

# **Critical Infrastructure Dependencies**

Prepared for

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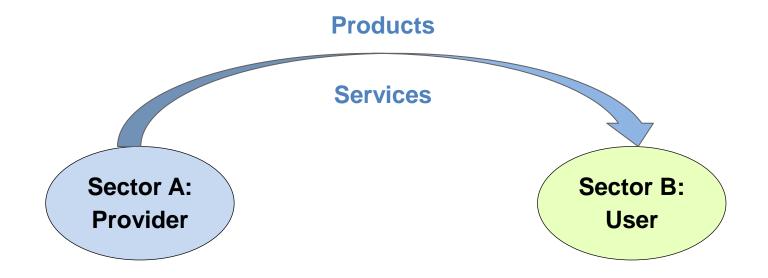


#### **Critical Infrastructure Dependency**

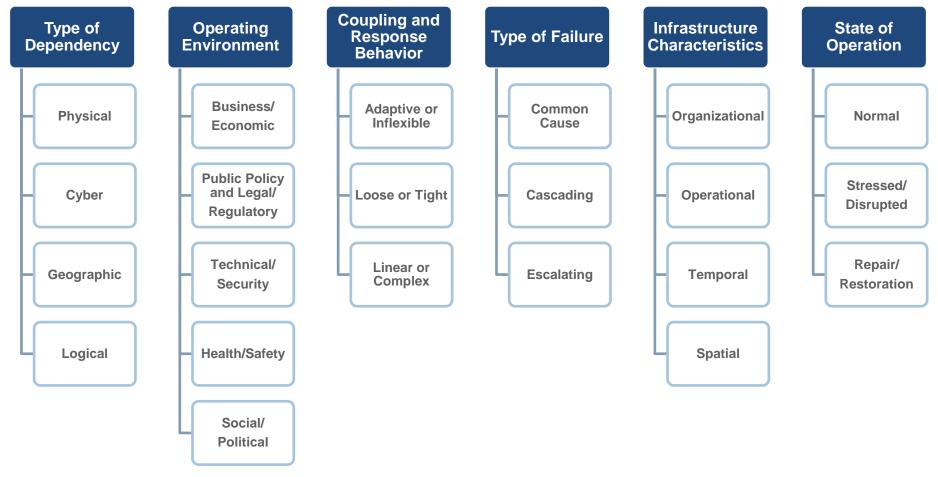


## **Critical Infrastructure Dependency**

 linkage or connection between two infrastructures, by which the state of one infrastructure influences or is reliant upon the state of the other



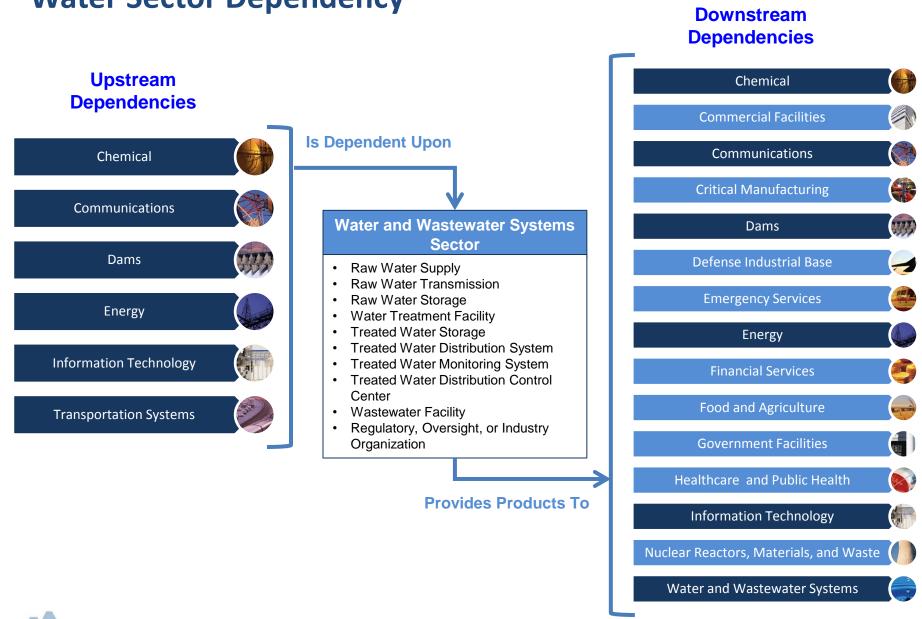
## **Dimensions of Dependencies**



(Adapted from Rinaldi, Peerenboom, and Kelly, 2001)

