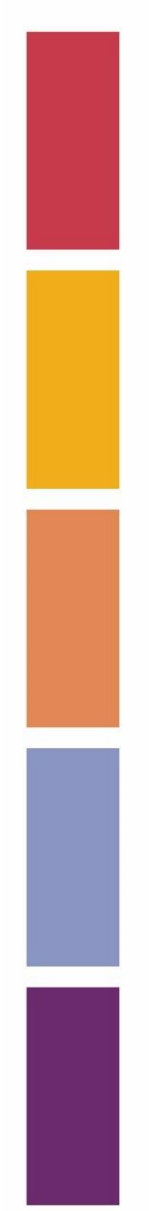

Plan Evaluation for Heat Resilience: City of Flagstaff, AZ

Plan Quality Evaluation for Heat Resilience and Plan Integration for Resilience Scorecard™ for Heat

Plan Evaluation for Heat Resilience: City of Flagstaff, AZ

July 31, 2024

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Recommended Citation: Keith, Ladd; Meerow, Sara; Roy, Malini; Trego, Shaylynn; Barrett, Karli; Jordan, Lindsey; and Gowda, Kavana Sadashive. (2024). *Plan Evaluation for Heat Resilience: City of Flagstaff, AZ*. Southwest Urban Corridor Integrated Field Laboratory (SW-IFL) – Arizona State University and University of Arizona.

Acknowledgments: This material was supported by the U.S. Department of Energy (DOE), Office of Science, Office of Biological and Environmental Research's Urban Integrated Field Laboratories research activity, under Award Number(s) DE-SC0023520. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. DOE.

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Executive Summary

The combination of climate change and the urban heat island (UHI) effect is increasing the number of dangerously hot days and the need for all communities to plan for urban heat resilience equitably. Urban heat resilience requires an integrated planning approach that coordinates strategies across community plans and uses the best available heat risk information to prioritize heat mitigation and management strategies for the most vulnerable communities. This report, supported by the U.S. DOE-funded Southwest Urban Corridor Integrated Field Laboratory (SW-IFL), summarizes the findings from two complementary methods for examining how different city plans shape urban heat resilience.

The first methodology, **Plan Quality Evaluation for Heat Resilience**, provides a broad assessment of how plans address heat and their effectiveness likelihood. We adapted well-established plan quality assessment approaches to heat (Meerow et al. 2024). We then applied the methodology to assess whether Flagstaff's plans meet 56 criteria across seven established principles of high-quality heat resilience planning. We also cataloged the types of heat mitigation and management strategies included in the plans.

The second methodology, the **Plan Integration for Resilience Scorecard™ (PIRS™) for Heat** provides a more detailed assessment of the heat mitigation policies and their spatial alignment with heat vulnerability. PIRS™ for Heat was developed as an extension of the original Plan Integration for Resilience Scorecard™, a methodology developed by Berke et al. (2015), and then further advanced and translated to planning practice by Malecha et al. (2019) for spatially evaluating networks of plans to reduce vulnerability to hazards. With support from the U.S. National Oceanic and Atmospheric Administration (NOAA) Climate Program Office's Extreme Heat Risk Initiative and in partnership with the American Planning Association, PIRS™ for Heat was initially piloted in five geographically diverse U.S. communities, including Baltimore, MD, Boston, MA, Fort Lauderdale, FL, Seattle, WA, and Houston, TX. The rationale, methodology, and findings from the first five cities are published in the guidebook *The Plan Integration for Resilience Scorecard™ (PIRS™) for Heat: Spatially evaluating networks of plans to mitigate heat*.

We analyzed all policies in Flagstaff's network of plans, including their comprehensive plan, hazard mitigation plan, and climate action plan. Policies were only included if they had the potential to impact urban heat, were place-specific, and contained a recognizable policy tool. Policies were then scored based on how they would likely impact urban heat. Scored policies were mapped to relevant census tracts across the city to evaluate their spatial distribution and the net effect on urban heat. The resulting PIRS™ for Heat scorecard was then compared with physical and social vulnerability data to assess policy alignment with heat risks and to identify opportunities for improved urban heat resilience planning.

