Pedestrian Disaster Preparedness and Emergency Management:

White Paper for Executive Management

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Executive Summary

The following technical white paper summarizes the latest state-of-the-art Information and best practices for pedestrian-related disaster preparedness and emergency evacuation planning. While “walk-out plans” have been developed for selected cities; no facility and/or infrastructure planning, engineering or implementation has yet occurred that was directly related to expediting or improving mass pedestrian evacuation safety and access. Since the New York State Department of Transportation (NYSDOT) has pioneered the study of pedestrian infrastructure and its impact on mass pedestrian evacuation, we recommend more support for this activity and ongoing outreach efforts. This paper concludes with a brief critique based on a prior discussion of the impact of pedestrian evacuation on vehicle movement that was published in the first federal guidance exclusively on managing pedestrian evacuations.2

Introduction

This white paper will cover recognition of the significance of mass evacuation on foot, type of threats, temporal issues that impact what modes are feasible, threat scope and scale, existing guidance on pedestrian-related disaster preparedness and emergency evacuation planning, short/mid-term and long term operational, capacity/facility, and regulatory, zoning, and site design action elements, how infrastructure improvements that facilitate mass evacuation on foot meets existing ADA, safety and mobility requirements, when/where walking is faster during evacuations, pedestrian evacuation dynamics and modeling, existing walk-out plans, walk-out plans under development, existing pedestrian streetscape and regulatory and zoning efforts, confidentiality issues, how successful evacuations are multimodal, ongoing collaboration and follow-up activities, defining our leadership role, guidance and outreach activities, and a brief critique of the March 2007 FHWA Report “Managing Pedestrians During Evacuations of Metropolitan Areas.”3

Recognition

What we have repeatedly observed, throughout history, as the primary means of urban center evacuation during sudden catastrophic events, are finally being documented, and recommendations specifically geared toward pedestrian evacuation are being made:

“The major forms of transportation…after the attack were walking, etc…” (Source: USDOT Draft Report – Effects of Catastrophic Events on Transportation System Management and Operations: New York City – 9/11/01, April 21, 2002).4


**Type of Threat**

The type of threat encountered during a sudden catastrophic event will impact:

- The ability of those evacuating on foot to escape the threat without bodily harm,
- Availability and number of first responders that can effectively provide aid,
- Ability or availability of other transportation modes to reach safe pick-up points.

Of course, neither firestorms nor flooding conditions (beyond the ability to escape to higher ground, multistory buildings, and/or elevated highway structures) are conducive to successful mass evacuation on foot. However, it’s an extremely rare occurrence when the odds of survival are not increased (even marginally) by evacuation on foot. While the ability to survive a sudden and catastrophic man-made nuclear, chemical or biological disaster is highly uncertain; the degree and duration of exposure may still be influenced and partially mitigated (along with wind direction, level of toxicity, size of the plume, etc…) by the ability to walk as far away from the threat as is humanly possible.

**Temporal Issues**

Those threats that can provide some prior warning of their onset, either eliminate the need for mass pedestrian evacuations or allow additional time for those evacuating on foot to be more appropriately dressed for prevailing weather conditions, and better supplied with food, water, and other essentials for the walking journey to safety zones.

Ideally, 3 or 4 days warning in advance of a natural occurrence (such as a major hurricane) would provide sufficient time, facility management resources, and first responder staffing to expedite single occupancy vehicle, high occupancy vehicle, public transportation (via bus, subway, commuter and intercity rail), ferry, and air evacuation.

When the “window of opportunity” for evacuation drops between 48 and 24 hours, more significant delays, including vehicular gridlock conditions, may occur throughout the impacted area.

For 24 hours or less warning, total highway/transit gridlock is likely, and mass evacuation on foot begins.

**Threat Scope/Scale**

The scope and scale of the event may range from a collapsed building within a single block, to a regional natural or man-made event that is extremely variable and complex. Depending on the above scenarios, the types of pedestrian evacuation, traffic,
and crowd control that would be required to manage this event is related to its size and complexity. In most cases, a localized event within the radius of a couple of blocks would involve pedestrian evacuation by way of the existing sidewalk and crosswalk network. Stairwell, bus/rail transit platform, and rolling stock capacity would also be impacted in the proximity of the event (assuming that there were no interruptions in transit service). Without disaster and emergency operational planning for a major urban center event, mass pedestrian evacuations would spill over into both the local street system and limited access highway network and overwhelm travel lanes on all bridge and gateway crossings. The effective management (rather than prohibition) of evacuation on foot is critical for saving the most lives in the shortest possible amount of time.