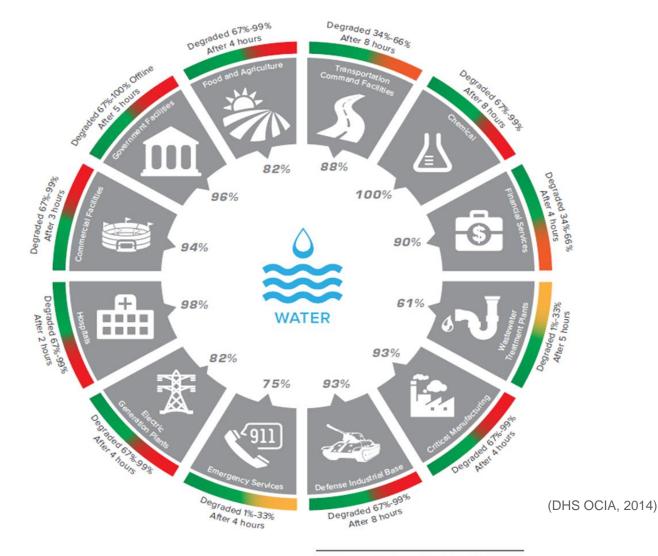
## **Sector Dependency Matrix**

		SUPPORTING SECTOR														
SECTOR OF	CHEMICAL	COMMRERCIAL EAC.	COMMUNICAT	Carrions Manuecol	DAnac	DEFENSE INDUSTRIA.	EMERGENCY SERVICE	ENERGY	FINANCIALSERVICE	FOOD AND AGRICUTT	GOVERNIMENT FACUL	HEALTHCARE AND PUBLIC HEALTHCARE AND PUBLIC	INFORMATION	NUCLEAR REACTORS	TRANSPORTATION SYSTER	WATER AND WASTEWATER SYSTEMS
CHEMICAL									1							
COMMERCIAL FACILITIES																
COMMUNICATIONS																
CRITICAL MANUFACTURING							8		57. 57.		5			5 0		
DAMS														2		
DEFENSE IN DUSTRIAL BASE														2		
EMERGENCY SERVICES																
ENERGY			2	4	-						2		1			
FINANCIAL SERVICES			2		-	2					×.	-				
FOODANDAGRICULTURE			2		19	2	- 23	x								
GOVERNMENTFACILITIES														2		
HEALTHCARE AND PUBLIC HEALTH																
INFORMATION TECHNOLOGY																
NUCLEAR REACTORS, MATERIALS, AND WASTE																
TRANSPORTATION SYSTEMS																
WATER AND WASTEWATER SYSTEMS																