Community Context

The City of Flagstaff, Arizona had a population of 76,831 in 2020. Located in the Southwest region of the U.S., Flagstaff's average daily maximum temperature is currently 69.9°F (21.06°C), with an average of 12 days over 100°F (37.8°C). Under high emissions scenarios, the average daily maximum temperature would increase to 77.9 °F (29.9°C) by 2100, with up to 50 days over 100°F (37.8°C), according to the U.S. Federal Government's *U.S. Climate Resilient Toolkit Climate Resilience Explorer*.

Table 1 lists the different plans that were analyzed for Flagstaff, the year they were adopted, the scale they were developed at (e.g., city, county), and the type of plan. We included comprehensive, climate, and hazard mitigation plans. We worked with city officials to select which plans would be most relevant for heat resilience.

Table 1. Network of plans

Plan Name	Year Adopted	Scale	Plan Category
Flagstaff Regional Plan	2014	City	Comprehensive
Coconino County Multi-Jurisdictional Hazard Mitigation Plan	2021	County	Hazard Mitigation
City of Flagstaff Climate Action & Adaptation Plan	2018	City	Climate

Plan Quality Evaluation for Heat Resilience

Methodology

Plan quality evaluation is an established method for evaluating the content of plans to see whether they contain elements that are thought to be important to the plan's effectiveness in achieving community goals (Berke and Godschalk 2009; Woodruff and Stults, 2016). Plan quality evaluation complements PIRS™ for Heat because, while the latter focuses on land use policies with the potential to mitigate heat, plan quality evaluation assesses the full range of potential heat mitigation and management strategies contained in plans as well as other principles of quality planning, including the goals, fact base, implementation and monitoring, coordination, public participation, and uncertainty. Together, these methods can help communities holistically evaluate heat resilience planning across their network of plans as demonstrated by Meerow et al. (2024).

Our **Plan Quality Evaluation for Heat Resilience** methodology (Meerow et al. 2024) draws on previous plan assessments by Woodruff and Stults (2016), Gabbe et al. (2021), and Keith, Gabbe, and Schmidt (2023) and follows best practices for content analysis. The assessment has two components: the Quality Principles Evaluation and the Heat Strategies Evaluation.

The **Quality Principles Evaluation** includes 56 criteria spanning seven principles as outlined in Meerow and Woodruff (2020) and Keith and Meerow (2022): goals, fact base, strategy identification, implementation and monitoring, coordination, public participation, and uncertainty. We conduct a binary assessment for all criteria: 1 if it is met in the plan, 0 if it is not. A full list of the Quality Principles criteria and their definitions, as well as the individual plan scores, are provided in Appendix A. It should be recognized that plans have different purposes and regulatory frameworks, and it is not necessarily expected that all plans meet all criteria.

The **Heat Strategies Evaluation** includes 27 distinct strategies spanning eight general categories of heat mitigation and management strategies (Figure 1). This is a generic typology of heat resilience strategies drawn from Keith and Meerow (2022); it is important to note that not all strategies will be equally relevant to all communities (Meerow & Keith, 2022) or plan types. The assessment is meant to show which potential strategies the city is proposing in each plan and whether they are explicitly linked to heat resilience. A full list of the Heat Strategies criteria and their definitions are provided in Appendix B.

Two members of the research team independently coded each plan and then any discrepancies were discussed by the full team. Following best practices for plan evaluation, we calculated intercoder reliability indicators, including the percent agreement and Krippendorf's Alpha.

Figure 1. Heat resilience strategies framework (Keith and Meerow, 2022)

Overall Plan Quality

Table 2 summarizes the three Flagstaff plans evaluated and their individual principle and overall plan quality scores (the average of the seven individual principle scores). All three plans had fairly similar overall plan quality scores. The City of Flagstaff Climate Action and Adaptation Plan 2018 received the highest overall plan quality score, with an average principle score of 68%. The County of Coconino Multi-Jurisdictional Hazard Mitigation Plan (2021) was second at 66%, followed by the Flagstaff Regional Plan 2030 at 61%.

