Southeast Virginia/Northeast North Carolina
Regional Catastrophic Planning Project

Phase I Mass Evacuation Products

June 2, 2011

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Three General Scenarios

1. A multiple IED event
2. An aerosolized anthrax attack
3. A catastrophic hurricane event

Phase I Products

- Behavioral Report
- Scenario Analysis and Traffic Modeling Report
- Transportation Requirements Report and Gap Analysis
- Evacuation Traffic and Evacuee Participation Monitoring Report
- Mass Evacuation Annex
- VIPER Compatible Evacuation Model Tool
- Virginia Risk Profile / HURREVAC Updates

Worst Case Category 3 & 4 Hurricanes

- Recent FEMA / USACE HES scenario assumptions (100% surge area participation)
- FIU / Morrow destination assumptions with HES participation rates
- FIU / Morrow destination and participation rates (partial surge area and higher inland)
- Time and roadway constrained evacuation

IED Scenarios

- Local representative school – Virginia Beach
- Hoffman U.S. Courthouse - Norfolk
- Hampton Roads Bridge Tunnel
- Gloucester Courts Building – Gloucester
- Newport News / Williamsburg Airport
- Accomack County Administration Offices
- Chesapeake Energy Storage Yards – Elizabeth River Southern Branch
- Dare County Courthouse

Modeling Approach

Focused on several key input assumptions related to:

- Study area geography
- Incident footprint selection
- Socioeconomic data
- Behavioral assumptions
- Inland destinations
- Directional travel
- Route usage

Socioeconomic Data

Jurisdiction	Permanent Population	Permanent Occupied Units	Mobile Home Units	Seasonal Units
York	68,800	24,442	392	6,685
Poquoson	12,000	4,323	184	0
Hampton	149,600	62,531	1,003	2,340
Newport News	191,999	74,270	2,373	3,807
James City	48,100	20,771	1,414	343
Williamsburg	11,996	3,619	57	65
Peninsula Totals	**482,495**	**189,956**	**5,423**	**13,240**
Portsmouth	101,376	38,478	165	779
Chesapeake	230,000	80,714	2,290	3,182
Norfolk	236,339	86,924	485	5,075
Virginia Beach	444,800	161,553	1,351	12,897
Southside Metro Totals	**1,012,515**	**367,669**	**4,291**	**21,933**
Isle of Wight	33,090	12,599	1,805	49
Suffolk	89,800	32,835	925	786
Surry	7,101	2,724	470	369
Southside West Totals	**129,991**	**48,158**	**3,200**	**1,204**

Socioeconomic Data

Jurisdiction	Permanent Population	Permanent Occupied Units	Mobile Home Units	Seasonal Units
Gloucester	38,487	14,526	2,427	508
Mathews	9,500	5,307	149	919
Middlesex	11,498	5,711	607	1,882
Lancaster	12,198	5,277	612	857
Northumberland	13,299	6,397	674	2,019
Richmond	9,600	3,915	489	305
Westmoreland	17,600	7,207	790	1,764
Mid Pen / N Neck Totals	**112,182**	**48,340**	**5,748**	**8,254**
Accomack	39,000	15,298	4,507	2,672
Northampton	14,000	5,298	843	413
Eastern Shore Totals	**53,000**	**20,596**	**5,350**	**3,085**
Dare	34,000	12,675	2,530	18,000
Currituck	24,000	8,150	2,275	4,295
Northeast NC Totals	**58,000**	**20,825**	**4,805**	**22,295**

Participation Rate Examples

Zone Groups	Storm Scenarios			
	Category 1	Category 2	Category 3	Category 4
Category 1	100% / 40%	100% / 40%	100% / 76%	100% / 76%
Category 2	1% / 28%	100% / 40%	100% / 76%	100% / 76%
Category 3	1% / 25%	3% / 25%	100% / 50%	100% / 76%
Category 4	1% / 25%	3% / 25%	5% / 50%	100% / 76%
Non-Surge	1% / 20%	3% / 20%	5% / 50%	10% / 60%
Southside				

Evacuee Destinations

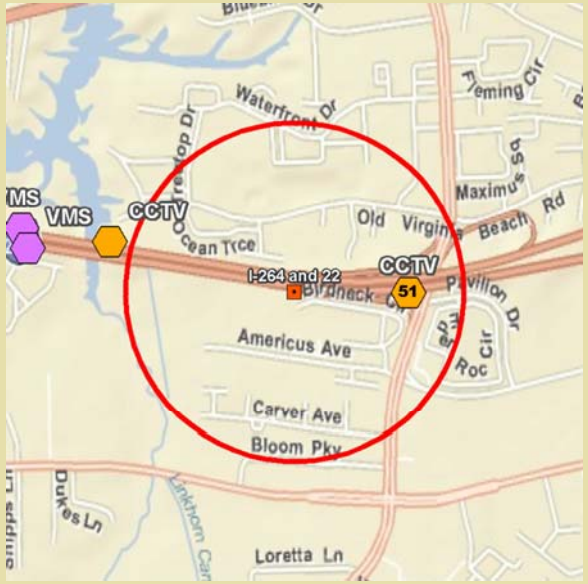
Destination	Peninsula	Southside	Mid Pen / N Neck	Eastern Shore	Northeast NC
Stay in Local Region	25%	24%	26%	25%	--
Richmond	21%	13%	16%	4%	--
North Virginia / DC / Misc. North	16%	15%	19%	43%	--
Western Virginia / Misc. West	12%	11%	16%	5%	--
Virginia Beach / Southside	--	--	--	3%	--
Emporia / Petersburg	--	1%	--	--	--
North Carolina / Misc. South	5	10	4	3	--
Not Sure / Other	21	26	19	17	--
NC I-95 North Towns / Rock Mount	--	--	--	--	10%
NC I-95 South Towns / Fayetteville	--	--	--	--	15%
Raleigh	--	--	--	--	25%
Greensboro / Winston Salem	--	--	--	--	10%
Charlotte / Western North Carolina	--	--	--	--	10%
Virginia Northward	--	--	--	--	30%

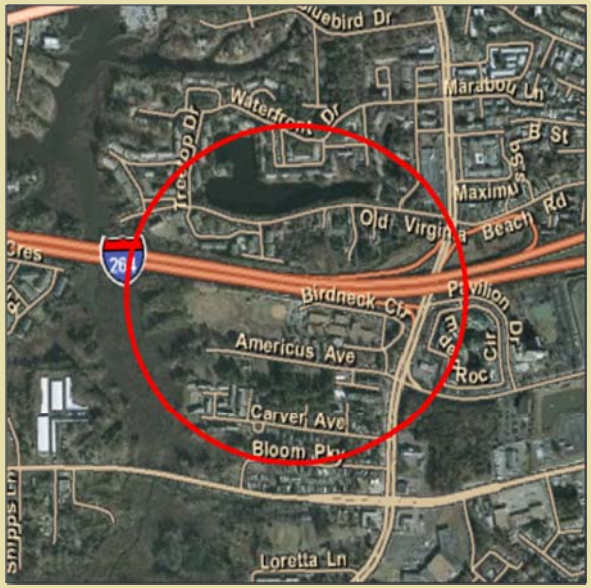
Intended Destination & Travel Distance

How Far Would Go	Public Shelter 10%	Family / Friends Inside Area 17%	Family / Friends Outside Area 47%	Hotel 21%	Other 6%
< 10 Miles	27%	16%	2%	1%	7%
10-50 Miles	30%	41%	11%	18%	19%
50-100 Miles	19%	21%	30%	38%	29%
100-200 Miles	17%	11%	28%	26%	23%
> 200 Miles	6%	11%	30%	17%	22%

