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SoCal Metropolitan Statistical Area

Health Hazard Assessment and Prioritization Tool Manual

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Primary Authors
Brandon Dean, MPH, Dee Ann Bagwell, MA, MPH, and Whitney Li, BS.

Senior Contributors
Alonzo Plough, PhD, MPH, Ms. Terre Duensing, Ms. Betsey Lyman and Gina Anderson, RN, MSN.

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Health Hazard Assessment and Prioritization Tool

OVERVIEW AND OBJECTIVES

All communities face a broad range of natural and manmade hazards that can threaten the public's health and safety. Since the inception of the U.S. Centers for Disease Control and Prevention's (CDC) Public Health Emergency Preparedness (PHEP) grant, public health departments across the country have been tasked with developing plans for coordinated response to these hazards in order to save lives, reduce suffering, and improve recovery. Some of these plans have been based on CDC mandates (Smallpox, Anthrax, Strategic National Stockpile), while others have come from other federal requirements (Pandemic Influenza, All Hazards). How to prioritize the development of response plans for other hazards has been left largely to PHEP recipients. In the absence of a qualified instrument or system to accomplish this, some have looked at the U.S. Department of Homeland Security (DHS) National planning scenarios; others have commissioned public health hazard risk assessments, or participated in jurisdictional disaster risk analysis as required by the Disaster Mitigation Act of 2000. (Birkmann, 2007; DHS THIRA)

The CDC's Risk-Based pilot project (2012) and recent guidance from the National Preparedness System, presents an opportunity to apply a systematic, health centered approach to hazard assessment and response plan development that is inclusive of existing community and response resources. This process ensures that jurisdictional health priorities can be effectively assessed so that the most important hazards—highly probable and/or major public health impacts—are planned for first, and hazards with lower probabilities or minor public health impacts are deferred. (Wisner, *et al,* 2003) The renewed focus on capability based planning—employed by a broad range of federal and state stakeholders, particularly CDC's PHEP, Health Human Services' Healthcare Preparedness Program (HPP), and the Federal Emergency Management Agency (FEMA)—highlights the need for reality based, inter-disciplinary planning, aimed at improving true capabilities available for responding to realistic threats, hazards and response scenarios. (Donahue, *et al,* 2011)

In response to this renewed call for clear and effective "whole community planning," the Los Angeles County Department of Public Health (LACDPH), in conjunction with the Orange County Health Care Agency, the Long Beach Department of Health and Human Services and the Pasadena Department of Public Health, developed the **Health Hazard Assessment and Prioritization (hHAP)** tool to assess and prioritize planning and mitigation efforts for those hazards which are most important in Southern California. (Perry, *et al*, 2003)

The overall goals of this project are to:

1) Establish and provide a foundational framework to identify, assess and prioritize the health and medical impacts of various potential hazards, from which consistent, hazard specific*,* agency and/or jurisdictional hazard specific planning can effectively occur.
2) Provide a process for engaging traditional and non-traditional community based planning partners in which hazards, threats and resources, relevant and specific to the community, can be identified and discussed, in meaningful whole community planning.

The hHAP is an instrument for conducting a *public health* focused assessment of numerous potential hazards facing Southern California. Assessing and ranking impacts from potential hazards is an

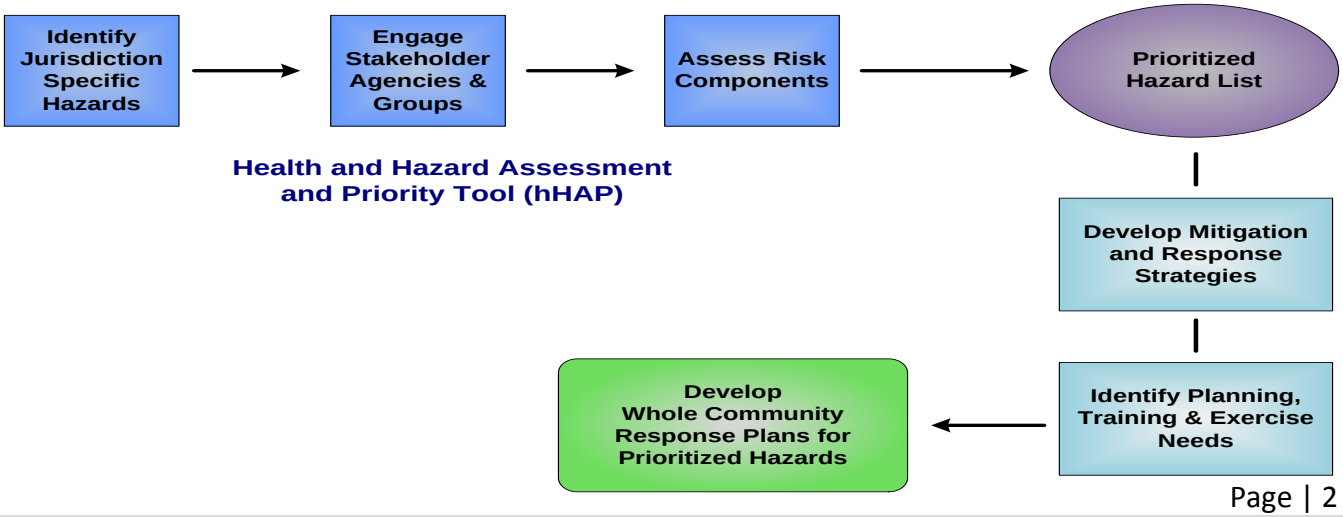
inherently challenging process. Far-reaching threats and hazards require a foundational, systematic process of risk assessment that estimates response capabilities as a precursor to building and validating sustainable, effective response plans (DHS *National Preparedness System*). The hHAP instrument and process was developed to address these needs and meet the following objectives:

- Assess the public health and medical impact of numerous potential threats;
- Provide a mechanism for community engagement in order to identify available jurisdictional and community-based response resources;
- Prioritize identified threats based on stakeholder experience and empirical data on projected consequences;
- Establish a health risk assessment baseline for all future Departmental, Operational Area and Metropolitan Statistical Area (MSA) planning and mitigation activities; and
- Offer an effective, simple and adaptable tool and process for other jurisdictions and agencies to utilize when conducting health based hazard assessments.

The hHAP instrument represents a public health focused approach to hazard assessment. The tool was based on adaptations of several other existing resources, namely: UCLA's Hazard Risk Assessment Instrument and Kaiser Permanente's Medical Center Vulnerability Analysis instrument. Although it incorporates elements from other tools, in purpose, form and methodology, hHAP stands uniquely independent from previous assessment instruments and processes. Though developed primarily for utilization within Los Angeles County, the hHAP instrument—and supportive methodology—were designed to be flexible and adaptive, applicable to other health jurisdictions and numerous potential hazards.

The hHAP tool and methodology are the first steps of a larger, Whole Community Planning process to improve overall all public health emergency planning and response outcomes in Los Angeles County and throughout the Los Angeles-Long Beach-Santa Ana (SoCal MSA) (see Figure 1). The true value of both tool and process is achieved with the development of improved hazard specific response plans and implementation of risk based mitigation projects.

Figure 1: Health Hazard Risk Assessment and Whole Community Planning



RISK ASSESSMENT

Effective emergency planning and management starts with an unbiased assessment of risk; predicated upon understanding the inherent and ubiquitous nature of risk and risk assessment. Risk is the end product of the relationship between a hazard and associated vulnerability, though that association is not strictly arithmetic. (Landesman, 2005) The assessment of risk is a process that determines the likelihood of adverse health effects in a population following exposure to a specified hazard; the outcome of which being used to target resources and planning at the hazards that are most likely to occur and/or are most destructive. (Brnich & Mallet, 2003) As there is no standard definition of risk, the values, weights and metrics associated with assessing and evaluating risk are somewhat open to user interpretation. (Dean, et al, 2013)

The hHAP tool focuses on the relative perceived risk, expressed through a relationship and interaction of several Risk Components: Probability of hazard occurrence; Health Severity of the hazard (potential for increase in morbidity, hospitalizations and mortality); Impact (consequences) of hazard on health and medical systems and the community; and the protective value of existing response and community preparedness resources. Each Risk Component has a corresponding metric input for each associated hazard. hHAP determines a Relative Risk Score for each hazard through the following formula:[*]

RELATIVE RISK SCORE =

PROBABILITY x HEALTH SEVERITY x IMPACTS x AGENCY RESOURCES

Each Relative Risk Score is a representation of the total risk to the affected community. The dynamic nature of this relationship presumes a link between impacts and resources, where an increase in one results in a decrease in the other. As such, each hazard should be considered and measured independently of all other hazards. Brief, reality based scenarios of potential hazard outcomes—size and scope—are provided in Appendix C to assist participants in more uniform assessment and scoring of Risk Component values.

After hHAP has generated a Relative Risk Score for each hazard, the respective Scores can be sorted to determine jurisdictional priorities (see Step 5: Rank & Prioritize Results, and Step 6: Mitigation Planning, Review and Update).

