DEPARTMENT OF ENVIRONMENT
CAYMAN ISLANDS GOVERNMENT

Coastal Works Review

Marriott Beach Resort, Seven Mile Beach Club, South Bay Beach Club, Plantation Village & Tamarind Bay

Southern Seven Mile Beach – Shoreline Modification

Block: 13B **Parcels:** 2, 102, 193, 142 & 143

Refs: DOE/CWK/381, 382, 383, 384 & 385

PREPARED FOR: MINISTRY OF HEALTH, ENVIRONMENT, CULTURE AND HOUSING

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Project Proposal

The applicants – LR (Cayman Hotel) Limited (Marriott Beach Resort), Proprietors Strata Plan No. 89 (Seven Mile Beach Club), Proprietors Strata Plan No. 73 (South Bay Beach Club), Proprietors Strata Plan No. 46 (Plantation Village) and Proprietors Strata Plan No. 49 (Tamarind Bay) – are seeking permission to for the placement of 96 sand-filled mattresses along approximately 1000 linear feet of shoreline from the Marriott resort down to Plantation Village (Block 13B Parcels 2, 193, 143), the placement of 26 sand-filled GeoTubes® in front of the Marriott (off-shore Block 13B Parcel 2) and the excavation of sand off-shore from the Marriott (as shown in Figure 1 below). The proposal estimates the use of approximately 4,510 cubic yards of sand for the purpose of filling the sand mattresses and GeoTubes® and nourishing the shorelines from Marriott resort to Plantation Village (Block 13B Parcels 2, 193, 143).

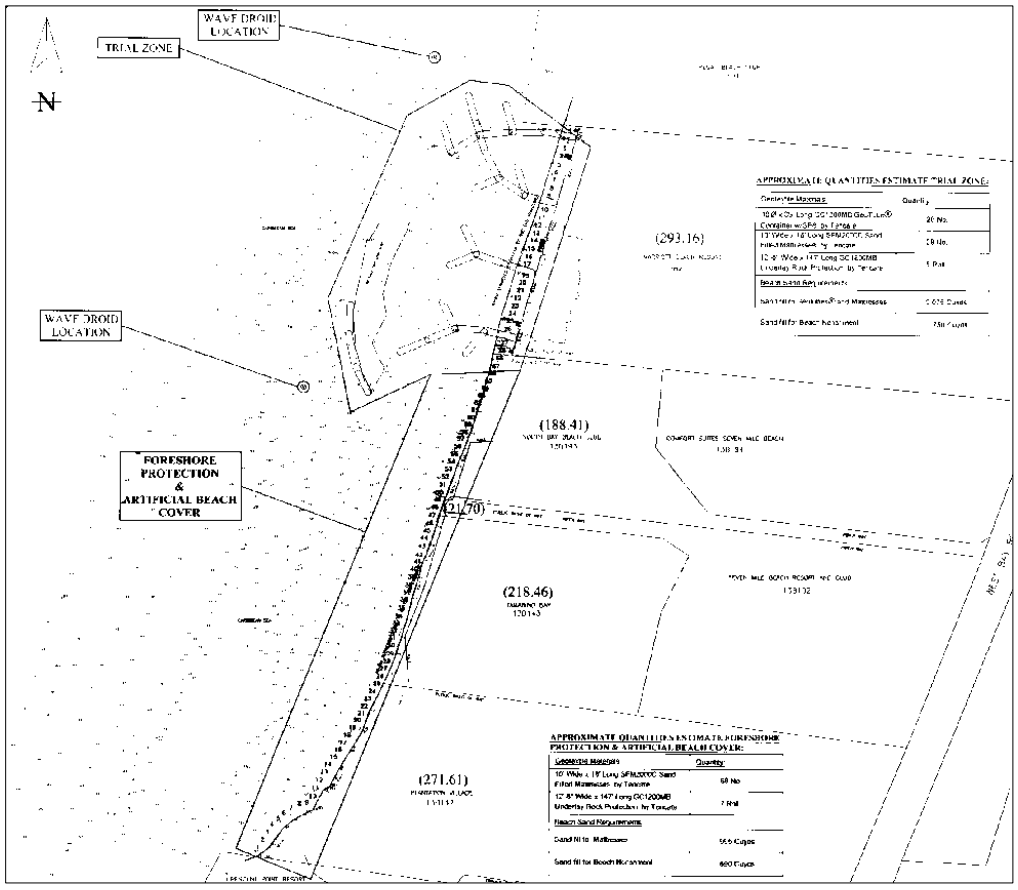

Figure 1: Cropped image from the applicant's site plan showing the approximate location of the proposed works.