**Existing Guidance**


Published guidance at the national level (and the basis for NYSDOT guidance) was found in “Importance of Pedestrian Facilities in Disaster Preparedness: State of New York,” on page 15 (image 21) at [www.walkinginfo.org/howtoguide](http://www.walkinginfo.org/howtoguide).


Beyond the above generic guidance, the following two presentations (in power-point and PDF formats) more clearly define pedestrian disaster-preparedness-related planning, operations, facility/capacity-related measures and regulatory recommendations.

The following documents are available upon request or may be obtained electronically from the Department of Homeland Security’s (DHS) Lessons Learned Information Sharing (LLIS) system at [www.LLIS.gov](http://www.LLIS.gov). The latter document will also be available shortly from the University of New Orleans website [www.carlessevacuation.org](http://www.carlessevacuation.org):

“Pedestrian Disaster Preparedness: What’s a Walk-out Plan?” (by the NYSDOT Pedestrian Program for the TRB Committee on Pedestrians, Pro Walk Pro Bike Conference, Madison – Wisconsin, September 6th, 2006) developed a conceptual framework for pedestrian-related disaster preparedness and evacuation planning, described existing and planned walk-out plans for a number of American cities, and provided best practice design guidance for Central Business or Walking Districts.
“Importance of Pedestrian Facilities & Walk-Out Plans in Disaster Preparedness: Why Walking is the Primary Mode of Urban Evacuation during Sudden Catastrophic Events” (by the New York State Department of Transportation for the National Conference on Disaster Planning for the Car-less Society, University of New Orleans, February 8, 2007) improved upon the 2006 presentation by defining short-term, mid-term, and long-term actions for integrating pedestrians into disaster operation, capacity and regulatory efforts.\textsuperscript{10}

The first United State Department of Transportation/Federal Highway Administration (USDOT/FHWA) report solely dedicated to pedestrian evacuation was released in March 2007, and is titled “Managing Pedestrians During Evacuation of Metropolitan Areas, Final Report,” Publication No. FHWA-HOP-07-066. While this guidance is described as “cursory,” helpful insights such as those provided in captioned text called “Selected points important for practitioners” were provided. I strongly recommend a thorough read of this document, in its entirety, at the following website: http://ops.fhwa.dot.gov/publications/pedevac/index.htm.

Due to the vagueness of guidance provided in the text of the above report concerning the impacts of pedestrian evacuation on vehicle movement, a brief critique for further clarification of this issue is provided in the last discussion section of this paper.\textsuperscript{11}

A one page article entitled “Pedestrian Disaster Preparedness and Mass Evacuation on Foot,” was published by the author, on page 2, Issue 2 in the 2007, “The Bike/Ped Professional - Journal of the Association of Pedestrian and Bicycle Professionals.”\textsuperscript{12}

The above mentioned 3 step process for integrating pedestrians into disaster operation, facility capacity measures, and regulatory, zoning and site design efforts were summarized.

An electronic copy of the above document, along with other reports cited in this report may be obtained via email from jercolano@dot.state.ny.us.

**Operational Elements (Short Term Action Plan)**

Predetermined pedestrian evacuation planning (the operational element of pedestrian-related disaster preparedness and emergency action planning) results in walk-out plans. The basic logistical components of a “walk-out plan” are listed below:

1. Establish a cordon area where walking is the fastest primary mode. The size and configuration of this area can be determined through appropriate evacuation modeling, any unique geographic features, and engineering judgment.

2. Assess and designate priority pedestrian evacuation routes (portions of the existing sidewalk/crosswalk network, walking paths, and travel and/or bridge lanes for catastrophic events) within the “walk-out zone.”
3. Safety zone shelters or terminals at the fringe of the “walk-out zone” would provide a pick-up point to access high occupancy vehicles, public transit, commuter rail, ferry and other modes of transportation.

