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Recovery from Chemical, Biological, and Radiological Incidents:

Critical Infrastructure and Economic Impact Considerations

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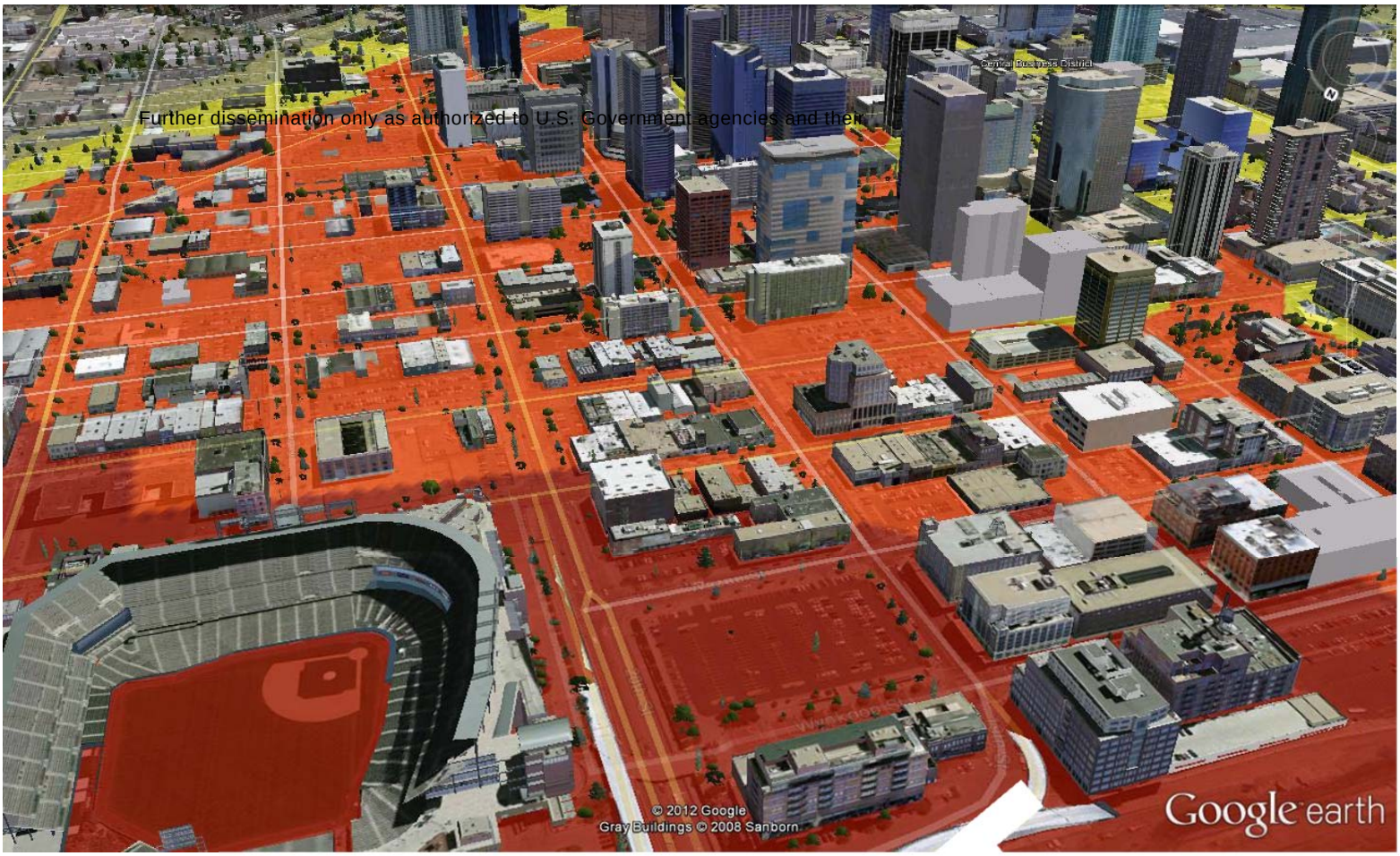
Abstract

To restore regional lifeline services and economic activity as quickly as possible after a chemical, biological or radiological incident, emergency planners and managers will need to prioritize critical infrastructure across many sectors for restoration. In parallel, state and local governments will need to identify and implement measures to promote reoccupation and economy recovery in the region. This document provides guidance on pre-disaster planning for two of the National Disaster Recovery Framework Recovery Support Functions: Infrastructure Systems and Economic Recovery. It identifies key considerations for infrastructure restoration, outlines a process for prioritizing critical infrastructure for restoration, and identifies critical considerations for promoting regional economic recovery following a wide-area disaster. Its goal is to equip members of the emergency preparedness community to systematically prioritize critical infrastructure for restoration, and to develop effective economic recovery plans in preparation for a wide-area CBR disaster.



Response and Recovery Knowledge Product:

Critical Infrastructure and Economic Impact Considerations

For Recovery from Chemical, Biological, and Radiological Incidents

September 2012

Homeland Security

Science and Technology

Foreword:

The "*The Critical Infrastructure and Economic Impact Considerations*" is a document developed by Sandia National Laboratories (SNL) under contract to DHS S&T as a stand-alone deliverable to the Wide Area Resiliency and Recovery Program (WARRP). This document is one of five reports for the Response and Recovery Knowledge Products (RRKP) data transition agreement established between DHS S&T and FEMA in September 2011. It identifies key considerations for infrastructure restoration, outlines a process for prioritizing critical infrastructure for restoration, and identifies critical considerations for promoting regional economic recovery following a wide-area disaster.

DHS S&T would like to thank the following individuals and groups for their support in development and review of this document. The content represents the best efforts of the participants based on the information available at the time of publication, but is not intended to convey formal guidance or policy of the federal government or other participating agencies. The views and opinions expressed herein do not necessarily state or reflect those of their respective organizations or the U.S. Government.

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Critical Infrastructure and Economic Impacts Considerations

Executive Summary

To restore regional lifeline services and economic activity as quickly as possible after a chemical, biological or radiological (CBR) incident, emergency managers and business continuity planners across all sectors of the community will need to prioritize critical infrastructure for restoration. In parallel, state and local governments will need to identify and implement measures to promote reoccupation and economy recovery in the region. Regions that have initiated pre-disaster planning to understand the infrastructure interdependencies and potential economic impacts from a disaster will be more resilient. Pre-planning can shorten the response time and enable populations, governments, and businesses to return to a near normal state much more quickly and stabilize the impacts to the local economy.

There are several important pre-event actions that can be taken by emergency managers and recovery planners that support a more rapid economic recovery following a wide-area CBR incident; these are summarized below:

- Develop baseline knowledge of critical infrastructure assets and characteristics to include the service types provided by the asset, dependencies on other assets, and workaround capabilities.
- Develop and exercise prioritization approaches with a multi-disciplinary group of stakeholders (e.g., emergency planners, private sector partners, infrastructure owners, government officials).
- Develop disaster economic recovery strategies and plans in concert with the federal government, local government, and private sector partners.
- Ensure availability of adequate capital for rebuilding, remediation, and recovery to include negotiation of agreements, identification of funding mechanisms, and implementation of appropriate insurance policies.
- Build economic resistance and resiliency into the regional economy; a robust economy can help a region rebound more effectively than an economically depressed region.

This document provides guidance on pre-disaster planning for two of the National Disaster Recovery Framework Recovery Support Functions: Infrastructure Systems and Economic Recovery. It identifies key considerations for infrastructure restoration, outlines a process for prioritizing critical infrastructure for restoration, and explores methods for promoting regional economic recovery following a wide-area disaster. Its goal is to equip members of the emergency preparedness community to systematically prioritize critical infrastructure for restoration, and to develop effective economic recovery plans in preparation for a wide-area CBR disaster.

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ACRONYMS

CBR	Chemical, Biological, or Radiological
CI	Critical Infrastructure
EOC	Emergency Operations Center
FEMA	Federal Emergency Management Agency
HAZUS-MH	Hazards U.S. Multi-Hazard model
PATH/AWARE	Prioritization Analysis Tool for All-Hazards/Analyzer for Wide-Area Restoration Effectiveness
NPG	National Preparedness Goal
NDRF	National Disaster Recovery Framework
RSF	Recovery Support Function
WARRP	Wide-Area Recovery and Resiliency Program
WRO	Washington Recovery Organization (concept)

TERMINOLOGY[1]

Asset: Structure or facility that has value, and provides a service.

Critical Infrastructure: Systems and assets, whether physical or virtual, so vital that the incapacity or destruction of such may have a debilitating impact on the security, economy, public health or safety, environment, or any combination of these matters, across any Federal, State, regional, territorial, or local jurisdiction.

Dependency: The one-directional reliance of an asset, service, system, network, or collection thereof, within or across sectors, on input, interaction, or other requirement from other sources in order to function properly.

Infrastructure: The basic facilities, services, and installations needed for the functioning of a community or society, such as transportation and communications systems, water and power lines, and public institutions including schools, post offices, and prisons.

Infrastructure sector: A logical collection of assets, systems, or networks that provide a common function to the economy, government, or society.

Recovery objectives: High-level desired end-states of a recovery effort, such as minimizing economic disruption, minimizing impacts to public health and safety.

Service: The functions and capabilities provided by an asset or set of assets to the economy, government, or society.

Wide Area: A geographical area that covers multiple jurisdictions, large populations, or critical infrastructure in multiple sectors.

Wide area restoration: Effort to rebuild or repair the assets and services in a geographical area (which may cover multiple jurisdictions, large populations, and critical infrastructure in multiple sectors) back to normal operation following a disaster or other disruption.

Workaround: An alternative mechanism for the provision of a service, function, or product, such as a back-up, surge capacity elsewhere, etc.

