COASTAL SYSTEMS INTERNATIONAL, INC.
464 South Dixie Highway • Coral Gables, Florida 33146
Tel: 305-661-3655 • Fax: 305-661-1914
www.coastalsystemsint.com

415000

September 25, 2023

Mr. Sai Nidval
DART ENGINEERING & CONSTRUCTION CO. LTD.
89 Nexus Way, Camana Bay
Grand Cayman, Cayman Islands

RE: PEER REVIEW OF THE BEACH RESTORATION AND SHORELINE MANAGEMENT REPORT, SEVEN MILE BEACH, GRAND CAYMAN, CAYMAN ISLANDS

Dear Mr. Nidval,

This is to present our peer review of the DHI Draft Final Report dated July 21, 2023, titled "Seven Mile Beach, Grand Cayman – Beach Restoration & Shoreline Management" presenting mathematical modeling studies and analysis (Report). In general, the Report fully achieved the stated main objective of 'creating profound knowledge of the coastal system', which serves as a basis for developing a shoreline management plan for Seven Mile Beach (SMB). Phase 1 of the recommended shoreline management plan includes initially placing 200,000 m³ of sand at two specific locations along SMB. This represents a very good starting point for shoreline management, particularly given the vulnerability of beachfront properties and the associated economic impacts if the beach is not expeditiously improved.

Beach renourishment is recommended every five years, or on an adjusted timeframe depending on storm frequency and beach performance. A twice-yearly shoreline monitoring program is further recommended in the Report to facilitate future shoreline management planning. These further recommendations also represent very good starting points. However, additional technical studies and economic assessments are needed to further refine a long-term shoreline management plan for SMB. The following presents a synopsis of the Report, provides comments, and outlines additional studies needed to further compliment the Report and support future planning:

Report Synopsis

The following highlights important findings presented in the Report:

Study Objectives: The Report successfully serves as a technical foundation and well-informed assessment for on-going development of a shoreline management plan.

Wave Conditions Influencing Sediment Transport: The study effectively utilizes available meteorological and bathymetric data to mathematically model and predict the transformation of offshore waves to the nearshore, towards predicting nearshore current conditions and sediment movement along SMB. Forty-three years (1979 to 2022) of available meteorological data was analyzed to assess nearshore wave conditions and the resulting influence on sediment transport along SMB. Twenty-three tropical storms and hurricanes (between 2000 & 2022) were simulated to determine their influence on sediment balance along SMB. The following was concluded:

- Normal wave conditions arriving at SMB are minimal, contributing to negligible sediment movement.
- Nor'westers cause sediment transport along SMB from north to south. Data indicates that nor'wester events have declined in intensity since the late 1990s, reducing recent southward sand movement.
- Tropical storms and hurricanes cause sediment transport from south to north along SMB. Since 2020, a series of storms and hurricanes have contributed to excessive northerly sediment movement, further exasperating erosion along the southern shoreline of SMB.
- Hurricanes cause complex current patterns around the offshore reef system, contributing to sand transport across the shoal that results in the loss of sediment into deep water.
- Hurricanes also cause erosion of the beach face, where up to 30 m^3/m of sand is re-deposited offshore, resulting in up to a 20-meter horizontal retreat of the shoreline during a single hurricane event.

Longshore Sediment Transport: The numerical modeling predicted longshore sediment transport (littoral drift) volumes associated with nor'westers, utilizing data from 1979 to 2022, as well as for 23 simulated tropical storms/hurricanes occurring between 2000 and 2022. The following was concluded:

- Nor'wester events prior to 2000 predicted littoral transport rates of 20,000 to 30,000 m^3/year towards the south. In the last decade littoral transport associated with nor'westers is predicted at less than 5,000 m^3/year towards the south.
- The accumulated sediment transport along SMB was predicted for all 23 simulated tropical storms/hurricanes over 22 years, assuming sand is available in the system to be transported.
- Predicted northward sediment transport volumes associated with storms range from 400,000 m^3 in the southern part of the beach to 100,000 m^3 towards the north. Average annual transport rates therefore vary from 18,000 m^3/year in the south to 4,500 m^3/year in the north.
- The three strongest simulated storms predicted transport rates along SMB of between 31,000 m^3 and 11,000 m^3 per event.