4. A prior public information and education (PI&E) program would be necessary, since the first reaction of many evacuees might be to attempt to drive or use public transit when neither mode may be operational or viable at that time.\(^\text{13}\)

5. Local community emergency response teams (CERTS), in cooperation with various first responders, would apply information already obtained from a master registry to evacuate the “at-risk” population within the “walk-out zone.”\(^\text{14}\)

**Capacity/Facility Elements (Mid-Term Action Plan)**

Pedestrian traffic capacity flow on sidewalks and crosswalks, access, and safety during an evacuation, as well as during regular or seasonal peak period use, would be improved with the following measures:

1. Widen sidewalks/crosswalks to match existing/latent demand of pedestrian traffic.\(^\text{15}\)

2. Add permanent pedestrian access during bridge rehabilitations/reconstructions.\(^\text{16}\)

3. Use signal phasing such as leading pedestrian interval and split phasing, calming green wave progression, signal crosswalk timing (3.5 ft/sec or 1.1 m/s as is suggested by the National Committee of Uniform Traffic Control Devices, NCUTCD), and coordination to improve safety.\(^\text{17}\)

4. Complete bike lane system, and off-street shared use path and trail networks.\(^\text{18}\)

5. Redesign urban portions of managed and contra-flow highway facilities to accommodate pedestrian evacuation.\(^\text{19}\)

6. Use intelligent transportation system (ITS) lane and shoulder designation systems (including movable barrier systems) to accommodate emergency pedestrian uses.\(^\text{20}\)

**Regulatory, Zoning, and Site Design Elements (Long Term Action Plan)**

The following long term regulatory, zoning, and site design recommendations are listed below for Central Business Districts, Walking Districts, and other high density locations:

1. Building codes and environmental quality review regulations should require expanded sidewalk and crosswalk capacity with higher residential and commercial population densities and with the needs of mass evacuation on foot in mind.\(^\text{21}\)
2. For the above locations, establish a “Long Range Plan for Sidewalk and Crosswalk Design and Capacity Needs,” as part of the routine regional MPO planning process.22

3. For gateways (major bridges and strategic highway connections), require that the planning process to provide ample non-motorized (pedestrian and bicycle) access and facility capacity along these connections, gateway bottlenecks, and shorefront trails.23

Additional benefits of pedestrian disaster preparedness and emergency evacuation planning (other than potentially saving thousands of lives) are the existing needs and regulatory requirements that would also be met by these actions. Compliance with the mandatory Americans with Disabilities Act (ADA) Community Transition Plans would support evacuation infrastructure needs in the following manner:24

- Provide a list of prioritized retrofits, including sidewalks, curb ramps, detectable warnings, accessible street crossings, operationally effective street crossings (for the pedestrian and the motorist), etc. to improve surface access, safety, and mobility.
- Make it possible (if stamina permits or if an able bodied pedestrian can assist) to accommodate people who use mobility aids such as wheelchairs, scooters, walkers, canes, etc., to safely use the public right-of-way for mass evacuation purposes.
- More adequately provide for existing, latent, and upcoming increases in pedestrian street traffic and levels of service along sidewalks, within crosswalks, and on transit-related stairwells and terminal platform areas.

When Walking is Faster

In cooperation with Minnesota DOT and the Army Research Laboratory, Professor Shashi Shekhar of the University of Minnesota ran computer models of urban evacuation routes and found that, because of the time people took to get to their cars and the traffic jams that are created, leaving the car behind was the best option for the area evaluated. Minnesota DOT now recommends evacuation on foot within a 1 mile radius of an event.25 Based on the results of the modeling, the researchers found that a walking-based evacuation within a one-mile radius is roughly three (3) times faster than driving on congested roads (based on an assessment of Minneapolis-St. Paul, Minnesota).26 It’s anticipated that the “walk-out zone” that would be most appropriate for any particular area will be based on the type of evacuation model applied, relevant data used as input, local demographics and density, topography, geographic boundaries, grid pattern, etc.
**Pedestrian Evacuation Dynamics and Modeling**

Professionals from many disciplines (particularly in Europe) are actively working on many different approaches to understand various aspects of pedestrian flow and crowd behavior during localized pedestrian movements and mass evacuation scenarios. On the micro level, these include analyses involving the simulation of pedestrian crowds in normal and evacuation situations, flow capacities from cellular automata modeling of proportional splits for pedestrians by direction, optimal velocity models, and use of video footage. These will not be discussed here.

For macro level evacuation simulations, a heuristic algorithm called the Capacity Constrained Route Planner (CCRP – developed by the University of Minnesota/US Army and Minnesota DOT), models capacity as a time series and uses a capacity-constrained approach to incorporate route capacity constraints. Performance evaluation on various network configurations shows that the CCRP algorithm produces high-quality solutions and significantly reduces the computational costs compared to linear programming approaches. CCRP is also scalable to the number of evacuees and size of the network.

