City of Virginia Beach Comprehensive Sea Level Rise and Recurrent Flooding Response Plan

Study Overview

July 11, 2017
Flood Complaints

Ocean Park Flooding

During the November and December 2009 northeasters, extreme flooding due to abnormally high storm tides and heavy rainfall occurred which impacted the Ocean Park neighborhood, among others. The City of Virginia Beach commissioned a study of these occurrences and the Draft report from Parsons Brinckerhoff was received and made available October 2010, may be viewed by clicking.

Virginia Beach looks for long-term Shore Drive flooding fixes

Va. Beach residents seek answers about flooding
City Response to Issues

• Virginia Beach City Council provided funding for a comprehensive sea level rise and recurrent flooding assessment and response plan in FY15

• Dewberry, a national consultant firm, retained by the City to conduct study in January 2015

• City awarded $850k grant from NOAA in March 2016

• Collaborative effort with Stormwater Master Plan
Study Goal and Outcomes

Goal:
Produce information and strategies that will enable Virginia Beach to establish long-term resilience to sea level rise and associated recurrent flooding

Outcomes:

• A full understanding of flood risk and anticipated changes over planning and infrastructure time horizons
• Actionable flood resilience plans that combine engineered protection measures, accommodation, and/or land use management strategies
• A fine-tuned public outreach process to advance resilience initiatives
Watershed Level Plans

• Economic and environmental diversity require 4 distinct plans

<table>
<thead>
<tr>
<th>Planning Area/ Natural Resources</th>
<th>Defining Characteristics</th>
<th>Challenges</th>
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<tbody>
<tr>
<td>Lynnhaven / Tidal sheltered bay, estuarine, fringing marsh</td>
<td>Mixed residential, military, commercial, lower elevation properties with high tax base. High quality natural resources. Assets at vulnerable elevations.</td>
<td>Addressing repetitive losses from recurrent flooding and preservation of low-lying natural resources.</td>
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<td>Oceanfront / Ocean, headland beaches, tidal inlet, bay</td>
<td>Dense commercial and residential development. Tourism as primary economic driver. Redevelopment opportunities. USACE Civil Works flood risk reduction project.</td>
<td>Protecting existing development and economic base while instilling resilience as a keystone in redevelopment.</td>
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<td>Elizabeth River / Estuarine, fringing marshes</td>
<td>Dense residential, commercial, industrial development. Aging infrastructure.</td>
<td>Upgrading infrastructure and maintaining water-based industrial economy with higher sea levels.</td>
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<td>Southern / Ocean, barrier beaches, back bays and extensive marshes</td>
<td>Light residential, military, rural, recreational, waterfowl and land preserves. Agriculture important economic concern. Low elevation gradients.</td>
<td>Establishing land use strategies that preserve resources and limit new development and infrastructure in areas susceptible to future flooding.</td>
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Comprehensive SLR Study Approach

1. Sea Level Rise/ Recurrent Flooding Impacts
   Defining the problem

2. Adaptation Strategies
   Tailoring the solutions

3. Implementation
   Planning the actions
Phase 1: Sea Level Rise/Recurrent Flooding Impacts

- Objective: Identify the location, frequency and potential cost of existing and future flood risk to the City

- How will vulnerability change with increasing flood levels due to SLR?
  - Where will we see the flood footprint expand?
  - How much more frequent will flooding occur?
  - What assets are vulnerable?
  - What are the losses, how will they change?
  - What assets are at the highest risk?
## VB SLR Planning Scenarios

<table>
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<tr>
<th>Life Cycle Alignment</th>
<th>Time Horizon/Time Period</th>
<th>SLR Value</th>
<th>Relevance</th>
<th>Use</th>
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<tbody>
<tr>
<td>Municipal Planning</td>
<td>20-40 years 2035-2055</td>
<td>1.5 ft</td>
<td>Comprehensive Plan &amp; Outcomes</td>
<td>Vulnerability assessment Key planning value Basis for evaluation of all adaptation strategies</td>
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<td>Short end of Commercial and Utility life-cycles</td>
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<td>Critical Infrastructure Long-term awareness</td>
<td>50-70 years 2065-2085</td>
<td>3.0 ft</td>
<td>Utility Infrastructure life-cycle Transportation infrastructure lifecycles Residential structure lifecycles</td>
<td>Secondary vulnerability assessment to provide insight into long-term risk Basis for long-term infrastructure decisions Evaluate cost-effectiveness of additional protection for adaptable resilience strategies</td>
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Flood Assessment Conditions

- **Tidal**
  - Daily tidal flooding
  - Future permanent inundation
  - Defined by NOAA, Mean Higher High Water

