Marine Consulting and Research
P.O. Box 320599, Cocoa Beach, Florida 32932, USA
Ph. +1 321 613-2528, jhearin@asr-america.com
www.asr-america.com

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ASR America Response to the Brevard County Multi-Purpose Artificial Surfing Reef Feasibility Study: Final Report - Draft

We have addressed specific items within the report in the order in which they appear except when logic dictated otherwise. A complete list of all references cited may be found at the end of this report.

Executive Summary:

> *"-Mixed performance has been realized relative to enhanced surfing and erosion control.*
> *-- There remains uncertainty as the predictability of ASRs to enhance surfing or significantly improve the stability of adjacent beaches."*

This statement is not supported by the body of the report, appendices, or existing international peer-reviewed literature.

- This implies that the 4 ASR's were designed for coastal protection and surfing, which is not the case and is clearly shown in table 2.1. Only 1 ASR, the Narrowneck Reef, has been designed to protect the coast (the only MPASR in existence), coastal protection is not relevant in the other 3 cases.
- Since Narrowneck Reef is the only ASR designed for coastal protection, how can there be any interpretation of "Mixed performance with respect to coastal protection of the ASR in terms of coastal protection, and uncertainty as the predictability of ASR's to significantly improve the stability of adjacent beaches", this interpretation is deliberately misleading.
- There are several peer-reviewed publications and technical reports available for the beach monitoring of the Narrowneck reef that clearly demonstrate the success of the beach protection, how the reef acts as a 'control point' for that coastline and how the monitoring closely matches the detailed numerical and physical modeling for the design.
- For example, Turner (2004) describes the independent analysis of the first 2 years of monitoring data (which is prior to the completion of construction, which began in August 1999 and was completed 5 years later (annual container placements were undertaken), which clearly shows the coastal protection aspects of the structure, even in it's unfinished form. In addition, this report describes the enhanced surfing conditions. (see below)
- The Water Research Laboratory at the University of New South Wales has performed constant monitoring of the Gold Coast beaches since 1999. They publish semi-annual reports which are available online at www.wrl.unsw.edu.au/coastalimaging/public/goldcst. The latest report, dated April 2008, has been attached to our report for your convenience.
- Turner (2004), Ranagsinghe (2006) and Jackson (2007), have all presented papers on the successful coastal protection of the Narrowneck reef, as is repeated in the Appendix C of the feasibility report. The size of the salient being very similar to that predicted by the numerical modelling (Black, 1998c) and physical modelling (Turner et al, 2001) (i.e. 70 m).Pattiaratchi (2007) and Jackson (2007) both presented peer-reviewed papers on the success of surfing at Narrowneck and Cables Reef.

- The Mount Maunganui Reef was unfinished at the time of initial writing but is now complete and has provided some good surf which is evident from postings on New Zealand surfing web sites such as www.mountreef.co.nz , www.caughtonradar.com, www.surf2surf.com.

In summary, three of the four reefs reviewed have succeeded in performing their primary function.

Only Pratte's Reef has failed to perform its primary function, which is documented in the literature as being due to its very small size which was inadequate for performance as a MPASR .

CTC's finding is incorrect and not supported by any data, analysis, technical reports or peer-reviewed publications, and is either deliberately misleading or indicates a lack of understanding on CTC's part.

Turner, I.L., 2004. **Analysis of Shoreline Change: February 2004 to July 2004. Report 10: Northern Gold Coast Coastal Imaging System**. WRL Technical Report 2004/07, Water Research Laboratory, University of New South Wales.

"North of the reef construction site, the beach in the vicinity of Narrowneck can be seen to have widened by 20 – 25 m through the latter part of 1999, stabilised in the first months of 2000, and then evolved to a generally erosional state from April to August 2000. Accretion then occurred up to December 2000, followed by modest erosion again in January 2001. The net result by this time had been an increase in beach width of the order of 40 – 50 m. The beach then eroded though the first half of 2001, resulting in a net gain in beach width since the start of monitoring period of approximately 10 – 20 m. During the six month period August 2001 to January 2002 the beach recovered fully, regaining some 30 – 40 m beach width, of which some 20 – 30 m was removed again during February 2002 – July 2002. From August 2002 the beach again recovered some 40 – 50 m, then receded again during the period February 2003 to July 2003, followed again by a general trend of beach recovery during August 2003 to January 2004. During the present monitoring period February 2004 to July 2004, a distinct erosion trend was measured, followed by recovery to the conditions that prevailed at the end of January 2004.

By the end of the present six month monitoring period the beach immediately north of the reef Narrowneck was typically of the order 20 m wider than at the commencement of monitoring in 1999. It should be noted that extensive sand nourishment had commenced in this area prior to the commencement of monitoring (refer Section 2.3), so the actual increase in beach width since implementation of the NGBPS is likely to be somewhat greater than this figure. At the centre of the reef construction site and the two transects to the south (all located in deposition area A3), beach widening of 50 – 60 m was observed through to early 2000 in response to ongoing nourishment during this time. At the centre of the reef construction site and 150 m south, this was followed by a period of erosion through to March then accretion to May, after which time a general accretionary trend persisted. At the transect 300 m south the beach continued to increase in width at a generally steady rate through 2000. Again, the net result had been an increase in beach width of the order of 50 – 60 m. Storms in March, April and July 2001 resulted in recession of the shoreline, with the beach in mid 2001 approximately 30 m wider than at the commencement of the monitoring program.

Through August 2001 to January 2002 the beach in the lee of the reef and to the south recovered to the conditions of January 2001. During the period February 2002 to July 2002 the beach width decreased by 20 – 30 m, then recovered through to the end of 2002 and continue to accrete some 30 – 40 m, mirroring the shoreline erosion–accretion changes observed north of the reef. Through to July 2003 recession again occurred, followed by accretion to January 2004. As was observed to the north of the reef, a period of erosion followed by recovery was measured from February 2004 to July 2004.

By the end of the present monitoring period the beach to the south (up-drift) of the reef was of the order of 40+ m wider than at the commencement of monitoring. In the lee of the reef, an additional 30 m had been maintained.

Wave breaking on the reef at Narrowneck is commonly visible in images obtained by the coastal imaging system (photo 8). In previous monitoring reports completed during the initial construction phase of the reef, the progressive increase in the occurrence of wave breaking was documented and quantified as additional geocontainers were added. Further geocontainers were placed on the reef crest in late 2001 and again in November 2002.2). Since that time it has been observed that waves break across the reef structure once the incident significant wave height exceeds around 1 m. It is concluded that the reef continues to achieve the objective of enhancing potential surfing opportunities at Narrowneck."

Executive Summary:

With respect to these 'uncertainties' of coastal protection and shoreline response, CTC is implying that submerged breakwaters don't work to protect the coast and are a 'novel' invention. On the contrary, they have been around for decades and are being used more and more these days because they are an environmentally-sensitive and sustainable solution, and because it is being realized that sources of sand for renourishment are not infinite and additional means are required to retain the sand.

For example, "Environmentally Friendly Coastal Protection: Proceedings of the NATO Advanced Research Workshop on Environmentally Friendly Coastal Protection Structures Varna, Bulgaria 25–27 May 2004" includes the descriptions of the application of a variety of reef structures:

- Performance of Submerged Breakwaters as Environmental Friendly Coastal Structures. Sevket Cokgor and M. Sedat Kapdasli
- Low-Crested Structures: Boussinesq Modeling of Waves Propagation P. Prinos, I. Avgeris and Th. Karambas
- Interaction of Waves and Reef Breakwaters. Valeri Penchev
- Flow Measurements and Numerical Simulation on Low-Crested Structures for Coastal Protection. Pedro Lomonaco, Cesar Vidal, Iñigo Losada, Nicolas Garcia and Javier Lara
- Performance of Submerged Breakwaters as Environmental Friendly Coastal Structures. Sevket Cokgor and M. Sedat Kapdasli

There are numerous texts and technical papers on the design and function of submerged breakwaters (e.g. Pilarzyck, 2003 ; Pilarzyck and Zeilder, 1996). Again, this 'finding' is incorrect and not supported by any data, analysis, technical reports or peer-reviewed publications, and is either deliberately misleading or indicates a lack of understanding on CTC's part.

