Storm Surge

The Merrimack Valley Coastal Adaptation Workgroup

C/O The Greater Newburyport Eco Collaborative
10 Mulliken Way
Newburyport, MA 01950

February 21, 2014

The group Storm Surge exists to encourage and support our communities to prepare for the impacts of sea level rise, extreme weather events and other effects of long-term climate change. To that end the bad case storm scenario that follows was developed for a program titled “Rolling the Dice with Big Storms” that was presented to area emergency management directors and a viewing audience on February 3, 2014. The purpose of the event was to give audience members the opportunity to envision what effect a large storm would have on our area, and what a bad case scenario might be like. The scenario was intended to make us all ponder our vulnerabilities, so that we as a community might better prepare for future weather events.

Storm Surge does not support or oppose any specific project. It is for communities to decide which projects best support their needs. It is our purpose to provide relevant information to stakeholders so that the best decisions can be made with regards to whatever plans are to be carried out. It is in this manner that we assist our communities to best mitigate the effects of climate enhanced storm activity and the effects of sea level rise.

Sincerely,

Michael Morris
Chairman, Storm Surge

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Meteorological Overview…

By:
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Picture early March in New England…
Though frost is still in the ground, a lack of precipitation coupled with a strong March sun has left the coastal plain devoid of snow cover. Well to our NE, a strong area of high pressure (1040mb) centered over Greenland pushes south and expands toward the mouth of the St. Lawrence River, while it interacts with a 960mb low to its east. The steep pressure gradient between the high and the low establishes strong winds along a broad E/NE fetch of the Atlantic sending a sizable long period swell westward toward Nova Scotia and the eastern U.S. seaboard. Meanwhile, over the Nation's midsection, a chilly high pressure cell extends its winds and cold air deep into the southern states forming a major undulation in the polar jet establishing a cold front off the SE Atlantic coast. Ahead of it, to the east, a sub-tropical jet pumps moisture from the eastern Pacific and the Gulf of Mexico northward along the front. The two upper air jets phase over the Gulf Stream east of Cape Hatteras, and a deepening area of low pressure forms 600 miles E/SE of New England with increasing cyclonic winds. Blocked by the Greenland high, the developing low can't escape to the NE. Instead, it follows the undulated Jet to the N/NW and bombs out (950mb) as it retrogrades into New England.

Invigorated by the merging jets, and fueled by the Gulf Stream's energy, the system winds up and blossoms to cover 700 miles of ocean. On its northern side, the storm interacts with the Greenland high to establish a steep pressure gradient with a 1000 mile long easterly fetch that infuses additional wind energy into the westerly traveling long period swell already in the water. Near shore, stiff E/NE winds develop ahead of the approaching system. Then, as the storm center approaches the eastern end of Long Island, sustained winds rotate to the E/SE and increase to 45-55 mph, with frequent gusts of 60-75 mph. To the north of the low center, the forward momentum of the storm adds additional velocity to the system's already potent winds. There, along the steep pressure gradient, sustained storm force winds of 50-60 mph with hurricane force gusts of 80-90 mph, move toward the New England coast.

As the storm approaches the coastline, it sets the waters of the Gulf of Maine into motion and piles them against the coastal barrier islands. With each successive tide the Atlantic rises, but wind and wave energy never let it recede. Sea level peaks at 5 feet over mean high water, making for a 15 foot tide with a 30 foot, 17 second sea from the E/SE. Buoys measure wave energy at 20,000 – 30,000 Kilojoules per meter. (As a reference, wave energy from the January 3, 2014 Northeaster didn't exceed 2500 Kilojoules/meter, and the March 7th 2013 storm yielded waves of 10,000-15,000 Kilojoules/meter).

Onshore, winds topple numerous trees and power lines and also damage homes and businesses. The system releases 10 inches of cold rain that the frozen ground can't absorb. Tributaries rapidly swell and

fill the Merrimack River with the runoff water, but the elevated sea level of the Atlantic won't let the river empty into the sea. Flood waters backup into the Merrimack expanding over the Great Marsh and invade the barrier Islands of Salisbury & Plum Island from the rear. As the Merrimack backs up further, it begins flooding the low lying areas of Newbury and Salisbury, then portions of Downtown Newburyport, Amesbury, and beyond. The storm rages on for 3.5 days (8 high tides) before spinning itself out over northeast New York State. Peak wind, waves, tides and coastal flooding occur between days 2 and 3, but a subsiding, although still sizable, swell continues to roll in for 4 days to come. River flooding peaks between days 3 and 4 as runoff waters make their way to the Merrimack River Basin.

TimeLine…

Day One - storm center well established 350 mi SE of Nantucket moving NW at 6 mph. Cyclogenesis well underway

- Winds E/NE 25-35mph and increasing
- Clouds overspread area and Seas build to 10-15 ft at 8-10 sec from the NE wave power 2500 KJ/M
- Spiral bands of snow showers spin in & turn into cold rain
- A 1 foot storm surge raises the nine foot tide to 10 feet.
- Increased Sea level & surf begin keep the Merrimack from flowing to sea. Waters rise behind the barrier Islands & marsh.

Day Two – Storm center has bombed out at 950mb offshore. Center 150 mi SE of Nantucket still moving NW but at a crawl 3-5 mph.

