

Helping Hampton Roads Residents in Vulnerable Locations Evacuate during Hurricane Approach

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At VDOT Norfolk Residency

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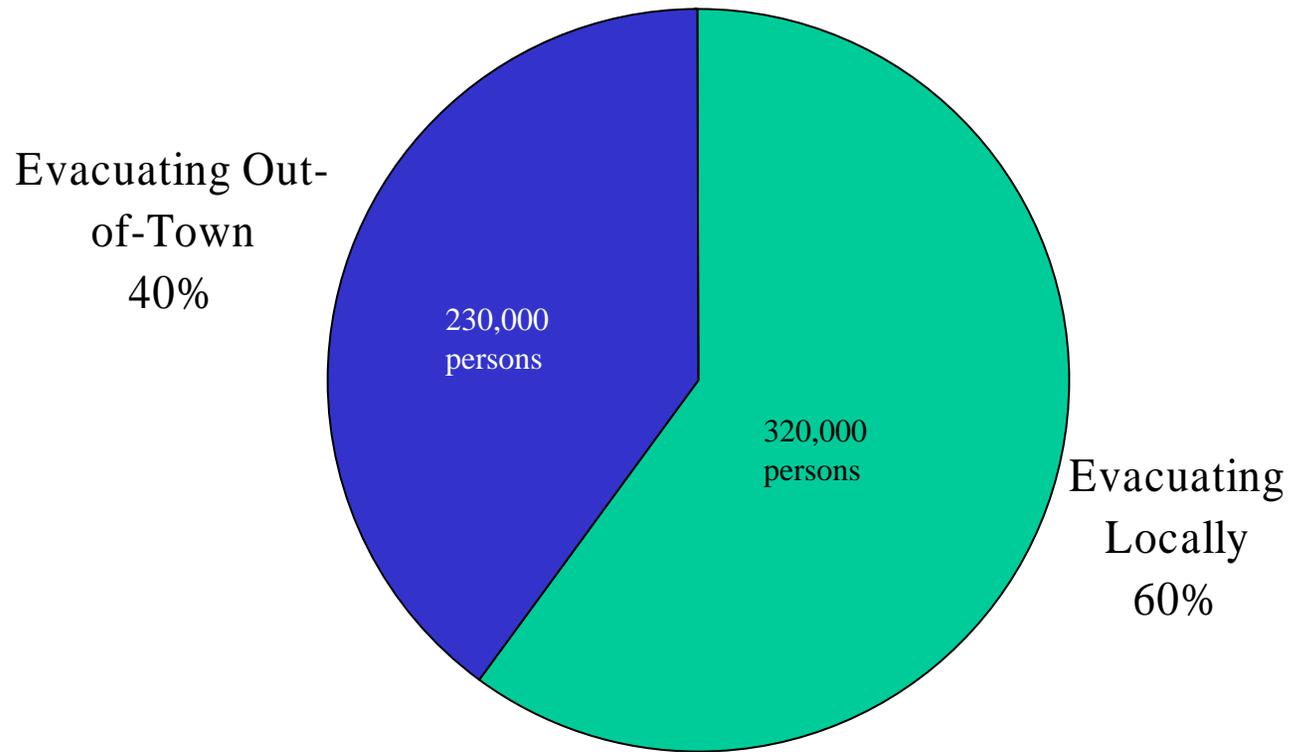
Terminology

The word “evacuation” brings to mind a picture of Hampton Roads residents on I-64 heading for Richmond...



...but more than half of those who evacuate do so locally.

(to friends/family, shelter, hotel)



Source: Hurricane Evacuation Plan Impact Study, HRPDC, 1996,
based on Virginia Hurricane Evacuation Study (VHES), Corps of Engineers, 1992.

Terminology

- “*Evacuation*” refers to people leaving their houses for a variety of destinations—some far, but most near.
- “*Vulnerable*” will be used in this analysis to denote mobile homes and/or low-lying areas, as it was used in the Virginia Hurricane Evacuation Study (VHES).

