



Main Beach Shoreline Project

Project Objective

The primary objective of the project is to investigate options to undertake modification of the existing coastal protection structure (also known as the Jonson Street Protection Works or JSPW) at Main Beach, Byron Bay with the sole intent to improve the current situation. The investigation is multi-faceted and determining the best solution to improve the structure will be based on the various themes of coastal processes, public safety and public amenity.

The delivery of the project and assessment of modification options is based on using a 'multiple lines of evidence' approach. As such the project will comprise coastal modelling, geomorphological assessment of the shoreline, in-situ collection of wave and current data and expert observations, with the sole intent of testing the predicted response of the shoreline for each modification option as a means of understanding whether an option may cause unwanted impacts either side of the structure both down-drift (west) and up-drift (east).

In addition, social, environmental, economic values will all be determined and considered as part of the evidence based approach. The assessment of the options being based on a multiple lines of evidence approach means that the decision on suitable options is not just based on coastal modelling, or coastal processes, or economic or environmental considerations, but is based on all relevant project objective factors in concert, adopting a holistic approach to developing the best possible option.



Why do we need to do this project?

The structure is degraded and not to a contemporary or conventional engineering standard. Secondary reasons are to improve amenity, public access, and if possible coastal processes outcomes.



Council resolved Project Objectives (Res 18-839: 13 December 2019):

1. To provide adequate protection to the Byron Bay town centre against current and future coastal hazards.
2. To mitigate adverse current and future risks from coastal hazards, taking into account the effects of climate change.
3. To mitigate impacts on coastal processes (e.g. down-drift effects) through reduction of the project footprint.
4. To improve the structural integrity of the JSPW (structure).
5. To improve public safety around the JSPW (structure).
6. To enhance recreational amenity, public access and use of the foreshore around the JSPW (structure).

Project Appreciation

Getting the science right

Finding the right solution from a coastal processes and climate change perspective will be challenging. The solution must be supported and justified by robust evidence that clearly illustrates the comparative impacts between distinct and well selected options. The solution should align with the visions of Council's Coastal Management Program (CMP) for Cape Byron to South Golden Beach, being developed concurrently.

The alignment of the modification options will be a key consideration when developing options and the structure footprint will also be a factor regarding amenity, with the formation of mini-rips (public safety concerns) and end effects to be considered. The impacts, positive and negative, on surfing amenity at popular and nearby surf spot, including The Wreck, will also be considered.

A design solution using a 'multiple lines of evidence' approach incorporates coastal observations from monitoring data, numerical modelling, physical modelling and a quantified conceptual model of sand movement. This approach will provide confidence in the options assessment against the performance outcomes and relevant project objectives.

Getting the engineering right

The design solution needs to be well engineered and buildable. Stable rock sizing, appropriate toe level based on scour level, crest levels and details, ground conditions, beach access and adaptability are all key consideration for the structure modification works. A practical understanding of the engineering design will be required during the design development stage and critical to ensure that a wealth of experience is harnessed to finalise the detailed design.



Getting the story right

The design solution needs to be bespoke and reflect the informal nature of Byron Bay and the broader Shire. Traditionally an important meeting place for the Arakwal people of the Bundjalung Nation, Cavanbah, or Byron Bay is much loved for its natural beauty. The benign subtropical climate encourages outdoor living and the foreshore area is a focal point for outdoor activities and gatherings. The list of users is eclectic and extensive and includes whale

watchers, runners, dog walkers, drummers, ocean swimmers, yoga practitioners, surf lifesavers, buskers, surfers, surf and ocean observers, beachgoers, snorkelers and people looking for somewhere to relax and hang out. A design solution for this area needs to be based on this existing use pattern and the desire to enhance and protect the area without resorting to a standard urban solution.



Structure alignment, terracing and softening characteristics, provision of beach effective access, including compliant disability access, recreational, beach and surf amenity, visual amenity and usage and value of existing assets (e.g. pool and car park) are important considerations.

A strong connection to the Byron Masterplan will benefit the design development and evaluation processes.



