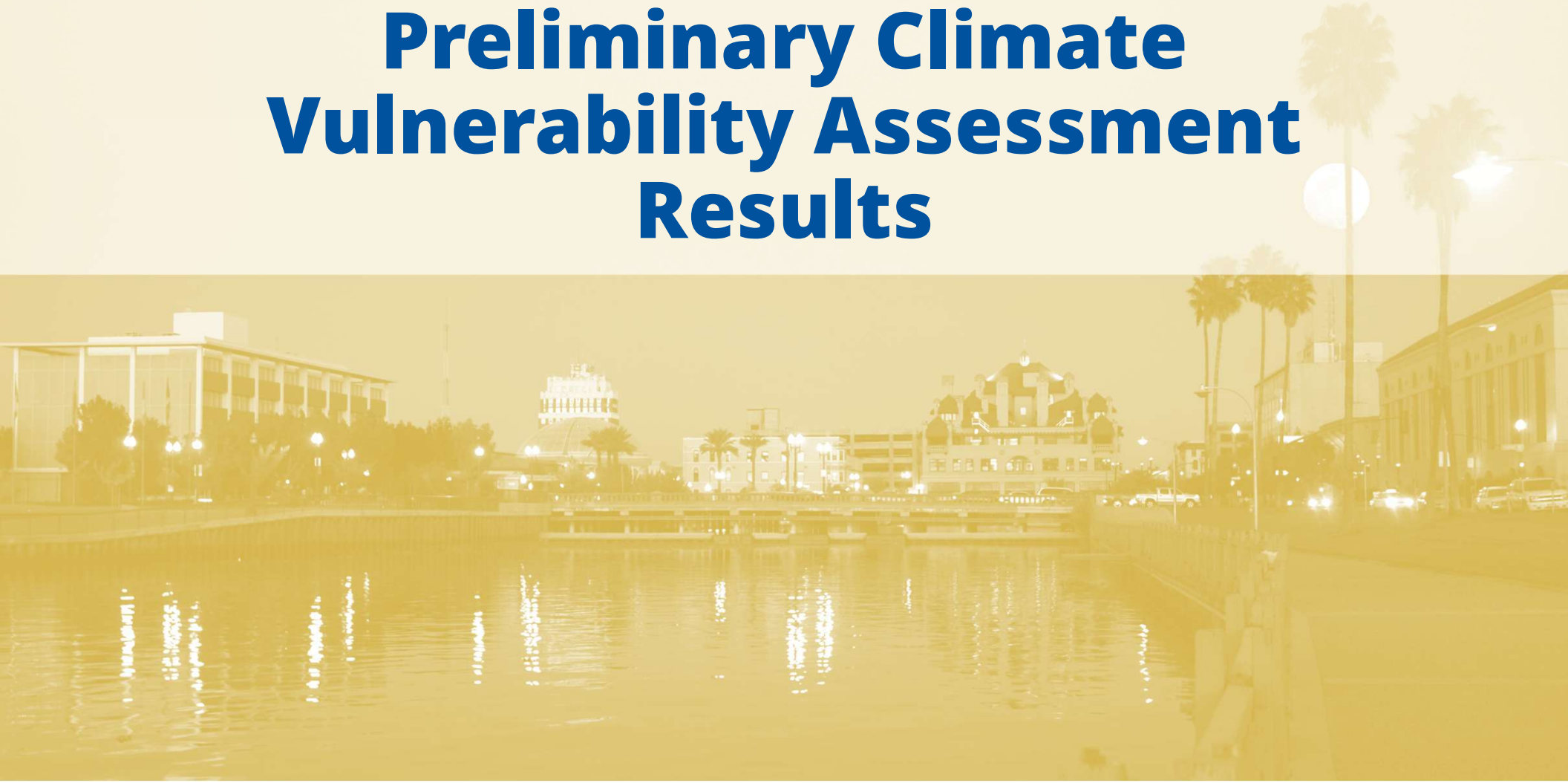
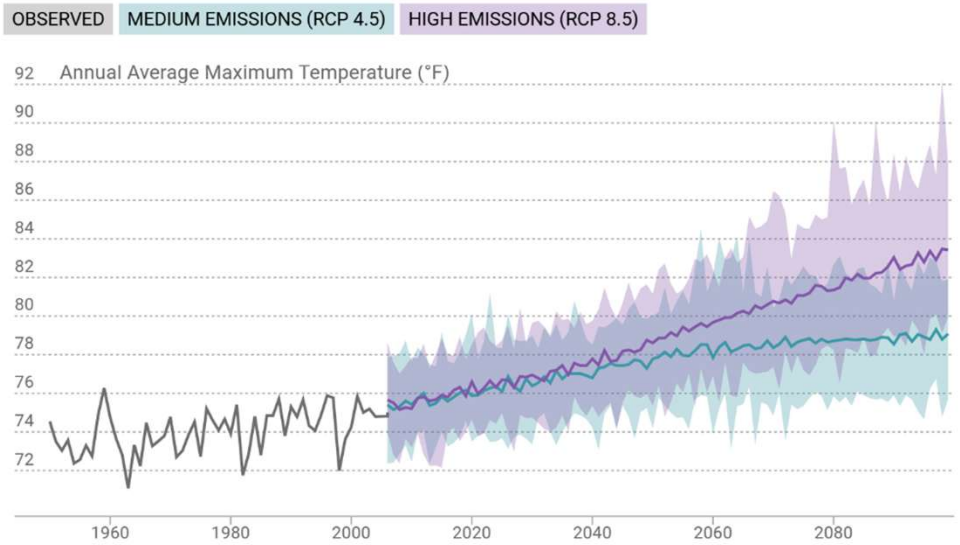
Preliminary Climate Vulnerability Assessment Results