Foundation

- Hippocrates wrote to doctors:
 - “As to diseases, make a habit of two things—to help, or at least to do no harm.”
- Based on the experience of hurricanes in other areas, the approach of a big hurricane to Hampton Roads will bring major traffic jams. As traffic and emergency professionals:
 - First, we should not make the problems worse.
 - Secondly, we should try to reduce the problems.

Nature of the Problem

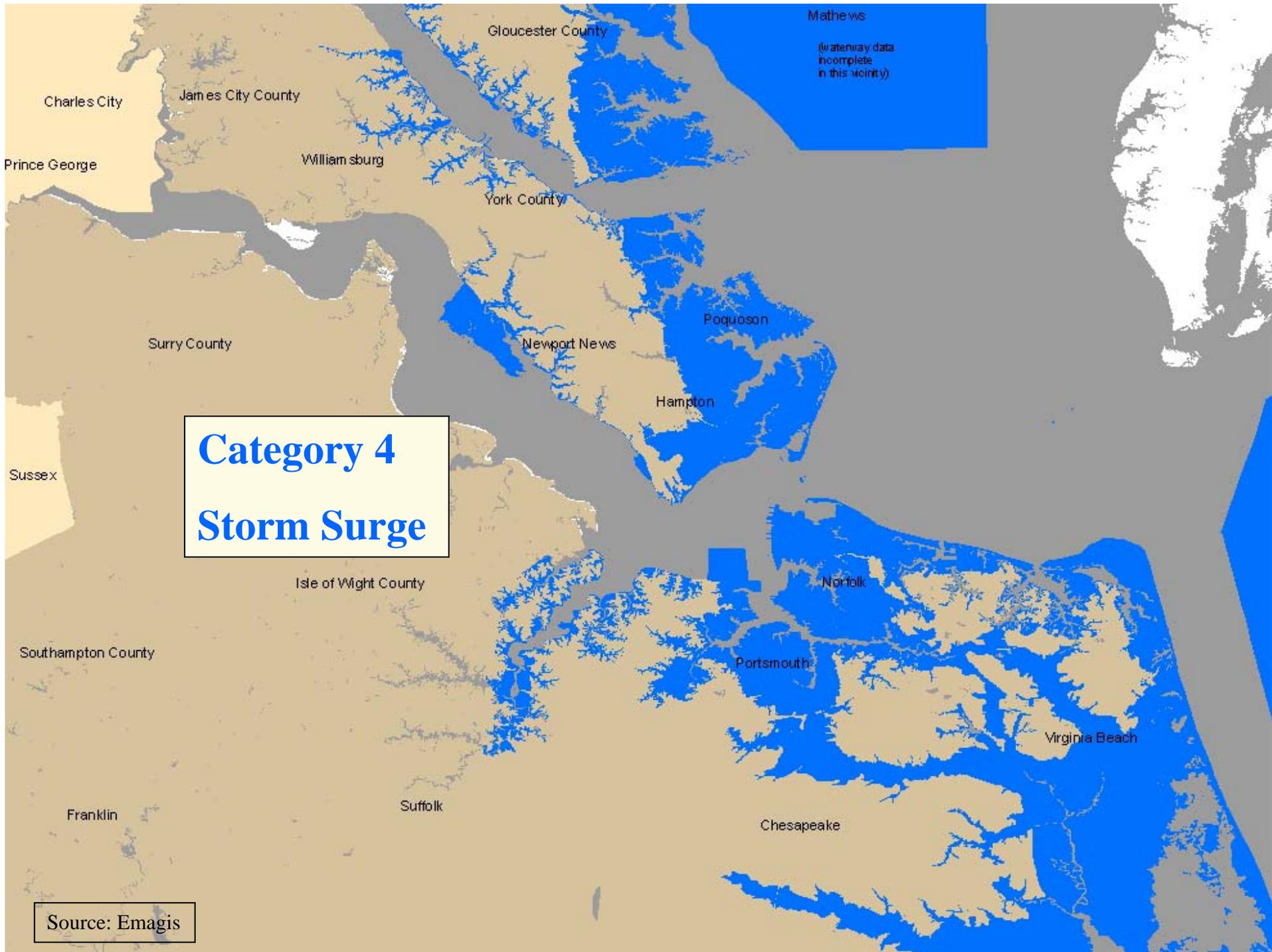
- Parts of the network are congested on a daily basis, including the river crossings and the I-64 choke-point at Bland Blvd (where 8 lanes become 4 lanes).
- As a hurricane approaches, in addition to regular types of trips (working, shopping, etc.), 3 additional types of storm-related trips will be made on the network:
 - Out-of-Hampton-Roads evacuation trips (100k trips expected)
 - Inside-Hampton-Roads evacuation trips (150k trips expected)
 - Storm preparation trips (e.g. buying supplies, moving grandmother)

