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Phase 6 Technical Appendix

Bundaberg Region Coastal Hazard Adaptation Strategy

Bundaberg Regional Council

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APPENDIX A
LAND USE PLANNING REVIEW

1 PLANNING SCHEME REVIEW

The Bundaberg Region Planning Scheme was adopted and commenced in 2015 and is drafted under the rules of the Queensland Planning Provisions with a planning horizon to 2031. The planning scheme is currently at version 4.1. including amendments in July 2017 to align with the *Planning Act 2016*. Proposed changes continue with Planning Scheme Amendment No.5 (major) on consultation from 16 September 2019 to 21 October 2019. This section discusses the various parts of the planning scheme which are relevant to the CHAS.

The intent of this section is to provide background and reviews to the land use planning adaptation options in the context of the legislative framework, the current planning tools employed, the current regulatory response and the level of risk and exposure for each settlement. Land use planning is listed in the adaptation pathways for all settlements as an ongoing activity which will always have a role in mitigating risk for people and property.

The review is high-level and the coastal hazards of permanent inundation from sea level rise, storm tide inundation and erosion are not at a scale which permits accurate street-scale or property-scale advice. Recommendations are provided to shape further policy change, planning actions and investigation by planners at a smaller scale and in significant detail. The review does not consider existing permits, unactioned, fine grain topography or any other small ale site-based matter.

1.1 Part 3 - Land Use Planning Vision

The strategic vision is categorised by themes and the 'settlement pattern' theme is most relevant to this project. The overall introduction states (emphasis added):

> *"The settlement pattern of the region is focussed Bundaberg city which is the principal service centre for the region and the location where all major retail, health, commercial, financial and government agencies are located.* ***The region also includes the coastal settlements of Buxton and Woodgate Beach in the south, Moore Park in the north and Elliott Heads, Innes Park, Bargara and Burnett Heads which form a central coastal urban area*** *directly to the east of Bundaberg. In 2011 there were 10 major population centres (with approximately 1,000 or more people) in the Bundaberg Region accommodating most of the urban population. These are, in order of population size:- "*
>
> *(a) Bundaberg (52,371);*
> *(b) Bargara (6,814);*
> *(c) Burnett Heads (2,739);*
> *(d) Innes Park (2,093);*
> *(e) Moore Park Beach (1,910);*
> *(f) Childers (1,559);*
> *(g) Gin Gin (1,191);*
> *(h) Coral Cove (1,097);*
> *(i) Elliott Heads (998); and*
> *(j) Woodgate (941)*

In the settlement pattern theme, the concepts relevant to the CHAS include:

(a) *Urban development is contained to within identified areas to protect the Bundaberg Region's character, lifestyle, rural production capacity and environmental attributes.*

(b) *Identified greenfield areas in Bundaberg City, including the major urban expansion areas of Kalkie-Ashfield and Branyan and the coastal settlements between Burnett Heads and Elliott Heads are the focus for accommodating regionally significant levels of growth. Growth in these areas is to be in accordance with local area structure planning undertaken by the Council.*

(c) *Identified rural and coastal villages provide opportunities for additional services, facilities and residential development subject to demonstrated need and appropriate address of physical and environmental constraints*

The Defined Urban Areas map accompanies the strategic framework. Section 3.3.2 of part three states that development is confined to mapped defined urban areas. The Strategic_framework Map SFM-001 contains much detail but reinforces the LGIP position. Buxton, Winfield, Coonarr, Elliott Heads, Riverview and Miara are not included as 'local activity centres'. Buxton and Winfield are noted as 'villages' and Innes Park, Coral Cove, and Miara are noted as 'district activity centre – rural'.

Elliott Heads, Woodgate Beach, Moore Park, Burnett Heads and Bargara (north and south) are mapped as local activity centres which Bargara is further classified as a district activity centre. An extract is shown as figure two-one below.

(b) The pattern of settlement for the region provides for:-

(ii) Bargara, Burnett Heads, Coral Cove, Innes Park and Elliott Heads to also accept moderate to significant levels of urban growth within a central coastal urban area that supports and complements the role of Bundaberg City and takes advantage of significant investment in a coastal sewerage scheme;

(iv) other coastal and rural towns and villages to be maintained as small scale towns and villages.

(g) The scale and sequencing of development within urban areas:-

(ii) is consistent with Council's plans for infrastructure investment and, in particular, the provision of reticulated sewerage to the central coastal urban area and the eastern part of Bundaberg City;

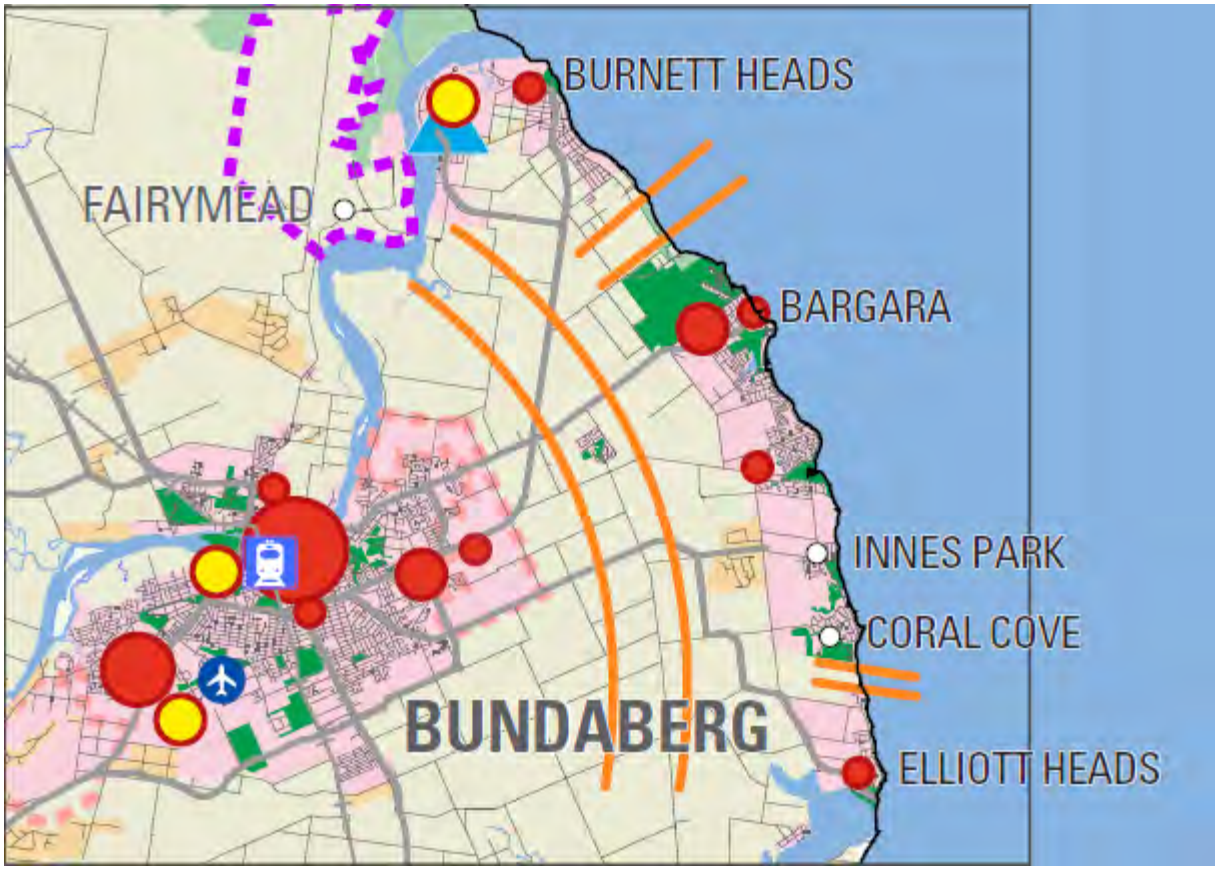

Figure 1-1 Extract from SFM-001 Strategic Framework Map, Bundaberg Planning Scheme 2015

The larger the red dot the higher the centre is categorised in the centres' hierarchy, starting with a Principal Centre in the CBD. The medium sized dot indicates Major and District centres for Bargara while the smaller white dots are local centres (rural).

Overall the strategic framework does not promote considerable development in areas of risk identified by the CHAS. The growth centres of Bargara, Innes Park and Coral Cove have some small areas of concern, but for the most part display less risk exposure than the smaller coastal villages with higher risk profiles.

1.2 Part 4 - Local Government Infrastructure Plan

The LGIP for Bundaberg is in a standard format and provides a dark hatched black line to depict the extent of infrastructure provision in settlements to 2031. The line appears under the zone colours on the mapping system, making legibility problematic, so separate maps have been generated for the place-based visions in the main document in section three. The LGIP makes provision for:

- roads;
- sewerage;
- water;
- stormwater;
- community facilities; and
- parks

The planning scheme binds the LGIP and the land use provisions using the infrastructure theme of the strategic framework. Development must proceed in a coordinated and logical sequence to maximise use of existing infrastructure. The LGIP boundary is an inidicator of the vision for growth for a settlement and has been used to frame the vision or each settelment in the Phase 6 report.

Overall, the LGIP is consistent with the settlement theme in Part three of the scheme and further demonstrates the level of development expected to occur in the life of the planning scheme.

1.3 Part 6 – Zone Codes

The project includes a technical zone analysis which lists the number of zones, quantity and areas contained within the storm tide inundation area and erosion prone zone on a regional basis in Phase 5. This technical appraisal is not on a settlement or property scale. The zone of an area will serve as some indication of the intent for development, along with the capacity for that land to be further developed.

The Bundaberg Planning Scheme does not use a village or township zone which is common in other local government areas for isolated settlements where growth is not intended. Development of a dual occupancy in all settlements is accepted subject to requirements, which on the surface appears to allow infill development in the smaller settlements where growth is not forecast. On closer scrutiny the requirements include a minimum lot size of 2,000 square metres which would exclude available zoned land in the settlements of Riverview (Elliott Heads south), Buxton, Moore Park Beach, Miara and Winfield. Coonarr does not have any Low density residential zoned land.

Looking at the zones for each settlement, Winfield, Buxton and Riverview contain only Low density residential, Rural and Open space zones. Buxton on the Burrum River and Coonarr are completely rural with areas of Rural residential settlement. Miara contains a small amount of Low-density residential zone and is principally zoned Limited development (constrained land) apart from the Community facilities zone at the caravan park.

The areas with capacity for development include Moore Park Beach with Low and Medium density residential, Rural residential, Local centre and Community facilities zone at the caravan park. Burnett Heads includes a full range of zones as does Bargara. Bargara is the only area to include High density residential outside of Bundaberg city. It also has a District centre zone.

Further south, Innes Park only has residential zones of Low density and Emerging community while Coral Cove and Woodgate have small areas of Medium density and Local centre. Elliott Heads is similar with large areas of expansion and only low and medium density residential zones with no centre zones. The zone codes do not specifically refer to any centres other than for the purposes of growth where settlements feature land in the Emerging community zone. Bargara is mentioned a number of times in the relation to the centres. The mandatory purpose statements for each zone in the study area are provide din Table 1-1.

TABLE 1-1 ZONES AND PURPOSE STATEMENTS IN THE STUDY AREA

Zone Name	Mandatory Purpose
Low density residential zone	The purpose of the low density residential zone is to provide for— (a) a variety of low density dwelling types, including dwelling houses; and (b) community uses, and small-scale services, facilities and infrastructure, to support local residents.
Medium density residential zone	The purpose of the medium density residential zone is to provide for— (a) medium density multiple dwellings; and (b) community uses, and small-scale services, facilities and infrastructure, to support local residents.
High density residential zone	The purpose of the high density residential zone is to provide for— (a) high density multiple dwellings; and (b) community uses, and small-scale services, facilities and infrastructure, to support local residents.
Neighbourhood centre zone	The purpose of the neighbourhood centre zone is to provide for— (a) a small variety of uses and activities to service local residents; and (b) other small-scale uses and activities that directly support local residents, including, for example, community services, convenience shops or offices.
Local centre zone	The purpose of the local centre zone is to provide for— (a) a limited variety of commercial, community and retail activities to service local residents; and (b) other uses and activities that integrate with, and enhance, the local centre, including, for example, entertainment, shopping or residential uses.
District centre zone	The purpose of the district centre zone is to provide for a large variety of uses and activities to service a district of the local government area, including, for example, administrative, business, community, cultural, entertainment, professional, residential or retail uses or activities.
Open space zone	The purpose of the open space zone is to provide for— (a) local, district and regional parks for the use of residents and visitors; and (b) facilities and infrastructure that support, and are required by, users of the parks.
Sport and recreation zone	The purpose of the sport and recreation zone is to provide for— (a) a variety of cultural, educational, recreation and sporting uses and activities that require built infrastructure, including, for example, clubhouses, gymnasiums, swimming pools or tennis courts; and (b) facilities and infrastructure to support the uses and activities stated in paragraph (a).

Zone Name	Mandatory Purpose
Environmental management and conservation zone	The purpose of the environmental management and conservation zone is to provide for the protection and maintenance of areas that support 1 or more of the following— (a) biological diversity; (b) ecological integrity; (c) naturally occurring landforms; (d) coastal processes.
Community facilities zone	The purpose of the community facilities zone is to provide for community-related uses, activities and facilities, whether publicly or privately owned, including, for example— (a) educational establishments; and (b) hospitals; and (c) transport and telecommunication networks; and (d) utility installations.
Emerging community zone	The purpose of the emerging community zone is to— (a) identify land that is intended for an urban purpose in the future; and (b) protect land that is identified for an urban purpose in the future from incompatible uses; and (c) provide for the timely conversion of non-urban land to land for urban purposes.
Limited development zone	The purpose of the limited development zone is to identify land that is significantly affected by 1 or more development constraints, including, for example, constraints relating to defence requirements, flooding, historical subdivisions, land contamination, past or future mining activities or topography.
Rural zone	The purpose of the rural zone is to— (a) provide for rural uses and activities; and (b) provide for other uses and activities that are compatible with— (i) existing and future rural uses and activities; and (ii) the character and environmental features of the zone; and (c) maintain the capacity of land for rural uses and activities by protecting and managing significant natural resources and processes.
Rural residential zone	The purpose of the rural residential zone is to provide for residential uses and activities on large lots, including lots for which the local government has not provided infrastructure and services.

The Limited Development zone is used a number of times in the scheme. The purpose of this zone is to limit development where it is affected by considerable constraints, typically natural hazards. The zone is also used to limit development on historical subdivisions, at Burnett Heads, for example.

Queensland is dotted with already subdivided small community which were created during early development years to encourage settlement and some were created post-war to provide returned soldiers with opportunity. Many of these existing subdivisions are in very risk-exposed, isolated, un-serviced and in inappropriate locations but carry land use rights for a dwelling house. The scheme has applied this zone to a number of historic subdivisions in the region ad includes the purpose statement:

(e) historical subdivisions included in the zone may only be further developed for residential purposes subject to appropriate servicing arrangements and the provision of a more contemporary and responsive subdivision pattern and layout;

Overall, the coastal areas included in the CHAS provide a full range of zones for growth and as expected of a beach-side and coastal settlement. The focus is on residential uses with supporting local services as outlined in the part three strategic framework. There are 14 zones represented from a potential suite of 41 with a distinct absence of higher order commercial zones, industry or special purposes zones.

1.4 Part 7 - Local Area Plans

There is one Local Area Plan (LAP) within the planning scheme: the Central Coastal Urban Growth Area LAP which is more akin to a structure plan; and the more recent Burnett Heads LAP. The Burnett Heads LAP was done after the adoption of the planning scheme but is principally used to inform changes.

Development within the red outlined areas in the Strategic Framework Map is triggered for assessment under this local area plan. Assessment is triggered at Reconfiguration of a Lot stage. The purpose of the Central Coastal Urban Growth Area Local Plan Code is to ensure growth occurs in the identified growth areas in a way that maintains coastal character as follows:

(a) development for urban purposes occurs only in areas identified for urban development so as to protect the natural environment, preserve areas of open space, minimise impact on economic resources, avoid highly constrained land, maintain separation between discrete communities along the coast and provide for the efficient provision of infrastructure and services;
(b) development contributes to a pattern of settlement that maintains and reinforces the local character and identity of discrete communities and neighbourhoods along the central coastal urban growth area by:-
(i) preserving two large non-urban areas (inter-urban breaks), between Burnett Heads and Bargara in the north and Coral Cove and Elliott Heads in the south; and (ii) retaining and enhancing smaller non-urban areas (intra-urban breaks) that help to distinguish individual places within the urban fabric

Many of the provisions of the code seek to maintain and create walkable, accessible and vibrant coastal centres with identity and subservience to the natural environment.

The LAP is consistent with the other provision of the scheme reviewed in that growth is strategically envisaged in this coastal growth areas accommodating principally residential purposes with local supporting land uses. Importantly it seeks to preserve the coastal area for public access and future development is set back from the shoreline. Future development maintains the relatively low density scale and intensity of development which characterises the Bundaberg Region.

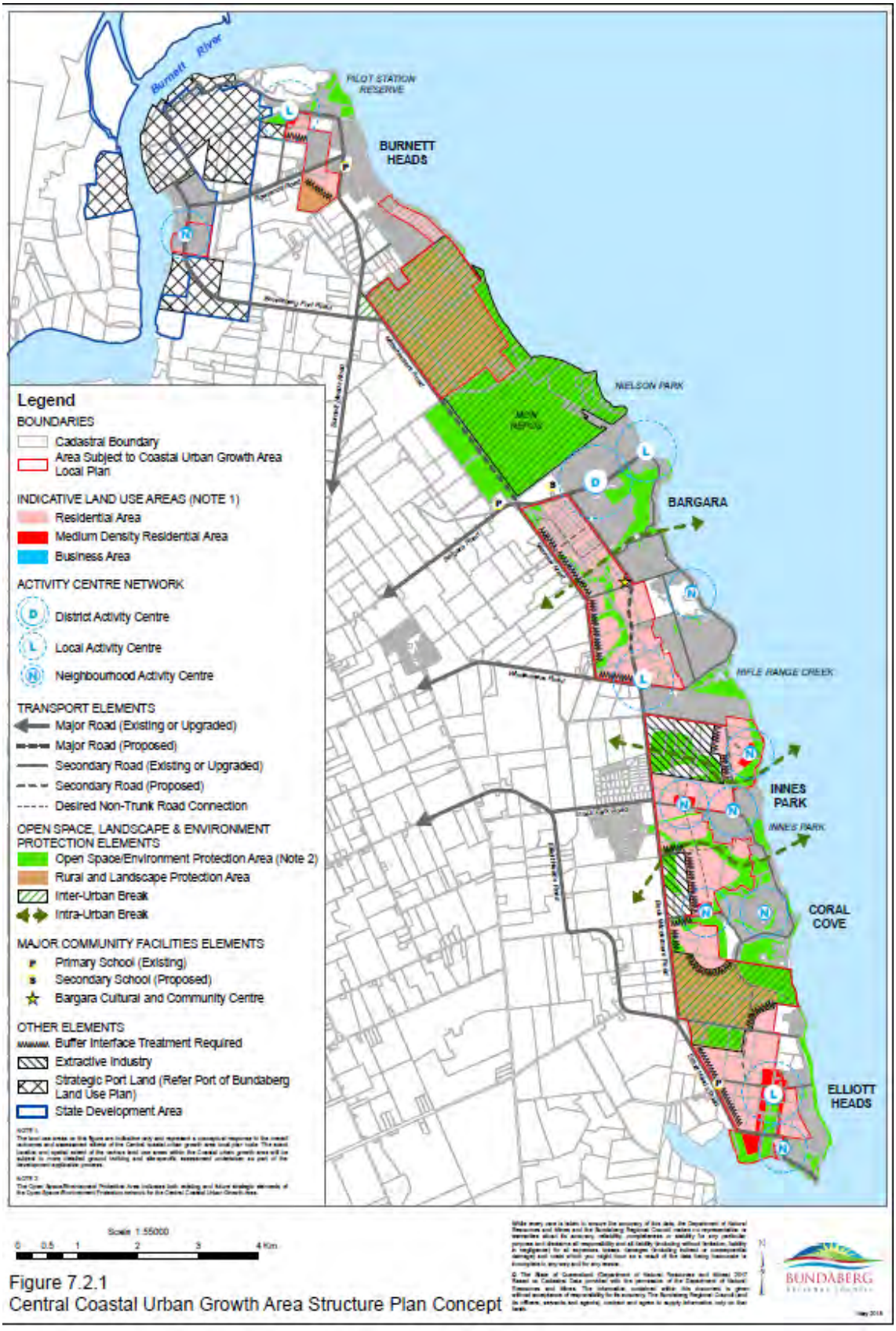

Figure 7.2.1
Central Coastal Urban Growth Area Structure Plan Concept

FIGURE 1-2 LOCAL AREA PLAN MAP FOR THE COASTAL GROWTH AREAS

1.5 Part 8 – Overlays

The scheme includes a Coastal Protection Overlay code which is triggered by development shown within the CMD or the EPZ identified in the SPP interactive mapping system discussed above at the time it was adopted in 2015. The overlay includes a coastal set back line and adopts the SPP mapping for the Coastal Management district and the Ersoion prone Zone but not the storm tide inundation which was included in the SPP in more recent versions after the scheme was adopted.

To accompany the overlay mapping is the written code containing provisions for assessing development. The code provides a very clear purpose statement with emphasis added below. The intent of the code conveys the need to avoid any further intensification of the built environment in the erosion prone zone.