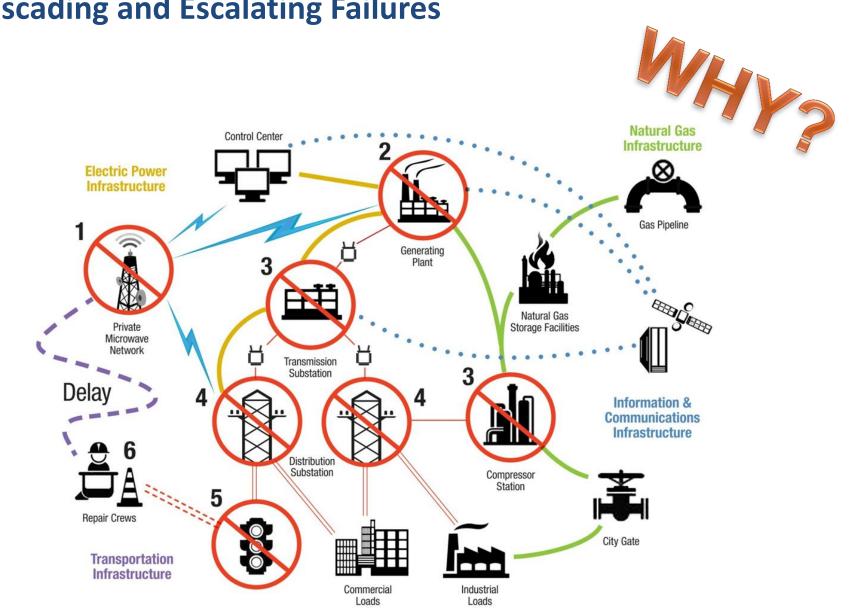


#### Water Sector Dependency

#### Water Facility Dependency



% of surveyed facilities dependent upon water



#### **Cascading and Escalating Failures**

## **Critical Infrastructure Dependencies and Risk**



# **Critical Infrastructure Dependency**

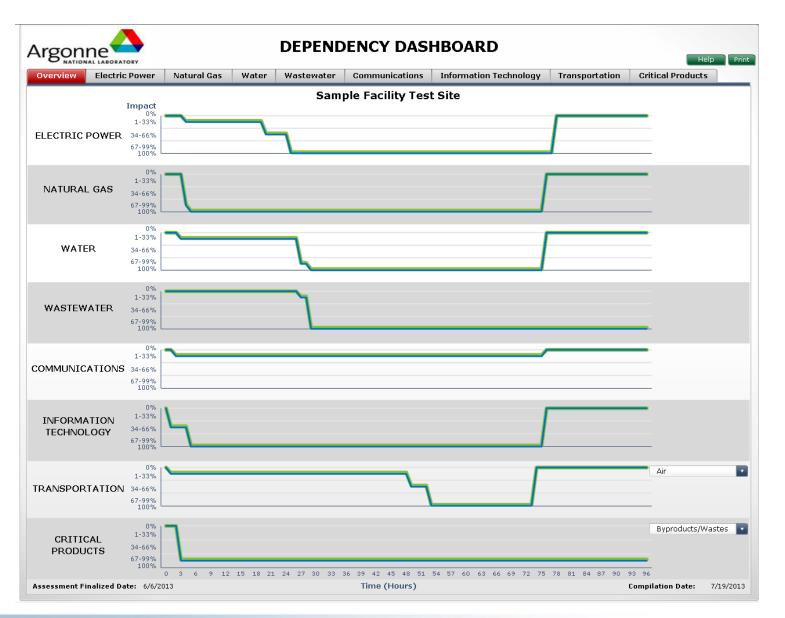
- Typical approaches
  - Top-Down
  - Bottom-Up



