DESIGNING FOR RESILIENCE WITH THE

B3 GUIDELINES

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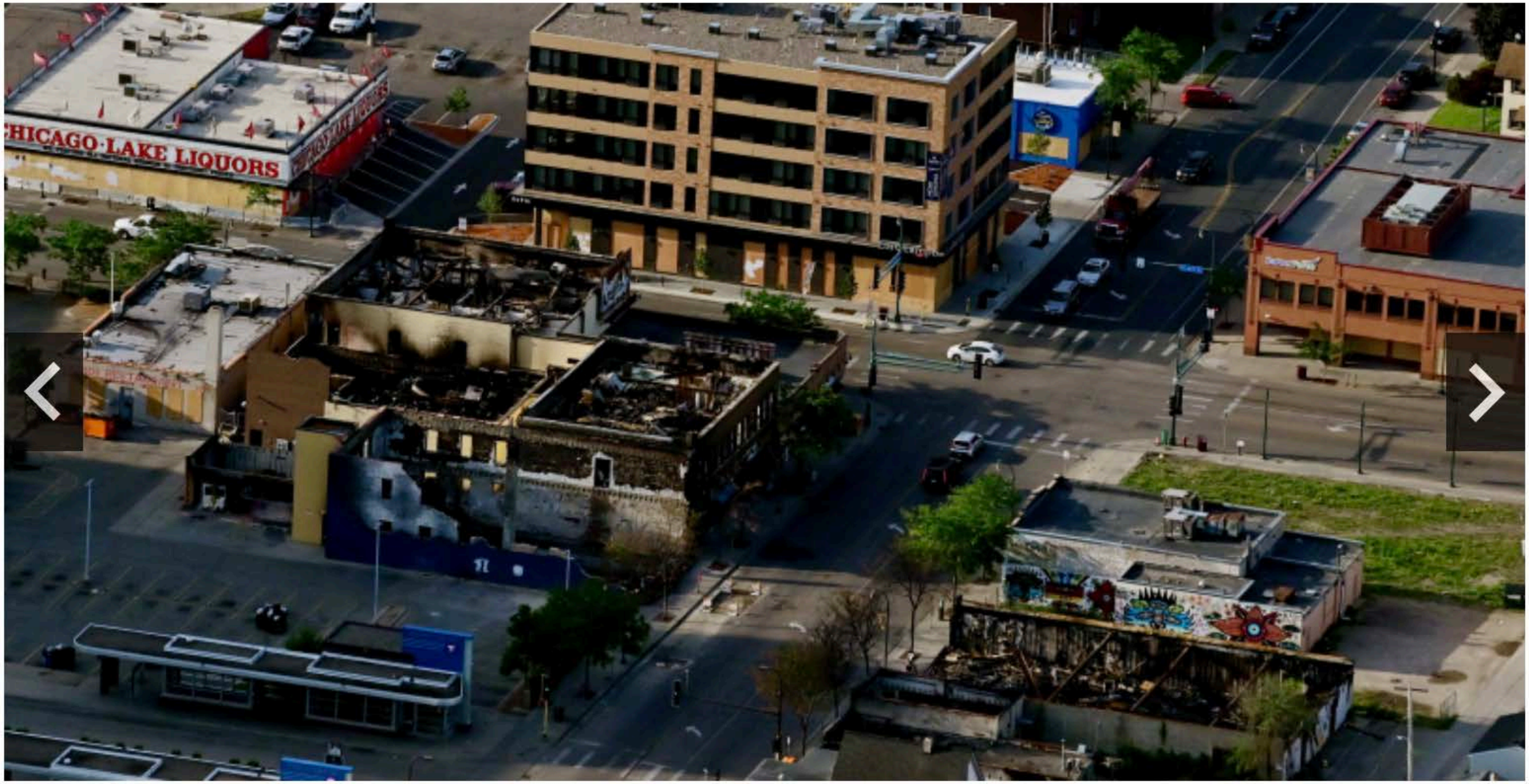
WHAT IS RESILIENCE?

Weeks after Tesla founder Elon Musk and Gov. Ricardo Rossello spoke about the tech company aiding Puerto Rico, Tesla says it has restored electricity to a children's hospital, using solar energy and batteries.

Tesla

WHAT IS RESILIENCE?



3 of 7

An aerial photo of burned buildings at the intersection of Lake St. and Chicago Ave. in Minneapolis on Tuesday, June 9, 2020. (John Autey / Pioneer Press)

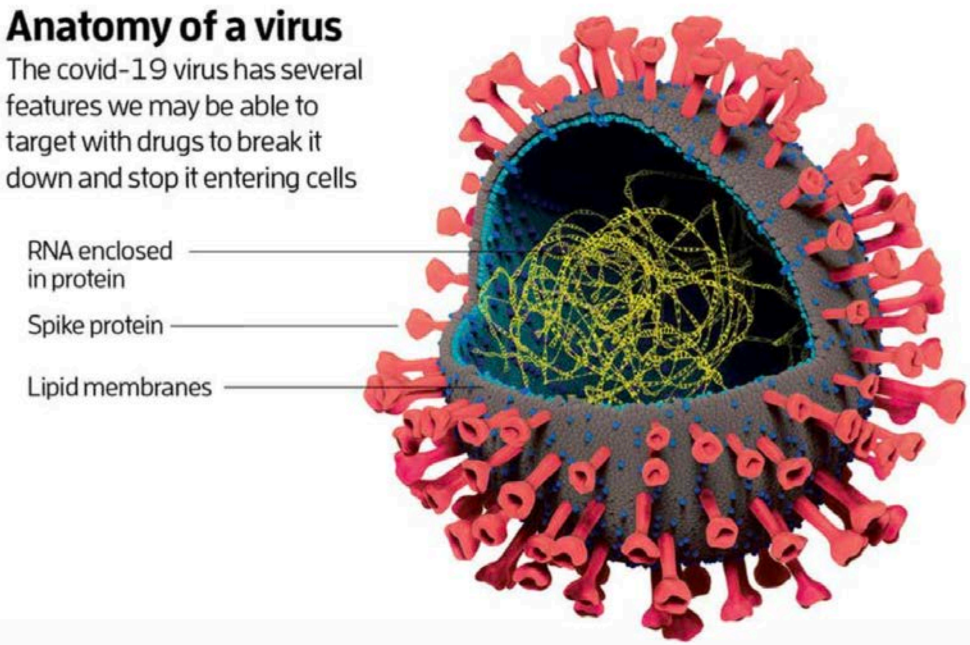
WHAT IS RESILIENCE?

We're beginning to understand the biology of the covid-19 virus

Scientists are working around the clock to understand the biology of the covid-19 virus and how it infects human cells, which will help us design treatments to stop it

HEALTH 19 March 2020

By **Michael Marshall**



WHAT IS RESILIENCE?

Photo by: Justin Sullivan

WHAT IS RESILIENCE?

Resilience is the capacity to deal with change and continue to develop.

Social-ecological systems are linked systems of people and nature. The term emphasizes that humans must be seen as a part of, not apart from, nature — that the delineation between social and ecological systems is artificial and arbitrary. Scholars have also used concepts like ‘coupled human-environment systems´, ‘ecosocial systems´ and ‘socioecological systems´ to illustrate the interplay between social and ecological systems. The term social-ecological system was coined by Fikret Berkes and Carl Folke in 1998 because they did not want to treat the social or ecological dimension as a prefix, but rather give the two same weight during their analysis.

Ecosystem resilience is a measure of how much disturbance (like storms, fire or pollutants) an ecosystem can handle without shifting into a qualitatively different state. It is the capacity of a system to both withstand shocks and surprises and to rebuild itself if damaged.

Social resilience is the ability of human communities to withstand and recover from stresses, such as environmental change or social, economic or political upheaval. Resilience in societies and their life-supporting ecosystems is crucial in maintaining options for future human development.

WHAT IS RESILIENCE?

Vulnerability refers to the propensity of social and ecological systems to suffer harm from exposure to external stresses and shocks. Research on vulnerability can, for example, assess how large the risk is that people and ecosystems will be affected by climate changes and how sensitive they will be to such changes. Vulnerability is often denoted the antonym of resilience.

Anthropocene is a term coined in 2000 by the Nobel Prize winning scientist Paul Crutzen. It describes the most recent period in the Earth's history, starting in the 18th century, when the activities of humans first began to have a significant global impact on the Earth's climate and ecosystems.

MINNESOTA SUSTAINABLE BUILDING 2030

CASE STUDY METRICS – www.casestudies.b3mn.org


Bear Head Lake State Park


Hennepin County 911 Facility


BSU Decker Hall Renovation


MnSCU Mankato Clinical Sciences Building


Hamline Station


Tettegouche Visitor Center and Rest Area


Western U Plaza

Kendall's Payne Avenue Hardware


Big Bog State Recreation Area


Minnesota National Guard Winona Armory Renovation


MSU Science Education Building


NHCC Biosciences and Health Careers Center

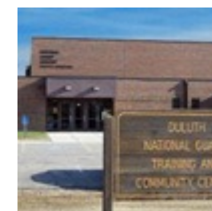

NCC Academic Partnership Center


SCC Classroom Renovation and Addition


UMM Green Living and Learning Community


BSU Memorial Hall Renovation


Camp Ripley COE Training Facility



Duluth Armory


Maplewood Mall Parking Structure


PTC Entrepreneurship Center and Business Incubator

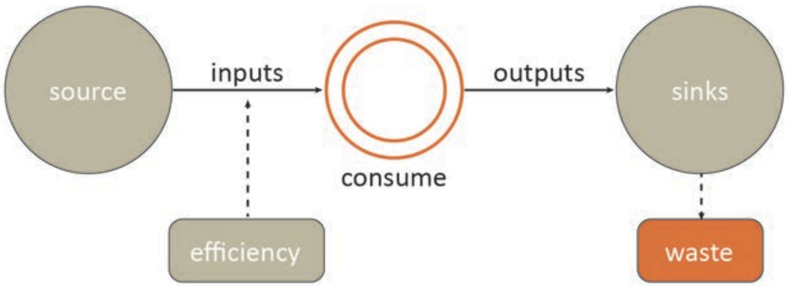

Washburn Center for Children


STCC Medium Heavy Truck and Auto Body

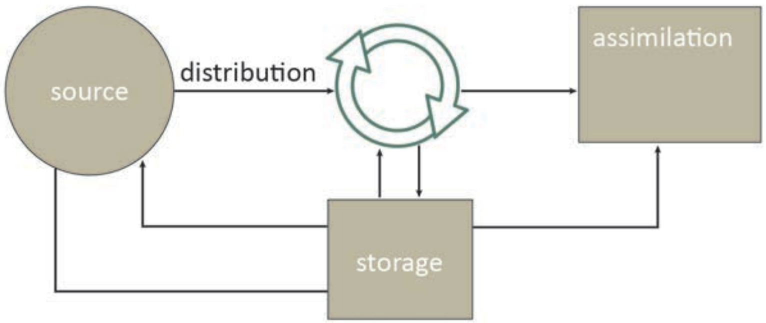

Duluth Entertainment and Convention Center


Silver Creek Corner

System Design



- Efficiency as end goal
- Degenerative linear flows



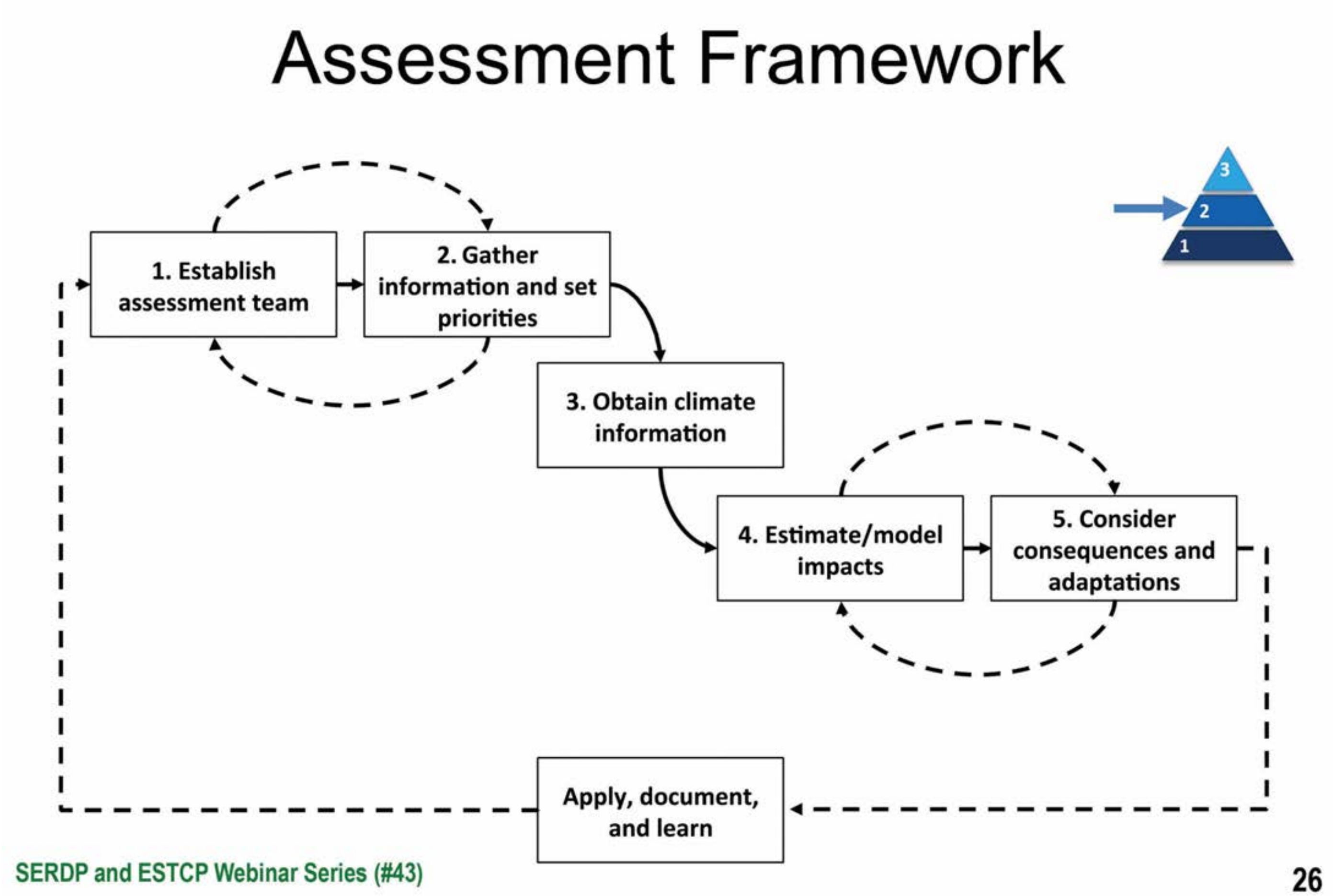
- Effectiveness as end goal
- Within renewal capacity
- Integrate with natural processes
- Symbiosis
- Closed-loop system
- Multiple pathways

Existing

Regenerative

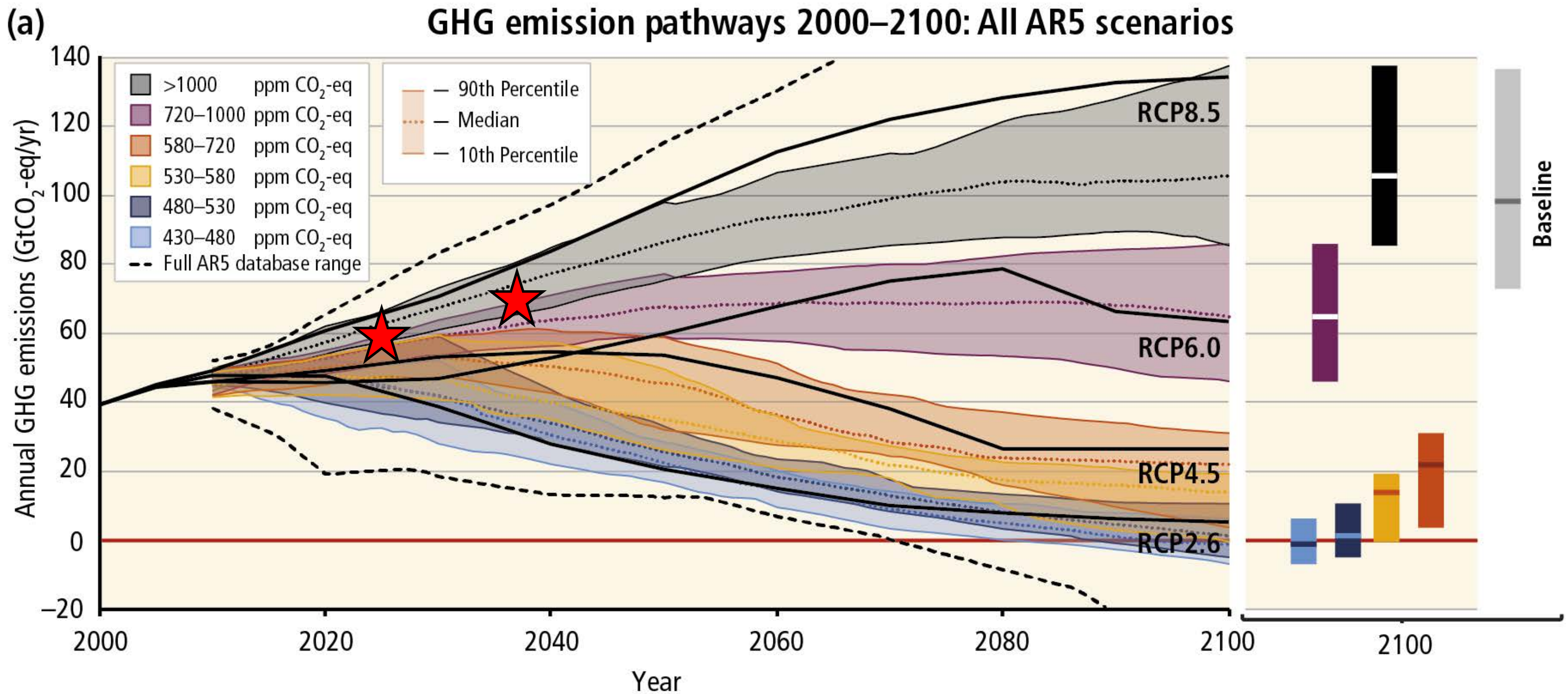
John Tillman Lyle, Regenerative Design for Sustainable Development, 1994