Drone survey (Oct 2019) of the coastal protection structure and adjacent shoreline

Phase 1: Baseline Understanding

A comprehensive review of all relevant previous studies, data sets and the current condition of the coastal structure will be completed to provide a baseline understanding for the project including the community and cultural values of the area. The team will monitor shoreline change as well as local waves, currents and sea levels and simulate waves that occurred over the last 30-years. This will help understand the underlying coastal processes driving erosion and flooding risk. Combining this information will highlight the opportunities and constraints of the proposed modification of the coastal structure.

The literature review assessment will involve:

- Development of a historical timeline for the coastal protection works
- Completion of a drone survey to provide a detailed 3D model of the structure in its current state.
- Coastal engineering condition assessment to document the structural features and current condition of the works.
- Constraints and opportunities analysis (land ownership and management arrangements; economic values; community and cultural values and uses; environmental values; coastal processes and hazards; climate change; geotechnical conditions; public safety; and opportunities).



Image looking east from drone survey (Oct 2019) of the coastal protection structure and adjacent shoreline



Phase 2: Development of Concept Design Options

The **first part of this phase** will be to determine a set of suitable concept designs that offer a range of viable solutions in accordance with the project objectives. Bluecoast operates on the building with nature approach and has considerable experience in applying this philosophy to identify suitable coastal management/protection solutions. Where hard engineering structures are required consideration of incorporating appropriate environmentally friendly elements will be discussed. Adaptive design measures to accommodate future climate change and sea level rise will be assessed.

A review of the previously proposed design options will be undertaken in-light of contemporary best practice and cost-effective coastal protection works, such as concepts that were proposed in the Worley Parsons (2014) report. Given the site constraints and opportunities identified in 'Phase 1 - Baseline Understanding', a technical and literature review of a long-list of feasible options will be considered including different material types, seawall and revetments, groynes, submerged reefs, artificial headlands, sand by-passing, nourishment, dune rehabilitation and retreat. The inclusion of options that re-align the structure landward will be considered as will options to remove or reduce in length the existing groynes.

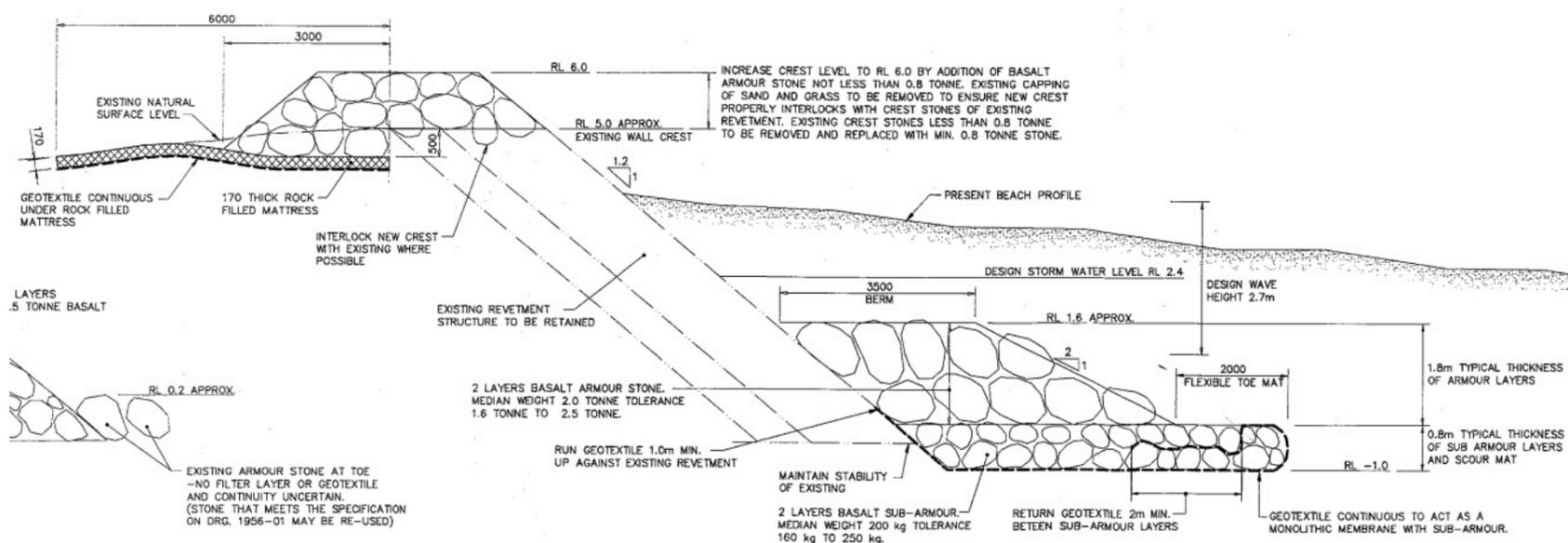
Each will be summarised in relation to the six project objectives and justification provided where options are considered unfeasible or marginally feasible. The assessment will consider the positive and negative aspects of each option using a wide range of criteria -including coastal protection, the natural environment, community values, ecology and economics.

