Considerations for Beach Design: Incorporating Large Storms into Renourishment Projects

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Presentation Overview

- History of Project Area
- Study Objectives
- Results
- Comparison with Previous Design Standards
- Conclusions & Recommendations
Project Details

- Template based upon the GRR Design
  - 6.6 ft-NAVD berm (1988 7 ft-NGVD contour)
  - 30 and 50 ft. design widths
  - Transitions near R-17

Project Reaches

<table>
<thead>
<tr>
<th>REACH</th>
<th>PROFILES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carillon Beach &amp; Pinnacle Port</td>
<td>R1 to R4</td>
</tr>
<tr>
<td>Western Reach</td>
<td>R5 to R29</td>
</tr>
<tr>
<td>Middle Reach</td>
<td>R30 to R65</td>
</tr>
<tr>
<td>Eastern Reach</td>
<td>R66 to R91</td>
</tr>
</tbody>
</table>

Note: CB-PP added to the Federal project area in 2009
Panama City Beach History

• Nourished initially in 1998/1999
  • 9 million cubic yards over 17.5 miles
  • Avg. MHW shoreline Change (May 1999 to June 2004)
    • -23.3 feet
  • Avg. Volumetric Change (May 1999 to June 2004)
    • -669,626 cubic yards
  • Project performed above expectations
    • 85% of as-built volume remained in 2004

And then....
Hurricane Ivan

- Impacts study area in 2004
- One of most destructive hurricanes to impact Panhandle

- 2.5 million cubic yards lost
- Nourishment needed to address losses
- Beach suffered profile lowering and dune erosion
Panama City Beach History (continued)

Volume required to Address Storm Losses & Restore Beach

Hurricane Loss Replacement (FCCE) 2,411,560
Renourishment Volume (CG) 1,549,270
Total 3,960,830

• Renourished in 2005/2006
  • 3.3 million cubic yards
    • Fill volume reduced due to borrow area limitations
  • Hurricane Dennis, Katrina, and Wilma impact the area during construction
    • Loss unmeasurable due to construction
    • Estimated at least 1.5 million cubic yards lost
  • Western and Eastern Reach impacted the greatest
• 2005-6 project advanced shoreline approximately 30 ft.

• Beach did not fully recover to pre-Ivan conditions
  • Active profile still gaining sand 5 years later

• Beach remains ~12 ft. short of volumetric expectations
Objectives of Study

• Analyze impacts that various periods have upon advanced nourishment
  • periods of recovery
  • major storms
  • calm periods/mild weather
• Policy versus Implementation
• Another means to create robust beaches
Advanced Nourishment

- "Sacrificial Sand"
- Maintains the design fill section during the initial renourishment interval
  - Time of completion of the project to the next scheduled renourishment

FIGURE D-5  The construction template.
Advanced Nourishment Calculations

“Traditional Method”

• Based on long-term shoreline recession
  • Historic/background erosion rates
  • Tends to favor non-storm periods

• Erosion rates were generalized for many areas in the original project
  • Did not account for small areas with higher erosion rates
## Historical Shoreline Analysis Rates

<table>
<thead>
<tr>
<th>Stations</th>
<th>Shoreline Change Rate (ft/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0+00 to 410+00 (R-1 to R-38)</td>
<td>-0.5</td>
</tr>
<tr>
<td>410+00 to 830+00 (R-38 to R-81)</td>
<td>0.5</td>
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<tr>
<td>830+00 to 990+00 (R-81 to R-97)</td>
<td>-2.1</td>
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</table>

Note: from 1994 GRR

R-1 to R-81 time period = 1855/1872 to 1988

R-81 to R-97 time period = 1934 to 1988
### Fill Volume from PCB GRR (1994)

<table>
<thead>
<tr>
<th>STATION</th>
<th>FILL BEHIND ECL (CY)</th>
<th>DESIGN** VOLUME (CY)</th>
<th>OVERFILL (CY)</th>
<th>'88-'99 EROSION LOSSES (CY)</th>
<th>TOTAL CONSTRUCTION VOLUME (CY)</th>
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<td>11,625</td>
<td>22,911</td>
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</tbody>
</table>

**TotaLs**

| 1,016,528 | 4,153,300 | 1,245,990 | 366,314 | 683,020 | 6,448,624|

* Includes 30% overfill
** Design volume includes fill behind ECL
## Advanced Nourishment Calculations

