

**New York City Department of Health and Mental Hygiene**  
**Public Health Hazard Risk Assessment**

**Office of Emergency Preparedness and Response**  
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## **Executive Summary**

Risk assessments are tools that assess the likely impact of a set of predefined scenarios over a fixed period of time. Although relatively new to the field of public health, the Centers for Disease Control (CDC), along with others, argue that they can increase a public health department's ability to respond to an event by coordinating and prioritizing its preparedness and mitigation activities. In the following, we present a risk assessment for the New York City Department of Health and Mental Hygiene (DOHMH). The result of the risk assessment are based on three surveys – a multi-round Delphi survey of subject matter experts and senior staff, a survey of continuity of operations staff, and a preparedness survey. We combine the results of these surveys using Borda Counts to measure manageable risk, or risks that can be lessened by agency action.

Overall, we found that scenarios can be divided into four priority categories. Coastal storm is the highest order priority, while second order priorities include a combination of medium-impact and high-probability weather-related events (flooding, heat wave), and lower- probability, high-impact events (pandemic influenza, radiological dispersal device, aerosolized anthrax release). Of those events, DOHMH is least prepared or an aerosolized anthrax release, and a radiological dispersal device. Interpretation of these results should be informed by the limitations of the methods used to conduct the surveys and analyze survey results. Future risk assessments should use these results to help prioritize planning not only for hazards but also for specific response related activities.

## Introduction

Assume that there are two hazards. Hazard A occurs infrequently, say once every twenty five years, but when it does occur it can have a dramatic impact. Alternatively, Hazard B occurs nearly every year with only minor consequences. Now you are a business owner who can dedicate your limited resources to either planning and preparing for Hazard A or Hazard B. How do you decide?

To help answer this question many private and public sector risk managers perform a risk assessment. According to Landesman (2005: 122) risk assessments “determine the probability of a specified outcome from a given hazard that affects a community.” In many cases, the risk managers will perform risk assessments to compare the potential impacts of different hazards over a fixed time period. Risk managers then use these comparisons to channel resources to plan, prepare, and perform mitigation activities for those hazards that pose the greatest threat.

Although relatively new to the field public health, according to the Centers for Disease Control (CDC), conducting a risk assessment can substantially increase a public health department’s ability to identify and prepare for hazards that may impact its jurisdiction. In its public health preparedness capabilities, the CDC (2011: 17) advises agencies to conduct a jurisdictional risk assessment that identifies “potential hazards, vulnerabilities, and risks in the community” and their potential impact on morbidity, mortality and the public health, medical, and mental/behavioral health services. The results of the risk assessment, in turn, are used to prioritize and coordinate a number of community and agency preparedness activities.

In the following we present the results of the New York City Department of Health and Mental Hygiene’s risk assessment. The risk assessment is based on the results of three surveys – a Delphi based multi-round survey of agency leadership, a survey of continuity of operations staff, and a preparedness survey. We combine the results of these surveys to generate an overall score for manageable risk. Overall, we found that scenarios can be divided into four priority categories. Coastal storm is the highest order priority, while second order priorities include a combination of medium-impact and high-probability weather-related events (flooding, heat wave), and lower-probability, high-impact events (pandemic influenza, radiological dispersal device, aerosolized

anthrax release). Of those events, DOHMH is least prepared on an aerosolized anthrax release, and a radiological dispersal device.

In the next section we review some of the basic aspects of a risk assessment including defining risk and outlining the methods to calculate it and measure its component parts. In the next section, we review assessment data and methods. In the third and fourth section we present results and limitations of the study. Finally, in the conclusion we review our findings and present next steps.

## **Background**

Although risk assessments are increasingly common, the term “risk” eludes easy definition. In this document we follow the United Nations Department of Humanitarian Affairs (1992) by defining risk as "expected losses (of lives, persons injured, property damaged, and economic activity disrupted) due to a particular hazard for a given area and reference period." Underlying this definition are two basic concepts. First, is the likelihood or probability that a hazard or hazard scenario will occur. Second, is vulnerability or a hazard or scenario’s potential impacts.

Like “risk,” there are multiple definitions of “vulnerability.” How risk managers define vulnerability depends on the context of their work. While a transportation planner defines loss in terms of roads destroyed, a business may define loss in terms of missed days of work or reduction in sales (Alwang, Siegel, and Jorgensen 2001). In public health, loss is frequently defined in terms of morbidity and mortality. We refer to these outcomes as a hazard’s human impacts. A hazard, however, may impact the work of a health department in many ways. In addition to human impacts, a hazard can impact healthcare services, mental health services, the environment, and agency operations (figure 1).

<p><b>Human Impact</b> – the number of deaths, injuries, or adverse health outcomes</p> <p><b>Impact on Healthcare Services</b> – interruptions in the health care delivery system including hospitals, clinics, skilled nursing homes, pharmacies, and dialysis centers</p> <p><b>Mental Health Impacts</b> – changes in the magnitude and frequency of mental health outcomes as well as interruptions in the provision of mental health services</p> <p><b>Environmental Impacts</b> – the hazards effect on land, water, air or any other component of the environment. These effects may be long or short term.</p> <p><b>Intra-Agency (COOP) Impacts</b> – interruptions to the operations of the health department itself including the ability of the agency to perform essential services.</p>
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Figure 1. A hazard’s potential public health impacts

To a certain extent, risk is mutable. Planning and mitigation can lessen risk by either reducing the probability of occurrence or the severity of impact. Increased intelligence activity, for example, may reduce the likelihood of a terrorist attack, while barriers and other increased security measures may reduce the impacts if a terrorist attack does occur. The impact of these actions, however, is necessarily limited, and in almost all cases agency actions can reduce certain risks while others remain outside agency control. We refer to the first category as manageable risks and the second as residual risks.

*Measuring Risk*

In order to assess a hazard’s risk, the analyst must measure the hazard’s probability, severity and any other selected risk components. For frequent events, the analyst can rely upon historical data. In many parts of the world, for example, heatwaves are common. Analysts can thus use observations of past heatwaves to estimate both the probability of future occurrence as well the expected impacts for future events. For infrequent events, however, there is little empirical data readily available. In these instances analysts can estimate the probability and severity of occurrence, along with planning and mitigation impact, in one of two ways. First, they can generate numeric estimates either using simulation models or from extrapolating from similar events that occurred in other jurisdictions. Second, they can solicit the opinion of subject matter experts through surveys or polls.

One survey method that is increasingly used in risk assessments is the Delphi method (for a review see Markmann, Darkow, and von der Gracht in press). The RAND Corporation initially developed the Delphi for the Air Force in the 1950s. Since that time it has been adapted for many different purposes in multiple settings. Although implementation of the Delphi technique may vary, they all enable anonymous group members, who may be in different locations, to respond to a survey multiple times. With each iteration, group members are given the opportunity to change their responses based on controlled feedback like the responses of other group members (Linstone and Turoff 1975; Rowe and Wright 1999). Turoff and Plotnick (2012) demonstrate the application of Delphi in their future threat assessment for the International Association for Information Systems for Crisis Management (ISCRAM). In this assessment the authors first convene a meeting of survey respondents and ask each to provide a 3 to 5 potential threats. In the second round, respondents were asked to score the importance of each of the 86 hazards that group members had identified in the first round of the survey. The authors then suggest that a possible third round would have given the participants the opportunity to discuss points of divergence and possibly change their votes.

### *Calculating Risk*

Once they have values for the component parts, analysts must then identify a method to compress these values into a single risk score. Equation 1 shows one of the most common methods for doing so (Smith 1991: 38).

$$\text{Risk} = \text{Probability} \times \text{Vulnerability} \tag{1}$$

Where probability is equal to the likelihood of occurrence within a particular time frame and vulnerability refers to estimated losses given event magnitude, duration, and timing. To illustrate equation 1, consider a hazard that occurs once every 5 years and cause 20 deaths with each occurrence. Using equation 1, we can thus estimate that over a 25 year period, that hazard will cause 100 deaths. Researchers have extended this formula to include terms for mitigation, preparedness, and coping capacity (for a review see Villagran De Leon 2006).

In their use of Borda counts, Garvey and Lansdowne (1998) provide an alternative method for deriving a risk score. The Borda counts are primarily used in elections where voters rank candidates. In these instances, each candidate is given a score based on the sum of his or her rankings (eq 2).

$$b_i = \sum_k (N - r_{ik}) \quad (2)$$

Where  $b_i$  is the Borda count for candidate  $i$ ,  $N$  is the total number of candidates, and  $r_{ik}$  is the rank of candidate  $i$  on ballot  $k$ . Analysts have extended the use Borda counts beyond voting to address ordinal preference ranking problems (Cook 2006). Although it has noted limitations, particularly in relation to tied rankings, the Borda counts are one of the most widely used and easy to understand methods for ranking options based on multiple ordinal criteria (Cook and Seiford 1982).

#### *Public Health Risk Assessment*

While risk assessments are common practice in many fields, they are relatively new in the field of public health. In 2006 the UCLA Center for Public Health and Disasters released the Hazard Risk Assessment Instrument (Shoaf et al. 2006). The HRAI is based on a four step process: determine the probability of a mishap, assess the severity of consequences, score the consequences, and analyze the risks. Eschewing survey-based methodologies, the process emphasizes the role of data collection. To determine impacts, analysts first calculate a number of baseline values, they then estimate these values for each scenario and calculate the percentage increase or decrease. Based on these changes, the analyst can then calculate the human impact, interruption of healthcare services, community impact, and impact on the public health infrastructure. These values are then compressed to a single impact score for each hazard and visualized along with preparedness values.

Building on the work of Shoaf et al, DOHMH created the Public Health Jurisdictional Risk Assessment Tool (RCPT2012). Rather than a purely data-based or survey-based instrument the PHRAT combines the two approaches. Like the HRAI, the PHRAT starts with data collection on baseline values for a number of indicators and their estimated values during an event. Unlike the HRAI, these values are intended to provide background information and inform the responses of survey recipients who will then score 8 aspects for each hazard divided into three categories:

- Probability
- Human Impact
- Healthcare Services
- Community
- Public Health Infrastructure
- Mitigation
- Medical Response
- General Response

These values are then entered into an Excel spreadsheet that will automatically calculate both risk and risk with preparedness scores. In January, 2012, DOHMH distributed the PHRAT to its regional partners through the Regional Catastrophic Planning Team<sup>1</sup> (RCPT).

Following the release of the PHRAT public health departments in a number of jurisdictions including the Texas Department of State Health (2012), Pennsylvania Department of Health (2013), the New Jersey Department of Health (2012), and the Los Angeles County Department of Health (Bagwell, Dean, and Khan 2012) have released public health risk assessments or public health risk assessment tools. Although they differ, like the PHRAT, all of the tools are survey-based with the analyst providing respondents basic information on expected impacts and probabilities.

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<sup>1</sup> The RCPT is a steering committee to guide the activities of the Regional Preparedness Grant Program, which in turn, is a program created by the Department of Homeland Security to encourage inter-jurisdictional catastrophe planning.

## Data and Methods

### *Identifying Scenarios*

The DOHMH risk assessment used three sources to determine scenarios. First, were five scenarios identified in the Regional Catastrophic Hazard Analysis (RCPT 2011). RCPT selected these five scenarios from the National Planning Scenarios. Part of the National Preparedness Guidelines (DHS 2007), the National Planning Scenarios depict a diverse set of high consequence threats that Federal, State, and local emergency response agencies can use to assess overall preparedness. For each of the five selected scenarios, the RCPT ran models to estimate the public awareness, public safety/fire, economic, social, medical, lifeline, transportation, and essential facility impacts. Second, four additional scenarios were then selected from the national planning scenarios based on their applicability to New York City. Third, using the Spatial Hazard and Losses Database for the United States (Hazards & Vulnerability Research Institute 2012) we identified those hazards that had caused at least one death or \$500,000 in damage in New York City since 1961. Based on that review we added three additional scenarios to the list of 9. Appendix A contains the full list and scenario descriptions.

### *Identifying Participants*

Participants were selected through a convenience sample to represent leadership from across the agency with knowledge and expertise in either emergency management or one or more of the scenarios being evaluated. Using a snow-ball sampling methodology (Creswell 2002) each of these respondents were then asked to identify other possible respondents. Overall, there were 24 respondents representing 8 divisions. Table 1 shows the distribution of respondents by division. A full list of participants is available in Appendix B.

<b>Division / Office</b>	<b>Group Members</b>
Administration	1
Disease Control	4
Environmental Health	6
Epidemiology	2
Health Promotion and Disease Prevention	1
Mental Hygiene	2
Emergency Preparedness and Response	7
Informatics, Information Technology, and Telecommunications	1
<b>Total</b>	<b>24</b>

Table 1. Group members by division

*Delphi survey*

To solicit participant opinion we executed a three round Delphi survey. In the first round, we convened a meeting of participants, described the survey, provided them with an initial list of scenarios, and asked if there were additional scenarios that were not included in the list. The scenario list was then revised based on their responses.

In the second round, survey respondents received a request to fill out an on-line survey through the site Survey Monkey (<http://surveymonkey.com>). The survey included six questions for each of twelve scenarios (72 questions overall). Survey questions are shown in Appendix C. An initial round of 8 responses was completed in late September to early October, 2012. Following a suspension of activities do to Superstorm Sandy, an additional 15 responses were collected in January and February, 2013.

In the third round of the survey participants were invited to a 2 hour meeting to discuss survey responses. Prior to the meeting, we distributed a summary of group responses to each question to survey participants. At the meeting, questions were discussed based on the degree of respondent disagreement with questions with the highest variability in response discussed first. Following approximately five to ten minutes of discussion for each question respondents were given the opportunity to change their initial score. 13 out of the 23 respondents attended this meeting. 10 of the remaining respondents were contacted via e-mail and given the opportunity to change their

initial response based on the group responses and a summary of changes made during the meeting. We were unable to contact 1 respondent who had left the agency.