Traffic Monitoring Location Example

I-264 interchange 22 at Birdneck Rd. – Southside Metro





Available Monitoring Devices within One-Quarter Mile

DEVICE ID	TYPE	ROUTE	DIRECTION	DESCRIPTION	MILE MARKER	LATITUDE	LONGITUDE
51	CLOSED CIRCUIT TV	N/A	EAST	I-264 EB BIRDNECK RD OVERPASS	N/A	36.84618	-75.99538

2008 Traffic Count

ROUTE	START	END	LENGTH	DAILY COUNT	% 2/4 TIRE VEHICLES	% BUSES	% TRUCKS 2 AXLE	% TRUCKS 3+ AXLE	% TRUCKS COMBO (ADD'L TRAILERS)
I-264 EAST	BIRDNECK RD	PARKS AVE	0.64 MILES	12,000	97%	0%	0%	2%	1%

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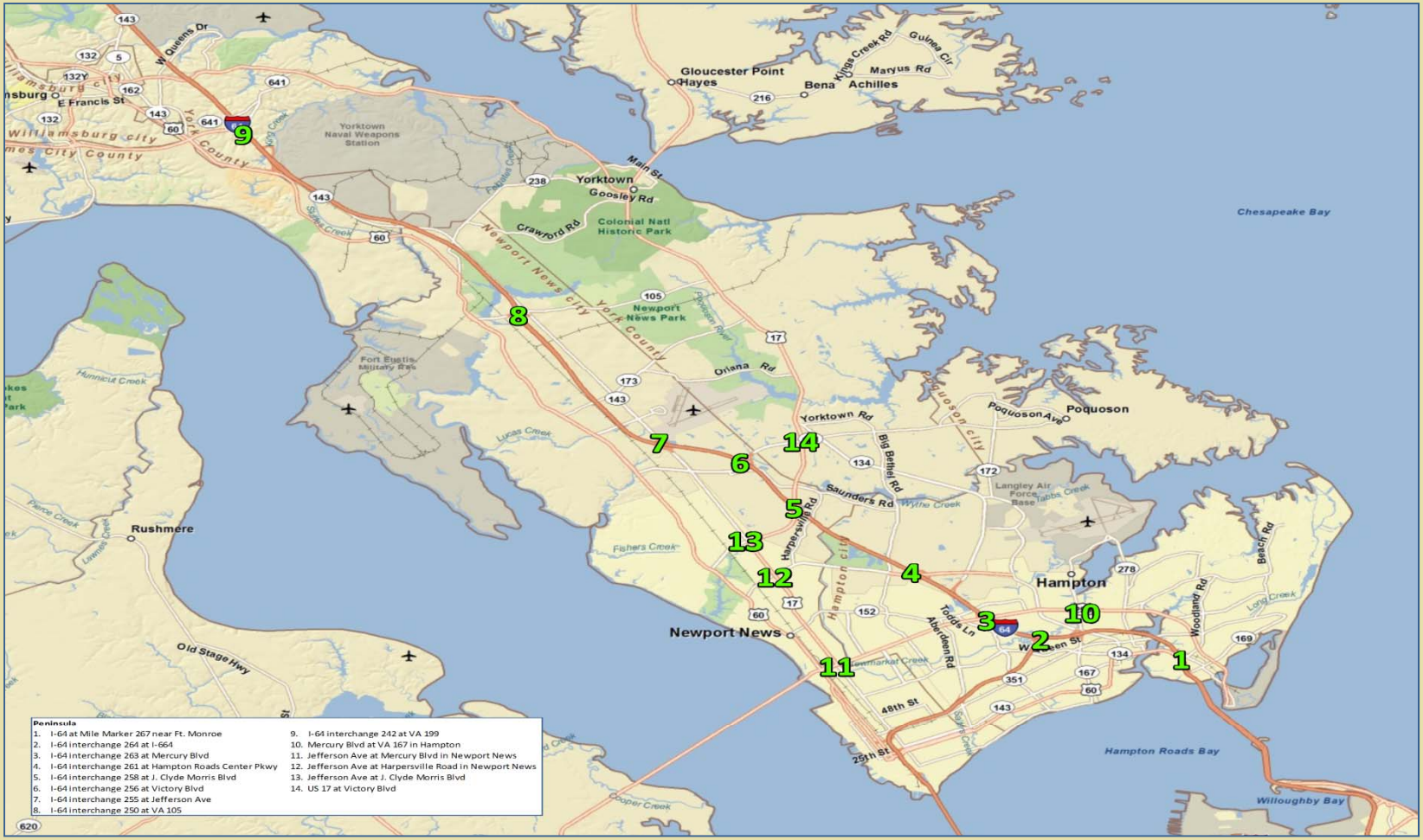
Traffic Monitoring & Modeling Location

Peninsula



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Traffic Monitoring & Modeling Location