- **Nuisance**
  - Wind-driven surge, extreme tide events
  - Repetitive losses/
    loss of function or service
  - Defined by water level analysis

- **Storm Surge**
  - Nor’easters, tropical storms, hurricanes
  - 10-, 25-, 50-, 100-, 500-yr recurrence intervals
  - Defined by probabilistic analysis
Hazard Assessment Process

- **Flood Stillwater Surfaces**: Integrate best source data into seamless 3D surface
- **SLR Non-linearity**: Apply non-linear factors to surfaces
- **Floodplain Delineation**: Map new floodplains at each flood frequency
- **Wave Hazard Modeling**: Model changes to wave heights/dune erosion
- **Total Flood Elevation Surface**: Build new 3D surface including wave effects
- **Depth Grids**: Calculate depth of flood for each condition

To Loss Estimation
Be cognizant of **full** future condition

### Diagram

- **SOURCE:** Increased Precipitation
- **RECEPTOR:** Floodplain
  - Increased flood frequency, elevation, and saltwater intrusion
- **PATHWAY:** Marshes
  - Degradation & loss
- **PATHWAY:** Barrier Islands
  - Overtopping, breaching, & inundation
- **SOURCE:** Sea-Level Rise & Increased Storminess
- **RECEPTOR:** Watershed
  - Increased runoff
- **RECEPTOR:** Built Environment
  - Increased exposure & losses
- **RECEPTOR:** Estuary
  - Ecology, water quality, & circulation changes
- **RECEPTOR:** Barrier Islands
  - Erosion, dune lowering, and failure
Flood elevations - Not a static increase!

• SLR Integration:
  • 1.5 ft SLR scenario
    • Added as a static increase to surge elevations
    • Non-linear aspects captured through re-evaluation of dune erosion and wave modeling over increased water levels.
  • 3 ft SLR scenario
    • Detailed modeling from USACE and North Carolina used to integrate non-linear response in surge elevations
    • Wave modeling and dune erosion also re-evaluated.
“Whole Picture” Analyses

- Rainfall/surge correlation
  - >50% of rainfall events occur during elevated water levels
- Joint-probability of rainfall/storm surge
  - Rainfall/surge design probabilities
- Regional Precipitation Trends
  - Heavy rainfall increasing
- Future precipitation conditions
  - Up to 30% increase in design rain
- Probable maximum event precipitation
  - Design “check storm”
Stormwater incorporation

• Higher coastal water levels diminish stormwater system performance

• Coastal Flooding

• Stormwater Conveyance

• Combined Flooding
Projected Changes in Coastal Flooding

- Areas subject to flooding will increase:
  - In 30-40 years: 1.5 times
  - In 60-70 years: 2 times
Change in Flood Area

All City Watersheds

Flood Recurrence Interval
- 500 Year
- 100 Year
- 50 Year
- 25 Year
- 10 Year
- MHHW

Square Miles of Land Flooded

Sea Level Rise Scenario
- Today
- 1.5 ft SLR
- 3 ft SLR

Legend
- Flood Change
  - Mild
  - Low
  - Moderate
  - High
  - Severe
Loss Estimation Process

Data Improvement
- Collect, combine, improve City building data

Loss Estimation Database
- Relate City database to Hazus database

Assign Depth Damage Function
- Building and wave environment specific setting

Perform Damage/Loss Estimation
- Depth-damage analysis for 5 flood frequencies

Data Summarization
- Compile data to City planning units

Impacts
- Change in risk, risk clusters
Loss Information - Context

- Losses represent today’s built environment and flood control infrastructure
- In today’s dollar - future losses do not include inflation
- Potential reduction of loss by flood risk management strategies NOT represented
- Starting point for identification of needed policy and engineering measures
## Risk Metric – Annualized Losses

- Expected monetary loss for any given year
- Based on event analysis, examined probabilities

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Impact</th>
<th>Loss Expectancy (Millions)</th>
<th>Annual Event Probability</th>
<th>Annualized Loss (Millions)</th>
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</thead>
<tbody>
<tr>
<td>Very High</td>
<td>Low</td>
<td>$52</td>
<td>10%</td>
<td>$5.2</td>
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<tr>
<td>High</td>
<td>Moderate-Low</td>
<td>$133</td>
<td>4%</td>
<td>$5.3</td>
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<tr>
<td>Moderate</td>
<td>Moderate</td>
<td>$240</td>
<td>2%</td>
<td>$4.8</td>
</tr>
<tr>
<td>Low</td>
<td>Severe</td>
<td>$414</td>
<td>1%</td>
<td>$4.1</td>
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<tr>
<td>Very Low</td>
<td>Catastrophic</td>
<td>$1,558</td>
<td>0.2%</td>
<td>$3.1</td>
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</table>