### *Coop and Preparedness Surveys*

In addition to the Delphi survey, we conducted separate surveys to assess the scenarios' impact on continuance of agency operations (COOP) as well as the agency's preparedness for each of the scenarios. For the COOP survey, a meeting was held with 4 employees responsible for continuance of operations planning where attendees were asked to score how each of the 12 scenarios would impact the agency's staffing, infrastructure, and facilities. Scores were on a scale of 1 to 5, with 1 being no anticipated effect and 5 being a catastrophic impact. For the preparedness survey 3 OEPR employees responsible for grants administration were asked to score the agency's preparedness for each of the twelve scenarios using criteria outlined in the Centers for Disease Control's Public Health Preparedness Capabilities (Centers for Disease Control 2011). The Public Health Preparedness Capabilities identifies 64 functions divided between 15 capabilities to assist state and local public health departments in evaluating their overall preparedness. Survey respondents were asked to score each of the 64 functions on a scale of 0 to 4, with 0 being no ability and 4 being full ability. Appendix B includes the names of respondents to both the COOP and preparedness surveys.

### *Evaluating Risks*

Figure 2 shows the four step process used to assess risks. In the first step the three indicators from the COOP survey were averaged to generate an overall COOP impact score for each scenario. In the second step, the COOP impact score for each scenario was added to the environmental, healthcare, human, and mental health impact scores and divided by 5 to generate an overall impact score for each scenario. In the third step we generated a manageable risk score for each scenario, by calculating Borda counts based on the scenario's preparedness, impact, and planning impact scores. In the fourth step, manageable risk values were compared with preparedness scores to identify those hazards with the highest risk and lowest degree of preparedness. We calculated the preparedness score by first averaging the functions scores for each of the 15 capabilities for each scenario, and then calculating the mean of each of the capability averages for each scenario.

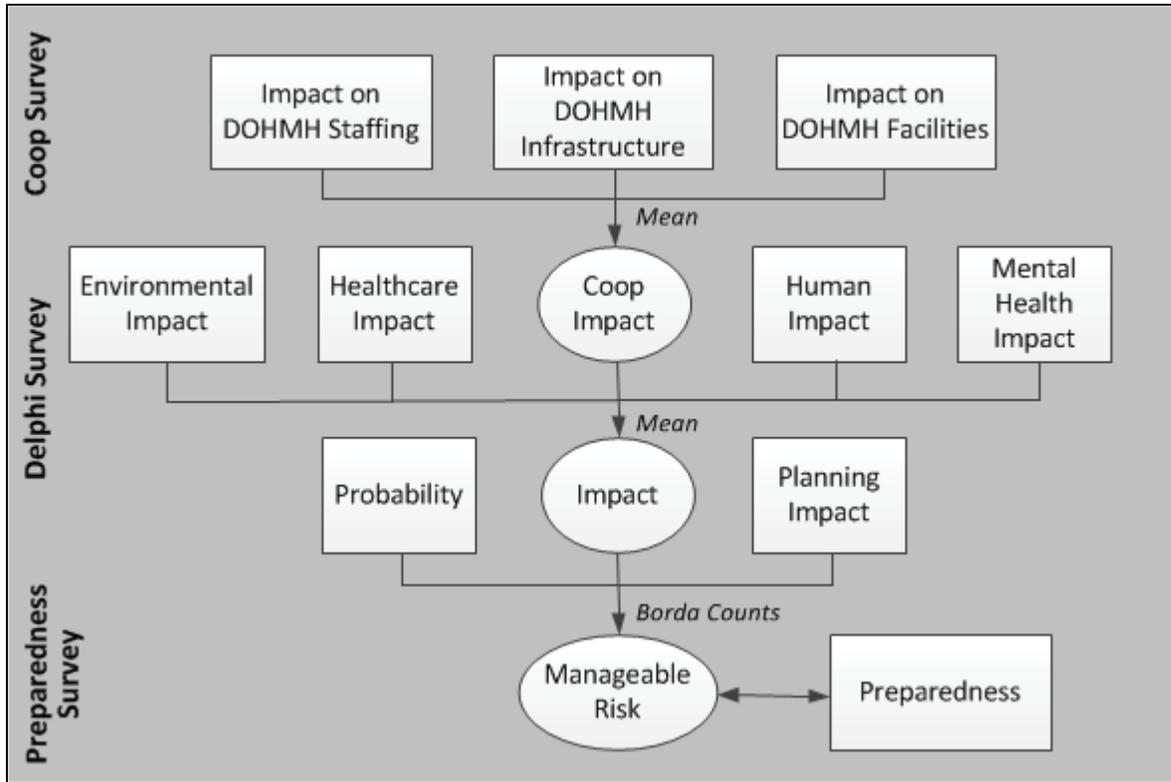


Figure 2. Risk Assessment analysis workflow

**Results**

Full survey results are available in Appendix D. Below we examine the three major inputs to manageable risk (impact, probability, and planning impact) manageable risk, and preparedness.

*Impact*

Figure 3 shows how the respondents ranked hazard impact. In general, hazards can be divided into four groups based on their impact scores. Respondents ranked the improvised nuclear device (IND) scenario as having the highest score in 4 out of 5 categories and significantly greater aggregate impact than all other scenarios (mean=4.7). Respondents ranked the aerosolized anthrax (mean=3.9), radiological dispersal device (mean=4.0), and coastal storm (mean=4.2) scenarios as on average having a critical impact. The remaining scenarios clustered around marginal impact, with the exception of food contamination (mean = 2.3) with a near negligible impact.

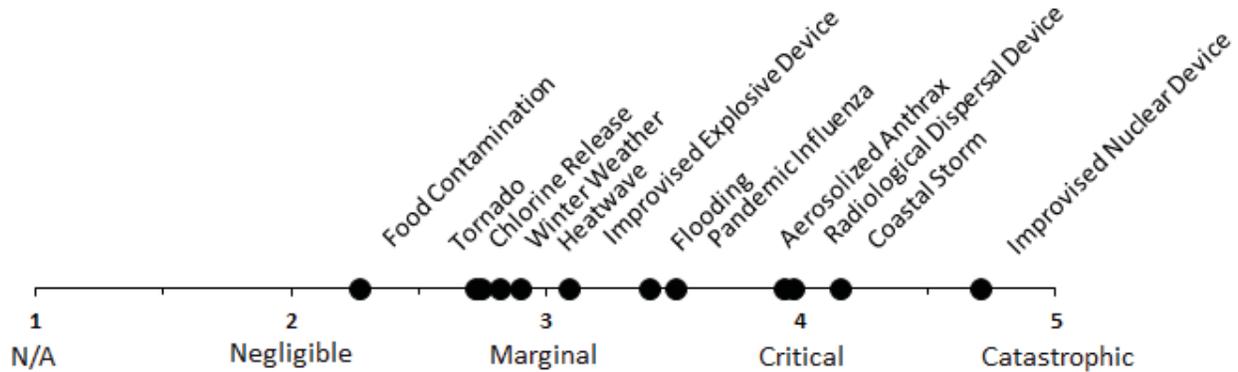


Figure 3. Scenario severity

There was a great deal of variability around environmental. There was substantial disagreement around the environmental impacts of the improvised explosive device ( $sd=1.04$ ) and aerosolized anthrax ( $sd=1.00$ ) scenarios. By contrast there was general consensus around the healthcare, human and mental health impacts with only moderate disagreement to the mental health impacts of the chlorine release ( $sd=.88$ ), major flooding ( $sd=.87$ ), and major winter weather scenarios ( $sd=.86$ ).

*Probability*

Figure 4 shows respondents average scores for the probability that a given scenario would occur. In general, respondents rated the probability of scenarios almost inversely to their severity. Respondents ranked high severity scenarios like improvised nuclear device (mean=2.0), radiological dispersion device (mean=2.7), and aerosolized anthrax (mean=2.7) as having either a remote or occasional chance of occurrence. Conversely they ranked low severity events like food contamination (mean=4.1), winter weather (mean=4.1), and heatwave (mean=4.2) as having a slightly greater than probable occurrence. Only flooding (mean=4.0) and coastal storm (mean=3.7) had high values for both probability and severity.

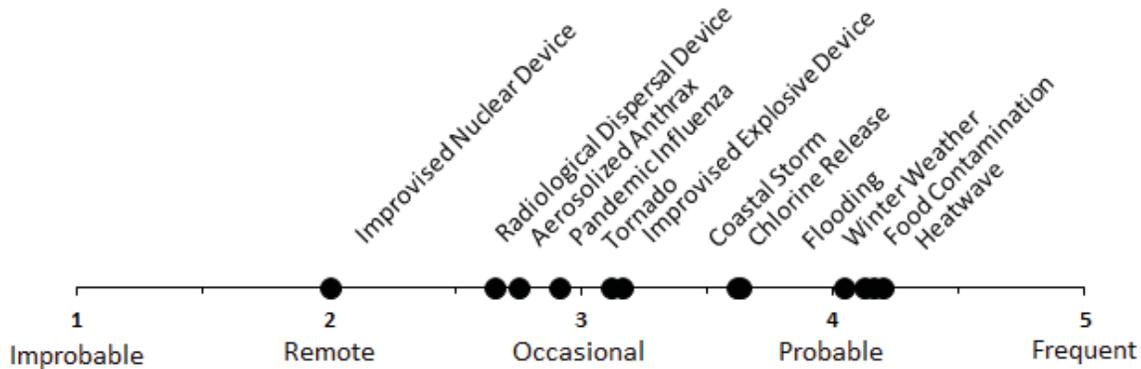


Figure 4. The probability of scenario occurrence

Even though respondents expressed unease about assessing scenario probability there was not a great deal of variability between their scores with three notable exceptions. There was substantial disagreement about the likelihood of the chlorine release scenario ( $sd=1.08$ ) with answers almost equally distributed between categories. This may be due to confusion over the chlorine release scenario. There was also substantial disagreement in relation to the probability of the food contamination ( $sd=.97$ ) and coastal storm scenarios ( $sd=.93$ ). The last may be because many respondents considered both Hurricane Irene and Superstorm Sandy as major coastal storms, but the scenario was for a category 4 hurricane.

Figure 4 shows the relationship between severity and probability on a risk matrix. As argued earlier there is an inverse relationship between the two measures forming a spectrum from high-probability/low-severity to high-severity/low-probability scenarios. There are notable outliers like the coastal storm scenario and the tornado scenarios.

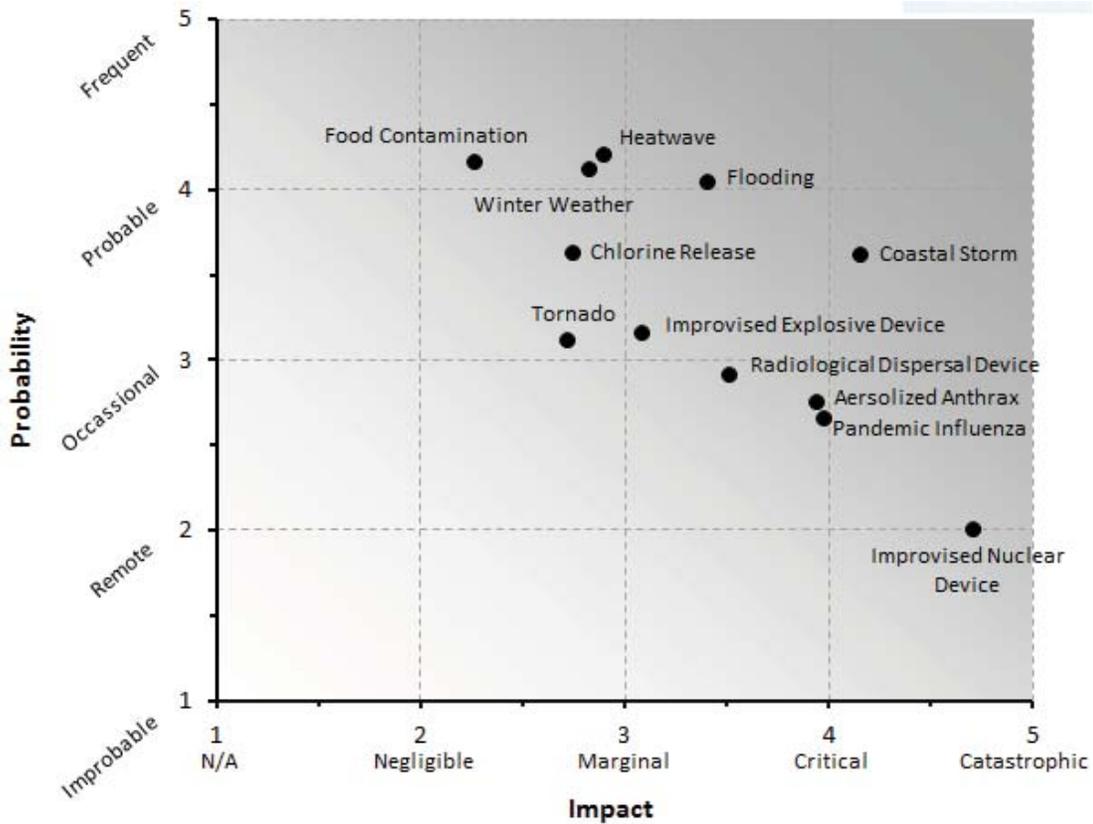


Figure 4. Risk matrix

*Planning*

Figure 5 shows the extent to which respondents believed that planning would lessen a scenario’s impact. Overall, respondents felt that planning could significantly decrease risks. Respondents scored every scenario with the exception of the tornado (mean=2.3) and food contamination (mean=2.5) as at least important. According to the survey respondents, planning would have the most significant impact on the coastal storm (mean=4.4) and pandemic influenza (mean=4.4) scenarios with both scenarios rated between very important and important.

