Tasmania Parks and Wildlife Service

Freycinet Foreshore Link Track Engineering Assessment

Stage 1 - Coastal Vulnerability Report

March 2021

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1. Introduction

1.1 Background

One of the priority initiatives of the 2019 Freycinet Peninsula Master Plan is to construct a new foreshore track, the Foreshore Connection Track, linking the town of Coles Bay to the Freycinet National Park. In the long-term, this track will link to the Coles Bay Foreshore Track, to be constructed by Glamorgan Spring Bay Council, the Freycinet National Park Visitors Centre, and to the recently constructed Wineglass Bay Carpark Shared Use Track.

The Foreshore Connection Track is to link Esplanade East Road, Coles Bay, to the existing roads and tracks within the Freycinet Visitor Centre precinct. The track is to be a nominally 2 m wide shared use track catering for pedestrians and cyclists. GHD understands Tasmania Parks and Wildlife Service (PWS) has identified and assessed options for the route of new Foreshore Connection Track, with a preferred route identified between Esplanade East Road and the existing tracks and roads within the Freycinet Visitor Centre precinct, as shown in red in Figure 1. Two alternative routes are also being considered by PWS (routes R1 and R2) as it has been identified that the preferred track alignment passes through private property.

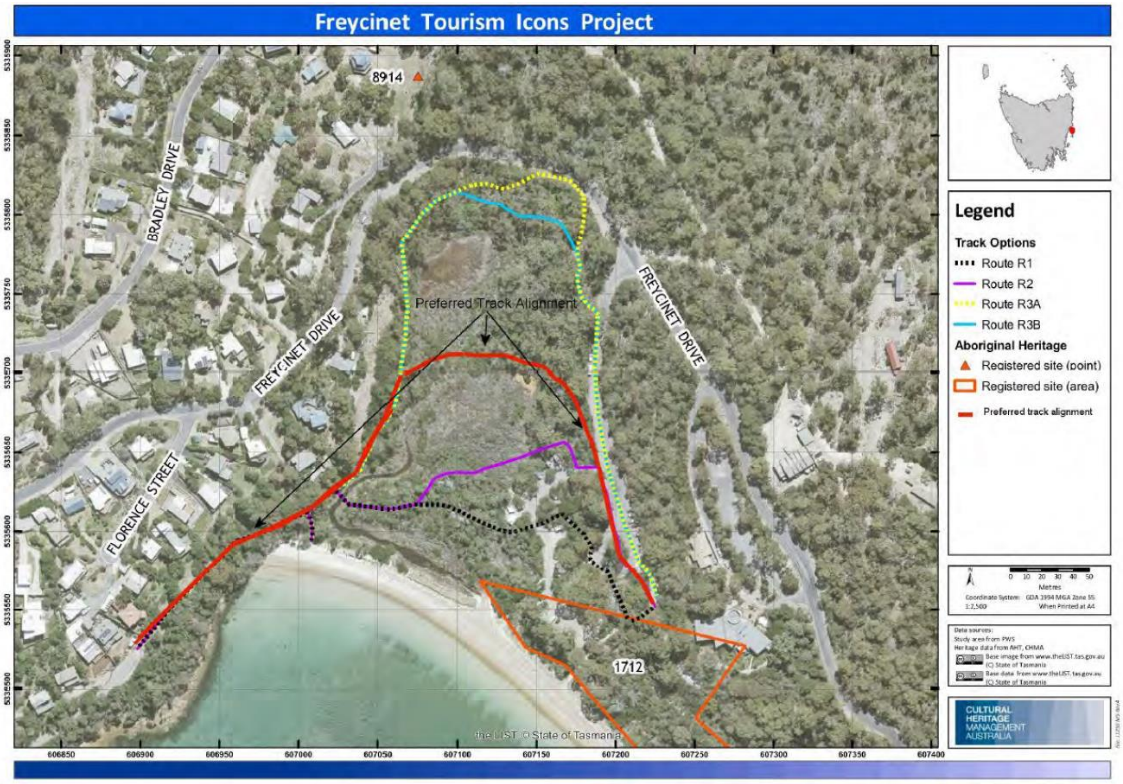

Figure 1 Proposed track option (red line) (source: PWS)

In addition to the Foreshore Connection Track, we understand that PWS has identified the Ranger Creek Track from the Visitor Centre to Ranger Creek, as shown in Figure 2, requires an upgrade to provide a link from the Visitors Centre to the recently constructed Wineglass Bay Carpark Shared Use Track which starts at Ranger Creek.

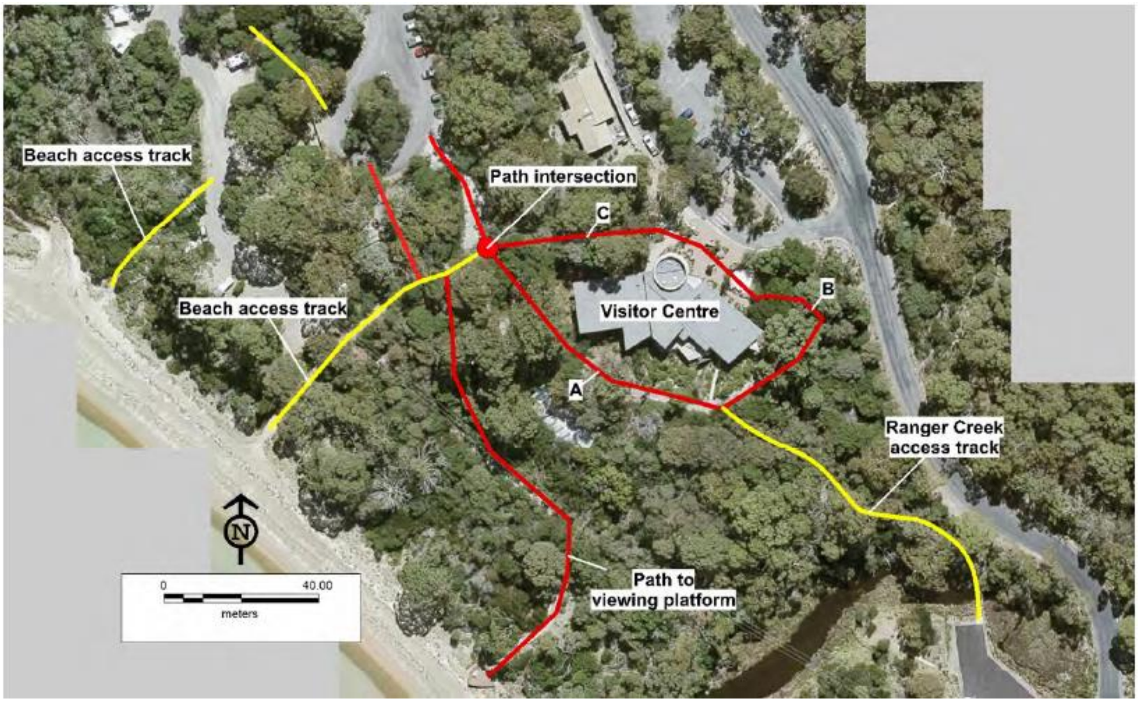

Figure 2 Aerial image of additional foreshore area to be included in the Assessment

GHD understands that background studies, including a natural values assessment and Aboriginal heritage assessment have been completed for the project. To progress the project to construction, GHD was engaged by PWS to provide assistance with the engineering aspects of the planning and design, including a coastal vulnerability assessment. PWS propose to deliver the project in two stages:

- Stage 1 – Development Application Phase
- Stage 2 – Detailed Design and Documentation Phase

This report details the coastal vulnerability assessment and forms one of the deliverables for Stage 1.

1.2 Scope of work

GHD's scope of work for Stage 1 includes:

- Source and review available project specific site background information. Identify, request, and review additional relevant project and site-specific background information from PWS.
- Site inspection by a GHD Civil Engineer to:
  – Inspect the proposed preferred route of the Foreshore Connection Track.
  – Inspect the site with a focus on the beach setting/environment, beach scarp, debris line, vegetation line, etc.
- Prepare a Coastal Vulnerability Report
  – Estimate the position of the extreme water level (incl. sea level rise) relative to the sites, with the use of the topography survey from the Land Information System Tasmania (the LiSTmap). Preparation of simple GIS sketches to show estimated water levels.
  – Review historical aerial images to identify shoreline changes.