Total: $22.6
City-Wide Losses – Changes with SLR

- Combined Structure and Content Annualized Loss by Recurrence Interval

![Graph showing loss changes with SLR](image)
City-Wide Loss Factor Increases Over Today

<table>
<thead>
<tr>
<th>Recurrence Interval</th>
<th>1.5 ft SLR</th>
<th>3 ft SLR</th>
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<tbody>
<tr>
<td>10-yr</td>
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<td>500-yr</td>
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</table>
Projected Changes in Flood Loss

Annualized Losses (Millions)

- **Today**: $22
- **1.5 ft SLR**: 3.5x increase
- **3.0 ft SLR**: 15x increase

4.4x increase over 1.5 ft
Watershed Loss Changes with SLR

Annualized Losses, Millions

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Today</th>
<th>1.5 SLR</th>
<th>3 ft SLR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elizabeth River</td>
<td>2.48</td>
<td>8.18</td>
<td>23.60</td>
</tr>
<tr>
<td>Lynnhaven</td>
<td>15.97</td>
<td>53.27</td>
<td>158.14</td>
</tr>
<tr>
<td>Southern</td>
<td>4.62</td>
<td>17.94</td>
<td>165.31</td>
</tr>
<tr>
<td>Oceanfront</td>
<td>0.49</td>
<td>2.37</td>
<td>15.72</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>23.56</strong></td>
<td><strong>81.76</strong></td>
<td><strong>362.77</strong></td>
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</tbody>
</table>

Today

- Lynnhaven: 68%
- Southern: 20%
- Oceanfront: 2%
- Elizabeth River: 10%

1.5 ft SLR

- Lynnhaven: 65%
- Southern: 22%
- Oceanfront: 3%
- Elizabeth River: 10%

3 ft SLR

- Lynnhaven: 44%
- Southern: 46%
- Oceanfront: 4%
- Elizabeth River: 6%
Categorized Total loss by Sub-Watershed

- Total loss, relative risk classification by scenario
Strategic Growth Areas

50-yr recurrence interval flood, 3 ft SLR Scenario

Legend
- Today
- 1.5 ft SLR
- 3 ft SLR

SGAs

Risk
- Low
- Medium
- High

Loss by SGA

Legend
- Today
- 1.5 ft SLR
- 3 ft SLR

Total Losses, Millions of $
Concentration of Risk

- Aggregated from building level risk
- Efficiently ID High Risk Areas for solutions
Citywide Context

Most of the City has limited coastal flood exposure, in clustered areas

- Today: <1% of buildings
- In 30 years: 2% of buildings
- In 60 years: 7% of buildings

Bottom line:
Proactive solutions can help the City avoid future losses
Phase 2: Adaptation Strategies

• **Objective:**
  Develop, assess and prioritize a range of strategies through feasibility and cost-performance metrics to minimize short- and long-term flood risk

• What planning, policy, and engineering strategies are needed to address the risk portfolio?
  - What policy has to be created or changed?
  - How can land use be managed?
  - Where do structural solutions make sense?
  - What’s the return on investment?
  - What strategies work best?
  - When should implementation occur?
# Example Policy/Regulatory Strategies

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<tr>
<th>Strategy</th>
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<tbody>
<tr>
<td>Incorporate resilience measures into design and siting standards</td>
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<tr>
<td>Increase freeboard and/or require in future floodplain</td>
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<tr>
<td>Downzone flood prone areas through regulation or voluntary agreement</td>
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<tr>
<td>Restrict rebuilding of severe repetitive loss structures</td>
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<tr>
<td>Require site plan review and SLR checklists for development (large or small)</td>
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<tr>
<td>Develop special services districts to finance local flood control measures</td>
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<tr>
<td>Provide property tax discounts or rebates for flood resilience or open space conservation</td>
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<tr>
<td>Extend and improving public education and outreach about flood risks and climate change</td>
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<tr>
<td>Evaluate joining Community Rating System</td>
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</tbody>
</table>
Strategy Evaluation Process

Initial Identification

Risk Portfolio

Qualitative Evaluation & Quantitative Evaluation

Prioritizes Alternatives
Evaluation and Prioritization

- Qualitative:
  - Feasibility Scoring

<table>
<thead>
<tr>
<th>Feasibility</th>
<th>Technical</th>
<th>Administrative</th>
<th>Political</th>
<th>Legal</th>
<th>Fiscal</th>
<th>Environmental</th>
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<tbody>
<tr>
<td>Access to Needed Tools</td>
<td>Complexity</td>
<td>Staffing</td>
<td>Maintenance</td>
<td>Political Support</td>
<td>Public Support</td>
<td>Consistent with State and Federal Laws</td>
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</tbody>
</table>

