# Site Investigations for Design of an Open Water Dive Attraction off the Gold Coast

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**Abstract**

The Gold Coast is a popular coastal holiday destination but beaches and surf are now not enough to remain competitive in the Australian tourist market and the destination needs new and innovative attractions. There are already high quality dive sites – natural and artificial. Studies are being undertaken to identify and investigate opportunities to become a world class dive destination by providing a focus by sinking of a suitable ship or construction of a purpose designed structure to grow the existing local recreational scuba dive industry.

A 12-month site monitoring program focusing on two potential offshore sites located in 30m water depth was undertaken by International Coastal Management and Griffith Centre for Coastal Management on behalf of the Gold Coast City Council. The objectives of the investigations were to (1) obtain site data to estimate the number of safe 'dive-able days' for the two sites based on the prevailing wind, wave conditions, currents and visibility and (2) to compare and evaluate each site for suitability as a dive site. The methodology involved surveying and mapping of the two prospective sites, including bathymetric/hydrographic surveys, benthic characteristics, in situ continuous current and turbidity measurements and identification of existing natural reefs. A range of instruments were deployed and maintained at the two sites to provide a continuous dataset for a 12 month monitoring period. This information was supplemented with coincident data of the local wind and wave environment while, turbidity measurements were transformed into a measure of diver "visibility" using novel techniques that were developed, implemented and verified.

The characteristics of the world's top-ranked 100 dive sites were analysed and compared to the characteristics of the two study sites used here. Overall, the monitoring data indicated a high proportion of safe dive-able days for both sites and therefore both sites were suitable for creation of world class dive sites. However, the high costs associated with preparation of a wreck(s) was found to be not cost-effective and would be unlikely to achieve the potential for top 100 ranking. Rather, a 20m high trial structure is now being prepared as the next stage of this process of enhancing the local dive industry with the data obtained used as the basis for innovative eco–engineering design of a larger artificial structure.

*Keywords: Gold Coast, dive attraction, turbidity, visibility, continuous monitoring*

## 1. Introduction

The aim of the project was to investigate opportunities to grow dive tourism on the Gold Coast, Australia as a contribution towards supporting sustainable tourism growth. There are a number of natural and artificial dives sites already located in this region, however no iconic dive wreck or similar exists that acts as a focus to attract visitors and encourage repeat visitation. The existing artificial dive sites (Narrowneck reef and the Gold Coast Seaway) are both the results of major engineering works that did not anticipate diving and habitat creation as major benefits.

Creation of dive sites and artificial reefs is too often a *"sink a wreck or drop a structure(s) and the fish and divers will come"* approach. This usually works but misses the opportunities to maximise the habitat value and / or dive experience.

The objective of these site investigations was to carry out a comprehensive physical survey of the conditions for two candidate sites for a 12 month period to aid estimation of the number of safe dive-able days for each of the candidate sites given the prevailing wind, wave and current environment. A secondary objective was to provide baseline data that could inform the design and approvals of the dive site infrastructure in accordance with the State and Commonwealth regulations (including the sea dumping permit process).

## 2. Investigations

The location of the two monitoring sites (labelled as "North site" and "South site") are presented in Figure 1 & Figure 2. Site monitoring of each site occurred for a period of 12 months [1,2] and included the following:

- Site-specific surveying and mapping including bathymetric / hydrographical surveys, side-scan, dive inspections to determine seabed characteristics and undertake water clarity surveying.
- Implementation, upkeep and data collection from current meters and turbidity meters deployed at the candidate dive sites.
- Assessment of prevailing wave and wind conditions using data obtained from local wave rider buoys and meteorological weather stations.
- Site inspections by divers to establish location of any existing reef structures to avoid habitat loss and impact on fishing sites.
- Estimation of 'dive-able days' over the monitoring period based on wind, wave and current conditions and expectation of achievable visibility.
- Assessment of accessibility from nearest navigable entrance.

## 3. Site information

### 3.1. North Site

The proposed location for a northern dive site was investigated first as it emerged as the preferred site based on the initial public consultation and economic feasibility studies. It is located 2.5km east of Main Beach in 30m of water and the nearest access is the Gold Coast Seaway (Figure 1).

Surveys from a single frequency echo sounder bathymetric survey and side scan sonar were undertaken to provide preliminary understanding about the local seabed for the monitoring site and to ensure that there were no obvious reef outcrops that could diminish the site's suitability as a dive site. This surveying highlighted that some small outcrops occurred within the 500m investigation zone for this site.

