



October 19, 2017

## MEMORANDUM

TO: Cliff Ogburn, Town of Nags Head (NC)

FROM: HL Kaczowski, Project Engineer  
TW Kana, Project Director

RE: Nags Head Post-Project Monitoring [CSE 2458–Year 6 After the 2011 Project]  
**Annual Beach Condition Survey – July 2017 – Preliminary Results**

This memorandum offers preliminary results of CSE’s July 2017 condition survey of Nags Head. Profiles were measured at 500 feet (ft) spacing between the foredune and deep water at the same stations used before and after the 2011 nourishment. As plotted in the attachment to this memo, the July 2017 profiles are compared with corresponding profiles obtained in November 2010 (pre-project), November 2011 (post-construction), June 2012 (Year 1 post-project and before 2012 hurricane season), November 2012 (Year 1 post-project and after Hurricane *Sandy*), June 2013 (Year 2 post-project), June 2014 (Year 3 post-project), June 2015 (Year 4 post-project), June 2016 (Year 5 post–project before Hurricane *Matthew*), and October 2016 (Year 5 post-project after Hurricane *Matthew*). Each survey provides a measure of the total volume of sand contained within the Nags Head 10-mile-long project area between the foredune and the depth of the FEMA reference limit at 19 ft NAVD.

The main finding of the July 2017 survey is that **~200,000 cubic yards (cy)** of sand have returned to the Nags Head project area since the post-*Matthew* survey in October 2016. As of July 2017, there are 2,935,772 cy more sand in the project area than the condition before nourishment. Approximately 36 percent of the sand that was placed in 2011 has eroded from the project area over the past six years, and **~64 percent of the nourishment volume remains**. This is equivalent to an annual erosion rate of ~290,000 cubic yards per year (cy/yr) (or ~5.5 cubic yards per foot per year–cy/ft/yr), which is slightly higher than the historical erosion rate of 275,000 cy/yr (~5.2 cy/ft/yr) that was adopted in the 2011 project planning and design.

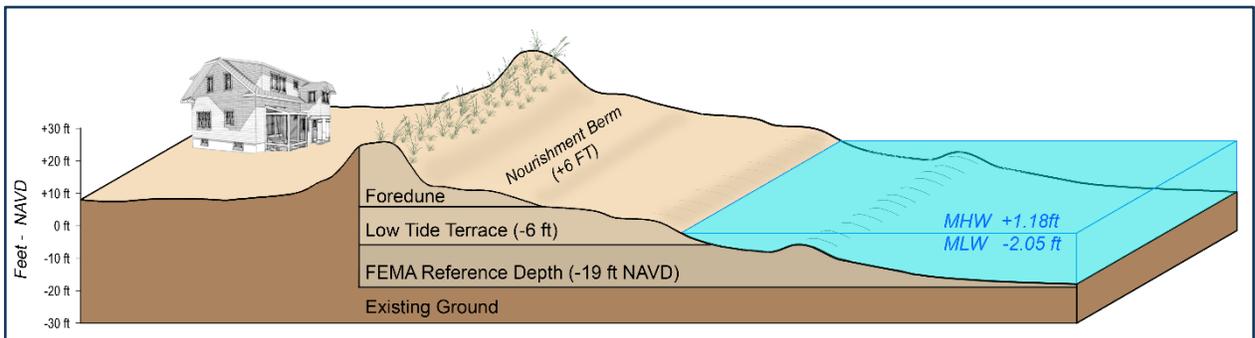
Similar to prior reports, we have computed the volume of sand by lens as well as by reach. This memo contains the preliminary results of the volume calculations. Survey methodology and data analysis results will be discussed in more detail in the final monitoring report. The full report is expected to be delivered to the Town for review before the end of November 2017.