CCRP is a contra-flow algorithm that considers congested conditions during evacuations, can be applied using ArcGIS network graphics, the model is currently applicable to vehicular and pedestrian traffic, and provides a ranking of evacuation times by either of those modes. As described in the April 2006 power-point presentation titled: “Evacuation Route Planning: A Scientific Approach”, by Professor Shashi Shekhar, University of Minnesota Director, Army High Performance Computing Research Center, pedestrian evacuations are significantly faster than vehicular evacuations in the following density scenario:

> “If evacuation volumes are over 5,000 persons per square mile, walking is more efficient; if volumes are less than 5,000 persons per square mile, driving is more efficient.”

The implications of these findings are quite remarkable. They suggest that a far wider application of at least the operational “walk-out plan” element of pedestrian disaster preparedness would further enhance reductions in the potential loss of human life during a sudden catastrophic event. Besides Central Business and Walking Districts in the center of urban areas, a 5,000 person per square mile threshold would include urban residential, office, and retail areas, as well as high-density residential suburbs with quarter acre lots, suburban multistory office towers, and our growing major edge cities.

**Existing Walk-out Plans**

The following plans were discovered based on internet searches in July 2007. Other plans may exist:

- Minneapolis-St. Paul Evacuation Plan: recommends walking within a 1 mile radius of the CBD or disaster site, when evacuation volumes exceed 5,000 people.
• New York City Hurricane Evacuation Pamphlet: recommends seeking shelter with family and friends in safe zones first, and notes that not all Evacuation Centers are accessible to all modes of transportation – while other modes are alluded to, only public transit is specifically referenced (assumes no shutdowns or transit gridlock).\(^{34}\)

• Cleveland Downtown Business District: recommends walking for a sudden threat disaster event.\(^{35}\)

• Norfolk, VA offers the option to leave on foot, and walk to pick-up/transfer sites as part of a comprehensive and integrated multimodal evacuation plan.\(^{36}\)

• Charlotte, NC City Center Evacuation Plan: advises walking for a direct/sudden threat.\(^{37}\)

**Walk-out Plans under Development**

The only “walk-out plan” that we know is currently being developed, is underway by Washington, DC. The DC effort designates specific sidewalk routes for pedestrian evacuation.\(^{38}\) The presentation on that plan will be available shortly from the University of New Orleans website [www.carlessevacuation.org](http://www.carlessevacuation.org). Based on 9/11, the August 2003 Blackout, and the December 2005 Transit Strike, New York City’s confidential emergency plans designates various bridges and tunnels for channeling pedestrian, vehicular, and emergency vehicle traffic.\(^{39}\) The status of their plan is not known.

**Existing Pedestrian Streetscape Efforts**

To our (7/2007) knowledge; no existing, planned or ongoing streetscape capital program is deliberately considering and/or accounting for the access, safety, and mobility needs attributed to mass pedestrian evacuations. However, these efforts, when completed, almost always improve travel conditions for both able-bodied and disabled pedestrians evacuating on foot. There is also no evidence that any local transportation agency, operating authority or metropolitan planning organization (in New York State or elsewhere in the United States) is looking at mass pedestrian evacuations as a criteria for assessing their sidewalk, crosswalk, signal timing, traffic operations, or intelligent transportation system (ITS) needs, either for existing, latent, or future pedestrian traffic demand.

**Existing Regulatory/Zoning Elements**

To our knowledge; no existing, planned or ongoing land use plans, environmental quality review processes, zoning ordinances and site design codes deliberately consider and/or account for the access, safety, and mobility needs attributed to mass pedestrian evacuations. However, trends toward “new urbanism” type development that reduce dependency on vehicular traffic and rely on a denser/compact street grid pattern will be
more conducive to mass evacuation on foot. There is also no evidence that any local, regional, or metropolitan planning organization (in New York State or elsewhere in the United States) is looking at mass pedestrian evacuation as a criteria for assessing their land use policies, their environmental quality review process, their zoning ordinance, or site design code needs, either for existing, latent, or future pedestrian traffic demand resulting from pedestrian mass evacuation.