- Preliminary risk assessment (commentary type) on the potential for shoreline movement (if any) and water levels to impact the proposed infrastructure. High-level qualitative commentary on the potential impacts of the proposed infrastructure development to the coastal process.
- Draft documentation review meeting/teleconference with PWS.
- Finalise and issue final deliverables to PWS.

1.3 Purpose of this report

This Coastal Vulnerability Report is prepared to document the scope of work as described in Section 1.2. The Coastal Vulnerability Report covers the two foreshore areas where the shared use track development is proposed, as detailed in Section 1.1.

The Report (interchangeable with “the Assessment”) documents the procedures, steps, assumptions, and limitations pertaining to the delivery of the scope.

1.4 Clarifications

- The Coastal Vulnerability Report was prepared referencing several reports endorsed by the Tasmania State Government, as listed in Section 6. No independent verification on the information provided in the reports were carried out by GHD.
- The proposed track alignments presented in the GHD-produced figures were traced from that provided in the PWS project document. Some variation may be visible due to inexact scaling of images and as such, the track alignments presented in the GHD figures should be considered for reference only.
- In absence of more detailed wave and water level information, it has been assumed that the extreme wave heights and water levels will have a joint probability of occurring at the study site. This is generally a conservative assumption when storm tide component is small compared to tidal prism at the study site.

1.5 Disclaimer

This report has been prepared by GHD for Tasmania Parks and Wildlife Service and may only be used and relied on by Tasmania Parks and Wildlife Service for the purpose agreed between GHD and the Tasmania Parks and Wildlife Service as set out Section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than Tasmania Parks and Wildlife Service arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

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GHD has not been involved in the preparation of and has had no contribution to, or review of the documents other than those prepared by GHD. GHD shall not be liable to any person for any error in, omission from, or false or misleading statement in, any other part of the documents prepared other than by GHD.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

2. Basis of assessment

2.1 Infrastructure design life

The design life of the coastal track was assumed to be 30 years (to 2050), however, an additional review to year 2100 was also carried out for code compliance.

2.2 Return period of storm events

Return periods of 50 yr ARI (2% AEP) and 100 yr ARI (1% AEP) were considered in this Assessment.

2.3 Hydrographic and topographic surveys

The profiles of Richardsons Beach in front of the proposed preferred track alignment and the Visitor Centre, shown in Figure 3 and Figure 4[1], were extracted from the bathymetry survey undertaken by Marine Solutions in January 2020 and the digital elevation model (DEM) of Coles Bay[2].

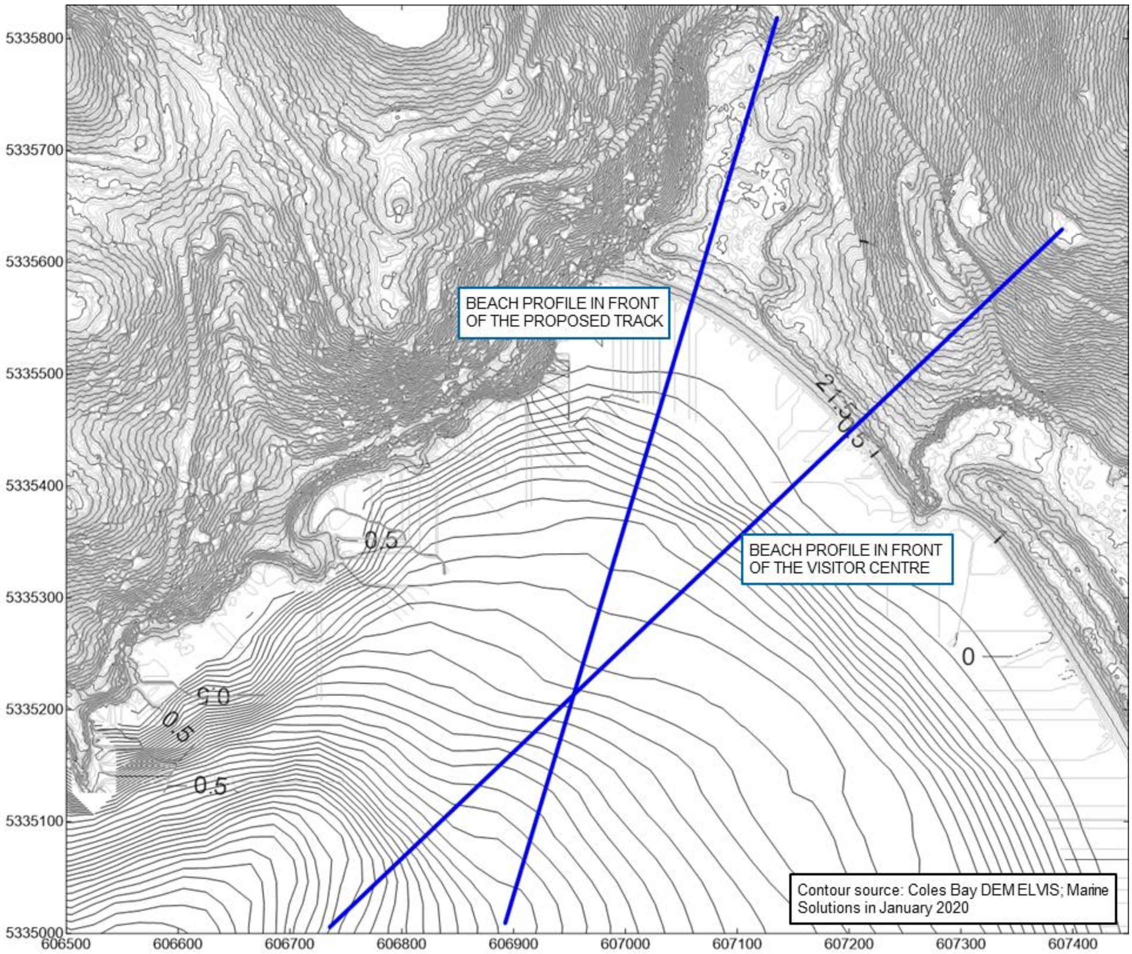

Figure 3 Plan view showing the location of the beach profile cuts

[1] GHD reasoned that the discontinuity of the profiles was due to data unavailability in the wave breaking zone.
[2] https://elevation.fsdf.org.au/