**VOLUME ANALYSES BY LENS**

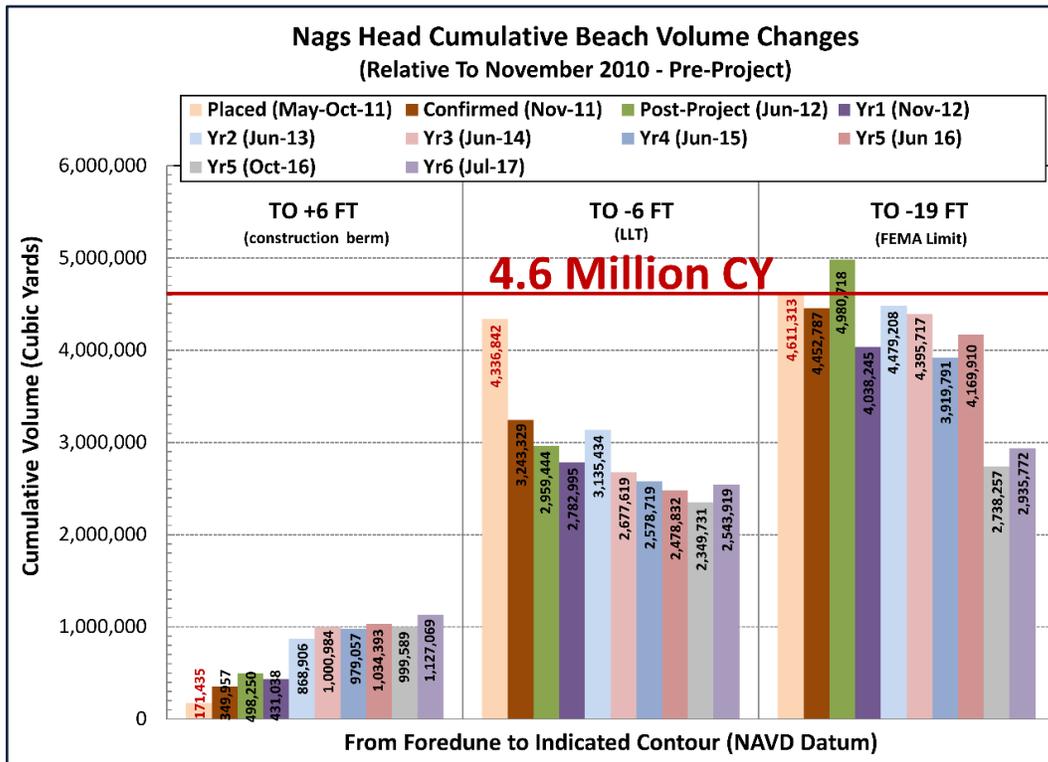
The three reference depth contours used in the analyses are defined as follows and illustrated in Graph A.

- Lens 1 — Foredune – From the face of dune to +6 ft NAVD
- Lens 2 — Beach – Between +6 ft and -6 ft NAVD
- Lens 3 — Underwater – Between -6 ft and -19 ft NAVD

Graph B provides overall results for the project area relative to November 2010. The first set of bars represents net volume changes in the foredune (ie – Lens 1), the second set of bars represents net volume changes along the foredune and beach (ie – Lenses 1 & 2), and the third set of bars represents net volume changes from the foredune to beach and underwater zone (ie – the “sand box” or Lenses 1, 2, and 3).