Nature of the Problem

- Regular trips will decrease (e.g. fewer going to work) but, because of storm-related trips, the total number of vehicle-miles traveled on the day the hurricane approaches (“approach day”) may be high.
 - Some will stay at home, but many will be making trips, e.g.:
 - essential personnel going to work and making work-related trips (e.g. police, fire)
 - going to hardware store for plywood
 - moving business equipment to higher ground
 - picking up mother-in-law and bringing her to daughter’s house
 - evacuating to friends’ house on higher ground
 - leaving Hampton Roads
 - going to grocery store to stock up on food, water, batteries
 - going to doctor
 - making regular trips (no one knows if storm will actually hit)

Nature of the Problem

- River Crossings
 - Because of the high demand for approach-day trip making, Hampton Roads river crossings—which will carry all types of approach-day trips, including large concentrations of evacuation trips—may be severely congested.
- Evacuation Choke Points
 - Based on recent hurricanes threatening southern states, at points where evacuation trips converge (e.g. in Hampton Roads: HRBT, Bowers Hill, I-64 choke-point at Bland Blvd, etc.), travel demand will greatly exceed the supply of roadway capacity causing trips which ordinarily require minutes to complete to require hours to complete.



Focus of Efforts

- Most hurricane deaths occur where storm surge floods low-lying areas.
- Therefore, our efforts should focus on helping those in vulnerable locations evacuate.

First, Do No Harm

- The restrictions to interstate access in VDOT's Hurricane Traffic Control Plan (TCP) will shift millions of vehicle-miles of travel to arterials.
 - I-664: The TCP closes the MMBT to northbound traffic, which may cause congestion on the James River Bridge and US 17 leading toward the bridge.
 - I-64: The TCP closes or meters:
 - all westbound ramps between Indian River Rd (exit 286) and Camp Peary (exit 238)
 - all eastbound ramps between I-664 at Hampton Coliseum and Bowers Hill.

First, Do No Harm

- Impact of Restrictions to Interstate Access
 - Traffic Shifts to Arterials
 - Many of the approach-day trips (out-of-HR evacuation trips *plus* local evacuation, storm preparation, and regular trips) which would have been made in part on interstates will now be made solely on arterials, adding to arterial congestion.
 - Queues Threaten Arterial Travel
 - Because the interstate access queues will contain vehicles making both long and medium distance trips, the TCP interstate restrictions will increase the total number of vehicles in queues*
 - Instead of the queues being located at choke points on the interstate affecting the 40% of evacuees trying to leave the area, queues will be located on arterials affecting both the 40% and much of the 60% of evacuees trying to move within HR.

*Interstate choke-point queues would contain fewer vehicles making medium distance trips.

First, Do No Harm

- Because of the threat to arterials—and to the necessary evacuation trips which use them—interstate access should only be restricted if certain that it will do no harm.
 - The recent VTRC hurricane travel modeling did not model arterial travel.
- **Recommendation: Do not implement the interstate restriction portion of VDOT's Hurricane TCP until an analysis—which includes arterials—shows that restrictions would definitely not harm storm preparation and evacuation.**

Potential Ways for Government to Help People Evacuate from Vulnerable Homes

1. Increase roadway capacity.
2. Reduce unnecessary demand.
3. Spread demand over time.
4. Help persons in queues.
5. Redirecting demand and capacity.