Vulnerability Assessment Framework



SERDP and ESTCP Webinar Series, Vulnerability Assessments and Resilience Planning at Federal Sites, 2016
Strategic Environmental Research and Development Program (SERDP), Environmental Security Technology Certification Program (ESTCP)

Future Weather Files

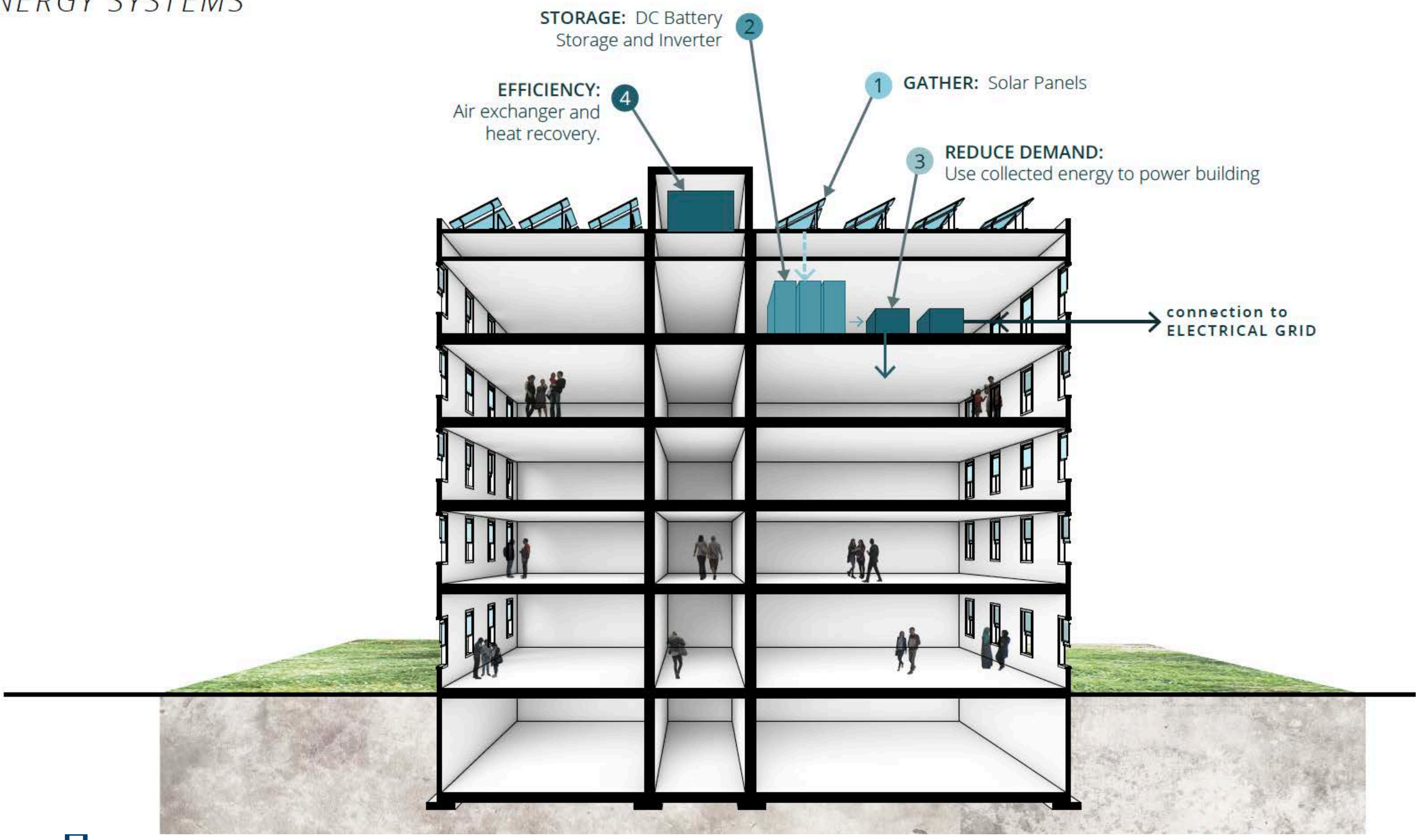


Intergovernmental Panel on Climate Change, Fifth Assessment Report. 2014

- Morphed weather files for the Minneapolis / Saint Paul Area
- Future performance analyzed using RCP 8.5, 50th percentile

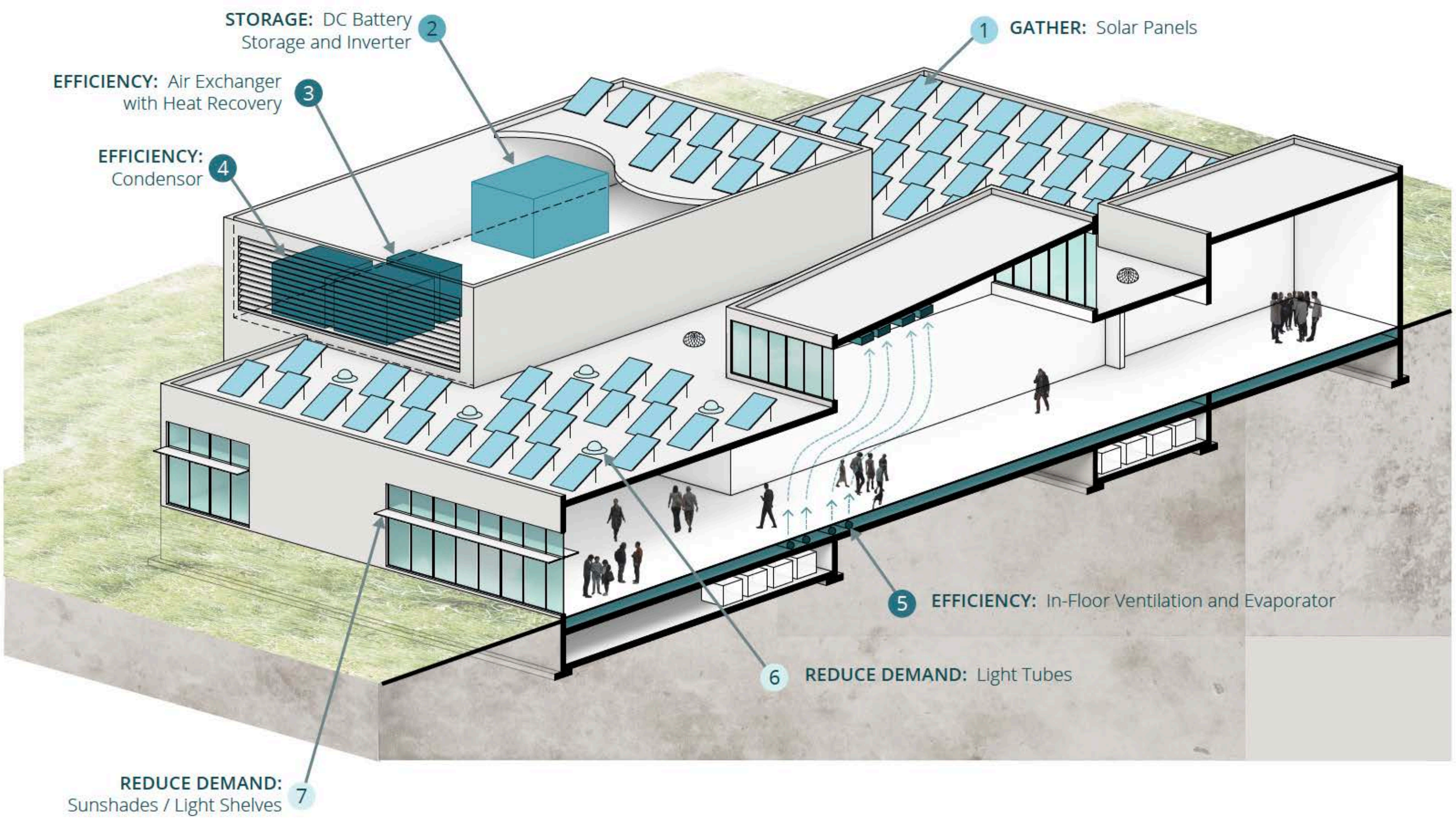
Prototype: Multi-Family Residential: “Shelter in Place”

ENERGY SYSTEMS

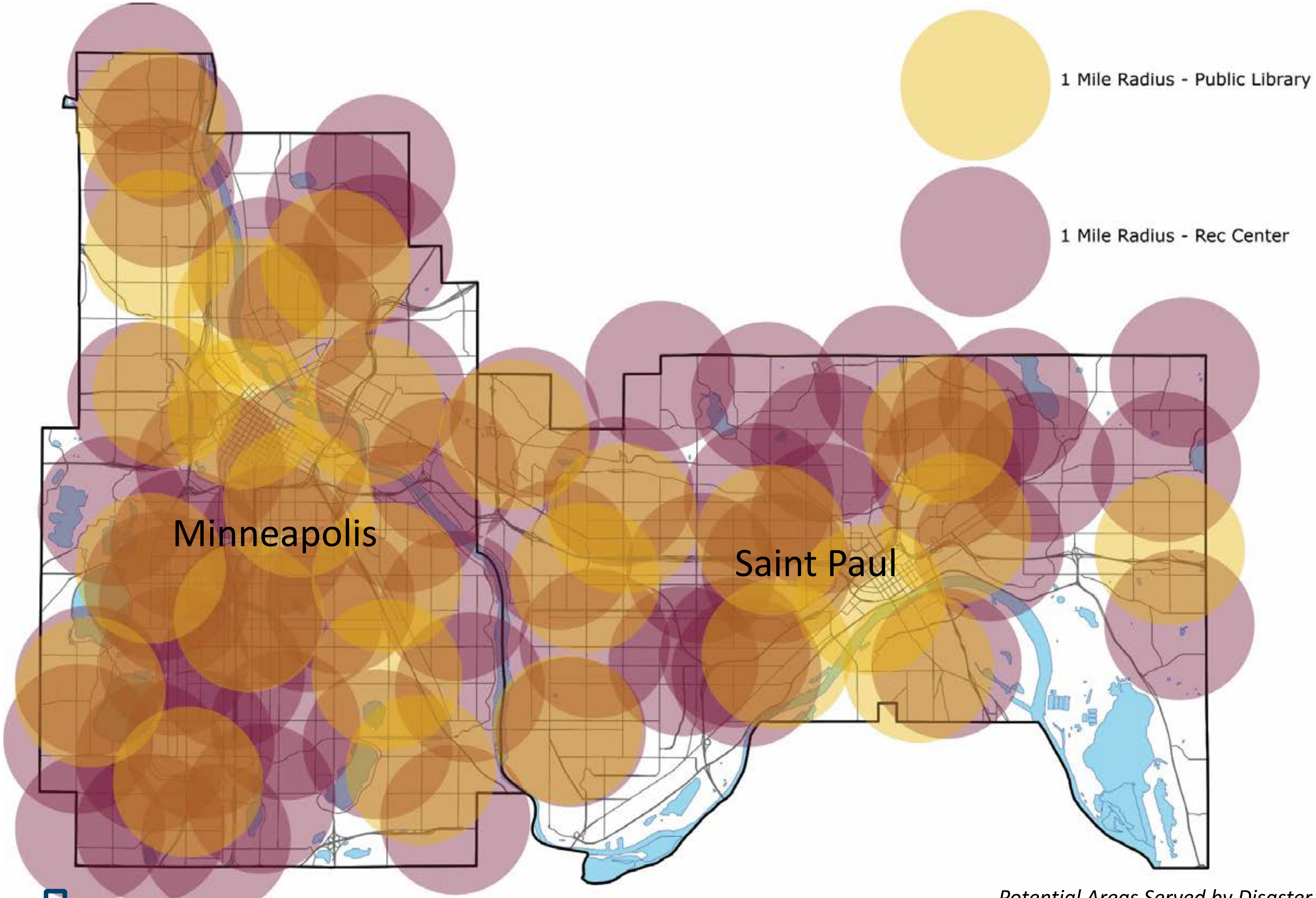


Prototype: Library: "Resilience Hub"

ENERGY SYSTEMS



Prototype: Library



Potential Areas Served by Disaster Hubs

Prototype: Library

Library can support approximately 550 people in 'hub mode'

- Roughly 10% of population living within ½ mile
- Statistically will include:
  - 64 people with a disability
  - 125 people living within 150% of poverty line
  - 42 children under age 5
  - 52 people over age 65

Potential Population Served by Disaster Hubs
American Community Survey, 2015

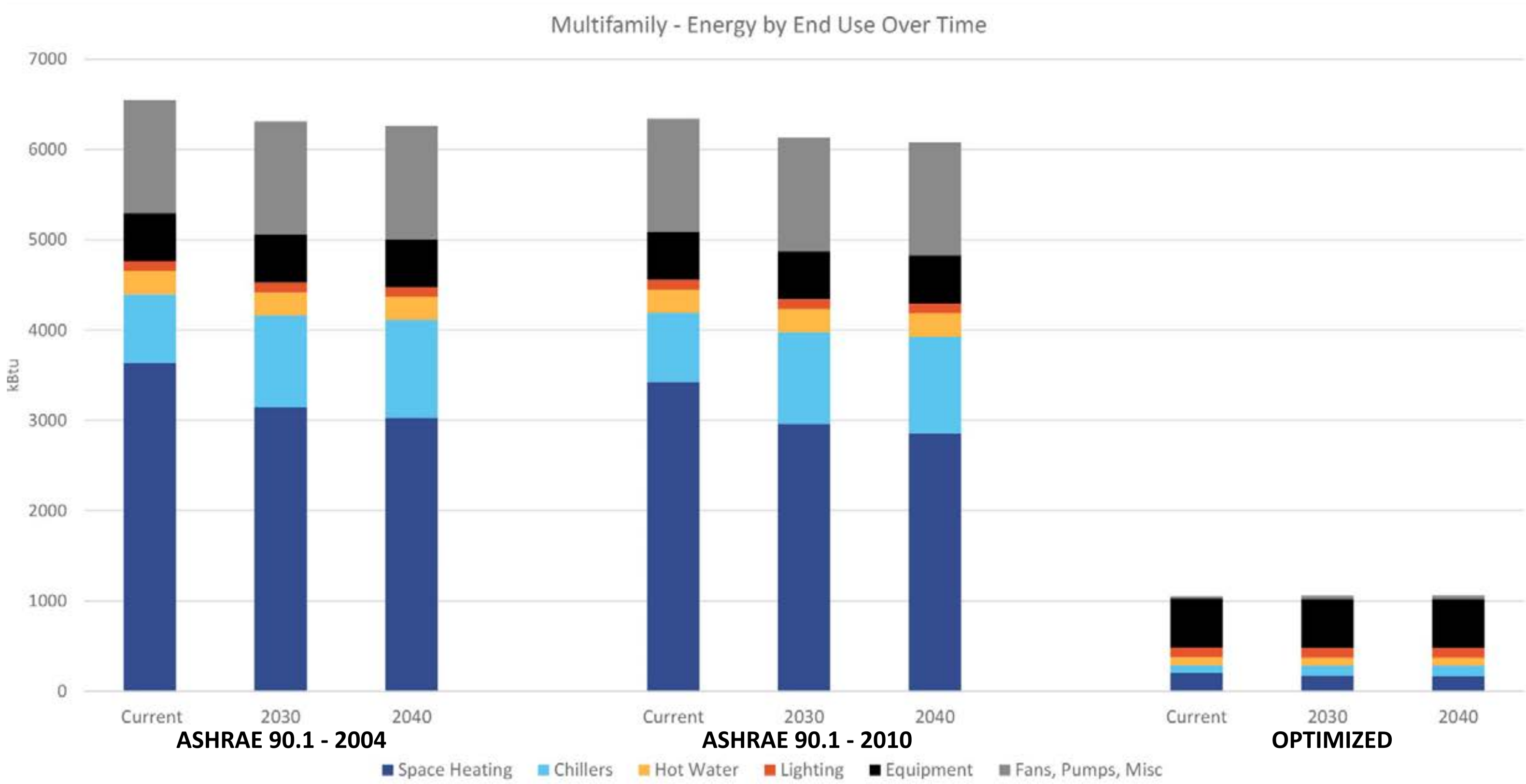
Future Weather Files

Strategy	Hours: Actual and Percentage					
	Now		2030		2040	
Comfort	942	11%	885	10%	936	11%
Sun Shading of Windows	586	7%	778	9%	817	9%
High Thermal Mass	154	2%	217	2%	240	3%
High Thermal Mass Night Flushed	154	2%	228	3%	256	3%
Direct Evaporative Cooling	109	1%	179	2%	198	2%
Two-Stage Evaporative Cooling	111	1%	192	2%	216	2%
Natural Ventilation Cooling	104	1%	162	2%	170	2%
Fan-Forced Ventilation Cooling	72	1%	104	1%	106	1%
Internal Heat Gain	1589	18%	1353	15%	1361	16%
Passive Solar Direct Gain Low Mass	899	10%	826	9%	796	9%
Passive Solar Direct Gain High Mass	624	7%	559	6%	539	6%
Wind Protection of Outdoor Spaces	259	3%	254	3%	249	3%
Humidification Only	0	0%	0	0%	0	0%
Dehumidification Only	491	6%	659	8%	692	8%
Cooling, add dehumidification if needed	305	3%	549	6%	604	7%
Heating, add humidification if needed	4791	55%	4545	52%	4436	51%

Predicted Effectiveness of Comfort Strategies for Minneapolis / Saint Paul – Climate Consultant, UCLA Energy Design Tools Group

Future Weather Files

- Energy use in code buildings decreases over time
- Increase in cooling load is outweighed by decrease in heating loads
- Energy use in high performing buildings stable over time



