development of rainforest vegetation.</p> <p>Development envelope centred on pasture, with positive impact of removing primary invasive weed source, and maintenance of the remaining pasture via mowing to form lawns will minimise propagule production and dispersal.</p> <p>No residential subdivision to be established adjacent to Crown land (nearest located >300m west) hence no risk of any garden or other significant waste dumping.</p> <p>All plantings in interface zone to be based on local indigenous species to avoid risk of exotic escapees.</p>

		<p>Other problem weeds such as Coastal Morning Glory (<i>Ipomoea cairica</i>), Morning Glory (<i>I. indica</i>) and Turkey Rhubarb (<i>Acetosa sagittata</i>) are also present.</p> <p>Pasture grasses eg Rhodes Grass) and weeds (eg Crofton Weed) dominate the beach access. A few Native Tobacco also occur.</p>	
Fencing	<p>Fences have potential to obstruct the movement of threatened fauna across the site. Some threatened fauna can be injured by collision with wire fences, particularly barbed wire eg the Yellow-Bellied Glider, owls and Squirrel Glider have been recorded being injured by barbed wire fences (Lindenmayer 2002, Berrigan 2001c, Woodford 1999).</p>	<p>Eastern boundary is currently fenced with strand boundary fence. South of the beach access, the fence is largely overgrown with native species. North of the access, the fence stands out from the forest. This poses a minor (compared to barbed wire) potential injury risk to birds and perhaps Microbats at dusk and dawn, and at night during times of limited visibility.</p>	<p>Fence retained to act as impediment to human penetration and minimise soil disturbance. Native vegetation to be planted around it to incorporate the fence as a structure within the forest.</p>
Noise and Physical Disturbance	<p>Noise effects on fauna in Australia are relatively poorly studied (Clancy 2001, Berrigan 2001d). Most evidence presented is anecdotal, but suggests most fauna have a fair degree of tolerance and adaptation at least to residential noise depending on species, situation, habitat/lifecycle stage affected, habitat significance, etc. Generally as noise is accompanied with a physical disturbance, it has a greater negative effect (ERM 1996, Clancy 2001, Radle <i>undated</i>).</p>	<p>Background noise dominated by ocean. No proximate roads and limited vehicle activity on beach.</p>	<p>Noise will increase due to:</p> <ul style="list-style-type: none"> • Public using beach access as primary access to beach. • Establishment of a tourist facility adjacent. • Establishment of carpark. <p>This elevated level of anthropogenic activity may deter use of habitat in close proximity to the beach access by diurnal birds. Limited activity is expected at night (eg fishermen) with consequentially limited impacts.</p>
Erosion and Sedimentation	<p>Sedimentation and erosion impacts can occur at both the construction and establishment phases. Erosion/sedimentation may occur via erosion of fill material and disturbed soils, scouring of exposed soil, earthen banks and habitats adjacent to the development area via directed flow (eg stormwater), or where runoff is concentrated.</p>	<p>Local topography is generally flat hence erosion by water flow is a very minor risk.</p> <p>Beach access is highly eroded (gully formation) at eastern end. Requires rehabilitation to prevent penetration by large seas.</p>	<p>Beach access to be completely reconstructed to be erosion resistant, mitigate penetration of maritime stresses, prevent wave access, and passable when wet (to avoid people detouring through adjacent vegetation to avoid mud and puddles). Fencing along side of beach access and planting of appropriate species (eg Spiney-Headed Matrush) will deter creation of informal tracks.</p> <p>Construction adjacent to Crown land on flat land, with all construction activity confined to designated areas to avoid compaction in the vegetated screen areas. Standard erosion and sedimentation controls will also apply.</p>

<p>Introduction of feral/introduced species</p>	<p>Urban and rural developments are often associated with the introduction of non-native species ie rodents, cats and dogs. Cats are significant predators of native species (NSWSC 2000a, Dickman 1996), and domestic dogs are significant threats to species such as the Koala (Wilkes and Snowden 1998, Port Stephens Council 2001, Connell Wagner 2000b, DECC 2009b). Rodents compete with native species but also form component of native species prey (DECC 2009b, Debus 1993). Foxes may also be attracted to urbanised and rural areas by opening up forest to open woodland (NPWS 2001, NSWSC 2000b), and food scraps (NPWS 2001, NSWSC 2000b).</p>	<p>Berrigan and Bray (2004) and Parker (2002) have in total surveyed almost all of SEPP 26 #116. Both surveys recorded a high abundance of native species.