[1] Terminology definitions taken and/or adapted from the Department of Homeland Security, *National Infrastructure Protection Plan*, 2009

SECTION 1. INTRODUCTION

1.1 Need

A wide-area disaster—such as a chemical, biological or radiological (CBR) incident—within an urban area will likely impact many critical infrastructure assets and businesses, degrading capabilities and lifeline systems that support the region's population and core economic interests.[2] The loss of this infrastructure, catastrophic in and of itself, can lead to other severe long-term regional consequences. For example, extended disruption of community services—such as education, medical care, and social services—will deter individuals and families from remaining in, or returning to, their communities. Businesses that support the directly affected entities will suffer as demand for their products and services declines and consumers are unable to meet financial obligations. Moreover, industries across the nation may be affected due to cascading effects of supply chain disruption. Further, mounting national and international concerns over product safety and quality could put entire industries at risk.

To manage this situation and restore regional services as quickly as possible, planners will need to prioritize critical infrastructure for restoration across many different critical infrastructure sectors. In parallel, state and local governments will need to identify and implement measures to promote reoccupation and economy recovery in the region. These efforts are intertwined e.g., critical infrastructure provides an essential backbone to regional economies, and should be coordinated under the National Disaster Recovery Framework (NDRF). These requirements are applicable to both natural disasters and human-initiated incidents.

1.2 Objectives

This document is designed to help emergency planners and managers, business continuity planners, and other members of the state and local emergency preparedness community conduct pre-disaster planning for two Recovery Support Functions (RSFs): Infrastructure Systems and Economic.[3]

Pre-planning for both RSFs is crucial. For prioritization of critical infrastructure restoration, pre-planning will allow planners to acquire key pieces of information that may be difficult to obtain. Developing and agreeing on methods for prioritization of critical infrastructure will improve resource utilization and expedite the resumption of critical services that people and businesses need to safely and viably return to a region. Additionally, efficient critical infrastructure restoration supports economic recovery. Developing effective recovery plans ahead

[2] Wide-area is defined as a geographical area which covers multiple jurisdictions, large populations, or critical infrastructure in multiple sectors

[3] To facilitate pre-disaster planning and foster coordination among State and Federal agencies, nongovernmental partners and stakeholders, the National Disaster Recovery Framework (NDRF) (Federal Emergency Management Agency, 2011) identifies functional areas of assistance, known as the Recovery Support Functions (RSFs.) The RSFs are: Community Planning and Capacity Building, Economic, Health and Social Services, Housing, Infrastructure Systems, Natural and Cultural Resources.

of time will increase stakeholder confidence and create the conditions and incentives to motivate people and businesses to reoccupy.

To support these objectives, this document identifies key considerations for infrastructure restoration, outlines a process for prioritizing critical infrastructure for restoration, and identifies the critical considerations for promoting regional economic recovery following a wide-area disaster.[4] This information will enable members of the emergency preparedness community to systematically and objectively prioritize critical infrastructure for restoration, and to develop more effective economic recovery plans in preparation of a wide-area CBR disaster.[5]

[4] The considerations identified in this document are derived from the key performance gaps identified by the wide area response and resiliency program (WARRP) systems study conducted in 2012 (Einfeld, et al., 2012), critical considerations identified during facilitated discussions in the WARRP Chemical, Biological, and Radiological Workshop (the first workshop under the WARRP Knowledge Enhancement Working Group), held in Denver, CO on January 30-31 of 2012, and comprehensive literature review.

[5] Though developed to support pre-disaster planning for wide-area CBR incidents, the prioritization process and economic recovery considerations are applicable to natural disasters as well.

SECTION 2. CRITICAL INFRASTRUCTURE RESTORATION

The National Preparedness Goal (NPG) defines the Infrastructure Systems Mission Area Capability as the stabilization of critical infrastructure functions, minimization of health and safety threats, and efficient restoration and revitalization of systems and services that support a viable, resilient community. To attain this capability, the NPG calls for the following actions:

- Restore and sustain essential services (public and private) to maintain community functionality
- Develop a plan with a specified timeline for redeveloping community infrastructures to contribute to resiliency, accessibility, and sustainability
- Provide systems that meet community needs while minimizing service disruption during restoration within the specified timeline in the recovery plan

To accomplish these actions, planners will need a detailed and prioritized action plan for repairing, rebuilding, or reopening infrastructure assets in their region following a CBR incident. To develop an effective set of priorities for their region, planners will need to take into account a number of critical considerations, assumptions, and constraints. The sections below outline these considerations, and then describe the process steps during two phases of activity: pre-incident planning and post-incident implementation.

2.1 Considerations for Critical Infrastructure Restoration

Prioritization should take place before, during, and after a CBR event. Pre-planning allows the planning and response community to identify infrastructure assets and characteristics of those assets, as well as to examine priorities, actions, interconnections, and roles under hypothetical scenarios that detail different levels of infrastructure function. Prioritization during and after the event enables personnel to identify the most effective path forward under the scenario at-hand (which is continually changing).

The primary factors that affect the prioritization of critical infrastructure are as follows:

- Disaster impacts and consequences
- Recovery objective priorities
- Service status and relationship to recovery objectives
- Infrastructure asset status and contribution to services
- Interdependencies
- Workaround availability
- Milestone requirements

Table 1 below describes these factors in greater detail, and Figure 1 shows interdependencies between critical services.

Table 1. Key considerations for critical infrastructure restoration

Consideration: Disaster impacts and consequences	
Description	The effects of a wide-area CBR incident on a region's critical infrastructure and functions must be accounted for. These effects include contamination of critical infrastructure assets, disruption of lifelines and services within the region, and population reduction due to illness, death, or relocation.
Importance	These effects will impact the region's ability to provide public health, public welfare, social, economic, and security functions. Through direct damage or denial of use, critical infrastructure and functions that are disrupted will likely need to be prioritized for restoration.
Recommendation	During pre-disaster planning, identify, understand, and account for impacts of a wide-area CBR scenario on regional critical infrastructure and function (e.g., contamination of a port area will disrupt the shipping and transportation functions).
Consideration: Recovery objective priorities	
Description	Recovery objectives—such as protecting health and safety, minimizing disruption to economy, ensuring continuity of government operations, minimizing environmental impacts, and maintaining national security—must be prioritized based on both regional and national needs.
Importance	Recovery objective priorities underpin the entire restoration strategy, including prioritization of infrastructure for restoration. Effective recovery can only occur if coordinated actions are taken to support the highest priority objectives.
Recommendation	At restoration outset, clearly identify and prioritize recovery objectives. As the restoration proceeds, continually re-assess priorities to account for changes to the situation.
Consideration: Services status and relationship to recovery objectives	
Description	After a wide-area CBR incident, many regional services will be disrupted. These services will need to be restored in order to achieve recovery objectives. For efficient prioritization, the contribution of these services to all recovery objectives should be accounted for.
Importance	Establishing clear relationships between services and recovery objectives will enable planners to identify services that contribute to the highest priority objectives and provide the most value to the recovery effort. For example, transportation of goods and people into and throughout the recovery area is nearly always a top priority, because it contributes to multiple objectives, including public health, public safety, economic, and security objectives.
Recommendation	During pre-planning, identify all the services within the region to be considered for prioritization; and define the contribution of these services to all recovery objectives. Services that are degraded below what is needed and that contribute to multiple high priority recovery objectives should be a top priority.

Consideration: Infrastructure asset status and contribution to services	
Description	To prioritize infrastructure assets, each asset's functional status and contribution to the provision of services must be assessed. This assessment should be conducted using metrics that provide an objective assessment of an asset's ability to provide a service. For example, the number of staffed beds could be a metric for assessing the contribution of hospitals, clinics, and other medical facilities to a general medical care service. Similarly, the number of employees may be used to assess economic contributions. These metrics will be useful in comparing assets of different types as a percent contribution. For example, if a hospital contains 100 of the 1000 total beds in the region, its percentage of contribution to general medical care can be assessed as 10%. This percentage may be compared with other assets' percentage of contribution for various services.
Importance	Assessing asset status and using metrics to evaluate an assets contribution to one or more services enables planners to identify those assets in a systematic and objective manner.
Recommendation	During pre-planning, identify critical infrastructure assets that contribute to the provision of critical services to the region. Identify metrics to help determine each asset's contribution to these services. During prioritization, assign highest priority to infrastructure assets that are degraded below required levels, and that provide multiple high priority services or that produce significant capacity or throughput of a high priority service.
Consideration: Dependencies	
Description	To function, a region's services or assets may be dependent on other services and assets (see Figure 1). These interdependencies must be accounted for.
Importance	Restoring an asset, such as hospital, will not be effective unless the services on which that asset depends—diagnostic laboratory services, power, water, public road transport, and communication—are also restored. Further, because dependencies may be multiple layers deep, restoration of many secondary services may be required to enable a single high priority service.
Recommendation	During pre-planning, identify dependencies between services and assets, considering multiple layers of dependencies as needed. During prioritization, assign highest priority to dependencies that enable the highest priority services and assets to function.
Consideration: Workaround availability	
Description	The availability of alternative mechanisms for the provision of a service, function, or product—such as back-up systems, surging capacity elsewhere, relocation, or quick fixes—may affect the prioritization of that service or asset.

Importance	Services may be restored through the remediation of infrastructure that provides comparable services or through the development of workarounds. If the critical services that a high priority asset provides can be delivered relatively quickly and effectively through a workaround, then the restoration priority for that asset should be reduced.
Recommendation	During pre-planning, assess the availability or ability to create a workaround. During prioritization, reduce the priority for services and assets that have workarounds available to them. Since workarounds can be time dependent, re-prioritize resources if a workaround has expired or becomes unavailable.