METHODS

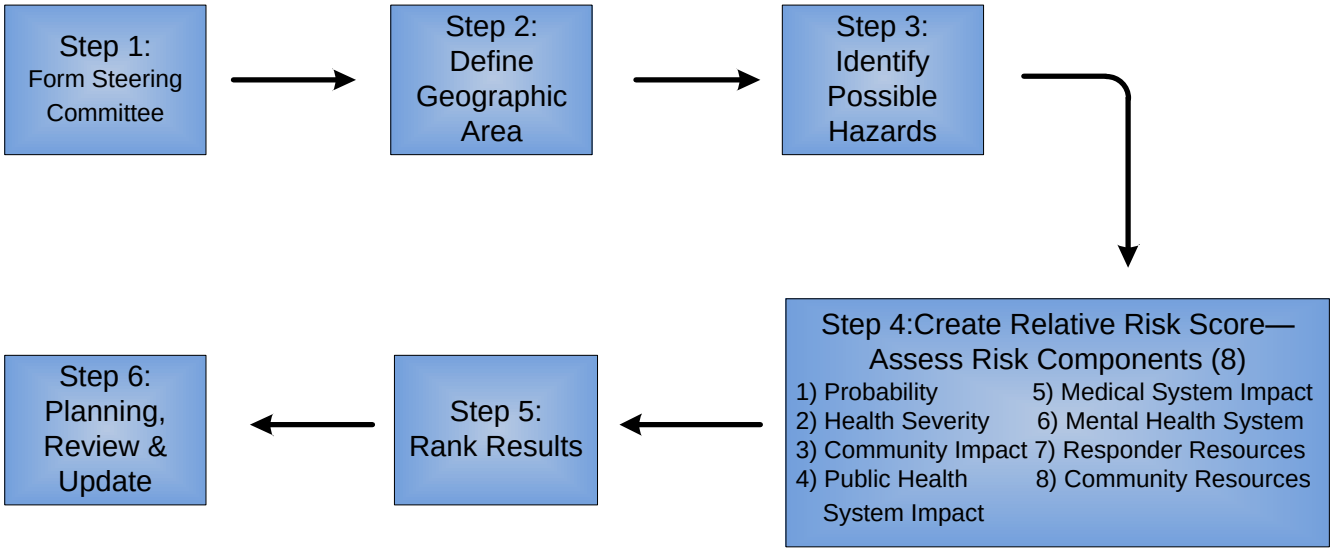
The objective of hHAP is to identify, rank and prioritize the health and medical impacts of potential hazards relevant to a specific jurisdiction/agency based upon the user provided input (scores). Once prioritized, appropriate mitigation strategies and response plans can be developed to minimize identified risks. Successful completion of this process is predicated on the following recommended steps (see Figure 2):

[*] See Methods section for complete explanation of Risk Components, Weights, Modifiers and Relative Risk Formula

Step 1: Form a Steering Committee

Each agency and/or organization invited to participate in this assessment is a valuable contributor to the process. Numerous and varied types of hazards will be considered in this process, many of which have a range of potential impacts on the agency and/or community in different ways. The entire hHAP process works best when managed by a representative group or committee to steer the entire assessment process. While no single agency or individual can be expected to have full knowledge of both potential hazards and impacts, committee representatives from participating agencies should have a working knowledge of their organization as well as individual and/or systematic emergency preparedness and response mission(s), objectives and functions. Potential representation from the following groups should be considered when forming the steering group: business; community leadership; cultural and faith-based groups and organizations; emergency management; fire, healthcare; law enforcement; social services; housing and sheltering; media; mental/behavioral health; office of aging; education and childcare representatives.

Figure 2. Health Hazard Assessment and Prioritization Methodology



Step 2: Define Geographic Area

Originally designed to meet the needs of the SoCal MSA as part of the CDC's Risk-Based pilot project, other agencies and communities using this instrument should understand the geographic boundaries of their jurisdictional authority and/or planning scope and select the appropriate geographic areas. hHAP can be utilized for any defined geography and jurisdictions should consider utilizing the tool in assessing as many sub-divisions of their jurisdiction as necessary.

Step 3: Identify Possible Hazards

As risk varies across jurisdictional and geographical boundaries, the Steering Committee must decide which hazards to include in their assessment. In addition to probability and historical occurrences, consider geographic, topographic, and meteorological features unique to each jurisdiction when selecting potential hazards. The hHAP Excel tool has been pre-loaded to include 62, scenario based hazards, assigned into one of four pre-identified Hazard Type Worksheets: Natural, Biological,

Chem/Rad and Technological (see Appendix C). If so desired, the Steering Committee can add and/or remove different hazards from the standard list by inserting or deleting the hazard specific rows in the the Excel tool. As the tool utilizes several linked Excel worksheets to track and perform the assessment calculations, the user should also adjust the *Calculations* and *Complete Ranking* worksheets to reflect the selected hazards and to ensure that the Risk Components values are appropriately routed into the Calculations worksheet. In the SoCal MSA, the Steering Committee selected 36 hazards of the 62 possible hazard scenarios that were felt to be most appropriate for the geographic region for further assessment and scoring.

Step 4: Create Relative Risk Score—Assess Risk Components

Once the potential list of hazards has been selected, each hazard's risk is evaluated individually and independently from the other identified hazards. A Relative Risk Score is composed of eight (8) Risk Components. The hHAP Excel tool is programmed to allow the user to manually input numerical values for each of the eight Risk Components—outlined in the following steps—for each individual hazard. The Excel tool will then calculate a Relative Risk Score for each identified hazard by routing the Risk Components into a pre-programmed formula.

Community and Stakeholder Inclusion
The Excel tool currently allows the user to enter the Risk Component responses of one participant into the appropriate hazard specific cells (e.g. Probability of Moderate Earthquake, Public Health Impact of Pandemic Influenza, etc.). However, the hHAP process is designed to be implemented across—and inclusive of input from—multiple community stakeholder groups. To adjust for input from additional participants, the tool can be modified by averaging multiple participant responses for a single Risk Component (consider the *Sample Average Calculation Worksheet*) and linked to the corresponding cell in the hazard tabs. Please note that the cells in the *Sample Average Calculation* Worksheet are not presently linked to the corresponding cells in the four hazard type worksheets (see *Instructions* worksheet).

Risk Component #1: Hazard Probability
Estimating the probability of a specific hazard occurring is informed by historical experience and data but is inherently a complex and subjective process. (March, *et al*, 2003) The timeframe or "planning window" of potential hazard is an important consideration. hHAP assumes a 25 year planning lifecycle. Each jurisdiction should consider and adjust the lifecycle of their planning perspectives to meet their objectives as needed.

To estimate each hazard's Probability, consider the following issues while consulting the Criteria below:

- Known risk for hazard occurrence
- Historical data for hazard occurrence; e.g. San Andreas fault line rupture occurs approximately once every 150 years
- Research and/or modeling data specific to each hazard

Hazard Probability Scoring Criteria	
Improbable (0)	– The probability of the occurrence of the hazard within the next 25 years is zero
Remote (1)	– The hazard is not likely to occur within the next 25 years, but it is possible.
Occasional (2)	– The hazard is likely to occur at least once within the next 25 years.
Probable (3)	– The hazard is likely to occur several times within the next 25 years.
Frequent (4)	– The hazard is likely to occur cyclically or annually within the next 25 years.

Risk Component #2: Health Severity

A unique and defining feature of the hHAP is the explicit focus on public health and medical effects and impacts of each hazard. Different from the separate health system impact assessments, this Risk Component specifically focuses on including and assigning a value to the estimated health impacts of the hazard. Utilize the following Health Severity Criteria, along with the scenario examples in determining hazard severity:

- Potential for increase in morbidity
- Potential for increase in hospitalizations
- Potential for increased mortality

Health Severity Scoring Criteria	
Not Applicable (0)	There is no elevated health or medical impact associated with this hazard.
Marginal (1)	The hazard presents a minimal threat to safety, health and well-being of the surrounding community.
Limited (2)	May result in moderately elevated rates of severe disease, injury, hospitalizations and deaths.
Critical (3)	May result in considerably elevated rates of severe disease, injury, hospitalizations and deaths.
Catastrophic (4)	May result in significantly elevated rates of severe disease, injury, hospitalizations and deaths.

Risk Components #3: Community Impact

Each hazard will impact the surrounding community in unique and specific ways. As the interaction between each hazard and each community is unique, this assessment should be included as part of each community based engagement activity. Utilize the following Community Impact Criteria in addressing the following potential issues:

- Disruption of routine community activities:
  - Schooling and education
  - Employment and business
  - Religious services

  - Sports, entertainment and other public gatherings
- Damage or disruption of communication and infrastructure systems.
- Interruption of critical social services and resources.