(2) The purpose of the code will be achieved through the following overall outcomes:-

> *(a) development allows for natural fluctuations of the coast as far as practicable,* ***including appropriate allowance for climate change and sea level rise;***
>
> *(b) unless explicitly anticipated by the planning scheme through the allocation of zones, development within an erosion prone area* ***avoids:-***
>
> > *(i)* ***intensification*** *of existing uses;*
> >
> > *(ii) new permanent built structures; or*
> >
> > *(iii) seaward extensions to existing built structures;*
>
> (*c) development avoids adverse impacts to coastal landforms and alterations to physical coastal processes and, as far as practicable, avoids the need for coastal protection works;*
>
> *(d) development preserves the integrity of the coastal setback line as the defined seaward boundary for building work and other development adjacent to the beachfront;*
>
> *(e) development maintains public access to the coast consistent with maintaining public safety and conserving coastal resources;*
>
> *(f) development preserves opportunities for locating coastal-dependant land uses in areas adjoining tidal waters.*

The overlay has two Bundaberg-specific aspects which are the Coastal Building Line and the Sea Turtle Sensitive Area. The Turtle Sensitive Area, extends for the full length of the coast in the local government area for a depth of approximately 1,500m landward from what appears to be the toe of the frontal dune; and the Coastal setback line which applies to approximately 475m of coast at Kellys Beach and approximately 330m (15 properties) on Theodolite Creek Drive and Woodgate Beach.

This provision applies to building and structure setbacks to beach fronts due to sections of coast featuring some cadastral anomalies requiring regulation or being at high risk of erosion. New development including swimming pools is required to be setback 6m landward of the coastal building line. See Figure 1-3 below.

FIGURE 1-3 THE COASTAL SETBACK LINE AT WOODGATE BEACH AND KELLY'S BEACH

Examples of the provisions contained in the code which are applicable to current development proposals are shown below.

Extracts from the Costal Protection Overlay Code

AO1 All buildings and other permanent structures are setback at least 6m landward of the coastal setback line for the site.; or

Where there is no coastal setback line for the site, and the site adjoins the beachfront or a beachfront reserve, all buildings and permanent structures are located:- (a) landward or equal to the seaward alignment of any buildings on neighbouring properties; or (b) where there are no neighbouring properties, at least 6m from the seaward property boundary of the site.

Note—'permanent structures' includes swimming pools and retaining walls.

AO2 Development is situated wholly outside of an erosion prone area in a coastal management district, except where:- (a) essential community infrastructure; (b) temporary and/or relocatable development; (c) redevelopment; or (d) coastal-dependent development.

Bundaberg Region Planning Scheme p8-19

FIGURE 1-4 EXTRACT FROM PART 5 - TABLES OF ASSESSMENT FOR THE COASTAL PROTECTION OVERLAY

The concern for the coastal overlay is that the levels of assessment do not capture low-risk style of development which might be placed in future high risk areas. This applies to allotments already created and zoned a long time ago without regard to the risk. There is no changed in assessment levels for land affected by the overlay in the case of a Material Change of Use.

Coastal protection overlay – if within a coastal management district, erosion prone area or coastal setback line		
Material change of use involving the construction of a new building or structure, or an increase in the gross floor area of an existing building or structure, if:- (a) within a coastal management district or erosion prone area as identified in the SPP interactive mapping system (plan making); or (b) located on a site that is subject to a coastal setback line as identified on a Coastal protection overlay map.	**No change**	Coastal protection overlay code

FIGURE 1-5 EXTRACT FROM THE COASTAL OVERLAY

The overlay is an essential planning tool and the employment of building setback lines is useful in established areas where risk has emerged. The overlay has the capacity to be a more powerful regulatory response for council in the context of coastal hazards. This is reflected in the recommendations in section three of this document.

2 STATE PLANNING POLICY

The minimum requirements for local governments to forward the state interests for management of coastal matters are set out in two sections of the State Planning Policy 2017 (SPP). The state interest of Planning for Safety and Resilience to Hazards which, for the purposes of this report, covers planning policy for sea level rise, the erosion prone zone (EPZ) and storm tide inundation. The state interest in protecting coastlines is found in the Environment and Heritage section of the policy. This interest includes the adopted Coastal Management District (CMD) which defines and area over which the state has a particular interest. The SPP outcomes are mandatory for local governments to integrate into planning instruments, as they apply to the local context.

The Bundaberg Planning Scheme was adopted in 2015 after the first version of the current SPP was issued in 2014. The scheme confirms that SPP interactive mapping has been adopted (refer table 1.7.4 in the scheme) and that the scheme has integrated all state interests effective July 2014 (refer section 2.1 of the scheme).

After the ascension of the *Planning Act* in 2016 and its commencement on 1 July 2017, the state issued a new version of the SPP also dated 1 July 2017. Thus, there are differences in the SPP mandatory components, between 2014 and 2017 and therefore implications for the Bundaberg Region Planning Scheme 2015. The policy statement for the natural hazards, risk and resilience component of the Planning for Safety and Resilience to Hazards says:

> **The risks associated with natural hazards, including the projected impacts of climate change, are avoided or mitigated to protect people and property and enhance the community's resilience to natural hazards. *(SPP, 2017, p.51)***

This part of the SPP includes state interests for coastal biodiversity, cultural heritage, water quality and the coastal environment. The CMD is mapped under this policy interest. The policy statement for the coastal environment is:

> **The coastal environment is protected and enhanced, while supporting opportunities for coastal-dependent development, compatible urban form, and maintaining appropriate public use of and access to, and along, state coastal land. (SPP, 2017, p.41)**

The policy includes tidal waters dunes and wetlands and seeks to maintain existing landforms and access for all to coastal areas for liveability and scenic amenity. The policy requires that future development is achieved through infill and reclamation occurs only in very limited circumstances.

The provisions of the SPP are considered at plan-making stage and generally do not have a role in development assessment, where the policy has been integrated. The SPP is purposefully, for the most part a strategic plan making tool and local planning instruments should apply the policy intent in a more detailed and localised manner when plan-making.

Local government is free to build on the SPP framework when drafting planning instruments to address local land use planning issues in a fit-for-purpose manner using other planning tools. These may include changing zones, applying alternative assessment levels, requiring higher standards of compliance, applying alternative solutions for development intensity, set back, built form or conducting local technical studies to update state-wide mapping. In all cases, local government must demonstrate how the SPP outcomes are achieved through

the planning instrument while enabling this to occur in consideration of broader strategic themes for a locality such as growth aspirations, economy, industry, topography and exposure to natural hazards to name a few.

The SPP statements come with a range of state-wide mapping. Local government can either adopt the state prepared mapping as provided or in many cases are able to vary the mapping where local conditions warrant. The SPP also provides recommended code provisions and suggested regulatory responses for inclusion in planning schemes. These responses are reviewed and approved by the state government agencies as part of the planning scheme state interest review, prior to adoption.

For the purposes of land use planning recommendations in this report, the more recent SPP 2017 is the appropriate benchmark for the minimum planning response. The planning scheme should seek to reflect the most up to date information wherever possible for the benefit of the community and planners. Recommendations are found in section three of this report.

2.1 The Coastal Management District and The Erosion Prone Zone

Included in the state-provided policy tools is the mapping associated with two state interests, which for the purposes of this analysis is the extent of the Coastal Management District (CMD) and the Erosion Prone Zone (EPZ). Land inside the CMD is subject to referral to the state government for development activity. It is declared under the *Coastal Protection and Management Act 1995*. The EPZ is an area deemed to be at risk of coastal erosion in the next 100 years either through permanent inundation or coastal morphology and storm impacts. The risk profiles prepared in this study specifically address sea level rise.

The affected areas for Bundaberg are shown below Figure 2-1 shows the northern area from Winfield to the Burnett River, while Figure 2-2 shows the southern area from Burnett Heads to Coonarr. Starting at the north, the CMD occupies vast areas of low-lying Miara, Mullet Creek and Winfield along existing water courses and swampland and in many cases more than a kilometre inland from the coastline. The EPZ follows a similar line completely covering the Miara Caravan Park, but specifically excluding the Low-Density Residential zone settlement at Winfield.

Further south, Moore Park Beach surrounds are similarly included in the CMD along with the entire beachfront including the surf club and the Golden Sands Tourist Park. These features are also within the EPZ. The EPZ stretches in a north-south direction like parallel strands for a distance of 2.5km landward of the beach with intermittent areas unaffected. These unaffected areas are typically those which are higher and developed. At the location of Moore Park Road, the EPZ stretches some 3.6km inland to Welcome Creek.

Burnett Heads residential properties on the seaward side around Burnett Heads Road are outside both the CMD and the EPZ save for a handful of properties on Sea Esplanade near Scott Street, at the northern end of Sea Esplanade and the Lighthouse Holiday Park. On the Burnett River side, the row of properties on the river edge are all affected by the EPZ and all the homes between Adams and Coates streets.

At Bargara, low lying areas are affected by both the CMD and the EPZ but generally the developed areas are higher and remain unaffected with some minor exceptions. The Bargara Golf Club is within the EPZ as are all the homes at Kellys Beach on the beach side of Miller Street, and all the homes on Woongarra Scenic Drive, south to Rifle Range Creek and Mary Kinross Park.

The mapping is similar, south to Innes Park and Coral Cove where only the narrow coastal strip is affected and obvious low-lying inlets and estuaries. Homes on Barolin Esplanade are affected at the north end, and a number at Chantelle Circuit at Coral Cove.

This format continues to Elliott Heads, but with no homes built on the beach side of the esplanade, the effects on built form are negligible. Elliott Heads features no private properties in the EPZ, except the Elliott Heads Holiday Park which is entirely within the CMD and the EPZ. Riverview residential areas are also outside mapped areas except four properties on Biggs Street and three homes which abut into the water.

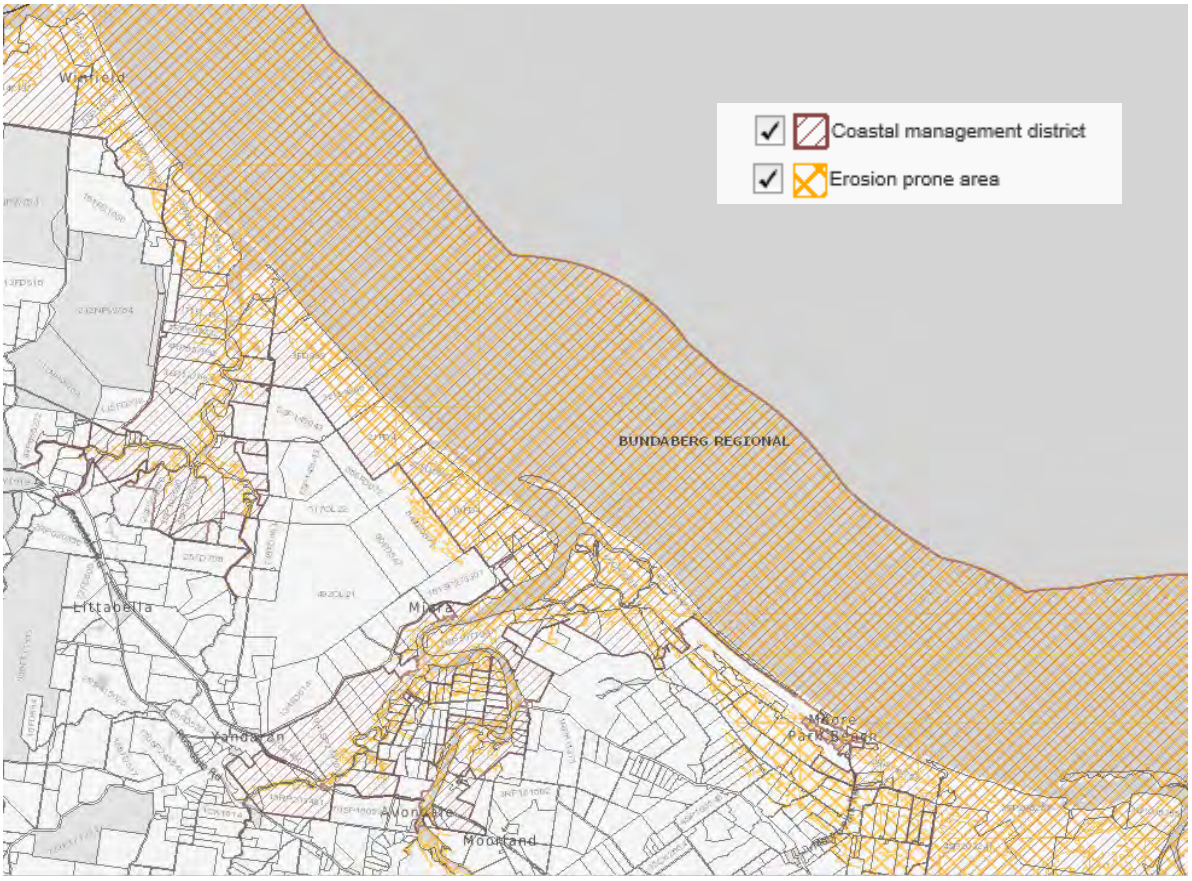

FIGURE 2-1 CURRENT DSDMIP MAPPING FOR PLAN-MAKING – WINFIELD TO BURNETT RIVER AND FAIRYMEAD

Source: https://spp.dsdip.esriaustraliaonline.com.au/geoviewer/map/planmaking

On the south side of Elliott Heads at Coonarr the EPZ again starts to extend inland, and at Coonarr Park the EPZ is 400m deep extending to over 800m on the south side of Coonarr Beach Road. The five homes at Coonarr Beach are entirely within that zone, but snipped out of the CMD.

At Woodgate the situation is similar to Moore Park Beach. While the developed areas are generally not mapped as erosion prone, the EPZ comes in parallel to the settlement behind it in north-south corridors or low-lying land. Homes to the north on Theodolite Creek Drive are entirely within the EPZ as are all the homes on the northern end of the esplanade, Cypress Street and First Avenue. Homes continue to be affected on the Esplanade moving south for various depths for the full length of Woodgate Beach.

At Buxton there is a low-lying drainage line separating the north and south sides of the settlement. The north side is not in the CMD or the EPZ. The south side areas of Wharf Street, east end of Powers Street and generally along the Isis River frontage are within the EPZ. The rural residential area further upstream is for the most part included in the CMD and many of the properties on the river's edge are mapped within the EPZ.

FIGURE 2-2 CURRENT DSDMIP MAPPING FOR PLAN-MAKING BURNETT HEADS TO COONARR

Source: https://spp.dsdip.esriaustraliaonline.com.au/geoviewer/map/planmaking

The versions of the SPP between 2014 and 2017 have changed considerably. The 2014 SPP did not include the provisions three to six inclusive. The 2014 version required all hazards to be mapped, a risk assessment completed (items 1-4) and then item 5 which seeks similar outcomes to the 2017 item 8. The 2014 version is found here: http://www.dlgrma.qld.gov.au/resources/policy/state-planning/state-planning-policy-jul-2014.pdf.

The policy position in section three essentially maintains the current urban form, allowing development to continue where identified in a planning scheme in a strategic sense. However, on a site basis, development becomes confined to areas not at risk or must mitigate that risk. In addition, the policy clearly articulates that development on properties which are mapped to be in both the EPZ and the CMD is not to occur unless mitigation to a tolerable level occurs (see item 8). The policy also says that built protection work is not to occur in an EPZ unless it is the last resort (see item 7).

Critically, this state interest includes assessment benchmarks (p.52) which must be applied to any development where a planning scheme does not reflect the 2017 issue of the SPP. This applies to Bundaberg as the scheme integrates the 2014 version of the SPP. The policy applies a different regulatory response for

development within the EPZ and development within the CMD . The benchmark for development which is in both the EPZ and the CMD is:

Erosion prone areas within a coastal management district:

(1) Development does not occur in an erosion prone area within a coastal management district unless the development cannot feasibly be located elsewhere and is:

Development only within the EPZ must comply with benchmark (3):

(3) Development other than that assessed against (1) above, avoids natural hazard areas, or where it is not possible to avoid the natural hazard area, development mitigates the risks to people and property to an acceptable or tolerable level.

This provision only applies to new development. Generally, the CMD is clipped to exclude all existing urban areas and is a planning tool which becomes applicable at the time of expanding growth areas, plan making or proposing new development in a CMD. There are a number of properties considered in this analysis which are within the CMD and these are discussed as they arise.

Importantly the 2014 version did not include the storm tide inundation mapping and therefore this is not reflected in the planning scheme. The SPP shows medium and high areas for storm tide inundation. The state storm tide inundation is very similar to the mapping prepared by this project.

The coastal settlements have varying visions for growth and the scheme can regulate how that development occurs. The existing regulatory response in the scheme is examined to determine how development currently responds to coastal hazards.

3 PLACE CONSIDERATIONS - BUNDABERG REGION PLANNING SCHEME 2015

This section provides a place-based review of the planning tools outlined in previous sections for insertion into the adaptation tables in section 6.3 of the Phase 6 report.

3.1 Miara

The vision for this locality is to maintain the village character of the area as it is generally unserviced by urban infrastructure. The two settlements at Winfield and Miara have limited capacity for further dwelling houses. Miara features a caravan park at the mouth of Yandaran Creek in the Community Facilities zone. There are two historic subdivisions at Miara which are mostly in the Limited Development zone. There is a small area zoned Low density residential (LDR).

Rocky Point just upstream from Winfield and Gil Blas Point just downstream are private properties which feature beach shacks and camping areas. These are in the Rural zone along with all the surrounding property. Winfield itself is an older established riverside settlement with only seven vacant allotments has limited scope for growth. In the LDR zone, development rights for dwelling house construction go with the land and this is not assessable development.

The risk exposure for permanent inundation and erosion to .8m are similar in this locality and both small villages remain clear of the extreme risk but will be on the precipice in the future. The Miara Holiday Park is entirely within the permanently inundated area and erosion prone area. Both private camping areas remain in the Rural zone but are entirely within the extreme risk area.

Recommendations:

- **maintain the settlement pattern and vision for limited growth and urban services are not extended; and**
- **commence planning to transform the Miara Holiday Park ify operations in the short-medium term and transforming to a new location in the long term.**

3.2 Moore Park Beach

The vision for Moore Park Beach is to support modest growth and service a confined footprint. The locality is typical of a coastal village with a number of residential zones: Rural Residential; Low and Medium Density, a surf club in the Sport and Recreation zone, small commercial areas in in Local Centre zone.

There is approximately 40 hectares of native vegetation in the centre of the locality which is zoned Emerging Community. This land is significantly impacted by matters of state environmental protection, regulated vegetation and wetland buffer zones. Any proposal for development would require state assessment and approval and the yield on this highly constrained land is unclear. Similarly, areas already zoned Emerging Community an LDR along Woodlands lane and Murdochs Road are highly constrained and partially within the EPZ and the CMD.

The locality faces existing medium risk of erosion, in a parallel formation eroding behind the settlement. At .4 metres sea level rise the erosion prone area covers properties on Pacific Boulevard, seaward of the LDR area at Palm Court. This area is already fully developed. The beach area features beachfront properties on Sylvan Drive in the MDR zone. The surf club and adjacent caravan park are also entirely in this mapped area at .4 metres and also within the CMD.

Storm tide and permanent inundation at .8 metres places almost the entire community at intolerable risk and extensive areas of medium risk. Where individual properties are not specifically impacted the surrounding infrastructure and access loss isolates the community.

Recommendations:

Overall, given the number of properties which will face intolerable risk in the future it is recommended that the vision for growth is revisiteded to ensure it is not placing more people and property at risk or placing council under financial pressure to provide infrastructure and disaster management resources to a growing at risk community.

As noted in the main report, the risk mapping does not allow detail assessment on a cadastral basis. Council should undertake its own local detailed assessment with appropriately scaled maps.

Specific recommendations:

- **maintain a vision for low or no growth and the characteristics of a coastal township. Development capacity should not increase in future planning schemes;**
- **consider informing residents on a more personal level such as letters to each household once the Bundaberg Coastal Hazard Adaptation strategy is released;**
- **consider elevating the level of assessment for current acceptable development within the EPZ to code which would enable council to enforce setbacks from the EPZ for all development;**
- **review the MDR zoned areas for appropriateness and development capacity including assessing the practical servicing, isolation, evacuation and infrastructure issues associated with a higher population;**
- **review the appropriateness of the large Emerging community and LDR allotments around Murdochs road to further develop, which are constrained by the EPZ. Depending on results consider rezoning as rural residential or applying precinct provisions, building lines or other appropriate tools;**
- **consider extended the building line regulatory tool to the rurls residential allotemnts on Slyvan Road;**
- **continue plans to modify the surf club in the short term and transforming to a safe location and seek funding from a resilience fund to rebuild in a safer location;**
- **continue plans to modify the caravan park which appears to be on reserve transforming to a safe location and seek funding from a resilience fund to rebuild in a safer location;**
- **review property-scale risk and investigate the criteria of the Feasible Alternative Assessment Report to modify the MDR areas to LDR; and**
- **consider removing or significantly reducing the Local Centre zone which is entirely within the CMD.**

3.3 Burnett Heads – Current Vision

There are no settlements on the north side of the Burnett River at Fairymead. The vision for the south side of the Heads is for the locality to form part of the coastal growth area discussed in section 1.4 and will feature a local centre around Zunker Street and a neighbourhood centre at the riverside area around Power Street. Significant areas of the locality are strategic port land. Given the vision for the area it features an array of zones including Low and Medium Density and Rural Residential, Emerging Community zone, Local Centre, Sport and Recreation and Community Facilities. There are extensive areas of Limited Development (constrained land) zone over historic subdivisions and one small industrial area entirely within the port which appears to be a fuel farm.

Burnett Heads is subject to extreme risk for both inundation and erosion at .8 metres. Much of the supporting industry and port land is exposed to that risk level and is entirely within the CMD and EPZ. It is unclear if this risk profile will affect future port operations and master planning. Burnett Heads land uses are currently characterised by low density single dwelling houses.