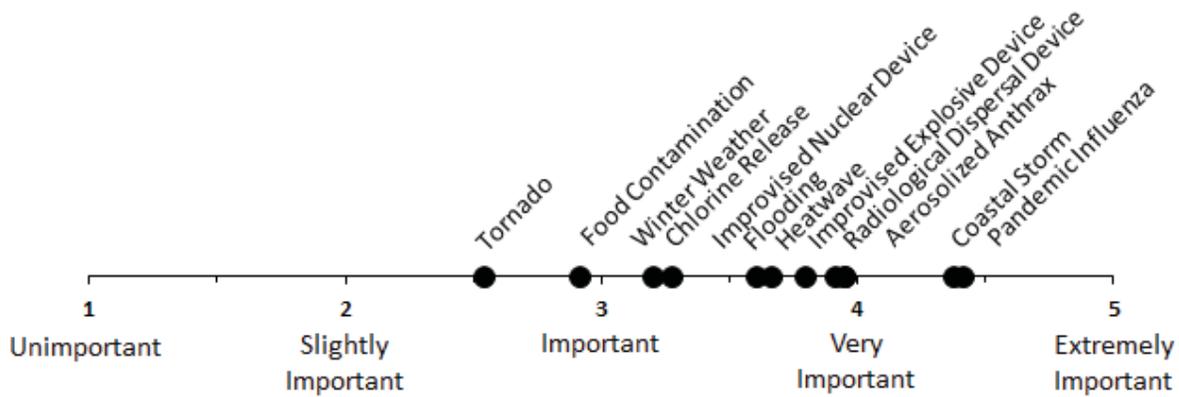


Figure 5. The impact of planning on scenario outcomes

Despite the high confidence in planning there was broad disagreement on how much planning would impact different scenarios. The Improvised Nuclear Device scenario ( $sd=1.24$ ) in particular elicited a wide range of responses with 2 respondents finding that planning was unimportant and 4 finding that it was very important. There was similarly divergent responses for both the flooding ( $sd=1.08$ ) and the improvised explosive device ( $sd=.95$ ) scenarios and, to a lesser extent, the winter weather ( $sd=.88$ ) and heatwave ( $sd=.88$ ) scenarios. It was originally hypothesized that these broad disagreements reflected ambiguity about the question’s meaning. Over the course of the follow-up meeting, however, it became clear that the variability in responses partially stemmed from different understandings and disagreements about the agency’s role in the response.

*Manageable Risk*

Table 2 shows the probability, severity, and planning scores and ranks, as well as the manageable risk for each hazard. In general, hazards can be divided into four groupings based on their manageable risk. With the second highest value for both planning and severity and the sixth highest value for probability, the coastal scorm (manageable risk score = 26) scenario is clearly the first order priority. The second order priority includes pandemic influenza (21), heatwave (21), flooding (19), aerosolized anthrax (18.5), and radiological dispersal device (18.5) scenarios. These scenarios can roughly be divided between attack and outbreak scenarios (pandemic influenza, aerosolized anthrax, and radiological dispersal device) which all have lower probability but higher severity and planning impact scores, and weather related scenarios (heatwave, flooding) with moderate planning and

impact scores but high probability. The third group of scenarios have a high value in one category but lower values in the other two. These include the improvised explosive device (17), improvised nuclear device (15), winter weather (14), chlorine release (12), and food contamination (11) scenarios. The tornado scenario (5) was the only fourth order scenario with a low value in all three categories.

	Severity		Probability		Planning		Manageable Risk
	Score	Rank	Score	Rank	Score	Rank	
Coastal Storm	<b>4.2</b>	<b>2</b>	3.6	6	<b>4.4</b>	<b>2</b>	26.0
Pandemic Influenza	<b>3.5</b>	<b>5</b>	2.9	9	<b>4.4</b>	<b>1</b>	21.0
Heatwave	2.9	8	<b>4.2</b>	<b>1</b>	3.8	6	21.0
Flooding	3.4	6	<b>4.0</b>	<b>4</b>	3.7	7	19.0
Aerosolized Anthrax	<b>3.9</b>	<b>4</b>	2.8	10	<b>4.0</b>	<b>3</b>	18.5
Radiological Dispersal Device	<b>4.0</b>	<b>3</b>	2.7	11	<b>4.0</b>	<b>3</b>	18.5
Improvised Explosive Device	3.1	7	3.2	7	<b>3.9</b>	<b>5</b>	17.0
Improvised Nuclear Device	<b>4.7</b>	<b>1</b>	2.0	12	3.6	8	15.0
Winter Weather	2.8	9	<b>4.1</b>	<b>3</b>	3.2	10	14.0
Chlorine Release	2.7	10	<b>3.6</b>	<b>5</b>	3.3	9	12.0
Food Contamination	2.3	12	<b>4.2</b>	<b>2</b>	2.9	11	11.0
Tornado	2.7	11	3.1	8	2.5	12	5.0

Table 2. Scenario severity, probability, planning, and manageable risk. The top 5 scores for each are in bold.

*Preparedness*

Table 3 shows the distribution of preparedness scores for the 12 scenarios sorted in ascending order (lower scores = less preparedness). The scenarios’ preparedness scores tightly clustered. Seven of the scenarios had a preparedness score between 2.5 and 3 and four additional scenarios had scores between 2.25 and 2.5. Only the improvised nuclear device scenario (1.44) had a score less than 2. Of the first or second order priority scenarios preparedness was lowest for the aerosolized anthrax and radiological dispersal device scenarios. The preparedness for the heatwave (2.94) and flooding (2.69) scenarios are respectively the first and fourth highest.

	Manageable Risk		Preparedness	
	Score	Rank	Score	Rank
Improvised Nuclear Device	15	8	1.44	12
Aerosolized Anthrax	18.5	5.5	2.25	10.5
Radiological Dispersal Device	18.5	5.5	2.25	10.5
Chlorine Release	12	10	2.28	9
Improvised Explosive Device	17	7	2.48	8
Pandemic Influenza	21	2.5	2.55	7
Coastal Storm	26	1	2.59	6
Tornado	5	12	2.66	5
Flooding	19	4	2.69	4
Food Contamination	11	11	2.70	3
Winter Weather	14	9	2.81	2
Heatwave	21	2.5	2.94	1

Table 3. Manageable Risk and Preparedness

**Limitations**

There are several limitations to the above study:

- By definition, the results reflect the opinions and beliefs of either subject matter experts or agency leadership. As such, the risk assessment should be understood as an expression of respondents’ shared perceptions than as an accurate prediction of future events and outcomes.
- In many cases respondents may have expertise in one area but not another. To a certain extent these shortcomings were addressed in the third round meeting where those with known expertise in certain fields could voice their opinion. Nonetheless, not all votes were equally well-informed.
- Many of the scenarios originated from the national planning scenarios and did not directly apply to New York City.

- The initial survey sample was a convenience sample roughly based on the researchers' knowledge of expertise throughout the agency. Although, the researchers solicited respondents for the names of additional people to survey, very few respondents provided more contacts. As such, survey response may have been skewed to those known by the researchers and may have excluded those with relevant expertise.
- Due to Superstorm Sandy there was an approximate gap of two months between surveys submitted in September and October and those submitted in January and February. It is entirely possible that events that occurred between these two rounds of responses skewed the later respondent opinion.
- Although those who did not attend the meeting were given the opportunity to change their scores and they were provided with the range of responses, they did not have the benefit of the discussion to inform their decisions.
- In the absence of experience it is difficult to assess agency preparedness. Although the CDC's preparedness capabilities provide guidance in this regard, they are not designed to be scenario specific. It would be in the interest of DOHMH, as well as other health departments, if the CDC, or some other external agency provided guidance on how to assess scenario specific preparedness.

## Conclusion

In the above we describe the methods and results of the DOHMH risk assessment. The purpose of the risk assessment is to assess the severity, probability, planning impact, and preparedness for twelve hazard scenarios. In general, there was agreement amongst participants in regards to scenarios' severity, probability, and planning impact. In many cases disagreements were resolved or lessened through discussion in the follow-up meeting. Nonetheless, there remained divergent opinions particularly in relation to the impact of planning.

Overall, we found that there was an inverse relationship between probability and risk and that most hazards fall along a spectrum with low frequency/high impact scenarios (like improvised nuclear device) at one end and high frequency/low impact scenarios (like food contamination) at the other. When we combine severity, planning, and probability to calculate an overall manageable risk score, we found that the coastal storm scenario has the greatest manageable risk followed by a cluster of

five scenarios – pandemic influenza, heatwave, flooding, aerosolized anthrax, and radiological dispersion device. In general, these five hazards can be divided between low probability/high severity and high probability/lower severity. There is no consensus opinion which of these two groups poses a greater risk. When these hazards are viewed in light of preparedness both the aerosolized anthrax and radiological dispersion device are the hazards that is least prepared to respond to. There were several limitations to these findings particularly in regard to the survey sample, instrument, and methods.

The risk assessment process could be improved in several ways in the future. First, scenarios should be carefully worded and vetted to be applicable to New York City. When expected outcomes are listed, the source and methods for deriving these outcomes should also be explicit. Second, there should be a more comprehensive effort to identify a sample of respondents. Third, the meeting turned out to be a productive exercise and should be retained in future iterations. Fourth, it may be appropriate to consult sources external to DOHMH, particularly as it relates to scenario probability. Fifth, future iterations should utilize the latest preparedness indicators. Sixth, and finally, future iterations of the risk assessment should associate response functions with scenarios so that leadership could allocate resources to plan for those functions that can most directly impact outcomes across multiple event-types.

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**Appendix A**  
**Scenarios**

**Aerosolized Anthrax:**

A single aerosol anthrax attack in New York City is delivered by a truck using a concealed improvised spraying device. The exposed population will disperse widely before the incident is detected. The first cases of anthrax begin to present to emergency rooms approximately 36 hours post release with rapid progression of symptoms and fatalities in untreated patients. This attack results in hundreds of thousands of exposures with 13,000 untreated fatalities. Although property damage will be minimal city services will be hampered by safety concerns.

**Key Points:**

- 13,000 fatalities
- 17,000 – 20,000 seek hospital care

**History of Occurrence**

- 25 Incidents using biological terrorism have occurred worldwide since 1970.
- 5 of these incidents occurred in New York City

**Chlorine Release**

A series of explosive blasts occur at an industrial chemical facility, located in close proximity to residential neighborhoods. Casualties occur onsite due to explosive blast and fragmentation, fire, and vapor/liquid exposure to toxic industrial chemicals. Downwind casualties occur due to vapor exposure. Approximately 350 fatalities, 1,000 hospitalizations. 10,000 individuals evacuated; 1,000 seek shelter in safe areas, 25,000 instructed to temporarily shelter-in-place as plume moves across the city. Chlorine is heavier than air and will settle in low lying areas including sewers, subways and basements or ground level floors before dispersing in a few hours.

**Key Points:**

- 350 Fatalities
- 1,000 hospitalizations

**History of Occurrence**

- Across the country, data going back to 1993 show that chlorine accidents occur in the United States at the rate of at least once every two or three days, and about one-third of them cause injuries.
- Based on the Hazardous Substances Emergency Events Surveillance (HSEES) data of 40,000 chemical incidents from 1996 through 2001, Chlorine releases in fixed facilities resulted in victims and evacuations in more industry categories than any other substance.
- 11 chlorine incidents occurred in New York City between 1996 and 2009

**Food Contamination**

A large amount of food is contaminated with Salmonella during transport, manufacturing, after distribution to a wholesaler or in retail settings (e.g., restaurants). The first signs of patients with salmonellosis appear within 1-5 days depending on the scale of incident. DOHMH is notified by a

medical provider or laboratorian. Time, location, method of dissemination and severity and would be unknown when the incident was detected.

**Key Points:**

- Significantly above average rates of hospitalization and mortality among frail, elderly and immuno-suppressed
- Potential for several thousand cases, several hundred hospitalizations and scores of fatalities

**History of Occurrence**

- 1749 Salmonella incidents within the United States from 1998 – 2012. ‘Incidents’ reported as Salmonella exposures by State agencies to the CDC.
- 96 Salmonella incidents in NYS from 1998 -2012

**Improvised Explosive Device (IED)**

During a large event at Madison Square Garden, multiple suicide bombers are strategically prepositioned around the arena. They ignite their bombs and self-destruct in order to guarantee mass panic and chaotic evacuation of the arena. In all, there are a total of eight (8) IED bombings:

- Three (3) portable IEDs in the arena;
- One (1) vehicle borne IED (VBIED) outside of the arena;
- Two (2) portable IEDs on a subway;
- One (1) VBIED in the arena parking garage; and
- One (1) VBIED at a nearby hospital.

**Key Points:**

- 440 fatalities
- 1200 Critical Injuries. In the Oklahoma City bombing 32% of patients transferred by ambulance had critical injuries

**History of Occurrence**

- 90 successful terrorism related bombings in the 30 most populous metropolitan areas OR that occurred within the United States. Time frame: 1985 – 2010.

**Improvised Nuclear Device (IND)**

A terrorist group assembles a gun-type nuclear device using highly enriched uranium (HEU) stolen from a nuclear facility in another country. Using a delivery van, terrorists transport the device to the wall street area of New York City. A detonation of an Improvised Nuclear Device (IND) containing HEU at ground level, produces a nuclear yield of 10kT within the lower Manhattan area. Location and removal of injured and disabled people will be a significant undertaking that will be greatly complicated by the need to keep the radiation dose of the individual workers as low as reasonably achievable (ALARA). Tens of thousands will require decontamination and both short-term and long-term treatment.