It was determined that their small size and low relief meant that any potential for negative environmental impact would be minimal and that dive site infrastructure could be located at this site. However, further detailed sub-bottom may be necessary depending on the final design of the dive site infrastructure.

### 3.2. South Site

The southern monitoring location was located 2.5km north east of Tugun in 30m of water and the nearest access is the Tweed River entrance (Figure 2).

The initial side scan survey identified rocky outcrops located in the area and the investigation area was relocated a short distance to a location where there were no identifiable features (i.e. rock outcrops) within the 500m investigation zone.

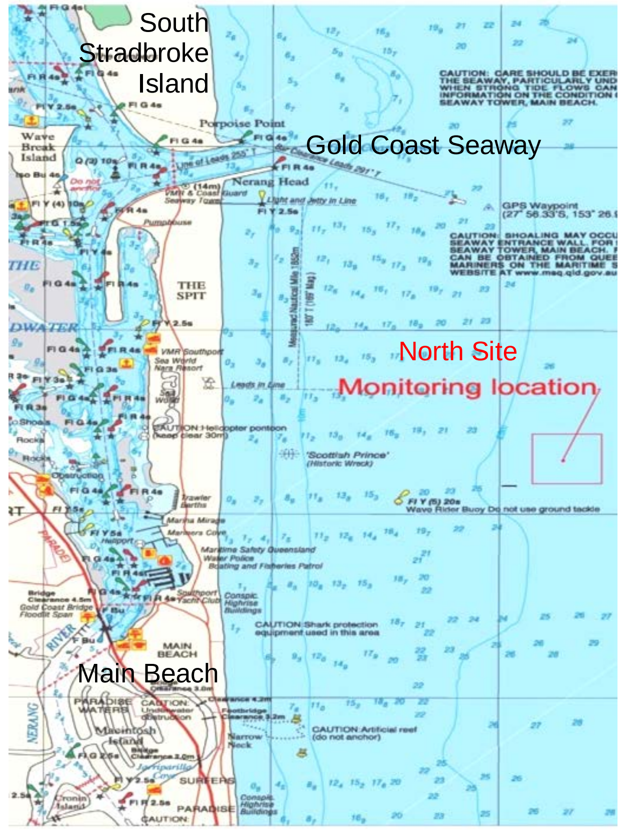


Figure 1 North Site Monitoring Location

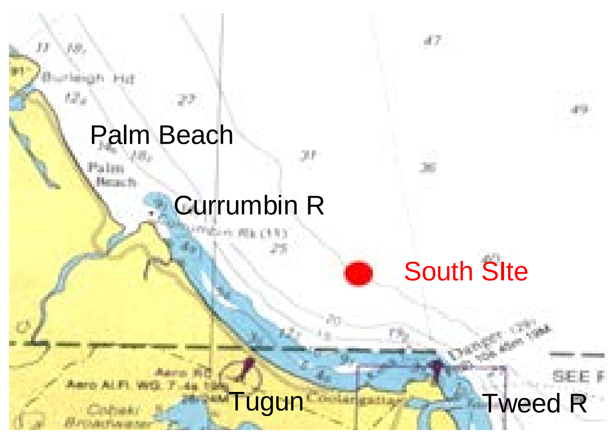


Figure 2 South Site Monitoring Location

## 4. Monitoring

### 4.1. Instrumentation

The continuous monitoring program for the two study sites took place between 2011 and 2013. The instrumentation used at each site consisted of (Figure 3):

- An ADCP to monitor ocean current strength and direction, placed approximately 1m above the seabed (Figure 4).
- An RBR Turbidity gauge located approximately 10m above the seabed and used to record turbidity levels.
- A thermister string to record the temperature profile throughout the water column.

