Australian Government

BUILDING OUR FUTURE

NSW GOVERNMENT

Coffs Harbour Bypass

Environmental Impact Statement

September 2019

VOLUME 7

Socio-economic and agriculture assessments

Appendix K

- Sub-appendix K1 – Property impacts
- Sub-appendix K2 – Agricultural assessment
- Sub-appendix K3 – Business and community surveys



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APPENDIX

K

Appendix K

Sub-appendix K1

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Appendix K

SUB-APPENDIX

K1

Appendix K

Sub-appendix K1

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Sub-appendix K1

Property impacts

Appendix K1 – Property impacts

Property ID	Owner	Primary land use	Total lot area (ha)	Percentage directly impacted (%)	Area directly impacted (ha)	Building impacted	Potential management options
0.5	Private	Rural residential	20	0.50	0.1	None	Partial
1	Private	Rural residential	9.51	6.60	0.63	None	Partial
1.1	Private	Rural residential	11.07	0.10	0.01	None	Partial
2	Private	Rural residential	0.73	35.20	0.26	None	Partial
3	Private	Rural residential	0.51	14.30	0.07	None	Partial
4	CHCC	Commercial	71.73	4.70	3.35	Industrial Industrial Industrial	Partial
5	Private	Extensive agriculture	11.73	3.90	0.45	Residential	Partial
6	Private	Extensive agriculture	0.2	100.00	0.2	Residential	Total
7	Private	Extensive agriculture	2.03	16.00	0.33	None	Partial
7.5	Private	Extensive agriculture	3.48	10.80	0.38	None	Partial
8	Roads and Maritime	Native vegetation	0.14	100.00	0.14	None	Total
9	Crown Land	Native vegetation	0.76	100.00	0.76	None	Total
9.5	Private	Commercial	2.55	19.90	0.51	None	Partial
10	Roads and Maritime	Commercial	1.58	100.00	1.58	Residential	Total
11	Roads and Maritime	Commercial	0.27	100.00	0.27	Industrial	Total
12	Roads and Maritime	Commercial	0.52	100.00	0.52	Industrial	Total
13	Private	Commercial	0.37	100.00	0.37	Residential	Total
13.1	Private	Commercial	0.31	100.00	0.31	Industrial Industrial	Total
13.2	Private	Commercial	0.21	100.00	0.21	Industrial	Total

Property ID	Owner	Primary land use	Total lot area (ha)	Percentage directly impacted (%)	Area directly impacted (ha)	Building impacted	Potential management options
13.3	Private	Commercial	0.22	5.10	0.01	None	Partial
14	Roads and Maritime	Commercial	2.06	100.00	2.06	Industrial	Total
15	Roads and Maritime	Commercial	1.95	100.00	1.95	None	Total
16	Roads and Maritime	Rural residential	18.11	100.00	18.11	Residential Residential	Total
17	Roads and Maritime	Public use	11.52	100.00	11.52	Residential	Total
18	Roads and Maritime	Extensive agriculture	51.08	12.50	6.39	None	Partial
18.1	Private	Extensive agriculture	44.58	4.80	2.13	None	Partial
19	Department of Education and Training	Extensive agriculture	13.49	86.60	11.69	None	Partial
20	Private	Extensive agriculture	9.61	5.10	0.49	None	Partial
21	Private	Native vegetation	20.11	34.90	7.01	None	Partial
22	Roads and Maritime	Extensive agriculture	8.75	100.00	8.75	None	Total
22.1	Roads and Maritime	Rural residential	0.44	100.00	0.44	None	Total
22.5	Private	Rural residential	3.71	3.90	0.14	None	Partial
23	Roads and Maritime	Extensive agriculture	4.57	100.00	4.57	None	Total
24	Roads and Maritime	Native vegetation	5.23	100.00	5.23	None	Total
25	Private	Irrigated plants	3.43	70.60	2.42	None	Partial
26	Private	Irrigated plants	3.43	81.40	2.79	None	Partial
27	Private	Irrigated plants	4.08	7.40	0.3	None	Partial
28	Private	Irrigated plants	5.47	9.20	0.5	Residential	Partial
29	Private	Irrigated plants	21.34	41.90	8.94	Residential Residential Residential	Partial

Property ID	Owner	Primary land use	Total lot area (ha)	Percentage directly impacted (%)	Area directly impacted (ha)	Building impacted	Potential management options
30	Private	Irrigated plants	8.81	11.00	0.97	None	Partial
31	Private	Irrigated plants	4.26	4.10	0.17	None	Partial
32	Private	Irrigated plants	5.21	3.50	0.18	None	Partial
33	Private	Irrigated plants	2.82	8.20	0.23	None	Partial
34	Roads and Maritime	Irrigated plants	2.48	20.50	0.51	None	Partial
34.1	Private	Irrigated plants	1.94	20.50	0.4	None	Partial
35	Roads and Maritime	Rural residential	0.76	100.00	0.76	Residential	Total
36	Roads and Maritime	Rural residential	0.79	100.00	0.79	None	Total
36.1	Private	Rural residential	1.87	84.40	1.58	Residential	Partial
37	Roads and Maritime	Rural residential	3.52	100.00	3.52	None	Total
38	Roads and Maritime	Extensive agriculture	23.07	100.00	23.07	Shed	Total
39	Roads and Maritime	Rural residential	0.66	100.00	0.66	Residential Residential	Total
40	Roads and Maritime	Native vegetation	10.62	100.00	10.62	None	Total
41	Roads and Maritime	Irrigated plants	10.22	20.30	2.08	None	Partial
41.1	Private	Irrigated plants	8.14	11.00	0.89	None	Partial
42	Roads and Maritime	Irrigated plants	7.82	47.30	3.7	None	Partial
42.1	Private	Rural residential	4.12	16.90	0.7	Shed	Partial
43	Roads and Maritime	Rural residential	5.74	14.80	0.85	Residential	Partial
44	Roads and Maritime	Rural residential	4.53	57.70	2.61	Residential Shed	Partial
44.1	Private	Irrigated plants	1.92	42.40	0.81	None	Partial
45	Roads and Maritime	Irrigated plants	6.41	41.90	2.69	None	Partial
45.1	Private	Rural residential	3.72	22.70	0.85	None	Partial

Property ID	Owner	Primary land use	Total lot area (ha)	Percentage directly impacted (%)	Area directly impacted (ha)	Building impacted	Potential management options
46	Roads and Maritime	Rural residential	4.84	100.00	4.84	None	Total
47	Roads and Maritime	Native vegetation	4.11	53.10	2.18	None	Partial
47.1	Private	Native vegetation	1.93	39.60	0.76	None	Partial
47.5	Roads and Maritime	Native vegetation	N/A	N/A	0.37	None	Partial
48	Private	Irrigated plants	1.36	100.00	1.36	Residential Garage	Total
49	Private	Irrigated plants	6.59	11.30	0.74	None	Partial
50	Private	Irrigated plants	11.52	33.20	3.82	Residential	Partial
51	Roads and Maritime	Irrigated plants	8.32	16.10	1.34	Shed	Partial
51.1	Private	Irrigated plants	3.89	17.80	0.69	None	Partial
52	Roads and Maritime	Irrigated plants	7.56	50.50	3.82	None	Partial
53	Roads and Maritime	Rural residential	6.64	2.30	0.15	None	Partial
54	Roads and Maritime	Irrigated plants	4.99	91.40	4.56	Unknown	Partial
55	Private	Irrigated plants	5.18	22.80	1.18	Unknown	Partial
56	Roads and Maritime	Irrigated plants	13.2	100.00	13.2	None	Total
57	Roads and Maritime	Rural residential	4.67	100.00	4.67	Water tank Residential Garage Unknown	Total
58	Private	Irrigated plants	17.05	37.20	6.34	Shed	Partial
59	Private	Irrigated plants	4.05	38.50	1.56	Residential	Partial
59.5	Private	Irrigated plants	4.71	6.60	0.31	None	Partial
61	Roads and Maritime	Rural residential	5.18	100.00	5.18	Residential	Total
62	Private	Rural residential	6.1	28.50	1.74	None	Partial

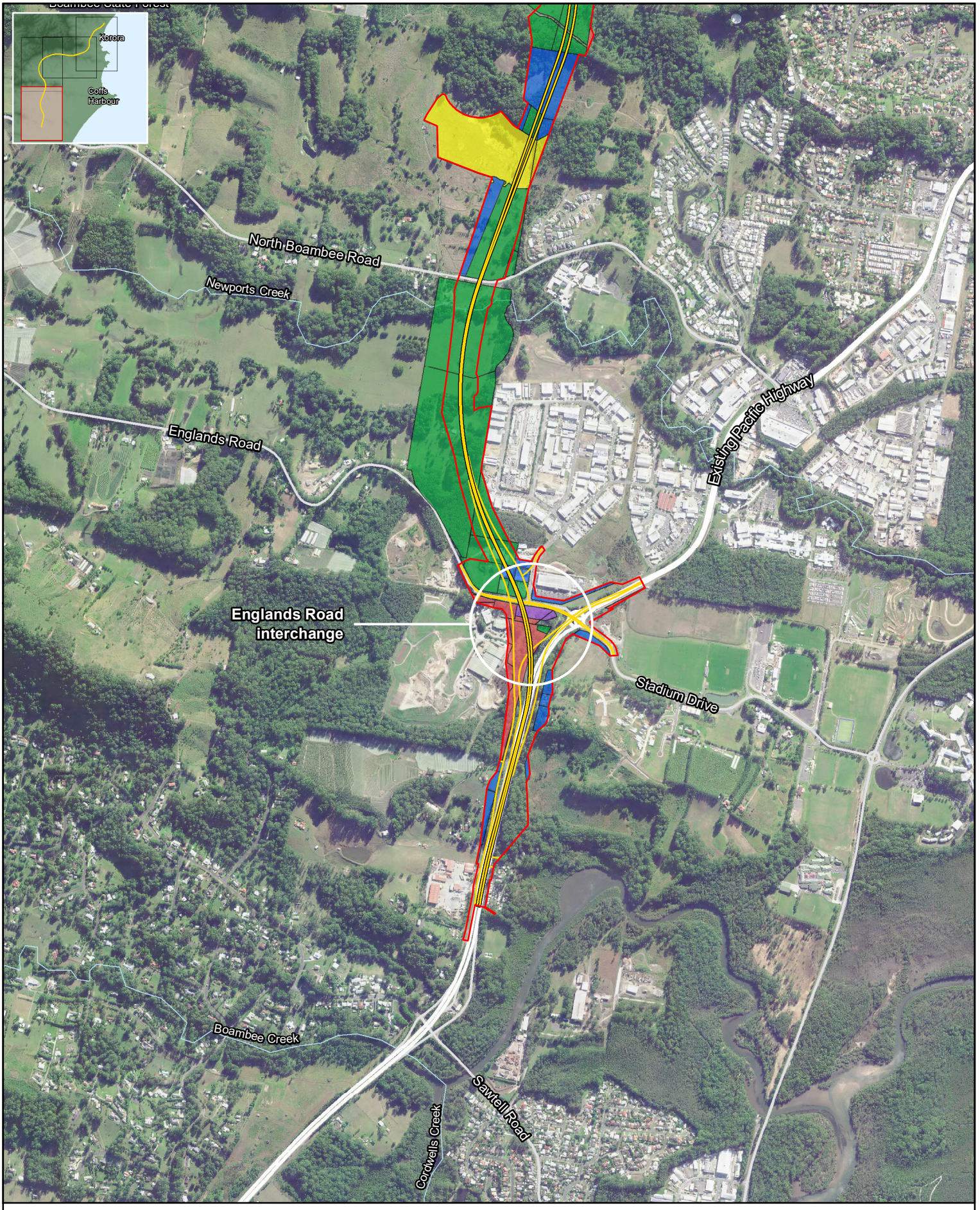
Property ID	Owner	Primary land use	Total lot area (ha)	Percentage directly impacted (%)	Area directly impacted (ha)	Building impacted	Potential management options
63	Roads and Maritime	Rural residential	1.81	21.00	0.38	Unknown	Partial
63.1	Private	Rural residential	3.81	9.70	0.37	None	Partial
63.2	Private	Rural residential	2.97	13.90	0.41	None	Partial
64	Roads and Maritime	Rural residential	4.02	100.00	4.02	Auxiliary Residential Residential	Total
65	Private	Rural residential	2	100.00	2	Garage Residential Residential	Total
66	Private	Rural residential	1.75	100.00	1.75	Residential	Total
67	Roads and Maritime	Native vegetation	9.56	100.00	9.56	Residential Shed	Total
68	Roads and Maritime	Rural residential	5.05	100.00	5.05	Residential	Total
69	Roads and Maritime	Native vegetation	1.2	29.40	0.35	None	Partial
71	Private	Irrigated plants	7.65	23.30	1.79	Unknown	Partial
72	Private	Irrigated plants	4.39	100.00	4.39	Residential Residential	Total
73	Private	Irrigated plants	8.34	1.60	0.13	Residential	Partial
74	Private	Irrigated plants	7.07	20.80	1.47	Shed Residential Shed	Partial
75	Roads and Maritime	Irrigated plants	12.15	100.00	12.15	Residential Residential Vacant house	Total

Property ID	Owner	Primary land use	Total lot area (ha)	Percentage directly impacted (%)	Area directly impacted (ha)	Building impacted	Potential management options
76	Roads and Maritime	Irrigated plants	0.89	100.00	0.89	Unknown	Total
77	Roads and Maritime	Irrigated plants	18.41	11.80	2.17	None	Partial
77.1	Private	Extensive agriculture	16.24	5.50	0.9	None	Partial
78	Roads and Maritime	Irrigated plants	5	100.00	5	Unknown	Total
79	Private	Extensive agriculture	25.01	20.40	5.09	Residential	Partial
80	Roads and Maritime	Rural residential	10.07	100.00	10.07	Residential Residential Residential	Total
81	Private	Irrigated plants	2.72	100.00	2.72	Residential Residential	Total
82	Private	Public use	0.93	100.00	0.93	Church Church	Total
83	Private	Commercial	23.35	1.20	0.28	None	Partial
84	Roads and Maritime	Rural residential	3.14	100.00	3.14	None	Total
85	Roads and Maritime	Rural residential	3.22	100.00	3.22	Residential Residential	Total
86	Private	Public use	0.99	100.00	0.99	Residential Residential Residential Residential	Total
87	Private	Urban	3.2	14.90	0.48	Shed	Partial
87.5	Private	Urban	0.2	12.70	0.03	None	Partial
87.6	Private	Urban	0.18	27.80	0.05	None	Partial
88	Roads and Maritime	Urban	0.43	100.00	0.43	Shed	Total

Property ID	Owner	Primary land use	Total lot area (ha)	Percentage directly impacted (%)	Area directly impacted (ha)	Building impacted	Potential management options
						Residential	
89	Roads and Maritime	Rural residential	2.32	100.00	2.32	Residential	Total
						Residential	
90	Roads and Maritime	Rural residential	4.69	100.00	4.69	Residential	Total
						Residential	
91	Roads and Maritime	Rural residential	5.68	48.90	2.78	None	Partial
92	Private	Irrigated plants	19.07	14.40	2.75	Residential	Partial
						Unknown	
						Unknown	
						Unknown	
92.5	Private	Urban	4.71	14.60	0.69	None	Partial
93	Private	Native vegetation	1	8.70	0.09	None	Partial
94	Roads and Maritime	Urban	0.24	100.00	0.24	Residential	Total
95	Roads and Maritime	Native vegetation	0.13	100.00	0.13	Residential	Total
						Residential	
96	Crown Land	Native vegetation	0.56	43.20	0.24	None	Partial
97	Private	Urban	0.08	100.00	0.08	Residential	Total
98	Private	Urban	0.17	100.00	0.17	None	Total
99	Private	Urban	0.23	5.60	0.01	None	Partial
100	Private	Rural residential	0.32	21.10	0.07	None	Partial
101	Roads and Maritime	Rural residential	3.53	31.80	1.12	None	Partial
101.1	Private	Rural residential	2.41	16.70	0.4	None	Partial
102	Roads and Maritime	Rural residential	0.85	100.00	0.85	Residential	Total
						Residential	

Property ID	Owner	Primary land use	Total lot area (ha)	Percentage directly impacted (%)	Area directly impacted (ha)	Building impacted	Potential management options
						Residential	
						Residential	
103	Private	Rural residential	1.2	26.60	0.32	Residential	Partial
104	CHCC	Combination of rural residential and native vegetation	7.47	6.80	0.51	None	Partial
104.1	CHCC					None	Partial
104.2	CHCC					None	Partial
104.3	CHCC					None	Partial
104.4	CHCC					None	Partial
104.5	CHCC					None	Partial
104.6	CHCC					None	Partial
105	Roads and Maritime	Commercial	0.87	100.00	0.87	Residential	Total
						Residential	
						Residential	
106	Private	Commercial	0.37	2.40	0.01	Residential	Partial
						Residential	
107	Private	Commercial	2.3	19.90	0.46	None	Partial
107.5	Private	Commercial	0.01	100.00	0.01	Residential	Total
107.6	Private	Commercial	0.01	100.00	0.01	Residential	Total
107.7	Private	Commercial	0.01	100.00	0.01	Residential	Total
108	Private	Rural residential	0.62	15.80	0.1	None	Partial
108.5	Private	Commercial	0.02	100.00	0.02	Residential	Total
109	Private	Urban	4.93	2.60	0.13	None	Total
109.5	Private	Urban	0.96	17.70	0.17	None	Partial
110	Private	Rural residential	1.14	3.40	0.04	None	Partial

Property ID	Owner	Primary land use	Total lot area (ha)	Percentage directly impacted (%)	Area directly impacted (ha)	Building impacted	Potential management options
111	Roads and Maritime	Rural residential	1.52	100.00	1.52	Residential	Total
112	Roads and Maritime	Commercial	0.2	100.00	0.2	Residential	Total
112.5	Roads and Maritime	Rural residential	1.12	100.00	1.12	None	Total
112.6	Private	Rural residential	2.06	3.10	0.06	None	Partial
113	Private	Rural residential	0.76	6.90	0.05	Residential	Partial



Legend

- Construction footprint
- North Coast Railway
- Alignment

Ownership

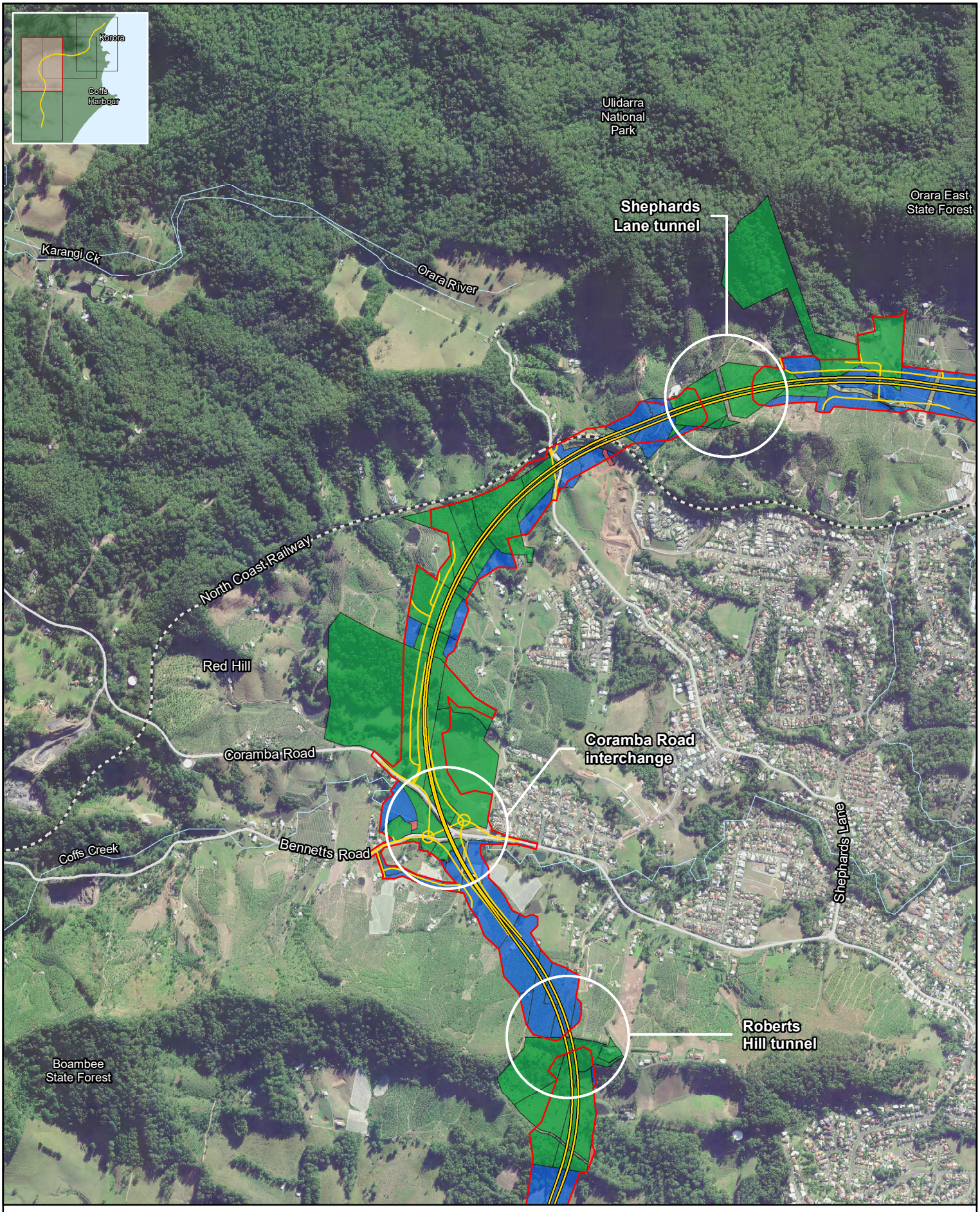
- Department of Education and Training
- Roads and Maritime
- Crown Land
- Coffs Harbour City Council
- Private

Coffs Harbour Bypass
Property impacts and ownership
Figure K1-01

0 0.2 0.4 0.6 km

Scale @A4: 1:20,000
GDA 1994 MGA Zone 56

N



Legend

- Construction footprint
- North Coast Railway
- Alignment

Ownership

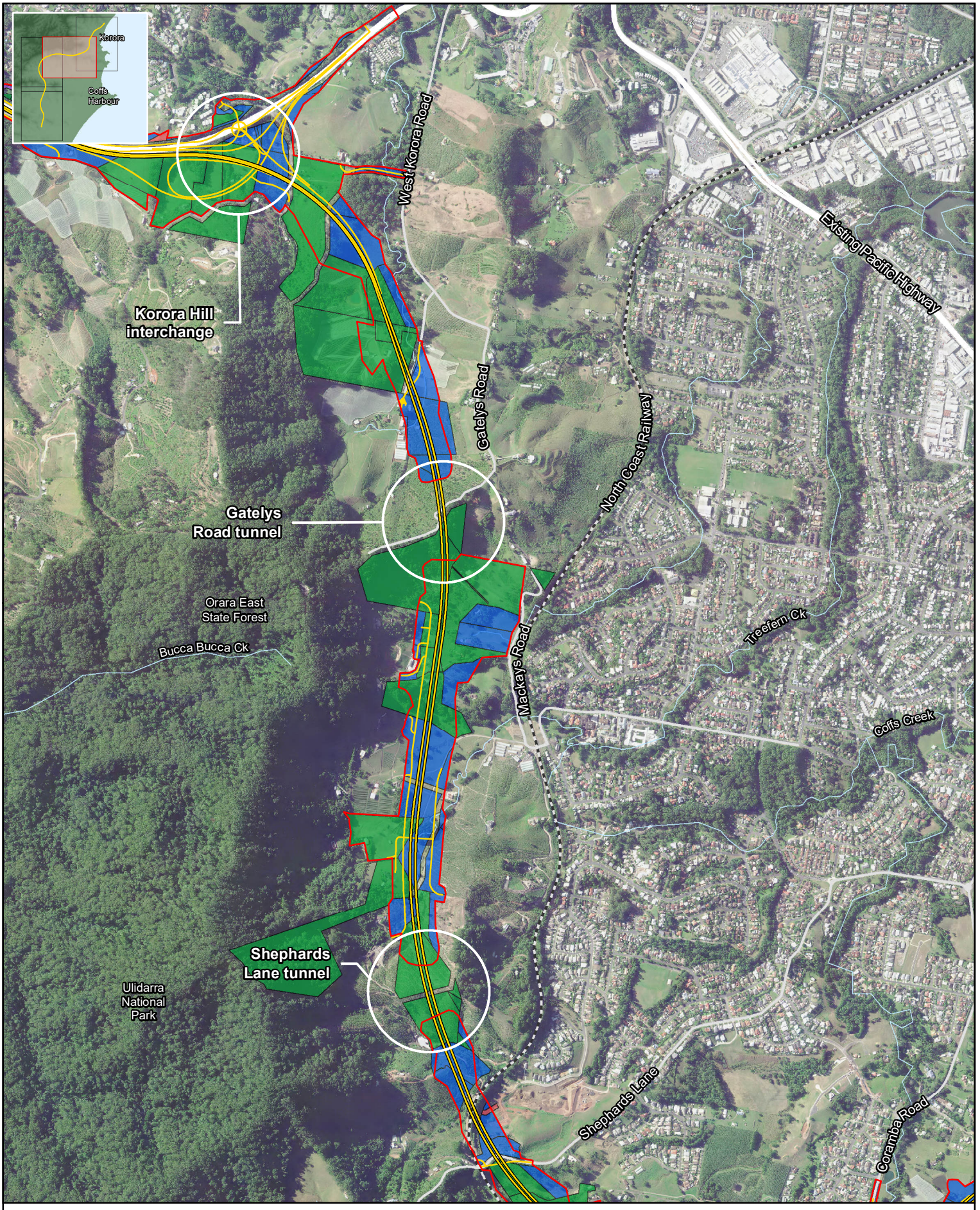
- Department of Education and Training
- Roads and Maritime
- Crown Land
- Coffs Harbour City Council
- Private

Coffs Harbour Bypass
Property impacts and ownership
Figure K1-02

0 0.2 0.4 0.6 km

Scale @A4: 1:20,000
GDA 1994 MGA Zone 56

N



Legend

- Construction footprint
- North Coast Railway
- Alignment

Ownership

- Department of Education and Training
- Roads and Maritime
- Crown Land
- Coffs Harbour City Council
- Private

Coffs Harbour Bypass
Property impacts and ownership
Figure K1-03

0 0.2 0.4 0.6 km

Scale @A4: 1:20,000
GDA 1994 MGA Zone 56

N



Legend

- Construction footprint
- North Coast Railway
- Alignment

Ownership

- Department of Education and Training
- Roads and Maritime
- Crown Land
- Coffs Harbour City Council
- Private

Coffs Harbour Bypass
Property impacts and ownership
Figure K1-04

0 0.2 0.4 0.6 km

Scale @A4: 1:20,000
GDA 1994 MGA Zone 56

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SUB-APPENDIX

K2

Appendix K

Sub-appendix K1

Sub-appendix K2

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Sub-appendix K2

Agricultural assessment

Coffs Harbour Bypass
Agricultural Assessment






EDGE
LAND PLANNING

July 2019

Coffs Harbour Bypass

Agricultural Assessment

Prepared for Arup
by



Rural and Environmental
Planning Consultants

P.O. Box 470
Narrabeen, NSW, 2101
www.ruralplanning.com.au

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1 Introduction

1.1 Project description

Roads and Maritime Services (Roads and Maritime) is seeking approval for the Coffs Harbour Bypass (the project). The approval is being sought under Division 5.2 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) as Critical State Significant Infrastructure (CSSI).

The project includes a 12 km bypass of Coffs Harbour from south of Englands Road to Korora Hill in the north and a 2 km upgrade of the existing highway between Korora Hill and Sapphire. The project would provide a four-lane divided highway that bypasses Coffs Harbour, passing through the North Boambee Valley, Roberts Hill and then traversing the foothills of the Coffs Harbour basin to the west and north to Korora Hill.

The key features of the project include:

- Four-lane divided highway from south of Englands Road roundabout to the dual carriageway highway at Sapphire
- Bypass of the Coffs Harbour urban area from south of Englands Road intersection to Korora Hill
- Upgrade of the existing Pacific Highway between Korora Hill and the dual carriageway highway at Sapphire
- Grade-separated interchanges at Englands Road, Coramba Road and Korora Hill
- A one-way local access road along the western side of the project between the southern tie-in and Englands Road, connecting properties to the road network via Englands Road
- A new service road, located east of the project, connecting Solitary Islands Way with James Small Drive and the existing Pacific Highway near Bruxner Park Road
- Three tunnels through ridges at Roberts Hill (around 190 m long), Shephards Lane (around 360 m long), and Gatelys Road (around 450 m long)
- Structures to pass over local roads and creeks as well as a bridge over the North Coast Railway
- A series of cuttings and embankments along the alignment
- Tie-ins and modifications to the local road network to enable local road connections across and around the alignment
- Pedestrian and cycling facilities, including a shared path along the service road tying into the existing shared path on Solitary Islands Way, and a new pedestrian bridge to replace the existing Luke Bowen footbridge with the name being retained
- Relocation of the Kororo Public School bus interchange
- Noise attenuation, including low noise pavement, noise barriers and at-property treatments as required
- Fauna crossing structures including glider poles, underpasses and fencing
- Ancillary work to facilitate construction and operation of the project, including:
  - Adjustment, relocation and/or protection of utilities and services
  - New or adjusted property accesses as required
  - Operational water quality measures and retention basins
  - Temporary construction facilities and work including compound and stockpile sites, concrete/asphalt batching plant, sedimentation basins and access roads (if required).

The project passes through a number of agricultural land uses including bananas, blueberry, cucumbers, avocados, custard apples as well as other uses which are mostly rural residential.

Edge Land Planning has been engaged to prepare this agricultural assessment to support the Environmental Impact Statement (EIS) prepared for the project. This agricultural assessment aims to assess the impact of the project on the agricultural properties either directly impacted and/or adjacent to the project.

1.2 Location and study area

The study area for this assessment consists of both the land within the construction footprint (to assess direct impacts of the project) and the land within a buffer 500m either side of the construction footprint (to assess the indirect construction impacts which may potentially occur during construction of the project). The study area is shown on Figure 1.

1.3 Purpose of Report

The purpose of this report is to assess potential agricultural impacts from construction and operation of the project, and where required, identify feasible and reasonable management measures to manage potential impacts. This assessment has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) for the project. The relevant SEARs for this assessment are shown in Table 1 below.

Table 1 SEARs relevant for agricultural assessment

Ref	Key Issue SEARs
7.	**Socio-economic, Land Use and Property**
1.	The Proponent must assess social and economic impacts in accordance with the current guidelines (including cumulative ongoing impacts of the project).
2.	The Proponent must assess impacts from construction and operation on potentially affected properties, businesses, Council assets and services, recreational users and land and water users, including property acquisitions/adjustments, access amenity and relevant statutory rights.
3.	The design, construction and operation of the project should address and minimise (existing and future) land use conflicts and operations (including existing and ongoing horticultural activities). Siting of project elements should be located in such a way that functional, contiguous areas of residual land and land uses are maximised.

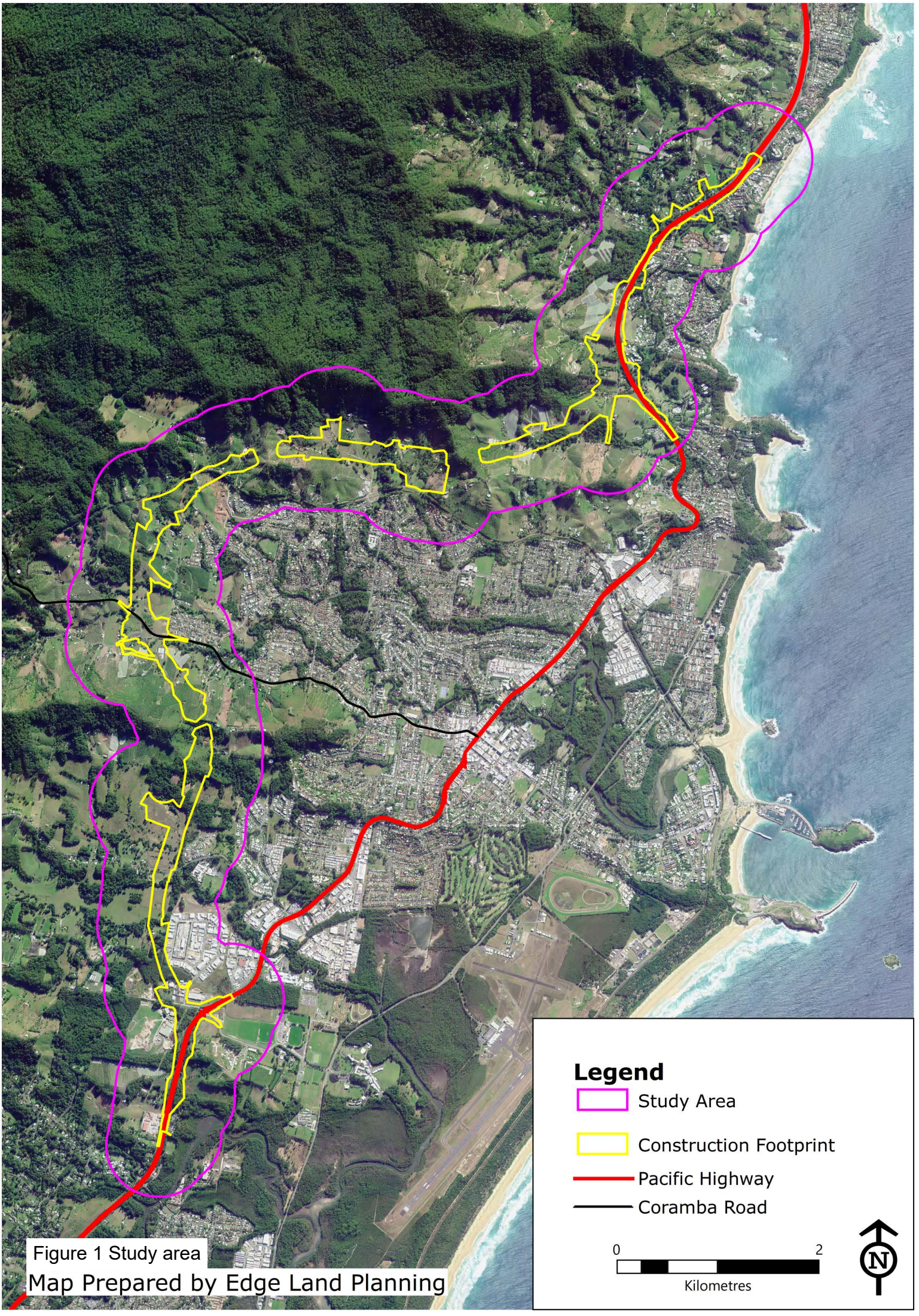


Figure 1 Study area

Map Prepared by Edge Land Planning

2 Assessment methodology

2.1 Introduction

This chapter outlines the methodology that has been used to assess the direct and indirect impact of the project on agriculture within the region.