Climate Vulnerability Assessment Overview

- Focused on the City of Stockton
- Develop a **vulnerability assessment** for the City of Stockton's infrastructure and communities through geospatial analysis.
- **Climate data:**
  - Extreme heat, drought, and precipitation climate projections are downscaled through Cal-Adapt, developed by the State of California
  - Flooding data uses FEMA flood maps.
  - Climate projections use the "business as usual" Representative Concentration Pathway (RCP) 8.5 scenario for global GHG emissions.
- **Asset data:** Sourced from the City of Stockton and State of California.
- Vulnerability determined as a product of **exposure and sensitivity:**

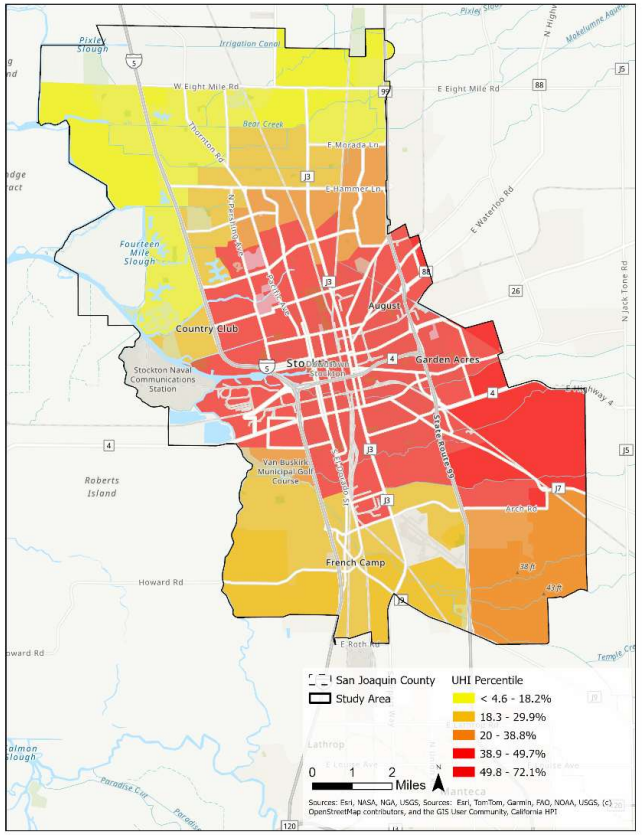
EXPOSURE x SENSITIVITY = VULNERABILITY



Extreme Heat & UHI Analysis

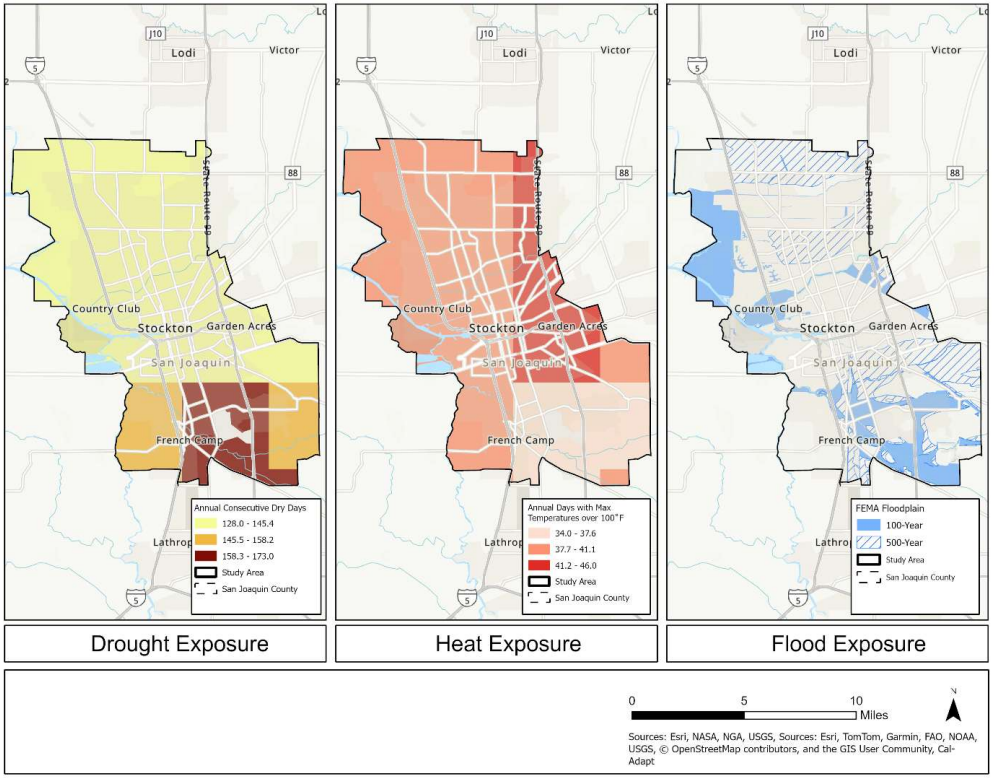
- **Extreme heat exposure was updated to account for the Urban Heat Island (UHI) effect, which reflects how land cover and development patterns influence local temperatures.** Highly urbanized areas with dense buildings, pavement, and limited tree canopy experience higher temperatures than areas with more vegetation and open space.
- **The Urban Heat Island Index from CalEPA (2015), used in the Healthy Places Index, measures how much hotter urban areas are compared to nearby rural reference areas, expressed as a statewide percentile.** Within Stockton, the highest UHI values occur in Downtown, Midtown, and South Stockton, while lower UHI values are observed in Bear Creek and Trinity.
