Flood Control Structures – Sometimes Neither Fish Nor Fowl

David Rubenstein, CFM
Jim Murphy, PE, CFM
Agenda

– Approach
– Study Area
– Flood Control System overview
– Levee Analysis and Mapping Procedure (LAMP)
– Primary Frontal Dune
– Phase 1 modeled scenarios
– The reality of the community
  • Zone D
  • Impacted by Hurricane Sandy
  • Economics
  • Community/ State working upgrading levees
  • Congressional authorization for flood control projects
  • How was LAMP conveyed to communities?
    – Participants
  • Other items to consider
  • Conclusion
Fact

Public safety remains at risk from aging levees. The cost to repair or rehabilitate these levees is roughly estimated to be $100 billion. However, the return on investment is clear – as levees helped in the prevention of more than $141 billion in flood damages in 2011.

Estimated Investment Needed by 2020: $3.6 Trillion

*National Committee on Levee Safety*
Approach

Technical Review
Complex Flood Control System
Primary Frontal Dune
Levees

Challenges for the community
Study area
Vicinity map

- Monmouth County, New Jersey
- Northernmost county along the Jersey Shore
- Fifth-most populous county in the state
- Most populous community is Middletown Township
- 38th “highest-income county” in the US
Analysis and Mapping Procedure (LAMP)
Overview of LAMP approach

There are five procedures detailed in the LAMP Final Approach Document.

- Sound Reach
- Freeboard Deficient
- Overtopping (Levee)
- Structural-Based Inundation
- Natural Valley

A levee system can be broken up into multiple reaches in order to analyze the flood risk in its vicinity.
Flood control system overview
Bayshore LAMP study of Monmouth County, New Jersey – flood control system includes dunes and levees
Region II storm surge study

- Flood Gate assumed open
- 1 low point on Thorn Creek Levee
- 1 low point on Pews Creek Levee
- Dunes did not allow inundation
LAMP First Pass 2D modeling

- Flood Gate assumed closed
- 1 breach in Thorn Creek Levee
- 1 breach in Pews Creek Levee
- Overtopping of dune line
Pop Quiz

Who owns and operates the majority of levees in the US?
   a) FEMA
   b) Community or private
   c) USACE
   d) State

**Answer: b) Community or private**
Levee portfolio or USACE program levees, account for only about 15 percent of the nation’s levees

http://www.leveesafety.org
Primary Frontal Dune
Erosion analysis

Dunes:
Dune erosion based on the 540 ft² rule

- Reservoir < 540 ft²: Dune removal
- Reservoir > 540 ft²: Dune retreat

Primary Frontal Dune Reservoir

Is it:
> 540 square feet?
or
< 540 square feet?

1%-annual-chance stillwater elevation

Dune Crest

Dune Toe

← Bay

Land →
Removal vs. retreat

Dune Removal

Dune Retreat

*Wave runup and overtopping can introduce flood waters behind remnant dune
Coastal study revealed 3 areas where erosion analysis allows inundation by 1%-annual-chance storm surge landward of the dunes.
Pop Quiz

What is the longest levee system in the United States?

**Answer: Mississippi River Levee System**

3,500 miles of levees extending some 620 mi along the Mississippi, stretching from Cape Girardeau, MO, to the Mississippi Delta.

Mississippi Water Resource Association
Phase 1 modeled scenarios
**Phase 1 modeled scenarios**

7 scenarios modeled in FLO-2D

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<td>Pews Breach</td>
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**Navigation Gate**
- Thornes Low Point
- Thornes Floodwall
- Pews Floodwall
- Pews Breach
- Dune Overtopping (Sandy)
- Dune Overtopping (FEMA)
Model set-up

Topography

Land Use

Storm Surge

Dune Erosion/
Overtopping

FLOOD2D
Results – run 1

- LAMP: Overtopping, Sound Reach
- Flood sources:
  - Navigation gate
  - Natural low point along Thornes Creek Levee
- Gate is open for 36 hours until surge rises to 4 feet
- Low point along Thornes Creek Levee varies from 0.2 to 1.4 feet below peak surge.
- Floodplain approximately 0.38 sq. mi.
- Approximately 350 structures within floodplain
Results – run 2

- LAMP: Overtopping, Sound Reach, Structural Inundation

- Flood sources:
  - Navigation gate
  - Natural low point along Thornes Creek Levee
  - Thornes Creek Floodwall

- 150 foot section of floodwall removed, natural ground elevation varies between 3.9 and 6 feet below peak surge

- Floodplain approximately 1.05 sq. mi.

- Approximately 2,580 structures within floodplain
Results – run 3

– LAMP: Overtopping, Sound Reach, Structural Inundation

– Flood sources:
  • Navigation gate
  • Natural low point along Thornes Creek Levee
  • Pews Creek Floodwall

– Entire floodwall removed (approximately 100 feet). Natural ground elevation 5.6 feet below peak surge.

– Floodplain approximately 1.39 sq. mi.