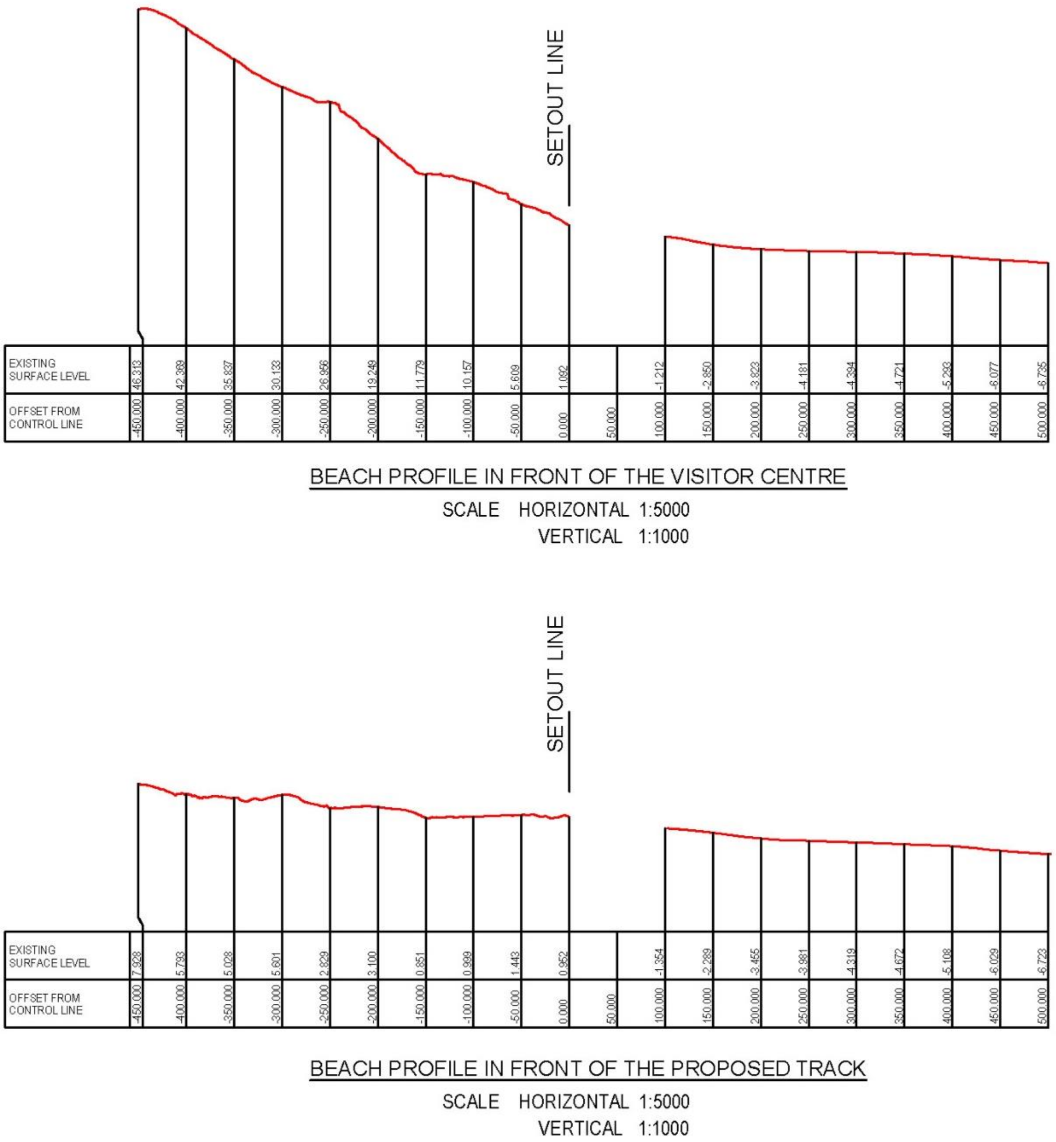

Figure 4 Beach profiles

Based on the surveys, the typical beach slope and the beach elevation adopted in this Assessment for use in estimating wave properties can be summarised as in Table 1.

Table 1 Adopted beach profile characteristics

Location	Typical beach profile slope
In front of the proposed preferred track alignment	1V:65H to 1V:43H
In front of the Visitor Centre	1V:64H to 1V:43H

2.4 Metocean condition

2.4.1 Tidal plane

Tidal planes taken from Australian National Tide Tables (2018) for Coles Bay are shown in Table 2. The 0.0 m Australia Height Datum (AHD) is assumed to be at Mean Sea Level.

Table 2 Tidal planes at Coles Bay

	Water level (m LAT)	Water level (m MSL)	Water level (m AHD)
Highest Astronomical Tide (HAT)	1.4	0.7	0.7
Mean High Water Spring (MHWS)	1.2	0.5	0.5
Mean Sea Level (MSL)	0.7	0.0	0.0
Mean Low Water Spring (MLWS)	0.1	-0.6	-0.6
Lowest Astronomical Tide (LAT)	0.0	-0.7	-0.7

2.4.2 Storm surge and sea level rise (SLR)

Antarctic Climate and Ecosystems Cooperative Research Centre (ACE CRC) has published the report “Extreme Tide and Sea-Level Events” which describes the estimated storm surge at various Tasmanian coastal communities (McInnes et. al., 2012). Table 3 summarises the estimates for the closest report station, Bicheno. It is important to note that Bicheno differs from Coles Bay in that it is situated on the open coast. Nevertheless, the report published by ACE CRC is considered the best available data and has been adopted for this project.

Table 3 Storm tide estimates for present-day for Bicheno (unit: m MSL)

ARI (AEP)[3]	Present day
10 (10%)	0.93±0.07 m
20 (5%)	0.97±0.07 m
50 (2%)	1.01±0.07 m
100 (1%)	1.04±0.07 m

In addition to McInnes et. al. (2012), following the publication of the 5th edition Assessment Report by Inter Intergovernmental Panel on Climate Change (IPCC, 2014), CSIRO (McInnes et. al., 2016) updated the sea level rise estimates to years 2050 and 2100 across various locations of Tasmania per the latest guideline. In this update, the closest reporting station for the project site is Glamorgan-Spring Bay, opposite the project site across Great Oyster Bay. The estimated sea level rise under the RCP 8.5 scenario is:

- 0.23±0.07 m to 2050
- 0.73±0.22 m to 2100

Combining the storm surge estimate and the SLR projection, Table 4 presents the storm tide estimates for years 2050 and 2100 adopted for the Assessment.

Table 4 Storm tide estimate for 2050 and 2100 (unit: m MSL)

ARI (AEP)	2050		2100	
	5% confidence level, SLR = 0.16 m	95% confidence level, SLR = 0.30 m	5% confidence level, SLR = 0.51 m	95% confidence level, SLR = 0.97 m
10 (10%)	1.02	1.30	1.37	1.97
20 (5%)	1.06	1.34	1.41	2.01
50 (2%)	1.10	1.38	1.45	2.05
100 (1%)	1.13	1.41	1.48	2.08

[3] AEP – Annual exceedance probability; ARI – Average Recurrence Interval (years)

The design water level for the Assessment consist of the following components:

- Storm tide
- Sea level rise
- Wave set-up

A wave set-up allowance of 0.3 m was made based on the foreshore geometry/bathymetry of Coles Bay. Referencing AS 4997, the proposed preferred track alignment can be considered as a low degree of hazard to life or property, where a return period of 2% AEP is considered sufficient. Nevertheless, for comparison purpose the water level to 1% AEP event in 2100 is included in the Assessment.

On the basis that the AHD is equal to MSL and using the 95% confidence level of storm tide and SLR estimate, the design water levels adopted in the Assessment are summarised in Table 5.

Table 5 Design water levels

AEP	2050	2100
2%	1.68 m AHD	2.35 m AHD
1%	1 71 m AHD	2.38 m AHD

2.4.3 Wind

Design wind speed at Coles Bay is taken from AS 1170 for region A3, and converted to a 1-hour average wind for wave estimation. The wind speed for 2% AEP is 25 m/s, while for a return period of 1% AEP is 26 m/s.

2.4.4 Wave

Swells approaching from the south into Great Oyster Bay experience multiple diffractions before being able to reach the project site. To this end, GHD envisage that the regular wind-induced wave will play a more dominant role to the project site than extreme ocean swells.

The empirical equation proposed by Kamphuis (2010) for wind-induced waves was applied for the Assessment to estimate the wave properties coming from the southwest fetch, as shown in Figure 5. The shoaling effect of wave as it propagates nearshore was subsequently considered by applying the empirical method described in Goda (2000).