- **Previously, extreme heat exposure was based only on the number of extreme heat days.** This did not reflect local heat amplification caused by urban development and limited tree canopy.

Updated Extreme Heat Exposure = (Days over 100 °F Exposure Score * 50%) + (UHI Exposure Score * 50%)



Climate Hazard Exposure Ratings

Climate Hazard	Source	Indicator	Low Exposure Range	Moderate Exposure Range	High Exposure Range
Extreme Heat	Cal-Adapt (4th Climate Change Assessment)	Annual days with max temperatures over 100˚F	34.0 – 37.6 days	37.7 – 41.1 days	41.2 – 46.0 days
	Cal EPA	Urban Heat Island Index (°F)	0 – 1.056	1.057 – 1.989	1.999 – 2.921
Flooding	FEMA Flood Map Hazard Severity Zones	100- or 500-year floodplain	Not in any floodplain	In the 500-year floodplain	In the 100-year floodplain
Drought	Cal-Adapt (4th Climate Change Assessment)	Annual number of consecutive dry days	128.0 – 145.4 days	145.5 – 158.2 days	158.3 – 173.0 days



Drought Exposure | Heat Exposure | Flood Exposure

Vulnerable Communities Exposure

Exposure for populations is only determined for **heat and flooding**, the hazards that pose the greatest risk to communities in the Stockton MSA.