Community Impact Scoring Criteria	
Not Applicable (0)	– There is no potential impact associated with this hazard.
Low (1)	– The hazard presents a low threat to the safety, health and well-being of the surrounding community. – Negligible potential to disrupt normal day-to-day activities.
Moderate (2)	– May result in moderate impacts and disruptions of normal activities and functions, including communication functionality and capabilities. – May cause delay or suspension of social services and resources.
High (3)	– Considerable disruption to normal activities and functions, including communication functionality and capabilities. – Delay or suspension of social services, resources and public infrastructure.
Extreme (4)	– Significant disruption to normal activities and functions, including communication functionality and capabilities. – Destruction or significant delay and/or suspension of social services, resources and public infrastructure.

Risk Components #4-6: Systems Impact
In addition to assessing the Health Severity and Community Impact of each hazard, another unique, health focused aspect of the hHAP model evaluates the potential impact on the three primary sectors that provide health and healthcare services to the impacted community:

- **Public Health—**public health departments and/or related agencies *(Risk Component #4)*
- **Healthcare—**healthcare delivery systems and resources, e.g. hospitals, clinics, provider networks (*Risk Component #5)*
- **Mental-Behavioral Health—**departments, agencies or other resources that provide mental-behavioral health services (*Risk Component #6)*

The potential impact(s) from each hazard may or may not be unique and/or specific to each of the three key sectors. A separate impact assessment for each sector should be conducted, including sector specific subject matter experts, if possible. The following criteria scales are provided as a template for each assessment to utilize; potential issues to consider include, but are not limited to:

- Potential for staff illness, injury or death
- Business interruption; Reliance on Continuity of Operational Planning (COOP)
- Employees unable to report to work
- Interruption of critical supplies and resources

- Facilities damaged and unusable
- Facilities damaged and/or temporarily relocated

Risk Component #4: Public Health System Impact

Public Health System Impact Scoring Criteria	
None (0)	– No potential to disrupt normal day-to-day public health operations. – No projected impact on public health personnel, resources, and/or facilities. – No need to activate the Continuity of Operations Plan (COOP).
Negligible (1)	– Negligible potential to disrupt normal day-to-day public health operations. – Negligible projected impact on public health personnel, resources, and/or facilities (few, if any, adjustments need to be made to staff schedules or work locations). – There is no need to activate the COOP.
Limited (2)	– Limited potential to disrupt normal day-to-day public health operations. – There is limited projected impact on public health personnel, resources, and/or facilities (small adjustments may be made to staff schedules and work locations; procurement of some additional services and supplies through normal channels). – There is no need to activate the COOP.
Critical (3)	– Public health emergency declared by Local officials. State emergency declared by Governor. – Disruption of the day-to-day public health operations would require deferring all non-essential services. – Public health personnel and/or facilities are impacted: high absenteeism due to injury, illness, death; infrastructure and building damage. – All available personnel, resources, and facilities would be dedicated to performing essential public health emergency services o *Biosurveillance* - laboratory testing, surveillance and epidemiological investigation; o *Community Resilience* – preparedness and recovery; *Countermeasures and Mitigation* –dispensing, medical materiel management and distribution, non-pharmaceutical interventions, responder safety and health, volunteer management; o *Incident Management* - emergency operations coordination, emergency public information and warning, information management; o *Surge Management* - medical surge, mass care, fatality management

	– COOP would be activated. Additional staff, supplies and services would be needed.
Catastrophic (4)	– National emergency is declared by the President. – Immediate deferment of all non-essential services. – Public health resources would be rapidly overwhelmed due to the impact on public health personnel and/or facilities: extreme absenteeism, illness, death; infrastructure and building damage. – All available personnel, resources, and facilities would be dedicated to performing essential public health emergency services o *Biosurveillance* - laboratory testing, surveillance and epidemiological investigation; o *Community Resilience* – preparedness and recovery; *Countermeasures and Mitigation* –dispensing, medical materiel management and distribution, non-pharmaceutical interventions, responder safety and health, volunteer management; o *Incident Management* - emergency operations coordination, emergency public information and warning, information management; o *Surge Management* - medical surge, mass care, fatality management – COOP would be activated though insufficient to meet need. Additional staff, supplies and services would be rapidly needed.

Risk Component #5: Healthcare System Impact

Healthcare System Impact Scoring Criteria	
None (0)	– No potential to disrupt normal day-to-day operations. – No projected impact on public health personnel, resources, and/or facilities. – No need to activate the Continuity of Operations Plan (COOP).
Negligible (1)	– Negligible potential to disrupt normal day-to-day operations. – Negligible projected impact on personnel, resources, and/or facilities (few, if any, adjustments to staff schedule or work locations). – There is no need to activate the COOP.
Limited (2)	– Limited potential to disrupt normal day-to-day operations. – There is limited projected impact on personnel, resources, and/or facilities (small adjustments to staff schedules and work locations; procurement of additional resources through normal channels). – There is no need to activate the COOP.
Critical (3)	– Health emergency declared by Local officials. State emergency declared by Governor. – Disruption of the day-to-day operations would require deferring all non-essential services.

	– Adjustment—relaxation or suspension—of state regulations and statutes may be necessary to maintain service capabilities. – Impact to staff and/or facilities: high absenteeism due to injury, illness, death; infrastructure and building damage. – All available personnel, resources, and facilities would be dedicated to performing essential emergency services – COOP would be activated. Additional staff, supplies and services would be needed.
Catastrophic (4)	– National emergency is declared by the President. – Immediate deferment of all non-essential services. – Suspension of state regulations and statutes necessary to maintain service capabilities. – Resources would be rapidly overwhelmed due to the impact on staff and/or facilities: extreme absenteeism, illness, death; infrastructure and building damage. – All available personnel, resources, and facilities would be dedicated to performing essential emergency services – COOP would be activated. Additional staff, supplies and services would be needed.

Risk Component #6: Mental-Behavioral Health System Impact

Mental-Behavioral Health System Impact Scoring Criteria	
None (0)	– No potential to disrupt normal day-to-day operations. – No projected impact on public health personnel, resources, and/or facilities. – No need to activate the Continuity of Operations Plan (COOP).
Negligible (1)	– Negligible potential to disrupt normal day-to-day operations. – Negligible projected impact on personnel, resources, and/or facilities (few, if any, adjustments to staff schedule or work locations). – There is no need to activate the COOP.
Limited (2)	– Limited potential to disrupt normal day-to-day operations. – There is limited projected impact on personnel, resources, and/or facilities (small adjustments to staff schedules and work locations; procurement of additional resources through normal channels). – There is no need to activate the COOP.
Critical (3)	– Health emergency declared by Local officials. State emergency declared by Governor. – Disruption of the day-to-day operations would require deferring all non-essential services. – Adjustment—relaxation or suspension—of state regulations and statutes may be necessary to maintain service capabilities. – Impact to staff and/or facilities: high absenteeism due to injury, illness, death; infrastructure and building damage.

	– All available personnel, resources, and facilities would be dedicated to performing essential emergency services – COOP would be activated. Additional staff, supplies and services would be needed.
Catastrophic (4)	– National emergency is declared by the President. – Immediate deferment of all non-essential services. – Suspension of state regulations and statutes necessary to maintain service capabilities. – Resources would be rapidly overwhelmed due to the impact on staff and/or facilities: extreme absenteeism, illness, death; infrastructure and building damage. – All available personnel, resources, and facilities would be dedicated to performing essential emergency services. – COOP would be activated. Additional staff, supplies and services would be needed.

Risk Component #7: Responder Agency Resources
Each potential response agency within the jurisdiction has specific resources that could be utilized to respond to and/or mitigate the negative effect of each hazard. Identifying and scoring the strength of these resources is another key Risk Component in the hHAP process.

To assign a score representing the hazard specific state of readiness, the jurisdiction should assess the strength of existing jurisdictional/agency resources that could be utilized in response to the specific hazard scenario. These types of resources should include, but are not limited to:

- Specialized staff and systems to detect, investigate and respond to biological, chemical or radiological threats
- Status of agency/department's current plans
- Training status
- Exercise status
- Availability of back-up systems

Responder agencies vary considerably by primary mission, functions and organizational structure. Assessment leaders should consider these variations and adjust the assessment criteria accordingly. The following provides a suggested template for assessing responding agency resources and should be adjusted and adapted to meet the local need.

Responder Agency Resource Scoring Criteria	
None (0)	– The agency does not have a hazard specific response plan. – Hazard specific exercises and drills have not been conducted. – The agency does not have any specialized trainings or assets to mitigate the potential impact of the scenario.