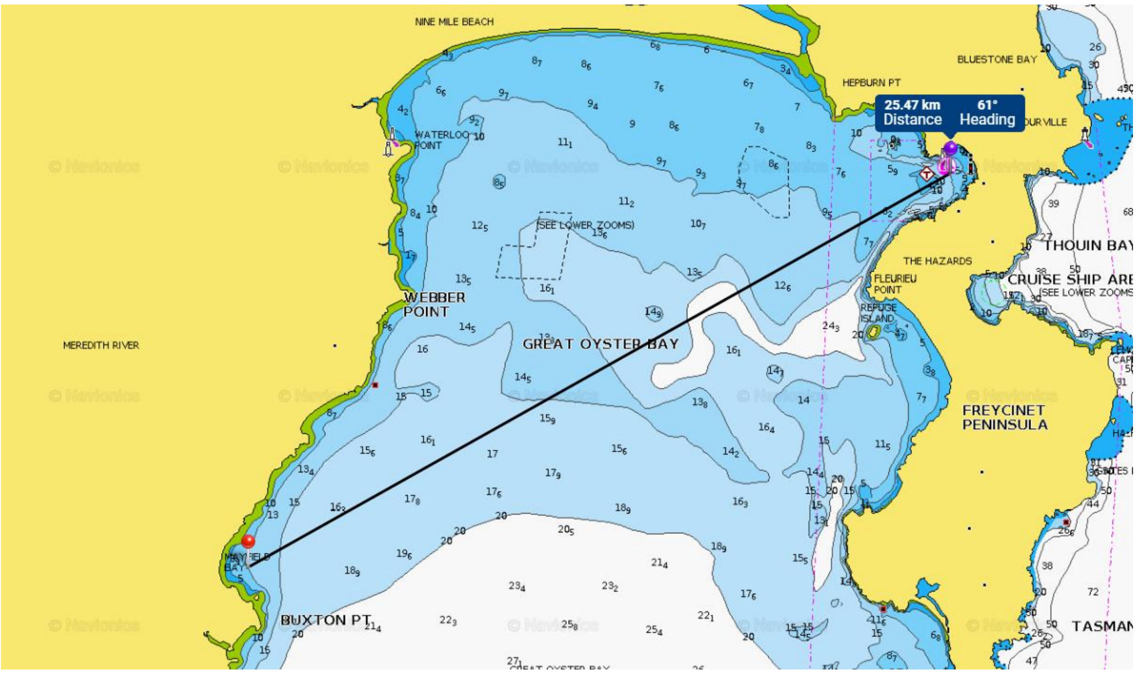

Figure 5 Fetch affecting the project site

Table 6 summarises the wind-induced wave properties derived from Kamphuis (2010) for both years 2050 and 2100.

Table 6 Wind-induced wave estimate for fetch across Great Oyster Bay

AEP	Fetch direction	Fetch length (m)	Average water depth (m)	Sig. wave height, H_s (m)	Peak wave period T_p (sec)
2%	SW	26000	14~15	1.8	5.7
1%	SW	26000	14~15	1.9	5.8

After applying the Goda (2020) to take into account the shoaling effect of the wave due to limited water depth, Table 7 and Table 8 summarises the resultant wave properties.

Table 7 Estimated design wave parameters to year 2050

Location	Typ. seabed elevation (m AHD)	Design water level (m AHD)	Sig. wave height, H_s (m)	Peak wave period T_p (sec)
Proposed preferred track alignment	0.35	1.68 (2% AEP) 1.71 (1% AEP)	1.0 1.0	5.0~6.0
Visitor Centre	0.52	1.68 (2% AEP) 1.71 (1% AEP)	0.9 0.9	5.0~6.0

Table 8 Estimated design wave parameters to year 2100

Location	Typ. seabed elevation (m AHD)	Design water level (m AHD)	Sig. wave height, H_s (m)	Peak wave period T_p (sec)
Proposed preferred track alignment	0.35	2.35 (2% AEP) 2.38 (1% AEP)	1.4 1.4	5.0~6.0
Visitor Centre	0.52	2.35 (2% AEP) 2.38 (1% AEP)	1.3 1.3	5.0~6.0

As the differences in wave properties yielded from different planning horizons and return periods are minimal for the project site, for the purpose of this Assessment the following representative wave properties were adopted:

- Year 2050: H_s = 1.0 m, T_p = 5.0~6.0 sec
- Year 2100: H_s = 1.4 m, T_p = 5.0~6.0 sec

3. Hazard definition and vulnerability assessment

3.1 Hazard definition

3.1.1 Coastal inundation

Coastal inundation is when sea water rises high enough that it floods infrastructure and buildings or endangers peoples' safety. In addition to the design water levels identified in Section 2.4.2, the factor of “wave run-up” is also to be taken into account.

The wave run-up is usually expressed as the maximum onshore elevation that could be reached by a wave, neglecting the friction and blockage/hinderance along the path of wave run-up propagation from vegetation. It is important to note that in this instance, the dense vegetation is expected to significantly reduce the maximum theoretical run up levels[4].

For the project site, wave run-up resulted from the design wave established in Section 2.4.4 was estimated to range in between 0.12 m to 0.22 m above the design water levels summarised in Table 5. Superimposing the design water level, the total elevations resulting from the wave run-up are summarised in Table 9.

Table 9 Estimated wave run-up elevations

ARI (AEP)	2050	2100
50 (2%)	1.8 m AHD	2.5 m AHD
100 (1%)	1.9 m AHD	2.6 m AHD

Figure 6 overleaf plots the estimated wave run-up elevations inclusive of the design water levels with respect to the proposed track alignment. An enlarged version of the same figure can be found in Appendix A.

[4] To take into account the frictions and potential reduction in wave run-up due to vegetation, overland flood modelling will be required to be conducted. For the agreed scope of this Assessment, the modelling was not performed by GHD.

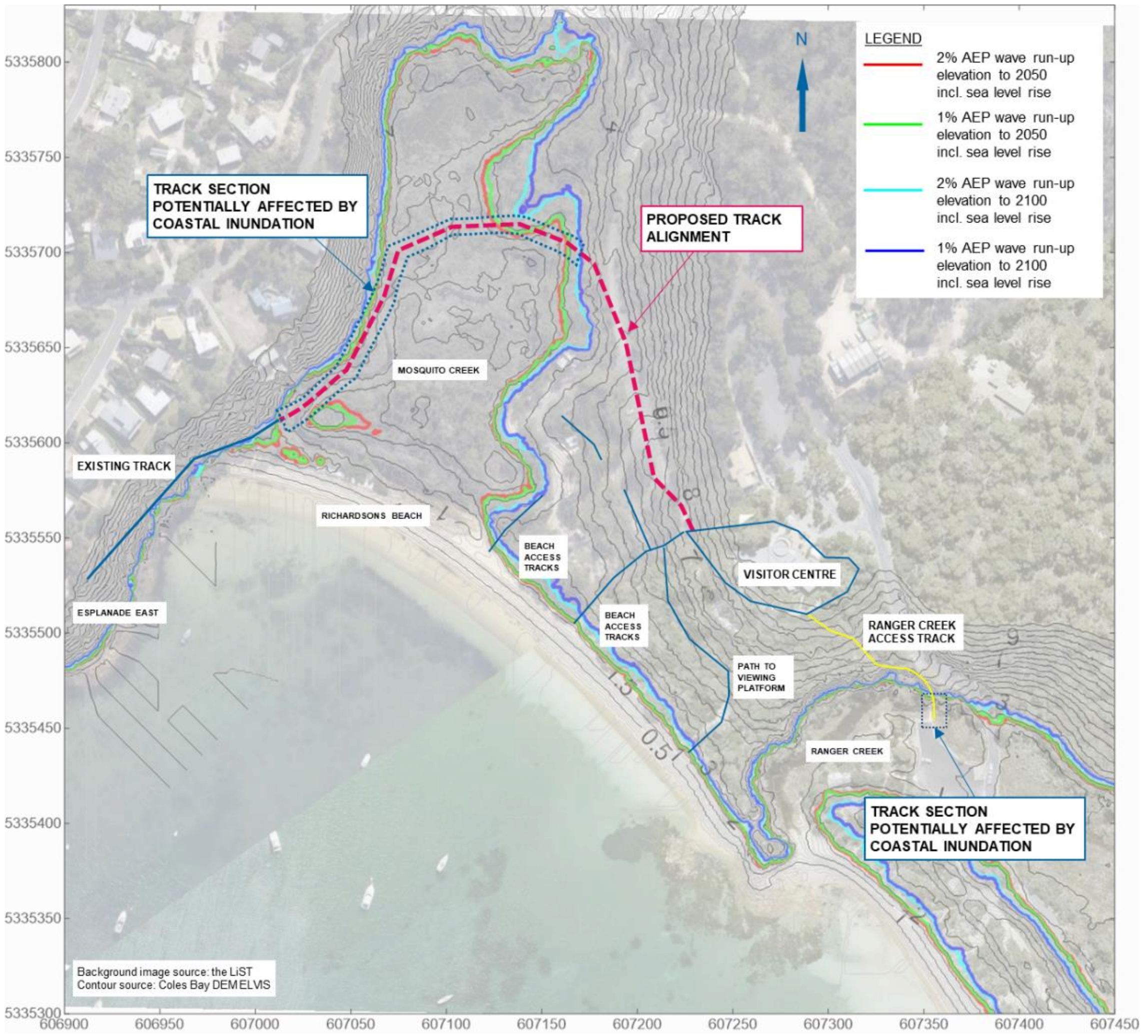

Figure 6 Extent of estimated run-up elevations

As highlighted in the figure, a section of the proposed preferred track alignment is located in an area lower than the 2% AEP wave run-up elevation in 2050, as are the two alternative routes being considered by PWS. In contrast, the existing tracks near the Visitor Centre appeared to be located on higher ground and are therefore less exposed to coastal inundation. Only the southern end of the Ranger Creek access track is in an area lower than the 2% AEP wave run-up elevation in 2050.