</p> <p>In survey of property, Darkheart (2009) also did not record small exotic mammals but did observe evidence of deer, foxes and wild dogs. Deer tracks are evident in the rainforest and dune vegetation, and control measures has seen 9 removed since August 2007 from the property. Deer are particularly problematic as they may graze plantings and damage regeneration areas.</p>	<p>Domestic dogs currently allowed on the adjacent beach, and local residents may walk their dogs along this beach via the beach access. It is expected these would be required by Council statute to be leashed when entering or leaving the beach. Dogs will be allowed within the residential area to the west. Dogs and cats potentially could roam from future residential development to the north-northwest due its closer proximity. Control measures will be required to mitigate access to the littoral rainforest by non-native species.</p> <p>Foxes may currently use the vegetated Crown land and other remnant vegetation for refuge. Feral cats may also occur and may potentially increase with future urban development in the area. Deer may be deterred by high human presence.</p> <p>Exotic rodents likely to establish in the residential areas in the medium to long term, and may potentially move into the Crown land.</p> <p>Ongoing deer control to be undertaken, and plantings to be protected eg via tree guards.</p>
<p>Artificial Lighting</p>	<p>Lighting may potentially discourage particularly nocturnal native species from foraging near areas of development (eg Squirrel Gliders), especially given light may travel significant distances and it can have a similar effect to a full moon on the hunting success of predators such as owls, or a behavioural avoidance impact by potential prey species (DEC 2004a, Andrews 1990, Grayson and Calver 2004, ERM 1996). Artificial lighting also shown to affect Microchiropteran bat assemblages positively and negatively (Scanlon and Petit 2008).</p> <p>Conversely, wallabies, kangaroos, Tawny Frogmouth Owls, Kookaburras, Magpies and possums have been noted foraging under artificial lighting in residential areas eg around Lake Innes, Port Macquarie and Kendall (personal observations). Artificial lighting may also be</p>	<p>Currently no artificial light source in any proximity to Crown land.</p>	<p>Artificial lighting will exist in close proximity to the Crown land from:</p> <ul style="list-style-type: none"> • Street and path lighting. • Lighting in any carpark. • Lighting around and in any building. • Vehicle headlights. <p>Light spillage dissipates with distance (ERM 1996), but in general ambient light levels are expected to significantly increase. This may affect nocturnal fauna in the adjacent Crown land.</p>

	<p>beneficial to Microchiropteran bats by localised aggregation of insects, with these animals being observed foraging under streetlights, floodlights, and even landing on fully lit footpaths in Horton St, Port Macquarie, to scamper for insects (personal observations).</p> <p>Artificial lighting can also have the positive impact of increasing sight detection of fauna on roads, thus reducing risk of road kills eg Koalas (Wilkes and Snowden 1998, AKF 2003, Connell Wagner 2000, Port Stephens Council 2001, Lunney <i>et al</i> 1999, DECC 2008d).</p>		
Bushfire	<p>Bushfire is an extinction threat to the ecological integrity of littoral rainforest (ERM 1996, Keith 2004, NSWSC 2004a, DEWHA 2009). Small fires only burning the edges can also open up closed canopies, altering microclimates, resulting in lower humidity and drying out. This also prevents extension of the community, and provides an edge for weeds to establish (ERM 1996, DEWHA 2009, NSWSC 2004a).</p>	<p>There is no evidence of recent fire in the Crown land but extensive fire could readily lead to local extinction of the local occurrence.</p> <p>Adjacent land to west is grassland with a high component of Bladey Grass, hence risk of grass fire burning into rainforest, though periodic slashing and minimum arson risk as no proximate residential area.</p>	<p>Pasture will be removed/maintained by development, hence this threat will be eliminated.</p> <p>Higher human presence especially due to pathway adjacent to Crown land and beach access will increase risk of arson, but high vigilance due to high human presence. Enhancement of edge to maintain high moisture levels would also reduce fire risk.</p>
Overshadowing	<p>Overshadowing by buildings does not appear to be an issue for this community. ERM (1996) suggests overshadowing may have positive impacts via protecting exposed western edges from drying out and disadvantaging light favouring weeds.</p>	<p>Current edge exposed to western sun due to extent of pasture and limited or no ecotone vegetation.</p>	<p>At most three storey buildings may be erected though single storey more likely. With required setbacks for Asset Protection Zones, very limited potential for any substantial overshadowing.</p>