Executive Summary:

> *"The ASR will produce rip currents during large wave events that pose a risk to swimmers and surfers."*

Large wave events produce rip currents all along the coast of Brevard County. This statement is misleading in that it suggests that the ASR would be the cause of the rip currents. Most surfers will utilize rip currents to help them get out into the line up during large wave events. The risk is primarily to swimmers unfamiliar with ocean waves. Jackson et al, (2005) relate that the Gold Coast life-guards recorded 60% *less* rescues at the Narrowneck surfing reef that on other parts of the coast, despite its popularity.

> *To reasonably provide for public safety, it is expected that the County will need to:*
> *_ Provide a year-round lifeguard and tower at an estimated cost of approximately $75,000/year.*
> *_ Adopt regulations regarding vessel use on and around the ASR.*

The County recently authorized a significant expansion of the lifeguard stations for the beaches of Brevard County, including sites adjacent to the proposed reef site. This action was totally independent of the proposed reef. The proposed reef site may be moved based on the results of this report and further design studies. It is not evident at this point that an additional life guard station would be required specifically for the reef.

Executive Summary:

A "sand bag" ASR, as recommended by ASR America, is identified as the preferred material at a probable construction cost of $5.7M.

A geotextile sand filled mega-container is not the same as a "sand bag". This statement may give readers the wrong impression.

To serve as hardbottom mitigation in Brevard County, an ASR would need to be comprised of limestone boulders or limestone embedded in concrete.

This statement above is not supported by the environmental assessment prepared by CSA in Section 7 of this feasibility study:

7.2.5.3. Mitigation Potential
Because Geotextile containers filled with sand will support algae and fishes they may be suitable in part as mitigation for hard bottom impacts. As mentioned in Section 7.2.2.3 for limestone boulders, these structures could be incorporated into UMAM calculations to garner credit for some portion of the mitigation acreage.

Executive Summary:

For the purposes of this study:
_ It is conservatively assumed that no maintenance or associated costs will be required over the potential 25-year life of the structure.
_ Probable total costs for the ASR are based upon multiple conservative assumptions that likely underestimate the true cost.

As we stated in our report (Appendix C2), the potential life of the structure is 40+ years based on estimates from the manufacturer for use in locations protected from ultra-violet radiation (under water and covered with marine growth). We will address these comments further in the body of the report.

Based upon the current criteria for potential State and Federal funding towards an ASR as assessed in this study:
_ Total annual benefits are estimated at up to $209,284 per year.
_ Total annual costs are conservatively estimated to be at least $462,954 per year.
_ An ASR is determined to have a benefit-cost ratio of 0.45.
_ An ASR is not economically justified in Brevard County and would not be expected to qualify for State or federal funds.

These figures are a total misrepresentation of the data and based on flawed assumptions – indeed, the benefit-cost analysis presented by CTC is the most restrictive that any of our consultants have ever reviewed. We will address each of these estimates in the body of the report.

Section 1.2 Scope:

Our Conceptual Design Report, submitted for Task 2b in March 2008, is not included in the appendices. We have attached a copy for your reference.

Section 2.1 Literature Review:

> *The Cables ASR provided no appreciable accretion along the shoreline nor was it intended to do so.*

Why is this statement included but not a statement regarding its success at providing a surf break?

The Mount Maunganui Reef is now complete. We would like to update our literature review (Appendix C) to reflect this.

Section 2.1 Literature Review:

> *At Cables, as described by Dr. Pattiaratchi, the ASR "…raised the number of "surfing days" from 20 to greater than 150 days per year." On the other hand, Geoff Trigg, Manager of Engineering Services for the Town of Cottlesloe, stated "No significant surf improvements are obvious". No economic analysis was conducted in association with the construction of the Cables ASR.*

Why is the unsubstantiated opinion of a town employee given equal weight with a peer-reviewed technical report which monitored surf on the Cables reef using verifiable scientific data (Pattiaratchi, 2007)?

> *John McGrath of the Gold Coast City Council, Australia, also stated "…the (surfing) improvements were well short of the expectation of our local surfing community."*

This quote is taken out of context and actually refers to the unrealistic expectations created by the media prior to reef construction (Jackson et al. ,2007). There are abundant peer-reviewed publications, statements, photographs and video evidence of surfing on the Gold Coast reef.

> *Per Stephen Town, Chief Executive of the Tauranga City Council:*
> *o "It was fully understood from the beginning that the reef design was experimental in nature - Council accepted this risk being the first design of its type in New Zealand.*
> *o There is speculation that the performance of the reef will not meet the predicted performance stated in the design."*

This is pure speculation on Mt Town's part. There is no data, analysis or peer-reviewed publications to substantiate his claims, on the contrary, wave breaking on the reef is as designed and there was nothing experimental about it.

Here is the latest press release from the client, The Mount Reef Trust:

Trust Press Release 26 June 2008

Repairs to the Mount Reef finally in place

The insurance work to replace a large container that was removed from the Mt Reef more than a year ago and further containers to replace unfilled containers on the front of the reef is done and it's ready to be surfed.

First swells have drawn many positive comments and locals are starting to see the benefits of the reef after long delays.

"We completed the insurance work and repairs recently", said Colin Baskin Chairman of the Mt Reef Trust. "and we are very happy to completed these major works to bring the reef closer to the original design and completion".

"Congratulations to all participants throughout this project. The donors need to be thanked for standing by the Trust throughout this long period and all the people of Tauranga and New Zealand who wished us well.", he said.

The outstanding insurance work on the artificial surfing reef at Tay Street went ahead without a hitch 2 weeks ago, with the added bonus of 2 new 'focus' containers to make a definite place to take-off on the waves. ASR Ltd undertook the construction with the assistance of the Port of Tauranga.

This is a great news for the Mount Reef after the protracted construction process has left many local residents and stakeholders with a pessimistic "believe it when I see it" attitude.

In November 2006, one of the massive sand-filled geotextile containers (geobags) that make up the mount reef was split during construction leaving a 60 m long by 5 m wide gap on the right-hand breaking side of the reef. Fortunately its replacement was covered by the reefs insurance policy, however, it wasn't possible to complete the job for over a year. The reef designers, Raglan-based company ASR Ltd, had previously stated that completing these works should improve the quality of the surfing waves by defining the take-off and making the reef more useable in mediocre conditions.

Local surfing "personality" Josh Guinness was quoted a few weeks ago after ASR's announcement saying he was still waiting for the first class waves promised at the start of the project. Four days of work on the reef has just been completed and the contractors say it will all come good. Mr Guinness responded: "We've heard the same thing over and over. I don't mind eating humble pie if it does work." The initial results during a couple of 'sub par' swells in the past week indicate that the Mount Reef is breaking well as promised. After the recent swell Josh Guinness was asked about his thoughts on the progress and responded saying; "After ASR recently completed construction of the reef there were good rights and lefts breaking on it the very next swell. I am pretty happy with the results which is a lot for me to say because I have been skeptic of its ability to live up to expectations after all the problems with the construction. I am still going to keep an eye on it but I am stoked about what I've seen since ASR finished the work a few weeks ago."

"We're pretty excited to know the reef has been worked on again, it's been a long haul and sometimes difficult, especially with respect to funding" said Colin Baskin, Chairman of the Mount Reef Trust. "Late last year a further $45K was received for stabilization of the

containers that had lost sand. It was stipulated that ASR (the reefs designers) must manage this work, rather than a construction contractor as was previously the case to try and avoid further problems. ASR agreed to do it for no charge, providing their own diving and pumping gear for free, and also pledged further funds to buy additional containers to improve the offshore focus of the reef that was left too deep to work properly after sand was lost from the existing containers. Along with the huge support that they have provided since the project started, including all the monitoring work they have undertaken at no charge, we are very grateful for all of ASR's assistance."