- **For flooding,** the percentage of each census tract in the 100- or 500-year floodplain was determined.
- **For heat,** the weighted average (based on area in square miles) of extreme heat days per year projected for the mid-century timeframe and the Urban Heat Island Index Score form the Cal EPA was determined for each census tract.

Indicator	0-25th Percentile (1)	25th- 50th Percentile (2)	50th-75th Percentile (3)	75th to 100th Percentile (4)
Percent of tract in the 100- or 500-year floodplain	N/A	N/A	In the 500-year floodplain	In the 100-year floodplain
Cal EPA Urban Heat Island Index (°F)	0.84076	1.36910	2.42143	4.03559
Annual Days with Extreme Heat	39.65125	40.58	41.5785	42.8

Asset and Population Sensitivities

- Sensitivity determines how likely it is an asset or population will be disrupted, damaged, or harmed by exposure to a hazard.
- Population sensitivities used data from American Community Survey, Healthy Places Index, and the Climate Change and Health Vulnerability Indicators tool

Indicator	Source	Hazards	Rationale
Percent of Population Aged 16 and Older Working Outdoors	ACS 5 Year Estimates 2019-2023 (table C24010)	Heat	More sensitive to extreme heat due to prolonged exposure during high-temperature events.
Percent Population with a Disability	ACS 5 Year Estimates 2019-2023 (table DP02_0072PE)	Flooding	Individuals with disabilities may have reduced mobility or access to resources, making evacuation and recovery during floods more difficult.
Percent of Population Aged 65 and Older	ACS 5 Year Estimates 2019-2023 (table S0101_C01_030E)	Heat, Flooding	Older adults are more vulnerable to heat-related illness and may have limited ability to evacuate during floods.
Linguistic Isolation - Percent of households with no one aged > 5 years speaking English well	ACS 5 Year Estimates 2019-2023 (table DP02_011PE)	Heat, Flooding	Language barriers can limit access to emergency alerts, preparedness information, and recovery resources during disasters.
HPI Percentile (lower values = less healthy)	California Healthy Places Index	Heat, Flooding	Lower HPI scores indicate communities with poorer health outcomes and fewer resources, increasing vulnerability to climate hazards.
Poverty Rate (200% FPL)	ACS 5 Year Estimates 2019-2023 (table S1701_C01_042E)	Heat, Flooding	Low-income populations often have limited access to cooling, safe housing, and emergency resources, increasing risk during extreme events.
Percent Impervious Surface Cover - Population Weighted Average	Climate Change and Health Vulnerability Indicators, California Department of Public Health 2016	Flooding	High impervious surface cover reduces natural drainage, increasing flood risk and severity in urban areas.

Vulnerable Communities - Flooding

- **Over 74% of the census tracts** in the Stockton MSA have a **1% or 0.2% annual chance of flooding**.
- **Flood sensitivity is greatest in Central Stockton, driven by a combination of socioeconomic factors and impervious surfaces,** including disability, linguistic isolation, poverty, age 65+, and lower Healthy Places Index values.
- **Flood vulnerability** is greatest in western Stockton near Country Club and the Port and Mount Diablo Waterfront, as well as in North Stockton and South Stockton.

