

Phase 7 Technical Appendix

Bundaberg Region Coastal Hazard Adaptation Strategy

Bundaberg Regional Council

17 September 2020





Document Status

Version	Doc type	Reviewed by	Approved by	Date issued
01	Technical Appendix	AXS	RWS	07/05/2020
02	Technical Appendix	AXS	RWS	09/06/2020
03	Technical Appendix	IZ	RWS	17/09/2020

Project Details

Project Name	Bundaberg Region Coastal Hazard Adaptation Strategy
Client	Bundaberg Regional Council
Client Project Manager	Dwayne Honor
Water Technology Project Manager	Richard Sharp
Water Technology Project Director	Steve Clark
Authors	Richard Sharp
Document Number	Phase 7 Technical Appendix

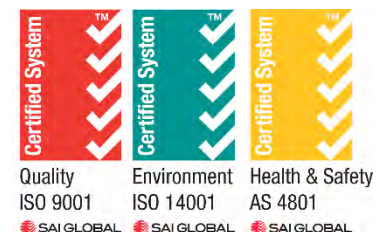


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Level 5, 43 Peel Street
South Brisbane QLD 4101
Telephone (07) 3105 1460
Fax (07) 3846 5144
ACN 093 377 283
ABN 60 093 377 283





APPENDIX A BENEFITS AND BCR CALCULATIONS



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01	Appendix A	AXS	RWS	07/05/2020
02	Appendix A	IXZ	RWS	08/06/2020
03	Appendix A	IXZ	RWS	17/09/2020

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Level 5, 43 Peel Street
South Brisbane QLD 4101

Telephone (07) 3105 1460
Fax (07) 3846 5144
ACN 093 377 283
ABN 60 093 377 283



Benefit Calculations

Methods

Phase 7 of the CHAS assessed benefits of physical and structural coastal adaptation options in terms of the reduction of economic damages that the study area would incur under each Annual Exceedance Probability (AEP) and sea level scenario. Where possible, damages were quantified in monetary terms and converted to Net Present Value (NPV) to discount future costs to present day values to account for the time value of money.

The methodology described in this Appendix Report is an excerpt from the Phase 5 Appendix E Economic and Social Analysis Technical Report and Consequence Results, specifically the Risk Assessment Final Report prepared by Molino Stewart.

Residential Damage Calculations

In generating stage damage curves suitable for the Bundaberg CHAS, the following assumptions were made:

- Geoscience Australia's contents damage model included curves for households with and without content insurance and accounting for three possible behaviours of the building occupants before the storm: protect content by moving to a higher level, exposing content by moving it to lower level (to claim a greater insurance compensation), or do nothing. These were aggregated in a single curve per each building type using a weighted average based on the proportion of Australian households with and without contents insurance (i.e. 71% and 29% respectively) (Tooth, 2015). The damage figures corresponding to the three different occupant behaviours were averaged excluding the option of exposing contents because it was deemed relatively unlikely to happen.
- Rather than providing the actual damage expressed in dollars, Geoscience Australia's structural damage curves outputs a Damage Index for each inundation depth, ranging from zero to 1. The Damage Index represents the ratio between the cost to repair a given damage and the cost to replace the whole building (or the content). This includes an allowance of +30% for structural repair costs to cover items such as the removal of the damaged parts, or the cost of matching the existing building style, and 20% for building replacement costs (to cover demolition). The Damage Index was applied to the total building structural and content replacement value to obtain the cost to repair the building structure or to replace the contents. Buildings were assumed to need full replacement when the cost of repair is uneconomical.
- Geoscience Australia's content damage curves and datasets provide the cost to replace and repair (if repairable) of the most common items found in Australian homes. Because these costs were published in 2012, they were then inflated to year 2018 using an inflation rate based on the ratio between the relevant Average Weekly Earnings (AWE). The resulting storm stage-damage curves for residential buildings, inclusive of damage to contents is shown in Figure A1.

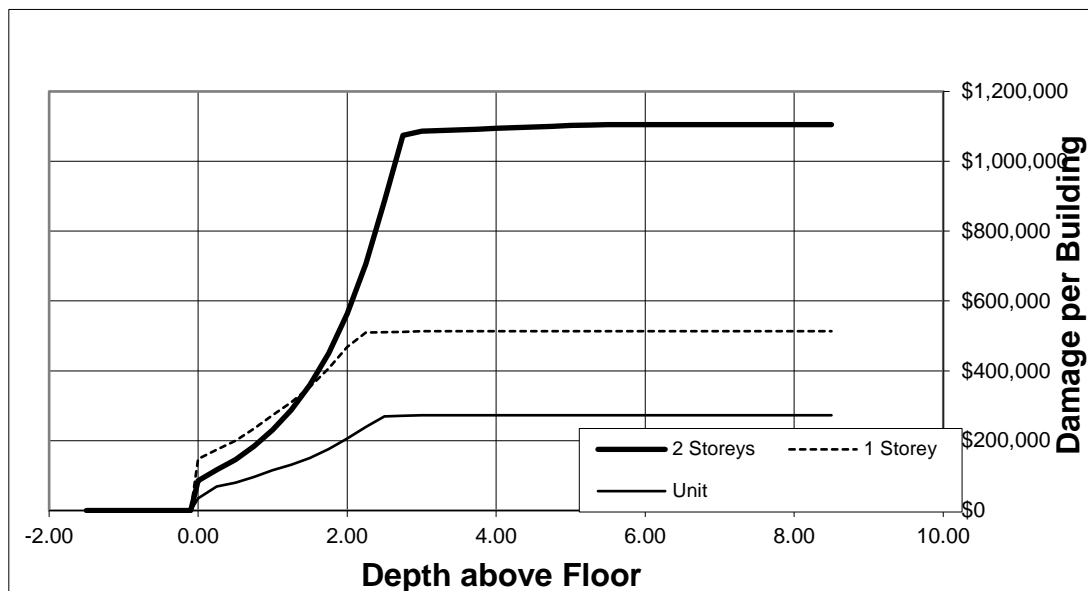


FIGURE A1 – STAGE DAMAGE CURVE – RESIDENTIAL BUILDINGS

Non-residential Buildings

The replacement value of non-residential buildings has been taken from a dataset developed by the Flood Hazard Research Centre (FHRC, 2013) at Middlesex University in the UK. While a potentially more accurate estimate of the value of Australian non-residential buildings could have been possible, the values proposed by FHRC (2013) were adopted for consistency with the damage model selected for the Bundaberg CHAS which were deemed the most suitable among those available globally. The replacement costs of commercial and industrial buildings were then inflated to present day obtaining the following replacement costs, which include building structure and contents:

- Commercial buildings: \$2,241/m²
- Industrial buildings: \$1,870/m²

Similarly, to the methodology used for residential damages calculations, the value of commercial land has been extracted from recent real estate sale records and current listings.

An average value of \$100/m² was used.

Damage Models

Direct damages to commercial and industrial buildings were assessed using the following damage models:

Sea Level Rise and Erosion

Non-residential buildings affected by sea level rise or erosion were assumed to be totally and permanently lost. The damage was obtained by summing the estimated building and land value.

Storm Tide Inundation

At the time of publication, there is no adopted industry standard suite of stage-damage curves for calculating direct commercial and industrial flood damages in Australia.

- The most widely adopted stage-damage functions in Australia were those developed for the ANUFLOOD model, developed in 1983 and revised in 1994. Many studies have used the ANUFLOOD functions with adjustment factors to derive current values, based on CPI or AWE inflation.
- Other studies in Australia adopted the FLDAMAGE model developed by Water Studies in 1992. FLDAMAGE is similar to ANUFLOOD in that it derives an estimate of total flood damages for inundated buildings by applying stage-damage curves appropriate to each type of property.

- Both sets of stage damage curves were derived from data collected following Australian floods in the 1970s and 1980s when the contents of commercial and industrial premises were very different to today.
- An international literature review shows the most up to date stage damage curves have been developed by the Flood Hazard Research Centre (FHRC, 2013) at Middlesex University in the UK. These stage-damage curves are based on field observations made in the UK between 2003 and 2005. As such, they provide a contemporary evaluation of the damage to buildings and building contents. They are referred to as FLOODsite MCM.
- The relevant stage damage curves for commercial and industrial buildings are shown Figure A2.
- The commercial and industrial curves used in the Bundaberg CHAS were derived from average values across the full range of MCM commercial and industrial damage curves respectively. The original MCM curves were converted to Australian dollars and adjusted to 2018 values.

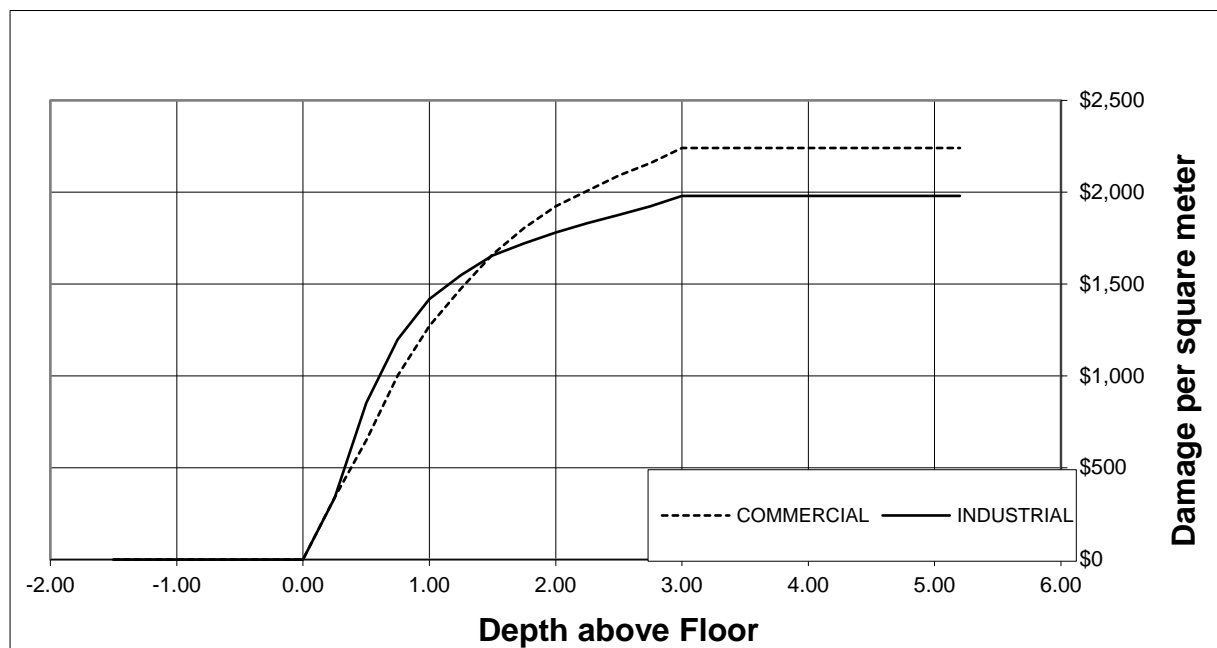


FIGURE A2 STAGE DAMAGE CURVE – NON RESIDENTIAL BUILDINGS

Cost Benefit Analysis Approach

The cost-benefit analysis requires present and future costs and benefits to be discounted to present time figures, in a way that takes into account the probability of hazard events and the selected range of sea level conditions.

For each hazard type, this was achieved by estimating the expected damages out to the 80-year planning horizon and discounting these to present time by calculating the Present Value (PV) of the losses they will cause. The planning horizon of 80 years has been chosen because sea level has been assumed to rise at a rate of 1cm per year. This time scale is also consistent with the expected life span of any structural risk reduction measures.

The PV is the sum of all future damages that can be expected over a fixed period (i.e. 80 years in this study) expressed as a cost in today's dollars. The present value is determined by discounting the future flood damage costs back to the present-day situation, using a discount rate. In this study we adopted a discount rate of 7%.

The permanency, probability, and time horizon of each of the three types of damages varies and must be accounted for differently. The following sets out how the annual damages from each were estimated and summed to create a present value.

Sea Level Rise Damage

Four sea level rise scenarios were modelled: current conditions; 0.2m of sea level rise; 0.4m of sea level rise; and 0.8m of sea level rise. It was found that even under existing conditions some assets were damaged by the high astronomical tide, so this was determined to be the present-day cost of existing sea level. As sea level rise is a permanent change which increases over time, anything which falls below the HAT level can be considered permanently lost from the time that occurs. The total damages due to sea level rise were therefore estimated for 20cm (year 2040), 40cm (year 2060) and 80cm (year 2100).

Using the current damages and these future totals the annual incremental damage from sea level rise could then be interpolated for each year. The present value of each increment was then calculated based on the year it will occur in the future. These present values were all summed to estimate the present value of the damages caused by all of the future sea level rise.

Storm Surge Damage

For hazard types, such as storm surge, that over time tend to cause periodical damages to the same assets, an economic appraisal will require calculating the hazard's Annual Average Damages (AAD). AAD is a measure of the cost of storm surge inundation damage that could be expected each year by the community, on average. When applicable, AAD is a convenient yardstick to compare the economic benefits of various proposed mitigation measures with each other and the existing situation. Figure 5 describes how AAD relates to actual losses recorded over a long period. For the current study, AAD was assessed using the potential damages derived for each AEP storm event, under the assumption that there would be no flood damages in events as frequent as the 50% AEP.

AAD estimates are based on the assumption that after each storm event, the damaged assets would be repaired or rebuilt and brought back to the same condition they were before the disaster. In this study there was the added complication that storm surge damages will change over time because of changes in sea level. For this reason, the following approach was taken.

Firstly, in each storm surge event for each future sea level rise scenario, only that component of damage attributable to storm surge was estimated. That is, the permanent damages caused by the permanent change in sea level was excluded.

Secondly, the AADs were estimated for the suite of storm surge events in each of the four sea level rise scenarios. This provided an AAD for 2020, 2040, 2060 and 2100.

Thirdly, these were interpolated linearly to estimate an AAD for each year between now and 2100.

Finally, as with the sea level rise damages for each year, each year's AAD was discounted to a PV and then all of the PVs summed to get a total PV for storm surge which takes into account how AADs vary over time.

Erosion Damage

As with sea level rise, the losses from coastal erosion were assumed to be permanent however, there is also a probabilistic component as to whether they are experienced or not during the planning horizon. The permanency of the damage means that AAD is not a meaningful way of measuring annual damages from erosion. Furthermore, once one erosion event occurs, any damage from the next erosion event will be diminished by the damage caused by the previous event. For application to the Bundaberg CHAS the following approach was taken:

- Within each sea level rise scenario, the loss from each coastal erosion event (5%, 2% and 1% AEP) has been estimated as incremental damage above that caused by the permanent sea level rise for the same scenario,
- For example, as the losses from a 1% AEP event are greater than those of a 2% AEP event, incremental losses were estimated for the 1% AEP. The 2% AEP event losses are greater than those of the 5% AEP event, the incremental losses were estimated for the 2% AEP and so on.
- Using the 80-year planning horizon, the likelihood of each event (5%, 2% and 1% AEP) occurring over that time period has been estimated by multiplying the losses associated with each AEP event by the likelihood.
 - For example:
 - The 5% AEP event has a $1-(1-1/20)^{80} = 98\%$ chance of occurring over the 80 years. If it were estimated that a 5% AEP erosion event would cause \$1m worth of damage, then a total loss of \$980,000 has been assigned to that event.
 - The 2% AEP event has an 80% chance of occurring over the 80 years and if that event would cause \$2m worth of damage then its incremental loss is \$1m more than the 5% AEP event, and this is multiplied by 80% to give \$800,000 damages assigned to that event.
 - The 1% AEP event has a 55% of occurring within the 80 years period and if that event would cause \$3m worth of damage then its incremental loss is \$1m more than the 2% AEP, and this is multiplied by 55% to give \$550,000 damages assigned to the 1%AEP event.
- To account for when each event might occur, the year by which there would be a 50/50 chance of it occurring has been used an assumption of the event happening once, i.e.:
 - 5% AEP event would occur after 13.5 years
 - 2% AEP event would occur after 34 years; and
 - 1% AEP event would occur after in 68 years.
- The erosion damages in year 13.5 was estimated by interpolating linearly between the erosion damage from a 5% event in 2020 (present day) and a 5% event in 2040 (0.2m sea level rise in 20 years).
- The erosion damage in year 34 was estimated by interpolating linearly between the erosion damage from a 2% event in 2040 (0.2m sea level rise in 20 years) and a 2% event in 2060 (0.4m sea level rise in 40 years); and
- The erosion damage in year 68 was estimated by interpolating linearly between the erosion damage from a 1% event in 2060 (0.4m sea level rise in 40 years) and a 1% event in 2100 (0.8m sea level rise in 80 years).

Each of these three damages costs are then discounted to a net present value (NPV) by discounting them from the year in which they were assumed to occur. The three NPVs calculations have then been summed to obtain a total NPV from erosion.

Benefits Calculations

The buildings and infrastructure affected by coastal hazards to all settlements were identified and NPV applied to the economic damages of the buildings and infrastructure. The full set of base case damages presented as NPV are summarised in Table A1, this is to enable the calculation of benefits. The benefits of each adaptation option were calculated as the present value of the reduction of the damages to property, which equates to the damages without options in place minus the damages with the options in place.

The CBA was complemented by a sensitivity analysis. Specifically, a new set of BCRs has been calculated using a discount rate of 4% and 10%, in addition to the standard value of 7%. Queensland Treasury does not provide specific recommendations on the discount rates to be used, however, recent guidelines from Infrastructure Australia, (March 2018) recommends the use of 4%, 7% and 10%.

The sensitivity to variations in costs and benefits was also assessed by looking at the following two scenarios:

- Best case scenario (costs reduced by 10%, benefits increased by 10%), and
- Worst case scenario (costs increased by 10%, benefits reduced by 10%)

The benefits of all sensitivity tests are presented in tables A2 to A5.

Table A1 –Adaptation Options Benefits Calculations (NPV) – Residential, Non-residential, Infrastructure and Intangible Damage Reductions (7% Discount Rate)

Description	Trigger		Resid Damages (inc indirect) - NPV	Total Resid Damage (inc 15% infrastr and 25% intangibles) - NPV	Non Resid Damage (inc indirect) – NPV	Total Non Resid Damage (inc 15% infrastr and 25% intangibles) - NPV	Total Damage (inc 15% infrastr and 25% intangibles) - NPV	NPV of Total Whole of Life Option Costs	Option Benefit Relative to current condition	Benefit/Cost Relative to current condition
Moore Park Beach Beach Nourishment with Dune (re)construction	0.4m SLR	Current Condition	\$19,353,351	\$27,094,692	\$1,730,267	\$2,422,374	\$29,517,065	na		
		With Options	\$16,620,938	\$23,269,314	\$1,726,964	\$2,417,749	\$25,687,063	\$525,220	\$3,830,002	7.29
Moore Park Beach Seawall / Rockwall / Buried Seawall	0.4m SLR	Current Condition	\$19,353,351	\$27,094,692	\$1,730,267	\$2,422,374	\$29,517,065	na		
		With Options	\$16,620,938	\$23,269,314	\$1,726,964	\$2,417,749	\$25,687,063	\$1,014,986	\$3,830,002	3.77
Burnett Heads Storm Surge Barrier and Dyke	0.8m SLR	Current Condition	\$31,339,766	\$43,875,672	\$3,235,120	\$4,529,168	\$48,404,840	na		
		With Options	\$31,315,356	\$43,841,498	\$3,235,120	\$4,529,168	\$48,370,666	\$80,273	\$34,174	0.43
Bargara Beach Nourishment with Dune (re)construction	0.8m SLR	Current Condition	\$23,623,065	\$33,072,291	\$696	\$974	\$33,073,265	na		
		With Options	\$23,462,233	\$32,847,126	\$696	\$974	\$32,848,100	\$5,846	\$225,165	38.51
Bargara, Kellys beach Seawall / Rockwall / Buried Seawall	0.8m SLR	Current Condition	\$23,623,065	\$33,072,291	\$696	\$974	\$33,073,265	na		
		With Options	\$23,462,233	\$32,847,126	\$696	\$974	\$32,848,100	\$33,271	\$225,165	6.77
Innes Park and Coral Cove Beach Nourishment with Dune (re)construction	0.8m SLR	Current Condition	\$987,964	\$1,383,149	\$0	\$0	\$1,383,149			
		With Options	\$923,928	\$1,293,500	\$0	\$0	\$1,293,500	\$11,595	\$89,649	7.73
Innes Park and Coral Cove Seawalls /Rock wall / Buried Seawall	0.8m SLR	Current Condition	\$987,964	\$1,383,149	\$0	\$0	\$1,383,149	na		
		With Options	\$923,928	\$1,293,500	\$0	\$0	\$1,293,500	\$23,890	\$89,649	3.75
Coonarr Beach Nourishment with Dune (re)construction	0.2m SLR	Current Condition	\$495,182	\$693,254	\$0	\$0	\$693,254	na		
		With Options	\$12,653	\$17,715	\$0	\$0	\$17,715	\$177,477	\$675,539	3.81
Coonarr Seawalls /Rock wall / Buried Seawall	0.2m SLR	Current Condition	\$495,182	\$693,254	\$0	\$0	\$693,254	na		
		With Options	\$12,653	\$17,715	\$0	\$0	\$17,715	\$617,036	\$675,539	1.09
Coonarr Retreat/ Land Use and Tenure Transition	0.2m SLR	Current Condition	\$495,182	\$693,254	\$0	\$0	\$693,254	na		
		With Options	\$0	\$0	\$0	\$0	\$0	\$1,553,137	\$693,254	0.45
Woodgate Beach Beach Nourishment with Dune (re)construction	0.4m SLR	Current Condition	\$11,930,336	\$16,702,470	\$2,003,481	\$2,804,873	\$19,507,343	na		
		With Options	\$7,619,763	\$10,667,669	\$2,003,481	\$2,804,873	\$13,472,541	\$1,072,437	\$6,034,801	5.63
Woodgate Beach Seawalls /Rock wall / Buried Seawall	0.4m SLR	Current Condition	\$11,930,336	\$16,702,470	\$2,003,481	\$2,804,873	\$19,507,343	na		
		With Options	\$7,619,763	\$10,667,669	\$2,003,481	\$2,804,873	\$13,472,541	\$2,282,388	\$6,034,801	2.64
Woodgate Beach Retreat/ Land Use and Tenure Transition	0.4m SLR	Current Condition	\$11,930,336	\$16,702,470	\$2,003,481	\$2,804,873	\$19,507,343	na		
		With Options	\$11,775,020	\$16,485,028	\$2,003,481	\$2,804,873	\$19,289,901	\$914,490	\$217,442	0.24
Innes Park and Coral Cove Do nothing	0.8m SLR	Current Condition	\$987,964	\$1,383,149	\$0	\$0	\$1,383,149	na		
		With Options	\$987,964	\$1,383,149	\$0	\$0	\$1,383,149	\$0	\$0	1.00
Coonarr Do nothing	0.2m SLR	Current Condition	\$495,182	\$693,254	\$0	\$0	\$693,254	na		
		With Options	\$495,182	\$693,254	\$0	\$0	\$693,254	\$0	\$0	1.00
Moore Park Beach Do nothing	0.4m SLR	Current Condition	\$19,353,351	\$27,094,692	\$0	\$0	\$27,094,692	na		
		With Options	\$19,353,351	\$27,094,692	\$0	\$0	\$27,094,692	\$0	\$0	1.00
Burnett Heads Do nothing	0.8m SLR	Current Condition	\$31,339,766	\$43,875,672	\$3,235,120	\$4,529,168	\$48,404,840	na		
		With Options	\$31,339,766	\$43,875,672	\$3,235,120	\$4,529,168	\$48,404,840	\$0	\$0	1.00
Bargara Do nothing	0.8m SLR	Current Condition	\$23,623,065	\$33,072,291	\$696	\$974	\$33,073,265	na		
		With Options	\$23,623,065	\$33,072,291	\$696	\$974	\$33,073,265	\$0	\$0	1.00
Woodgate Beach Do nothing	0.4m SLR	Current Condition	\$11,930,336	\$16,702,470	\$2,003,481	\$2,804,873	\$19,507,343	na		
		With Options	\$11,930,336	\$16,702,470	\$2,003,481	\$2,804,873	\$19,507,343	\$0	\$0	1.00

Table A2 - Adaptation Options Benefits Calculations (NPV) 4% Discount Rate Sensitivity