Future Weather Files

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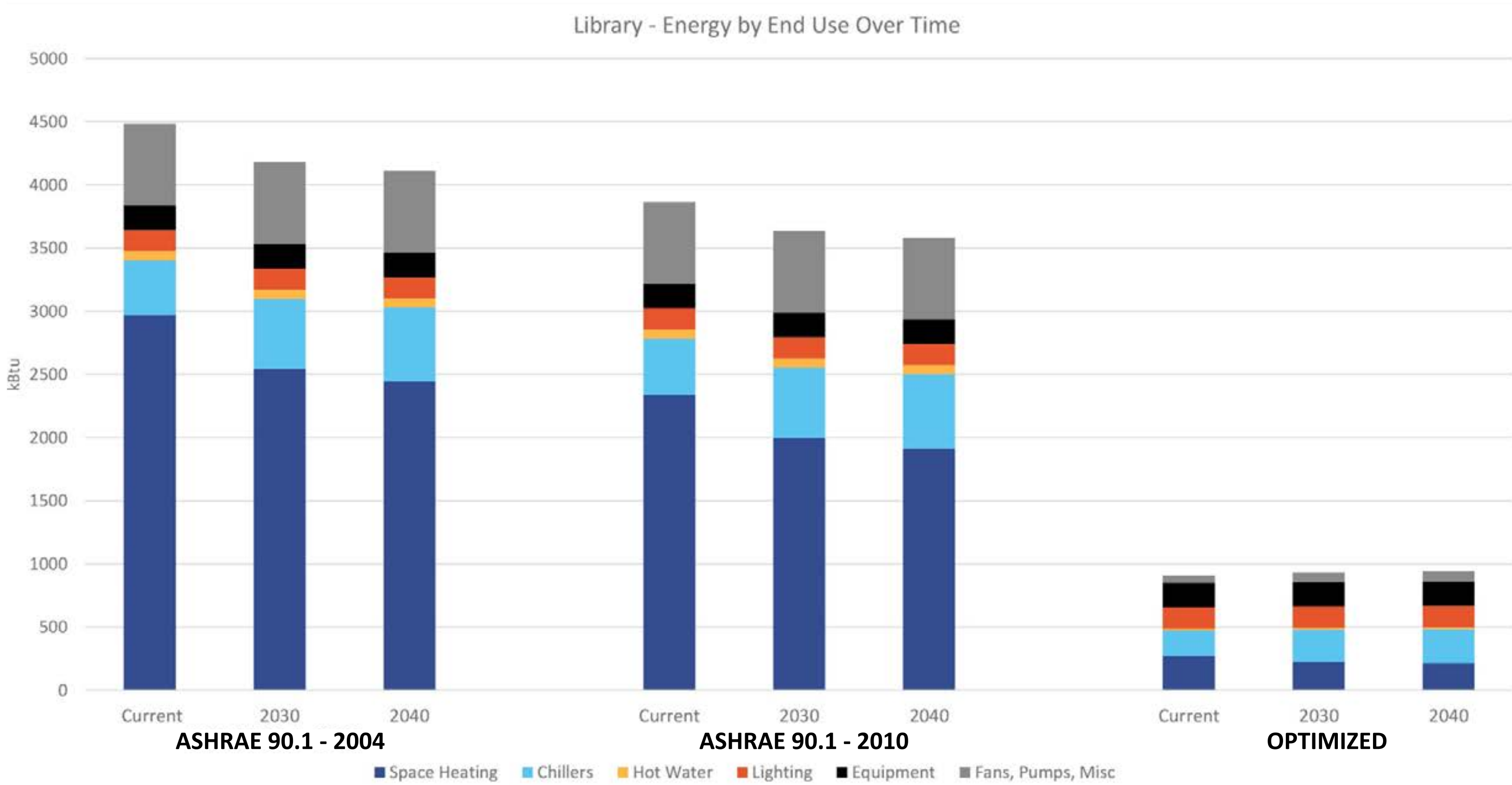
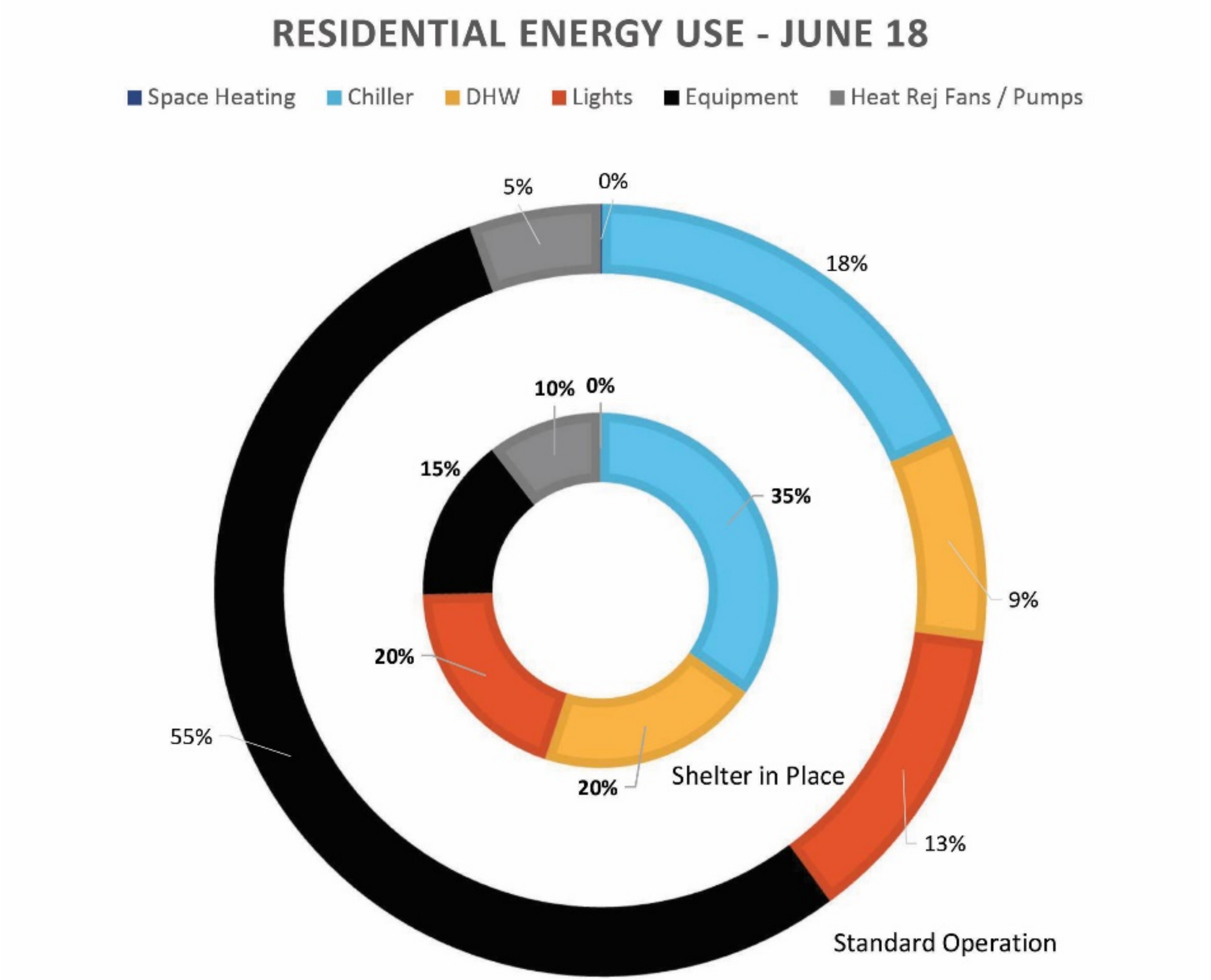
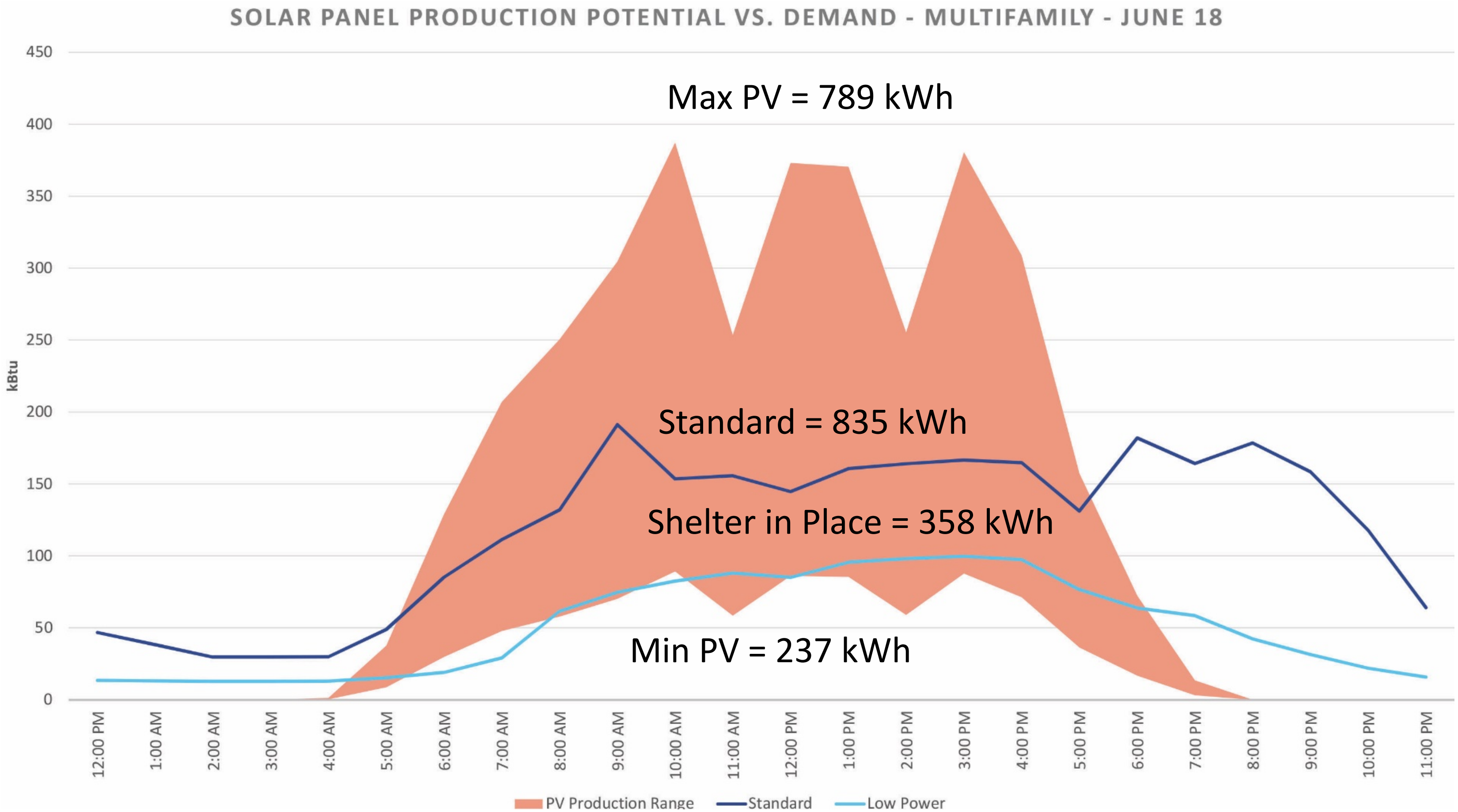


Prototype: Multi-Family Residential



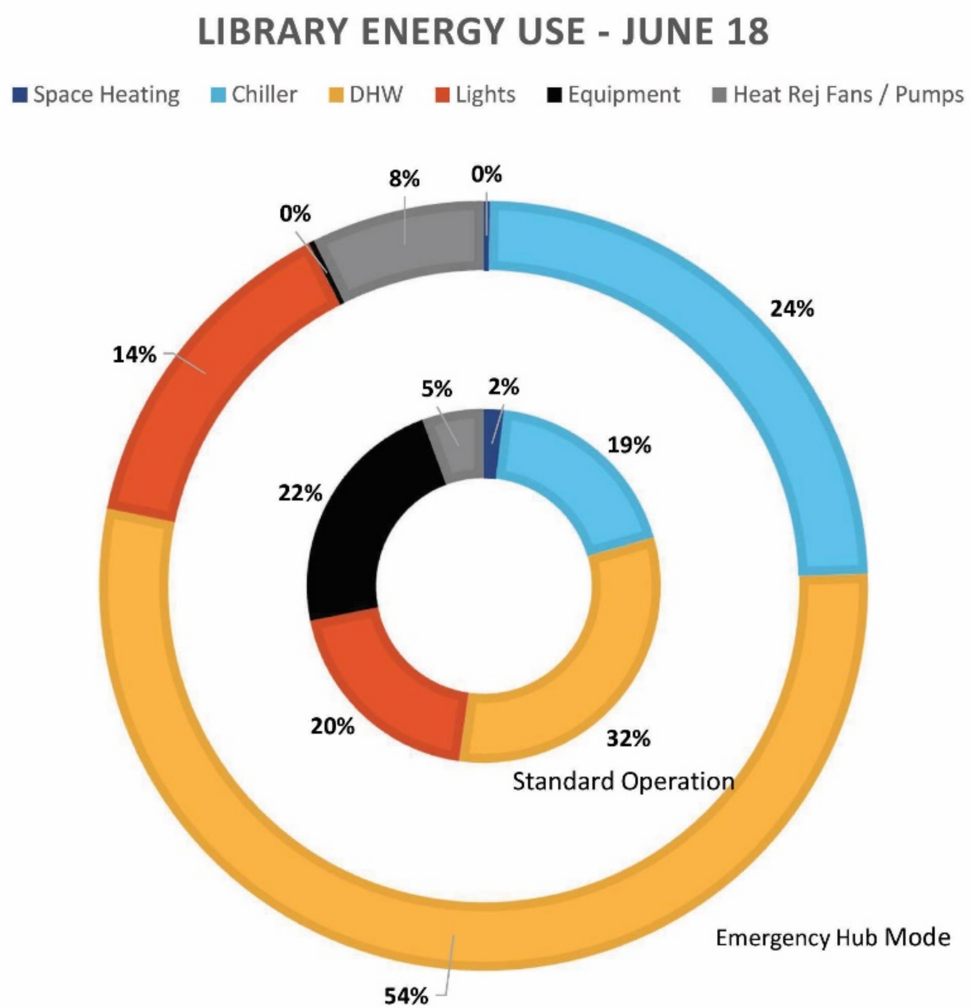
Simulated Energy Use during Standard Operation and Shelter in Place Operation. Energy Modeled in IES-VE 2015

Prototype: Multi-Family Residential



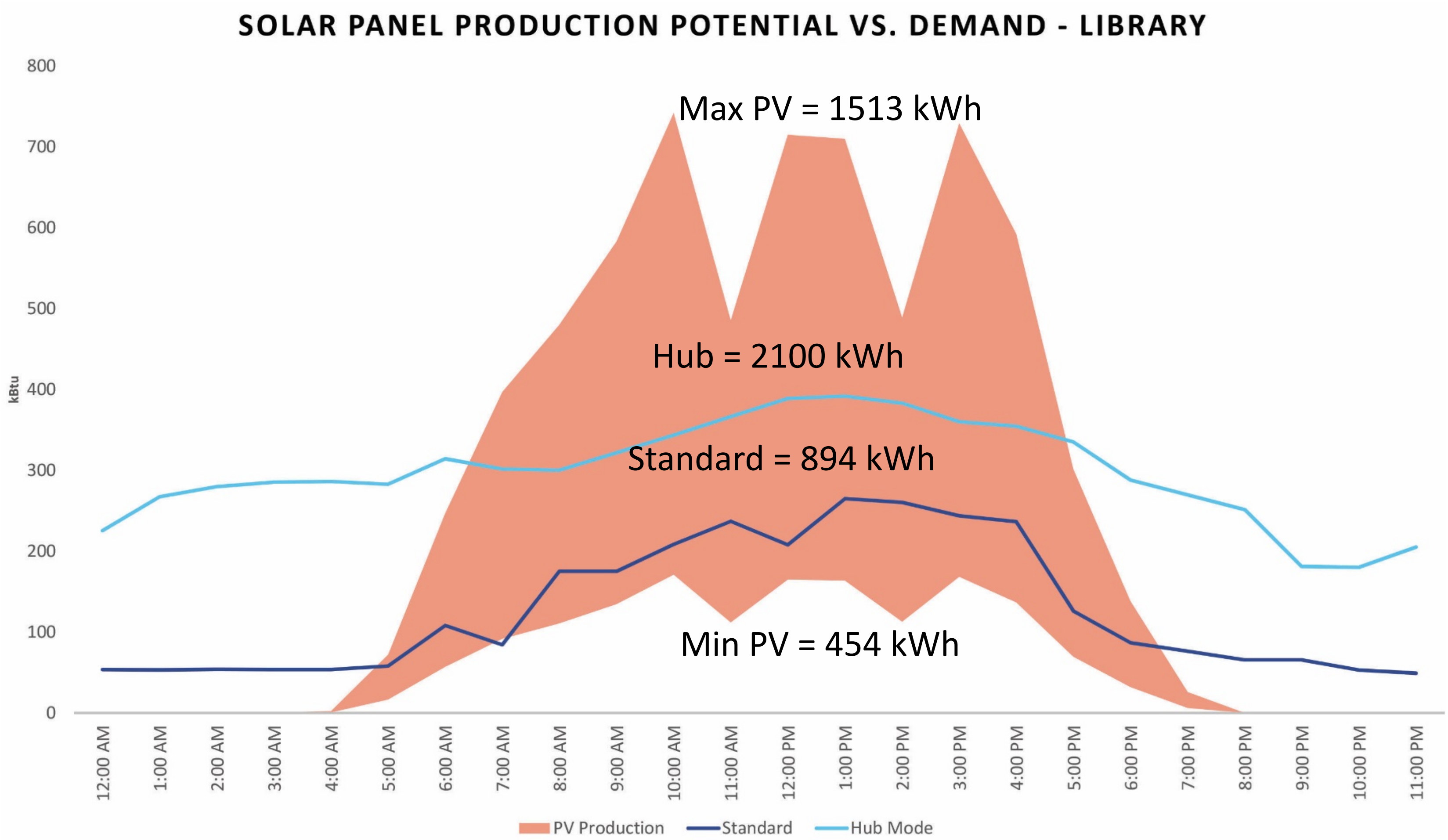
Predicted PV Production and Predicted Energy Use. Energy Modeled in IES-VE 2015, PV data from NREL PVWatts