The Mount Reef is not a surf break for the faint of heart and it was never designed to be. The reef was designed to be a very fast and steep wave, similar to a reef break that you would find only the most experienced surfers enjoying when the conditions are right. On a couple of swells during the construction period in 2006 some local surfers got what they said were "Indonesian" like barrels and were surprised with the amount of power that the reef created at their often weak beach break. This elation was only temporary as the removal of the damaged container on the right hand break and loss of roughly 20% of the reefs overall volume through unsecured filling ports was very disappointing to both the Trust and the community. Surfers who had started to check the reef regularly and had seen its potential even though construction wasn't yet complete were understandably upset. The protracted construction timeline, lack of funding, contractor issues, and construction errors all contributed to leaving the community feeling as though they had been oversold and under delivered.

There has been a tremendous amount of speculation surrounding the reasons behind the reefs shortcomings to date and ASR have received much of the negative feedback even though they have had very little to do with the actual source of the problems.]"We have received a lot of flack about the Mount Reef" said Dr. Shaw Mead of ASR. "It is amazing how much misinformation is out there about what has transpired. We are regularly having to educate people about the realities of the situation. Some of the biggest misconceptions are that ASR has made a lot of money on the Mount Reef
project and doesn't really care that it isn't finished. I can assure you that this is about as far from the truth as you can possibly get".

ASR certainly has not gotten rich on this project, having been paid less than 10% of the Mount Reef's $1.5M budget over an almost 10 year period, and in the past few years have provided over $150,000 of further work monitoring and technical assistance, at no cost. ASR has done majority of its work at or below cost to try and help this grass roots, community-based project achieve success. "We believe in our designs, and we believe in the Mount Reef Project despite all the problems with construction. As a New Zealand based company we take pride in the fact that a local community has supported our concepts and we are fully committed to doing everything within our power to give back to the community that has believed in the project. This is why we have done a great deal of work for free, and have taken the responsibility of getting the reef completed after the original contractor pulled out without finishing" said Mead. "While we've finished everything that can be done on the reef at present, there are still some of the bags on the left were buried before filling and we will continue to monitor the reef to see if any further improvement can be made", he said.

"People need to understand that this project was undertaken with a very small budget initially and with construction problems things have been very difficult. The overall volume and size of the reef compared to natural breaks has been a real challenge from the design perspective. That is why we designed the reef to be like a heavy slab type reef break so we could maximize the impact of the reef with respect to wave quality and intensity while working with a very small budget" said Dr. Jose Borrero, another member of ASR's design team. "The reef has produced some very heavy waves. So much so that in some cases surfers have claimed that the wave is too heavy for surfing and is better suited for body boarding, but the best surfers are getting good rides."

It's great to finally have the reef so much closer to completion and be able to see the results almost immediately. We are looking forward to surf season at the Mount so everyone that has supported the project for so long can really enjoy it. The Mount Reef Trust would like to thank everyone for their support and patience throughout this project.

Section 3.2 Longshore Sediment Transport and Erosion:

Detailed assessment of the effects of an ASR upon sediment processes is beyond the scope of this study. In consideration of longshore transport and erosion to identify candidate ASR sites, it is assumed that:

- *Eroding beach segments with maximum volumetric and shoreline change rates – commonly referred to as "hot-spots" – are coincident with the maximum gradients in longshore sediment transport.*
- *An ASR is expected to reduce longshore transport in the lee of the structure.*
- *At a location with a maximum change rate and with a decreasing change rate in the downdrift direction – for both shoreline and volumetric change - an ASR might be constructed to "smooth out" the gradient without a significant increase in downdrift erosion.*

and Section 8.4:

No adverse impacts to adjacent beaches will occur due to expected sand trapped by the ASR; this assumption is inconsistent with basic coastal engineering principles associated with "conservation of mass".

These assumptions, made by CTC, on the longshore sediment transport in the lee of offshore submerged structures are not accurate and are not supported by peer reviewed literature. An explanation by Dr. Shaw Mead follows:

Offshore submerged structures do not cause erosion of the adjacent beach for a number of reasons, as demonstrated by the thousands of natural and man-made offshore submerged structures on the coasts around the world. A relatively brief investigation into the principles and mechanisms that form salients (rather than tombolos, which can cause down coast erosion) and the results of the many applications of submerged breakwaters worldwide demonstrates this. It is assumed that the reference to inconsistency with the basic coastal engineering principles with "conservation of mass" is referring to the mass of sediment, rather than the conservation of mass of hydrodynamics where this principle is usually applied. In terms of hydrodynamics, one of the world's leading experts in submerged structures and geotextiles for coastal protection, Krystian W. Pilarczyk (1996, 2003) , describes this well ," the purpose of offshore submerged structures is to reduce the hydraulic loading to a required level that maintains the dynamic equilibrium of the shoreline (i.e. develops a dynamically stable salient in the lee of the structure). To attain this goal, the structures are designed to allow the transmission of a certain amount of wave energy over the structure by wave breaking and energy dissipation on shallow crest (submerged structures)".

In terms of “conservation of mass” of sediment volumes along the beach, the reason is very simple - the structures are offshore and underwater providing a gap between the structure and the dry beach for sediment transport to occur, i.e. sand can move back and forth past the offshore structure in the nearshore zone - because of this, the sand that forms the salient comes from the whole beach system, not from the adjacent beach and nor does it 'starve' the adjacent beach like say a groyne or a tombolo. Once the salient forms to its dynamic equilibrium shape (if a structure is built, then the salient should be 'placed' on the beach in the form of nourish material), the principles of conservation of mass ensure that sand continues to move up and down the coast between the structure and the beach - the offshore submerged reef is a control point that widens the beach in its lee, the salient does not keep building forever, starving the beach of sand in adjacent areas. Groynes and tombolos (natural or man-made) stop the flow of sand along the beach and cause adjacent erosion (which is why groyne fields of tapered groynes (a series of shorter and shorter groynes downstream of the principle groyne) are needed - e.g. (Basco and Pope, 2004)).

Offshore submerged structures do not block the movement of sand up the coast. Monitoring of the Gold Coast reef supports this, i.e. monitoring of downcoast beach profiles indicates no downstream erosion of the Gold Coast Beach as shown in Figure 1 (WRL, 2008). This picture was annotated by John McGrath, a GCCC coastal engineer. The salient is formed by several principles, including wave dissipation (e.g. Pilarczyk and Zeidler, 1996; Black and Andrew, 2001), wave rotation (e.g. Black and Mead, 1999; Pilarczyk, 2003) and modification of circulation patterns (e.g. Black 2003; Ranasinghe and Turner, 2006). The combination of these processes 'modifies' the beach, but does not interrupt the sediment supply, not only during average conditions, but also during a storm. A groyne will lead to accelerated erosion during a storm period, an offshore submerged reef will not, the sand in the salient acts as a buffer and moves offshore to help protect the coast (and moves back on in calm conditions) and the structure does not block alongshore movement. Figure 2 shows a picture of the Gold Coast reef salient after a 6 m significant wave height storm event in 2003.