Southside Metro

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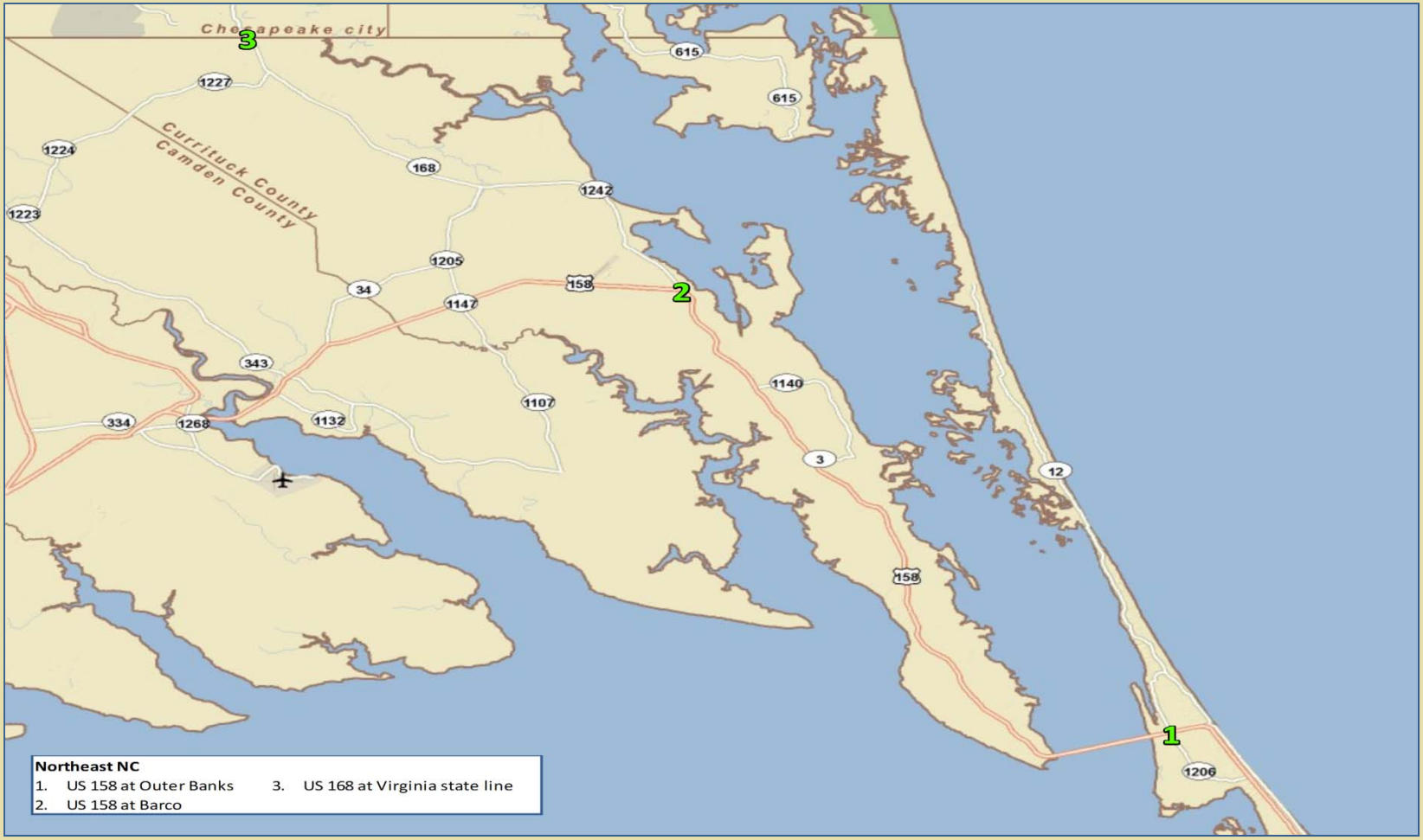
Traffic Monitoring & Modeling Location

Northeast North Carolina



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Roadway Evacuation Service Volumes

- Number of vehicles per hour that can be processed given:
  - facility type
  - lane
  - geometric characteristics
- Service volume that deteriorates through the first three quarters of the evacuation
- Recovers in the final quarter

Traffic Control / Contraflow

- I-64 Reversal
- Barco Diversion

Total Evacuees

- With little to no major hurricane experience, many residents will underestimate their vulnerability and overestimate the ability of regional roadways to allow their escape.

- This creates a difficult dilemma for modeling evacuee behavior particularly related to resident participation.

Total Evacuating People

Jurisdictions	Cat 3 - Total Evacuees				Cat 4 - Total Evacuees			
	Recent HES	FIU with HES part	FIU as is	Roadway Constrained	HES	FIU with HES part	FIU as is	Roadway Constrained
York	43,000	41,237	51,115	46,176	46,875	44,871	60,214	52,543
Poquoson	12,000	12,001	9,480	10,741	12,000	12,001	9,480	10,741
Hampton	120,900	120,198	104,174	112,186	155,200	154,514	123,101	138,808
Newport News	40,050	39,017	107,671	73,344	65,630	64,490	131,179	97,835
James City	NA	9,659	14,536	12,098	NA	12,209	18,215	15,212
Williamsburg	NA	1,702	3,387	2,545	NA	2,288	4,221	3,255
Peninsula Totals	**215,950**	**223,814**	**290,363**	**257,089**	**279,705**	**290,373**	**346,410**	**318,392**
Portsmouth	103,250	103,013	68,026	85,520	103,250	103,013	78,682	90,848
Chesapeake	237,650	236,684	142,488	189,586	237,650	236,684	181,484	209,084
Norfolk	181,570	180,114	144,648	162,381	248,520	246,997	190,273	218,635
Virginia Beach	213,500	209,771	273,721	241,746	383,200	379,355	348,620	363,988
Southside Metro Totals	**735,970**	**729,582**	**628,883**	**679,233**	**972,620**	**966,049**	**799,059**	**882,554**
Isle of Wight	19,450	19,460	20,719	20,090	20,625	20,684	22,462	21,573
Suffolk	39,950	39,713	52,433	46,073	42,700	42,491	61,195	51,843
Surry	2,435	2,335	4,374	3,355	2,950	2,848	5,114	3,981
Southside West Totals	**61,835**	**61,508**	**77,526**	**69,517**	**66,275**	**66,023**	**88,771**	**77,397**
Gloucester	12,930	12,792	20,898	16,845	16,170	16,016	21,077	18,547
Mathews	9,239	8,970	6,738	7,854	10,148	9,872	6,872	8,372
Middlesex	8,619	8,094	9,681	8,888	10,759	10,195	9,932	10,064
Lancaster	4,593	4,359	8,089	6,224	5,748	5,490	8,142	6,816
Northumberland	7,123	6,573	11,068	8,821	8,763	8,159	11,155	9,657
Richmond	2,456	2,372	5,588	3,980	3,342	3,248	5,634	4,441
Westmoreland	9,036	8,553	12,567	10,560	11,810	11,282	12,857	12,070
Mid Pen / N Neck Totals	**53,996**	**51,713**	**74,629**	**63,171**	**66,740**	**64,262**	**75,669**	**69,966**
Accomack	24,383	25,191	25,505	25,348	25,897	27,621	27,330	27,476
Northampton	5,267	5,410	6,793	6,102	5,949	6,091	7,426	6,759
Eastern Shore Totals	**29,650**	**30,601**	**32,298**	**31,450**	**31,846**	**33,712**	**34,756**	**34,234**
Dare	171,835	169,084	162,067	165,576	171,885	171,885	164,867	168,376
Currituck	48,830	47,087	43,497	45,292	48,830	48,830	44,636	46,733
Northeast NC Totals	**220,665**	**216,171**	**205,564**	**210,868**	**220,715**	**220,715**	**209,503**	**215,109**

