



Why are we doing this project?

The concept of an artificial surf reef in Albany has been around for at least 20 years and has been heavily driven by the community.

Currently, the closest suitable surfing locations from Albany are around 30 minutes' drive, and are generally unsuitable for beginner and junior surfers. With a lack of public transport available to reach appropriate locations (e.g Mutton Bird or Nananup), opportunities to surf are limited, particularly for young people. The current locations are isolated and unpatrolled. Enabling these activities to be undertaken at Middleton Beach will improve safety through increased monitoring, and proximity to the Albany Surf Life Saving Club and medical and emergency facilities.

The City of Albany is hoping to attract and retain a younger generation, who currently tend to move to metropolitan areas where a wider variety of recreational facilities exist. It is hoped that the artificial surf reef will be a significant attraction that will help retain this demographic, as well as expanding the recreational amenity for residents and visitors.

The project complements other initiatives in the region to further develop adventure tourism assets and experiences and diversify and grow our regional economy.



PROJECT VISION

"To create a consistent, surfable wave central to Albany, driving benefits for the community, tourism, economic development, and the retention of the region's younger age demographic"

KEY BENEFITS

- Provide a consistent surfable wave central to Albany and accessible by public transport;
- Attract and retain a younger generation;
- Deliver benefits relating to economic development, social, health, ecological, environmental and safety outcomes;
- Provide a significant tourism drawcard in Albany's Winter season;
- Deliver a recreational project that contributes to Albany's liveability and reputation as one of WA's key tourism destinations, helping to create a more liveable regional city; and
- Create an opportunity for Albany to be recognised as a surfing town; a clustering of multiple recognised surfing spots in the region (the only other such towns being Margaret River) and attract high quality events.

PROJECT OBJECTIVES

- Deliver improved recreational and surfing amenity through the creation of a consistent surfable wave, targeted at beginner to intermediate abilities;
- Create a quality wave appropriate for holding events, creating an opportunity for Albany to be recognised as a surfing town;
- Enhance marine ecology in and around the reef structure; especially for snorkeling and diving based activities during periods when the wind and wave conditions are less than ideal for surfing;
- Work in partnership with key stakeholders throughout the project, taking a collaborative approach to design, planning, implementation and management decisions; and
- Maintain Middleton Beach's unique landscape character, whilst enhancing lifestyle, tourism and recreational opportunities to benefit the community.

1. What is an artificial surf reef?

An artificial reef is a man-made underwater structure that has been designed to achieve a specific objective. Typically, these reefs are built for coastal protection, to promote marine life or to improve surfing amenity. The Albany artificial surf reef is being constructed to improve recreational and surfing amenity at Middleton Beach.

2. Why Middleton Beach?

Middleton Beach has a set of existing unique characteristics sought after in artificial reef design:

Wave period in excess of 12 seconds - results in an increase in wave height in response to a reef;

Unidirectional wave climate - small degree of directional spread for wave focussing in response to a reef;

Low tidal range - maximises the duration that swell will break on the reef structure;

Predictable wave conditions; and

Predominant offshore winds.

A community survey undertaken in February 2015 received a total of 732 responses; the largest response for any City of Albany community survey undertaken, with results revealing 90% support for an artificial surf reef at Middleton Beach. A subsequent survey in September 2020 revealed a continued 87% project support for the reefs implementation.

3. What were the key performance indicators for the reef design?

The key performance indicators for the reef design were all met and included:

Surfing amenity (increase in the number of surfable waves for beginner and intermediate surfers, no negative impact of surfing conditions in the lee of the structure);

Shoreline impacts (Maintaining coastal response to the reef within the erosion and accretion triggers outlined in the draft operational and Environmental Management Plan, Maintain or improve beach amenity);

Environmental impacts (minimise environmental impact during construction and operational phase, increase in abundance and diversity of marine life in the local area of the reef);

Cost (Minimise cost for the construction and maintenance of the reef); and

Safety (Minimise harm for construction and subsequent maintenance or removal works, rip current generated over the reef to be within acceptable levels and wave breaking characteristics over the reef to be consistent with safe surfing).

4. How was the reef designed?

Coastal engineering projects of this nature are complex and challenging. The City has worked with a team of experts in coastal science and engineering to deliver the best possible outcome for delivering successful surf amenity at Middleton Beach.