Low (1)	– The agency does have a hazard specific response plan, but it is outdated. – Some hazard specific exercises and drills have been conducted, but not with any consistent regularity. – The agency has few specialized or resources that could be used to mitigate the potential impact of the scenario.
Moderate (2)	– The agency has an approved hazard specific response plan. – Drills and exercises have been conducted, but generally not with other response agencies. – Some specialized capabilities assets to mitigate the hazard impact with limited availability. Some back-up systems have been developed and are available. – Few MOUs with external agencies or vendors are in place to provide needed resources. – Some engagement with community stakeholder groups to educate the public on this specific hazard and potential response.
High (3)	– The agency has an approved and updated hazard response plan. – The agency uses the plan to conduct drills and exercises, often, in cooperation with other partner agencies. – It also has an agency specific COOP plan. – The agency has developed specialized response capabilities and assets, some of which have been pre-positioned. – Back-up systems for primary response functions have been developed. – While the agency has some MOUs and MOAs in place with several partner agencies and vendors to provide needed resources and supplies, they have not been tested. – The agency does engage with community stakeholder groups and promotes preparedness kits and plans for this specific hazard.
Extreme (4)	– The agency has approved and updated hazard response and COOP plans. – The agency regularly tests and exercises to these plans, often, in cooperation with other partner agencies. – The agency has a significant degree of specialized resources and capabilities to mitigate the hazard impact. – The agency has developed and maintains ready, back-up systems for all of its primary response functions. – MOU/MOAs with key partner agencies and vendors are in place and have been tested. – The agency regularly engages with community stakeholder groups and supports preparedness activities for this specific hazard.

Risk Component #8: Community Agency Resources
This last Risk Component provides an assessment and scoring of existing community-based resources that would be available during an emergency response.

For each hazard, the jurisdiction should consider existing community-based resources—via Community-Based Organizations (CBOs), Faith-Based Organizations (FBOs), and Non-Governmental Organizations (NGOs)—that contribute to increasing the community's "resiliency" or capacity to respond to or recover from an emergency situation. (Magsino, 2009) Potential resources include, but are not limited to:

- Types of agreements and partnerships with other community agencies (CBOs, FBOs and NGOs) to maintain or provide services
- Level of coordination with local and state governmental agencies
- Level of coordination with CBOs and FBOs in formal resilience-building activities
- Community level preparedness based on performance measures and metrics

Community resilience has been defined as the "ability to effectively prepare for, respond to, and successfully recover from a manmade or natural disaster, by having the ability to quickly: return citizens to work, minimize disruption to life and economies, reopen schools and businesses, and prevent and mitigate cascading failures, often characteristic of critical infrastructure impacts." (Chandra, et al, 2011)

Community agencies vary considerably by primary mission, functions and organizational structure. Assessment leaders should consider these variations and adjust the assessment criteria accordingly. The following provides a suggested template for engaging community agencies and assessing their resources and should be adjusted and adapted to meet the local need.

Community Agency Resource Scoring Criteria	
None (0)	– The agency does not have a clear understanding of its potential role or opportunity to assist in a potential response. – There are no resource assets in place. – There are no plans in place to maintain agency services and functions during this emergency. – No communications plan.
Low (1)	– The agency has a limited understanding of its potential role or opportunity to assist in a potential response. – Some resource assets are in place. – There are no plans in place to maintain agency services and functions during this emergency. – Limited (and perhaps outdated) communications plan is in place.
Moderate (2)	– The agency understands its potential role or opportunity to assist in a potential response. – Some key resources assets are available and in place. – Has a plan to ensure key agency services and functions are available

	during this emergency. – Has a limited communications plan in place.
High (3)	– The agency understands its potential role or opportunity to assist in a potential response. – Key resources assets are available and in place. – Has a plan to ensure key agency services and functions will be available during this emergency. – Has a communications plan in place. Plan includes protocols for communicating with leadership, staff and clients.
Extreme (4)	– The agency understands its potential role or opportunity to assist in a potential response. – Key resources assets are available and in place; including backup systems and resources. – Has a plan to ensure key agency services and functions will be available during this emergency. – Has a communications plan in place. The plan is regularly updated and includes protocols for communicating with leadership, staff and clients.

Step 5: Rank and Prioritize Results

Once all eight Risk Components have been entered for each hazard, the *Calculations* worksheet is designed to automatically calculate and display the Relative Risk Score for each hazard. The Relative Risk Scores will then populate back into the *Complete Ranking* worksheet and Relative Risk Score column within each of the four hazard worksheets. The *Complete Ranking* worksheet allows the user to alphabetize, sort and rank a listing of all identified hazards. Note that the hHap includes tie score rankings. Using the rankings from the *Complete Ranking* worksheet, the *Top 10 Hazards* tab provides a visual representation of the top 10 identified hazards. These rankings serve to prioritize the identified hazards, improve understanding of existing gaps, risks and resources, as well as providing an assessment based foundation for development of response plans, training, exercising, mitigation and/or response preparation efforts at the Jurisdictional, Response or Community Agency level.

Weights and Modifiers

As there is no standard definition of risk, the values, weights and metrics associated with assessing and evaluating risk are open to user interpretation (Dean, 2013). The hHAP tool comes pre-loaded with numerical values attached—as weights or modifiers—to each of the eight Risk Components. These weights and modifiers can be found in the *Calculations* worksheet and were developed to more accurately represent the perceived value of each Risk Component variable in determining the associated risk of each particular hazard. See Appendix D—Weighting Risk for a more thorough description of the analytic weights and modifiers utilized in hHAP.

Step 6: Planning, Review and Update

The ranking and prioritization of the most important, i.e. “Top 10,” hazards is an essential step in understanding and identifying: current response capacities, existing gaps, and most importantly, what

hazard specific planning and improvement activities (plans, training, exercises, etc.) should be conducted in both the short and long term to mitigate against the associated risk.

Effective response planning and mitigation strategies must be grounded in true, reality based response capabilities. The "Capability-Based" focus of federal agencies (FEMA) and programs (PHEP and HPP) provides an ideal opportunity for jurisdiction wide adoption and action toward those prioritized elements identified by hHAP. In Los Angeles County, to further improve and strengthen LACPH's response capacities, the hHAP prioritized hazards will be evaluated against each of the 15 PHEP Capabilities to determine—on a capability-by-capability basis—which and how specific tasks, resource and planning elements are needed to improve LACDPH's true response capabilities.

In addition to aligning with federal initiatives and grants, hHAP results could also be used to:

- Identify areas for improved coordination and integration of PHEP and HPP Capability-based planning, tasks, functions and resource elements needed to effectively improve true preparedness and response capabilities.
- Provide foundational framework for development of response plans and policies to address noted gaps and weaknesses.
- Analyze existing imbalances between funding streams and jurisdictional priorities.
- Develop evaluation plan(s) to measure a reduction in risk over time.
- Provide a basis for ongoing community engagement in plan development and exercises.

Finally, the assessment and prioritization of health hazards is an ongoing process. Changes in population, demographic, environmental and disease specific risk factors, as well as improvements in planning, training, exercising and mitigation based activities completed by the department or agency alter the risk relationship. This process and supporting tool will be most useful if it is utilized in an ongoing cycle. Once measurable changes have occurred, the assessment process should be updated, with subsequent results and prioritization guiding future planning and preparedness efforts.

Link to Whole Community Planning

Effective emergency planning cannot happen without the focused and systematic engagement of local response and community-based stakeholder agencies. (FEMA, 2011). Many of the challenges associated with risk-assessment and emergency planning stem from the social and perceived nature of vulnerability that varies across communities. The hHAP process includes the community input as a key step in determining a jurisdiction's planning priorities. In Los Angeles County, over the next five years, the established pattern of community engagement will continue to be strengthened and applied as a key feature in development of 10 comprehensive emergency plans to address our Top 20 hHAP driven planning priorities. This systematic approach and engagement of community agencies into the planning process allows for development of emergency plans defined by broader, more community focused aims and driven by targeted, clear and executable courses of action that effectively align the Department's efforts to broad federal capabilities and, more importantly, to specific and locally driven community needs and available resources. We believe this operationalization of the "whole community" concept presents a clear path and opportunity to more effectively prepare the Department and the community to prepare for, respond to and recover from our prioritized threats and ultimately to prevent illness, injury, hospitalizations and deaths.

APPENDIX A—GLOSSARY

Hazard

1) Anything that may pose a danger; it is used in this discussion to mean a natural or human-made phenomenon or a mixture of both, that has the potential to adversely affect human health, property, activity, and/or the environment. (Sundes & Birnbaum, 2003)
2) A naturally occurring or man-made condition or phenomenon that presents a risk or is a potential danger to life and property. (American Geological Institute)

Hazard Assessment

1) Identification and scaling of latent conditions that represent a threat. (Sundes)
2) The process of determining what events are likely to occur in a specified region or environment. (Landesman)

Mitigation

Alterations that are achieved before an event occurs that decrease vulnerability. (Sundes)

Resilience

1) The pliability, flexibility, or elasticity of the population/environment to absorb, buffer, and/or manage the event/damage. (Sundes)
2) The ongoing and developing capacity of the community to account for its vulnerabilities and develop capabilities that aid that community in (1) preventing, withstanding, and mitigating the stress of a health incident; (2) recovering in a way that restores the community to a state of self-sufficiency and at least the same level of health and social functioning after a health incident; and (3) using knowledge from a past response to strengthen the community's ability to withstand the next health incident. (Chandra)
3) The ability to effectively prepare for, respond to, and successfully recover from a manmade or natural disaster, by having the ability to quickly: return citizens to work, minimize disruption to life and economies, reopen schools and businesses, and prevent and mitigate cascading failures, often characteristic of critical infrastructure impacts. (White House Office of Science and Technology)

Relative Risk

The end product of the hHAP assessment process; The cumulative score of eight Risk Components that denotes the relative risk of a specific hazard when measured against another assessed hazard.