2.2 Land use survey and selection criteria

The land use of the area to the west of Coffs Harbour is a mix of intensive plants (for example bananas and blueberries) as well as some extensive agriculture, native vegetation and rural residential uses.

The land use survey has been carried out in two stages – a detailed survey of the construction footprint and a wider desktop survey of the land 500m on either side of the construction footprint.

Potentially impacted agricultural properties were identified through use of MapInfo Geographical Information System (GIS) software and aerial data. Cadastral information was used to assess property size.

Each parcel of land was inspected and given a land use designation. The land use was categorised into primary and secondary land use categories. Definitions used for land uses are:

- ***Commercial*** – A commercial or industrial type of use with no dwellings.
- ***Extensive Agriculture*** – Growing of plants using natural rainfall or the rearing of animals using grazing as a feeding method. It also includes the growing of fodder crops and irrigated pasture and have a lot size of greater than 2 ha.
- ***Extractive Industry*** – Extracting of material from the land and includes mining, sand and clay mining and quarrying of sandstone and other stones.
- ***Intensive Animals*** – means the rearing of animals using a feeding method other than natural grazing and includes poultry and horse studs and equestrian facilities.
- ***Intensive plants*** – growing of fruit, vegetables and ornamental plants for commercial gain using the application of irrigation and includes market gardening, protected cropping structures, orchards, vineyards etc. This includes bananas, blueberries, cucumbers and avocados. Lots are greater than 2 ha in size.
- ***Native Vegetation*** – A lot with no dwellings or structures, majority of land covered in native vegetation.
- ***Public Uses*** – Commonly used and/or operated by a public authority or associated body. Includes community facilities, golf courses and Government owned uses.
- ***Rural Residential*** – A house on a lot greater than 1 ha and in a rural environment where the main source of income is from other sources than agriculture.
- ***Urban*** – includes any land that is zoned as residential, commercial, industrial, etc and is a settlement.
- ***Vacant*** – Land mostly cleared of native vegetation with no dwellings or structures and less than 2 ha in area.

2.2.1 Preliminary land identification

Preliminary identification of land use was established by desktop investigation, using aerial photography (dated 2018). Land use has been assessed per lot (cadastral data), noting that multiple lots can form individual properties, particularly with regards to agricultural land. Through desktop investigations, major land use characteristics were identified including extensive agriculture, intensive plants (particularly bananas and blueberries), dwellings on small lots, vacant land, lots which are totally covered with native vegetation, and extractive industries.

2.2.2 Site inspection

The study area was inspected to verify the desktop-identified land use categories and to identify potential secondary land uses that could not be identified from the aerial photos. Each public road adjacent to properties was driven and the land use clarified against the preliminary identification. Signage, which gives an indication that the property may be used for a secondary use such as a home business or a commercial use was also noted.

Each agricultural property within the study area was provided with an Affected Property Owner (APO) number. Some farms consist of multiple lots (APOs) which have been assessed as individual agricultural properties.

2.3 Baseline

Interviews were arranged with 15 property owners as a representative sample of farms within the area. The interviews were conducted in late August 2018 and each property was also inspected. The farmers were asked a number of questions in a semi-structured interview that lasted approximately 20-30 minutes.

The purpose of the interviews was to gather information on agricultural land use within the study area (for example, the type and nature of the agricultural business, operations, access and water requirements) and perceptions of business owners and managers about potential benefits and impacts of the project's construction and operation.

A number of technical reports were reviewed to further inform potential impacts to affected properties, which included:

- Coffs Harbour Bypass Groundwater Assessment Report (ARUP, 2019)
- Coffs Harbour Bypass Air Quality Assessment (ERM Australia Pacific, 2019)
- Impact wind flow and changes to microclimate for Coffs Harbour Bypass Concept Tunnel design (Ramboll Danmark, 2019) (Appendix 2).

2.4 Impact Assessment

The following impacts have been assessed for the project:

- Direct – an assessment of the impacts on properties that fall wholly or partially within the construction footprint of the project
- Indirect – an assessment of potential impacts on properties outside this construction footprint, but within a 500m buffer
- Panama disease – consideration of potential to spread the pathogen and impact on industry
- Microclimate – consideration of the potential for the project to impact existing microclimate
- Industry – a qualitative assessment of impacts to blueberries and banana industries.

More information on each of these elements and the assessment methodology are discussed in the following sections.

2.4.1 Direct Impacts

A range of assessment criteria for direct physical impacts has been considered for each property within the construction footprint, outlined in Table 2.

Table 2 Direct impact assessment criteria

Criteria	Description
Direct land take	Amount of land being directly impacted (acquired) as a percentage of the total farm.
Crop impact	The extent of the direct physical impact on the crops on the property.
Structures	The direct impact on structures required for operation of a farm (eg packing shed), and consideration of the impact on the overall farm operation and management.
Type of acquisition	**Strip acquisition** – where a small strip of the lot is to be acquired for the project. **Subsurface** – where a tunnel is to be constructed beneath a property, subsurface acquisition may be required. This generally would allow farming to continue on the surface. **Fragmentation** – Where the existing farm would be fragmented or severed as a result of the construction of the project.
Access	The degree of impact on internal access. The project may affect one end of the property, change the entry into the farm, cross the farm and/or impact on farming operation.
Irrigation water	Impacts on water supply such as bores and dams, and the degree to which access to water is affected. Includes reliance on water for agricultural purposes.
Dust	Risk level for dust has been determined considering proximity and extent of earthworks and ancillary facilities, as well as crop sensitivity to dust impacts

Each property was assessed against the criteria in Table 2 and a residual level of impact assigned between moderate and critical. A description of these impact levels is provided in Table 3.

Table 3 Level of Impact

Impact Level	Description
Minor	The farm would continue in its current state, with potential impacts being minor in nature and adequately mitigated during construction.
Moderate	The project would have an influence on the operation of the farm, but farming would be able to continue operating with some alterations and management measures being implemented.
Serious	Farming viability is likely to be seriously compromised unless significant mitigation measures are implemented. This may include measures such as provision of replacement structures (packing sheds) or water sources.
Critical	Farm is likely to cease operation in its current capacity. There is the opportunity for the residual agricultural land to be purchased by adjacent property owners.

2.4.2 Indirect impacts

A desktop assessment has been undertaken of agricultural properties within a 500m buffer either side of the construction footprint. The potential impact was assessed based on topography and distance of the farm to the construction footprint.

Dust can impact farm crops in various ways. Bananas are bagged when they emerge from the bell, however, when the fingers are young and not bagged there is potential for dust to coat them. This can lead to discolouration of the skin as well the banana fingers rubbing on the dust and leading to discolouration. While this does not impact the quality of the fruit inside the skin in the case of bananas, consumers reject purchasing discoloured fruit.

Dust can also coat blueberries and avocados, affecting the skin colour and again leading to consumer rejection. While washing can remove some dust, there is the risk that not all dust would be removed. If not washed off, dust can become a permanent stain on the fruit.

Cucumbers are generally grown in cropping structures which are opened for climate control. Dust can enter these structures when they are open, however dust can generally be washed off cucumbers.

A coating of dust on leaves may also interfere with photosynthesis and delay growth.

Properties may also be temporarily impacted by construction impacts such as road closures which alter their access arrangements as well as temporary changes to water access and sources.

2.4.3 Panama Disease

Panama disease is a soil-borne fungal disease that kills banana plants. It invades plants through the roots and blocks the vascular tissue, cutting off the supply of water and nutrients and leads to the death of the plants.

There are four races of Panama disease, including:

- Race 1 which infects Lady Finger, Sugar and Ducasse bananas, but not Cavendish
- Race 2 which infects cooking bananas like Bluggoe and Blue Java bananas
- Race 3 which infects only Heliconia species, not bananas
- Race 4 which infects most varieties of bananas, including the main commercial variety, Cavendish.

Races 1 and 4 are relevant to the Coffs Harbour LGA given the varieties of bananas grown, however; the two strains of Race 4 (Tropical and Subtropical) have not been detected Coffs Harbour LGA.

The disease is easily spread by the movement of infected planting material and over short distances via root to root contact and through movement of contaminated soil. The disease can also spread from parent plants to suckers. The disease can also be moved with soil (including dust), water and on contaminated equipment and vehicles. Fungal spores can survive in the soil for over 50 years and once Panama disease is present in the soil it cannot be eradicated (Queensland Government Department of Agriculture and Fisheries, 2018).

Consultation with DPI Agriculture in September 2018 identified three properties with known Panama disease close to the project, which are all are infected with Race 1. Given the pathogen's longevity and the potential for Race 1 to be present within banana plantations growing Cavendish varieties (either in the soil or within the root mass), a precautionary approach has been followed for the purposes of this assessment, and it is assumed the Panama disease pathogen could be present within former and existing plantations within the construction footprint.

2.4.4 Microclimate

The project is located to the west of Coffs Harbour urban area and traverses a hilly to steep terrain for the majority of the alignment with some flat land on the valley floors. The landscape form in this area creates a unique microclimate, which is important for the agricultural land uses in the area. Responding to a previous alternative design which included cuts into the terrain near local banana plantations, the Banana Growers Association of Coffs Harbour and District provided a submission that identified “increased wind, particularly from the south, which would cause banana blow-downs; and the southerly winds would blow in colder air, which causes fruit chilling.”

2.4.5 Industry

Agriculture in Coffs Harbour is a key aspect of the economy. It supplies the food and fibre processing and manufacturing industry and is serviced and supported by the local agribusiness sector. Coffs Harbour City Council (CHCC) prepared an Issues and Options paper as part of their Local Growth Management Strategy in 2017 which was informed by a number of community workshops in 2016. The importance of farming and its value as an economic driver was one of the highest priorities mentioned by the community at the workshops (Edge Land Planning, 2017).

3 Site context and agricultural baseline

3.1 Introduction

This chapter outlines the physical landscape of the study area and discusses the landscape form, land use and the soil landscapes of the area. It also provides an overview of the agricultural sector of Coffs Harbour and a background of the primary agricultural uses. This provides the context considered when assessing the impacts of the agricultural properties within the study area.

3.2 Site Context

3.2.1 Landscape Form

The project is located to the west of Coffs Harbour urban area and traverses a hilly to steep terrain for the majority of the alignment with some flat land on the valley floors. The landscape form in this area creates a unique microclimate, which is important for the agricultural land uses in the area.

The topography associated with the Great Dividing Range at Coffs Harbour creates impressive scenery. The foothills of the range mark the transition of topography with ridgelines, including Roberts Hill, extending in an east-west direction declining in height to the coastline. The typical terrain can be seen from Photograph 1 which shows Roberts Hill and was taken from Shephards Lane, Photograph 2 for the land along the northern area, taken from the top of Roberts Hill and Photograph 3 shows the land in Mackays Lane from Gatelys Road. Figure 2 shows the existing topography of the site, which shows the contour lines with heights above sea level.

The topography of the Coffs Harbour area is characterised by a number of relatively short and narrow east – west aligned valleys ranging in size from smaller valleys in the north to a wide valley around the Coffs Harbour urban area. The Coffs Creek valley sides are relatively steep with the three ridgelines (Roberts Hill, Shephards Lane, Gatelys Road) in the construction footprint being about the same height. This has created a unique microclimate that is shaped by the proximity to the ocean and the topography being east facing valleys with relatively steep ridges. Responding to a an alternative previous design which included cuts into the terrain near local banana plantations, the Banana Growers Association of Coffs Harbour and District provided a submission on the previous preliminary concept design that identified potential microclimate impacts from the use of “deep and wide cuttings”, including “increased wind, particularly from the south, which would cause banana blow-downs; and the southerly winds would blow in colder air, which causes fruit chilling.” The steepness of the valleys is also conducive to the growing of bananas and the north facing slope is preferred due to its longer exposure to sun, especially in winter. Blueberries grow on the less steep land.

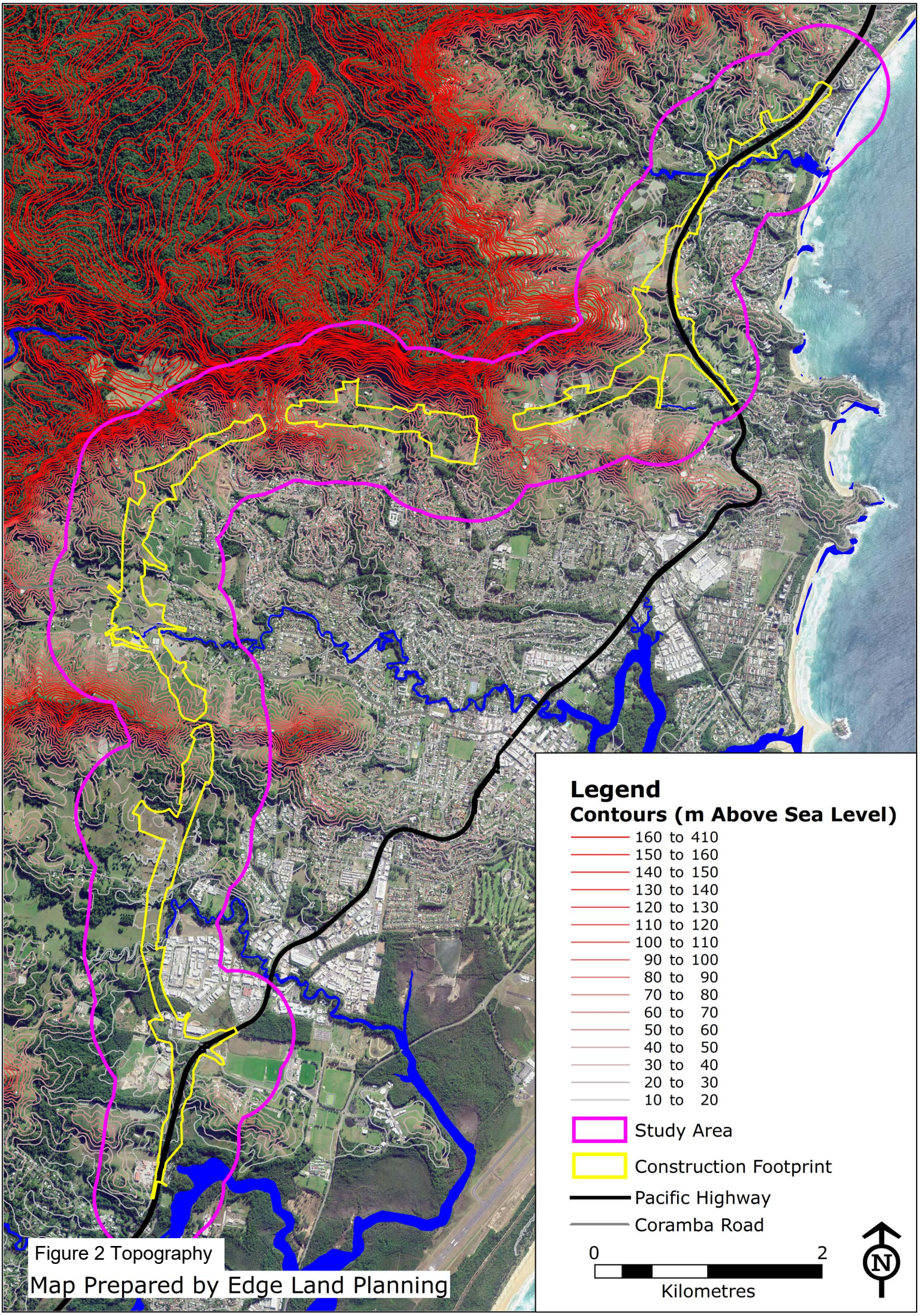


Figure 2 Topography

Map Prepared by Edge Land Planning



Photograph 1 View of Roberts Hill, taken from Shephards Lane
Date of Photo: August 2018



Photograph 2 Typical landscape form facing north from Roberts Hill showing typical banana &
Date of Photo: August 2018



Photograph 3 Typical landscape form in Mackays Lane taken from Gatelys Road
Date of Photo: August 2018

3.2.2 Soil landscapes

The soil landscapes of the Coffs Harbour 1:100,000 map sheet and has been used to determine details about the soils within the construction footprint. Figure 3 shows the soil landscapes that the project would traverse. Soil landscapes include:

- Coffs Creek. This is associated with the floodplains of the Coffs Creek. It is described as an alluvial landscape with level to gently undulating floodplains, inset floodplains and terraces on Quaternary alluvium in the lower catchments of coastal streams. The soils are described as being deep, moderately poorly drained. They are also soils with low wet bearing strength, foundation hazard, high organic matter in the topsoils, low fertility in the subsoils, strong to very strong acidity. The land use is grazing land and rural residential development.
- Megan. This landscape covers most of the project. It is described as rolling low hills to hills. It has a local relief to 90 m, occasionally to 200 m; slopes typically 5 - 20%, occasionally to 33%; elevation to 317 m. Partially cleared, tall open-forest and tall closed-forest. The soils are moderately to deep and well drained. They are strongly acid, stony soils of high erodibility, aluminium toxicity potential and low subsoil fertility. The land use on this soil landscape is mostly bananas and blueberries as well as some grazing associated with rural residential development.
- Moonee. There is only a small patch of this landscape to the south of Roberts Hill. It is described as undulating rises, footslopes and drainage plains adjacent to steeper low hills and hills on the Coast Range. The soils are moderately deep to deep and poorly drained. They are strongly to very strongly acid soils with low to very low wet bearing strength, slow permeability, high subsoil erodibility, high subsoil sodicity and low fertility. It has local relief of less than 30 m; slopes typically 3 - 5%, occasionally 10%; elevation less than 20 m. The land use is grazing and native vegetation.
- Suicide. This covers the hillslopes of the northern escarpment. It is described as steep hills and dissected valleys on along the Coast Range. It has a local relief of 100 - 300 m with slopes of 33 -

56% and elevation up to 590 m. The soils are moderately deep to deep well-drained, stony structured. They are strongly acid stony soils with low wet bearing strength, strong subsoil acidity and low fertility. The land use is mostly bananas and blueberries and rural residential with some grazing.

- Ulong. This landscape covers the ridgelines associated with North Boambee and Englands Roads in the southern part of the project. It is described as undulating to rolling low hills. It has a local relief of up to 90m with slopes of 5 – 20% occasionally to 33% and an elevation to 360m. The soils are moderately deep to deep, well drained structured. They are strongly to very strongly acid soils with low wet bearing strength, subsoil aluminium toxicity potential and low subsoil fertility. The land use is mostly rural residential and commercial.

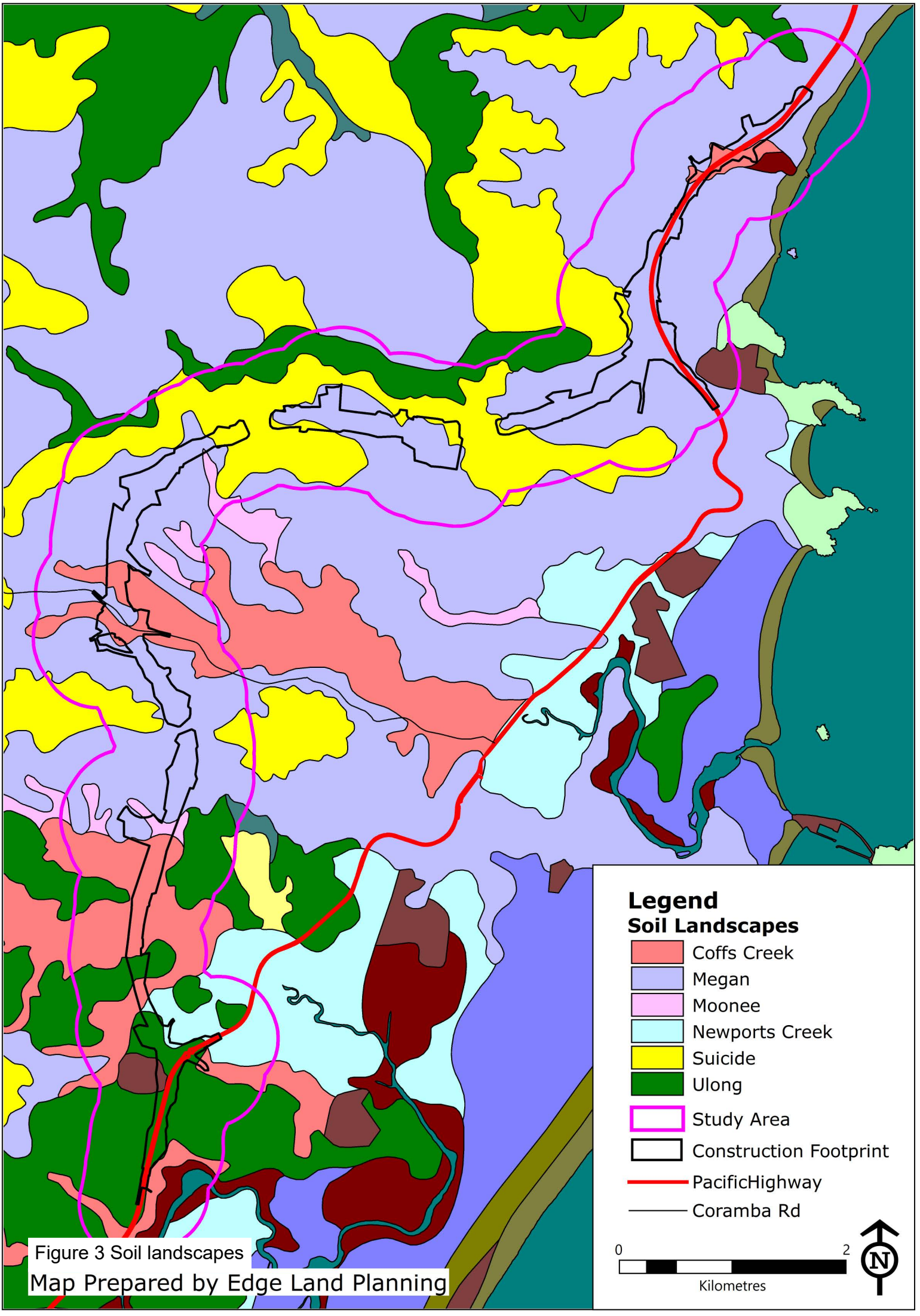


Figure 3 Soil landscapes

Map Prepared by Edge Land Planning

3.3 Agriculture

3.3.1 Background

Historically the Coffs Harbour area was a grazing landscape before bananas began being grown on the steep lands around the Coffs Harbour urban area and on land to the north and south along the coastal strip. Northern NSW was the home of the first major commercial banana plantations in Australia and in the 1950s and 1960s Coffs Harbour was the major banana producing LGA in Australia (Centre for Coastal Management, 1995). The Coffs Harbour area and further north along the far north coast of NSW were the main growing regions for bananas in Australia up until the late 1900s when North Queensland began to increase production. NSW produces 1.4% of Australia's bananas with Queensland producing 98.3% (ABS, 2017b) and the rest is produced by Western Australia and the Northern Territory. Coffs Harbour is currently the number one banana producing LGA in NSW with 43.3% of the production followed by Tweed with 25.5% and Nambucca with 13.6% (ABS, 2018).

Over the past 10-15 years, the banana industry has reduced as the blueberry sector has had a major increase in production. In 2001, there were 22 blueberry farms within the Coffs Harbour LGA, and as of 2017 there were 127 blueberry farms. By comparison, there are currently 111 banana farms in the Coffs Harbour LGA (OEH & ABARES, 2017).

Blueberries are now the most significant agriculture sector in the Coffs Harbour LGA. Over the past 15 years many banana growers transitioned to growing blueberries, and Coffs Harbour is now the number one blueberry producing LGA in Australia (Edge Land Planning, 2017).

3.3.2 Land use within the construction footprint

There are 151 individual lots within the construction footprint. As noted above, often multiple lots are combined to form one property, such as with farms. **Table** 4 lists land uses by primary land use, area of ownership as a whole of the construction footprint, and percentage of area as a whole of the construction footprint by percentage of land, the primary use of native vegetation is the largest land use in the study area followed by intensive plants, rural residential and extensive agriculture with these three land uses making up 92% of the total area. Figure 4 shows the land uses both within the construction footprint as well as within 500m of it.

Table 4 Primary Land Uses

Primary Land Uses	Area (ha)	% of Total Area
Commercial	8.9	3.2%
Extensive Agriculture	44.8	15.9%
Intensive Animals	0.4	0.1%
Intensive Plants	60.3	21.5%
Native Vegetation	94.3	33.5%
Public Uses	1.1	0.4%
Rural Residential	59.9	21.3%
Urban	0.1	0.0%
Vacant	11.4	4.1%
Total Uses	**281.2**	**100.0%**

Source: Coffs Harbour Bypass Land Use Survey

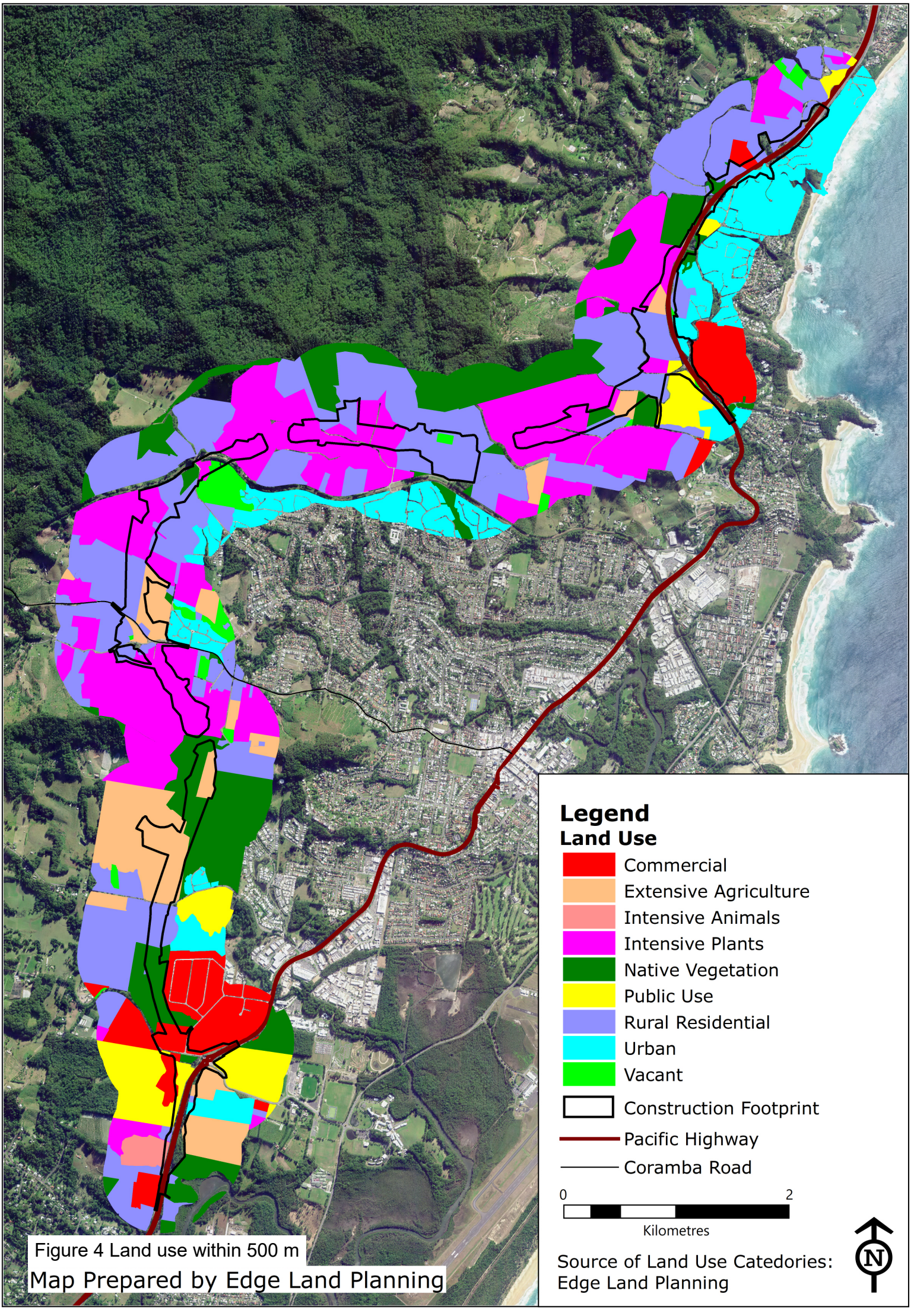


Figure 4 Land use within 500 m

Map Prepared by Edge Land Planning

Intensive plant land use properties can farm one or multiple crops, and as stated above, can consist of multiple lots. The results of the land use survey for farms within the construction footprint are shown in Table 5. The crops grown in the study area include bananas, blueberries, avocados, custard apples and protected cropping (generally cucumbers). Appendix 1 provides a summary of agricultural lots and identifies where multiple lots are combined to form one farm.

Table 5 Number of farms of intensive plant use

Intensive Plant Use	Number of Properties	Approx. % of Total Properties
Bananas	12	50%
Blueberries	6	25%
Bananas & Blueberries	2	9%
Bananas, Blueberries & Protected Cropping	1	4%
Bananas, Avocados & Protected Cropping	1	4%
Bananas, Avocados & Custard Apples	1	4%
Protected Cropping	1	4%
Total farms	**24**	**100%**

Source: Coffs Harbour Bypass Land Use Survey (Edge Land Planning)

Figure 5 shows the main intensive plant land uses within 500m of the construction footprint as well as those within the footprint. It details the bananas, blueberries and cucumber farms as well as the Oz Group packing shed.

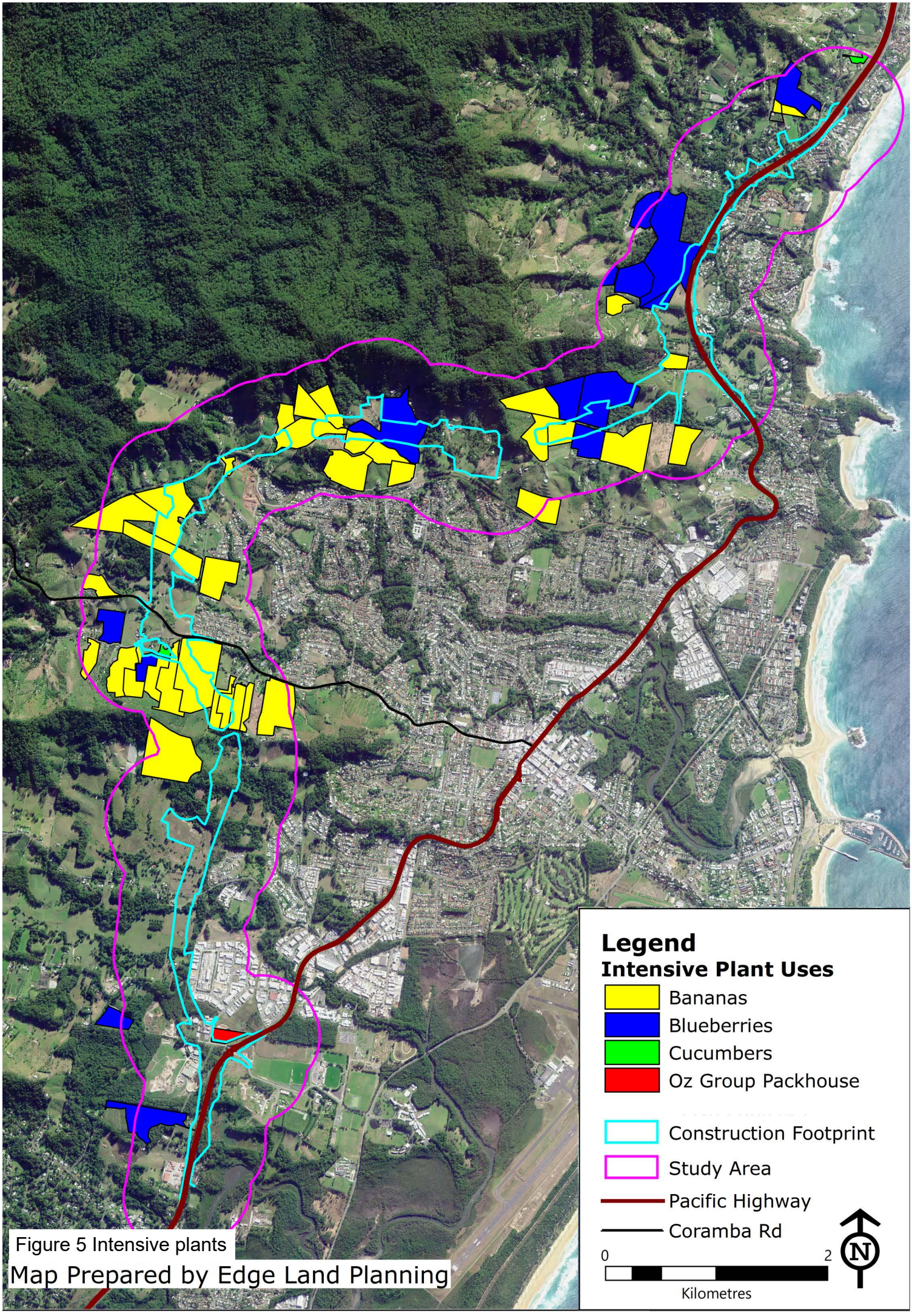


Figure 5 Intensive plants

Map Prepared by Edge Land Planning

3.3.3 Value of Agriculture

The agricultural sector provides a rural backdrop to the region which is a significant tourism asset to the local economy. The tourism sector of the Coffs Harbour LGA is estimated to be worth $154m direct and $141m indirect value added giving a total of $295m (.id The Population Experts, 2019). This represents 10.9% of the total LGA economy, significantly greater than for NSW which has a tourism value of 5.9% of the total economy. The identity of Coffs Harbour is synonymous with the Big Banana, which is a tourist attraction that was built in 1964 when the local banana industry was much bigger than it is today (Centre for Coastal Management, 1995).

In 2017-18, the gross value of agricultural production in Coffs Harbour-Grafton region was $278 million, which was two per cent of the total value of agricultural production in NSW of $13.2 billion (ABS, 2019)The Coffs Harbour-Grafton region consists of Bellingen, Clarence Valley and Coffs Harbour LGAs.

Data for agricultural commodities provided by ABS (2015-2016) provides a further breakdown of commodity and crop types. This data shows that the Coffs Harbour LGA had a total value of agriculture of $113.5m (ABS, 2018). The crops contributing to these quantities are detailed in Table 6. Fruit crops contributed significantly to the total value, with blueberries ($89.8 m), bananas ($2.7 m) and avocados ($0.7 m) being the largest contributors, and vegetables also contributing $2.9 M.

It should be noted that the ABS figures are conservative and likely under report the actual situation. This is due to the voluntary nature of the census which means that not all farmers respond to it and there is little validation of the data supplied.