The data collection sources to inform the design include acoustic wave and current and wind measuring devices, hydrographic and 3D survey, beach transects and photo monitoring, together with extensive numerical (computer) and scaled physical modelling to develop and refine the design of the reef

structure and verify its performance.

The City has partnered with the Wave Energy Research Centre based at UWA's Albany campus to assist in a peer review throughout the design process to strengthen confidence in the design, methodologies and outcomes at a local level.

5. How big would the reef be, what is it made out of and where would it be located?

Subject to the final detailed design outcome, the artificial reef would be located approximately 145 metres offshore from 'Surfers', Middleton Beach. It would be constructed of large granite boulders and approximately 1.0 metre below the average water level at its highest point, with no visual affect from the beach. The footprint of the artificial reef would be approximately 16,000m² with an approximate overall length of 165 metres and up to 100 metres in width.

Rock structures are tried, tested and proven to be stable and deliver the following:

- Most effective in attenuating wave energy
- Reduce wave driven currents
- Can be constructed to attain the design shape
- Provide acceptable safety for recreational users.

6. What surfing conditions would the reef provide and why is it a left-hander?

The artificial reef will improve the seabed conditions and the resulting wave breaking character, and consequently surfability for a range of target surfer groups from beginner to intermediate abilities.

It is the intent that the introduction of an artificial surf reef will convert the current dumping (close out) waves to a plunging to spilling wave, with a surfable wave breaking on the reef a minimum 41% of the year.

The artificial surf reef will also deliver improved conditions for surfing inshore; shorter and faster breaks created inside and either side of the structure that will suit a variety of surfing enthusiasts, including body boarders.

The outcome of detailed design investigations revealed that a left-hand wave would produce the best wave for this location to maximise performance and value for money, including the best outcome for the structures' stability and longevity. Pre-conditioning of the incoming wave field by an offshore shoal also favoured a left-hand wave.

All shaped reef options were considered and modelled during the feasibility and detailed design stages. The A Frame structure was ruled out as it made modifying the reef to accommodate changing sea levels less possible and costlier.

7. Would the wave break year round?

The Artificial Surf Reef is designed to maximise the available swell at Middleton Beach. Surfable waves on a regular basis are expected all year round, with Winter being most consistent. Surfable waves on the reef are estimated to occur on average around 41% of the time (standard surfing craft, such as shortboards). The modelling investigations show that during times when waves are too small to break on the reef, more frequent surfable waves are expected between the reef and shore due to shoaling and greater variation in near-shore sand

bars; both conducive to surfing. Regular wave breaking on the artificial surf reef is expected for wave heights from around 0.5 to 0.6m (significant wave height) during low tide.

8. The winds at Middleton Beach aren't always offshore, what does this mean for surf-ability?

The artificial surf reef is designed to break waves in a surfable manner so it can be assumed that any wave breaking on the structure will result in surfable waves (i.e. regardless of wind or other parameters influencing surf quality). Analysis of local wind data indicates that for 72% of the time wind conditions at the site can be expected to be average or above (in terms of surf quality). 28% of the time surf conditions are expected to be 'wind affected'. There will still be surfable waves during these wind affected conditions but not of as good a quality. Reef breaks also generally still hold the shape and quality of the wave in unfavourable winds better than beach breaks, as observed at other artificial and natural reef breaks around the world. The surf-ability numbers are based on comprehensive statistical analysis of long-term measured wind records considering not only offshore/onshore direction, but also all directional sectors and various levels of wind speeds.

9. Why is the artificial reef so far out?

The reef has been located a sufficient distance from shore to mitigate any shoreline impacts. Some ocean users may not wish to paddle out this distance, however the artificial reef will also enhance surf amenity closer to shore (i.e. inshore of the structure itself). This is predicted to occur as a result of the reef breaking up incoming wave crests and creating 'peaky' beach breaks. These inshore breaks will cater for surfers who do not wish to paddle out to the reef itself.

10. Have environmental impacts been considered?

The City of Albany have undertaken an Environmental Impact Assessment and a draft Operational and Environmental Management Plan for the project's potential implementation with the project also assessed by the Environmental Protection Authority under the Environmental Protection Act 1986.