Prototype: Library



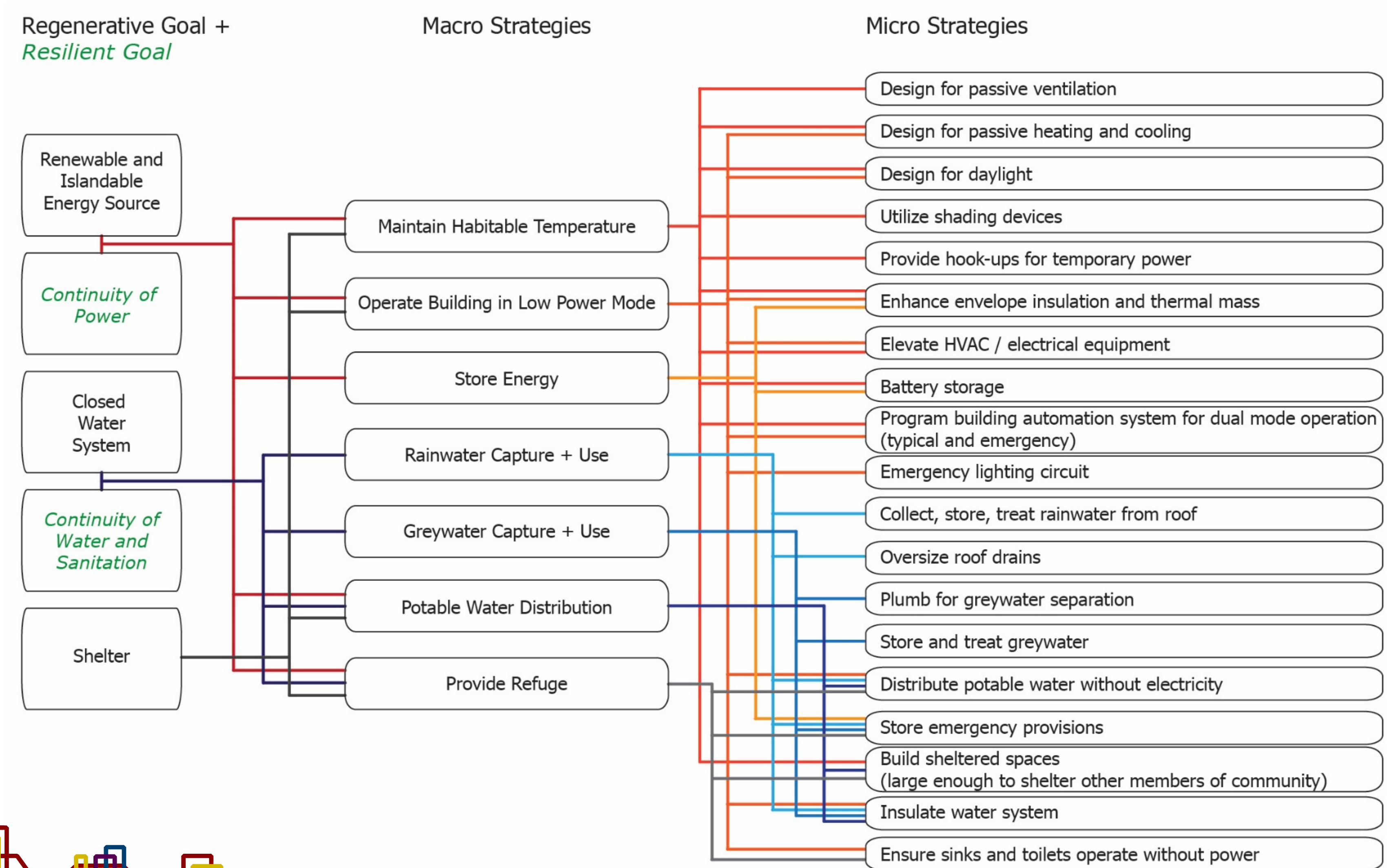
Simulated Energy Use during Standard Operation and Disaster Hub Operation. Energy Modeled in IES-VE 2015

Prototype: Library



Predicted PV Production and Predicted Energy Use. Energy Modeled in IES-VE 2015, PV data from NREL PVWatts

Regenerative and Resilient Design Strategies



B3 RESILIENCE GUIDELINES

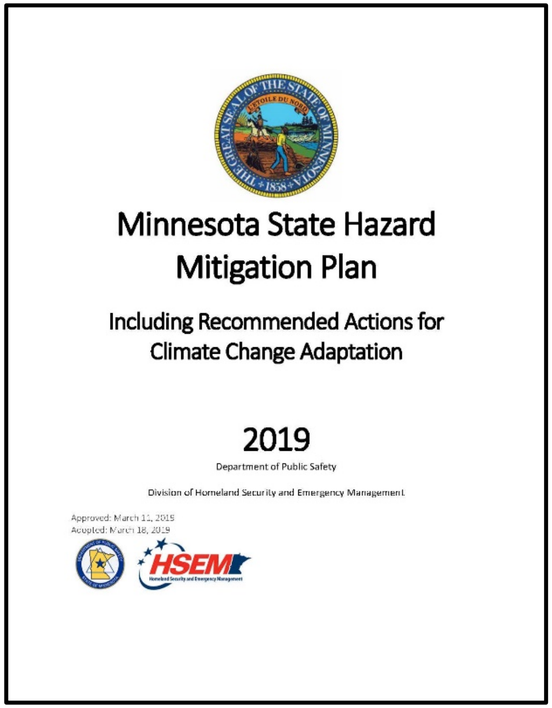
Liz Kutschke, Center for Sustainable Building Research

NEW B3 GUIDELINE

- New guideline added to Performance Management section
- Project teams will complete a vulnerability and capacity assessment using the B3 Resilience Tool
- Project teams will implement at least one resilient design strategy based on vulnerability and capacity assessment

B3 RESILIENCE TOOL

- Excel worksheet tool
- County level data, sourced from Minnesota State Hazard Mitigation Plan, 2019
- Natural hazards and human-made hazards
- System assessment and goal setting
- Resilient design strategy bank


Minnesota State Hazard Mitigation Plan

Including Recommended Actions for Climate Change Adaptation

2019

Department of Public Safety

Division of Homeland Security and Emergency Management

Approved: March 11, 2019

Accepted: March 18, 2019

B3 RESILIENCE TOOL – VULNERABILITY ASSESSMENT

KEY:

Blue	Blue highlighted areas show constants or outputs calculated by the spreadsheet
Yellow	Yellow highlighted areas show required inputs
Dark yellow	Dark yellow highlighted areas show required inputs with a drop-down selection
Grey	Grey highlighted areas will remain blank

Step 1

Project Address:

Project County (select from dropdown):

Hazard Mitigation / Management Plan Status | (Approved, Draft, Pending, or Expired) | PDF Available?

Step 2 | **Step 3**

Natural Hazards	**Scale / Metric**	**Scale / Metric Explaination or Source**	**Risk**	**Primary Service Impact**	**Secondary Service Impact (Optional)**	**Source**
Flooding		FEMA Flood Zone Types - High, Moderate, Minimal Risk				Flood Zone (FEMA)
High Wind		FEMA/NIST Wind Zone, Max Windspeed in Extreme Events				Wind Zone (NIST)
		Minimum Design Load Wind Speed for 100-year Mean Recurrence Interval (MRI) from ASCE 7-16 (2016)				Wind Speed for 100 Year Event (ATC)
		Windstorm Vulnerability Ranking (1 = most vulnerable, red , 87= least vulnerable, green)				2019 Minnesota Hazard Mitigation Plan - County Rankin
		Average Windstorm Events per Year				
		Expected Windstorm Events per Year (highlighted if expected increase)				
Tornado		Design Load Windspeed for Tornado, If ≥ 250mph some project types require a shelter				Tornado Windspeed (ATC)
		FEMA Tornado Risk By Tornado Count and Wind Zone				Tornado Risk Level (FEMA)
		Tornado Vulnerability Ranking (1 = most vulnerable, red , 87= least vulnerable, green)				2019 Minnesota Hazard Mitigation Plan - County Rankin
		Historic Storm Count per Year				
		Expected Storm Count per Year (highlighted if expected increase)				
Wildfire		USDA/USFA Wildfire Hazard Potential - average rating within 5 miles				USDA/USFA Wildfire Hazard Potential
Drought		% of Time from 2000-2018 in Moderate Drought or Worse				2019 Minnesota Hazard Mitigation Plan
Hail		Hail Storm Vulnerability Ranking (1 = most vulnerable, red , 87= least vulnerable, green)				2019 Minnesota Hazard Mitigation Plan - County Rankin
		Average Hail Storm Events per Year				
		Expected Hail Storm Events per Year (highlighted if expected increase)				
Winter Storm		Perceived Risk - Minnesota Hazard Mitigation Plan				2019 Minnesota Hazard Mitigation Plan

DIRECTIONS | 1 - Vulnerability Assessment | 2 - Project Assessment | 3 - ASCE 7 - Table 1604.5 | 4 - Design Strategies | 5 - References

B3 RESILIENCE TOOL – VULNERABILITY ASSESSMENT

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Step 1

Project Address: 2200 Larpenteur Ave, Saint Paul MN 55109

Project County (select from dropdown): Ramsey County

Hazard Mitigation / Management Plan Status: Draft (Approved, Draft, Pending, or Expired)

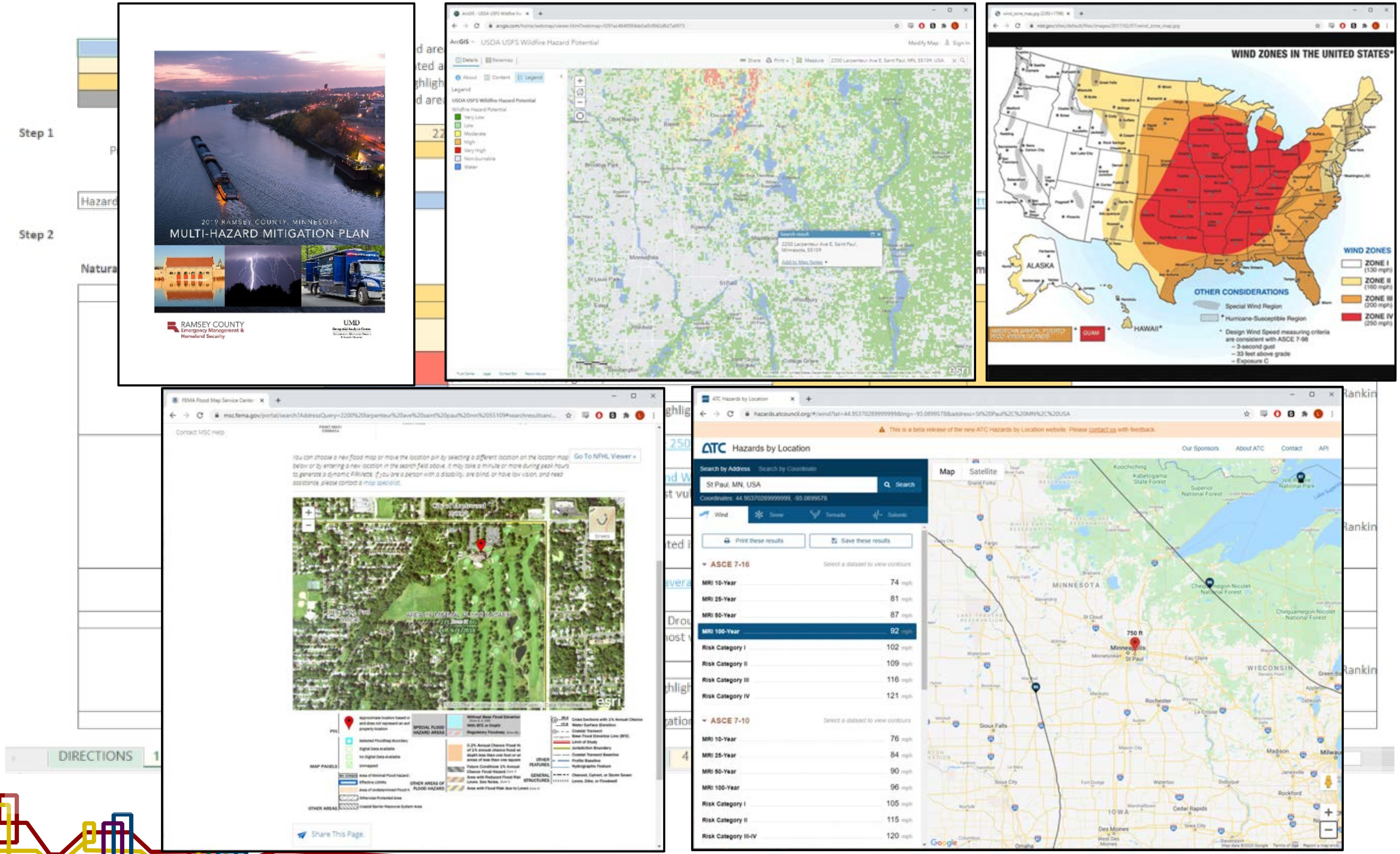
PDF Available? Yes https://www.ramseycounty.us/sites/default/files/Emergency%20Response

Step 2 **Step 3**

Natural Hazards	Scale / Metric	Scale / Metric Explaination or Source	Risk	Primary Service Impact	Secondary Service Impact (Optional)	Source
Flooding		FEMA Flood Zone Types - High, Moderate, Minimal Risk				Flood Zone (FEMA)
High Wind		FEMA/NIST Wind Zone, Max Windspeed in Extreme Events				Wind Zone (NIST)
		Minimum Design Load Wind Speed for 100-year Mean Recurrence Interval (MRI) from ASCE 7-16 (2016)				Wind Speed for 100 Year Event (ATC)
	10	Windstorm Vulnerability Ranking (1 = most vulnerable, red, 87= least vulnerable, green)				2019 Minnesota Hazard Mitigation Plan - County Rankin
	1.48	Average Windstorm Events per Year				
	0.49	Expected Windstorm Events per Year (highlighted if expected increase)				
Tornado		Design Load Windspeed for Tornado, if ≥ 250mph some project types require a shelter				Tornado Windspeed (ATC)
		FEMA Tornado Risk By Tornado Count and Wind Zone				Tornado Risk Level (FEMA)
	8	Tornado Vulnerability Ranking (1 = most vulnerable, red, 87= least vulnerable, green)				2019 Minnesota Hazard Mitigation Plan - County Rankin
	0.1	Historic Storm Count per Year				
	0.05	Expected Storm Count per Year (highlighted if expected increase)				
Wildfire		USDA/USFA Wildfire Hazard Potential - average rating within 5 miles				USDA/USFA Wildfire Hazard Potential
Drought	25.1-27.5%	% of Time from 2000-2018 in Moderate Drought or Worse				2019 Minnesota Hazard Mitigation Plan
Hail	10	Hail Storm Vulnerability Ranking (1 = most vulnerable, red, 87= least vulnerable, green)				2019 Minnesota Hazard Mitigation Plan - County Rankin
	1.18	Average Hail Storm Events per Year				
	0.31	Expected Hail Storm Events per Year (highlighted if expected increase)				
Winter Storm	High	Perceived Risk - Minnesota Hazard Mitigation Plan				2019 Minnesota Hazard Mitigation Plan

DIRECTIONS | 1 - Vulnerability Assessment | 2 - Project Assessment | 3 - ASCE 7 - Table 1604.5 | 4 - Design Strategies | 5 - References

B3 RESILIENCE TOOL – VULNERABILITY ASSESSMENT



B3 RESILIENCE TOOL – VULNERABILITY ASSESSMENT

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Step 1

Project Address:	2200 Larpenteur Ave, Saint Paul, MN 55109
Project County (select from dropdown):	Ramsey County

Hazard Mitigation / Management Plan Status	Draft	(Approved, Draft, Pending, or Expired)	PDF Available?	Yes	https://www.ramseycounty.us/sites/default/files/Emergency%20Response

Step 2 | **Step 3**

Natural Hazards	Scale / Metric	Scale / Metric Explaination or Source	Risk	Primary Service Impact	Secondary Service Impact (Optional)	Source
Flooding	Minimal Risk (Zone X, Unshaded)	FEMA Flood Zone Types - High, Moderate, Minimal Risk	Low	Potable Water		Flood Zone (FEMA)
High Wind	Zone IV (250 mph)	FEMA/NIST Wind Zone, Max Windspeed in Extreme Events	Medium	Electricity	Structure	Wind Zone (NIST)
	92	Minimum Design Load Wind Speed for 100-year Mean Recurrence Interval (MRI) from ASCE 7-16 (2016)				Wind Speed for 100 Year Event (ATC)
	10	Windstorm Vulnerability Ranking (1 = most vulnerable, red, 87= least vulnerable, green)				2019 Minnesota Hazard Mitigation Plan - County Rankin
	1.48	Average Windstorm Events per Year				
	0.49	Expected Windstorm Events per Year (highlighted if expected increase)				
Tornado	250	Design Load Windspeed for Tornado, if ≥ 250mph some project types require a shelter	Low	Structure	Electricity	Tornado Windspeed (ATC)
	High Risk	FEMA Tornado Risk By Tornado Count and Wind Zone				Tornado Risk Level (FEMA)
	8	Tornado Vulnerability Ranking (1 = most vulnerable, red, 87= least vulnerable, green)				2019 Minnesota Hazard Mitigation Plan - County Rankin
	0.1	Historic Storm Count per Year				
	0.05	Expected Storm Count per Year (highlighted if expected increase)				
Wildfire	Very Low	USDA/USFA Wildfire Hazard Potential - average rating within 5 miles	Low	Structure		USDA/USFA Wildfire Hazard Potential
Drought	25.1-27.5%	% of Time from 2000-2018 in Moderate Drought or Worse	Low	Potable Water		2019 Minnesota Hazard Mitigation Plan
Hail	10	Hail Storm Vulnerability Ranking (1 = most vulnerable, red, 87= least vulnerable, green)	Medium	Safety		2019 Minnesota Hazard Mitigation Plan - County Rankin
	1.18	Average Hail Storm Events per Year				
	0.31	Expected Hail Storm Events per Year (highlighted if expected increase)				
Winter Storm	High	Perceived Risk - Minnesota Hazard Mitigation Plan	High	Transportation	Electricity	2019 Minnesota Hazard Mitigation Plan