Consideration: Milestone requirements	
Description	Milestone requirements are time-based factors that affect the magnitude of the benefits that result from the restoration of a critical service or asset.
Importance	If an asset or service is not restored within the milestone time required, the benefits of restoration will decrease significantly. For example, if operations at a disrupted shipping port are not restored within a specific number of months, the alternative routes used may become permanent, reducing the likelihood that the shipping traffic to that port—and the attendant regional economic benefits—will return. Similarly, restoring education services prior to the start of a new school year will have a much more positive effect on population retention than would restoring those same services three months after the scheduled start of the school year.
Recommendation	During pre-planning, for high priority services or assets identify milestone requirements. During prioritization, compare the restoration timeline with milestone requirements and assess if all requirements are met. To better accommodate milestones that aren't met, consider re-prioritization or development of alternative workarounds.

2.2 Prioritization Planning

Incorporating the considerations listed above into an objective step-by-step process provides a number of benefits. During restoration planning and implementation, this process creates a starting point for negotiating infrastructure assumptions and priorities among multiple stakeholders involved in wide area restoration. It will thus yield a transparent solution, as those involved will understand and accept the subjective, negotiated decision-maker inputs, such as restoration objectives, as well as the objective criteria, such as dependencies between assets. In addition, the use of a transparent, explicit process enables emergency planners and managers to rationalize prioritization decisions to their executives and the public. Further, pre-planning to identify assets and their characteristics can save time needed in planning recovery after an incident, and can also identify (and potentially quantify) bottlenecks in the process that can be improved upon by such measures as establishing workarounds.

This process has been developed into a formalized prioritization methodology that includes quantitative measures and calculations.[6] Further, the quantitative methodology is encoded into an easy-to-use software tool, PATH/AWARE that can be used to conduct detailed analyses for prioritization of services and assets. Both the formalized methodology and a beta version of the PATH/AWARE tool are available upon request.[7] (For more details on PATH/AWARE, see Section 2.3.)

Pre-incident Planning

Pre-planning consists of two steps. The first is gathering of information that is not specific to an incident or scenario. Emergency planners should develop baseline knowledge and a written record of regional critical infrastructure assets and characteristics, including the following:

- Asset names and locations
- Critical services provided by the asset
- The dependencies between services and between assets
- The workaround capabilities for services provided by each asset
- Milestone requirements for services and assets

The second step involves bringing together emergency planners, executives, infrastructure owners, and other private and public stakeholders in neighboring jurisdictions to consider and negotiate restoration objectives and priorities, using Table 1 above, as appropriate.

[6] This methodology is discussed in the Interagency Biological Restoration Demonstration Program, *Interim Consequence Management Guidance for a Wide Area Biological Attack*, Document #IBRDPLL035, Chapter 5, September 15, 2010.

[7] PATH/AWARE: Prioritization Analysis Tool for All-Hazards/Analyzer for Wide Area Restoration Effectiveness. Contact DHS S&T, Christopher Russell (Christopher.E.Russell@dhs.gov) or DOD-DTRA, Ryan Madden (Ryan.Madden@dtra.mil) to request PATH/AWARE.

Organizational Frameworks

To support the pre-incident planning objectives as well as post-incident disaster management, an organizational structure consistent with the National Incident Management System (NIMS) should be implemented. One example (Seattle Urban Area, IBRD Project) of a local level organizational framework is described in the below and depicted in Figure 1. A Regional Recovery Task Force (RRTF) comprised of both the private and public sectors is formed to address critical infrastructure prioritization decision-making.[8] Formulating this group in advance of an emergency to develop the baseline understanding of infrastructure assets and recovery priorities is essential both to develop and document the plans as well as to establish relationships within the community prior to an actual response.

Following an incident, the RRTF (or similar entity) defines the geographical or jurisdictional area impacted as it relates to infrastructure interdependencies and prioritization decisions. RRTF post-disaster management also involves coordination with the local EOCs and Incident Command Groups to gather situational awareness on critical asset and service status within the area. In parallel, the RRTF establishes incident specific priority objectives. All of this data is sent to the planning group at the Regional EOC, where prioritization strategies are identified and assessed. The most effective options are presented back to the RRTF, where they are considered for implementation. The RRTF makes a decision and communicates this decision to the regional and local EOCs for implementation. If additional resources are needed, a request for resources is made to the Washington Recovery Organization (WRO) or State EOC. The WRO evaluates these resource requests in the context of state recovery objectives and makes resource allocation decisions.

Another example of a framework for identifying and achieving infrastructure system recovery goals is the Infrastructure Systems Recovery Support Function (RSF) under the National Disaster Recovery Framework (NDRF)[9]. This model integrates capabilities of the federal government to support local, state and tribal governments as well as infrastructure owners and operators to reduce risks from disasters and expedite the recovery process. The Infrastructure Systems RSF connects with the RRTF or a state/local RSF to coordinate federal and other external resources to support local and state prioritized needs. As outlined in the National Infrastructure Protection Plan (NIPP)[10], local or regional partnerships are essential to understanding the interdependencies and undertaking the operational actions within the jurisdiction. By partnering with national-level entities, a framework that facilitates information sharing and coordination across all sectors is recognized.

[8] IBRD, *Regional Recovery Framework for a Biological Attack in the Seattle Urban Area*, September 2010.

[9] FEMA, *National Disaster Recovery Framework: Infrastructure Systems Recovery Support Function*, September 2011.

[10] FEMA, *National Infrastructure Protection Plan*, 2009.

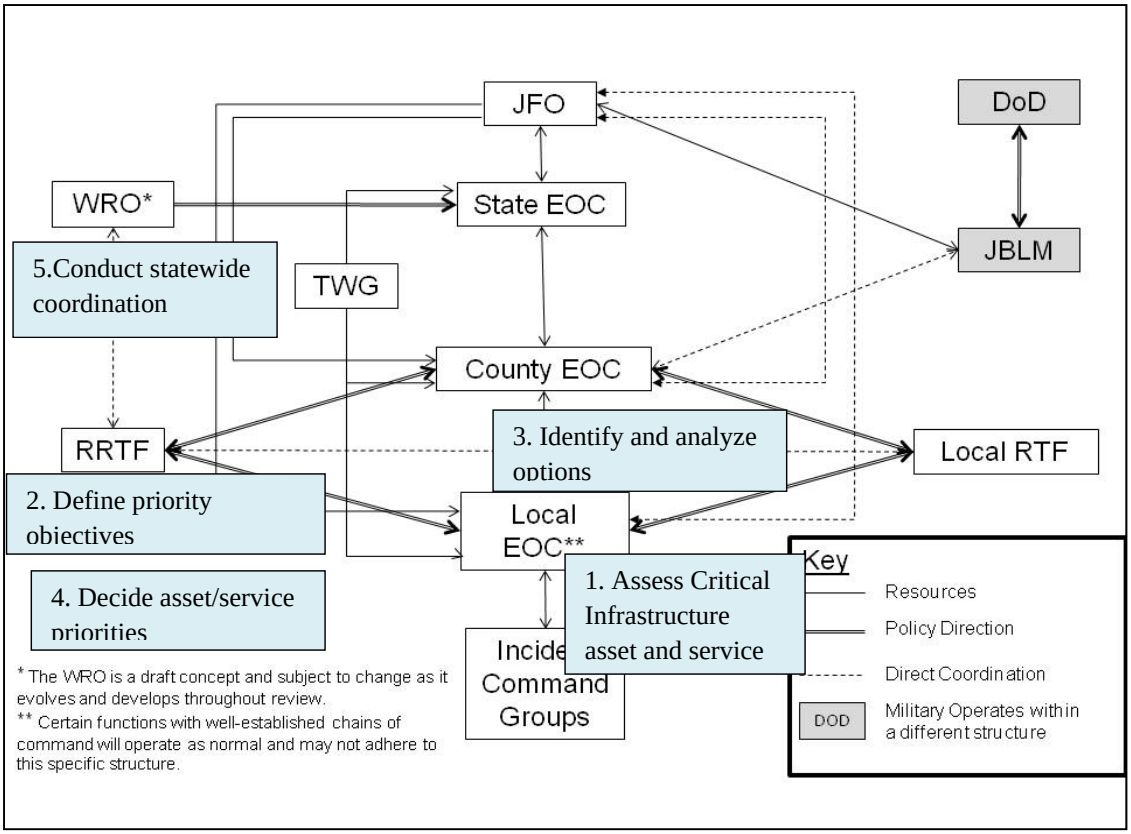

Figure 1. Recovery Organizational Framework (Seattle Urban Area Example)
(DoD: Department of Defense, JBLM: Joint Base Lewis-McChord, TWG- Technical Working Group, JFO: Joint Field Office, RTF: Recovery Task Force)

An illustrative scenario is described to provide a backdrop for the prioritization post-incident prioritization process. This scenario is summarized below.

Illustrative Scenario

On an autumn Monday morning, a specially fitted truck drives north on I-25 near downtown Denver, Colorado. As the truck crosses the South Platt River on I-25 just north of exit 210A and the Aurora Parkway, the driver's companion turns on a concealed improvised spraying device with a conventional nozzle that rapidly aerosolizes approximately 100 liters of wet-fill *Bacillus anthracis* spore (i.e., anthrax spore) slurry. The wind blowing out of the west moves the plume eastward over downtown Denver (Figure 2).

Denver area BioWatch samplers detect the presence of *Bacillus anthracis,* and authorities determine that a bioterrorism

Figure 2. Schematic image of the Bacillus anthracis release point in this hypothetical scenario

event has occurred.[11] The appropriate notifications are made, and patients begin to report to metro area hospitals.

Thousands of residents have been evacuated and thousands more are seeking medical care and shelter in immediate area. Many individuals are self-evacuating due to concerns over public health and the fear of future attacks.