Quality Principles Evaluation

Table 2 shows the percentage of criteria met for each of the seven principles. Flagstaff's plans were strongest in the *public participation, implementation and monitoring, and coordination* principles. Flagstaff plans included more than 75% of criteria for both *public participation* and

implementation and monitoring with the Climate Action & Adaptation Plan scoring 100% for *participation* and 91% for *implementation and monitoring*.

There are opportunities to improve four principles: *goals, fact base*, *strategy identification,* and *uncertainty* in different plans. Despite scoring high in other principles, the Climate Action & Adaptation Plan showed room for improvement in *fact base*, especially in terms of its information pertaining to heat risk and vulnerability. Similarly, Flagstaff Regional Plan 2030 did not meet any of the criteria for the *strategy identification* principle. While Flagstaff is relatively cooler than other Arizona cities, in a high emissions scenario, it could experience more than 100 days above 100°F by 2100. Developing a detailed fact base on heat risks and vulnerability and designing specific policies to address these vulnerabilities are crucial steps to proactively plan for heat risks in Flagstaff.

All Flagstaff plans have the opportunity to improve on the *uncertainty* principle. While the plans recognize climate uncertainty or multiple time frames, all three plans could benefit from aligning these concepts of uncertainties with strategy options. For example, Flagstaff plans could incorporate combinations of robust, flexible, no-regret strategies or adaptive management to balance the tradeoffs between changing planning capacities and climate impact uncertainties.

Table 2. Quality Principles Evaluation

Criteria	Flagstaff Regional Plan 2030 (2014)	Coconino County Multi-Jurisdictional Hazard Mitigation Plan (2021)	Flagstaff Climate Action & Adaptation Plan (2018)
Goals	67%	33%	67%
Fact Base	58%	67%	42%
Strategy Identification	0%	80%	80%
Implementation and Monitoring	73%	91%	91%
Coordination	88%	75%	75%
Public Participation	86%	86%	100%
Uncertainty	29%	14%	29%
Overall Plan Quality	**61%**	**66%**	**68%**

Heat Strategies Evaluation

Table 3 lists the different types of heat mitigation and management strategies (Figure 1) included in the three Flagstaff plans. One check mark indicates that the strategy was mentioned but not explicitly linked to heat, whereas two check marks indicate that the strategy was explicitly tied to heat in that plan.

Strategies like *green stormwater infrastructure, building waste heat reduction programs, education and awareness,* and *grid resilience* were found in all three plans. On the other hand, *land use and urban design policies like ventilation corridors, built shade structures,* and *building and street orientation* were not found in any of the three plans. Similarly, heat management strategies on *indoor cooling, school operations, heat response planning,* and *occupational safety regulations* were not integrated into any of the plans.

For both heat management and mitigation, the City of Flagstaff Climate Action and Adaptation Plan (2018) included the greatest diversity of strategies. The County of Coconino Multi-Jurisdictional Hazard Mitigation Plan had the most strategies explicitly linked to heat. There are also opportunities for the Regional Plan 2030 to include more heat management policies and tie proposed *land use, urban design,* and *urban greening* strategies directly to heat.

Table 3. Heat Strategies Evaluation

	Criteria	Flagstaff Regional Plan 2030 (2014)	Coconino County Multi-Jurisdictional Hazard Mitigation Plan (2021)	City of Flagstaff Climate Action & Adaptation Plan (2018)
Mitigation Strategies	***Land Use***			
	Ventilation corridors			
	Land conservation	✓		✓
	Urban Development Patterns	✓		✓
	Roadways and parking lots	✓		✓
	Urban Design			
	Built shade structures			
	Cool pavements			
	Building shape and massing	✓		
	Building and street orientation			
	Urban Greening			
	Vegetated parks and open spaces	✓		✓
	Green roofs and walls	✓		✓
	Urban forestry	✓		✓
	Water features	✓	✓	
	Green stormwater infrastructure	✓	✓	✓ ✓
	Waste Heat			
	Building waste heat reduction programs	✓	✓ ✓	✓ ✓
	Vehicle waste heat reduction	✓		✓
	Cool roofs and walls			
Management Strategies	***Emergency Preparedness***			
	Early warning systems		✓ ✓	
	Heat response plan			
	Cooling centers and resilience hubs		✓ ✓	✓ ✓
	Public Health			
	Education and awareness	✓	✓ ✓	✓ ✓
	Personal Heat Exposure			
	Transit systems operations			✓
	Parks and trails operations			✓
	School operations			
	Occupational safety regulations			
	Energy			
	Indoor cooling			
	Grid resilience	✓	✓ ✓	✓
	Accessible and affordable energy	✓		✓