Table 6 Value of Agriculture Production (for 2016)

Commodity	Gross Value of Production
Nurseries	$2,961,395
Cut Flowers	$2,387,604
Turf	$306,562
Vegetables	$2,856,639
Avocados	$685,841
Bananas	$2,698,802
Blueberries	$89,782,894
Other Fruit	$193,566
Nuts	$1,264,386
Other Crops	$404,283
Total Crops	**$103,541,972**
Cattle	$5,471,922
Other Livestock	$33,318
Milk	$4,435,986
Other Livestock Products	$9,849
Total Livestock	**$9,951,076**
Total Agriculture	**$113,493,048**

Source: (ABS, 2018)

The ABS Commodity data provides information on the agricultural production of the Coffs Harbour LGA, which can be compared to the region, NSW and Australia. This data is from the 2016 Agricultural Census which is the most up to date data for the LGA level. This data shows production of the following significant commodities for 2016:

- Blueberries: 3,747 tonnes which represents 93.5% of the North Coast Region (Coffs Harbour – Grafton and Richmond Tweed), 76.6% of NSW and 55.0% of Australia's production. This makes Coffs Harbour LGA the number one blueberry producer in Australia.
- Bananas: 2,074 tonnes which represents 50.3% of the region, 43.3% of NSW and 0.06% of Australia's production. Banana production has dropped by 4,039 tonnes since 2011. Coffs Harbour LGA is the primary producer of bananas in terms of tonnes produced (ABS, 2012, 2017b).

The Agriculture, Forestry and Fishing sector is estimated to have a value of $157.3 m (.id The Population Experts, 2019) which contributes 5.6% of the Coffs Harbour LGA economy. This is an indicator of business productivity in Coffs Harbour and shows how productive each industry sector is at increasing the value of its inputs. Figure 5 shows the value added figures for the different industry. It shows how productive each industry sector is at increasing the value of its inputs. It is a more refined measure of the productivity of an industry sector than output (total gross revenue), as some industries have high levels of output but require large amounts of input expenditure to achieve that. The Agriculture, Forestry and Fishing Industry is the sixth highest industry sector behind Health Care and Social Assistance; Construction; Retail Trade; Education and Training; and Public Administration and Safety. It is significant to note that Agriculture, Forestry and Fishing is the third highest private industry sector behind Construction and Retail Trade.

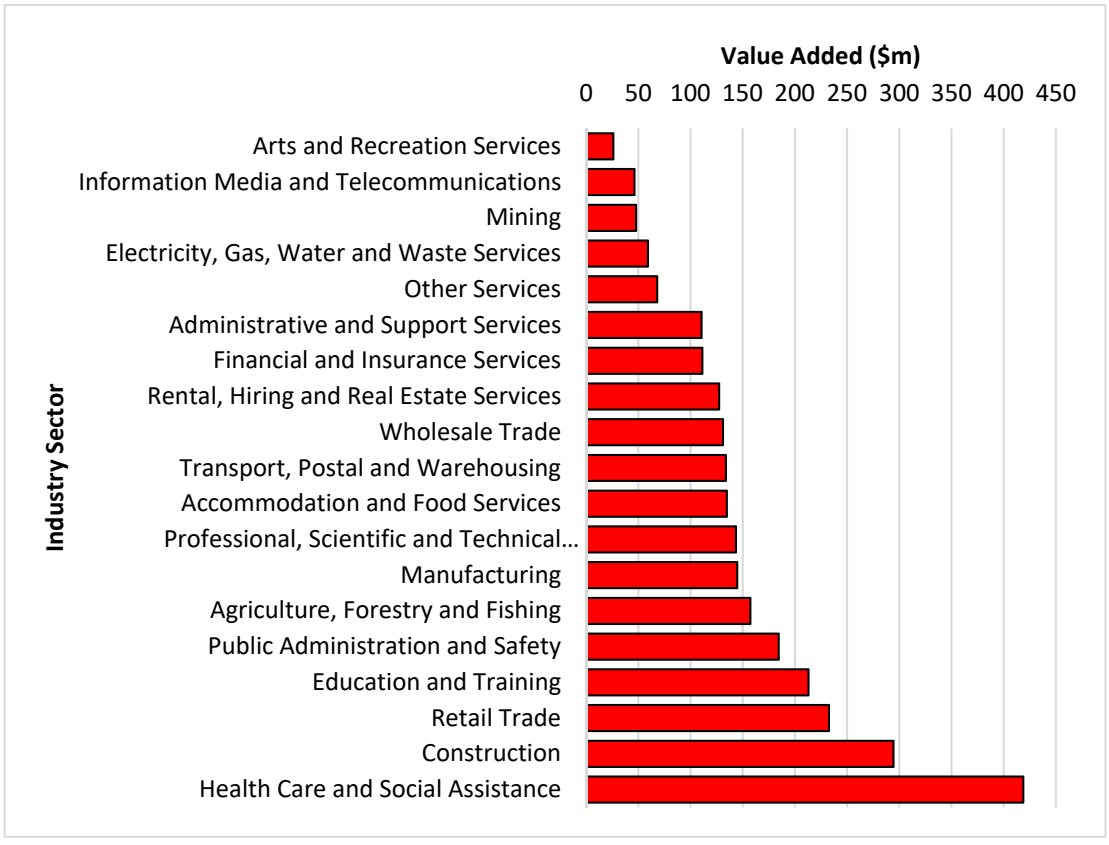


Figure 5 Value Added Economic Indicator for Industry Sections within Coffs Harbour LGA

Source: (.id The Population Experts, 2019)

Location Quotient is a ratio used when working in the area of economic development that is used to compare the dominance or specialisation of a particular industry in the local economy. The ratio compares the importance of the industry to the LGA relative to the importance to Australia. A Location Quotient of 1 indicates the same level of importance within the LGA and Australia-wide and generally, a ratio of greater

than 1.5 indicates that there is a degree of specialisation in that particular industry within the LGA. The higher the ratio, the more important it is to the LGA.

The Location Quotient for each of the industry sectors have been calculated and are shown in Figure 6. Agriculture, Forestry and Fishing sector has the highest Location Quotient at 2.1 which demonstrates the strength of the agriculture sector as an economic driver of the Coffs Harbour economy. This data has been derived from the 2016 ABS Census of Population and Housing, which is the most recently available.

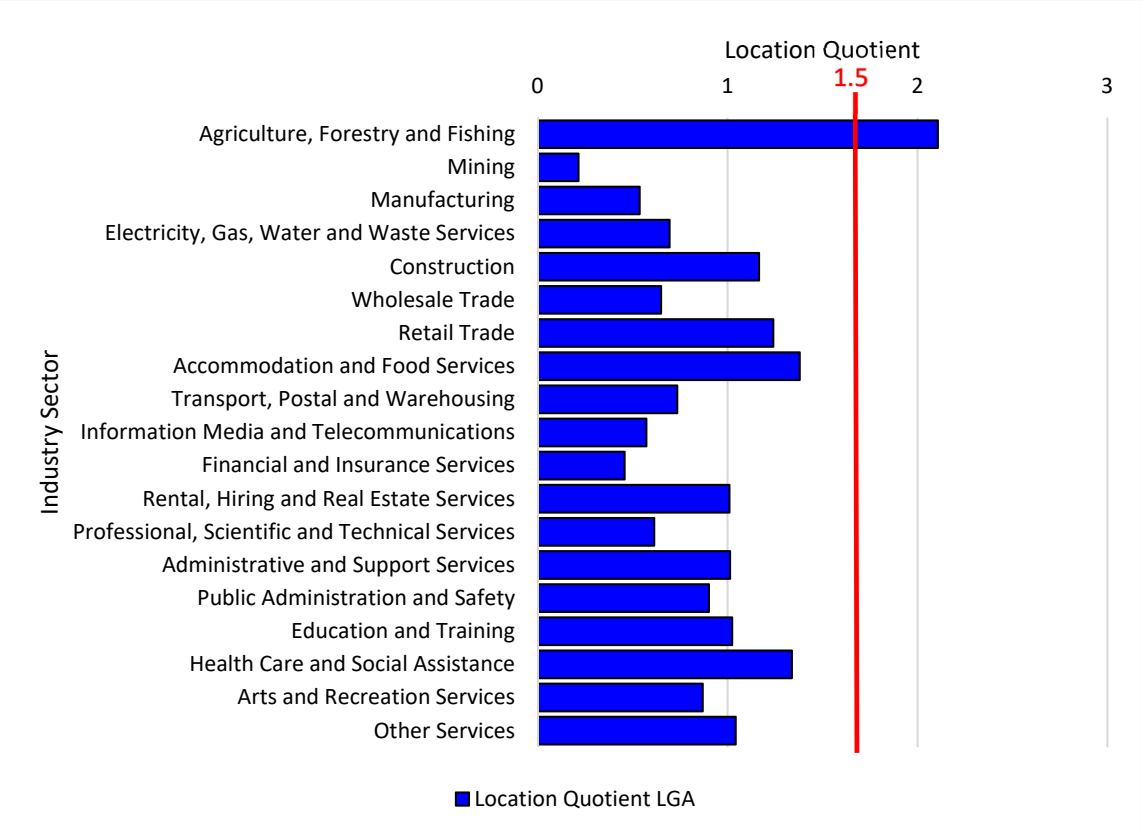


Figure 6 Location Economic Indicator

Source: (ABS, 2017a)

The key crops that contribute to the agricultural sector of Coffs Harbour LGA are discussed in the following sections.

Bananas

Within the construction footprint are 12 banana farms, with an additional five properties growing bananas with another crop. Data from ABS states that in 2015-2016, bananas grown in the Coffs Harbour LGA contributed $2.69 million to the agricultural industry, or around 43 per cent of total NSW banana production. The most common banana variety grown in the area is Cavendish with Lady Finger and Ducasse also grown.

The banana industry in Coffs Harbour has declined sharply since 2011. This decline is attributed to a number of farmers transitioning to growing blueberries instead of bananas (Edge Land Planning, 2016, 2017). It is not expected that the decline will continue and has levelled out according to industry sources interviewed for this project. A recent project to map banana plantations in NSW identified 344 farms

growing bananas on 1463 ha of land. Coffs Harbour LGA has 111 farms covering 508 ha of land, second behind Tweed Shire LGA (134 farms covering 595 ha (OEH & ABARES, 2017).

The Coffs Harbour area has a long history of producing bananas. The topography of ridges and valleys with steep, well drained slopes with an orientation that means they are protected from more destructive winds and are frost free has well suited banana production. Bananas are predominantly grown on the Megan and Suicide soil landscapes because of the good drainage which is suited to banana growing.

Cavendish variety is grown on a dryland basis and Lady Finger and Ducasse varieties require irrigation to get the best yield.

After harvesting the fruit, the banana corms (the above-ground structure) are cut down and left to mulch the surrounding land, and a new trunk is grown from the root system. The composting of the old corms adds to the soil fertility by adding organic matter to the soil. It is not uncommon for the banana plants to be 20 to 30 years old.

Once banana fingers emerge from the bell, they are covered with plastic bags. Bagging is undertaken on a single day which means that some bunches may be left in the open without any bag for up to a week. The bunches are cut and then transported to the packing shed via a 4WD vehicle. Here they are sorted, packed and sent to the ripening facility where they are ripened and then sent to the local, Sydney and interstate markets. Packing sheds are generally located at the bottom of the slope for ease of transport.

Banana plants are susceptible to wind damage and are normally staked to prop the trunks up. The northerly aspect is the best for growing and gets a much higher yield than the southerly sloping lands, particularly in winter when from 2pm the southern slopes are in shade whilst the northern slopes are still in full sun. When the temperature is lower, the bananas are slower to grow, and the cooler weather can also lead to dull coloured fruit rather than the bright yellow that comes from warmer areas. This dull fruit is rejected by the consumers, and there are no major secondary markets for blemished or discoloured bananas unlike other fruit and vegetables. For this reason, dull or blemished fruit is disposed of as it cannot be sold.

Photograph 4 shows a typical banana farm on the north facing slope showing the stakes propping the trunks up as well as the plastic bags to protect the bunches. Photograph 5 shows the fingers that have emerged from the bell but not yet covered with a plastic bag.



Photograph 4 Typical Banana Farm



Photograph 5 Typical Banana bunch

Blueberries

The blueberry industry is currently valued at $140 million (in 2011 it was valued at $67.2 million) and it is expected to continue to grow, with overseas export markets currently being investigated (ABS, 2017d). There were 22 farms in the Coffs Harbour LGA in 2001, 29 in 2006, 54 in 2011 and today it is estimated that there are about 130 farms. The industry in the Coffs Harbour LGA currently employs 6,000 to 7,000 casual employees and approximately 2,000 permanent employees (Edge Land Planning, 2017). Most of these employees are seasonal and itinerant workers and so would not be counted by the ABS Census of Population and Housing as their place of residence would not necessarily be in Coffs Harbour LGA.

Blueberries are harvested all year round, but the main harvest season is for ten months from March to December. The plants are grown in raised beds which are irrigated via drip or sub-surface irrigation. Water is sourced from bores, pumped from creeks or farm dams which are mostly spring fed. They are grown on flat to hilly land, but most farmers prefer flatter land because of the ease of harvest which happens by hand. There is a need to provide netting to protect the crop from birds and other animals. Photograph 6 shows a typical blueberry farm with netting and watering system.



Photograph 6 Typical Blueberry Farm

Cucumbers

Cucumbers are grown as secondary crops for banana and blueberry farms to provide an alternate source of income for some farmers. They are more commonly grown in conjunction with blueberries to provide an income stream when there is no production from the blueberries. There is only one cucumber grower in the construction footprint.

The growing of vegetables in the Coffs Harbour LGA is not very significant with the production being 0.6% of the value of NSW total vegetable production (ABS, 2017c).

Cucumbers are grown in protected cropping structures (greenhouses) and require a constant source of water. Photograph 7 shows a cucumber farm which is located on flat land but is part of a mixed farming operation.



Photograph 7 Cucumbers (foreground), bananas and netted blueberries

Avocados and custard apples

Avocados and custard apples are also grown as a secondary crop. They can be either grown on a dryland basis or irrigated, with irrigation producing a better yield.

There are three avocado growers in the construction footprint and only one is irrigated. There is only one custard apple grower in the construction footprint.

Coffs Harbour grows 0.2% of Australia's avocado crop. Most of Australia's custard apples are grown in the sub-tropical and tropical coast of Queensland and Northern NSW. Coffs Harbour is at the southern end of the growing area.

4 Impact Assessment

4.1 Introduction

This chapter addresses the impact the project would potentially have on agriculture, specifically impacts on the intensive plant land uses (farms). It summarises the impact on each farm and discusses broader impacts on the industry.

Potential impacts considered include direct impacts, where farms are located within the construction footprint and indirect impacts for farms within a 500m buffer of the construction footprint. Potential construction impacts dust impacts, access changes during construction, and risk of the spread of Panama disease.

4.2 Direct impact assessment

There are 24 farms within the construction footprint. Each farm was assessed to determine the level of impact as detailed in Table 2. The sections below provide a summary of the level of the range of impacts on each element and description of types of impacts.

4.2.1 Direct land take

The size of the 24 farms within the construction footprint range from less than one hectare in size, to close to 50 ha. On average, farms are around 10 ha. The area of farm land acquired for the project ranges from less than 1% to total acquisition (100%), with a greater area of bananas being impacted than any other crop.

4.2.2 Crop impact

An assessment of the extent of the direct physical impact on the crops on the property. Impacts range from no impacts on crops, through to removal of small strips or sections of crops, large swathes of crop areas and then total acquisition. Table 7 provides a summary of the levels of impact on crops within the construction footprint.

Table 7 Crop impact summary table

Level	Description	Number of farms assessed at this level
No impact	No area of crop impacted.	3
Minor	Only a small impact on total crop area.	7
Moderate	Generally less than 50% of total crop area impacted by the project.	6
Serious	Generally more than 50% total crop area impacted, with enough crop area retained to remain potentially viable.	4
Critical	No viable area of crop would be retained.	4

4.2.3 Structures

An assessment of the level of impact on structures required for operation of a farm (such as packing sheds) and how this would potentially impact overall farm operation and management. Impacts range from an impact on one packing shed or cropping structure when there is multiple operating on the farm, removal of all structures, including the removal of facilities for workers. Table 8 provides a summary of the levels of impact on structures within the construction footprint.

Table 8 Structures impact summary table

Level	Description	Number of farms assessed at this level
No impact	No structures impacted.	9
Minor	Limited impact or single structure when multiple used on the farm.	1
Moderate	Structures impacted by the project, but use could continue with modification.	7
Serious	Main operating structure/s impacted	4
Critical	All structures removed.	3

4.2.4 Type of acquisition

The type of acquisition has been assessed for the farms within the construction footprint. Acquisition ranges from areas of less than a one per cent strip acquisition, to a longer strip generally along one side of the property. Subsurface acquisition has the potential to limit development above the project in some circumstances, though there would be no direct impact to the properties at the surface, or the use of the land. Generally, property owners would be able to continue farming activities. Where properties are fragmented or severed, it is unlikely that they could continue to operate in the existing capacity and would likely cease to operate as a farm.

Roads and Maritime currently owns two agricultural farms within the construction footprint. This land is currently being farmed under a lease arrangement and is being considered as part of the agricultural assessment. Leased agricultural land within the construction footprint would have its lease extinguished prior to the start of construction with other areas unaffected by construction likely to remain being leased for farming and/or sold afterwards as a viable farming operation.

Table 9 provides a summary of the numbers of farms impacted by each type of acquisition within the construction footprint.

Table 9 Type of acquisition impact summary table

Level	Description	Number of farms assessed at this level
Minor	Small strip of lot acquired for the project or area of subsurface acquisition required.	9
Moderate	Larger strip of lot acquired for the project and / or area of subsurface acquisition required.	4
Serious	Lot could be fragmented or severed, or large proportion of the lot acquired.	4
Critical	Whole property would be fragmented or acquired in total.	7

4.2.5 Access

Impacts on both internal and external access have been assessed. Level of impacts range from no change to access, minor changes to access to properties that would be reinstated once the project was constructed, impacts to internal access roads and paths or critical where the property has been fully acquired by Roads and Maritime. Table 10 provides a summary of the number of each type of impact on access.

Table 10 Access impact summary table

Level	Description	Number of farms assessed at this level
No impact	No changes to access.	3
Minor	Minor impacts to access arrangements and existing access would be reinstated	10
Moderate	Access arrangements would be altered by the project.	7
Serious	Significant changes or adjustments to the original access to the property required	1
Critical	Access cut off, likely where property has been fully acquired.	3

4.2.6 Irrigation water

Producing blueberries, avocados and cucumbers, Lady Finger and Ducasse bananas generally relies on irrigation. Although avocados and these banana varieties can grow without irrigation, they get the best yield if they are irrigated. Cavendish bananas do not need irrigation and rely only on rainfall. For the farms being impacted by the project, irrigation is sourced from dams, creeks and bores.

Irrigation water is generally sourced from spring fed dams, creeks and bores. Of the eleven farms within the construction footprint that use irrigation, there are seven farms that have spring fed dams, four who have a licence to extract from creeks, one that has a bore and two that have rain fed dams. Some of these farms have both creek extraction and spring fed dams.

Where these sources of irrigation water are impacted, these sources would be replaced (such as providing a new water pump, or relocating a bore), and this is likely for two properties. However, there are circumstances where there are no appropriate alternative sources of water, and three banana farms would have their irrigation water source critically impacted. One of these farms would be entirely acquired as a result of the project and cease to operate, and the other two properties have no appropriate alternative sources of water resulting in a critical impact. Potential impacts on water sources have been assessed and Table 11 provides a summary of this assessment.

Table 11 Impacts on water sources

Level	Description	Number of farms assessed at this level
No impact	No change to existing conditions.	13
Minor	N/A	
Moderate	Source such as a pump is impacted by the project but could be replaced.	2
Serious	Dam or bore impacted by the property but could potentially be relocated.	6
Critical	Water source would be completely removed and no possibility of replacement	3

4.2.7 Dust impact

Dust has the potential to impact crops within the construction footprint during the construction phase. Dust impacts will vary depending on the construction activity occurring, duration, soil type and the topography, wind speed and direction. The risk of dust impact has been assessed based on the proximity of crops to proposed earthwork and ancillary sites, as well as the sensitivity of the crop. No farms would be critically impacted by dust impacts, with most being assessed as having a moderate to serious risk of dust impact. Potential risk of dust impact has been assessed and Table 12 provides a summary of the assessment.

Table 12 Potential risk of dust impact

Level	Description	Number of farms assessed at this level
Minor	Limited earthworks, crops further from construction footprint.	1
Moderate	Closer to areas of earthworks, proximity of crops to construction footprint.	7
Serious	Substantial areas of earthworks, crops in close proximity to construction footprint and ancillary sites.	16
Critical	NA	-

4.2.8 Microclimate

The impact of the tunnels at Roberts Hill, Shephards Lane and Gatelys Road was assessed to consider the changes to wind speed and changes to temperature once the tunnels have been constructed. According to "Bananas and Plantains, 2nd Edition", (Robinson & Saúco, 2010) regular winds in the 5- 10 m/s range can cause leaf tearing, leading to reduced productivity. This speed range occurs in the study area roughly a third (33%) of the time, currently.

The wind direction for speeds >5m/s is aligned with the Shephards Lane and Gatelys Road tunnels around 3% of the time and with Roberts Hill tunnel around 12% of the time. The proposed tunnels will have a very low impact in terms of changes to wind speed considering the existing local wind environment and the alignment of the tunnels.

The recorded temperature by direction was noted. Temperatures are moderate, 10 - 30°C the vast majority (93.3%) of the time. The most common direction of cooler (<10°C) wind is from the west 3% of the time. Cooler wind comes from the north 1% of the time, from the south 0.1% of the time and not at all from the east. Overall, tunnels will have a very low impact on the surrounding microclimate (see Appendix 2 for the full report).

4.2.9 Direct impact assessment summary

The overall impact on farms has been assessed considering all of the criteria discussed and a summary of these results is provided in Table 13. Six farms within the construction footprint would cease operation entirely, all of which are banana farms.

Table 13 Summary of total impact on farms within the construction footprint

Impact level	Description	Number of farms assessed at this level							
		Banana	Blueberry	Banana & blueberry	Banana, blueberry, cucumber	Banana, avocado, cucumber	Banana, avocado, custard apple	Protected cropping	Total
Minor	The farm would continue in its current state, with potential impacts being minor in nature and adequately mitigated during construction.	1	2	1			1	1	**6**
Moderate	The project would have an influence on the operation of the farm, but farming would be able to continue operating with some alterations and management measures being implemented.	2	3	1					**6**
Serious	Farming viability is likely to be seriously compromised unless extensive mitigation measures are implemented. This may include measures such as provision of replacement structures (packing sheds) and/or water sources, reconfiguration of internal farm management access, etc.	3	1		1	1			**6**
Critical	Farm is likely to cease operation in its current capacity. There is the opportunity for the residual agricultural land to be purchased by adjacent property owners	6							**6**

4.3 Indirect impact assessment

Potential indirect impacts are likely to be temporary and experienced during the construction phase of the project. These impacts include dust, temporary access changes and temporary impacts on irrigation water sources.

The Oz Group Packhouse is located within the construction footprint at the intersection of Englands Drive and the existing Pacific Highway. While this is not an agricultural property and has not been assessed as such, it is a significant facility for the local area and would be highly sensitive to potential dust impacts during construction.

4.3.1 Dust

Within the 500m buffer area, agricultural properties may experience dust soiling, which can stain or bruise the skin of fruit and may not be removed through washing.

Dust impacts would vary depending on the construction activity occurring, duration, soil type and the topography, wind speed and direction. There is potential for adverse dust impacts at sensitive receivers outside the construction footprint as winds may transport dust and emissions. For all construction activities, the construction contractor would adopt appropriate mitigation measures to reduce the risk of significant impacts on sensitive receivers. Given the proximity and number of sensitive receivers to the construction footprint, there is the risk that they would experience some occasional dust spoiling impacts. However, it is anticipated that impacts would be local and temporary.

4.3.2 Temporary access changes

Some roads would be required to be temporarily closed during construction, and diversions would be implemented to provide access to private properties and farms. There would be temporary changes to traffic conditions, including access to local roads and the existing Pacific Highway and increased travel times due to construction works. Temporary Traffic Management Strategies will be developed as part of the detailed design phase in consultation with the landowners, farmers and businesses to minimise impacts to operations.

4.3.3 Irrigation Water

Irrigation water is sourced from spring fed dams, creeks and bores. Of the eleven farms who have irrigation, there are seven farms that have spring fed dams, four who have a licence to extract from creeks, one who has a bore and two who have rain fed dams. Some of these farms have both creek extraction and spring fed dams.

The Coffs Harbour Bypass Groundwater Assessment Report (Arup, 2019) states that changes to groundwater level or local throughput in the fractured bedrock may impact on the availability of water recharging the agricultural dams. Further investigations at detailed design will be undertaken to evaluate the potential impact on those dams.

4.4 Panama disease

Panama disease is easily spread by the movement of infected planting material and over short distances via root to root contact and through movement of contaminated soil. The disease can also spread from parent plants to suckers. The disease can also be moved with soil (including dust), water and on contaminated equipment and vehicles. Fungal spores can survive in the soil for over 50 years and once Panama disease is present in the soil it cannot be eradicated (Queensland Government Department of Agriculture and Fisheries, 2018).

Consultation with DPI Agriculture in September 2018 identified three properties with known Panama disease close to the project. All areas are infected with Race 1. Given the pathogen's longevity and the potential for Race 1 to be present within banana plantations growing Cavendish varieties (either in the soil or within the root mass), a precautionary approach has been followed for the purposes of this assessment and it is assumed the Panama disease pathogen could be present within former and existing plantations within the construction footprint.

Excavation of soil and movement of material around the site during construction has the potential to spread Panama disease or other pathogens into uncontaminated areas resulting in banana plant deaths and potentially risking the viability of banana plantations. Given the characteristics of Panama disease and the ease with how it can be spread, effective controls and procedures will need to be developed and implemented to manage risks associated with spreading the disease. A Panama Disease Control Procedure would be developed to manage risks associated with potentially infected plant material during and following clearing and grubbing, movement of the pathogen in soils and water due to erosion and sedimentation during construction and movement of the pathogen via contaminated construction equipment and vehicles entering and leaving the construction footprint.

4.5 Industry

The loss of six banana farms out of 111 within the Coffs Harbour LGA would not have a significant detrimental impact on the industry in Coffs Harbour. No blueberry farms would be removed by the project, and there is unlikely to be a significant impact on the industry. There may be opportunities where a critical impact occurs and a farm ceases to operate in its current capacity for the residual agricultural land to be amalgamated into adjacent properties. The mitigation of impact associated with this occurring has not be factored into the assessment of those adjacent farms. There may be some impacts on the industry during the construction period as dust impacts could negatively impact crop quality and yield. These potential impacts are likely to be minor and temporary in nature.

5 Impact Mitigation

Table 14 provides a range of mitigation and management measures proposed to address and minimise impacts on agricultural properties during construction and operation of the project. Where applicable, property-specific measures have been recommended for the affected property owners included in Appendix 1. General measures would apply across the project.

In addition to the measures provided in Table 14, Roads and Maritime would continue consulting with directly affected properties during the acquisitions process. This consultation may identify additional or revised mitigation and management measures to further minimise impacts.

Table 14 Environmental management measures

ID No	Mitigation and management measure	Type
AG01	Where a property is not subject to a total acquisition, a specialist agricultural consultant will be engaged at the request of affected property owners whose properties are seriously or critically impacted by the project to assist in assessing, but not limited to, considering opportunities for agricultural diversification and/or revised farm management practices.	Property-specific
AG02	Impacted irrigation water sources and/or infrastructure will be restored, replaced, relocated or compensated for in consultation with affected property owners.	Property-specific

ID No	Mitigation and management measure	Type
AG03	Impacted structures, eg packing sheds and cropping structures etc, will be replaced or reconfigured in consultation with affected property owners where feasible.	Property-specific
AG04	Internal farm access impacted by the project will be reconfigured in consultation with affected property owners where reasonable and feasible.	Property-specific
AG05	Existing property accesses will be maintained during construction. Where this is not feasible or reasonable, temporary alternative access arrangements will be provided in agreement with and following consultation with the affected property owners with consideration to existing farming practices.	General
AG06	Where property accesses are permanently impacted as a result of the project, an alternative access will be designed in consultation with the affected property owner with consideration to existing farming practices.	Property-specific
AG07	An Air Quality Management Plan will be prepared and implemented during construction. The Plan will include but not be limited to: • Mitigation and suppression measures to minimise the potential for generation of dust during construction including the use of water carts, soil binders and progressive revegetation. • Methods to manage or stop works during strong winds or other adverse weather conditions. • Requirements for monitoring to assess the effectiveness of the applied measures and notification procedures.	General
AG08	Real time dust monitoring will be undertaken at representative locations of dust sensitive agricultural receivers along the project alignment to allow for the timely management of dust generation on-site and to minimise potential impacts. The representative locations of dust sensitive agricultural receivers will be determined during detailed design and will include the Oz Group Packhouse. Monitoring would be undertaken in accordance with the Approved Methods for the sampling and analysis for air pollutants in NSW (DEC, 2005) where applicable.	General / Project-specific
AG09	A Panama Disease Control Management Plan will be prepared and implemented during construction in consultation with DPI Agriculture and representatives of the Banana Growers Association of Coffs Harbour & District. The Plan will be prepared in accordance with relevant Queensland's Department of Agriculture and Fisheries guidelines including Panama disease tropical race 4: Biosecurity standards and guidelines (2015) and Panama disease tropical race 4: Decontamination guide (2016). Specific management measures and controls will address the following as a minimum for all existing and former banana plantations within the construction footprint: • Cleaning and washdown procedures for construction plant, vehicles and equipment and personnel	General

ID No	Mitigation and management measure	Type
	• Clearing and grubbing practices • Stockpile management procedures for topsoil and other materials • Procedures for the management and/ or disposal of contaminated and/ or potentially contaminated Panama disease soils including its identification as such to prevent accidental spread of the disease by others • Erosion and sediment control requirements • Dust management controls • The movement of construction plant, vehicles and equipment and personnel both within the project and externally, including where construction plant and equipment may have previously worked in other affected areas such as north east Queensland • Revegetation and rehabilitation practices.	
AG10	An Automatic Weather Station (AWS) will be established at a representative location to confirm the outcomes of the wind flow and microclimate investigations detailed in Appendix 2. The AWS will be established in accordance with the Bureau of Meteorology's Observation Specification No. 2013.1: Guidelines for siting and exposure of meteorological instruments and observing facilities.	General

6 Conclusion

This agriculture assessment identifies that the Coffs Harbour LGA is an important production area for bananas, blueberries and cucumbers. Agriculture is an important part of the Coffs Harbour economy with Coffs Harbour being the highest blueberry producing LGA in Australia and the number one banana producer in NSW

There are 24 farms that will be directly impacted by the project, with farms in the wider 500m radius of the construction footprint also experiencing temporarily impacts during construction. Six banana farms would be critically impacted and cease to operate as a result of the project. These impacts are not considered to be significant within the context overall agricultural production of the Coffs Harbour LGA.

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Appendix 1. Individual Property Impact Report

Individual property assessment

Both direct and indirect impacts have been considered to inform this assessment. This section provides a detailed assessment of the direct impacts on farms as a result of the project.

A range of assessment criteria for direct physical impacts has been consider for each property within the construction footprint and are outlined Table 15.

Table 15 Direct impact assessment criteria

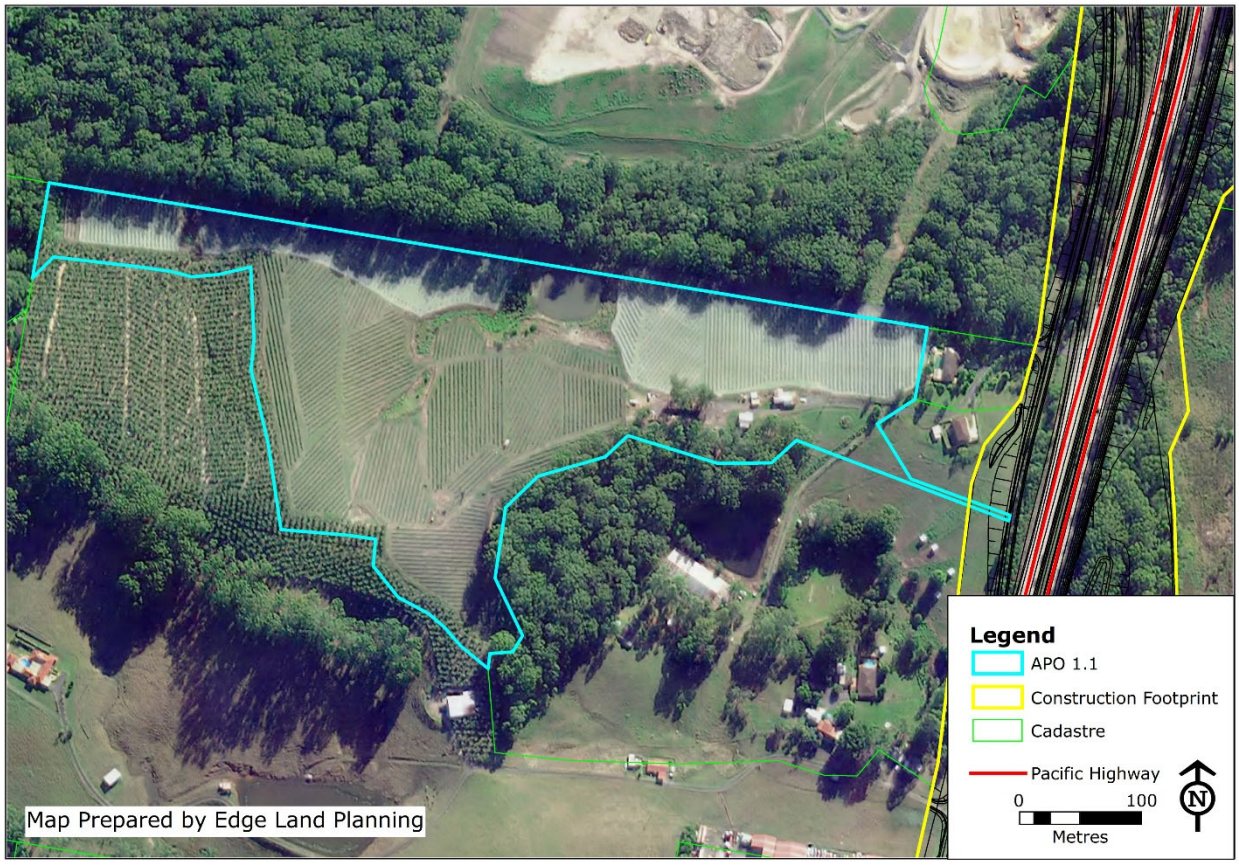
Criteria	Description
Direct land take	Amount of land being directly impacted (acquired) as a percentage of the total farm.
Crop impact	The extent of the direct physical impact on the crops on the property.
Structures	The direct impact on structures required for operation of a farm (eg packing shed), and consideration of the impact on the overall farm operation and management.
Type of acquisition	**Strip acquisition** – where a small strip of the lot is to be acquired for the project. **Subsurface** – where a tunnel is to be constructed beneath a property, subsurface acquisition may be required. This generally would allow farming to continue on the surface. **Fragmentation** – Where the existing farm would be fragmented or severed as a result of the construction of the project.
Access	The degree of impact on internal access. The project may affect one end of the property, change the entry into the farm, cross the farm and/or impact on farming operation.
Irrigation water	Impacts on water supply such as bores and dams, and the degree to which access to water is affected. Includes reliance on water for agricultural purposes.
Dust	Risk level for dust has been determined considering proximity and extent of earthworks and ancillary facilities, as well as crop sensitivity to dust impacts.

