



**WHOLE INFRASTRUCTURE SYSTEMS
FOR RESILIENT DEVELOPMENT**

**Session: Changing the Fundamental Approach to Infrastructure for
Resilient Development**

Presented to
Growing Sustainable Communities Conference
Dubuque, Iowa

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October 4, 2016



Reliability

- “Dependable, or trusted”
- The assumption that our infrastructure systems are reliable is built into planning methodology and the frameworks.

Resiliency

- The basic definition of *resiliency* is the ability of a system to perform the same function, or quickly recover, after some adversity or shock.
- ‘Resiliency’ is not a subset of sustainability, but rather a common denominator of all systems.

Sustainability and Livability

- *"... development that meets the needs of the present without compromising the ability of future generations to meet their own needs."*

- Gro Brundtland, "Our Common Future" 1987

- "...meet their own needs" assumes systems are working.
- Does this definition provide any guidance on livability, i.e., aesthetics, community character, and sense of place?

The 3 Different Community Goals

...Definitions and Metrics

Livable

← Aesthetics, diversity, and access to societal systems; Quality of Life indexes

Sustainable

← Equilibrium between environmental, economic, and social equity; long-term perspective

Reliable (normal)
+ Redundant (extreme)
= Resilient Systems

← Well-maintained systems, operating within design life

← Backup systems for protection from external shocks and collocation failure