The area features over 10 hectares of developable MDR land. Directly adjacent is 17 hectares of Emerging Community zone land and 8.5 hectares of undeveloped LDR. The Emerging Community and LDR lands are clear of the extreme risk areas, however all the MDR areas in Burnett Heads - which are largely undeveloped and are located on the Harbour Esplanade or Kelly Street areas - are entirely within the extreme and high-risk areas for inundation at .8m.

Areas north of Rowlands Road are entirely within the intolerable risk area as are the waterfront properties which feature individual boat jetties to the Burnett River. Despite the older nature of some of the dwellings there remains significant use rights for dwellings and 75 vacant allotments in the River and Power Street area of Burnett Heads.

Recommendations:

- **review the extent and capacity of the MDR land to develop for its appropriatenss in consideration of risk exposure especially at Kelly Street and Harbour Esplanade;**
- **maintain the rural residential properties on Rowlands Road with no intensification;**
- **consider planning to transform the Burnett Heads Lighthouse Holiday Park away from the at-risk areas; and**
- **consider vacant and low asset value land for land use and tenure transititon in the area north of Geary Street and along Rowlands Road.**

3.4 Burnett Heads - State Development Area – Port of Bundaberg

The Port of Bundaberg located at Burnett Heads has recently undergone some expansion with the Coordinator General's office expanding the State Development Area Regulatory boundary to include land on the north side of the Burnett River in December 2017. The current proposed planning scheme major amendments will incorporate these changes into the scheme.

The land is in various tenures and jointly managed by the Port of Bundaberg and Gladstone Ports Corporation. Some of the rural residential parcels on Rowlands Road are entirely within the SDA.

The timeframes and circumstances of the development of the Port of Bundaberg, any proposed coatal process adaptation works and the land uses which proceed within will certainly change the look and feel of Burnett Heads and most likely the properties on the river side of the SDA.

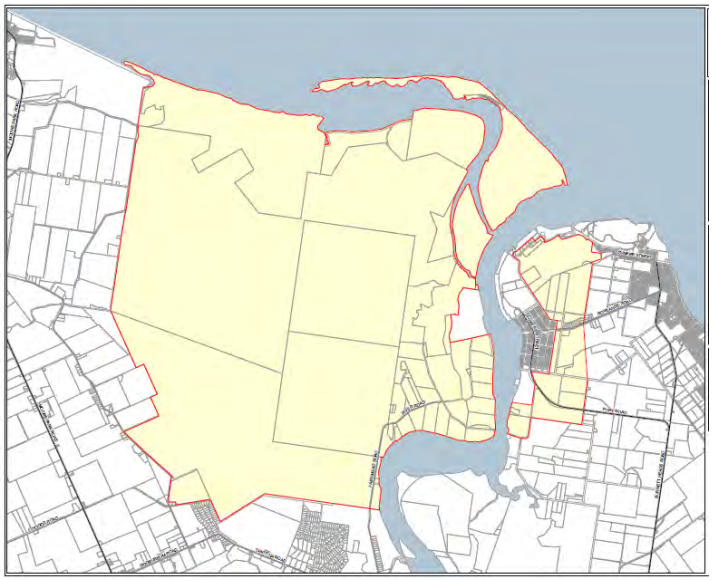

FIGURE 3-1: BUNDABERG SDA REGULATORY BOUNDARY DECEMBER 2017

Source: https://www.statedevelopment.qld.gov.au/coordinator-general/state-development-areas/current/bundaberg-state-development-area.html

Recommendation: That council remain in conversation with the Port of Bundaberg throughout its development and ensure proposals for the SDA area are cognisant of risk exposure to surrounding communities and development contributes to adaptation and mitigation of that risk.

3.5 Burnett Heads - Proposed Major Planning Scheme Amendments 2019

Council is currently proposing a major amendment package for the planning scheme. Consultation with the community commenced on 16 September and concludes on 21 October 2019. The proposed amendment incorporates changes to better reflect the Burnett heads AP which was complete after the scheme was adopted in 2015

The Vision for the rear in the LAP is quite different to the vision in the planning scheme, in that there is no such explicit growth vision for Burnett Heads articulated in the scheme. Works have now been completed to enliven the Burnett Heads Town Centre

> *Burnett Heads and the Port of Bundaberg are expected to experience significant growth over the next 10 to 20 years as the potential of the locality becomes a reality.*
>
> *With the construction of the $71 million Knauf plasterboard plant and the recently declared State Development Area at the Port, there is immense potential for development at Burnett Heads.*
>
> *Following these developments, Council expects that the town centre of Burnett Heads will come under development pressure as developers and landowners look to take advantage of surrounding economic development. To guide this development and ensure it is appropriate for Burnett Heads, Council has prepared a local plan.*
>
> *Throughout April 2017, Council undertook public consultation within the Burnett Heads community. Following consideration of submissions, Council made some changes to the local plan. The local plan was adopted by Council at its meeting held 10 October 2017.*
>
> *Council, in partnership with both the Australian Government under the Building Better Regions Fund and the Queensland Government under the Building our Regions Fund, delivered the Burnett Heads Town*

Centre Redevelopment. The construction tender was awarded to Development Construction Pty Ltd (DEVCON).

In October 2018, the Burnett Heads Town Centre Redevelopment reached practical completion as a key component in the implementation of the Burnett Heads Town Centre Local Plan.(BRC website).

The Vision in the Burnett Heads LAP

In 2036 the Burnett Heads Town Centre is a thriving coastal town that services the broader Burnett Heads community through shopping, dining, and entertainment. The urban form reflects its coastal location with mainly low to medium rise buildings that address and interact with the street, particularly along Zunker Street. However, in appropriate locations, namely the Town Centre and the Marina development area, well designed medium rise buildings are accommodated to promote growth and provide an immediate resident population to support the commercial centre. Buildings within the Zunker St, Moss St, and Hermans Rd vicinity are built to the street frontages and are provided with wide awnings to promote activity within the street and provide pedestrians with all-weather protection.

The Burnett Heads Town Centre and its immediate surrounds promote active transport, particularly walking. Through well design public spaces that are safe, shaded, and are provided with comfort facilities to encourage all ages and abilities to choose to walk or use alternative transport rather than a car throughout the locality.

Burnett Heads and the Port of Bundaberg are expected to experience significant growth over the next 10-20 years as the potential of the locality becomes a reality. This growth will be instigated by investment in regional infrastructure, including infrastructure to service the Bundaberg Port and the servicing with wastewater infrastructure.

The local plan recommends infrastructure and land use planning outcomes to ensure infrastructure delivery matches the intended land uses and ensures the Town Centre area is not negatively impacted by nearby regionally significant developments. This includes prioritising the Town Centre with wastewater infrastructure, streetscape upgrades to Zunker Street, and amendments to the Planning Scheme to support development of private land holdings.

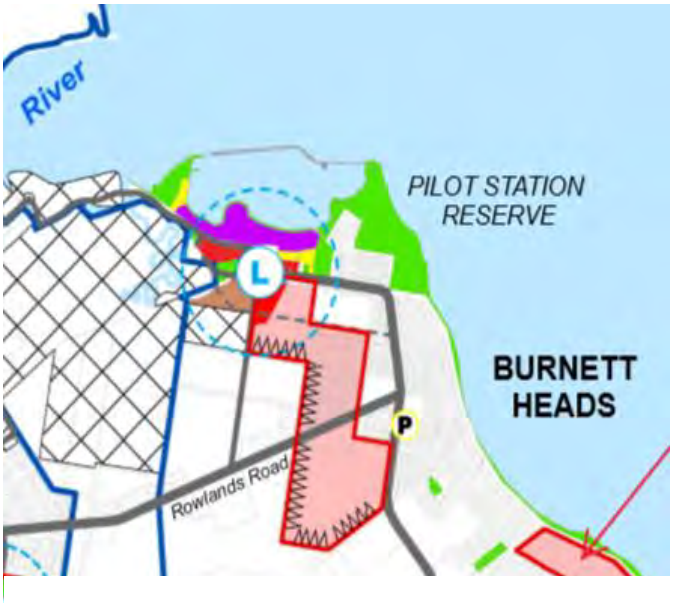

Figure 3-3 The proposed amendments to Part 7 LAP map showing the Burnett Heads Boat Harbour (in pruple)

Figure 3-3 The proposed amendments to Schedule 2 - Mapping at Burnett Heads

It is understood that there is a current devent applciation for the Burnett Heads Boat Harbour and a preliminary approval to that effect is already in place. It should be noted in the first instance that construction of a boat harbour will chage the risk profile for Burnett Heads.

The planning scheme is currently undergoing major amendments. One of the amendments is to incorporate changes to enliven the Burnett heads LAP. Amendments to incorporate recommendations from the Burnett Heads Town Centre Local Plan.

Recommendation: consider applying the CHAS project as a relevant matter for the assessment of development proposals at Burnett Heads and ensure proposals are cognisant of risk exposure to surrounding communities and development contributes to adaptation and mitigation of that risk.

3.6 Bargara

The vision for Bargara is to be the coastal hub for the region. It includes all zones to facilitate this including the only location for High Density residential (HDR). The north end of Bargara at Mon Repos and Rookery Road features some extreme risk exposure for inundation; however, this is not zoned for development nor have an existing settlement.

Between Nielsen's Beach and Bargara is exposed to some high and medium risk from inundation. Much of this is zoned MDR and is already developed with a number of high-rise apartment buildings on McCavanagh Street including the north end of the High Density Residential (HDR) zone on the esplanade. This area is not at risk for erosion.

The areas of Kellys Beach which is subject to extreme risk features a building set back line however the area is already developed. The land is entirely within the CMD and therefore any development proposals are subject to state approval processes. The extreme risk extends into the golf course as does the CMD. There are a number of homes further south outside the building line which are similarly subject to high risk of erosion and extreme risk of sea level rise on Woongarra Scenic Drive.

The small area of medium risk in Larder Street is already in the limited development zone. At the southern end of the Bargara locality around Rifle Range Road, there are further areas of extreme risk. These are all located in the open space zone.

Recommendations:

- **as a minimum, the MDR zone should be maintained and no further intensification of land uses is appropriate the land fronting Kellys Beach;**
- **review the development capacity at Kellys Beach and apply further containment through a precinct, increased assessment levels, or the overlay provisions to ensure no intensification or increase in risk if necessary;**
- **consider strategic land purchases of lower value or vacant land on the foreshore;**
- **maintain the open space and sport and recreation zone at the golf club and corner of Rifle Range Road and Woongarra Scenic Drive areas;**
- **maintain the Limited Development zone on Larder Street;**

- **review risk at a property-scale and consider applying a coastal building line to the properties on the seaward side of Woongarra Scenic Drive for the extent properties are impacted by coastal erosion and seal level rise;**
- **review risk at a property-scale and where the development provisions are enhanced at Kellys Beach, consider applying the same to Woongarra Scenic Drive; and**
- **maintain development intensity at Turtle Sands Caravan Park and avoid any change in use or capitalisation.**
-

3.7 Innes Park and Coral Cove

This locality's vision is to support Bargara as a coastal growth area. The two localities are principally zoned for residential development with large area of open space and Sport and Recreation zone. There is the largest capacity for growth in these localities evidenced by the extensive areas of Emerging Community zone

The medium and high-risk exposure runs the full length of the coastline in this locality. It is evident from the development pattern of new development off Logan Road in the north that council has required a significant portion of the coastal land to be provided as open space. The frontage at Coolanblue Avenue does not have the benefit of an open space buffer and therefore homes in this area are exposed to medium and high risk of inundation.

The areas around Palmer Creek and the Coral Cove Environmental Reserve are at extreme risk. The development potential in this area includes one large area of LDR and significant areas of Emerging Community zone, however the entire low-lying basin of Palmer Creek is within the CMD and therefore any proposal for subdivision will be referred to the state government and it is assumed conditions would be applied to restrict development outside the EPZ and CMD in accordance with the SPP 2017.

Recommendations:

- **ensure future development at Palmer Creek is maintained wholly outside the at-risk areas;**
- **ensure the scheme maintains the requirement for high medium risk areas along the coast to be converted to open space as development proceeds; and**
- **maintain a low density settlement pattern and dominance of open space in all foreshore areas.**

3.8 Elliott Heads

The vision for Elliott Heads is to continue the coastal growth area in the northern section. It has similar characteristics to Innes Park in that it has extensive areas zoned for future development. Land uses are limited to residential. Open space, and a caravan park are located at the Heads. According to the risk profile mapping there are no extreme risk areas at Elliott Heads.

There are dwellings at high risk with regards to erosion at Riverview, including three homes directly on the Elliott River frontage at Doblo Park, and the Elliott Heads Tourist Park These dwelling are in the LDR zone and appear to have some revetment structures existing. Six properties at the north end of Riverview at high risk including four facing Biggs Street and two adjacent.

Recommendations:

- **maintain a low density settlement pattern and dominance of open space in all foreshore areas;**
- **in the medium term the Elliott Heads Tourist Park may consider modifying some operational practices with a long-term view of transforming or relocation; and**
- **consider targeted engagement with at risk properties at Riverview.**

3.9 Coonarr

Coonaar is to be maintained as a character area with limited potential for development. The areas of rural residential development are outside the risk area. Extreme risk and isolation occurs for the eight beach front properties already at .2m sea level rise for erosion. These parcels are in the rural zone, save one which is zoned open space. They are all approximately 520m^2 and five are already developed there is no strategic land use solution. There are two vacant allotments and there is currently no regulatory tool to stop a dwelling house being constructed.

This is a good test case for a land swap however the capital investment made in the existing five homes may prohibit any tenure transition or change in land use over time by acquiring land. The remaining five dwellings will expect that access to their homes is maintained by council despite the dwellings being unaffected. At .8m sea level rise the homes remain islands without viable access for over 600 metres of Coonarr Beach Road.

Recommendations:

- **the Rural Residential zone further inland should be maintained into the future;**
- **maintain the settlement pattern for low growth and urban services are not extended;**
- **consider purchasing the two vacant allotments and rezoning to open space; and**
- **consider targeted engagement with at risk properties at Riverview.**

3.10 Woodgate Beach

The vision for Woodgate is for a small amount of growth. There is an area of approximately 56ha in the Emerging Community zone at the north of Woodgate Beach for future development. The development footprint will likely be approximately 50 per sent smaller than that to account for the mapped area of EPZ and wetland biodiversity constraints. This land zoned for expansion is entirely within the CMD and approval for further development would be subject to referral to the state.

The concern is for the development in the intolerable and extreme risk profile at .4m sea level rise which can be described as a Theodolite Creek overflow, running parallel and through the existing settlement between the esplanade and Frizellis Road.

Part of this area has already been zoned Limited Development (constrained land) zone, however other parts which will be equally affected are in the MDR zone with development capacity, especially those in parts of First Avenue, Paperbark Court, Second Avenue and the north end of Acacia Street. There is capacity to increase

the population in these areas with 13 vacant lots in the LDR Zone and greater development potential MDR zone.

The MDR zone code and assessment tables provides for a range of compatible uses to proceed in that zone including:

(a) Caretaker's accommodation;

(b) Dual occupancy;

(c) Dwelling house;

(d) Multiple dwelling;

(e) Relocatable home park;

(f) Residential care facility;

(g) Retirement facility;

(h) Rooming accommodation;

(i) Short-term accommodation; or

(j) Tourist park.

Residential purposes can proceed to three storeys while non-residential is confined at two levels. The scheme promotes density in area of high amenity and where sewer infrastructure is present, both of which apply to Woodgate Beach and also Moore Park Beach, discussed above. Given much of this MDR land has double street frontage to The Esplanade and Paperbark Court with evidence that a further internal street is planned the additional density could be in the order of 5.5 hectares with a 40 per cent site cover and three storeys of development, this could result in 250 additional dwellings where all opportunities were taken up for multiple dwelling units. The Bundaberg planning scheme does alter the level of assessment for dwelling houses in the MDR zone, thus it is likely the zone will develop with a mix of housing.

Applying the 2017 SPP benchmarks and the overlay, development must avoid areas of hazard. It is assumed the SPP takes precedence in this regard.

Further south the continuation of the MDR zone on the beachfront lots, although free of risk, puts council under pressure to continue to provide access and services in circumstances where part it may be cost prohibitive to do this.

The settlement at Walker's Point is in the LDR zone and is completely developed save one allotment. There is limited capacity for a planning response in this instance given that the settlement itself is outside the extreme risk area.

Recommendations:

- **maintain a vision for low or no growth and the characteristics of a coastal township. Development capacity should not increase in future planning schemes;**
- **consider informing residents on a more personal level such as letters to each household once the Bundaberg Coastal Hazard Adaptation strategy is released;**
- **consider elevating the level of assessment for current acceptable development within the EPZ to code which would enable council to enforce setbacks from the EPZ for all development;**

- **review the MDR zoned areas for appropriateness and development capacity including assessing the practical servicing, isolation, evacuation and infrastructure issues associated with a higher population;**
- **review the development capacity of the MDR zoned areas in the context of a Feasible Alternative Assessment Report and assess property-scale risk to determine if rezoning to LDR is more appropriate;**
- **maintain the areas of Limited development (Constrained land) zone; and**
- **consider strategic land use and tenure transition of some land in the First Avenue area.**

3.11 Buxton

The area of Buxton is bounded on the north side by the Gregory River and on the south by the Burrum and Isis Rivers. The area is mostly unsettled and entirely within the CMD save for the small village of Buxton. The village has two distinct areas separated by a low-lying drainage path.

On the north side, there is an extensive esplanade area in the open space zone. The dwellings on the north side remain outside the risk profile area. On the south side of the Buxton village the open space buffer to the Burrum River is not so wide and some dwellings on Wharf Street are exposed to extreme risk. Many of these allotments are vacant with questionable development capacity and this presents a good opportunity for purchase of this land to convert to open space. Development which has occurred appears very low intensity and lower capital value.

Further settlement in the Buxton locality includes a number of rural residential properties on the Isis River. These are all developed save two and the shoreline areas are exposed to high risk. The cadastral pattern of the rural residential lots shows that subdivision has occurred and there is potential for this to continue. The rural residential zone should be maintained,

Recommendations:

- **maintain all areas of open space;**
- **maintain Buxton as a coastal charter village with limited growth;**
- **consider expanding the open space area on Wharf Street with strategic purchase of these allotments; and**
- **assess the further subdivision capacity of the rural residential allotments and consider a further building set back line in this location.**

The above recommendations are provided form a desk-top perspective in consideration of the regulatory framework in place at the time. In all instances further smaller-scale mapping and review should occur, considering development potential and likely scenarios, planning visions, constraints and risk exposure to determine the most appropriate course of action

APPENDIX B
FRC ENVIRONMENTAL REPORT

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Our Reference: 180407 Phase 6

Bundaberg CHAS: Adaptation Options – Preliminary Assessment

1 Introduction

In this memo we provide:

- brief commentary about the Environmental Impacts of the suggested Structural Options provided by Water Technology in a memo dated 11 September 2019, and further advice by email on 17 September 2019
- brief commentary about suggested 'adaptation options' for ecological features to adapt to coast hazard for Burnett Heads, Coonarr, Innes Park, Moore Park Beach Woodgate Beach, and Bargara and Kellys Beach.

All assessments and conclusions are preliminary, and are based on a brief desktop assessment that did not include a detailed literature review. Further, there was no field assessment to provide verification.

In the team meeting on 30 August 2019 some comments were also made regarding the adequacy of State mapping of turtle nesting areas, in particular around Mon Repos, and the significance of intertidal and shallow subtidal reefs in the area. Brief commentary on these issues is also provided below. If required, further information can also be provided on other key intertidal and subtidal habitats, such as mangrove, saltmarsh and seagrass habitats.

Brief comments are also provided best practice with respect to coastal protection works, and to creek and wetland crossings.

2 Turtle Nesting

Turtle eggs are laid within a few metres above or below the Highest Astronomical Tide (HAT), and these areas are consequently highly vulnerable to impacts from sea level rise and storm surge[1].

While Mon Repos is the most significant beach for turtle nesting in the area, there is also significant nesting at Moore Park Beach and Bargara, with turtles also nesting in lower numbers at other beaches in the area including Coonarr and Woodgate.

2.1 Mon Repos

The beach at Mon Repos should be classified as an area of high concern as it:

- supports the largest concentration of nesting sea turtles on the east Australian mainland
- is the most important breeding site for the endangered loggerhead turtle in the South Pacific, with approximately 1200 clutches laid per season on this beach.
- supports green and flatback turtle nesting, and
- contributes significantly to the economy.

Erosion associated with king tides and cyclones has had a significant impact on the survival of clutches at Mon Repos (e.g. in 2013, 60% of nests were lost due to the impact of a cyclone, floods, and high tides). In addition, cyclones can also result in the deposition of sediment on the nesting beach, resulting in the burial of nests and death of the turtles.

[1] The map of Sea Turtle Sensitive Areas used in the initial assessment indicated areas where artificial lighting may negatively impact sea turtles, rather than areas where sea turtles nest (BRC 2019a). The Sea Turtle Sensitive Area mapping layer was prepared by BRC as an overlay for a proposed amendment to the planning scheme – the Sea turtle sensitive overlay code (BRC 2019b).

2.2 Impact of Light and Clutch Relocation

Both direct lights and the glow or 'loom' of lights at night disorient nesting and hatching turtles, decreasing survival rates. Light from Bargara negatively impacts hatchlings on Mon Repos.

Clutches are frequently relocated from Bargara beach to darker beaches, as the light from Bargara can disorient hatchlings, decreasing their survival rate.

Development at Moore Park Beach is predominantly set back from the beach, such that only the glow from lights is an issue, rather than direct light. However, clutches are also relocated from Moore Park Beach when they are laid too close to high water mark and are at risk of being washed away or being inundated. Turtles may nest too low on the beach when storm erosion creates a high dune scarp, turtles will nest lower on the beach. Nests on Moore Park Beach are also disturbed by four wheel drive users, dogs and foxes.