Each property was assessed against the criteria in Table 15 and a residual level of impact assigned between moderate and critical. A description of these impact levels is provided in Table 16.

Table 16 Level of Impact

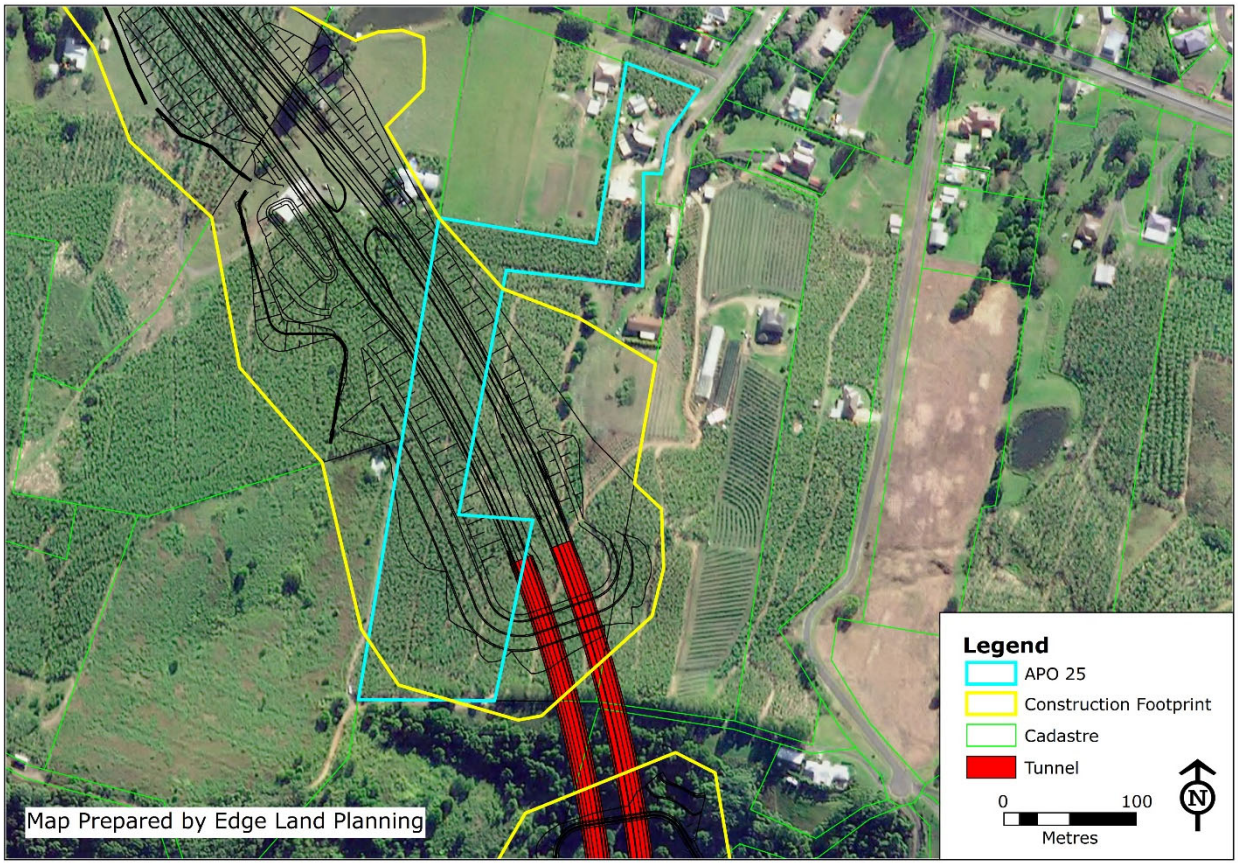
Impact Level	Description
Minor	The farm would continue in its current state, with potential impacts being minor in nature and adequately mitigated during construction.
Moderate	The project would have an influence on the operation of the farm, but farming would be able to continue operating with some alterations and management measures being implemented.
Serious	Farming viability is likely to be seriously compromised unless significant mitigation measures are implemented. This may include measures such as provision of replacement structures (packing sheds) or water sources.
Critical	Farm is likely to cease operation in its current capacity. There is the opportunity for the residual agricultural land to be amalgamated into adjacent properties.

APO 1.1 – Blueberry farm



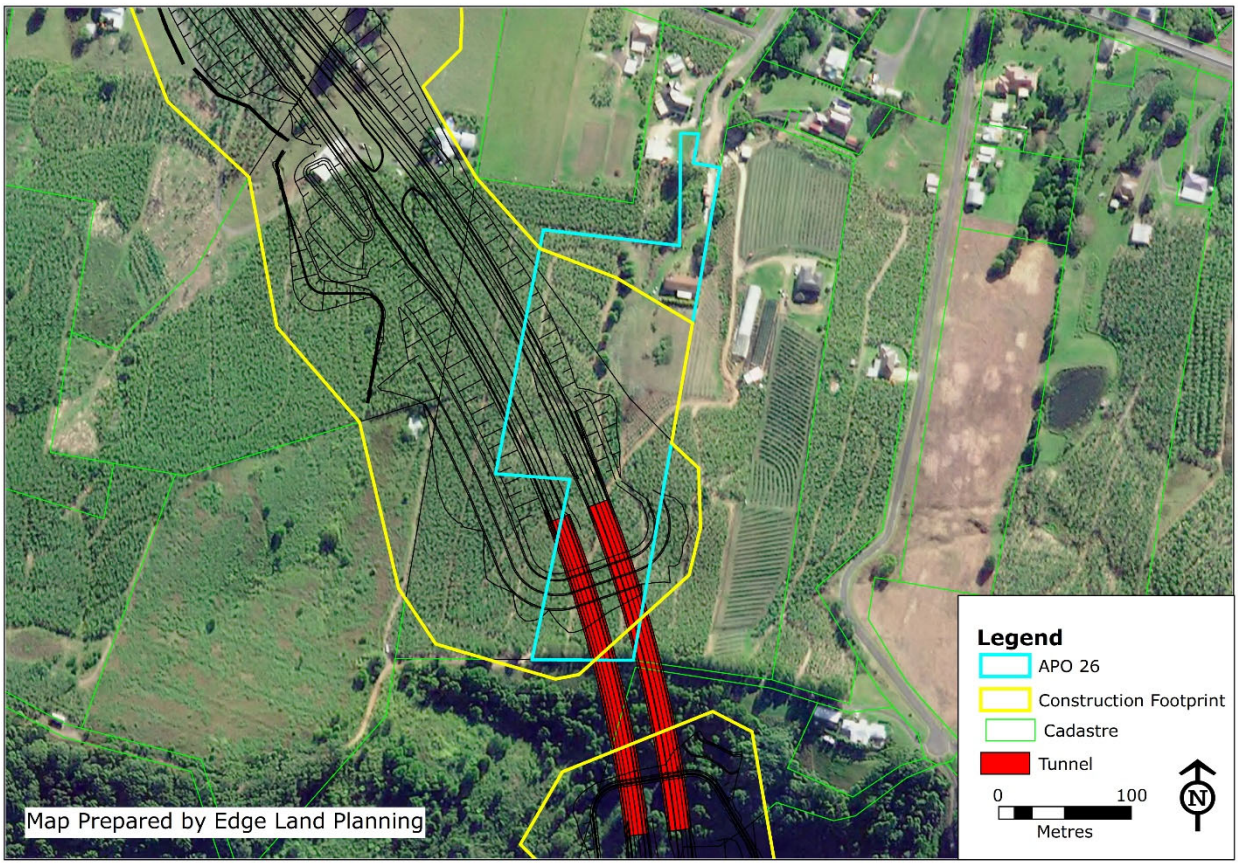
Criteria	Impact level	Assessment / comment
Direct land take	0.09%	
Crop impact	No impact	
Structures	No impact	
Type of acquisition	Minor	A small strip of access from the existing Pacific Highway would require acquisition. However, access from the proposed property access road would be provided during operation.
Access	Minor	While there would be some temporary impacts during construction, access would be provided from the proposed property access road.
Irrigation water	No impact	
Dust	Minor risk of impact	Risk level determined given relatively limited earthworks and distance of crops to construction footprint.
Overall impact	**Minor**	Farming of blueberries anticipated to continue.
Mitigation measures	–	AG06

APO 25 – Bananas



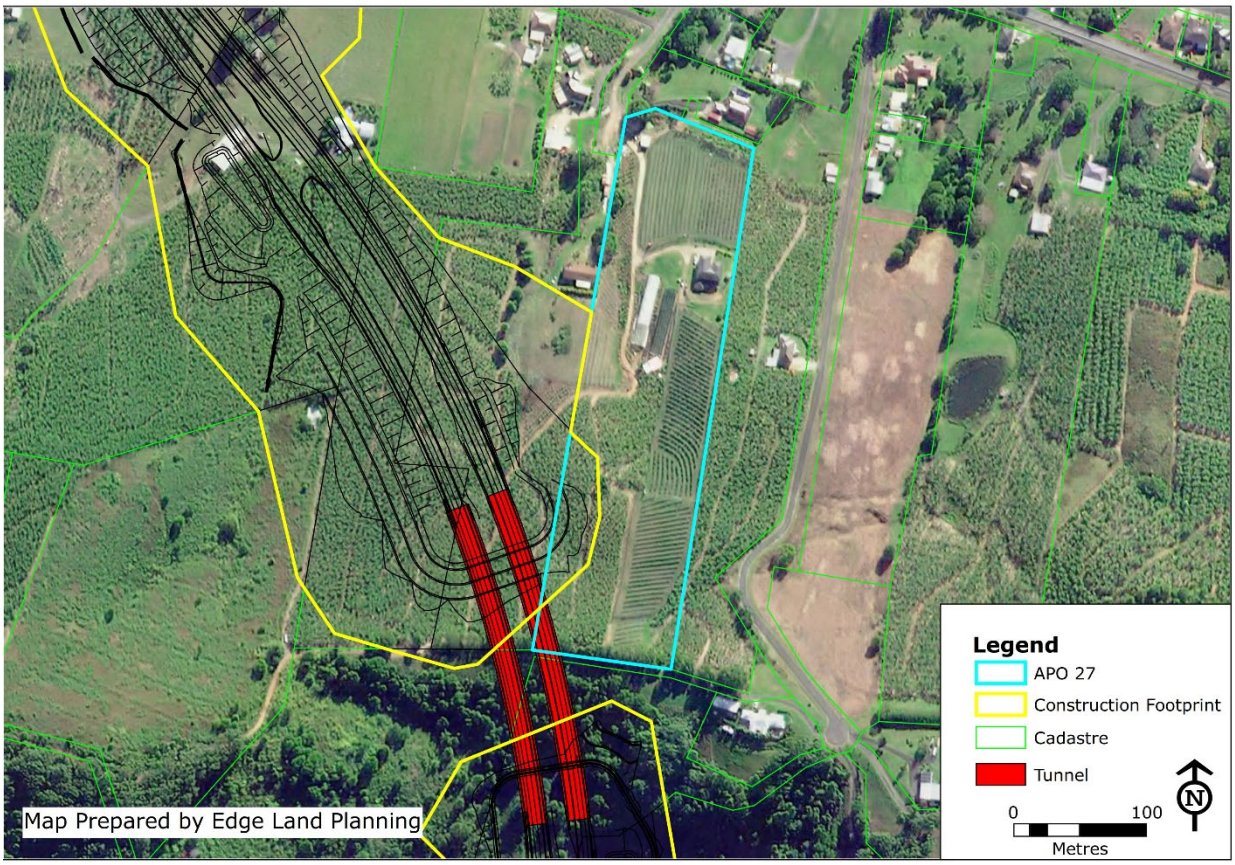
Criteria	Impact level	Assessment / comment
Direct land take	68.31%	
Crop impact	Serious	A small section of banana crop could be retained.
Structures	No impact	
Type of acquisition	Critical	The property would be fragmented.
Access	No impact	
Irrigation water	Critical	A spring fed dam is within the construction footprint and would be impacted by the project. There would be changes to surface water runoff / flows which would be intercepted by the project.
Dust	Serious risk of impact	Risk level determined given substantial earthworks and proximity of crops to construction footprint.
Overall impact	**Critical**	The farm would likely cease operation in its current capacity. Structures and access would not be impacted, and a small portion of banana crop could remain.
Mitigation measures	-	AG01

APO 26 – Bananas



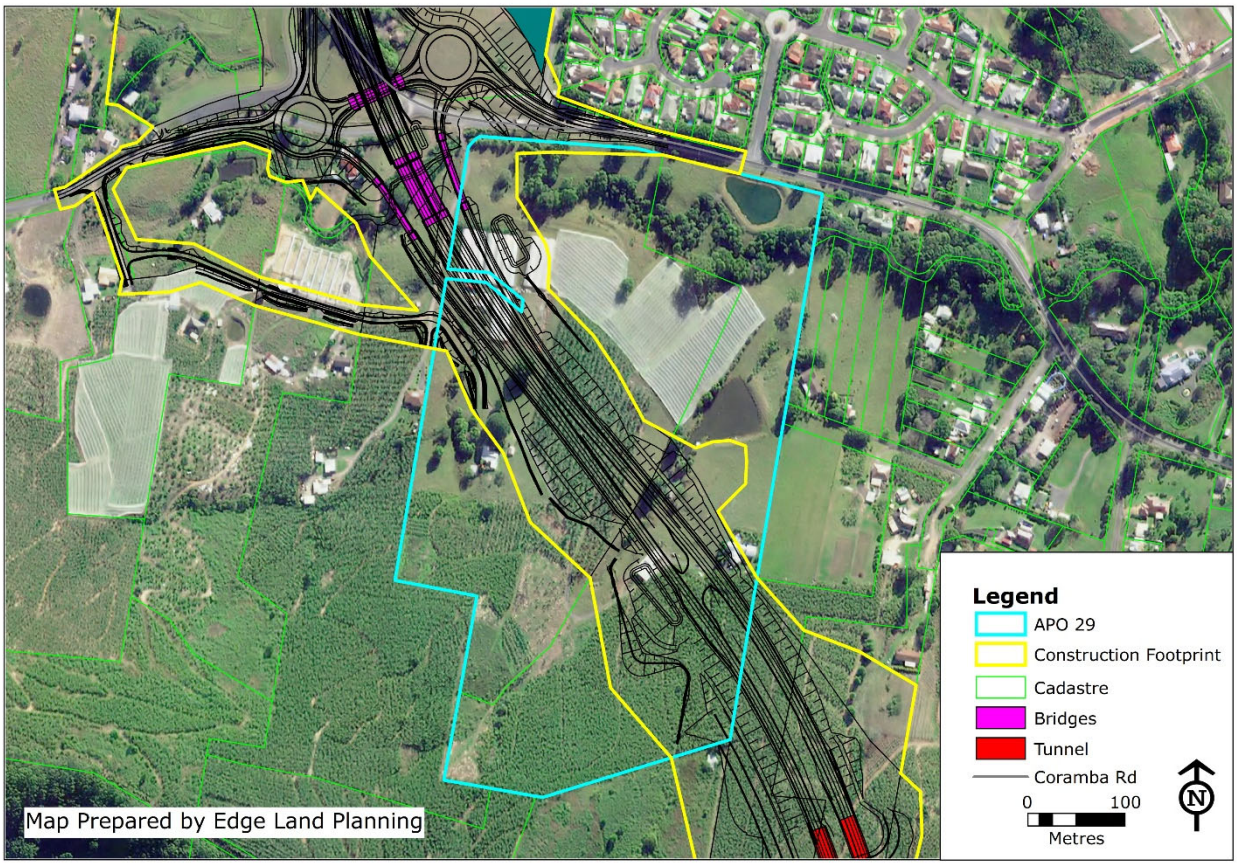
Criteria	Impact level	Assessment / comment
Direct land take	62.94%	
Crop impact	Serious	A small section of banana crop could be retained.
Structures	No impact	
Type of acquisition	Critical	The property would be fragmented.
Access	No impact	
Irrigation water	No impact	
Dust	Serious risk of impact	Risk level determined given substantial earthworks and proximity of crops to construction footprint.
Overall impact	**Critical**	The farm would likely cease operation in its current capacity. Structures and access would not be impacted, and a small portion of banana crop could remain, or an alternative crop could be considered.
Mitigation measures		AG01

APO 27 – Banana and blueberry farm



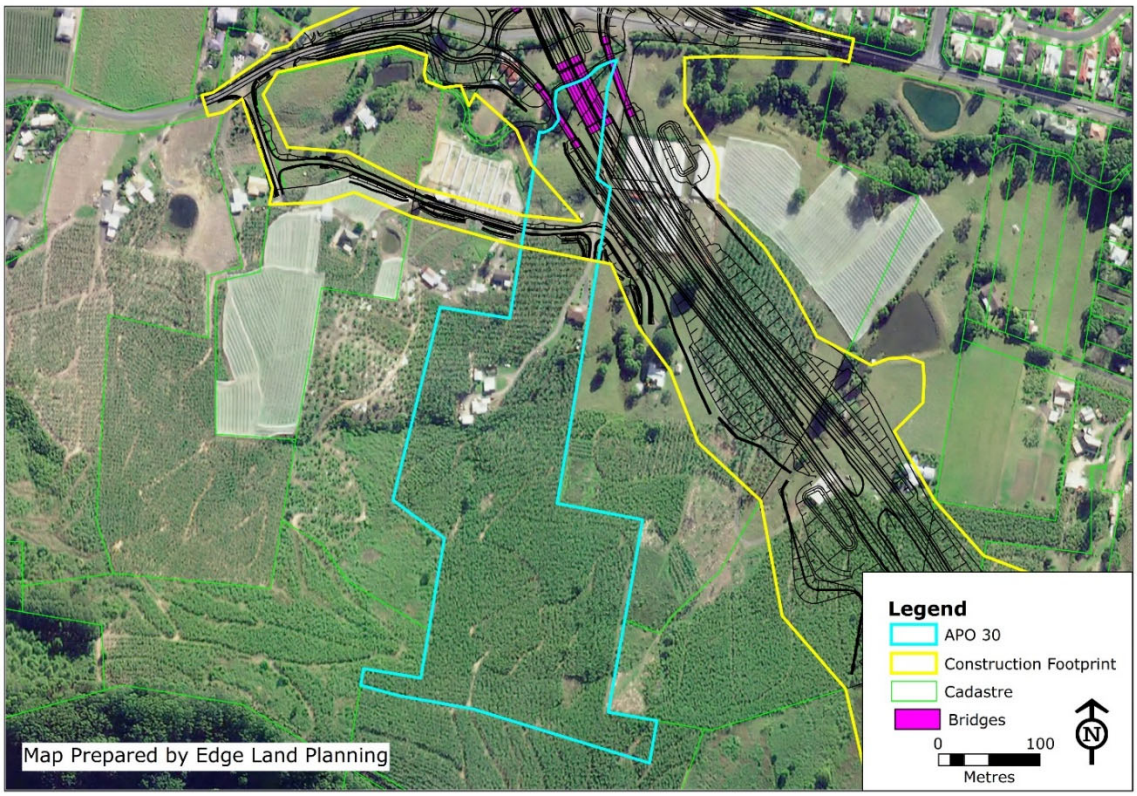
Criteria	Impact level	Assessment / comment
Direct land take	7.52%	
Crop impact	Minor	A small section of the existing banana plantation would be removed.
Structures	No impact	
Type of acquisition	Minor	A strip of the lot would be acquired to allow for the project.
Access	Minor	Internal access would be affected.
Irrigation water	No impact	
Dust	Moderate risk of impact	Risk level determined given earthworks and proximity of crops to construction footprint
Overall impact	**Minor**	Farming at this property would continue with only minor impact on banana plantation.
Mitigation measures		AG04

APO 29 – Banana, blueberry and cucumber farm



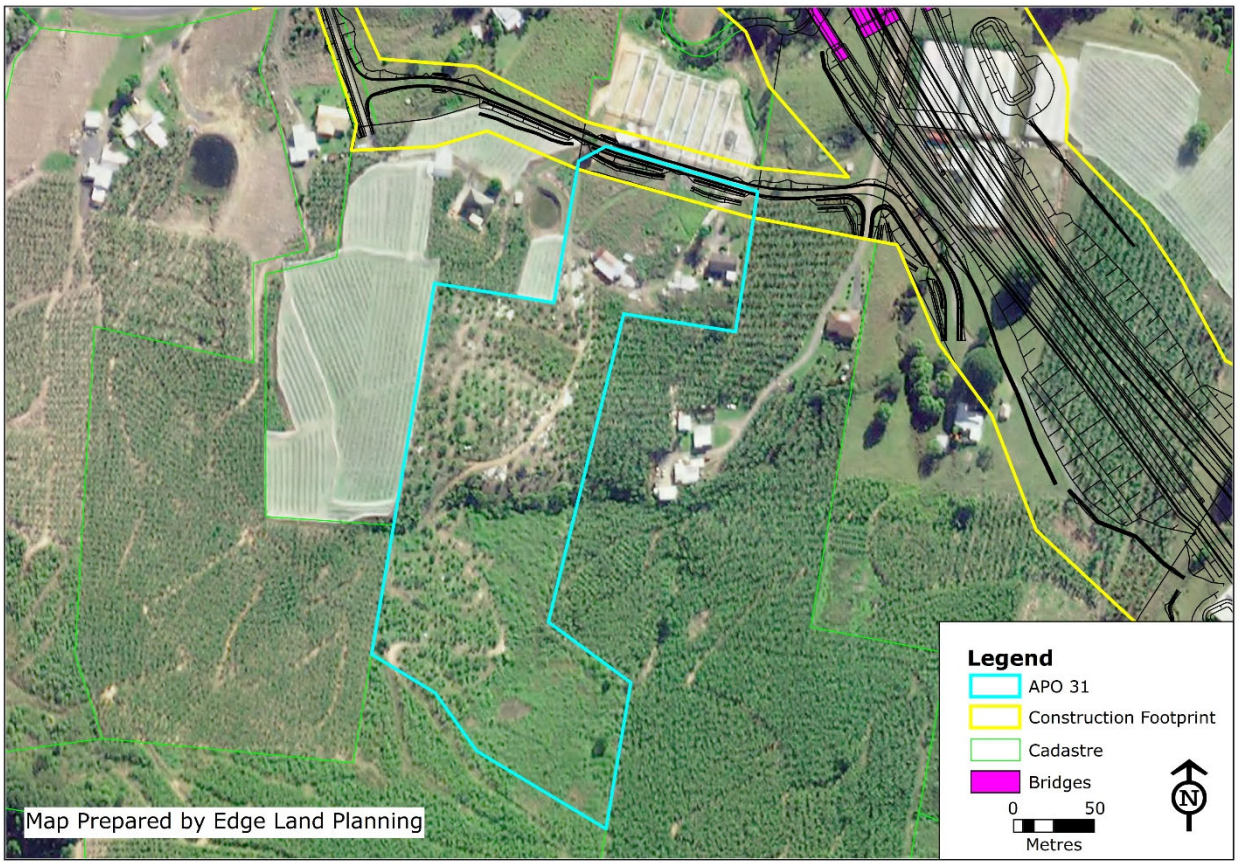
Criteria	Impact level	Assessment / comment
Direct land take	39.01%	
Crop impact	Serious	A large section of banana plantations would be removed from the property as would the protected cropping areas (cucumbers). Blueberry crops would be retained.
Structures	Serious	Packing sheds and protected cropping structures would be directly impacted as a result of the project.
Type of acquisition	Critical	The property would be completely fragmented by the project being constructed through the middle of the existing farm.
Access	Moderate	There would be some temporary impacts during construction, and new access to the northern portion of the property would be required from Coramba Road or Nelson Street.
Irrigation water	Moderate	One dam would be directly impacted by the project, and two would be retained.
Dust	Serious risk of impact	Risk level determined given substantial earthworks and proximity of crops to construction footprint.
Overall impact	**Serious**	This property would be seriously impacted and is likely to cease operation in its current capacity. Impacts on the blueberry plantation have been avoided and this crop production could continue. Residual agricultural land may represent an opportunity for consolidation with an existing adjacent land owner.
Mitigation measures		AG01, AG02, AG03, AG06

APO 30 – Lady Finger Banana farm



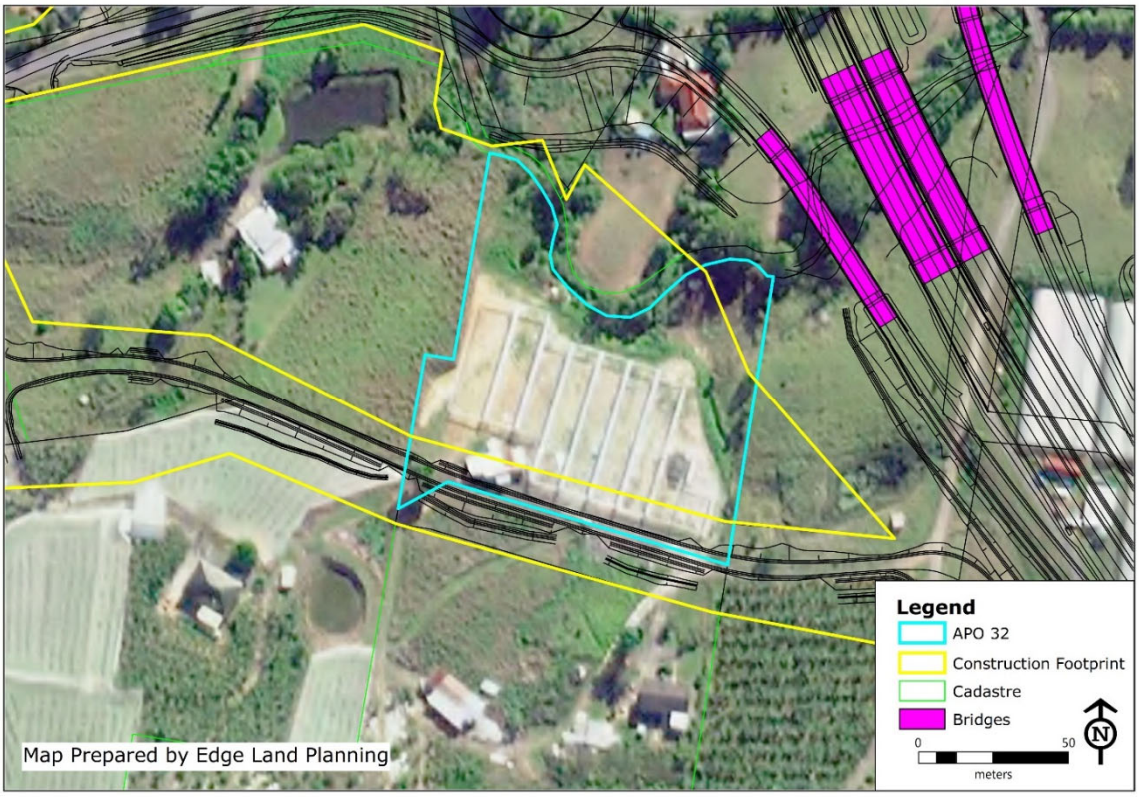
Criteria	Impact level	Assessment / comment
Direct land take	11.26%	
Crop impact	Minor	A small section of banana planation would be removed along the access road.
Structures	Moderate	A pumphouse would be impacted as a result of the project.
Type of acquisition	Moderate	A section of the northern extent of the property would be acquired however this is currently vacant land.
Access	Minor	While there would be some temporary impacts during construction, the existing property access off Bennetts Road would be reinstated.
Irrigation water	Serious	The farm relies on irrigation pumped from Coffs Creek to a dam which would be removed as part of the project.
Dust	Serious risk of impact	Risk level determined given substantial earthworks and proximity of crops to construction footprint.
Overall impact	**Moderate**	The connection to Coffs Creek would need to be reinstated via poly pipes and a pump for farming to continue at this property.
Mitigation measures		AG02, AG03, AG06

APO 31 – Banana, avocado, custard apple farm



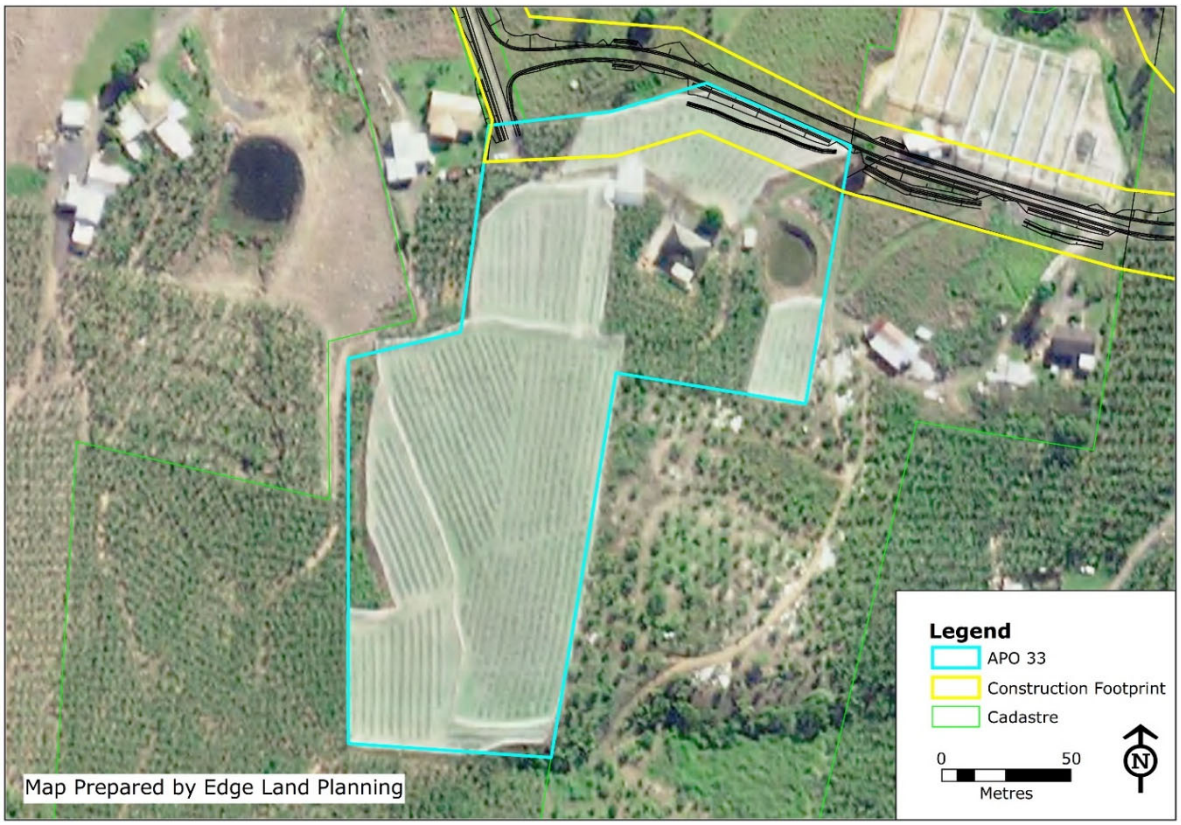
Criteria	Impact level	Assessment / comment
Direct land take	4.10%	
Crop impact	No impact	
Structures	No impact	
Type of acquisition	Minor	A strip of the lot along the front of the property would be impacted.
Access	Minor	While there would be some temporary impacts during construction, the existing property access off Bennetts Road would be reinstated.
Irrigation water	No impact	
Dust	Moderate risk of impact	Risk level determined given substantial earthworks and proximity of crops to construction footprint, but also considering crop sensitivity to dust (avocado and custard apples).
Overall impact	**Minor**	Farming at this property should continue with minimal impact.
Mitigation measures		AG06

APO 32 – Cucumbers



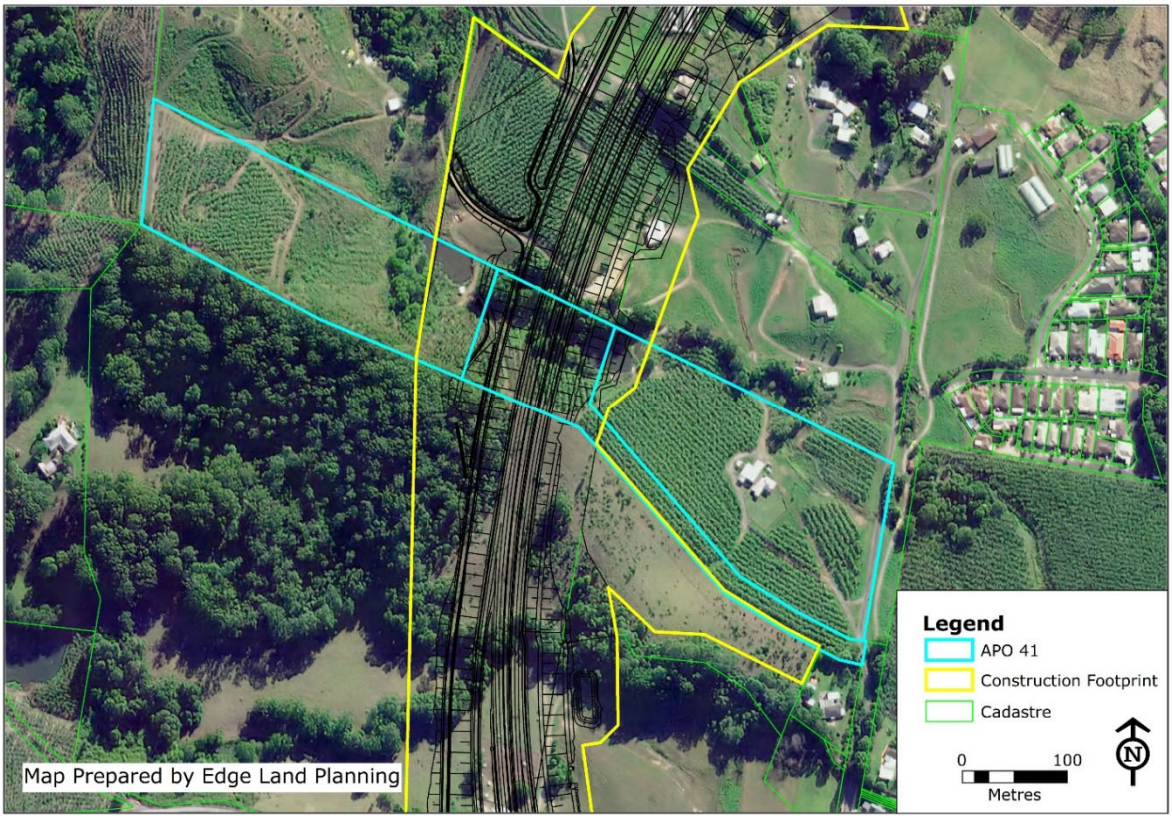
Criteria	Impact level	Assessment / comment
Direct land take	3.89%	
Crop impact	Minor	A small section of protected cropping structures is within the construction footprint.
Structures	Moderate	A packing shed would be removed as result of the project.
Type of acquisition	Minor	A small strip along the access road would be acquired.
Access	Minor	While there would be some temporary impacts during construction, the existing property access off Bennetts Road would be reinstated.
Irrigation water	No impact	
Dust	Moderate risk of impact	Risk determined given substantial earthworks and proximity of crops to construction footprint but also considers sensitivities of crops to dust (cucumbers).
Overall impact	**Minor**	Without redesign of the road to the south of the property, the existing greenhouse structures would need to be relocated, however farming could continue.
Mitigation measures		AG03, AG06