Dr Shaw Mead
Director
ASR America

Figure 1 - Annotated Photo of Narrowneck Salient

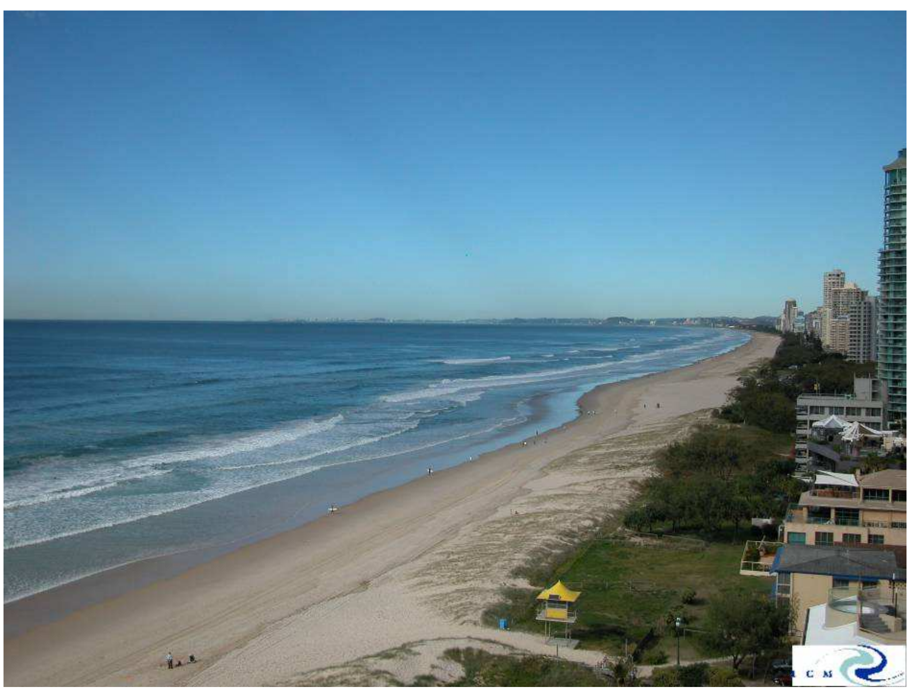


Figure 2- Narrowneck Salient after 6 meter significant wave height storm (2003)

SES also contradicts CTC's assumptions in Section 5.7 of the feasibility study:

> *"Regardless of the actual net longshore transport rate, because of the small size of the ASR and its submerged design, the ASR will have little long-term impact on the longshore transport rate. In the short term, the sheltering effect of the structure will cause a salient to form, with sand being supplied to it from transport from either direction. However, as the salient reaches maturity and the fronting beach steepens, the natural longshore transport rate is re-established. It is also important to understand that the salient will never reach a true equilibrium, because the wave climate continually changes. The salient will grow during quiescent times, and then be obliterated during severe storms."*

<u>Section 4.1 Conceptual Design:</u>

> *John Hearin, of ASR America, previously developed a conceptual design for Brevard County to yield erosion control and recreational benefits; this configuration is herein proposed for the purposes of this study.*

ASR America developed a completely new conceptual reef design for this feasibility study. The design primarily focused on the coastal protection benefits of the reef, for example, an asymmetric reef is used in the present design. The reef will require significant assessment during the detailed design phase, using both numerical and physical modeling, to optimize the surfing characteristics of the reef.

<u>Section 4.2 Evaluation of Surfing Skill:</u>

> *For Brevard County, wave heights are predominantly less than 2 meters (_6'). At a wave height of about 2 meters, according to Figure 4.1 or Figure 4.2, the peel angle on an ASR might be varied to achieve a desirable target skill to yield appeal for (a) surf contests that might be lured to the ASR, or (b) experienced or expert surfers, who would most likely be willing to paddle the distance offshore (300+m) necessary to reach the ASR.*

The reef position was set at 300m offshore to maximize the coastal protection benefits of the reef as prescribed by the County in our initial meetings. Should the County choose to emphasize the surfing enhancement and economic benefits of the reef, the design would be modified to reflect that primary function.

<u>Section 4.3 Shoreline Response:</u>

> *Note that there is no known documented data surrounding the determination of salient size and volume in the lee of an ASR. As cited by Ranasinghe et al (2006):*
> *_ "Not only is there insufficient published information available on shoreline response to multi-functional ASRs, relatively little is known about shoreline response to submerged structures in general."*

CTC's assertion is completely wrong and a misrepresentation of Ranasinghe's paper. Please refer to page 3 of this response for documentation regarding the salient formation at Narrowneck and our description of shoreline response to MPASR in Appendix C of the feasibility study. Also refer to "Sand Bank Responses to a Multi-Purpose Reef on an Exposed Sandy Coast", published in the Fall 2007 issue of Shore & Beach, for a detailed assessment of salient formation behind the Mount Maunganui Reef and comparisons to empirical and numerical predictions (Black and Mead, 2007).

Section 4.6 ASR Configuration:

With a crest elevation of -2.7' NGVD, the configuration presented herein is expected to predominantly produce waves suitable for a beginner to intermediate "surfing skill level" - as identified in Figure 4.1.

As stated in Section 4.2, Figure 4.1 is outdated and has been superseded by Figure 4.2. Figure 4.2 should be utilized to determine the surfing skill level (beginner to expert).

Section 5.0 Wave Analysis:

ASRA's conceptual reef design is a preliminary design which focused on the coastal protection benefits of the proposed reef. The major reef parameters, size, volume, elevation, location and shape were established to provide a basis for preliminary evaluation of the reef's ability to provide wave sheltering and wave rotation, two key aspects of coastal protection, as well as some rough gage of surfing enhancement. This preliminary reef design has not been optimized for surfing enhancement as that process requires numerical and physical modeling well beyond the scope of this feasibility study. Attempts by SES to critically evaluate the surfability of this design are premature. The final reef design will be refined to maximize the surfing enhancement for the local wave climate during the detailed design phase of this project.

Section 5.3 Wave Breaking and Surf Enhancement:

ASRA performed a significant amount of numerical analysis with regard to wave breaking and surfing enhancement for this feasibility study (Appendix C3). None of our results were referenced in the body of the report.

As identified in the SES Report (2008), Appendix B:
_ Based upon local knowledge of surfing conditions in Brevard County:
o During conditions associated with the typical peak period of 8 seconds, "if the waves are of sufficient height, conditions everywhere along the coast are expected to be surfable."
o However, with sufficient wave height "during times of long-period swell, … local beach-breaks tend to close out".
_ It is herein assumed that surfable swell conditions correspond to a peak period equal to or greater than 9 seconds and an incident wave height equal to or greater than 2.3 feet (0.7m).
_ Based upon the above, "the ASR would be expected to create significantly improved surfbreak approximately 34 days per year."
_ "September is the most likely month for creating new/improved break, with January, October, and December also in contention. However, as the wave height threshold is increased to 1.0m and 1.25m, only September and October retain their claim of creating new surfbreak."

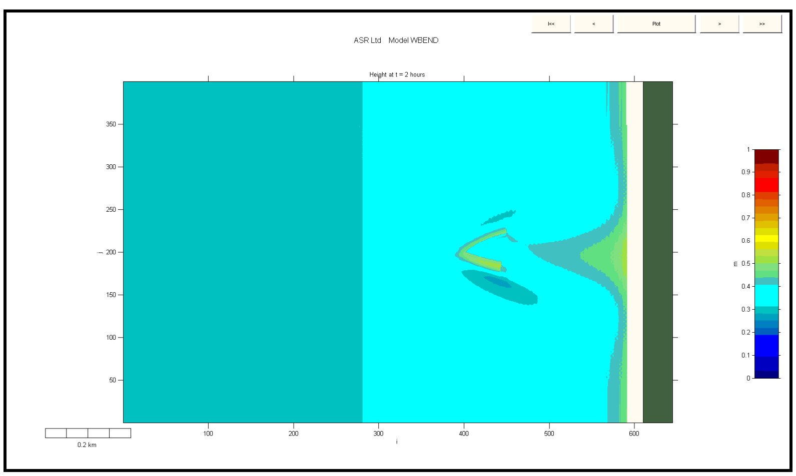
The assertion, based upon local knowledge instead of data, that the reef will only produce improved surf conditions 34 days a year is not an accurate assessment of the surfing enhancement possibilities of the MPASR. According to the SES report:

