A Guiding Principle
1837 - Mayor’s Proposal to Drain the City of Charleston

“The present plan of draining the City, was unequivocally condemned, and an improved system declared to be indispensable to the health, comfort and convenience of the citizens.”
Charleston

- 1849
- 2016 w 2.5 ft slr
Local trends

1.05 ft in 100 yrs

1.04 ft in 100 yrs

1.28 ft in 100 yrs
Sea Level Rise in Action: Nuisance Flooding

SOURCES: UCS Analysis; Morales and Alsheimer 2014; NOAA Tides and Currents 2013.
Sea Level Rise in Action: Nuisance Flooding
What drives global sea level change?

Source: 2014 National Climate Assessment
SLR Viewer

- Google sea level rise viewer Charleston

SLR Viewer  0 feet
SLR Viewer 1.5 feet
SLR Viewer 2.5 feet
October 2015 Flood Event

Record Setting Rainfall

23.76 inches near Clark Sound on James Island in Charleston (Oct. 1-5, 2015)

22.04 inches near the Whitehouse Plantation area of James Island in Charleston (Oct. 2-6, 2015)

21.57 inches near Wappoo Creek in Charleston (Oct. 2-6, 2015).
Road closures during October 2015 rainfall event

157 total* roads closed

*some roads closed more than once due to tidal cycles
Hurricane Matthew - October 2016

In the Charleston region:

- Peak wind gusts: 75-80 mph
- Total rainfall: 8-11 inches
- Storm surge: 6.2 feet

USDA
3rd highest tidal level ever recorded in Charleston of 9.29 feet

Matthew landfall (*not* at high tide); storm surge of 6.2 feet
Strategies

Of the 76 strategies recommended in the City of Charleston’s Sea Level Rise Strategy which was adopted in 2016,

27 are in Progress
Sea Level Rise Strategy

Reinvest

Respond

Ready
Reinvestment actions will provide long-term improvements to public health, safety and quality of life through additional investment in infrastructure and physical modifications.
Capital Drainage Investments

- 2010 Church Creek: $3.7 mil
- 2017 Forest Acres: $15 mil
- 2020 Spring/Fishburne: $154 mil
- 2001 Calhoun East: $15.8 mil
- 2000 Ardmore: $5 mil
- 2007 Byrnes Down: $6.7 mil
- 2016 Calhoun West Preliminary Engineering: $1.1 mil
- 2018 Market St: $30 mil
Reinvest –

- Reinvestment actions will provide long-term improvements to public health, safety and quality of life through additional investment in infrastructure and physical modifications.

- Three categories with 37 initiatives under Reinvestment
Reinvest –

- Evaluate the impact of SLR and prioritize improvements (include compounding effects such as rain bombs and hurricanes)
  - Maintain a relationship with the scientific community

- Establish programs to address specific solutions for repetitive flooding areas
  - Prioritize capital projects and continue investment in infrastructure that improves drainage and reduces flooding.
  - Evaluate impact of SLR on public infrastructure and prioritize improvements
  - Improve stormwater drainage
  - Utilize green infrastructure solution

- Establish more appropriate standards to protect public and private investments
  - Consider additional freeboard for new structures
  - Adopt stormwater design standards that take SLR into account
1984 Master Drainage and Floodplain Management Plan

City of Charleston
South Carolina

Davis & Floyd, Inc.
Consulting Engineers
$235,000,000+
Capital Investment
Between 1990 and 2020

- $82 M Complete
- $27 M Under construction
- $127 M Funded
- $4+ 2016 Maintenance Budget
Gravity, Capacity and Storage

Ardmore Drainage Improvements
Completed 2005

- 11 acres of detention ponds
- 5x9.5 and dual 5x8 box culverts
- $5,048,000
Byrnes Down
Completed 2007
$6,683,561

Gravity, Capacity and Storage

- 10,000 lf of box culvert and pipes
- Largest box culverts were 4x7 and 5x6 ft.
Gravity, Capacity and Storage
Tunnel Collection and Pumping
Tunnel Collection and Pumping

Calhoun Street Drainage Improvements

Completed 2001

10 ft. and 6 ft. Tunnels
Tunnel Collection and Pumping

Calhoun Street Drainage improvements

$15.8 million

3 Pumps – discharging 120,000 gpm
Tunnel Collection and Pumping

Market Street Drainage Improvement Project
Tunnel Collection and Pumping

Market Street Shaft and Tunnel
Tunnel Collection and Pumping

10 ft tunnels
Tunnel Collection and Pumping

$30 m Investment   Work Underway
Tunnel Collection and Pumping

Photo courtesy of Post & Courier
8,232 LF of 8-ft to 12-ft diameter tunnel ranging in depth from 100-ft to 150-ft below grade
Lockwood Shaft Site