3.1.2 Coastal erosion

Aerial images collected from the Department of Primary Industries, Parks, Water and Environment historical aerial image archive (1980 – 2009) and Google Earth (2016 – 2019) were reviewed in approximately five-year intervals to establish the likely historical movement of the shoreline along the project site.

Images were georeferenced using between four to seven visually selected reference points. Figure 7 demonstrates the shoreline movement for the last 40 years from 1980 to 2019. An enlarged version of the same figure can be found in Appendix B.

It is noted that the vegetation lines were traced manually, and the discrepancy in between the 1980 and 2019 vegetation lines may be a result of inaccuracy with manual tracing (or from the alignment of the aerial images).

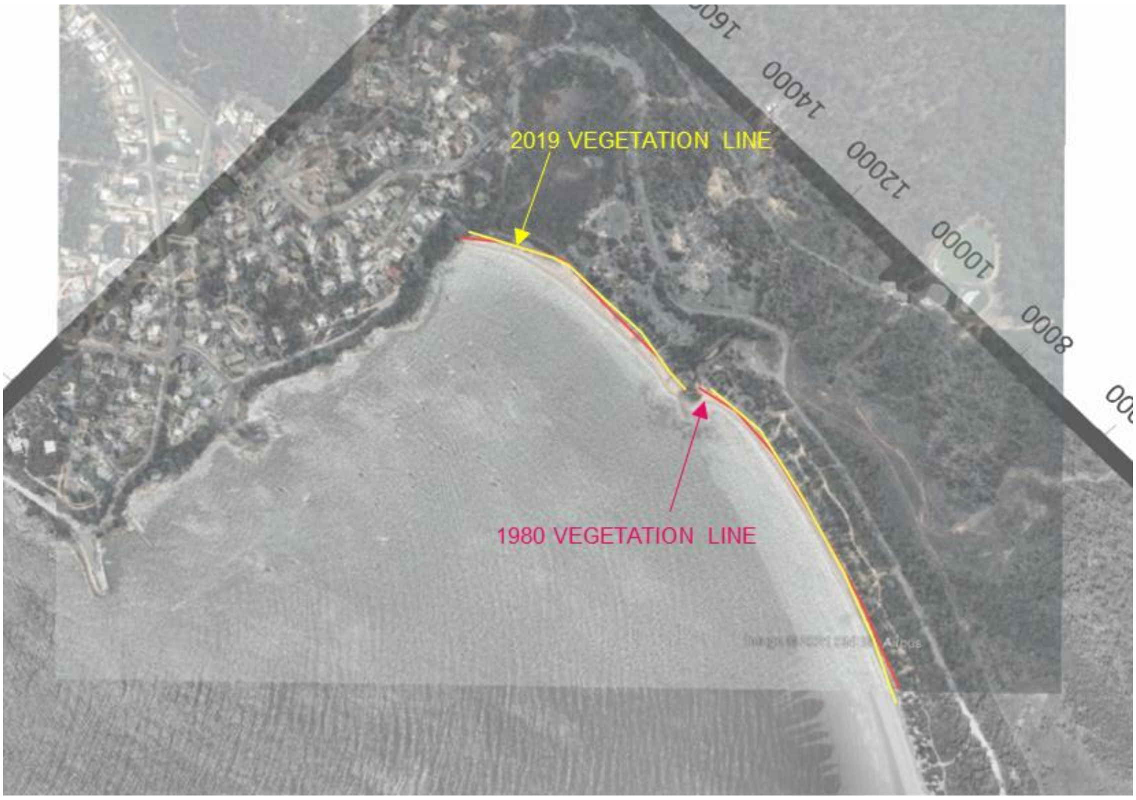

Figure 7 Overlay of 2019 (50% transparency) and 1980 images including trace of vegetation lines

Observations on the images indicate that:

- The vegetation line of the project site has been relatively stable, given the two lines from the 1980 and 2019 are almost overlapped. The differences between the two lines are likely to be resulted from the accuracy of image georeferencing.
- A recession rate was not estimated for the project site given the stability of the vegetation line. An estimate of the recession rate would likely be incorrect, and any rate obtained would most likely be from an error associated with georeferencing the images
- The width of visible dry beach varies; however, this is most likely due to variation in water levels when the images were taken. The changes could also be caused by seasonal changes.

Overall, the shoreline at the project site appears to be stable, evident from the overlapping vegetation line from the 1980 and 2019 aerial images.

Lacey (2016) investigated the coastal inundation and erosion hazard of the foreshore as part of the input to the LIST. Figure 8 shows the overlay of the existing and proposed preferred track alignment to the coastal erosion hazard map available from the LIST.

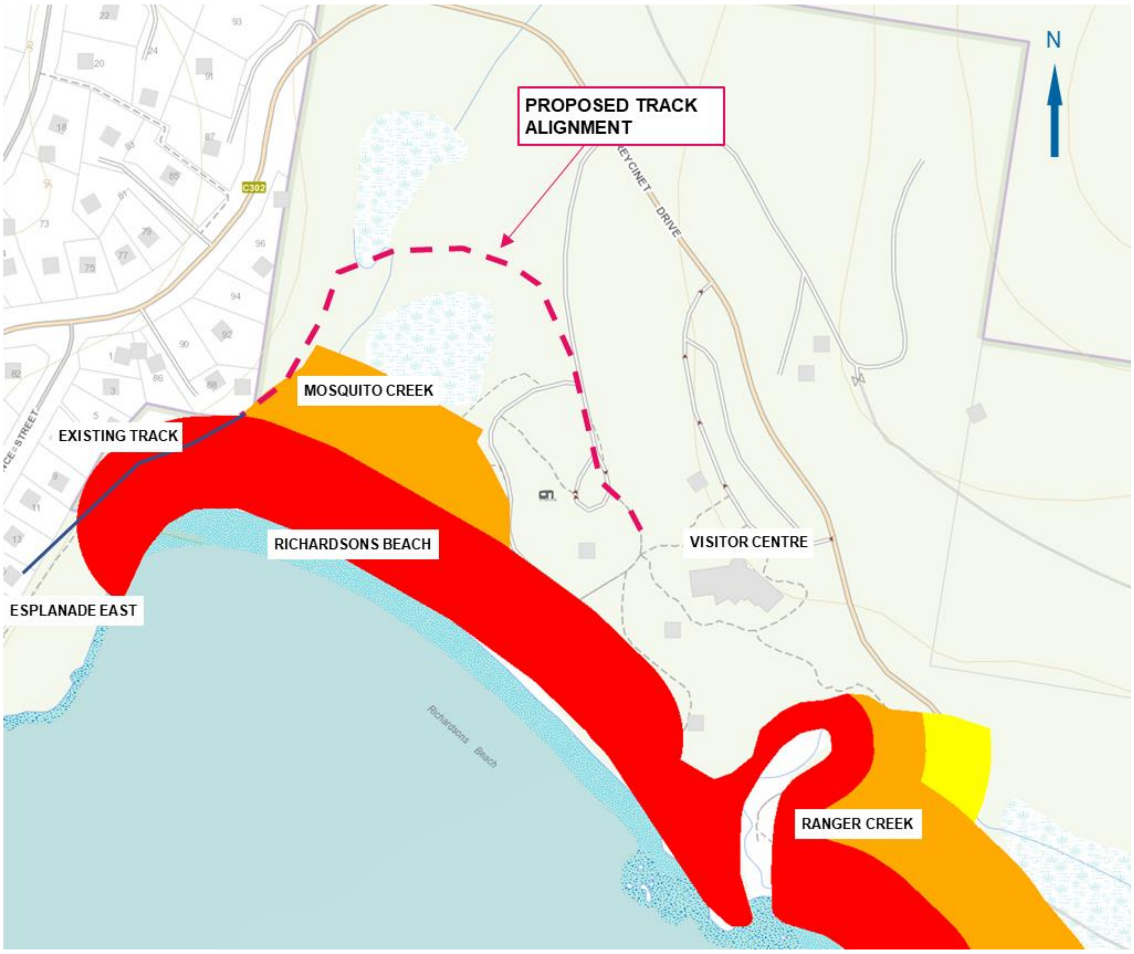

Figure 8 Coastal erosion hazard band of project site (background image source: the LiSTmap. Track alignment traced from Figure 1)

It can be observed from the figure that the proposed track alignment is mostly outside of the "medium" erosion hazard band (orange), whereas the existing track linking to Esplanade East is located in the "high" erosion hazard band (red). Nevertheless, a review of the Lacey (2016) report was carried out by GHD as part of the Assessment, and unlike the definition of coastal inundation which was clearly defined, limited discussion was provided in the report as to how the coastal erosion hazard was determined. In the site visit conducted by GHD on 04/03/2021, it appeared that Richardsons Beach is terminated at the western end by a rock headland formation which could be expected to limit the potential shoreline erosion (refer Figure 9).