APO 33 – Blueberries and bananas



Criteria	**Impact level**	Assessment / comment
Direct land take	8.54%	
Crop impact	Moderate	A section of blueberry crop would be directly impacted.
Structures	No impact	
Type of acquisition	Minor	A small strip of the northern extent of the property would be acquired along the existing access road.
Access	Minor	While there would be some temporary impacts during construction, the existing property access off Bennetts Road would be reinstated.
Irrigation water	Serious	Irrigation water is sourced from Coffs Creek and this would be impacted as a result of the project.
Dust	Serious risk of impact	Risk determined considering substantial earthworks and proximity of crops to construction footprint
Overall impact	**Moderate**	While a part of the existing blueberry crop would be impacted by the project, farming could continue once an alternative water source or relocation of the water pump occurred. There is the potential for the road to be redesigned to avoid the blueberry crop.
Mitigation measures		AG02, AG03, AG06

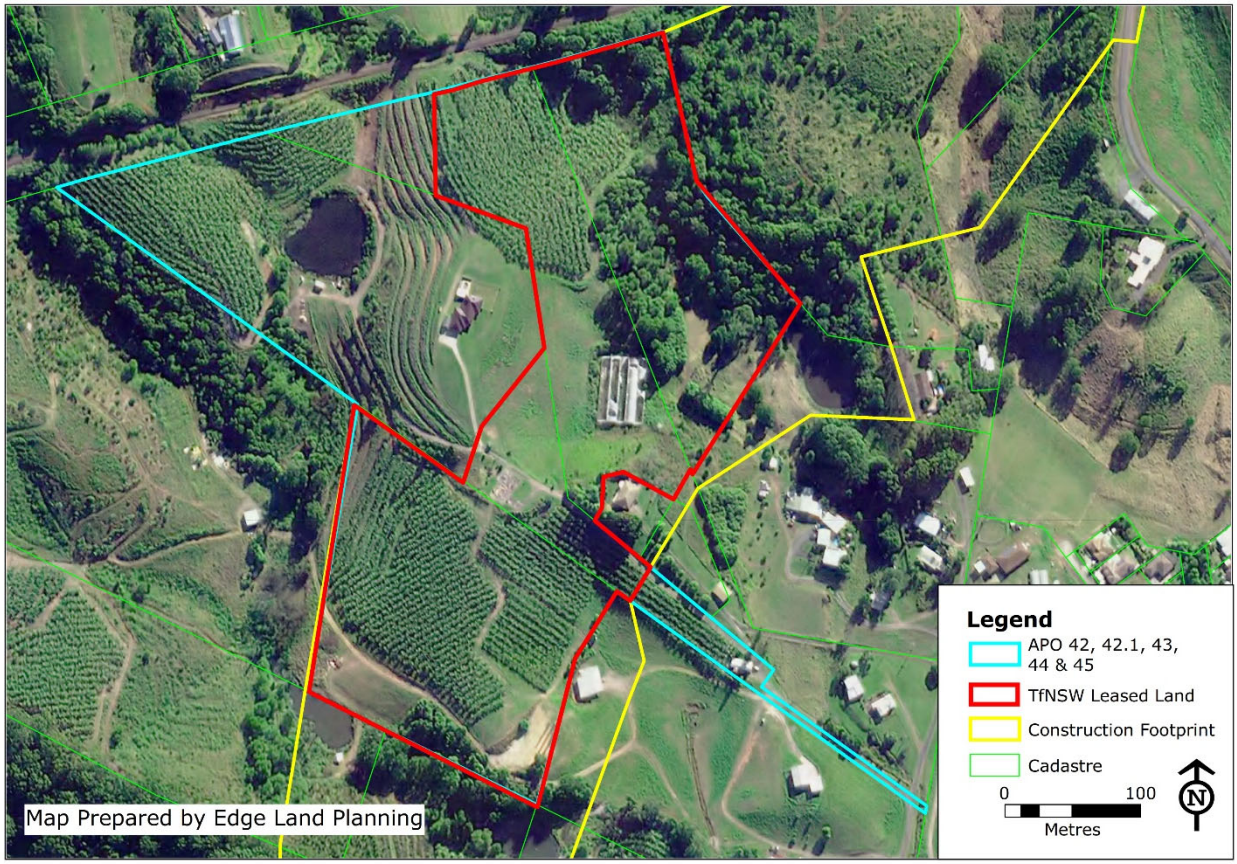
APO 41 - Bananas



Criteria	Impact level	Assessment / comment
Direct land take	20.18%	
Crop impact	Moderate	A section of banana plantation in the middle of the farm would be removed.
Structures	Moderate	A pumphouse would be impacted as a result of the project.
Type of acquisition	Serious	The property would be fragmented as a result of the project.
Access	Serious	There would be some temporary impacts during construction, and access to the western part of the property would be lost.
Irrigation water	Critical	Two dams within construction footprint would be impacted.
Dust	Serious risk of impact	Risk level determined given substantial earthworks, proximity to potential ancillary facilities and proximity of crops to construction footprint.
Overall impact	**Serious**	Farm would not continue to operate in its current capacity as it would be severed by the project. For farming to continue at this property, the connection to Coffs Creek would need to be reinstated via poly pipes and a pump. Residual agricultural land may represent an opportunity for consolidation with an existing adjacent land owner.
Mitigation measures		AG01, AG02, AG04, AG06

APO 42, 42.1, 43, 44 and 45 – Bananas

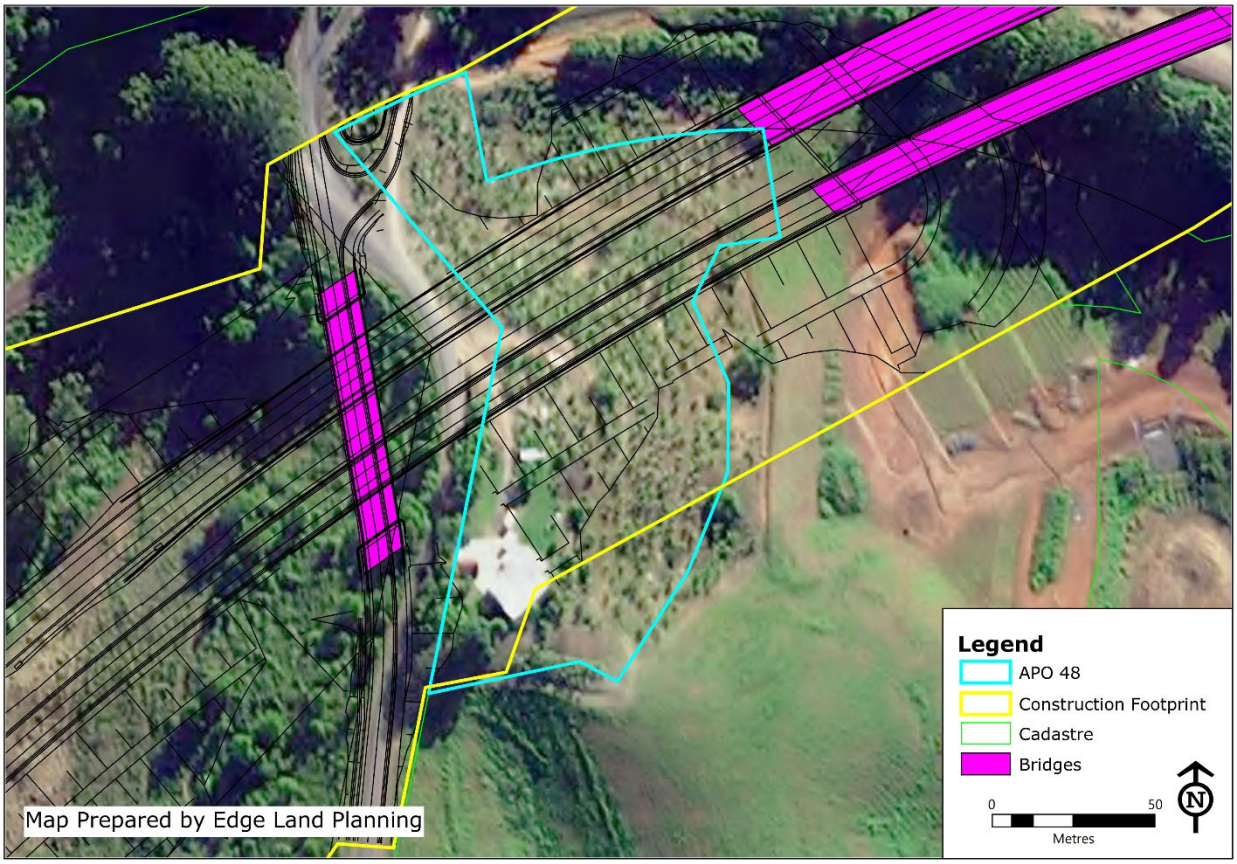
Roads and Maritime has carried out past acquisition of the properties listed above (with the exception of APO 42.1). The acquired land is shown within the figure below. The Roads and Maritime owned land is collectively farmed under a lease arrangement which will be extinguished prior to the start of construction. As such, the five APOs are being assessed together for the purposes of this property impact report.



Criteria	Impact level	Assessment / comment
Direct land take	61.17%	
Crop impact	Serious	A large portion of the currently farmed banana plantations would be impacted.
Structures	Moderate	A packing shed would be removed as a result of the project.
Type of acquisition	Critical	Past acquisition has fragmented the properties. The lease arrangement will be extinguished prior to start of construction which will remove the Roads and Maritime owned farming land.
Access	Minor	While there would be some temporary impacts during construction, the existing property access would be reinstated.
Irrigation water	No impact	
Dust	Serious risk of impact	Risk level determined given substantial earthworks, proximity to potential ancillary facilities and close proximity of crops to construction footprint.

Overall impact	**Serious**	Farm would not continue to operate in its current capacity due to the large portion of banana plantations being impacted. However, there remains opportunity to continue farming bananas on land not impacted on the western side of the project with the implementation of mitigation measures.
Mitigation measures		AG01, AG03, AG04, AG06

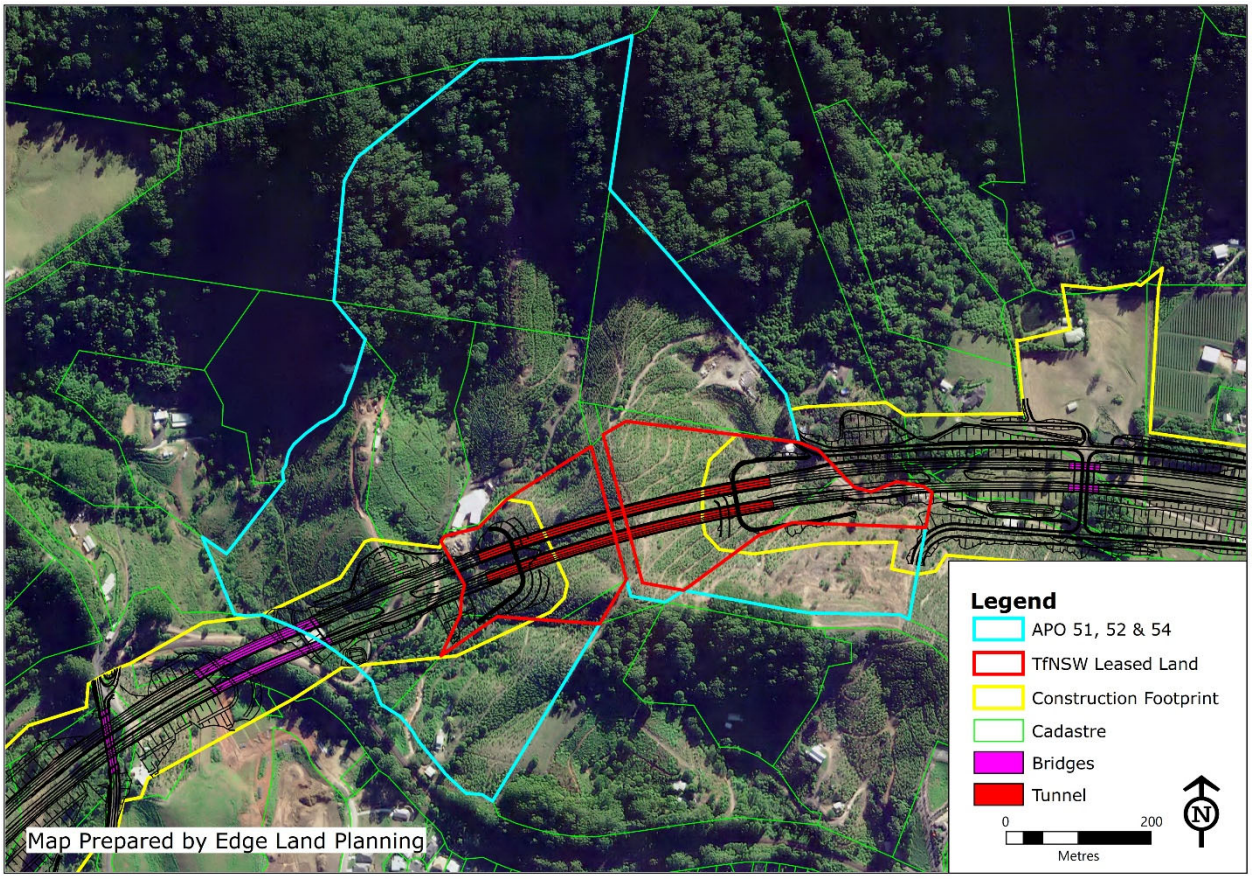
APO 48 – Bananas



Criteria	Impact level	Assessment / comment
Direct land take	100%	
Crop impact	Critical	All banana crops would be removed as a result of the project.
Structures	Critical	All structures would be impacted as a result of the project.
Type of acquisition	Critical	The entire property would be acquired for the project.
Access	Critical	
Irrigation water	No impact	
Dust	Serious risk of impact	Risk level determined given substantial earthworks and proximity of crops to construction footprint.
Overall impact	**Critical**	Entire lot is being acquired as a result of the project.
Mitigation measures		As this is a total acquisition, no mitigation measures are proposed.

APO 51, 52 & 54 – Bananas

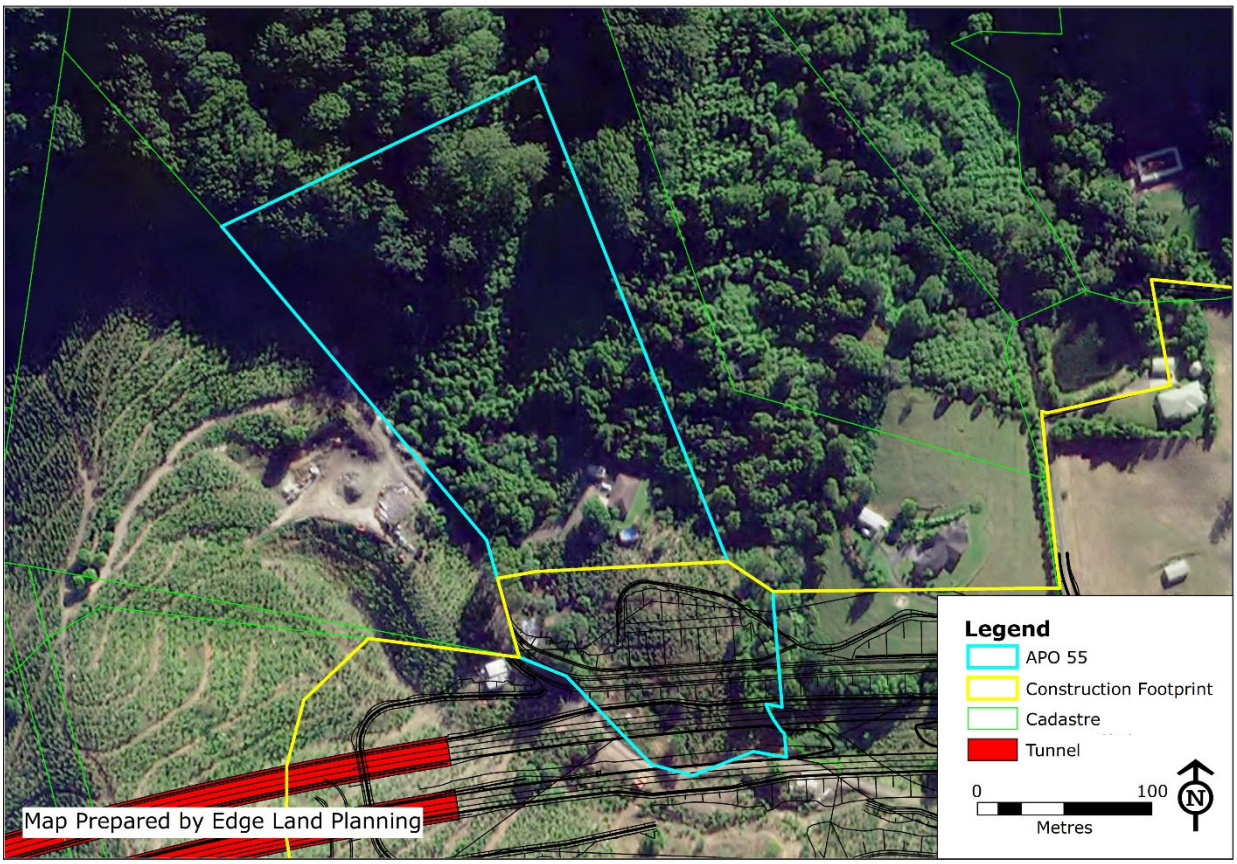
Roads and Maritime has carried out past acquisition of the properties listed above. The acquired land is shown within the figure below. The Roads and Maritime owned land is currently under a lease arrangement allowing for the banana plantation to be farmed although this is currently not being actively farmed. The land within the construction footprint will have its leased extinguished prior to the start of construction. During operation, Roads and Maritime will retain ownership of the subsurface land for the tunnel with the residual surface land proposed to be sold to allow its continued existing use. As such, the three APOs are being assessed together for the purposes of this property impact report with the assumption that the residual surface land would continue to operate as a banana farm during operation of the project.



Criteria	Impact level	Assessment / comment
Direct land take	19.41%	
Crop impact	Moderate	Crops around the tunnel portals on either side of ridge would be impacted by the project.
Structures	Moderate	The packing shed on the eastern side of the ridgeline would be impacted. The large packing shed on the western side of the ridgeline would be avoided.
Type of acquisition	Serious	Past acquisition has already fragmented the properties. The lease arrangement for the areas within the construction footprint will be extinguished prior to start of construction. Residual surface land above the tunnel is proposed to be sold to allow its continued existing use.

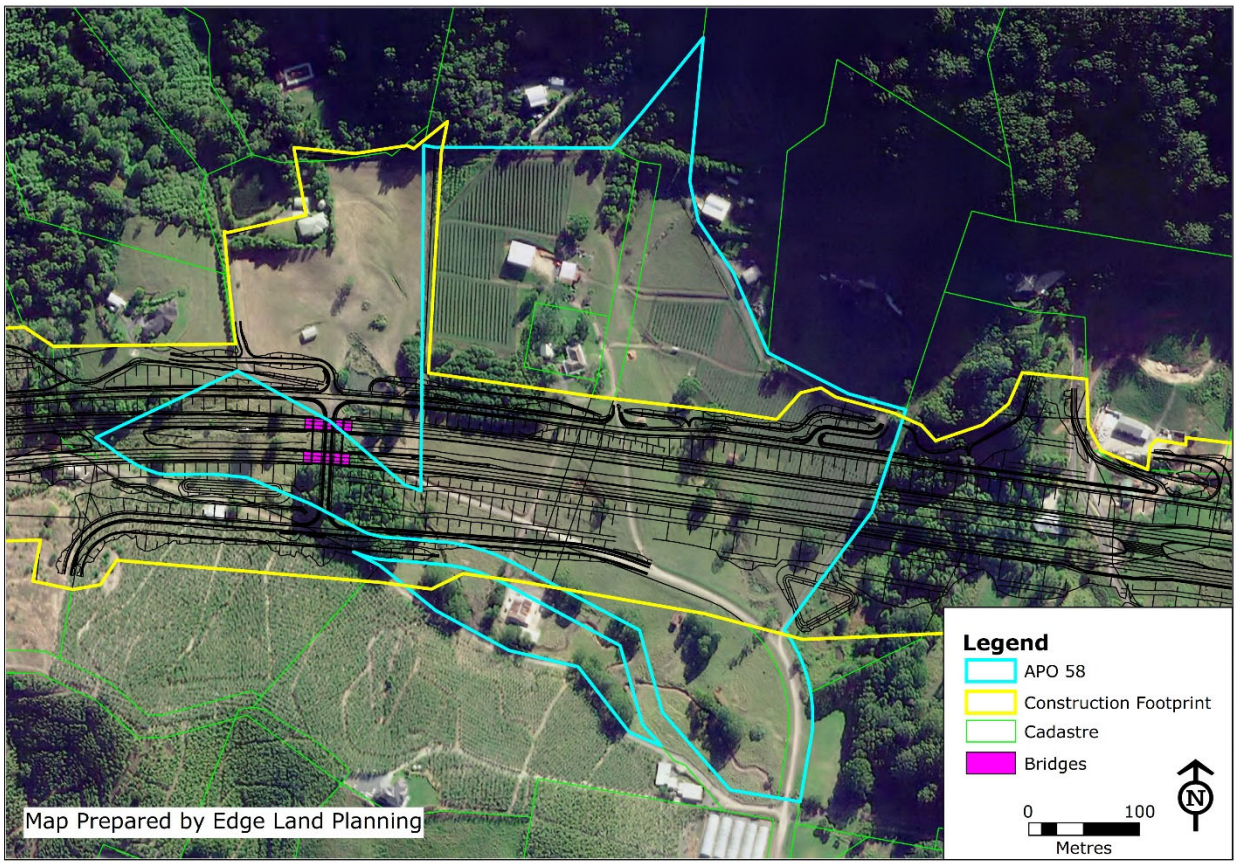
Access	Moderate	While there would be some temporary impacts during construction, the existing property access would be reinstated. Internal access tracks will require reconfiguration.
Irrigation water	No impact	
Dust	Serious risk of impact	Risk level for dust based on substantial earthworks and close of proximity of crops to construction footprint.
Overall impact	**Moderate**	Farming could continue at a reduced scale with some alterations and management measures being implemented.
Mitigation measures		AG03, AG04, AG06

APO 55 – Bananas



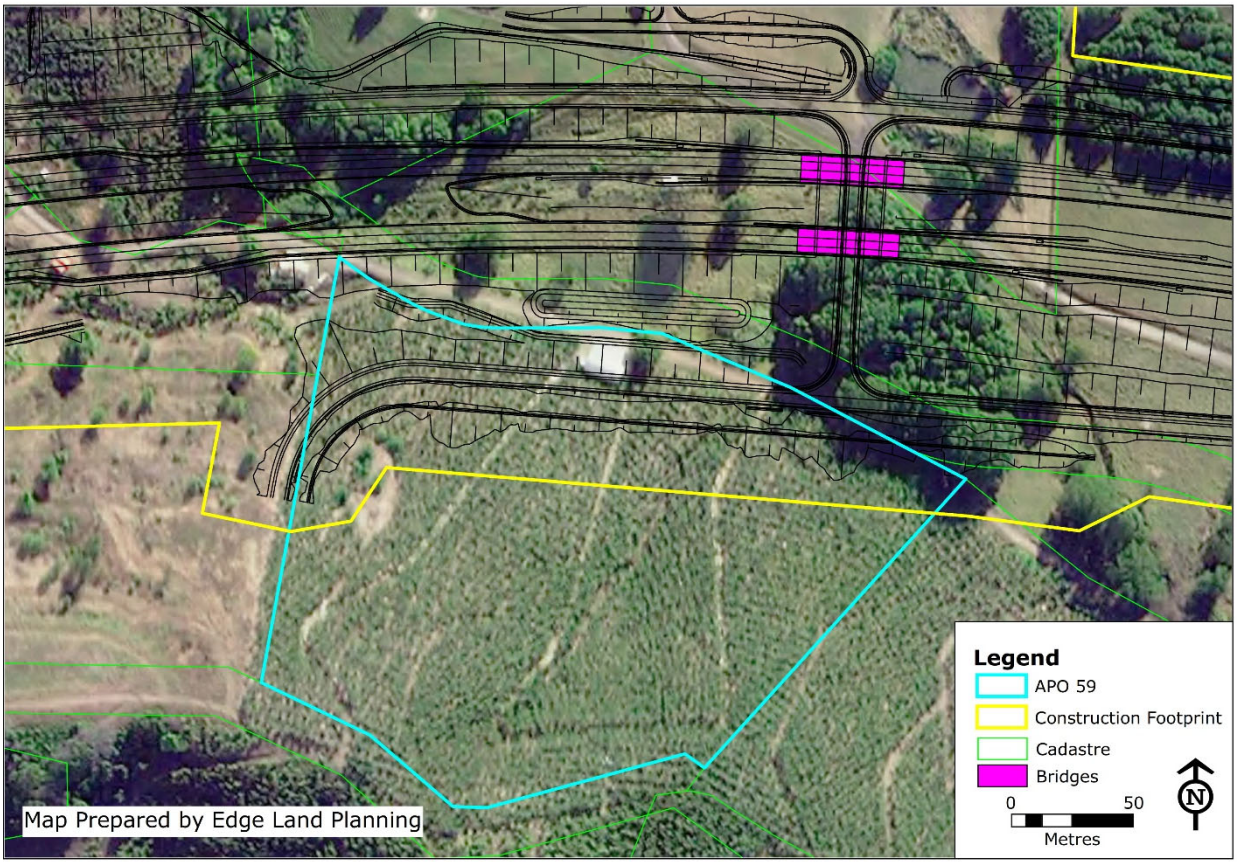
Criteria	Impact level	Assessment / comment
Direct land take	16.52%	
Crop impact	Critical	Almost all the banana plantation would be removed as a result of the project.
Structures	Moderate	A packing shed is within the construction footprint and would be removed.
Type of acquisition	Minor	Only a small strip of the southern part of the lot would be acquired for the project.
Access	Moderate	Access arrangements would be altered by the project.
Irrigation water	No impact	
Dust	Serious risk of impact	Risk level for dust based on substantial earthworks and close proximity of crops to construction footprint.
Overall impact	**Critical**	While the direct land take of this property is relatively small, the area impacted consists of the entire banana plantation. Farming on this property would cease in its current capacity.
Mitigation measures		AG01

APO 58 - Blueberries



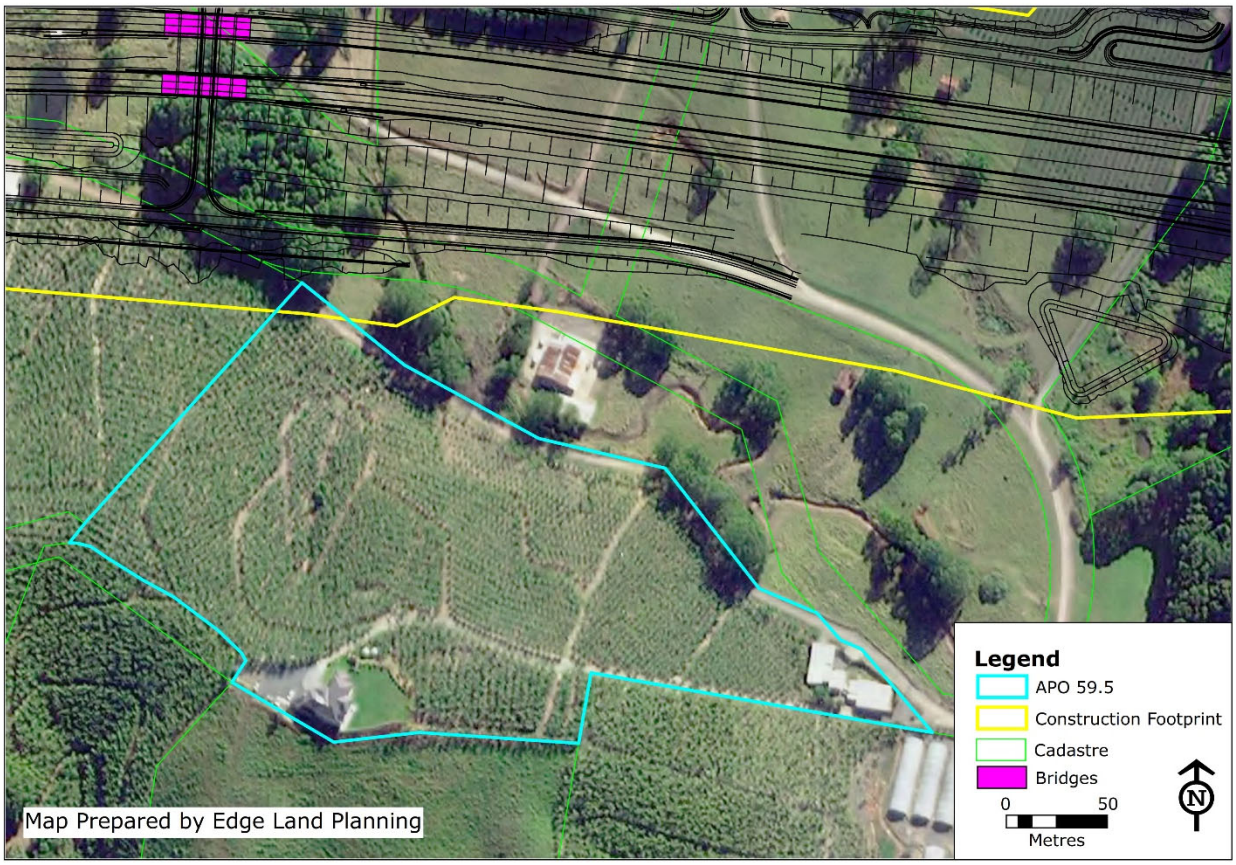
Criteria	Impact level	Assessment / comment
Direct land take	46.07	
Crop impact	Minor	A small area of blueberry crops would be removed as a result of the project, as would cattle grazing land.
Structures	No impact	
Type of acquisition	Serious	The property would be fragmented as a result of the project.
Access	Moderate	The farm would be severed and would need to use a public road for access between residual areas of land.
Irrigation water	Serious	Water is currently pumped from Treefern Creek. The dam and pump would be removed by the project.
Dust	Serious risk of impact	Risk level for dust based on substantial earthworks, proximity to potential ancillary facilities and close proximity of crops to the construction footprint.
Overall impact	**Moderate**	Provided the irrigation water source can be replaced, farming could continue.
Mitigation measures		AG02, AG06

APO 59 – Lady Finger Bananas



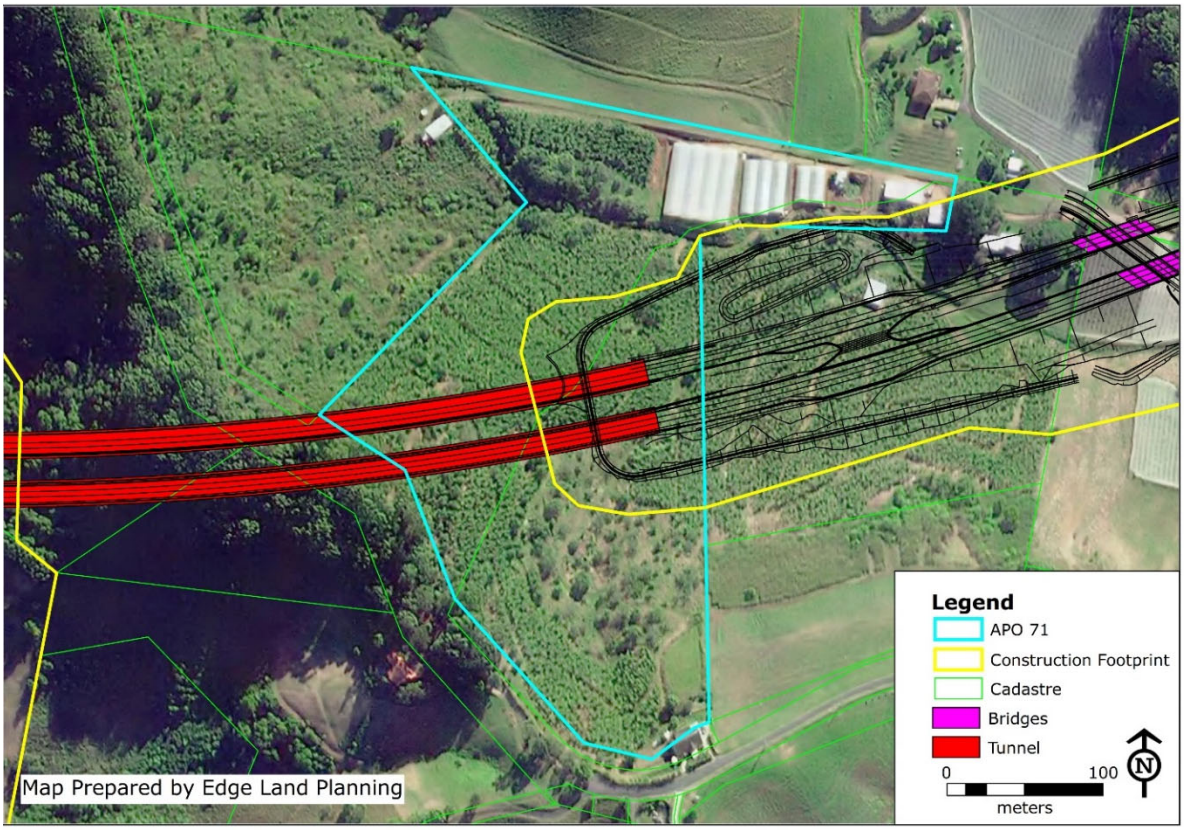
Criteria	Impact level	Assessment / comment
Direct land take	37.75%	
Crop impact	Moderate	Around a third of the existing Lady Fingers would be removed as a result of the project.
Structures	Serious	The packing shed would be removed as a result of the project.
Type of acquisition	Moderate	The northern strip of the lot would be acquired as a result of the project.
Access	Moderate	Access arrangements would be altered by the project.
Irrigation water	No impact	
Dust	Serious risk of impact	Risk level for dust based on substantial earthworks and close proximity of crops to the construction footprint.
Overall impact	**Serious**	In order for the farm to remain viable, a new packing shed would need to be provided for the farm.
Mitigation measures		AG01, AG03, AG04, AG06