1. Increasing Roadway Capacity

- It is believed that the formation of a queue (when demand exceeds capacity) causes the vehicles “breaking away” from front of queue to flow at 90% of the roadway’s capacity, thereby reducing the capacity of the roadway by 10% (re: Mike Cassidy, PhD, UC Berkeley).
- Therefore, one might try to preserve that 10% by restricting (via metering and closure) the usage of the interstates.
 - For example, the TCP restricts usage of the interstate system “in order to smooth flow and help prevent over-saturation.”

1. Increasing Roadway Capacity

- In order to use this 10%, one must:
 - know the roadway's capacity exactly,
 - restrict the roadway's usage exactly, and
 - know exactly how many vehicles will get off prior to reaching the bottleneck.
- For example:
 - If one assumes the roadway's capacity is 1,800 vphpl, and the actual roadway capacity is 1,800 vphpl (w/ 1,620 vphpl break-away), but one guard at one ramp allows extra vehicles so that 1,900 vphpl approach the bottleneck thereby exceeding its capacity, then 1,620 vphpl will break-away from queue, and the restriction will not have improved the flow of traffic at the bottleneck (vs. no restriction).
 - If one assumes the roadway's capacity is 1,800 vphpl (as in TCP), but the roadway's actual capacity is 2,200 vphpl (w/ 1,980 vphpl break-away flow), and one successfully meters the traffic to 1,800 vphpl, then the flow of traffic will have been harmed (reduced by 180 vphpl vs. no restriction).

1. Increasing Roadway Capacity

- Conclusion: The chances of increasing roadway capacity via restrictions designed for queue elimination are small; the chances of decreasing roadway capacity via these restrictions are significant.
- Recommendation:
 - Do not seek zero queues on interstate.
 - Instead, develop plans to shorten and ameliorate queues by reducing and spreading demand and by helping persons in queues (as follows).

2. Reducing Unnecessary Demand

- Purpose: Retaining capacity for those in danger.
- Due to the threat of drowning, evacuations from low-lying areas are more important than evacuations from solid houses on high elevations.
- **Recommendation:**
 - Cities and State should inform the public annually:
 - Inform public that, given current forecasting technology, there is not enough time and road capacity for all persons to evacuate. Therefore, non-vulnerable populations should consider preparing to ride out the storm in place.
 - Help the public determine whether they are vulnerable to drowning in their homes (i.e. single-story homes in low-lying areas and any homes subject to wave action).
 - Help the public determine whether they are NOT vulnerable to drowning in their homes (i.e. homes on high elevations).

3. Spreading Demand Over Time

- Promote evacuation in phases.
 - VDOT's TCP divides HR into two phases:
 - Phase 1- VB, Norf., N&E Hamp.*, York, Poq., Middle Peninsula, Northern Neck, Eastern Shore.
 - Phase 2- Ports., Ches., Suf., NN, remainder of Hamp.
 - TCP phasing is apparently based on threat:
 - Phase 1 localities are the most threatened: mostly low-lying localities, with limited evacuation routes, and evacuation routes which pass thru (and are therefore threatened by) other vulnerable localities.
 - Phase 2 localities are less threatened: they mostly have higher topography, have multiple evacuation routes, and have evacuation routes which do not pass thru other vulnerable localities.