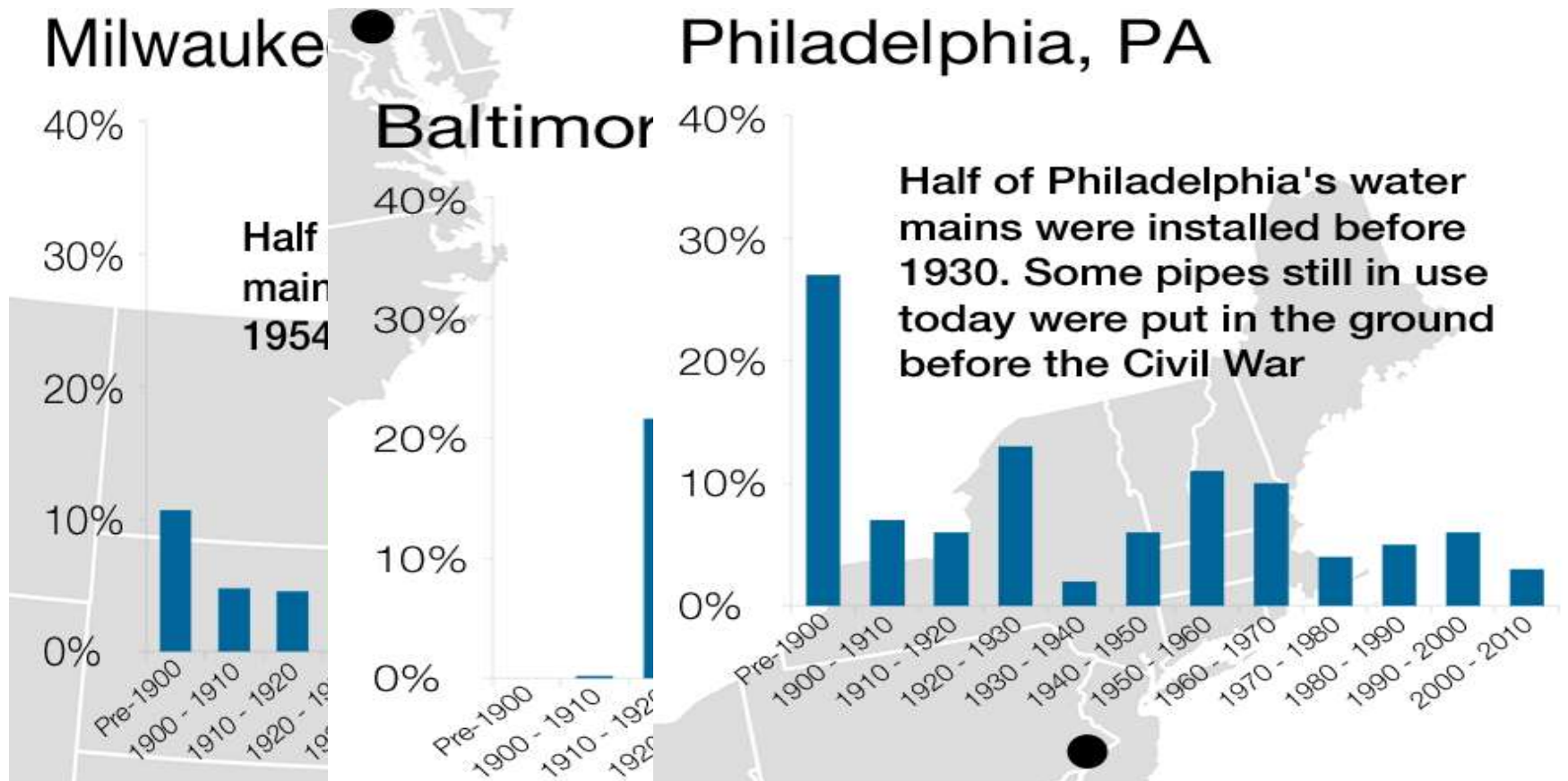
The Dependence on the Built Environment

...How is it being addressed in City Resilience/Sustainability Frameworks?

- City Planners and Managers are faced with numerous frameworks that attempt to guide how cities can be more resilient, sustainable, and livable.
- The built environment is typically a separate category from other systems.
- Without recognizing the dependency of all systems on a working and reliable built environment, these frameworks are only providing partial solutions.

This is “The Replacement Era”

...according to the American Water Works Association



Infographic: The Age of U.S. Drinking Water Pipes — From Civil War Era to Today

<http://www.circleofblue.org/waternews/2016/world/infographic-the-age-of-u-s-drinking-water-pipes-from-civil-war-era-to-today/>

The Current State of U.S. Infrastructure

...according to the American Society of Engineers (ASCE)



<http://www.infrastructurereportcard.org/>

- Primarily due to aging infrastructure
- Onus of investment is on municipal infrastructure
- Represents a “failure of communication”

Aging Infrastructure is NOT a Hazard

...according to the dictionary and FEMA

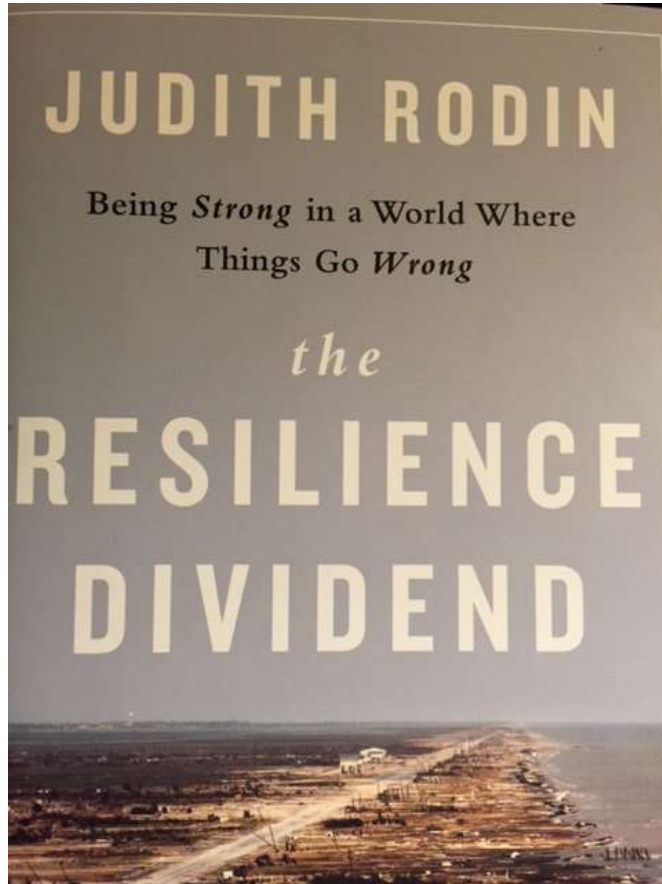
- Dictionary: “an unavoidable danger or risk, even though often foreseeable.”
- FEMA’s guidance for Hazard Mitigation Plans (HMP): addresses
 - natural hazard design events
 - manmade and technological hazards
 - the HMP does NOT require an overview of aging infrastructure