**Keeping Evacuation Plans Confidential**

A dilemma facing emergency evacuation and disaster preparedness planners is the problem of the confidentiality of their evacuation plans. If the public is not educated about the evacuation plan routes and has no prior knowledge of these evacuation routes (regardless of what mode the evacuees are using at that time), how is that evacuation plan going to save lives and benefit public safety? This issue is particularly critical when a sudden catastrophic event occurs and information about route guidance (after the fact) is difficult to disseminate to those who are already in the self-evacuation mode.

Since the pedestrian evacuation route system options should be more numerous and ubiquitous than that of other modes, it may be sufficient to keep “key, priority, and major gateway” routes confidential – while still advertising their applicability without giving them any extra emphasis in the public information and education (PI&E) literature.

Even if some of these routes are significantly impacted by a catastrophic event or post event sabotage, the entire emergency pedestrian evacuation network should be dense enough, and redundant enough to convey most evacuees on foot to pick-up locations within the fringes of established safety zones. We suggest that we err on the side of informing the public.

**Successful Evacuations are Multimodal**

While pedestrian access to safety zone pick-up points is the first and most fundamental transportation link toward being able to escape from a disaster or eminent threat, the availability of motorized and vehicular transportation at these pick-up points is critical to the completion of a successful regional evacuation effort. Transferring to transit, intercity bus, rail, ferry, and air is essential for completing the evacuation task, and conveying people beyond the relative or short-term safety provided immediately outside the “walk-out zone.” For example, between 300,000 to one (1) million people may have fled Manhattan Island by ferry, barge, motor, or tugboat on 9/11.40

**Ongoing Collaboration and Follow-Up Activities**

The following ongoing activities are underway to disseminate best practices guidance and expanded state-of-the-art knowledge on how to effectively manage local, sub-regional, and regional mass evacuations on foot:
1. As a friend of the committee, I’m working with the Transportation Research Board (TRB) Pedestrian Committee (ANF10) to educate and coordinate mass pedestrian evacuation guidance with the TRB Subcommittee on Emergency Evacuation (ANB10-3).

2. Through the Department of Homeland Security’s Lessons Learned Information Sharing system website www.LLIS.gov, we were invited to share our state and national guidance on pedestrian disaster preparedness and emergency evacuation planning with emergency management and first responder staff around the country. DHS/LLIS staff also attended the University of New Orleans “National Conference on Disaster Planning for the Car-less Society” and will update their planning guidance to include the NYSDOT presentation from that conference. In June 2007, the LLIS launched a resource page entitled “Emergency Planning with Persons with Disabilities and Special Needs,” to more effectively meet the needs of the “at-risk.”

3. Participating in an upcoming January 2008 Conference, which is being organized by “Protect New York,” consisting primarily of university professors, first responders, and civil servants involved with disaster preparedness. “Protect New York” is an academic society with a mission to foster research and education on ways to protect the public from disasters, both natural and man-made. See http://protectnewyork.org/

4. Through the Transportation Equity and Evacuation Planning Program, at the University of New Orleans Transportation Center, those people who attended the 2007 “National Conference on Disaster Planning for the Car-less Society,” will continue to work together after the conference to bridge the transportation, emergency management, and health care professions, as well as to establish a dialogue between the local, county, state, and federal governments, and represent all travel modes.

5. Guidance already provided in Chapter 18, Pedestrian Facility Design, NYSDOT Highway Design Manual, will be updated to reflect available best practices (on walk-out plans) and other state-of-the-art measures in the next revision of that chapter.41

6. Expect to be working with staff at the USDOT/FHWA Office of Operations, Office of Emergency Transportation Operations. Our hope is to collaborate in the development of guidance for all stages of pedestrian disaster planning/evacuation.

**Building Momentum from our Leadership Role**

Since NYSDOT’s executive management, two committees of the Transportation Research Board (of the National Academies), the USDOT/FHWA Office of Safety (in collaboration with Highway Safety Research Center – University of North Carolina at
Chapel Hill, NC), the Department of Homeland Security, Protect New York, and the University of New Orleans, LA have found this guidance useful and extremely timely for urban centers, downtowns, walking and central business districts, etc., we recommend that the NYSDOT continue to maintain a technical leadership and guidance role in pedestrian disaster preparedness and emergency evacuation action planning.

**Guidance for Municipalities, Counties and Metropolitan Planning Organizations**

Due to the particular vulnerability of New York City and upstate cities such as Buffalo, Syracuse, Rochester, Albany, etc… to natural and man-made situations that may result in mass pedestrian evacuation without any prior warning – we believe it is very important to get this guidance to emergency management and disaster preparedness authorities in the above communities and MPO areas. The department’s Pedestrian Program of the Office of Integrated Modal Services in the Policy & Planning Division, may be uniquely qualified to conduct an ongoing technical outreach effort that includes conducting presentations, poster sessions, and serving as a technical clearinghouse for operational, capacity/access oriented, and long term pedestrian evacuation planning.