Resources

The material and personnel available to meet needs generated by a hazard. (Shoaf, 2011)

Risk

1) The objective (mathematical) or subjective (inductive) probability that something negative will occur. (Sundes)

2) A relationship that is frequently depicted by the following basic formula—although the association is not strictly arithmetic: Risk = Hazard x Vulnerability. (Landesman)

Risk Assessment

1) The prediction and estimation of risk. (Sundes)
2) A systematic process that determines the likelihood of adverse health effects in a population following exposure to a specified hazard. Health consequences may depend on the type of hazard and damage to infrastructure, loss of economic value, loss of function, loss of natural resources, loss of ecological systems, environmental impact, and deterioration of health, mortality, and morbidity. The major components of a risk assessment include: hazard identification/analysis and vulnerability analysis that answers the following questions: What can happen? How likely are each of the possible outcomes? When the possible outcomes happen, what are the likely consequences and losses? Risk is frequently presented as a probability estimate. Risk assessment is a key planning tool for overall disaster management, especially prevention and mitigation activities. (Landesman)

Risk Component

One of eight primary variables necessary to complete the hHAP; namely: Hazard Probability, Health Severity, Community Impact, Public Health System Impact, Healthcare System Impact, Mental/Behavioral Health Impact; Responder Agency Resource Assets; and Community Agency Resource Assets.

Vulnerability

The propensity for being damaged/impacted by a hazard (Shoaf, 2011)

APPENDIX B—RELEVANT SOURCES

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APPENDIX C—HAZARD SCENARIOS

The following scenarios represent a potential range of hazards that could face many health jurisdictions. They depict a diverse set of high and low consequence threats caused by natural, accidental, or intentional means. Collectively, they are intended to facilitate assessment of the hazards by providing reasonable descriptions and potential impacts. Though based in historical data where possible, these scenarios should not be considered as exact projections, "best" or "worst"-case scenarios. Rather, the scenarios were provided to form the contextual basis for grounded discussion and consistent assessment process. For the SoCal MSA Health Hazard Assessment, data specific to Los Angeles County, Southern California and/or California was utilized. Agencies and jurisdictions outside of the Southern California area should adjust scenarios with area specific data and results as applicable. Potential sources of data include, but are not limited to: fact sheets, national, regional and local data reports, existing public health surveillance systems, press releases, local news reports and/or research articles.

NATURAL	
Hazard	**Scenario**
Avalanche	Description: A heavier than usual winter storm creates one of the largest and deepest snow packs in recent decades. The local snow resort has a surge of business, with many skiers venturing into unstable areas. A group of skiers triggers a dry slab avalanche on the east facing cliff overlooking a small town. The skiers are immediately engulfed. Within minutes snow is upon the town, impacting more than half the town.[1] Impact: Within 2 days, 62 injuries, 38 hospitalizations, 50 deaths.
Active Shooter	Description: A gunman rampages through the local community. He first opens fire in his home. He forcibly enters an elementary school and opens fire at others before turning the gun on himself. Casualties include a family member, elementary school students and faculty members.[2] Impact: Within 5 minutes, 28 deaths and 2 injuries.[3] Potential for elevated levels of stress by survivors.[4]
Civil Disorder	Description: Several communities and areas within the county are upset at the outcome of an emotionally charged court case; they retaliate with several days of rampant civil disorder in several of the metropolitan neighborhoods. Over 600 buildings are completely destroyed by fire; 2,325 injuries are reported, including 53 deaths. Nearly 50 private medical and dental offices, along with 45 pharmacies are destroyed. Environmental impact and cleanup also has numerous long term societal, economic and health effects.[5] Impact: After 2 weeks: 1,200 injuries, 148 hospitalizations, 53 deaths.
Climate Change	Description: Increasing temperatures are sustained in the county for several consecutive years, with numerous, ongoing health related challenges, including increased incidence of heat related illnesses,

NATURAL	
Hazard	**Scenario**
	casualties related to extreme weather events (storms, floods, structural collapses, etc.) and increased incidence of vector based diseases.[6] Impact: Within 3 months, 10 hospitalizations, 5 deaths. Potential for environmental consequences.[7]
Coastal Erosion	Description: Persistent storms and run off have caused above normal coastal erosion throughout coastal areas of the county.[8] Public safety for those in affected areas is potentially compromised.[9] Impact: Within 1 week, 3 hospitalizations due to injuries from water activities and approximately 1 death. Potential damage to infrastructure and the environment.
Dam Failure	Description: Failure in a 12 year old dam occurs due to internal seepage induced erosion and results inundation of downstream rural community of 6,500. With little over an hour warning, many of the residents are evacuated to higher ground. Impact: Within 2 days, 500 individuals report injuries, 180 hospitalizations, and 5 reported deaths.[10]
Drought	Description: Caused in part by strong "La Niña" episodic conditions, the region and state are under persistent drought conditions.[11] For several consecutive years, the percentage of average precipitation has remained below 70%, with percentage of average runoff below 45% and state reservoirs at just 40% capacity.[12] As a result of the hot and dry conditions, several large urban and wild land fires occur throughout the region, leading to increased burden of respiratory effects and illness.[13] Impact: Within 3 months, 10 hospitalizations, 5 deaths. Potential for long-term environmental consequences.
Major Earthquake	Description: A magnitude 7.8 earthquake ("ShakeOut" like) occurs on the region's major fault line. Close proximity of fault line to several major urban centers, coupled with area's geographical features produce high energy shaking (MM Scale VIII or greater) for a sustained period of time over a large swath of the area. Healthcare, transportation, utility and sewage infrastructure systems are severely impacted. [14] The earthquake kills and injures many people, by causing buildings to collapse, creating falling debris and flying objects, and increasing traffic accidents when drivers lose control of automobiles. Additional deaths and injuries stem from fires that follow the shaking. Impact: Within 7 days, 20,000 hospitalizations (750 people with severe injuries that require rapid advanced medical care to survive) and 1,800 deaths. In addition, approximately 20,000 people have injuries that need emergency room care. Severe impact on infrastructure.
Moderate Earthquake	Description: A magnitude 6.4 earthquake erupts along a previously

NATURAL	
Hazard	**Scenario**
	unknown fault line, in the heart of a populated suburban valley north of downtown. Healthcare, transportation, utility and sewage infrastructure systems are significantly impacted. There are more than 5,000 injuries and hundreds of buildings and structures are damaged.[15] Impact: Within 3 days, 1,500 hospitalizations[16], 57 deaths. Potential for serious infrastructural damage.
Expansive Soil	Description: Expansive soil is a hazard posed by the negative effects of differential water content—caused swelling and shrinking clay materials—which can lead to unstable ground foundations, footings and floor slabs.[17] Large swaths and areas of expansive soil could potential lead to cracked and damaged foundations and pipelines.[18] Impact: Within 3 days, 3 hospitalizations and 1 death. Potential for damaged infrastructure and buildings. [19]
Extreme Summer Weather	Description: Unusual weather patterns of record breaking heat and humidity affect the county for several consecutive days. Extended overuse of utilities overtaxes the utility grid, leading to thousands of homes and businesses without power for as long as five days.[20] Impact: At week's end, 37 hospitalizations and 5 deaths.[21]
Fire—Large scale Urban	Description: A series of large scale fire breaks out in the suburban foothills and valleys. Due to unusually high winds, temperature and dry conditions, the fires proves difficult to control and contain. They burn for 3 days, consuming more than 28,000 acres. Over 2,800 structures, including 2,200 homes and 150 commercial buildings, are destroyed.[22,23] Because of the size and scope of the fire, fire response resources are severely stretched and limited in their ability to respond to calls for mutual aid. Evacuation of patients is required at two major hospitals, four health care clinics and 3 long-term care (nursing home) facilities that serve the affected areas. Impact: 300,000 evacuated, 400 patient transfers; 300 hospitalizations; 25 deaths.[24]
Flood	Description: A vigorous low pressure system circulates above the region for several days, unleashing unprecedented amounts of rain. The county's flood control river and tributary channels are overwhelmed. Numerous homes, businesses and service—including a hospital and several clinics—within the 50 and 100 year flood plains are affected.[25] Impact: Within 9 days, 60 hospitalizations, 10 deaths.[26] Potential for environmental and infrastructural impact.
Hailstorm	Description: An unusually powerful storm with wind and hail strikes the area. Numerous traffic accidents and injuries were reported, with several hospitals reporting a spike in emergency room demand during