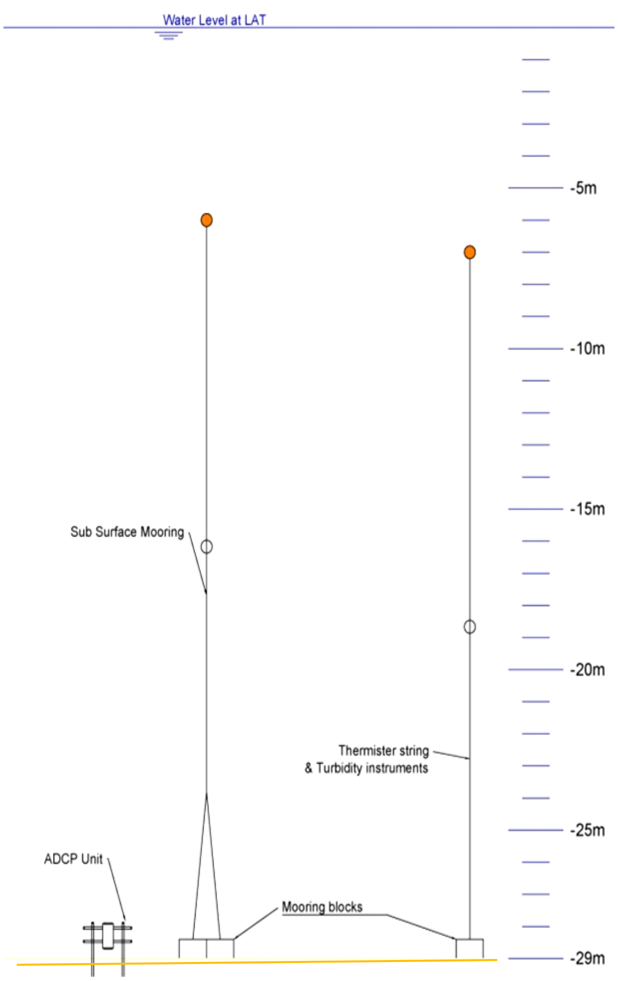


Figure 3 Cross section of installed instruments

Figure 4 Photo of ADCP [Source: Ian Banks]

### 4.2. Waves

Wave data was obtained from the Department of Environment and Heritage Protection (EHP) wave rider buoys located at the Seaway (north site) and the Tweed River (south site) (Figure 5). Wave records were also measured at the two study sites using ADCPs. These values were compared against the wave rider buoy data as a validation step for the wave rider buoys. The wave rider records were consistent with those recorded by the ADCPs for both sites and therefore were assumed to be representative of the local wave conditions.

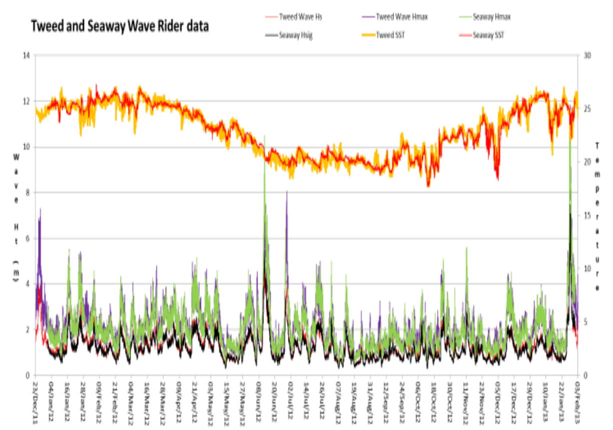


Figure 4 Recorded wave data for the Gold Coast Seaway and Tweed wave rider buoy.

### 4.3. Wind

Wind data was obtained from the Bureau of Meteorology (BOM) weather stations located at the Gold Coast Seaway (north site) and Coolangatta (south site) (Figure 4).

Wind data from the Gold Coast Seaway indicated that during 33% of the days over the monitoring period there was least one wind speed measurement that exceeded the 20 knot threshold. It was noted, however, that only 7% of all the wind speed measurements were greater than the designated 20 knot threshold (i.e. for many days wind exceedances were limited to a small number of isolated peaks during the day).

For the wind data measured at the Coolangatta meteorological station, there were few exceedances in wind speed and this was attributed to natural landforms affecting the recording of stronger southerly conditions (Figure 4). As a result, the Gold Coast Seaway wind data was utilized for both sites.

