APPENDIX B

EXPOSURE METRICS USED TO DEVELOP HAZARD RATINGS

TABLE A1: EXPOSURE METRICS USED BY ASSET-HAZARD COMBINATION

Hazard	Asset Type Affected	Measure/Depiction
Extreme heat	Roads (asphalt binder grade)	Average annual degree days over 50°F
	Bike paths (asphalt binder grade)	Average annual degree days over 50°F
	Bridges (thermal expansion)	Maximum four day moving average high temperature
Extreme cold	Roads (asphalt binder grade)	Absolute minimum temperature over 30-year period
	Bike paths (asphalt binder grade)	Absolute minimum temperature over 30-year period
	Bridges (thermal contraction)	Minimum four day moving average low temperature
Freeze-thaw	Roads (pavement)	Number of days per year with high temperature >= 32°F and low temperature < 32°F
	Bike paths (pavement)	Number of days per year with high temperature >= 32°F and low temperature < 32°F
	Bridges (concrete)	Number of days per year with high temperature >= 32°F and low temperature < 15°F
	Slopes (rockfall)	Number of days per year with high temperature >= 32°F and low temperature < 32°F

Hazard	Asset Type Affected	Measure/Depiction
Heavy precipitation and flooding	Roads	2019 SMHMP (largely FEMA) 100-year floodplain
	Bike paths	2019 SMHMP (largely FEMA) 100-year floodplain
	Bridges	Percent change in 24-hour precipitation depth in hydraulic unit code 4 or 10 watershed for 50-year return period
	Large culverts	Percent change in 24-hour precipitation depth in hydraulic unit code 4 or 10 watershed for 50-year return period
	Pipes (highway culverts)	Percent change in 24-hour precipitation depth in hydraulic unit code 4 or 10 watershed for 50-year return period
	Pipes (entrance culverts)	Percent change in 24-hour precipitation depth at asset for 10-year return period
	Stormwater ponds	Percent change in 24-hour precipitation depth at asset for 100-year return period
	Catch basins & drop inlets	Percent change in 24-hour precipitation depth at asset for 10-year return period
	Stormwater pump stations	Percent change in 24-hour precipitation depth at asset for 50-year return period
	Slopes	Percent change in 24-hour precipitation depth at asset for 100-year return period
	Traffic signals	2019 SMHMP (largely FEMA) 100-year floodplain
	ITS devices	2019 SMHMP (largely FEMA) 100-year floodplain
	RWIS devices	2019 SMHMP (largely FEMA) 100-year floodplain
	WIM and ATR devices	2019 SMHMP (largely FEMA) 100-year floodplain
	Buildings	2019 SMHMP (largely FEMA) 100-year floodplain

Hazard	Asset Type Affected	Measure/Depiction
Winter weather	Roads	Average annual precipitation depth on days when maximum temperature < 32°F
		Annual average maximum precipitation depth on days when maximum temperature < 32°F
Wildfire	Roads	Annual wildfire burn probability
	Bike paths	
	Bridges	
	Culverts	
	Stormwater pump stations	
	Slopes	
	Traffic signals	
	ITS devices	
	RWIS devices	
	WIM and ATR devices	
	Buildings	
Coastal erosion	Roads	Lake Superior shoreline erosion susceptibility mapping
	Bike paths	
	Bridges	
	Culverts	
	Stormwater ponds	
	Catch basins & drop inlets	
	Stormwater pump stations	
	Slopes	
	Traffic signals	
	ITS devices	
	RWIS devices	
	WIM and ATR devices	
	Facilities	

DATA SOURCES FOR EXPOSURE METRICS

Measure/Depiction	Data Source
Average annual degree days over 50°F	LOCA[1] CMIP6[2]
Maximum four day moving average high temperature	LOCA CMIP6
Minimum four day moving average low temperature	LOCA CMIP6
Absolute minimum temperature	LOCA CMIP6
# of days per year with high temperature >= 32°F & low temp. < 32°F	LOCA CMIP6
# of days per year with high temperature >= 32°F & low temp. <= 15°F	LOCA CMIP6
100-year floodplain	2019 SMHMP
% change in 24-hr. 10-year precip. depth	LOCA CMIP5 to align with projections in the ongoing Extreme Flood Vulnerability Assessment (EFVA) study[3]
% change in 24-hr. 50-year precip. depth	LOCA CMIP5 to align EFVA projections
% change in 24-hr. 100-year precip. depth	LOCA CMIP5 to align EFVA projections
Annual precipitation depth on days when max temp. < 32°F	LOCA CMIP6
Annual max precipitation depth on days when max temp. < 32°F	LOCA CMIP6
Annual wildfire burn probability	Northeast-Midwest State Foresters Alliance Northeast-Midwest Wildfire Risk Explorer
Coastal erosion and lake level variability	Arrowhead Regional Development Commission

[1] Locally Constructed Analogues (LOCA), a statistically-based method of climate model downscaling (spatial resolution enhancement)
[2] Coupled Model Intercomparison Project (CMIP), a United Nations' Intergovernmental Panel on Climate Change (IPCC) led effort to coordinate climate modeling amongst various research groups around the world. CMIP6 is the latest round of this ongoing project.
[3] Extreme Flood Vulnerability Assessment, MnDOT study to look at climate risks to bridges and culverts.