Maritime Stresses	<p>Onshore salt laden winds are a primary environmental factor responsible for the character of this community (NSWSC 2004a, DEWHA 2009, ERM 1996, Keith 2004, Floyd 1990). The wind and salt content is a prime influence in the dune vegetation succession, but also provides nutrients to otherwise poor soils.</p> <p>Clearing or modification of seafront vegetation can allow salt-laden winds to penetrate into the closed rainforest, affecting humidity and moisture content, as well as toxic effects resulting die off of sensitive species and invasion by weeds or seral natives eg Banksias and Leptospermums.</p>	<p>The foredune vegetation contains at times high infestations of low Bitou Bush which hampers development of a tall Banksia woodland which is required to protect the littoral rainforest. Much of the littoral rainforest immediately northeast of the site has little or no buffering vegetation, with salt burn evident. Occurrence adjacent to site has good protection, but south of beach access, senescent Banksias are not being replaced by recruits due to smothering by Bitou, leaving rear vegetation exposed hence hampering regeneration. Numerous old tracks/drains also cut through dunes, providing tunnels for maritime stresses.</p>	<p>Beach access will be formalised with design to minimise penetration of wind funnel effect.</p> <p>Removal of weeds along edge will be undertaken to minimise risk of salt penetration and burn, and re-establish an effective edge based on native species.</p>

		The current access cuts to just above mean high tide level in the foredune, and forms a wind funnel to and from the beach. Despite this, the generally dense edge vegetation along the track appears to limit salt damage.	
Other Wind Impacts	<p>Turbulence formed by the lack of continuity to the forest or a gradual ecotone, as well as gaps in the canopy on the western side allow the microclimate to dry out by hot westerly winds (ERM 1996). Salt burn may also result on the western due to turbulence and eddies (ERM 1996).</p> <p>Windshear effects created by locating buildings close to littoral rainforest where there is no height gradation in vegetation or a funnel effect between buildings and retained vegetation (ERM 1996), This may also contribute to wind shear, exacerbating the above impacts.</p>	<p>ERM (1996) report dieback on the western side of the community due to salt burn as a result of loss of buffering vegetation and impacts on wind patterns. No salt damage was evident on western side of rainforest adjacent to the site.</p> <p>Vegetation north of beach access generally has typically wind-sheared shaped canopy with limited gaps. Vegetation south of beach access very patchy with many gaps promoting turbulence.</p>	<p>Buildings will be setback from Crown land vegetation at least 30m due to APZs, hence will create an open space between built zone and Crown land vegetation, and may affect wind patterns.</p> <p>Measures proposed to provide more effective buffers and vegetation canopies to mitigate environmental stresses and support ecological succession processes.</p>
Rubbish Dumping	Rubbish dumping can assist the introduction of some weeds via transport of propagules and crushing of native vegetation during access or by dumped materials.	Several piles of old concrete lie on the eastern boundary of the site. Possibly a relic of former sandmining activities.	Concrete piles will be removed. Litter will be controlled by Council fines advertised on signage, with sufficient bins provided at the tourism facility and along paths for litter control.
Stock Grazing	Stock access leads to modification of floristics and structure, and creates access for weeds, feral animals and maritime stresses, collectively leading to degradation of littoral rainforest (NSWSC 2004a, DEWHA 2009, ERM 1996).	Stock are kept on the property, but have no access to Crown reserve other than reaching through the fence to graze.	Stock will be permanently removed from the property with residential and tourist development.
Hydrology and Eutrophication	Conversion of catchments into urban areas modifies local hydrology eg more and faster runoff, less groundwater penetration, etc. Nutrients from lawn fertilisers, dog faeces and petrochemical residues are also directed via stormwater to areas where runoff may collect. Where stormwater discharges into native vegetation, localised elevated moisture and nutrient levels can lead to dieback or displacement of native species with other natives adapted to such conditions, or weed species (ERM 1996, Webb 1995, DLWC 1998a, 1998b).	No risk as catchment has limited urbanisation and located well away from stormwater collection areas.	<p>Crown land and adjacent area of site falls on flat land, hence rain will most likely infiltrate in situ, or be directed to Duchess Gully.</p> <p>Runoff from adjacent future residential land to north will be subject to Water Sensitive Urban Design (WSUD) principles and appropriate treatment before discharge to Duchess Gully.</p>