**Key Points:**

- 500,000 to 1 million fatalities based on blast injuries and building damage fatalities
- 10,000 times more radiation exposure than a large dirty bomb

### History of Occurrence

- Zero nuclear events from 1980 - 2010

### Major Coastal Storm

A Category 4 Hurricane with winds of 111-155 mph and a 30 foot storm surge hits the New York City area impacting all five boroughs. As the storm moves closer to land, massive evacuations are required. Certain low lying areas are inundated by water 4 hours before the eye of the hurricane reaches land.

### Key Points

- Over one million evacuate the city
- Hundreds of fatalities

### History of Occurrence

- 8 Hurricanes/Tropical storms that resulted in at least 1 fatality or at least \$50,000 in damages were recorded in NYC between 1960 – 2010.

### Major Flooding

A major low pressure system circulates above the region for several days, unleashing unprecedented amounts of rain causing several river systems to experience record flood levels. Structures in low lying areas are inundated from several days of rain. Many older facilities suffer structural collapse due to swift influx of water and degradation of the supporting structural base. Numerous homes, businesses and service, including a hospital and several clinics, within the 50 and 100 year flood plains are affected.

### Key Points:

- Major portions of the city are without power and mass transit service for several hours
- Healthcare facilities experience increase in injuries and ED usage

### History of Occurrence

- 49 major flooding events that resulted in at least 1 fatality or at least \$50,000 in damages occurred in NYC between 1960 – 2010.

### Major Heat Wave

In-Mid July, a multi-day heat wave occurs in New York city that results in 2,217 heat related deaths. The exceptionally high demand on the electrical grid has caused a series of rolling brown outs throughout the city. Hardest hit have been the poorest communities, where air conditioning is infrequently available and ventilation in high-rise apartment buildings is poorest. In retirement and convalescent homes the heat and humidity have had a serious impact on the elderly, particularly with shortages in electrical power limiting the use of air conditioning.

### Key Points:

- Extended overuse of utilities overtaxes the utility grid leading to thousands of homes and businesses without power
- Approximately 10,000 excess ED visits

**History of Occurrence**

- 34 Heat waves in the United States from 1900 - 2011
- 8 major heat wave events in NYC from 1960 to 2010 that resulted in at least 1 fatality or at least \$50,000 in damages.

**Major Winter Weather**

A major Nor'easter drops more than 20 inches of snow on New York City. Strong winds push the falling snow into drifts that measure up to four feet. Transportation suffers major delays as airports and rail shuts down across the city and Long Island. The abandoned vehicles make it difficult for the city's plows to clear the accumulating snow. Emergency room admissions for myocardial infarction rise markedly and mortality from ischemic heart disease increases dramatically for a five-day period after the storm.

**Key Points:**

- Thousands without power
- 5,000 plus injuries attributed to the Nor'easter

**History of Occurrence**

- 43 winter weather events in NYC that resulted in at least 1 fatality or at least \$50,000 in damages. Dates: 1960 - 2010

**Radiological Dispersal Device (RDD)**

A terrorist group purchases stolen cesium chloride (CsCl) to make a Radiological Dispersal Device (RDD) or dirty bomb. The explosive and the shielded cesium-137 (Cs-137) sources are smuggled into the Country. The Device which contains Ammonium Nitrate / Fuel Oil (ANFO) creates an explosive yield of ~3,000 lbs of Trinitrotoluene (TNT) and contains 2,300 curies of Cesium-137. There is an estimated 24,000 people in the RDD impact zone. Buildings in the surrounding area will experience structural damage. Potentially 10,400 housing units in Manhattan are impacted. Debris management will be a major issue with this scenario, contaminated waste will require containment and appropriate disposal. Over 1,000 fatalities are estimated to occur and the medical community will need surge capacity from trained volunteers to address the number of fatalities and injuries.

**Key Points:**

- Major fatality management incident with approximately 1,000 fatalities
- Over 4,000 people are injured in the explosion with 21,000 exposed to radiation

**History of Occurrence**

- 16 Incidents of terrorism using radiation worldwide. 5 of these events were foiled terrorist plots to use RDDs. 1 of these plots was in the United States.

### Severe Pandemic Influenza

A severe pandemic hits New York City over a 10 week period. The pandemic flu illness attack rate is 30% with a case fatality rate of 2.0 (similar to the flu of 1918). Mortality and morbidity will be very high during this event. There will be great demand on the Fire/EMS system to respond to medical calls, but their capacity is greatly diminished. Although no immediate impact on the public health infrastructure occurs, there are severe economic impacts due to job loss and absenteeism. Hospital capacity within the city is heavily impacted especially during peak demand.

#### Key Points:

- 92,000 fatalities across the 5 boroughs
- 42% of hospital personnel would be both able and willing to show up to work during a pandemic

#### History of Occurrence

- 5 pandemics have occurred since 1918
- Since 1500, there appear to have been 14 or more influenza pandemics; in the past 133 years of the “microbial era” (1876 to the present) there were undoubted pandemics in 1889, 1918, 1957, 1968, 1977, and 2009.

### Tornado

A sudden turbulent change in the weather during a thunderstorm causes a F3 tornado (136 – 165 mph wind speed) to touch down in multiple spots in New York City. Emergency alert broadcasts provide very little warning. Injuries due to flying debris and broken glass are widespread. Additionally, scores of trees and power lines are knocked down which causes electricity and transportation disruptions. Structural damage includes some roofs and walls torn off well-constructed buildings and several cars lifted and thrown.

#### Key Points:

- Thousands are injured due to structural collapse and flying debris
- Approximately 100 fatalities

#### History of Occurrence

- 7 Tornado events in NYC from 1960 – 2010 that resulted in at least 1 fatality or at least \$50,000 in damages.

**Appendix B**  
**Survey Participants**

**Dephi Survey Respondents**

Joel Ackelsberg - DIS  
Linda Adamson - DIITT  
John Beatty - ADM  
Jane Bedell - HPD  
Chris D'Andrea - EHS  
Don Decker - MHY  
Monika Eros-Sarnyai - MHY  
Nathan Graber - EHS  
Tiffany Harris - EPI  
Andy Karam - EHS  
Ram Koppaka - EPI  
Monica Marquez - OEPR  
Tom Matte - EHS  
Mark Misener - DIS  
Jeanine Prudhomme - EHS  
Darrin Pruitt - OEPR  
Jennifer Rosen - DIS  
Allison Scaccia - OEPR  
Sally Slavinski - DIS  
Lewis Soloff - OEPR  
David Starr - OEPR  
Colin Stimler - OEPR  
Mitchell Stripling - OEPR  
Elaine Verneti - EHS

**Preparedness Survey Respondents**

Erich Giebelhaus  
Monica Marquez  
Prachee Patel

**COOP Survey Respondents**

Dale McShine  
Lachelle Francis  
Marina Thompson  
Monica Marquez

**Appendix C**  
**Delphi Survey**

#### Overview

A first step in effective emergency preparedness and management is defining and analyzing the hazards that affect a jurisdiction. Although every hazard should be addressed, resource limitations make it impossible to plan for each hazard. Risk assessments help jurisdictions establish priorities so that the hazards with the highest potential consequences are addressed first and those least likely to occur and/or least likely to cause major problems can be considered later.

#### Purpose

The purpose of this risk assessment is to prioritize emergency planning by including subject matter expert opinion regarding the most frequently occurring and damaging hazard scenarios.

#### Process

For this risk assessment, we are following a 3 round "Delphi" method.

- Round 1 – Identify DOHMH subject matter experts for the following areas Human Impact, Healthcare Services, Mental Health Impact, and Environmental Impact. An overview of the process and scenarios will be given and participants have the opportunity to address any concerns with scenarios, and suggest additional scenarios or participants.
- Round 2 – Participants have one month to complete the Risk Assessment Survey and have the option of completing the survey via hard copy or online through [surveymonkey.com](https://www.surveymonkey.com).
- Round 3 – A final meeting to present aggregate survey results and give participants a chance to revise their responses, based on the group results.

#### What is done with the results?

After survey results are analyzed, each hazard will be ranked according to probability, impact, and overall risk (Probability x Impact). The results of this analysis will be provided to participants and a risk assessment report generated to present to agency leadership. The prioritization of individual hazard risk scores will provide a clearer picture of operational needs of a public health agency. Planning strategies can then be developed to reduce risk to specific hazards.

#### Instructions

Read each scenario and answer the questions below. We ask that if you do not feel confident in your answer to a question, please do not answer that question, leave it blank. Your answers will be reported in aggregate form with those of other respondents and your identity will only be known to the survey team. Individual responses will not be displayed to other participants or agency leadership.

For most scenarios the number of times the hazard type occurred in New York City is included. Where no NYC data was found, NY State, or worldwide occurrence data was used and is indicated for that scenario.

If you would like to view the large data set of estimated impact information for these hazards, email Michael Porter at [mporter1@health.nyc.gov](mailto:mporter1@health.nyc.gov).

### \*1. What is your name?

#### Aerosolized Anthrax:

A single aerosol anthrax attack in New York City is delivered by a truck using a concealed improvised spraying device. The exposed population will disperse widely before the incident is detected. The first cases of anthrax begin to present to emergency rooms approximately 36 hours post release with rapid progression of symptoms and fatalities in untreated patients. This attack results in hundreds of thousands of exposures with 13,000 untreated fatalities. Although property damage will be minimal city services will be hampered by safety concerns.

#### Key Points:

- 13,000 fatalities
- 17 – 20,000 seek hospital care

#### History of Occurrence

- 25 terrorist incidents using biological weapons have occurred worldwide since 1970
- 5 of these incidents occurred in New York City

### 2. What is the likelihood of this type of incident occurring in New York City within the next 25 years?

- Improbable. The probability of this hazard occurring within the next 25 years is zero
- Remote. Not likely to occur within the next 25 years, but it is possible
- Occasional. Likely to occur at least once within the next 25
- Probable. Likely to occur several times within the next 25 years
- Frequent. Likely to occur cyclically or annually within the next 25 years

#### Comments

**3. Choose an option below based on your estimate of HUMAN IMPACT (Human Impact refers to death or injury).**

- N/A. No elevated human impact associated with this hazard
- Negligible. Minimal threat to the health and well-being of the jurisdiction
- Marginal. Elevated rates of severe disease, injury, hospitalizations and deaths
- Critical. Moderately elevated rates of severe injury, disease, hospitalizations and deaths
- Catastrophic. Significantly elevated rates of severe disease, injury, hospitalizations and deaths

Comments (Optional)

**4. Choose an option below based on your estimate of the impact on HEALTHCARE SERVICES (collective impact on the health care delivery system: hospitals, clinics, skilled nursing facilities).**

- N/A. No anticipated effect or impact associated with this hazard
- Negligible. Minimal disruption and/or prevention of the health care delivery system's day-to-day operations
- Marginal. Minor disruption and/or prevention of the health care delivery system's day-to-day operations
- Critical. Significant disruption and/or prevention of the health care delivery system's day-to-day operations
- 4. Catastrophic. Serious disruption and/or prevention of the health care delivery system's day-to-day operations

Comments (Optional)

**5. Choose the option below based on your estimate of the impact on the MENTAL HEALTH care delivery system/agencies.**

- N/A. No anticipated effect or impact associated with this hazard
- Negligible. Minimal disruption and/or prevention of the mental health system's day to day operations
- Marginal. Minor disruption and/or prevention of the mental health system's day-to-day operations
- Critical. Significant disruption and/or prevention of the mental health system's day-to-day operations
- Catastrophic. Serious disruption and/or prevention of the mental health system's day-to-day operations

Comments (Optional)

**6. Choose an option below based on your estimate of the impact on the ENVIRONMENT (hazard effect on land, water, air or any other component of the environment). For this question, consider both immediate impacts and any long term implications of this hazard such as population displacement and environmental remediation.**

- N/A. There is no anticipated effect or impact associated with this hazard
- Negligible. The hazard presents a minimal threat to the environment
- Marginal. The hazard presents a minor threat to the environment
- Critical. The hazard presents a significant threat to the environment
- Catastrophic. The hazard presents a serious threat the environment

Comments (Optional)

**7. Choose an option below based on the importance of PLANNING to reduce the risk of the hazard.**

- Unimportant. Planning has no effect on reducing the risk
- Slightly Important. Fourth order priority, Planning has only a little impact, There is not much possible that can be done
- Important. Is relevant, Third order priority, Planning has significant impact but less than other items, Does not have to or cannot be completely dealt with
- Very Important. A most relevant item, Second order priority, Planning has direct bearing and/or impact, Must be dealt with or planned for
- Extremely Important. An extremely relevant item, First order priority, Planning can greatly reduce the risk and be addressed immediately. It must receive more attention

Comments (Optional)

Scenario Sources:

- DHS National Planning Scenarios P2-6;
- RCPT Catastrophic Hazard Analysis 2011 (available upon request)

History of Occurrence Source:

- Global Terrorism Database. <http://www.start.umd.edu>

#### Chlorine Release

A series of explosive blasts occur at an industrial chemical facility, located in close proximity to residential neighborhoods. Casualties occur onsite due to explosive blast and fragmentation, fire, and vapor/liquid exposure to toxic industrial chemicals. Downwind casualties occur due to vapor exposure. Approximately 350 fatalities, 1,000 hospitalizations. 10,000 individuals evacuated; 1,000 seek shelter in safe areas, 25,000 instructed to temporarily shelter-in-place as plume moves across the city. Chlorine is heavier than air and will settle in low lying areas including sewers, subways and basements or ground level floors before dispersing in a few hours.