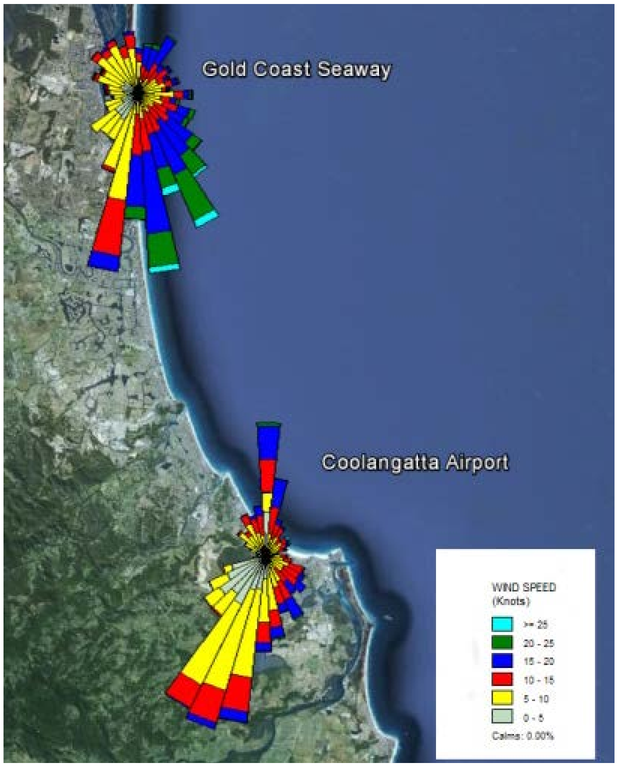


Figure 5 Wind direction and speed for the Seaway and Coolangatta monitoring stations

## 4.4. Site Accessibility

This data was compared with threshold values (limiting factors) to determine the accessibility of each of the two sites. Although these thresholds are likely to be vessel and operator specific, nominal thresholds of maximum wave height ($H_{MAX}$) of 2m and wind speed of 20 knots were selected. These values were based on the threshold that operators of the Ex-HMAS Brisbane and Ex-HMAS Adelaide provided about limiting conditions for their operations.

## 5. Site monitoring

### 5.1. Visibility – Secchi Disk readings

To correlate the continuous data from the turbidity instruments with diver visibility, a key parameter for safety and quality of a dive, manual Secchi disk measurements were taken regularly during each site visit (approximately monthly intervals). The Secchi disk readings were taken horizontally at five metre intervals throughout the water column. Figure 6 shows that the visibility measurement being taken by divers with the results presented in Figure 7 (North Site) and Figure 8 (South Site).


Figure 6 Visibility Measurement using Secchi disk with diver and Secchi disk just visible.

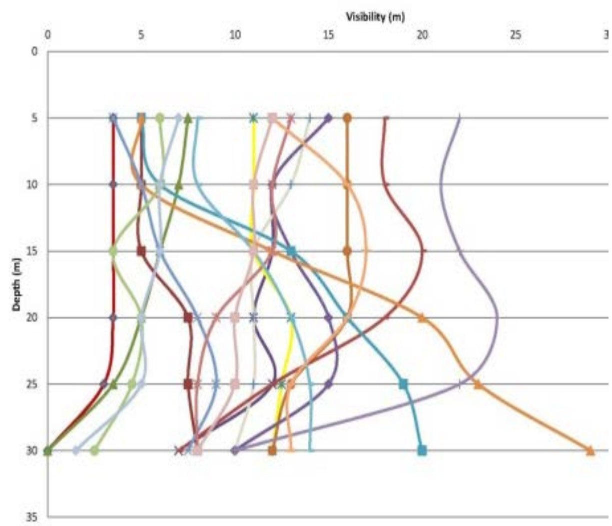


Figure 7 Secchi Disk Measurements North Site

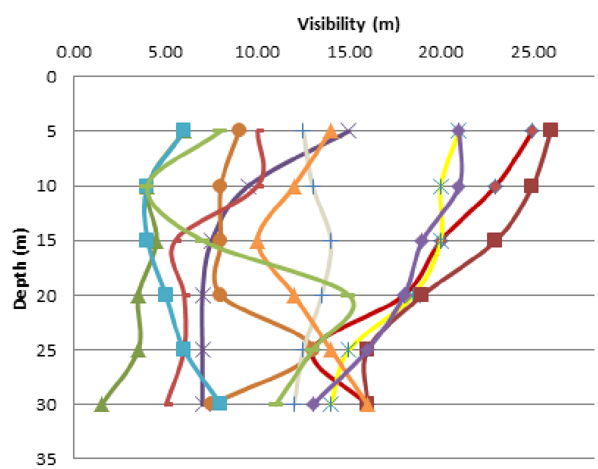


Figure 8 Secchi Disk Measurements South Site

### 5.2. Turbidity and Visibility Correlations

The Secchi disk data collected by the divers as part of this study was compared against the turbidity readings to derive a site-specific relationship between these parameters. This data was supplemented by data obtained from existing (and local) monitoring programs such as the environmental health monitoring program (EHMP).