*northern and eastern portions of Hampton

3. Spreading Demand Over Time

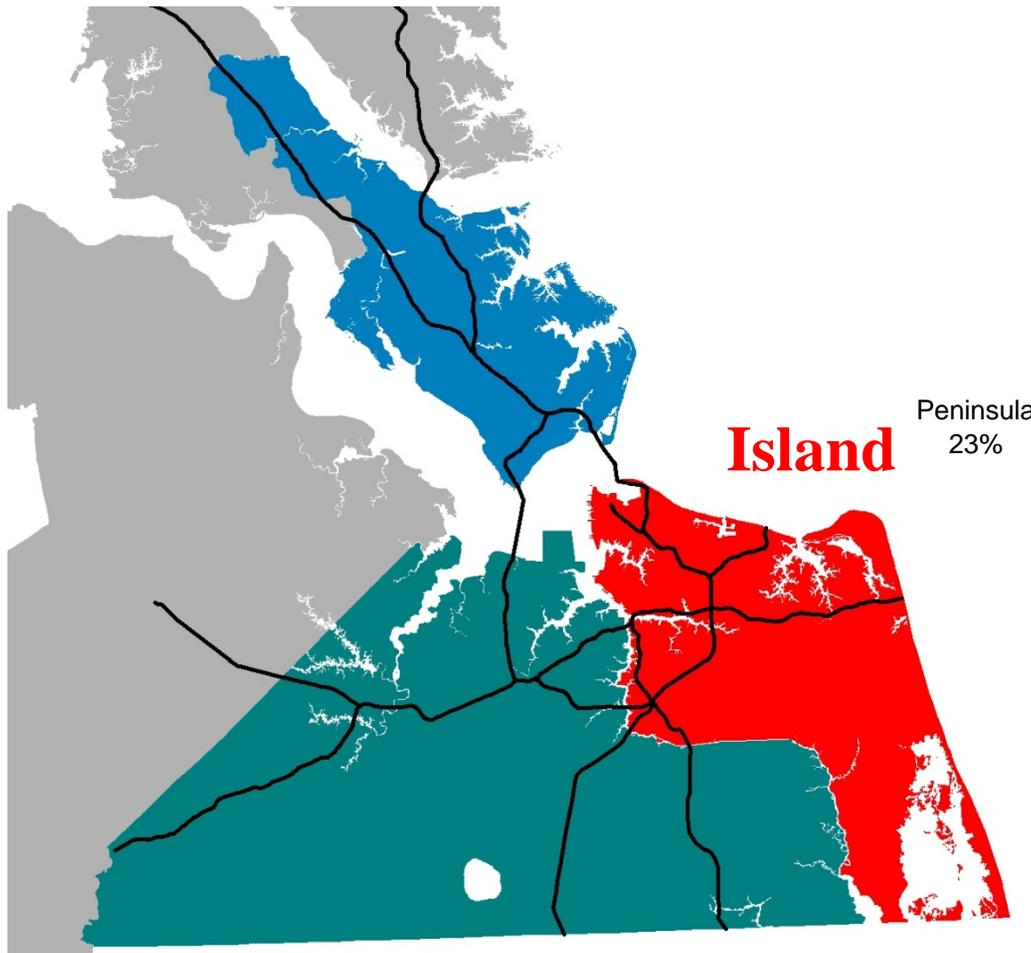
- **Recommendation:**
 - Cities and State should inform the Phase 1 residents annually (during hurricane season) that they live in more vulnerable localities and therefore, if they evacuate, must do so EARLY or they may get stuck in a low-lying area during storm.
 - Cities and State should inform the Phase 2 residents annually (during hurricane season) that they live in less vulnerable localities and therefore will be called to evacuate (if in a mobile home or low-lying area) LATER than those from more vulnerable localities.