The efficacy of the ASR in creating enhanced surfing conditions at R-18 can be crudely assessed in the following manner. Firstly, it is assumed that any wave that breaks on the ASR will be surfable, and will in fact provide a better break than would naturally occur at the site. Secondly, linear wave theory is use to transform each wave condition in the SWR from the archive point (10.6m mean depth) to its respective point of incipient breaking, i.e. representing *shoaling & refraction, and assuming Hb = 0.78 hb. Predicted astronomical tides are included in these computations. If the incipient breaking depth is less than the design-crest elevation of the ASR (-1.52m MHW), it is assumed that the waves will not break on the ASR. Figure 16 presents a histogram of the parameter defined as the difference between the depth at breaking and the depth on the crest of the ASR (negative values are lumped into the first bin of the histogram). Based upon this approach, waves would be expected to at least 'trip' on the ASR approximately 56% of the time. However, it is noted that tripping does not necessarily constitute an improvement in surf quality, nor in frequency-of-occurrence, as compared to the natural surfbreak at R-18.*

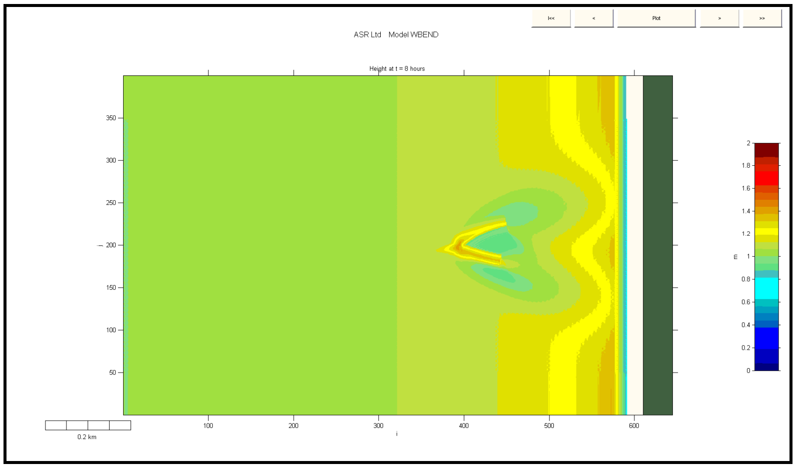
ASRA agrees that the most significant improvement in surfing will occur during long period swells and higher wave heights. Anybody who surfs knows that longer period swells produce the best surfing conditions – scientifically, this is because of increased energy in the wave. What SES and CTC have not taken into account is the increase in breaking wave height and intensity that will occur over the reef due to wave focusing and the significantly increased bottom gradient of the reef with respect to the natural seabed. These phenomena are explored in great detail by Mead and Black (2001a and 2001b) and Mead (2003).

According to SES, "Firstly, it is assumed that any wave that breaks on the ASR will be surfable, and will in fact provide a better break than would naturally occur at the site". ASRA agrees with this assumption. According to the SES report, waves will break on the reef 56% of the time or 204 days per year. While it is understood that not all of those 204 days will be good surfing days, based on our local knowledge, if there are waves breaking on the reef, surfers will try to surf them. Another factor is that both the Narrowneck reef and the Mount reef result in adjacent sand banks that are conducive to surfing (Cable Station is constructed on an existing reef, so these benefits are not realized).

Additionally, numerical modeling performed by ASRA, predicted that when the combination of wave height and tide level does not support wave breaking on the reef the reef will act as a wave focus creating an A-frame peak at the shoreline with higher wave heights than the adjacent shoreline (Appendix C3, page 11, Figures 4.2 and 4.3). Why was this information not included in the body of the report?



High Tide: H=0.3m T=6s Dir = 100º
Reef acts as wave focus for shore break



High Tide: H=1.0m T=9s Dir = 100º
Reef acts as wave focus for shore break

Section 5.4 Wave Sheltering:

ASRA performed a significant amount of numerical analysis with regard to wave sheltering for this feasibility study (Appendix C3). None of our results were referenced in the body of the report.

> *Note that relatively little wave sheltering is predicted by SES for normal wave conditions. Under northeast storm conditions, Figure 5.4 indicates a 30-40% reduction in the lee of the ASR. Note that the breaker height distribution is similar for the low and mean tide levels under storm conditions; however, "at high tide the breaker height distribution for the storm waves sits well above the other two tide stages, indicative of the ASR losing its effectiveness in tripping waves and dissipating their energy" (SES, 2008), Appendix B.*

The wave sheltering results provided by SES do not agree with the results provided by ASRA. According to our numerical modeling results, the reef will dissipate wave heights by 30-50% behind the reef for all wave conditions tested (Hs = 0.3m to 3.0m), except small waves (Hs ≤ 1.0 m) at high tide (Appendix C3, Section 4.2).

Section 5.5 Rip Currents:

> *Under northeast swell conditions, rip cells appear more likely to occur, particularly at high tide – as reflected in Figure 5.5.*

As we stated previously, during storm conditions at high tide, rip currents may form anywhere along the Brevard County shoreline. SES has not presented any data which confirms that these rip currents are the direct result of the reef. ASRA 's modeling results indicate that four cell counter-rotating circulation cells will occur behind the reef for all wave conditions tested (Appendix C3, Section 4.4.4). These cells are conducive to salient accretion (Ranasinghe, 2006; Black, 2003 and 2007).

Section 5.8 Predicted Shoreline Response:

Note that review of the literature indicates that their exist no known quantitative data associated with constructed reefs to verify the empirical methods employed by ASRA; these methods appear to significantly over estimate the volume of the salient expected with an ASR.

This statement is blatantly wrong. Please refer to page 3 of this response for results for the Narrowneck Reef. Also refer to "Sand Bank Responses to a Multi-Purpose Reef on an Exposed Sandy Coast", published in the Fall 2007 issue of Shore & Beach, for a detailed assessment of salient formation behind the Mount Maunganui Reef and comparisons to empirical and numerical predictions (Black and Mead, 2007). Further details on salient predictions are described by Dr. Shaw Mead:

The most important papers on empirical predictions are Black and Andrews 2001a and b – some 360 cases of salient and tombolo formation from aerial photographs were digitized and analysed and the resulting curves fit to the shore line response were correlated to the B/S ratio, with the resulting correlation coefficient of 0.997, i.e. an almost perfect fit.

There are many examples in consulting reports where the predictions are the same as natural examples, the following is from the St Francis Bay project, which was also featured in the peer-reviewed Shore and Beach paper (Fall 2007).

It is important to note that the empirical prediction and NGENIUS model are quick methods to give feedback on the potential size and whether or not deposition will occur. 2DBEACH or POL3DD with measurements to calibrate are required to undertake reliable numerical modeling on which to base final salient predictions.

The following is from Mead, S. T., Black, K. P., J. C. Borrero, J. Frazerhurst, D. Anderson, D. J. Phillips and M. Kramer, 2006. St Francis Bay Beach Project: Feasibility Study. Prepared for the St Francis Bay Beach Reef Trust, May 2006.,

The primary way that an offshore reef creates a salient is due to wave sheltering, although the previously promoted method of wave diffraction and nearshore circulation (e.g. Hsu and Silvester, 1990; Pilarczyk and Zeidler, 1996) may also be part of the mechanism in some cases (Black and Andrews, 2001b), and refraction resulting in re-alignment of wave crests can also play a significant role (Mead and Black, 2002). The shape of the salient that forms in the lee of an offshore reef can be predicted using empirical equations (Black and Andrews, 2001a). At St Francis Bay, calculations (Eqn. 5.1) using the preliminary reef dimensions are worked through below to predict the level of coastal protection that each offshore reef would provide.

The longshore width of the reef (B) and the distance between the reef and the undisturbed shoreline (S), indicate that the reef would form a salient.