Plan Integration for Resilience Scorecard™ (PIRS™) for Heat

Methodology

This application of the PIRS™ for Heat follows the steps outlined in the guidebook (Keith et al. 2022). This includes the creation of the scorecard by assembling the network of plans, identifying, categorizing, and scoring policies in those plans, and then mapping them. These results are analyzed by comparing them with data on physical and social vulnerability, leading to recommendations for future heat mitigation planning. PIRS™ for Heat has been used to conduct a detailed assessment of the heat mitigation policies and their spatial alignment with heat vulnerability across network of plans in Baltimore, MD, Boston, MA, Fort Lauderdale, FL, Seattle, WA, and Houston, TX by Keith et al. (2023), in Kent, WA by Trego, Meerow, and Keith (2023), and Tempe and Tucson, AZ by Meerow et al. (2024).

Plans and Policies

Table 4 summarizes the three Flagstaff plans assessed using the PIRS™ for Heat approach. Across the three Flagstaff plans, we identified 120 heat-relevant policies that met the criteria for inclusion.

Table 4. Plan detail summary

Plan Name	Year Adopted	Scale	Plan Category	Number of policies
City of Flagstaff Regional Plan 2030	2014	City	Comprehensive	65
Coconino County Multi-Jurisdictional Hazard Mitigation Plan	2022	County	Hazard Mitigation	3
Flagstaff Climate Action and Adaptation Plan	2018	City	Climate	52

We coded the 120 policies into six of the eight categories of land use policy tools (Table 5). Most of the policies were categorized as *capital improvements* (63 policies), followed by *development regulations* (23) and *land use analysis and permitting process* policies (21). We also collected several policies that used *financial incentives and penalties* (11). Few heat-related policies were identified that used *land acquisition* and *density transfer provisions* and none used *siting/sizing of public facilities* or *post-disaster reconstruction* decisions related to heat.

Table 5. Land use policy tool categories

Policy Tool Category	Number of Policies
Land Use Analysis and Permitting Process	21
Capital Improvements	63
Development Regulations	23
Land Acquisition	1
Density Transfer Provisions	1
Financial Incentives and Penalties	11
Public Facilities	0
Post Disaster Reconstruction Decisions	0

We also coded the 120 policies into all four heat mitigation strategy categories (Table 6). The most common categories of heat mitigation strategies were related to *waste heat* (67 policies), followed by *land use* (40) and *urban greening* (32). Together these accounted for the majority of policies. We found three policies focused on mitigating heat through *urban design*. Note that some policies were associated with more than one heat mitigation strategy category/subcategory, so individual heat mitigation strategy category totals add up to more than the 120 policies identified.

Table 6. Heat mitigation strategy categories

Heat Mitigation Strategy Category	Number of Policies
Land use	40
Urban design	3
Urban greening	32
Waste heat	67

Scorecard

Out of the 120 policies we coded, 88 policies were found with the potential to decrease heat in the built environment (receiving a score of +1), and six policies were found with the potential to increase heat in the built environment (receiving a score of –1). We did not code any policies with the potential to have a neutral heat impact in the built environment (receiving a score of 0). There were 26 policies classified as having an unknown impact on heat. Only the policies that received a score of +1 or -1 were mapped; the policies with an unknown impact on heat were excluded from the scorecard map.

Figure 2 shows the PIRS™ for Heat net scores (the sum of all the applicable +1 and -1 policies) for each census tract. Net scores ranged from 70 to 85 across the city. While there is some spatial variation in scores, the highest-scoring tracts tend to be near downtown Flagstaff and along Highway 40. Lower scores were found in the city's periphery.