Figure 9 Rock headland at the western end of the beach. Photos taken by GHD on 04/03/2021

The discrepancies between the erosion hazard mapping and the site condition may be related to the numerical method applied by Lacey (2016). No further investigation on this subject was considered necessary for the purpose of this Assessment.

3.2 Vulnerability assessment

Vulnerability of an asset is determined through the potential impact an event would have on the asset and the adaptive capacity of the asset to the impact. The "potential impact" is further defined as the combination of exposure (of the subject to the hazards) and sensitivity. As such, the type of structure to be adopted to form the proposed preferred track alignment will have material impact on the outcome of the vulnerability assessment.

For the purpose of this assessment and given no track design has been carried out to-date to inform this stage 1 assessment, based on Hawes (2020) the Assessment assumes the proposed preferred track alignment will be in the form of an unsealed gravel path.

Vulnerability is typically rated as being "low", "medium", or "high", which is defined as follows:

- Low: asset has high resilience; it is able to cope with the impacts of coastal hazards without additional support.
- Medium: asset has some ability to cope with the impacts of coastal hazards.
- High: asset has limited ability to cope with the impacts of coastal hazards.

The following sections discuss the vulnerability of the proposed infrastructure to the coastal hazards identified in Section 3.1.

3.2.1 Vulnerability to coastal inundation - proposed preferred track alignment

Potential impact

As demonstrated in Section 3.1.1, the entirety of the proposed track alignment is located in a low-lying topography below the 2% AEP wave run-up elevation at 2050. From this perspective, the area is exposed to coastal inundation.

While the rising water may cause damage to the surface of an unsealed gravel path, it is expected that the path has some degree of resiliency against submergence. As such, a medium sensitivity is considered for the proposed preferred track alignment.

With the exposure and a medium sensitivity to coastal inundation, the resultant rating of potential impact from coastal inundation on the asset is **high**.

Adaptative capacity

The construction of a gravel pathway is common and conventional, and does not require specialist material and or construction plant. The track can be relatively repaired from damage caused by inundation, as no substantial formation preparation is required for a gravel track. Nevertheless, considering the project site is located in a somewhat remote area of Tasmania where mobilisation/demobilisation and transportation of material may require some effort, the adaptative capacity of the proposed preferred track alignment is rated as **medium**.

Resulting vulnerability to coastal inundation

Combining the ratings of potential impact and adaptative capacity, the proposed preferred track alignment has a **high** vulnerability to coastal inundation and will require consideration of mitigation measures as outlined in Section 5.

3.2.2 Vulnerability to coastal inundation – Ranger Creek access track

Potential impact

Based on the run-up elevation estimated by GHD, the Ranger Creek access track is mostly located higher than the 2050 2% AEP wave run-up elevation, except the southern-most tip of the track linking to the car park which is within (i.e. lower) the 2050 2% AEP wave run-up elevation.

With regarding to sensitivity of the track to coastal inundation, on the basis that the access track is an unsealed gravel path as that for the proposed preferred track alignment, a medium sensitivity is considered for Ranger Creek access track.

With the exposure and a medium sensitivity to coastal inundation, the resultant rating of potential impact from coastal inundation on the asset is **high**.

Adaptative capacity

Adaptative capacity of the Ranger Creek access track is considered to be similar to that for the proposed preferred track alignment, as the assumed structural type of the two assets is the same. As such, the adaptative capacity of Ranger Creek access track is rated as a **medium**.

Resulting vulnerability to coastal inundation

Combining the ratings of potential impact and adaptative capacity, the Ranger Creek access track is considered to have a **high** vulnerability to coastal inundation.

3.2.3 Vulnerability to coastal erosion - proposed preferred track alignment

Potential impact

The exposure of the proposed preferred track alignment to coastal erosion can be divided into two sections:

- The western section near Mosquito Creek, which is located in a ‘medium” coastal erosion hazard band (orange).
- The remaining section which is outside of the coastal erosion hazard zone. For the purpose of the vulnerability assessment, the remaining section is excluded.

In the event that erosion occurs to the western section of the proposed track, while it will depend largely on the extent and severity of the erosion, it will have an impact on the proposed preferred track alignment. To this end, a medium sensitivity is assigned to the western section of the track.

With a possible exposure and medium sensitivity, the resulting rating for the potential impact of coastal erosion to the proposed track alignment is **medium** and will require consideration of mitigation measures as outlined in Section 5.

Adaptative capacity

A gravel track is flexible and can be remediated relatively easily with typical material and construction plant and as such, a **high** adaptative capacity rating is given the proposed preferred track alignment.

For the remaining section of the track alignment, which is not subject to coastal erosion hazard, no rating can be provided.

Resulting vulnerability to coastal erosion

From the perspective of coastal erosion, the western section of the proposed track alignment yielded a **low** vulnerability. The vulnerability of the remaining section of the track is considered "not applicable", as it is outside of the coastal erosion hazard band.

3.2.4 Vulnerability to coastal erosion – Ranger Creek access track

Potential impact

Based on the erosion hazard map from the LiSTmap, The Ranger Creek access track has two exposures to coastal erosion:

- The southern end of the track, which is located in a 'medium" coastal erosion hazard band (orange).
- The remaining section which is outside of the coastal erosion hazard zone. For the purpose of the vulnerability assessment, the remaining section is excluded.

Similar to that of the proposed preferred track alignment, the sensitivity of the southern end of Ranger Creek access track is dependent on the extent and severity of the erosion. As such, a medium sensitivity is assigned to the southern end of the track.

With a possible exposure and medium sensitivity, the resulting rating for the potential impact of coastal erosion to Ranger Creek access track is **medium**.

Adaptative capacity

A **high** adaptative capacity is assigned to Ranger Creek access track, as the damage caused by coastal erosion is envisaged to be reparable.

For the remaining section of the track that is not subject to coastal erosion hazard, no rating can be provided.

Resulting vulnerability to coastal erosion

The resulting vulnerability of the southern end of Ranger Creek access track to coastal erosion is **low**. The vulnerability of the remaining section of the track is considered "not applicable", as it is outside of the coastal erosion hazard band.

4. Qualitative risk assessment

Given the vulnerability of the proposed preferred track alignment and Ranger Creek access track to coastal inundation and erosion, a qualitative risk assessment concerning the likelihood and consequences arising from either hazard is presented in this section to inform appropriate mitigation action where necessary.

The qualitative risk assessment adopted the risk management strategy prepared by Glamorgan Spring Bay Council[5]. Table 10 to Table 12, extracted from the aforementioned document, shows the definition of likelihood and consequences considered in this assessment.