Working Shaft
60 ft. diameter and 150 ft. deep
Lockwood Working Shaft
Tunnel Boring Machine
Tunnel Collection and Pumping

3 main storm-water pumps and triple 8-ft by 10-ft outfall boxes

US17 Spring/Fishburne Drainage Improvement Project
Readiness type actions will enable prevention and preparedness through continued planning, monitoring and identification of changing vulnerabilities and risks.
Evaluate and assess impact of sea level rise on future development

- Trees as Green Infrastructure
- Conduct comprehensive plan integrating SLR in the range of 1.5 – 2.5 feet
- Study zoning code to promote development that minimizes SLR
- Incentivize Low Impact Development Best Management Practices
- Revise maximum % impervious surface,
- Encourage open space connectivity to marshes and creeks
- Encourage best practices for hard and landscape features that absorb, sustain, cleanse and release water
- Study zoning changes to encourage retrofits of existing buildings and construction of new resilient buildings in the 100 year floodplain
Response actions will improve our response to, communication during, and management of flooding and related events to minimize service disruptions and to ensure public safety and quality of life.
Respond – In Progress

- Enhance and promote real time flood incident information
- Install flood gauge devices in repetitive flood area
- Enhance current use technology for awareness and management of flooded roadways
Respond – In Progress

- Assess public safety resources
  - Identify and acquire appropriate response assets for public safety agencies to secure flooded roadways
  - Acquire additional rescue equipment, personnel and training for our first responders
Meeting the Challenge

How will the City of Charleston continue to adapt to the challenges of living by a rising sea? The City will need to continue to choose from a wide variety of potential resilience initiatives; each with its own costs, benefits, and implementation challenges.

Resilience offers a framework through which investments can be coordinated and planning integrated across agencies, communities and the region. The City of Charleston has identified three essential aspects of resilience: ReInvest, Respond, Ready. The City of Charleston is committed to taking action to address each of these aspects of resilience in the future.

This section contains a series of initiatives that are designed to strengthen the City of Charleston’s resilience to sea level rise. These initiatives were developed by a multi-disciplinary task force of staff representing the City’s Public Service, Planning, Preservation and Sustainability, Emergency Management and Geographic Information System (GIS) departments. As part of the development, this team reviewed other communities that are taking steps to meet this challenge, such as New York, Norfolk and Copenhagen.

These initiatives involve a blend of traditional structural approaches, such as incorporating more pumping, raising streets and sea walls, along with other initiatives such as:

- Purchasing repetitive loss properties and using these lowlands to absorb future waterways.
- Developing clear and immediate communication initiatives to enhance public safety.
- Recognizing our seas do not respect civic boundaries and our work will require and benefit from regional collaboration.

This section is not intended to be a complete analysis of all potential responses to sea level rise. In deciding how to implement or prioritize different initiatives the City, along with community stakeholders, will need to evaluate the tradeoffs between the strategies and begin to implement those chosen.

Goals and Initiatives

GOALS: Put in place systems that prevent or reduce the impacts of SLR and significant rainfall
Ensure public safety given flooding potential
Ensure community and economic viability and recovery given flooding potential

INITIATIVES:

**Evaluate Impact of SLR and prioritize improvements (include compounding impacts such as rain bombs and hurricanes)**
- Maintain a relationship with the scientific community, Federal and state agencies and local governments for the free and timely exchange of information related to SLR and its impacts to the City and our region
- Maintain an active leadership role in the newly formed Charleston Resilience Network (CRN) to encourage a regional response to SLR
- Request USACE's study for a comprehensive flood protection study of Charleston Harbor
- Work with the USACE and FEMA to collaborate more closely on flood protection project standards
- For public lands, consider City lands lying in SLR areas for ability to absorb or attenuate SLR
- Recalibrate science for appropriate planning levels at least every 5 years

**ReInvest**
- Establish more-appropriate standards to protect public and private investments
  - Advocate and adopt building codes that support construction which is more resilient to SLR
  - Seek out, advocate and adopt stormwater design standards that support stormwater management facilities which take into account and will be resilient to SLR
  - Consider additional freeboard for structures that are long term investments or house critical facilities (1.5 to 2.5 ft.)
Resilience Work Group

- City Resilience Working Group
  - Most and soon ALL Department Heads
  - Meeting since January 2017
    - 2x Month
    - 1.5 hours

- Goals
- Where are we as a City? – Take a Fix!
- Collective input on 76 Goals and Initiatives from SLRS
- Report to Mayor and Council
- Outline Next Steps
Resilience Work Group