Context for WISRD

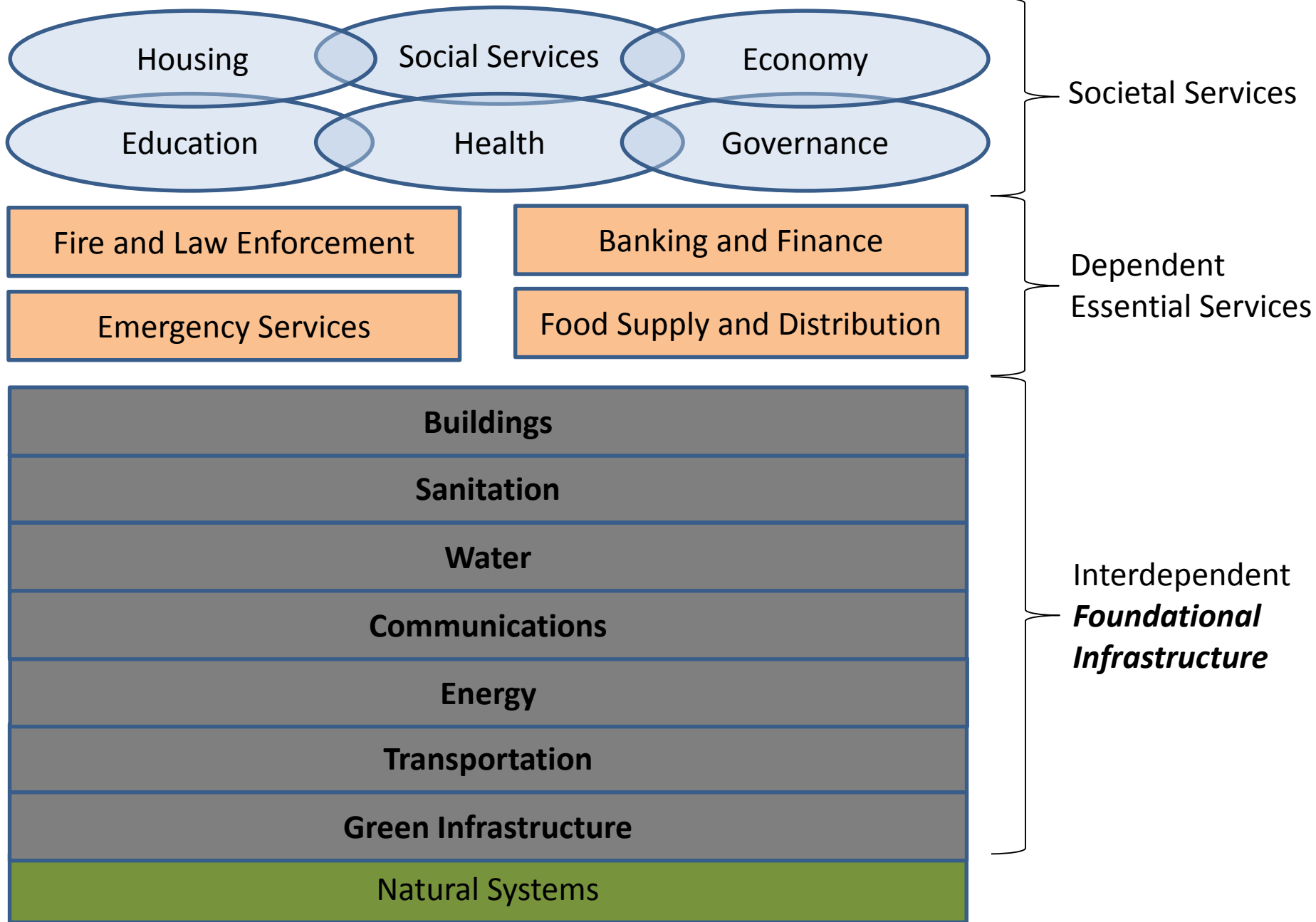
FOUNDATIONAL INFRASTRUCTURE

Resilience...requires a holistic, 'system of systems' perspective



*“Because everything is interconnected – a massive system of systems – **a single disruption often triggers another**, which exacerbates the effects of the first, so that the original shock becomes a **cascade of crises**” (p. 5)*