The coastal works application forms state that the objective of the proposed works is to rehabilitate the beach along the southern end of Seven Mile Beach, specifically in front of the Marriott Beach Resort, South Bay Beach Club, Tamarind Bay and Plantation Village. The applicant's submissions also state that they aim to increase the amount of beach in front of the properties and increase the length of Seven Mile Beach. Figures 2 to 6 illustrate the lack of beach at the properties. There has been some temporary recovery of beach sediment following the north-westerly wind and wave conditions over the Christmas period.

Figure 2: Marriott looking north

Figure 3: Marriott looking south

Figure 4: South Bay Beach Club looking south

Figure 4: South Bay Beach Club

Figure 5: Tamarind Bay

Figure 6: Plantation Village

Background

History of Erosion along Seven Mile Beach

Globally beaches are eroding due to anthropogenic influences, exacerbated by rising sea levels and increased instances of severe storms caused by climate change. Regionally the Caribbean is suffering from the loss of narrow but economically important beaches. Locally we are experiencing these losses in areas such as Boggy Sands and other areas of Seven Mile Beach. Seven Mile Beach in particular is a highly active beach with a long-standing history of documented cycles of beach erosion and accretion.

In one of the applicant's cover letters addressed to the Hon. Premier, they state that "Over the past two years the beach has deteriorated so significantly that it has resulted in a visible impact on visitor numbers and the guest experience at the resort." Whilst the Department understands the impact a loss of beach can have on a beach resort, it notes that this is not a new phenomenon. The main application site, the Grand Cayman Marriott Beach Resort (previously the Radisson) has a long track record of unsuccessful attempts at beach erosion prevention measures, ranging from erosion control mats with artificial seagrass in 1999 to the installation of an artificial breakwater in the form of reef balls in the early 2000s.

In 2005, post-Hurricane Ivan, the Cayman Islands Government (Department of Environment) undertook a major beach re-nourishment on the southern end of Seven Mile Beach, placing around 7,000 cubic yards of beach sand from Regal Beach Condos (just north of the Marriott) to Crescent Point. The nourishment exercise was designed by a coastal engineer in order to create a relatively stable beach profile that would allow the beach to function normally for a period of time (in the order of several years). However, it was recognised at that time that the nourishment was unlikely to provide a long-term solution as the erosion at the southern end of Seven Mile Beach is significantly worse than in other areas due to the presence of hard structures such as seawalls and pool decks on the active beach.

For several years the Marriott and neighbouring properties have experienced seasonal accretion and erosion of their beaches. Although accretion and erosion is natural for a beach system such as the Seven Mile Beach, these instances of erosion have been worsened and the recovery of the beaches has been slowed for a number of well-documented reasons. The below excerpt from the *Beach Review and*

Assessment Committee Interim Report[1] (May, 2003) lists the following as contributors of the erosion problems on Seven Mile Beach:

1. *Development on the beach ridge and associated dune system has removed the rapid self-healing capability from much of the length of the beach. Typically the dune system behind the beach ridge would consist of sand reserves deposited over decades or centuries. During major erosion events these sand reserves would be exposed and would form an important contribution to the recovery by providing additional sand. Development on the beach dune system effectively removes this reserve by locking it behind seawalls, buildings, covering it for carparks or removing it for foundation construction.*

2. *Inappropriately sited structures, in particular seawalls, have been the root cause of almost all the development-induced problems on Seven Mile Beach. When properly constructed and properly sited, seawalls are an important means for protection from all but the most extreme storms [National Academy of Sciences, 1995, page 222]. However, seawalls built within the expected range of incursion of the shoreline will inevitably be at the water's edge at some point and will impede or deny both lateral access and the recreational use of the beach surface.*

3. *The Seven Mile Beach system has been described as a 'leaky beach' with potential for large losses of sand through gaps in the outer reef. The western shelf seaward of Seven Mile Beach can be considered as narrow with extremely deep water and steep slopes close to shore. Consequently the loss of sand to deep water down the slopes of the outer shelf is potentially large. The existence of large 'rivers' of sand (sand chutes) moving over the 'West Wall' to deeper water and potentially out of the system has been demonstrated, but actual volumes of sand lost from the system through these 'leaks' is not known.*

4. *The Development and Planning Regulations have over the years not adequately protected the beach and have significantly contributed to the problem by allowing developments to be sited on the active beach relative to a continually fluctuating Low Water Mark. Additionally, historic building practices have permitted the removal of large quantities of sand for foundation construction and cement ingredients. Beach ridges have also been mined as a source of sand for local building and road construction, a practice that still continues in all three Islands.*

Some 16 years later many of these issues still exist and have been worsened by the effects of sea level rise.