The initial estimated area of contamination is more than 10 square miles. Hundreds of buildings are contaminated and a number of critical infrastructure and services have been impacted: sections of I-25 and major arterials near downtown are closed; the RTD Light Rail and bus service in area are stopped; a number of hospital and public health facilities east of Downtown Denver, such as the Anschutz medical complex, have been closed (see Figure 3). Additional infrastructures outside of the area, such as wastewater treatment plants, are suspected of contamination due to agent migration.

Local government operations have been relocated and local businesses are shut down or relocating critical operations. Temporary housing and shelters are extremely limited and the demand is overwhelming. No clear timelines for recovery have been developed as of yet.

The demand for resources to remediate facilities in the area far exceeds the amount available, and decision-makers are being forced to defend their priorities and allocations of resources at every turn.

Figure 3. Downtown area contaminated with *Bacillus anthracis*

Post-incident Process Steps

Following a wide-area CBR disaster, such as in the scenario outlined above, a process for prioritizing critical infrastructure is necessary. Figure 4 shows steps in this prioritization process, which is described in more detail in Table 2. The lists presented in Table 2 are not comprehensive; they represent subsets of assets/services that would be disrupted based on the scenario. It is recognized that impacts on local critical infrastructure may have far-reaching regional, national, and possibly international impacts.

[11] BioWatch is an early warning system designed to detect the release of biological agents in the air through a comprehensive protocol of monitoring and laboratory analysis. BioWatch is funded and managed by the Department of Homeland Security.

Figure 4. Process steps for prioritizing critical infrastructure for restoration

As wide-area restoration operations progress or priorities shift, this process should be repeated. When possible, rely upon information identified in pre-planning efforts.

Table 2. Steps for post-incident planning

1.	Assess critical infrastructure and service status	Notional Example
a.	• Determine the geographical and jurisdictional boundaries of the area under consideration for prioritization	Facilities (both public and private) within the city's jurisdictional boundaries
b.	• In the restoration area, identify and determine the status of critical infrastructure assets and services • Assemble separate lists of the assets and the services that require restoration and record the status of each asset and service, including: o Extent of disruption or degradation: none/some/all assets and services o Level of disruption or degradation: low/medium/high	• Within city limits, the following subset of critical infrastructure assets have been severely disrupted and should be prioritized: o Hospital A o Medical center B o Highway 1 o Interstate 4 o Water treatment plant D o Rail yard o Industrial park o Police Station • Within the city limits, the following notable services have been severely disrupted: o Emergency medical services o Kidney dialysis o Law enforcement o Industrial services o Shipping o Transportation o Water treatment *These lists are not comprehensive. They simply represent subsets of assets/services that would be disrupted based on the scenario.*
c.	• Assess the impact of disrupted services and assets on the region's public health, public welfare, society, economy, and security • If appropriate, assess national impacts	This wide-area contamination incident has the following impacts: • Public health: Significantly impacted • Public safety: Moderately impacted • Economic: Very significantly impacted • Environmental: Significantly impacted • National security: Moderately impacted
2.	**Prioritize recovery objectives**	**Example**

a.	• Determine the priority of objectives based on the disruption of services assessed in Step 1b, high level consequences assessed in Step 1c, and other driving factors • As appropriate, add objectives established during pre-incident planning and objectives specific to the incident • As appropriate, negotiate objectives among governments in multiple jurisdictions, public and private entities, and local stakeholders	Recovery Objective priorities are: 1. Maintain Public Health 2. Maintain Public Safety 3. Minimize Economic Impact 4. Maintain National Security 5. Minimize Environmental Impact
3.	**Prioritize services**	
a.	• Identify services on the list created in step 1b that directly contribute to each high level recovery objective • Note services that contribute to more than one objective	Service contributions to recovery objectives: • Emergency medical services contributes to public health • Kidney dialysis contributes to public health • Law enforcement contributes to public safety, national security • Industrial services contribute to economic objectives • Shipping contributes to economic objectives
b.	• Increase priority for services that contribute to higher-priority recovery objectives • Increase to even higher the priority services that contribute to multiple higher-priority objectives	Service Priority List: 1. Law enforcement 2. Emergency medical services 3. Kidney dialysis 4. Shipping 5. Industrial services 6. In this example, restoring law enforcement is highest priority because restoring this service helps to meet two objectives, public safety and national security, whereas restoration of emergency medical services and kidney dialysis only supports a single objective.

c.	• Identify existing dependencies of the services on the priority list • Ensure that the list accounts for dependencies: o Start with the highest-priority services o Increase the priority of enabling services upon which the high-priority services depend until high-priority services and dependencies are grouped together	For example, law enforcement and emergency medical services both depend upon: • Transportation • Power* • Water • Communications* *In this scenario, power and communications services remain available Revised service Priority List (w/ dependencies): 1. Law enforcement 1a. Transportation 1b. Potable water 2. Emergency medical services 2a. Transportation 2b. Potable water 3. Kidney dialysis 4. Shipping 5. Industrial services
d.	• Reduce priority for services with workaround capabilities • Determine the time to expiration of temporary workarounds • Reprioritize services before temporary workarounds expire	For example, short-term workarounds may be available for both law enforcement and potable water services. So long as these workarounds remain available, permanent restoration of these services can be lower priority. Revised Service Priority List (w/ workarounds): ~~1. Law enforcement*~~ ~~1a. Transportation~~ ~~1b. Potable water~~ 2. Emergency medical services a. Transportation ~~b. Potable water*~~ ~~c. Commercial laundry services*~~ 3. Kidney dialysis 4. Shipping 5. Industrial services

4.	Prioritize critical infrastructure assets	Example
a.	• Using the asset list created in Step 1b, Determine which assets contribute to prioritized services • Determine the level (high, medium, low) the asset contributes to the service in terms of capacity, population served, throughput, etc.	These assets provide the following services: • Hospital A o Emergency medical services (High) o Employment (Moderate) • Medical center B o Emergency medical services (Moderate) o Kidney Dialysis (High) o Employment (Low) • Highway 1 o Transportation (Moderate) • Interstate 4 o Transportation (High) • Water treatment plant D o Water treatment (High) o Employment (Low) • Rail yard o Shipping (High) o Employment (High) • Industrial park o Industrial services (High) o Employment (Moderate)
b.	• Using the service priorities previously established increase priority for assets that contribute to one or more high-priority services • Group assets based on their contribution to restoring a service	Asset Priority List with rational 1. Interstate 4 (provides transportation needed to enable provision of medical services) 2. Highway 1 (provides transportation needed to enable provision of medical services) 3. Medical center B (provides multiple medical services that support top priority public health objective) 4. Hospital A (provides emergency medical services that support top priority public health objective) 5. Rail yard (provides shipping services support economic objectives) 6. Industrial Park (provides industrial services that support economic objectives)

c.	• Account for dependencies by increasing the priority of enabling assets	For example, Medical center B depends upon: • Highway 1 • Electrical substation A* • Water treatment plant D • Water transmission line #21* *In this example, these assets are not disrupted As a result, the revised Asset Priority List is: 1. Interstate 4 2. Medical center B 2a. Highway 1 2b. Water treatment plant D 3. Hospital A (+ dependencies) 4. Rail yard (+ dependencies) 5. Industrial Park (+ dependencies)
d.	• Reduce priority for assets with workaround capabilities • Determine the time to expiration of temporary workarounds • Reprioritize services before temporary workarounds expire	For example, workarounds may be available for Highway 1. As a result, the revised Asset Priority List: 1. Interstate 4 2. Medical center B ~~2a. Highway 1~~ 2b. Water treatment plant D 3. Hospital A (+ dependencies) 4. Rail yard (+ dependencies) 5. Industrial Park (+ dependencies)
5.	**Develop order of restoration for critical infrastructure assets**	**Example**
a.	• Identify critical milestones that establish a time deadline for restoring a service or asset	For example, the shipping services provided by the rail yard need to be restored within 30 days or shipping traffic will permanently shift elsewhere

b.	• For the resulting priority lists, estimate restoration timelines for critical services and assets and compare with critical milestone requirements established in Step 5a • Adjust/trade-off priorities as needed to achieve milestones	Asset Restoration Timelines 1. Interstate 4: Day 3 2. Medical center B: Day 12 3. 2a. Water treatment plant D: Day 12 4. Hospital A (+ dependencies): Day 21 5. Rail yard (+ dependencies): Day 45 6. Industrial Park (+ dependencies): Day 80 Based on the plan above, the 30-day milestone to restore rail yard shipping services is not met. Adjustments to increase the rail yards priority should be considered.

In conclusion, the prioritization considerations and process outlined above enables restoration planner to objectively and efficiently prioritize critical infrastructure services and assets for restoration after a wide-area CBR incident. Implementation of this process will help to optimize the utilization of scarce resource and justify difficult decisions to the community and stakeholders are large.

2.3 Tools for Prioritization of Critical Infrastructure

As mentioned earlier, software tool PATH/AWARE provides a quantitative methodology for the infrastructure prioritization process.[12] Using PATH/AWARE, emergency planners can view an interactive GIS map of the restoration area with real-time situational awareness data on asset and service status. They can also input priority weightings on recovery objectives, as well as service and asset objective characteristics data. Based on the inputs, the tool outputs a prioritized list of infrastructure for restoration by applying a quantitative algorithm and the considerations discussed in this paper. The user can manually shift the priority of assets and services, as needed. Current prioritization modeling capabilities are available to support recovery planning for all-hazards.

For CBR recovery planning, PATH/AWARE also generates estimates of restoration timelines. The tool can be used to compare the timeline against milestones, adjust the order of restoration to meet critical milestones if needed, and examine trade-offs between alternate prioritization strategies.