Key stakeholders will be invited to be part of the evaluation processes (through a Multi Criteria Analysis Workshop), which in collaboration with the specialist team will select a few of the most suitable options to take forward for detailed assessment.

The concept design phase will also have regard to:

- Improving public access, safety, and amenity across the whole project precinct. With consideration of two beach accesses either side of the car park and disability access arrangements on at least one access.
- Construction costs will be considered based on the costs of previous projects, material availability and selection.
- Maintenance and whole of asset costs based on the expected longevity of the design options over a 50-year planning horizon and beyond. Access requirements for equipment to undertake maintenance on the structure will be considered.
- Inclusion of a shower, viewing platform, natural features, terracing and informal seating associated with the western access.
- Byron Bay Town Centre Masterplan.

Up to **five distinct options** will be developed for the modification of the structure. It is anticipated that one of these design options would comprise a berm type rock revetment seawall, which has been applied by Bluecoast successfully for other projects to provide significant savings in the capital cost of the works.



An example typical cross-section of a berm type seawall is shown above

The creation of a berm at the toe of the seawall (which would only be exposed during extreme events) allows waves to break on the structures at an earlier stage, which in turn reduces the wave run-up and overtopping experienced at the structure and enables a reduced rock size to be applied on the sloped face of the seawall than would have otherwise been required without a berm.

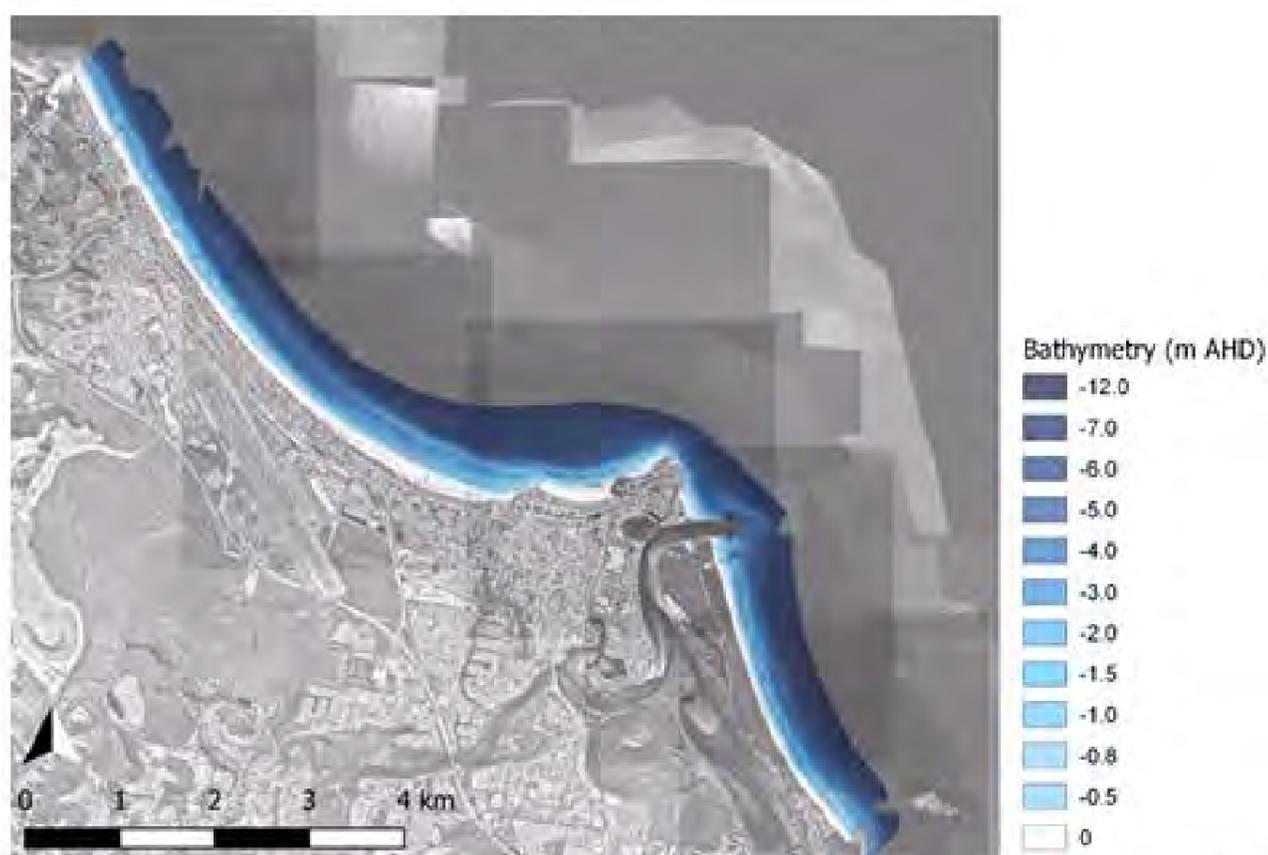
These concept options will be reported to Council outlining the assessment process completed to this point, and outcomes of the Multi-Criteria Analysis Workshop, clearly identifying which options should be further considered. Council will then decide on which **three options will be modelled** during the second part of the phase.