#### Key Points:

- 350 Fatalities
- 1,000 hospitalizations

#### History of Occurrence

- 11 chlorine incidents occurred in New York City between 1996 and 2009.
- Across the country, data going back to 1993 show that chlorine accidents occur in the United States at the rate of at least once every two or three days, and about one-third of them cause injuries.
- Based on the Hazardous Substances Emergency Events Surveillance (HSEES) data of 40,000 chemical incidents from 1996 through 2001, Chlorine releases in fixed facilities resulted in victims and evacuations in more industry categories than any other substance.

### **8. What is the likelihood of this type of incident occurring in New York City within the next 25 years?**

- Improbable. The probability of this hazard occurring within the next 25 years is zero
- Remote. Not likely to occur within the next 25 years, but it is possible
- Occasional. Likely to occur at least once within the next 25
- Probable. Likely to occur several times within the next 25 years
- Frequent. Likely to occur cyclically or annually within the next 25 years

#### Comments

### **9. Choose an option below based on your estimate of HUMAN IMPACT (Human Impact refers to death or injury).**

- N/A. No elevated human impact associated with this hazard
- Negligible. Minimal threat to the health and well-being of the jurisdiction
- Marginal. Elevated rates of severe disease, injury, hospitalizations and deaths
- Critical. Moderately elevated rates of severe injury, disease, hospitalizations and deaths
- Catastrophic. Significantly elevated rates of severe disease, injury, hospitalizations and deaths

#### Comments (Optional)

**10. Choose an option below based on your estimate of the impact on HEALTHCARE SERVICES (Collective impact on the health care delivery system: hospitals, clinics, skilled nursing facilities).**

- N/A. No anticipated effect or impact associated with this hazard
- Negligible. Minimal disruption and/or prevention of the health care delivery system's day-to-day operations
- Marginal. Minor disruption and/or prevention of the health care delivery system's day-to-day operations
- Critical. Significant disruption and/or prevention of the health care delivery system's day-to-day operations
- Catastrophic. Serious disruption and/or prevention of the health care delivery system's day-to-day operations

Comments (Optional)

**11. Choose an option below based on your estimate of the impact on the MENTAL HEALTH care delivery system/agencies.**

- N/A. There is no anticipated effect or impact associated with this hazard
- Negligible. Minimal disruption and/or prevention of the mental health system's day-to-day business operations
- Marginal. Minor disruption and/or prevention of the mental health system's day-to-day business operations
- Critical. Significant disruption and/or prevention of the mental health system's day-to-day business operations
- Catastrophic. Serious disruption and/or prevention of the mental health system's day-to-day business operations

Comments (Optional)

**12. Choose an answer below based on your estimate of the impact on the ENVIRONMENT (hazard effect on land, water, air or any other component of the environment). For this question, consider possible long term implications of this hazard such as population displacement and environmental remediation.**

- N/A. No anticipated effect or impact associated with this hazard
- Negligible. This hazard presents a minimal threat to the environment
- Marginal. This hazard presents a minor threat to the environment
- Critical. This hazard presents a significant threat to the environment
- Catastrophic. This hazard presents a serious threat to the environment

Comments (Optional)

**13. Circle the score below based on the importance of PLANNING to reduce the risk of the hazard.**

- Unimportant. Planning has no effect on reducing the risk
- Slightly Important. Fourth order priority, Planning has only a little impact, There is not much possible that can be done
- Important. Is relevant, Third order priority, Planning has significant impact but less than other items, Does not have to or cannot be completely dealt with
- Very Important. A most relevant item, Second order priority, Planning has direct bearing and/or impact and must be addressed or planned for
- Extremely Important. An extremely relevant item, First order priority, Planning can greatly reduce the risk and be addressed immediately. It must receive more attention

Comments (Optional)

References:

DHS National Planning Scenarios April, 2005. P8-4. <http://cees.tamtu.edu/covertheborder/TOOLS/NationalPlanningSen.pdf>.

Wenck, et al. Rapid assessment of exposure to chlorine released from a train derailment and resulting health impact. Public Health Reports Nov-Dec 2007; 122: 784-792. <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1997246/>

#### Food Contamination

A large amount of food contaminated with Salmonella during transport, manufacturing, after distribution to a wholesaler or in retail settings (e.g., restaurants). The first signs of patients with salmonellosis appear within 1-5 days depending on the scale of incident. DOHMH is notified by a medical provider or laboratorian. Time, location, method of dissemination and severity and would be unknown when the incident was detected.

#### Key Points:

- Significantly above average rates of hospitalization and mortality among frail, elderly and immuno-suppressed
- Potential for several thousand cases, several hundred hospitalizations and scores of fatalities

#### History of Occurrence:

-96 Salmonella incidents in New York State from 1998 -2012

-1749 Salmonella incidents within the United States from 1998 – 2012. 'Incidents' reported as Salmonella exposures by State agencies to the CDC.

### **14. What is the likelihood of this type of incident occurring in New York City within the next 25 years?**

- Improbable. The probability of this hazard occurring within the next 25 years is zero
- Remote. Not likely to occur within the next 25 years, but it is possible
- Occasional. Likely to occur at least once within the next 25
- Probable. Likely to occur several times within the next 25 years
- Frequent. Likely to occur cyclically or annually within the next 25 years

Comments

### **15. Choose an option below based on your estimate of HUMAN IMPACT (Human Impact refers to death or injury).**

- N/A. No elevated human impact associated with this hazard
- Negligible. Minimal threat to the health and well-being of the jurisdiction
- Marginal. Elevated rates of severe disease, injury, hospitalizations and deaths
- Critical. Moderately elevated rates of severe injury, disease, hospitalizations and deaths
- Catastrophic. Significantly elevated rates of severe disease, injury, hospitalizations and deaths

Comments (Optional)

**16. Choose an option below based on your estimate of the impact on HEALTHCARE SERVICES (Impact on the health care delivery system: hospitals, clinics, skilled nursing facilities).**

- N/A. No anticipated effect or impact associated with this hazard
- Negligible. Minimal disruption and/or prevention of the health care delivery system's day-to-day operations
- Marginal. Minor disruption and/or prevention of the health care delivery system's day-to-day operations
- Critical. Significant disruption and/or prevention of the health care delivery system's day-to-day operations
- Catastrophic. Serious disruption and/or prevention of the health care delivery system's day-to-day operations

Comments (Optional)

**17. Choose an option below based on your estimate of the impact on the MENTAL HEALTH care delivery system/agencies.**

- N/A. No anticipated effect or impact associated with this hazard
- Negligible. Minimal disruption and/or prevention of the mental health system's day to day operations
- Marginal. Minor disruption and/or prevention of the mental health system's day-to-day operations
- Critical Significant disruption and/or prevention of the mental health system's day-to-day operations
- Catastrophic. Serious disruption and/or prevention of the mental health system's day-to-day operations

Comments (Optional)

**18. Choose an option below based on your estimate of the impact on the ENVIRONMENT (hazard effect on land, water, air or any other component of the environment). For this question, consider both immediate impacts and any long term implications of this hazard such as population displacement and environmental remediation.**

- N/A. No anticipated effect or impact associated with this hazard
- Negligible. This hazard presents a minimal threat to the environment
- Marginal. This hazard presents a minor threat to the environment
- Critical. This hazard presents a significant threat to the environment
- Catastrophic. This hazard presents a serious threat to the environment

Comments (Optional)

**19. Choose an option below based on the importance of PLANNING to reduce the risk of the hazard.**

- Unimportant. Planning has no effect on reducing the risk
- Slightly Important. Fourth order priority, Planning has only a little impact, There is not much possible that can be done
- Important. Is relevant, Third order priority, Planning has significant impact but less than other items, Does not have to or cannot be completely dealt with
- Very Important. A most relevant item, Second order priority, Planning has direct bearing and/or impact and must be addressed or planned for
- Extremely Important. An extremely relevant item, First order priority, Planning can greatly reduce the risk and be addressed immediately. It must receive more attention

Comments (Optional)

Scenario Sources:

-DHS National Planning Scenarios, April 2005 P13-3;

-Torok TJ, et al. A Large Community Outbreak of Salmonellosis Caused by Intentional Contamination of Restaurant Salad Bars. JAMA. 1997;278:389-395

History of Occurrence Source:

-Foodborne Outbreak Online Database. <http://wwwn.cdc.gov/foodborneoutbreaks/Default.aspx>

#### Improvised Explosive Device (IED)

During a large event at Madison Square Garden, multiple suicide bombers are strategically prepositioned around the arena. They ignite their bombs and self-destruct in order to guarantee mass panic and chaotic evacuation of the arena. In all, there are a total of eight (8) IED bombings:

- Three (3) portable IEDs in the arena;
- One (1) vehicle borne IED (VBIED) outside of the arena;
- Two (2) portable IEDs on a subway;
- One (1) VBIED in the arena parking garage; and
- One (1) VBIED at a nearby hospital.

#### Key Points:

- 440 fatalities
- 1200 Critical Injuries. In the Oklahoma City bombing 32% of patients transferred by ambulance had critical injuries

#### History of Occurrence:

- 90 successful terrorism related bombings in the 30 most populous metropolitan areas OR that occurred within the United States. Time frame: 1985 – 2010.

### **20. What is the likelihood of this type of incident occurring in New York City within the next 25 years?**

- Improbable. The probability of this hazard occurring within the next 25 years is zero
- Remote. Not likely to occur within the next 25 years, but it is possible
- Occasional. Likely to occur at least once within the next 25
- Probable. Likely to occur several times within the next 25 years
- Frequent. Likely to occur cyclically or annually within the next 25 years

Comments

### **21. Choose an option below based on your estimate of HUMAN IMPACT (Human Impact refers to death or injury).**

- N/A. No elevated human impact associated with this hazard
- Negligible. Minimal threat to the health and well-being of the jurisdiction
- Marginal. Elevated rates of severe disease, injury, hospitalizations and deaths
- Critical. Moderately elevated rates of severe injury, disease, hospitalizations and deaths
- Catastrophic. Significantly elevated rates of severe disease, injury, hospitalizations and deaths

Comments (Optional)

**22. Choose an option below based on your estimate of the impact on HEALTHCARE SERVICES (collective impact on the health care delivery system: hospitals, clinics, skilled nursing facilities).**

- N/A. No anticipated effect or impact associated with this hazard
- Negligible. Minimal disruption and/or prevention of the health care delivery system's day-to-day operations
- Marginal. Minor disruption and/or prevention of the health care delivery system's day-to-day operations
- Critical. Significant disruption and/or prevention of the health care delivery system's day-to-day operations
- Catastrophic. Serious disruption and/or prevention of the health care delivery system's day-to-day operations

Comments (Optional)

**23. Choose an option below based on your estimate of the impact on the MENTAL HEALTH care delivery system/agencies.**

- N/A. No anticipated effect or impact associated with this hazard
- Negligible. Minimal disruption and/or prevention of the mental health system's day to day operations
- Marginal. Minor disruption and/or prevention of the mental health system's day-to-day operations
- Critical Significant disruption and/or prevention of the mental health system's day-to-day operations
- Catastrophic. Serious disruption and/or prevention of the mental health system's day-to-day operations

Comments (Optional)

**24. Choose an option below based on your estimate of the impact on the ENVIRONMENT (hazard effect on land, water, air or any other component of the environment). For this question, consider both immediate impacts and any long term implications of this hazard such as population displacement and environmental remediation.**

- N/A. No anticipated effect or impact associated with this hazard
- Negligible. This hazard presents a minimal threat to the environment
- Marginal. This hazard presents a minor threat to the environment
- Critical. This hazard presents a significant threat to the environment
- Catastrophic. This hazard presents a serious threat to the environment

Comments

**25. Choose an option below based on the importance of PLANNING to reduce the risk of the hazard.**

- Unimportant. Planning has no effect on reducing the risk
- Slightly Important. Fourth order priority, Planning has only a little impact, There is not much possible that can be done
- Important. Is relevant, Third order priority, Planning has significant impact but less than other items, Does not have to or cannot be completely dealt with
- Very Important. A most relevant item, Second order priority, Planning has direct bearing and/or impact and must be addressed or planned for
- Extremely Important. An extremely relevant item, First order priority, Planning can greatly reduce the risk and be addressed immediately. It must receive more attention

Comments (Optional)

Scenario Sources:

- Oklahoma City Bombing Injuries. Oklahoma State DPH. December 1998.
- US Dept. of Homeland Security Regional Catastrophic Planning Team (RCPT). Catastrophic Hazard Analysis. 2011.

History of Occurrence Source:

- Global Terrorism Database, [www.start.umd.edu](http://www.start.umd.edu)

#### Improvised Nuclear Device (IND)

A terrorist group assembles a gun-type nuclear device using highly enriched uranium (HEU) stolen from a nuclear facility in another country. Using a delivery van, terrorists transport the device to the wall street area of New York City. A detonation of an Improvised Nuclear Device (IND) containing HEU at ground level, produces a nuclear yield of 10kT within the lower Manhattan area. Location and removal of injured and disabled people will be a significant undertaking that will be greatly complicated by the need to keep the radiation dose of the individual workers as low as reasonably achievable (ALARA). Tens of thousands will require decontamination and both short-term and long-term treatment.