Regression analysis has been used to establish a functional relationship between Secchi depths and turbidity (Figure 9) that can be used to inform the researchers about the visibility of the study sites (Figure 10 and Figure 11) in the context of dive-ability. Note that the data gap (February-March 2012) for the north site (Figure 10) was a result of monitoring equipment failure (i.e. turbidity measurements were not available for this period).

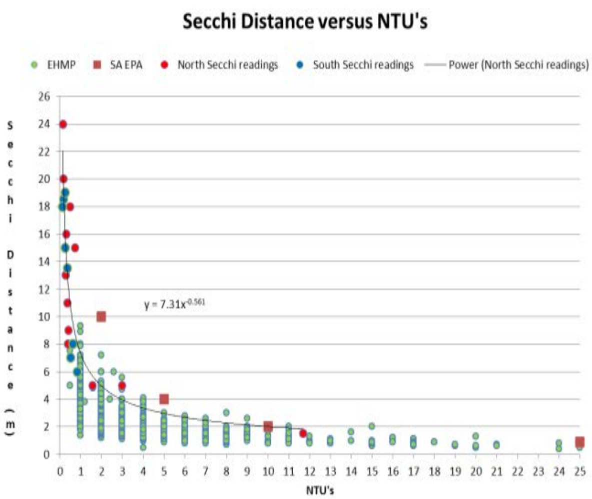


Figure 9 Conversion of NTU to Secchi depth (visibility)

### 5.3. Visibility

A 2 metre safety threshold was specified for visibility based on discussions with the dive industry. This threshold was then used as the basis for evaluating the conditions experienced on the site in regards to diver safety.

Throughout the monitoring period the day-averaged visibility (as indicated by the red lines in Figure 10 and Figure 11) did not drop below the 2m threshold for either site. Also, the absolute minimum visibility experienced only drops below 2m a few times during the monitoring period. Conversely, the visibility for both sites exceeded 10m more than 60% of the time. These results indicate that visibility is unlikely to be a limiting condition for either site.

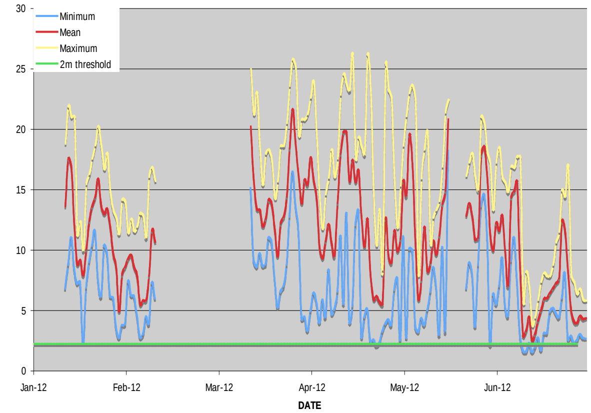


Figure 10 Visibility Data (north site)

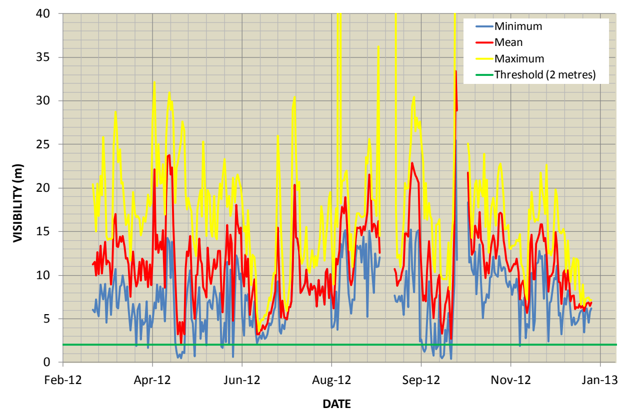


Figure 11 Visibility data (south site)

### 5.4. Ocean Currents

The potential effects of ocean currents on dive site safety were evaluated using the ADCP velocity data. Current profiles were summarised by eliciting the minimum, maximum and average currents experienced throughout the water column (Figure 12 and Figure 13). A nominal limiting threshold of 0.5m/s (or 1 knot) was selected to determine when it would be safe to dive.