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Evacuating Summary

Jurisdictions	Current Perm Population	Out of Local Area Evacuees HES	FIU with HES part	FIU as is	Roadway Constrained	Staying in Area Evacuees HES	FIU with HES part	FIU as is	Roadway Constrained
York	68,800	26,200	28,392	33,186	26,170	16,800	12,845	17,929	20,006
Poquoson	12,000	6,000	7,802	6,162	5,935	6,000	4,199	3,318	4,806
Hampton	149,600	58,600	75,855	65,187	59,943	62,300	44,343	38,987	52,243
Newport News	192,000	18,250	25,776	63,142	37,790	21,800	13,241	44,529	35,554
James City	48,100	NA	5,989	8,452	6,137	NA	3,670	6,084	5,960
Williamsburg	12,000	NA	1,084	1,960	1,294	NA	618	1,427	1,251
Peninsula Totals	**482,500**	**109,050**	**144,896**	**178,089**	**137,269**	**106,900**	**78,918**	**112,274**	**119,820**
Portsmouth	101,400	48,275	62,290	41,294	44,023	54,970	40,723	26,732	41,496
Chesapeake	230,000	106,050	143,697	87,202	98,132	131,600	92,987	55,286	91,454
Norfolk	236,350	84,100	111,002	89,981	85,418	97,500	69,112	54,667	76,963
Virginia Beach	444,800	106,300	132,801	171,359	129,268	107,200	76,970	102,362	112,478
Southside Metro Totals	**1,012,550**	**344,725**	**449,790**	**389,836**	**356,841**	**391,270**	**279,792**	**239,047**	**322,391**
Isle of Wight	33,100	8,850	10,728	11,422	9,414	10,630	8,732	9,297	10,676
Suffolk	89,800	18,550	22,274	29,280	21,910	21,400	17,439	23,153	24,163
Surry	7,100	1,220	1,502	2,611	1,748	1,210	833	1,763	1,607
Southside West Totals	**130,000**	**28,620**	**34,503**	**43,313**	**33,072**	**33,240**	**27,005**	**34,213**	**36,445**
Gloucester	38,500	5,130	7,307	11,789	8,116	7,800	5,485	9,109	8,729
Mathews	9,500	4,935	5,445	4,253	4,122	4,304	3,525	2,485	3,732
Middlesex	11,500	5,360	5,623	6,558	5,177	3,259	2,471	3,123	3,710
Lancaster	12,200	2,475	2,923	4,985	3,361	2,118	1,436	3,104	2,863
Northumberland	13,300	4,630	4,905	7,361	5,213	2,493	1,668	3,707	3,608
Richmond	9,600	1,095	1,513	3,293	2,042	1,361	859	2,295	1,938
Westmoreland	17,600	5,145	5,810	8,062	5,896	3,891	2,743	4,505	4,664
Mid Pen / N Neck Totals	**112,200**	**28,770**	**33,526**	**46,302**	**33,927**	**25,226**	**18,187**	**28,327**	**29,244**
Accomack	39,000	13,000	19,030	18,746	16,055	11,383	6,161	6,759	9,293
Northampton	14,000	3,000	3,924	4,751	3,687	2,267	1,486	2,042	2,414
Eastern Shore Totals	**53,000**	**16,000**	**22,954**	**23,497**	**19,742**	**13,650**	**7,647**	**8,801**	**11,708**
Dare	34,000	170,000	161,888	156,314	135,236	1,835	7,196	5,753	30,340
Currituck	24,000	48,000	43,423	40,407	35,628	830	3,664	3,090	9,664
Northeast NC Totals	**58,000**	**218,000**	**205,311**	**196,721**	**170,864**	**2,665**	**10,860**	**8,843**	**40,004**

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Total Public Shelter Demand

Hampton Roads vs. Tampa Bay:

- Generally the number of actual public shelter evacuees has been less than what was predicted.

- While Tampa Bay's evacuation dilemma is more severe than the Hampton Roads area, the implied parallels are striking. Since many of the evacuees who may desire to go out of the area will not be able to leave the region, this will place greater demand on local shelters in the Hampton Roads area.

In-Area Public Shelter Demand

	Cat 3 - In Area Pub Shelter Demand				Cat 4 - In Area Pub Shelter Demand			
Jurisdictions	HES	FIU with HES part	FIU as is	Roadway Constrained	HES	FIU with HES part	FIU as is	Roadway Constrained
York	2,700	2,284	3,418	3,707	3,165	2,521	4,202	7,130
Poquoson	680	600	474	687	688	600	474	1,063
Hampton	7,965	7,365	6,644	8,783	13,110	10,793	8,537	18,437
Newport News	4,320	2,961	9,886	7,907	8,450	5,435	12,165	16,831
James City	NA	686	1,284	1,204	NA	936	1,583	2,363
Williamsburg	NA	116	306	258	NA	173	374	513
Peninsula Totals	**15,665**	**14,012**	**22,012**	**22,545**	**25,413**	**20,458**	**27,335**	**46,337**
Portsmouth	8,230	7,134	4,361	7,071	8,230	7,134	5,427	12,632
Chesapeake	20,250	19,064	10,607	18,301	20,250	19,064	14,505	35,145
Norfolk	15,210	14,051	11,196	15,698	25,180	20,697	15,758	38,414
Virginia Beach	16,090	13,888	21,369	22,113	41,670	30,772	28,832	63,043
Southside Metro Totals	**59,780**	**54,137**	**47,533**	**63,184**	**95,330**	**77,667**	**64,522**	**149,233**
Isle of Wight	1,520	1,153	1,468	1,552	1,770	1,275	1,643	3,303
Suffolk	3,380	2,686	4,232	4,118	3,920	2,960	5,103	9,241
Surry	260	146	356	311	350	189	423	765
Southside West Totals	**5,160**	**3,985**	**6,056**	**5,981**	**6,040**	**4,424**	**7,169**	**13,309**
Gloucester	1,600	964	1,877	1,699	2,170	1,278	1,896	3,223
Mathews	580	513	387	559	710	599	400	1,104
Middlesex	500	365	553	609	790	550	578	1,406
Lancaster	410	244	624	547	590	342	629	1,110
Northumberland	450	274	705	657	670	398	714	1,436
Richmond	315	175	497	413	465	257	501	815
Westmoreland	680	477	886	877	1,085	722	915	1,928
Mid Pen / N Neck Totals	**4,535**	**3,012**	**5,529**	**5,362**	**6,480**	**4,146**	**5,633**	**11,021**
Accomack	1,980	1,982	2,122	2,952	2,225	2,223	2,303	7,676
Northampton	455	454	604	724	525	524	671	1,818
Eastern Shore Totals	**2,435**	**2,436**	**2,726**	**3,676**	**2,750**	**2,747**	**2,974**	**9,494**
Dare	NA	0	0	0	NA	0	0	0
Currituck	1,218	1,571	1,362	4,197	1,218	1,690	1,419	26,313
Northeast NC Totals	**1,218**	**1,571**	**1,362**	**4,197**	**1,218**	**1,690**	**1,419**	**26,313**

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Inland Shelter Demand

	Other Evacuation/Roadway Stats			
	HES	FIU with HES part	FIU as is	Roadway Constrained
Cat 3 Worst Case				
Max Evacuees to Richmond	NA	147,973	151,341	128,639
Richmond Public Shelter Demand @ 10%	NA	14,797	15,134	12,864
Richmond Public Shelter Demand @ 17%	NA	25,155	25,728	21,868
Cat 4 Worst Case				
Evacuees to Richmond	NA	212,229	206,910	120,640
Richmond Public Shelter Demand @ 10%	NA	21,222	20,691	12,064
Richmond Public Shelter Demand @ 17%	NA	36,079	35,175	20,509