The **second part of this phase** will be to undertake coastal processes modelling and geomorphological assessment on the confirmed three concept options that have progressed. This will involve **local data collection**:

- Measurement of directional waves and currents using a current profiler located in the nearshore area of the embayment
- Water level at the toe of the structure will be measured using a high frequency pressure sensor in front of the existing rock revetment (at approximately mean sea level)

Other data collected will include:

- GPS and drone surveys either side of the structure length (3 surveys four months apart)
- Satellite derived bathymetry - new technology that converts satellite imagery into accurate nearshore high resolution bathymetry



Example of 2m resolution satellite derived bathymetry for the Tweed Sand Bypass study area for July 2017.

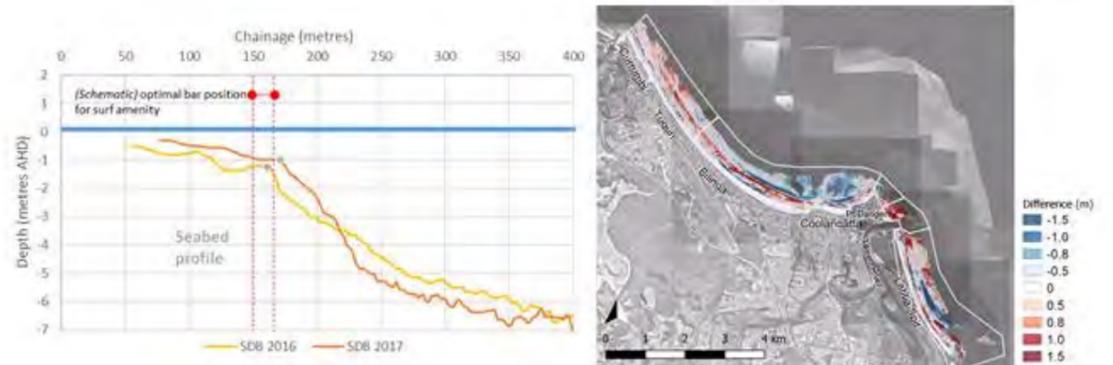


deployment of a Marotte HS current meter

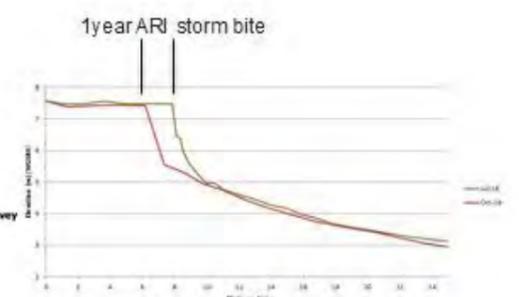


Examples of previous Bluecoast ADCP deployments and driver-less 'L-shape' mooring system developed by our engineers.