Other tools that may support decision-making in the context of economic recovery

[12] D.O. Franco, et al., *Prioritization Methodology and Toolset for Restoring Military Operations Following Biological Contamination,* Chemical and Biological Defense Physical Science and Technology Conference, 16-20, November 2009, Dallas, Texas.

and critical infrastructure restoration include[13]:

FASTMap[14]: a software suite capable of providing detailed GIS-based and statistical data on important economic sectors as well as the location of critical infrastructure and economic assets at risk. Serves to answer questions directly or as pre-modeling input for more comprehensive future analysis.

REAcct[15]: provides county level economic impact estimates in terms of Gross Domestic Product (GDP) and employment for any area in the U.S.; incorporates geo-spatial computational tools and site-specific economic data. Estimates are provided quickly, software is easy to use and is based on established and widely used input-output methodology and GIS data.

N-ABLE™[13]: capable of producing large scale supply chain models and simulation environments to estimate economic impacts over time; requires advanced analysis and high performance computers.

REMI[16]: publically available model to estimate long-run structural changes to the U.S. economy; used to produce annual models (retrospective).

In addition, PATH/AWARE produces diagrams of dependencies (such as in Figure 1.) It also outputs prioritization results in presentation slide format, automatically appending recovery objective priorities and other critical assumptions for the analysis. A beta version of PATH/AWARE is available through the Department of Homeland Security, Directorate of Science and Technology, Chemical and Biological Division.[17]

[13] Mark A. Ehlen, et. al. "*Economics Definitions, Methods, Models, and Analysis Procedures for Homeland Security Applications*". SANDIA report, July 2010.

[14] FASTMap contact: Leo Bynum, GIS Team Lead, NISAC at Sandia National Laboratories (lbynum@sandia.gov).

[15] REAcct and N-ABLE™ contact: Mark Ehlen, Team Lead Computational Economics Group, NISAC at Sandia National Laboratories (maehlen@sandia.gov).

[16] Regional Economic Models, Inc., http://www.remi.com

[17] Contact DHS S&T, Lori Miller (Lori.Miller@hq.dhs.gov) or DOD-DTRA, Ryan Madden (Ryan.Madden@dtra.mil) to request PATH/AWARE.

SECTION 3. ECONOMIC RECOVERY

As previously noted, the National Preparedness Goal, along with the National Disaster Recovery Framework (NDRF), identifies Economic Recovery as a core capability and recovery support function. Developing economic recovery plans prior to a wide-area CBR incident will enable state and local government and business leaders to take prompt, coordinated action shortly after the incident, thereby reducing the economic impacts and supporting the return of business activities that result in a sustainable and economically viable community. In order to conduct economic recovery pre-planning, it is important to understand the basic components that underpin a region's economy, assess the mechanisms by which a CBR incident will result in significant economic consequences, and identify considerations central to the development of an effective economic recovery plan. The remainder of Section 3 provides information on each of these three topic areas.

3.1 Economic Conceptual Model

Many of the existing economic models include the following components: people, business, infrastructure, government/policy, environment, and technology (see Figure 5). In such a conceptual model, each of these components provides one or more functions necessary to support sustained economic growth.

There are many interdependencies between these components. When all the components work in harmony and access to external markets exists, the region's economy tends to prosper. If one or more of these components is compromised, the economy stalls and actions are needed to bolster that component. A brief description of each component and its role in a regional economy follows.

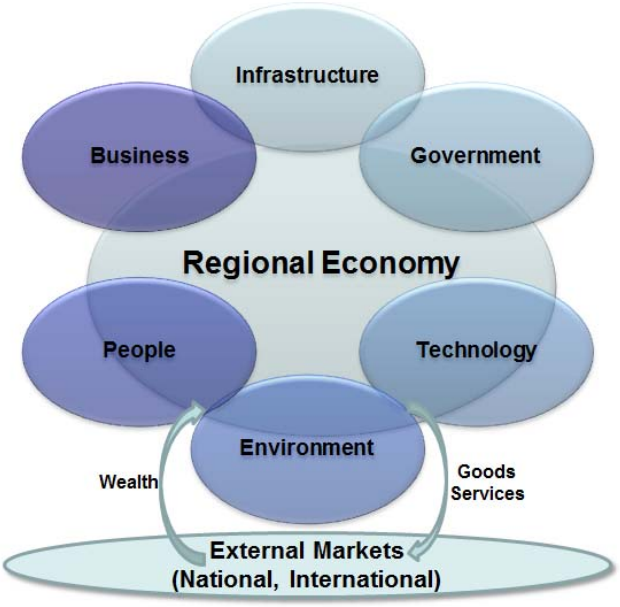

Figure 5. Conceptual economic model

People

People are the primary stakeholders in any regional recovery effort. They make up the community workforce, as well as provide a market for goods and services. In addition, the taxes levied on their purchases and incomes provide valuable cash flows to fund government operations and investments.

In turn, people rely on government to provide basic services, maintain law and order, and manage policies. The population relies on the private sector to provide employment opportunities and services that improve the quality of life. They rely on infrastructure to meet housing needs and facilitate movement about the region, and on technology to acquire information, manage the household, and for entertainment purposes. Finally, people rely on the environment for natural resources, health, and well being.

Business

Businesses drive economic growth through the production of goods, provision of services, and employment of the region's population. Businesses develop new technologies, provide tax revenue to the government, and provide a market for other businesses to cater to. They also convert natural resources into finished goods and products of increased value.

Businesses rely upon the environment to provide natural resources used in the production of goods and services. They depend upon infrastructure to house operations, ship goods, and import raw materials. Businesses depend upon government to provide oversight, manage commerce, and set economic and fiscal policy, all of which promote confidence and stability. Businesses rely upon people to provide a stable workforce and to consume goods/services. Finally, businesses rely upon technology to increase access to the market, facilitate management of the business, and enable new business opportunities.

Infrastructure

Infrastructure consists of the physical assets that enable the production and flow of goods and services within the region, as well as access to external markets. Infrastructure enables transportation of materials, such as movement of raw materials to production sites, and provides the physical facilities and equipment needs (to include agricultural infrastructure and natural resources) to produce goods and provide services. Infrastructure also enables provision of basic services, including power, housing, medical services, and waste management.

Much infrastructure development is funded by government and the private sector and relies on the availability of the natural resources needed. Additionally, technology is often used to improve the design, development, and maintenance of infrastructure.

Government

In our economic recovery conceptual model, government sets many of the policies that drive regional economic growth[18]. In

[18] In this context, the term government refers primarily to local, regional, and state governments. However, after a disaster declaration, Federal government will provide resources and money to support the affected region.

addition, government employs large numbers of people and provides public services, such as law enforcement, education, and waste management, to name just a few. Government also controls city ordinances and policies, including land-use and permitting, and will be responsible for overseeing the majority of recovery efforts. Local government will need to communicate and facilitate the coordination with federal government. To function properly, government depends upon infrastructure to conduct operations and tax revenue from the individuals and business owners alike.

Environment

The environment is the air, sea, and land that the regional community is built upon and provides natural resources to be used in the development of goods and services. The environment must meet minimum health and safety standards to sustain human civilizations—and often relies upon government to manage policies necessary ensure its long-term sustainability.

Technology

Technology enables business and government operations to function more efficaciously and increases the quality of life for a population. On the public side, technology enables access to information in near-real time via mobile and other computing devices. On the private side, technology increases access to the market, facilitates management of the business, and enables new business opportunities. In addition, technology facilitates communication between the private and public sectors.

3.2 Economic Impacts of a Wide-Area CBR Incident

A wide-area CBR incident will have significant economic impacts. For example, some studies have estimated the economic impact of a radiological dispersion device detonation at over $100 billion,[19] a figure that reflect losses due to capital damage and business interruption. To better understand the specific impacts of a wide-area CBR incident, it is useful to look at general disaster effects, assess their relevance for a wide-area CBR scenario, and then correlate those effects to the six economic pillars.

CBR-Specific Disaster Effects

Generally, economic disaster effects can be grouped into two distinct categories: resource loss effects and behavioral effects.[20] Resource loss effects include injuries, deaths, capital damage, and business interruption. Behavioral effects include a rise in regional required rate of return, rise in regional wage premium, and fall in willingness to pay for regional goods. These are discussed below.

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[19] Rosoff, H. and D. von Winterfeldt, *Risk and Economic Analysis of Dirty Bomb Attacks on the Ports of Los Angeles and Long Beach*., CREATE report, October 2005.

[20] Resource loss effects are the direct impacts of the incident and include injuries, deaths, capital damage, and business interruption. These effects have been well studied and accounted for. Behavioral effects are consequences that result from a heightened fear and risk perceptions and include rise in regional required rate of return, rise in regional wage premiums, and fall in willingness to pay for regional goods. These effects are less studied and less quantifiable—and they are likely to be extremely significant in a wide-area CBR incident. (Giesecke, 2012)

Resource Loss Effects

Injuries and Deaths

The number of injuries and/or deaths that result from a wide-area CBR incident is highly variable. For example, in "dirty bomb" attack aimed at contaminating a wide-area, casualties will likely be extremely limited or even nil. In contrast, an effective biological attack may result in hundreds of thousands of casualties. Given this high degree of variability, assessing the relevance of this effect can be challenging. However, from an economic perspective, the reduction in functioning members of the community may be the most significant. With this in mind, it is likely that in the vast majority of wide-area scenarios the population will be diminished not only through injuries and deaths, but also through relocation to due fears over short- and long-term public health risks.

Capital Damage

After a CBR incident, widespread contamination will limit the usability of infrastructure (including housing) in the area. Though minimal physical destruction will occur, concerns of contamination will force officials to cordon off areas and will deter people from inhabiting potentially affected areas. Many building owners will find their property value to be drastically reduced. Homeowners, who are not likely to be insured against chemical, biological, or radiological contamination from a terrorist attack, will be hit particularly hard by the incident. It is likely that many commercial buildings and private residences will simply be abandoned.