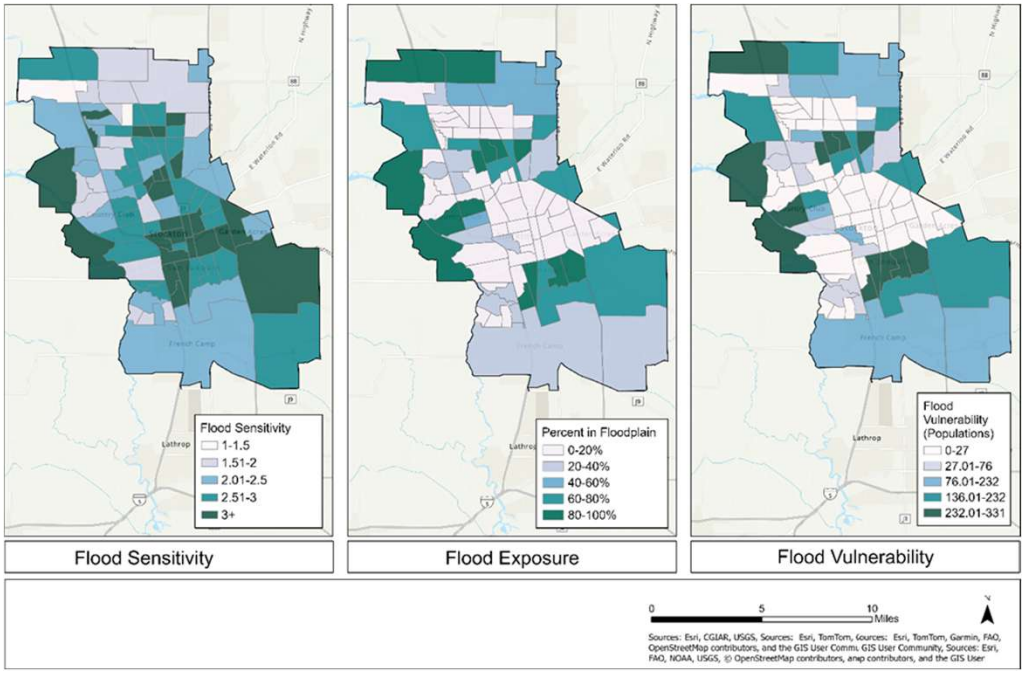


Image: Flood Population Sensitivity, Exposure, and Vulnerability

Vulnerable Communities - Extreme Heat

- **Heat vulnerability is greatest in Central Stockton, where the urban heat island is most intensely concentrated,** particularly in Downtown, Garden Acres, and through August to Morada/Holman.
- **Heat vulnerability** is highest in Country Club, Brookside, Midtown, Downtown, and Garden Acres, while heat exposure is highest in the eastern part of the city from August and Morada/Holman into the Eight Mile and Bear Creek area**.**