Salients form when $$\frac{B}{S} < 2.00 \qquad (5.1)$$

Next, by substituting the reef dimensions into the salient equations (Eqns. 5.2 and 5.3) of Andrews (1997) and Black and Andrews (2001a), the geometry of the salient can be predicted. The average salient amplitude for offshore reefs is given by,

$$\frac{X}{B} = 0.498\left(\frac{B}{S}\right)^{-1.268} \qquad (5.2)$$

where X is equal to S - Y_{off}, which is the distance between the undisturbed shoreline and the reef (S), minus the length of the shore normal between the undisturbed shoreline and offshore extremity of the salient (Y_{off}). Salient basal width is given by,

$$\frac{Y_{off}}{D_{tot}} = 0.125 \qquad (\pm 0.020) \qquad (5.3)$$

where, D_{tot} is the total length of shoreline affected.

From these equations, using the results described above, the predicted salients at St Francis Beach have maximum dimensions cross-shore at the widest point of 90 m, tapering down to zero accretion some 365 m in each direction longshore (Fig. 5.11). However, the alongshore length is normally reduced to allow for 10% of the across width (since it asymptotes to zero), which results in an alongshore length of approximately 400 m in this case. The width of the salient refers to the distance moved offshore by the beach isobaths and MSL.

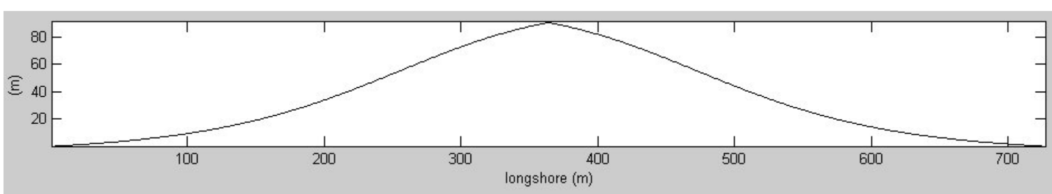


Figure 5.11. *Schematic diagram of the salient formation behind in the lee of an offshore reef at St Francis Bay Beach*

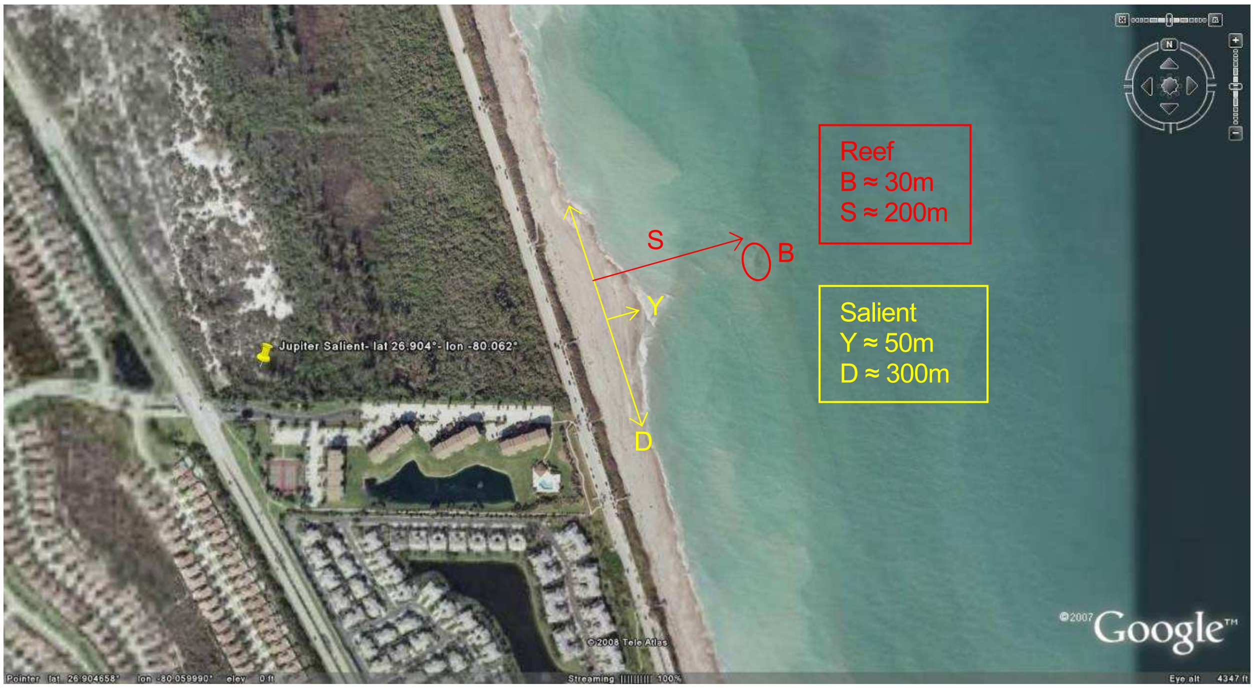
This salient above is used as a demonstration of a local salient in the peer-reviewed paper S. T. Mead, J. C. Borrero, K. P. Black and D. Anderson, 2007. Multi-Faceted Beach Management at St Francis Bay Beach, South Africa. Shore and Beach 75(4):43-54, and in fact shows a greater response than the 8 to 1 reponse (or Yoff/Dtot = 0.125)

Further modelling was undertaken at Cape St Francis to demonstrate whether the beach will erode or accrete, including the empirical methods of Ranasinghe and Turner, (2006) and Savoli et al, (2007), both showed accretion.

It is also important to note that where there is a dominant alongshore sediment direction, an assymetrical salient will build. Detailed numerical modeling of the Narrowneck Reef indicated that the salient would build south down to Burleigh heads, several kilometers away (Black, 1998c). The Gold Coast beach stabilization results, documented in the WRL monitoring reports, has confirmed these predictions.

Dr Shaw Mead
Director
ASR America

In order to further demonstrate the accuracy of the empirical technique we located a naturally occurring salient caused by a submerged reef near Jupiter, Florida. All measurements were performed using the Google Earth tools.



The submerged reef is approximately 30m wide and 200m offshore of the unaffected shoreline. The empirical predictions for this salient are a cross-shore width of 36m (Y) and an alongshore length of 288m (D). The actual measurements from Google Earth are Y ≈ 50m and D ≈ 300m. In both cases the empirical estimates are less than the actual measurements.

Section 5.8 Predicted Shoreline Response:

> *Note that Figure 5.6 indicates the salient is predicted to be primarily limited to area in the lee of the ASR; this prediction by ASRA is generally consistent with wave sheltering predictions results by SES as reflected in Figures 5.1 through 5.4.*

This statement is a complete misinterpretation of our data and demonstrates a lack of understanding of salient formation. As described above, salients typically assume a tapered shape (Figure 5.11 above). What Figure 5.6 of the feasibility study actually shows is that all the shoreline profiles have moved seaward indicating accretion along the entire length of the model grid which is 800 meters wide. The NGENIUS model predicted a salient at least 800m wide, confirming the empirical predictions. Simple wave sheltering model plots should not be used to predict salient widths.

Section 5.8 Predicted Shoreline Response:

> *Uncertainty remains as to the full extent of a salient that would accrete in the lee of an ASR. However, based upon the conceptual analysis results presented in this section, the following conclusions are adopted relative to shoreline response for the purposes of this study:*
> *_ As reflected in Figures 5.1 through 5.4, the ASR is expected to primarily shelter the shoreline in the lee of the 308-foot (94m) shore-parallel ASR structure.*
> *_ As reflected in Figure 5.6, the salient predicted to be created by the ASR is expected to be evident along the shoreline in the immediate lee of the ASAR structure. This condition has also been observed at the Narrowneck Reef, where "there is a clear salient at times" as illustrated in Figure 5.7.*
> *_ Although the shoreline in the lee of the structure and any salient are subject to erosion during high wave events, it is reasonable to expect that the salient will return during normal wave conditions and thus the ASR will provide for a fluctuating or dynamic state of stability to the 308-feet (94m) of shoreline in the lee of the structure.*

The salient prediction of 800 meters, determined using the empirical method (Black and Andrews, 2001a,b) and confirmed using the NGENIUS model, is a reasonable estimate on which to base shoreline response for the purposes of this feasibility study. More detailed numerical analysis will be required, using models calibrated for the local conditions, to make the final salient predictions prior to reef construction.