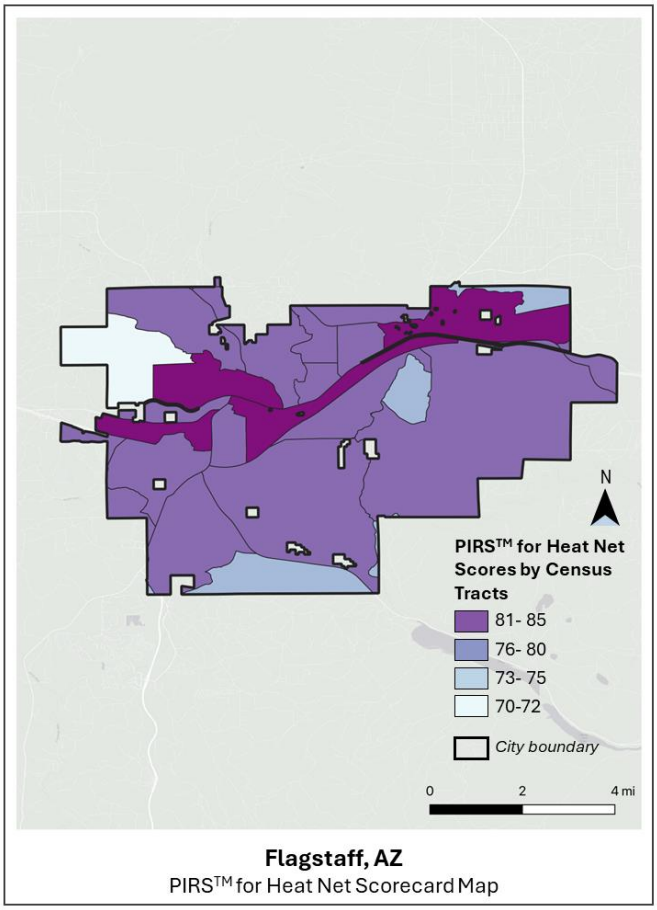

Figure 2. Flagstaff PIRS™ for Heat net scores by census tract

Analysis

Figure 3 shows: 1) Flagstaff's PIRS™ for Heat net scores for 2020 census tracts; 2) the 2015-2020 Mean Land Surface Temperature, by census tracts measured in Fahrenheit; and 3) CDC Social Vulnerability Index (SVI) ranking by 2020 census tract. We calculated Pearson correlation coefficients to determine if there was a statistically significant relationship between tract net scores and vulnerability indicators. We found a positive and marginally statistically significant correlation ($p < 0.1$) between PIRS™ for Heat net scores and the SVI index (coefficient: 0.41, p-value: 0.056). The marginal statistically significance may be due to the small sample, but may also reflect relatively higher heat mitigation policy attention in a few socially vulnerable areas.