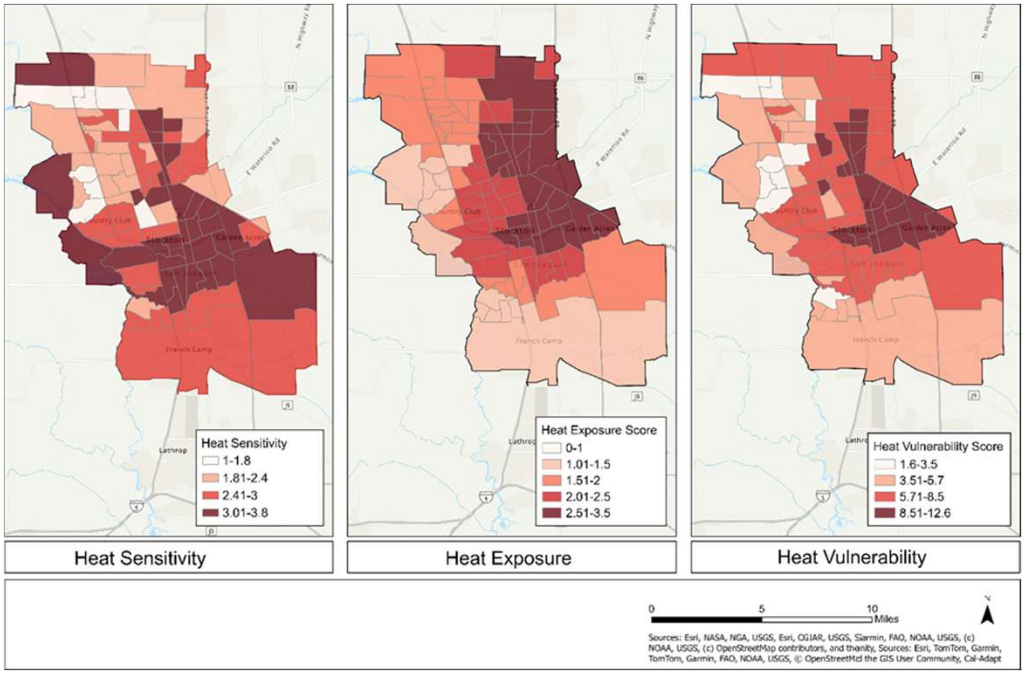


Image: Heat Population Sensitivity, Exposure, and Vulnerability

Vulnerability Findings – Critical Facilities

MEDICAL FACILITIES

Vulnerability Rating	None	Low	Moderate	High
Drought	0	5	1	0
Share of all facilities (%)	*0%*	*83%*	*17%*	*0%*
Extreme Heat	0	0	6	0
Share of all facilities (%)	*0%*	*0%*	*100%*	*0%*
Flooding	5	0	0	1
Share of all facilities (%)	*83%*	*0%*	*0%*	*17%*

POLICE STATIONS

Vulnerability Rating	None	Low	Moderate	High
Drought	0	3	2	0
Share of all facilities (%)	*0%*	*60%*	*40%*	*0%*
Extreme Heat	0	0	5	0
Share of all facilities (%)	*0%*	*0%*	*100%*	*0%*
Flooding	3	0	0	2
Share of all facilities (%)	*60%*	*0%*	*0%*	*40%*

Vulnerability Findings – Critical Facilities

FIRE STATIONS

Vulnerability Rating	None	Low	Moderate	High
Drought	0	11	1	0
Share of all facilities (%)	*0%*	*92%*	*8%*	*0%*
Extreme Heat	0	0	11	1
Share of all facilities (%)	*0%*	*0%*	*92%*	*8%*
Flooding	8	0	0	4
Share of all facilities (%)	*67%*	*0%*	*0%*	*33%*

Vulnerability Findings – Critical Facilities

SCHOOLS

Vulnerability Rating	None	Low	Moderate	High
Drought	0	7	79	53
Share of all facilities (%)	0%	5%	57%	38%
Extreme Heat	0	112	20	7
Share of all facilities (%)	0%	81%	14%	5%
Flooding	106	0	0	33
Share of all facilities (%)	76%	0%	0%	24%

COMMUNITY CENTERS

Vulnerability Rating	None	Low	Moderate	High
Drought	0	4	3	0
Share of all facilities (%)	0%	57%	43%	0%
Extreme Heat	0	0	3	4
Share of all facilities (%)	0%	0%	43%	57%
Flooding	3	0	0	4
Share of all facilities (%)	43%	0%	0%	57%

Vulnerability Findings - Transportation

ROAD AND STREETS

Vulnerability Rating	None	Low	Moderate	High
Drought	-	104.7	740.7	514.9
Share of all facilities (%)	0%	8%	54%	38%
Extreme Heat	-	1,049.0	214.1	97.3
Share of all facilities (%)	0%	77%	16%	7%
Flooding	1,074.1	-	221.0	65.3
Share of all facilities (%)	79%	0%	16%	5%

BRIDGES

Vulnerability Rating	None	Low	Moderate	High
Drought	0	130	17	0
Share of all facilities (%)	*0%*	*88%*	*12%*	*0%*
Extreme Heat	0	94	13	0
Share of all facilities (%)	*0%*	*88%*	*12%*	*0%*
Flooding	111	0	14	22
Share of all facilities (%)	*76%*	*0%*	*10%*	*15%*

Vulnerability Findings - Transportation

BIKE PATHS

Vulnerability Rating	None	Low	Moderate	High
Drought	-	243.7	51.4	31.3
Share of all facilities (%)	*0%*	*75%*	*16%*	*10%*
Extreme Heat	-	8.0	264.3	54.1
Share of all facilities (%)	*0%*	*2%*	*81%*	*17%*
Flooding	225.3	-	65.6	35.5
Share of all facilities (%)	*69%*	*0%*	*20%*	*11%*