Description	Trigger		Resid Damages (inc indirect) - NPV	Total Resid Damage (inc 15% infrastr and 25% intangibles) - NPV	Non Resid Damage (inc indirect) - NPV	Total Non Resid Damage (inc 15% infrastr and 25% intangibles) - NPV	Total Damage (inc 15% infrastr and 25% intangibles) - NPV	NPV of Total Whole of Life Option Costs	Option Benefit Relative to current condition	Benefit/Cost Relative to current condition
Moore Park Beach Beach Nourishment with Dune (re)construction	0.4m SLR	Current Condition	\$37,953,754	\$53,135,255	\$4,002,039	\$5,602,854	\$58,738,109	na		
		With Options	\$29,640,742	\$41,497,039	\$3,991,890	\$5,588,646	\$47,085,685	\$1,970,358	\$11,652,424	5.91
Moore Park Beach Seawall / Rockwall / Buried Seawall	0.4m SLR	Current Condition	\$37,953,754	\$53,135,255	\$4,002,039	\$5,602,854	\$58,738,109	na		
		With Options	\$29,640,742	\$41,497,039	\$3,991,890	\$5,588,646	\$47,085,685	\$3,669,276	\$11,652,424	3.18
Burnett Heads Storm Surge Barrier and Dyke	0.8m SLR	Current Condition	\$50,584,815	\$70,818,740	\$5,696,382	\$7,974,934	\$78,793,674	na		
		With Options	\$50,431,808	\$70,604,531	\$5,696,382	\$7,974,934	\$78,579,465	\$780,918	\$214,209	0.27
Bargara Beach Nourishment with Dune (re)construction	0.8m SLR	Current Condition	\$38,860,616	\$54,404,863	\$696	\$974	\$54,405,837	na		
		With Options	\$38,058,278	\$53,281,590	\$696	\$974	\$53,282,564	\$56,875	\$1,123,273	19.75
Bargara, Kellys beach Seawall / Rockwall / Buried Seawall	0.8m SLR	Current Condition	\$38,860,616	\$54,404,863	\$4,014	\$5,619	\$54,410,482	na		
		With Options	\$38,058,278	\$53,281,590	\$4,014	\$5,619	\$53,287,209	\$323,664	\$1,123,273	3.47
Innes Park and Coral Cove Beach Nourishment with Dune (re)construction	0.8m SLR	Current Condition	\$2,715,892	\$3,802,249	\$0	\$0	\$3,802,249			
		With Options	\$2,260,276	\$3,164,386	\$0	\$0	\$3,164,386	\$112,799	\$637,863	5.65
Innes Park and Coral Cove Seawalls /Rock wall / Buried Seawall	0.8m SLR	Current Condition	\$2,715,892	\$3,802,249	\$0	\$0	\$3,802,249	na		
		With Options	\$2,260,276	\$3,164,386	\$0	\$0	\$3,164,386	\$232,410	\$637,863	2.74
Coonarr Beach Nourishment with Dune (re)construction	0.2m SLR	Current Condition	\$1,339,019	\$1,874,626	\$0	\$0	\$1,874,626	na		
		With Options	\$56,173	\$78,642	\$0	\$0	\$78,642	\$373,596	\$1,795,984	4.81
Coonarr Seawalls /Rock wall / Buried Seawall	0.2m SLR	Current Condition	\$1,339,019	\$1,874,626	\$0	\$0	\$1,874,626	na		
		With Options	\$56,173	\$78,642	\$0	\$0	\$78,642	\$1,288,551	\$1,795,984	1.39
Coonarr Retreat/ Land Use and Tenure Transition	0.2m SLR	Current Condition	\$1,339,018	\$1,874,625	\$0	\$0	\$1,874,625	na		
		With Options	\$0	\$0	\$0	\$0	\$0	\$2,742,955	\$1,874,625	0.68
Woodgate Beach Beach Nourishment with Dune (re)construction	0.4m SLR	Current Condition	\$29,037,973	\$40,653,162	\$3,710,642	\$5,194,899	\$45,848,061	na		
		With Options	\$14,654,277	\$20,515,987	\$3,710,642	\$5,194,899	\$25,710,886	\$4,033,310	\$20,137,175	4.99
	0.4m SLR	Current Condition	\$29,037,973	\$40,653,162	\$3,710,642	\$5,194,899	\$45,848,061	na		

Description	Trigger		Resid Damages (inc indirect) - NPV	Total Resid Damage (inc 15% infrastr and 25% intangibles) - NPV	Non Resid Damage (inc indirect) - NPV	Total Non Resid Damage (inc 15% infrastr and 25% intangibles) - NPV	Total Damage (inc 15% infrastr and 25% intangibles) - NPV	NPV of Total Whole of Life Option Costs	Option Benefit Relative to current condition	Benefit/Cost Relative to current condition
Woodgate Beach Seawalls /Rock wall / Buried Seawall		With Options	\$14,654,277	\$20,515,987	\$3,710,642	\$5,194,899	\$25,710,886	\$8,251,061	\$20,137,175	2.44
Woodgate Beach Retreat/ Land Use and Tenure Transition	0.4m SLR	Current Condition	\$29,037,974	\$40,653,164	\$3,710,642	\$5,194,899	\$45,848,062	na		
		With Options	\$28,073,472	\$39,302,861	\$3,710,642	\$5,194,899	\$44,497,760	\$2,852,307	\$1,350,302	0.47
Innes Park and Coral Cove Do nothing	0.8m SLR	Current Condition	\$2,715,892	\$3,802,249	\$0	\$0	\$3,802,249	na		
		With Options	\$2,715,892	\$3,802,249	\$0	\$0	\$3,802,249	\$0	\$0	1.00
Coonarr Do nothing	0.2m SLR	Current Condition	\$1,339,019	\$1,874,626	\$0	\$0	\$1,874,626	na		
		With Options	\$1,339,019	\$1,874,626	\$0	\$0	\$1,874,626	\$0	\$0	1.00
Moore Park Beach Do nothing	0.4m SLR	Current Condition	\$19,353,351	\$27,094,692	\$0	\$0	\$27,094,692	na		
		With Options	\$19,353,351	\$27,094,692	\$0	\$0	\$27,094,692	\$0	\$0	1.00
Burnett Heads Do nothing	0.8m SLR	Current Condition	\$31,339,766	\$43,875,672	\$5,696,382	\$7,974,934	\$46,680,545	na		
		With Options	\$31,339,766	\$43,875,672	\$5,696,382	\$7,974,934	\$46,680,545	\$0	\$0	1.00
Bargara Do nothing	0.8m SLR	Current Condition	\$23,623,065	\$33,072,291	\$696	\$974	\$35,877,164	na		
		With Options	\$23,623,065	\$33,072,291	\$696	\$974	\$35,877,164	\$0	\$0	1.00
Woodgate Beach Do nothing	0.4m SLR	Current Condition	\$11,930,336	\$16,702,470	\$4,014	\$5,619	\$19,507,343	na		
		With Options	\$11,930,336	\$16,702,470	\$4,014	\$5,619	\$19,507,343	\$0	\$0	1.00

Table A-3 Adaptation Options Benefits Calculations (NPV) – 10% Discount Rate Sensitivity Test

Description	Trigger		Resid Damages (inc indirect) - NPV	Total Resid Damage (inc 15% infrastr and 25% intangibles) - NPV	Non Resid Damage (inc indirect) - NPV	Total Non Resid Damage (inc 15% infrastr and 25% intangibles) - NPV	Total Damage (inc 15% infrastr and 25% intangibles) - NPV	NPV of Total Whole of Life Option Costs	Option Benefit Relative to current condition	Benefit/Cost Relative to current condition
Moore Park Beach Beach Nourishment with Dune (re)construction	0.4m SLR	Current Condition	\$12,655,806	\$17,718,128	\$888,900	\$1,244,459	\$18,962,587	na		
		With Options	\$11,649,488	\$16,309,283	\$887,699	\$1,242,779	\$17,552,062	\$154,398	\$1,410,525	9.14
Moore Park Beach Seawall / Rockwall / Buried Seawall	0.4m SLR	Current Condition	\$12,655,806	\$17,718,128	\$888,900	\$1,244,459	\$18,962,587	na		
		With Options	\$11,649,488	\$16,309,283	\$887,699	\$1,242,779	\$17,552,062	\$308,369	\$1,410,525	4.57
Burnett Heads Storm Surge Barrier and Dyke	0.8m SLR	Current Condition	\$22,692,584	\$31,769,618	\$2,137,826	\$2,992,956	\$34,762,574	na		
		With Options	\$22,688,151	\$31,763,411	\$2,137,826	\$2,992,956	\$34,756,367	\$8,787	\$6,207	0.71
Bargara Beach Nourishment with Dune (re)construction	0.8m SLR	Current Condition	\$15,591,009	\$21,827,413	\$696	\$974	\$21,828,387	na		
		With Options	\$15,548,679	\$21,768,150	\$696	\$974	\$21,769,124	\$640	\$59,263	92.60
Bargara, Kellys beach Seawall / Rockwall / Buried Seawall	0.8m SLR	Current Condition	\$15,591,009	\$21,827,413	\$137	\$192	\$21,827,605	na		
		With Options	\$15,548,679	\$21,768,150	\$137	\$192	\$21,768,342	\$3,642	\$59,263	16.27
Innes Park and Coral Cove Beach Nourishment with Dune (re)construction	0.8m SLR	Current Condition	\$431,953	\$604,734	\$0	\$0	\$604,734			
		With Options	\$422,451	\$591,432	\$0	\$0	\$591,432	\$1,269	\$13,302	10.48
Innes Park and Coral Cove Seawalls /Rock wall / Buried Seawall	0.8m SLR	Current Condition	\$431,953	\$604,734	\$0	\$0	\$604,734	na		
		With Options	\$422,451	\$591,432	\$0	\$0	\$591,432	\$2,615	\$13,302	5.09
Coonarr Beach Nourishment with Dune (re)construction	0.2m SLR	Current Condition	\$191,003	\$267,404	\$0	\$0	\$267,404	na		
		With Options	\$3,294	\$4,612	\$0	\$0	\$4,612	\$92,174	\$262,792	2.85
Coonarr Seawalls /Rock wall / Buried Seawall	0.2m SLR	Current Condition	\$191,003	\$267,404	\$0	\$0	\$267,404	na		
		With Options	\$3,294	\$4,612	\$0	\$0	\$4,612	\$324,055	\$262,792	0.81
Coonarr Retreat/ Land Use and Tenure Transition	0.2m SLR	Current Condition	\$191,004	\$267,406	\$0	\$0	\$267,406	na		
		With Options	\$0	\$0	\$0	\$0	\$0	\$893,371	\$267,406	0.30
Woodgate Beach Beach Nourishment with Dune (re)construction	0.4m SLR	Current Condition	\$6,323,794	\$8,853,312	\$1,261,697	\$1,766,375	\$10,619,688	na		
		With Options	\$4,804,495	\$6,726,293	\$1,261,697	\$1,766,375	\$8,492,669	\$314,676	\$2,127,019	6.76
Woodgate Beach Seawalls /Rock wall / Buried Seawall	0.4m SLR	Current Condition	\$6,323,794	\$8,853,312	\$1,261,697	\$1,766,375	\$10,619,688	na		
		With Options	\$4,804,495	\$6,726,293	\$1,261,697	\$1,766,375	\$8,492,669	\$693,426	\$2,127,019	3.07

Description	Trigger		Resid Damages (inc indirect) - NPV	Total Resid Damage (inc 15% infrastr and 25% intangibles) - NPV	Non Resid Damage (inc indirect) - NPV	Total Non Resid Damage (inc 15% infrastr and 25% intangibles) - NPV	Total Damage (inc 15% infrastr and 25% intangibles) - NPV	NPV of Total Whole of Life Option Costs	Option Benefit Relative to current condition	Benefit/Cost Relative to current condition
Woodgate Beach Retreat/ Land Use and Tenure Transition	0.4m SLR	Current Condition	\$6,323,795	\$8,853,313	\$1,261,697	\$1,766,376	\$10,619,689	na		
		With Options	\$6,295,278	\$8,813,389	\$1,261,697	\$1,766,376	\$10,579,765	\$302,568	\$39,924	0.13
Innes Park and Coral Cove Do nothing	0.8m SLR	Current Condition	\$431,953	\$604,734	\$0	\$0	\$604,734	na		
		With Options	\$431,953	\$604,734	\$0	\$0	\$604,734	\$0	\$0	1.00
Coonarr Do nothing	0.2m SLR	Current Condition	\$191,003	\$267,404	\$0	\$0	\$267,404	na		
		With Options	\$191,003	\$267,404	\$0	\$0	\$267,404	\$0	\$0	1.00
Moore Park Beach Do nothing	0.4m SLR	Current Condition	\$19,353,351	\$27,094,692	\$0	\$0	\$27,094,692	na		
		With Options	\$19,353,351	\$27,094,692	\$0	\$0	\$27,094,692	\$0	\$0	1.00
Burnett Heads Do nothing	0.8m SLR	Current Condition	\$31,339,766	\$43,875,672	\$2,003,481	\$2,804,873	\$46,680,545	na		
		With Options	\$31,339,766	\$43,875,672	\$2,003,481	\$2,804,873	\$46,680,545	\$0	\$0	1.00
Bargara Do nothing	0.8m SLR	Current Condition	\$23,623,065	\$33,072,291	\$2,003,481	\$2,804,873	\$35,877,164	na		
		With Options	\$23,623,065	\$33,072,291	\$2,003,481	\$2,804,873	\$35,877,164	\$0	\$0	1.00
Woodgate Beach Do nothing	0.4m SLR	Current Condition	\$11,930,336	\$16,702,470	\$2,003,481	\$2,804,873	\$19,507,343	na		
		With Options	\$11,930,336	\$16,702,470	\$2,003,481	\$2,804,873	\$19,507,343	\$0	\$0	1.00

Table A-4 Adaptation Options Benefits Calculations (NPV) – Best Case Scenario (costs reduced by 10%, benefits increased by 10%)

Description	Trigger		Resid Damages (inc indirect) - NPV	Total Resid Damage (inc 15% infrastr and 25% intangibles) - NPV	Non Resid Damage (inc indirect) - NPV	Total Non Resid Damage (inc 15% infrastr and 25% intangibles) - NPV	Cars AAD	Total Damage (inc 15% infrastr and 25% intangibles) - NPV	NPV of Total Whole of Life Option Costs	Option Benefit Relative to current condition	Benefit/Cost Relative to current condition
Moore Park Beach Beach Nourishment with Dune (re)construction	0.4m SLR	Current Condition	\$19,353,351	\$27,094,692	\$1,730,267	\$2,422,374		\$29,517,065	na		
		With Options	\$16,620,938	\$23,269,314	\$1,726,964	\$2,417,749		\$25,687,063	\$472,698	\$4,213,002	8.91
Moore Park Beach Seawall / Rockwall / Buried Seawall	0.4m SLR	Current Condition	\$19,353,351	\$27,094,692	\$1,730,267	\$2,422,374		\$29,517,065	na		
		With Options	\$16,620,938	\$23,269,314	\$1,726,964	\$2,417,749		\$25,687,063	\$913,487	\$4,213,002	4.61
Burnett Heads Storm Surge Barrier and Dyke	0.8m SLR	Current Condition	\$31,339,766	\$43,875,672	\$3,235,120	\$4,529,168		\$48,404,840	na		
		With Options	\$31,315,356	\$43,841,498	\$3,235,120	\$4,529,168		\$48,370,666	\$72,246	\$37,591	0.52
Bargara Beach Nourishment with Dune (re)construction	0.8m SLR	Current Condition	\$23,623,065	\$33,072,291	\$696	\$974		\$33,073,265	na		
		With Options	\$23,462,233	\$32,847,126	\$696	\$974		\$32,848,100	\$5,262	\$247,681	47.07
Bargara, Kellys beach Seawall / Rockwall / Buried Seawall	0.8m SLR	Current Condition	\$23,623,065	\$33,072,291	\$696	\$974		\$33,073,265	na		
		With Options	\$23,462,233	\$32,847,126	\$696	\$974		\$32,848,100	\$29,943	\$247,681	8.27
Innes Park and Coral Cove Beach Nourishment with Dune (re)construction	0.8m SLR	Current Condition	\$987,964	\$1,383,149	\$0	\$0		\$1,383,149			
		With Options	\$923,928	\$1,293,500	\$0	\$0		\$1,293,500	\$10,436	\$98,614	9.45
Innes Park and Coral Cove Seawalls /Rock wall / Buried Seawall	0.8m SLR	Current Condition	\$987,964	\$1,383,149	\$0	\$0		\$1,383,149	na		
		With Options	\$923,928	\$1,293,500	\$0	\$0		\$1,293,500	\$21,501	\$98,614	4.59
Coonarr Beach Nourishment with Dune (re)construction	0.2m SLR	Current Condition	\$495,182	\$693,254	\$0	\$0		\$693,254	na		
		With Options	\$12,653	\$17,715	\$0	\$0		\$17,715	\$159,729	\$743,093	4.65
Coonarr Seawalls /Rock wall / Buried Seawall	0.2m SLR	Current Condition	\$495,182	\$693,254	\$0	\$0		\$693,254	na		
		With Options	\$12,653	\$17,715	\$0	\$0		\$17,715	\$555,332	\$743,093	1.34
Coonarr Retreat/ Land Use and Tenure Transition	0.2m SLR	Current Condition	\$495,182	\$693,254	\$0	\$0		\$693,254	na		
		With Options	\$0	\$0	\$0	\$0		\$0	\$1,397,824	\$762,580	0.55
Woodgate Beach Beach Nourishment with Dune (re)construction	0.4m SLR	Current Condition	\$11,930,336	\$16,702,470	\$2,003,481	\$2,804,873		\$19,507,343	na		
		With Options	\$7,619,763	\$10,667,669	\$2,003,481	\$2,804,873		\$13,472,541	\$965,194	\$6,638,281	6.88
	0.4m SLR	Current Condition	\$11,930,336	\$16,702,470	\$2,003,481	\$2,804,873		\$19,507,343	na		

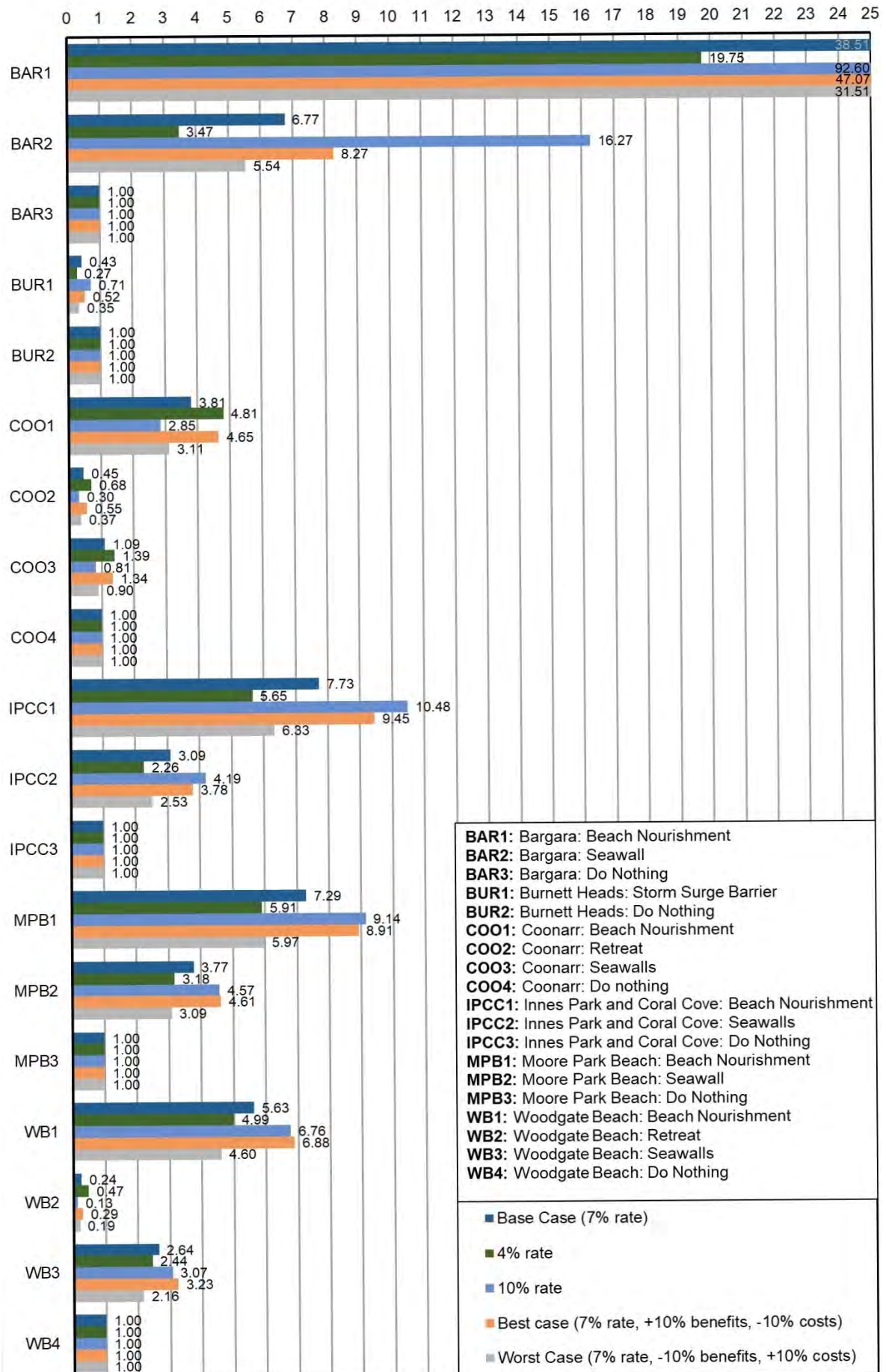
Description	Trigger		Resid Damages (inc indirect) - NPV	Total Resid Damage (inc 15% infrastr and 25% intangibles) - NPV	Non Resid Damage (inc indirect) - NPV	Total Non Resid Damage (inc 15% infrastr and 25% intangibles) - NPV	Cars AAD	Total Damage (inc 15% infrastr and 25% intangibles) - NPV	NPV of Total Whole of Life Option Costs	Option Benefit Relative to current condition	Benefit/Cost Relative to current condition
Woodgate Beach Seawalls /Rock wall / Buried Seawall		With Options	\$7,619,763	\$10,667,669	\$2,003,481	\$2,804,873		\$13,472,541	\$2,054,150	\$6,638,281	3.23
Woodgate Beach Retreat/ Land Use and Tenure Transition	0.4m SLR	Current Condition	\$11,930,336	\$16,702,470	\$2,003,481	\$2,804,873		\$19,507,343	na		
		With Options	\$11,775,020	\$16,485,028	\$2,003,481	\$2,804,873		\$19,289,901	\$823,041	\$239,186	0.29
Innes Park and Coral Cove Do nothing	0.8m SLR	Current Condition	\$987,964	\$1,383,149	\$0	\$0		\$1,383,149	na		
		With Options	\$987,964	\$1,383,149	\$0	\$0		\$1,383,149	\$0	\$0	1.00
Coonarr Do nothing	0.2m SLR	Current Condition	\$495,182	\$693,254	\$0	\$0		\$693,254	na		
		With Options	\$495,182	\$693,254	\$0	\$0		\$693,254	\$0	\$0	1.00
Moore Park Beach Do nothing	0.4m SLR	Current Condition	\$19,353,351	\$27,094,692	\$0	\$0		\$27,094,692	na		
		With Options	\$19,353,351	\$27,094,692	\$0	\$0		\$27,094,692	\$0	\$0	1.00
Burnett Heads Do nothing	0.8m SLR	Current Condition	\$31,339,766	\$43,875,672	\$2,003,481	\$2,804,873		\$46,680,545	na		
		With Options	\$31,339,766	\$43,875,672	\$2,003,481	\$2,804,873		\$46,680,545	\$0	\$0	1.00
Bargara Do nothing	0.8m SLR	Current Condition	\$23,623,065	\$33,072,291	\$2,003,481	\$2,804,873		\$35,877,164	na		
		With Options	\$23,623,065	\$33,072,291	\$2,003,481	\$2,804,873		\$35,877,164	\$0	\$0	1.00
Woodgate Beach Do nothing	0.4m SLR	Current Condition	\$11,930,336	\$16,702,470	\$2,003,481	\$2,804,873		\$19,507,343	na		
		With Options	\$11,930,336	\$16,702,470	\$2,003,481	\$2,804,873		\$19,507,343	\$0	\$0	1.00

Table A-5 Adaptation Options Benefits Calculations (NPV) – Worst Case (costs increased by 10%, benefits reduced by 10%)