4. Helping Persons in Queues

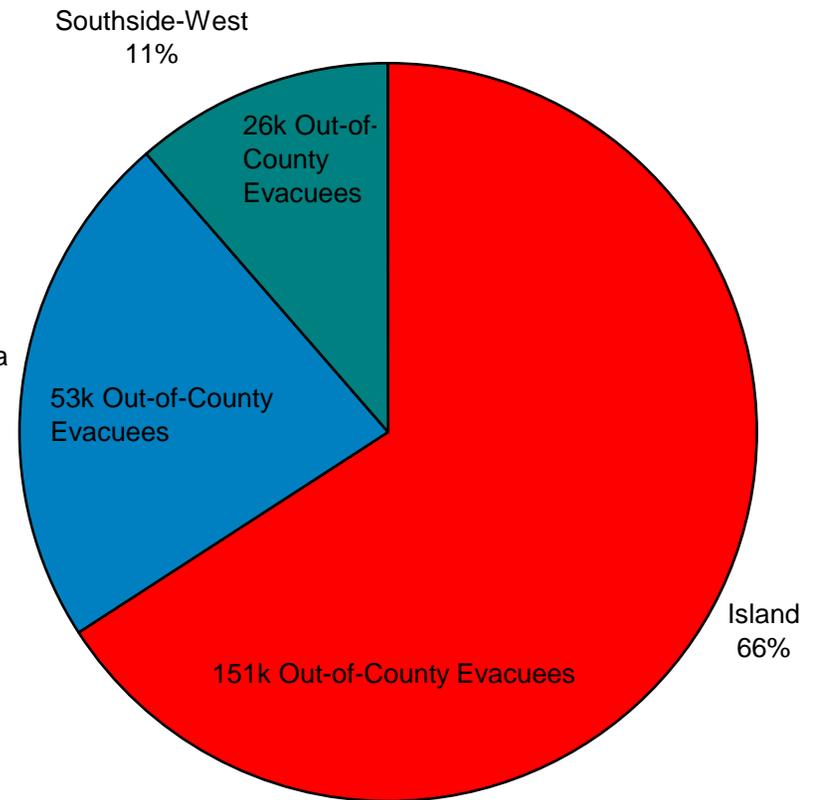
- People will be spending hours in their cars idling in queues.
- **Recommendation: The State could distribute gasoline (e.g. in 5 gallon plastic cans) to motorists on interstate shoulders who have run out of gas.**

5. Redirecting Demand and Capacity

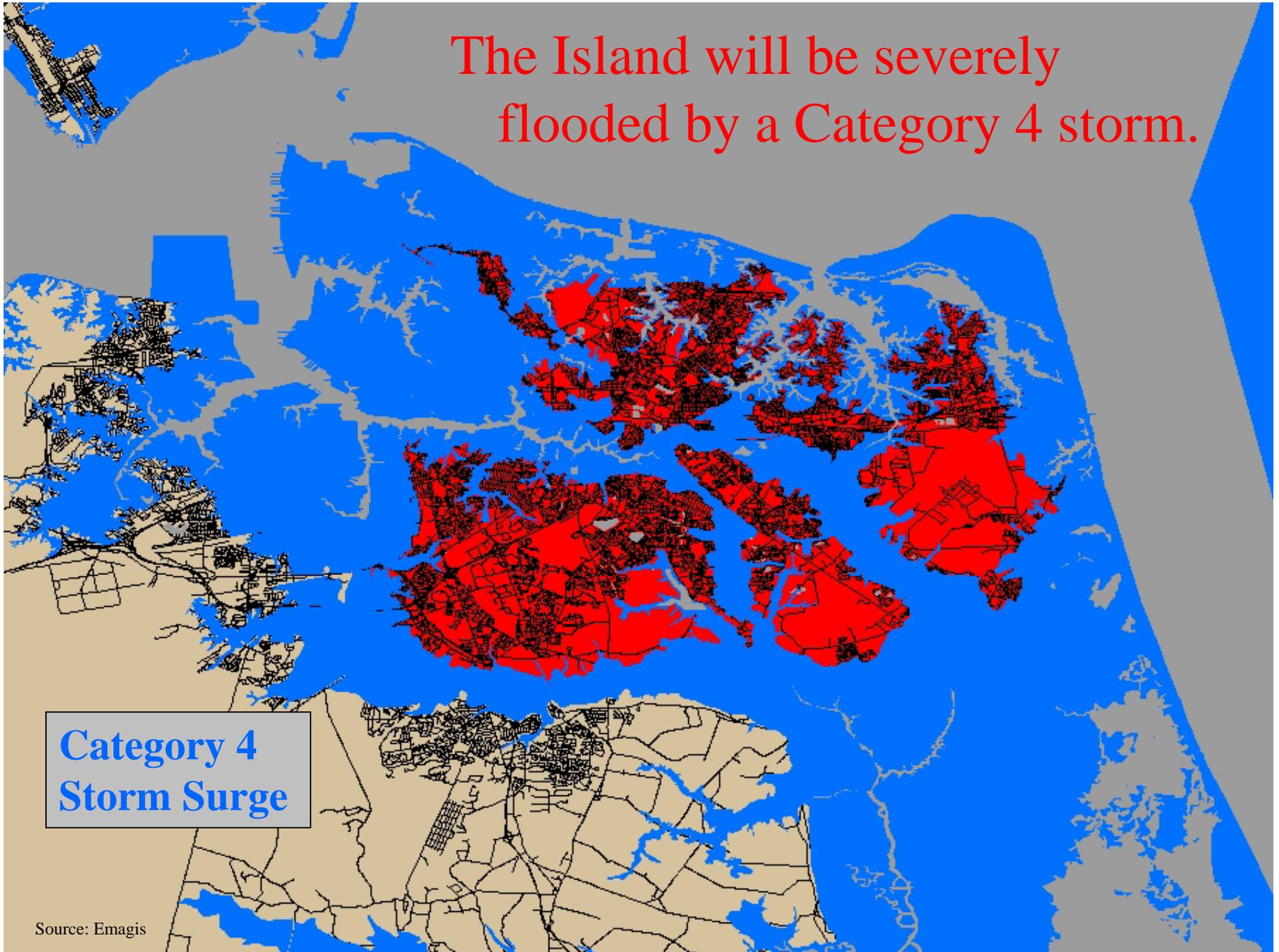
- Two-thirds of HR's vulnerable population lives on the Island formed by the Intra-Coastal Waterway.