**Graph A.** Illustration of the three lenses used in the profile volume analysis for Nags Head.

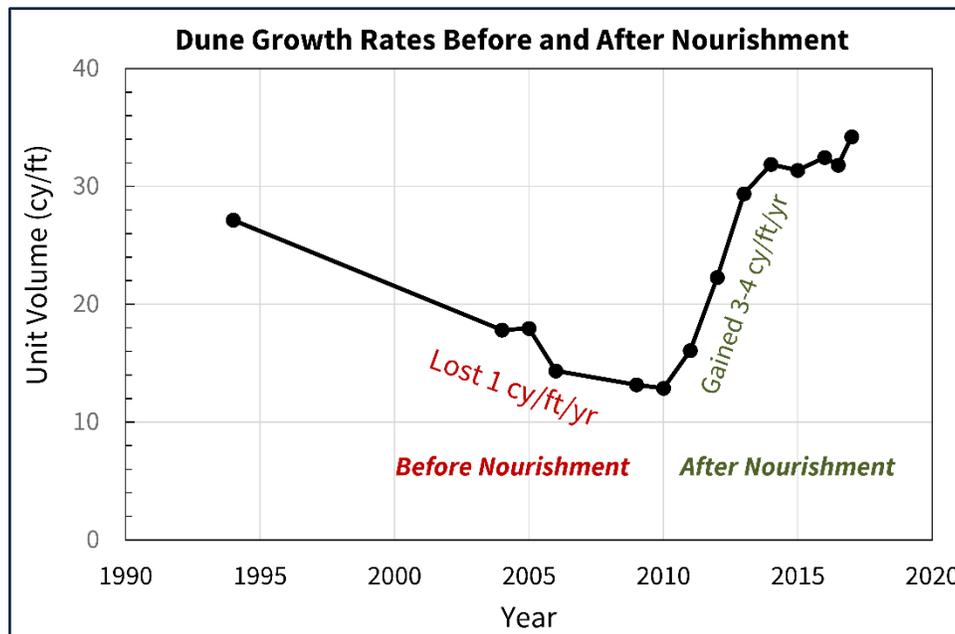


**Graph B.** Cumulative overall volume changes relative to November 2010 (pre-project) survey results between the foredune and indicated contours.

**Foredune (Lens 1)**

The back beach and dune areas have accumulated sand by natural, wind-generated sediment transport since project completion. As of July 2017, Lens 1 has ~1.1 million cubic yards more sand than the before-nourishment condition. This is equivalent to a gain of ~21 cy/ft or ~3.7 cy/ft/yr above +6 ft NAVD (nourishment berm elevation). The gain is considered significant for Nags Head because before nourishment between 1994 and 2010—Nags Head experienced sand losses averaging ~1 cy/ft/yr along this portion of beach as shown in Graph C.

The results also show that there are 127,480 cy more sand in this lens than the condition after Hurricane *Matthew* (Oct 2016), indicating beach recovery after the storm.



**Graph C.** Dune growth/loss rates before and after nourishment.

**Foredune and Beach (Lenses 1 & 2)**

The second set of bars in Graph B shows the total volume changes from the face of the dune to low-tide wading depth (-6 ft NAVD). Following the initial sand adjustment in the first year after project completion, the beach volume has been relatively stable over the past four years. The July 2017 survey shows over 55 percent of nourishment sand remains in the foredune and the beach.



### **Foredune, Beach and Underwater (Lenses 1, 2 & 3)**

The third set of bars in Graph B shows the cumulative volume changes from the face of the dune to –19 ft (FEMA limit). Hurricane *Matthew* caused a total volume loss of 1,431,653 cy, which is equivalent to ~30 percent of the nourishment volume. The July 2017 results indicate that ~197,500 cy of the lost sand has shifted back to the “sand box.” It is expected that the beach will continue to recover and more sand will return to the project area if no extreme conditions occur in the next couple of years. These results yield an average erosion rate of ~290,000 cy/yr (5.5 cy/ft/yr) over the past six years since project completion.