Description	Trigger		Resid Damages (inc indirect) - NPV	Total Resid Damage (inc 15% infrastr and 25% intangibles) - NPV	Non Resid Damage (inc indirect) - NPV	Total Non Resid Damage (inc 15% infrastr and 25% intangibles) - NPV	Total Damage (inc 15% infrastr and 25% intangibles) - NPV	NPV of Total Whole of Life Option Costs	Option Benefit Relative to current condition	Benefit/Cost Relative to current condition
Moore Park Beach Beach Nourishment with Dune (re)construction	0.4m SLR	Current Condition	\$19,353,351	\$27,094,692	\$1,730,267	\$2,422,374	\$29,517,065	na		
		With Options	\$16,620,938	\$23,269,314	\$1,726,964	\$2,417,749	\$25,687,063	\$577,742	\$3,447,002	5.97
Moore Park Beach Seawall / Rockwall / Buried Seawall	0.4m SLR	Current Condition	\$19,353,351	\$27,094,692	\$1,730,267	\$2,422,374	\$29,517,065	na		
		With Options	\$16,620,938	\$23,269,314	\$1,726,964	\$2,417,749	\$25,687,063	\$1,116,485	\$3,447,002	3.09
Burnett Heads Storm Surge Barrier and Dyke	0.8m SLR	Current Condition	\$31,339,766	\$43,875,672	\$3,235,120	\$4,529,168	\$48,404,840	na		
		With Options	\$31,315,356	\$43,841,498	\$3,235,120	\$4,529,168	\$48,370,666	\$88,300	\$30,757	0.35
Bargara Beach Nourishment with Dune (re)construction	0.8m SLR	Current Condition	\$23,623,065	\$33,072,291	\$696	\$974	\$33,073,265	na		
		With Options	\$23,462,233	\$32,847,126	\$696	\$974	\$32,848,100	\$6,431	\$202,648	31.51
Bargara, Kellys beach Seawall / Rockwall / Buried Seawall	0.8m SLR	Current Condition	\$23,623,065	\$33,072,291	\$696	\$974	\$33,073,265	na		
		With Options	\$23,462,233	\$32,847,126	\$696	\$974	\$32,848,100	\$36,598	\$202,648	5.54
Innes Park and Coral Cove Beach Nourishment with Dune (re)construction	0.8m SLR	Current Condition	\$987,964	\$1,383,149	\$0	\$0	\$1,383,149			
		With Options	\$923,928	\$1,293,500	\$0	\$0	\$1,293,500	\$12,755	\$80,684	6.33
Innes Park and Coral Cove Seawalls /Rock wall / Buried Seawall	0.8m SLR	Current Condition	\$987,964	\$1,383,149	\$0	\$0	\$1,383,149	na		
		With Options	\$923,928	\$1,293,500	\$0	\$0	\$1,293,500	\$26,279	\$80,684	3.07
Coonarr Beach Nourishment with Dune (re)construction	0.2m SLR	Current Condition	\$495,182	\$693,254	\$0	\$0	\$693,254	na		
		With Options	\$12,653	\$17,715	\$0	\$0	\$17,715	\$195,225	\$607,986	3.11
Coonarr Seawalls /Rock wall / Buried Seawall	0.2m SLR	Current Condition	\$495,182	\$693,254	\$0	\$0	\$693,254	na		
		With Options	\$12,653	\$17,715	\$0	\$0	\$17,715	\$678,739	\$607,986	0.90
Coonarr Retreat/ Land Use and Tenure Transition	0.2m SLR	Current Condition	\$495,182	\$693,254	\$0	\$0	\$693,254	na		
		With Options	\$0	\$0	\$0	\$0	\$0	\$1,708,451	\$623,929	0.37
Woodgate Beach Beach Nourishment with Dune (re)construction	0.4m SLR	Current Condition	\$11,930,336	\$16,702,470	\$2,003,481	\$2,804,873	\$19,507,343	na		
		With Options	\$7,619,763	\$10,667,669	\$2,003,481	\$2,804,873	\$13,472,541	\$1,179,681	\$5,431,321	4.60

Description	Trigger		Resid Damages (inc indirect) - NPV	Total Resid Damage (inc 15% infrastr and 25% intangibles) - NPV	Non Resid Damage (inc indirect) - NPV	Total Non Resid Damage (inc 15% infrastr and 25% intangibles) - NPV	Total Damage (inc 15% infrastr and 25% intangibles) - NPV	NPV of Total Whole of Life Option Costs	Option Benefit Relative to current condition	Benefit/Cost Relative to current condition
Woodgate Beach Seawalls /Rock wall / Buried Seawall	0.4m SLR	Current Condition	\$11,930,336	\$16,702,470	\$2,003,481	\$2,804,873	\$19,507,343	na		
		With Options	\$7,619,763	\$10,667,669	\$2,003,481	\$2,804,873	\$13,472,541	\$2,510,627	\$5,431,321	2.16
Woodgate Beach Retreat/ Land Use and Tenure Transition	0.4m SLR	Current Condition	\$11,930,336	\$16,702,470	\$2,003,481	\$2,804,873	\$19,507,343	na		
		With Options	\$11,775,020	\$16,485,028	\$2,003,481	\$2,804,873	\$19,289,901	\$1,005,939	\$195,697	0.19
Innes Park and Coral Cove Do nothing	0.8m SLR	Current Condition	\$987,964	\$1,383,149	\$0	\$0	\$1,383,149	na		
		With Options	\$987,964	\$1,383,149	\$0	\$0	\$1,383,149	\$0	\$0	1.00
Coonarr Do nothing	0.2m SLR	Current Condition	\$495,182	\$693,254	\$0	\$0	\$693,254	na		
		With Options	\$495,182	\$693,254	\$0	\$0	\$693,254	\$0	\$0	1.00
Moore Park Beach Do nothing	0.4m SLR	Current Condition	\$19,353,351	\$27,094,692	\$0	\$0	\$27,094,692	na		
		With Options	\$19,353,351	\$27,094,692	\$0	\$0	\$27,094,692	\$0	\$0	1.00
Burnett Heads Do nothing	0.8m SLR	Current Condition	\$31,339,766	\$43,875,672	\$2,003,481	\$2,804,873	\$46,680,545	na		
		With Options	\$31,339,766	\$43,875,672	\$2,003,481	\$2,804,873	\$46,680,545	\$0	\$0	1.00
Bargara Do nothing	0.8m SLR	Current Condition	\$23,623,065	\$33,072,291	\$2,003,481	\$2,804,873	\$35,877,164	na		
		With Options	\$23,623,065	\$33,072,291	\$2,003,481	\$2,804,873	\$35,877,164	\$0	\$0	1.00
Woodgate Beach Do nothing	0.4m SLR	Current Condition	\$11,930,336	\$16,702,470	\$2,003,481	\$2,804,873	\$19,507,343	na		
		With Options	\$11,930,336	\$16,702,470	\$2,003,481	\$2,804,873	\$19,507,343	\$0	\$0	1.00

BENEFIT TO COST ANALYSIS AND SENSITIVITY TESTING





APPENDIX B COST ESTIMATE DETAILS



Document Status

Version	Doc type	Reviewed by	Approved by	Date issued
01	Appendix B	AXS	RWS	07/05/2020
02	Appendix B	IXZ	RWS	09/06/2020
03	Appendix B	IXZ	RWS	17/09/2020

Project Details

Project Name	Bundaberg Region Coastal Hazard Adaptation Strategy
Client	Bundaberg Regional Council
Client Project Manager	Dwayne Honor
Water Technology Project Manager	Richard Sharp
Water Technology Project Director	Steve Clark
Authors	Richard Sharp / Chris Curd (HIG)
Document Number	Phase 7 Technical Appendix B



APPENDIX B – COST ESTIMATE DETAILS

Introduction

The cost estimates provided in this Appendix Report are based upon the assumptions provided by the Harrison Infrastructure Group (HIG) as part of Phase 5. HIG were requested to undertake preliminary costing of the Coastal Engineering options and affected Infrastructure works associated with the Bundaberg Coastal Hazard Adaptation Strategy civil engineering options. The preliminary costs are to be developed for 50 year whole of life costs and provide an indicative level of capital and revenue expenditure for each Coastal Engineering option.

High Level Cost Estimates

The figures presented in the cost estimates tables in this report were based on a desktop review only and no detailed assessment has been undertaken of the infrastructure costs. The accuracy presented is limited to its intended use, i.e. for a high-level assessment of the relative cost and benefit of each structural adaptation option. The intention of the Coastal Hazard Adaptation Strategy is to present a relative assessment of the options that is high level to inform scenario and adaptation pathways planning. The figures in this report should be viewed as estimates only and not absolute figures.

Beach Nourishment

Beach nourishment is the artificial addition of sand to a beach system, increasing the buffer against erosion or halting erosional losses. Beach nourishment reduces the risk of storm tide inundation when combined with dune creation and vegetative stabilisation. A long-term beach nourishment strategy requires continuous monitoring of shoreline changes to identify timing of renourishment campaigns. Monitoring campaigns are typically carried out annually or in response to significant erosion events. Monitoring campaigns can be conducted with remote cameras or traditional survey techniques. Operational plans to mobilise sand in the short term from strategic sand deposits should be put in place to reduce risks for settlements and infrastructure during emergencies.

Locations:

- Moore Park – Proposed treatment extends along the ocean fronting area of intolerable risk for 2.2km. The treatment should extend offshore for 34m minimum. It is noted that the area becomes less populated north of Palm View Drive and a reduced length of 1.2km should be considered. Please note that there is no “holding structure” in place (e.g. groyne or headland etc.), therefore the sand placed there will disperse over time.
- Coonarr – The treatment extents are proposed to protect the existing road and about 6 houses that are ocean fronting. Protection would be required for about 400m. The treatment should extend offshore for 13m minimum. Please note that there is no “holding structure” in place (e.g. groyne or headland etc.), so the sand placed there will disperse over time.
- Woodgate – The Intolerable risk area extends along the whole ocean front. Nourishment extent is initially recommended for the boat ramp to south of Twelfth Avenue (approx. 5km) to protect the Esplanade Road. The treatment should extend offshore for 34m minimum. Please note that there is no “holding structure” in place (e.g. groyne or headland etc.), so the sand placed there will disperse over time.
- Innes Park – Proposed treatment extends along the ocean fronting area of intolerable risk for approximately 1km. The treatment should extend offshore for 34m minimum. Please note that in this case there is a natural rocky outcrop to the north of the site which acts as a holding structure.

- Kellys Beach - The treatment extents are proposed to protect the private properties that front Kellys Beach either side of the lagoon entrance. Protection would be required for about 1.4km. The treatment should extend offshore for 14m minimum. Please note that there is no “holding structure” in place (e.g. groyne or headland etc.), so the sand placed there will disperse over time.

TABLE B1 BEACH NOURISHMENT COST ESTIMATES

Settlement	Length/ Dimensions	Implementat ion Cost ¹ (inc. 40% contingency)	Initial Cost m ² / m	Annual Maintenanc e ²	Discounted from year	NPV
Moore Park	length: 2.2km extent offshore: 34m area: 74,800m ²	\$ 4,574,080	\$ 2,079	\$ 246,840	40	\$525,220
Coonarr	length: 400m extent offshore: 13m area: 5200m ²	\$449,960	\$ 1,125	\$ 17, 160	20	\$177,477.21
Woodgate Beach	length: 5km extent offshore: 34m area: 155000m ²	\$ 9,240,000	\$ 1, 848	\$ 511,500	40	\$1,072,437.4 3
Bargara	length: 1.4km extent offshore: 14m are: 19,600m ²	\$ 1,310,960	\$ 936	\$64, 680	80	\$5,846
Innes Park	Length: 1km extent offshore: 34m are: 34,000m ²	\$2,600,000	\$2,600	\$134,000	80	\$11,595

¹ Implementation costs include sand sourcing study, initial survey, design and approval costs

² Annual maintenance to undertake a sand re-nourishment campaign is 5% each year along the at-risk foreshore (inc. 10% contingency)

Seawalls

Seawalls do not typically require continuous maintenance; however, extreme storms can damage the structures and intervention can be required. A maintenance cost due to extreme storm damage has been included in the estimated whole of life cost. The maintenance cost assumed a 30% replacement of the seawall due to extreme storm event every 10 years over a 50-year lifetime.

TABLE B-2 SEAWALL COST ESTIMATES

Option	Seawall Length	Initial Cost ³	Cost per m	Maintenance Cost ⁴	Discounted from year	Whole of Life Cost NPV (7%)
Moore Park Beach Seawall	2.2km	\$ 11,786,866	\$5,357 /m	\$3,536,060	40	\$1,014,986
Kellys Beach Bargara	1.4km	\$ 7,460,400	\$5,328/m	\$2,238,120	80	\$33,271
Innes Park	1km	\$ 5,357,000	\$5,357/m	\$1,607,100	80	\$23,890
Coonarr	340m	\$ 1,837,200	\$5,403/m	\$551,160	20	\$617,036
Woodgate Beach	5km	\$ 26,505,000	\$5,301/m	\$7,951,500	40	\$2,282,388

³ Initial costs include initial survey, design and approval costs

⁴ Includes a maintenance cost that is assumed at 30% replacement cost of the seawall due to extreme storm event every 10 years over 50-year lifetime

Sea Dykes and Storm Surge Barrier

Sea dykes or levees are an artificially constructed fill or wall commonly designed to regulate water levels to avoid inundation from storm tides. It is usually earthen, covered with vegetation and parallel to the shore of low-lying coastlines. Sea dykes can be used to control extreme water levels associated with storm tides and in conjunction with sea level rise. Storm surge barriers are hard engineered structures designed to prevent coastal flooding and maintain navigation at other times. They are normally part of a combined system of barriers (dykes, dunes, etc.) preventing storm tide water inundation within estuaries, lagoons, or waterways.

TABLE B-3 STORM SURGE OR DYKE COST ESTIMATE

Settlement	Dimension	Rate ⁵	Initial Cost ⁶	Total preliminary cost	Discount ed from year	Whole of Life Cost NPV (7%)
Burnett Heads	3.1km Earth Dyke	\$3,000 m3/m	\$9,300,000	\$ 18,000,000	80	\$80,273
	80m Storm Surge Barrier		\$8,700,000			

⁵ Assuming 30m3/m fill

⁶ Initial costs include initial survey, design and approval costs

Land Use and Tenure Transition

The property and land valuation assumptions are based on the Molino Stewart Phase 5 report (2019).

Council's building dataset allowed differentiation between the following three residential building types:

- Single storey houses;
- Double storey houses; and,
- Units.

The value of the building structure for each of the above-mentioned building types was obtained from average 2018 construction costs per square metre for Australian buildings estimated for tax depreciation purposes (<https://www.bmtqs.com.au/construction-cost-table>). The average area of each building type was obtained from Council's building dataset. Finally, the overall building replacement costs were obtained by augmenting construction costs by a factor of 1.2, to account for demolition and clean up (Geoscience Australia, 2012).

TABLE B-4 RESIDENTIAL DWELLING COST ASSUMPTIONS

Dwelling	Construction Cost (per m2)	Average Area (m2)	Total Cost	Total Replacement (inc Demolition)
Single Storey	\$1,849	207	\$382,778	\$459,333
Double Storey	\$2,049	427	\$875,137	\$1,050,164
Unit	\$2,277	80	\$182,200	\$218,640

TABLE B-5 LAND USE AND TENURE TRANSITION VALUATION ASSUMPTIONS

Settlement	Lots	Property Value	Land Value	Total Cost	NPV
Coonarr	5	\$1,050,164; (DS)	\$50/m2	\$6,010,152	\$1,553,137
	1	\$459,333 (SS)			
Woodgate	10	\$1,050,164 (DS)	\$350/m2	\$13,693,985	\$914,490
	4	\$459,333 (SS)			

Priority Settlements – Total Whole of Life Costs

The following table represents the net present value of the total whole of life costs for the shortlisted options. It is important to note that options that are assumed to be in place after year 80 do not include maintenance in the net present value.

TABLE B-6 SHORTLISTED OPTIONS - TOTAL WHOLE OF LIFE COSTS (NPV)

Location	Description	Capital Cost (Present Value)	Maintenance Cost Unit cost	recurrence (years)	TOTAL WOLC COST (Net present value)	Sea Level Scenario	Comment
Moore Park Beach	Beach Nourishment with Dune (re)construction	\$305,459	\$246,840	1	\$525,219.62	0.4m SLR	
Moore Park Beach	Seawall / Rockwall / Buried Seawall	\$787,131	\$3,536,060	10	\$1,014,986	0.4m SLR	
Burnett Heads	80m Storm Surge Barrier and 3.1km Earth Dyke	\$80,273	\$90,000	5	\$80,273	0.8m SLR	Maintenance is not considered as it occurs after year 80
Bargara	Beach Nourishment with Dune (re)construction	\$5,846	\$64,680	1	\$5,846	0.8m SLR	Maintenance is not considered as it occurs after year 80
Bargara, Kellys beach	Seawalls /Rock wall / Buried Seawall	\$33,271	\$2,238,120	10	\$33,271	0.8m SLR	Maintenance is not considered as it occurs after year 80
Innes and Coral Cove	Beach Nourishment with Dune (re)construction	\$11,595	\$134,000	1	\$11,595	0.8m SLR	Maintenance is not considered as it occurs after year 80

Location	Description	Capital Cost (Present Value)	Maintenance Cost Unit cost	recurrence (years)	TOTAL WOLC COST (Net present value)	Sea Level Scenario	Comment
Innes Park and Coral Cove	Seawalls /Rockwall / Buried Seawall	\$23,890	\$1,607,100	10	\$23,890	0.8m SLR	Maintenance is not considered as it occurs after year 80
Coonarr	Beach Nourishment with Dune (re)construction	\$116,278	\$17,160	1	\$177,477.21	0.2m SLR	
Coonarr	Seawall / Rockwall / Buried Seawall	\$474,767	\$551,160	10	\$617,036	0.2mSLR	
Coonarr	Land Use and Tenure Transition Coonarr Beach properties	\$1,553,137	0	0	\$1,553,137	0.2m SLR	
Woodgate Beach	Beach Nourishment with Dune (re)construction	\$617,051	\$511,500	1	\$1,072,437.43	0.4m SLR	
Woodgate Beach	Seawall / Rockwall / Buried Seawall	\$1,770,014	\$7,951,500	10	\$2,282,388	0.4m SLR	
Woodgate Beach	Land Use and Tenure Transition	\$914,490	0	0	\$914,490	0.4m SLR	

Raising Access Points

Raising key access routes to reduce the likelihood of isolation to communities. Several options have been investigated to lessen the isolation impact on affected communities, these include:

1. Raise the road above the level where the community becomes isolated
2. Construction of a causeway crossing which may experience inundation
3. Maintaining the existing road and undertaking reconstruction/repairs when required.

TABLE B-7 RAISING OF ACCESS POINTS COST ESTIMATES

Town	Distance	Raise Road ⁷	Causeway ⁸
Moore Park Road, Moore Park Beach	800m including a bridge	\$ 7,200,000	\$ 2,062,500
Murdoch Linking Road, Moore Park Beach	350m plus minor drainage work	\$ 1,905,000	\$ 1,470,000
Malvern Drive, Moore Park Beach	70m including a bridge	\$ 3,150,000	\$ 294,000
Coonarr Beach Road, Coonarr	300m	\$1,629,000	\$ 1,260,000
Walkers Point Road, Woodgate	170m plus minor drainage	\$1, 005,000	\$ 715,000
Theodolite Creek Road, Woodgate	300m plus minor drainage	\$ 1,462,500	\$ 1,260,000
Paperbark Court to First Avenue, Woodgate	49m plus minor drainage	\$ 3,937,500	\$ 1,010,000
Acacia Street, Woodgate	300m plus minor drainage	\$ 2,400,000	\$ 1,260,000

⁷ Initial cost plus 5% maintenance cost per 10 years

⁸ Minimal road level increase, inclusion of concrete protected causeway, excludes new bridge construction unless stated

Resilient Infrastructure

The Bundaberg Coastal Hazard Adaptation Strategy has identified numerous infrastructure assets i.e. water supply infrastructure, electricity networks etc. within the coastal hazard extent. The below table summarises the assets that are affected at each location: Cost estimates for existing infrastructure are based on full reconstruction of the asset. These costs may be reduced by minimising the impact of the coastal hazard extent by relocating the assets when the existing asset requires replacement.

TABLE B-8 EXISTING ASSET MANAGEMENT COSTS

Town	Length	Cost
Moore Park Beach		
Water Supply (major >150mm)	1.6km	\$260,000
Electricity Network	8.4km	\$1,800,000
Stormwater Drainage Network (major)	4.4km	\$3,960,000
Woodgate Beach		
Electricity Network	2.7km	\$324,000
Stormwater Drainage Network (major)	1.2km	
Innes Park		
Water Supply (major >150mm)	1.6km	\$260,000
Bargara		
Water Supply (major >150mm)	2.1km	\$336,000



APPENDIX C

MULTI CRITERIA ANALYSIS: RAW SCORES



Document Status

Version	Doc type	Reviewed by	Approved by	Date issued
01	Appendix C	AXS	RWS	07/05/2020
02	Appendix C	IXZ	RWS	09/06/2020
03	Appendix C	IXZ	RSW	17/09/2020

Project Details

Project Name	Bundaberg Region Coastal Hazard Adaptation Strategy
Client	Bundaberg Regional Council
Client Project Manager	Dwayne Honor
Water Technology Project Manager	Richard Sharp
Water Technology Project Director	Steve Clark
Authors	Richard Sharp / Filippo Dal'Osso (Molino Stewart)
Document Number	Phase 7 Technical Appendix C



BUNDABERG CHAS PHASE 7 - MCA and CBA Raw Results (Molino Stewart, HIG, FRC Environmental)

OVERVIEW

This has all the main results, namely:

- the MCA results, including the score (0-100, where 100 is favourable) applied to each option under each criterion. These are based on calculations shown in sheets numbered 1 to 7 (one for each criterion).
- the aggregated total MCA score (weighted) per option
- the aggregated total MCA score (weighted) per option, rescaled on a 0-100 range for simplicity
- the ranking of all options based on the MCA (this does NOT depend on the BCA results, which are provided separately as per the minimum standards), where 1 is the best performing option
- the final benefit to cost ratio (BCR) of each option in the base case (7% interest rate)
- the final BCR for each option under the sensitivity analysis conditions, namely:
 - interest rate at 4%
 - interest rate at 10%
 - best case scenario: +10% increase in benefits and -10% increase in costs (7% interest rate), and
 - worst case scenario: +10% increase in costs and -10% increase in benefits (7% interest rate)

Non Normalised scores: this sheet is a calculation sheet and has the raw MCA scores given to each option. These scores are not comparable because they use different units or scales (i.e. in some cases a higher figure indicates a good performance, in others it indicates a bad performance). These were then normalised in terms of scale and range with a min-max normalisation in the sheet labelled SUMMARY.

Usually, in economic evaluation a benchmark option is included so that the evaluated scores and value for money of other options are directly comparable to current service provision. In this case two 'do nothing' options were considered. Even these options have consequences on the environment, beaches and amenity which are scored accordingly in sheets 1 to 7.

Sheets 1 to 7 have the scoring of options under each individual criterion. There is a red text box in each sheet explaining the assumptions that were made. In some cases these are largely subjective and Council may want to modify the scores. If this is done, the sheet will update automatically and any changes will reflect in the SUMMARY sheet and final MCA ranking. Council may also want to modify the final normalised 0-100 score given to a particular option in the SUMMARY sheet. This is also possible, and it will also automatically update the final option ranking (however this will break the link with the upstream calculations).

The last four sheets present the calculations underlying the BCA (one sheet for each interest rate or sensitivity testing scenario).