RAILWAYS

Vulnerability Rating	None	Low	Moderate	High
Drought	-	84.0	22.2	-
Share of all facilities (%)	*0%*	*79%*	*21%*	*0%*
Extreme Heat	-	26.5	79.7	-
Share of all facilities (%)	*0%*	*25%*	*75%*	*0%*
Flooding	76.1	-	21.7	8.4
Share of all facilities (%)	*72%*	*0%*	*20%*	*8%*

Vulnerability Findings - Utilities

WATER TREATMENT PLANTS

Vulnerability Rating	None	Low	Moderate	High
Drought	0	0	2	0
Share of all facilities (%)	*0%*	*0%*	*100%*	*0%*
Extreme Heat	0	1	1	0
Share of all facilities (%)	*0%*	*50%*	*50%*	*0%*
Flooding	1	0	0	1
Share of all facilities (%)	*50%*	*0%*	*0%*	*50%*

WASTEWATER TREATMENT PLANTS

Vulnerability Rating	None	Low	Moderate	High
Drought	0	1	0	0
Share of all facilities (%)	*0%*	*100%*	*0%*	*0%*
Extreme Heat	0	1	0	0
Share of all facilities (%)	*0%*	*100%*	*0%*	*0%*
Flooding	1	0	0	0
Share of all facilities (%)	*100%*	*0%*	*0%*	*0%*

Vulnerability Findings - Utilities

SANITARY SYSTEM PUMP STATIONS

Vulnerability Rating	None	Low	Moderate	High
Drought	0	34	1	0
Share of all facilities (%)	0%	97%	3%	0%
Extreme Heat	0	23	2	0
Share of all facilities (%)	0%	92%	8%	0%
Flooding	26	0	2	7
Share of all facilities (%)	74%	0%	6%	20%

SANITARY SYSTEM LINES

Vulnerability Rating	None	Low	Moderate	High
Drought	-	841.3	170.1	45.3
Share of all facilities (%)	0%	80%	16%	4%
Extreme Heat	-	487.3	271.7	-
Share of all facilities (%)	0%	64%	36%	0%
Flooding	788.7	-	209.0	59.1
Share of all facilities (%)	75%	0%	20%	6%

Vulnerability Findings - Utilities

STORM SEWER LINES

Vulnerability Rating	None	Low	Moderate	High
Drought	-	668.1	131.7	42.5
Share of all facilities (%)	0%	79%	16%	5%
Extreme Heat	-	338.8	256.1	247.5
Share of all facilities (%)	0%	40%	30%	29%
Flooding	598.8	-	185.4	58.2
Share of all facilities (%)	71%	0%	22%	7%

WATER DISTRIBUTION LINES

Vulnerability Rating	None	Low	Moderate	High
Drought	-	536.2	87.6	55.3
Share of all facilities (%)	0%	79%	13%	8%
Extreme Heat	-	517.1	6.2	-
Share of all facilities (%)	0%	99%	1%	0%
Flooding	487.9	-	151.5	39.7
Share of all facilities (%)	72%	0%	22%	6%

Vulnerability Findings – Natural Systems

PARKS

Vulnerability Rating	None	Low	Moderate	High
Drought	0	76	12	3
Share of all facilities (%)	*0%*	*84%*	*13%*	*3%*
Extreme Heat	0	47	4	0
Share of all facilities (%)	*0%*	*92%*	*8%*	*0%*
Flooding	70	15	6	0
Share of all facilities (%)	*77%*	*16%*	*7%*	*0%*

WETLANDS

Vulnerability Rating	None	Low	Moderate	High
Drought	-	2.2	0.5	0.3
Share of all facilities (%)	*0%*	*74%*	*16%*	*10%*
Extreme Heat	-	2.2	0.6	0.1
Share of all facilities (%)	*0%*	*75%*	*21%*	*4%*
Flooding	0.8	-	0.4	1.8
Share of all facilities (%)	*27%*	*0%*	*14%*	*59%*