Table 10 Definition of hazard likelihood

Likelihood	Description
Rare	Only ever occurs under exceptional circumstances
Unlikely	Conceivable but not likely to occur under normal operations; no evidence of previous incidents
Possible	Not generally expected to occur but may under specific circumstances
Likely	Will probably occur at some stage based on evidence of previous incidents
Almost certain	Event expected to occur most times during normal operations

Table 11 Definition of hazard consequence to financial

Consequence	Description
Insignificant	Negligible financial loss (<AUD 10,000); no impact on program or business operations
Minor	Minor financial loss (AUD 10,000 – AUD 50,000); minimal impact on program or business operations
Moderate	Significant financial loss (AUD 50,000 – AUD 500,000); considerable impact on program or business operations
Major	Major financial loss (AUD 500,000 – AUD 1,000,000); severe impact on program or business operations
Catastrophic	Extensive financial loss (>AUD 1,000,000); loss of program or business operation

Table 12 Definition of hazard consequence to property and infrastructure

Consequence	Description
Insignificant	Isolated or minimal loss; short term impact; repairable through normal operations
Minor	Minor loss with limited downtime; short term impact; mostly repairable through normal operations
Moderate	Significant loss with temporary disruption of services; medium term impact on organisation
Major	Critical loss or event requiring replacement of property or infrastructure; long term impact on organisation
Catastrophic	Disaster with extensive loss and long term consequences; threat to viability of service or operation

[5] https://gsbc.tas.gov.au/wp-content/uploads/2020/06/Risk-Management-Strategy.pdf

4.1 Likelihood

The likelihood of coastal inundation during the design events examined in the Assessment is associated with the probability of occurrence of the inundation events and the topography feature of the project site. On the assumption that the topography will remain unchanged for the planning horizon, then the likelihood of the occurrence of coastal inundation can be categorised as **possible**, meaning that it is not generally expected to occur but may occur under specific circumstances.

For the coastal erosion, the basis of the erosion hazard band presented in the LiSTmap has been identified to be not clearly documented. Nevertheless, the review of historical aerial images suggests that the shoreline at the project site has been relatively stable over the past 40 years in that minimum shoreline change was observed. As such, the likelihood of coastal erosion is envisaged to be **unlikely** subject to further investigation as required. An unlikely rating means that coastal erosion is conceivable but not likely to occur under normal operations, or no evidence of previous incidents.

4.2 Consequences

Consequences of coastal hazards to the proposed preferred track alignment and Ranger Creek access track can be evaluated from multiple receivers. From the Glamorgan Spring Bay Council risk management strategy, the following receivers are identified to be relevant to the proposed track alignment.

Financial

Temporary inundation of a gravel path is likely to require some remediation work to be undertaken post the event. The extent of the remediation will be dependent on the location of the damage as well as the severity, however, it is not envisaged that the damage will cause considerable impact on business operation (i.e. tourists visiting Freycinet and or Wineglass Bay). For the purpose of this assessment, a **minor** rating indicating a financial loss (arising from remediating the damaged track) of between AUD 10,000 to 50,000 is assigned.

Erosion of a gravel path would require repair works to mitigate minor to significant physical impacts. Similar to inundation, the extent of remediation effort required is dependent on location and severity. With reference to the uncertainty on erosion hazard information from publicly available source, a **minor** rating indicating a financial loss of between AUD 10,000 to 50,000 is assigned.

Property and Infrastructure

Temporary inundation of a gravel path would be seen to present isolated or minimal loss with a short-term impact and so may be rated **insignificant**.

Impacts of erosion on a gravel path could present significant loss of the structure with potential for temporary disruption to its serviceability. To this end, it is given a **moderate** rating.

4.3 Resultant qualitative risk assessment

Table 13 and Table 14 summarises the likelihood and consequence ratings for the receivers considered relevant to the proposed track alignment and Ranger Creek access track, and the resulting risk rating.

Table 13 Qualitative risk assessment of the proposed track alignment and Ranger Creek access track to coastal inundation

Receiver	Likelihood	Consequence	Risk rating
Financial	Possible	Minor	Moderate
Property and Infrastructure	Possible	Insignificant	Low

Table 14 Qualitative risk assessment of the proposed track alignment and Ranger Creek access track to coastal erosion

Receiver	Likelihood	Consequence	Risk rating
Financial	Unlikely	Minor	Low
Property and Infrastructure	Unlikely	Moderate	Moderate

In accordance with the Glamorgan Spring Bay Council risk management policy, the response for medium and low risks is as follows:

- Moderate risk: assess in terms of other competing priorities and take action to fix if resources permit.
- Low risk: no immediate action required – could be managed by routine procedures such as ad-hoc maintenance/repair.

It is pointed out that the risk assessment presented in this report is to provide guidance and qualitative assessment only. The final risk assessment should be determined based on the actual track design, as well as with the participation of relevant stakeholders where various views from different perspectives can be considered and incorporated in the resultant mitigation measures and management plan.

5. Conclusions and recommendations

5.1 Conclusions

- GHD estimated wave run-up for various return periods and planning horizons. The resulting wave run-up elevations for the Freycinet area are likely to reach +1.8 m AHD for a 2% AEP event in 2050, and +2.6 m AHD for a 1% AEP event in 2100. Both water levels are inclusive of the corresponding sea level rise projections.
- In view of coastal inundation and coastal erosion, on the basis that the proposed preferred track alignment will be formed as a gravel path, its vulnerability to coastal inundation is **high** while that to coastal erosion is **low**. The same vulnerability applies to the southern end of Ranger Creek access track.
- The qualitative risk assessment undertaken as part of the Assessment indicates that the risk of the proposed track alignment and Range Creek access track to coastal hazards presents **low** to **moderate** risk to natural hazards, financial, and property and infrastructure receivers, in accordance with the likelihood and consequence descriptors provided in the Glamorgan Spring Bay Council risk management policy.

5.2 Recommendation

5.2.1 Measures in response to coastal inundation

- Given the proposed track alignment has high vulnerability to coastal inundation, the following mitigation measures may be considered and/or implemented in order to reduce the vulnerability of the infrastructure (or to increase its resilience):
  - Shifting the track alignment outside of the wave run-up elevation contour
  - Raising the elevation of the track alignment to above the wave run-up elevation. This could be in the form of a soil mound with rip rap protection at the side slopes, or piled foundation such as elevated boardwalk.
- Where the above mitigation measures are not considered, the alternative would be to keep the track alignment as is and on ground elevation, and have a management and response plan in place to implement track remediation when the damage exceeds the acceptable threshold, as agreed with relevant stakeholders

5.2.2 Measures in response to coastal erosion

- It may be prudent to carry out geotechnical investigation along the proposed preferred track alignment to update the information presented in the LiSTmap, in response to the uncertainties on the source and basis of the hazard mapping as discussed in this Assessment.
- To further improve the vulnerability of the proposed preferred track alignment and Range Creek access track (which is rated as low) to coastal erosion hazard, the following measures may be considered:
  - To elevate the track alignment with a piled foundation, such as in the form of a timber/Fibre-Reinforced Plastic (FRP) boardwalk. The piles of the boardwalk should take into account the possible loss of ground material due to coastal erosion, where adequate embedment of the piles should be provided.
  - Alternatively, implement reactive measures such as top-up/backfill and remediate the eroded track sections, when the damage exceeds the acceptable threshold as agreed with relevant stakeholders.

5.2.3 Risk assessment

GHD would also recommend a more comprehensive risk assessment be undertaken once a track form has been determined. Consultation with relevant stakeholders may form part of the risk assessment process in order to agree on the mitigation and management measures/plan for the track infrastructure.