The collection of local data will help to understand wave transformation, hydrodynamic processes and validation for numerical coastal models. The data enables a detailed understanding of the long-term morphological conditions of the nearshore and sub-aerial beaches within the Byron Bay embayment. Bluecoast are experts in the analysis of spatial data to infer sediment processes and have an in-depth knowledge of interpreting long term coastal sediment processes as well as event based coastal response along the east coast of Australia. Bringing a well-respected geomorphologist, **Andrew Short**, on the project team will maximise the value of this analysis.



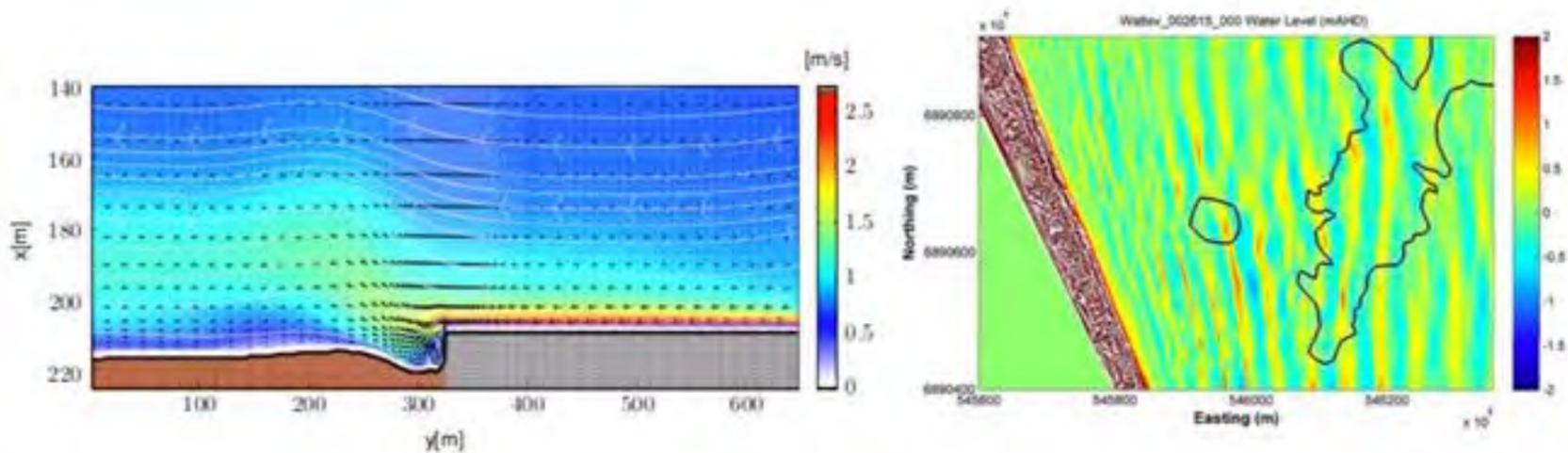
Examples of long-term bathymetric change analyses between two satellite derived bathymetry 'survey' dates at the Tweed Sand Bypassing study area.



Coastal Modelling

The SWASH numerical model is a shallow water wave model which accounts for wave breaking and wave transformation as it reaches the shore. The model also accounts for interaction with structures and estimation of wave induced water level set up. This model is an ideal tool for assessing baseline conditions and impacts (any down-drift or up-drift impacts caused by the structures) of the selected concept designs on the nearshore wave and hydrodynamic processes at the coastal protection structure.

The model will be used to estimate design wave conditions and overtopping volumes during storm conditions for the baseline and selected concept design options. A selection of annual recurrence interval (ARI) events (e.g. 1, 5, 10, 50, 100 year ARI) will be simulated to assess the design wave height, water level and the structure's performance in limiting overtopping during these events and during future sea level rise scenarios.