MCA AND CBA RESULTS SUMMARY TABLE

ADAPTATION OPTIONS	TRIGGER	CRITERIA							MCA RESULTS			BENEFIT TO COST ANALYSIS AND SENSITIVITY TESTING				
		1. COST of putting the measure in place (NPV including maintenance over 50 years)	2. IMPACT on beach accessibility and amenity	3. IMPACT on environment/culture	4. ADAPTABILITY to unexpected climate trends	5. EFFECTIVENESS in reducing erosion and storm risks to property and people	6. APPROVAL - Difficulty in obtaining required permits	7. TECHNICAL viability	Final Score (higher is better)	Final Score (rescaled zero to 100) (higher is better)	MCA RANK (1 is preferable)	Benefit to Cost Ratio BASE CASE (7% rate)	Benefit to Cost Ratio (4% rate)	Benefit to Cost Ratio (10% rate)	Benefit to Cost Ratio BEST CASE (7% rate, +10% benefits, -10% costs)	Benefit to Cost Ratio WORST CASE (7% rate, -10% benefits, +10% costs)
	CRITERIA WEIGHTING	4	15	13	22	32	5	9								
Moore Park Beach Beach Nourishment with Dune (re)construction	0.4m SLR	77	100	92	78	67	30	82	77.3	100	1	7.29	5.91	9.14	8.91	5.97
Woodgate Beach Beach nourishment with Dune (re)construction	0.4m SLR	53	100	55	50	100	0	73	73.8	91	2	5.63	4.99	6.76	6.88	4.60
Moore Park Beach Seawall / Rockwall / Buried Seawall	0.4m SLR	65	69	92	56	67	30	82	67.4	75	3	3.77	3.18	4.57	4.61	3.09
Coonarr Beach nourishment with Dune (re)construction	0.2m SLR	92	100	100	96	11	15	73	63.8	66	4	3.81	4.81	2.85	4.65	3.11
Burnett Heads Storm Surge Barrier and Dyke	0.8m SLR	96	100	0	38	100	30	0	60.6	58	5	0.43	0.27	0.71	0.52	0.35
Coonarr Retreat/ Land Use and Tenure Transition	0.2m SLR	32	60	99	97	12	100	73	59.6	55	6	0.45	0.68	0.30	0.55	0.37
Burnett Heads Do nothing	0.8m SLR	100	100	29	100	0	100	100	58.8	53	7	1.00	1.00	1.00	1.00	1.00
Innes Park and Coral Cove Beach nourishment with Dune (re)construction	0.8m SLR	99	100	88	90	1	15	82	58.8	53	8	7.73	5.65	10.48	9.45	6.33
Bargara Beach Nourishment with Dune (re)construction	0.8m SLR	100	100	82	86	4	25	82	58.4	52	9	38.51	19.75	92.60	47.07	31.51
Moore Park Beach Do nothing	0.4m SLR	100.0	69.3	50.2	100.0	0.0	100.0	100.0	56.9	48	10	1.00	1.00	1.00	1.00	1.00
Coonarr Seawalls /Rock wall / Buried Seawall	0.2mSLR	78	60	97	93	11	15	73	56.3	47	11	1.09	1.39	0.81	1.34	0.90
Woodgate Beach Do nothing	0.8m SLR	100	23	88	100	0	100	100	54.9	43	12	1.00	1.00	1.00	1.00	1.00
Coonarr Do nothing	0.2m SLR	100	0	99	100	0	100	100	52.8	38	13	1.00	1.00	1.00	1.00	1.00
Innes Park and Coral Cove Do nothing	0.8m SLR	100	0	83	100	0	100	100	50.8	33	14	1.00	1.00	1.00	1.00	1.00
Bargara Do nothing	0.8m SLR	100	0	76	100	0	100	100	49.8	31	15	1.00	1.00	1.00	1.00	1.00
Woodgate Beach Retreat/ Land Use and Tenure Transition	0.4m SLR	59.9	100.0	31.5	50.0	6.4	100.0	72.7	46.1	21	16	0.24	0.47	0.13	0.29	0.19
Woodgate Beach Seawalls /Rock wall / Buried Seawall	0.4m SLR	0	23	8	0	100	0	73	43.1	13	17	2.64	2.44	3.07	3.23	2.16
Innes Park and Coral Cove Seawalls /Rock wall / Buried Seawall	0.8m SLR	99	0	78	80	1	15	82	40.3	7	18	3.75	2.74	5.09	4.59	3.07
Bargara, Kellys beach Seawall / Rockwall / Buried Seawall	0.8m SLR	99	0	62	72	4	25	82	37.7	0	19	6.77	3.47	16.27	8.27	5.54
MIN		0.00	0.00	0.00	0.00	0.00	0.00	0.00	37.7	0.00	1.00					
MAX		100.00	100.00	100.00	100.00	100.00	100.00	100.00	77.3	100.00						

MCA EVALUATION RESULTS 'NON-NORMALISED SCORES' TABLE

	WHEN	1. COST of putting the measure in place (NPV including maintenance over 50 years)	2. IMPACT on beach accessibility and amenity	3. IMPACT on environment/culture	4. ADAPTABILITY to unexpected climate trends	5. EFFECTIVENESS in reducing erosion and storm risks to property and people (INVERTED DIRECTION)	6. APPROVAL - Difficulty in obtaining required permits	7. TECHNICAL viability
Moore Park Beach Beach Nourishment with Dune (re)construction	0.4m SLR	\$525,220	0.00	0.17	0.05	0.34	14.00	2.00
Moore Park Beach Seawall / Rockwall / Buried Seawall	0.4m SLR	\$802,348	0.31	0.17	0.11	0.34	14.00	2.00
Burnett Heads Storm Surge Barrier and Dyke	0.8m SLR	\$80,273	0.00	1.66	0.15	0.50	14.00	11.00
Bargara Beach Nourishment with Dune (re)construction	0.8m SLR	\$5,846	0.00	0.32	0.03	0.02	15.00	2.00
Bargara, Kellys beach Seawall / Rockwall / Buried Seawall	0.8m SLR	\$33,271	1.00	0.64	0.07	0.02	15.00	2.00
Innes Park and Coral Cove Beach nourishment with Dune (re)construction	0.8m SLR	\$11,595	0.00	0.23	0.02	0.01	17.00	2.00
Innes Park and Coral Cove Seawalls /Rock wall / Buried Seawall	0.8m SLR	\$23,890	1.00	0.38	0.05	0.01	17.00	2.00
Coonarr Beach nourishment with Dune (re)construction	0.2m SLR	\$177,477	0.00	0.03	0.01	0.06	17.00	3.00
Coonarr Seawalls /Rock wall / Buried Seawall	0.2mSLR	\$511,532	0.40	0.08	0.02	0.06	17.00	3.00
Coonarr Retreat/ Land Use and Tenure Transition	0.2m SLR	\$1,553,137	0.34	0.05	0.01	0.06	0.00	3.00
Woodgate Beach Beach nourishment with Dune (re)construction	0.4m SLR	\$1,072,437	0.00	0.76	0.12	0.50	20.00	3.00
Woodgate Beach Seawalls /Rock wall / Buried Seawall	0.4m SLR	\$2,282,388	0.77	1.53	0.24	0.50	20.00	3.00
Woodgate Beach Retreat/ Land Use and Tenure Transition	0.4m SLR	\$914,490	0.00	1.15	0.12	0.03	0.00	3.00
Innes Park and Coral Cove Do nothing	0.8m SLR	\$0	1.00	0.31	0.00	0.00	0.00	0.00
Coonarr Do nothing	0.2m SLR	\$0	1.00	0.05	0.00	0.00	0.00	0.00
Moore Park Beach Do nothing	0.4m SLR	\$0	0.31	0.84	0.00	0.00	0.00	0.00
Burnett Heads Do nothing	0.8m SLR	\$0	0.00	1.18	0.00	0.00	0.00	0.00
Bargara Do nothing	0.8m SLR	\$0	1.00	0.43	0.00	0.00	0.00	0.00
Woodgate Beach Do nothing	0.4m SLR	\$0	0.77	0.23	0.00	0.00	0.00	0.00

EVALUATION CRITERIA RAW SCORES - COST

	Sea level rise scenario. Option assumed to be implemented.	COST of putting the measure in place (NPV including maintenance over 50 years):
Moore Park Beach Beach Nourishment withDune (re)construction	0.4m SLR	\$ 525,219.62
Moore Park Beach Seawall / Rockwall / Buried Seawall	0.4m SLR	\$ 1,014,986.06
Burnett HeadsStorm Surge Barrier and Dyke	0.8m SLR	\$ 80,273.15
BargaraBeach Nourishment withDune (re)construction	0.8m SLR	\$ 5,846.38
Bargara, Kellys BeachSeawall / Rockwall / Buried Seawall	0.8m SLR	\$ 33,270.54
Innes Park and Coral CoveBeach nourishment withDune (re)construction	0.8m SLR	\$ 11,595.01
Innes Park and Coral CoveSeawalls /Rock wall / Buried Seawall	0.8m SLR	\$ 23,890.18
CoonarrBeach nourishment withDune (re)construction	0.2m SLR	\$ 177,477.21
CoonarrSeawalls /Rock wall / Buried Seawall	0.2mSLR	\$ 617,035.75
CoonarrRetreat/ Land Use and Tenure Transition	0.2m SLR	\$ 1,553,137.49
Woodgate Beach Beach nourishment withDune (re)construction	0.4m SLR	\$ 1,072,437.43
Woodgate BeachSeawalls /Rock wall / Buried Seawall	0.4m SLR	\$ 2,282,388.34
Woodgate BeachRetreat/ Land Use and Tenure Transition	0.4m SLR	\$ 914,489.55
Innes Park and Coral CoveDo nothing	0.8m SLR	\$ -
CoonarrDo nothing	0.2m SLR	\$ -
Moore Park BeachDo nothing	0.4m SLR	\$ -
Burnett HeadsDo nothing	0.8m SLR	\$ -
BargaraDo nothing	0.8m SLR	\$ -
Woodgate BeachDo nothing	0.4m SLR	\$ -

EVALUATION CRITERIA RAW SCORES - IMPACT ON ACCESS AND AMENITY

Assumptions:

- Beach nourishment has no impact on access or amenity.
- Impact of seawalls on beach access and amenity depends on what proportion of the beach is affected, not by the length of the seawall
- Impact on access and amenity is 50% worse if the beach affected is backed by a developed area, compared to a portion of the beach backed by a natural area. This is because access to the beach occurs predominantly from developed areas, and the beach amenity is also more often enjoyed at these locations. This is expressed as urbanised beach given a weight of 3/5 (60%) and total beach length including natural beach is given a weight of 2/5 (40%). This is because the part of the beach that is urbanised is where access to the beach is more prevalent and where beach access and amenity is most valued by the community. The option length is divided by both the total beach length and urbanised beach length and expressed as an index between 0 and 1.

Specifically:

- The barrier at Burnett Heads is not on the beach so it has no impacts on the access or amenity.
- Land Use and Tenure Transition at Woodgate Beach is not on the beach so this also has no impacts on the access or amenity.
- Generally, Land Use and Tenure Transition or do nothing options imply migration of the beach backwards with significant loss of beach amenity (beach would erode in most instances). These cases were given the same impact coefficient of their equivalent seawall case. There is an exception in Coonarr, because if all residential land use is transitioned then there is no more an urbanised part of the beach so the value of beach accessibility is lower.

	OPTION LENGTH (Km)	Total beach length (km)	Urbanised Beach length (km)	Access and Amenity Index (higher score implies higher impact on access and amenity)
Moore Park Beach Beach Nourishment with Dune (re)construction	2.20	14.00	5.40	0.00
Moore Park Beach Seawall / Rockwall / Buried Seawall	2.20	14.00	5.40	0.31
Burnett Heads Storm Surge Barrier and Dyke	3.10	not on beach	not on beach	0.00
Bargara Beach Nourishment with Dune (re)construction	1.40	1.40	1.40	0.00
Bargara, Kellys Beach Seawall / Rockwall / Buried Seawall	1.40	1.40	1.40	1.00
Innes Park and Coral Cove Beach nourishment with Dune (re)construction	1.00	1.00	1.00	0.00
Innes Park and Coral Cove Seawalls /Rock wall / Buried Seawall	1.00	1.00	1.00	1.00
Coonarr Beach nourishment with Dune (re)construction	0.40	0.40	3.70	0.00
Coonarr Seawalls /Rock wall / Buried Seawall	0.34	0.40	3.70	0.40
Coonarr Retreat/ Land Use and Tenure Transition	0.34	0.40	0.00	0.34
Woodgate Beach Beach nourishment with Dune (re)construction	5.00	12.00	5.00	0.00
Woodgate Beach Seawalls /Rock wall / Buried Seawall	5.00	12.00	5.00	0.77
Woodgate Beach Retreat/ Land Use and Tenure Transition	N/A	not on beach	not on beach	0.00
Innes Park and Coral Cove Do nothing	0.00	N/A	N/A	1.00
Coonarr Do nothing	0.00	N/A	N/A	1.00
Moore Park Beach Do nothing	0.00	N/A	N/A	0.31
Burnett Heads Do nothing	0.00	N/A	N/A	0.00
Bargara Do nothing	0.00	N/A	N/A	1.00
Woodgate Beach Do nothing	0.00	N/A	N/A	0.77

EVALUATION CRITERIA RAW SCORES - IMPACT ON ENVIRONMENT / CULTURE

Assumptions:

An overall environmental impact index is calculated as follows:

- 1. By assigning a score to each individual impact identified for each option
- 2. Scores to individual impacts were decided based on expert judgement
- 3. By summing the above mentioned scores for each option
- 4. By weighting the resulting summed scores based on the option dimension (length)

ENVIRONMENTAL IMPACT	Contribution to Environmental Impact Score (higher is worse)
Base impact for nourishment	1
Base impact for seawalls	2
Potential impact on tidal flushing, when tidal waterways are within the area affected by the option	1
Severe impact on tidal flushing, when tidal waterways are within the area affected by the option	2
Potential impact on reefs , when this is in front of area affected by option	1
Potential impact on seagrass , when this is in front of area affected by option	1
Moderate impact on turtle nesting	1
Severe impact on turtle nesting	2
Possible loss of protected communities	1
Loss of fish habitat	1
Loss of estuarine ecosystems (mangroves, saltmarsh, saltflats) due to marine inundation	1
Potential loss of endangered ecosystem upstream of creeks and rivers due to migration of estuarine wetland system	1
Loss of coastal dune ecosystem for inundation	1

	INPUT PARAMETERS			OUTPUT		
	Option Length (KM)	Total Natural Beach Length (KM)	Impacts Description	Unweighted Environmental Impact Score	Weight (length of option divided by sum of all lengths)	Weighted Environmental Impact Score (higher score indicates greater impact on environment)
Moore Park Beach Beach Nourishment with Dune (re)construction	2.20	14.00	Minimal (+1) but: - tidal waterways south of nourishment area (care required) +0	1	16.8%	0.17
Moore Park Beach Seawall / Rockwall / Buried Seawall	2.20	14.00	Base impact (+2): Moore Park Beach is a significant beach for turtle nesting, however currently, foredune erosion can reduce success rates. Seawalls at Moore Park Beach are likely to be located as far landward as possible. Where seawalls are placed further landward, the dune would be able to retreat landward, providing the opportunity for turtles to nest (-1). Seawalls would need to be designed to ensure they do not adversely impact tidal flushing of the small creeks to the south, as this may negatively impact water quality and ecological condition.	1	16.8%	0.17
Burnett Heads Storm Surge Barrier and Dyke	3.10	not on beach	Base impact: +2, plus: ☒ Loss of high value wetland complex comprising mangrove shrubland, EPBC listed saltmarsh community, Corymbia tessellaris +/- Eucalyptus tereticornis, C. intermedia and Livistona decora woodland on beach ridges, and endangered Melaleuca quinquenervia / Casuarina glauca forests (+1). Preventing tidal water from inundating this area would lead to the degradation of this eco-system. The sediment in the mangrove and saltmarsh areas would remain saline, preventing colonisation by freshwater wetland plants. Likely to be higher variation in salinity in the creek, loss of tidal fluctuation, prolonged periods of high and low water depending on rainfall. Mangroves and saltmarsh likely to die-off, may be replaced by more 'weedy' species such as Phragmites with lower value as a fisheries habitat. (+2) ☒ Loss of fish habitat (+1) ☒ Prevention of fish passage (+1) Ponding or flooding landward of the dyke following storm events resulting in: ☒ Poor water quality in the existing creek and upstream ponded area ☒ Death of vegetation, and ☒ Associated impacts to fauna dependent on vegetation	7	23.7%	1.66
Bargara Beach Nourishment with Dune (re)construction	1.40	1.40	Minimal impacts (+1) but: The proposed sand rehabilitation at Bargara is likely to adversely impact tidal flushing (+1) of Moneys Creek and Kellys Creek (located south of Durdins Road and in the vicinity of Larder St and Woongarra Scenic Drive). Moneys Creek has a shallow lagoon that is infilling as the result of development of its catchment. There is a causeway across the mouth of the lagoon, that was originally built to provide connection to the north and south, and also to stop mangrove growth (and sandflies) in the lagoon. Tidal gates on the causeway are now regularly opened by Council to allow seawater to enter the lagoon, to enable the lagoon to flush water out, and to enable fish to pass through the causeway (BRC 2016). Never-the-less water quality in the lagoon is frequently poor, particularly after extreme weather events, and there have been a number of fish kills (Bundaberg Now 2019). The Burnett Mary Regional Group is currently investigating catchment issues at Moneys Creek, in an effort to address these issues. The proposed beach nourishment, unless carefully managed is likely to exacerbate these issues. Kellys Creek is a small coastal creek that may intermittently be tidally inundated, or discharge to the sea. Beach nourishment may also adversely impact this creek. Further there are significant areas of reef close to the shore (+1) at the northern section of the area proposed for sand nourishment. Placement of sand on, or dispersion of sand to these areas would significantly negatively impact them.	3	10.7%	0.32
Bargara, Kellys beach Seawall / Rockwall / Buried Seawall	1.40	1.40	Base impact(+2), plus: This is a significant beach for turtle nesting, although lighting reduces success rates. As urban development is close to foredune, the seawall is likely to be placed at the top of HAT, resulting in loss of turtle nesting habitat (+2). Potential impact on tidal flushing at Moneys Creek (+1) and on reef close to the shore (+1)	6	10.7%	0.64
Innes Park and Coral Cove Beach nourishment with Dune (re)construction	1.00	1.00	Minimal (+1) but: - potential impact on tidal flushing of the creek (+1) - potential impact on shallow reefs and seagrass offshore (+1)	3	7.6%	0.23

	INPUT PARAMETERS			OUTPUT		
Innes Park and Coral Cove Seawalls /Rock wall / Buried Seawall	1.00	1.00	Base impact (+2) plus: Most of the proposed seawall at Innes Park is adjacent to a rocky foreshore (brown in your attached photo), turtles would not nest here. However while Innes Park is not noted as an important breeding area, turtles may occasionally nest on the sandy beaches on the extreme northern end of the proposed seawall (+1). As with other seawalls, impacts need to be minimised to important ecological features, such as the rocky reefs along the foreshore of Innes Park, by locating them as far landward as possible. See section 4 for Best Management Practices. The seawall would need to be designed to ensure it did not impact tidal flushing and associated habitats of the Creek in the south (i.e. it could not go across the mouth of the creek as depicted). (+2)	5	7.6%	0.38
Coonarr Beach nourishment with Dune (re)construction	0.40	0.40	Minimal (+1) but: - tidal waterway south of nourishment area (care required) +0 - more modelling required to avoid shallow reefs and seagrass offshore +1	1	3.1%	0.03
Coonarr Seawalls /Rock wall / Buried Seawall	0.34	0.40	Base Impact (+2). While turtles nest on this beach, nests are in lower numbers than at Moore Park Beach and Bargara. Nesting habitat would be lost where seawalls are placed at HAT (+1).	3	2.6%	0.08
Coonarr Retreat/ Land Use and Tenure Transition	0.34	0.40	Intolerable risks to ecology in this area broadly comprise risks to (+1): <ul style="list-style-type: none">• estuarine ecosystems (mangroves, saltmarsh, salt flats etc) that will be increasingly inundated with deeper water along Elliott River• estuarine and wetland ecosystems along Coonarr Creek to the south of the creek mouth• estuarine and dunal systems to the north of the north of Coonarr Creek Further (+1), it is likely that estuarine wetlands will migrate landward, putting at risk ecosystems outside of the currently mapped area of intolerable risk, including endangered ecosystems such as 12.5.2a.	2	2.6%	0.05
Woodgate Beach Beach nourishment with Dune (re)construction	5.00	12.00	Minimal (+1) but: - careful with tidal flushing on Theodolite Creek north of the nourishment area +0 - potential impact on seagrass offshore of nourishment area +1	2	38.2%	0.76
Woodgate Beach Seawalls /Rock wall / Buried Seawall	5.00	12.00	Base impact (+2), plus: While turtles nest on this beach, nests are in lower numbers than at Moore Park Beach and Bargara. Seawalls are likely to be built close to HAT or the upper extent of dune vegetation at this beach, as there is little space between assets and the beach. Where seawalls are placed at HAT, the dune would gradually erode up to the seawall, and turtle nesting habitat would be removed (+1). Potential impact on seagrass offshore of nourishment area +1	4	38.2%	1.53
Woodgate Beach Retreat/ Land Use and Tenure Transition	5.00	12.00	Intolerable risks to ecology in this area broadly comprise risks to: <ul style="list-style-type: none">• estuarine ecosystems (mangroves, saltmarsh, saltflats etc) that will be increasingly inundated with deeper water along the Burrum River (+1)• estuarine ecosystems (mangroves, saltmarsh, saltflats etc) that will be increasingly inundated with deeper water along Theodolite River, and• coastal dune ecosystems in the vicinity of Theodolite River, that will become tidally inundated (+1) Further, the extensive beds of seagrass offshore of this area may be negatively impacted by increased water depth, and consequent decrease in light. (+1)	3	38.2%	1.15
Innes Park and Coral Cove Do nothing	1.00	0.00	Intolerable risks to ecology in this area broadly comprise risks to: <ul style="list-style-type: none">• estuarine ecosystems (mangroves, saltmarsh, saltflats etc) that will be increasingly inundated with deeper water, landward migration currently partially constrained by urban land use and (+1)• coastal dune ecosystems, that will become tidally inundated, and (+1)• extensive intertidal and subtidal reefs (+1) Further, the extensive beds of seagrass offshore of this area may be negatively impacted by increased water depth, and consequent decrease in light. (+1)	4	7.6%	0.31
Coonarr Do nothing	0.34	0.00	Intolerable risks to ecology in this area broadly comprise risks to (+1): <ul style="list-style-type: none">• estuarine ecosystems (mangroves, saltmarsh, saltflats etc) that will be increasingly inundated with deeper water along Elliott River• estuarine and wetland ecosystems along Coonarr Creek to the south of the creek mouth• estuarine and dunal systems to the north of the north of Coonarr Creek Further (+1), it is likely that estuarine wetlands will migrate landward, putting at risk ecosystems outside of the currently mapped area of intolerable risk, including endangered ecosystems such as 12.5.2a.	2	2.6%	0.05
Moore Park Beach Do nothing	2.20	0.00	Moore Park Beach is a significant beach for turtle nesting, for dune erosion can reduce success rates (+1) Impact of tidal flushing of the small creeks to the south, as this may negatively impact water quality and ecological condition.(+2) loss of coastal dune ecosystem for inundation (+1)	5	16.8%	0.84
Bargara Do nothing	1.40	0.00	Minimal risks to ecology in this area broadly comprise risks to: <ul style="list-style-type: none">• Adverse impact of tidal flushing (+1) of Moneys Creek and Kellys Creek (located south of Durdins Road and in the vicinity of Larder St and Woongarra Scenic Drive). Water quality in the lagoon is frequently poor, particularly after extreme weather events, and there have been a number of fish kills (Bundaberg Now 2019). The Burnett Mary Regional Group is currently investigating catchment issues at Moneys Creek, in an effort to address these issues. Significant areas of reef close to the shore (+1) at the northern section of the area. <ul style="list-style-type: none">• coastal dune ecosystems, that will become tidally inundated, and (+1)	4	10.7%	0.43
Burnett Heads Do nothing	3.10	0.00	Intolerable risks to ecology in this area broadly comprise risks to: <ul style="list-style-type: none">• Severe impact on tidal flushing, when tidal waterways are within the area affected by the option(+2) Possible loss of protected communities(+1) Loss of estuarine ecosystems (mangroves, saltmarsh, saltflats) due to marine inundation(+1) Potential loss of endangered ecosystem upstream of Burnett River due to migration of estuarine wetland system(+1)	5	23.7%	1.18
Woodgate Beach Do nothing	1.00	0.00	Minimal risks to ecology in this area broadly comprise risks to: <ul style="list-style-type: none">• Adverse impact of tidal flushing (+1) of Moneys Creek and Kellys Creek (located south of Durdins Road and in the vicinity of Larder St and Woongarra Scenic Drive). Water quality in the lagoon is frequently poor, particularly after extreme weather events, and there have been a number of fish kills (Bundaberg Now 2019). The Burnett Mary Regional Group is currently investigating catchment issues at Moneys Creek, in an effort to address these issues. Significant areas of reef close to the shore (+1) at the northern section of the area. <ul style="list-style-type: none">• coastal dune ecosystems, that will become tidally inundated, and (+1)	3	7.6%	0.23

EVALUATION CRITERIA RAW SCORES - ADAPTABILITY

Assumptions:

An adaptability score per km of coastal protection option was given to each option as follows:

- +1 for beach nourishment
- +1 for Land Use and Tenure Transition
- +2 for seawalls
- 0 for do nothing

This score was then weighted according to the option length in km because it was assumed that larger options are less adaptable (more expensive to modify)

The scores above were chosen based on the following considerations:

- Beach nourishment is more adaptable as it requires periodic top ups anyway and can be adjusted each time based on SLR trend
- Land Use and Tenure Transition is reversible (i.e. land can be sold again) and it would not be too complicated provided this is done if SLR is slower than expected
- Do nothing has a high adaptability to cases in which SLR is slower than predicted, and there is no point in adapting to higher than expected SLR as the option itself is to let the coast erode
- Seawalls would be more difficult to adapt, even if they are made of sand bags and there would be a higher cost involved which is proportional to the length of the wall

	LENGTH (Km)	Adaptability score per unit (linear km)	Weight based on length of option	Score per option (higher indicates difficult to adapt option)
Moore Park Beach Beach Nourishment with Dune (re)construction	2.20	1	5.4%	0.05
Moore Park Beach Seawall / Rockwall / Buried Seawall	2.20	2	5.4%	0.11
Burnett Heads Storm Surge Barrier and Dyke	3.10	2	7.6%	0.15
Bargara Beach Nourishment with Dune (re)construction	1.40	1	3.4%	0.03
Bargara, Kellys Beach Seawall / Rockwall / Buried Seawall	1.40	2	3.4%	0.07
Innes Park and Coral Cove Beach nourishment with Dune (re)construction	1.00	1	2.4%	0.02
Innes Park and Coral Cove Seawalls /Rock wall / Buried Seawall	1.00	2	2.4%	0.05
Coonarr Beach nourishment with Dune (re)construction	0.40	1	1.0%	0.01
Coonarr Seawalls /Rock wall / Buried Seawall	0.34	2	0.8%	0.02
Coonarr Retreat/ Land Use and Tenure Transition	0.34	1	0.8%	0.01
Woodgate Beach Beach nourishment with Dune (re)construction	5.00	1	12.2%	0.12
Woodgate Beach Seawalls /Rock wall / Buried Seawall	5.00	2	12.2%	0.24
Woodgate Beach Retreat/ Land Use and Tenure Transition	5.00	1	12.2%	0.12
Innes Park and Coral Cove Do nothing	1.00	0	2.4%	0.00
Coonarr Do nothing	0.34	0	0.8%	0.00
Moore Park Beach Do nothing	2.20	0	5.4%	0.00
Burnett Heads Do nothing	3.10	0	7.6%	0.00
Bargara Do nothing	1.00	0	2.4%	0.00
Woodgate Beach Do nothing	5.00	0	12.2%	0.00

EVALUATION CRITERIA RAW SCORES - EFFECTIVENESS**Assumptions:**

- An Effectiveness Index was calculated by aggregating the option's economic benefits (expressed as reduction in direct and indirect damages, discounted to present time) and the reduction of the number of people at risk (PAR).
- The economic benefits and reduction in PAR were normalised using a min-max technique before being aggregated in the Effectiveness Index
- The aggregation was done as a simple average
- While future damages were discounted to today's dollar value, future PAR were not discounted. As such, it was assumed that the value of a person at risk today is the same as the value of a person at risk in 80 years.