– Approximately 3,765 structures within floodplain
Results – run 4

- LAMP: Overtopping, Sound Reach, Structural Inundation

- Flood sources:
  - Navigation gate
  - Natural low point along Thornes Creek Levee
  - Thornes Creek Floodwall
  - Pews Creek Floodwall

- Floodwalls modeled as described for Runs 2 & 3 combined

- Floodplain approximately 1.69 sq. mi.

- Approximately 4,425 structures within floodplain
Results – run 5

- LAMP: Overtopping, Sound Reach, Structural Inundation

- Flood sources:
  - Navigation gate
  - Natural low point along Thornes Creek Levee
  - Pews Creek Levee Breach

- Levee Breach represented by removing 150 feet of levee. Natural ground elevation 7.5 feet below peak surge.

- Floodplain approximately 1.61 sq. mi.

- Approximately 4,300 structures within floodplain
Results – run 6

- LAMP: Overtopping (Levee), Sound Reach, Dune Overtopping

- Flood sources:
  - Navigation gate
  - Natural low point along Thornes Creek Levee
  - Sandy-based Dune Overtopping

- Dune overtopping occurs along 3 sections of dune

- Floodplain approximately 0.9 sq. mi.

- Approximately 2,090 structures within floodplain
Results – run 7

- LAMP: Overtopping (Levee), Sound Reach, Dune Overtopping

- Flood sources:
  - Navigation gate
  - Natural low point along Thornes Creek Levee
  - FEMA Erosion-based Dune Overtopping

- Dune overtopping occurs along 6 of 10 dune sections

- Surge overflow occurs along 5 of 10 dune sections

- Significant flow into system produces natural valley scenario
Results – natural valley/all flood control structures removed

- Natural Valley mapping represents the minimum extent of Zone D
- Floodplain is approximately 2.27 sq. mi.
- Approximately 5,605 structures within floodplain
Pop Quiz

How many miles of levees are there in the United States?
   a) 50,000
   b) 75,000
   c) 100,000
   d) 125,000

**Answer: b) 100,000**

http://www.leveesafety.org
The reality for the community
Zone D – natural valley

- Example using Natural Valley Zone D and Run 3 floodplains
- Final floodplains and mapping will not match this figure, and will not be known until later in the project
- Zone D occupies areas outside of Zone VE or AE where BFE’s are defined
Zone D – Challenges

- High Insurance Rates
- No credit for elevation

“Flood insurance rates for properties in Zone D are commensurate with the uncertainty of the flood risk.” - FEMA
Impacted by Hurricane Sandy

- Stakeholders recognized residual risk behind levees and dunes
- Reconstruction included some elevation of structures
Economics

**Keansburg** – as of 2014 Median household income (in 2014 dollars), 2010-2014 – $43,696

**Union Beach** – as of 2014 Median household income (in 2014 dollars), 2010-2014 – $74,081

**Middletown** – as of 2014 Median household income (in 2014 dollars), 2010-2014 – $103,907

http://www.census.gov/
Community/State working repairing/upgrading levees and dunes
# Congressional authorization for flood control projects

<table>
<thead>
<tr>
<th>Date of Corps Construction</th>
<th>1962 - Initial Project Construction</th>
<th>2013 - Repair and Restoration Activities Post-Hurricane Sandy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purpose of Work/Description of Authority</td>
<td>Provide Beach Erosion &amp; Hurricane Damage Reduction</td>
<td>Corps authorized to repair damage from Hurricane Sandy &amp; restore to the original Design Template of 1962.</td>
</tr>
<tr>
<td>Design Development Considerations</td>
<td>Design of top elevation was based upon maximum record surge of 10.4ft; 25 Nov 1950. Other design consideration were based upon current engineering practices.</td>
<td>Designs were developed to achieve the original design while incorporating current standard engineering where possible. Construction Costs were limited in that they must support a positive benefit to cost ratio (at current price levels).</td>
</tr>
</tbody>
</table>
How was LAMP conveyed to communities?
Participants

– Mayors and decision makers
– Congressional Staff
– Engineers and Floodplain managers
– Universities
– Community developers
Other items to consider
RARITAN BAY AND SANDY HOOK BAY
NEW JERSEY

BEACH EROSION AND HURRICANE PROJECT
KEANSBURG SECTION

OPERATION AND MAINTENANCE MANUAL

NEW YORK, NEW YORK
JULY 1976

WAYCAKE CREEK

NAVIGATION CLOSURE GATE

PUMP STATION

THORNS CREEK

RARITAN BAY

RIPRAPPED LEVEE

ACCESS ROAD

KEANSBURG, NEW JERSEY - BEACH EROSION CONTROL AND HURRICANE PROTECTION PROJECT
Pop Quiz

According to the 2013 report card for American Infrastructure, America’s grade for levees is what?

**Answer: D-**

http://www.infrastructurereportcard.org/
In conclusion....
In conclusion

– Falls on communities hands

– Coordination between governments
  • Recognized the value of risk reduction
  • Understood the issue is greater than just insurance rates

– There is no easy solution
Questions?
Contact information

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