Example of simulated currents at the downdrift interface between a seawall and sandy beach (left) and wave transformation over nearshore reef (right) using SWASH.

Shoreline response to the selected ARI offshore wave and water level conditions (as determined using SWASH and outlined above) will be simulated using a 2D non-hydrostatic XBEACH model for the baseline and selected concept design options. This will predict morphology changes in front of the structures (including scour at the structure's toe) as well as in unprotected updrift and downdrift areas and sediment bypassing at the structure. It is proposed that the XBEACH model be calibrated to the measured nearshore wave and currents as well as water levels at the structure's toe to ensure wave setup during these events is correctly resolved.

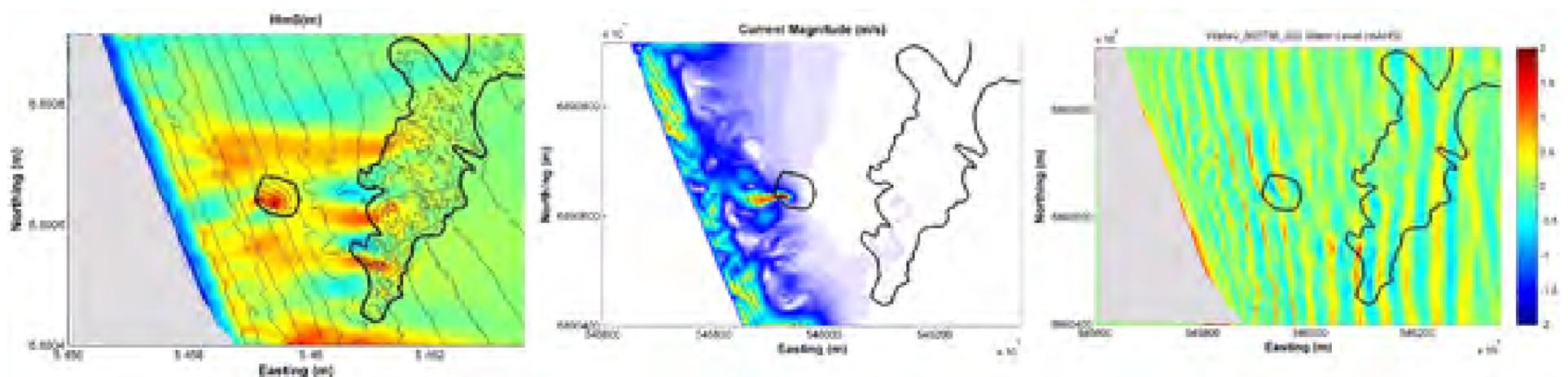
The XBEACH morphology modelling for storm events will benefit the study by providing event-based/extreme nearshore morphology; impact/performance of modification options on nearshore morphology; and critical information of design parameters (e.g. design profile, scour depth, toe configuration).

Amenity assessment

To understand the surrounding surf breaks and swimming areas (i.e. between Main Beach and The Wreck), a baseline characterisation of the existing wave mechanics will be undertaken first considering effects of bathymetry, incident wave conditions (height, period, direction) and water levels. This approach will then be reproduced for modification option conditions (i.e. structures, alignment and inferred/modelled bathymetry) to evaluate relative changes in incident and reflected wave energy and wave breaking positions and potential effects on the wave quality and swimmer's safety.

Surf specific metocean conditions will be derived from the ~40-year wave hindcast and known 'good surfing' conditions (determined in consultation with the local surfing community or social media research). The high-resolution and calibrated SWASH model will be used to understand wave breaking patterns and wave-driven current simulations defining general wave breaking footprints, wave sections as well as key features of the surf break circulation.

Furthermore, the results will be assessed with a focus on identifying any changes in the location and magnitude of rip currents that could pose a safety risk for swimmers.



Example of surf amenity assessment for a multi-purpose reef at Palm Beach using SWASH

Conceptual coastal processes model

The findings from the literature and data review, geomorphological assessment as well as analysis of the coastal modelling results will be used to form and reiterate coastal process understanding at the project site. A conceptual coastal process model, as seen in below figure will be developed.

The conceptual model will include the key coastal processes and key morphological features (e.g. nearshore reefs, wrecks, etc), clear presentation of inferred impact (positive and negative) of modification options on local coastal processes; and enhancement of overall coastal processes understanding.