APO 59.5 – Bananas



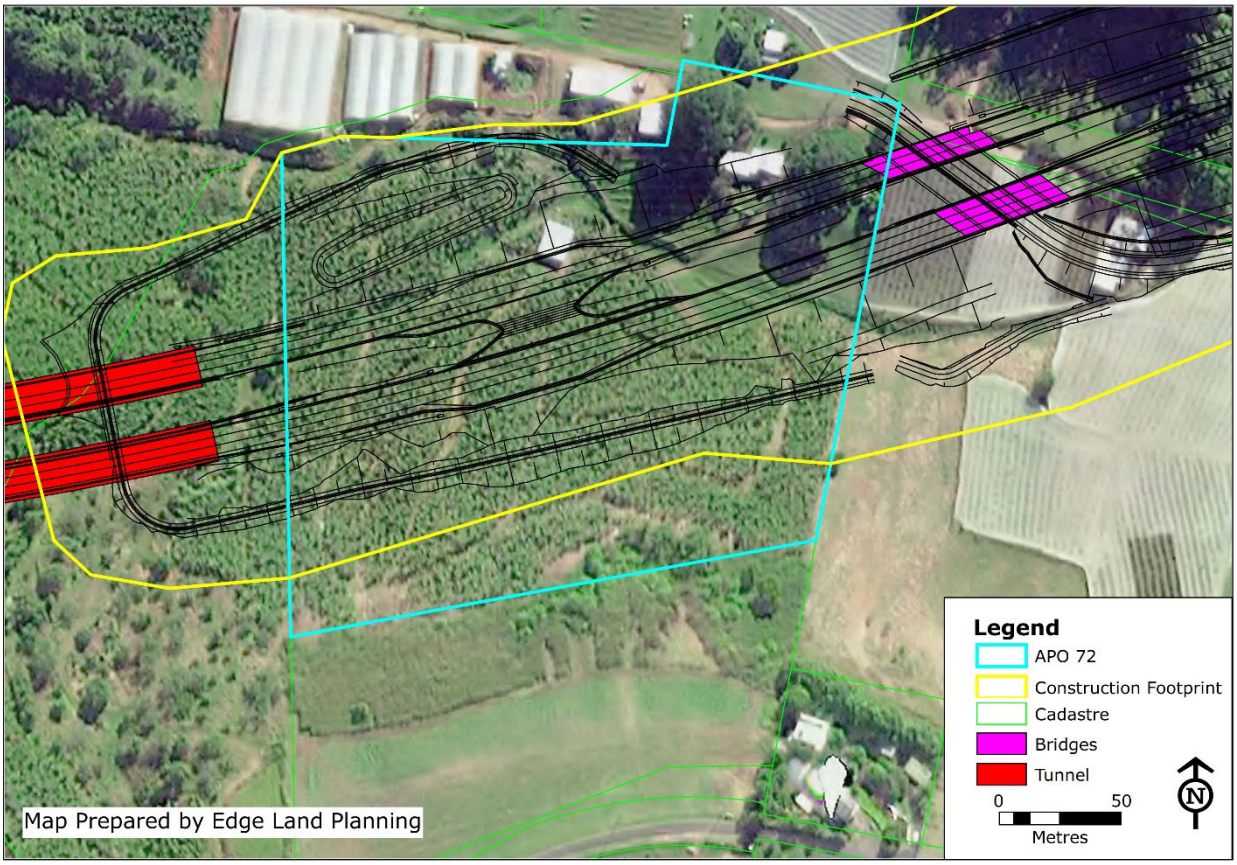
Criteria	Impact level	Assessment / comment
Direct land take	0.64%	
Crop impact	No impact	
Structures	No impact	
Type of acquisition	Minor	A small corner of the lot would be acquired as a result of the project.
Access	No impact	
Irrigation water	No impact	
Dust	Moderate risk of impact	Risk level for dust based on earthworks and proximity of crops to the construction footprint.
Overall impact	**Minor**	The farm would continue to operate with very little impact.
Mitigation measures		AG06

APO 71 – Bananas, avocados, cucumbers



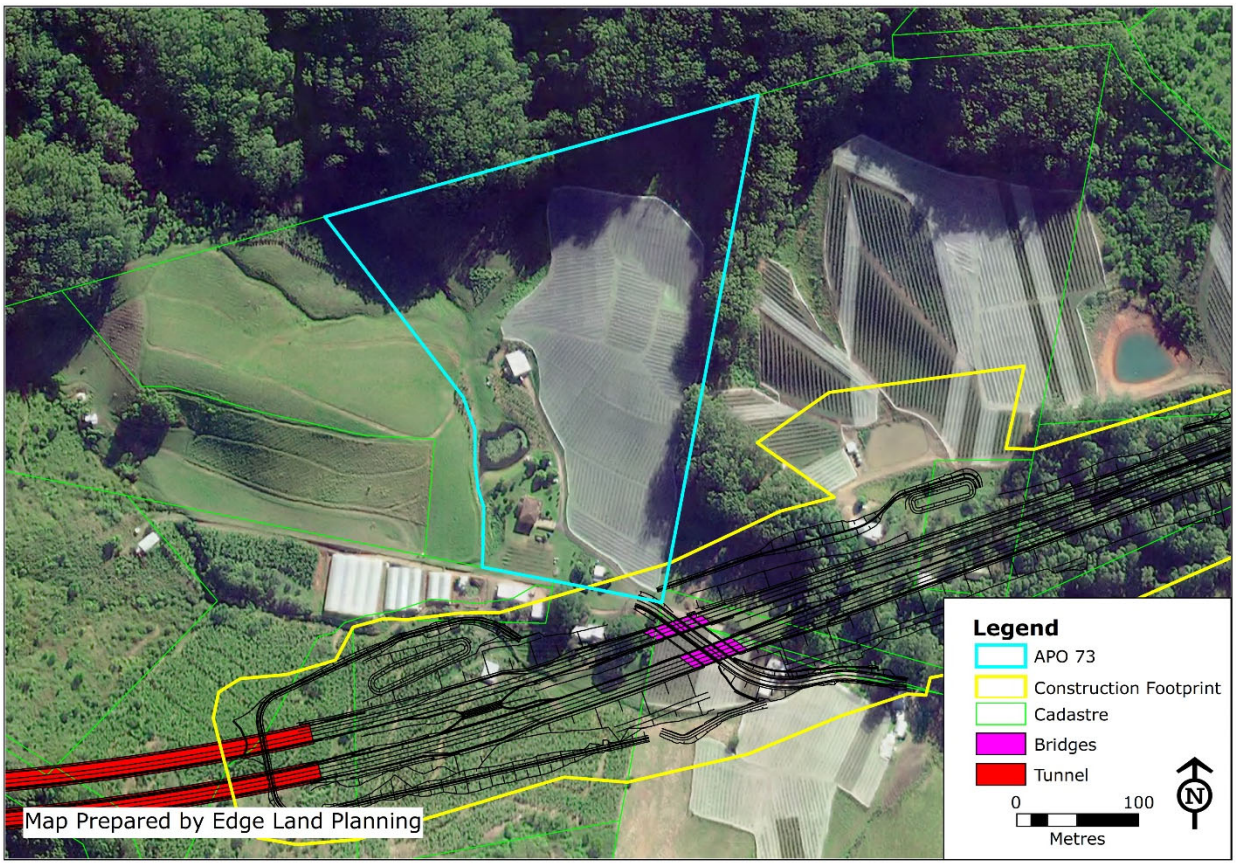
Criteria	Impact level	Assessment / comment
Direct land take	17.02%	
Crop impact	Moderate	Areas of banana plantation would be impacted by the project. Tunnelling through the ridgeline means that the land along the ridge can continue to be farmed.
Structures	Minor	The design has been refined to avoid most of the packing sheds and protected cropping structures. One shed would be removed as a result of the project.
Type of acquisition	Serious	While the area above the tunnels would be retained by the owner, the subsurface land would be acquired by Roads and Maritime. The property would be fragmented by the project.
Access	Moderate	Access arrangements would be altered by the project.
Irrigation water	Serious	There is an irrigation system on the farm which would be removed as a result of the project.
Dust	Moderate risk of impact	Risk level for dust based on substantial earthworks and proximity to construction footprint, but also considers sensitivities of crops (avocados and cucumbers).
Overall impact	**Serious**	In order for the farming to continue to be viable, measures will need to include replacement or movement of a packing shed, new irrigation system, altered internal access tracks.
Mitigation measures		AG01, AG02, AG03, AG04, AG06

APO 72 – Bananas



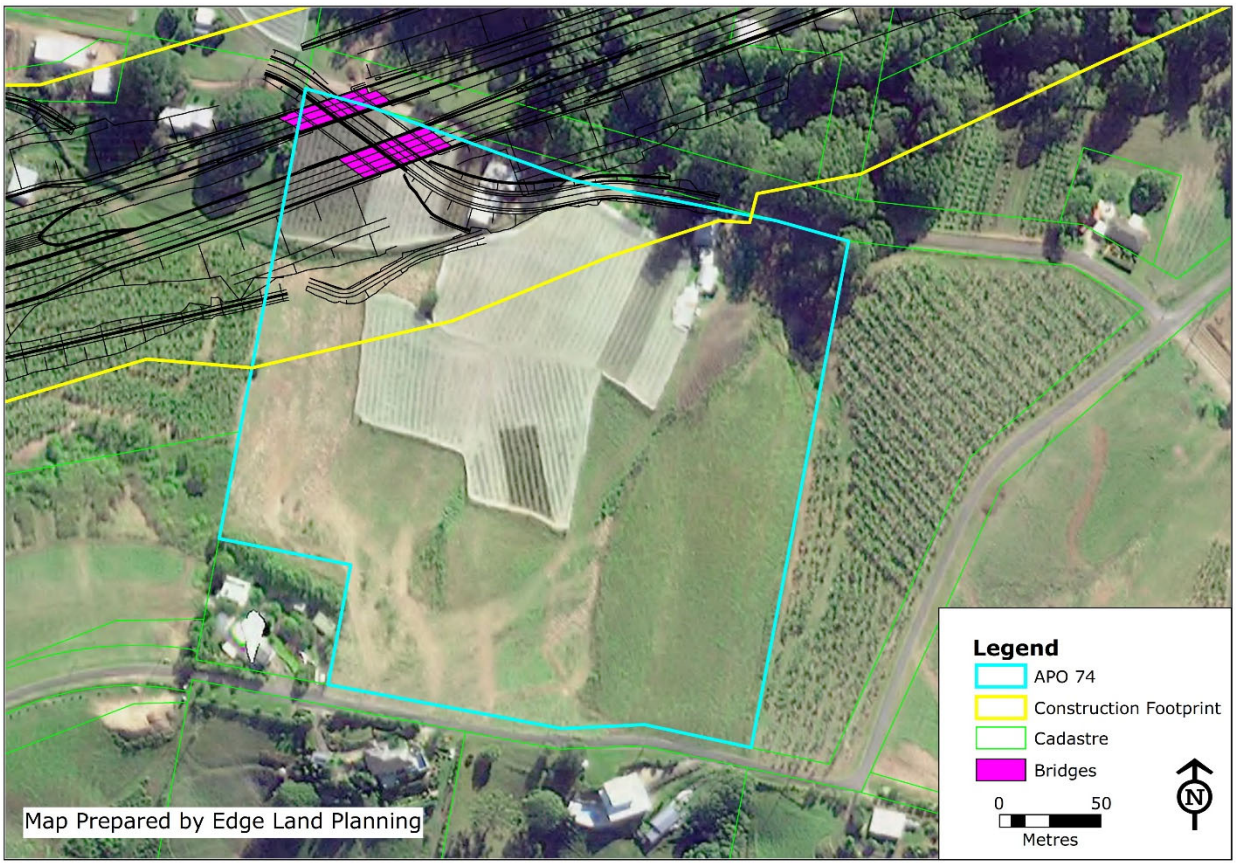
Criteria	Impact level	Assessment / comment
Direct land take	100%	
Crop impact	Critical	
Structures	Critical	All structures would be removed as part of the project.
Type of acquisition	Critical	The entire lot would be acquired for the project.
Access	Critical	
Irrigation water	No impact	
Dust	Moderate	Risk level for dust based on substantial earthworks and close proximity of crops to construction footprint.
Overall impact	**Critical**	This property would cease to operate as a farm.
Mitigation measures		As this is a total acquisition, no mitigation measures are proposed.

APO 73 – Blueberries



Criteria	Impact level	Assessment / comment
Direct land take	1.23%	
Crop impact	Minor	A small section of blueberries would be impacted by the project.
Structures	No impact	
Type of acquisition	Minor	A small corner of the lot would be acquired by the project.
Access	Minor	While there would be some temporary impacts during construction, the existing property access would be reinstated off Korora Road.
Irrigation water	No impact	
Dust	Moderate	Risk level for dust based on earthworks and proximity crops to construction footprint.
Overall impact	**Minor**	Blueberry farming on this property could continue with minimal impacts.
Mitigation measures		AG03, AG06

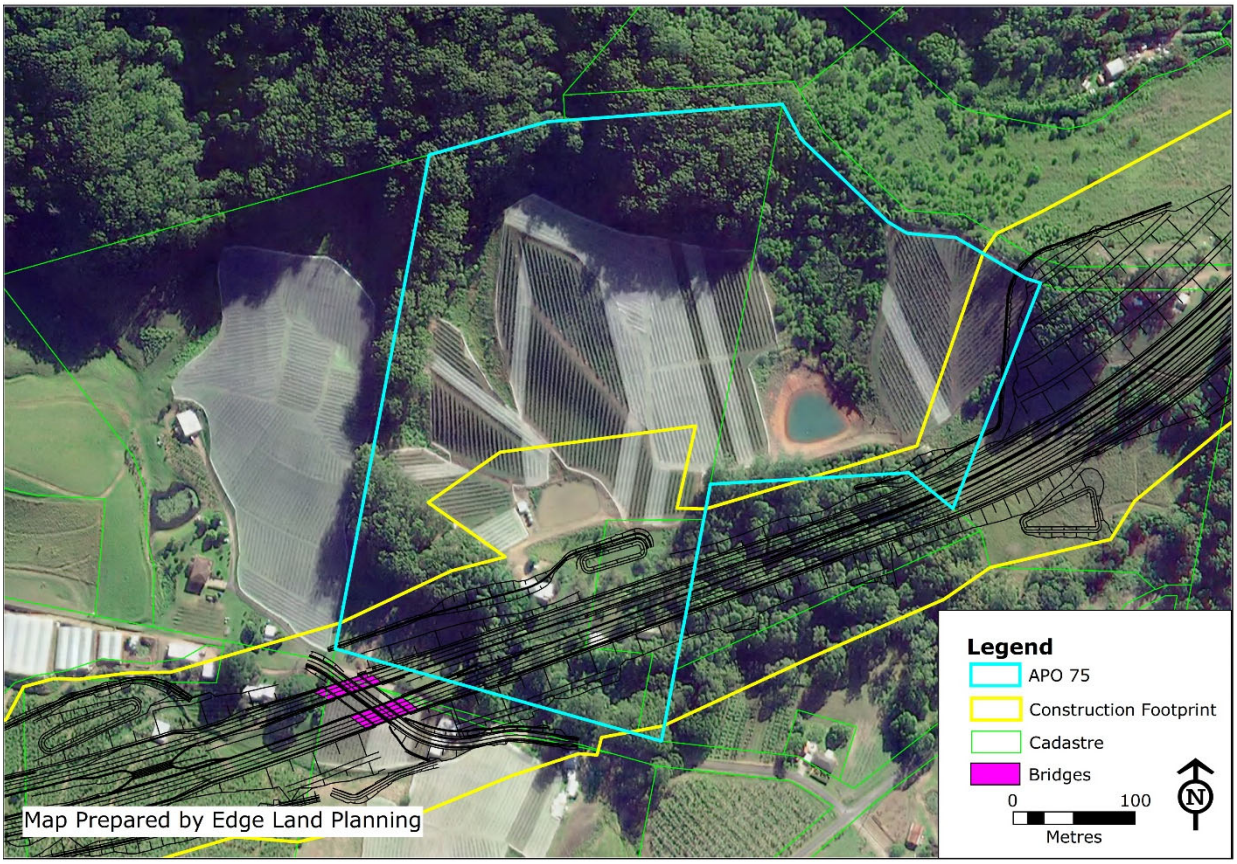
APO 74 – Blueberries



Criteria	Impact level	Assessment / comment
Direct land take	25.39	
Crop impact	Moderate	A large extent of the blueberry crop would be impacted.
Structures	Serious	Packing sheds and worker's quarters are within the construction footprint and would be removed as a result of the project.
Type of acquisition	Moderate	The north-west corner of the lot would be acquired.
Access	Minor	While there would be some temporary impacts during construction, the existing property access would be reinstated off Korora Road.
Irrigation water	Serious	Water bores are within the construction footprint and would be directly impacted.
Dust	Serious	Risk level for dust based on substantial earthworks and proximity crops to construction footprint.
Overall impact	**Serious**	For the farm to remain viable a replacement water bore would need to be arranged, as well as the relocation of packing sheds and worker's quarters.
Mitigation measures		AG01, AG02, AG03, AG06

APO 75 & 78 – Blueberries

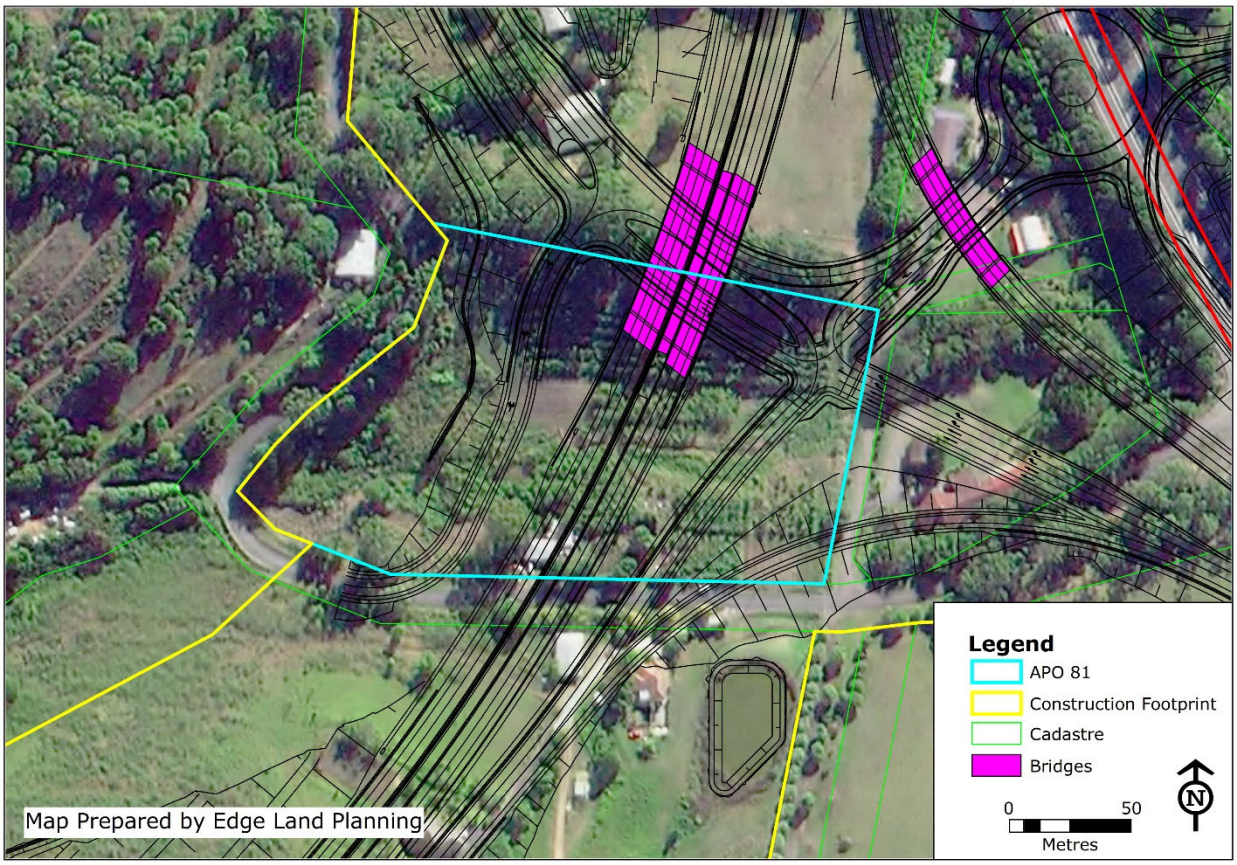
Roads and Maritime has carried out past acquisition of the properties listed above. The acquired land is shown within the figure below. The Roads and Maritime owned land is currently under a lease arrangement allowing for blueberries to be farmed. The lease arrangement for the areas within the construction footprint will be extinguished prior to start of construction. During operation, Roads and Maritime will only retain ownership of the land required for the road corridor with the residual land proposed to be sold to allow its continued existing use. As such, the two APOs are being assessed together for the purposes of this property impact report with the assumption that the residual land would continue to operate as a blueberry farm during operation of the project.



Criteria	Impact level	Assessment / comment
Direct land take	30.95%	
Crop impact	Minor	Blueberry crops within the construction footprint would be impacted by the project.
Structures	Moderate	A packing shed and a small ancillary shed would be removed as a result of the project. Minor impact to cropping structures would also occur.
Type of acquisition	Moderate	Both properties were subject to total acquisition in the past. The lease arrangement for the areas within the construction footprint will be extinguished prior to start of construction. Residual land is proposed to be sold to allow its continued existing use.

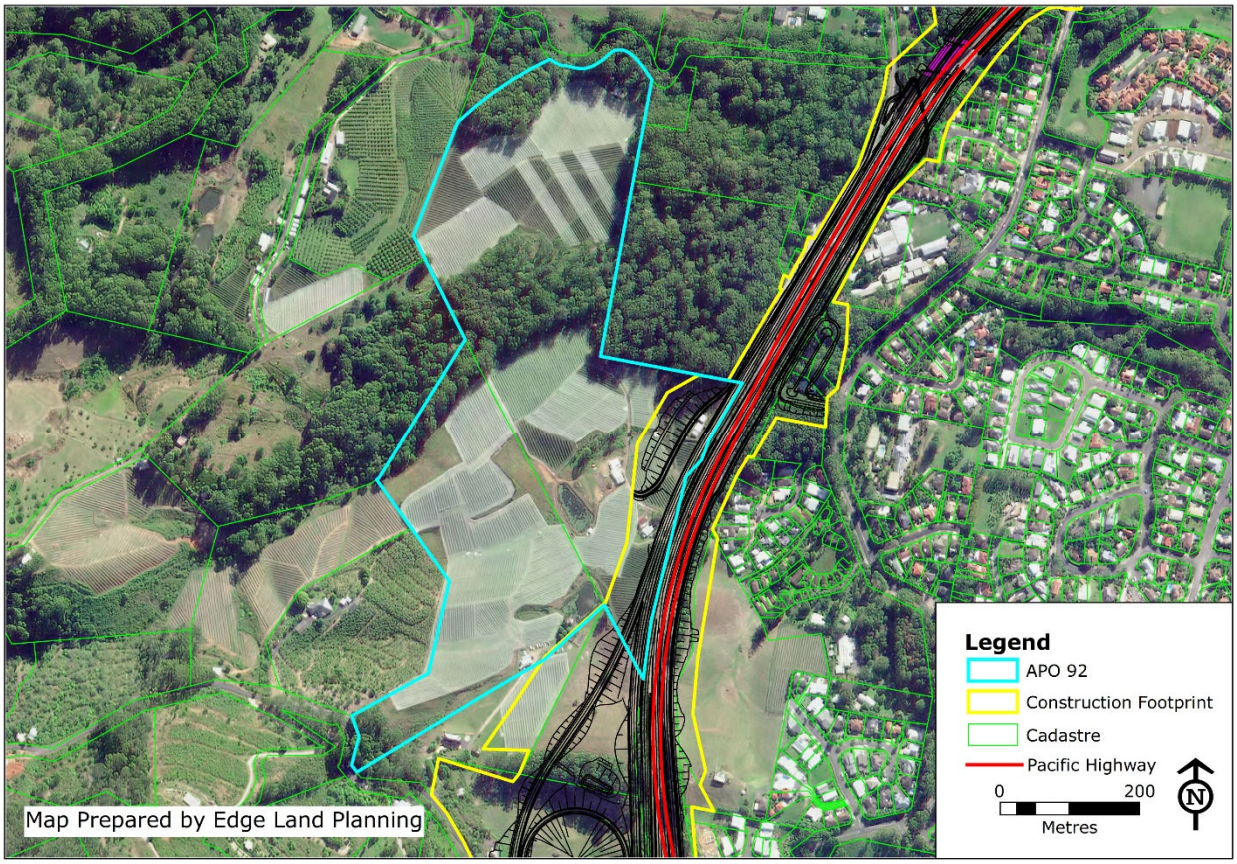
Access	Moderate	There would be some temporary impacts during construction and the existing property access would need to be relocated.
Irrigation water	Serious	A water storage dam and associated pumping infrastructure used to irrigate the blueberries would be impacted by the project.
Dust	Serious risk of impact	Risk level for dust based substantial earthworks, proximity to potential ancillary facilities and close proximity of crops to construction footprint
Overall impact	**Moderate**	For the farm to remain viable, the irrigation source would need to be reinstated, and a replacement packing shed provided.
Mitigation measures		AG02, AG03, AG06

APO 81 – Bananas



Criteria	Impact level	Assessment / comment
Direct land take	100%	
Crop impact	Critical	No crops would remain.
Structures	Critical	All structures would be removed.
Type of acquisition	Critical	The entire lot would be acquired as a result of the project.
Access	Critical	
Irrigation water	Critical	
Dust	Serious risk of impact	Risk level for dust based substantial earthworks, proximity to potential ancillary facilities and close proximity of crops to construction footprint.
Overall impact	**Critical**	For the farm to remain viable, the irrigation source would need to be reinstated, and a replacement packing shed provided.
Mitigation measures		As this is a total acquisition, no mitigation measures are proposed.

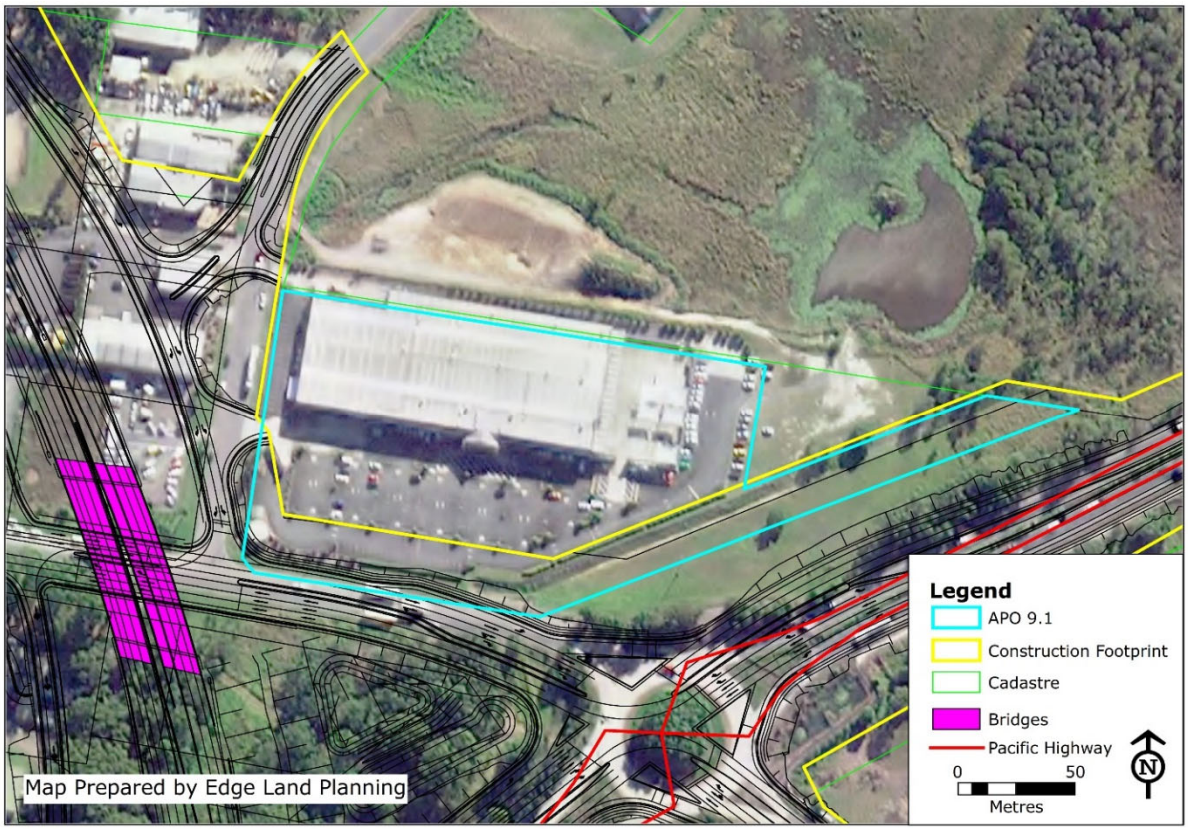
APO 92 – Blueberries



Criteria	Impact level	Assessment / comment
Direct land take	9.96%	
Crop impact	Minor	A small strip of blueberry crop would be removed as part of the project.
Structures	Serious	A packing shed and worker's accommodation would be impacted as a result of the project.
Type of acquisition	Minor	A strip of land along eastern boundary of lot would be acquired as part of the project.
Access	Minor	While there would be some temporary impacts during construction, the existing property access would be reinstated.
Irrigation water	Moderate	A dam would be impacted as a result of the project.
Dust	Serious risk of impact	Risk level for dust based on substantial earthworks, proximity to potential ancillary facilities and close proximity of crops to construction footprint.
Overall impact	**Moderate**	Provided the packing shed and worker's accommodation could be relocated, the farm could continue to operate in its current state.
Mitigation measures		AG02, AG03, AG04, AG06

APO 9.1 – Oz Group Packhouse

The Oz Group Packhouse is located within the construction footprint at the intersection of Englands Drive and the existing Pacific Highway. While this is not an agricultural property and has not been assessed as such, it is a significant facility for the local area and would be highly sensitive to potential dust impacts during construction.



Criteria	Impact level	Assessment / comment
Direct land take	24.81%	
Crop impact	No impact	
Structures	Minor	A small section of the parking area would be removed.
Type of acquisition	Minor	A strip of land along southern boundary of lot would be acquired as part of the project.
Access	Minor	While there would be some temporary impacts during construction, the existing property access would be reinstated.
Irrigation water	No impact	
Dust	Serious risk of impact	Risk level for dust based on proposed works, proximity to potential ancillary facilities and sensitivities associated with being a food handling premises
Overall impact	**Minor**	The Oz Group Packhouse would continue operation with minimal impact, however would be highly sensitive to potential dust impacts during construction.
Mitigation measures		AG06, AG08

Appendix 2. Microclimate Report

Intended for
Roads and Maritime Services

Document type
318000631

Date
May 2019

COFFS HARBOUR BYPASS

REVIEW OF THE IMPACT WIND FLOW AND CHANGES TO MICROCLIMATE FOR TUNNEL DESIGN

RAMBOLL Bright ideas. Sustainable change.

COFFS HARBOUR BYPASS
REVIEW OF THE IMPACT WIND FLOW AND CHANGES TO MICROCLIMATE FOR TUNNEL DESIGN

Project name	***Coffs Harbour Bypass:*** *Review of the impact wind flow and changes to tunnel design*
Project no.	**318000631**
Recipient	**Roads and Maritime Services**
Document type	**Peer review**
Version	**Final**
Date	**30/05/2019**
Prepared by	**Jens Chr. Bennetsen**
Checked by	**Bart Brashers**
Approved by	**Bart Brashers**

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1. INTRODUCTION

1.1 Background

Roads and Maritime Services (Roads and Maritime) is seeking approval to upgrade about 14 kilometres of the Pacific Highway from south of England's Road roundabout to the southern end of the dual carriageway at Sapphire, New South Wales (the Project). There are several sections where the project that would cut into the terrain and to avoid the creation of narrow valley-like terrain features associated with the use of large cuts, some tunnels are proposed.

The potential impacts of these tunnels on the existing microclimate around the tunnel portals must be evaluated. Responding to a proposed cut into the terrain near local banana plantations, the Banana Growers Association of Coffs Harbour and District provided a submission on the preliminary concept design that reiterated potential microclimate impacts from the use of "deep and wide cuttings", including "increased wind, particularly from the south, which would cause banana blow-downs; and the southerly winds would blow in colder air, which causes fruit chilling." Support for tunnels was expressed to reduce these effects and particularly tunnels at Gatelys Road, Shephards Lane and Roberts Hill ridge.

Microclimate impacts were also raised in interviews undertaken during the 2018 Agricultural Assessment for the EIS with the farmers concerned with the cuts increasing frequency of strong winds, and that an increase in the cooler southerly winds will cause a drop in the temperature, especially in winter, which will have a resultant impact on the growth of the bananas.

As an alternative to the open cut in the terrain, the tunnel designs provide a much less dramatic change in the terrain, reducing the potential impacts on the microclimate.

Ramboll was engaged to evaluate the three different tunnels in relation to the local microclimate and potential change around the tunnel portals. The evaluation included:

- A review of the tunnel layout/drawings
- An evaluation of the statistical metrological data around the proposed tunnel portals and outwards flow from them, including wind speed and temperature
- Review of statistical meteorological impact, including consideration of:
    - Current frequency of winds surpassing speeds that would damage banana crops:
        - 15m/s (blow down)
        - 5-10m/s (leaf tearing and reduced productivity)
        - 2.5-5m/s (reduction in fruit quality by enhancing leaf and dust abrasion)
    - The fractional increase in the occurrence of those wind speeds may be expected after the proposed tunnels are built
- Assessment of the region of impact from tunnel air flow:
    - What changes in wind speed and temperature may be expected after the proposed tunnels are built.

2. EVALUATION OF THE TUNNEL DESIGN FOR COFFS HARBOUR BYPASS

Replacing a cut into the terrain with a tunnel section is often referred to as the "zero-impact" case, because the wind flow through a tunnel is less than through a cut in the terrain. In general, a tunnel longer than one kilometre has a resistance towards letting wind pass through the tunnel, due to friction of the surfaces (walls, floor). Very little air will be forced through by larger atmospheric forces (such as ambient wind) and only traffic-induced air flows will occur.

For shorter tunnels, between 500 metres to one kilometre long, the wind can have an effect. The roughness or pressure resistance inside the tunnel does not always prevent wind from flowing into the tunnel and, to a smaller degree through the tunnel. But in most cases, it can be regarded as minimal, so only traffic-induced air flow out of the tunnel needs to be considered.

For tunnels shorter than 500 metres, the wind starts to be able to overcome the resistance to flow inside the tunnel. In this case, the local surrounding terrain and the metrological conditions will determine if it is easier for the wind to pass over compared to through the short tunnel section. All three proposed tunnels considered as part of this evaluation are shorter than 500 metres long.