Clearance Times

	Other Evacuation/Roadway Stats			
	HES	FIU with HES part	FIU as is	Roadway Constrained
Cat 3 Worst Case				
Clearance Times on I-64 out	35.9	45.5	49.2	40.0
Clearance Times on I-64 out w Reverse Lane	23.0	31.9	32.2	27.0
Clearance Times on US 58/Bowers Hl	35.8	52.4	43.4	40.0
Clearance Times on local feeder routes	18.0	18.1	22.4	16.0
Cat 4 Worst Case				
Clearance Times on I-64 out	61.3	70.8	67.2	40.0
Clearance Times on I-64 out w Reverse Lane	38.8	49.4	43.5	27.0
Clearance Times on US 58/Bowers Hl	58.9	67.5	59.4	40.0
Clearance Times on local feeder routes	28.5	30.4	29.0	27.0

IED / Anthrax Event

IED / Anthrax Scenario / Site	Locality	Area Max # Evacuees	Max Immediate Shelter Demand	Area Specific Max Traffic Clearance	
				Off Peak *(in hours)*	Peak *(in hours)*
Representative Elementary School	Virginia Beach	21,000	4,000	1.9	3.5
Walter Hoffman U.S. Courthouse	Norfolk				
600 Granby St.					
--With Scope Empty		4,000	500	2.0	3.9
--With Scope Full		13,500	700	3.0	5.5
Hampton Roads Bridge Tunnel	Norfolk Hampton	4,900 27,000	950 5,200	3.5	6.9
Gloucester Courts Building	Gloucester	1,900	380	1.8	2.5
7400 Justice Dr.					
Newport News / Williamsburg Airport	Newport News York Co.	16,000 12,000	3,100 1,100	1.9	4.1
900 Bland Blvd.					
Accomack County Admin. Offices	Accomack	1,800	290	1.4	1.7
23296 Courthouse Ave.					
Chesapeake Energy Storage Yards	Chesapeake	25,000	5,000	2.5	5.2
Elizabeth River Southern Branch					
Dare County NC Courthouse	Dare	10,000	1,200	1.0	2.0
Manteo, NC					

VIPER Compatible Model Interface

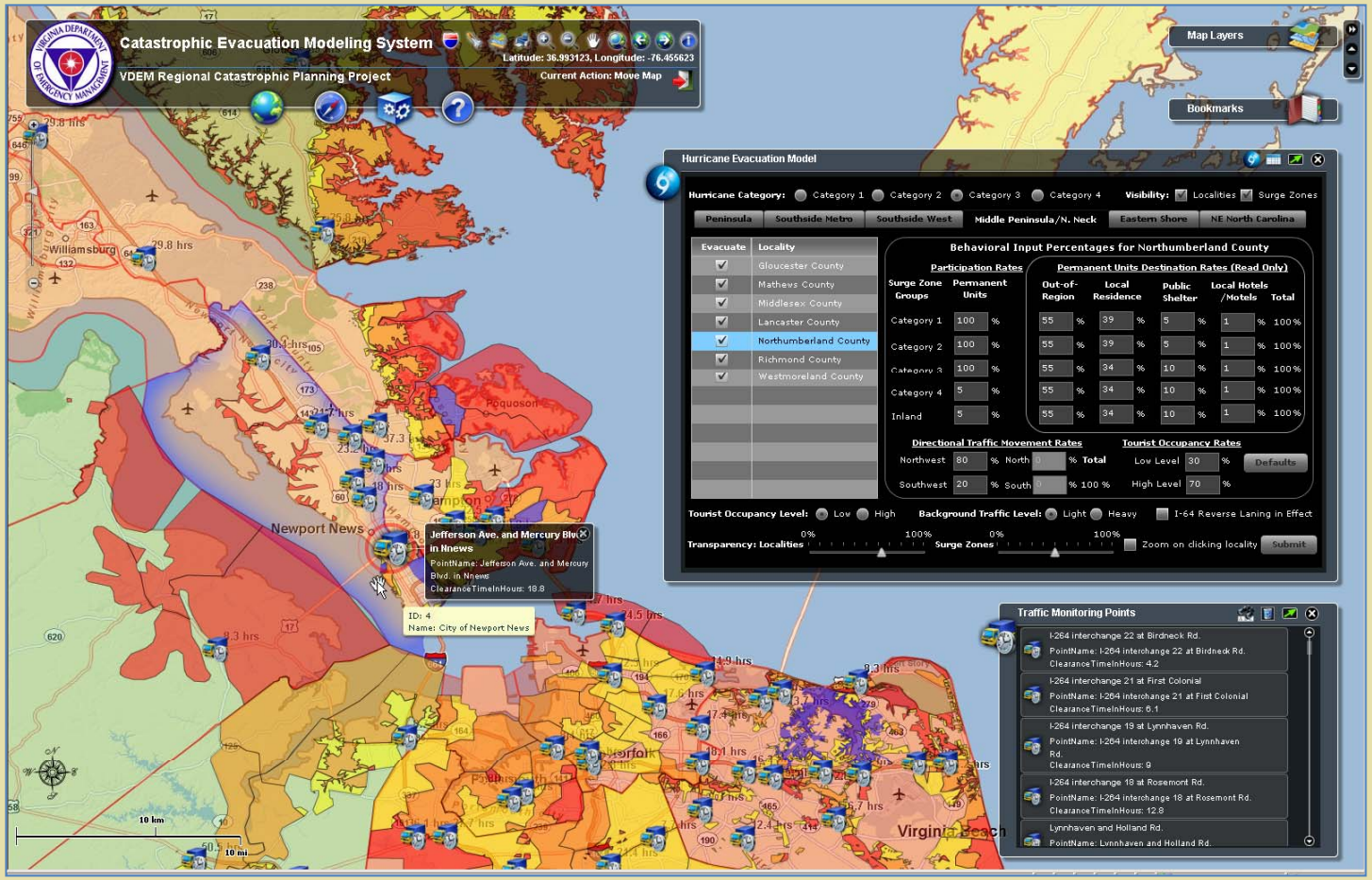
- Online system that could be used to model evacuation of the study area
- Allows users to interact with the model inputs and then automatically estimates evacuation statistics
- User inputs and specified socio economic and behavior data
- Estimate of clearance times
- Allows visualization of the most congested locations

Operating / Programming Environment

- VDEM CEMS
- Adobe Flex SDK (Software Development Kit)
- ESRI's ArcGIS Flex API (Application Programming Interface)
- ActionScript
- Application runs on an IIS web server running on Windows Server 2003 and connects to a SQL Server 2005 backend database