DIRECTIONS | **1 - Vulnerability Assessment** | 2 - Project Assessment | 3 - ASCE 7 - Table 1604.5 | 4 - Design Strategies | 5 - References

B3 RESILIENCE TOOL – VULNERABILITY ASSESSMENT

Human-Made Hazards	Scale / Metric	Scale / Metric Explaination or Source	Risk	Primary Service Impact	Secondary Service Impact (Optional)	Reference
Epidemic / Pandemic						
Civil Unrest						
Cyber Attack						
Infrastructure Failure						
Fire						
Explosion						
Major Accident						
Air or Water Pollution						

Step 4	Service(s) Most Likely to be Disrupted:	
		(Required)
		(Optional)
		(Optional)

Step 5	Highest Priority Hazard(s):	
		(Required)
		(Optional)
		(Optional)

DIRECTIONS | 1 - Vulnerability Assessment | 2 - Project Assessment | 3 - ASCE 7 - Table 1604.5 | 4 - Design Strategies | 5 - References

B3 RESILIENCE TOOL – VULNERABILITY ASSESSMENT

Human-Made Hazards	Scale / Metric	Scale / Metric Explaination or Source	Risk	Primary Service Impact	Secondary Service Impact (Optional)	Reference
Epidemic / Pandemic	200 sq/ft/person	Occupant density of designed use	Low	Safety		
Civil Unrest	Minimal	Proximity to commercial district	Low	Structure		
Cyber Attack	Minimal	Reliance on internet /digital systems	Low	Communication		
Infrastructure Failure	Moderate	Proximity to major infrastructure	Low	Safety		Active heavy rail line
Fire	Minimal	Flammable materials stored on site	Low	Safety	Structure	
Explosion	Minimal	Combustibles stored on site	Low	Safety	Structure	
Major Accident	Moderate	Proximity to hazardous processes or sites	Low	Structure		
Air or Water Pollution	Minimal	Air quality concern level	Low	Potable Water	Safety	

Step 4	Service(s) Most Likely to be Disrupted:	
	Structure	(Required)
	Safety	(Optional)
	Potable Water	(Optional)

Step 5	Highest Priority Hazard(s):	
	Winter Storm (ice, snow, hail, etc.)	(Required)
	Extreme Wind (including tornado)	(Optional)
		(Optional)

... 1 - Vulnerability Assessment | 2 - Project Assessment | 3 - ASCE 7 - Table 1604.5 | 4 - Design Strategies | 5 - References | Hazards Services Impacts

B3 RESILIENCE TOOL – PROJECT ASSESSMENT

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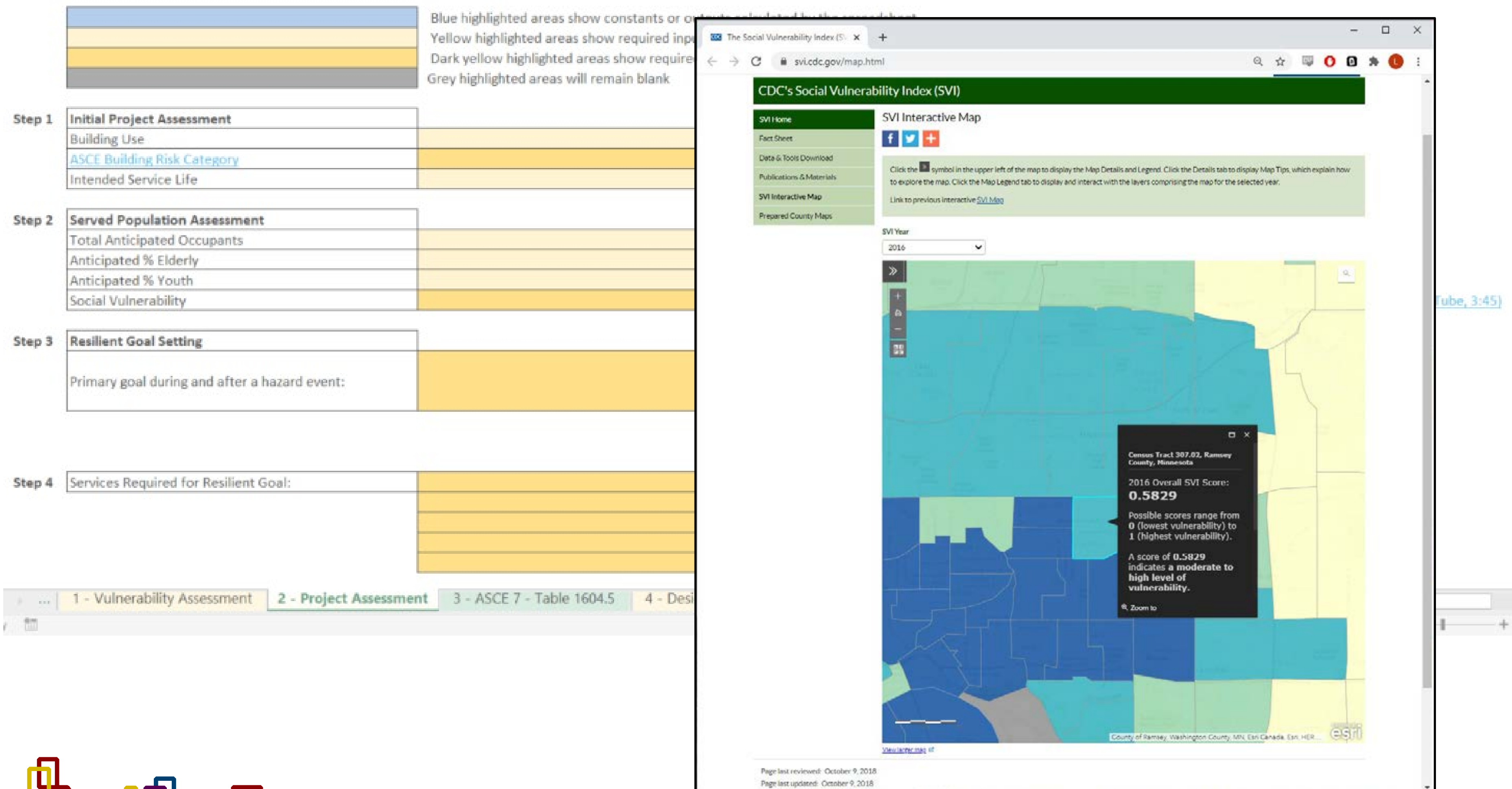
(dark yellow)	Dark yellow highlighted areas show required inputs with a drop-down selection
(grey)	Grey highlighted areas will remain blank

Step 1	**Initial Project Assessment**		
	Building Use		
	ASCE Building Risk Category		(reference tab 'ASCE Table 1604.5')
	Intended Service Life		
Step 2	**Served Population Assessment**		
	Total Anticipated Occupants		
	Anticipated % Elderly		
	Anticipated % Youth		
	Social Vulnerability		Social Vulnerability Index by census tract (CDC) - 2016 Introduction to CDC's Social Vulnerability Index (YouTube, 3:45)
Step 3	**Resilient Goal Setting**		
	Primary goal during and after a hazard event:		
Step 4	Services Required for Resilient Goal:		(Required)
			(Optional)
			(Optional)
			(Optional)
			(Optional)

... 1 - Vulnerability Assessment | 2 - Project Assessment | 3 - ASCE 7 - Table 1604.5 | 4 - Design Strategies | 5 - References | Hazards Services Impacts

B3 RESILIENCE TOOL – PROJECT ASSESSMENT



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Step 1

Initial Project Assessment		
Building Use	Multifamily Residential	
ASCE Building Risk Category	II	(reference tab 'ASCE Table 1604.5')
Intended Service Life	100 Years	

Step 2

Served Population Assessment		
Total Anticipated Occupants	187	
Anticipated % Elderly	Unknown	
Anticipated % Youth	Unknown	
Social Vulnerability	Moderate-to-High	Social Vulnerability Index by census tract (CDC) - 2016 Introduction to CDC's Social Vulnerability Index (YouTube, 3:45)

Step 3

Resilient Goal Setting		
Primary goal during and after a hazard event:	Shelter In Place	Secure current occupants and support health, safety, and welfare for duration of outage or 4 days

Step 4

Services Required for Resilient Goal:	Cooling / Heating	(Required)
	Restrooms	(Optional)
	Food Storage (Including Refrigeration)	(Optional)
	Device Charging	(Optional)
	Accessibility	(Optional)

... 1 - Vulnerability Assessment | 2 - Project Assessment | 3 - ASCE 7 - Table 1604.5 | 4 - Design Strategies | 5 - References | Hazards Services Impacts

B3 RESILIENCE TOOL – PROJECT ASSESSMENT

Resilience Goals in the Event of an Emergency:

- Shelter-In-Place: Secure current occupants and support health, safety, and welfare for duration of 4 days during a system outage
- Resilience Hub: Secure occupants and accept others in need of shelter, and support health, safety, and welfare for duration of 4 days during a system outage
- Evacuate and Shut Down: Safely evacuate occupants and secure building systems against physical damage.

B3 RESILIENCE TOOL – PROJECT ASSESSMENT

Step 5

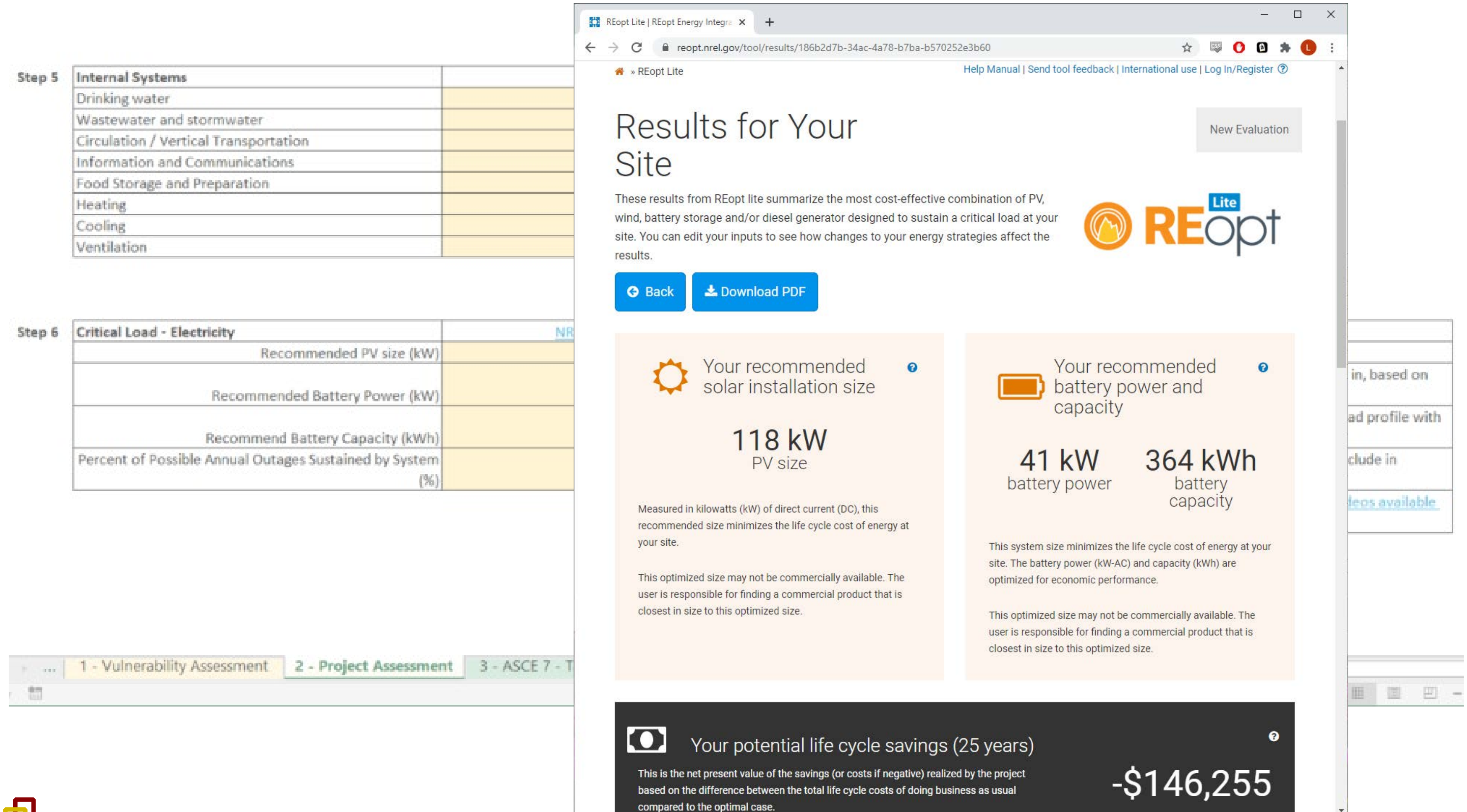
Internal Systems	Primary System	Secondary or Back-Up System
Drinking water		
Wastewater and stormwater		
Circulation / Vertical Transportation		
Information and Communications		
Food Storage and Preparation		
Heating		
Cooling		
Ventilation		

Step 6

Critical Load - Electricity	NREL's ReOpt Lite Tool	Project Data Needed for ReOpt Lite Tool:	Notes:
Recommended PV size (kW)		Site Location	Chose 'Resilience' in Step 1
Recommended Battery Power (kW)		Critical Load Factor % (percent of typical load that must be met during outage)	Some building profiles built in, based on DOE reference buildings
Recommend Battery Capacity (kWh)		**Required Inputs for this assessment:**	Can build custom critical load profile with account registration
Percent of Possible Annual Outages Sustained by System (%)		Outage Duration - 4 days / 96 hours	Download results PDF to include in submission
		Outage Start Date - Select 'Autoselect using critical load profile' and select 'Start Outage on Peak'	User Guides and tutorial videos available here
		Type of Outage Event: Major Outage	

... 1 - Vulnerability Assessment | 2 - Project Assessment | 3 - ASCE 7 - Table 1604.5 | 4 - Design Strategies | 5 - References | Hazards Services Impacts

B3 RESILIENCE TOOL – PROJECT ASSESSMENT



B3 RESILIENCE TOOL – PROJECT ASSESSMENT

Step 5

Internal Systems	Primary System	Secondary or Back-Up System
Drinking water	Municipal water	Unknown
Wastewater and stormwater	Municipal sewer	Unknown
Circulation / Vertical Transportation	Elevator	Stair
Information and Communications	Telephone and internet	Unknown
Food Storage and Preparation	n/a	n/a
Heating	Electric heating system	Natural gas
Cooling	Electric cooling system	Unknown
Ventilation	DOAS	Natural ventilation

Step 6

Critical Load - Electricity	NREL's ReOpt Lite Tool	**Project Data Needed for ReOpt Lite Tool:**	**Notes:**
Recommended PV size (kW)	66	Site Location	Chose 'Resilience' in Step 1
Recommended Battery Power (kW)	36	Critical Load Factor % (percent of typical load that must be met during outage)	Some building profiles built in, based on DOE reference buildings
Recommend Battery Capacity (kWh)	173	**Required Inputs for this assessment:**	Can build custom critical load profile with account registration
Percent of Possible Annual Outages Sustained by System (%)	94	Outage Duration - 4 days / 96 hours	Download results PDF to include in submission
		Outage Start Date - Select 'Autoselect using critical load profile' and select 'Start Outage on Peak'	User Guides and tutorial videos available here
		Type of Outage Event: Major Outage	

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B3 RESILIENCE TOOL – DESIGN STRATEGIES

Step 1

Highest Priority Hazard(s):	Winter Storm (ice, snow, hail, etc.)
	Extreme Wind (including tornado)
	0
Resilience Goal:	Shelter In Place

Service(s) Most Likely Disrupted:	Structure
	Safety
	Potable Water
Services Required for Resilince Goal:	Cooling / Heating
	Restrooms
	Food Storage (Including Refrigeration)
	Device Charging
	Accessibility

Step 5

Strategy Selected:		(Required)
Strategy Selected:		(Optional)
Strategy Selected:		(Optional)