Woodgate and Coonarr are generally darker beaches, but don't have as many turtles nesting on them, potentially due to their more exposed aspect.

Note, while 'doomed' turtle nests can be moved, there is a limited window of opportunity to move them, and hatching rates are likely to be lower than in undisturbed nests that do not need to be moved. Relocating a high proportion of turtle nests is not considered to be an appropriate management strategy in response to climate change.

2.3 The Temporary Local Planning Instrument

The State Government has recently introduced a Temporary Local Planning Instrument (TLPI). This provides an interim policy response to protect sea turtles from the adverse impacts on sea turtle nesting and activity, and to provide greater certainty to building heights at Bargara (Queensland Government 2019). The purpose of the TLPI is to regulate:

- building heights in the high density residential zone at Bargara, and
- artificial light for new urban development on the coast.

The TLPI will apply for up to 2 years (Queensland Government 2019), while Council amends its planning scheme.

2.4 Proposed Amendment to Bundaberg Regional Council Planning Scheme

Council released proposed amendments to the Bundaberg Regional Council Planning Scheme 2015 for public comment between 16 September 2019 to 21 October 2019. Amendment No. 6 provides a greater level of protection for the Mon Repos Conservation Park and to sea turtles from the effects of urban development (BRC 2019b). This amendment includes (BRC 2019b):

- a sea turtle sensitive area overlay code to ensure assessable development in coastal areas avoids adverse impacts on sea turtles, including impacts from artificial lighting, and
- zoning changes to include land at Shelley Street, Burnett Heads (currently included in the Emerging community zone) in the Rural residential zone – Precinct RRZ1 (2000m^2 minimum lot size area).

2.5 Other Initiatives by Bundaberg Regional Council

In addition, Council and a range of community organisations are currently introducing measures to reduce lighting impacts on turtles, including:

- Sensors strategically placed around key nesting beaches to record real time light pollution (DITCRG 2019)
- Online access to this data to encourage community engagement, and to guide the design and deployment of smart lighting solutions in the areas of highest urban glow DITCRG 2019)
- Planting vegetation buffers e.g. at Barolin Nature Reserve near Mon Repos (Greenfleet 2019)

Combined, this may result in some beaches increasing in importance as turtle nesting areas.

3 Significance of Rocky and Coral Reefs

The Woongarra Coast stretches from Burnett Heads in the north to Elliott Heads in the South. The coastline in this area consists of an exposed rocky foreshore of hummock basalt interspersed with areas of sandy beach habitat. Along much of the coastline, this rocky substrate extends offshore to create intertidal and subtidal rocky outcrops on which coral

reefs have developed. These fringing coral reefs systems are some of the southernmost coral reefs found on the east coast of Australia and support an extensive flora and fauna community (DES 2019a).

As well as providing homes for many animals, rocky shores and reefs are a productive food source and an important nursery area for many fish and crustacean species. The commercially and recreationally important fish found around rocky shores include blackfish, yellowfin bream, snapper, tarwhine, trevally, yellowtail and samson fish (DES 2019b).

There are at least 46 species of hard coral in the Great Sandy Marine Park reef communities, some of which are endemic or rare to this region. These communities are an interesting mix of tropical, subtropical and temperate species of hard and soft corals.

These reefs support recreational and commercial fisheries species and provide habitat for crustaceans, hard and soft coral, worms, molluscs, fish, turtles, sponges, sea urchins, sea snakes, algae and sharks and many invertebrates. They also promote quality of life and aesthetics, play an important role in source and sink of calcium carbonate and carbon dioxide and provide protection to coastal communities by buffering storm surges, intense wave action and erosion by acting as natural breakwater. The reefs in the Great Sandy Marine Park may offer refugia for Great Barrier Reef coral species that have been affected by climate change (DES 2019b).

4 Best Management Practices for Construction of Erosion Control Structures

Best management practices to reduce the adverse impacts of erosion control structures such as seawalls, groins and artificial reefs include (Batton 2007):

- Use design elements that provide habitat complexity
- Design structures to allow for fish and water movement above the structure during high tides but to prevent stranding of fish (e.g. gabions, or revetments with openings), when structures need to be located in areas with riparian vegetation.
- Design structures to minimise scouring and other hydrological impacts that may cause changes to sediment composition and profiles.
- Increase the amount of intertidal habitat available, with structures to be sloping rather than vertical if this can be achieved without the loss of important natural habitats.

- Enhance structure designs to allow uses such as fishing, while minimising any disturbance of fishing activities in the vicinity.
- Undertake construction outside of target species' key times of biological activity and fishing in the area.
- Use structures that may be modified or removed (e.g. geotextile structures) if required.
- Fill geotextile structures used along shorelines with sand sourced from:
  - above the highest astronomical tide, either onsite or off site, or
  - the trench where the structure is to be placed (where applicable).

5 Best Management Practices for Waterway Crossings

Water way crossings or barriers should ensure that (DILGP 2019):

- fish movement and connectivity throughout waterways and within and between fish habitats is maintained
- the health and productivity of fisheries resources and fish habitat is maintained
- community and fishing sectors' use of the area and access to fisheries resources is maintained
- barriers are only constructed when there is a need for the development and no other reasonable alternative exists
- adequate fish passage is provided, including a fish way, if necessary
- impacts on marine plants, waterways that provide for fish passage and declared fish habitat areas that are matters of state environmental significance are avoided, and where avoidance is not reasonably possible, minimises and mitigates impacts, and provides an offset for significant residual impacts where appropriate.

6 Environmental Impacts of Suggested Structural Options

6.1 Beach Nourishment/ Dune Revegetation

Beach nourishment / dune revegetation has been proposed as an option to protect properties and infrastructure at:

- Moore Park Beach (either 1.2 or 2.2. km long, minimum of 34 m offshore)
- Coonarr (6 houses, approximately 400 m long, minimum of 40 m offshore extent)
- Woodgate (whole beach, 5 km minimum offshore extent 34 m) and
- Bargara (whole beach pocket, 1.4 km long, minimum of 10 m offshore extent).

Negative environmental impacts of depositing additional sand on the foreshore are minimal, assuming:

- the sand is placed outside of the turtle nesting or hatching season, which is predominantly from early November to late March
- sand is not placed over rocky foreshores or seagrass beds
- sand is of a similar particle size to the sand already on the beach
- sand is placed gradually, allowing vegetation to colonise
- dune revegetation is by appropriately qualified and experienced people and is of native plants

There may also be adverse environmental impacts associated with the sourcing of the sand. It has been assumed the sand is sourced from offshore and will not result in the depletion of sand on nearby beaches.

Moore Park Beach

No additional comments on the assumption that beach nourishment does not adversely impact tidal flushing of the small creeks to the south of the nourishment area, as this may negatively impact water quality and ecological condition.

Coonarr

There appears to be some shallow reefs offshore of the proposed sand placement at Coonarr, and seagrass further offshore. It is likely that modelling is required to ensure that sand is not displaced over these habitats.

No additional comments on the assumption that beach nourishment does not adversely impact tidal flushing of Coonarr Creek to the south of the nourishment area, as this may negatively impact water quality and ecological condition.

Woodgate

There is some seagrass offshore of the proposed sand placement at Woodgate. It is likely that modelling is required to ensure that sand is not displaced over this habitat.

No additional comments on the assumption that beach nourishment does not adversely impact tidal flushing of Theodolite Creek, as this may negatively impact water quality and ecological condition.

Bargara

The proposed sand rehabilitation at Bargara is likely to adversely impact tidal flushing 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 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.

6.2 Seawalls (Sandbags or Rocks)

Seawalls have been proposed as an option to protect properties and infrastructure at:

- Moore Park Beach (either 1.2 or 2.2. km long)

- Coonarr (6 houses, approximately 400 m long)
- Woodgate (whole beach, 5 km long) and
- Bargara (whole beach pocket, 1.4 km long).

Seawalls would be built at approximately highest astronomical tide (HAT) / at the seaward limit of dune vegetation in areas where there is limited space between assets and the beach, e.g. Woodgate. In other locations, e.g. Moore Park Beach, the seawall would be as far landward as possible. It is assumed that best management practices will be used for the construction of these sea walls (Section 4).

Where seawalls are placed at HAT, the dune would gradually erode up to the seawall, and turtle nesting habitat would be removed.

Where seawalls are placed further landward, the dune would be able to retreat landward, providing the opportunity for turtles to nest.

Any erosion of surrounding areas as a result of construction and placement of the seawalls may also negatively impact turtle nesting areas, and foredune ecology.

Moore Park Beach

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.

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.

Coonarr

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.

Seawalls would need to be designed to ensure they do not adversely:

- impact the offshore shallow reefs and seagrass

- impact tidal flushing of Coonarr Creek, as this may negatively impact water quality and ecological condition.

Woodgate

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.

Seawalls would need to be designed to ensure they do not adversely:

- impact the offshore seagrass
- impact tidal flushing of Theodolite Creek, as this may negatively impact water quality and ecological condition.

Bargara

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.

Seawalls would need to be designed to ensure they do not:

- exacerbate poor tidal flushing, poor water quality and ecosystem health of Moneys Creek nor water quality
- ecosystem health of Kellys Creek, or
- adversely impact the reefs in the area.

6.3 Artificial Reef (Rocks or Sandbags)

Artificial reefs have been proposed as an option to protect properties and infrastructure at:

- Innes Park (rocky foreshore, approximately 1 km)
- Coonarr (to benefit an area 340 m long)

- Woodgate (to benefit an area 5 km long), and
- Bargara (to benefit an area 1.4 km long).

It is noted that the protective benefits of artificial reefs in these areas are doubtful, due to low sediment transport and availability in the area.

In addition to providing foreshore protection, ecological benefits of appropriately designed artificial reefs include:

- increased habitat diversity – providing hard habitat in an area of predominantly soft habitat
- shelter from predators for small and juvenile fish and mobile invertebrates
- substrate for colonisation by algae and invertebrates (barnacles, corals, sponges etc) increasing biodiversity
- increased food diversity and availability
- fish aggregation.

Innes Park

There are extensive intertidal and subtidal reefs of high ecological value in the vicinity of the proposed artificial reefs. The artificial reefs would need to be carefully designed and placed to ensure these reefs were not adversely impacted.

While there are seagrass beds offshore and to the south of Innes Park, these are likely to be offshore of the proposed artificial reefs.

The artificial reefs would also need to be carefully placed to avoid sand accumulation in the entrance to Palmer Creek, which may result in a reduction in tidal exchange and adverse impacts to water quality and ecosystem health.

Coonarr

Artificial reefs in this area would need to avoid adverse impacts to:

- the shallow offshore reefs and seagrass
- tidal flushing of Coonarr Creek.

Woodgate

Artificial reefs in this area would need to avoid adverse impacts to:

- the seagrass
- tidal flushing of Theodolite Creek.

Bargara

Artificial reefs in this area would need to avoid adverse impacts:

- to tidal flushing of Moneys and Kellys Creek, and
- the rocky reefs.

The risk from artificial reefs to these habitats is considered to be much less than for sand nourishment or seawalls

6.4 Groyne (Rocks or Sandbags)

Groynes have been proposed as an option to protect properties and infrastructure at Woodgate (to benefit an area 5 km long). Groynes would be every 50 to 100 m along the beach, would extend approximately 50 m offshore from the future position of HAT, and would be approximately 20 m wide.

Groynes would provide additional reef habitat, particularly if they were rocks, which would be a positive impact. However, if the groynes were placed over seagrass beds this would be a negative impact.

6.5 Dyke

A dyke has been proposed as an option to protect properties and infrastructure at Burnett Heads. The dyke would be 300 m long, and there would also be an 80 m long storm surge barrier in the creek, that would only be used in a storm event. Dykes only have water on one side, and protect the land behind them from flooding from the sea or river.

Potential environmental impacts of the proposed dyke include:

- 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. 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.
- Loss of fish habitat
- Prevention of fish passage
- 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.

6.6 Raise Key Access Routes

Raising roads to reduce the likelihood of isolation of communities has been proposed as a management option for:

- Moore Park Beach - Moore Park Road
- Moore Park Beach – Murdochs Linking Road
- Moore Park Beach – Malvern Drive
- Woodgate Beach – Walkers Point Road
- Woodgate Beach – Theodolite Creek Road
- Woodgate Beach – Paperbark Court – First Avenue, and
- Coonarr.

Three options are considered for each location:

1. raising the road above the level where the community becomes isolated, without any additional bridges

2. a causeway which may be subject to inundation, and may also impact ponding and tidal inundation regimes, and
3. continually maintaining the existing road over 50 years.

Best practice for waterway barriers outlined in Section 5. Negative impacts on aquatic ecosystems of waterway crossings include:

- restriction fish movement
- restriction connectivity between aquatic habitats
- restriction tidal inundation
- direct or indirect damage to marine plants.

Thus, raising a road or building a causeway without providing additional bridges or culverts significantly negatively impacts waterways and wetlands. Where causeways have culverts to allow for tidal flows and fish passage, impacts can be significantly reduced. Consequently, raising the level of the road without a bridge has a great impact than a causeway with culverts, that has a greater impact than maintaining the current crossing.

Specific issues for each proposed access upgrade are provided in the section below.

Moore Park Beach - Moore Park Road

Three sections are proposed for upgrading in this area:

- The southern section crosses cane paddocks.
- The middle section of the proposed works crosses an estuarine waterway, that is lined by mangroves. Upstream of the current road vegetation either side of the drain is cleared and while still a waterway, is likely to have poor habitat quality.
- The northern section of the proposed works borders mangroves to the east, and a cleared low lying paddock to the west.

With climate change, the entire area under will be inundated by saline water, and the area of estuarine wetlands will increase.

While the habitat values of the current wetlands and waterway in this area is relatively low, there will be negative impacts to the aquatic ecology of this area unless:

- regular tidal ingress and egress to the estuarine wetlands is maintained

- fish passage is maintained, and
- water is not impounded upstream of the proposed works, as this may cause dieback of the estuarine wetlands.

Moore Park Beach – Murdochs Linking Road

The proposed works are between two cane fields. Current value to aquatic ecology is low, impacts to current ecosystems would be low. However, as the area will experience more saline inundation, estuarine plants may colonise, and consequently negative impacts of the proposed works will increase with time.

Moore Park Beach – Malvern Drive

The proposed works cross a waterway and estuarine and dune ecosystems. The area of estuarine wetlands and waterways in the vicinity of the proposed works will increase. There will be negative impacts to the aquatic ecology of this area unless:

- regular tidal ingress and egress to the estuarine wetlands to the north of the proposed works is maintained
- fish passage between the north and south of the proposed works is maintained, and
- water is not impounded upstream of the proposed works, as this may cause dieback of the estuarine wetlands.

Woodgate Beach – Theodolite Creek Road

The proposed works are adjacent to a wetland area. The proposed works run roughly parallel to the drainage line and consequently would have less impact on flows, fish passage and connectivity than works that are perpendicular to the main channel.

Woodgate Beach – Paperbark Court – First Avenue

The proposed works are in an area of mangroves and saltmarsh. The proposed works run roughly parallel to the drainage line and consequently would have less impact on flows, fish passage and connectivity than works that are perpendicular to the main channel.

Woodgate Beach – Acacia St

The proposed works on Acacia St do not appear to have a direct impact on tidal ingress, fish passage or connectivity to the adjacent wetland (to the west).

Woodgate Beach – Walkers Point Road

There are two proposed section for this area:

- a short section on the north, that passes through a coastal dune ecosystem with Corymbia and Eucalyptus, and with palustrine wetlands, and
- a longer section in the south that passes through a coastal dune ecosystem dominated by Melaleuca.

These communities are already bisected by roads, and are not as dependent on the maintenance of flows as other habitats discussed in this section. The proposed works will not have as significantly a negative impact as other works discussed in this section, particularly where any standing water or waterways are avoided.

Coonarr

The proposed works cross a waterway and estuarine and dune ecosystems. The area of estuarine wetlands and waterways in the vicinity of the proposed works will increase. There will be negative impacts to aquatic ecology of this area unless:

- regular tidal ingress and egress to the estuarine wetlands to the north of the proposed works is maintained
- fish passage between the north and south of the proposed works is maintained, and
- water is not impounded upstream of the proposed works, as this may cause dieback of the estuarine wetlands.
- Prevention of water impounding upstream of the proposed works, and causing dieback of estuarine wetlands.

7 Suggested Adaptation Options for Ecological Features to Adapt to Coastal Hazard

Ecological features considered for adaptation options to adapt to coastal hazards are limited to those shown on the map set produced by Water Technology showing “Risk Evaluation at 0.4 m SLR Erosion Hazard, Priority Assets” for the following areas:

- Bargara and Kellys Beach
- Burnett Heads
- Coonarr
- Innes Park
- Moore Park Beach
- Woodgate Beach

As noted in Section 2 above, state mapping may not have been sufficiently accurate to determine all areas of intolerable risk, in particular significant turtle nesting areas may not be adequately represented. Consequently, significant turtle nesting areas are also considered below.

When considering adaptation options, a whole of catchment approach should be undertaken, to ensure ecological linkages between key habitats are preserved or created. The discussion below provides suggestions that could be incorporated into such a whole of catchment approach.

7.1 Bargara and Kellys Beach

Risks

Intolerable risks to ecology in this area broadly comprise risks to:

- turtle nesting on Mon Repos Beach
- estuarine ecosystems associated with Mon Repos Creek and Lagoon
- estuarine ecosystems associated with Moneys Lagoon that will be increasingly inundated with deeper water, landward migration constrained by urban land use
- estuarine ecosystems associated with Riflerange Creek that will be increasingly inundated with deeper water, and

- extensive intertidal and subtidal reefs.

Suggested Adaptive Strategies

Note that the response to turtle nesting risk on Mon Repos should be co-ordinated with State Government. However currently the State Government does not have any plans to manipulate the beach in anyway. However they do have a comprehensive research and monitoring program and in future may respond to trends (C. Limpus pers comm 2019).

- **Defend:** Strategic beach nourishment to improve habitat for turtle nesting (noting constraints listed in Section 6).
- **Accommodate:** Allow estuarine wetlands around Mon Repos Creek and Lagoon to migrate landward coastal dune ecosystems.
- **Accommodate:** Allow estuarine wetlands around Riflerange Creek to migrate landward into parklands.
- **Accommodate:** Improve catchment runoff to improve estuarine water quality, and increase colonisation of seagrass in inshore estuarine areas.
- **Retreat:** Allow the intertidal and subtidal reefs to be inundated more frequently / to greater depths. This may have a negative impact on species diversity, and decrease abundance of marine plant and coral growth due to decrease in light with increased depth.

7.2 Burnett Heads

Modify the dyke to allow limited tidal ingress and egress and fish passage, to maintain existing communities.

7.3 Coonarr

Risks

Intolerable risks to ecology in this area broadly comprise risks to:

- 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, 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.

Suggested Adaptive Strategies

- **Retreat:** Allow estuarine wetlands to colonise dune habitat – will result in loss of dune habitat and increase in estuarine wetland.

7.4 Innes Park

Risks

Intolerable risks to ecology in this area broadly comprise risks to:

- estuarine ecosystems (mangroves, saltmarsh, saltflats etc) that will be increasingly inundated with deeper water, landward migration currently partially constrained by urban land use and
- coastal dune ecosystems, that will become tidally inundated, and
- extensive intertidal and subtidal reefs.

Further, the extensive beds of seagrass offshore of this area may be negatively impacted by increased water depth, and consequent decrease in light.

Suggested Adaptive Strategies

- **Retreat:** Allow the intertidal and subtidal reefs to be inundated more frequently / to greater depths. This may have a negative impact on species diversity, and decrease abundance of marine plant and coral growth due to decrease in light with increased depth
- **Accommodate:** Purchase non-urban land to landward of existing estuarine wetlands, and mange to become new wetland habitat.

- **Defend:** Tidal gates to limit the ingress of tidal water onto select dune habitat. This would need to be carefully managed – current best practice is to remove tidal gates and allow fish passage and tidal inundation.

7.5 Moore Park Beach

Risks

Intolerable risks to ecology in this area broadly comprise risks to:

- estuarine ecosystems (mangroves, saltmarsh, saltflats etc) that will be increasingly inundated with deeper water, landward migration currently constrained by agricultural and urban land use
- coastal dune ecosystems, that will become tidally inundated, and
- turtle nesting.

Suggested Adaptive Strategies

- **Retreat:** Allow estuarine wetlands to colonise dune habitat – will result in loss of dune habitat and increase in estuarine wetlands
- **Accommodate:** Purchase of cane land that currently abuts estuarine wetlands. Rehabilitation of this land to become estuarine wetlands / dunal ecosystem / freshwater wetlands. This may also assist with flood storage, and provide high value ecotourism and cultural tourism opportunities e.g. Sunshine Coast Blue Heart: major regional project (Sunshine Coast Regional Council 2019).
- **Accommodate:** Improve catchment runoff to improve estuarine water quality, and increase colonisation of seagrass in inshore estuarine areas
- **Defend:** Strategic beach nourishment to improve habitat for turtle nesting (noting constraints listed in Section 6).
- **Defend:** Tidal gates to limit the ingress of tidal water onto select dune habitat. This would need to be carefully managed – current best practice is to remove tidal gates and allow fish passage and tidal inundation.

7.6 Woodgate Beach

Risks

Intolerable risks to ecology in this area broadly comprise risks to:

- estuarine ecosystems (mangroves, saltmarsh, saltflats etc) that will be increasingly inundated with deeper water along the Burrum River
- 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.

Further, the extensive beds of seagrass offshore of this area may be negatively impacted by increased water depth, and consequent decrease in light.

Suggested Adaptive Strategies

- **Retreat:** Allow estuarine wetlands along the Burrum River to colonise dune habitat – will result in loss of dune habitat and increase in estuarine wetlands

  Defend: Tidal gates to limit the ingress of tidal water onto select dune habitat. This would need to be carefully managed – current best practice is to remove tidal gates and allow fish passage and tidal inundation.
- **Defend:** Strategic beach nourishment to prevent inundation of coastal dune ecosystems (noting constraints listed in Section 6).

