# DESIGNING FOR RESILIENCE WITH THE **B3 GUIDELINES**

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FUTURE CHANGES	TREND / ATTRIBUTION
HEAT AND COLD	۵
∧ High confidence of increase	∧ Upward trend without attribution
∧ High confidence of increase	
$\checkmark$ High confidence of decrease	
$\checkmark$ High confidence of decrease	
WET AND DRY	0
Medium confidence of increase	
∧ High confidence of increase	Opward trend with medium confidence of attribution
Medium confidence of increase	
Medium confidence of increase	
Medium confidence of increase	
wind 🥥	
∧ Medium confidence of increase	
∧ Medium confidence of increase	
SNOW AND ICE	الله الله الله الله الله الله الله الله
$\checkmark$ High confidence of decrease	igvee Downward trend without attribution

International Panel on Climate Change, Sixth Assessment - Regional Synthesis

### Minnesota's Climate is Already Changing

Minnesota's climate is already changing rapidly and will continue to do so into the foreseeable future.

These changes are impacting Minnesota's wildlife, plants, waters, historic resources, infrastructure, and available outdoor recreation activities.

We have a responsibility to adapt to these changes.

We take mitigation steps to reduce our carbon dioxide and other greenhouse gas emissions.

We need your help to adapt to the changing climate and reduce its impact on Minnesota's resources and people.

Action starts with you.

Find out more! mndnr.gov/climate



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increase in the number of 1" rains

65% increase in the number of 3" rains

#### 13%

increase in the size of the heaviest rainfall of the year.



The length of the frost-free season is increasing over time and is expected to continue to increase through the century.

## since 2000

widespread rains of more than 6" are 4x more frequent than in the previous three decades. our climate is becoming Warmer and wetter Nights have warmed 55% faster than days since 1970.

Average temperatures in Minnesota have warmed by nearly 3°F since 1895.





The 10 warmest and wettest years on record have all occurred in the past 20 years.

Increases in temperature and precipitation are expected to continue through the century.

#### winter is warming

much faster than summer with fewer days and nights of extreme cold.

Minnesota Department of Natural Resources

Precipitation has been increasing in Minnesota over the last century, as shown in the Figure below, which illustrates historic annual precipitation, from 1865-2016.



National Weather Service: https://www.weather.gov/wrh/Climate?wfo=mpx



https://metrocouncil.maps.arcgis.com/apps/webappviewer/index.html?id=100fa3012dcc4e288a74cbf4d95027bf





Intergovernmental Panel on Climate Change, Fifth Assessment Report. 2014

Strategy	
	Γ
Comfort	Γ
Sun Shading of Windows	Γ
High Thermal Mass	Γ
High Thermal Mass Night Flushed	Γ
Direct Evaporative Cooling	Γ
Two-Stage Evaporative Cooling	Γ
Natural Ventilation Cooling	
Fan-Forced Ventilation Cooling	Γ
Internal Heat Gain	
Passive Solar Direct Gain Low Mass	
Passive Solar Direct Gain High Mass	
Wind Protection of Outdoor Spaces	Γ
Humidification Only	
Dehumidification Only	
Cooling, add dehumidification if needed	
Heating, add humidification if needed	Γ



Hours: Actual and Percentage						
Now		2030		2040		
942	11%	885	10%	936	11%	
586	7%	778	9%	817	9%	
154	2%	217	2%	240	3%	
154	2%	228	3%	256	3%	
109	1%	179	2%	198	2%	
111	1%	192	2%	216	2%	
104	1%	162	2%	170	2%	
72	1%	104	1%	106	1%	
1589	18%	1353	15%	1361	16%	
899	10%	826	9%	796	9%	
624	7%	559	6%	539	6%	
259	3%	254	3%	249	3%	
0	0%	0	0%	0	0%	
491	6%	659	8%	692	8%	
305	3%	549	6%	604	7%	
4791	55%	4545	52%	4436	51%	

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

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

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



Multifamily - Energy by End Use Over Time

#### **Needed Research**

- Downscaling of Global Weather Data to Minnesota
- Application of Weather Data to Design and Operations
- Impact of Changing Climate of Energy Efficiency and Design
- Impact of Changing Climate on Site and Water Desig
- Assessment of Additional Risks and Impacts
- Other?