	NPV of Benefits (i.e. reduction in damages)	Reduction in Population at Risk (PAR)	NPV of Benefits (normalised min max)	Reduction in PAR (normalised min max)	Effectiveness Index (higher score implies greater effectiveness)
Moore Park Beach Beach Nourishment with Dune (re)construction	\$3,830,002	4.86	0.63	0.04	0.34
Moore Park Beach Seawall / Rockwall / Buried Seawall	\$3,830,002	4.86	0.63	0.04	0.34
Burnett Heads Storm Surge Barrier and Dyke	\$34,174	130.35	0.01	1.00	0.50
Bargara Beach Nourishment with Dune (re)construction	\$225,165	0.21	0.04	0.00	0.02
Bargara, Kellys Beach Seawall / Rockwall / Buried Seawall	\$225,165	0.21	0.04	0.00	0.02
Innes Park and Coral Cove Beach nourishment with Dune (re)construction	\$89,649	0.01	0.01	0.00	0.01
Innes Park and Coral Cove Seawalls /Rock wall / Buried Seawall	\$89,649	0.01	0.01	0.00	0.01
Coonarr Beach nourishment with Dune (re)construction	\$675,539	0.48	0.11	0.00	0.06
Coonarr Seawalls /Rock wall / Buried Seawall	\$675,539	0.48	0.11	0.00	0.06
Coonarr Retreat/ Land Use and Tenure Transition	\$693,254	0.31	0.11	0.00	0.06
Woodgate Beach Beach nourishment with Dune (re)construction	\$6,034,801	1.20	1.00	0.01	0.50
Woodgate Beach Seawalls /Rock wall / Buried Seawall	\$6,034,801	1.20	1.00	0.01	0.50
Woodgate Beach Retreat/ Land Use and Tenure Transition	\$217,442	3.77	0.04	0.03	0.03
Innes Park and Coral Cove Do nothing	\$0	0.00	0.00	0.00	0.00
Coonarr Do nothing	\$0	0.00	0.00	0.00	0.00
Moore Park Beach Do nothing	\$0	0.00	0.00	0.00	0.00
Burnett Heads Do nothing	\$0	0.00	0.00	0.00	0.00
Bargara Do nothing	\$0	0.00	0.00	0.00	0.00
Woodgate Beach Do nothing	\$0	0.00	0.00	0.00	0.00

EVALUATION CRITERIA RAW SCORES - EFFECTIVENESS				
Population At Risk (PAR) Storm Surge Reduction afforded from implementation of adaptation option.				
Settlement	Residential	Non-Res	Infrastructure	Total Storm Surge
Bargara	0.21	0.00	0.00	0.21
Burnett Heads	130.35	0.00	0.00	130.35
Buxton	0.00	0.00	0.00	0.00
Coonarr	0.48	0.00	0.00	0.48
Elliott Heads	0.00	0.00	0.00	0.00
Innes Park and Coral Cove	0.00	0.00	0.00	0.00
Miara and Norval Park	0.00	0.00	0.00	0.00
Moore Park Beach	0.00	4.86	0.00	4.86
Woodgate Beach	1.20	0.00	0.00	1.20
Total Sum	132.24	4.86	0.00	137.10

EVALUATION CRITERIA RAW SCORES - APPROVALS

Assumptions:

- Each legislative matter was rated in terms of its potential to impact on project delivery, then assigned ratings ranged from Insignificant to Moderate. A brief description of assigned ratings follows:
Moderate - Development approval required, additional investigations, Species Management Program or scheduling implications are likely (score 2).
Minor - Development approval, permit, Species Management Program or additional investigations may be required (score 1).
Insignificant - Works unlikely to be impacted by legislation; development approvals or permits may not be required (score 0).
Approval viability is calculated by attributing a score against each legislative matter and summing the total to obtain a total Approvals Score.

Option	Approvals (higher score implies difficult to obtain permits)
Moore Park Beach Beach Nourishment with Dune (re)construction	14.00
Moore Park Beach Seawall / Rockwall / Buried Seawall	14.00
Burnett Heads Storm Surge Barrier and Dyke	14.00
Bargara Beach Nourishment with Dune (re)construction	15.00
Bargara, Kellys Beach Seawall / Rockwall / Buried Seawall	15.00
Innes Park and Coral Cove Beach nourishment with Dune (re)construction	17.00
Innes Park and Coral Cove Seawalls /Rock wall / Buried Seawall	17.00
Coonarr Beach nourishment with Dune (re)construction	17.00
Coonarr Seawalls /Rock wall / Buried Seawall	17.00
Coonarr Retreat/ Land Use and Tenure Transition	0.00
Woodgate Beach Beach nourishment with Dune (re)construction	20.00
Woodgate Beach Seawalls /Rock wall / Buried Seawall	20.00
Woodgate Beach Retreat/ Land Use and Tenure Transition	0.00
Innes Park and Coral Cove Do nothing	0.00
Coonarr Do nothing	0.00
Moore Park Beach Do nothing	0.00
Burnett Heads Do nothing	0.00
Bargara Do nothing	0.00
Woodgate Beach Do nothing	0.00

EVALUATION CRITERIA RAW SCORES - APPROVAL SCORE BREAKDOWN

Legislative Matter	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10
	Moore Park	Moore Park	Burnett Heads	Bargara	Bargara	Innes Park/ CC	Innes Park/ CC	Coonarr	Coonarr	Coonarr
	Beach Nourishment / Dune reconstruction	Seawall	Storm Surge Barrier	Beach Nourishment / Dune reconstruction	Seawall	Beach Nourishment / Dune reconstruction	Seawall	Beach Nourishment / Dune reconstruction	Seawall	Land Use and Tenure Transition
	Proposed treatment extends along the ocean fronting area of intolerable risk for 2.2km. Should extend offshore for 34m min	Proposed treatment extends along the ocean fronting area of intolerable risk for 2.2km.	Treatment includes 3.1Km earth dyke plus 80 m storm surge barrier	Treatment extends for whole beach pocket (approximately 1.4 km).	Treatment extends for whole beach pocket (approximately 1.4 km).	Treatment extends approximately 1km	Treatment extends approximately 1km	Treatment extends 400m.	Treatment designed to protect houses along foreshore (340 m)	Potential voluntary resumption of 6 dwellings on Coonarr beach front.
Commonwealth										
Matters of National Environmental Significance (MNES)	2	2	2	2	2	2	2	2	2	0
State matters – Protected areas										
Protected areas	2	2	0	1	1	1	1	1	1	0
State matters – Coastal development										
Coastal management district (CMD) Erosion prone area Tidal water	2	2	2	2	2	2	2	2	2	0
State matters – Wetlands, watercourses and other water resources										
Wetland protection trigger area	0	0	0	0	0	0	0	2	2	0
Wetland as identified on the vegetation management wetlands map	0	0	0	0	0	0	0	0	0	0
MSES declared high ecological value waters (wetland)	0	0	0	1	1	1	1	0	0	0
MSES high ecological significance wetlands	0	0	0	0	0	0	0	0	0	0
Watercourse as identified on the vegetation management watercourse and drainage feature map	0	0	1	1	1	1	1	0	0	0
MSES Watercourses in high ecological value (HEV) waters	0	0	0	0	0	0	0	0	0	0
Water resources regulated under the Water Act 1000	0	0	0	0	0	1	1	0	0	0
State matters - Vegetation and threatened flora										
Regulated vegetation	1	1	1	1	1	1	1	1	1	0
Protected plants	0	0	0	0	0	0	0	1	1	0
State matters – Fauna and fauna habitat										
Essential habitat	1	1	1	0	0	0	0	1	1	0
MSES wildlife habitat	0	0	0	0	0	0	0	0	0	0
Conservation significant fauna	2	2	1	2	2	2	2	2	2	0
Flying fox roosts	0	0	0	0	0	0	0	0	0	0
State matters - Fisheries resources										
Waterway barrier works	0	0	2	1	1	2	2	1	1	0
Marine plants	2	2	2	2	2	2	2	2	2	0
Declared fish habitat areas	0	0	0	0	0	0	0	0	0	0
Land and soils										
Contaminated land	1	1	1	1	1	1	1	1	1	0
Acid Sulphate Soils (ASS)	1	1	1	1	1	1	1	1	1	0
TOTAL	14.00	14.00	14.00	15.00	15.00	17.00	17.00	17.00	17.00	0.00
AVERAGE	0.67	0.67	0.67	0.71	0.71	0.81	0.81	0.81	0.81	0.00

EVALUATION CRITERIA RAW SCORES - APPROVALS AND LEGISLATIVE ASSESSMENT - DESCRIPTIONS

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10
Approval / Legislative Matter	Moore Park	Moore Park	Burnett Heads	Bargara	Bargara	Innes Park/ CC	Innes Park/ CC	Coonarr	Coonarr	Coonarr
	Beach Nourishment / Dune reconstruction	Seawall	Storm Surge Barrier	Beach Nourishment / Dune reconstruction	Seawall	Beach Nourishment / Dune reconstruction	Seawall	Beach Nourishment / Dune reconstruction	Seawall	Land Use and Tenure Transition
	Proposed treatment extends along the ocean fronting area of intolerable risk for 2.2km. Should extend offshore for 34m min	Proposed treatment extends along the ocean fronting area of intolerable risk for 2.2km.	Treatment includes 3.1Km earth dyke plus 80 m storm surge barrier	Treatment extends for whole beach pocket (approximately 1.4 km).	Treatment extends for whole beach pocket (approximately 1.4 km).	Treatment extends approximately 1km	Treatment extends approximately 1km	Treatment extends 400m.	Treatment designed to protect houses along foreshore (340 m)	Potential voluntary resumption of 6 dwellings on Coonarr beach front.
Commonwealth										
Matters of National Environmental Significance (MNES)	Moderate - Previous records of conservation significant species (threatened and migratory/marine bird spp and marine turtles) in project area. No REs listed as equivalent to TECs but C. glauca recorded immediately north of project area.	Moderate - Previous records of conservation significant species (threatened and migratory/marine bird spp and marine turtles) in project area. No REs listed as equivalent to TECs.	Moderate - Habitat for conservation significant bird species (threatened and marine/migratory). Waterway provides connectivity to regionally significant artificial ponds which provide value foraging habitat for listed migratory shorebird species. RE12.1.2 present which is listed as equivalent to Subtropical and Temperate Coastal Saltmarsh TECs (vulnerable under EPBC Act - impacts do not trigger referral).	Moderate - Previous records of conservation significant species (threatened and migratory/marine bird spp and marine turtles) in project area. RE 12.3.3 which may contain the Coastal floodplain eucalypt forest of eastern Australia community (currently under consideration as a TEC) is mapped adjacent to the project area.	Moderate - Previous records of conservation significant species (threatened and migratory/marine bird spp and marine turtles) in project area. RE 12.3.3 which may contain the Coastal floodplain eucalypt forest of eastern Australia community (currently under consideration as a TEC) is mapped adjacent to the project area.	Moderate - Marine turtle nesting habitat present and previous records of conservation significant birds nearby. No REs listed as equivalent to TECs.	Moderate - Marine turtle nesting habitat present and previous records of conservation significant birds nearby. No REs listed as equivalent to TECs.	Moderate - Habitat for conservation significant species (threatened and marine/migratory bird spp and listed marine turtles). No REs listed as equivalent to TECs. Additional investigations required.	Moderate - Habitat for conservation significant species (threatened and marine/migratory bird spp and listed marine turtles). No REs listed as equivalent to TECs. Additional investigations required.	Insignificant - Gradual effect on habitat for conservation significant species (threatened and marine/migratory bird spp and listed marine turtles).
State matters – Protected areas										
Protected areas	Moderate - Permit required for minor works in Great Sandy Marine Park (Moore Park beach zoned as General Use). Offsets unlikely Zoning plan currently under review. Offsets unlikely. Burrum Coast NP adjacent. Mouth of Kolan River Conservation Park located immediately north.	Moderate - Permit required for minor works in Great Sandy Marine Park. Offsets unlikely Zoning plan currently under review. Offsets unlikely. Burrum Coast NP adjacent. Mouth of Kolan River Conservation Park located immediately north.	Insignificant - None present within project area. River mouth excluded from Great Sandy Marine Park	Minor - Occurs within marine national park zone and conservation park zone of Great Sandy Marine Park. Permit required for minor works in Great Sandy Marine Park. Offsets unlikely. Zoning plan currently under review. Offsets unlikely.	Minor - Occurs within marine national park zone and conservation park zone of Great Sandy Marine Park. Permit required for minor works in Great Sandy Marine Park. Offsets unlikely. Zoning plan currently under review. Offsets unlikely.	Minor - Occurs within marine national park zone and conservation park zone of Great Sandy Marine Park. Permit required for minor works in Great Sandy Marine Park (Zoned turtle monitoring area). Offsets unlikely. Zoning plan currently under review. Offsets unlikely.	Minor - Occurs within marine national park zone and conservation park zone of Great Sandy Marine Park. Permit required for minor works in Great Sandy Marine Park (Zoned turtle monitoring area). Offsets unlikely. Zoning plan currently under review. Offsets unlikely.	Minor - Occurs within habitat protection zone of Great Sandy Marine Park. Permit required for minor works in Great Sandy Marine Park (Zoned turtle monitoring area). Offsets unlikely. Zoning plan currently under review. Offsets unlikely.	Minor - Occurs within habitat protection zone of Great Sandy Marine Park. Permit required for minor works in Great Sandy Marine Park (Zoned turtle monitoring area). Offsets unlikely. Zoning plan currently under review. Offsets unlikely.	Insignificant - no impact on protected areas. No offsets required.
State matters – Coastal development										
Coastal management district (CMD) Erosion prone area Tidal water	Moderate - Project is considered assessable development under the <i>Planning Regulation 2017</i> (Operational work that is tidal works or work in a coastal management district) as it involves works in tidal water which are designed to prevent erosion of the land by sea. It also involves interfering with quarry material on State Coastal land above high-water mark and possibly removing or interfering with coastal dunes on land other than State coastal land in an erosion prone area. Minor work exclusions unlikely to be applicable as erosion prone area present.	Moderate - Project is considered assessable development under the <i>Planning Regulation 2017</i> (Operational work that is tidal works or work in a coastal management district) as it involves works in tidal water which are designed to prevent erosion of the land by sea. It also involves interfering with quarry material on State Coastal land above high-water mark and possibly removing or interfering with coastal dunes on land other than State coastal land in an erosion prone area. Minor work exclusions unlikely to be applicable as erosion prone area present.	Moderate - Project is considered assessable development under the <i>Planning Regulation 2017</i> (Operational work that is tidal works or work in a coastal management district) as it involves works in tidal water which are designed to prevent erosion of the land by sea. It also involves interfering with quarry material on State Coastal land above high-water mark. Minor work exclusions unlikely to be applicable as erosion prone area present.	Moderate - Project is considered assessable development under the <i>Planning Regulation 2017</i> (Operational work that is tidal works or work in a coastal management district) as it involves works in tidal water which are designed to prevent erosion of the land by sea. It also involves interfering with quarry material on State Coastal land above high-water mark and possibly removing or interfering with coastal dunes on land other than State coastal land in an erosion prone area. Minor work exclusions unlikely to be applicable as erosion prone area present.	Moderate - Project is considered assessable development under the <i>Planning Regulation 2017</i> (Operational work that is tidal works or work in a coastal management district) as it involves works in tidal water which are designed to prevent erosion of the land by sea. It also involves interfering with quarry material on State Coastal land above high-water mark and possibly removing or interfering with coastal dunes on land other than State coastal land in an erosion prone area. Minor work exclusions unlikely to be applicable as erosion prone area present.	Moderate - Project is considered assessable development under the <i>Planning Regulation 2017</i> (Operational work that is tidal works or work in a coastal management district) as it involves works in tidal water which are designed to prevent erosion of the land by sea. It also involves interfering with quarry material on State Coastal land above high-water mark and possibly removing or interfering with coastal dunes on land other than State coastal land in an erosion prone area. Minor work exclusions unlikely to be applicable as erosion prone area present.	Moderate - Project is considered assessable development under the <i>Planning Regulation 2017</i> (Operational work that is tidal works or work in a coastal management district) as it involves works in tidal water which are designed to prevent erosion of the land by sea. It also involves interfering with quarry material on State Coastal land above high-water mark and possibly removing or interfering with coastal dunes on land other than State coastal land in an erosion prone area. Minor work exclusions unlikely to be applicable as erosion prone area present.	Moderate - Project is considered assessable development under the <i>Planning Regulation 2017</i> (Operational work that is tidal works or work in a coastal management district) as it involves works in tidal water which are designed to prevent erosion of the land by sea. It also involves interfering with quarry material on State Coastal land above high-water mark and possibly removing or interfering with coastal dunes on land other than State coastal land in an erosion prone area. Minor work exclusions unlikely to be applicable as erosion prone area present.	Moderate - Project is considered assessable development under the <i>Planning Regulation 2017</i> (Operational work that is tidal works or work in a coastal management district) as it involves works in tidal water which are designed to prevent erosion of the land by sea. It also involves interfering with quarry material on State Coastal land above high-water mark and possibly removing or interfering with coastal dunes on land other than State coastal land in an erosion prone area. Minor work exclusions unlikely to be applicable as erosion prone area present.	Insignificant - unlikely to require assessment under CMD, EPA or Tidal Works
State matters – Wetlands, watercourses and other water resources										
Wetland protection trigger area	Insignificant - No wetland protection areas or associated trigger areas are present within the project area.	Insignificant - No wetland protection areas or associated trigger areas are present within the project area.	Insignificant - No wetland protection areas or associated trigger areas are present within the project area.	Insignificant - No wetland protection areas or associated trigger areas are present within the project area.	Insignificant - No wetland protection areas or associated trigger areas are present within the project area.	Insignificant - No wetland protection areas or associated trigger areas are present within the project area.	Insignificant - No wetland protection areas or associated trigger areas are present within the project area.	Moderate - Occurs within wetland protection trigger area. High impact earth works in a wetland protection trigger area trigger development approval unless accepted development otherwise exempt. Exemption possible.	Moderate - Occurs within wetland protection trigger area. High impact earth works in a wetland protection trigger area trigger development approval unless accepted development otherwise exempt. Exemption possible.	Insignificant - no assessment required under wetland protection area
Wetland as identified on the vegetation management wetlands map	Insignificant - None present within project area.	Insignificant - None present within project area.	Insignificant - None present within project area.	Insignificant - None present within project area.	Insignificant - None present within project area.	Insignificant - None present within project area.	Insignificant - None present within project area.	Insignificant - None present within project area.	Insignificant - None present within project area.	Insignificant - None present within project area.
MSES declared high ecological value waters (wetland)	Insignificant - None present within project area.	Insignificant - None present within project area.	Insignificant - None present within project area.	Minor - Mapped adjacent to headland at northern extent of project area. Requirement to maintain water quality objectives in HEV waters.	Minor - Mapped adjacent to headland at northern extent of project area. Requirement to maintain water quality objectives in HEV waters.	Minor - Mapped adjacent to southern end of project area. Requirement to maintain water quality objectives in HEV waters.	Minor - Mapped adjacent to southern end of project area. Requirement to maintain water quality objectives in HEV waters.	Insignificant - None present within project area.	Insignificant - None present within project area.	Insignificant - None present within project area.
MSES high ecological significance wetlands	Insignificant - None present within project area.	Insignificant - None present within project area.	Insignificant - None present within project area.	Insignificant - None present within project area.	Insignificant - None present within project area.	Insignificant - None present within project area.	Insignificant - None present within project area.	Insignificant - None present within project area.	Insignificant - None present within project area.	Insignificant - None present within project area.
Watercourse as identified on the vegetation management watercourse and drainage feature map	Insignificant - None present within project area.	Insignificant - None present within project area.	Minor - One mapped watercourse/drainage line present. Exemptions likely.	Minor - One mapped watercourse/drainage line present. Exemptions likely.	Minor - One mapped watercourse/drainage line present. Exemptions likely.	Minor - Two watercourses/drainage lines present. Exemptions likely.	Minor - Two watercourses/drainage lines present. Exemptions likely.	Insignificant - None present within project area.	Insignificant - None present within project area.	Insignificant - None present within project area.
MSES Watercourses in high ecological value (HEV) waters	Insignificant - None present within project area.	Insignificant - None present within project area.	Insignificant - None present within project area.	Insignificant - None present within project area.	Insignificant - None present within project area.	Insignificant - None present within project area.	Insignificant - None present within project area.	Insignificant - None present within project area.	Insignificant - None present within project area.	Insignificant - None present within project area.
Water resources regulated under the <i>Water Act 2000</i>	Insignificant - None present within project area. Unmapped waterway shown on WIM immediately south of project area	Insignificant - None present within project area. Unmapped waterway shown on WIM immediately south of project area	Insignificant - None present within project area. Unmapped waterway commences 200 m upstream.	Insignificant - None present within project area.	Insignificant - None present within project area.	Minor - Two unmapped waterways on the WIM. Further assessment required.	Minor - Two unmapped waterways on the WIM. Further assessment required.	Insignificant - None present within project area.	Insignificant - None present within project area.	Insignificant - None present within project area.
State matters - Vegetation and threatened flora										

EVALUATION CRITERIA RAW SCORES - APPROVALS AND LEGISLATIVE ASSESSMENT - DESCRIPTIONS

[illegible]

	Site 11	Site 12		Site 14	Site 15	Site 16	Site 17	Site 18	Site 19
Approval / Legislative Matter	Woodgate	Woodgate	Woodgate	Innes park	Coonarr	Moore Park Beach	Burnett Heads	Bargara	Woodgate Beach
	Beach Nourishment / Dune reconstruction	Seawall	Land Use and Tenure Transition	Do Nothing	Do Nothing	Do Nothing	Do Nothing	Do Nothing	Do Nothing
	Nourishment extent recommended for boat ramp to south of Twelfth Ave (approximately 5 km) to protect the Esplanade Road. The treatment should extend offshore for 34m min.	Seawall extent recommended for boat ramp to south of Twelfth Ave (approximately 5 km) to protect the Esplanade Road.	Potential voluntary resumption of dwellings in First Avenue that are affected by coastal hazards.	Allow natural processes to occur with the onset of sea level rise - no active intervention	Allow natural processes to occur with the onset of sea level rise - no active intervention	Allow natural processes to occur with the onset of sea level rise - no active intervention	Allow natural processes to occur with the onset of sea level rise - no active intervention	Allow natural processes to occur with the onset of sea level rise - no active intervention	Allow natural processes to occur with the onset of sea level rise - no active intervention
Regulated vegetation	Minor - Category B vegetation present along foreshore comprising least concern RE 12.2.14. Clearing exemption likely.	Minor - Category B vegetation present along foreshore comprising least concern RE 12.2.14. Clearing exemption likely.	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required
Protected plants	Minor - High risk trigger area present along foreshore. Flora survey required and possible permit.	Minor - High risk trigger area present along foreshore. Flora survey required and possible permit.	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required
State matters – Fauna and fauna									
Essential habitat	Moderate - Essential habitat for eastern curlew and greater glider mapped along foreshore. Considered by DNRME when assessing vegetation clearing applications. Breeding habitat survey and species management program likely to be required.	Moderate - Essential habitat for eastern curlew and greater glider mapped along foreshore. Considered by DNRME when assessing vegetation clearing applications. Breeding habitat survey and species management program likely to be required.	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required
MSES wildlife habitat	Minor - mapped over coastal waters	Minor - mapped over coastal waters	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required
Conservation significant fauna	Moderate - Several conservation significant species likely to occur. Additional investigations and impact assessments likely.	Moderate - Several conservation significant species likely to occur. Additional investigations and impact assessments likely.	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required
Flying fox roosts	Insignificant - None present within project area	Insignificant - None present within project area	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required
State matters - Fisheries resource									
Waterway barrier works	Minor - Coastal waters and beach mapped as a fisheries tidal waterway. Discussions with fisheries required.	Minor - Coastal waters and beach mapped as a fisheries tidal waterway. Discussions with fisheries required.	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required
Marine plants	Moderate - Marine plants likely to be impacted by the works. Survey for marine plants required. Seagrass beds mapped in vicinity of shoreline. Development approval and offsets likely.	Moderate - Marine plants likely to be impacted by the works. Survey for marine plants required. Seagrass beds mapped in vicinity of shoreline. Development approval and offsets likely.	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required
Declared fish habitat areas	Insignificant - None present within project area.	Insignificant - None present within project area.	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required
Land and soils									
Contaminated land	Unknown - Search not conducted.	Unknown - Search not conducted.	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required
Acid Sulphate Soils (ASS)			Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required	Insignificant - No assessment required
	Minor - Potential for disturbance of ASS or PASS within the project area is high. Additional investigations and management likely	Minor - Potential for disturbance of ASS or PASS within the project area is high. Additional investigations and management likely							

EVALUATION CRITERIA RAW SCORES - TECHNICAL VIABILITY

Assumptions:
Each adaptation option treatment was rated in terms of its potential to impact on project delivery and treatment life. Assigned ratings ranged from High to insignificant. A brief description of assigned ratings follows:
- High - Project will impact local community/Cost of treatment (score 3)
- Moderate - Treatment has the potential to require unique design/construction elements (score 2)
- Minor - Proven treatment with established design and construction processes that can be tailored for individual sites (score 1)
- Insignificant - Risk associated with works unlikely to impact treatment (score 0).
Technical viability is calculated by attributing a sum of each technical viability score to obtain an overall index (total score).