Business Interruption

Businesses in the area of suspected contamination are likely to close immediately in response to public health fears. Furthermore, companies that depend upon these businesses for resources or to purchase goods will be impacted. Cornerstone industries such as agriculture, exportation, and industrial industries will likely be impacted. Simultaneously, the environmental resources needed to produce goods may no longer be suitable, and the demand for goods and services produced in the region will drop dramatically. In the long-term, major employers may move or close due to labor shortages, nonfunctional critical infrastructure, or a reduction in competitive advantage.

Behavioral Effects

Rise in Regional Required Rate of Return

As a result of a CBR disaster, the perceived risks associated with investing in the region will increase. Businesses will require increased rates of return in order to justify investment in these communities, rather than alternative locations. If increased rates of return are not available, the risk will not be justified and many businesses will choose to relocate or invest elsewhere.

Rise in Regional Wage Premium

The rise in regional wage premium reflects an increase in compensation required to employ workers in both the private and public sectors due to actual or perceived risks to public health or the community. As a result of this increase, the costs to conduct operations and produce goods and govern are likely to increase, and it may be challenging to motivate skilled workers to

the area. In some cases (e.g., families with young children), no rise in regional wage premium will justify the perceived health risks associated with living and/or working in the contaminated area.

Reduction in Willingness to Pay for Regional Goods

Fears of contamination will significantly reduce the market demand for regional goods and services. Industries that depend upon tourism, such as the hospitality industry, will be deeply impacted. National and international willingness to pay for regional goods and products will drop, and as a result, industries that produce goods and services for export will face extremely challenging circumstances. The scope of the economic impact may extend to goods that pass through the area as consumers cannot be certain the items are safe, resulting in a ban of many more goods or of a much more expansive area (e.g., entire state or country).

Economic Impacts

The effects described above will result in economic impacts likely to exceed billions of dollars[21]. These impacts will be the result of disruptions to the six economic pillars: the population will be reduced through illness, death, or relocation; the environment and infrastructure will be affected due to contamination, affecting natural resource availability and agricultural areas; businesses and facilities will remain closed off and inaccessible; and local governments will face extraordinary workloads and higher than normal costs. Figure 6 shows the cascading effects of a wide-area CBR incident on the six economic pillars.

6.a

6.b

6.c

Figure 6. Cascading effects of a wide-area CBR incident on the six economic pillars

[21] Rosoff, H., 2005.

6.a: Initial contamination incident that compromises the environment and infrastructure. **6.b:** The population is reduced through illness, death, and relocation; and demand for goods and services drops rapidly. **6.c:** Long-term business interruptions and population loss erode local government tax bases and threaten government operations.

These effects are captured in more detail, in Table 3, and the color coding reflects the degree of impact on the pillar, with red reflecting severe impact, yellow reflecting moderate impact, and blue reflecting minimal impact.

Table 3. CBR disaster effects mapped onto the six economic components

		People	Business	Infrastructure	Government	Environment	Technology
Resource Loss Effects	**Injuries/deaths**	Tens to thousands ill or dead; hundreds to thousands "worried well"	Many employees will be ill or absent	Minimal impact	Many government employees will be ill or absent	Minimal impact	Minimal impact
	Capital damage	Many homes and public areas likely contaminated and unusable	Many business facilities likely contaminated and unusable	Many CI assets and areas likely contaminated and unusable	Many government facilities likely unusable	Many areas of the environment (e.g. agriculture production areas) likely usable	Minimal impact
Behavioral Effects	**Business interruption**	Loss of employment and income; many goods and service may be unavailable	Business closed indefinitely; loss of revenue	Contract services (e.g., maintenance and repair) may be unavailable	Long-term reduction in tax revenue	Minimal impact	Some technology services may be disrupted
	Rise in regional rate of return	Increased interest rates; loans may be unavailable	Increased interest rates; loans may be unavailable	Minimal impact	Increased interest rates; loans may be unavailable	Reduced environmental development	Minimal impact
	Rise in regional rate of return	Wages requirements increase	Business costs increase	Minimal impact	Government costs increase	Minimal impact	Minimal impact
	Reduction in willingness to pay for regional goods	Minimal impact	Revenues decrease	Minimal impact	Tax revenue decreased	Minimal impact	Minimal impact

3.3 Tools for Economic Recovery Planning

Models to evaluate the economic impacts of wide-area disasters, including CBR incidents, exist but are limited in their application. Of these existing models, HAZUS-MH, is probably the most widely utilized and accepted.[22] However, HAZUS-MH is limited to estimating the resource loss effects of earthquakes, hurricane winds, and floods. Recently, development is focusing on more advanced models that more comprehensively account for business interruption effects. However, these models remain in a relative state of infancy.[23] Challenges assessing the impacts due to business interruption include the difficulties of separating disaster-caused effects from non-disaster-related phenomena, and defining an end-time (i.e., recovery completion).

Frameworks for estimating economic losses may be more useful for informing economic recovery decision-making. The Center for Risk and Economic Analysis of Terrorism Events (CREATE) at the University of Southern California has recently a proposed a framework for improving the estimation of business interruption[24]; variations of this framework have been applied to estimating the impacts of CBR scenarios, such as dirty bombs.[25] However, these frameworks will likely need further development before state and local planners can apply them to their economic recovery planning efforts. Until this development occurs, historical case studies may be the best resource for informing regional economic recovery planning.

3.4 Considerations for Economic Recovery

To address these issues discussed above, an effective recovery plan must account for impacts to various elements that support the region's recovery. This section identifies 10 considerations that should be accounted for when developing a regional economic recovery plan. Figure 7 summarizes these considerations. The considerations are then described and supported by case studies as appropriate.

[22] The Hazards U.S. Multi-Hazard (HAZUS-MH) model is a nationally applicable standardized methodology that estimates potential losses from earthquakes, hurricane winds, and floods. (FEMA: HAZUS-MH. Overview website available at http://www.fema.gov/plan/prevent/hazus/hz_overview.shtm)

[23] Rose, A. and C. Huyck, Improving Catastrophe Modeling for Business Interruption Insurance Needs, *National Bureau of Economic Research Conference on Insurance Markets and Catastrophic Risk*, May 10-11, 2012.

[24] Rose, A. 2012.

[25] Giesecke, J.A., W.J. Burns, A. Barrett, A. Rose, P. Slovic, and M. Suher, Assessment of the Regional Economic Impacts of Catastrophic Events: CGE Analysis of Resource Loss and Behavioral Effects of an RDD Attack Scenario, *Risk Analysis*, 2012; 12:583-600.

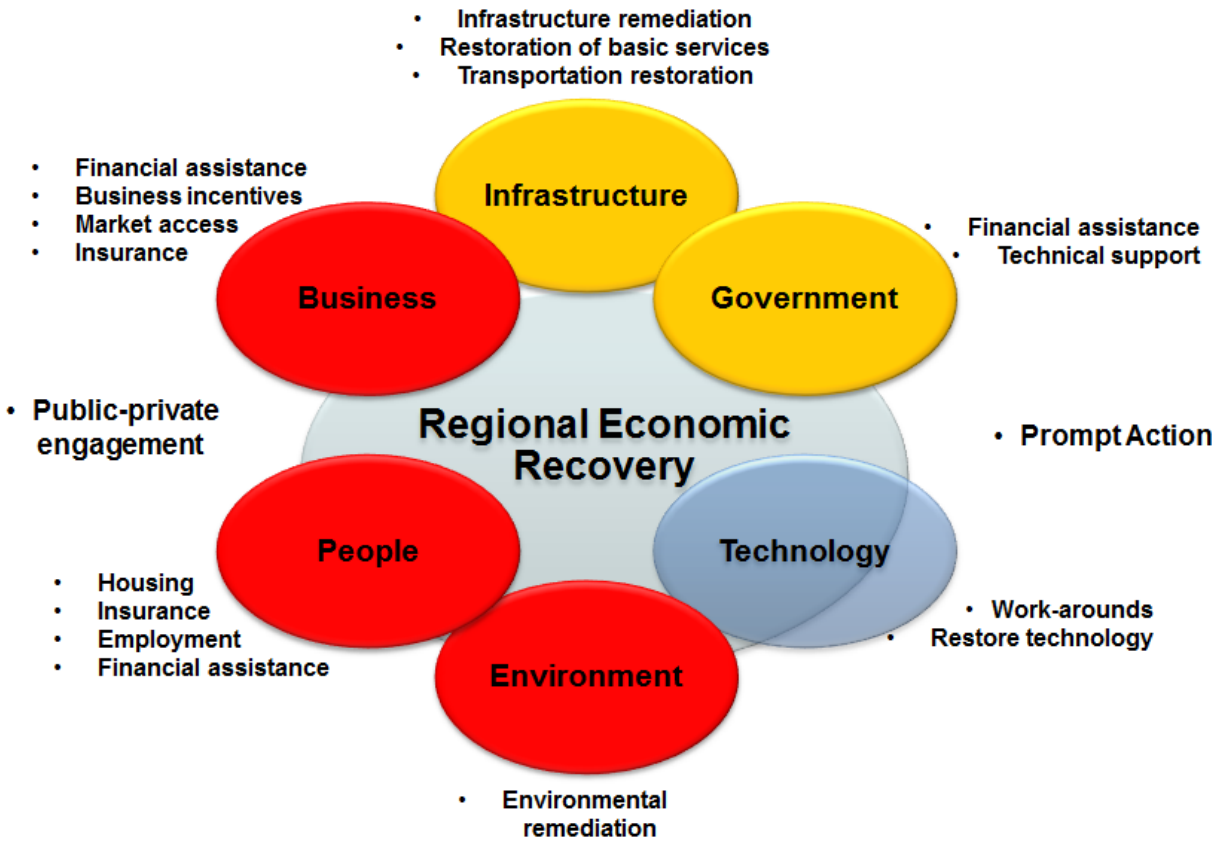

Figure 7. Considerations to bolster each of the economic pillars

General Considerations

Public-Private Engagement

Community engagement and public-private sector coordination is essential to economic recovery planning. This approach is consistent with FEMA's "Whole community" approach, as outlined in Presidential Policy Directive 8. Recovery planners should develop relationships with key community business partners well in advance of a disaster and coordinate planning efforts. This includes understanding what support could be provided, ensuring that communications channels are in place, and providing a business case to the private sector so that they understand the specific benefits to their organization of participating in disaster recovery efforts (manmade or natural.) This approach helps to increase community ownership of the economic recovery plan and reduce unintended consequences.