NATURAL	
Hazard	**Scenario**
	the day of the storm.[27] Impact: Within 1 day, 150 injuries, 112 hospitalizations, 1 death.[28] Potential for damage to buildings, automobiles and infrastructure.
Major Hurricane	Description: A Category 5 hurricane hits the major metropolitan area. Sustained winds are at 160 mph with a storm surge greater than 20 feet above normal. As the storm moves closer to land, massive evacuations are required. Certain low-lying escape routes are inundated by water beginning five hours before the eye of the hurricane reaches land. Impact: 1,000 fatalities; 5,000 hospitalizations; 1 million evacuated; 100,000 homes seriously damaged.[29] Potential for elevated levels of stress.[30]
Landslide	Description: A series of landslides–from a combination of burned ground cover in the fall and unusually heavy winter rain—occurs throughout the suburban hillside and beach communities. The most serious of threats are a 900 and 100 foot section of a neighborhood perched on a seaside cliff, which resulted in numerous homes and several buildings sliding down ravine.[31] Impact: Within 2 days, 19 hospitalizations, 8 deaths.[32] Potential for ongoing environmental and infrastructural impact.
Land Subsidence	Description: A combination of unusually heavy rains and aggressive construction for new water wells have caused land subsidence—the loss of surface elevation (i.e. sinkhole)—in a localized suburban area.[33] The subsidence causes significant disruption of transportation and utility infrastructure services, with impact to local stores and a small clinic. Impact: Within 1 day, 50 hospitalizations and 4 deaths.[34]
Population Displacement — Mass Evacuation	Description: A large scale emergency occurs in a nearby county, severely impacting the resident population there.[35] A significant portion of the population is displaced and seeks refuge in the many parks and open spaced areas within the county.[36] Impact: Within 2 weeks, multiple localized outbreaks among refugees, 300 hospitalizations and 25 deaths.
Severe Winter Storm	Description: An unusually cold and wet winter storm hits the region. Rainfall in excess of 3” in a single day inundates flood control systems and triggers widespread flooding. Cold temperatures lead to low elevation snow levels in mountain areas of county unaccustomed to accumulation of snow. On the coast, heavy rains trigger mudslides as several homes are lost. Impact: Within 2 days, 120 injuries, 62 hospitalizations, 23 deaths (most due to automobile accidents). Potential for damage to infrastructure and residential homes.[37]

NATURAL	
Hazard	**Scenario**
Storm Surge	Description: Storm surge is an abnormal rise in sea level accompanying a hurricane, tropical cyclone or other storm over water. A very complex phenomenon, the maximum potential storm surge for a particular location depends on a number of different factors.[38] Potential for serious health and medical impacts depending on geographic and topographic factors. Impact: 1,500 hospitalizations, 250 fatalities.
Thunderstorm & Lightning	Description: Fast-moving lightning storm sweeps through the county, inducing several fires and sporadic power outages to wide swaths of communities. Reports of several injuries and some fatalities from lightning strikes in parks and athletic fields. Noticeable, but short-lived surge on some 9-1-1 receiving hospitals in affected areas.[39] Impact: Within 1 day, 18 hospitalizations and 4 deaths.
Tornado	Description: Unusual meteorological events trigger a series of serious night-time tornado strikes in the heart of the suburban valley north of the city. Emergency alert broadcasts provide very little warning. Collectively, the storms destroy more than three hundred structures, the majority of which are homes. [40, 41] In the hours following the storm, the local hospitals are inundated by ambulatory patients seeking care. Impact: Within 2 days, over a thousand injured with 862 hospitalizations and 100 deaths.[42]
Major Tropical Cyclone	Description: A Category 5 tropical storm hits the major metropolitan area. Sustained winds are at 160 mph with a storm surge greater than 20 feet above normal. As the storm moves closer to land, massive evacuations are required. Low-lying escape routes are inundated by water beginning five hours before the eye of the hurricane reaches land. Impact: 1,000 fatalities; 5,000 hospitalizations; 1 million evacuated; 100,000 homes seriously damaged.[29]
Tsunami	Description: An earthquake occurs on a previously unidentified fault line several miles off the coast. The earthquake triggers a tsunami, which produces a series of wave oscillations that occur for several hours, with moderate peak wave heights of approximately 7-10 feet. [43] The harbor and port are at greatest risk and sustain some reports of injuries and physical damage. Geographical and prevailing fault type features inhibit large scale impact in Southern California.[44] Impact: Within 1 day, 15 hospitalizations and 1 death. Potential for some infrastructure damage.[45, 46]
Volcano	Description: A volcano several hundred miles to the north of the area, which has been spewing CO2 for several years, erupts with relatively little warning.[47] The release produces an enormous pyroclastic cloud of

NATURAL	
Hazard	**Scenario**
	ash into the atmosphere, and, due to on shore air flow, affects the region. For several days, the air quality is significantly degraded, which produces an excess burden of inhalational symptoms and challenges throughout the county.[48] Impact: Within 1 week, 104 hospitalizations and 57 deaths due to thermal burns and asphyxiation from inhaling volcanic ash.[49]
Wildfire	Description: A large scale wildfire breaks out in a dry part of the county. The fire proves extremely difficult to control and threatens numerous communities and buildings. The fire burns for nearly a week and consumes more than 8,300 acres before it is contained. Because of the size of the affected area, fire response resources are severely taxed. Numerous homes are destroyed. Impact: Within 1 week, 22 injuries, including 8 hospitalizations, and 19 deaths. [50, 51] Potential for elevated levels of stress among some, including the injured and those who experienced property damage.[52]
Windstorm	Description: Sustained hurricane force winds of 100 mph blast through a valley area, damaging buildings, downing trees and knocking out power for over 350,000 people across the region. A range of health complications occur including falls due to power outages, heart attacks and injuries from fallen trees and fires caused by downed power lines.[53] Impact: Within 5 days, 12 hospitalizations and 1 death. Potential for moderate damage to infrastructure.

BIOLOGICAL	
Hazard	**Scenario**
Aerosolized Anthrax	Description: *Bacillus anthracis* is released, undetected, with modest efficiency in a densely populated urban city with a significant commuter workforce. Approximately 330,000 individuals are exposed from release and seasonal winds.[54] Incubation period: 1-7 days (up to 48 days), most cases within 48 hours.[55] Rapid distribution of medical countermeasures is required for treatment and mass prophylaxis. Impact: Within 48 hours, 20,000 cases, 17,000 hospitalizations[56] 5,000 deaths (nearly 100% case-fatality for untreated[57]). Potential for long-term environmental contamination.
Agroterrorism	Description: A terrorist group has successfully infiltrated a high volume meat processing facility with direct distribution to local markets and fast

BIOLOGICAL	
Hazard	**Scenario**
	food restaurants. E. coli 0157 is introduced into batches of ground beef. Within days, local hospitals begin seeing young children and older adults with severe illness. Over next 3 weeks, new cases continue to present throughout the area.[58] Impact: Within 10 days, 600 cases, 100 hospitalizations (25 hemolytic uremic syndrome cases requiring ICU), and 3 deaths.[59]
Botulism	Description: The Israeli Film Festival is being held in the city. There is a large opening night gala hosted by the Israeli embassy that 500 people attend. Within 12 hours of the event, many attendees go to local hospitals with blurred vision, difficulty swallowing, and descending paralysis. An ED doctor suspects *Clostridium botulinum* intoxication and notifies the health department. Symptomatic individuals continue to seek medical care over the next several days.[60] The nature of the event suggests a possible terrorist attack. The health department and FBI investigate through interviews and testing of event catering facilities. Impact: Within 24 hours, 50 cases, 45 hospitalizations (10 intensive care), and 5 deaths[61]. Until the source is identified, there is potential for additional hospitalizations and deaths.[62]
Communicable Disease Outbreak	Description: A 15 year-old refugee from Burma arrives in the area after a flight from Kuala Lumpur with a fever and rash. On arrival, the child's family and other refugees are bused to a local motel. The next morning, they attend a welcome party at a local temple with 500 guests. Declining vaccination rates have decreased the community immunity threshold for measles below the 94% level necessary to maintain herd immunity.[63] Suspect measles is reported to the health department by two separate pediatricians in twelve month and nineteen month old children who were also on the flight. A case is also reported in a 25-year old immigration agent. Subsequent outbreaks of measles are reported in the jurisdiction. Impact: Within two weeks, 24 cases (61% of which are younger than 20 years old)[64], 8 hospitalizations, and 1 death.
Emergent Disease	Description: Emergence and global spread of novel, SARS-like, febrile disease. Early epidemiology indicates high rates of spread via droplet transmission.[65,66] No viable vaccine candidate expected for minimum of 12 months. Local surveillance systems have detected influenza like illness signals at several hospitals in the community. Impact: After 6 months, 25,000 cases, 3,000 hospitalizations; 2,300 deaths.[67]
Food Supply Contamination	Description: A large food production facility is unknowingly contaminated with *E. coli* 0157. The facility produces and provides

