

## ENGINEERING WONDER: DELIVERING WONDER REEF ON THE GOLD COAST

Matthew Allen, MMA Offshore Pty Ltd, [Matthew.Allen@mmaoffshore.com](mailto:Matthew.Allen@mmaoffshore.com)  
Nathan Cook, Reef Ecologic, [nathan.cook@reefecologic.org](mailto:nathan.cook@reefecologic.org)  
Jack Francis, MMA Offshore Pty Ltd, [Jack.Francis@mmaoffshore.com](mailto:Jack.Francis@mmaoffshore.com)  
Kristy Konings, City of Gold Coast [KKONINGS@goldcoast.qld.gov.au](mailto:KKONINGS@goldcoast.qld.gov.au)  
Adam Smith, Reef Ecologic, [adam.smith@reefecologic.org](mailto:adam.smith@reefecologic.org)  
Sean van Steel, Core Marine, [svs@core-marine.com](mailto:svs@core-marine.com)

### Summary

Wonder Reef on the Gold Coast is a new and exciting ecotourism destination. Wonder Reef is a unique fusion of art, science and engineering delivering a nature based solution to create both an iconic dive tourism destination and new, complex habitat 2km offshore from The Spit on the Gold Coast.

Wonder Reef stands a staggering 22m off the seabed in 30m water depth and is designed for the 200 year cyclonic return period  $H_{MAX} = 18.6m$   $T_p = 18.6m$ . This in itself is a marvel of coastal engineering!

The team deployed used working with nature methods in the design of the reef flutes and foundations as well as cutting edge low carbon, earth friendly concrete and coral propagation in partnership with SeaWorld and Reef Ecologic.

This paper explores the key aspects of the project delivery including community consultation, permitting, tenure, structural and hydrodynamic design, dive aspects, coral out-planting and low carbon earth friendly concrete qualification.

*Wonder Reef, EcoTourism, Nature based Solutions, Coral, Reef*

### Introduction

Wonder Reef has been designed to attract and sustain a rich diversity of marine life and withstand cyclonic conditions yet appear light, buoyant and floating in the ocean. Over time, complex marine communities will take centre stage, creating a 'hanging garden' for divers to explore and admire.

This world first buoyant design is the outcome of a collaboration between global reef experts Subcon Blue Solutions, large scale sculptural artist Daniel Templeman and the City of Gold Coast, with specialist input from around the world.

A global first delivered by the City of Gold Coast and jointly funded by the Queensland Government, the \$5 million Wonder Reef is the outcome of a long-held vision to diversify the city's tourism offering and



Figure 1 - Ribbon Cutting at Wonder Reef

raise the profile of the region as a premier dive destination.

Inspired by the concept of a hot air balloon rising in the sky, nine reef sculptures become larger towards the surface, like oxygen bubbles rising in the ocean.

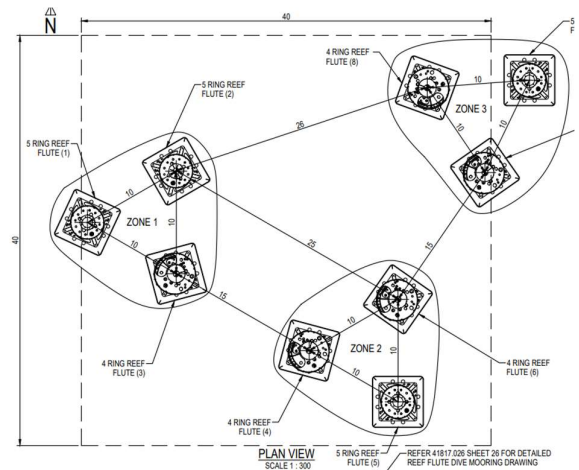


Figure 2 - General Arrangement of the sculptures at Wonder Reef showing dive zones and navigation plans

### Permitting and Design Certification

The permitting process presented some unique challenges as the site and classification of the reef spanned a number of jurisdictions. Department of Water and Environment (DAWE) provided the Reef

Permit under the provisions of the sea dumping act. DAVE permit review and conditions addressed material selection, installation, diver safety, navigation, long term monitoring and decommissioning.

MMA Offshore provided in house RPEQ design approval and Cardno acted as the clients third party engineers for the design review.

Finally a fishing exclusion zone was granted by Queensland Government effectively creating a Marine Protected Area around the site.