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9
Technical Viability	Moore Park	Moore Park	Burnett Heads	Bargara	Bargara	Innes Park/ CC	Innes Park/ CC	Coonarr	Coonarr
	Beach Nourishment / Dune reconstruction	Seawall	Storm Surge Barrier	Beach Nourishment / Dune reconstruction	Seawall	Beach Nourishment / Dune reconstruction	Seawall	Beach Nourishment / Dune reconstruction	Seawall
	Proposed treatment extends along the ocean fronting area of intolerable risk for 2.2km. Should extend offshore for 34m min	Proposed treatment extends along the ocean fronting area of intolerable risk for 2.2km.	Treatment includes 3.1Km earth dyke plus 80 m storm surge barrier	Treatment extends for whole beach pocket (approximately 1.4 km).	Treatment extends for whole beach pocket (approximately 1.4 km).	Treatment extends approximately 1km	Treatment extends approximately 1km	Treatment extends 400m.	Treatment designed to protect houses along foreshore (340 m)
Preconstruction									
Development	1	1	2	1	1	1	1	1	1
Land Acquisition	0	0	3	0	0	0	0	0	0
Construction									
Material availability	0	0	1	0	0	0	0	1	1
Construcability	1	1	2	1	1	1	1	1	1
Asset Managment									
Lifecycle	0	0	2	0	0	0	0	0	0
Maintenance	0	0	1	0	0	0	0	0	0
Total score	2	2	11	2	2	2	2	3	3
	2	2	11	2	2	2	2	3	3

Technical Viability	Site 10	Site 11	Site 12	Site 13	Site 14	Site 15	Site 16	Site 17	Site 18	Site 18
	Coonarr	Woodgate	Woodgate	Woodgate	Innes park	Coonarr	Moore Park Beach	Burnett Heads	Bargara	Woodgate Beach
	Land Use and Tenure Transition	Beach Nourishment / Dune reconstruction	Seawall	Land Use and Tenure Transition	Do Nothing	Do Nothing	Do Nothing	Do Nothing	Do Nothing	Do Nothing
	Potential voluntary resumption of 6 dwellings on Coonarr beach front.	Nourishment extent recommended for boat ramp to south of Twelfth Ave (approximately 5 km) to protect the Esplanade Road. The treatment should extend offshore for 34m min.	Seawall extent recommended for boat ramp to south of Twelfth Ave (approximately 5 km) to protect the Esplanade Road.	Potential voluntary resumption of dwellings in First Avenue that are affected by coastal hazards.	Allow natural processes to occur with the onset of sea level rise - no active intervention	Allow natural processes to occur with the onset of sea level rise - no active intervention	Allow natural processes to occur with the onset of sea level rise - no active intervention	Allow natural processes to occur with the onset of sea level rise - no active intervention	Allow natural processes to occur with the onset of sea level rise - no active intervention	Allow natural processes to occur with the onset of sea level rise - no active intervention
Development	0	1	1	0	0	0	0	0	0	0
Land Acquisition	3	0	0	3	0		0	0	0	0
Material availability	0	1	1	0	0	0	0	0	0	0
Construcability	0	1	1	0	0	0	0	0	0	0
Lifecycle	0	0	0	0	0	0	0	0	0	0
Maintenance	0	0	0	0	0	0	0	0	0	0
Total score	3	3	3	3	0	0	0	0	0	0
	3	3	3	3	0	0	0	0	0	0

EVALUATION CRITERIA RAW SCORES - TECHNICAL VIABILITY ASSESSMENT

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Technical Viability	Moore Park Beach	Moore Park Beach	Burnett Heads	Bargara	Bargara	Innes Park/ CC
	Beach Nourishment / Dune reconstruction	Seawall	Storm Surge Barrier	Beach Nourishment / Dune reconstruction	Seawall	Beach Nourishment / Dune reconstruction
Brief Description	Proposed treatment extends along the ocean fronting area of intolerable risk for 2.2km. Should extend offshore for 34m min	Proposed treatment extends along the ocean fronting area of intolerable risk for 2.2km.	Treatment includes 3.1Km earth dyke plus 80 m storm surge barrier	Treatment extends for whole beach pocket (approximately 1.4 km).	Treatment extends for whole beach pocket (approximately 1.4 km).	Treatment extends approximately 1km
Preconstruction						
Development	Minor - Established/proven design principles exist for treatment. Will require induvial design requirements	Minor - Established/proven design principles exist for treatment. Will require induvial design requirements	Moderate - Storm Surge Barrier will require unique design components.	Minor - Established/proven design principles exist for treatment. Will require induvial design requirements	Minor - Established/proven design principles exist for treatment. Will require individual design requirements	Minor - Established/proven design principles exist for treatment. Will require individual design requirements
Land Acquisition	Insignificant - Existing beach/dune area adequate for proposed works	Insignificant - Existing beach/dune area adequate for proposed works	High - Requires large land footprint for earth dyke and may impact local community.	Insignificant - Existing beach/dune area adequate for proposed works	Insignificant - Existing beach/dune area adequate for proposed works	Insignificant - Existing beach/dune area adequate for proposed works
Construction						
Material availability	Insignificant - construction materials within local area available	Insignificant - construction materials within local area available	Minor - Material for dyke will be required to be imported to site	Insignificant - construction materials within local area available	Insignificant - construction materials within local area available	Insignificant - construction materials within local area available
Constructability	Minor - Established/proven construction processes exist for treatment. Will require individual construction requirements	Minor - Established/proven construction processes exist for treatment. Will require individual construction requirements	Moderate - Storm Surge Barrier will require unique construction knowledge	Minor - Established/proven construction processes exist for treatment. Will require individual construction requirements	Minor - Established/proven construction processes exist for treatment. Will require individual construction requirements	Minor - Established/proven construction processes exist for treatment. Will require individual construction requirements
Asset Management						
Lifecycle	Insignificant - Minor maintenance required while dune revegetation is establishing	Insignificant - Minor reconstruction/raising maybe required over lifecycle	Moderate - Storm Surge Barrier has a definitive life and will require replacement/reconstruction	Insignificant - Minor maintenance required while dune revegetation is establishing	Insignificant - Minor reconstruction/raising maybe required over lifecycle	Insignificant - Minor maintenance required while dune revegetation is establishing
Maintenance	Insignificant - Minor maintenance required while dune revegetation is establishing	Insignificant - Minor periodic maintenance required over lifecycle	Minor - Storm Surge Barrier will require regular maintenance throughout lifecycle	Insignificant - Minor maintenance required while dune revegetation is establishing	Insignificant - Minor periodic maintenance required over lifecycle	Insignificant - Minor maintenance required while dune revegetation is establishing

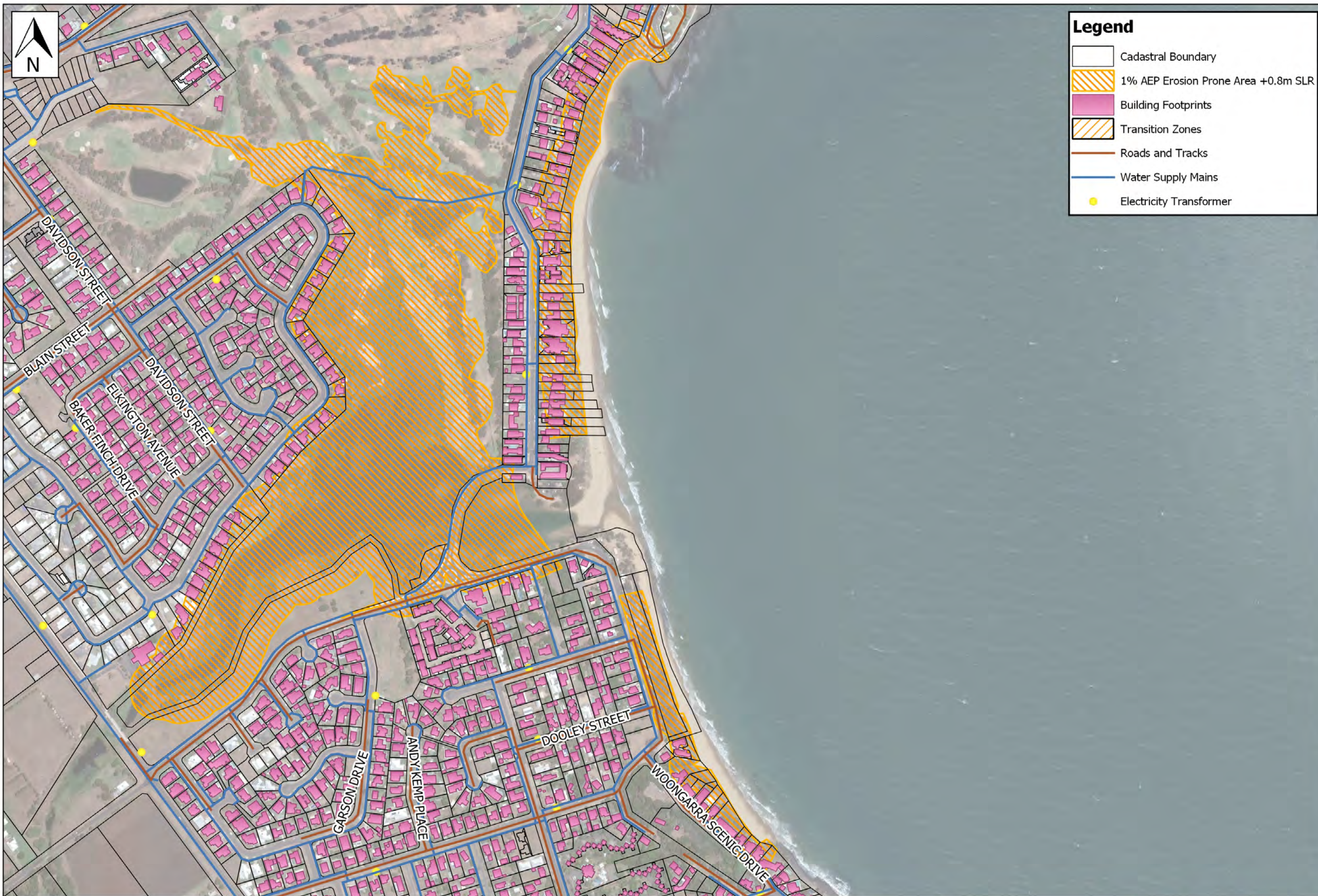
Technical Viability	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13
	Innes Park/ CC	Coonarr	Coonarr	Coonarr	Woodgate Beach	Woodgate Beach	Woodgate Beach
	Seawall	Beach Nourishment / Dune reconstruction	Seawall	Land Use and Tenure Transition	Beach Nourishment / Dune reconstruction	Seawall	Land Use and Tenure Transition
Brief Description	Treatment extends approximately 1km	Treatment extends 400m.	Treatment designed to protect houses along foreshore (340 m)	Potential voluntary resumption of 6 dwellings on Coonarr beach front.	Nourishment extent recommended for boat ramp to south of Twelfth Ave (approximately 5 km) to protect the Esplanade Road. The treatment should extend offshore for 34m min.	Seawall extent recommended for boat ramp to south of Twelfth Ave (approximately 5 km) to protect the Esplanade Road.	Potential voluntary resumption of dwellings in First Avenue that are affected by coastal hazards.
Preconstruction							
Development	Minor - Established/proven design principles exist for treatment. Will require individual design requirements	Minor - Established/proven design principles exist for treatment. Will require individual design requirements	Minor - Established/proven design principles exist for treatment. Will require individual design requirements	Insignificant - No establishment works necessary	Minor - Established/proven design principles exist for treatment. Will require individual design requirements	Minor - Established/proven design principles exist for treatment. Will require individual design requirements	Insignificant - No establishment works necessary
Land Acquisition	Insignificant - Existing beach/dune area adequate for proposed works	Insignificant - Existing beach/dune area adequate for proposed works	Insignificant - Existing beach/dune area adequate for proposed works	High - Will require acquisition of established land	Insignificant - Existing beach/dune area adequate for proposed works	Insignificant - Existing beach/dune area adequate for proposed works	High - Will require acquisition of established land
Construction							
Material availability	Insignificant - construction materials within local area available	Minor - Construction materials may need to be imported to site	Minor - Construction materials may need to be imported to site	Insignificant - No works necessary	Minor - Construction materials may need to be imported to site	Minor - Construction materials may need to be imported to site	Insignificant - No works necessary
Constructability	Minor - Established/proven construction processes exist for treatment. Will require individual construction requirements	Minor - Established/proven construction processes exist for treatment. Will require individual construction requirements	Minor - Established/proven construction processes exist for treatment. Will require individual construction requirements	Insignificant - No works necessary	Minor - Established/proven construction processes exist for treatment. Will require individual construction requirements	Minor - Established/proven construction processes exist for treatment. Will require individual construction requirements	Insignificant - No works necessary
Asset Management							
Lifecycle	Insignificant - Minor reconstruction/raising maybe required over lifecycle	Insignificant - Minor maintenance required while dune revegetation is establishing	Insignificant - Minor reconstruction/raising maybe required over lifecycle	Insignificant - Minor periodic maintenance of vacant block (lawn / vegetation management)	Insignificant - Minor maintenance required while dune revegetation is establishing	Insignificant - Minor reconstruction/raising maybe required over lifecycle	Insignificant - Minor periodic maintenance of vacant block (lawn / vegetation management)
Maintenance	Insignificant - Minor periodic maintenance required over lifecycle	Insignificant - Minor maintenance required while dune revegetation is establishing	Insignificant - Minor periodic maintenance required over lifecycle	Insignificant - Minor periodic maintenance of vacant block (lawn / vegetation management)	Insignificant - Minor maintenance required while dune revegetation is establishing	Insignificant - Minor periodic maintenance required over lifecycle	Insignificant - Minor periodic maintenance of vacant block (lawn / vegetation management)

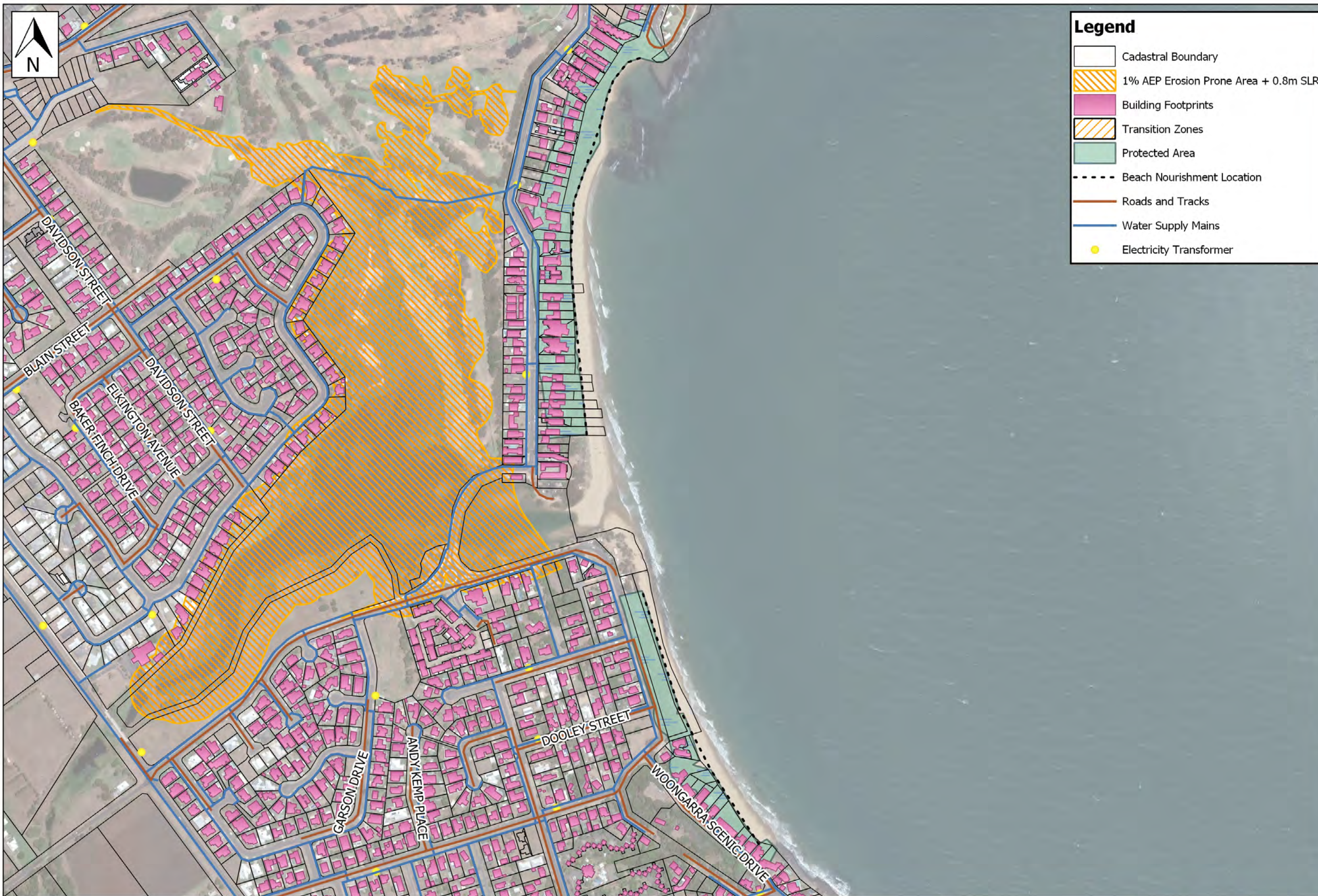
Technical Viability	Site 14	Site 15	Site 16	Site 17	Site 18	Site 18
	Innes park	Coonarr	Moore Park Beach	Burnett Heads	Bargara	Woodgate Beach
	Do Nothing	Do Nothing	Do Nothing	Do Nothing	Do Nothing	Do Nothing
Brief Description	Allow natural processes to occur with the onset of sea level rise - no active intervention	Allow natural processes to occur with the onset of sea level rise - no active intervention	Allow natural processes to occur with the onset of sea level rise - no active intervention	Allow natural processes to occur with the onset of sea level rise - no active intervention	Allow natural processes to occur with the onset of sea level rise - no active intervention	Allow natural processes to occur with the onset of sea level rise - no active intervention
Preconstruction						
Development	Insignificant - No establishment works necessary	Insignificant - No establishment works necessary	Insignificant - No establishment works necessary	Insignificant - No establishment works necessary	Insignificant - No establishment works necessary	Insignificant - No establishment works necessary
Land Acquisition	Insignificant - N/A	Insignificant - N/A	Insignificant - N/A	Insignificant - N/A	Insignificant - N/A	Insignificant - N/A
Construction						
Material availability	Insignificant - No works necessary	Insignificant - No works necessary	Insignificant - No works necessary	Insignificant - No works necessary	Insignificant - No works necessary	Insignificant - No works necessary
Constructability	Insignificant - No works necessary	Insignificant - No works necessary	Insignificant - No works necessary	Insignificant - No works necessary	Insignificant - No works necessary	Insignificant - No works necessary
Asset Management						
Lifecycle	Insignificant - N/A	Insignificant - N/A	Insignificant - N/A	Insignificant - N/A	Insignificant - N/A	Insignificant - N/A
Maintenance	Insignificant - N/A	Insignificant - N/A	Insignificant - N/A	Insignificant - N/A	Insignificant - N/A	Insignificant - N/A