#### Key Points:

- 500,000 to 1 million fatalities based on blast injuries and building damage fatalities
- 10,000 times more radiation exposure than a large dirty bomb

#### History of Occurrence

- Zero nuclear events from 1980 - 2010

### **26. What is the likelihood of this type of incident occurring in New York City within the next 25 years?**

- Improbable. The probability of this hazard occurring within the next 25 years is zero
- Remote. Not likely to occur within the next 25 years, but it is possible
- Occasional. Likely to occur at least once within the next 25
- Probable. Likely to occur several times within the next 25 years
- Frequent. Likely to occur cyclically or annually within the next 25 years

#### Comments

### **27. Choose an option below based on your estimate of HUMAN IMPACT (Human Impact refers to death or injury).**

- N/A. No elevated human impact associated with this hazard
- Negligible. Minimal threat to the health and well-being of the jurisdiction
- Marginal. Elevated rates of severe disease, injury, hospitalizations and deaths
- Critical. Moderately elevated rates of severe injury, disease, hospitalizations and deaths
- Catastrophic. Significantly elevated rates of severe disease, injury, hospitalizations and deaths

#### Comments (Optional)

**28. Choose an option below based on your estimate of the impact on HEALTHCARE SERVICES (Impact on the health care delivery system: hospitals, clinics, skilled nursing facilities).**

- N/A. No anticipated effect or impact associated with this hazard
- Negligible. Minimal disruption and/or prevention of the health care delivery system's day-to-day operations
- Marginal. Minor disruption and/or prevention of the health care delivery system's day-to-day operations
- Critical. Significant disruption and/or prevention of the health care delivery system's day-to-day operations
- Catastrophic. Serious disruption and/or prevention of the health care delivery system's day-to-day operations

Comments (Optional)

**29. Choose an option below based on your estimate of the impact on the MENTAL HEALTH care delivery system/agencies.**

- N/A. There is no anticipated effect or impact associated with this hazard
- Negligible. Minimal disruption and/or prevention of the mental health system's day-to-day operations
- Marginal. Minor disruption and/or prevention of the mental health system's day-to-day operations
- Critical. Significant disruption and/or prevention of the mental health system's day-to-day operations
- Catastrophic. Serious disruption and/or prevention of the mental health system's day-to-day operations

Comments (Optional)

**30. Choose an option below based on your estimate of the impact on the ENVIRONMENT (hazard effect on land, water, air or any other component of the environment). For this question, consider both immediate impacts and any long term implications of this hazard such as population displacement and environmental remediation.**

- N/A. No anticipated effect or impact associated with this hazard
- Negligible. This hazard presents a minimal threat to the environment
- Marginal. This hazard presents a minor threat to the environment
- Critical. This hazard presents a significant threat to the environment
- Catastrophic. This hazard presents a serious threat to the environment

Other (please specify)

**31. Choose an option below based on the importance of PLANNING to reduce the risk of the hazard.**

- Unimportant. Planning has no effect on reducing the risk
- Slightly Important. Fourth order priority, Planning has only a little impact, There is not much possible that can be done
- Important. Is relevant, Third order priority, Planning has significant impact but less than other items, Does not have to or cannot be completely dealt with
- Very Important. A most relevant item, Second order priority, Planning has direct bearing and/or impact and must be addressed or planned for
- Extremely Important. An extremely relevant item, First order priority, Planning can greatly reduce the risk and be addressed immediately. It must receive more attention

Comments (Optional)

Scenario Sources:

- US Dept. of Homeland Security Regional Catastrophic Planning Team (RCPT). Catastrophic Hazard Analysis. 2011.
- DHS National Planning Scenarios, April 2005 P1-1.
- Meade, Charles; Roger C. Molander. RAND. Center for Terrorism Risk Management Policy. Considering the Effects of a Catastrophic Terrorist Attack. 2006.

History of Occurrence Source:

- Global Terrorism Database: [www.start.umd.edu](http://www.start.umd.edu)

#### Major Coastal Storm

A Category 4 Hurricane with winds of 111-155 mph and a 30 foot storm surge hits the New York City area impacting all five boroughs. As the storm moves closer to land, massive evacuations are required. Certain low lying areas are inundated by water 4 hours before the eye of the hurricane reaches land.

#### Key Points

- Over one million evacuate the city
- Hundreds of fatalities

#### History of Occurrence

-In New York City between 1960 and 2010 there were 8 Hurricanes/Tropical storms that resulted in at least 1 fatality or at least \$50,000 in damages

### **32. What is the likelihood of this type of incident occurring in New York City within the next 25 years?**

- Improbable. The probability of this hazard occurring within the next 25 years is zero
- Remote. Not likely to occur within the next 25 years, but it is possible
- Occasional. Likely to occur at least once within the next 25
- Probable. Likely to occur several times within the next 25 years
- Frequent. Likely to occur cyclically or annually within the next 25 years

Comments

### **33. Choose an option below based on your estimate of HUMAN IMPACT (Human Impact refers to death or injury).**

- N/A. No elevated human impact associated with this hazard
- Negligible. Minimal threat to the health and well-being of the jurisdiction
- Marginal. Elevated rates of severe disease, injury, hospitalizations and deaths
- Critical. Moderately elevated rates of severe injury, disease, hospitalizations and deaths
- Catastrophic. Significantly elevated rates of severe disease, injury, hospitalizations and deaths

Comments (Optional)

**34. Choose an option below based on your estimate of the impact on HEALTHCARE SERVICES (Impact on the health care delivery system: hospitals, clinics, skilled nursing facilities).**

- N/A. No anticipated effect or impact associated with this hazard
- Negligible. Minimal disruption and/or prevention of the health care delivery system's day-to-day operations
- Marginal. Minor disruption and/or prevention of the health care delivery system's day-to-day operations
- Critical. Significant disruption and/or prevention of the health care delivery system's day-to-day operations
- Catastrophic. Serious disruption and/or prevention of the health care delivery system's day-to-day operations

Comments (Optional)

**35. Choose an option below based on your estimate of the impact on the MENTAL HEALTH care delivery system/agencies.**

- N/A. There is no anticipated effect or impact associated with this hazard
- Negligible. Minimal disruption and/or prevention of the mental health system's day-to-day operations
- Marginal. Minor disruption and/or prevention of the mental health system's day-to-day operations
- Critical. Significant disruption and/or prevention of the mental health system's day-to-day operations
- Catastrophic. Serious disruption and/or prevention of the mental health system's day-to-day operations

Comments (Optional)

**36. Choose an option below based on your estimate of the impact on the ENVIRONMENT (hazard effect on land, water, air or any other component of the environment). For this question, consider both immediate impacts and any long term implications of this hazard such as population displacement and environmental remediation.**

- N/A. No anticipated effect or impact associated with this hazard
- Negligible. This hazard presents a minimal threat to the environment
- Marginal. This hazard presents a minor threat to the environment
- Critical. This hazard presents a significant threat to the environment
- Catastrophic. This hazard presents a serious threat to the environment

Comments

**37. Choose an option below based on the importance of PLANNING to reduce the risk of the hazard.**

- Unimportant. Planning has no effect on reducing the risk
- Slightly Important. Fourth order priority, Planning has only a little impact, There is not much possible that can be done
- Important. Is relevant, Third order priority, Planning has significant impact but less than other items, Does not have to or cannot be completely dealt with
- Very Important. A most relevant item, Second order priority, Planning has direct bearing and/or impact and must be addressed or planned for
- Extremely Important. An extremely relevant item, First order priority, Planning can greatly reduce the risk and be addressed immediately. It must receive more attention

Comments (Optional)

Scenario Sources:

- Sullivant EE, et al. Nonfatal injuries following Hurricane Katrina - New Orleans, Louisiana 2005. Journal of Safety Research 37 (2006) 213 – 217.
- US Dept. of Homeland Security Regional Catastrophic Planning Team (RCPT). Catastrophic Hazard Analysis. 2011. Supplemental Report 3: Hurricane Scenarios.

History of Occurrence Source:

- ShieldUS. <http://webra.cas.sc.edu/hvri/products/sheldus.aspx>

#### Major Flooding

A major low pressure system circulates above the region for several days, unleashing unprecedented amounts of rain causing several river systems to experience record flood levels. Structures in low lying areas are inundated from several days of rain. Many older facilities suffer structural collapse due to swift influx of water and degradation of the supporting structural base. Numerous homes, businesses and service, including a hospital and several clinics, within the 50 and 100 year flood plains are affected.

#### Key Points:

- Major portions of the city are without power and mass transit service for several hours
- Healthcare facilities experience increase in injuries and ED usage

#### History of Occurrence

-Between 1960 and 2010 there were 49 major flooding events in New York City that resulted in at least 1 fatality or at least \$50,000 in damages.

### **38. What is the likelihood of this type of incident occurring in New York City within the next 25 years?**

- Improbable. The probability of this hazard occurring within the next 25 years is zero
- Remote. Not likely to occur within the next 25 years, but it is possible
- Occasional. Likely to occur at least once within the next 25
- Probable. Likely to occur several times within the next 25 years
- Frequent. Likely to occur cyclically or annually within the next 25 years

#### Comments

### **\*39. Choose an option below based on your estimate of HUMAN IMPACT (Human Impact refers to death or injury).**

- 1
- 2
- 3
- 4
- 5

#### Comment

**40. Choose an option below based on your estimate of the impact on HEALTHCARE SERVICES (Impact on the health care delivery system: hospitals, clinics, skilled nursing facilities).**

- N/A. No anticipated effect or impact associated with this hazard
- Negligible. Minimal disruption and/or prevention of the health care delivery system's day-to-day operations
- Marginal. Minor disruption and/or prevention of the health care delivery system's day-to-day operations
- Critical. Significant disruption and/or prevention of the health care delivery system's day-to-day operations
- Catastrophic. Serious disruption and/or prevention of the health care delivery system's day-to-day operations

Comments (Optional)

**41. Choose an option below based on your estimate of the impact on the MENTAL HEALTH care delivery system/agencies.**

- N/A. There is no anticipated effect or impact associated with this hazard
- Negligible. Minimal disruption and/or prevention of the mental health system's day-to-day operations
- Marginal. Minor disruption and/or prevention of the mental health system's day-to-day operations
- Critical. Significant disruption and/or prevention of the mental health system's day-to-day operations
- Catastrophic. Serious disruption and/or prevention of the mental health system's day-to-day operations

Comments (Optional)

**42. Choose an option below based on your estimate of the impact on the ENVIRONMENT (hazard effect on land, water, air or any other component of the environment). For this question, consider both immediate impacts and any long term implications of this hazard such as population displacement and environmental remediation.**

- N/A. No anticipated effect or impact associated with this hazard
- Negligible. This hazard presents a minimal threat to the environment
- Marginal. This hazard presents a minor threat to the environment
- Critical. This hazard presents a significant threat to the environment
- Catastrophic. This hazard presents a serious threat to the environment

Comments

**43. Choose an option below based on the importance of PLANNING to reduce the risk of the hazard.**

- Unimportant. Planning has no effect on reducing the risk
- Slightly Important. Fourth order priority, Planning has only a little impact, There is not much possible that can be done
- Important. Is relevant, Third order priority, Planning has significant impact but less than other items, Does not have to or cannot be completely dealt with
- Very Important. A most relevant item, Second order priority, Planning has direct bearing and/or impact and must be addressed or planned for
- Extremely Important. An extremely relevant item, First order priority, Planning can greatly reduce the risk and be addressed immediately. It must receive more attention

Comments (Optional)

Scenario Sources:

-Knowlton K, et al. Six climate change-related events in the United States accounted for about \$14 billion in lost lives and health costs. Health Affairs 2011. 30:11, 2167-2176.

-US Dept. of Homeland Security Regional Catastrophic Planning Team (RCPT). Catastrophic Hazard Analysis. 2011. Supplemental Report 3: Hurricane Scenarios.

History of Occurrence Source:

-ShieldUS. <http://webra.cas.sc.edu/hvri/products/sheldus.aspx>

#### Major Heat Wave

In-Mid July, a multi day heat wave occurs in New York city that results in 2,217 heat related deaths. The exceptionally high demand on the electrical grid has caused a series of rolling brown outs throughout the city. Hardest hit have been the poorest communities, where air conditioning is infrequently available and ventilation in high-rise apartment buildings is poorest. In retirement and convalescent homes the heat and humidity have had a serious impact on the elderly, particularly with shortages in electrical power limiting the use of air conditioning.

#### Key Points:

- Extended overuse of utilities overtaxes the utility grid leading to thousands of homes and businesses without power
- Approximately 10,000 excess ED visits

#### History of Occurrence

- Between 1960 and 2010 there were 8 major heat wave events in New York City that resulted in at least 1 fatality or at least \$50,000 in damages.
- Between 1900 and 2011 there were 34 Heat waves in the United States.