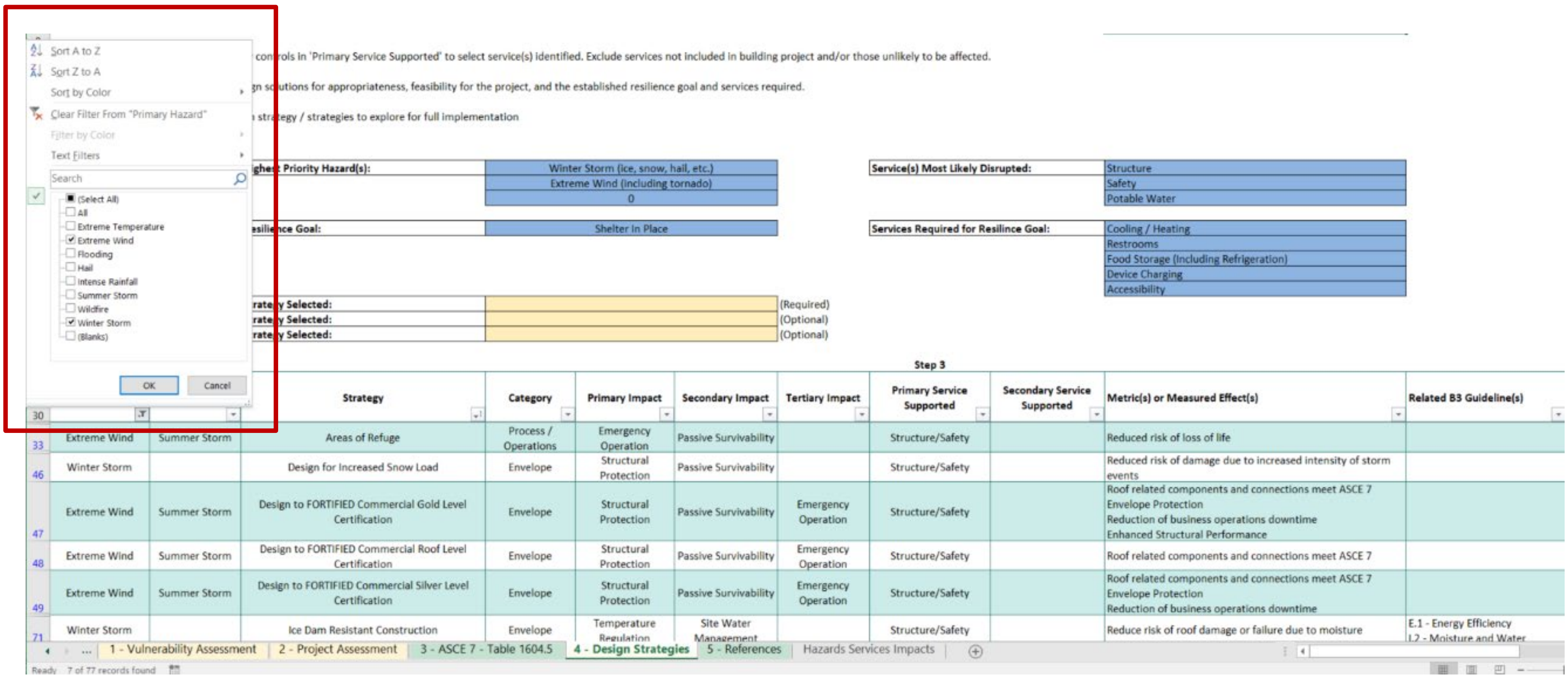
Step 2 **Step 3**

Primary Hazard	Secondary Hazard	Strategy	Category	Primary Impact	Secondary Impact	Tertiary Impact	Primary Service Supported	Secondary Service Supported	Metric(s) or Measured Effect(s)	Related B3 Guideline(s)	Control
Extreme Temperature		Beyond Code Insulation : Walls	Envelope	Temperature Regulation	Passive Survivability		Electricity / Natural Gas		Impact on heat gain (w/f2) Impact on heat loss (w/f2) Peak electrical demand impact (kW) Annual energy impact (kWh))	E.1 - Energy Efficiency I.4 - Thermal Comfort	Passive
Flooding	Extreme Temperature	Bioswales	Siting / Landscape	Site Water Management	Temperature Regulation		Structure/Safety		Volume of water captured from site (gal) Volume of pollutants and solids captured from site (cu ft/gal)	S.2 - Site Water Quality and Efficiency	Passive
All		Building Operations Manual	Process / Operations	Emergency Operation	Temperature Regulation		Electricity / Natural Gas		Reduction in electrical demand (kW) Reduction in electrical usage (kWh)	P.2 - Operations Process	Operations / Maintenance
Extreme Temperature		Building Orientation	Siting / Landscape	Passive Survivability	Temperature Regulation		Electricity / Natural Gas		Reduction in annual energy use (kWh) Reduction in summertime peak demand (kWh) Reduction in wintertime peak demand (kWh)	E.1 - Energy Efficiency	Passive
Extreme Temperature		Ceiling Fans	HVAC	Temperature Regulation	Passive Survivability		Electricity / Natural Gas		Reduction of interior air temperature (degrees) Reduction in peak electrical demand (kW) Reduction in annual electrical energy (kWh)	E.1 - Energy Efficiency I.3 - Ventilation	Passive
				Wild Fire Damage	Storm Damage					M.2 - Environmentally Preferred	

1 - Vulnerability Assessment | 2 - Project Assessment | 3 - ASCE 7 - Table 1604.5 | 4 - Design Strategies | 5 - References | Hazards Services Impacts

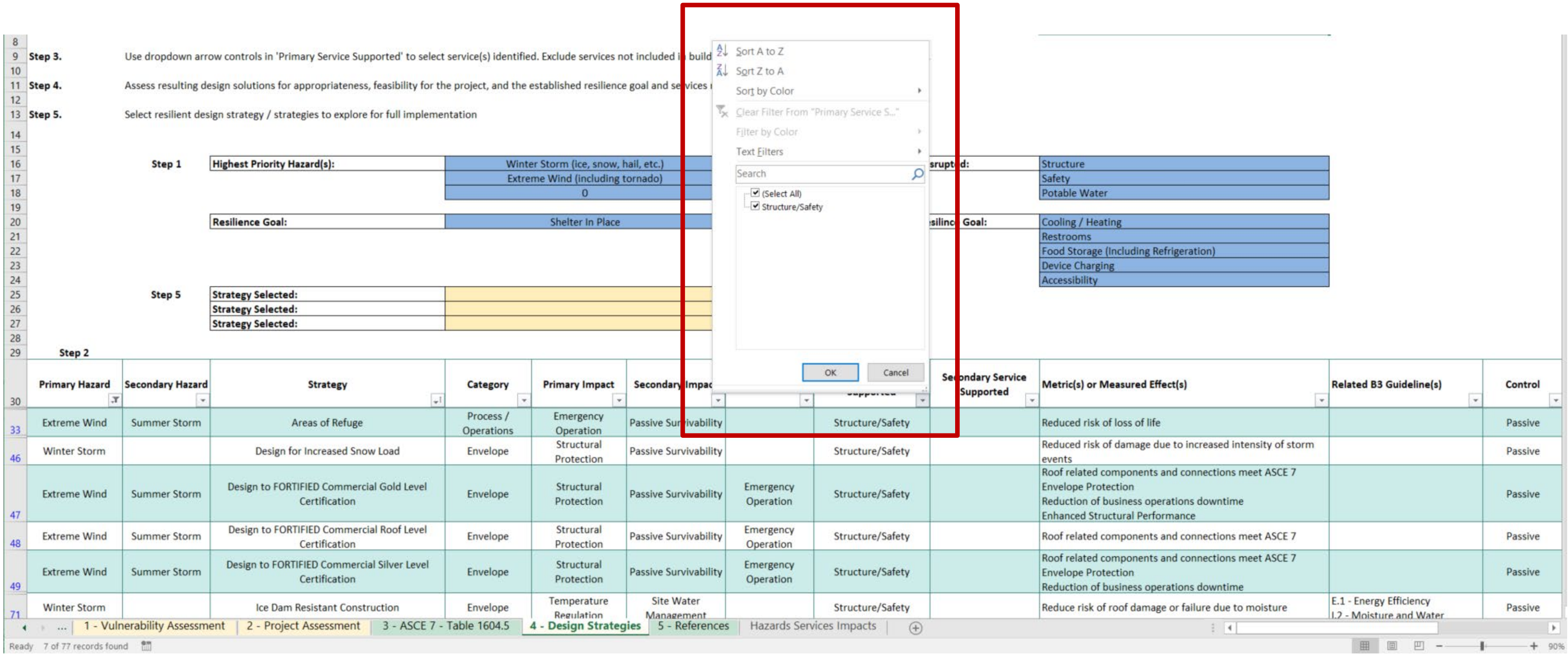
Ready

B3 RESILIENCE TOOL – DESIGN STRATEGIES



30			Strategy	Category	Primary Impact	Secondary Impact	Tertiary Impact	Primary Service Supported	Secondary Service Supported	Metric(s) or Measured Effect(s)	Related B3 Guideline(s)
33	Extreme Wind	Summer Storm	Areas of Refuge	Process / Operations	Emergency Operation	Passive Survivability		Structure/Safety		Reduced risk of loss of life	
46	Winter Storm		Design for Increased Snow Load	Envelope	Structural Protection	Passive Survivability		Structure/Safety		Reduced risk of damage due to increased intensity of storm events	
47	Extreme Wind	Summer Storm	Design to FORTIFIED Commercial Gold Level Certification	Envelope	Structural Protection	Passive Survivability	Emergency Operation	Structure/Safety		Roof related components and connections meet ASCE 7 Envelope Protection Reduction of business operations downtime Enhanced Structural Performance	
48	Extreme Wind	Summer Storm	Design to FORTIFIED Commercial Roof Level Certification	Envelope	Structural Protection	Passive Survivability	Emergency Operation	Structure/Safety		Roof related components and connections meet ASCE 7	
49	Extreme Wind	Summer Storm	Design to FORTIFIED Commercial Silver Level Certification	Envelope	Structural Protection	Passive Survivability	Emergency Operation	Structure/Safety		Roof related components and connections meet ASCE 7 Envelope Protection Reduction of business operations downtime	
71	Winter Storm		Ice Dam Resistant Construction	Envelope	Temperature Regulation	Site Water Management		Structure/Safety		Reduce risk of roof damage or failure due to moisture	E.1 - Energy Efficiency I.2 - Moisture and Water

B3 RESILIENCE TOOL – DESIGN STRATEGIES



9	**Step 3.**	Use dropdown arrow controls in 'Primary Service Supported' to select service(s) identified. Exclude services not included i build
11	**Step 4.**	Assess resulting design solutions for appropriateness, feasibility for the project, and the established resilience goal and se vices
13	**Step 5.**	Select resilient design strategy / strategies to explore for full implementation

Step 1

Highest Priority Hazard(s):	Winter Storm (ice, snow, hail, etc.)	srupt d:	Structure
	Extreme Wind (including tornado)		Safety
	0		Potable Water
Resilience Goal:	Shelter In Place	silinc Goal:	Cooling / Heating
			Restrooms
			Food Storage (Including Refrigeration)
			Device Charging
			Accessibility

Step 5

Strategy Selected:	
Strategy Selected:	
Strategy Selected:	

Sort A to Z
Sort Z to A
Sort by Color
Clear Filter From "Primary Service S..."
Filter by Color
Text Filters
Search
(Select All)
Structure/Safety
OK
Cancel

Step 2

Row	Primary Hazard	Secondary Hazard	Strategy	Category	Primary Impact	Secondary Impac			Se ondary Service Supported	Metric(s) or Measured Effect(s)	Related B3 Guideline(s)	Control
33	Extreme Wind	Summer Storm	Areas of Refuge	Process / Operations	Emergency Operation	Passive Sur ivability		Structure/Safety		Reduced risk of loss of life		Passive
46	Winter Storm		Design for Increased Snow Load	Envelope	Structural Protection	Passive Survivability		Structure/Safety		Reduced risk of damage due to increased intensity of storm events		Passive
47	Extreme Wind	Summer Storm	Design to FORTIFIED Commercial Gold Level Certification	Envelope	Structural Protection	Passive Survivability	Emergency Operation	Structure/Safety		Roof related components and connections meet ASCE 7 Envelope Protection Reduction of business operations downtime Enhanced Structural Performance		Passive
48	Extreme Wind	Summer Storm	Design to FORTIFIED Commercial Roof Level Certification	Envelope	Structural Protection	Passive Survivability	Emergency Operation	Structure/Safety		Roof related components and connections meet ASCE 7		Passive
49	Extreme Wind	Summer Storm	Design to FORTIFIED Commercial Silver Level Certification	Envelope	Structural Protection	Passive Survivability	Emergency Operation	Structure/Safety		Roof related components and connections meet ASCE 7 Envelope Protection Reduction of business operations downtime		Passive
71	Winter Storm		Ice Dam Resistant Construction	Envelope	Temperature Regulation	Site Water Management		Structure/Safety		Reduce risk of roof damage or failure due to moisture	E.1 - Energy Efficiency I.2 - Moisture and Water	Passive

... 1 - Vulnerability Assessment | 2 - Project Assessment | 3 - ASCE 7 - Table 1604.5 | 4 - Design Strategies | 5 - References | Hazards Services Impacts

Ready 7 of 77 records found 90%

B3 RESILIENCE TOOL – DESIGN STRATEGIES

Step 1	Highest Priority Hazard(s):	Winter Storm (ice, snow, hail, etc.)
		Extreme Wind (including tornado)
		0
	Resilience Goal:	Shelter In Place

Service(s) Most Likely Disrupted:	Structure
	Safety
	Potable Water
Services Required for Resilience Goal:	Cooling / Heating
	Restrooms
	Food Storage (Including Refrigeration)
	Device Charging
	Accessibility

Step 5	Strategy Selected:	Ice Dam Resistant Construction	(Required)
	Strategy Selected:	Design to FORTIFIED Commercial Roof Level Certification	(Optional)
	Strategy Selected:		(Optional)

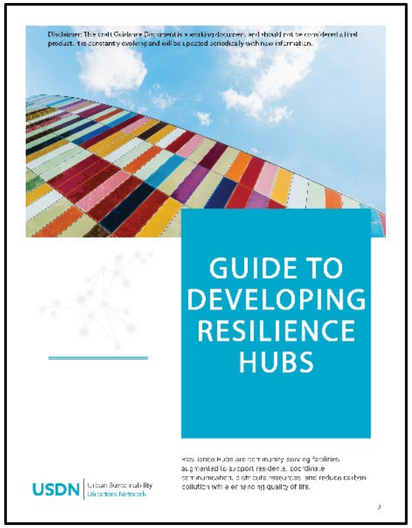
Step 2

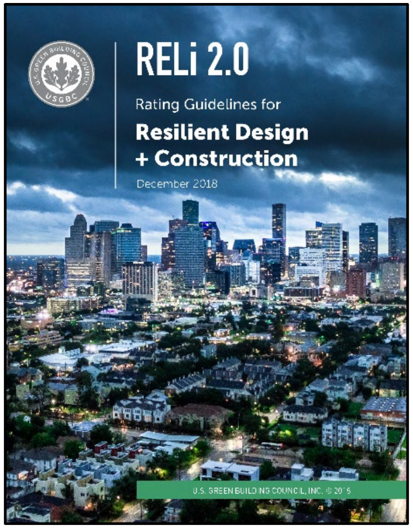
Step 3

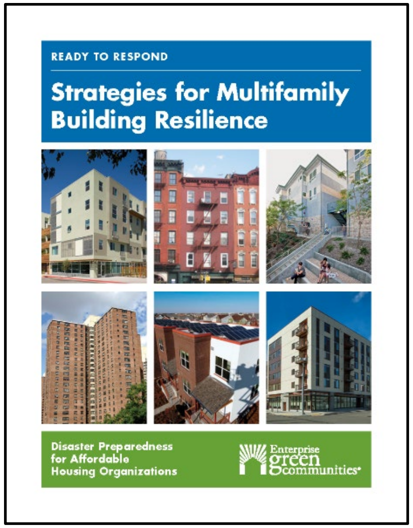
Primary Hazard	Secondary Hazard	Strategy	Category	Primary Impact	Secondary Impact	Tertiary Impact	Primary Service Supported	Secondary Service Supported	Metric(s) or Measured Effect(s)	Related B3 Guideline(s)	Control
Winter Storm		Design for Increased Snow Load	Envelope	Structural Protection	Passive Survivability		Structure/Safety		Reduced risk of damage due to increased intensity of storm events		Passive
Extreme Wind	Summer Storm	Design to FORTIFIED Commercial Gold Level Certification	Envelope	Structural Protection	Passive Survivability	Emergency Operation	Structure/Safety		Roof related components and connections meet ASCE 7 Envelope Protection Reduction of business operations downtime Enhanced Structural Performance		Passive
Extreme Wind	Summer Storm	Design to FORTIFIED Commercial Roof Level Certification	Envelope	Structural Protection	Passive Survivability	Emergency Operation	Structure/Safety		Roof related components and connections meet ASCE 7		Passive
Extreme Wind	Summer Storm	Design to FORTIFIED Commercial Silver Level Certification	Envelope	Structural Protection	Passive Survivability	Emergency Operation	Structure/Safety		Roof related components and connections meet ASCE 7 Envelope Protection Reduction of business operations downtime		Passive
Winter Storm		Ice Dam Resistant Construction	Envelope	Temperature Regulation	Site Water Management		Structure/Safety		Reduce risk of roof damage or failure due to moisture	E.1 - Energy Efficiency I.2 - Moisture and Water	Passive
Winter Storm	Summer Storm	Pitched Roof	Envelope	Site Water Management	Storm Damage Prevention		Structure/Safety		Reduced risk of roof failure from snow load		Passive

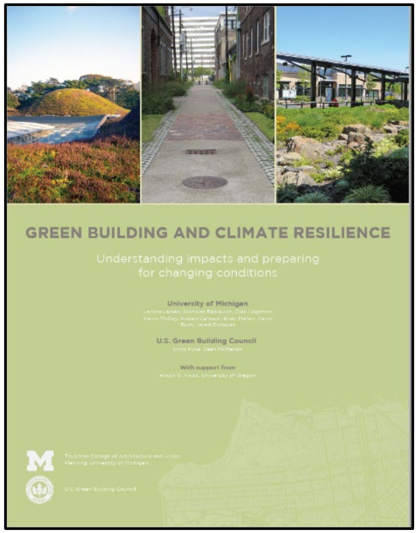
... 1 - Vulnerability Assessment | 2 - Project Assessment | 3 - ASCE 7 - Table 1604.5 | 4 - Design Strategies | 5 - References

DESIGN STRATEGY SOURCES

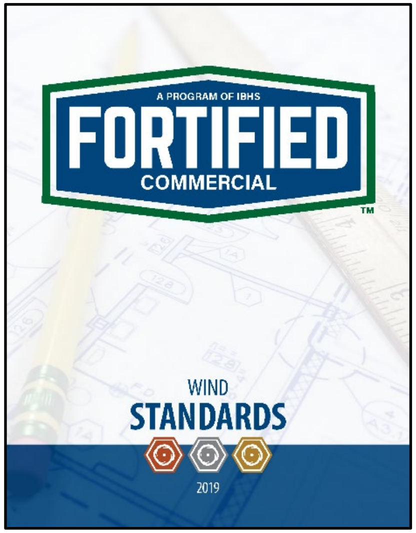








PILOT CREDITS



ADDITIONAL RESILIENCE GUIDELINES

- Energy Efficiency - Required
  - Perform energy model with future weather file to determine impacts on energy use and HVAC system sizing
- Thermal Comfort - Recommended
  - Demonstrate passive survivability in the event of a power outage lasting 4 days
- Environmentally Preferred Materials - Recommended
  - Fire-resistant and non-combustible exterior materials
  - High impact and wind resistance ratings for glazing
  - Locally sourced materials
  - Insect resistant materials

EXISTING RESILIENCE IN B3

- Site and Water
  - S.1- Human System Connections
  - S.2- Site Water Quality and Efficiency
  - S.3- Soil
  - S.4- Sustainable Vegetation Design
- Energy and Atmosphere
  - E.1- Energy Efficiency
  - E.2- Renewable Energy
  - E.3-Efficient Equipment and Appliances

EXISTING RESILIENCE IN B3

- Indoor Environmental Quality
  - I.2- Moisture and Water Control
  - I.4- Thermal Comfortt
  - I.5- Lighting and Daylighting
  - I.8- Ergonomics and Physical Activity
  - I.9- Wayfinding and Universal Access
- Materials and Waste
  - M.3- Waste Reduction and Management
  - M.4- Health

PEER PROGRAMS – OPTIONAL MEASURES

- LEED v4.1
  - Innovation Credit – Implement Pilot Credit, 1-5 pts
    - Pilot Credit 98 – Assessment and Planning for Resilience
    - Pilot Credit 99 – Design for Enhanced Resilience
- Enterprise Green Communities
  - Resilient Communities: Multi-Hazard / Vulnerability Assessment (10 pts)
  - Resilient Communities: Strengthening Cultural Resilience (8 pts)
  - Access to Potable Water During Emergencies (8 pts)
  - Resilient Energy Systems: Flood Proofing (8 pts)
  - Resilient Energy Systems: Critical Loads (8 pts)

RESILIENCE IN PRACTICE

Becky Alexander, LHB

WHAT IS THE ARCHITECT'S ROLE IN DESIGNING FOR RESILIENCE?