Loss of Sediment to Deep Water: The numerical models predict complex flow patterns around the reef and shoal system during tropical storms/hurricanes, resulting in the permanent offshore loss of sediment into depths greater than 5 meters. The following was concluded:

- The total potential sediment loss to the offshore for all hurricanes combined over 22 years is approximately 380,000 m^3, which corresponds to about 17,000 m^3/year of losses on average. This number may be high as the model may over-predict sand movement and some material may be returned to the system.
- Satellite imagery indicated areas where the sand bed appears wider in depths of 10 to 20 meters, which corresponds to areas where the model predicts offshore sand movement.
- Carbonate sand produced by living organisms on the reef is likely not sufficient to replace beach sand lost to the offshore during times of high hurricane activity.

Report Recommendations: The imbalance between northward and southward components of the annual sediment transport along with the offshore sand losses from the beach system are contributing to beach erosion along SMB. A beach renourishment project is recommended to replace the lost sand, as follows:

- An initial nourishment volume of 200,000 m³ is proposed, with the expectation that a five-year frequency will be required for regular renourishment.
- The initial nourishment volume will be distributed between two 'sand engines', or feeder beaches, allowing wave activity to distribute the sand along SMB without the need for extensive heavy equipment on the beach.
- Sand moving across the shore during storm events is proposed to be collected in designated sand traps in depths of between 10 and 20 meters, to be subsequently utilized as a source of sand fill for future renourishment projects.
- Shoreline monitoring twice a year is recommended to better understand sediment movement and facilitate planning for future maintenance activities.

Comments

As noted, the Report met its objectives and provided sound recommendations for a first step in developing a shoreline management plan for SMB. The following comments are offered for consideration to reinforce the findings and recommendations:

- The use of state-of-the-art numerical models by DHI was excellent in generally establishing potential sediment transport volumes. However, because the models make certain inherent assumptions, the sediment transport volumes should not be considered exact, but rather an indication of potential sediment transport volumes.
- The Report highlights previous studies conducted for SMB but did not provide a discussion of these prior report findings. Further discussions on prior surveys and prior erosion studies might serve to reinforce model findings presented in the Report. Specifically, incorporation of recent volumetric change studies along SMB based on published survey data would further validate the predicted volumes.
- The first renourishment project recommends placement of 200,000 m³ of sand as compared to predicted hurricane induced losses over the past 22 years of 380,000 m³. As noted above, a 200,000 m³ fill project is an excellent start. However, some further discussion on the optimization of this fill volume may be warranted as this first proposed project represents only about 50% of predicted losses from the last 22 years.
- A renourishment project requiring placement of between 50 m³/m and 100 m³/m would not be uncommon for this type of beach system. Based on 7,000 m length of sandy shoreline, a renourishment project of 350,000 m³ to greater than 500,000 m³ may be expected to bring the beach back to a historically healthy condition.
- It would be desirable to define a historically wider SMB shoreline and determine the volume of sediment needed to restore the present shoreline to that historical condition. This will again provide a frame of reference against the model predictions and support future shoreline management planning.
- The Report suggests limited southerly sediment movement, and thus limited loss of sediment towards the south. Historical aerials illustrate sand accumulation along and within the natural rock outcroppings to the south, suggesting some historical southerly sand

migration that may repeat again in the future. Some further mapping of historical deep water sand accumulation may be warranted in the south.

- The cost of mobilizing a dredge against the unit cost of pumping sand onto SMB may influence the scope of future renourishment projects. A high mobilization cost may justify placing a larger quantity of sand along SMB during each renourishment event.

Additional Studies

In general, the Report presented mathematical modeling studies and analysis of SMB. Follow-up technical engineering reports addressing the above comments is recommended for the following:

- Sub-bottom soundings to verify the quantity of beach quality sand offshore that may be available for future renourishment projects.
- The health and condition of the offshore reef and its ability to provide future protection to the beach and to continue producing sediment.
- The economics of storm protection associated with beach nourishment towards further refining the shoreline management plan.
- Financial strategies for beach maintenance.
- Results of on-going beach monitoring surveys presenting volumetric changes.

We appreciate the opportunity to review this high-quality Report. Should you have any questions please contact me.

Sincerely,
COASTAL SYSTEMS INTERNATIONAL, INC.

R. Harvey Sasso, P.E.
President

rhs:jao