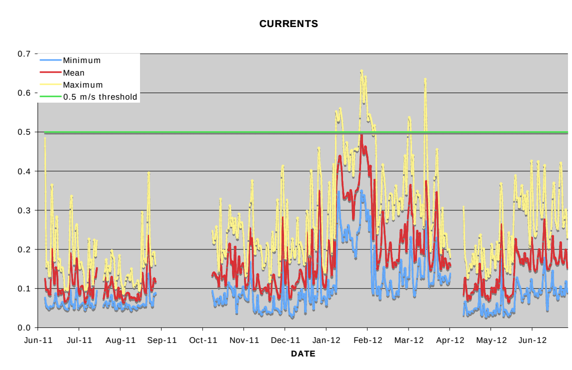


Figure 12 Water current measured by the ADCP - (north site)

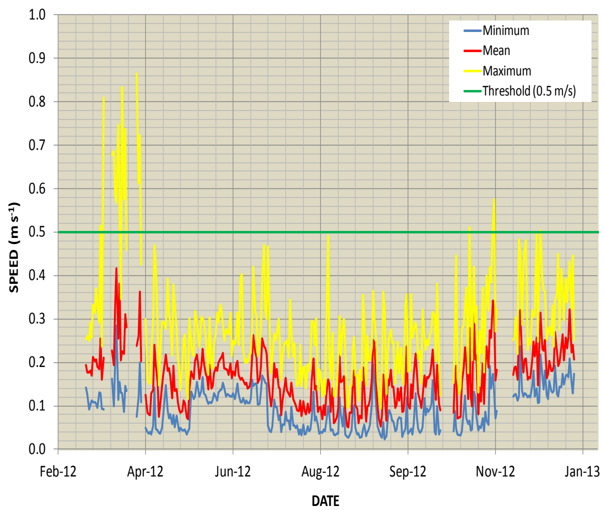


Figure 13 Water current measured by the ADCP - (south site)

During the monitoring period the maximum current throughout the water column only exceeded 0.5m/s for 5-6% of the time, which equates to around 18 - 22 days per year.

### 5.5. Marine ecology

As well as physical features, observations of the marine ecology was observed, photographed and evaluated by a commercial diver on the team, Ian Banks. From the photos and dive observations, the site has the potential to attract a diverse number of interesting pelagic and benthic species, including turtles and dolphins.

## 6. Summary

Based on the observations of the dive team and an assessment of the results of the continuous monitoring program, the two candidate dive sites that were investigated appear suitable for this purpose. If designed correctly, this would create a safe dive site with a diverse and sustainable marine habitat and provide a world class dive.

The consideration of all the factors and limiting thresholds indicates that:

- Around 55% of the year the site will experience days where there is no exceedance of any of the thresholds, which equates to around 195 diveable days per year.
- Waves are the key factor in accessibility and dive-ability of this site. This indicates that vessels, such as catamarans, with good stability will provide significantly higher diveable days per year.

## 7. Dive Sites Research

International Coastal Management have carried out R&D on the creation of fish habitats and dive sites to enable such sites to be designed to achieve specific project objectives. The top 100 dive sites in the world have been analysed as part of the R&D to determine what makes a top dive site. The attributes of the top 100 sites are:

- Dense marine life – 90%
- Interesting features and / or bathymetry
- Temperature, visibility & Currents important but not critical
- Only 13% were wrecks – wrecks needed to be more than just a sunken ship and need to have the other attributes such as interesting cargos and dense marine life.

## 8. Next Stages

To assist in the environmental impact statement (EIS) and to optimise the design to facilitate the rapid development of a complex habitat to achieve dense and diverse marine life, a monitoring frame is to be installed on the north site. The monitoring frame will evaluate a range of shapes and substrates at different depths.

The results from the monitoring structure will enable the eco-engineering of a world class purpose built dive attraction for the Gold Coast.

## 9. Acknowledgments

The investigation team acknowledges and appreciates funding provided by the Gold Coast City Council that enabled this project to be undertaken. We would also like to thank the generous assistance offered by Dr. Daijiro Kobashi in his interpretation of the inshore coastal oceanography, Mr. Ian Banks for his excellent photography and diving advice and the Queensland Museum for assistance in identifying various organisms found on site.

## 10. References

[1] Restall, J. Corbett B. Tomlinson, R Jackson, A. (2012) 12 months Site Monitoring of Preferred Dive Site for a Gold Coast Dive Attraction. Report prepared for Gold Coast City Council by International Coastal Management and Griffith Centre for Coastal Management.

[2] Restall, J. Hughes, L. Richards, R. Kobashi, D. Corbett B. Tomlinson, R Jackson, A. (2013) 12 month site monitoring of alternative site for a Gold Coast dive attraction – Tugun / Currumbin. Report prepared for Gold Coast City Council by International Coastal Management and Griffith Centre for Coastal Management.