The extensive modelling undertaken as part of the detailed design process determines the final reef site, size and distance off-shore to ensure the reef will not significantly impact coastal processes, the shoreline or existing beach amenity.

The artificial reef will be located on a sandy seabed away from areas of dense sea grasses and is not posed to be an issue for migratory species in the King George Sound, as determined through the approvals process it has been assessed by government agencies to make sure it adheres to strict environmental legislation. Following construction, the creation of a rocky reef with lots of voids will enhance the marine ecology over the reef.

11. Has the design considered climate change and sea level rise?

The extensive modelling process factors in climate change and the potential impact on the reef structure, its performance and the shoreline.

Sea level rise will lead to an increase in the free-board (depths) over the structure. Over time this will affect the performance of the structure during mid-to high tides. At present sea level, the

artificial reef is expected to have breaking waves 41% of the time. Based on sea level rise projections, this would be expected to reduce to 33% of the time by 2050 (in 30-years' time). The benefit of enhancing surf amenity inshore of the structure as unbroken waves pass over the reef will be greater under future sea level rise scenarios.

Topping up the artificial reef to maintain design heights would require remobilisation of specialist equipment to Albany, if after 30-years of service it was desirable to top-up and/or undertake a major refurbishment of the structure. However, the reef would still be providing a benefit if not topped up. The reef has a design life (i.e. it will maintain its overall shape and structural stability) for a period of 50-years or more.

The artificial reef economic assessment used a 25-year period over which costs and benefits were compared. That is the benefits derived from the initial investment in the reef have only been included over the first 25-years of the structure's life. Benefits derived after the 25-years of service life would be an economic bonus and do not underpin the economic drivers of the project.

12. Have shoreline impacts been considered?

Due to the importance of ensuring no negative shoreline response to the artificial reef, the investigations undertaken have used a multiple lines of evidence approach. Investigations including site-based data collection, numerical modelling, physical modelling and a quantified conceptual model have been completed to predict the shoreline response.

Coastal erosion is most evident at Middleton Beach following storms like the one in August this year. During storms sand is eroded from the beach and deposited in a storm bar in the near-shore. Following the storm, when conditions return to normal the beach recovers with sand moved back on to the beach.

Coastal erosion has been considered in the design of the artificial reef by using state-of-the-art numerical modelling as well as a quantified conceptual model. These models show that the wave shadowing effect on the reef are greater during storms, reducing the wave action on the shore. This is expected to reduce the degree of erosion of Middleton Beach in a localised area behind the structure. This modelling was completed for a range of storms including events that would be expected to only occur once in every 50-years as well as clusters of storms, whereby storms occur in quick succession allowing little time for recovery of the beach.

13. Will the artificial reef structure change the natural currents, sand movement or rips?

Yes, the artificial reef is designed to interact with the incoming waves and cause them to break further from shore than they normally do. This will result in some localised changes to the natural wave patterns, currents and movements of sand in the area directly adjacent to the artificial reef. The findings of extensive investigations show that the changes to the currents and sand movement will not adversely impact Middleton Beach, in fact, there will be a benefit; a wider and more stable beach inshore of the reef. The reasons why the beach will be widened behind the structure is that the reef creates a 'wave shadow' as well as local circulation patterns that promote a mild and localised build-up of sand. The investigations of coastal processes considered the entire Middleton Beach embayment.

PHASE 6 STAGE 1
Approvals + Agreements
Construction Tender
2023-2024

PHASE 7
Construction
Methodology
Refinement
TBD

PHASE 8
Community
Engagement
TBD

PHASE 9
Implementation
TBD

PHASE 10
Commissioning +
Completion
TBD

PHASE 11
Monitor + Research
Opportunities
TBD

This outcome is not an accident, the size and location of the artificial reef has been carefully planned not to adversely impact Middleton Beach. The finding of a positive change on the beach is further supported by other similar project structures that have successfully enhanced coastal protection and beach amenity.

Scour by wave driven currents is expected around the artificial reef, however has been accommodated in the structures design and a good deal of investigations have informed the predicted scour with design measures taken to accommodate this without compromising the structures integrity.