BIOLOGICAL	
Hazard	**Scenario**
	bagged salad products to nearly all the local schools and university facilities in the area, potentially exposing many thousands of children to the bacteria. Within days, syndromic surveillance detects gastro-intestinal signals at numerous hospitals throughout the region, primarily amongst children and young adults; the surge of cases continues for several days. 67% of individuals who present at the hospital are admitted, with higher rates among those individuals with suppressed immune systems.[68] Impact: Within 1 month, 2,120 cases, 640 hospitalizations, 16 deaths.[595959, 69]
Intentional Food Contamination	Description: An anti-government group, successfully and covertly distributes *salmonella enterica* (salmonella) throughout the community via contaminated food and condiments at nearly two dozen popular Mexican-food restaurants.[70] Syndromic surveillance detects gastro-intestinal signals at numerous hospitals throughout the region. Surge of cases continues for several days, with high rates of hospitalization and mortality among frail, elderly and immuno-suppressed.[71] Impact: 3,000 cases, 840 hospitalizations and 15 deaths.[72]
Intentional Water Contamination	Description: An intentional release of *Cryptosporidium* has been confirmed at a major water utility plant that provides water to a large segment of the county.[73] Potential for numerous affected individuals: illness, hospitalizations and mortality, depending on the extent of the contamination. Impact: Within 5 days, 200,000 cases, 2,000 hospitalizations, 270 deaths (susceptible populations most at risk).[74]
Pandemic Influenza	Description: Emergence and global spread of novel influenza strain with high transmission and virulence. 30% illness attack rate; 2% case fatality rate, higher among children and elderly. Significant and sustained surge on healthcare delivery systems. Multiple waves of disease present over year long duration of pandemic. Efficacious vaccine unavailable until 6 months after initial outbreak. Impact: Within 6 months, 3,600,000 cases, 396,000 hospitalizations, 76,120 deaths.[75]
Pneumonic Plague	Description: *Y. pestis*, the causative agent of plague, is disseminated via an agricultural sprayer while driving through a densely populated urban city.[76] Short incubation period (1-4 days), coupled with domestic and foreign travel leads to rapid dissemination of disease. Fatality rate of pneumonic plague is high, with real potential for secondary spread.[77] A variety of public health interventions are implemented, including: quarantine and isolation and rapid distribution of medical

BIOLOGICAL	
Hazard	**Scenario**
	countermeasures, both for treatment and prophylaxis. Impact: Within 5 days, 150,000 cases, 100,000 hospitalizations, 16,000 deaths[78] (Case fatality rate for untreated pneumonic plague approaches 100%[79]).
Smallpox	Description: *Variola major* is released, undetected, at a major political event in the downtown area. 18 days after the release, several individuals present at local hospitals with severe fever, abdominal cramps and backache; samples from two of these individuals are sent to local public health laboratory. At day 20, laboratory tests confirm presence of smallpox virus; onset of hospital surge by individuals with similar complaints begins.[80] Variable periods of contagiousness and waning immunity in older individuals leads to multi-wave smallpox epidemic occurs over following 12-15 weeks. Immediate mass vaccination campaign is required.[81] Case fatality rate approaches 30%.[82] Impact: After 6 months, 1,300,000 cases, 650,000 hospitalizations and 390,000 deaths.[83]
Tularemia	Description: An undiagnosed large scale tularemia epizootic among local rabbit populations leads to transmission of inhalational tularemia to humans.[84] Syndromic surveillance systems detect increase in numbers of individuals presenting with influenza-like illnesses.[85] Several thousand individuals exposed, with children under 9 and adults over 75 at greatest risk.[86] Community wide mass prophylaxis response will be needed to reduce illness and mortality.[87] Impact: Within 2 weeks, 600 cases, 312 hospitalizations, 42 deaths.[88]
Vectorborne Disease	Description: Hot weather and stagnant pools of water are the perfect breeding conditions for mosquitoes, which can carry the West Nile Virus (WNV). About 1 in 15 people infected with WNV will develop severe illness including high fever, headache, muscle weakness, vision loss, numbness and paralysis. 20 percent of people infected will develop milder symptoms. Symptoms of WNV appear within 3 to 12 days after infection.[89] Impact: Within 4 months, 78 cases, 15 hospitalizations, 2 deaths.[90]

CHEMICAL & RADIOLOGICAL	
Hazard	**Scenario**
Blister Agent	Description: Agent Yellow—a liquid mixture of the blister agents sulfur

CHEMICAL & RADIOLOGICAL	
Hazard	**Scenario**
	Mustard and Lewisite—is dispersed over a large outdoor athletic event. Individuals who breathe this mixture may experience damage to the respiratory system. Contact with the skin or eye can result in serious burns; high level exposure can be fatal. The stadium is immediately evacuated, resulting in some spread of contaminated material. The agent directly contaminates the stadium and the immediate surrounding area, and generates a downwind vapor hazard. Impact: 120,000 injured, 70,000 hospitalizations to treat chemical and inhalational burns, arsenic poisoning and evacuation related injuries. 150 total deaths.[91] Potential for significant environmental remediation.
Factory Chemical Spill	Description: An accidental release occurs at a modest industrial manufacturing factory located in a local business park. The factory uses several basic though caustic chemicals in their production. The release causes several casualties, some of which require treatment at local hospital.[92] Impact: Within 1 day, 6 hospitalizations and 1 death.
Industrial Plant Explosion	Description: A fertilizer plant explosion rocks a town of 2,800 people.[93] Burning embers, shrapnel and debris rain down on scared residents. Serious injuries include broken bones, cuts, head trauma, burns and some breathing problems. Damage to a local nursing home building prompts an evacuation of 133 patients, including some in wheelchairs. Surrounding residential neighbors were destroyed. Potential for additional evacuations.[94] Impact: Up to 15 deaths; at least 200 injuries and 110 hospitalizations.
Mass Casualty Hazardous Materials Accident	Description: A northbound passenger train (one locomotive, 3 passenger cars), carrying 250 passengers collides with a southbound Union Pacific Railroad freight train: 2 locomotives, 30 cars, 2 carrying pressurized chlorine gas.[95] Several cars from both trains are derailed, including one chlorine tanker which is compromised and leaking.[96] Impact: 180 injured in crash, 102 transferred to hospitals; 75 deaths (45 from crash, 30 from chlorine exposure).
Nerve Agent	Description: Sarin, a potent, clear, colorless and tasteless nerve agent, is released into the ventilation systems of a major commercial office building—via several spray dissemination devices—in the downtown area. The agent kills 95% of the approximately 4,000 individuals in the office building, and kills or sickens many of the first responders. In addition, some of the agent exits through rooftop ventilation stacks, creating a downwind hazard. Impact: 500 injuries, 350 hospitalizations, 3,800 deaths. The building and immediate surroundings will be require decontamination.[97]

CHEMICAL & RADIOLOGICAL	
Hazard	**Scenario**
Nuclear Explosion – 10 Kiloton	Description: A nuclear bomb (fission-fusion) is detonated downtown. Severe loss of life and infrastructure within 2 mile blast radius. Moderate damage and loss of life in other affected areas.[98] Explosion will release 10,000 times more radiation than a large dirty bomb.[99] Blast, thermal, and radiation injuries in combination will result in worse prognoses for patients than only sustaining one independent injury.[100] Impact: 500,000 injured, 300,000 require hospital level treatment. 61,680 deaths.[101] Significant long term environmental impact.
Nuclear Facility Failure	Description: An accident occurs at a nuclear power plant less than 100 miles from downtown. The cooling systems for two of the plants four cores are disabled and the cores experience full meltdown. Efforts to cool the cores have failed.[102] A buildup of radioactive infused steam cause several large explosions, resulting in dispersal and release of radiological contaminants into the surrounding region and atmosphere.[103] Evacuation order given for all individuals within 10 mile radius of the plan.[104] Approximately 300,000 individuals live within 10 mile evacuation zone. Numerous healthcare facilities potentially affected. Impact: At power plant, 25 reported injuries; 7 require hospitalization; 2 deaths. No immediately reported injuries and/or deaths reported in the community.[105]
Radiological Dispersal Device	Description: A Radiological Dispersal Device (RDD or "dirty bomb") — composed primarily of Cesium-137—is detonated in the downtown region of a major urban center. Radiation exposure causes skin damage similar to burns deep within the body. The contaminated region covers approximately thirty-six blocks, including the business district, residential row houses, crowded shopping areas, and a high school. Impact: 20,000 injuries; over 1,000 hospitalizations; 270 deaths. Significant disruption to economic and infrastructure resources.[106]
Radiological Incident – Fixed Facility	Description: An explosion occurs at a cancer treatment hospital located in a populated area of the county. Strong gusts of wind deposit the fallout up to 1 mile downwind from the hospital.[107] Hospital is disabled for extended period of time. Impact: Within 2 days, 10 hospitalizations due to radiation poisoning and 3 deaths. Nearly 2000 residents in the area who were exposed to radioactive materials.[108]
Ricin	Description: Ricin is disseminated in underground in jurisdiction's light rail transportation system during busy Monday morning commute. Ricin toxin is synthesized from castor plants endemic in the local area. It has a short incubation and within a few hours, numerous individuals begin