- Process
  - Valid or not?
  - Who owns it?
  - Impact?
  - $ - who and how much
  - Status? Is it already underway?, planned, next year, un-planned?
- Add new or take away?
- Report to Mayor and Council within 6 months.
  - Strategic Plan and 2 Pager
- Determine next steps!
Resilience Work Group

- **Valid** – will benefit the City’s efforts with current and future flooding from SLR and/or extreme and changing weather events?
- **High Impact** – immediate, positive on individuals, businesses and organizations
- **Medium Impact** – mid-term, positive on two of three constituent groups.
- **Low Impact** – longer term, positive impact on one or more constituent groups.
- **3 years** = 3 budget cycles
Resilience Work Group

- Progress to Date
  - 81 Total initiatives
    - 76 original
    - 5 additional
    - 2 completed
    - 12+ underway
    - 3 Long term
    - Removed overlaps
Resilience Work Group

- Department Heads have been given their lists:
  - Talk about prioritization
  - Agree on characterizations
    - Active/uw/funded/requires funding
    - 2018/2019/2020
    - Category – Built Environment/Public Safety/Planning & Leadership

- June 14th – Departments present lists to RWG
- June 15th – 16 Hampton Roads Meeting
- June 21st – 1 hr. – whole group votes on top priorities
  - Last 30 mins presented to Mayor
- Goal is to inform 2018 Budget by Department and City.
Resilience Work Group

- Concentrations
  - Built Environment
    - City owned
    - City regulated
  - Public Safety
    - Information, alerts, prevention
    - Response
- Planning
  - Vulnerability Assessment!
  - Comprehensive Plan integration/Vision
- Traffic and Transportation
  - Runs through ALL of these
- Leadership, Strategic Planning & Communications
  - Executive, CRO, CFO, PIO
Resilience Work Group

Thoughts:

- Time Horizons
  - Short – Mid – Long term
  - Ready – Respond – Re-invest
  - It doesn’t get better or cheaper
- SLR will impact many aspects of Low Country
  - Extreme Precipitation
  - Storm Surge
  - Sunny Day Flooding
- Communication/Education Component
- Personal Responsibility Component
- Neighborhood and Business Component
- Government Component
Local Initiatives

- Charleston Resilience Network
- SC Aquarium Resilience Initiative Coastal Education
- Urban Land Institute - Resilience Study
- Enough Pie - Awakening King Tide
- Carolina Clear – Clemson University
- The Nature Conservancy
- National Audubon Society
- Pew Charitable Trust – Flood Prepared Communities
- Many more
What You Can Do

- Share importance of this work with elected officials
- Share understanding that doing nothing is more costly than being prepared
- Clean Your Drains
- Manage your Stormwater Pond
- Plant trees
- Capture Water via Rain Barrels
- Install a Rain Garden
- Green Roofs
- Light Impact Development/ Green Infrastructure
- Collective Impact
Clean Your Drains and Ditches
Maintain Your Stormwater Pond

- Inspect
- Control Weeds
- Dredge
Plant Trees

- Can reduce a city’s stormwater runoff by 2 – 7%
During a rainfall event of 1 inch, 1 acre of forest will release 750 gallons of runoff, while a parking lot will release 27,000 gallons.

(PennState Extension).
Capture Water via Rain Barrels

- During a 1 inch rainfall, a 1000 square foot roof can capture over 600 gallons of water.
Install a Rain Garden

- A planted depression that allows rainwater runoff from impervious urban areas, like roofs, driveways, walkways, parking lots and compacted lawn areas, the opportunity to be absorbed.
Green Roofs and Green Walls

- Green roofs will intercept between 50 and 60% of rooftop runoff first $\frac{1}{2} +$ inch rainfall
Living Shoreline

- 15 feet of marsh can absorb 50% of incoming wave energy
Collective Impact

- Chesterfield Heights in Norfolk, Va
  - Under street cisterns with permeable paving
  - Downspouts connected to cisterns
  - Basement cistern waste storage units
  - Rain gardens/bio swales
  - 2000 ft living shoreline

- Reduced flooding by 90%
TIDEWATER RISING RESILIENCY DESIGN CHALLENGE - NEED AND OPPORTUNITY

$120 million- HUD National Disaster Resiliency Competition
Contacts

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Chief Resilience Officer and Emergency Management Director

Read it:  Sea Level Rise Strategy
http://www.charleston-sc.gov/DocumentCenter/View/10089

View it: Sea Level Rise Viewer
http://gis.charleston-sc.gov/interactive/slr/