### **44. What is the likelihood of this type of incident occurring in New York City within the next 25 years?**

- Improbable. The probability of this hazard occurring within the next 25 years is zero
- Remote. Not likely to occur within the next 25 years, but it is possible
- Occasional. Likely to occur at least once within the next 25
- Probable. Likely to occur several times within the next 25 years
- Frequent. Likely to occur cyclically or annually within the next 25 years

#### Comments

### **45. Choose an option below based on your estimate of HUMAN IMPACT (Human Impact refers to death or injury).**

- N/A. No elevated human impact associated with this hazard
- Negligible. Minimal threat to the health and well-being of the jurisdiction
- Marginal. Elevated rates of severe disease, injury, hospitalizations and deaths
- Critical. Moderately elevated rates of severe injury, disease, hospitalizations and deaths
- Catastrophic. Significantly elevated rates of severe disease, injury, hospitalizations and deaths

#### Comments (Optional)

**46. Choose an option below based on your estimate of the impact on HEALTHCARE SERVICES (Impact on the health care delivery system: hospitals, clinics, skilled nursing facilities).**

- N/A. No anticipated effect or impact associated with this hazard
- Negligible. Minimal disruption and/or prevention of the health care delivery system's day-to-day operations
- Marginal. Minor disruption and/or prevention of the health care delivery system's day-to-day operations
- Critical. Significant disruption and/or prevention of the health care delivery system's day-to-day operations
- Catastrophic. Serious disruption and/or prevention of the health care delivery system's day-to-day operations

Comments (Optional)

**47. Choose an option below based on your estimate of the impact on the MENTAL HEALTH care delivery system/agencies.**

- N/A. There is no anticipated effect or impact associated with this hazard
- Negligible. Minimal disruption and/or prevention of the mental health system's day-to-day operations
- Marginal. Minor disruption and/or prevention of the mental health system's day-to-day operations
- Critical. Significant disruption and/or prevention of the mental health system's day-to-day operations
- Catastrophic. Serious disruption and/or prevention of the mental health system's day-to-day operations

Comments (Optional)

**48. Choose an option below based on your estimate of the impact on the ENVIRONMENT (hazard effect on land, water, air or any other component of the environment). For this question, consider both immediate impacts and any long term implications of this hazard such as population displacement and environmental remediation.**

- N/A. No anticipated effect or impact associated with this hazard
- Negligible. This hazard presents a minimal threat to the environment
- Marginal. This hazard presents a minor threat to the environment
- Critical. This hazard presents a significant threat to the environment
- Catastrophic. This hazard presents a serious threat to the environment

Comments

**49. Choose an option below based on the importance of PLANNING to reduce the risk of the hazard.**

- Unimportant. Planning has no effect on reducing the risk
- Slightly Important. Fourth order priority, Planning has only a little impact, There is not much possible that can be done
- Important. Is relevant, Third order priority, Planning has significant impact but less than other items, Does not have to or cannot be completely dealt with
- Very Important. A most relevant item, Second order priority, Planning has direct bearing and/or impact and must be addressed or planned for
- Extremely Important. An extremely relevant item, First order priority, Planning can greatly reduce the risk and be addressed immediately. It must receive more attention

Comments (Optional)

Scenario Sources:

-Whitman S, et al. Am J Public Health. 1997; 87: 1515-1518. <http://ajph.aphapublications.org/cgi/reprint/87/9/1515.pdf>

-Knowlton K, et al. Six climate change-related events in the United States accounted for about \$14 billion in lost lives and health costs. Health Affairs 2011. 30:11, 2167-2176

History of Occurrence Sources:

-NYC Info: ShieldUS <http://webra.cas.sc.edu/hvri/products/sheldus.aspx>

-US Info: EM-DAT <http://www.emdat.be/search-details-disaster-list>

US Info Criteria:

- Ten (10) or more people reported killed
- Hundred (100) or more people reported affected
- Declaration of a state of emergency
- Call for international assistance

#### Major Winter Weather

A major Nor'easter drops more than 20 inches of snow on New York City. Strong winds push the falling snow into drifts that measure up to four feet. Transportation suffers major delays as airports and rail shuts down across the city and Long Island. The abandoned vehicles make it difficult for the city's plows to clear the accumulating snow. Emergency room admissions for myocardial infarction rise markedly and mortality from ischemic heart disease increases dramatically for a five-day period after the storm.

#### Key Points:

- Thousands without power
- 5,000 plus injuries attributed to the Nor'easter

#### History of Occurrence

-Between 1960 and 2010 there were 43 winter weather events in New York City that resulted in at least 1 fatality or \$50,000 in damages.

### **50. What is the likelihood of this type of incident occurring in New York City within the next 25 years?**

- Improbable. The probability of this hazard occurring within the next 25 years is zero
- Remote. Not likely to occur within the next 25 years, but it is possible
- Occasional. Likely to occur at least once within the next 25
- Probable. Likely to occur several times within the next 25 years
- Frequent. Likely to occur cyclically or annually within the next 25 years

#### Comments

### **51. Choose an option below based on your estimate of HUMAN IMPACT (Human Impact refers to death or injury).**

- N/A. No elevated human impact associated with this hazard
- Negligible. Minimal threat to the health and well-being of the jurisdiction
- Marginal. Elevated rates of severe disease, injury, hospitalizations and deaths
- Critical. Moderately elevated rates of severe injury, disease, hospitalizations and deaths
- Catastrophic. Significantly elevated rates of severe disease, injury, hospitalizations and deaths

#### Comments (Optional)

**52. Choose an option below based on your estimate of the impact on HEALTHCARE SERVICES (Impact on the health care delivery system: hospitals, clinics, skilled nursing facilities).**

- N/A. No anticipated effect or impact associated with this hazard
- Negligible. Minimal disruption and/or prevention of the health care delivery system's day-to-day operations
- Marginal. Minor disruption and/or prevention of the health care delivery system's day-to-day operations
- Critical. Significant disruption and/or prevention of the health care delivery system's day-to-day operations
- Catastrophic. Serious disruption and/or prevention of the health care delivery system's day-to-day operations

Comments (Optional)

**53. Choose an option below based on your estimate of the impact on the MENTAL HEALTH care delivery system/agencies.**

- N/A. There is no anticipated effect or impact associated with this hazard
- Negligible. Minimal disruption and/or prevention of the mental health system's day-to-day operations
- Marginal. Minor disruption and/or prevention of the mental health system's day-to-day operations
- Critical. Significant disruption and/or prevention of the mental health system's day-to-day operations
- Catastrophic. Serious disruption and/or prevention of the mental health system's day-to-day operations

Comments (Optional)

**54. Choose an option below based on your estimate of the impact on the ENVIRONMENT (hazard effect on land, water, air or any other component of the environment). For this question, consider both immediate impacts and any long term implications of this hazard such as population displacement and environmental remediation.**

- N/A. No anticipated effect or impact associated with this hazard
- Negligible. This hazard presents a minimal threat to the environment
- Marginal. This hazard presents a minor threat to the environment
- Critical. This hazard presents a significant threat to the environment
- Catastrophic. This hazard presents a serious threat to the environment

Comments

**55. Choose an option below based on the importance of PLANNING to reduce the risk of the hazard.**

- Unimportant. Planning has no effect on reducing the risk
- Slightly Important. Fourth order priority, Planning has only a little impact, There is not much possible that can be done
- Important. Is relevant, Third order priority, Planning has significant impact but less than other items, Does not have to or cannot be completely dealt with
- Very Important. A most relevant item, Second order priority, Planning has direct bearing and/or impact and must be addressed or planned for
- Extremely Important. An extremely relevant item, First order priority, Planning can greatly reduce the risk and be addressed immediately. It must receive more attention

Comments (Optional)

Scenario Sources:

-Campbell, Ballard C. "Disasters, Accidents, and Crises in American History: a reference guide to the nation's most catastrophic events." Infobase Publishing: 2008: p 359

-Preliminary Review of the City's Response to the December 2010 Blizzard. Mayor's Office. Page 4.

-[http://www.nyc.gov/html/om/pdf/2011/review\\_of\\_2010\\_blizzard\\_response\\_01-10-11.pdf](http://www.nyc.gov/html/om/pdf/2011/review_of_2010_blizzard_response_01-10-11.pdf). Accessed 12/14/2011

History of Occurrence Source:

-ShieldUS <http://webra.cas.sc.edu/hvri/products/sheldus.aspx>

#### Radiological Dispersal Device (RDD)

A terrorist group purchases stolen cesium chloride (CsCl) to make a Radiological Dispersal Device (RDD) or dirty bomb. The explosive and the shielded cesium -137 (Cs-137) sources are smuggled into the Country. The Device which contains Ammonium Nitrate / Fuel Oil (ANFO) creates an explosive yield of ~3,000 lbs of Trinitrotoluene (TNT) and contains 2,300 curies of Cesium-137. There is an estimated 24,000 people in the RDD impact zone. Buildings in the surrounding area will experience structural damage. Potentially 10,400 housing units in Manhattan are impacted. Debris management will be a major issue with this scenario, contaminated waste will require containment and appropriate disposal. Over 1,000 fatalities are estimated to occur and the medical community will need surge capacity from trained volunteers to address the number of fatalities and injuries.

#### Key Points:

- Major fatality management incident with approximately 1,000 fatalities
- Over 4,000 people are injured in the explosion with 21,000 exposed to radiation

#### History of Occurrence

-Between 1979 and 2003 there were 16 Incidents of terrorism using a radiation source. 14 were outside the United States, 2 were within the United States. 5 out of the 16 events were foiled terrorist plots to use RDDs, 1 of which was in Chicago, Illinois.

### **56. What is the likelihood of this type of incident occurring in New York City within the next 25 years?**

- Improbable. The probability of this hazard occurring within the next 25 years is zero
- Remote. Not likely to occur within the next 25 years, but it is possible
- Occasional. Likely to occur at least once within the next 25
- Probable. Likely to occur several times within the next 25 years
- Frequent. Likely to occur cyclically or annually within the next 25 years

#### Comments

### **57. Choose an option below based on your estimate of HUMAN IMPACT (Human Impact refers to death or injury).**

- N/A. No elevated human impact associated with this hazard
- Negligible. Minimal threat to the health and well-being of the jurisdiction
- Marginal. Elevated rates of severe disease, injury, hospitalizations and deaths
- Critical. Moderately elevated rates of severe injury, disease, hospitalizations and deaths
- Catastrophic. Significantly elevated rates of severe disease, injury, hospitalizations and deaths

#### Comments (Optional)

**58. Choose an option below based on your estimate of the impact on HEALTHCARE SERVICES (Impact on the health care delivery system: hospitals, clinics, skilled nursing facilities).**

- N/A. No anticipated effect or impact associated with this hazard
- Negligible. Minimal disruption and/or prevention of the health care delivery system's day-to-day operations
- Marginal. Minor disruption and/or prevention of the health care delivery system's day-to-day operations
- Critical. Significant disruption and/or prevention of the health care delivery system's day-to-day operations
- Catastrophic. Serious disruption and/or prevention of the health care delivery system's day-to-day operations

Comments (Optional)

**59. Choose an option below based on your estimate of the impact on the MENTAL HEALTH care delivery system/agencies.**

- N/A. No anticipated effect or impact associated with this hazard
- Negligible. Minimal disruption and/or prevention of the mental health system's day to day operations
- Marginal. Minor disruption and/or prevention of the mental health system's day-to-day operations
- Critical Significant disruption and/or prevention of the mental health system's day-to-day operations
- Catastrophic. Serious disruption and/or prevention of the mental health system's day-to-day operations

Comments (Optional)

**60. Choose an option below based on your estimate of the impact on the ENVIRONMENT (hazard effect on land, water, air or any other component of the environment). For this question, consider both immediate impacts and any long term implications of this hazard such as population displacement and environmental remediation.**

- N/A. No anticipated effect or impact associated with this hazard
- Negligible. This hazard presents a minimal threat to the environment
- Marginal. This hazard presents a minor threat to the environment
- Critical. This hazard presents a significant threat to the environment
- Catastrophic. This hazard presents a serious threat to the environment

Comments

**61. Choose an option below based on the importance of PLANNING to reduce the risk of the hazard.**

- Unimportant. Planning has no effect on reducing the risk
- Slightly Important. Fourth order priority, Planning has only a little impact, There is not much possible that can be done
- Important. Is relevant, Third order priority, Planning has significant impact but less than other items, Does not have to or cannot be completely dealt with
- Very Important. A most relevant item, Second order priority, Planning has direct bearing and/or impact and must be addressed or planned for
- Extremely Important. An extremely relevant item, First order priority, Planning can greatly reduce the risk and be addressed immediately. It must receive more attention

Comments (Optional)

Scenario Sources:

-US Dept. of Homeland Security Regional Catastrophic Planning Team (RCPT). Catastrophic Hazard Analysis. 2011. Radiological Dispersion Device, Page 37 – 48

-Hogan DE, et al. Emergency Department Impact of the Oklahoma City Terrorist Bombing. Annals of Internal Medicine 1999; 34:2, 160-167

History of Occurrence Source:

-Global Terrorism Database: [www.start.umd.edu](http://www.start.umd.edu)

### Severe Pandemic Influenza

A severe pandemic hits New York City over a 10 week period. The pandemic flu illness attack rate is 30% with a case fatality rate of 2.0 (similar to the flu of 1918). Mortality and morbidity are very high during this event. There is great demand on the Fire/EMS system to respond to medical calls, but their capacity is greatly diminished. Although no immediate impact on the public health infrastructure occurs, there are severe economic impacts due to job loss and absenteeism. Hospital capacity within the city is heavily impacted especially during peak demand.

#### Key Points:

-92,000 fatalities across the 5 boroughs

-42% of hospital personnel would be both able and willing to show up to work during a pandemic

#### History of Occurrence

-5 pandemics have occurred since 1918

-Since 1500, there appear to have been 14 or more influenza pandemics; in the past 133 years of the "microbial era" (1876 to the present) there were undoubted pandemics in 1889, 1918, 1957, 1968, 1977, and 2009.