6. References

- Glamorgan Spring Bay Council (2020), Risk Management Strategy, https://gsbc.tas.gov.au/wp-content/uploads/2020/06/Risk-Management-Strategy.pdf
- Hawes, M (2020), Assessment of options for a single-use or shared-use track linking Esplanade East to the vicinity of the Visitor Centre
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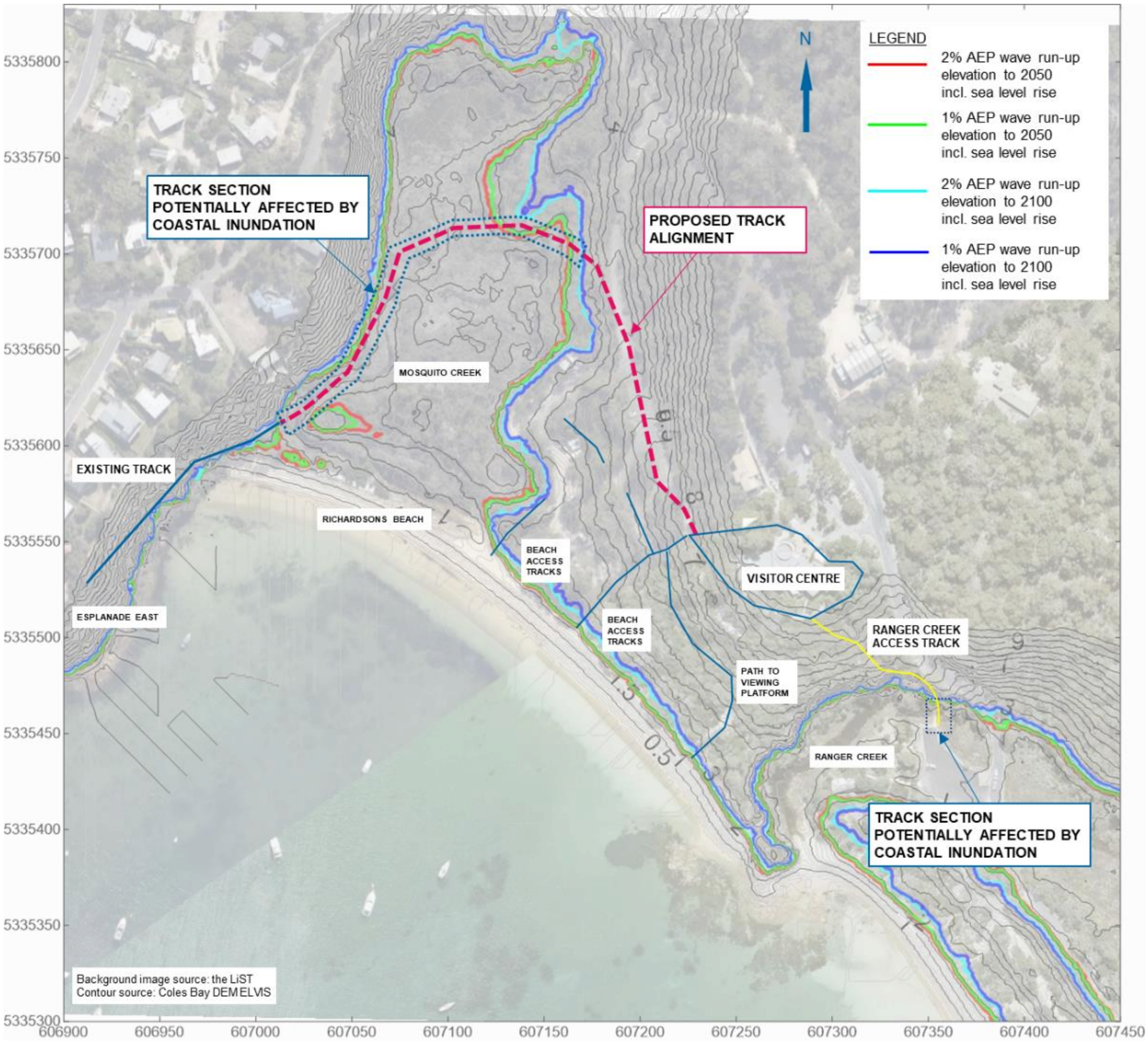
- Y. Goda (2000), Random Seas and Design of Maritime Structures, World Scientific

Appendices

Appendix A – Mapping of wave run-up elevation


LEGEND
2% AEP wave run-up elevation to 2050 incl. sea level rise
1% AEP wave run-up elevation to 2050 incl. sea level rise
2% AEP wave run-up elevation to 2100 incl. sea level rise
1% AEP wave run-up elevation to 2100 incl. sea level rise
N
TRACK SECTION POTENTIALLY AFFECTED BY COASTAL INUNDATION
PROPOSED TRACK ALIGNMENT
MOSQUITO CREEK
EXISTING TRACK
RICHARDSONS BEACH
BEACH ACCESS TRACKS
VISITOR CENTRE
ESPLANADE EAST
BEACH ACCESS TRACKS
RANGER CREEK ACCESS TRACK
PATH TO VIEWING PLATFORM
RANGER CREEK
TRACK SECTION POTENTIALLY AFFECTED BY COASTAL INUNDATION
Background image source: the LiST
Contour source: Coles Bay DEM ELVIS
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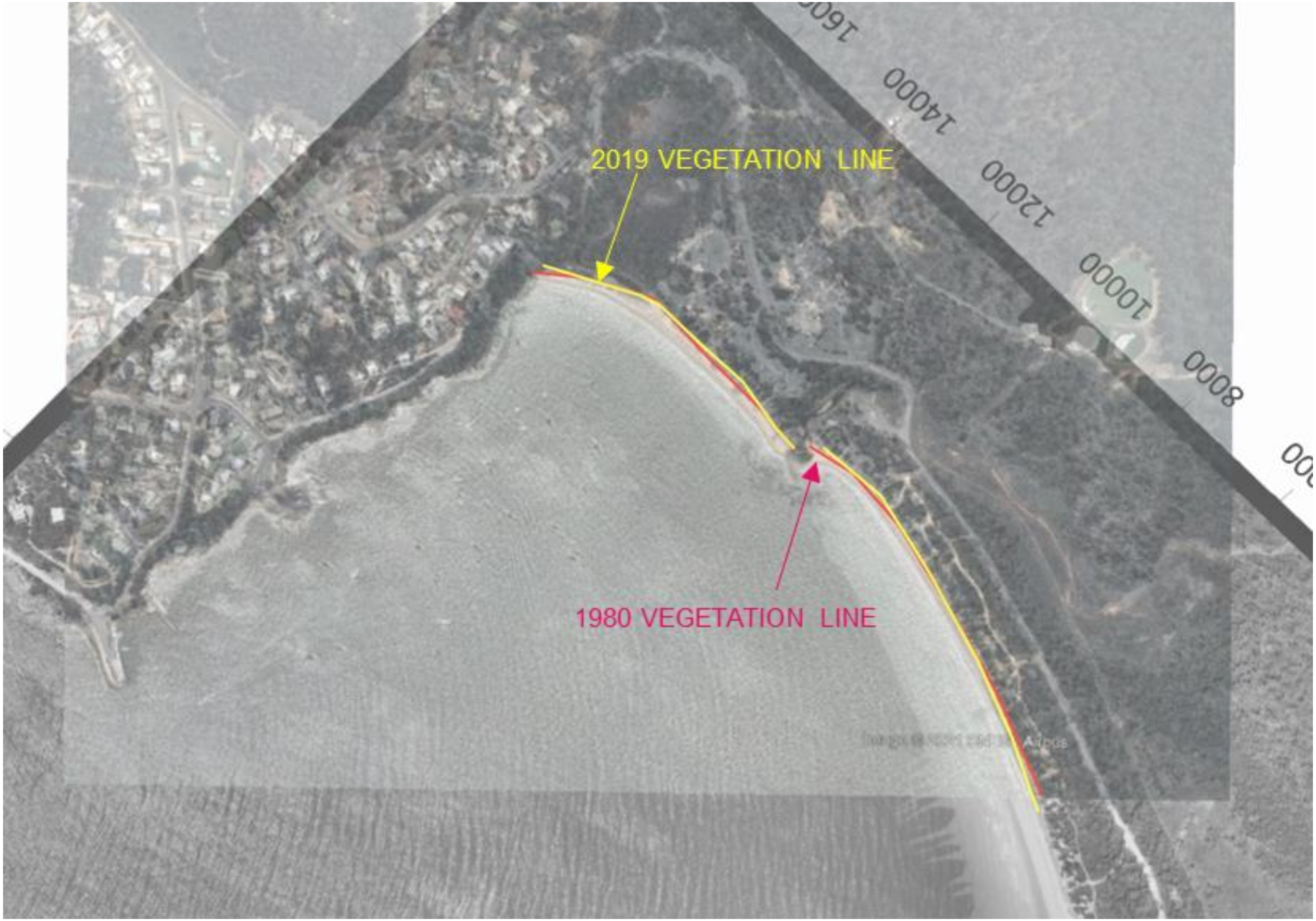
Appendix B – Mapping of shoreline movement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Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
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