The results of the modelling and geomorphological assessments including the predicted impacts to coastal processes associated with each of the three concept options will be evaluated first by Council and then key stakeholders in a second Multi-Criteria Analysis (MCA) Workshop.

The second Multi-Criteria Analysis (MCA) Workshop will be critical in the projects progression with each of the three concept options comprehensively assessed against the key themes (for example community values, economic factors, coastal processes, ecological impacts, climate change and SLR). Workshop attendees will be involved in setting criteria against which the concept options will be evaluated and scored. The pros and cons of each of the three concept options will be discussed and detailed under each MCA criteria.

Engagement with the broader community will be undertaken on the three concept design options, to assist Council in deciding which option/s progress to a more detailed concept design phase.



Phase 3: Detailed Assessment of Modification Options

This phase will involve building and updating the three endorsed concept designs to more detailed concept designs. The detailed concept designs will incorporate the following key opportunities for optimisation of the modification options:

- Byron Town Centre Masterplan – to effectively incorporate the findings of the Masterplan into the detailed concept design developments
- Understanding of risk management and adaptation options – to find the right balance of level of protection, sustainability and cost-effectiveness.
- Early construction expert involvement using industry professionals will bring cost certainty, sustainability and buildability.
- Quarry investigations
- Artists impressions and visualisations

The outcome of this further assessment of the options will be clearly described design specifications, design rationale, and design limitations for each detailed concept design. This will include a full suite of drawings for each detailed concept design including cross section, plan and elevation views.



Example of artists impression and visualisation for an offshore coastal protection concept design

Phase 4: Evaluation and Determination of Preferred Option

Further evaluation will then inform the selection of the preferred modification option for the existing coastal rock structure. In parallel with this design investigation, a separate project comprising Cost-Benefit Analysis (CBA) of the concept options will be undertaken. A detailed cost and benefits assessment is important as it helps to inform the final investment decision by Council. The results of the completed CBA will be considered by an economist who will undertake a technical comparison between the CBA results and the second-pass Multi-Criteria Analysis (MCA) Workshop to describe possible differences between the ranking of the proposed concept options.

Bluecoast will identify one, (or a maximum of two), detailed concept design that is recommended to Council for progression towards 'detailed design and costing' with accompanying justification. Broader engagement with the public through a formal public exhibition period will be completed to consider community feedback and agency comments on the proposed detailed concept design/s.

Once a detailed concept design has been endorsed, the project will then progress into the detailed engineering design phase and funding sources will be investigated.



Project Team

Richard Mocke

Project Director/Technical Review



Richard is a Chartered Civil Engineer with a Master's degree in Coastal/Maritime Engineering and over 25 years of experience in a range of civil engineering development and infrastructure projects across five continents, undertaking numerous technical design and design/construction management, project and contract management roles and overseeing a range of projects from concept development, managing on-site investigations, detailed design and through to final site construction and implementation.

Evan Watterson

Project Manager/Coastal Engineer



Evan is a Principal Coastal Engineer and Director of Bluecoast Engineering Consultants. He has over 15 years of experience in coastal engineering investigations and design. He previously worked within specialised coastal and marine teams at Royal HaskoningDHV, SMEC, WorleyParsons and Cardno Lawson Treloar.

Evan specialises in the investigations and design of complex coastal projects. Having worked on a range of projects in the consulting industry Evan has developed a sound understanding of dynamic coastal environments and has an extensive skill set. Evan has demonstrated leadership and acted as a project director, project manager and/or technical lead on projects involving monitoring, coastal engineering design, numerical modelling, physical modelling and community engagement.

Evan is currently completing his role as senior project engineer and project manager for the design team on the Palm Beach Shoreline Project. For this project, Evan will act as Project Manager and Principal Coastal Engineer with a role to ensure deliverables meet Councils expectations. Evan will be involved in much of the technical aspects of the work along with the other technical experts.