Evacuation Modeling System

Northumberland County – Category 3



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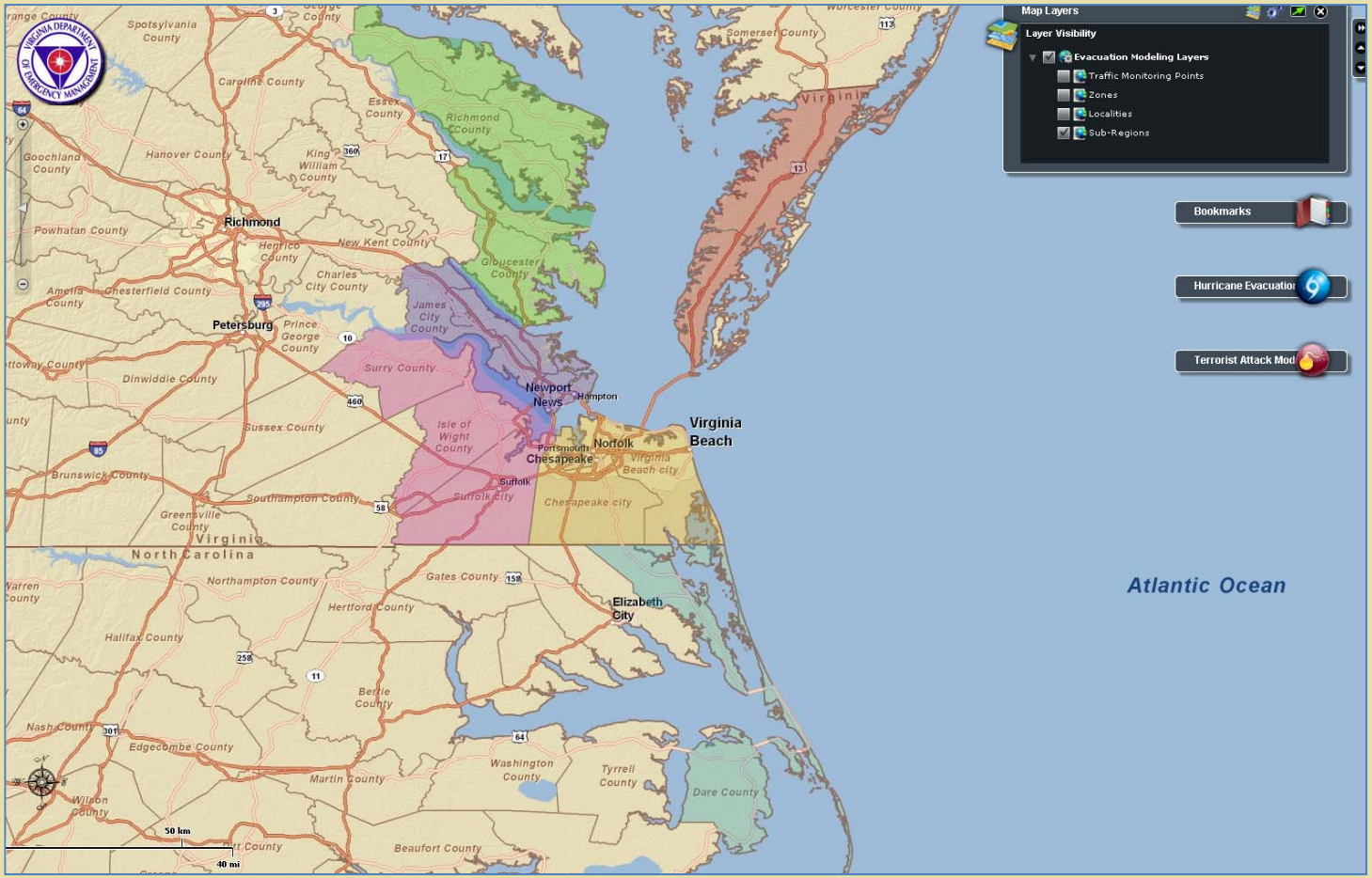
Evacuation Modeling System

Sub-Regions



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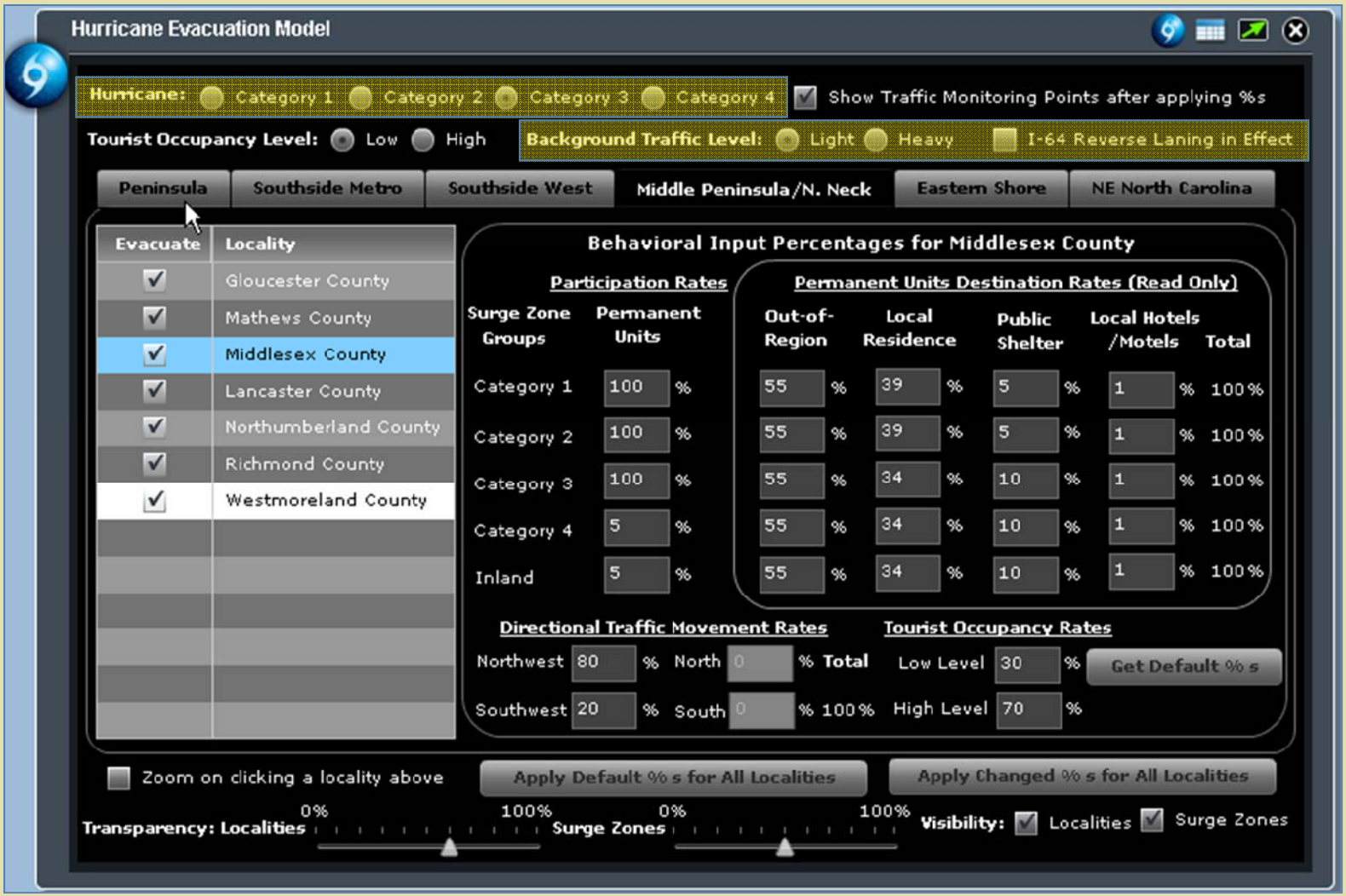
Evacuation Modeling System