It is mainly wind above a certain speed, and from specific directions that can pass through a shorter tunnel. For example, if the wind direction is within ±30° of the longitudinal direction of the tunnel, there is a higher possibility of wind blowing through the tunnel.

The inflow and flow through will also be affected by the internal resistance caused by traffic and fixed installations inside the tunnel. When the tunnel is short, it has less internal resistance, thus more potential flow-through of the wind can occur.

Traffic flow within a tunnel can also affect inflow and flow-through. If the traffic flow within the tunnel is similar in both directions, the wind flow inside the tunnel will be also be further reduced due to the interaction of the vehicles' turbulent wakes and the wind-forced flow.

Wind-to-tunnel alignment is further detailed in **Section 2.2**. The potential for forming an outflow jet-flow is discussed in **Section 2.3**, where the potential wind speed at the down-wind end of a tunnel portal is estimated for the present cross-sections, based on the decaying jet close to the ground.

2.1 Tunnel layout and orientation

An overview of the locations of the three proposed tunnels are shown in **Figure 2-1**. Additional detail showing location and orientation of the proposed Shephards Lane and Gatelys Road tunnels is provided in **Figure 2-2** and the location and orientation of the proposed Roberts Hill tunnel in **Figure 2-3**. Proposed tunnel lengths, cross sectional areas and portal dimensions are provided in **Table 1.**

Proposed cross sections are provided in **Figure 2-4, Figure 2-5** and **Figure 2-6.**

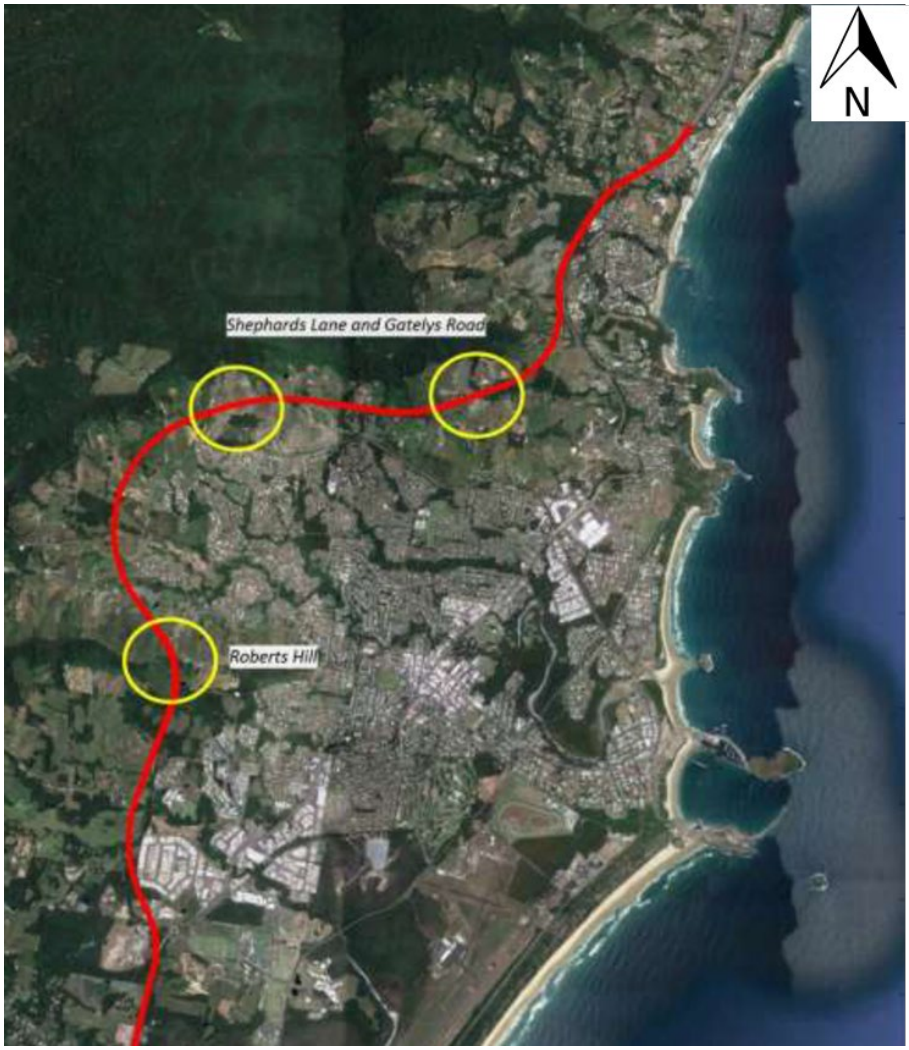


Figure 2-1 Overview of location and orientation of the three road tunnels around Coffs Harbour.

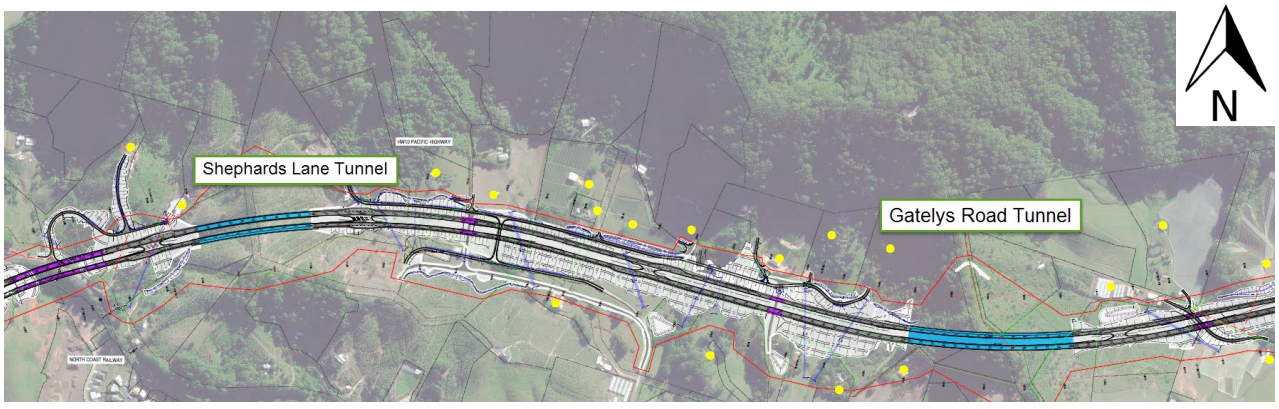


Figure 2-2 Location and orientation of Shephards Lane and Gatelys Road tunnels.

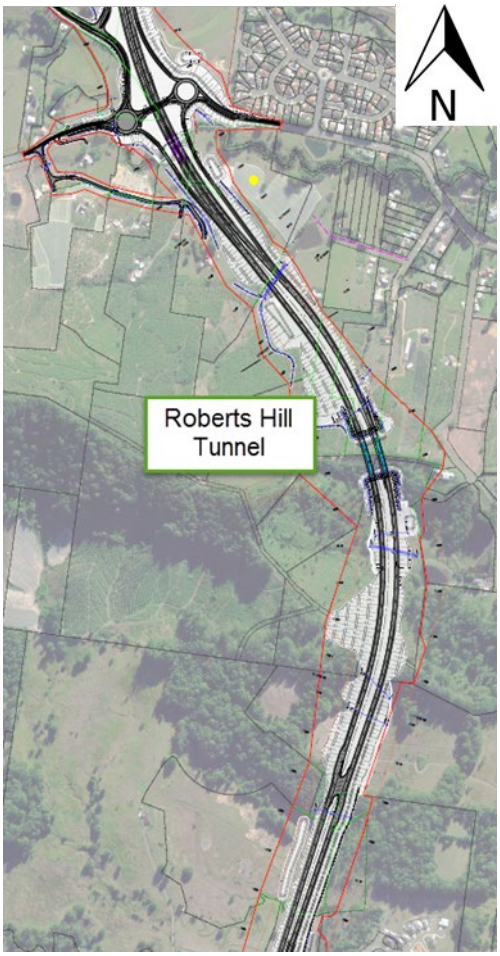


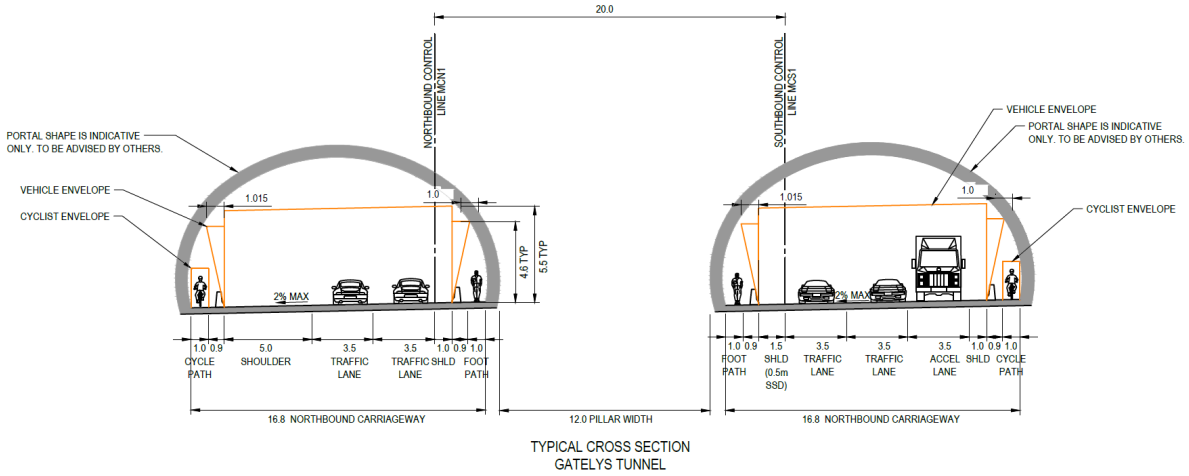
Figure 2-3 Location and orientation of Roberts Hill tunnel.

The length and dimension of each tunnel is shown below in **Table 1**.

Table 1 Tunnel and portal dimensions

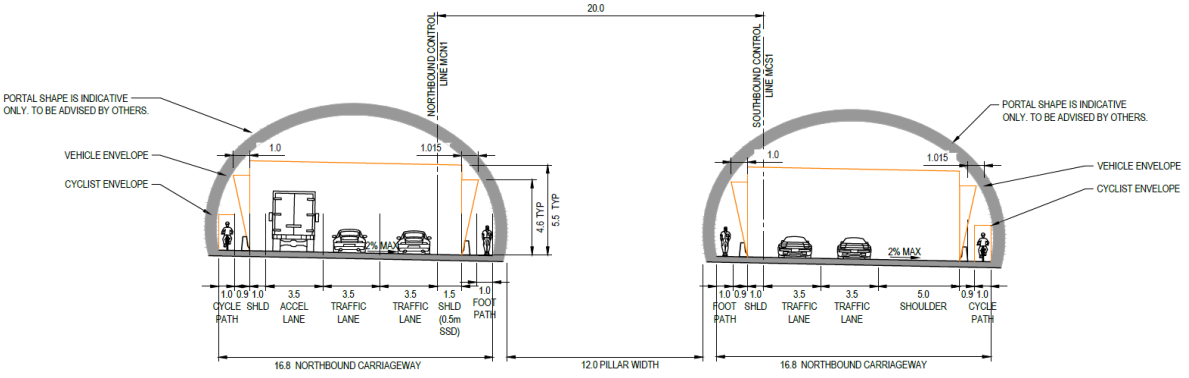
Tunnels and Portals	Tunnel Length / [m]	Cross sectional area / [m^2]	Portal height / [m]	Portal width / [m]
Roberts Hill Tunnel - north	190	122.3	6.5	18
Roberts Hill Tunnel - south				
Shepherds Lane Tunnel - north	360	111.6	6.5	16.8
Shepherd Lane Tunnel - south				
Gatleys Road Tunnel - north	450	111.6	6.5	16.8
Gatleys Road Tunnel - south				

The three tunnels consist of a combination of 2 and 3-lanes in each direction and include a separated cycle lane and emergency access for pedestrians on both sides of the road lanes. Proposed cross sections are shown below.



TYPICAL CROSS SECTION
GATELYS TUNNEL

Figure 2-4 Tunnel cross section for the Gatelys Road Tunnel (subject to detailed design)



TYPICAL CROSS SECTION
SHEPHARDS TUNNEL

Figure 2-5 Tunnel cross section for the Shephards Lane Tunnel (subject to detailed design)

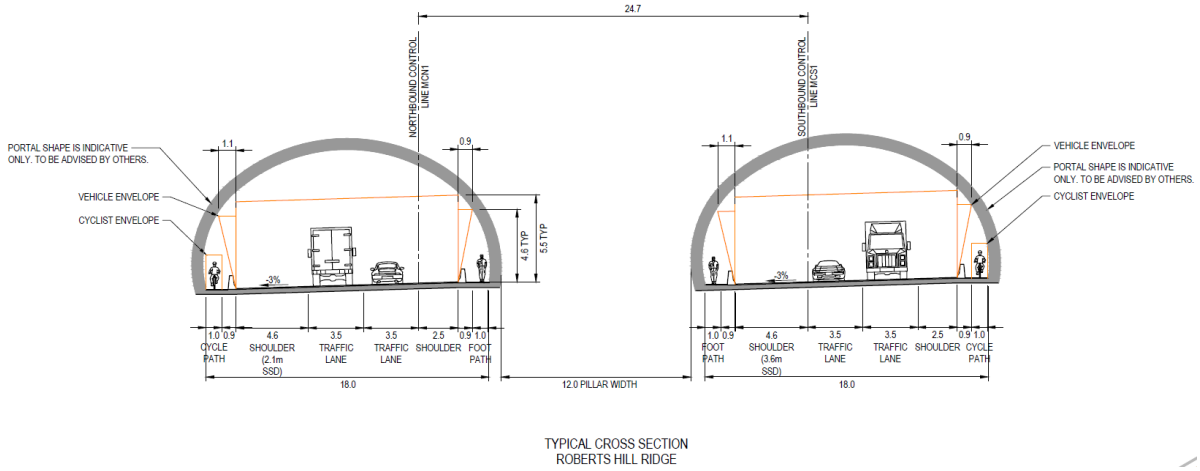


Figure 2-6 Tunnel cross section for the Roberts Hill Tunnel (subject to detailed design)

2.2 Review of metrological data near the project

Coffs Harbour Airport is the closest source of metrological data and is the most appropriate to use for this study. Coffs Harbour Airport is about one kilometre from the ocean, significantly less than the proposed tunnels, which range from about three kilometres to more than five kilometres inland.

Bureau of Meteorology (BoM) site 059040 operated from January 1989 to August 2015, and BoM site 059151 operated from August 2013 to the present day. With some overlap and a "move" of about one kilometre, these two sites (taken together) provide a long history of meteorological conditions. One-minute data collection commenced in September 2003 and provides a more robust estimate of the wind speeds when averaged to hourly values. These two meteorological stations were selected and combined to provide a 16-year representative dataset for the wind assessment and evaluation of the microclimate.

The Shephards Lane and Gatelys Road tunnels are aligned nearly east-west (90° or 270° in meteorological wind direction convention, where wind coming from the north is 0° and from the east is 90°, etc.), and the Roberts Hill tunnel is aligned between north-northwest and north (170° or 350° in meteorological wind direction convention).

Labelling these directions roughly as East (defined as wind coming from ±30° of 90°), West (wind from ±30° of 270°), South (wind from ±30° of 170°) and North (wind from ±30° of 350°), **Table 2** shows the frequency of occurrence of these wind direction bins, for a range of wind speeds.

Table 2 Frequencies of wind speeds for relevant wind directions

		Shephards Lane and Gatelys Road Tunnels		Roberts Hill Tunnel		
Wind Speed (m/s)	**Robinson and Sauco Criteria**	**From East (90°±30°)**	**From West (270°±30°)**	**From South (170°±30°)**	**From North (350°±30°)**	**All Directions**
All Speeds		6.5%	16.9%	13.0%	19.9%	100.0%
0 - 2.5		0.5%	7.0%	0.6%	3.0%	15.8%
2.5 - 5	Dust Abrasion	4.6%	8.8%	5.3%	11.7%	51.2%
5 - 10	Leaf Tearing	1.3%	1.2%	6.6%	5.1%	30.8%
10 - 15		0.1%	0.01%	0.5%	0.1%	2.1%
> 15	Blow down	0.000%	0.000%	0.010%	0.000%	0.010%

According to "Bananas and Plantains, 2nd Edition" (Robinson and Sauco), regular winds in the 5-10 m/s range can cause leaf tearing, leading to reduced productivity. This speed range occurs roughly a third (30.8%) of the time, currently. If the Robinson and Sauco statement is interpreted to mean any wind speeds between 5 m/s and 15 m/s (when the risk for blow down starts) then for 32.9% of the time, there is already a risk of leaf tearing. The risk of blow down (speeds exceeding 15 m/s) is small in this region.

It is possible that some banana plantations enjoy a "shielding" effect from winds from certain directions, by being in the "lee" (the downwind side) of a hill. The issue then becomes to what extent a tunnel through that hill would allow winds to pass through the tunnel and change the probability of being exposed to higher wind speeds on the lee side.

An estimate of the horizontal extent past the end of the tunnel where increased wind speeds might be felt is discussed separately, below.

The most commonly-occurring wind range bin of 2.5 to 5 m/s occurs roughly half (51.2%) of the time but is only aligned with the Shephards Lane or Gatelys tunnels for 13.4% of the time. For a banana plantation on the east (west) side of the Shephards Lane or Gatelys Road tunnels, wind speeds risking dust abrasion already occur for 42.4% (46.6%) of the time. This could potentially increase by 8.8% (4.6%) of the time, which is considered a modest change. For the Roberts Hill tunnel, the wind direction is aligned with the northern entrance for only 11.7% of the time, and with the southern entrance for only 5.3% of the time, which are also modest increases.

Only 1.3% of the time is the wind within 5-10 m/s range and the direction aligned with the east entrance to the Shephards Lane and Gatelys Road tunnels, so any changes in wind speeds on the outlet side would be negligible compared to that which is already occurring on the lee side (29.5% of the time). The change due to the wind in this speed range being from the west is similarly small compared to the roughly one-third of the time this wind speed range already occurs.

The proportions of time the wind would be aligned with either end of the Roberts Hill tunnel are similarly small compared to the proportion of hours this wind speed range already occurs, though not as dramatic as the east and west winds of the other two tunnels.

Although wind speeds between 10 and 15 m/s occur 2.1% of the time, only 0.6% of the time do they occur aligned with the Roberts Hill tunnel, and only 0.1% of the time aligned with the Shephards Lane or Gatelys tunnels. Again, the potential increases in frequency are much smaller than the existing frequency of those winds. Winds more than 15 m/s occur very infrequently (one hundredth of one percent of the time).

All in all, the proposed tunnel designs would have a very low impact, given the present local wind environment and the alignment of the tunnel portals.

Table 3 shows the distribution of observed temperatures by wind direction, for the four directions aligned with the proposed tunnels. The temperatures are a moderate 10 – 30 °C the clear majority (93.3%) of the time. There were no hours where the temperature exceeded 40°C in the meteorological dataset.

If "cooler winds" are defined as less than 10°C, then it can be seen that they seldom come from "south" defined as 170°±30°. Cooler winds come more often from the west (from inland) and secondarily from the north (night-time drainage flow in winter) but are still quite infrequent. The most frequent "cool" wind, from the west, would be aligned with the Shephards Lane and Gatelys Road tunnels, but occurs only 3% of the time.

Table 3 Frequencies of Temperatures for Relevant Wind Directions

	Shephards Lane and Gatelys Road Tunnel		**Roberts Hill Tunnel**		
Temperature (°C)	**From East (90°±30°)**	**From West (270°±30°)**	**From South (170°±30°)**	**From North (350°±30°)**	**All Directions**
All Temps	6.5%	16.9%	13.0%	19.9%	100.0%
0-10	0.0%	3.0%	0.1%	1.0%	6.3%
10-20	2.0%	11.6%	4.7%	8.9%	50.3%
20-30	4.4%	2.3%	8.2%	9.8%	43.0%
30-40	0.0%	0.03%	0.0%	0.2%	0.4%

The analysis presented in this section shows that the wind directions are aligned within ±30° of the proposed tunnels for an appreciable percentage of the time, but the co-occurrence of that alignment with unfavourable conditions (either high wind speeds or low temperatures) is very infrequent. Further, that co-occurrence happens less frequently than the occurrence of the unfavourable condition itself. This leads to the conclusion that no matter what the potential for a tunnel "leaking" an air mass from one side of a hill to the other to alter a microclimate, the winds are so seldom aligned with the tunnel that the potential changes might occur at most for 3% of the time.

2.3 Assessment of region of impact from tunnel air flow

The impact from a tunnel portal towards the surrounding microclimate outside comprises a combination of two main physical parameters: the wind flowing through the tunnel, and the traffic-induced air flow generated by the piston effect of the moving vehicles inside the tunnel (**Figure 2-7**).

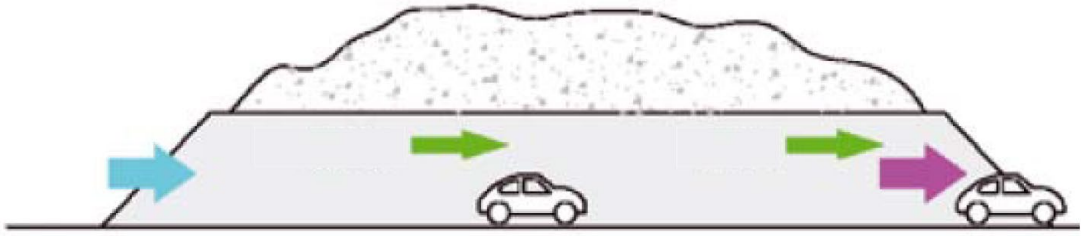


Figure 2-7 Wind flow into the tunnel and the traffic induced air flow from the vehicles resulting in a combined air flow out of the tunnel towards the surroundings.

Given the short length of the proposed tunnels, which are between 190 and 450 metres long, the thermal exchange between the tunnel structure and the air flow passing through is limited. Even though the structures have the potential to slightly cool the air flow as it passes, the heat generated by the vehicles will counter-act this tendency and increase the air temperature. The net outcome for the outflow from a tunnel is that temperature and humidity are similar as the air going into the tunnel. The main drivers for the temperature and humidity exiting a tunnel are the same conditions as on the inflow side of the tunnel.

The exiting air flow from the tunnel will initially behave as a "core" region and further from the tunnel, transition to a "decaying" region. The decaying region is enhanced with the sideway motion, which also reduces the air flow velocity (centre jet) more quickly (**Figure 2-8**).

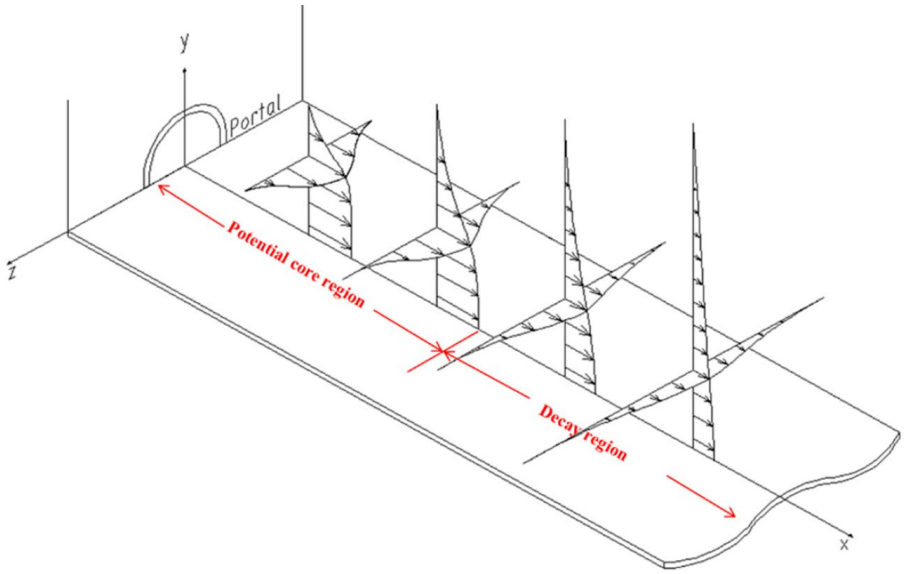


Figure 2-8 The sketches of three-dimensional velocity profiles of jet flow at tunnel exit. [Xin Zhang, 2018]

The velocity decay along the centre line from the tunnel exit is shown below for the generalised tunnel and wall bound flow (**Figure 2-9**). This is without any external wind speed forcing, which would affect the exiting flow from the tunnel.

Similar behaviour is shown in **Figure 2-10**, from a generalised tunnel with a cross sectional area of 64 m^2. Although the tunnel cross section is smaller, the behaviour of the tunnel portal will be similar. The only way to study this in closer detail would be to perform flow modelling using CFD of the wind passing through the tunnel and the decay of the outflow jet from the tunnel portal.

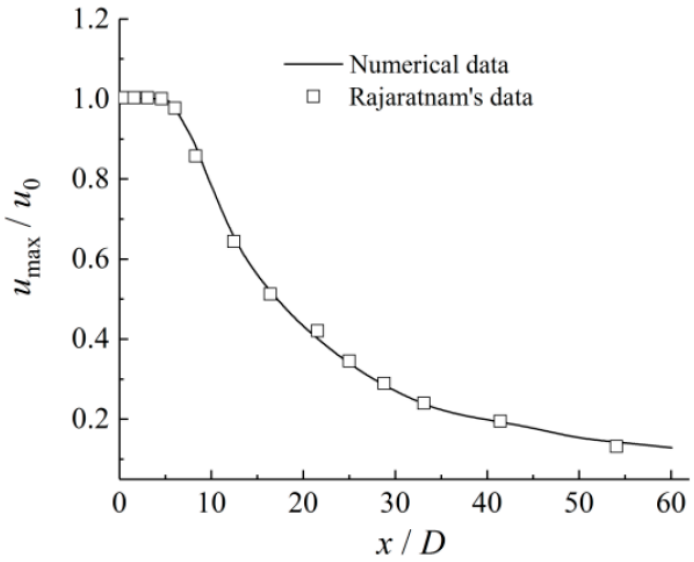


Figure 2-9 The decay of maximum velocity u_{max} in the plane symmetry of the wall jet going out. D is the hydraulic diameter of the tunnel portal. U_0 is the initial air velocity at the inflow area. [Xin Zhang, 2018]

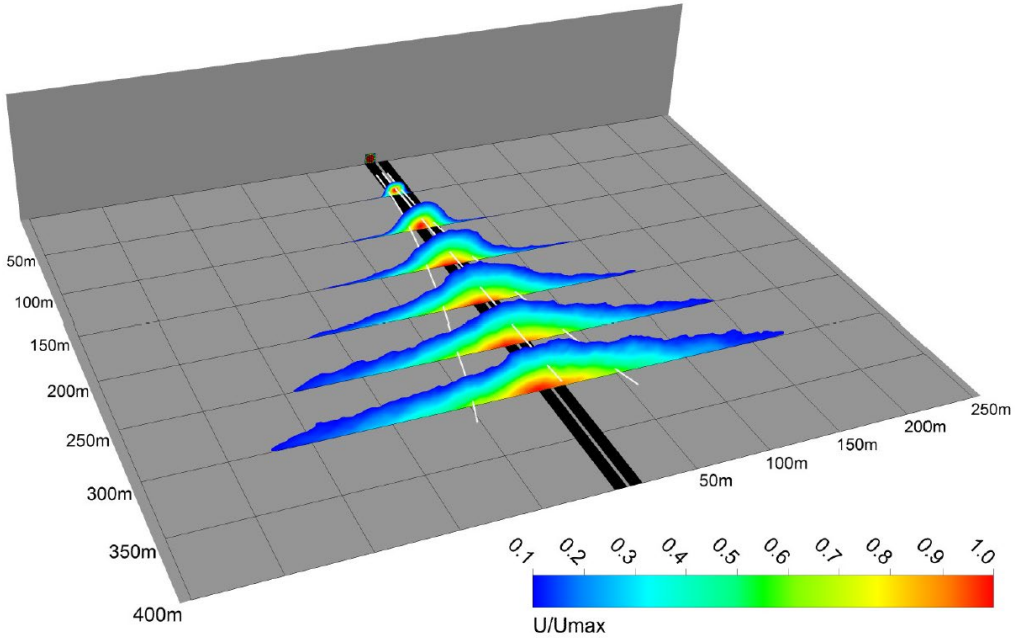


Figure 2-10 Normalised average streamwise velocity and half widths from Sun (2002). [Venås, Bård, 2014].

The results shown in **Figure 2-10** indicate that the region impacted by the tunnel air flow is within a half-width region, which can be approximately 30-40 metres to both sides of the centre line of the tunnel under low wind conditions (wind speeds less than 1m/s). The distance in the longitudinal directions would be about 150 metres, however this is on the road lanes itself.

At higher wind speeds, the core region of the exiting flow will interact with the surrounding wind flow, and the velocity will be reduced more rapidly. For wind directions aligned with the tunnel, the traffic-induced air flow and the inflow into the tunnel both contribute to the outflow velocity.

For situations with high traffic volumes, the traffic-induced flow alone will determine the flow out of the tunnel. High traffic volumes mean more resistance to free flow within the tunnel, which overcomes the forcing of even higher wind speeds aligned with the tunnel. For the situation with less traffic, it is difficult to estimate the inflow and through-flow of the tunnel without more detailed assessment of the wind flow and terrain.

Ramboll has, for similar projects, conducted computer simulation with CFD modelling and performed on-site measurement for shorter tunnels up to 500 metres long. The results of these studies show that for a narrow band (±25-30°) of wind directions aligned with the tunnel direction, wind speeds inside the tunnel could increase by as much as 7-9 m/s, when the reference external wind speed in the area was 12-16 m/s (measured at 10 metres above ground level). The surrounding terrain for these studies was flat without any hills.

The presence of hills for the Coffs Harbour bypass tunnels could potentially enhance the inflow for a few wind directions. Combining the wind statics shown in the previous section with the above knowledge, wind speed of this higher level is very infrequent for Coffs Harbour. Furthermore, using the analogy in **Figure 2-9**, the distance of the decaying region to reduce the air flow speed to below 5 m/s would be less than 150 metres.

The traffic-induced velocity inside the tunnel is very dependent on the vehicle speed, cross sectional area of the tunnel, tunnel length, and traffic density. If more larger, heavy vehicles are passing through the tunnel, the air flow is increased due to the additional drag and size of the trucks.

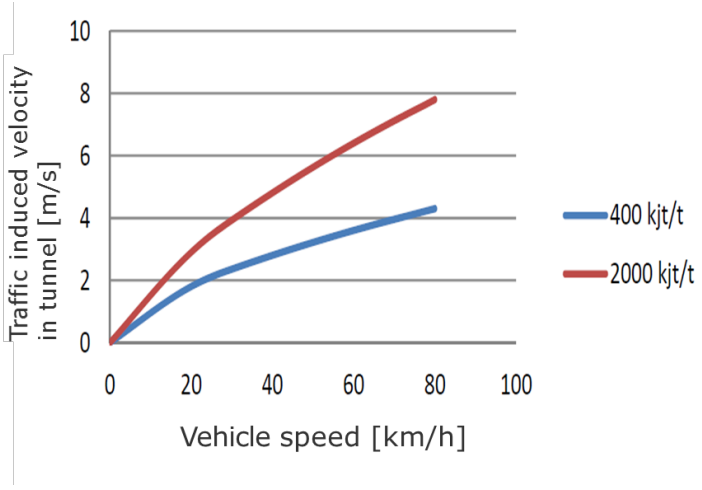


Figure 2-11 Traffic induced velocity compared to vehicle speed inside the tunnel. Blue line: 400 vehicles per hours; Red line: 2000 vehicles per hours. Results for the tunnel with cross sectional area of 54 m² and 12% heavy vehicles (Reference: Norwegian Public Roads Administration" [Statens Vegvesen], Norway).

The proposed traffic speed for each tunnel section, and the volume for the period just after the project is finished and 20 years later, is show in **Table 4**.

Table 4 Traffic speed and traffic forecast for 2024 and 2044 per year.

Tunnel	Posted speed / [km/h]	Minimum HV speed / [km/h]		Traffic lanes		Future traffic volume (2024)*		Future Traffic volume (2044)*	
		NB	SB	NB	SB	Average	% HV	Average	% HV
Roberts Hill ridge	110	72	80	2	2	23,400	14	27,900	14
Shephards Lane	110	67	75	3	2	19,300	15	24,000	16
Gatelys Road	110	92	68	2	3	19,300	15	24,000	16

** - same value for both north bound and south bound tunnels*

NB – North bound

SB – South bound

HV – Heavy vehicle

An estimation of the outflow due to the traffic-induced wind speed from the tunnel is shown below (**Table 5**) for two different tunnel cross sectional areas. The base line is the reference of exit velocity from a smaller cross-sectional tunnel, which is applied to estimate the outflow velocity for the proposed tunnel portals with a cross section area of 110-120 m^2.

Table 5 – Estimated exit velocity at tunnel portal based on vehicle speed. Reference: Norwegian Public Roads Administration" (Statens Vegvesen), Norway for tunnels with cross section of 54-60 m^2 and estimated for 110-120 m^2 tunnel portals. The smaller tunnel section is used as a direct reference and comparison.

		54-60 m2 tunnel	110-120 m2 tunnel
Tunnel	Averaged Traffic speed [km/h]	Exit Velocity at portal [m/s]	Exit Velocity at portal [m/s]
Roberts Hill ridge	105,24	7,4	3,7
Shephards Lane	104,15	7,3	3,6
Gatelys Road	105,5	7,4	3,7

From the estimated exit flow velocities from the tunnel portals (**Table 5**) and the possible decay of air speed outside, it is estimated that the region of influence would be limited to about 100 metres from the tunnel portal and 20 metres to each side of the road. This would be a very low wind speed scenario (< 1 m/s). At higher wind speed, the interaction will reduce the decay distance even further.

Thus, the exit velocity from the tunnel designs would be limited to mainly around the road lanes and does not pose a risk for the near-by banana plantations.

2.4 Microclimate changes to ambient temperature

A specific concern was raised regarding the potential for an increase in frequency of cooler southerly winds, causing a drop in the temperature, especially in winter, which could have a resultant impact on the growth of the bananas. As discussed in **Section 2.2** and **Section 2.3**, tunnels do not tend to heat or cool the air passing through them. Given the height of the hills that the proposed tunnel pass through compared to their surroundings and their modest slope, it is unlikely that the temperature on the upwind side of a hill is much different than the temperature on the downwind side of the hill.

However, a plot of temperature by wind direction (**Figure 2-12)** from the Coffs Harbour Airport site is useful to show that cooler temperatures co-occur with various conditions, including with stronger winds from the southwest, but also with weaker winds from the west-northwest (i.e. night-time drainage flow in winter).

Note that this plot does not contain any information about the frequency at which these winds occur – each pixel is plotted using the wind direction and speed and coloured by the temperature of that hour. Many pixels have many occurrences, but some pixels may have only one occurrence within the observational period.