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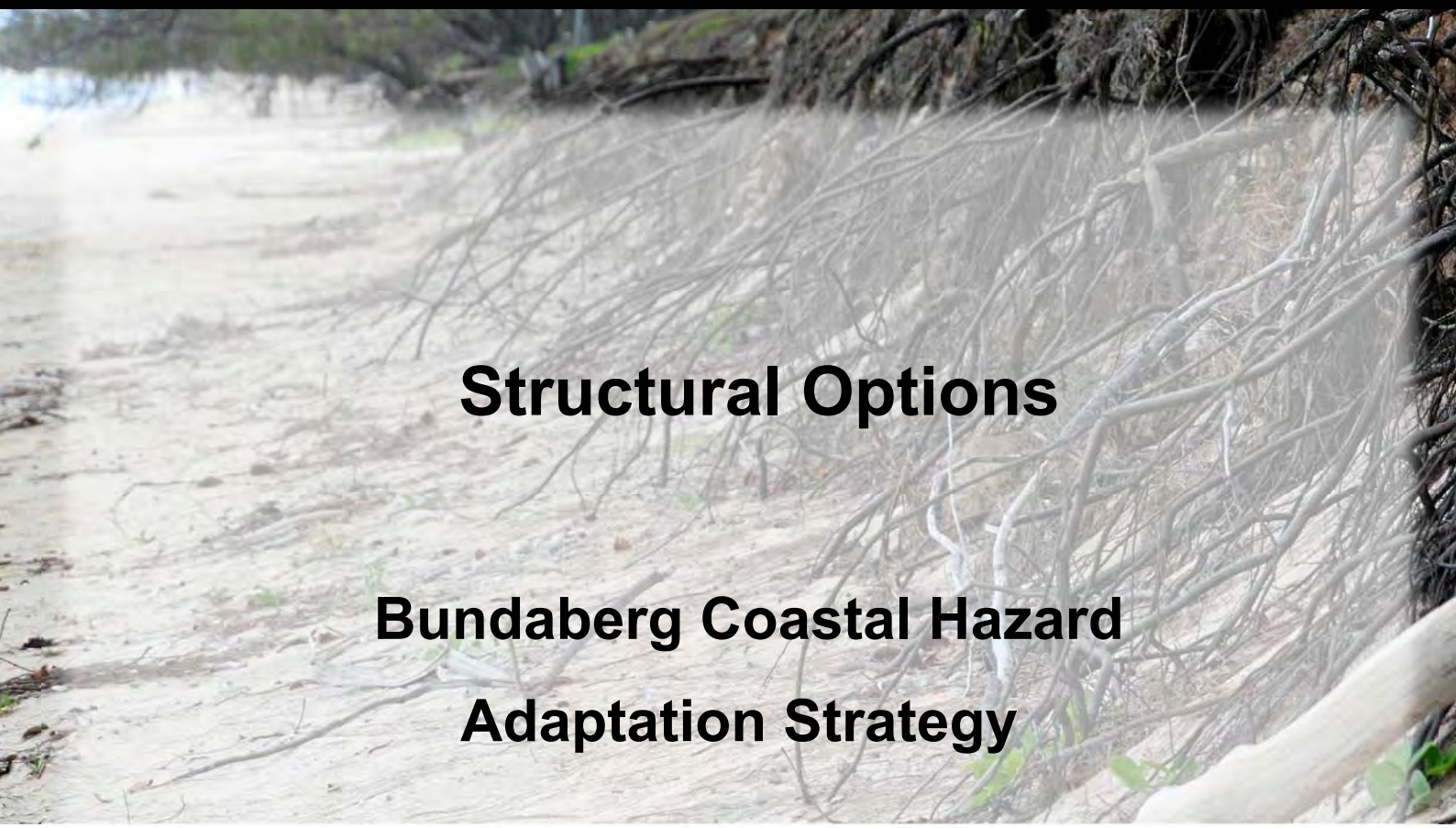
WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

APPENDIX C
HIG ENGINEERING DESIGN AND CONSTRUCTION COSTS

HARRISON INFRASTRUCTURE GROUP



Structural Options

Bundaberg Coastal Hazard Adaptation Strategy

Document control sheet

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Version history

Version No.	Date	Changed By	Details
Draft	04\10\2019	C. Curd	
Revision	22/10/2019	C. Curd	

Table of Contents

1. Introduction

Harrison Infrastructure Group have been 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 indication of the level of capital and revenue expenditure for each Coastal Engineering option. This report provides indicative costs for the following adaptation options.

- Beach Nourishment/ Dune Revegetation
- Seawall (sandbags or rocks)
- Groyne (sandbags or rocks
- Dyke/ Storm Surge Barrier
- Artificial Reef
- Raising key access roads
- Upgrading existing assets.

2. Coastal Defence Options

2.1. Beach Nourishment/Dune Revegetation

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 min. it is noted that the area becomes less populated north of Palm view Drive and a reduced length of 1.2km should be considered. Note that there is no “holding structure” in place (e.g. groyne or headland etc.), so the sand placed 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 40m min. Note that there is no “holding structure” in place (e.g. groyne or headland etc.), so the sand placed will disperse over time.

Woodgate – The Intolerable risk area extends along whole ocean front. Nourishment extent is initially recommended for boat ramp to south of Twelfth Ave (approx. 5km) to protect the Esplanade Road. The treatment should extend offshore for 34m min. Note that there is no “holding structure” in place (e.g. groyne or headland etc.), so the sand placed will disperse over time.

Bargara - Beach nourishment treatment should extend for the whole beach pocket (approx.. 1.4km). The treatment should extend offshore for 10m min. It is expected that the headlands will keep the sand in place for longer compared to the other areas. It should be noted that beach nourishment in this area can create other issues in relation to the creek outfall and water quality.

Town	Length / Dimensions	Implementation Cost [1] (inlc. 40% Contingency)	Initial Cost m^3/m	Annual Maintance [2]
Moore Park	Length: 2.2km Extent offshore: 34m Area: 74,800 m^3	$4,574,080.00	$2,079	$246,840.00
Moore Park (reduced)	Length: 1.2km Extent offshore: 34m Area: 40,800 m3	$2,670,080.00	$1,214	$134,640.00
Coonarr	Length: 400m Extent offshore: 13m Area: 5200 m^3	$449,960.00	$1,125	$17,160.00
Woodgate	Length: 5km Extent offshore: 31m Area: 155,000 m^3	$9,240,000.00	$1,848	$511,500.00
Bargara	Length: 1.4km Extent offshore: 14m Area: 19,600 m^3	$1,310,960.00	$936	$64,680.00

[1] Implementation costs include Sand Sourcing Study, Initial Survey, Design and Approval Costs

[2] Annual Maintance to undertake a sand renourishment campaign of 5% every year along the at-risk foreshore. (incl. 10% contingency)

2.2. Seawall (sandbags or rocks)

Seawalls are structures separating land and water areas designed to prevent coastal erosion and other damage due to wave action and storm tide inundations. Seawalls are normally very large structures as they are designed to resist the full force of waves and storm surges.

Seawalls are often incorporated into a Shoreline Erosion Management Strategy in combination with beach nourishment and dune regeneration to provide a last line of defence under the coastal dune, reducing the risks of erosion and floods.

Town	Seawall length	Initial Cost[1]	Whole of Life Cost
Moore Park Beach	1.2km	$6,429,200	$9,643,800
Coonarr	340m	$1,837,200	$2,755,800
Woodgate	5km	$26,505,000	$39,757,500
Bargara	1.4km	$7,460,400	$11,190,600

[1] Implementation costs include Initial Survey, Design and Approval Costs

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 50-year lifetime.

2.3. Groyne (rocks or sandbags)

Groynes are structures built perpendicular to the shoreline that trap sand moving along the coast, causing sand build up on the downdrift side. A variant of a groyne is an artificial headland which acts in the same manner but has a larger footprint. They can be effective in controlling coastal erosion and longshore transport.

Groynes are only effective in areas with sufficient longshore sediment transport rates. They cause the accumulation of material on one side and erosion in the lee side. Therefore, it is often required to build a whole groyne field to avoid negatively impacting on lee-side assets. Groynes are therefore recommended for a whole beach compartment.

Town	Groyne filed extent	Initial Cost	Whole of Life Cost
Woodgate	5km (2500m of Groyne)	$12,500,000	$18,750,000

The above treatment assumed the placement of groynes every 50m to 100m and extending approximately 50m offshore.

Groynes do not require high levels of maintenance, however extreme storms can damage the structures and intervention may 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 50% replacement of the groynes over 50-year lifetime.

It is questionable if the existing sediment transport rates are sufficient to make groynes a viable option in this location. The construction of groynes was not recommended from the SEMP study (in fact for all Woodgate options the SEMP should be referred to as the SEMP already analysed the best suitable option for the township).

2.4. Dyke/Storm Surge Barrier

A sea dyke or levee is an artificially constructed fill or wall commonly designed to regulate water levels and 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 but maintain navigation at other times. They are normally part of a combined system of barriers (dykes, dunes, etc.) preventing storm tide water levels to flood waters within estuaries, lagoons or waterways.

Town	Description	Cost
Burnett Heads	300m earth dyke plus 80m storm surge barrier	$10,500,000

2.5. Artificial Reef (rock or sandbags)

Artificial reefs are submerged structures designed to reduce wave energy and erosive processes on the coastal foreshore. Typically, artificial reefs are constructed with sand filled geotextile bags which are filled inside a split-hull hopper dredge. Once filled, the bags are transported offshore and dropped at pre-determined locations in accordance with the design. In some cases reefs have been constructed with rock or concrete blocks, where units are placed on the seabed according to design specifications using an excavator mounted on a barge.

Design and construction costs depends on the size and shape of the structure. Artificial reefs are normally designed to be effective for 20 years under average conditions. Artificial reefs do not require high levels of maintenance, however extreme storms can damage the structure of sand bags and intervention may be required.

Town	Beach Length (Benfit Area)	Cost
Innes Park	1km (2 structure)	$4,750,000
Coonarr	340m (1 structure)	$2,500,000
Woodgate	5km (5 structure)	$12,500,000
Bargara	1.4km (3 structure)	$5,750,000

Estimated costs are based on historical costs for similar structures.

3. Raising Key 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 causeway crossing which may experience inundation
3. Maintaining the existing road and undertaking reconstruction/repairs when required.

The estimated costs included maintenance of the proposed option for 50yr life.

Town	Raise Road [1]	Causeway[2]	Maintenance[3]
Moore Park Beach			
Moore Park Rd (800m, incl. bridge)	$7,200,000	$2,062,500	$400,000
Murdochs Linking Rd (350m, minor drainage)	$1,905,000	$1,470,000	$175,000
Malvern Drive (70m, incl bridge)	$3,150,000	$294,000	$35,000
Woodgate Beach			
Walkers Point Rd (170m, minor drainage)	$1,005,000	$715,000	$85,000
Theodolite Creek Rd (300m, minor drainage)	$1,462,500	$1,260,000	$150,000
Paperbark Court – First Ave (490m, minor drainage)	$3,937,500	$1,010,000	$245,000
Acacia Street (300m, minor drainage)	$2,400,000	$1,260,000	$150,000
Coonarr (300m)			
Coonarr Road (300m)	$1,629,000	$1,260,000	$100,000

[1] Initial Cost plus 5% maintenance cost per 10 yrs.

[2] Minimal road level increase, inclusion of concrete protected causeway, excludes new bridge construction.

[3] 10yr routine maintenance undertaken.

4. Existing Asset Management

The Bundaberg Coastal Hazard Adaptation Strategy has identified numerous infrastructure assets i.e. water supply infrastructure, electricity networks etc. within the Erosion Prone Area (+0.8m SLR). The below table summarises the assets that are affect at each location:

Town	Length	Replacement Cost
Moore Park Beach		
Water Supply	8.2km	$1,350,000
Electricity Network	25.1km	$5,770,000
Stormwater Drainage	5.8km	$5,220,000
Miara, Winfield and Norval Park		
Electricity Network	6.1km	$10,060,000
Stormwater Drainage	0.04km	$60,000
Bargara		
Water Supply	2.3km	$379,000
Electricity Network	3.1km	$713,000
Stormwater Drainage	2.0km	$2,400,000
Sewerage Mains	2.3km	$510,000
Burnett Heads		
Water Supply	6.3km	$1,040,000
Electricity Network	29.4km	$6,760,000
Stormwater Drainage	3.4km	$4,080,000
Sewerage Mains	0.6km	$150,000
Elliott Heads		
Water Supply	2.3km	$380,000
Electricity Network	1.5km	$345,000
Stormwater Drainage	0.5km	$450,000
Woodgate Beach		
Water Supply	8.7km	$1,440,000
Electricity Network	15.5km	$3,600,000
Stormwater Drainage	4.1km	$4,510,000
Innes Park and Coral Cove		
Water Supply	2.2km	$365,000
Electricity Network	2.4km	$560,000
Stormwater Drainage	0.5km	$550,000
Sewerage Main	0.2km	$50,000

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.

5. Approvals Required

The impacted zones sit within the context of Commonwealth and State legislation and Bundaberg Regional Council's local planning policies. This section provides a summary of the key legislative and planning requirements that may impact how coastal erosion is managed in the study area.

Each proposed treatment will require some form of approvals to enable construction of the treatment. A majority of the treatments will require similar approvals for works to be undertaken. The following is a general indication of the approvals that would be required to undertake any of the proposed treatments.

The basis and control of management of Queensland's coast is governed by the Coastal Protection and Management Act 1995 (Coastal Act) and the Planning Act 2016. Under these Acts, the Coastal Management Plan (CMP), the Coastal Protection State Planning Regulatory Provision (Coastal SPRP), the State Planning Policy (SPP) and the State Development Assessment Provisions (SDAP) are the primary statutory planning instruments for development planning and assessment.

The following table outlines the key legislative and planning requirements and the impact they may have on proposed treatments:

Legislation/Policy	Objectives
Coastal Protection and Management Act 1995	The *Queensland Coastal Protection and Management Act 1995* (Coastal Act) governs the way coastal land is managed in Queensland. The main objects of this Act are to: • Provide for the protection, conservation, rehabilitation and management of the coastal zone, including its resources and biological diversity; and • Have regard to the goal, core objectives and guiding principles of the National Strategy for Ecologically Sustainable Development in the use of the coastal zone; and • Ensure decisions about land use and development safeguard life and property from the threat of coastal hazards; and • Encourage the enhancement of knowledge of coastal resources and the effect of human activities on the coastal zone.
Planning Act 2016	The Planning Act 2016 mandates a state-wide, applicant-driven development assessment system, by which local governments (and state agencies in some circumstances) assess and make decisions on the various land-use and development proposals. There are two statutory state planning instruments. These being: • State Planning Policy (SPP) This instrument sets out the state planning matters considered as crucial to responsible land-use planning and development across the state. Councils must consider the state interests that apply to their local government areas when making, amending and implementing their planning schemes. • Regional Plans. A regional plan focuses on the growth and development of a specific part of Queensland. Regional planning matters are identified in collaboration with local governments, key industry groups and the wider community. Where a regional plan exists, the local government must consider it when making or amending its planning scheme. The Wide Bay Burnett Regional Plan (DLGP, 2011) includes the local government area of Bundaberg Regional Council.
State Planning Policy (SPP) 2017	The SPP includes 17 state interests that must be considered in every planning scheme across Queensland. Each of the 17 state interests in the SPP is

	supported by guidelines which help councils to implement the SPP provisions. State interests are arranged under five broad themes.
	• Liveable communities and housing
	  o Housing supply and diversity
	  o Liveable communities
	• Economic growth
	  o Agriculture
	  o Development and construction
	  o Mining and extractive resources
	  o Tourism
	• Environment and heritage
	  o Biodiversity
	  o Coastal environment
	  o Cultural heritage
	  o Water quality
	• Safety and resilience to hazards
	  o Emissions and hazardous activities
	  o Natural hazards, risk and resilience
	• Infrastructure
	  o Energy and water supply
	  o Infrastructure integration
	  o Transport infrastructure
	  o Strategic airports and aviation facilities
	  o Strategic ports

State Development Assessment Provisions	Development applications concerning certain matters of interest to the state are referred to the State Assessment and Referral Agency (SARA). In assessing applications, the state refers to both the SPP and the State Development Assessment Provisions (SDAP). *State Code 8: Coastal development and tidal works* of the SDAP provides a state code for development in the coastal management district or for tidal works. The criteria outlined in State Code 8 will need to be followed in a development application for coastal erosion protection works, as such works will be located within the coastal management district. The assessment criteria in relation to erosion prone areas generally emphasise avoiding new development and intensification, avoiding disruption to existing coastal processes and adopting "soft" solutions to coastal protection in preference to "hard" erosion control structures. Relevant performance outcomes (assessment criteria) include: • Natural processes and the protective function of landforms and vegetation are maintained in coastal hazard areas. • Erosion prone areas in a coastal management district are maintained as development free buffers, or where permanent buildings or structures exist, coastal erosion risks are avoided or mitigated. • Development avoids or minimises adverse impacts on coastal resources and their values, to the maximum extent reasonable. • Coastal protection work is undertaken only as a last resort where erosion presents an imminent threat to public safety or permanent structures. • Development avoids adverse impacts on matters of state environmental significance, or where this is not reasonably possible, impacts are minimised, and an environmental offset is provided for any significant residual impacts to matters of state environmental significance that are prescribed environmental matters.

	Coastal protection work is only to be undertaken to protect permanent structures which cannot reasonably be relocated or abandoned from imminent adverse coastal erosion impacts. Coastal protection work should involve beach nourishment as a first priority. The construction of an erosion control structure should only be considered if it is the only feasible option for protecting permanent structures from coastal erosion and those structures cannot be abandoned or relocated. Coastal protection work to protect private structures should be located on private land where possible and should not increase the coastal hazard risk for adjacent areas.
Wide Bay Burnett Regional Plan	The *Wide Bay Burnett Regional Plan* (DLGP, 2011) sets out the strategic directions, principles and policies to manage regional growth and change in the most sustainable way – to protect and improve the quality of life in the Wide Bay Burnett region. The regional plan provides context for local level planning. The regional plan is implemented by the coordinated actions of state and local government and the community to achieve this shared vision for the future. The regional plan identifies the regional framework and desired regional outcomes for the Wide Bay Burnett region. The regional plan is the pre-eminent plan for the region, and takes precedence over all planning instruments, other than state planning regulatory provisions. The regional plan is a “whole-of-region” document. It is intended that the regional framework and desired regional outcomes in the plan will be additionally informed by more detailed and local assessment of issues by state and local governments, and more specific state planning policies and local government planning schemes.
Coastal Management Plan	The Coastal Management Plan (CMP) seeks to manage all coastal land and coastal resources within the coastal zone as defined by the Coastal Act. It applies to all management planning, activities, decisions and works that are not assessable development under the SP Act, including the development of a SEMP. The guiding principle for the management of coastal landforms and processes is to preserve the long-term stability of dunes and other natural coastal landforms; and to allow physical coastal process including erosion, accretion and the movement of sediment to occur without interruption. However, the plan acknowledges that erosion can threaten communities and infrastructure. In this case, the CMP specifically calls for a Shoreline Erosion Management Plan (SEMP) to deliver a science-based solution to the erosion problem that considers social, environmental and economic issues. Other matters on which the CMP provides policy guidance include: • Conserving matters of state environmental significance (MSES), • Maintaining and enhancing the connection of Aboriginal People and Torres Strait Islanders to coastal and marine resources, • Maintaining and enhancing public access and use of the coast, • Ensuring continuous improvement in management outcomes through planning, monitoring, reporting and review, and • Sharing knowledge of coastal resources and management with the community and engaging the community in decision making processes.
Commonwealth Legislation	**Objectives**

Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	The Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) is the Federal Government's central piece of environmental legislation. Approval from the Minister responsible for the EPBC Act11 is required to take any action (e.g. project, development, activity) that is likely to result in a significant impact on a matter of national environmental significance (MNES).
Native Title Act 1993	The *Native Title Act 1993* provides for the recognition and protection of native title in Australia. It is a recognition by Australian law that indigenous people have rights and interests to their land that derive from their traditional laws and customs. Native title determinations are undertaken in the Federal Court, upon application by a native title claimant.
State Legislation	**Objectives**
Matters of State Environmental Significance	Matters of State Environmental Significance (MSES) are a component of the state's biodiversity interests that are defined under the State Planning Policy. MSES include certain environmental values that are protected under Queensland legislation, including the: • Protected areas (including all classes of protected area except coordinated conservation areas) under the Nature Conservation Act 1992. • Marine parks and land within a 'marine national park', 'conservation park', 'scientific research', 'preservation' or 'buffer' zone under the Marine Parks Act 2004. • Areas within declared fish habitat areas that are management A areas or management B areas under the Fisheries Regulation 2008. • Threatened wildlife under the Nature Conservation Act 1992 and special least concern animal under the Nature Conservation (Wildlife) Regulation 2006. • Regulated vegetation under the Vegetation Management Act 1999 • Strategic Environmental Areas under the Regional Planning Interests Act 2014. • Wetlands in a wetland protection area or wetlands of high ecological significance shown on the Map of Referable Wetlands under the Environmental Protection Regulation 2008. • Wetlands and watercourses in high ecological value waters as defined in the Environmental Protection (Water) Policy 2009, Schedule 2. • Legally secured offset areas.
Nature Conservation Act 1992	The *Nature Conservation Act 1992* (the NC Act) relates to the protection of native flora and fauna and the declaration of protected areas.
Environmental Protection Act 1994	The *Environmental Protection Act 1994* (the EP Act) and the *Environmental Protection Regulation 2008* provide the main framework for controlling environmental harm and pollution resulting from development.
Marine Parks Act 2004	The *Marine Parks Act 2004* (MP Act) establishes a framework for protecting the marine environment through the declaration of state marine parks.
Fisheries Act 1994	The *Fisheries Act 1994* sets out Queensland's Department of Agriculture and Fisheries responsibilities for the economically viable, socially acceptable and ecologically sustainable development of Queensland's fisheries resources.
Forestry Act 1959	Under the provisions of the *Forestry Act 1959,* the Department of Agriculture and Fisheries sells quarry material from land where such material has been reserved to the State - including in State forests, timber reserves, forest entitlement areas and State plantation forests. Sales permits are issued by the Department to enable local authorities, government agencies and private sector quarry operators to utilise State-owned quarry material. Because the definition of "mineral" in the *Mineral Resources Act 1989* excludes most materials used for construction purposes, quarry sites are mostly assessed, approved and administered by local government authorities.