- Winds east at 45-55 mph gusting frequently 60-75 mph
- Cold heavy rains becoming steady
- Seas 15-25 feet at 12-15 sec from the E/SE. Wave power increases 4 fold to 10,000 KJ/M
- Rocks on Plum Island's seawall become undermined and begin to wash from dune face.
- Surge rises another 2 ft making for a 12 ft tide over MLW.
- Waters creep across access roads to barriers and begin to seep into neighborhoods
- Heavy rains quickly run off frozen ground filling tributaries & further raising the Merrimack
- Barrier dune splash over at high tide.
- Trees begin to fall. Scattered power outages.

Day Three – Peak Intensity – Storm center makes landfall between eastern Long Island & Narragansett

- North of the storm center, storm force winds are sustained at 50-60 mph, gusting 80 – 90 mph from the E/SE
- Long period swell from the Azores storm enters the wind field, absorbs additional wind energy, builds further and phases with the existing sea state.
- Seas 25-35 ft at 17 sec. from the E/SE. Wave power increases to 20,000-30,000 KJ/M (2-3x that of the March 2013 Storm)
- Additional storm surge raises tide to 15 ft.
- Plum Island sea wall fails with 20 homes succumbing to sea. Significant over wash happens at PI Center, Annapolis way and near Mad Martha's. Water flows from ocean to marsh and into PI Basin. Homes and sand pushed onto Northern BLVD & Southern BLVD. Access via center blocked

by 2- 3ft of sand, wave wash & debris.

- Torrential rains fill the Merrimack, Parker & Hampton Rivers flooding the great marsh and barrier islands from the rear. Low lying Properties bordering Marsh & Parker River flooded.
- Numerous trees & utility poles fall, power outages widespread across region.
- Salisbury Beach
    - Significant over wash between 14-17th ST. on Salisbury beach. Numerous homes lost to sea or pushed into street. Sand & water, debris block Rte 1a
    - Access via Rte 1a Salisbury & 286 not possible due to flooding and downed utility poles
    - Ring's Island Isolated at High tide
    - Low lying Businesses along Rte 1 Bridge Rd flooded.
- Amesbury
    - Pow Wow River Backs up in response to Merrimac
    - Main St to Point Shore in Amesbury Flooded
    - Lake Gardner Dam a concern
    - Back River Floods businesses along Water St.
    - Water gushes down Pow Wow River under town center

- Newbury/Byfield.
    - Pine Island becomes isolated
    - Plum Island Turnpike remains flooded even at low tide.
    - Sections of Downtown Byfield flooded due to run off

- Newburyport
    - Major Waterfront Flooding from Joppa all the way to Chain Bridge. Many homes on river side of Merrimack & Water Streets inundated.
    - Water rise in Newburyport's industrial park as little river backs up & rain runoff tops old railroad bed.
    - National Grid facility & water treatment plant in south end flooded.

Day 4 - The Aftermath - The Storm center spins itself out over NE NY State

- Winds veer from E/SE to south and then SW at 25-30 mph
- Rains abate, some sun pokes through
- A still sizable swell of 15-20 ft at 14 seconds continues to roll in and subsides over the next 4 days.
- River Flood waters peak today and begin to recede tomorrow.
- Beach Access roads passable after peak of tides
- Damages are assessed

Town Specifics…

Plum Island…Newbury & Newburyport
Numerous homes flooded along the basin, PI point & old point Rd
Waves over wash at Fordham way, PI center and near PI Basin. Over wash sands 3ft deep obstruct the entrance to the island, northern BLVD and Fordham way.
South of the basin, some 20 barrier dune homes either fall into the sea or are pushed back onto southern Blvd
Plum Island turnpike becomes impassable at high tide and is still covered with water at low tide during & just after the storm's peak.
Wires and poles are down along the Plum Island Turnpike. There is no electrical power.

Salisbury Beach
Over wash occurs at Salisbury Beach Center where sand is piled 2-3 ft deep and sea water flows to the marsh
Surfside 5 & Blue Ocean Music Hall buildings are severely undermined and slumping into the sea.
Over wash & loss of homes between 17th St & 14th St.. Homes, debris & and sand obstruct route 1A
Rte 286 flooded at Brown's Lobster pound with sections of Beach Rd also inundated at high tide
Rings Island Isolated at highest tide
Major Sections of rte 1a/Bridge Rd and businesses flooded
Trees down with widespread power outages

Amesbury
Pow Wow River backs up in response to Merrimac
Main St. to Point shore area flooded
Lake Attitash Levee a concern, water rushes down Pow Wow under town center
Water backs up along Back River flooding businesses along Water St
Numerous trees down with wide spread power outages

Newbury
Plum Island Turnpike becomes impassable
Pine Island Becomes Isolated
Some low lying homes along parts of the Parker River are inundated with cold flood waters.
Parts of the commuter rail bed between Newbury & Rowley are flooded
Areas of downtown Byfield flood due to heavy runoff.

Newburyport
Major waterfront flooding from Joppa all the way to the Chain bridge
Many structures on the river side of Water Street flooded at highest tides.
National Grid & Waste Water Treatment Facilities in threatened.
Water backs up into the Industrial Park flooding businesses there.
Numerous trees down wide spread power outages