It is possible that cooler southerly winds would currently travel over the existing ridgelines, rather than be blocked to any significant degree, in which case the change because of the tunnels would be minimal. To demonstrate this, a meteorological monitoring station may be established within a suitable location representative of the banana plantations.

The hottest strong winds occur from the west-northwest (dark red in **Figure 2-12**). These potentially damaging winds are not aligned with the Roberts Hill tunnel. Although closer to aligned with the Shephards Lane and Gatelys tunnels, locations near those tunnels would already be protected by the hills to the north of Coffs Harbour (in the "lee" of the taller hills) and significant changes due to the construction of the tunnels are not likely.

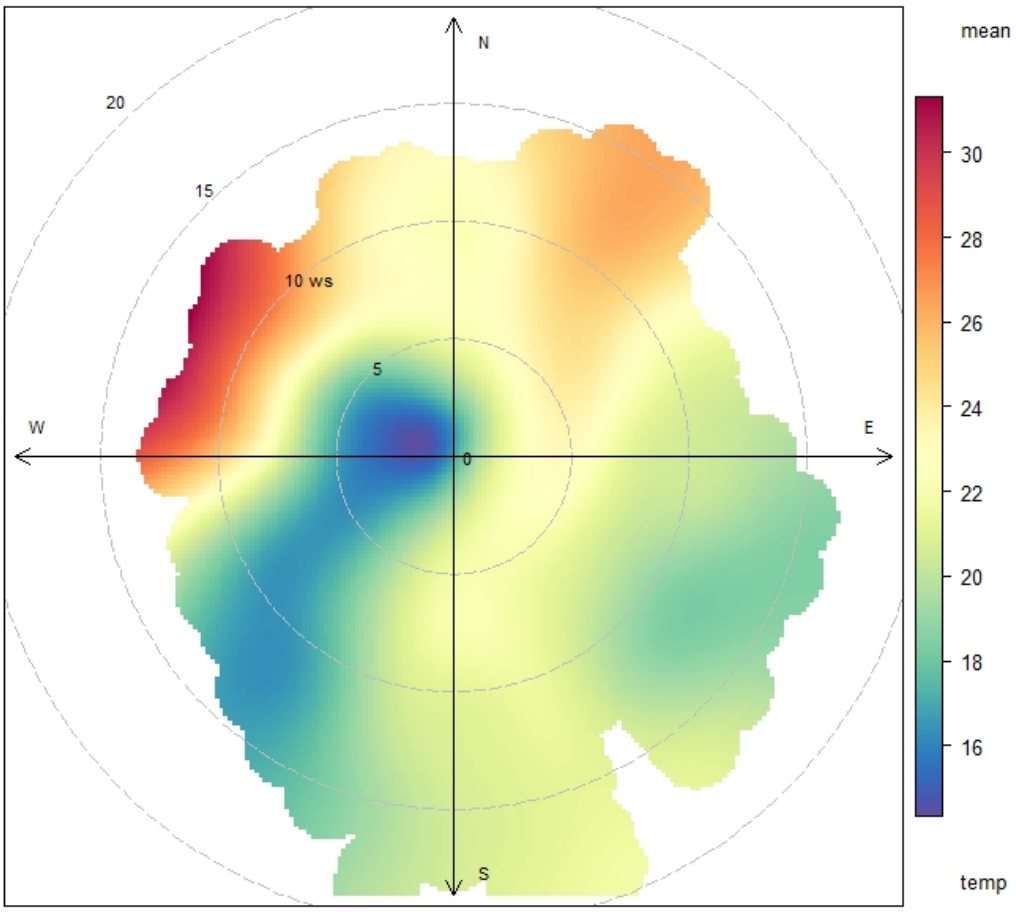


Figure 2-12 Polar plot of wind direction and temperature, showing cooler temp associated with winds from the southwest and northwest and warm temp associated with strong winds from the northwest

3. CONCLUSION

Ramboll was engaged to evaluate the three different proposed tunnel designs in relation to the local microclimate and potential changes around the tunnels. This review included the following steps:

- Review tunnel layout/drawings
- Evaluate the statistical metrological data around the tunnel portals and outwards flow from them, including wind speed and temperature
- Statistical meteorological impact:
    - How often does the wind speed currently surpass 15 m/s, 5-10 m/s, and 2.5-5 m/s
    - What fractional increase in the occurrence of those wind speed may be expected after the tunnels are built
- Assessment of the region of impact from tunnel air flow
    - What changes in wind speed and temperature may be expected after the tunnels are built.

The analysis shows that the observed wind directions are aligned within ±30° of the proposed tunnels for an appreciable percentage of the time, but the co-occurrence of that alignment with unfavourable conditions (either high wind speeds or low temperatures) is very infrequent. Further, that co-occurrence happens less frequently than the occurrence of the unfavourable condition itself. This leads to the conclusion that no matter what the potential for a tunnel "leaking" an air mass from one side of a hill to the other to alter a microclimate, the winds are so seldom aligned with the tunnel that the potential changes might occur at most 3% of the time.

Furthermore, changes due to the outflow of wind from the tunnels would be limited to an area in the immediate vicinity of the downwind tunnel end, due to the internal "friction" of the tunnel and the traffic slowing down the airflow within the tunnel. Only at high wind speeds, which are very infrequent in the region, could the changes surpass the criteria for 2.5 – 5 m/s change in wind speed (when minor impacts to banana plantations may occur). This conclusion also holds for changes in other microclimate parameters like temperature or humidity.

Given the current assessment, the tunnels would be expected to have very low impacts on the surrounding microclimate.

In **Figure 3-1** and **Figure 3-2** below, the small areas affected at the tunnel portals are shown. These areas all enclosed with the proposed road lanes. The main impact here is the traffic induced air speed near the vehicles. From these tables and figures, it can be concluded that the changes to local microclimate would be limited to within the road corridor and not the surrounding agricultural land.

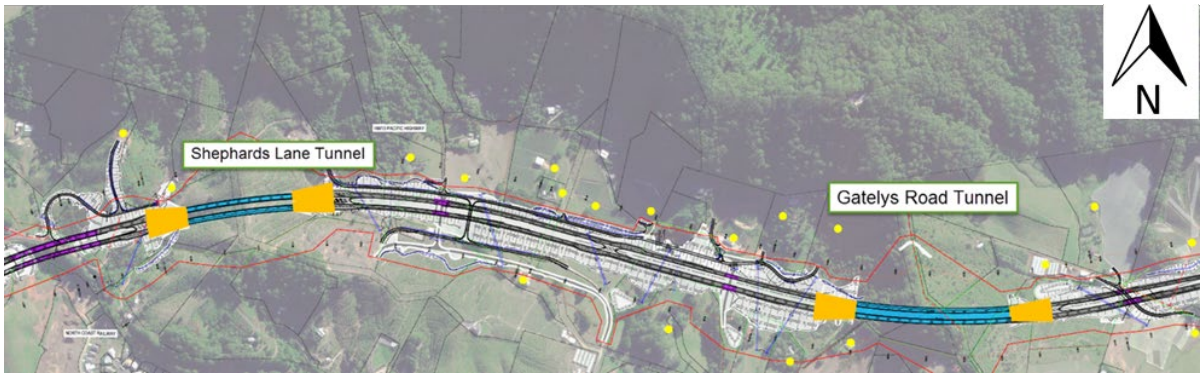


Figure 3-1 Potential change in local microclimate around the tunnel portals for Shephards Lane and Gatelys Road tunnels.

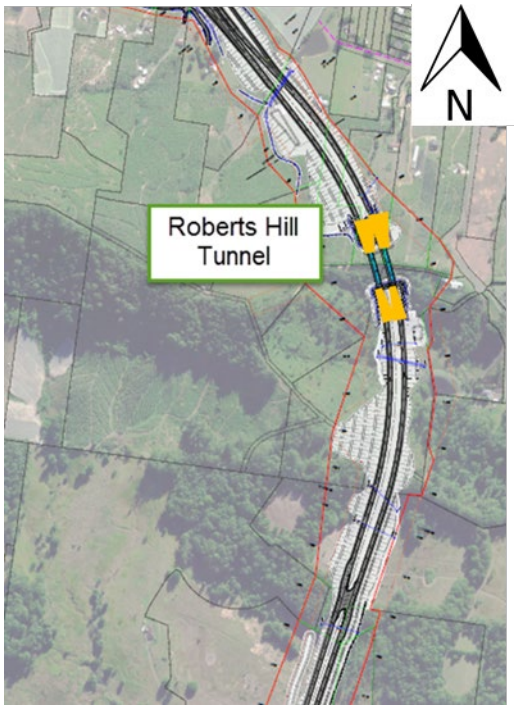


Figure 3-2 Potential change in local microclimate around the tunnel portals for Roberts Hill tunnel.

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SUB-APPENDIX

K3

Sub-appendix K3

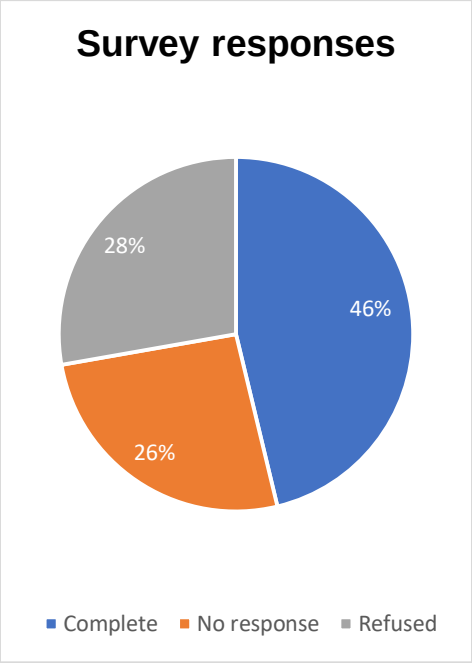
Business and community surveys

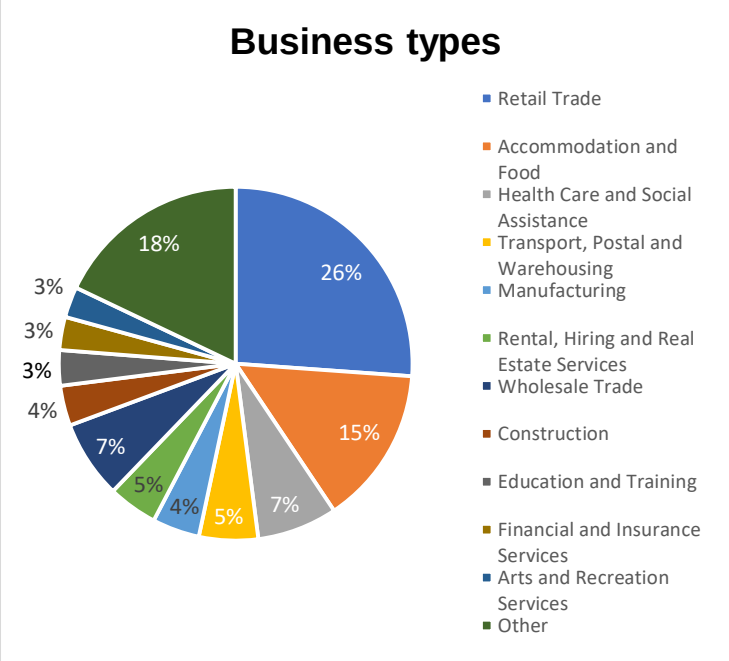
Business and community surveys

The business and community survey was conducted to understand perceived benefits and impacts associated with the bypass.

Business phone survey

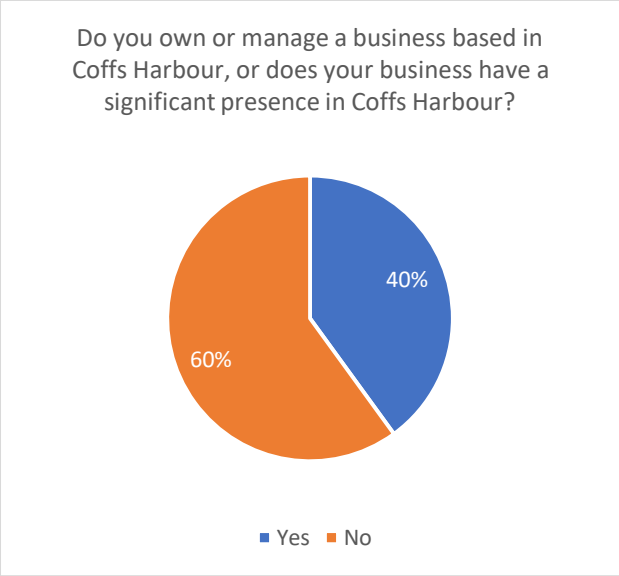
To assist the technical team preparing the traffic model for the Coffs Harbour bypass, a phone survey of Coffs Harbour businesses was undertaken between 21 to 25 November 2016. The aim of the survey was to gain more comprehensive data about business types, staff numbers and business related traffic movements. Over 900 businesses were identified in five key areas of Coffs Harbour, with 418 responding to the survey (46 per cent).

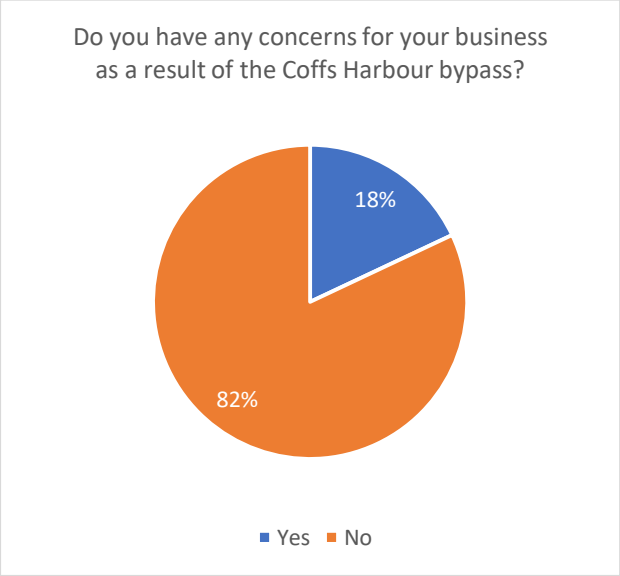




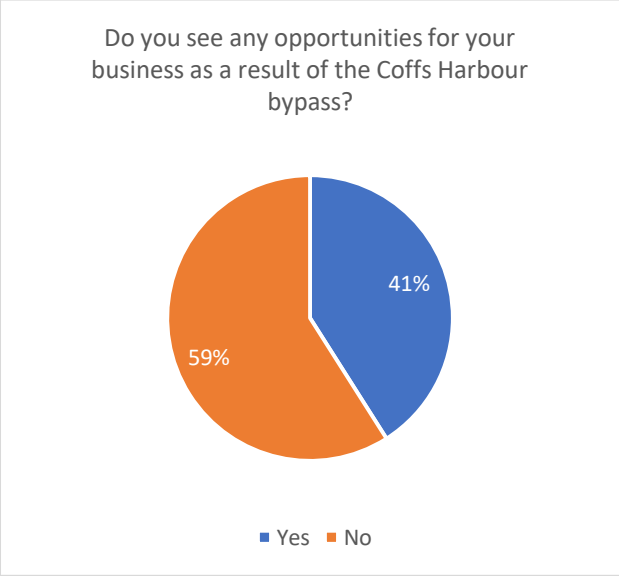
Online business and community survey

The business and community survey was available via the project website from 29 November 2016 and promoted in the December 2016 project update. Below is a summary of the 135 responses, by question.

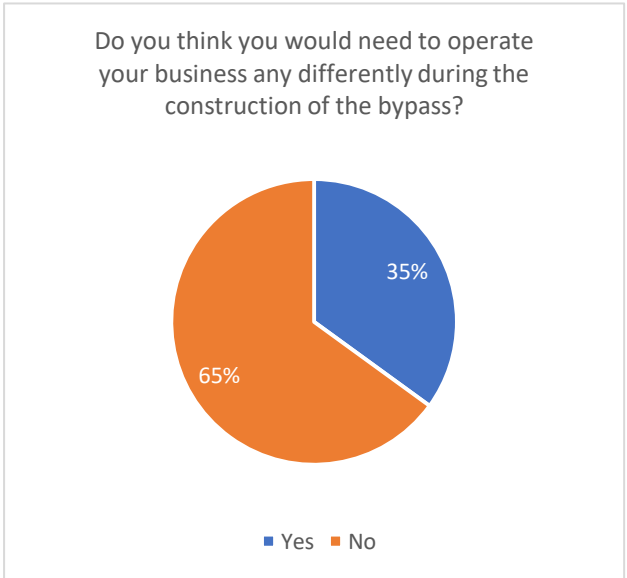




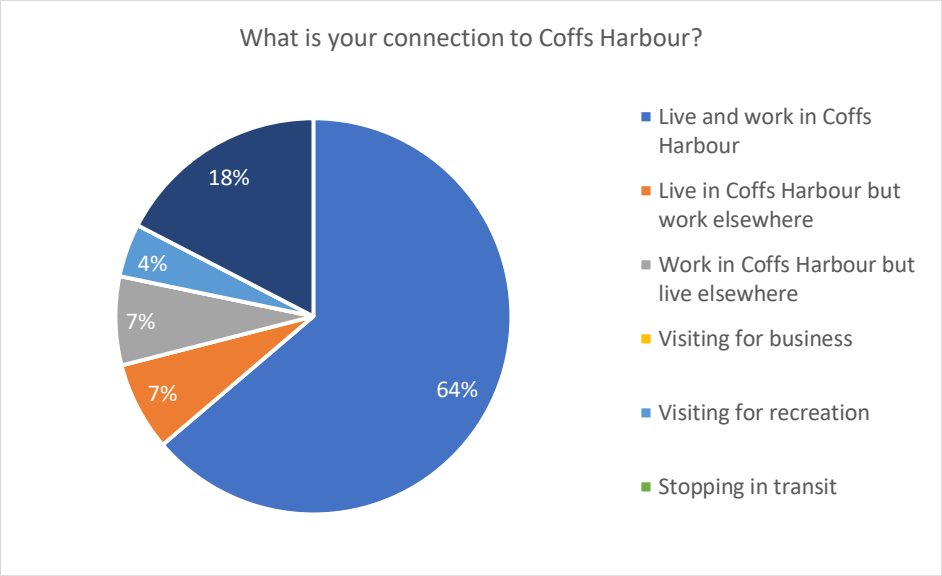
- signage visibility
- Coramba Road interchange
- traffic on Coramba Road
- changes to traffic flows.

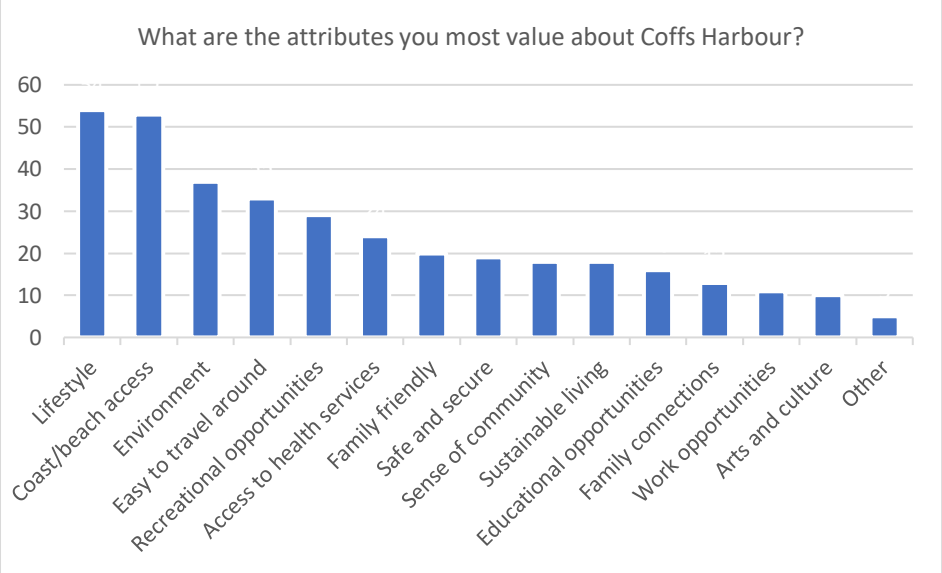


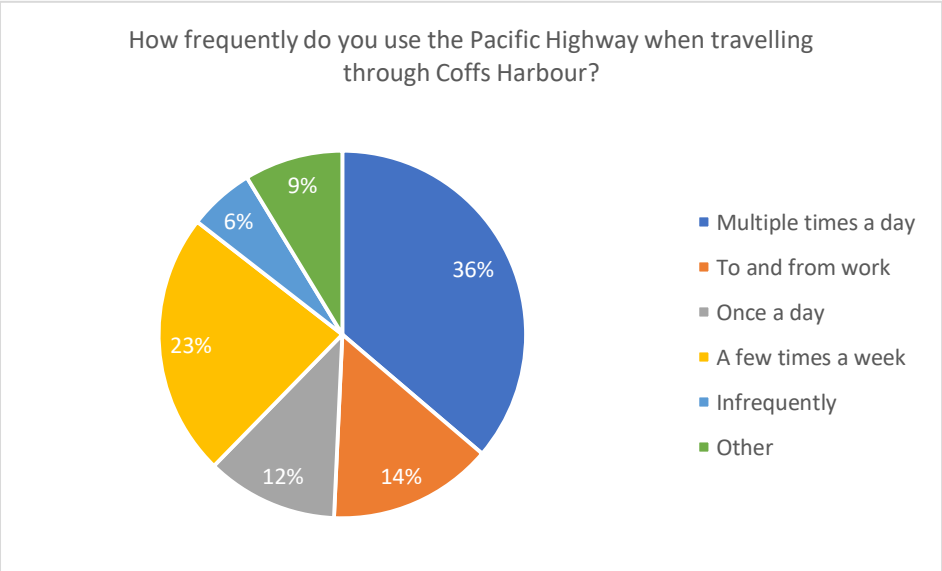
- growth potential
- making Coffs Harbour more attractive
- faster travel times in CBD area
- less congestion
- improved air quality in the city
- productivity improvements.

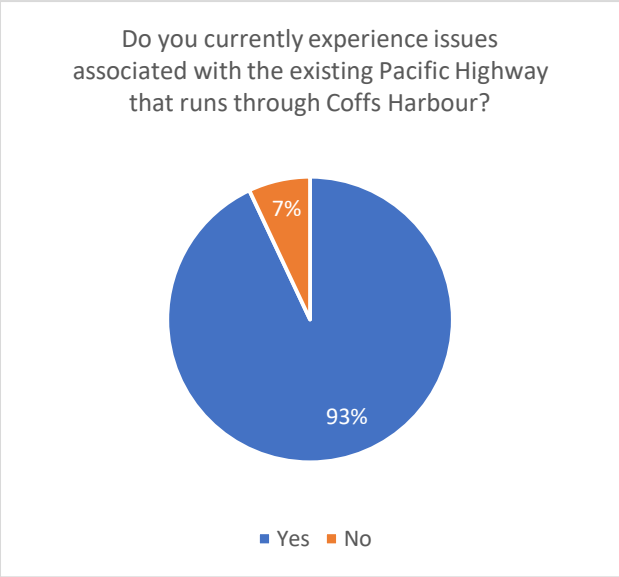


- allowing more time for construction activity and delays.

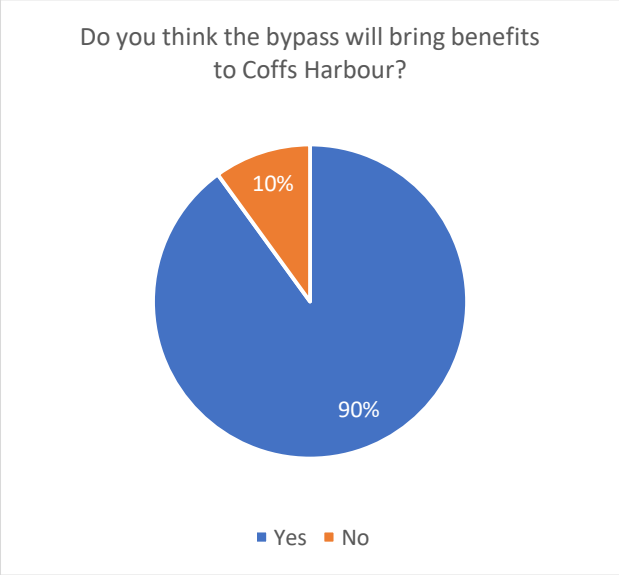

What is your connection to Coffs Harbour?
18%
4%
7%
7%
64%
Live and work in Coffs Harbour
Live in Coffs Harbour but work elsewhere
Work in Coffs Harbour but live elsewhere
Visiting for business
Visiting for recreation
Stopping in transit


What are the attributes you most value about Coffs Harbour?
60
50
40
30
20
10
0
Lifestyle
Coast/beach access
Environment
Easy to travel around
Recreational opportunities
Access to health services
Family friendly
Safe and secure
Sense of community
Sustainable living
Educational opportunities
Family connections
Work opportunities
Arts and culture
Other

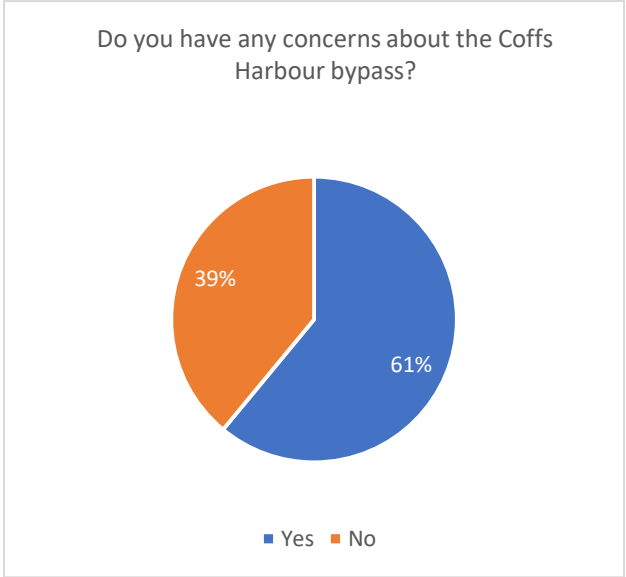

How frequently do you use the Pacific Highway when travelling through Coffs Harbour?
9%
6%
36%
23%
12%
14%
Multiple times a day
To and from work
Once a day
A few times a week
Infrequently
Other



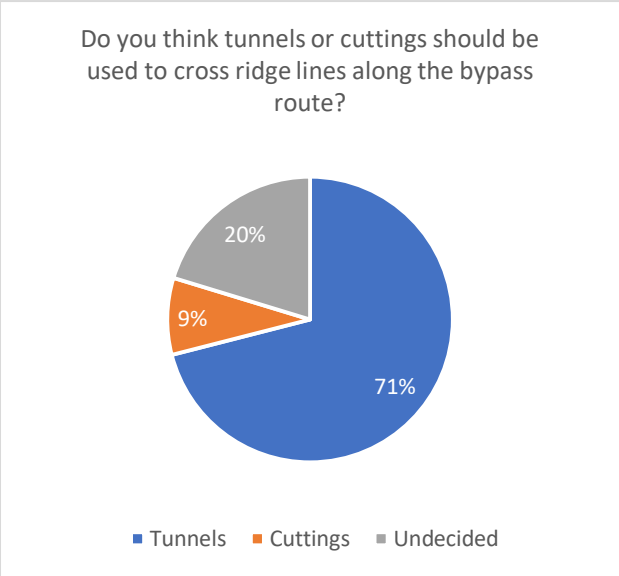
- heavy traffic
- exhaust break noise
- congestion and delays (especially in peak hour)
- traffic lights interfere with traffic flow
- crossing the highway
- cycle safety on the highway
- separation of east and west Coffs Harbour
- too many traffic lights
- holiday periods are very busy
- too many trucks.

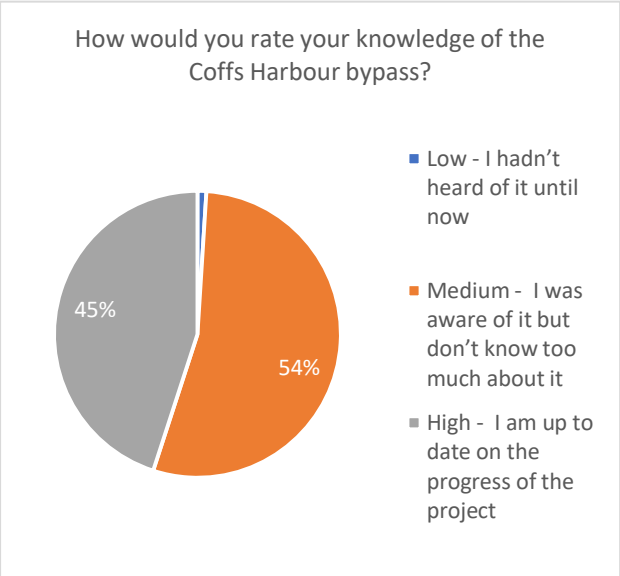


- reducing traffic through the centre of Coffs Harbour
- safer CBD area
- removing trucks from the city
- reducing noise and air quality impacts from the city
- potential for businesses on highway to upgrade/reinvigorate
- opportunity to reunite east and west
- improved amenity will allow the CBD area to prosper
- improved travel times within the city.



- impacts to wildlife corridors (including koala populations)
- 'amphitheatre' effect of the valley and concerns about noise
- complexity of interchanges at Englands Road and Korora
- concerns the corridor should be further west
- noise mitigation
- cycle access
- air quality
- property values
- visual amenity in the hills
- length of time it is taking to build
- business impacts, impact on schools
- Coramba Road interchange capacity of road and proximity to residential areas.


Do you think tunnels or cuttings should be used to cross ridge lines along the bypass route?
20%
9%
71%
Tunnels
Cuttings
Undecided


How would you rate your knowledge of the Coffs Harbour bypass?
45%
54%
Low - I hadn't heard of it until now
Medium - I was aware of it but don't know too much about it
High - I am up to date on the progress of the project

Passing trade survey: May – June 2018

Businesses located along the existing Pacific Highway were contacted by phone and email and invited to participate in a survey that focused on understanding their reliance on passing trade from the existing Pacific Highway. 96 businesses were contacted, and responses are summarised below.

Business type	How reliant is your business on passing trade from the current Pacific Highway?	Where do the majority of your customers come from?	Do you have any concerns for your business as a result of the Coffs Harbour Bypass?	Do you see any opportunities for your business as a result of the Coffs Harbour Bypass?	Do you think you would need to operate your business any differently during the construction of the bypass?	Do you think you would need to operate your business any differently once the bypass is operational?
Accommodation and Food Services	Somewhat reliant	People working or living locally	We rely on drop in holiday makers especially transient visitors looking for 1 or 2 night accommodation	It could possibly open up the front of the park for more Permanent accommodation as the decreased noise from trucks will make it viable.		We are going to increase our marketing budget tenfold to attract the same amount of transient guests.
Accommodation and Food Services	Heavily reliant	Visitors to Coffs Harbour	If Kempsey and Ballina are an indication then we will lose trade of up to 40% in the first year and hopefully recover most of this by year 3.		During construction greater occupancy as road workers require accommodation.	Not sure how
Retail Trade	Somewhat reliant	People working or living locally	My business is only just over its 1st year and yes passing trade helps a little however by the time this bypass is complete I should be established long enough to keep growing the business.	It will be a much nicer, safer city to pass through and go about daily business in without all the extra traffic congestion.		
Accommodation and Food Services	Heavily reliant	People working or living locally				

Business type	How reliant is your business on passing trade from the current Pacific Highway?	Where do the majority of your customers come from?	Do you have any concerns for your business as a result of the Coffs Harbour Bypass?	Do you see any opportunities for your business as a result of the Coffs Harbour Bypass?	Do you think you would need to operate your business any differently during the construction of the bypass?	Do you think you would need to operate your business any differently once the bypass is operational?
Retail Trade	Somewhat reliant	People working or living locally	Drop in trade and product volumes.	More local business.		Staffing and opening times would need to be reviewed
Retail Trade	Somewhat reliant	People working or living locally	Impact of passing holiday traffic.			it will be a lot easier for our delivery vans to get around CBD area
Other Services	Somewhat reliant	Visitors to Coffs Harbour	As a national icon that is reliant on passing tourist traffic, it is obvious that our trade will be affected by the bypass. It is extremely important that our business is permitted to erect signage in the new highway bypass, to educate new tourists of our existence and remind return visitors.			Certain areas of the business such as the Gift Shop and Cafe will be heavily affected by the bypass. Staffing number will need to be reduced to cater for the downturn. Patronage at our various attractions will no doubt be affected also.
Other Services	Heavily reliant	People working or living locally				
Retail Trade	Somewhat reliant	Passing trade via the Pacific Highway				
Retail Trade	Heavily reliant	Visitors to Coffs Harbour	Concerns are a reduced traffic flow straight past our door allowing for opportunist sales. Consumers will have to make an effort to come of the highway to see us.	Decreased congestion at North Boambee road lights at peak times.	Benefits of the construction will be temporary accommodation for workers on the bypass. Challenge will be pressure on wages due to the increased availability of higher wages working on the roads.	Creating ourselves as a destination for travellers to stop in. Possibly different marketing concepts to bring consumers off the highway. Adjust workforce according to the impact on sales and turnover IF this occurs.

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Health Care and Social Assistance	Not at all reliant	People working or living locally				
Other Services	Heavily reliant	People working or living locally	We need to make a city entry from Roberts Hill up king St			
Other Services	Heavily reliant	Passing trade via the Pacific Highway	After the bypass service station will loss % 50 of Petrol and shop sale after the bypass I am not sur how I will run this business			Loss %50 of sale
Health Care and Social Assistance	Heavily reliant	People working or living locally	Passing Trade Visitors			Advertisement
Retail Trade	Somewhat reliant	People working or living locally				
Accommodation and Food Services	Heavily reliant	Passing trade via the Pacific Highway	Passing trade will be reduced the majority are guests traveling from for example Brisbane to Sydney and stop half way being Coffs Harbour		If passing trade reduces then the number employed would also have to reduce	f passing trade reduces then the number employed would also have to reduce
Accommodation and Food Services	Heavily reliant	Visitors to Coffs Harbour				
Retail Trade	Heavily reliant	People working or living locally	Concerns arise due to considerable business coming from passing traffic.	Hopefully clients are able to access better due to lighter traffic and ability to enter and exit onto highway because of this.	Yes possibility more advertising costs	Yes possibility of more advertising costs

Business type	How reliant is your business on passing trade from the current Pacific Highway?	Where do the majority of your customers come from?	Do you have any concerns for your business as a result of the Coffs Harbour Bypass?	Do you see any opportunities for your business as a result of the Coffs Harbour Bypass?	Do you think you would need to operate your business any differently during the construction of the bypass?	Do you think you would need to operate your business any differently once the bypass is operational?
Accommodation and Food Services	Heavily reliant	Visitors to Coffs Harbour		Additional business generated from bypass workers		
Retail Trade	Somewhat reliant	People working or living locally				