The Foundational Infrastructure Framework (FIF)



Our Purpose, Product and Outcomes

...The focus of WISRD's work

Purpose

- WISRD's purpose is to help cities increase the resilience of foundational infrastructure systems by conducting comprehensive analyses that create *a vulnerability-based critical path* for prioritizing capital investment projects.

Product

- Built on the Esri ArcGIS platform, WISRD's decision-support software includes proprietary algorithms that use.



esri

Emerging Business
Partner

3 Primary Modes of Infrastructure Failure

1. **Existing Asset Condition:** When deterioration due to age, material type, and lack of maintenance causes failure.
2. **Collocation Risk:** When weak-links between different collocated infrastructure components create an even greater risk of cascading failure.
3. **External Event:** When external events such as natural hazards (e.g., landslides, floods, fires, earthquakes, hurricanes) or acts of terrorism deliver severe shocks to those systems.

1. Infrastructure Failure Due to *Existing Asset Condition*

...Aging, poorly maintained infrastructure, unsafe materials



“We have a quarter-million water mains that break every single year in this country. We waste about 15 percent of our drinking water — about 2 trillion gallons...”

2. Infrastructure Failure Due to *Collocation Risk*

...results in both transportation and electrical system failures

Interstate 5 bridge on the Skagit River

May 24, 2013
Mount Vernon,
Washington, USA



http://www.gannett-cdn.com/-mm-/f40f3606fa7f520417c0c9e02d7aa7a371d004ba/r=x513&c=680x510/local/-/media/USATODAY/USATODAY/2013/05/24/1369404829003-bridge052313-0019-1305241040_4_3.jpg

3. Infrastructure Failure Due to *External Event*

...Natural disasters can significantly damage infrastructure

Hurricane Sandy
East Coast USA
October 2012



<http://www.wbli.com/gallery/weather/hurricanes/images-hurricane-sandy/g568/#2827146>



<http://www.wbli.com/gallery/weather/hurricanes/images-hurricane-sandy/g568/#2832627>

What “*WISRD for Cities*” Provides...

- 1. A new rank order list of the vulnerability of existing infrastructure components based on 3 analyses**
 - Provides an overview of the existing infrastructure conditions and under natural hazards within municipal boundaries
 - Creates the context for cross-departmental information sharing and coordinated maintenance efforts
 - Provides a basis for establishing a formal process of capital investment planning
 - Serves as a baseline for evaluating different investment options to achieve resiliency goals
 - Provides essential information for applying for infrastructure improvement grants

What “*WISRD for Cities*” Provides...

2. Ease of Analysis and GIS Maps

- City staff can update when new projects are online to reevaluate priorities and show individual infrastructure sector assets and vulnerability levels

3. Executive Dashboard

- Allows leaders to view the status of infrastructure inventory at any time

What “*WISRD for Cities*” Provides...

4. **City Infrastructure Resiliency Score** for existing condition of municipal infrastructure assets. Working from a whole infrastructure system dependency framework, this score provides:
 - A meaningful measure of current infrastructure resilience levels by Sector and City
 - A simple way to communicate the value of infrastructure investments to stakeholders
 - A way to measure improvements in municipal infrastructure systems over time

Currently and Upcoming

...Building the cart, then finding the horse...

- Manitou Springs, CO. – free pilot
 - FEMA/DOLA
 - HMP/Planning
 - Intended to integrate with formal CIP process
- Next free pilot?
 - Starting January 1, 2017
- Demo video on
- <http://www.wisrd.com/our-products-services/>

Thank you



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