**Critique to Clarify Discussion on “Impacts of Pedestrian Evacuation on Vehicle Traffic”**

While the FHWA Final Report “Managing Pedestrians During Evacuation of Metropolitan Areas” makes a significant contribution to state-of-the-art knowledge of pedestrian evacuation at a public policy and operational level, its discussion of the implications of pedestrian impacts on vehicle movement appeared vague and easily subject to misinterpretation.\(^{42}\) The following guidance provides some basic ground rules and facts for emergency management officials to apply when faced with this issue:

1. When it’s faster for people to evacuate on foot, then pedestrian evacuation “must” be fully accommodated within the competent management of all traffic modes.

2. Pedestrians are “traffic”. Any mode, including vehicular traffic, that is not managed, can act as an impedance on the predominant mode of traffic. Pedestrians are defined as a “mode” of traffic in Sect. 1A-13, Article 86, of the Federal Highway Administration’s (FHWA) Manual on Uniform Traffic Control Devices (MUTCD).\(^ {43}\)

3. Ongoing emergency operational planning (at a minimum) is essential to facilitate mass evacuation on foot during a sudden catastrophic event.

4. Two-way vehicle access must be maintained for first responders, the hospitalized, the homebound, the institutionalized, and persons with disabilities and special needs.

5. We urgently need registry systems for all of the populations just listed above.

6. In a gridlock or shutdown situation, effective outbound vehicle traffic management in a sudden catastrophic event for metropolitan areas is nearly
impossible. Occupants can sit indefinitely or abandon their vehicles and continue their journey on foot. Unlike human life, vehicles can always be replaced!

7. People who neither have the sustained ability or stamina to walk, can be accommodated by first responder vehicles and other modes of transportation.

8. Each mode of transportation can serve an extremely critical and lifesaving role.

9. Our primary mission is to save as many lives as quickly as possible.

10. There will be circumstances when pedestrian evacuation is the quickest way.
Notes


3. Boltan, 11-12, 18, 39, 42, 45, 47-53, 56-57.


7. Millington and Ercolano, 18-70.


10. James M. Ercolano, Importance of Pedestrian Facilities and Walk-out Plans in Disaster Preparedness: Why Walking is the Primary Mode of Urban Evacuation
during Sudden Catastrophic Events, by the NYSDOT Community Assistance Delivery Bureau, provided as a power-point presentation for the National Conference on Disaster Planning for the Car-less Society, University of New Orleans, New Orleans, Louisiana (7 February 2007): 1-6.

11. Boltan, 11-12, 18, 39, 42, 45, 47-53, and 56-57.


15. Ivan Vamos, Board Member, New York Bicycle Coalition (NYBC), former Deputy Director of the New York State Office of Parks, Recreation, and Historic Preservation (NYSOPRHP), National Security And Public Spaces, power-point presentation provided by the NYBC, for the Creating Walkable Communities Conference (Rochester, New York 2005): 1-7.


24. Millington and Ercolano, 18-14 to 18-19.


31. Shashi Shekhar, McKnight Distinguished University Professor, University of Minnesota Director, Army High Performance Computing Research Center. _Evacuation Route Planning: A Scientific Approach_, University of Minnesota, Minneapolis, Minnesota, (April 2006), 33. Project Details are provided at <http://www.cs.umn.edu/~shekhar/talk/evacuation.html>

32. Shashi Shekhar, 33.


37. _Center City Evacuation Plan_, City of Charlotte, North Carolina, available at http://charmeck.org/Department/Police/About+Us/Departments/Center+City+Evacuation+Plan.htm

38. Philip Shapiro, _Pedestrian Evacuation Planning in the District of Columbia_ , by Vanasse Hangen Brustlin, Inc., provided as a power-point presentation for the


40. David Wagman, Get out of town: As they assemble mass-evacuation strategies, disaster planners are increasingly knowledgeable about human behavior. As one result, they trust the public more, Homeland Protection Professional, (September 2003): 1-6.

41. Millington and Ercolano, 18-70.

42. Boltan, 11-12, 18, 39, 42, 45, 47-53, 56-57.


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