Native Title (Queensland) Act 1993	The *Native Title (Queensland) Act 1993* is state legislation which ensures that Queensland law is consistent with the Commonwealth Native Title Act 1993 and validates pre-existing rights of the state. Certain past acts of the state, such as freehold grants, some leasehold grants, and public works are validated, such that they extinguish native title in relation to the land or waters concerned. Other rights such as existing ownership of natural resources, water and fishing access rights and public access to and enjoyment of beaches and other public places are confirmed by the act. Native title determinations and ILUAs made under the commonwealth's *Native Title Act 1993* are valid under this state Act.
Aboriginal Cultural Heritage Act 20	This Act recognises that Aboriginal people are the owners of their cultural heritage. In proclaiming *the Aboriginal Cultural Heritage Act 2003*, the state government provided statutory protection to all of Queensland's Aboriginal cultural heritage, irrespective of whether or not that heritage is known to land users.
Land Act 1994	The *Land Act 1994* regulates the management of non-freehold land for the benefit of the people of Queensland.
Vegetation Management Act 1999	*The Vegetation Management Act 1999* prohibits clearing of regional ecosystems (i.e. native vegetation communities) unless it is for a relevant purpose.
Queensland Heritage Act 1992	The object of the *Queensland Heritage Act 1992* is to provide for the conservation of Queensland's cultural heritage for the benefit of the community and future generations.
Local Government	**Objectives**
Local Government Act 2009 (LG Act)	The *LG Act* permits local governments to acquire jurisdiction from the State Government over the foreshore between the low-water and high-water lines for special purposes such as foreshore protection works. Bundaberg Regional Council controls land use and activities under the local planning scheme (under the SP Act) and Local Laws (LG Act).
Bundaberg Regional Council Planning Scheme	The current *Bundaberg Regional Council Planning Scheme 2015* and supporting Planning Scheme Policies (the planning scheme) came into effect on the 19th October 2015. It is the primary local planning instrument governing all planning and development within the Bundaberg Regional Council area.

Consultation with the following agencies may be required regarding the legislation detailed above:

- Department of Environment and Science (DES) for matters concerning foreshore protection works, conservation values, tidal quarry material allocations, management under the QCP; marine parks and NC Act permits;
- Department of Natural Resources, Mines and Energy (DNRME) for matters concerning the allocation and use of State Land, vegetation management, indigenous cultural issues and land title;
- Department of Agriculture and Fisheries (DAF) for matters concerning fisheries resources, marine plants, FHAs, and quarry operations.

Estimated costs for obtaining approvals for each proposed treatment have been included in the initial costs for the construction of the structure. Ongoing approval costs, if required, have been included in maintenance costs.

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APPENDIX D
INDICATIVE STRUCTURAL OPTION MAPPING

BEFORE

AFTER

N

Legend

Roads and Tracks

Coastal Area Boundary

Commercial Buildings

Residential Buildings

Industrial Buildings

Erosion Prone Area 1% AEP + 0.2m SLR

Erosion Prone Area 1% AEP + 0.4m SLR

Erosion Prone Area 1% AEP + 0.8m SLR

Indicative Structural Option Location

SYLVAN DRIVE

ANUS STREET

SYLVAN DRIVE

SYLVAN DRIVE

MURDOCHS ROAD

PALM VIEW DRIVE

EVANS LANE

ORCHID DRIVE

TRACK

LAGOON DRIVE

KINDT STREET

MURDOCHS ROAD

EGRET LANE

MURDOCHS ROAD

MURDOCHS ROAD

MOORE PARK ROAD

LINDEMANS ROAD

Projection GDA/MGA 94 Zone 56

Water Technology Pty Ltd

Imagery Source: Google Earth

0 0.6 1.2 1.8 km

Bundaberg CHAS Phase 3 - 8

Indicative Structural Options

Moore Park Beach

OUR COAST

BEFORE

AFTER

N

Legend

Roads and Tracks

- Coastal Area Boundary
- Commercial Buildings
- Residential Buildings
- Industrial Buildings
- Erosion Prone Area 1% AEP + 0.2m SLR
- Erosion Prone Area 1% AEP + 0.4m SLR
- Erosion Prone Area 1% AEP + 0.8m SLR

Indicative Structural Option Location

ESPLANADE
SEE STREET
MILLER STREET
BURKITT STREET
FAIRWAY DRIVE
THE CAUSEWAY
CAUSEWAY DRIVE
SHADY GROVE
DOOLEY STREET
ANDY KEMP PLACE
GARSON DRIVE
JUDITH STREET
ISAAC STREET
NATALIE STREET
TREVORS ROAD
HUGHES ROAD
WOONGARRA SCENIC DRIVE
WATSONS ROAD
SUNSEEKER AVENUE
BEACHSIDE CIRCUIT
BAUER STREET
BAXTER STREET
JESSE COURT

Projection GDA/MGA 94 Zone 56
Water Technology Pty Ltd
Imagery Source: Google Earth

0 0.4 0.8 km

Bundaberg CHAS Phase 3 - 8

Indicative Structural Options
Kellys Beach Bargara (Scenario 0.8m SLR)

BEFORE

AFTER

N

Legend

Roads and Tracks

Coastal Area Boundary

Commercial Buildings

Residential Buildings

Industrial Buildings

Storm Tide Inundation Extent 1% AEP +0.8m SLR

MARINA DRIVE
BONAVENTURE DRIVE
ROAD
WHARF DRIVE
BUSS STREET
NEWMAN STREET
HERMANS ROAD
NORTH CROSSETT STREET
ALDRIDGE STREET
DOCTOR STREET
POWERS STREET
BEACHMERE STREET
ROWLANDS ROAD
HOFFMANS ROAD

Indicative Structural Option Location

Projection GDA/MGA 94 Zone 56
Water Technology Pty Ltd
Imagery Source: Google Earth

0 0.6 1.2 1.8 km

Bundaberg CHAS Phase 3 - 8
Indicative Structural Options
Burnett Heads (0.8m SLR scenario)

BEFORE

AFTER

N

KALINA STREET
AMAROO CRESCENT
MUNCKTON COURT
ILUKA STREET
BADILLA STREET
COOLANBLUE AVENUE
VESTA STREET
INNES PARK ROAD
ESPLANADE
BARRA COURT
MARLIN DRIVE
AMIRONEL CLOSE

Legend

Roads and Tracks

Coastal Area Boundary
Commercial Buildings
Residential Buildings
Industrial Buildings
Erosion Prone Area 1% AEP + 0.2m SLR
Erosion Prone Area 1% AEP + 0.4m SLR
Erosion Prone Area 1% AEP + 0.8m SLR

Indicative Structural Option Location

Projection GDA/MGA 94 Zone 56
Water Technology Pty Ltd
Imagery Source: Google Earth

0 0.2 0.4 km

Bundaberg CHAS Phase 3 - 8

Indicative Structural Options Innes Park (Scenario 0.8m SLR)

BEFORE

AFTER

N

Legend

Roads and Tracks

Coastal Area Boundary

Commercial Buildings

Residential Buildings

Industrial Buildings

Erosion Prone Area 1% AEP + 0.2m SLR

Erosion Prone Area 1% AEP + 0.4m SLR

Erosion Prone Area 1% AEP + 0.8m SLR

Indicative Structural Option Location

ESPLANADE

COONARR BEACH ROAD

COONARR BEACH ROAD

ESPLANADE

ONARR BEACH ROAD COONARR BEACH ROAD

Projection GDA/MGA 94 Zone 56

Water Technology Pty Ltd

Imagery Source: Google Earth

0 0.1 0.2 km

Bundaberg CHAS Phase 3 - 8

Indicative Structural Options

Coonarr (Scenario 0.2m SLR)

BEFORE

AFTER

N

Legend

Roads and Tracks

Coastal Area Boundary

Commercial Buildings

Residential Buildings

Industrial Buildings

Erosion Prone Area 1% AEP + 0.2m SLR

Erosion Prone Area 1% AEP + 0.4m SLR

Erosion Prone Area 1% AEP + 0.8m SLR

Indicative Structural Option Location

THEODOLITE CREEK DRIVE

ESPLANADE

CYPRESS STREET

FIRST AVENUE

PAPERBARK COURT

ACACIA STREET

POINCIANA COURT

JACARANDA COURT

COUNCIL COMPOUND TRACK

Projection GDA/MGA 94 Zone 56

Water Technology Pty Ltd

Imagery Source: Google Earth

0 0.4 0.8 km

Bundaberg CHAS Phase 3 - 8

Indicative Structural Options
Woodgate Beach - North (Scenario 0.4m SLR)

BEFORE

AFTER

N

Legend

Roads and Tracks

Coastal Area Boundary

Commercial Buildings

Residential Buildings

Industrial Buildings

Erosion Prone Area 1% AEP + 0.2m SLR

Erosion Prone Area 1% AEP + 0.4m SLR

Erosion Prone Area 1% AEP + 0.8m SLR

Indicative Structural Option Location

ESPLANADE
PAPERBARK COURT
ACACIA STREET
JACARANDA COURT
POINCIANA COURT
BAUHINIA STREET
FIRE SHED FIREBREAK
DRIFTWOOD PLACE
BANKSIA WALKING TRACK
BEECH COURT
MACADAMIA COURT
WILLOW COURT
BANKSIA BOARDWALK
OAK STREET
WATTLE STREET

Projection GDA/MGA 94 Zone 56
Water Technology Pty Ltd
Imagery Source: Google Earth

0 0.4 0.8 km

Bundaberg CHAS Phase 3 - 8

Indicative Structural Options
Woodgate Beach - Central (Scenario 0.4m SLR)

BEFORE

AFTER

N

Legend

Roads and Tracks

Coastal Area Boundary

Commercial Buildings

Residential Buildings

Industrial Buildings

Erosion Prone Area 1% AEP + 0.2m SLR

Erosion Prone Area 1% AEP + 0.4m SLR

Erosion Prone Area 1% AEP + 0.8m SLR

Indicative Structural Option Location

ESPLANADE
KANGAROO COURT
WHITING STREET
BREAM STREET
TAILOR STREET
MACKEREL STREET
MAIN TOWN FIRE BREAK
EMPEROR STREET
ACACIA STREET
MORAY COURT
BARRAMUNDI DRIVE

Projection GDA/MGA 94 Zone 56
Water Technology Pty Ltd
Imagery Source: Google Earth

0 0.4 0.8 km

Bundaberg CHAS Phase 3 - 8

Indicative Structural Options
Woodgate Beach - South (Scenario 0.4m SLR)

OUR COAST

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APPENDIX E
KEY ACCESS ROAD INUNDATION

MEMORANDUM

KEY ACCESS ROAD INUNDATION

This memo illustrates the methodology Water Technology used to identify roads that become permanently inundated and under which sea level rise scenario.

1 METHODOLOGY

Water Technology have reviewed the mapping of the following inundation extents in the context of key access roads in and out of the coastal settlements:

- HAT,
- HAT +0.2m,
- HAT +0.4m; and
- HAT +0.8m of sea level rise

In a desktop analysis, the following activities were undertaken:

- Firstly, determine what sea level rise scenario the key access roads became completely cut and considered impassable by vehicles
- Secondly, by reviewing the alternative egress routes from the settlement to major transport routes, it was determined whether there was a risk of isolation to certain parts or all of the settlement.

The following chapters summarise at which point key access roads become permanently inundated and mapped examples from Moore Park Beach.

2 ASSUMPTIONS

For the purposes of this exercise, permanent inundation was taken to mean when land is covered by HAT.

Please note, for the purposes of reporting within the CHAS, permanent inundation is included as a factor within the Coastal Erosion Prone Areas as per the Coastal Hazard Technical Guidelines and risk of isolation due to permanent inundation is therefore part of the Coastal Erosion risk analysis and evaluation.

3 ROAD INUNDATION SUMMARY

Table 3-1 Road Inundation Summary

Settlement	HAT	HAT + 0.2 m slr	HAT + 0.4 m slr	HAT + 0.8 m slr
Woodgate Beach	No roads likely to experience regular inundation.	Acacia St (near 151 Esplanade) and Theodolite Creek Drive (24 to 8) likely to experience regular inundation. Regular inundation of key access route that causes significant impacts to key services.	Acacia St (154 Acacia St), Theodolite Creek Drive and First Avenue likely to experience regular inundation. Regular inundation of key access route that causes significant impacts to key services.	Walker Point Rd, Woodgate Rd and Acacia St, Acacia St (154 Acacia St), Theodolite Creek Drive and First Avenue likely to experience permanent inundation. Isolation risk to the community
Walkers Point				Walkers Point Rd, just outside Woodgate
Coonarr	Coonarr Beach Rd likely to experience regular inundation Regular inundation of key access route that causes significant impacts to key services.	Coonarr Beach Rd likely to experience permanent inundation. Isolation risk to the community	Coonarr Beach Rd likely to experience permanent inundation. Isolation risk to the community	Coonarr Beach Rd likely to experience permanent inundation. Isolation risk to the community

Settlement	HAT	HAT + 0.2 m slr	HAT + 0.4 m slr	HAT + 0.8 m slr
Moore Park Beach	Moore Park Road likely to experience regular inundation Regular inundation of key access route that causes significant impacts to key services.	Moore Park Road likely to be permanently Inundated. Residents can still egress via Lindemans and Murdochs Linking Rd Malvern Drive, Murdochs Linking Rd, and Lindemans Rd. likely to regular inundation. Regular inundation of key access route that causes significant impacts to key services.	Moore Park Road likely to be permanently Inundated. Residents can still egress via Lindemans and Murdochs Linking Rd Malvern Drive, Murdochs Linking Rd, and Lindemans Rd. Regular inundation of key access route that causes significant impacts to key services.	Moore Park Road, Malvern Drive, Murdochs Linking Rd, and Lindemans Rd. likely to be permanently Inundated. Isolation risk to the community
Bargara	No roads likely to experience regular inundation.	No roads likely to experience regular inundation.	The Causeway likely to experience regular inundation. Regular inundation of key access route that causes significant impacts to key services.	Mccavanagh St (houses 17-25) likely to be permanently Inundated. Residents can still egress via Tanner St and Holland St The Causeway likely to be permanently Inundated. Residents can still egress via Woongarra Scenic Drive to the south or Miller St to the north. Fred Courtice Avenue, likely to experience regular inundation. Regular inundation of key access route that causes significant impacts to key services.

Settlement	HAT	HAT + 0.2 m slr	HAT + 0.4 m slr	HAT + 0.8 m slr
Innes Park and Coral Cove	Barolin Esplanade likely to be likely to experience regular inundation. Regular inundation of key access route that causes significant impacts to key services.	Barolin Esplanade bridge likely to be permanently Inundated. Residents can still egress via the Esplanade to the north of Barolin Esplanade to the south.	Barolin Esplanade bridge likely to be permanently Inundated. Residents can still egress via the Esplanade to the north of Barolin Esplanade to the south.	Barolin Esplanade bridge likely to be permanently Inundated. Residents can still egress via the Esplanade to the north of Barolin Esplanade to the south.

4 MAPPING

Using **Moore Park Beach as a working example** the following maps illustrate how Water Technology have determined the isolation risk to the settlements within the CHAS.

Figure 4-1 shows that Moore Park Road is permanently inundated at HAT +0.2m.

Figure 4-2 and 4-3 shows that residents of Moore Park Beach area able to egress via Lindeman Rd, Murdochs Linking Road and Malvern Drive under a 0.2m and 0.4m sea level rise scenario

Figure 4-4 and 4-5 shows that these alternative routes are likely to be permanently inundated under a +0.8m sea level rise scenario.

Figure 4-6 shows that because these alternate routes are cut, isolation becomes a risk at 0.8m of sea level rise.