CHEMICAL & RADIOLOGICAL	
Hazard	**Scenario**
	reporting to local hospitals with respiratory distress, fever, cough, nausea and other symptoms.[109] No FDA approved treatments, supportive therapy only.[110] Symptoms worsen with death occurring 36-48 hrs from exposure.[111] Impact: By week's end, 8,500 cases; 6,000 hospitalizations; 2,500 deaths. Environmental remediation will be required.
Train Accident – Chlorine Release	Description: A train carrying a number of large, industrial chlorine tanks is derailed, resulting in an immediate explosion and release of chlorine gas into the air. A light breeze carries the plume toward residential and commercial areas. Several thousand people potentially exposed to smoke and chlorine plume. Several hospitals in the area have been instructed to shelter-in-place. [112] Impact: 250 total injured; 12 in train accident. Several dozen hospitalizations, 15 deaths.

TECHNOLOGICAL	
Scenario	**Description**
Communications Failure	Description: An unexplained atmospheric condition disables a broad range of communication functions throughout the area. The loss of infrastructure capacity causes an overload on existing system, triggering cascade of communication failures. Emergency response and healthcare services and systems experience periodic failures in communication capabilities, which lead to several delays in provision of emergency and health services.[113] Impact: After 3 days, 32 attributable hospitalizations and 11 related deaths.[114]
Cyber Attack	Description: A rogue cyber-criminal attacks the energy production of a major metropolitan area, disrupting electrical power service for a period of 8 hours. Generator failure at several hospitals negatively affects service delivery at those facilities.[115] Impact: Within 1 day, 840 patients are evacuated and relocated to other hospitals, while 6 patients die due to backup generator failure. [116]
Electrical Failure	Description: An unintentional mishap on a high-voltage power line causes a cascading series of electrical grid failures across the county, leaving more than 50% of the homes, businesses and healthcare facilities without power. Electrical utility companies estimate at least 48 hours will be needed to restore service.[117]

	Impact: After 2 days, 3 hospitalizations, 1 death.[118]
Information Systems Failure	Description: There are several significant emergencies and disasters that may cause and/or occur from a disablement of existing information systems.[119] The potential impact—direct or indirect—to health and medical services of the county are varied, and potential very serious. Existing resources, i.e. amateur radio operators, vary by community and could serve a mitigating role in this type of scenario. Impact: Within 1 day, 40 hospitalizations and 30 deaths.[120]
Improvised Explosive Device	Description: A large explosive device is detonated at a downtown government office building. The blast destroys or damages several dozen buildings within an 8 block radius of the explosion. Impact: Within 1 day, 700 injuries, 500 hospitalizations and 200 deaths.
Off-shore Oil Spill	Description: An oil drilling platform several miles off shore is damaged, leaking oil directly into the ocean for an extended period of time. Local seafood and fish hatchery products are contaminated.[121] A wide array of health impacts affect the surrounding community, including: skin rashes, persistent headaches, coughing.[122] Like previous oil spills, there is an increase in psychological effects from the spill in both cleanup workers and local residents. [123] Impact: Within 4 months, 11 deaths and 62 hospitalizations. Potential for major threats to the environment.[124]
Sewer Failure	Description: A large storm inundates and incapacitates several large wastewater pumping stations, resulting in sewer backups and failures in a large swath of the community. Approximately 8-12 hours for normal services to resume operations. Impact: After 3 days, 8 attributable hospitalizations and 1 death. Potential for long and short-term impacts on the environment including the presence of gross pollutants and bacteria in coastal waters.[125]
Supply Shortage	Description: Local, regional and national distribution systems are increasingly reliant upon just-in-time production.[126] A disruption of the production and distribution of medical supplies has occurred because of an emergency in another state. Lack of certain drugs and antibiotics have compromised and delayed care for patients. Impact: Within 3 months, 15 cases affected (among hospitalized patients) and 5 deaths (because proper or preferred drugs were not available).[127]
Transportation Infrastructure Failure	Description: A key bridge which serves as a major transportation artery for both automobiles and light rail is disabled due to recent discovery of a series cracks in the foundational footings. The freeway and light rail line have been closed for an undetermined period of time, with no expected timeline for reopening.[128] Potential effects of this type of scenario will vary by geography and jurisdiction. Impact: Within 1 week, 2 hospitalizations and approximately 1 death.[129]
Water Supply	Description: The network and systems that provide water to more than

Contamination	70% of the homes, industry and healthcare services in the jurisdiction are disabled for unknown reasons. This disruption of drinking water treatment process triggers an outbreak of *cryptosporidium* in the affected area. Affected patients include immune-compromised patients. Impact: After 7 days, 285 confirmed cases, 130 hospitalizations and 69 deaths.[130, 131]
Water Supply Disruption	Description: The network and systems that provide water to more than 70% of the homes, industry and healthcare services in the jurisdiction are disabled for unknown reasons. This disruption of drinking water treatment process triggers an outbreak of *cryptosporidium* in the affected area. Affected patients include immune-compromised patients. Impact: After 7 days, 285 confirmed cases, 130 hospitalizations and 69 deaths.[130,131]

APPENDIX D—Weighting Risk

The primary goal of hHAP is to assess and prioritize the potential public health risks facing a jurisdiction. As noted, the process of defining and assessing Risk is subjective. When comparing the various aspects—or Components—of risk, different variables present different levels (values or weights) of perceived risk. For example, in assessing the risk of a major earthquake, what is more important in determining the risk of such an event: the probability of occurrence or its potential health impact? Similar questions exist when trying to assess the value of different parts of the risk relationship for a specific hazard, primarily because the comparative values utilized often represent categories of risk (low, moderate, high, etc.). The challenge of comparative analysis becomes even more difficult when trying to compare "apples to oranges" across the spectrum of different types of hazards.

The hHAP instrument utilizes a weighting scheme of weights (Impacts) and modifiers (Probability, Health Severity and Agency Resources) to ensure an analytic process that is representative and sensitive to the nuances of assessing and prioritizing the public health and medical impact of the various hazards. The weighting scheme was developed with the assistance of Dr. Anke Richter, an Operations Researcher for the Department of Homeland Security and reflects the perceived values of the hHAP project leadership and Steering Committee. Following is a brief description of the various weights and modifiers developed to present and utilize a standardize system of risk metrics as part of the hHAP scoring methodology.

A key feature of this tool is its simple approach to assessment and analysis. This desire for simplicity however, must be balanced with analytic methods that are appropriately robust and clear. We believe this tool satisfies both imperatives and provides an effective way to assess and manipulate the various Risk Components in order to identify a jurisdiction's perceived hazard specific relative risk and as such strongly recommend using the provided weights and values. If an agency would prefer to adjust and/or utilize other weighting values to reflect different sector, agency or jurisdictional values the tool can be adjusted as necessary.

<u>Modifiers</u>

As noted, different hazards will result in different impacts. The relationship of specific hazards interacting with different aspects and resources of the impacted community, for example emergency response resources or community based organizations will—like many aspects of assessing risk—depend on the hazard and the initial overall health impact of the event, as well as its potential duration and potential resource needs. In order to adequately account for these dynamic features, hHAP uses a sliding scale of modifiers that change the associated relative risk by a certain multiplier for each of the following Risk Components:

- Probability
- Health Severity
- Responder Agency Resources
- Community Agency Resources

These modifiers provide the contextual profile necessary for determining a more realistic value for the perceived interaction between hazard, community and resources. For the complete array of modifier values see *Calculations* worksheet, rows 69-104. To change these values in the tool, the user would need to adjust the Modifier Values for each appropriate Risk Component; Probability: C71–C74; Health Severity: E71–E74; Agency Resources: C80 – 100.

Impact Weights

Any potential hazard will disproportionately impact both the surrounding community and the existing health and medical systems. hHAP represents the collective effect or weight of those impacts as follows (see *Calculations* worksheet, row 67 in hHAP Excel Instrument):

- Community Impact: 0.1
- Public Health System Impact: 0.5
- Healthcare System Impact: 0.3
- Mental/Behavioral Health System Impact: 0.1

To change these values in the tool, the user would need to adjust the Impact Weights for each of the four Impact Risk Components: Community Impact: D67; Public Health System Impact: E67; Healthcare System Impact: F67; Mental/Behavioral Health System Impact: G67. The total number of these weighting values must equal 1.00

APPENDIX E—SCENARIO REFERENCES

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