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Evacuation Modeling System

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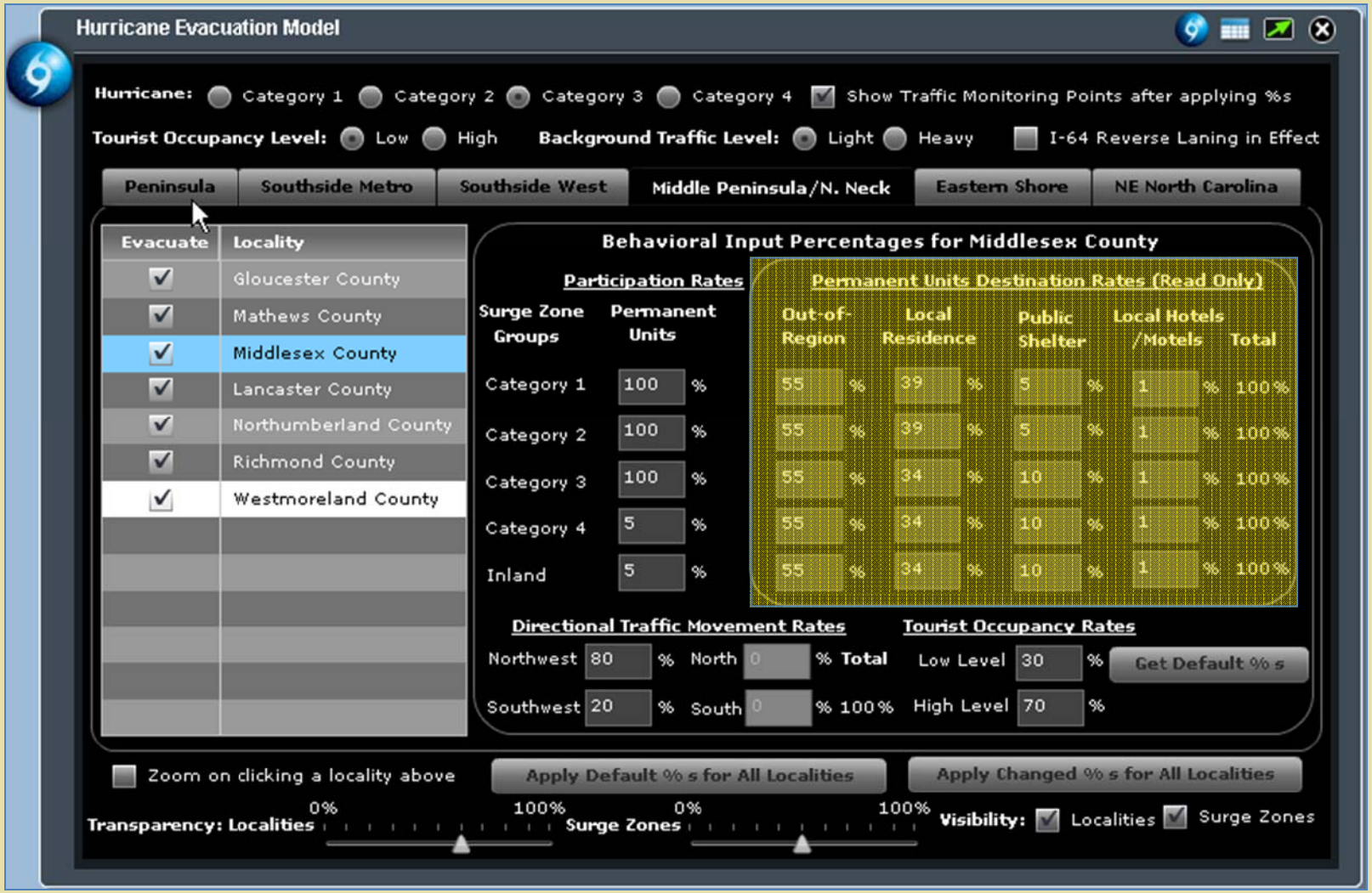

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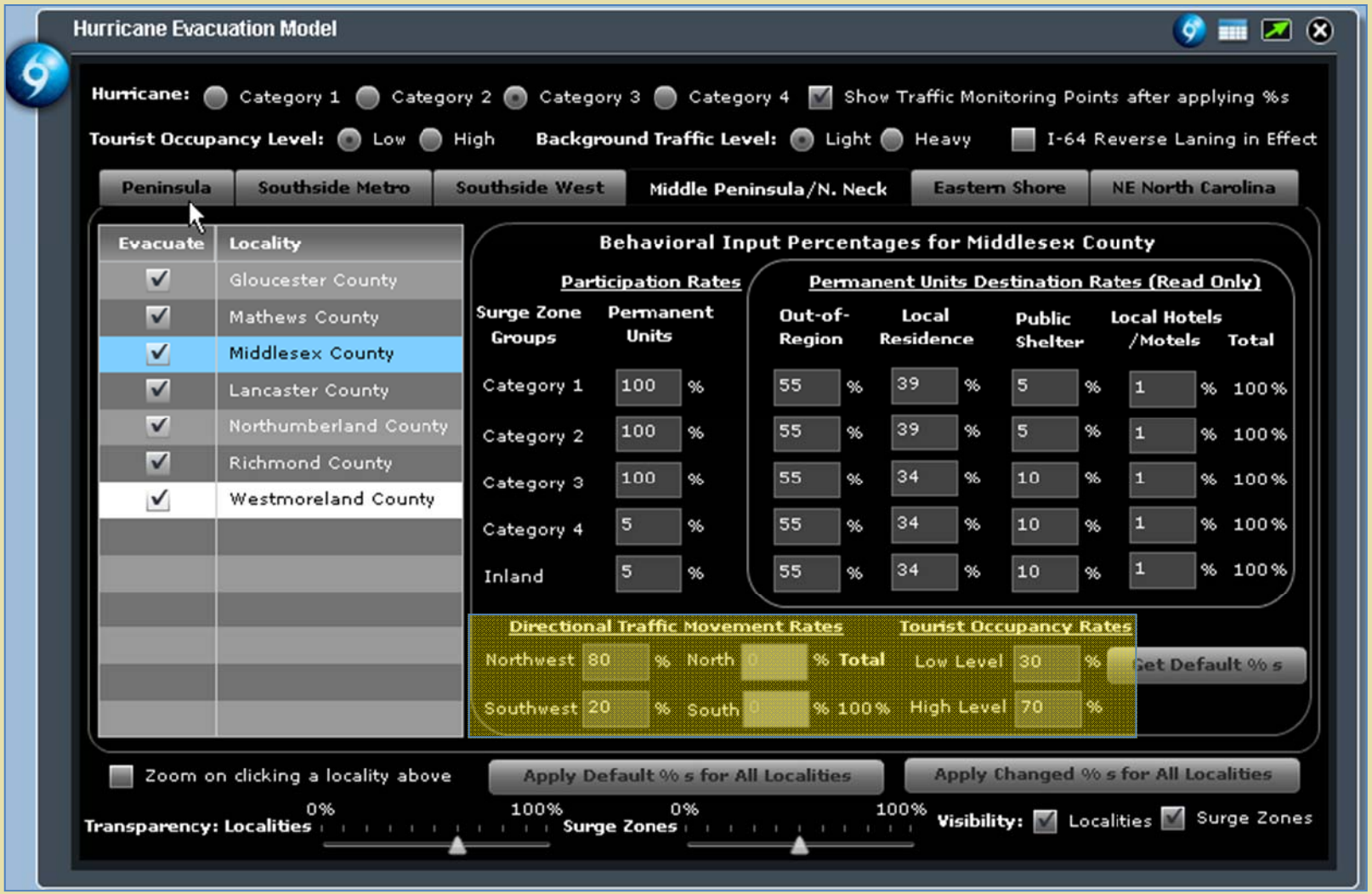