The main rip current is directed onshore and will occur over the reef itself. This current is driven by the wave breaking over the reef and will be present when wave breaking is occurring. Shoreward of the reef the rip dissipates rapidly. Further shoreward a range of circulation patterns are expected inshore of the artificial reef. While these will be altered from the natural currents the offshore directed rip currents that already exist at the site will be reduced compared to the natural conditions.

14. What maintenance would be required and when?

Due to accessibility the design has been completed with a low maintenance requirement. Based on the results of detailed physical modelling undertaken for the design, extreme storms are unlikely to trigger any maintenance requirements from a structural stability or structure performance perspective.

Some movement in the protective armour layer is possible in extreme storms but not sufficient to trigger maintenance. Monitoring (surveys or dive inspections) would be required following extreme storms. If construction is approved a monitoring and maintenance plan will be developed to establish the required monitoring and maintenance triggers to ensure that user safety is maintained.

Annual monitoring and maintenance costs have been estimated as 0.05% of the capital costs. This is lower than other coastal structures (1-2%). This low maintenance cost is a result of the low maintenance design philosophy, the low sensitivity of the performance to damage as well as the submerged and broad (i.e. mild sloping) nature of the structure.

15. Will rock settling occur over time?

Only minor settlement is expected. Settlement has been calculated for the design based on a review of geotechnical conditions and geophysical site investigations.

16. Is the amount of data collected enough to design a reef with confidence?

The City of Albany, in collaboration with local authorities, undertake a world-class coastal monitoring program. This data includes wave, currents, water levels, beach profiles, drone surveys, bathymetric surveys, geotechnical data, sediment grain sizes, sea-grass distribution and aerial photography. This dataset has been used to inform the design (i.e. the design is informed and derived from data). The period the data has been collected is more than sufficient to inform the design.

With the data available, the coastal engineers developed a numerical wave hindcast model used to produce a simulated 40-year record of wave conditions at the project site that reproduces the observed coastal processes and can undertake predictions with confidence. Importantly the 40-year hindcast record includes some examples of very large storm events including the 1984 storm event and storm events in the mid-

2000's. From the 40-year wave hindcast record, extreme value statistics are used to estimate the wave conditions that would be expected to occur once in every 100-years.

17. Why not build a wave pool instead?

Wave pools and surf reefs are not really comparable. Surf reefs are accessible to everyone and are a 'working with nature' approach, where we let mother nature create the waves and engineer a fixed seabed to help shape the breaking waves. Once constructed, no resources are required to operate this surf break. Participants chose to surf at the reef at their own risk, free of charge. Wave pools are commercial facilities that only cater for the part of the community that can afford it, typically around \$80/hour which would largely preclude the projects youth target market. The maintenance requirements for wave pools are also significant.

18. Has a business case been developed that suitably supports the project?

Yes. A Business Case was completed by Keston Technologies that concluded that the development of an artificial surf reef at Middleton Beach is a viable investment. The calculations demonstrated a positive Net Present Value of \$19.4m (Benefit Cost Ratio of 3.25), clearly deriving from the high level of community benefits that would accrue - hosting surfing events, uplift in visitation and length of stay, complementing adventure tourism and creation of a Surfing Hub. Note: Benefit Cost Ratio above 1 is considered a viable public investment.

The full Executive Summary of the Business Case can be found on the City of Albany web page.

19. If the reef fails or causes unforeseen coastal damage or safety risk, will it be removed?

Detailed investigations have been undertaken to provide the necessary confidence that there will be no unforeseen coastal damage or on-going safety risks. In the unlikely event these impacts manifest any necessary modifications or removal would be considered and will be further resolved prior to any potential implementation.

20. What is the status of the project?

State Government committed to allocate \$4.5 million towards the project, with a portion of these funds assigned in advance to commence the detailed design process, and the balance pledged for the reef's construction. The detailed design process was completed in October 2020. The Federal Government committed additional funding so that the estimated \$11.5 million artificial surf reef can be implemented.

This funding is subject to a successful Federal assessment through the Priority Community Infrastructure Program.

The City of Albany are awaiting a successful outcome and fully executed funding agreement.

CONSULTANT PROJECT TEAM

Project Management: **City of Albany**

Detailed Design: **Bluecoast Consulting Engineers**

Quantity Surveyors: **Muller Partnership**

Business Case: **Keston Technologies**

Peer Review: **UWA Wave Energy Research Centre**