Figure 4-1 Moore Park Road, inundated in 0.2m SLR

Figure 4-2 HAT + 0.2m SLR Egress Routes in Moore Park Beach

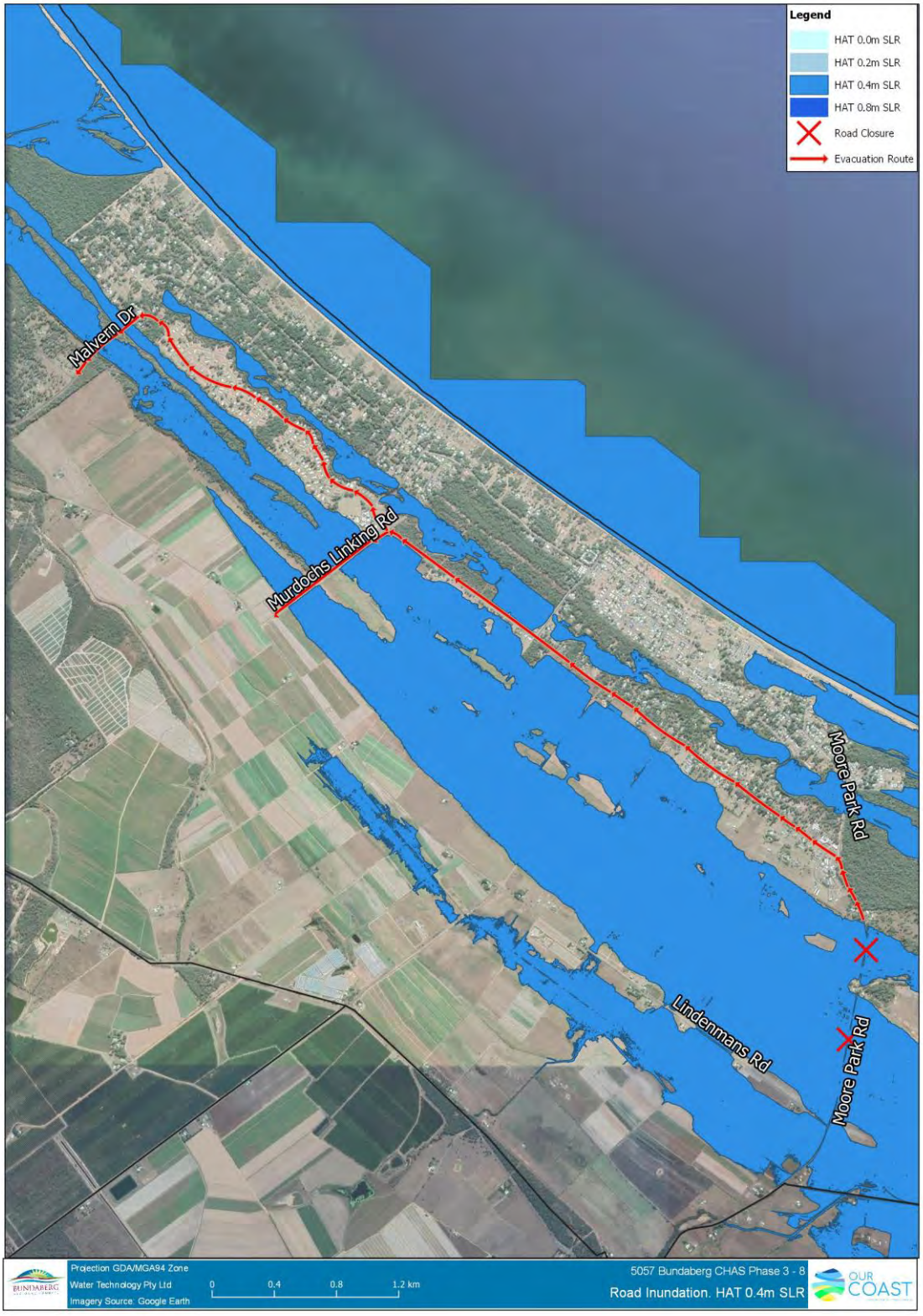


Figure 4-3 HAT +0.4m SLR Egress Routes in Moore Park Beach

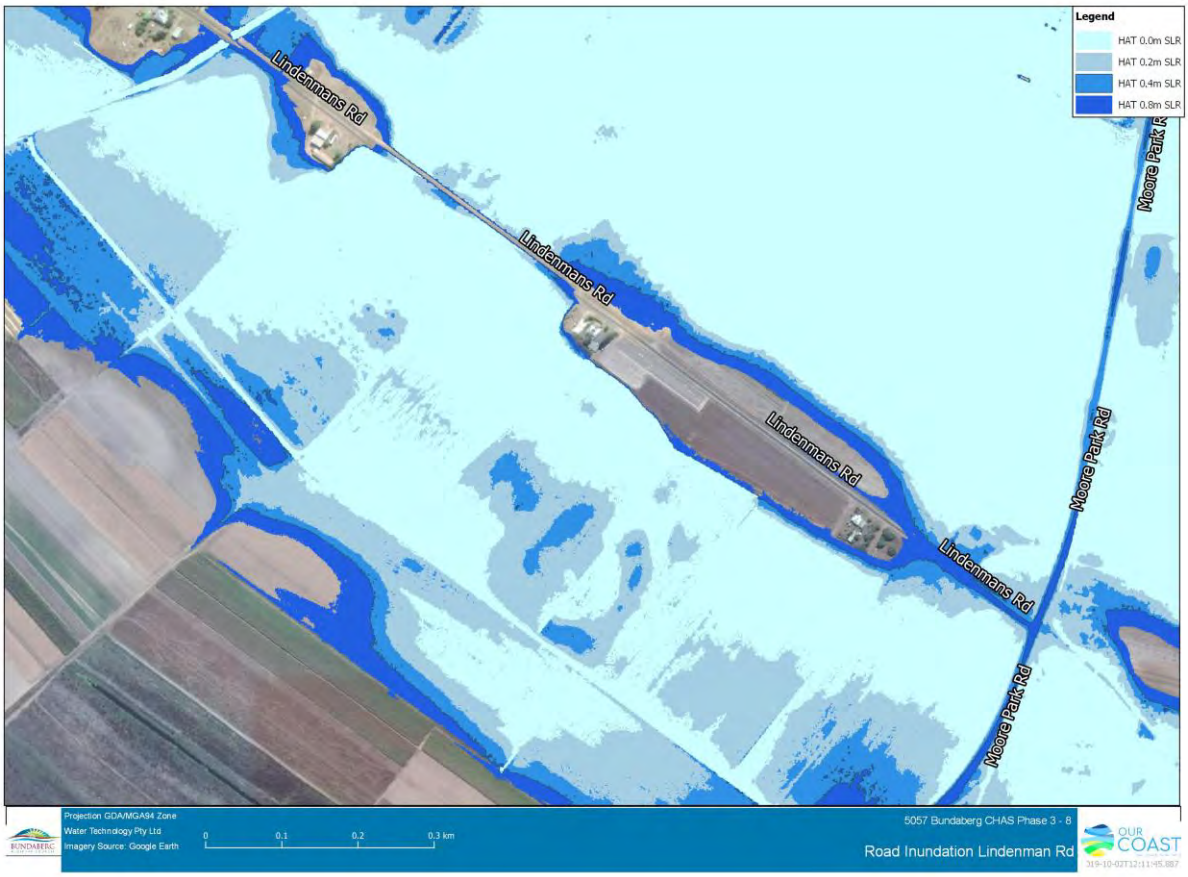


Figure 4-4 Lindeman Rd, inundated in 0.8m SLR

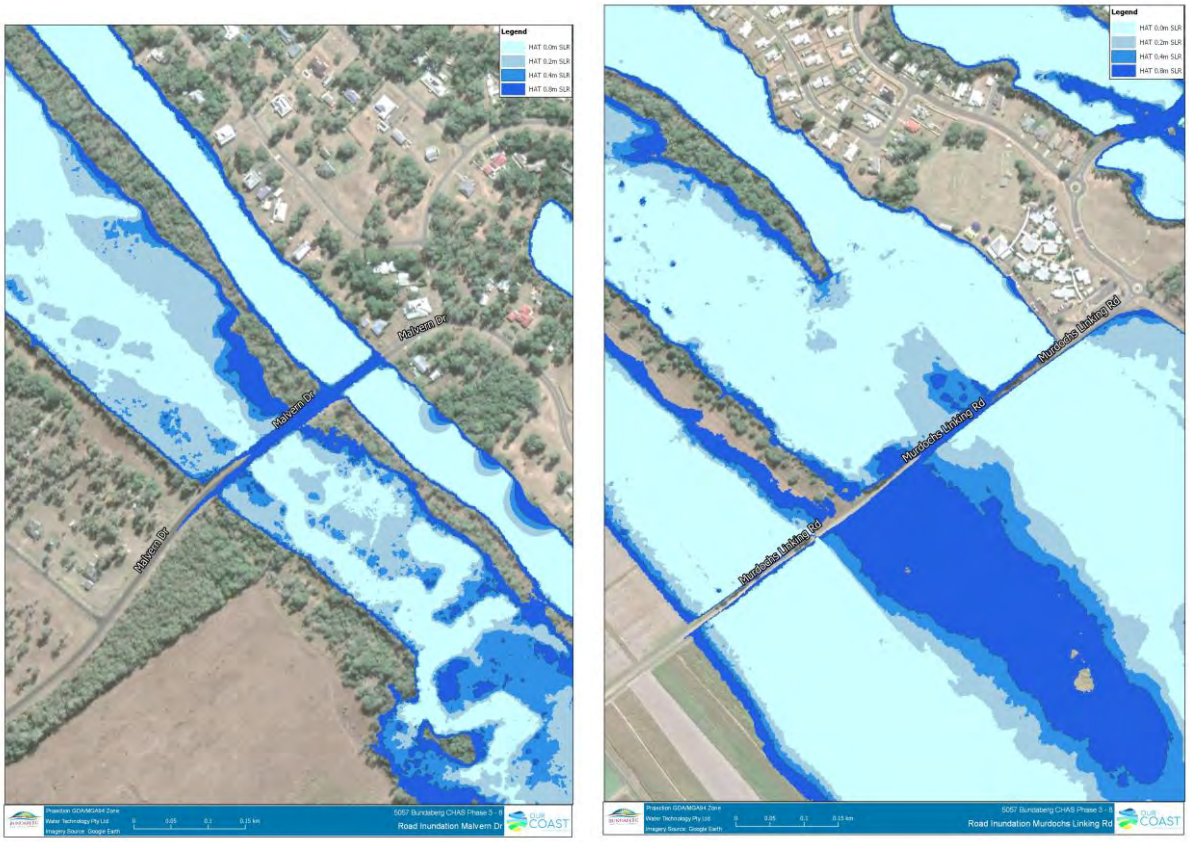


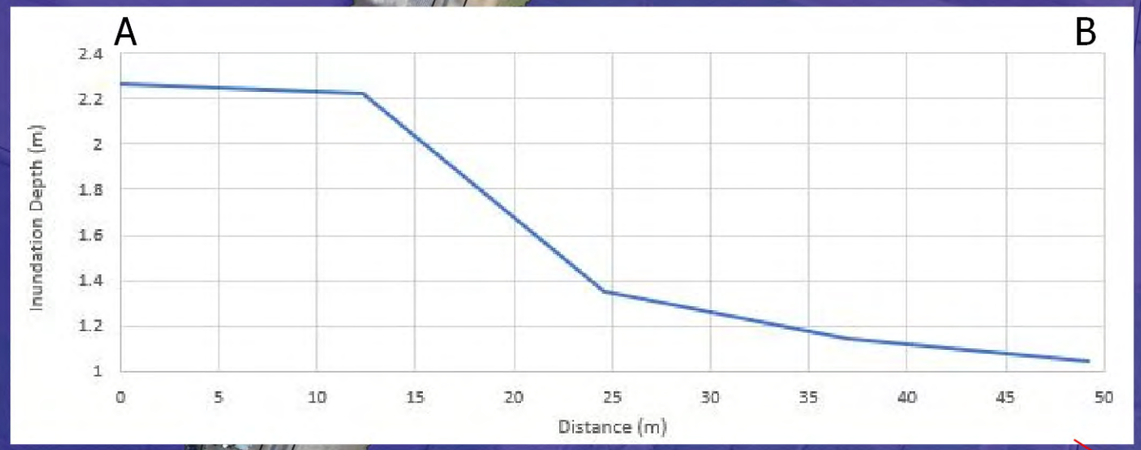
Figure 4-5 Malvern Drive and Murdochs Linking Rd, Inundated in 0.8m SLR

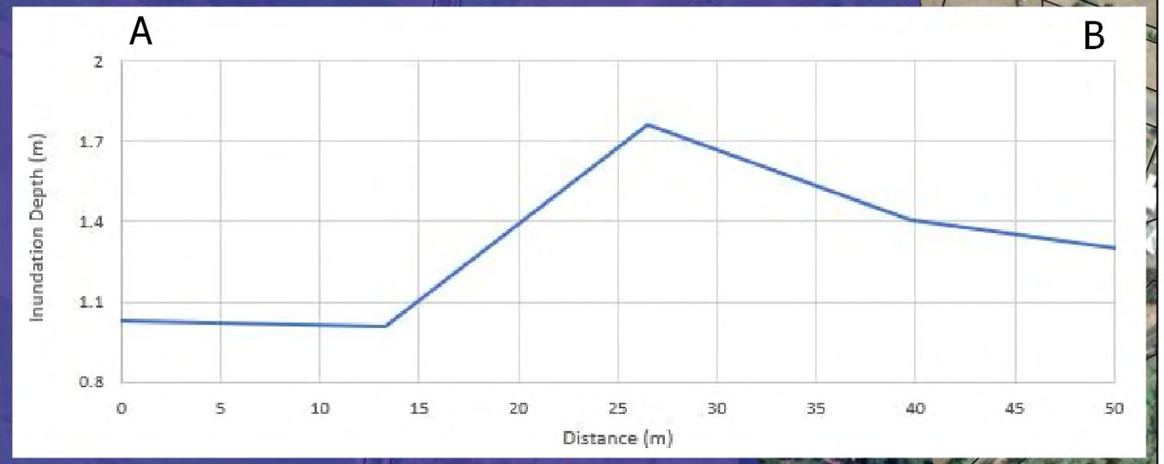
Figure 4-6 0.8m SLR Egress Routes in Moore Park Beach

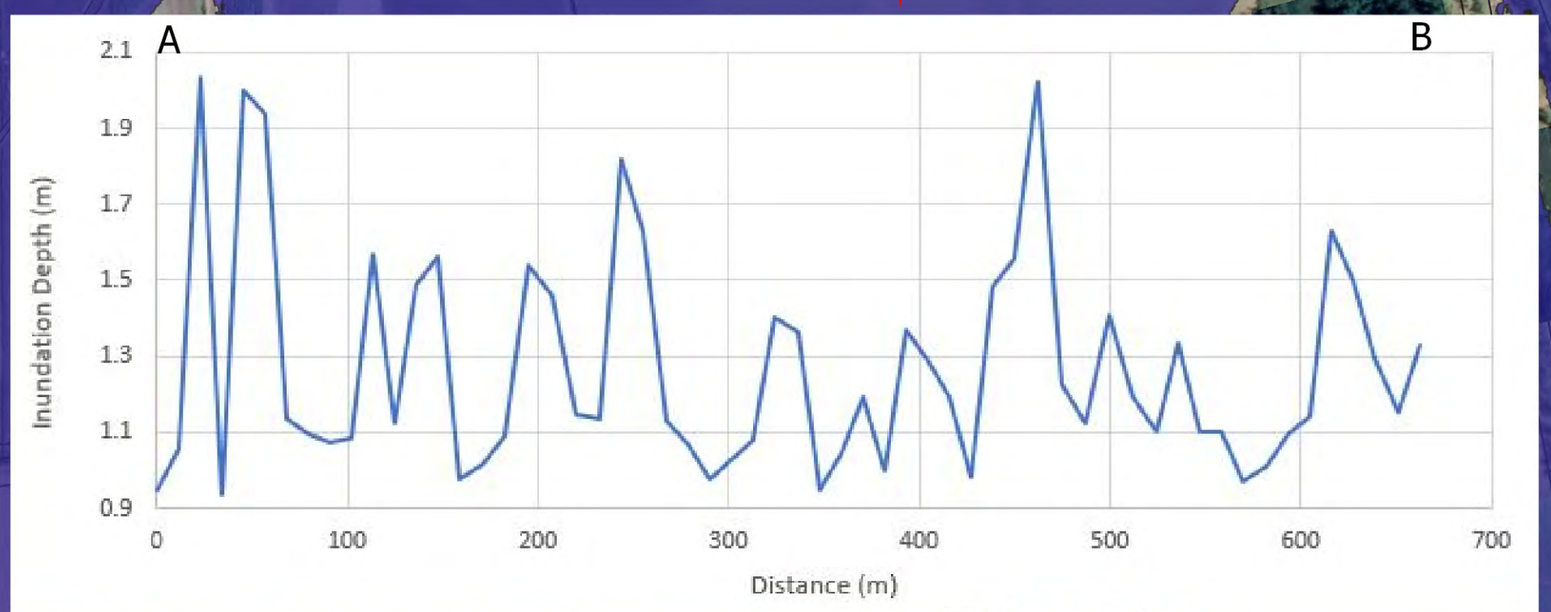
4.2 Options to Raise Key Access Routes

The following mapping outlines the options to raise key access routes to address potential isolation risk to the community in:

- Moore Park Beach
  - Moore Park Rd
  - Murdochs Linking Rd
  - Malvern Drive
- Coonarr
  - Coonarr Beach Rd
- Woodgate Beach
  - Acacia Street / Woodgate Rd
  - Walkers Point Rd
  - Theodolite Creek Dr
  - Paperback Court / First Ave







A
B
A
B
A
B

OPTIONS

- Raise land levels
- Causeway
- Periodic maintenance

Legend

Inundation Extent
1% AEP + 0.4m SLR

Projection GDA/MGA94 Zone
Water Technology Pty Ltd
Imagery Source: Google Earth

0 50 100 m

5057 Bundaberg CHAS Phase 3 - 8

Options Costing for Civil Design - Moore Park Rd

2019-09-09T14:02:33.390

OPTIONS

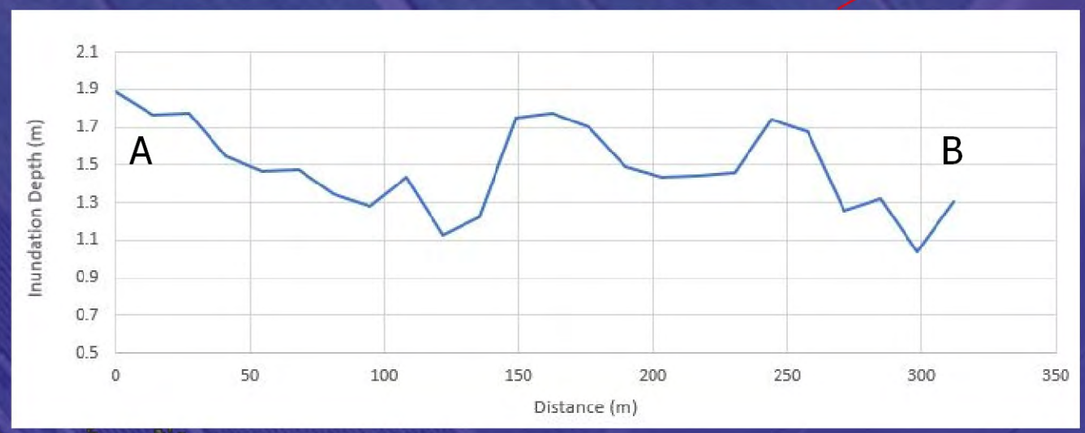
- Raise land levels
- Causeway
- Periodic maintenance

Legend

Inundation Extent
1% AEP + 0.4m SLR

A

B



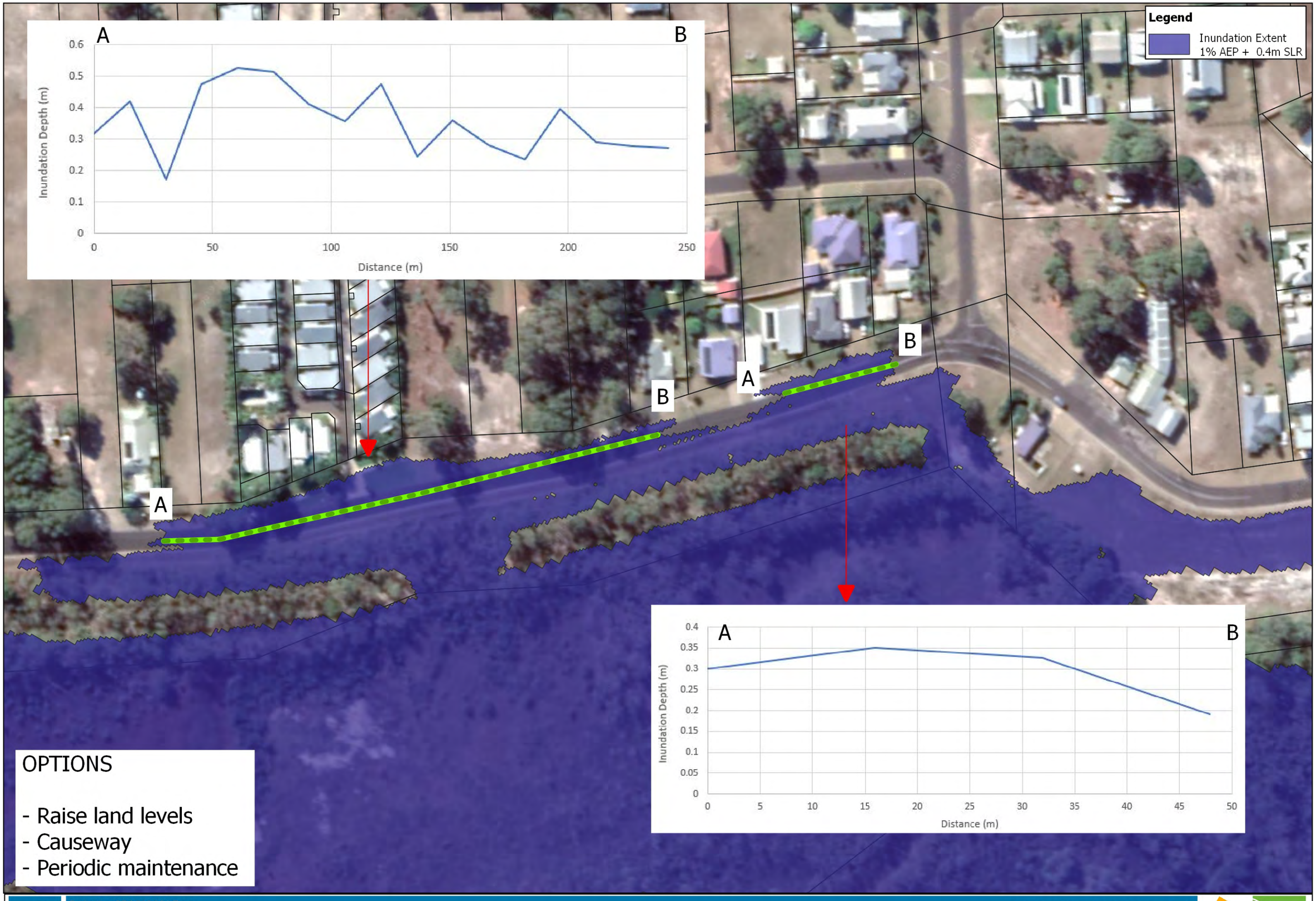
Projection GDA/MGA94 Zone
Water Technology Pty Ltd
Imagery Source: Google Earth

0 50 100 m

5057 Bundaberg CHAS Phase 3 - 8

Options Costing for Civil Design - Murdoch Linking Rd

2019-09-09T13:27:22.406



OPTIONS

- Raise land levels
- Causeway
- Periodic maintenance

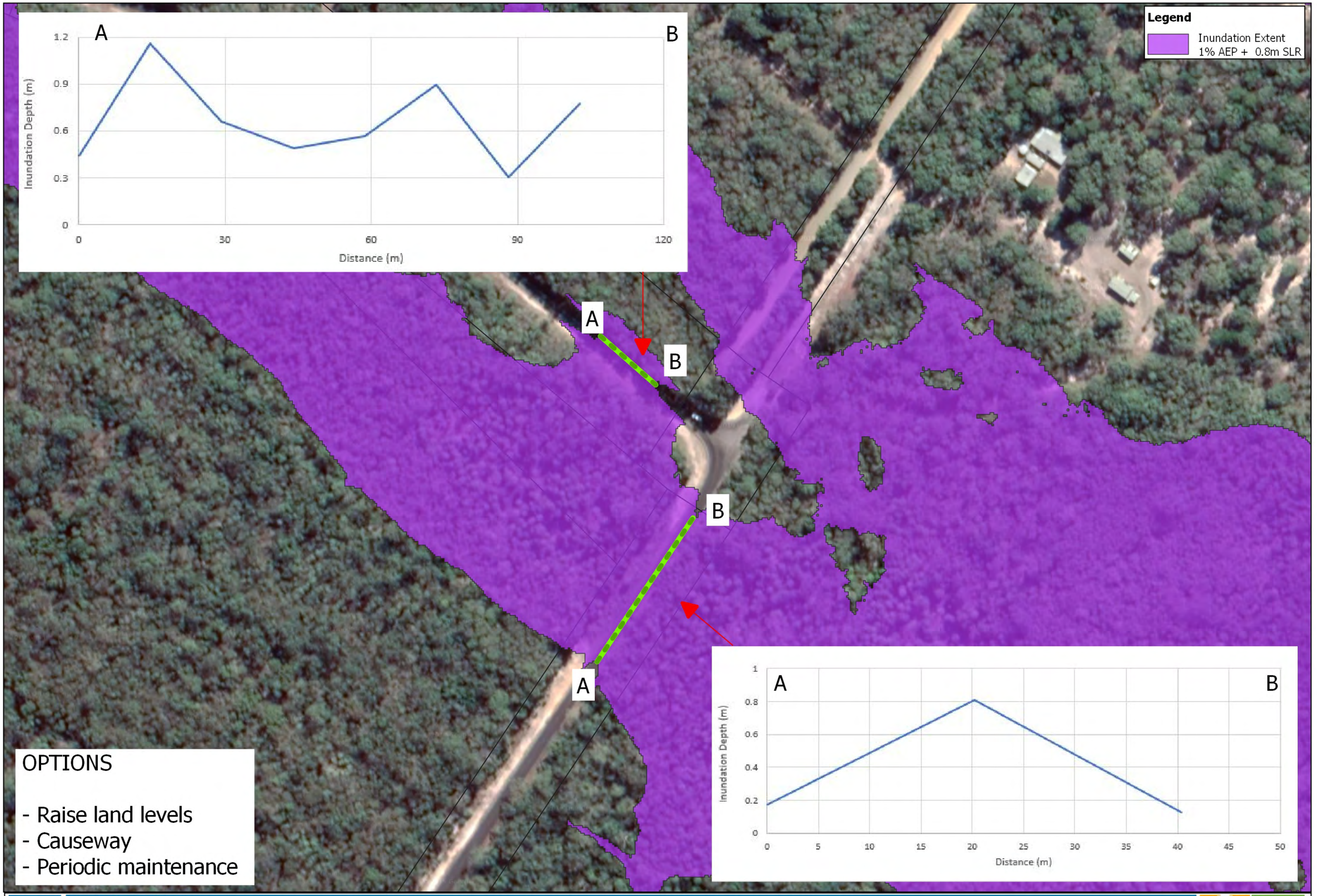
Projection GDA/MGA94 Zone
Water Technology Pty Ltd
Imagery Source: Google Earth