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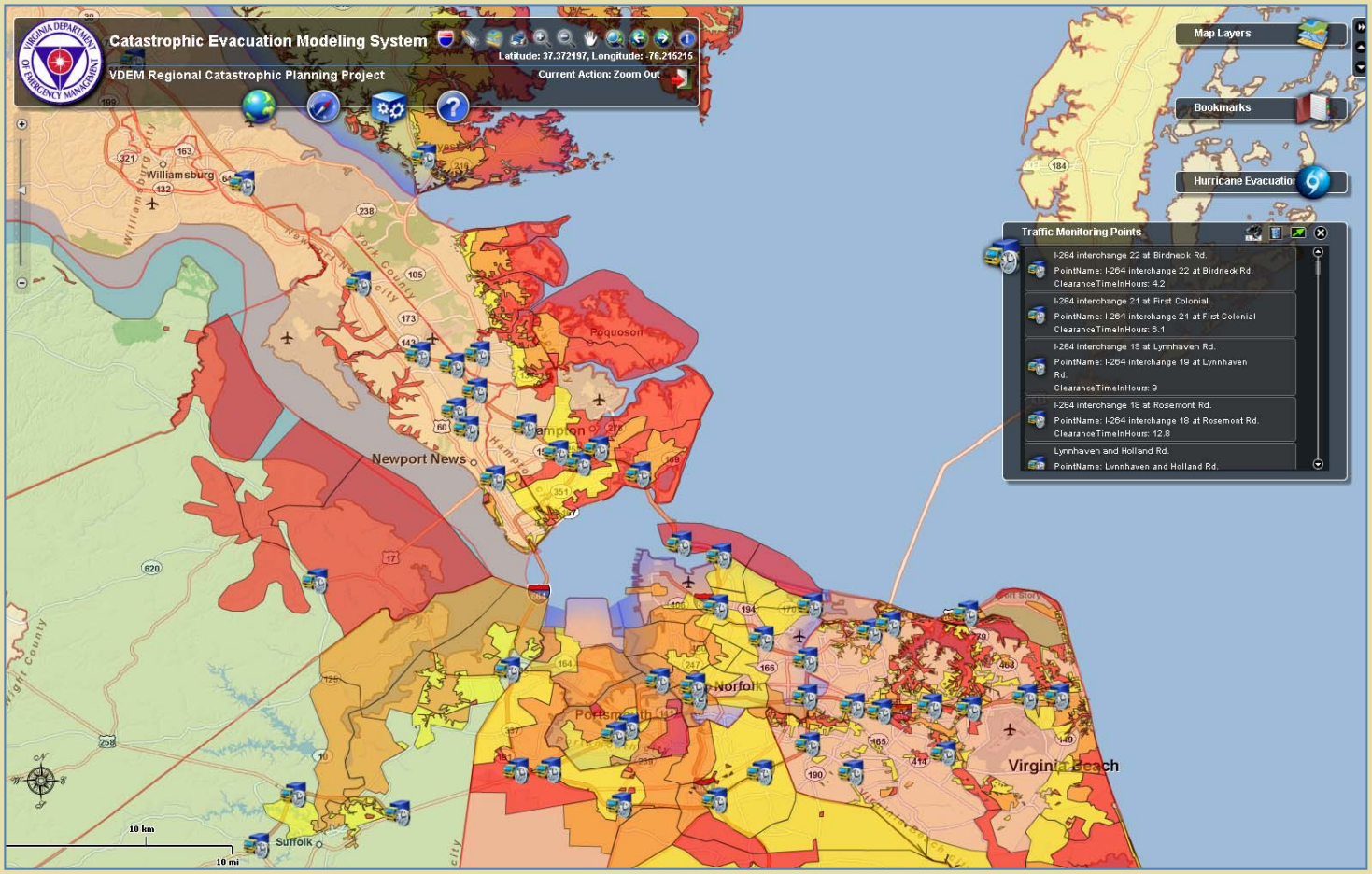
Traffic Monitoring Points



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Implications of Findings

Implications of Catastrophic Scenarios Analysis Findings for Decision Making / Public Response:

a) While we calculate clearance times up to 70 hours, the region will be fortunate to have even 48 hours available for evacuation and many will not move until there is more certainty in the strike forecast.

b) Even times of 24 hours or greater result in torturous individual evacuation commute times especially for those leaving in the heart of the evacuation; as seen in the Hurricane Floyd evacuations in the southeast, many residents will try to turn around and return home; those who continue may run into problems with refueling.

Implications of Findings (continued)

c) Since most storms will come from a southerly direction, even the smallest deviation in storm track 40 hours out may make the difference between a total miss or direct hit; or the difference between hitting South Carolina or staying over open water and hitting New England.

d) Forward speed of storms can be quite tricky in this part of the Atlantic. While a hurricane may only be moving at 10 mph forward speed at the time evacuation decisions are made, they can rapidly increase forward speed once they reach the mid-Atlantic cutting reaction and preparation time in half.

e) The demand on local resources will be significant in a catastrophic event if those who wish to leave the region are unable to navigate the trip due to time constraints.

f) While the I-64 reverse lane operation will be a huge help in reducing evacuation time requirements, it is not the “silver bullet” that solves all evacuation congestion.

Implications of Findings (continued)

g) While mainline roadway segments may be multi-lane, the one lane ramps connecting major thoroughfares will be constriction points that have much less capacity and great merging conflicts.

h) The reverse lane operation for the Bowers Hill area has not been totally worked out due to budgetary and staffing constraints, and will be a major obstacle for evacuees trying to leave the region.

i) Too many local residents are unsure of their surge vulnerability as evidenced by the behavioral study, and this is aggravating an already severe evacuation congestion situation for the regions escape routes.

j) Too many of those evacuating want to travel long distances; local sheltering options need to be expanded, bolstered, and explored.

Implications of Findings (continued)

k) The evacuation management mindset for the Richmond area is to discourage evacuees from sheltering in the Richmond area and to encourage them to stay on the road network. Richmond must anticipate large numbers of evacuees and plan for them. This will happen just as it did for Baton Rouge with New Orleans evacuees in Hurricane Katrina.

l) Northern Virginia must also be prepared for receiving a substantial number of evacuees, and this would include urban areas like Fredericksburg and Fairfax.

m) A third of the Outer Banks evacuees will try to come up Route 168 through the Hampton Roads area. While this is okay in a low tourist occupancy scenario, it will be very difficult to accommodate in a high tourist peak season scenario.