1. MEASURES OF PERFORMANCE

1.1 General

The SMART offshore, segmented breakwater attenuates wave energy through processes of wave shoaling and breaking, increasing bottom friction and inducing turbulence, refraction, reflection, diffraction. Measures of performance are proposed to evaluate whether the project meets the intended objectives generally defined by the Section 227 Demonstration Program. These proposed measures focus on quantifying three categories of performance criteria:

- Functional - sand retention and stabilization of shoreline.
- Economic - reduction of renourishment quantities and/or lengthening of renourishment intervals.
- Structural - stability of the reef, structural integrity, settlement and scour-resistance.

For each performance category, measurement parameters are defined, and performance criteria are suggested.

1.2 Functional Performance – Sand Retention and Shoreline Stabilization

Assessment of the functional performance of the SMART Reef will be based on protecting the southern terminus of the proposed alternative upland sand source beach renourishment project. In the event the beach fill project is not completed, the SMART Reef will be assessed on how effective the native beach sand is stabilized. However, it is assumed that the beach fill will take place.

Functional performance focuses on the degree to which the SMART offshore structure retains sand and reduces sand loss from the beach fill. Sand loss may occur, to a lesser degree, to cross-shore processes (post-construction equilibration, seasonal beach profile change, and storm-induced beach erosion) and, to a greater degree, to longshore processes (natural gradients in longshore sand transport, and interruption of sand transport by structures). In order to predict performance, it has been assumed that cross-shore losses are negligible.

It is difficult, even in ideal conditions, to predict the long-term fate of the beach fill, either with or without the SMART reef. To this end, we utilized the GENESIS numerical model to predict shoreline evolution for both cases: beach fill stabilization with and without the structure.

Inputs for the model include local shoreline positions obtained from LADS surveys (~2000), shoreline erosion rates from USACE reports (Martin 2001) and WIS hindcast data (Station 470, 1990-2000, including storms). Several assumptions concerning the beach fill must be made as the project has not yet been awarded and the sand source is

unknown at the time of this writing. The median grain size, construction or design template, and the volume of fill/LF are all unknown. Some data has been provided, such as a probable design template; this data has been used, with the assumption that the as-built construction profile may vary significantly from the proposed fill profile. Analysis addressing the potential error generated from the differences in planned vs. constructed templates is offered.

Comparisons of numerical results of the GENESIS shoreline model will be made with data collected during post-construction monitoring (beach profile surveys, aerial photography, Argus data, etc.). Functional performance can then be evaluated following each beach profile survey, starting from initial construction and continuing throughout the monitoring program. Performance should be evaluated over both incremental (survey to survey) and cumulative time scales.

Functional Parameters:

A. Volume Change: Loss or gain of volume measured over time between the landward point of profile closure and to a distance offshore defined by the depth of closure (in the absence of an offshore structure). The volumes will be determined from beach profile surveys.

B. Change in Dry Beach Width: Change in distance measured from the "R" markers to the berm crest. This will be determined from beach profile surveys and Argus video data. A standard mean "shoreline" needs to be determined for this study, either a datum-based line, (i.e. MHW) to be measured off the profiles or a visual line (e.g. the wet/dry line) to be measured off the aerial photography. These lines are not the same, so some provision will be needed to determine a relationship between these lines.

Performance Metrics:

A1. Difference in net volume change behind structure and north control site.
Evaluation Criterion: Structure is successful in retaining sand if volume loss is 30% or less than control site.

A2. Difference in net volume change between in-situ measurements and GENESIS and SBEACH output.
Evaluation Criterion: Actual structure sand retention is within +/- 20% of model results.

B1. Difference in dry beach width change behind structure and north control site.
Evaluation Criterion: Structure is successful in retaining dry beach width if beach width loss is 30% or less than north control site.

B2. Difference in dry beach width change between in-situ measurements and GENESIS output.

Evaluation Criterion: If relative reduction in beach width loss is +/- 20% of model results.

1.3 Economic Performance – Reduction of Renourishment Quantities/ Lengthening of Renourishment Cycle

Economic performance focuses on project cost savings realized for the Federal beachfill project as a result of reduced renourishment quantities and/or a longer renourishment cycle. Economic performance can be evaluated at the time of the renourishment following construction of the Federal project. The design renourishment cycle for the Federal project is assumed to be 5 years.

Parameters:

A. Renourishment Volume Requirements: Volume of sand required to restore the beach profile to the design template plus advanced nourishment (and associated cost). Determined from beach profile surveys and cost analysis.

B. Renourishment Interval: Length of time between beachfill activities (and associated renourishment cycle costs). Determined from beach profile surveys, aerial photography, and cost analysis.

Economic Metrics:

A1. Differential costs between amortized Smart Reef and annualized renourishment cost.
Evaluation Criterion: Structure is successful if average annual renourishment cost savings is greater than average annual structure cost.

A2. Beach usage increase with installation of SMART Reef.
Evaluation Criterion: Utilization of beach by tourists and locals increases over pre-construction usage, resulting in a positive regional financial impact to local economy.

B1. Difference in renourishment interval for structured versus non-structured beach. Average annual cost savings over 50 year project life for longer renourishment cycle of structured beach versus average annualized cost of structure.
Evaluation Criterion: Structure is successful if average annual cost savings of a longer renourishment interval is greater than average annual structure cost.

1.4 Structural Performance – Structure Stability

Structural performance measures focus on stability of the offshore structures. Objectives are that the structures maintain functionality over a design life consistent with that of a beachfill project (i.e., 50 yrs) while requiring minimal operation and maintenance. Structural performance should be evaluated throughout the duration of the monitoring program.

Parameters:

A. Change in Elevation of Mean Structure Crest: Decrease in elevation of mean structure crest due to settlement or translation. Determined from baseline elevation surveys along the crest of the structure immediately following construction.

B. Change in Alongshore Structure Integrity: Formation of gaps in structure due to separation of interlocking units or other structure failure resulting in loss of structural integrity and excessive wave transmission. Determined from elevation surveys along the structure.

C. Scour Depth: Elevation of seabed adjacent to structure (seaward and landward sides) in comparison to initial elevation at time of structure placement. Excessive scour may result in failure of structure.

Structural Performance Metrics:

Evaluation of above parameters for SMART structure.

Evaluation Criteria:

A. Successful if average lowering of crest elevation is < 1 ft.

B. Successful if no gaps form that result in structural instability.

C. Successful if average scour along seaward and leeward edges is < 3ft.