- Understand site hazards, vulnerability, and risks
- Analyze risks to building
- Discuss risks with the client
- Assist in setting resilience goals
- Recommend strategies

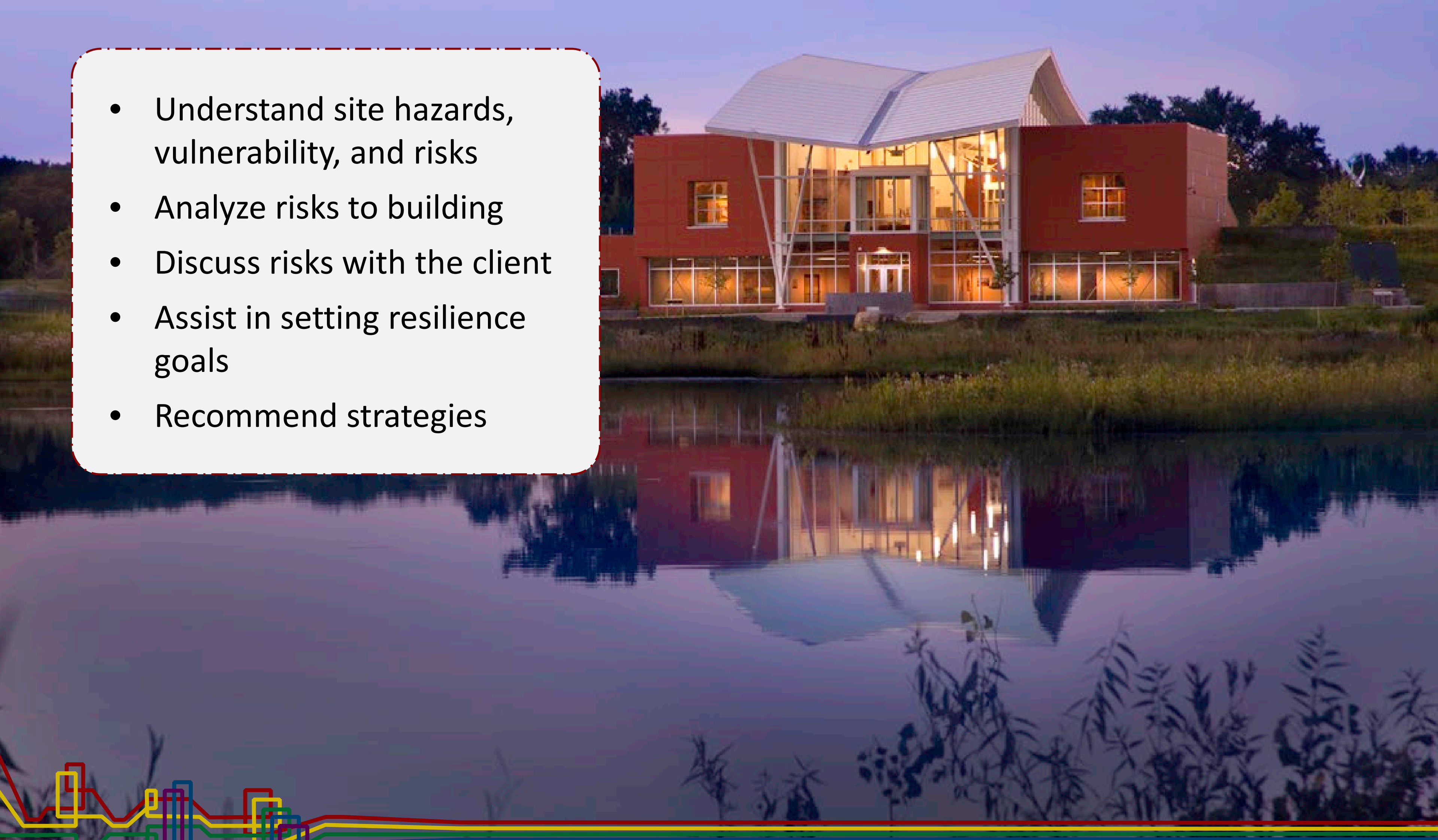
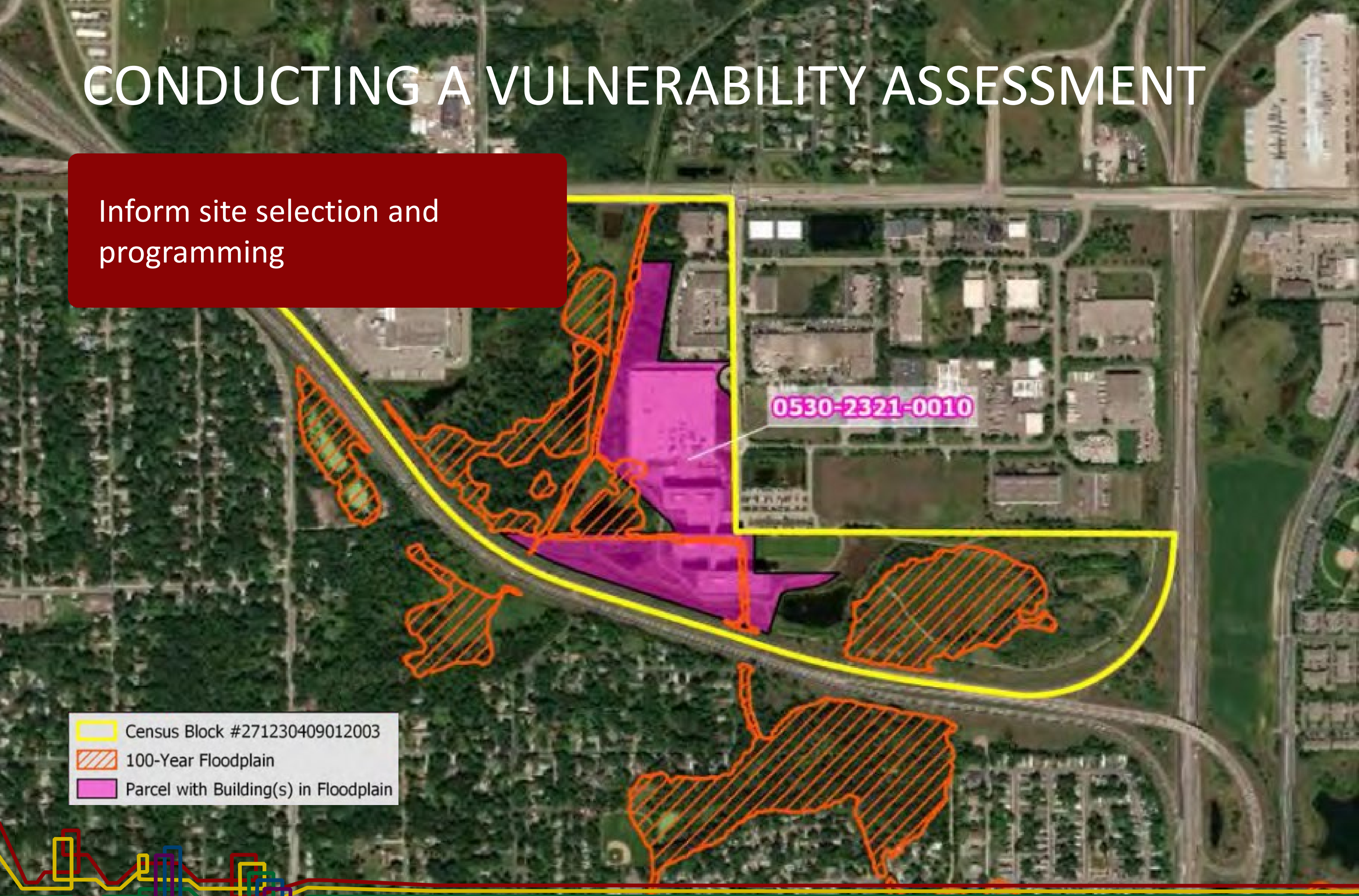


Photo of Cascade Meadows Wetlands and Environmental Science Center, LHB.

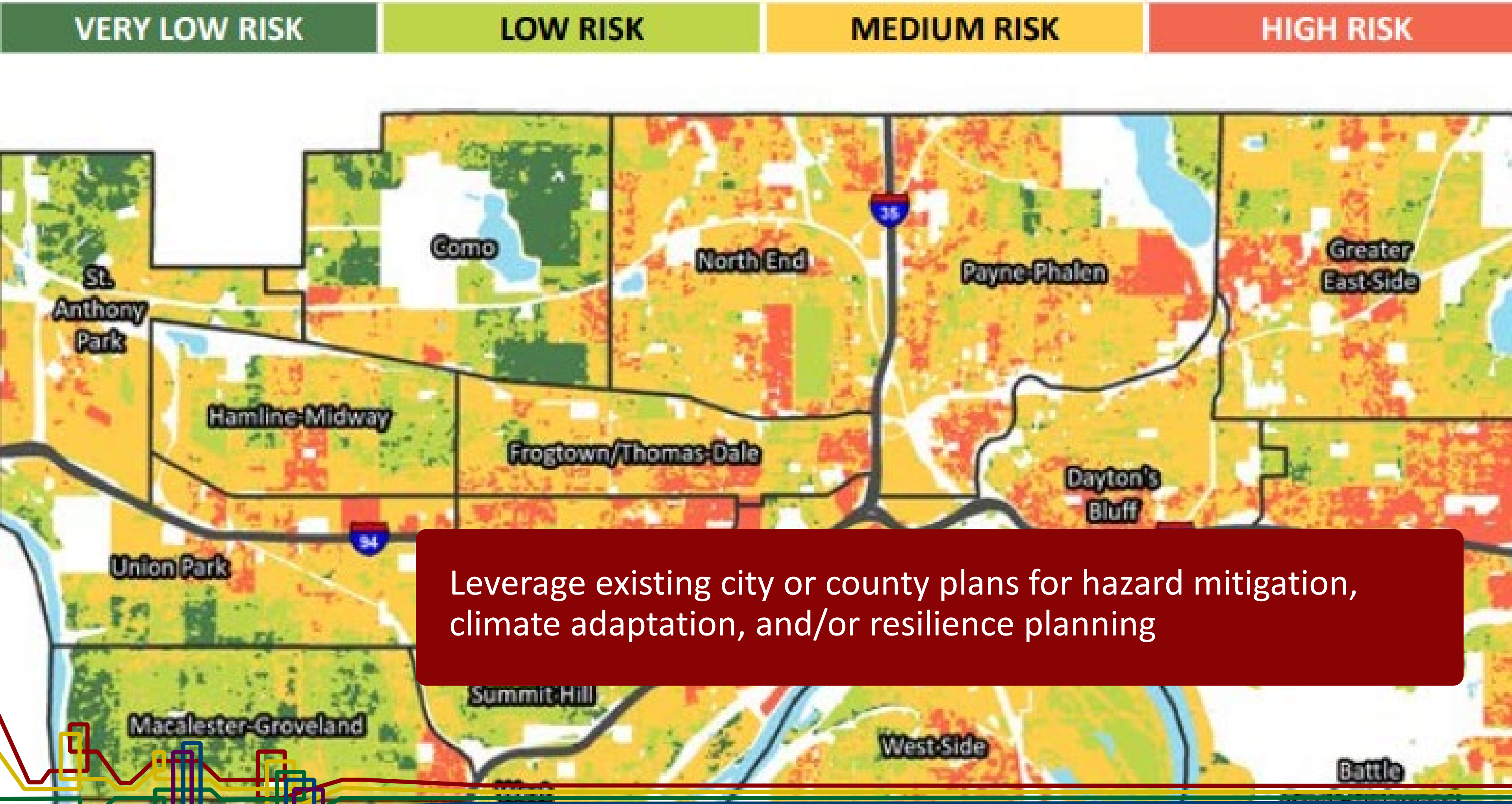
CONDUCTING A VULNERABILITY ASSESSMENT

Inform site selection and programming



Census Block #271230409012003 and 100-Year Floodplain in Mounds View, Ramsey County Multi-Hazard Mitigation Plan, 2019.

CONDUCTING A VULNERABILITY ASSESSMENT

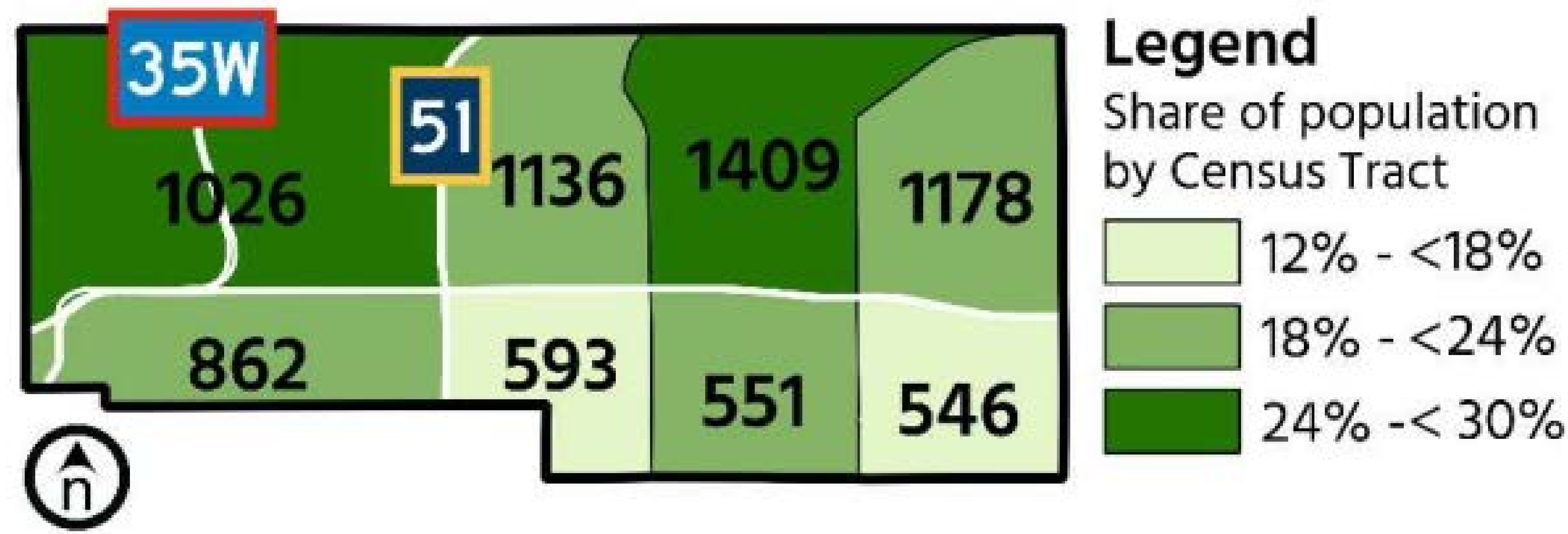


Leverage existing city or county plans for hazard mitigation, climate adaptation, and/or resilience planning

Saint Paul Extreme Heat Risk Map, Saint Paul Climate Action & Resilience Plan, December 2019.

CONDUCTING A VULNERABILITY ASSESSMENT

Use plans, maps, and data together.