As stated by Dr. Mead above, "It is important to note that the empirical prediction and NGENIUS predictions are quick methods to give feedback on the potential size and whether or not deposition will occur. 2DBEACH or POL3DD with measurements to calibrate are required to undertake reliable numerical modeling on which to base salient predictions."

Section 5.9 Public Safety:

> *He supports the top-ranked candidate site due to potential for crowd size being reduced; he does not recommend siting of the ASR at a "high-traffic" beach site (i.e. Shepard Park, Lori Wilson Park).*

In a personal conversation which occurred shortly after his meeting with CTC, Wyatt told me that he had suggested Fischer Park in Cocoa Beach as an ideal reef site based of its location, ample parking, and its current under-utilization by the public.

Section 6.3 Probable Costs:

Table 6.3.1- Life of the geotextile reef should be 40+ years as stated in our reports and confirmed by Simon Restall, Managing Director of ELCO Solutions PTY LTD.

Section 8.2 Erosion Control Benefits:

As cited in Section 5.8, the following conclusions are adopted relative to shoreline response of an ASR for the purposes of this study:
_ The ASR is expected to primarily shelter the shoreline in the lee of the 308-foot (94m) shore-parallel ASR structure.
_ The salient predicted to be created by the ASR is expected to be evident along the shoreline in the immediate lee of the ASAR structure.
_ Although the shoreline in the lee of the structure and any salient are subject to erosion during high wave events, it is reasonable to expect that the salient will return during normal wave conditions and thus the ASR will provide for a fluctuating or dynamic state of stability to the 308-feet (94m) of shoreline in the lee of the structure.

As we stated in Section 5.8, the alongshore salient estimate of 800 meters is a reasonable estimate for the purposes of this feasibility study (not 94 meters as reported by CTC). Therefore using CTC's method for calculating erosion control benefits the figures in Table 8.1 should be:

Volumetric loss rate	14.4 cy/ft/yr
Length of shoreline	800 meters
Length of shoreline	2624 feet
Annual volume loss prevented	37,785 cy/yr
Unit price	$9.68 / cy
Annual benefit	$ 365,764 per year

Based on these figures the estimated savings over the design life of the reef are:

$365,764 x 40 years = $14,630,560 (using 2008 dredging price estimates)

This would make the B:C ratio for sand retention alone well over 2:1.

The quoted unit price for sand nourishment of $9.68 /cy is very low compared to recent nourishment projects in Florida. Thomas Campbell of CP&E quoted a unit cost of over $14/cy for their latest project on the Gulf Coast (Campbell, 2008). The cost of dredging will certainly continue to rise over the life of this project thereby increasing the B:C ratio even more.

Section 8.3 Recreational Benefits:

The benefit figures presented in this section are extremely low and do not agree with economic impact studies performed for other MPASR projects. We will address the assumptions and methods used to calculate these figures in a separate economic impact section.

Section 8.4 Probable Costs:

> _ *No maintenance will be required to repair the sandbags or physically adjust the structure – as has commonly occurred for other comparable projects as identified in Section 6 of this Report.*
>
> _ *No adverse impacts to adjacent beaches will occur due to expected sand trapped by the ASR; this assumption is inconsistent with basic coastal engineering principles associated with "conservation of mass".*
>
> _ *The structure will have a maintenance-free Project Life of 25 years – there is no known comparable exposed sandbag structure that survived for 25 years.*

What comparable projects are CTC referring to with regard to maintenance? The only comparable project is the Narrowneck Reef.

The "conservation of mass" was addressed previously in Section 3.2 of this response.

It is true that there are no examples of geotextile MPASR which have survived for 25 years, since the first one was built in 1999-2000.

There are however numerous examples of other marine geotextile applications that have performed as designed for over 20 years (Harris, 2005, 2004, 2003a, 2003b, 1999, 1994, 1989, 1988, 1987), (Pilarczyk, 1996a). Simon Restall, the Managing Director of ELCO Solution PTY LTD, stands by their design life estimate of 40+ years for a submerged MPASR built using ELCOROCK geotextile containers. Simon cited two surf zone geotextile sand filled container projects in Australia, North Kirra Groins and Russell Heads, which have been in place since 1985 and 1990 respectively, without any major degradation. Those projects were built with materials which are now considered significantly inferior to their current geotextile products (ELCO, 2008).

Section 8.5 Benefit/Cost Analysis:

The B/C ratio presented in this section was based on misinterpreted salient predictions and unreasonably low recreational benefit calculations. These figures should be modified to reflect more accurate predictions as described above and in the economic impact section.

The County recently authorized a significant expansion of the lifeguard stations for the beaches of Brevard County, including sites adjacent to the proposed reef site. This action was totally independent of the proposed reef. The proposed reef site may be moved based on the results of this report and further design studies. It is not evident at this point that an additional life guard station would be required specifically for the reef. The $75,000 annual fee for the lifeguard tower should be removed from this cost estimate.

ASRA performed a re-calculation of the B/C ratio over 25 years based on our estimates for sand retention and recreational benefits. We believe the event benefits are way too low but will use PEFS data for arguments sake. The results are presented below:

Summary of Benefit / Cost Analysis

Present value surfing benefits	Based on 204 days per year for 25 years	$5,512,254
Present value event benefits	Based on PEFS data for 25 years	$1,679,494
Combined present value of Recreational benefits		$7,557,512
Annual recreation benefits	Based on 4% interest for 25 years	$805,883
Annual erosion benefit	800 m salient (based on $9.68/cy)	$ 365,764
Total annual benefits		**$1,171,647**
Total annual costs	Based on CTC data	**$462,954**
B/C Ratio		**2.53**

ASRA considers the B/C ratio of 2.53 a very conservative estimate since it does not include any provisions for marketing, public relations, fishing, diving, or other factors typically included in economic impact assessments of this nature.

ASR America Comments

Regarding the Economic Impact Study Prepared by Praecipio EFS

Overview:

The economic assessment, prepared by Praecipio EFS (PEFS), unfortunately only focuses on the recreational benefits directly related to surfers using the reef. Many other aspects of economic benefit are not considered. For example, no attempt was made to estimate the marketing value associated with a MPASR project. The Bournemouth Borough Council in England has estimated that the media exposure due to the planning and construction of the surfing reef at Boscombe has been worth at least £10M ($20,000,000 US) to the Council and community in free publicity. Note the recent notoriety created by the deployments of large ships as artificial reefs (Spiegel Grove in Key Largo and aircraft carrier in Pensacola). Economic studies for those projects show a tremendous amount of benefits in addition to that provided only by the divers diving these sites.

Other studies of benefits associated with the construction of multi-purpose reefs at various locations around the world have all shown significant positive benefit/cost ratios. The lowest being approximately 20:1 for the reef in Boscombe, UK (Black *et al*., 2000), to over 60:1 for the Narrowneck reef on the Gold Coast, Australia (Raybould and Mules, 1998) – since construction of the Narrowneck reef, the Benefit/cost ratio has since been re-evaluated at 70:1 (McGrath, 2002). A recent report for a multi-purpose reef in Wellington, New Zealand, estimated a "very conservative benefit:cost ratio of 24:1" (Baily and Lyons, 2003). Rafanelli (2004) undertook a socio-economic study on the impacts of a multi-purpose reef proposed for Back Beach in Geraldton, West Australia, and concluded that it would generate AU$1.5M of spending by tourists per annum. Economic benefits from artificial reefs and beach enhancement are summarized below.