### Engineering Wonder

Specific design guidelines and standards for artificial reefs do not exist. The designers considered the reef as a marine structure in accordance with AS 4997-2005 however stability and installation are more appropriately addressed by DNVGL-RP-N103 and DNVGL-ST-N001 were used for the analysis and marine operations for a reef.

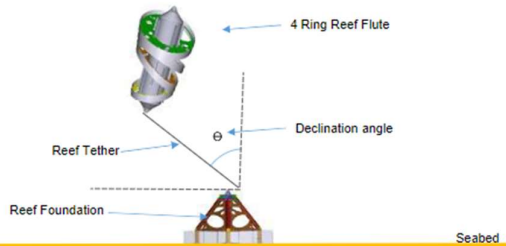


Figure 3 - Reef assembly components

Core Marine performed a dynamic analysis of the Reef Flutes and Reef Tether for the 200 year cyclonic return period  $H_{MAX} = 18.6m$   $T_p = 18.6m$ .

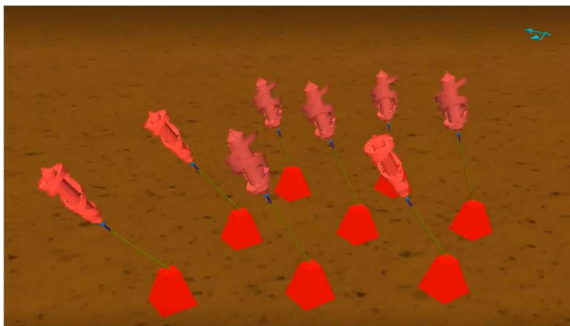


Figure 4 - OrcaFlex was used to model the reef motions in a 16.5m wave.

Orcina Orcaflex was used to conduct dynamic modelling of the Reef Flutes, again a world first. The purpose of this modelling was to determine the loading the Reef Flutes on the Reef Foundation as a result of the wave loading which was in-turn used for the structural assessment of the structures as well as to determine the required on-bottom weight for hydrodynamic stability.

### Building Wonder

The installation of the reefs was driven by the need to achieve immediate on bottom stability during the short weather windows prevalent during the construction phase. Consequently, the reefs were deployed using Foreshore Marine's St Vincent barge as single, preassembled systems.

Innovative construction methods were used to construct the Reef Foundations onboard the transport barge. 350m<sup>3</sup> of Earth Friendly Concrete supplied by Wagners was used to create the ballast in the foundations thereby significantly reducing the carbon footprint of the project.

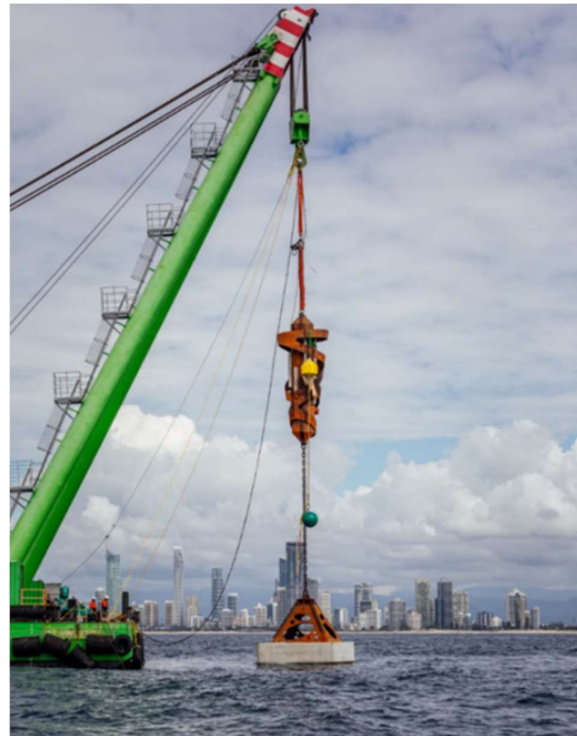


Figure 5 - St Vincent installing a reef assembly.

### Gardening Wonder

Marine scientists from Reef Ecologic and Seaworld undertook a unique coral transplantation experiment to trail and test methods and techniques for propagating corals on this unique location. The team collected approximately 150 local corals consisting of five genera of hard corals and four genera of soft corals from local harvest sites and transplanted these onto a number of the reef modules.

Over 100 species of fish have been identified in the nearly 12 months the reef was installed and a 9 month establishment period. This includes multiple sightings of the endangered Queensland grouper (*Epinephelus lanceolatus*).