### “Traditional Method”

<table>
<thead>
<tr>
<th>Region</th>
<th>Advanced Nourish (C.Y.)</th>
<th>30 % Overfill</th>
<th>Total (C.Y.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPP (R1-4)</td>
<td>108,814</td>
<td>32,644</td>
<td>141,458</td>
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<tr>
<td>West (R5-28)</td>
<td>170,283</td>
<td>51,085</td>
<td>221,368</td>
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<tr>
<td>Middle (R29-65)</td>
<td>3,383</td>
<td>1,015</td>
<td>4,398</td>
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<tr>
<td>East (R66-91)</td>
<td>93,533</td>
<td>28,060</td>
<td>121,593</td>
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<tr>
<td>TOTAL (R5-91)</td>
<td>267,199</td>
<td>80,160</td>
<td>347,359</td>
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</table>

- Calculated in same manor as 1994 values
- Time period = May 1999 to June 2004
- 30 % overfill vs the 10 % used today
- Approximately 350,000 cubic yards needed based upon traditional method
Advanced Nourishment Calculations

Incorporating Storm into Adv. Nourishment

• Long term erosion PLUS a major storm considered
• Profiles analyzed on an individual basis
  • No regional rates
  • Allows for areas with higher erosion to get more sand
• Creates more robust beach profiles
## Advanced Nourishment Calculations

### Incorporating Storm into Traditional

- **Time period** = May 1999 to Oct. 2004
- **10 % overfill factor used**

<table>
<thead>
<tr>
<th>Reach</th>
<th>Advanced Nourish (C.Y.)</th>
<th>Overfill (C.Y.)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>CB-PP (R1-4)</td>
<td>212,818</td>
<td>21,282</td>
<td>234,099</td>
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<td>West (R5-29)</td>
<td>779,059</td>
<td>77,906</td>
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<td>Middle (R30-65)</td>
<td>135,302</td>
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<td>East (R66-91)</td>
<td>355,866</td>
<td>35,587</td>
<td>391,453</td>
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<td>TOTAL (R1-91)</td>
<td>1,483,045</td>
<td>148,305</td>
<td>1,631,350</td>
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</tbody>
</table>
### Advanced Nourishment Calculations

#### Major Storm, Recovery, and Calm Periods

- **Time period**: May 1999 to May 2010
- **10% overfill factor used**

<table>
<thead>
<tr>
<th>Reach</th>
<th>Advanced Nourish (C.Y.)</th>
<th>Overfill (C.Y.)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>CB-PP (R1-4)</td>
<td>102,687</td>
<td>10,269</td>
<td>112,956</td>
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<td>West (R5-29)</td>
<td>297,873</td>
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<tr>
<td>Middle (R30-65)</td>
<td>170</td>
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<td>187</td>
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<tr>
<td>East (R66-91)</td>
<td>183,925</td>
<td>18,393</td>
<td>202,318</td>
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<tr>
<td><strong>TOTAL (R1-91)</strong></td>
<td><strong>584,655</strong></td>
<td><strong>58,466</strong></td>
<td><strong>643,121</strong></td>
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</tbody>
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- **Time period** = May 1999 to May 2010
- **10% overfill factor used**
Observations

- Major storm approx. every 5 years
- Offshore losses can recover after major storms
- Experiencing shoreline recovery, however sand not in its intended design location
Benefits of New Method vs Traditional

• Design beach less impacted after major storms
• Helps minimize tourism losses
• Aids design when there is small template design criteria
Other Observations found within Panama City during Study

- Pier Effects
  - City and County Piers act like groins
  - Observed typical updrift/downdrift effects

![Annualized Smoothed Volumetric Changes](image_url)

Note: Composite Erosion Rate is a combination of the 1999-2004 and 2006-2009 Erosion Rates.
Other Observations found within Panama City during Study

- Both piers were damaged in recent storms and both were removed and then re-constructed
  - Removed in 2008; Rebuilt in 2009
- When structures removed, accretional filet lost and less erosion downdrift
Conclusions

Incorporating major storms into advanced nourishment creates more robust beaches able to weather storms until full recovery/restoration has occurred

• Enough sand must remain to support tourism/business

• Aids in policy where long term or quick permits are not feasible
  • Can cause a delay implementing storm recovery projects

• Storms are driving factor for renourishment in Panama City Beach
  • Major storm impacts area approximately every 5 years

• Recovery is still occurring 5 to 6 years after major storms
  • Sand is still observed recovering from the offshore
Thank You!

FSBPA National Conference – February 2011 - Jacksonville, FL