James Lewis
Coastal Engineer



James is a Coastal/Metocean Engineer with ten years of experience in coastal, and metocean engineering. James has an in-depth knowledge of metocean deployment, data analysis and numerical modelling of coastal and estuarine environments. James has worked on major coastal infrastructure projects such as the Seaway Smart Release, Palm Beach Protection Strategy and the Hastings Container Port Project. James has been responsible for all facets of the feasibility, scoping and concept design of Albany Artificial Surfing Reef Project, a surfing specific submerged structure from leading extensive field monitoring and data collection campaigns, state-of-the-art numerical modelling and data analysis as well as project management and extensive stakeholder consultation.

James was technical lead on the City of Gold Coast's Surf Management Plan and more recently has undertaken a surf quality and amenity assessment of Duranbah Beach as it relates to the Tweed Sand Bypass Project for NSW Crown Lands.



Heiko Loehr
Coastal Engineer

Heiko is a coastal engineer specialising in metocean studies, coastal processes and coastal risk assessments. He previously worked within specialised coastal and marine teams at Royal HaskoningDHV, MetOcean Solutions (NZ) and the University of Southampton (UK).

Having worked on a range of innovative coastal industry projects, Heiko has developed a holistic understanding of dynamic coastal environments and has an extensive skill set ranging from problem definition to engineering design.

Heiko is also an expert in modelling of hydrodynamic, wave and sediment transport processes ranging from ocean scale to CFD modelling tools using numerous licensed and open source software. He has completed several numerical modelling courses including SWASH/XBEACH, Delft3D FM, MIKE 21, WaveWatch III and TELEMAC.

Project Collaboration

Bluecoast is collaborating with the following experts for the Main Beach Shoreline Project:

Tonkin & Taylor – We have an excellent relationship with T&T staff and have appointed Tom Shand as a Technical Reviewer for this study. Tom has undertaken assessments across NSW and Australia. These include, Assessment of the NSW Extreme Coastal Wave Climate, the results of which are still used frequently today and Review of the Effects of Seawalls on NSW Beaches for Department of Planning, Industry and Environment, including the Jonson Street seawall.

Space Studio – We have teamed with the local architects at Space Studio who were engaged on the Byron Bay Master Plan team as architects and local consultants. They understand the need for a bespoke solution reflecting the informal nature of Byron Bay and the broader Shire.



Rhelm – Our former colleagues at Rhelm are specialist consultants in engagement and economics in coastal management projects. They will draw on their NSW experience to complement the project team in the planning, environmental, economic and engagement tasks as well as the MCA assessment.



Andrew Short – We invited Andrew to lead our geomorphological assessment in this study. He is unrivalled in his wealth of knowledge of coastal processes in Australia. He will provide a key input to our multiple-lines of evidence approach, alongside the numerical modelling and data collection undertaken, and bring a high-level view in interpreting this information.

Sikko Krol – Bluecoast has included Sikko Krol in our design team. Sikko is a respected maritime construction expert in Australia. Sikko and our coastal engineers will ensure buildability of the concept designs, identify any opportunities and construction risks early in the project as well as an accurate construction cost and anticipated maintenance cost for each of the three detailed concept design options.

Estimated time line of historical coastal events and construction



How will surfing amenity and surf breaks be considered?



Surfing has long been part of the fabric of Byron Bay. Council understand the value this activity brings to locals and visitors alike and will consider surfing amenity as one of the key investigations under the Main Beach Shoreline Project.

For each modification option, the impacts on surfing amenity at popular and nearby surf spots, including Main Beach and The Wreck, will be considered. Through the multiple lines of evidence approach, a combination of physical data collection (wave and current measurements), local surfing knowledge, coastal modelling of waves and currents, and geomorphological assessment will be utilised to improve the understanding of local wave and hydrodynamic processes.

Through assessment of data and information, specific conditions will be better understood. For example, bar morphology and metocean conditions required for good or bad surfing conditions. This will be essential to not only infer the interaction between the current (e.g. mini-rips cells) and proposed structures with the nearshore wave and hydrodynamic processes, but will also provide an understanding of long-term wave statistics and a variety of characteristic conditions.

This understanding will ensure that the proposed concept options can be optimised to minimise any potential negative impacts to amenity (e.g. beach width, surfing quality) at an early stage of this project. For more detail on the exact collection of data and coastal modelling, please refer to the consultant's scope of work on Council's website.