A report by Ralph Clark to the Cayman Islands Government entitled *"Investigation of Erosion Conditions on the Seven Mile Beach Grand Cayman"* in 1988 made recommendations for the protection and management of Seven Mile Beach which included increasing coastal setbacks and siting development away from the active beach. Over the years these recommendations have consistently been put forth by the Department of Environment in reviews of development applications, but these recommendations have consistently been ignored.

[1] Beach Review & Assessment Committee. (2003) Interim Report May 2003.

Review of Application Submission

Given the scale of the proposed works (approximately 1,000 linear feet) and the potential for adverse impacts in a Marine Protected Area – the Seven Mile Beach Marine Park- the Department commissioned a firm of Coastal Engineers from Florida to review and comment on the application proposals.

We enclose at Appendix One a copy of the review prepared by Olsen & Associates. The Coastal Engineer that authored the review has 33+ years of coastal engineering practice including the design, construction-review and monitoring of approximately 100 oceanfront beach improvement projects throughout the world, particularly including the Caribbean basin and the Cayman Islands. He makes the following key comments/observations:

- *Unless the project is intended solely as an emergency erosion control measure – to armour the shorefront structures against undermining and damage, without regard to a sand beach –* ***the project is wholly inconsistent with contemporary coastal engineering practice for beach stabilization or enhancement along an ocean shoreline****. It will not perform as described (except to the extent that the marine mattresses placed against the seawalls may mitigate undermining of the structures).* ***It will not retain a sand beach amidst the geotube structures. It will retard the natural seasonal accretion of sand along the shoreline by introducing hard, reflective structures along the beach face that are ultimately deemed to be highly unaesthetic and prone to damage.***

- ***The layout of the geotube groyne field does not make physical sense and is mostly inconsistent with structural designs for beach stabilization/enhancement.*** *Its dendritic layout is more akin to the roots of a tree intended to hold soil as if on a hillside slope or riverbank; that is, not along an open coastal environment.*

- *The two embayment shapes created by the three southern principal shore-perpendicular groynes (labeled A, B, C in Figure 5) with fish-tail heads, is somewhat consistent with the creation of crenulate pocket-beach embayments (using T-head or fishtail groynes); but the width of the two openings are too small – 40 feet – because this is both uncomfortable for bathers and conducive to cause erosion through a "suck-and-draw" effect of waves moving into and out of an embayment through a narrow opening. (Pocket beach cell openings are usually >70+ ft wide.)*

- *The intermediate spurs near the landward ends of groynes A and C – located within 50 feet from shore – will induce beach erosion (through wave diffraction effects) because they are located too close to, and semi-parallel with, the shoreline.*

- ***The presence of the geotubes, as proposed, does not promote or stabilize the accretion of beach sand.*** *Instead, it can retard or resist sand accumulation because the geotubes are smooth, reflective surfaces.* ***They may block the longshore transport of sand (or on/offshore transport in the case of the north-end groynes), but only at the cost of inducing erosion on the downdrift side.*** *Structures do not manufacture sand; and in an under-nourished or sediment-*

deficient environment (such as this), they may only impound some sand at the detriment to other shorelines. ***The overall submerged groyne layout has no rational basis, precedent, or justification.***

- *Generally speaking, even if the geotube groyne field was properly designed, construction of a groyne field on an open coastline – amidst an otherwise continuous beach (given that the Marriott beach continues another 680-feet to the south) – is typically imprudent practice.*

- ***It is implausible that a 1-ft thickness of sand placed atop the shorefront mattresses in the surf-zone would remain in-place amidst this otherwise erosional environment*** *– that is, without a beach nourishment project that is much greater than that which is proposed, or without natural sand influx that wholly buries the mattresses with a very much thicker and wider deposition of sand.*

- *The proposed shorefront mattresses can provide undermining/scour protection along the foundation of the seawalls; but they will not promote a sand beach. Instead, their reflective, impermeable surface will retard natural accretion of sand. Upon construction, the mattresses will displace any sand beach that currently exists, and the post-project shorefront (in absence of major renourishment or significant seasonal influx of sand) will be armoured by sand bags, not a sand beach. A visual example of this is shown in the figure below, where shorefront armouring by the proposed Tencate mattresses was constructed along Kaanapali, Hawai'i. The structures protected the oceanfront walkway but do not provide for a practically usable sand beach. It is an armoured beach. Another example includes Waikiki Beach (c. 2017) – where the mattresses arrested erosion, but the beach in this area is more or less cordoned off from use by the public (per my correspondence with colleagues in Hawaii, this date.)*

KAANAPALI BEACH CLUB, HI 2018

Before After

Proposed mattresses deployed along Kaanapali Beach, HI.