"Out of County" Evacuating Population
1992 VHES, revised for 1996 HRPDC Study



The Island will be severely flooded by a Category 4 storm.



Category 4
Storm Surge

Source: Emagis

5. Redirecting Demand and Capacity

- More than half of the island will be flooded in a Category 4 storm, limiting opportunities for evacuating to safer locations on the Island.
- 6 major bridges and tunnels join the Island to the rest of Hampton Roads and the US:
 - Chesapeake Bay Bridge Tunnel
 - *Hampton Roads Bridge Tunnel*
 - *Midtown Tunnel*
 - *Downtown Tunnel*
 - *Gilmerton Bridge*
 - *High-Rise Bridge*
- 5 of these bridges and tunnels are severely congested on a daily basis.
 - With a storm approaching it may take many hours just to get off the Island.
- The TCP provides for reversal of I-64 but effectively closes the WB HRBT tube, thereby providing no additional capacity for leaving the Island.
- Of the three vulnerable areas (Island, Peninsula, and Southside-west), only the Island's population (when leaving) must pass into another vulnerable area, competing with that area for shelter and roadway capacity.

5. Redirecting Demand and Capacity

- Therefore—because of the Island’s high population, extensive flooding, limited exits, and being surrounded by vulnerable areas—of HR’s vulnerable population, the Island’s vulnerable population are probably the most at risk for flooding/drowning.

5. Redirecting Demand and Capacity

- **Recommendation:** Because of the threat to Island residents, revise the “reversal” portion of the TCP now to allow Island residents to use both EB and WB tubes at HRBT to leave the Island, thereby doubling the capacity of this vital link.

The Cost of Keeping Status Quo

- If the existing TCP is implemented:
 - its reversal of I-64 (which adds no capacity at HRBT) will provide no aid to the portion of the 151,000 vulnerable VB-Norf-Ches Island residents who will try unsuccessfully to leave the Island, and
 - its restrictions to interstate access may cause “super-congestion” on the arterial network used by essentially all approach-day trips.
- If dozens of people drown, regardless of fault, we will have to answer these questions after the storm:
 - “As the hurricane approached, why did you restrict the interstates, a large portion of the regional network?”
 - “As the hurricane approached, why did you close NB MMBT?”
 - “As the hurricane approached, why did you close the WB HRBT lanes?”

Summary of Recommendations

- Do not implement the interstate restriction portion of VDOT's Hurricane TCP until an analysis—which includes arterials—shows that restrictions would definitely not harm storm preparation and evacuation.
- Do not seek zero queues on interstate.
- Cities and State should inform the public annually:
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- The State could distribute gasoline (e.g. in 5 gallon plastic cans) to motorists on interstate shoulders who have run out of gas.
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