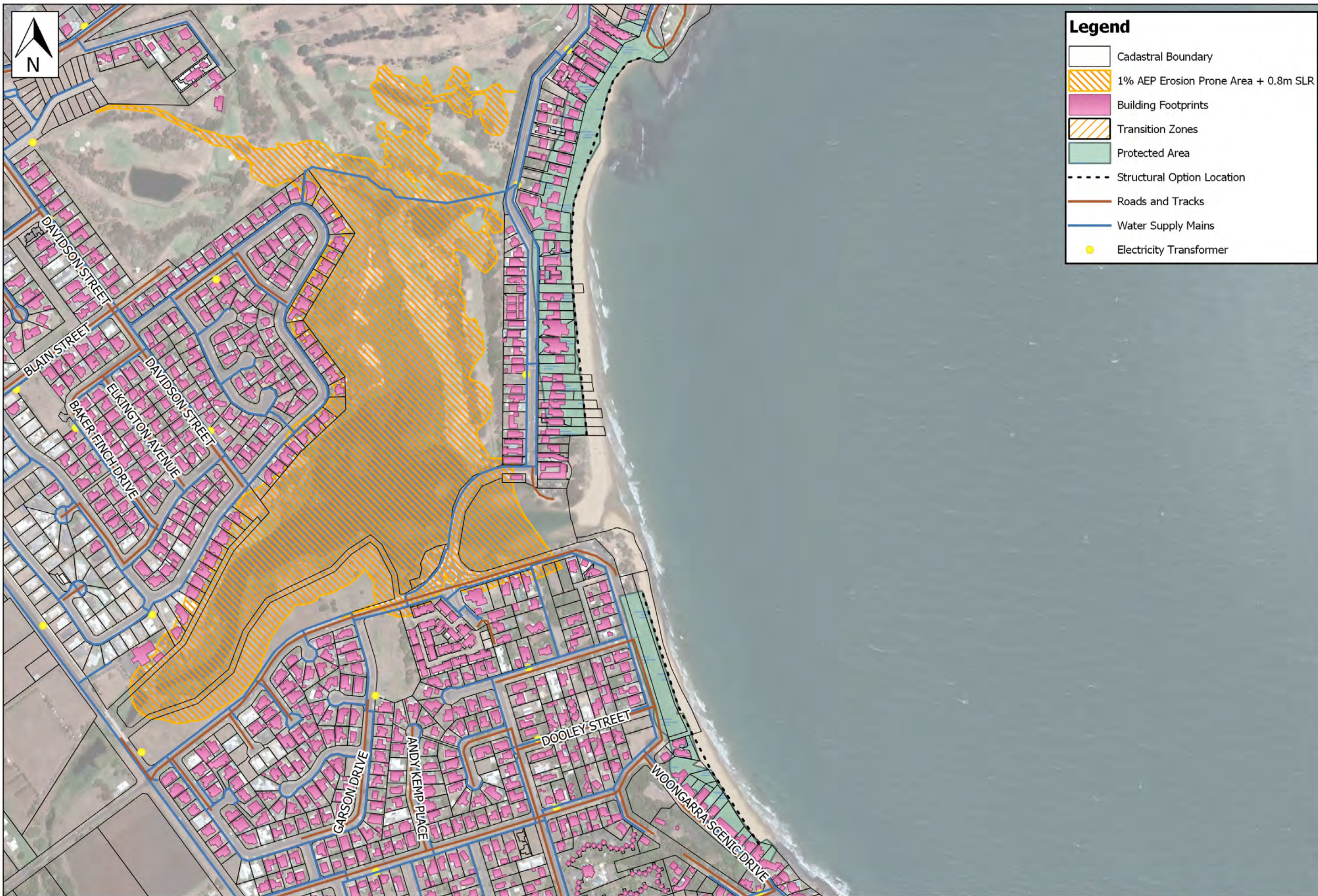


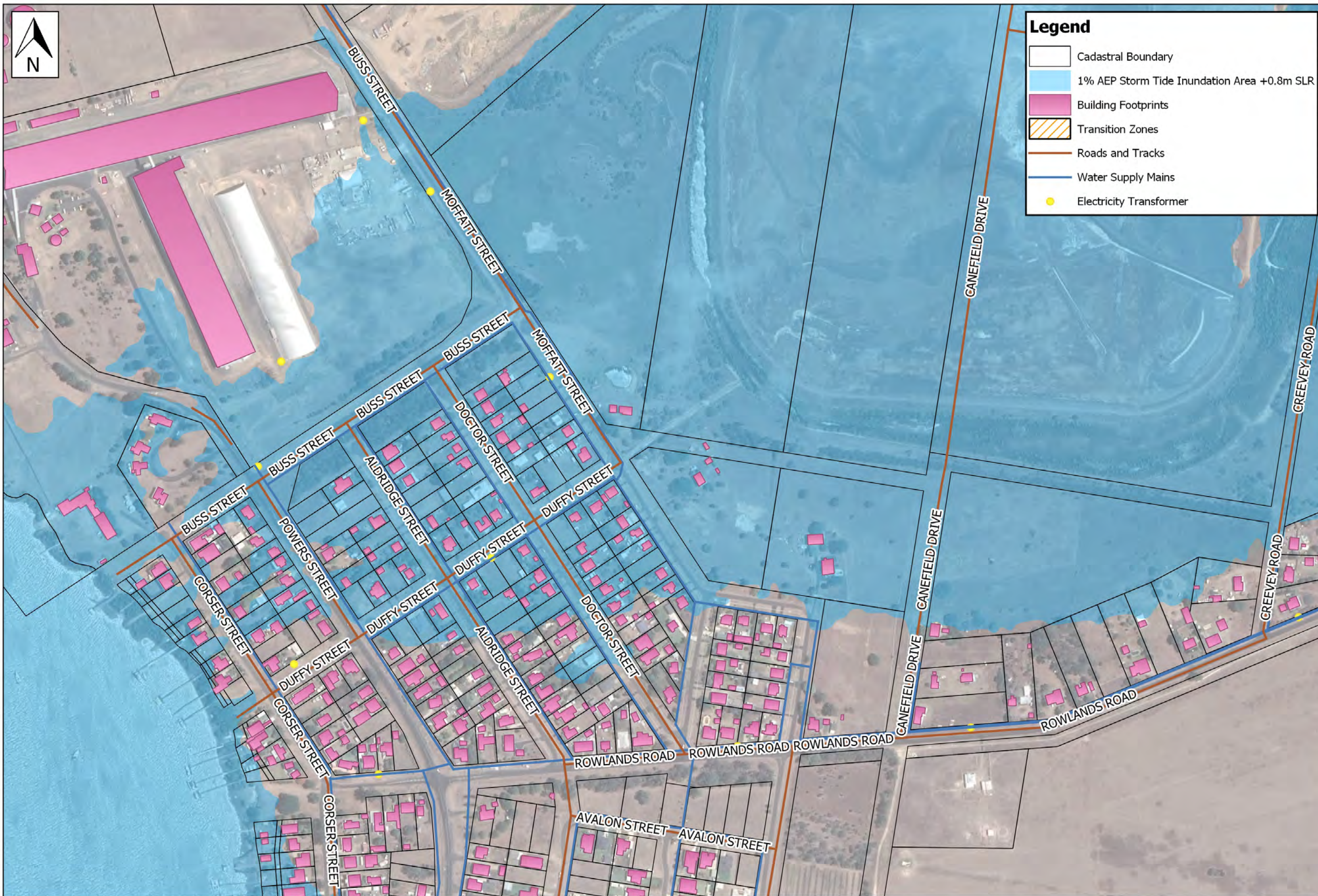
APPENDIX D MAPPING

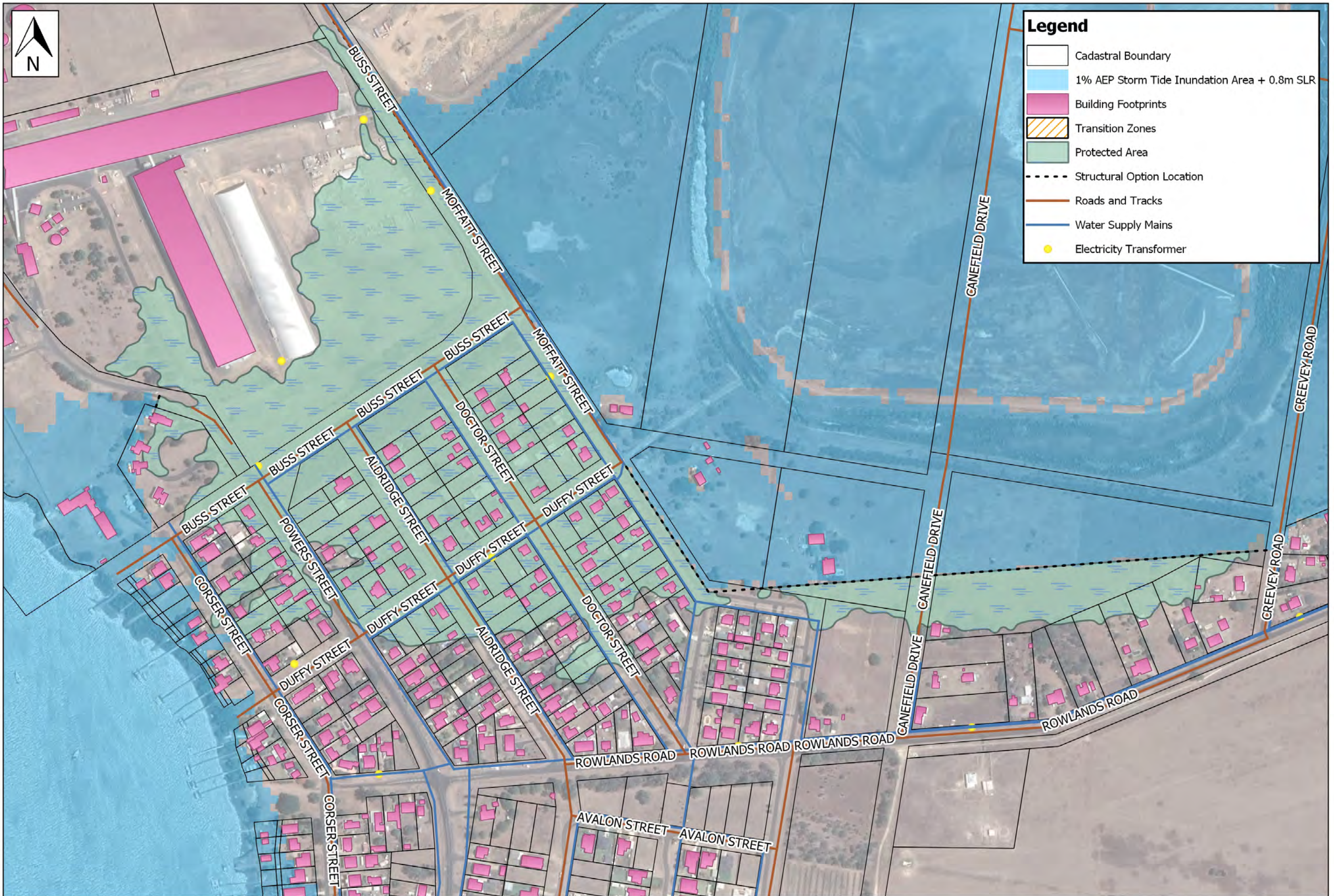


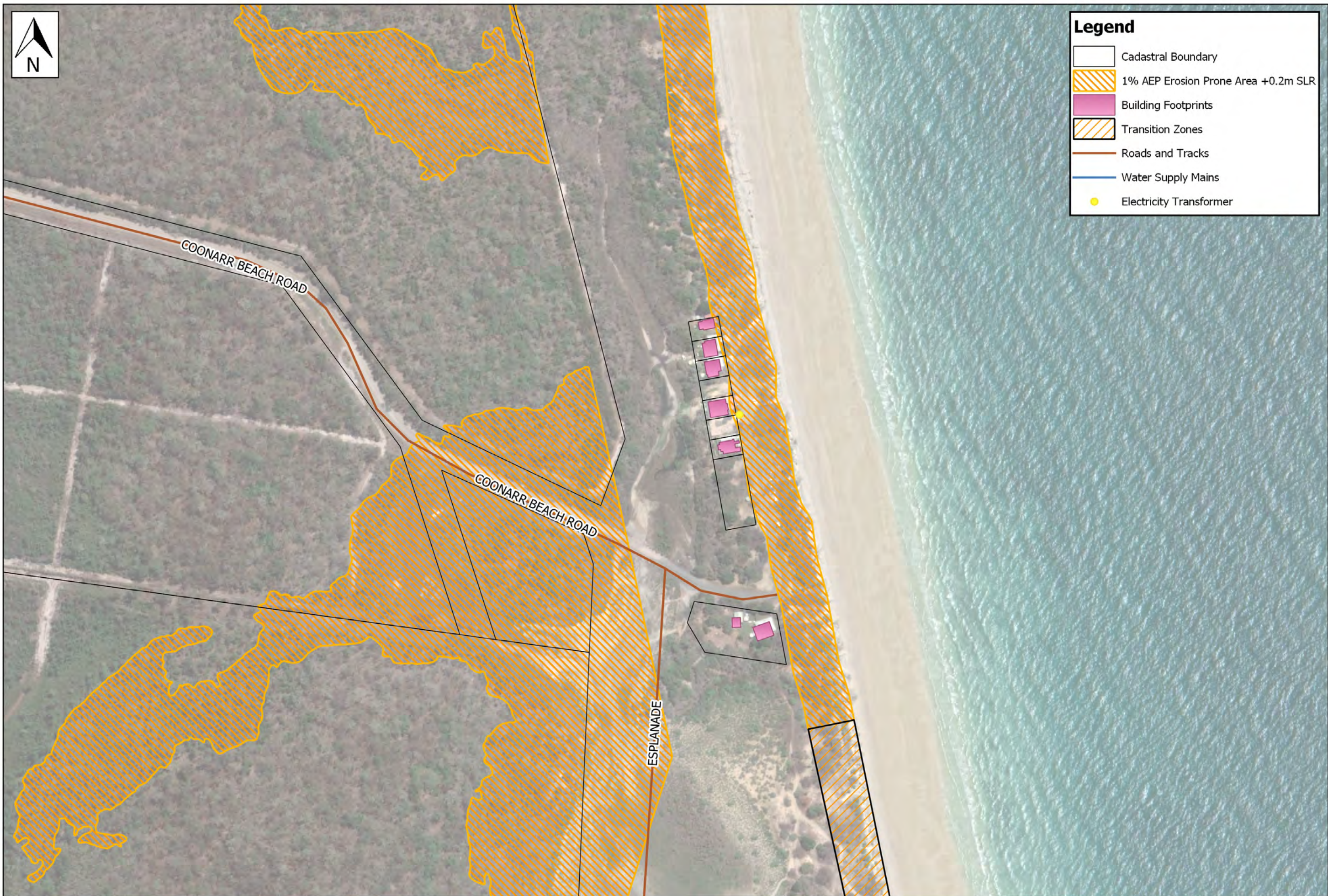


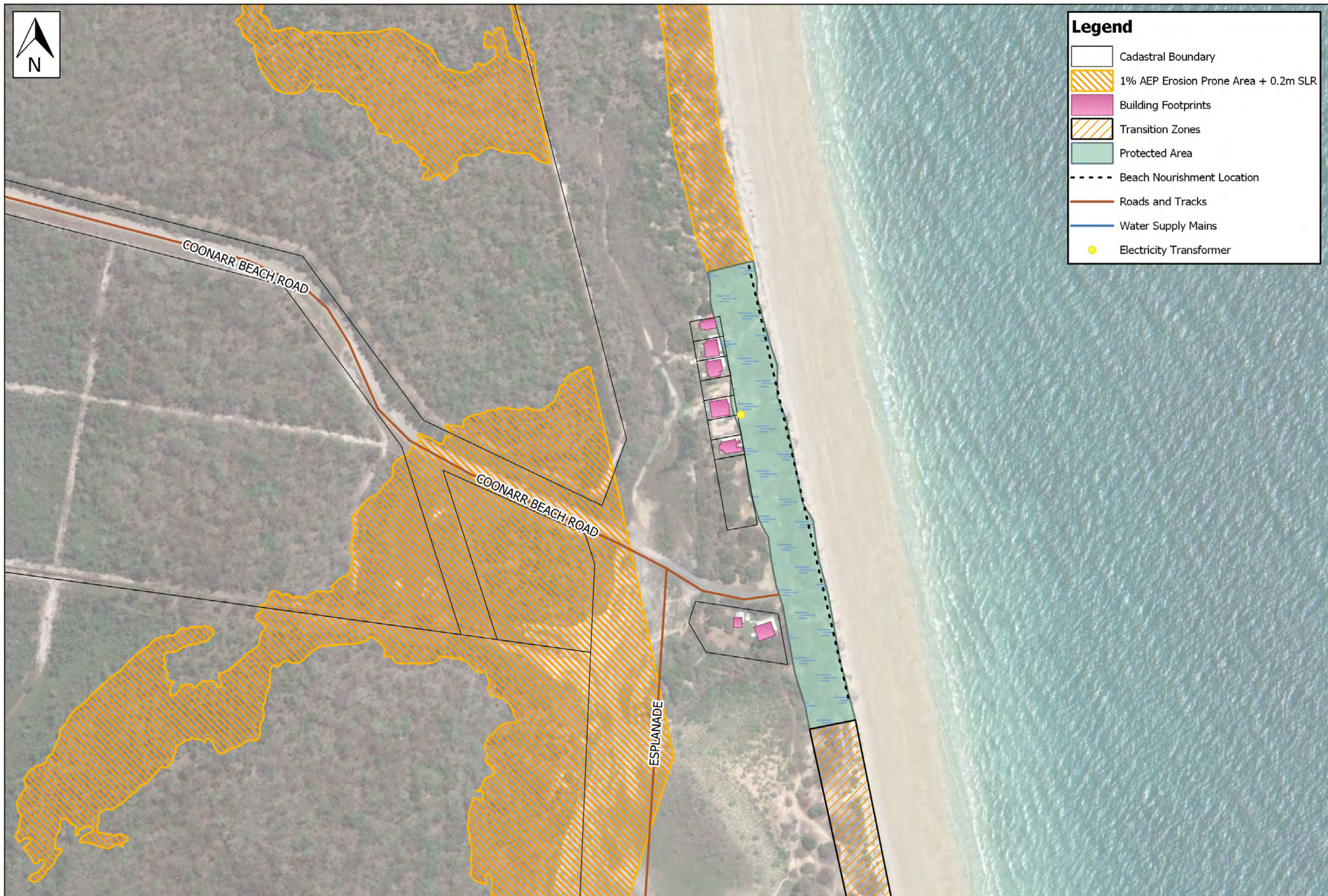


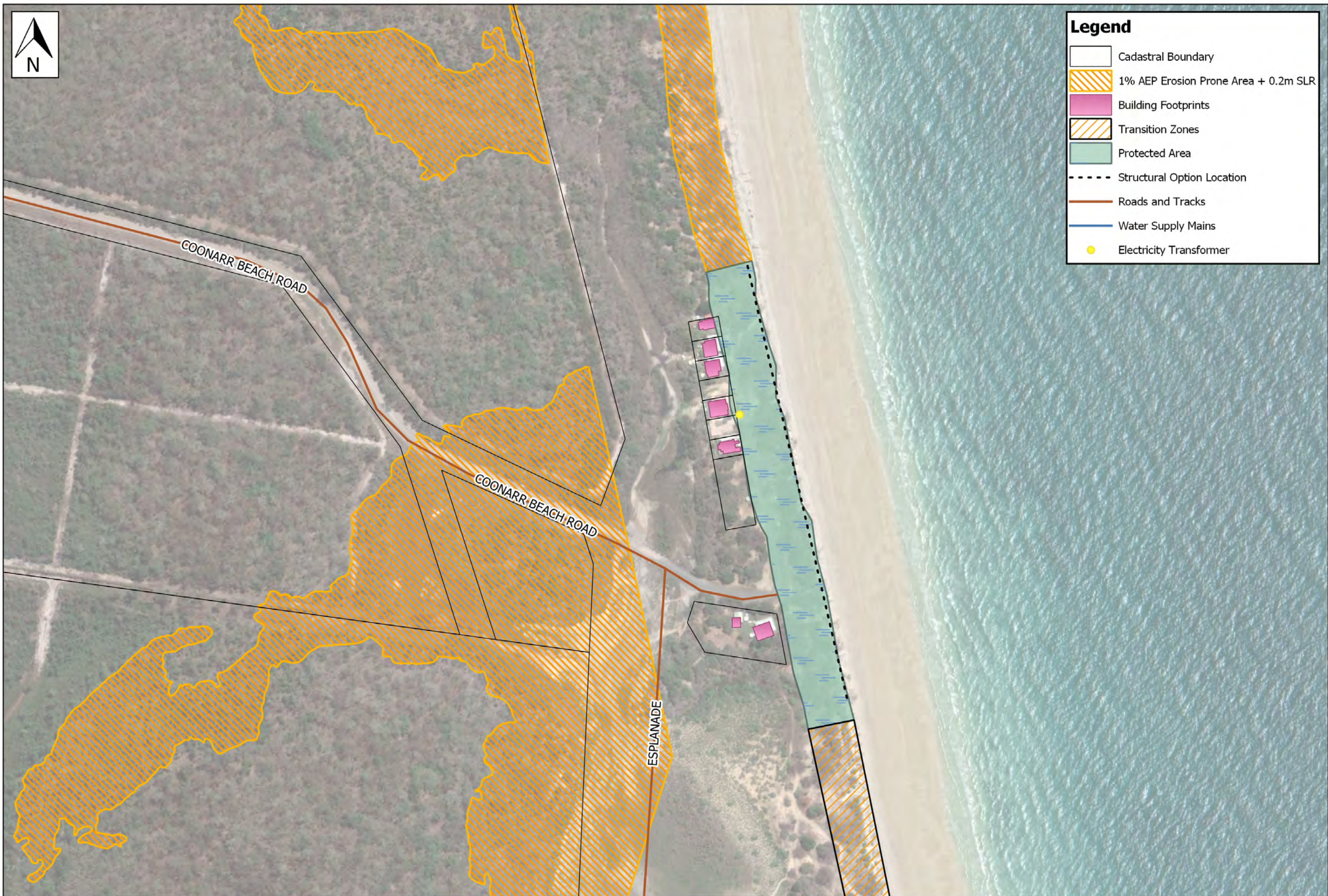


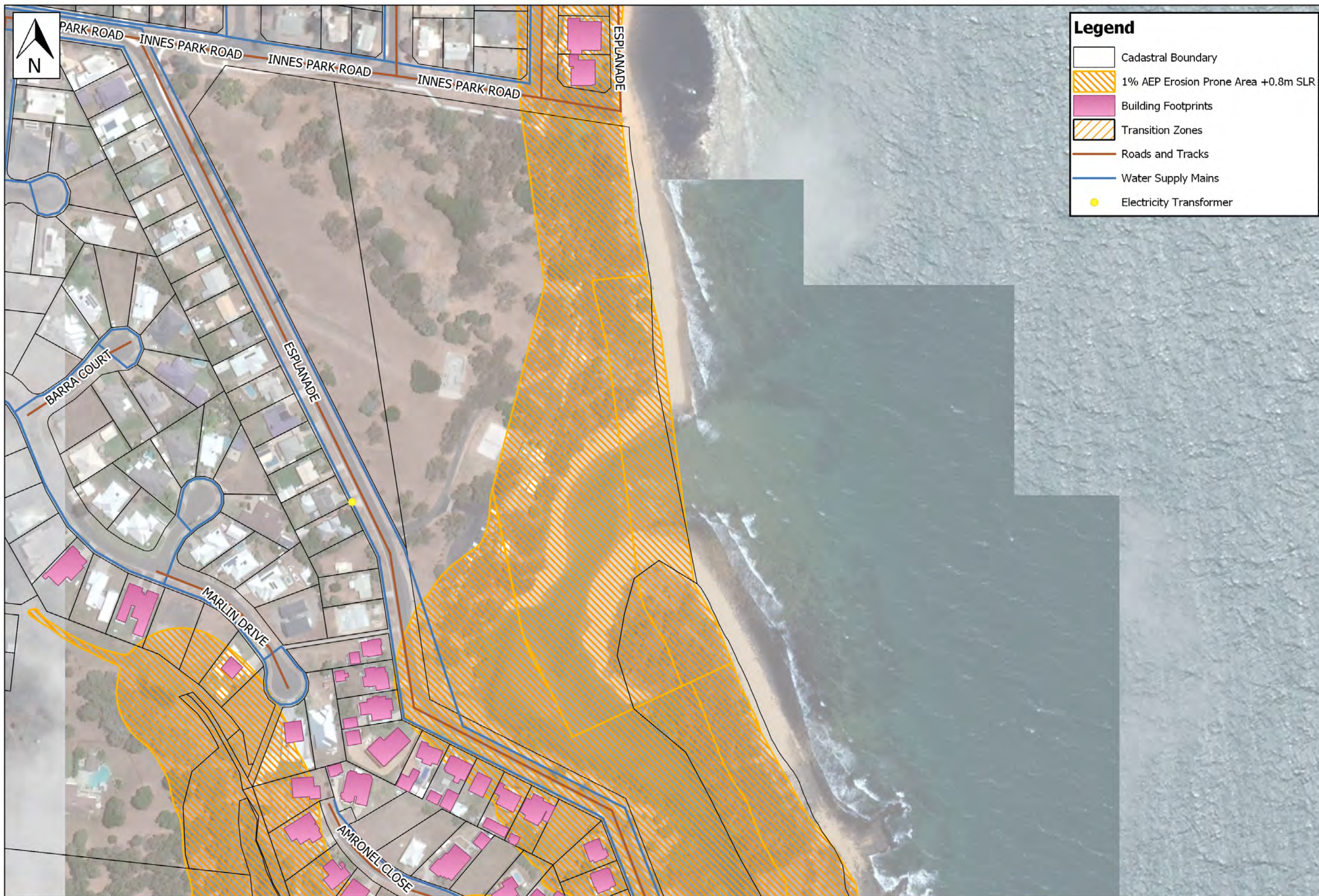






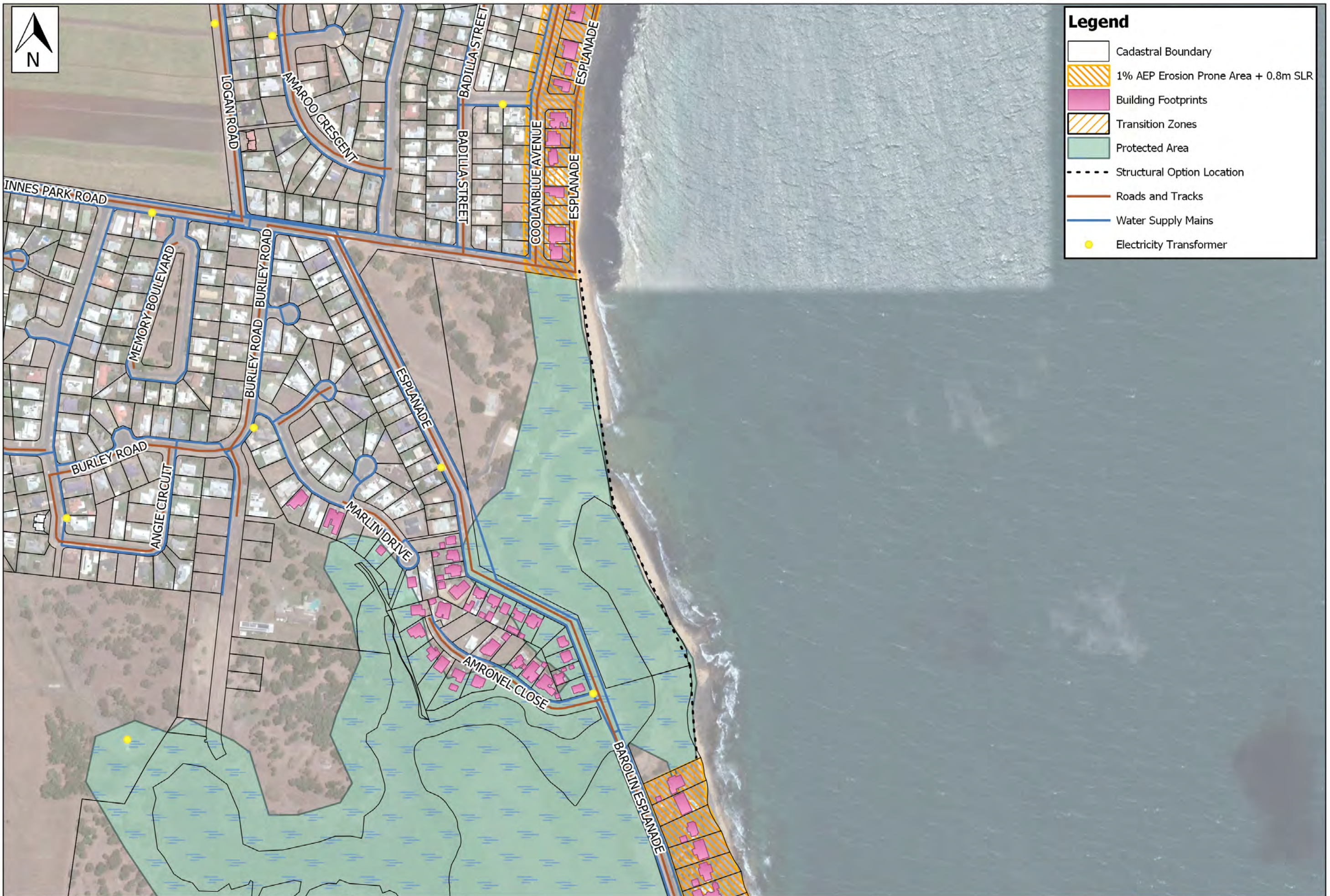


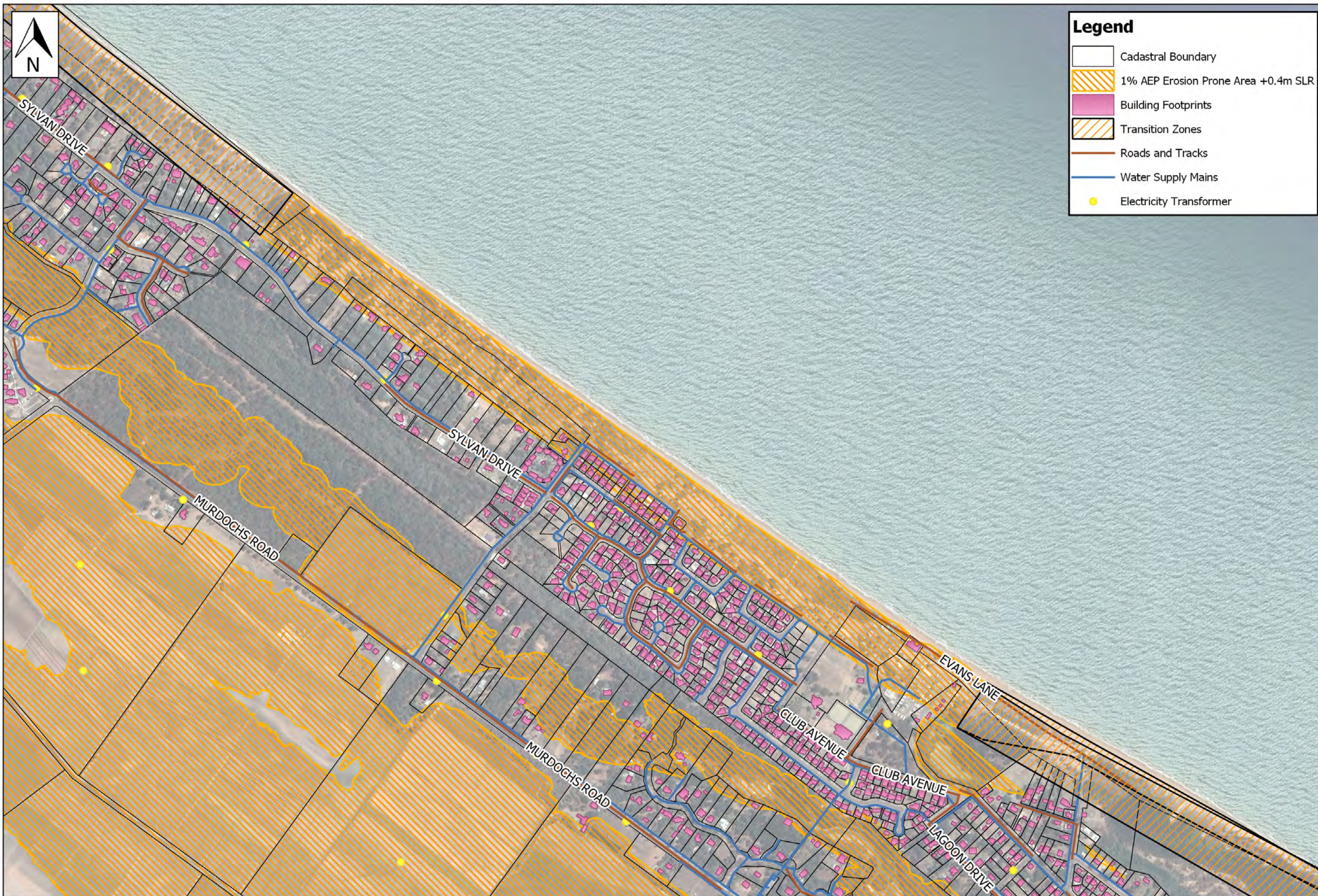




Legend

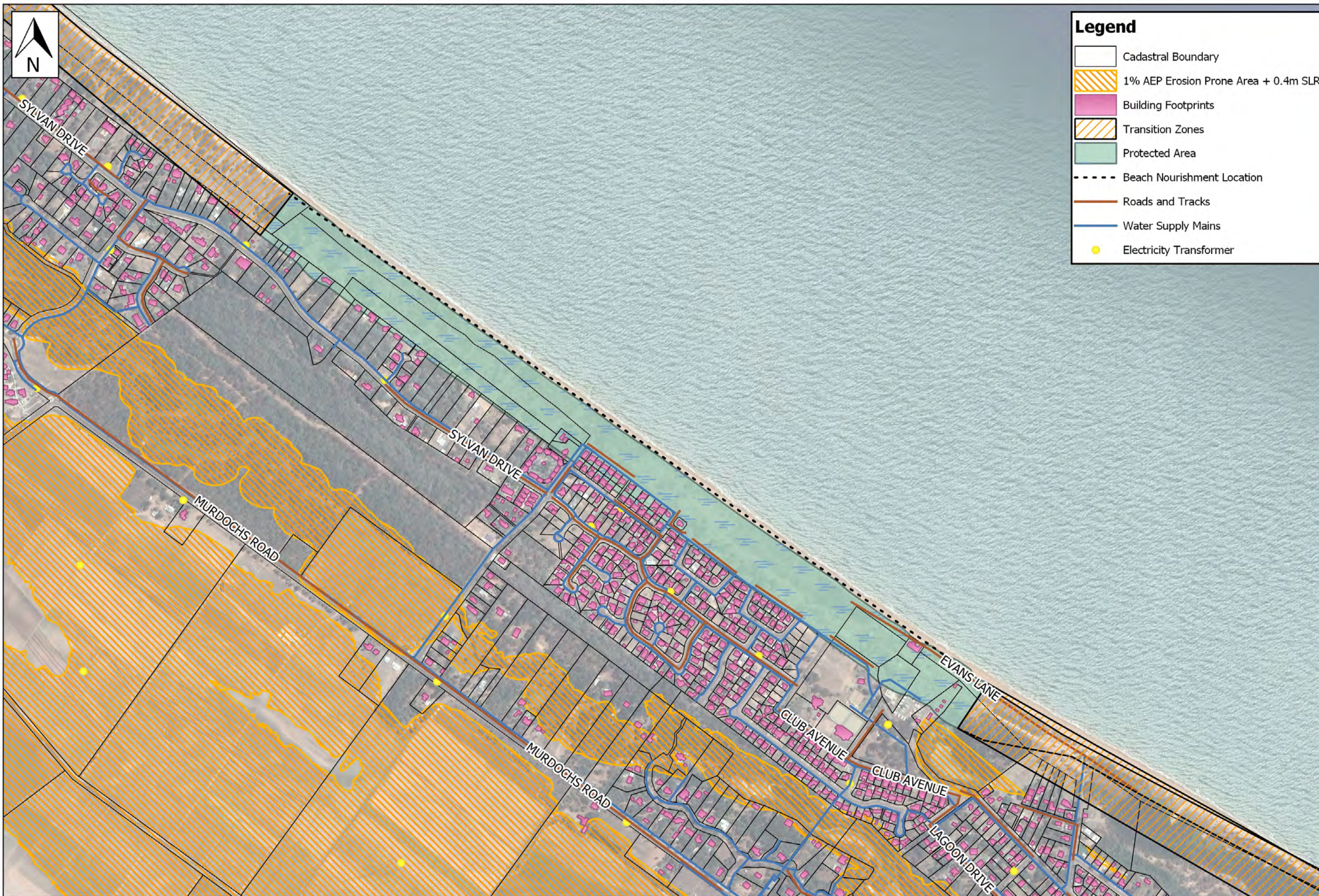
- Cadastral Boundary
- 1% AEP Erosion Prone Area +0.8m SLR
- Building Footprints
- Transition Zones
- Roads and Tracks
- Water Supply Mains
- Electricity Transformer

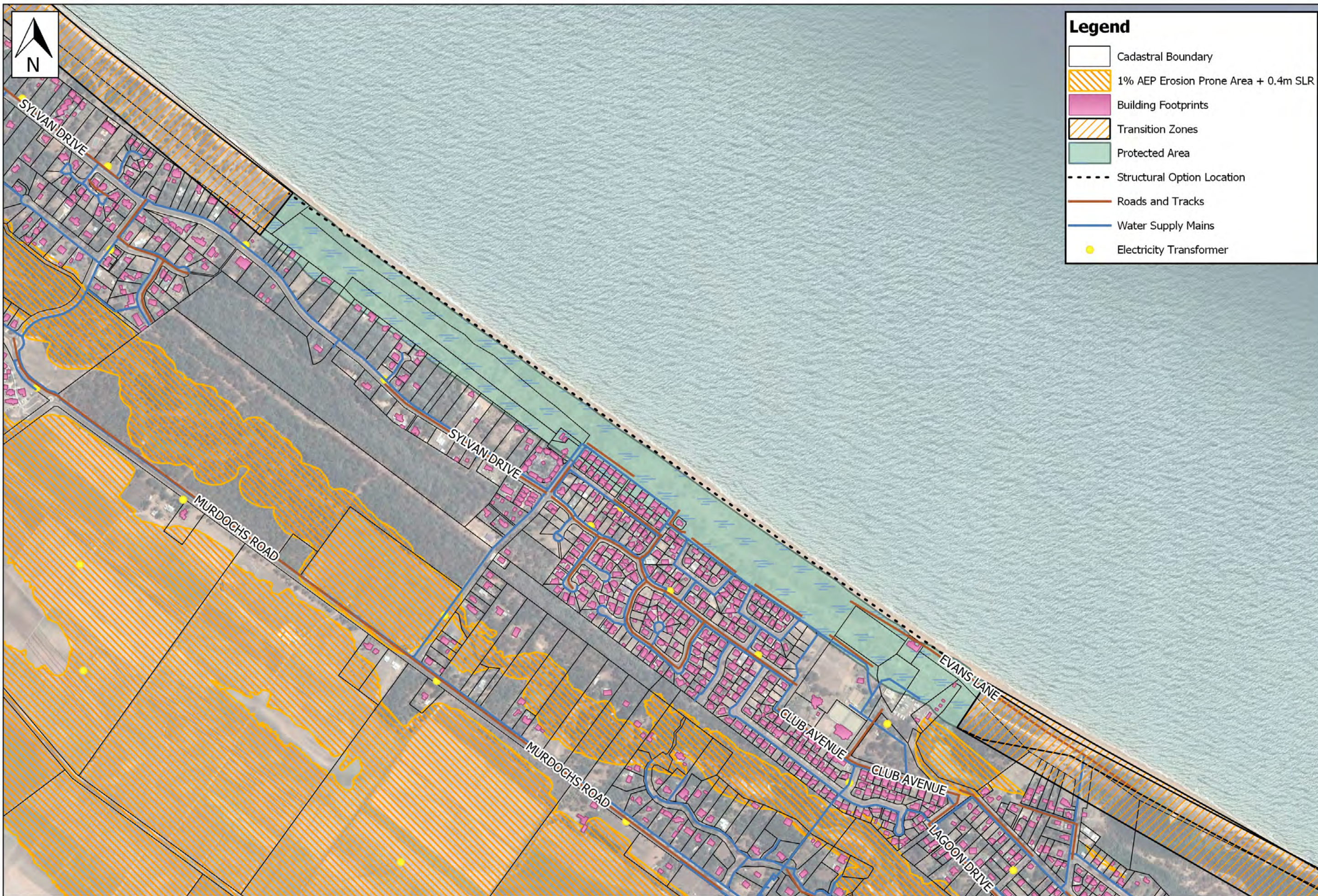