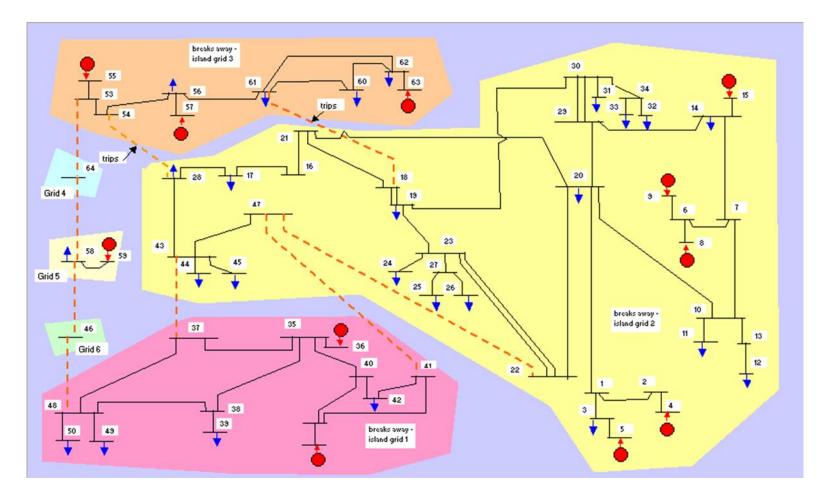
# **Dependency Curves Dashboard**

Argonne DEPENDENCY DASHBOARD													
Overview	Electric Power	Natural Gas	Water	Wastewater	Communicat	tions	s Information Technology Transportation Critical Products						
Impact 0% 🗖			2										
1-33% 34-66%							Existin	g					
67-99%			7			Scenario							
100% 0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48 51 54 57 60 63 66 69 72 75 78 81 84 87 90 93 96													
Time (Hours)  Is external water required for the Facility core operations (e.g., produce key services/goods)? No OYes													
Is ex	ternal water require	d for the Facility	y core oper	rations (e.g., prod	luce key servi	ices/g	/goods)? No OYes						
	If the external water alternative mode), he (hours)					Once external water service is lost (without considering any backup or alternative mode), what percentage of normal business functions are lost or degraded?							
	<b>-</b>				2.00		1-33%						
2.00 0 96						34-66%							
	Is there an alternate	to the external s	ource of wa	ter?		<b>0</b> 67-99%							
	No					100% (Offline)							
	Yes												
	_												
		- ( a) ! b				Are there external regulations/policies that mandate the facility shut down after loss of water including backup?							
	What is the duration				60.00	No							
(	) ' ' '   ' ' '   ' .		1.1.1	96	00.00	ΟY	Yes						
	Once external water	service is lost (a	nd consideri	ing vour backup or		After how long? (hours)							
Once external water service is lost (and considering your backup or alternative mode), what percentage of normal business functions are lost or degraded?							0 96 I.SO						
	None												
	0 1-33%					Once external service is restored, how long would it take before full resumption of operations? (hours)							
	34-66%												
	67-99%												
	100% (Offline)												
								2					

## **Dependency Curves Dashboard (Cont'd)**

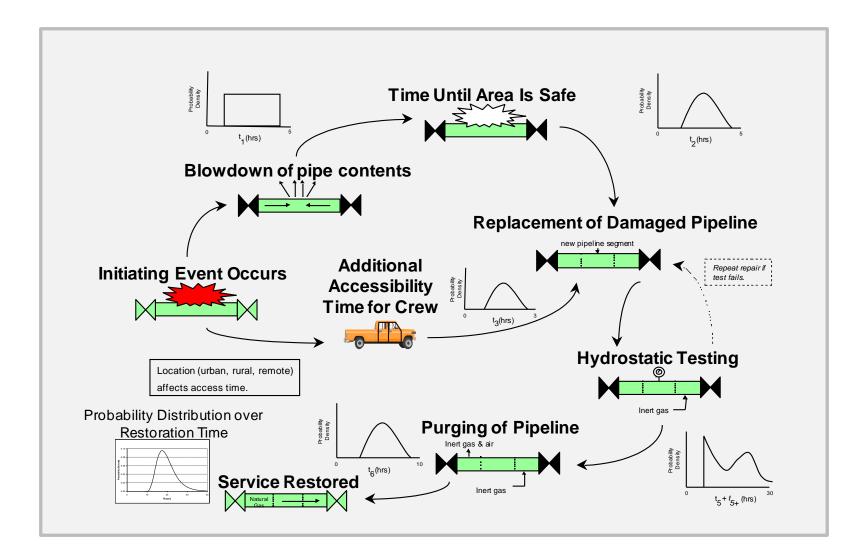


# **Critical Infrastructure Resilience**



(Portante et al., 2011)

# **Critical Infrastructure Resilience**



#### **Summary**

## <u>WHAT</u>

Dependencies are complex and multi-dimensional

# WHY

- Infrastructure dependencies should be factored into risk decisions protection/resilience
- Assessment of interdependencies

### HOW

- There is no one solution to analyzing dependencies
- Dependencies constitute a growing research area with great need for enhanced capability and innovation