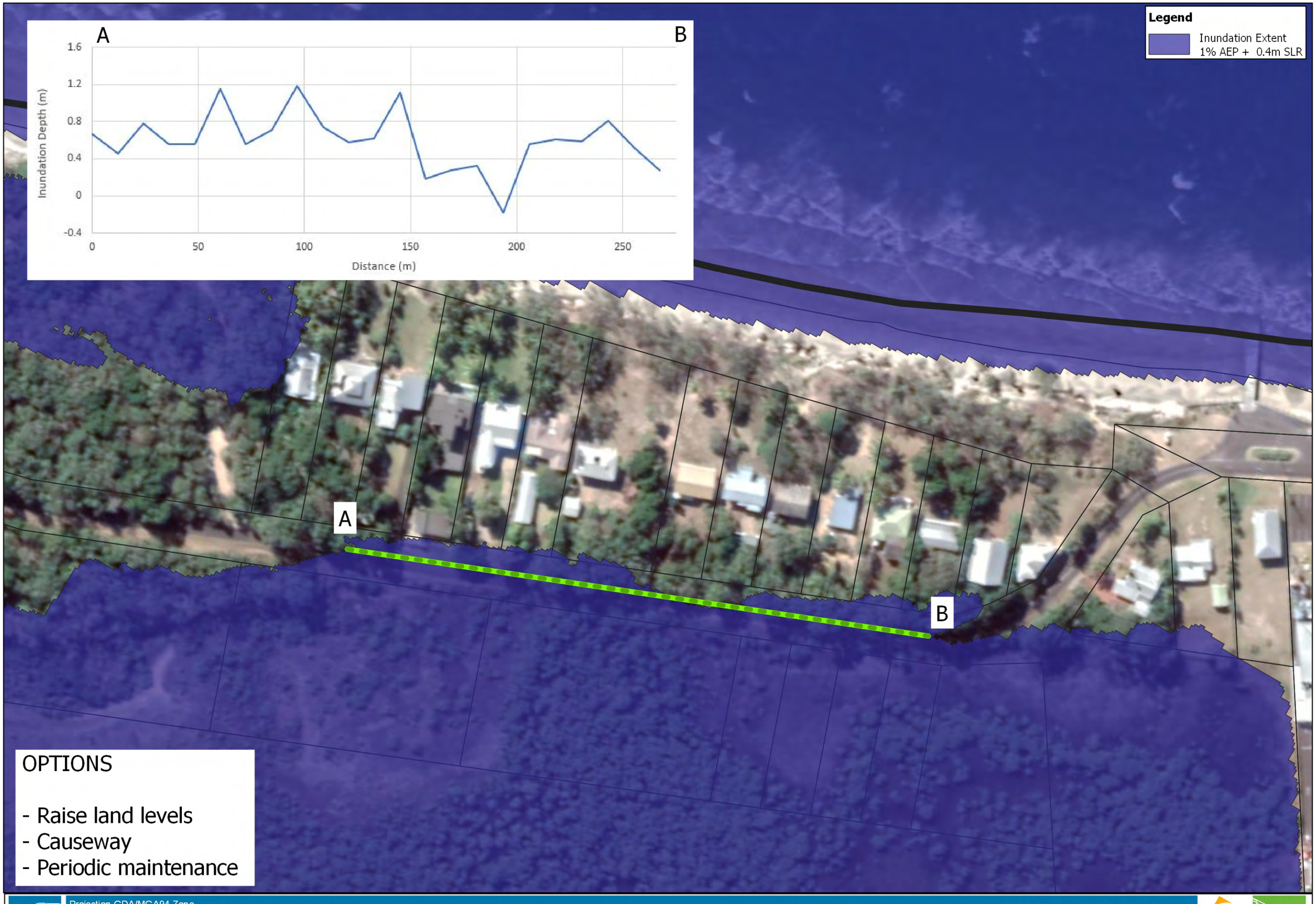
0 50 100 m

5057 Bundaberg CHAS Phase 3 - 8

Options Costing for Civil Design - Acacia St

019-09-09T13:10:12.527


Legend
Inundation Extent
1% AEP + 0.8m SLR
A
B
Inundation Depth (m)
1.2
0.9
0.6
0.3
0
0
30
60
90
120
Distance (m)
A
B
A
B
Inundation Depth (m)
1
0.8
0.6
0.4
0.2
0
0
5
10
15
20
25
30
35
40
45
50
Distance (m)
OPTIONS
- Raise land levels
- Causeway
- Periodic maintenance



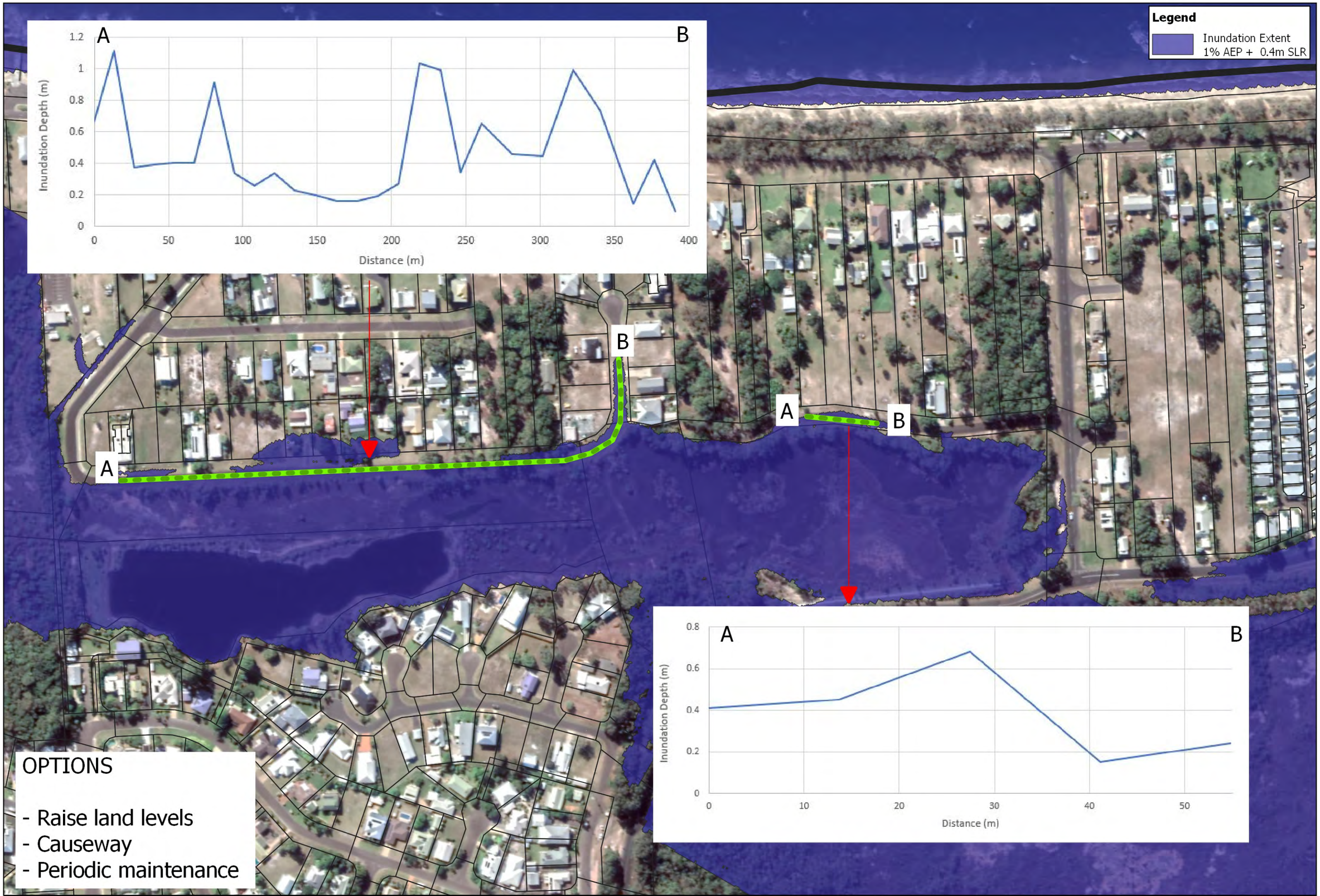
Projection GDA/MGA94 Zone
Water Technology Pty Ltd
Imagery Source: Google Earth

0 50 100 m

5057 Bundaberg CHAS Phase 3 - 8

Options Costing for Civil Design - Theodolite Creek Dr

019-09-09T10:55:22.904



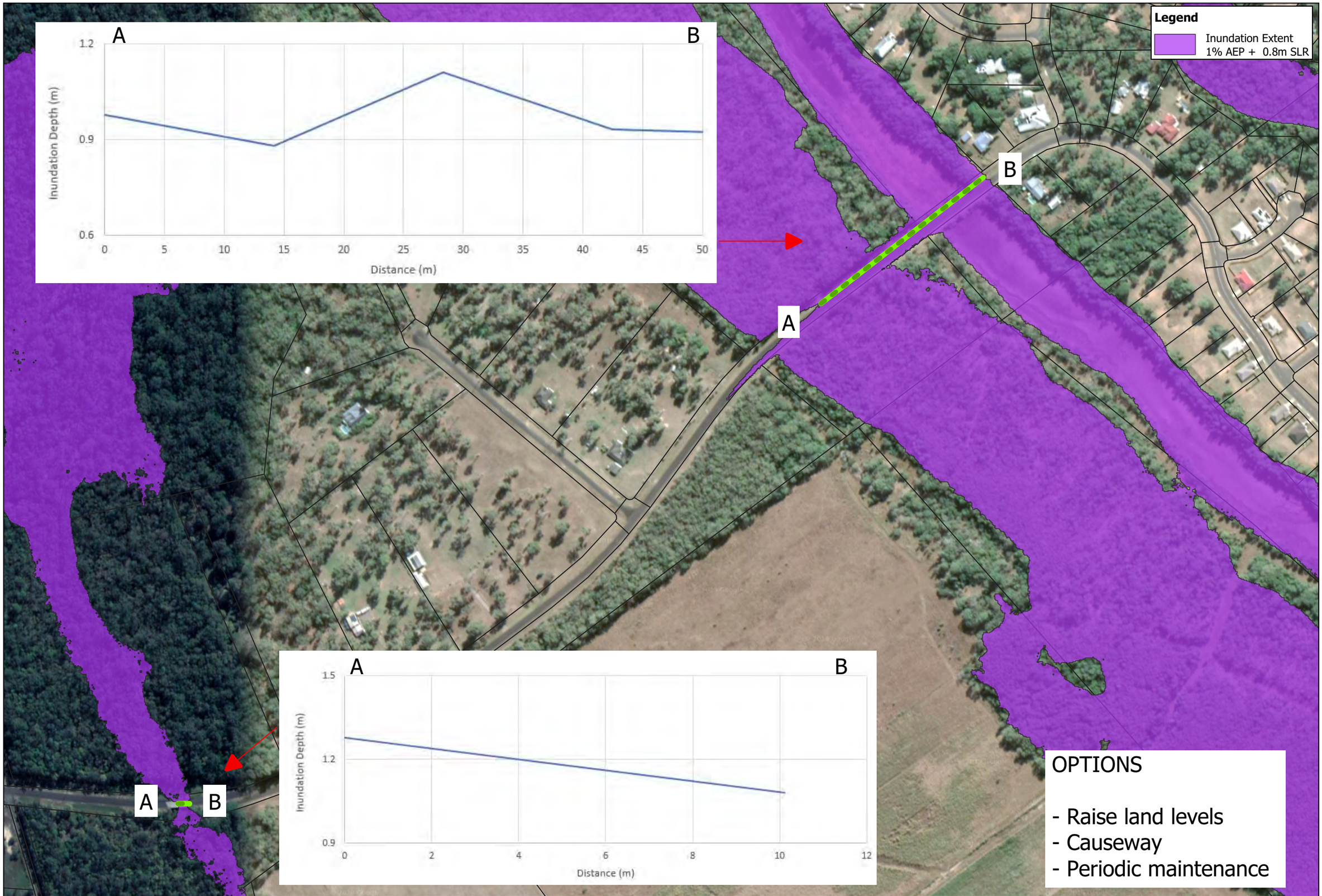
Projection GDA/MGA94 Zone
Water Technology Pty Ltd
Imagery Source: Google Earth

0 50 100 m

5057 Bundaberg CHAS Phase 3 - 8

Options Costing for Civil Design - Paperbark Court | First Ave

J19-09-09T10:54:38.071



OPTIONS

- Raise land levels
- Causeway
- Periodic maintenance

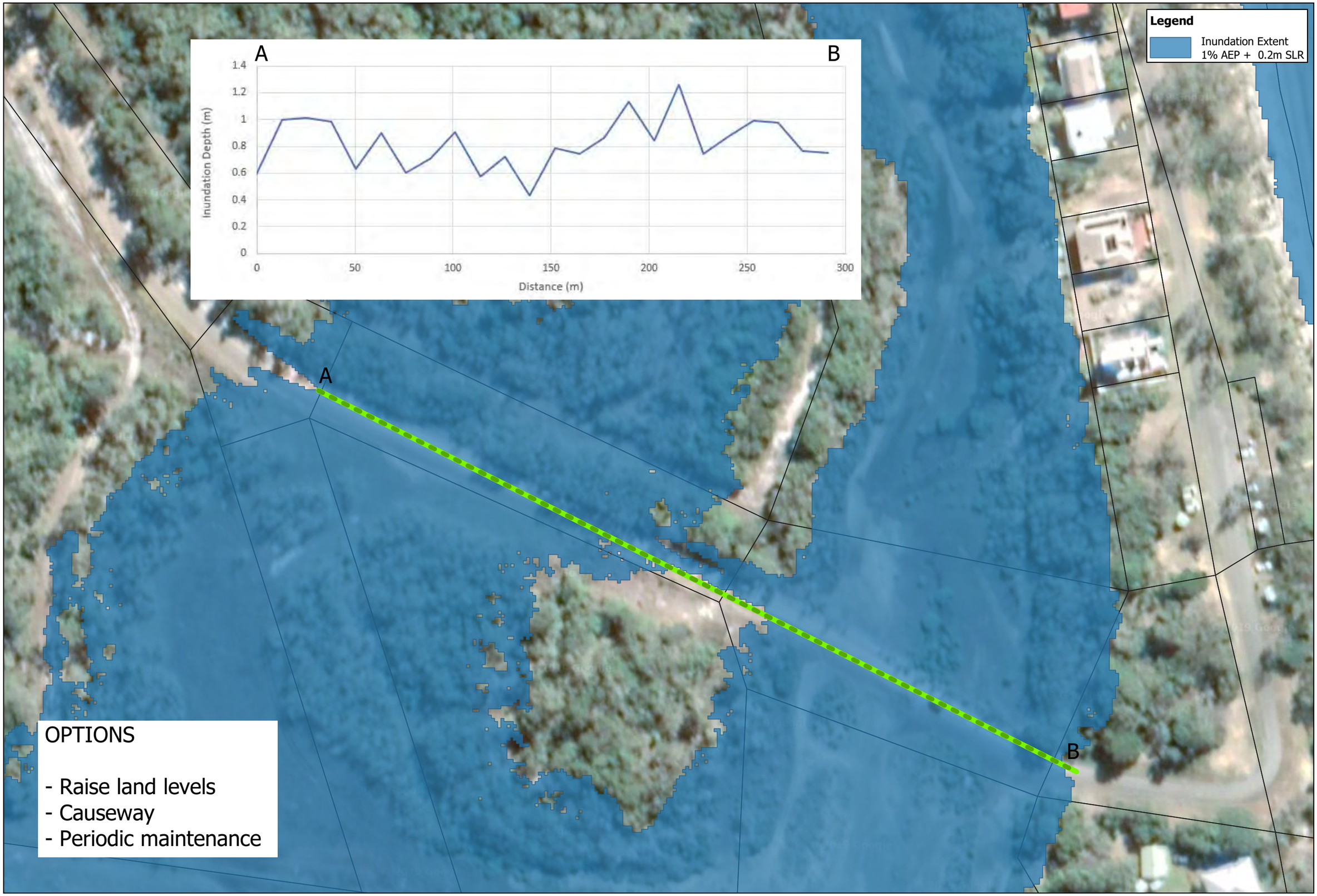
Projection GDA/MGA94 Zone
Water Technology Pty Ltd
Imagery Source: Google Earth

0 50 100 m

5057 Bundaberg CHAS Phase 3 - 8

Options Costing for Civil Design - Malvern Dr

019-09-09T10:48:44.683



Projection GDA/MGA94 Zone
Water Technology Pty Ltd
Imagery Source: Google Earth

0 50 100 m

5057 Bundaberg CHAS Phase 3 - 8

Options Costing for Civil Design - Coonarr Beach Rd

019-09-09T10:48:41.177

APPENDIX F
NON-STRUCTURAL OPTIONS – COST ASSUMPTIONS

F-1 Non-Structural Options – Cost Assumptions

The following figures are extracts from the Bundaberg Regional Council Budget Document of 2017. The figures are used as an estimate for the annual revenue costs to implement a non-structural option across the region.

Note: Annual costs presented below are region wide, for the purposes of the Phase 6 Report, the figure is extrapolated as a 'whole of life cost' i.e. over 10 year life of a planning scheme then divided by the nine settlements.

The symbology used in the Phase 6 Report is as follows:

Symbol	Range
Private cost	$0
$	$0 to $1million
$$	$1 to $5million
$$$	$5 to $10million
$$$$	$10 to $20million
$$$$$	$20million +

Disaster Management

The annual operational expenditure for the Disaster Management program in Bundaberg Regional Council is $984,259. For the purposes of assuming a cost for this option, it is represented as a single "$" symbol in the Optioneering screening process i.e. $0 to $1million

Disaster Management

Operation Type – Disaster Management	Strategic Links	Risk Id.	Budget		
Core Programs/Services Areas Prevention Strategies Disaster Management Plans Programs & Partnerships - S.E.S	1.1.3, 1.1.4 2.3.4, 4.1.1, 4.3.2	BP-CE-4:10-11	Operational Revenue	$	35,000
			Operational Expenditure	$	984,259
			Capital Revenue	$	0
			Capital Expenditure	$	0
Key Performance Indicators					

Land Use Planning

The annual operational expenditure for the land use planning and development controls in Bundaberg Regional Council is $4,446,676. For the purposes of assuming a cost for this option, it is represented as a two "$$" symbols in the Optioneering screening process i.e. $1 to $5million.

Infrastructure & Planning **Development**

Operation Type – Development	Strategic Links	Risk Id.	Budget		
Core Programs/Services Areas Community & Internal Customer Service Development Assessment Development Compliance Strategic Planning - Policy Development and Implementation	2.1.4, 2.3.1 4.4.1, 4.6.2	BP-IP-1:6-9	Operational Revenue	$	1,930,000
			Operational Expenditure	$	4,446,676
			Capital Revenue	$	0
			Capital Expenditure	$	0
Key Performance Indicators					

Education, Awareness and Environmental Monitoring

The annual operational expenditure for the 'Health Services' program in Bundaberg Regional Council is $1,143,793. This program includes Environmental Monitoring and Community Preparedness programs.

For the purposes of assuming a cost for Education and Awareness Campaigns and Monitoring Erosion options, these have been as one “$” symbols in the Optioneering screening process i.e. $0 to $1million.

Community & Environment — **Waste & Health Services**

Operation Type – Health Services	Strategic Links	Risk Id.	Budget		
Core Programs/Services Areas Food Safety Public Health Risks Environmental Nuisances & Pollution Environmental Health Promotion & Public Education	1.1.2,1.1.3 2.4.3, 4.4.1 4.6.1	BP-CE- 8b:7-11	Operational Revenue Operational Expenditure Capital Revenue Capital Expenditure	$ $ $ $	325,456 1,143,793 0 0

Key Performance Indicators

Task/ Action	Performance Measure	Target	Milestone
Environmental Monitoring & Community Preparedness	Percentage Environmental Monitoring & Community Preparedness programs have been effectively completed- includes Vector and Environmental monitoring and Disaster Management preparations.	100%	
Licencing, Assessment & Approvals	Percentage of inspections completed against the anticipated number of inspections for the year.	98%	

Land use and tenure transition

As presented in the Phase 5 Report the value of land was required to assess permanent losses of the lot resulting from erosion or sea level rise. These were obtained from average current residential land selling price per square meter used in real estate for beach-front lots (or lots close to the beach) within the study area, and were assumed at an average lot area of 1,000 m^2. The following rates apply per 1,000 m^2

- Burnett Heads: $150
- Moore Park Beach: $100
- Woodgate Beach: $350
- Miara, Winfield and Norval Park: $100
- Bargara: $400
- Buxton: $100
- Coonarr: $50;
- Elliott Heads: $250
- Innes Park and Coral Cove: $250

For the purposes of assuming a cost for the Land use and tenure transition option, the above land rates have been multiplied across the number of properties within the EPA or Storm Tide Inundation mapping area.

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Fax (03) 9558 9365

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Subiaco WA 6008
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