- *Generally speaking, the use of sand-filed mattresses or shore-parallel geotubes is a riverbank stabilization method – or an emergency shorefront measure. It is not otherwise appropriate as a*

solution for oceanfront beach erosion, particularly along a resort shoreline where an attractive recreational sand beach is expected.

- *No certain sand source is proposed to fill the geotubes & mattresses – or for beach nourishment – but a suggestion is made that the source may be "local deposits" presumably including the nearshore beach. As such, diverting 2075+995 = 3,070 CY from the natural beach environment to fill geotubes & mattresses – structures that can be expected to result in beach erosion (or retarded beach accretion) -- appears to be very imprudent.*

- *The plan proposes 750 cubic yards (CY) of beach nourishment along the ~280-ft Marriott shorefront, and 690 CY along the 680-ft southern shorefront. That equates to only 2.7 cubic yards per ft along the Marriott property, and 1.0 cy/ft along the rest. With an active beach profile height of at least 7-feet (seabed at -3.5 ft and berm at +3.5 ft), the Marriott fill of 2.7 cy/ft and the south beach fill of 1.0 cy/ft equates to a maximum beach fill advance of 10.4 feet and 3.9 feet,respectively. The actual advance would be much less than this, because the existing beach along the seawall is over-eroded. Thus, there would be little or no net realized nourishment (widening) of the beach beyond the mattresses; and, indeed, no net cover (burial) of the mattresses.*

- *The description of the sand-filled geotextile containers as "soft structures" is a misnomer. This term is used to differentiate geotextile containers from rock, concrete, or timber armor. Sand-filled geotubes and mattresses are anything but "soft". They are very hard; basically impermeable (relative to a sand beach); highly reflective (with no wave absorption like boulder structures); and very difficult to completely remove. The presumption in the design proposal that their elevation can be increased by stacking tubes is not realistic. That requires a wide, pyramidal structure – and the top tube will often roll off the stack anyway, during wave events.*

- *Our firm, including me, has significant and pioneering experience with the use of sand-filled geotextile tubes on beaches – including at Duck NC, Bald Head Island NC, Amelia Island FL, and Port Canaveral FL. These have been mostly used for demonstration and/or emergency projects (or required in lieu of rock boulders, such as at Bald Head Island NC). Even when built with ultra-high-quality coatings, the geotubes' actual life-span in an oceanfront environment (3 to 7 years, at most) is far less than that described in the proposal, and they are highly unaesthetic especially for a resort setting. A summary of their characteristics is presented as follows, based upon 25+ years of experience with design, construction and maintenance of sand-filled geotubes along ocean coastlines.*

    - *Of primary note: geotubes are highly "unaesthetic"*
    - *Geotubes have a limited life. At Bald Head Island, N.C. (an isolated location with somewhat limited public access): approximately 5-7 years. This is with a very expensive*

epoxy coating. They are at best a "temporary" structure. An inherent weak point is their seams.

- *Geotubes are subject to vandalism and deflation from penetration by floating debris during storm events.*
- *Geotubes will grow an algae outer-coating in the inner tidal zone which is slippery when walked upon by beach users. The algae coating is dangerous and likewise unattractive.*
- *They are an attractive nuisance and hazard to beach users and in particular to children.*
- *They can be a hazard to navigation and typically necessitate signage.*
- *Unless chocked, or partially buried, they are subject to rolling out of place during storm events.*
- *Once perforated they are very difficult (and in most instances impossible) to successfully patch.*
- *They do not absorb wave energy, but rather reflect wave energy.*
- *Without a properly designed underlayment (not just a simple flat geotextile fabric) they will subside into the seabed thereby compromising their design intent. Some tube products will change shape over time thereby changing their design height. They become flatter.*
- *They are very difficult to deploy in a sophisticated pattern or shape – without significant "compromise" to the intended design concept.*
- *A large portion of the cost of construction is mobilizing the appropriate (and unique) equipment used to fill them. Hence, single tube replacement can be very expensive.*
- *Stacked tubes are typically unstable – difficult to construct and maintain.*
- *To a large degree, they are the erosion control structure of last choice.*

- *Particularly when compromised, sand-filled geotextile containers present an aesthetic that is wholly contrary to the guests' expectations of a resort along Seven Mile Beach.*

- *Overall, an understanding of the littoral & erosional processes along the subject property, and a description of the rationale for the project design and its ability to meet project objectives – relative to accepted coastal engineering standards -- is not presented in the project proposal. As described above, the expectations of project performance are not substantiated by prior constructed beachfront projects with similar design features.*

- *The proposal recommends collection of directional wave data by two monitors, but collection or analysis of this data will not change the overall situation or meaningfully inform*

the beach management options. The beach erosion problem is fairly evident, and increased knowledge of the local wave field is not likely to change the mid- or long-term strategy.