Population 65 And Over

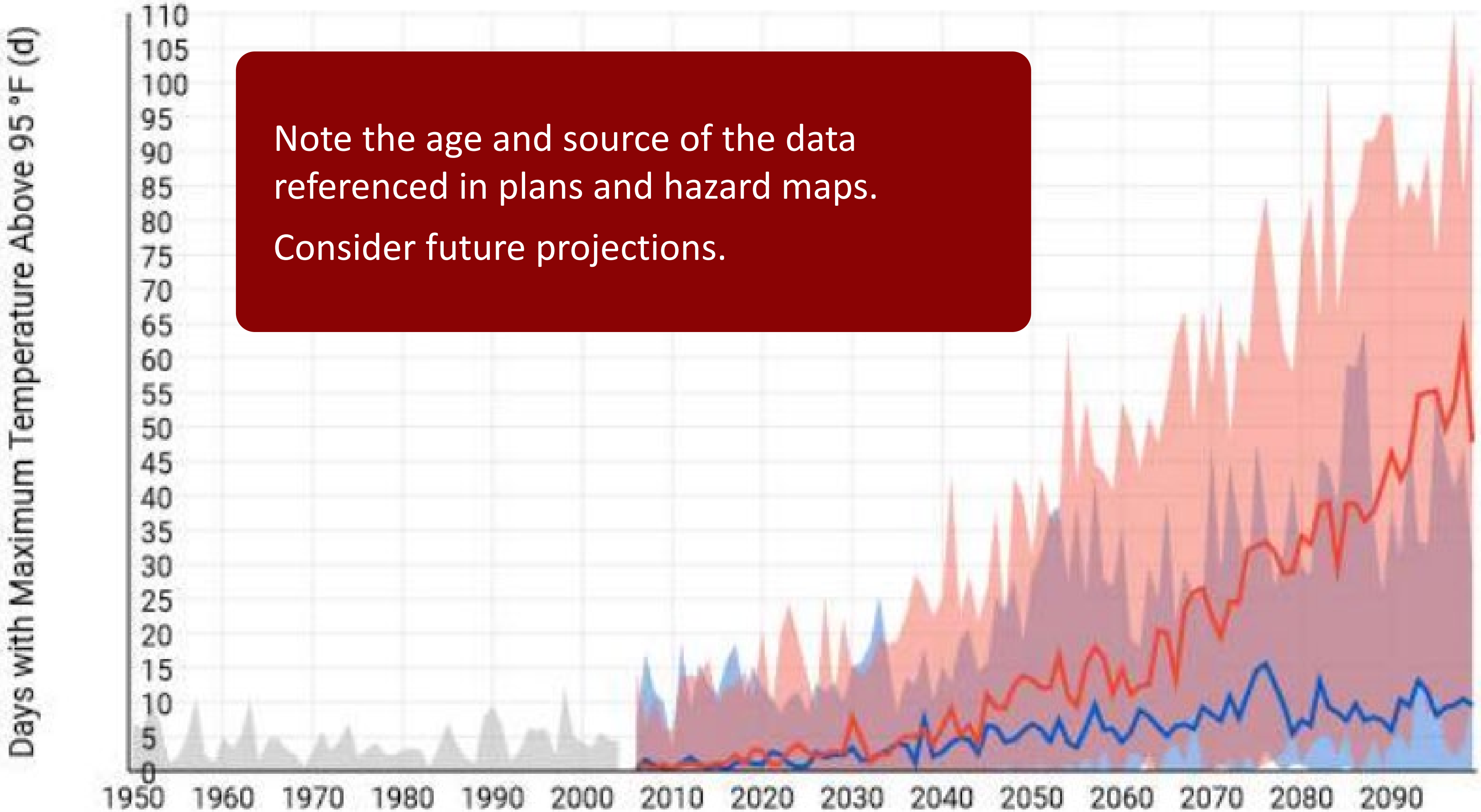
MPCA and Pale Blue Dot, Roseville Population Vulnerability Assessment and Climate Adaptation Framework, 2018.

CONDUCTING A VULNERABILITY ASSESSMENT

Use plans, maps, and data together.

MPCA and Pale Blue Dot, Roseville Population Vulnerability Assessment and Climate Adaptation Framework, 2018.

CONDUCTING A VULNERABILITY ASSESSMENT

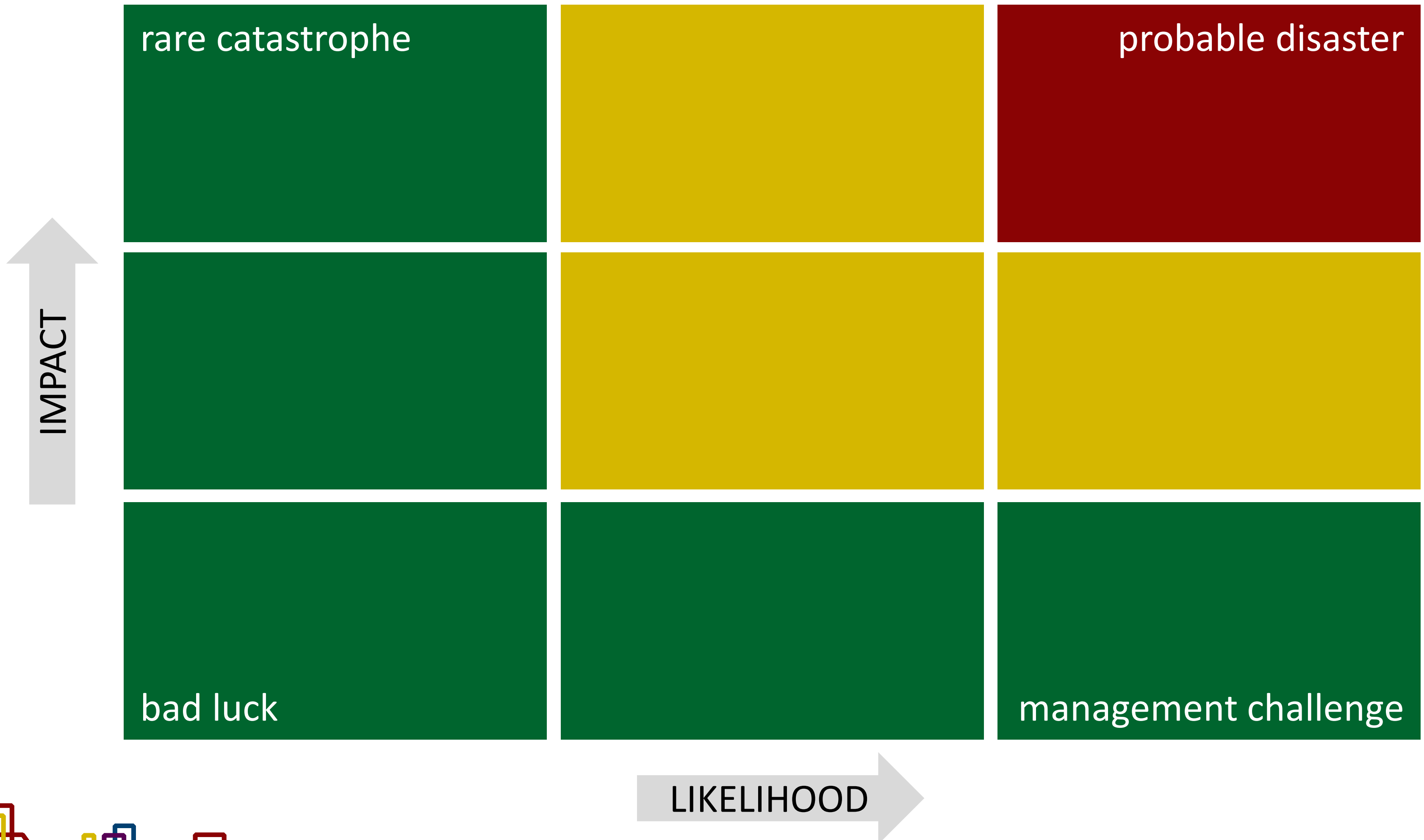


Note the age and source of the data referenced in plans and hazard maps.

Consider future projections.

MPCA and Pale Blue Dot, Roseville Population Vulnerability Assessment and Climate Adaptation Framework, 2018.

JUDGING THE RELATIVE RISKS



SETTING RESILIENCE GOALS

- Resilience is a design challenge
- Involve an integrated design team
- Goals will vary by program and hazard type

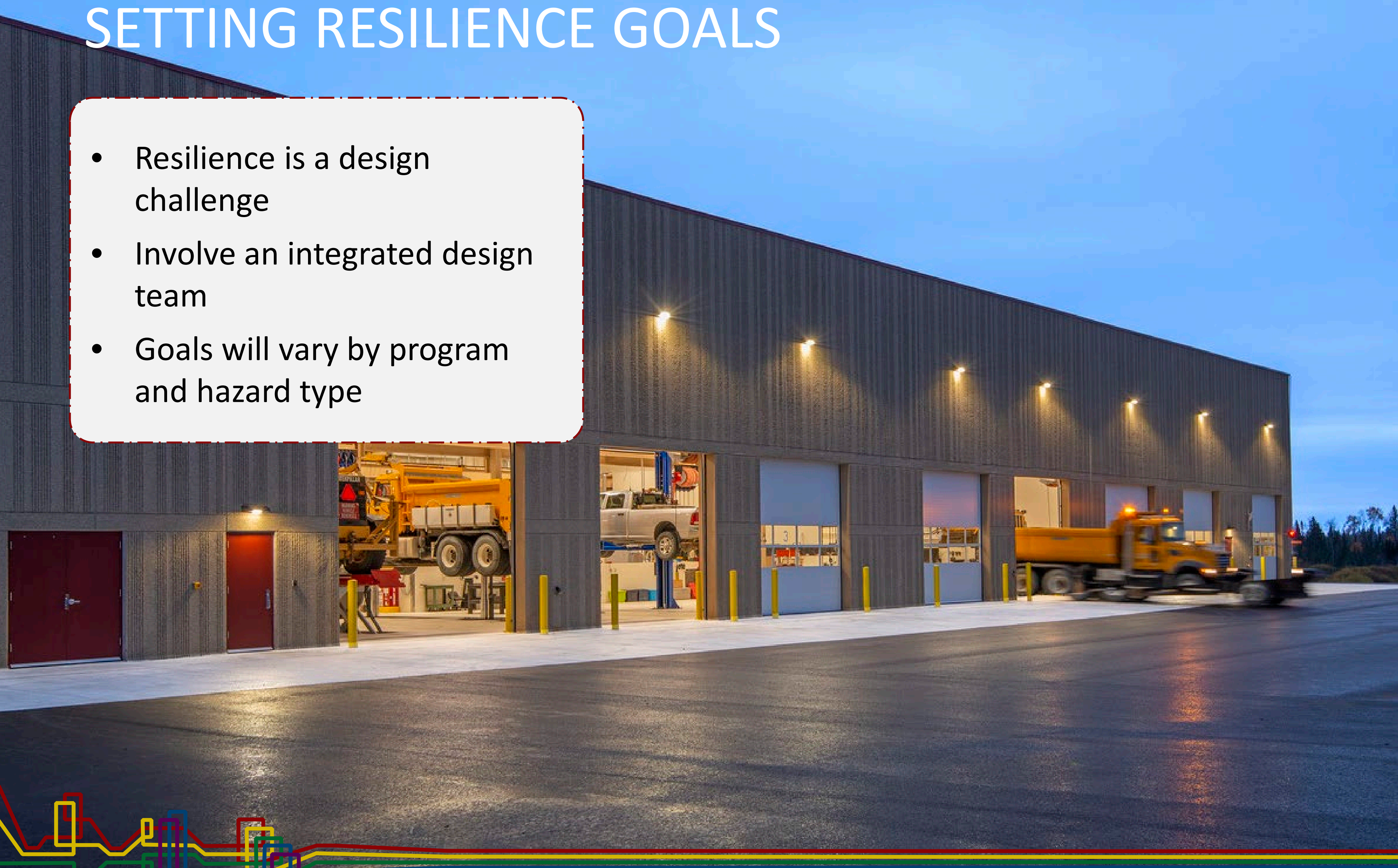


Photo of Saint Louis County Public Works Facility, LHB.

SETTING RESILIENCE GOALS

DEGENERATIVE

- loses critical functionality in response to short-term shocks; cannot accommodate social, economic, and environmental changes
- burdens the surrounding community during periods of disruption or stress

SUSTAINABLE

- maintains critical functionality in event of short-term shocks and predicted social, economic, and environmental changes
- neither supports nor burdens the surrounding community during periods of disruption or stress

REGENERATIVE

- dynamically adapts in order to thrive in event of short-term shocks and changing social, economic and environmental conditions
- serves as resource reservoir to replenish nearby stressed systems

SETTING RESILIENCE GOALS

Standard	Good	Better	Living Community Principles	Regenerative
No emergency plan or risk assessment conducted.	Emergency plan created and/or risks assessed.	Emergency plan includes access to nearby amenities and facilities. All community facilities have backup generators in case of emergency.	RESILIENT COMMUNITY CONNECTIONS Resilience through infrastructure, community resources, and social interactions. Place for residents to congregate in case of emergency. All facilities have backup power sources. Disaster Response Plan in place. Sensitive infrastructure located out of the flood plain.[2]	All residents know and understand the emergency plan and their role in a response. Community is able to assist other communities in the event of an emergency.

AIA Minnesota, CSBR, Colloqate Design, and the McKnight Foundation, 21st Century Development Matrix.

RESILIENCE HUB

- Coordinates resource distribution and services before, during, or after a hazard event
- Provides shelter, electricity, water, food, ice, refrigeration, charging stations, and basic medical supplies
- Could provide: space for growing food, trees for shade, resilience education
- Comprehensive model: Community ownership of hub within a well-trusted community building, offering services throughout the year

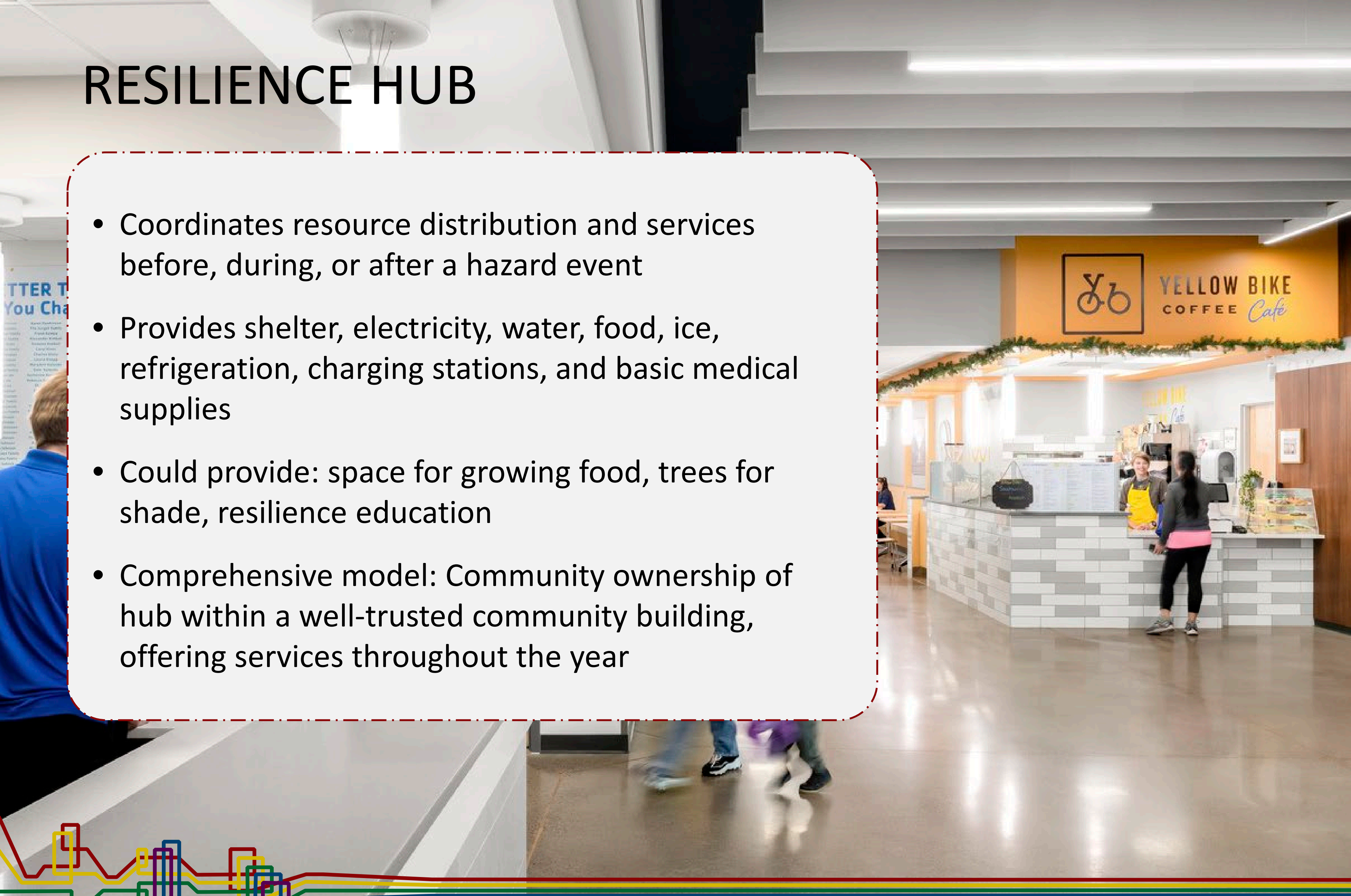


Photo of Essentia Wellness Center (Hermantown), LHB.

SUSTAINABILITY SYNERGIES

- Site selection
- Alternative transportation support
- Stormwater management
- Sustainable vegetation design
- Water and energy efficiency
- Passive strategies for thermal comfort and daylighting
- Renewable energy
- Design for disassembly
- Universal access and wayfinding

Photo of National Eagle Center, LHB.

SUSTAINABILITY CONFLICTS

- Programming for infrequently used services may increase building size
- Oversized/undersized systems (e.g. structural, mechanical)
- Redundant systems (e.g. power supply)
- Extra systems (e.g. air conditioning)

Photo of District Energy St. Paul's Jemne Building mechanical room, LHB.

KEY TAKEAWAYS

1. Value to client
2. Raise the topic
3. Consider the future
4. Envelope performance is critical
5. This is just another design problem to solve
    - Know your goal
    - Focus on the top hazard(s)
    - Synergize with other strategies

Photo of USFWS Necedah Visitor Center, LHB.

QUESTIONS?

SPEAKERS

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Becky Alexander, LHB
becky.alexander@lhbcorp.com

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DEPARTMENT OF ADMINISTRATION

PROJECT TEAM

CSBR

WILLDAN

LHB PERFORMANCE DRIVEN DESIGN.

cee Center for Energy and Environment

Martin & Guerin Design Research Influencing the future of design

www.b3mn.org

Footer graphic adapted from "Integrative Process" diagram by 7group and Bill Reed.