Summary table of the economic benefits that multi-purpose reefs can provide.

Site	Benefit:Cost Ratio	Annual Spend/Value	Surfing Competitions	Reference
*Gold Coast, Australia	70:1	-	AU$2.2M	Raybould and Mules, 1998; McGrath, 2002
†Mount Maunganui, New Zealand	-	NZ$0.5M	-	Gough, 1998
‡Cornwall, England	-	£21M	-	Ove Arup & Partners International, 2001
†Noosa Beach, Australia	-	-	AU$1M	Jackson *et al,* 1999
‡Florida, USA	-	US$84.63M		Johns *et al.,* 2001
†Lyall Bay, New Zealand	24:1	-	-	Baily and Lyons, 2003
†Bournemouth, UK	20:1	-	-	Black *et al*., 2000
**Miami Beach, USA	500:1	-	-	Houston, 2002
§Californian's Beaches	-	US$5.5B	-	King *et al*., 2001
‡Geraldton, West Australia	-	AU$1.5M	-	Rafanelli, 2004

*Based on the 'beach' amenity and associated businesses
†Based on additional income from attracting surfers
‡Based on revenue from all sources associated with surfing (e.g. hospitality, boat sales, equipment rental, etc.)
**This figure relates to the economic benefits of beach nourishment in Miami (i.e. is not associated with artificial reefs, although they can be used to greatly increase the success of nourishment projects).
§This is not an economic impact estimate of artificial reefs, but rather an estimate of the loss of GNP if beaches are not maintained in California, i.e. the present economic value of beaches in California.

Why is the Brevard County Economic Impact Estimate So Low (PEFS report Section 4)?
The Benefit/Cost estimates cited above make it very hard to reconcile the anaemic economic impact estimates presented by PEFS and CTC. Are they suggesting that all the other independent economic studies were wrong? Do economists in Australia, New Zealand, and England use different math? How could there be such a huge difference between Brevard County and the rest of the world? Perhaps PEFS does not fully comprehend the sport of surfing or surf tourism. Why wasn't marketing potential part of PEFS scope? Is the Brevard County Tourism Development Council (TDC), who paid for the PEFS study, aware of this?

What was the Intended purpose of the PEFS Report (PEFS report Section 4)?
It was ASRA's impression that the purpose of the PEFS report was to assess the economic impact of the proposed MPASR in relation to its ability to generate revenue as a surfing enhancement venue, independent of the coastal protection benefits. The point being that if the State and County would not or could not fund the reef on the basis of coastal protection benefits alone that the County may decide to build the reef for purely economic reasons much like the communities of Mount Maunganui, Opunake, and Boscombe. The economic study should therefore base its assumptions on the premise that the reef would be designed to optimize surfing enhancement rather than coastal protection. PEFS has based their report on the conceptual design developed by ASRA that was intended to maximize the coastal protection benefits of the reef. Consequently there are many negative remarks relating to the offshore position of the reef (300 meters). A reef designed purely for surfing enhancement could be smaller, less expensive, and positioned much closer to shore to enhance viewing opportunities and make it more accessible to less experienced surfers. In fact we could design several smaller surfing enhancement reefs for the same price as one large coastal protection reef. This would significantly increase the total number of surf visit days, thereby generating significantly more revenue.

Why was the reef impact based on only 34 days of use per year (PEFS report Section 3.22)?
As we stated in Section 5.3 of this response, the assertion that the reef will only produce improved surf conditions 34 days a year is not an accurate assessment of the surfing enhancement possibilities of the MPASR. It certainly is not an accurate estimate of how many days people will surf the reef. ASRA agrees that the most significant improvement in surfing will occur during long period swells and higher wave heights. Anybody who surfs knows that longer period swells produce the best surfing conditions. What SES and CTC have not taken into account is the increase in breaking wave height and intensity that will occur over the reef due to wave focusing and the significantly increased bottom gradient of the reef with respect to the natural seabed. These phenomena are explored in great detail by Mead and Black (2001a and 2001b) and Mead (2003). According to SES, " Firstly, it is assumed that any wave that breaks on the ASR will be surfable, and will in fact provide a better break than would naturally occur at the site". ASRA agrees with this assumption. According to the SES report, waves will break on the reef 56% of the time or 204 days per year. While it is understood that not all of those 204 days will be good surfing days, based on our local knowledge, if there are waves breaking on the reef, surfers will try to surf them.

Therefore PEFS should base their estimates on 204 surfing days, not 34. Additionally PEFS based part of their estimates on tourists who will visit Brevard County to surf the reef. This implies that Brevard County will become a surf destination, which is the point of building a surf enhancement reef. As any travelling surfer knows, even with the advent of global computer models to predict surf, no surf trip is guaranteed surf. As experienced travelling surfers, we have spent days or even weeks sitting at surf breaks around the world waiting for swell.

The point is that once tourists have committed to making a surf trip, they will be at their destination spending money whether there is surf or not. One could argue that they will spend more money when the surf is flat since they will be forced to seek other forms of entertainment. I am sure that the brewers of Bintang Beer have reaped mighty profits from frustrated surfers in Indonesia. The bottom line is that PEFS should recalculate their estimates based on the number of days that surfers might use the reef which is at least 204.

Why was fishing and diving enhancement not included in the economic assessment (PEFS report Section 3.4)?

The environmental assessment has predicted the that :

> *Shore- or vessel-based anglers would likely fish around the ASR, depending on individual access. Fishers operating from shore would be limited to fishing over portions of the reef within casting or wading range. Some fishers may use small, self-deployed watercrafts such as kayaks or surfboards to reach a reef outside of the surf zone. Access by fishers operating from larger boats will be limited to calm days with no ground swell or wind-generated waves or by the size of their vessel. The distance to the nearest inlet (Canaveral) is considerable and would limit the number of days that small vessels would be able travel to the site.*
> *Divers (primarily snorkelers) would utilize the proposed ASR; but, because of the generally poor visibility during much of the year, most divers would likely be spearfishers less concerned about water clarity and sight-seeing, instead using the guise of murky water as way to more closely approach their quarry when hunting (e.g., sheepshead, flounder, and gray snapper). Given appropriate conditions during the summer months, water clarity would be adequate for sight-seeing by snorkelers and possibly SCUBA divers. Similar to fishers, divers would be limited by mode of operation, accessibility, and sea conditions.*

There is no doubt that the reef will attract marine life and become a popular fishing and diving site when the conditions are favorable. Indeed it is fortuitous that the conditions which will not be favorable for surfing, calm seas, will be the best conditions for fishing and diving. Of course the reef will have to be buoyed to prevent boaters from running aground or damaging the reef . We do not understand the reference to the considerable distance to Port Canaveral since the proposed reef site is only three miles from the Port Canaveral entrance.

PEFS assertion that the reef could not become both a prime fishing spot and surf break is not supported by any real data. As mentioned above, the ideal days for each sport are mutually exclusive and should not pose a problem. The Narrowneck Reef has succeeded as both a surf break and a fishing spot (Jackson, 2007). Sebastian Inlet is another example of a prime surf break which is also a prime fishing spot.

Why did PEFS use such a high discount rate (PEFS report Section 3.29) ?

PEFS used a discount rate of 16% based on their assumption that the reef would be a high risk investment. They justify this rate by comparing the reef to small company stocks. Stocks, as we all know from recent events, are a risky venture where the possibility of losing all value is a real possibility. ASRA cannot envision a scenario, short of total destruction, where the reef would be worth nothing.

The Narrowneck Reef economic studies used a discount rate of 8% (Raybould and Mules, 1998). The Bocombe Reef economic study used a discount rate of 6% (Weight, 2003). Certainly these projects would have to be considered equally as risky as the proposed Brevard project. So why has PEFS chosen a discount rate that is double the rates used to assess other MPASR projects? This choice certainly had a huge impact on the economic benefit estimates.

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