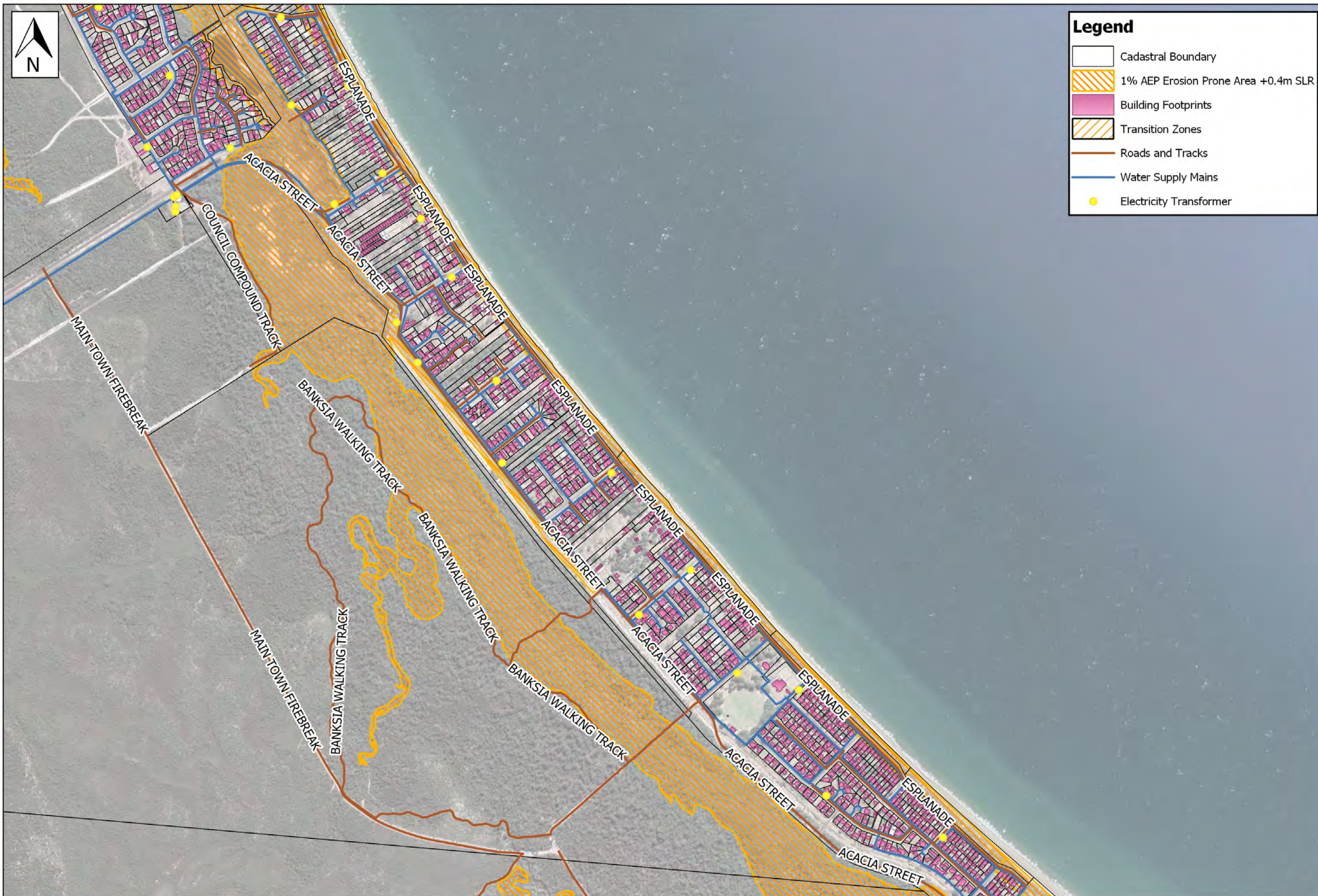


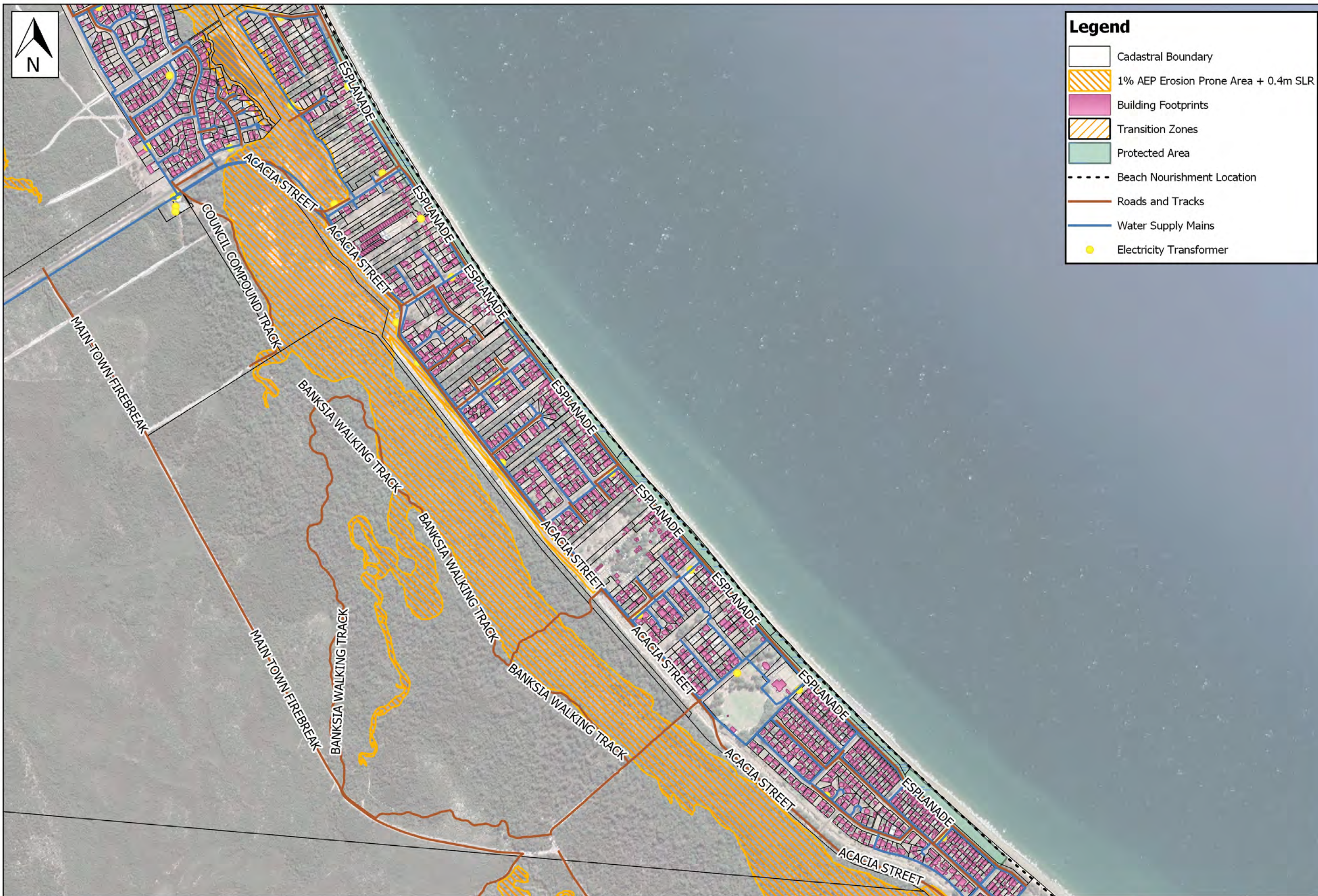
Legend

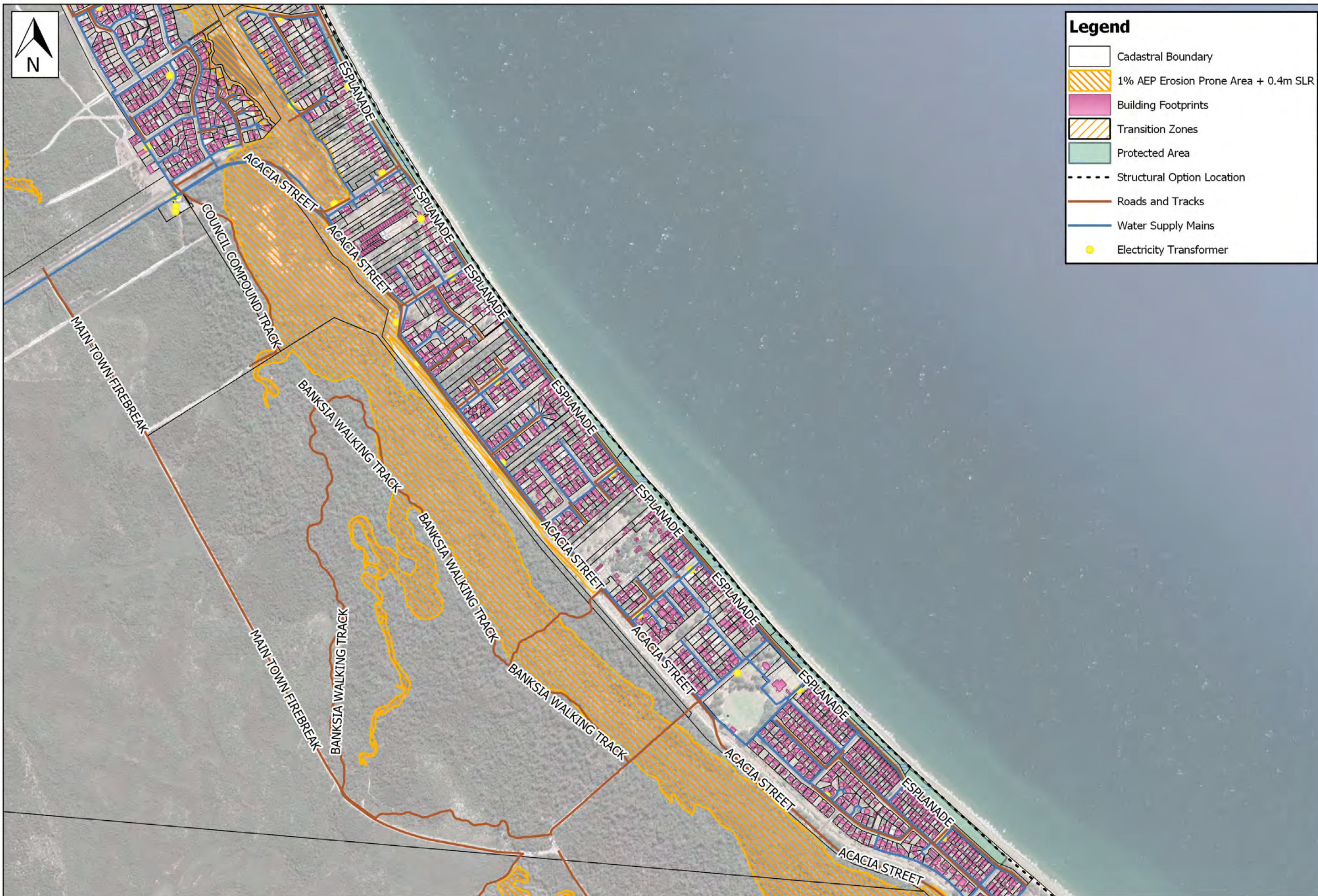
- Cadastral Boundary
- 1% AEP Erosion Prone Area +0.4m SLR
- Building Footprints
- Transition Zones
- Roads and Tracks
- Water Supply Mains
- Electricity Transformer

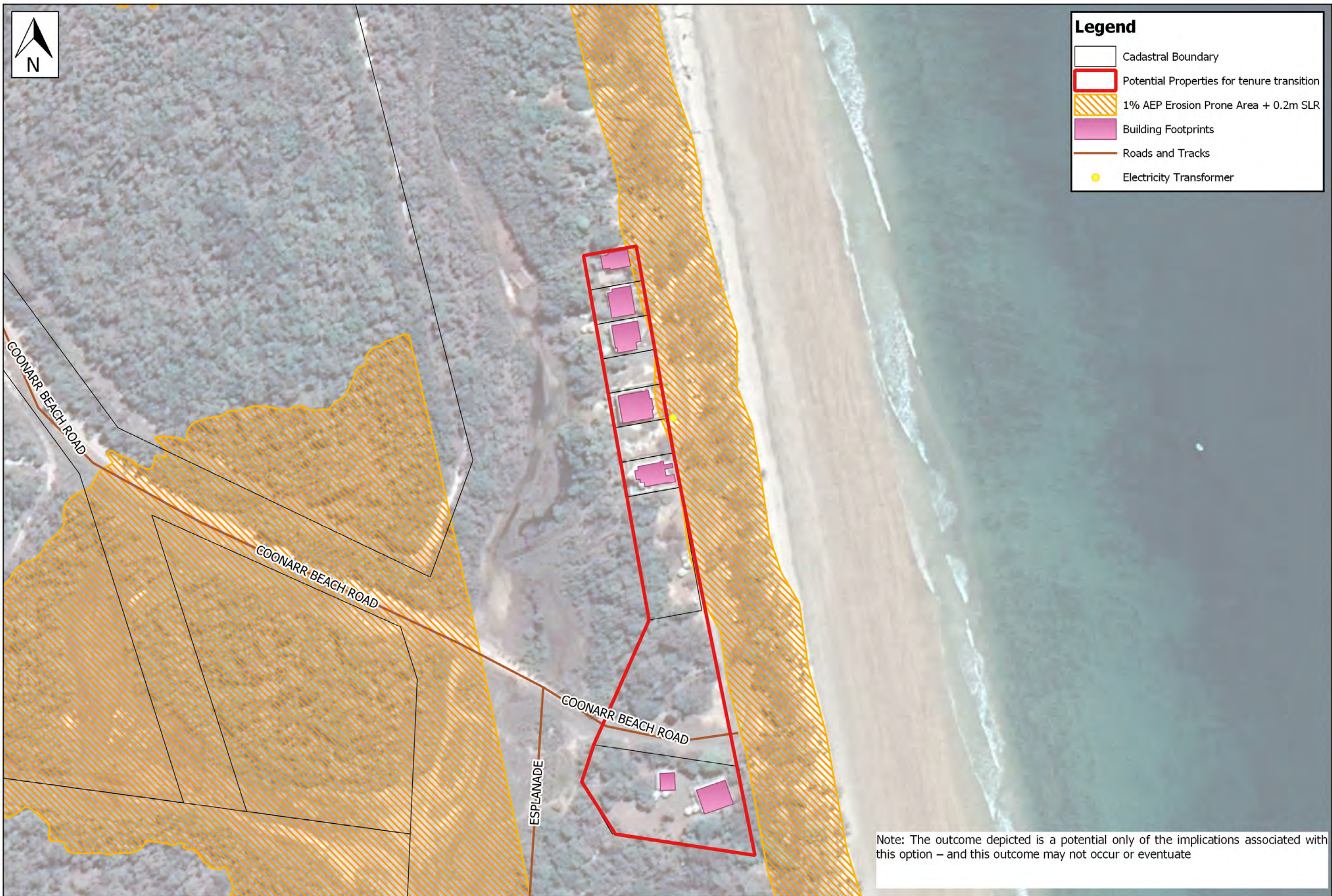












Legend

- Cadastral Boundary
- Potential Properties for tenure transition
- 1% AEP Erosion Prone Area + 0.2m SLR
- Building Footprints
- Roads and Tracks
- Electricity Transformer

Note: The outcome depicted is a potential only of the implications associated with this option – and this outcome may not occur or eventuate