During recovery, planners should work closely with the private sector to coordinate resources and cleanup efforts, as well as provide information to instill confidence in the long-term viability of the regional economy. For example, recovery planners could establish business continuity assistance centers post-disaster and make decisions to re-purpose and re-zone land made in coordination with the private sector. In addition, regional business and business organizations should have an active role in

the identification and consideration of incentives.

Prompt Action/Time

The timely provision of recovery-oriented actions, such as financial assistance and provision of various goods, services, and equipment to the public and private sector, is critical to maintaining confidence in the government response and the region's recovery. These actions include provision of unemployment insurance, housing assistance, health and medical support, and disease prevention.[26] If the response is lacking, confidence in the region's ability to recover will drop, members of the business and social community will leave, and the economic losses will increase.

Additionally, as time passes and the region's economic state remains insufficient, relocated individuals and families, will settle further into their new communities, increasing the probability that they will elect not to return to their former community. Most small business recovery decisions will be made in three to six months post disaster—the average amount of time that small business owners' emergency cash will last.[27]

By developing an economic recovery plan prior to an incident, prompt and effective action can be taken immediately to supporting the region's economic recovery and promote individual and business investment.

Considerations to Support Recovery of People

Housing

Housing decisions, including temporary and permanent housing decisions, will have significant impacts on the regions long-term economic recovery. Without adequate housing available, people may not be able to remain in the area, depriving the community of its workforce and local business market. Without a local market to cater to, many businesses will be unable to reopen or stay open, in turn reducing the employment opportunities.

While temporary housing is certain to be a high priority during response, the placement of temporary housing will be a challenge. Residents of communities outside of the contaminated area will fear that temporary housing parks, such as trailer parks, may become permanent "poverty zones" that reduce property and community value.

Development of permanent housing solutions must also occur. In a CBR scenario, solutions include rapid remediation of homes, construction of new homes, and development of communities adjacent to the contaminated area that can support business within the region.

[26] Birch, *Rebuilding Urban Places After Disaster*, 2006.
[27] BCLC, *Long-term Recovery Issues and Case Studies*, August 2007, p. 10.

Case Study: Housing Challenges following Hurricane Katrina

In the aftermath of Hurricane Katrina, selecting locations for temporary housing proved challenging due to fears of the rise of "Katrinavilles." Concerns that these temporary communities would become permanent resulted in significant political challenges. In New Orleans, city council members who were calling for the speedy return of residents voted against most of the temporary housing sites the mayor proposed.[28]

Ironically, the lack of housing caused challenges for employers seeking to re-open. Many service industries were crowded with customers but suffered from lack of a labor force. Prospective workers in these communities had really nowhere to live.[29]

Employment

Lack of employment opportunities often found after natural disasters will be a major challenge to the region's recovery.

Traditional disasters generally create opportunities for employment of regional citizens, performing low skilled jobs such as in debris removal and construction. However, after a CBR incident these opportunities will be limited. The vast majority of efforts will focus on wide-area remediation—a specialty area that requires significant training and equipment.

Effort should be made to take advantage of existing employment opportunities or to develop new ones. For example, residents could be trained and utilized to conduct low-tech remediation operations. In addition, efforts should be made to provide transportation of workers from areas of residence to areas with employment opportunities.

Case Study: Burger King

In 2005, Glen Helton was regional manager for over 100 Burger King restaurants in the Gulf area. As part of his pre-Katrina preparations, Glen rented over a dozen full-size vans, presumably to move goods and supplies. However, after Katrina, he faced the challenge of recruiting a labor force to serve in areas where housing was virtually non-existent. Over the next six months, Glen used those vans to shuttle employees from their new residences outside of New Orleans to these stores, enabling his businesses to re-open and providing valuable employment opportunities to the community.[30]

Insurance

The lack of insurance payouts will be a challenge particularly unique to a wide-area CBR incident. Regions recovering from a disaster typically benefit significantly from economic aid in the form of insurance payouts. For example, after Hurricane Katrina, over $40 billion dollars, or nearly 30% of total economic aid, came via insurance payouts. The events of September 11th resulted in over $20 billion dollars of insurance payouts, or nearly a quarter of all

[28] Birch, 2006, p. 234.

[29] One year on, *The Economist*, August 24, 2006.

[30] WARRP Private Sector Economic Resiliency and Restoration Working Group—Session 2. Centennial, Colorado, May 15, 2012.

economic aid.[31] However, it is highly likely that in a wide-area CBR incident, insurance payouts will be minimal, simply because the majority of business and homeowners are not likely to have insurance policies that cover losses due infrastructure damage or business interruption resulting from wide-spread contamination. The financial gap created by lack of insurance payout will significantly restrict the ability of the region to economically recover. In the absence of such payouts, greater demand will be placed on other financial mechanisms, such as government aid.

Financial Assistance and Forbearance for Homeowners

Obtaining financial assistance to fund recovery efforts will be challenging for business, government, and citizens alike. Homeowners in particular will be challenged, as many homeowners are likely to find themselves without employment and with mounting debt in form of mortgage payments and credit card bills. Without policies of temporary financial and regulatory forbearance, many individuals are likely to face foreclosures and bankruptcy even if their homes aren't contaminated.

Considerations to Support Recovery of Business

Business Incentives

The challenges facing business after a wide-area CBR disaster are significant and include inaccessible or unusable facilities, employee loss, reductions in markets for goods and services, and increased financial hurdles, such as increased loan rates. These challenges are particularly difficult for small businesses, which lack the large cash reserves of national businesses[32]. Incentives, such as those listed below, to help business overcome these challenges should be pursued:[33]

- Tax incentives to restore houses and property, needed to attract investors given the rise in required rate of return
- Direct business stimulus
- Financial incentives to move businesses to back-up locations within the region or to sustain them in place
- Expedited certification and inspection processes (such as building and health inspections) to promote rapid economic growth
- Preferential local vendor and buy policies to spur economic growth
- Policies to mitigate risk and liabilities
- Policy incentives to support the return of the population to the area
- Diversification policies to increase a region's economic resilience

In addition, it's important to identify disincentives to business and eliminate them, when and where possible.

[31] Birch, 2006.

[32] Small businesses make up large portion of the private sector in most, if not all, communities. Keeping these businesses open or providing assistance to ensure these don't close is critical to a local economy.

[33] WARRP Private Sector Economic Resiliency and Restoration Working Group—Session 2. Centennial, Colorado, February 21, 201, After Action Review.

Case Study: Joplin vs. Tuscaloosa.

In 2011, Joplin, Missouri, and Tuscaloosa, Alabama, both suffered disastrous tornados. One year later, 8 out of 10 businesses in Joplin have re-opened, while less than half of the business in Tuscaloosa have even applied for building permits. The difference? Joplin implemented an inclusive or bottom-up approach aimed at rapid rebuilding. That is, the business sector and local citizens were integrated into the planning process and were provided such incentives as reduced licensing and zoning mandates.

In contrast, Tuscaloosa implemented an exclusive or top-down approach, relying on outside consulting firms, delaying rebuilding while the redevelopment plan was completed, and providing disincentives in the form of additional regulations and hurdles. In both cases, the communities planned and then implemented actions according to the plan but utilized very different approaches and guiding principles.[34]

Access to Markets

One of the most significant considerations in economic recovery planning is the immediate loss of national and international markets for regionally produced goods. Fears of contaminated goods are likely to significantly reduce demand for those products. As an example, in 2006, hundreds of illnesses across the United States due to contaminated spinach resulted in an estimate loss of $50 to $100 million dollars (see case study below). The market reduction effects that result from contamination that has strong negative social and physiological associations, such as radiation or anthrax, are likely to be significantly greater.

Addressing these fears will be challenging but are necessary. Efforts should be made to immediately isolate the contaminated materials and goods, thereby limiting the potential for additional contamination. Communications with the national and international community should reinforce public messages around the health risks and safety of goods and materials.

Campaigns to inspire confidence in those goods and services and promote consumption may help reduce the market impacts. Enabling access to local markets, by facilitating transportation of goods and people between communities should be considered.

Case Study: 2006 E. Coli Outbreak

In September 2006, fresh spinach contaminated with *E. coli* O157:H7 caused hundreds of consumer illnesses across the United States and a few deaths.[35] Over the 17 months (68 weeks) following the outbreak, consumers decreased their expenditures on bagged spinach by 20% and on bulk spinach by 1%.[36] This sharp decrease in demand cost fresh spinach processors $50 to $100 million.[37]

[34] Beito, D. and D. Smith, Tornado Recovery: How Joplin is Beating Tuscaloosa, *Wall Street Journal*, April 14, 2012.

[35] Arnade, Carlos, Linda Calvin, and Fred Kuchler, Consumer Response to a Food Safety Shock: The 2006 Food-Borne Illness Outbreak of E. coli O157: H7 Linked to Spinach, *Review of Agricultural Economics*, Vol. 31, No. 4, pp. 734-750, December 2006.

[36] Arnade, Carlos, et al., 2006.

[37] Warnert, Jeannette and Editors., Expanded Research to Target E. Coli Outbreaks, *California Agriculture*, Vol. 61, No. 1, January-March 2007.