- Quantitative:
  - Cost Benefit Analysis –
    - Return on investment – are strategies cost-effective?
Adaptation Plan Development

- City-wide policy recommendations
- Watershed specific measures to address high risk areas
- Sequenced to complexity, short and long-term risks

High Risk Areas:
- Flood pathway(s)
- Alternative strategies
- Loss avoided by strategy
- Benefit cost ratio
- Project cost/feasibility
- Project priority
Objective: Integrate the best-performing adaptation strategies in actionable plans that mechanisms to ensure implementation.

• How do we move forward with the preferred solutions?
  • What are the costs and design features?
  • How do we sequence the short- and long-term measures?
  • How do we fund?
  • What is our action plan for each watershed?
  • How do we get public buy-in, sponsors, and/or regional support?
## Schedule

<table>
<thead>
<tr>
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<th>2017</th>
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<th>2018</th>
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If additional time needed for coordination, etc.
Ongoing Activities

• Finalize flood loss documentation
• Vulnerability assessment for other infrastructure
  • Roads
  • Municipal utility infrastructure
  • Social/Demographic
• Watershed Level Assessments
  • Key risk areas by watershed
  • Flood risk definition by area
  • Flood risk management strategies by area
  • Strategy evaluation and prioritization
  • Draft Adaptation Plan
• Public Engagement
Public Outreach & Community Engagement Strategy
Public Outreach

Goal:
Educate about the study and empower target audiences with accurate and timely information, and what they can do to reduce flood impacts.
Why is community outreach important?

- Most residents are unaware of the City’s resiliency efforts
- There is high awareness of Norfolk’s resiliency program and improvements.
- The City is assessing the 4 Watersheds for improve resiliency
- City Council committed approximately $300 million over 15 years for stormwater improvements
- The City has made some infrastructure improvements already over the past few years
- *Keeping residents informed and engaged is paramount!*
Why Is Public Engagement Important?

• Citizens must be informed with accurate and timely data

• Multiple communication options must be provided to engage the public

• Regular communication and updates keep the issue top of mind that the City cares about its residents and employers

• Citizens can share information with others when equipped with the right communication tools

• Citizen input and buy-in to future improvements and construction projects
Target Audiences

• Residents
• Businesses and commercial property owners
• Military
• Internal Stakeholders -- City Staff: EMS, PW, PU, STiR, Comm, COMIT, CM, Planning, Economic Development, City Boards, Councils and Commissions
• Environmental Stakeholders
• Policy Makers & Regulatory Agencies (local, state and federal)
• Media
Engagement Strategy

• Form SLR/RF Stakeholder Speakers Bureau
  • Cross-section of citizens who could be champions for the project
  • Conduct presentations at meetings of their constituents
  • Help man booths at key community events
    • Pungo Strawberry Festival
    • Oceana Air Show
    • State of the City luncheon
    • Boardwalk Art Show
Engagement Strategy

Watershed Area Public Meetings

• Phased Meetings in all 4 watershed areas
  • Lynnhaven
  • Elizabeth
  • Oceanfront
  • Southern
• Hybrid Format
  • Presentation
  • Open House
  • Q & A
  • Surveys
Engagement Strategy

• Online comment form (via vbgov.com) to allow a broad opportunity for the public to provide feedback on adaptation options

• Hold stakeholder meetings/discussion sessions to increase knowledge of flooding/SLR issues in community and to obtain feedback on adaptation options
  • Interactive table/mapping
  • Facilitated discussions
Engagement Strategy

• Questionnaires at community events
  • Online and on-site questionnaires to hear flooding concerns and personal experiences of the public
    • The questionnaires will be at all libraries, at community presentations, key public events such as festivals, civic meetings as well as posted on all city social media platforms (Next Door, FB, vbgov.com)
    • The questionnaire responses will be tabulated and analyzed
    • Response themes and anecdotal information will also be distributed publicly
Outreach Summary

• Develop messaging for target audiences
• Brief City Council
• Brief Boards, Commissions and Councils
• Form SLR/RF Stakeholder Speakers Bureau
• Coordinate efforts with City communications team
• Schedule events and presentations with teams of multi-departmental staff
• Engage the public for their flooding stories and input
• Provide timely information to all target audiences
• Remain in compliance with NOAA grant - ongoing and robust community outreach and engagement
Questions?