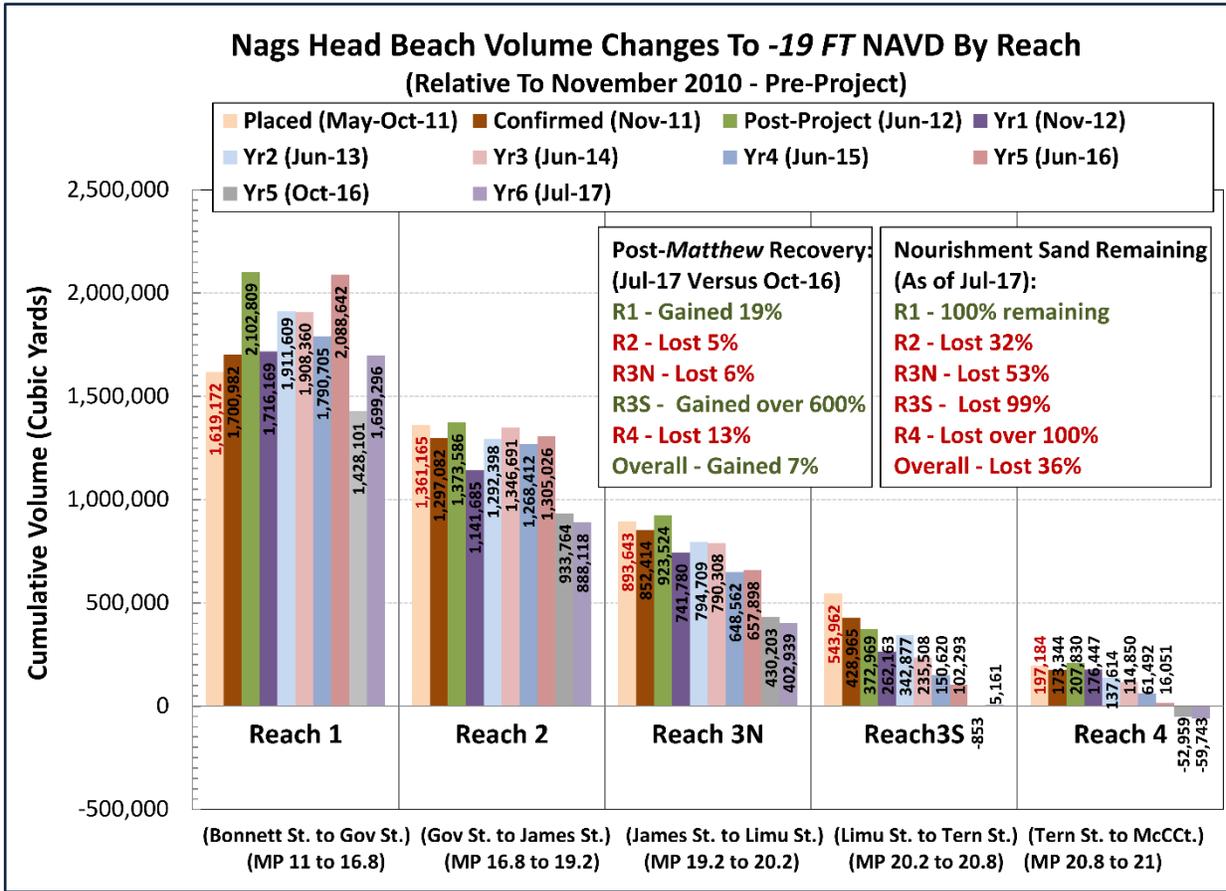
### **VOLUME ANALYSES BY REACH**

The 10-mile-long Nags Head shoreline was divided into five (5) project reaches as used in the 2018 renourishment design. The volumes from November 2010 are used as the baseline condition (pre-nourishment) and are subtracted from the results of subsequent surveys. This yields the change in beach volume with respect to conditions prior to nourishment.

Graph D provides comparisons of volumes remaining by reach relative to the November 2010 pre-project condition. All reaches lost sand during Hurricane *Matthew* as confirmed by CSE’s post-storm survey in October 2016. The results in Graph D show that Reach 1 (northern half of the project) has gained volume in the past nine months since *Matthew* and retains ~100 percent of the nourishment sand as of July 2017. Reach 2 (middle to southern ~2.5 miles of project area) has lost more sand since *Matthew*’s passage, but the majority (~68 percent) of the sand that was placed in 2011 along this reach remains between the foredune and the –19 ft contour. Reach 3N (~1 mile of project area near the south end) remained stable over the past nine months, but overall has lost more than half of the nourishment sand.

Despite the volume recovery after *Matthew* along Reach 3S (~3,500 ft), almost all nourishment volume was lost and this reach has returned to the same condition as before nourishment. Reach 4 (the last 1,500 ft at the south end of the project area) has lost all nourishment sand after *Matthew*’s passage, and volume analysis shows that beach condition in July 2017 is worse than the condition before nourishment. The annual loss rate for Reaches 3S and 4 (the south ~1 mile of the project area) since November 2011 has been over 20 cy/ft/yr which is significantly higher than the overall project area. One of the goals for the renourishment project is to address these higher erosion rates at the south end of Nags Head.

In conclusion, the total volume remaining after nourishment to –19 ft NAVD (FEMA-reference limit) in July 2017 is **~2.94 million cubic yards (~64 percent of the 2011 nourishment volume)** along the 10-mile-long Nags Head beach. The results to date indicate the project is performing as expected, and the erosion gradient from the north to the south is consistent with the historical trend. The planned renourishment project is considered crucial to augment the 2011 beach nourishment and replenish the project area with additional sand.



**Graph D.** Volume changes by reach relative to Nov 2010 (pre-project) survey results between the foredune and -19 ft NAVD.

**Attachment:** Nags Head Beach Profiles and Unit Volumes (survey dates are Nov 2010, Nov 2011, Jun 2012, Nov 2012, Jun 2013, Jun 2014, Jun 2015, Jun 2016 – before Hurricane *Matthew*, Oct 2016 – after Hurricane *Matthew*, and Jul 2017)