Considerations to Support Recovery of Government

Financial Assistance—Government

In the aftermath of a disaster, demand is high for government to provide for those impacted within the community while maintaining services expected under "normal" conditions. This is likely to hold true in a CBR incident as well. Government inspection teams will be needed to assess facilities and areas for contamination. Public health laboratories will need to process an enormous number of samples. Decontamination teams and equipment will be needed to conduct remediation activities. The demand for these resources will far exceed the supply. Federal government, after disaster declaration, will provide many resources and money to support the affected region; and local government will need to communicate and facilitate the coordination of these resources.

In the long-term, state and local governments will face a significantly reduced revenue stream. Decreased property values, sales taxes, and income taxes will require austerity measures or securement of additional sources of revenue. In general, expenditures are reimbursed with little or no money provided up front. Local governments may struggle to find financing to bridge immediate needs and meet long-term reimbursement obligations.

Financing mechanisms are needed to allow state and local governments to continue to function, coordinate the regional recovery effort, and provide basic social services such as education and healthcare to the region.

Considerations to Support Recovery of Infrastructure

Critical Infrastructure/Transportation Restoration

After a wide-area CBR incident, uncertainty will be high regarding the usability of many critical services and functions—potable water, food, and transportation, and medical services, for example—that support the local population and businesses. Many of the operators necessary to run these systems may avoid coming to work—particularly if they fear the infrastructure assets are contaminated. Rapid remediation and public declaration of safety of critical infrastructure assets will help to enable resumption of these services.

Transportation infrastructure should be a major focus because of its importance in the region's economic recovery. Restoration of transportation services not only enables resources to flow into and within the region, but also allows goods and services to flow out and into the national and international marketplace. This impact will certainly be significant for traditional disasters, but may be lessened in a CBR event due to the likely reduction in demand for regional goods.

Due to the limited resources, planners should utilize a transparent, objective, analysis-based process to prioritize infrastructure for restoration. Such a process was described in detail in Section 2 of this document.

Prioritization of "Cornerstone" Industries

In order to bolster economic recovery, "cornerstone" industries central to the region's economy should be identified and

prioritized for restoration. In addition, the critical infrastructure that these industries are dependent upon (e.g., transportation, shipping) should be accounted for. It is worth noting that in many regional economies, it is the export-oriented industries that often drive economic growth.[38]

Rapid restoration of these industries will help to retain the region's population and support smaller businesses that cater to these industries and employee population. Additionally, it is critical to consider the potential economic losses from agricultural infrastructure when prioritizing restoration activities and developing strategies to bolster community resiliency. It is possible to strengthen confidence in the region's recovery if these cornerstone industries are sustained.

Recovery planners should identify these cornerstone industries and provide mechanisms to increase preparedness prior to a wide-area CBR incident.

Considerations to Support Recovery of Environment

Environmental Remediation

The most direct way to recover a region's economy after a wide-area contamination incident is to remediate the environment and limit the spread of contamination. However, due to the significant lack of CBR remediation resources, a wide-area remediation effort may take months to years to complete. Alternative activities to reduce the health risk and limit spreading should be considered, including cordoning off an area and applying fixatives, or demolition and reconstruction.

Economic recovery objectives should be considered when making policy decisions, such as those regarding clearance standards, that drive remediation strategies and activities. For example, clearance standards that seek to eliminate all risk to public health may result in timelines and costs that are unworkable in any practical sense. Strategies to optimize remediation activities should also be pursued. Such strategies include prioritization of environmental areas that are sources for contamination spreading.

In summary, to promote regional economic recovery following a wide-area CBR incident, pre-planning should consider economic recovery, using the discussions above as a guide. Economic recovery plans should seek to identify and develop a set of coordinated actions and measures to support the region's people, businesses, government, infrastructure, and environment. Development and implementation of such plans will enable state and local governments and business leaders to take prompt, coordinated action shortly after the incident, thereby reducing the economic impacts and supporting the return of business activities that result in a sustainable and economically viable community.

[38] Birch, 2006.

4.0 CONCLUSIONS AND RECOMMENDATIONS

Disaster recovery is multi-faceted, and no single formula would apply to every scenario. Areas that have performed pre-planning and that have developed plans that can be adapted to different scenario types will likely be more resilient. Pre-planning can shorten response time, for example, because planners will already understand threat-specific impacts on critical infrastructure sectors, infrastructure dependencies, and infrastructure contribution to restoration objectives. In turn, in nearly every recovery situation, the faster the response, the more quickly populations, businesses, and governments will return in full force to rebuild the region's economy.

The recommendations below summarize the pre-event actions that regional emergency managers and recovery planners can take to support regional economic recovery after a wide-area CBR incident:

- Develop baseline knowledge and record of regional critical infrastructure assets and characteristics, including the following:
    - Asset names and locations
    - Critical services provided by the asset
    - Dependencies
    - Workaround capabilities
    - Milestone requirements
- Develop and exercise prioritization methods and approaches by bringing together emergency planners, business leaders, infrastructure owners, and other private and public stakeholders in neighboring jurisdictions
- Build economic resistance and resiliency into the regional economy
    - A robust economy can help a community to rebound effectively; an already economically depressed region may never recover after an incident
- Develop disaster economic recovery strategies and plans in concert with federal government, local governments, and the private sector:
    - Identify stakeholders and define clear recovery roles
    - Establish communication pathways between the public sector and the private sector
    - Identify incentives to help retain key service providers, employers, and employees
    - Develop temporary and permanent housing solutions
    - Expedite the application process for federal funds
    - Provide greater flexibility in the use of federal funds for increasing local capacity for economic recovery
- Ensure availability of adequate capital for rebuilding, remediation, and recovery
    - Identify mechanisms and negotiate agreements for financing restoration and recovery efforts ahead of time

- Ensure the availability of property and casualty insurance policies from viable insurers
- Consider providing funds for wage subsidy and job training programs to provide immediate-, medium-, and long-term assistance

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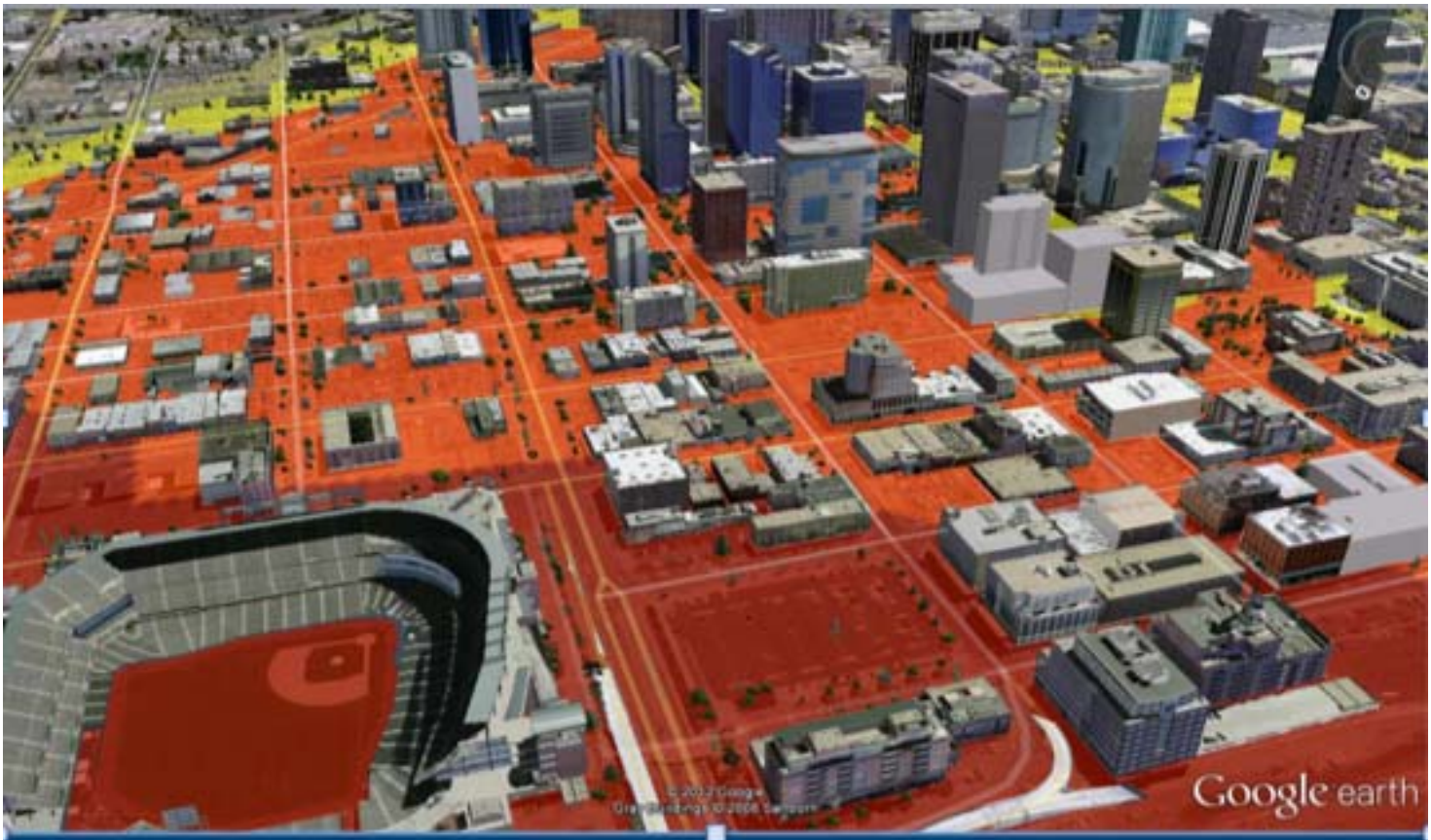

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