## 62. What is the likelihood of this type of incident occurring in New York City within the next 25 years?

- Improbable. The probability of this hazard occurring within the next 25 years is zero
- Remote. Not likely to occur within the next 25 years, but it is possible
- Occasional. Likely to occur at least once within the next 25
- Probable. Likely to occur several times within the next 25 years
- Frequent. Likely to occur cyclically or annually within the next 25 years

#### Comments

## 63. Choose an option below based on your estimate of HUMAN IMPACT (Human Impact refers to death or injury).

- N/A. No elevated human impact associated with this hazard
- Negligible. Minimal threat to the health and well-being of the jurisdiction
- Marginal. Elevated rates of severe disease, injury, hospitalizations and deaths
- Critical. Moderately elevated rates of severe injury, disease, hospitalizations and deaths
- Catastrophic. Significantly elevated rates of severe disease, injury, hospitalizations and deaths

#### Comments (Optional)

**64. Choose an option below based on your estimate of the impact on HEALTHCARE SERVICES (Impact on the health care delivery system: hospitals, clinics, skilled nursing facilities).**

- N/A. No anticipated effect or impact associated with this hazard
- Negligible. Minimal disruption and/or prevention of the health care delivery system's day-to-day operations
- Marginal. Minor disruption and/or prevention of the health care delivery system's day-to-day operations
- Critical. Significant disruption and/or prevention of the health care delivery system's day-to-day operations
- Catastrophic. Serious disruption and/or prevention of the health care delivery system's day-to-day operations

Comments (Optional)

**65. Choose an option below based on your estimate of the impact on the MENTAL HEALTH care delivery system/agencies.**

- N/A. There is no anticipated effect or impact associated with this hazard
- Negligible. Minimal disruption and/or prevention of the mental health system's day-to-day operations
- Marginal. Minor disruption and/or prevention of the mental health system's day-to-day operations
- Critical. Significant disruption and/or prevention of the mental health system's day-to-day operations
- Catastrophic. Serious disruption and/or prevention of the mental health system's day-to-day operations

Comments (Optional)

**66. Choose an option below based on your estimate of the impact on the ENVIRONMENT (hazard effect on land, water, air or any other component of the environment). For this question, consider both immediate impacts and any long term implications of this hazard such as population displacement and environmental remediation.**

- N/A. No anticipated effect or impact associated with this hazard
- Negligible. This hazard presents a minimal threat to the environment
- Marginal. This hazard presents a minor threat to the environment
- Critical. This hazard presents a significant threat to the environment
- Catastrophic. This hazard presents a serious threat to the environment

Comments

**67. Choose an option below based on the importance of PLANNING to reduce the risk of the hazard.**

- Unimportant. Planning has no effect on reducing the risk
- Slightly Important. Fourth order priority, Planning has only a little impact, There is not much possible that can be done
- Important. Is relevant, Third order priority, Planning has significant impact but less than other items, Does not have to or cannot be completely dealt with
- Very Important. A most relevant item, Second order priority, Planning has direct bearing and/or impact and must be addressed or planned for
- Extremely Important. An extremely relevant item, First order priority, Planning can greatly reduce the risk and be addressed immediately. It must receive more attention

Comments (Optional)

Scenario Sources:

- US Dept. of Homeland Security Regional Catastrophic Planning Team (RCPT). Catastrophic Hazard Analysis. 2011. Radiological Dispersion Device, Page 89-102
- Gerson RRM, et al. Factors associated with the ability and willingness of essential workers to report to duty during a pandemic. JOEM 2010. 52:10, 995-1003

History of Occurrence Sources:

- www.Flu.gov
- <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2862331/>
- Pandemic influenza--including a risk assessment of H5N1. Taubenberger JK, Morens DM. Rev Sci Tech. 2009 Apr;28(1):187-202.
- The 1918 influenza pandemic: insights for the 21st century. Morens DM, Fauci AS. J Infect Dis. 2007 Apr 1;195(7):1018-28. Epub 2007 Feb 23
- The persistent legacy of the 1918 influenza virus. Morens DM, Taubenberger JK, Fauci AS. National Institute of Allergy and Infectious Diseases, Bethesda, MD, USA. N Engl J Med. 2009 Sep 10;361(11):1123.

## Tornado

A sudden turbulent change in the weather during a thunderstorm causes a F3 tornado (136 – 165 mph wind speed) to touch down in multiple spots in New York City. Emergency alert broadcasts provide very little warning. Injuries due to flying debris and broken glass are widespread. Additionally, scores of trees and power lines are knocked down which causes electricity and transportation disruptions. Structural damage includes some roofs and walls torn off well-constructed buildings and several cars lifted and thrown.

### Key Points:

- Thousands are injured due to structural collapse and flying debris
- Approximately 100 fatalities

### History of Occurrence:

- From 1960 to 2010 there have been 7 tornados in New York City that resulted in at least 1 fatality or at least \$50,000 in damage.

## 68. What is the likelihood of this type of incident occurring in New York City within the next 25 years?

- Improbable. The probability of this hazard occurring within the next 25 years is zero
- Remote. Not likely to occur within the next 25 years, but it is possible
- Occasional. Likely to occur at least once within the next 25
- Probable. Likely to occur several times within the next 25 years
- Frequent. Likely to occur cyclically or annually within the next 25 years

### Comments

## 69. Choose an option below based on your estimate of HUMAN IMPACT (Human Impact refers to death or injury).

- N/A. No elevated human impact associated with this hazard
- Negligible. Minimal threat to the health and well-being of the jurisdiction
- Marginal. Elevated rates of severe disease, injury, hospitalizations and deaths
- Critical. Moderately elevated rates of severe injury, disease, hospitalizations and deaths
- Catastrophic. Significantly elevated rates of severe disease, injury, hospitalizations and deaths

### Comments (Optional)

**70. Choose an option below based on your estimate of the impact on HEALTHCARE SERVICES (Impact on the health care delivery system: hospitals, clinics, skilled nursing facilities).**

- N/A. No anticipated effect or impact associated with this hazard
- Negligible. Minimal disruption and/or prevention of the health care delivery system's day-to-day operations
- Marginal. Minor disruption and/or prevention of the health care delivery system's day-to-day operations
- Critical. Significant disruption and/or prevention of the health care delivery system's day-to-day operations
- Catastrophic. Serious disruption and/or prevention of the health care delivery system's day-to-day operations

Comments (Optional)

**71. Choose an option below based on your estimate of the impact on the MENTAL HEALTH care delivery system/agencies.**

- N/A. There is no anticipated effect or impact associated with this hazard
- Negligible. Minimal disruption and/or prevention of the mental health system's day-to-day operations
- Marginal. Minor disruption and/or prevention of the mental health system's day-to-day operations
- Critical. Significant disruption and/or prevention of the mental health system's day-to-day operations
- Catastrophic. Serious disruption and/or prevention of the mental health system's day-to-day operations

Comments (Optional)

**72. Choose an option below based on your estimate of the impact on the ENVIRONMENT (hazard effect on land, water, air or any other component of the environment). For this question, consider both immediate impacts and any long term implications of this hazard such as population displacement and environmental remediation.**

- N/A. No anticipated effect or impact associated with this hazard
- Negligible. This hazard presents a minimal threat to the environment
- Marginal. This hazard presents a minor threat to the environment
- Critical. This hazard presents a significant threat to the environment
- Catastrophic. This hazard presents a serious threat to the environment

Comments

**73. Choose an option below based on the importance of PLANNING to reduce the risk of the hazard.**

- Unimportant. Planning has no effect on reducing the risk
- Slightly Important. Fourth order priority, Planning has only a little impact, There is not much possible that can be done
- Important. Is relevant, Third order priority, Planning has significant impact but less than other items, Does not have to or cannot be completely dealt with
- Very Important. A most relevant item, Second order priority, Planning has direct bearing and/or impact and must be addressed or planned for
- Extremely Important. An extremely relevant item, First order priority, Planning can greatly reduce the risk and be addressed immediately. It must receive more attention

Comments (Optional)

Scenario Sources:

-May AK. The April 8, 1998 Tornado: Assessment of the Trauma System Response and the Resulting Injuries. The Journal of Trauma: Injury, Infection and Critical Care. 2000; 48:4, 666-672

-Ablah E, et al. Regional Health System Response to the 2007 Greensburg, Kansas, EF5 Tornado. Disaster Medicine and Public Health Preparedness. 2007;1:90-95

History of Occurrence Source:

-ShieldUS <http://webra.cas.sc.edu/hvri/products/sheldus.aspx>

Thank you for completing this survey. If you have questions or comments, feel free to contact Michael Porter, [mporter1@health.nyc.gov](mailto:mporter1@health.nyc.gov), (347) 446-4086.

**Appendix D**  
**Delphi Survey Results**

## Environmental Impact

	Number of responses by score						Avg	SD
	No Ans	1	2	3	4	5		
Improvised Nuclear Device (IND)	0	0	0	1	4	19	4.75	0.53
Major Coastal Storm	0	0	0	4	7	13	4.38	0.77
Radiological Dispersal Device (RDD)	0	0	0	2	12	10	4.33	0.64
Aerosolized Anthrax	0	0	3	3	9	9	4	1
Major Flooding	0	1	1	3	16	3	3.79	0.88
Chlorine Release	1	0	4	14	4	1	3.09	0.73
Tornado	0	2	7	11	3	1	2.75	0.94
Improvised Explosive Device (IED)	0	3	8	6	7	0	2.71	1.04
Major Winter Weather	0	1	11	10	2	0	2.54	0.72
Major Heatwave	1	2	15	5	1	0	2.22	0.67
Food Contamination	0	9	11	3	1	0	1.83	0.82
Severe Pandemic Influenza	0	6	17	1	0	0	1.79	0.51

## Healthcare Impact

	Number of responses by score						Avg	SD
	No Ans	1	2	3	4	5		
Improvised Nuclear Device (IND)	0	0	1	0	1	22	4.83	0.64
Severe Pandemic Influenza	0	0	0	0	7	17	4.71	0.46
Aerosolized Anthrax	0	0	0	1	11	12	4.48	0.59
Radiological Dispersal Device (RDD)	0	0	1	2	11	10	4.25	0.79
Major Coastal Storm	0	0	0	4	14	6	4.08	0.65
Improvised Explosive Device (IED)	0	0	0	9	13	2	3.71	0.62
Major Flooding	0	0	3	8	12	1	3.46	0.78
Major Heatwave	0	0	3	9	10	2	3.46	0.83
Major Winter Weather	0	1	3	10	10	0	3.21	0.83
Chlorine Release	0	0	3	14	7	0	3.17	0.64
Food Contamination	0	0	7	14	3	0	2.83	0.64
Tornado	0	1	10	9	3	1	2.71	0.91

## Human Impact

	Number of responses by score						Avg	SD
	No Ans	1	2	3	4	5		
Improvised Nuclear Device (IND)	0	0	1	1	0	22	4.79	0.72
Severe Pandemic Influenza	0	0	0	1	7	16	4.62	0.58
Aerosolized Anthrax	0	0	1	1	8	14	4.48	0.77
Radiological Dispersal Device (RDD)	0	0	0	6	9	9	4.12	0.8
Major Coastal Storm	0	0	0	8	12	4	3.83	0.7
Improvised Explosive Device (IED)	0	0	0	7	16	1	3.75	0.53
Major Heatwave	0	0	2	11	8	3	3.5	0.83
Chlorine Release	1	0	1	16	6	0	3.22	0.52
Food Contamination	0	0	5	14	5	0	3	0.66
Major Winter Weather	0	0	4	16	4	0	3	0.59
Tornado	0	0	8	13	2	1	2.83	0.76
Major Flooding	5	2	4	11	2	0	2.68	0.82

## Mental Health Impact

	Number of responses by score						Avg	SD
	No Ans	1	2	3	4	5		
Improvised Nuclear Device (IND)	0	0	0	0	4	20	4.83	0.38
Radiological Dispersal Device (RDD)	0	0	1	1	15	7	4.17	0.7
Aerosolized Anthrax	0	0	0	4	14	6	4.12	0.67
Severe Pandemic Influenza	0	0	1	5	12	6	3.96	0.81
Major Coastal Storm	1	0	0	6	14	3	3.87	0.63
Improvised Explosive Device (IED)	0	0	1	8	13	2	3.67	0.7
Major Flooding	0	0	6	9	8	1	3.17	0.87
Chlorine Release	1	0	8	9	5	1	2.96	0.88
Major Heatwave	0	0	8	12	3	1	2.88	0.8
Major Winter Weather	0	1	10	8	5	0	2.71	0.86
Tornado	0	1	14	6	3	0	2.46	0.78
Food Contamination	0	2	11	10	1	0	2.42	0.72

## Planning

	Number of responses by score						Avg	SD
	No Ans	1	2	3	4	5		
Severe Pandemic Influenza	0	0	0	3	7	14	4.46	0.72
Major Coastal Storm	0	0	0	4	6	14	4.42	0.78
Aerosolized Anthrax	0	0	1	1	13	9	4.2	0.76
Radiological Dispersal Device (RDD)	0	0	1	4	14	5	3.96	0.75
Major Heatwave	0	0	2	6	11	5	3.79	0.88
Improvised Explosive Device (IED)	0	0	3	6	10	5	3.71	0.95
Improvised Nuclear Device (IND)	0	2	6	6	6	4	3.17	1.24
Chlorine Release	2	0	3	14	4	1	3.14	0.71
Major Flooding	0	2	4	9	7	2	3.12	1.08
Major Winter Weather	0	0	7	9	7	1	3.08	0.88
Food Contamination	0	1	13	8	1	1	2.5	0.83
Tornado	0	2	14	6	2	0	2.33	0.76

## Probability

	Number of responses by score						Avg	SD
	No Ans	1	2	3	4	5		
Major Heatwave	0	0	1	2	12	9	4.21	0.78
Major Winter Weather	0	0	0	3	15	6	4.12	0.61
Major Flooding	0	0	0	8	7	9	4.04	0.86
Food Contamination	0	0	2	8	8	6	3.75	0.94
Major Coastal Storm	0	0	2	12	7	3	3.46	0.83
Improvised Explosive Device (IED)	0	1	2	13	7	1	3.21	0.83
Tornado	0	0	4	13	6	1	3.17	0.76
Chlorine Release	1	0	7	9	4	3	3.13	1.01
Severe Pandemic Influenza	0	0	5	16	3	0	2.92	0.58
Aerosolized Anthrax	0	0	8	14	2	0	2.72	0.61
Radiological Dispersal Device (RDD)	0	0	10	12	2	0	2.67	0.64
Improvised Nuclear Device (IND)	0	2	20	2	0	0	2	0.42