Comments & Recommendations

Given the clear and definitive advice provided by Olsen & Associates, the Department urges Cabinet to refuse permission of this proposal. However, the Department recognises that it is unacceptable for the Marriott and property owners along the southern end of Seven Mile Beach to be expected to continue with no option for shoreline rehabilitation. The Department is of the view that a Government-led renourishment exercise should be conducted along this coastline. This recommendation was relayed to the Ministry of Environment on 26 November 2019 and an urgent meeting with the Ministries of Planning and Environment was requested, but we have not received a response to-date.

The Engineering Report commissioned by the DoE, prepared by Olsen & Associates, endorses a beach renourishment exercise and provides specific comment and details as follows:

1) *The presently proposed plan is untenable and inconsistent with accepted coastal engineering practice. It will not achieve the described performance. It will be ultimately deleterious to the Marriott, Seven Mile Beach, and the Cayman Islands. The proposed plan should be rejected by the Marriott and by the Government.*

2) *The preferred and recommended alternative is beach nourishment along the Marriott and southerly-adjacent 680-ft shorefront (about 1000 feet total). A minimum beach fill of 12 cubic yards per ft alongshore (12 cy/ft) would result in a net beach width advance of about 50 feet from the seawall at mid-tide-level (and a reliably dry beach width of at least 15 feet), considering the existing over-eroded conditions. Along the Marriott, that equates to about 3,480 cubic yards of beach fill (2,660 cubic meters). But the project will not function unless built along the entire 1000-ft shorefront. A minimum 12 cy/ft project along the 1000-ft shorefront would equate to 12,000 cubic yards of beach fill (equivalent to 9,180 m3). An overall minimum beach fill quantity of 12,000 cubic yards is recommended.*

3) *Given the difficulty and current cost of procuring beach fill sand, I realize that beach nourishment is an expensive endeavour. In Jamaica, which likewise has limited beach compatible sand for nourishment, we recently imported over 8100 CY of sand for a single resort to completely restore and renew its oceanfront. That sand came from Ocean Cay, Bahamas – wholly beach compatible and very attractive, and readily available – at an in-place cost of probably about US$125/CY. Accordingly, at that valuation, a 12,000 CY beach project may cost on the order of US$1,500,000, if delivered from the Bahamas. Apportioned among the four resort properties along 1000-ft of shorefront, the individual cost may be in the order of between $300K and $450K per property, by shorefront length, without subsidy.*

4) *A volume of 3,480 CY along Marriott is only 655 CY (23%) greater sand volume than the proposal to fill geotubes & mattresses and to provide de-minimus beach fill that would result in basically no advance in beach width.*

5) *The other parallel and reliable solution is selected local strategic retreat. Any opportunity to remove at least parts of an existing seawall to create additional upland for the beach is a means to create reliable beach recreation area and guests' wading entry to the sea. It exchanges some upland terrace areas for valuable beach area that does not otherwise rely upon seasonal fluctuations, beach nourishment, or structures. This option is becoming more increasingly adopted in the face of rising sea levels and diminishing natural beach sand supply.*

6) *I would finally note that, in my experience, misappropriate beach management – such as unaesthetic geotubes-mattresses and/or an over-eroded beach – has far reaching consequences to the Cayman Islands beyond just the subject property. Guests' perception of an ugly, absent, or unusable sand beach along one major property quickly spreads like a cancer to the remainder of the beachfront, warranted or not. The reputation of Seven Mile Beach as a whole can become rapidly tarnished by the lack of beach (or an unattractive, unusable beach) at a few discrete properties along SMB. Accordingly, prudent action to ensure the value and attractiveness of the beach along any few single properties along SMB is of great overall value to all of the properties along SMB and the Cayman Islands in general.*

The Department supports the recommendations made by Olsen & Associates and reiterates its request for a meeting with the Ministry of Environment and Ministry of Planning to discuss the logistical arrangements for a Government-led nourishment exercise to assist these properties.

Technical Review Committee – Department of Environment
On behalf of the Director, Department of Environment