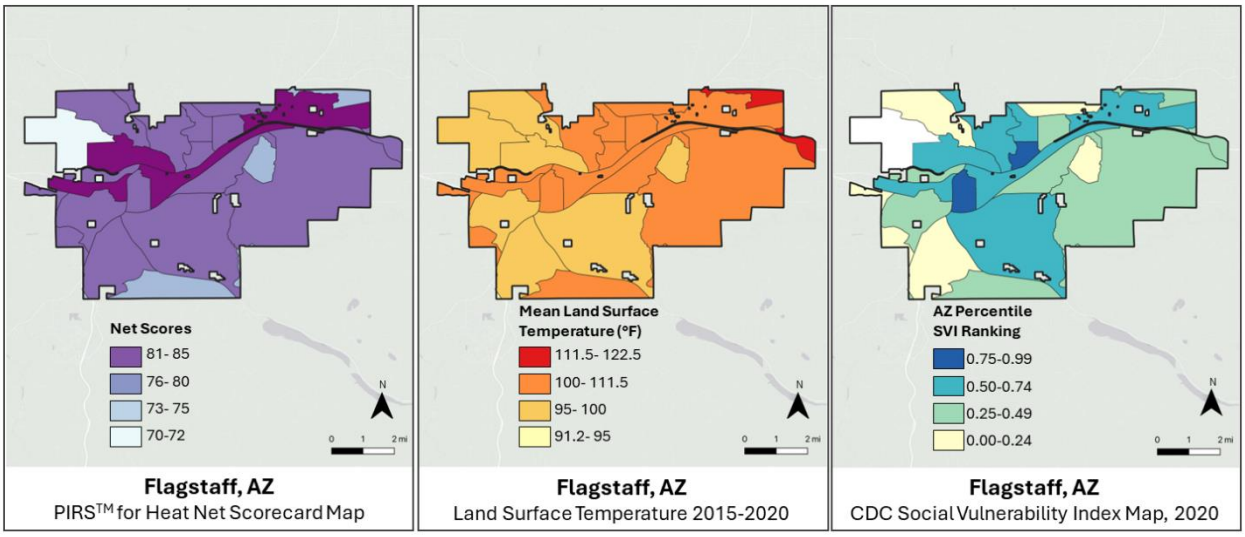

Figure 3. Flagstaff's PIRS™ for Heat net score by census tract (left), Mean Land Surface Temperature by census tract (middle), and CDC SVI ranking by census tract (right).

While we also see a positive correlation coefficient between the PIRS™ for Heat net score and Mean Land Surface Temperature, it was not statistically significant (coefficient: 0.198, p-value: 0.36). This suggests that Flagstaff plans do not systematically target areas with higher heat exposure with heat mitigation policies. This is especially true for rural census tracts at the city's periphery. The correlation coefficient between Mean Land Surface Temperature and SVI index is negligible and not statistically significant (coefficient: 0.06, p-value: 0.79). This suggests that in Flagstaff higher temperatures may not be experienced by areas with higher aggregate social vulnerability. This is in part because of a few outlying census tracts showing extreme surface temperatures.

Additionally, there are opportunities to review the six policies that were identified as potentially increasing heat hazard in Flagstaff. Moreover, 26 policies were coded as having an unknown impact on heat. It would be beneficial for the city to review these policies and add additional information on potential heat impacts or heat mitigation measures. Flagstaff may also want to consider the impact of policies on heat when developing future plans.

Going forward, Flagstaff can utilize the results from the PIRS™ for Heat analysis, as well as documented heat risk and social vulnerability data, to prioritize the most vulnerable areas of the city for policies that increase resilience to the impacts of heat and decrease heat in the built environment.

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Appendix: Plan Quality Evaluation for Heat Resilience

Appendix A. Quality Principles Evaluation

Principle	Criteria	Definition of the Criteria	Flagstaff Regional Plan 2030	Coconino County Multi-Jurisdictional Hazard	City of Flagstaff Climate Action & Adaptation
Goals	Plan purpose	Purpose of the plan is stated.	1	1	1
Goals	Vision Statement	Includes a vision statement. A vision statement establishes an overall image of a desired future (Berke et al. 2006).	1	0	1
Goals	Goals	Includes outcomes that the community aspires towards. Goals are usually expressed in adjectives and nouns (not verbs) and are not quantified (Berke et al. 2006).	1	1	1
Goals	Objectives	Includes objectives. Objectives are tangible, measurable outcomes leading to the achievement of a goal (Berke et al. 2006).	1	0	1
Goals	Heat risk reduction vision or goals	Goal or vision to reduce heat risks or damage. Heat is mentioned explicitly.	0	0	0
Goals	Heat equity goal	Goal or vision to reduce disparities in heat risk or enhance heat equity.	0	0	0
Goals Total	**6**		**4**	**2**	**4**
Goals Average	**100%**		**67%**	**33%**	**67%**
Fact Base	Data collection	Provides information about the type of data collected and analyzed in order to make the plan.	1	1	1
Fact Base	Heat hazard	Identifies heat as a community issue or threat to the city.	1	1	1

Principle	Criteria	Definition of the Criteria	Flagstaff Regional Plan 2030	Coconino County Multi-Jurisdictional Hazard	City of Flagstaff Climate Action & Adaptation
Fact Base	Urban heat island	Identifies the urban heat island as a community issue or threat to the city.	0	1	0
Fact Base	Climate change	Identifies climate change as a community issue or threat to the city.	1	1	1
Fact Base	Vulnerable populations	Identifies vulnerable populations that may be more affected by hazards or climate change broadly (e.g. referencing a social vulnerability index).	1	1	1
Fact Base	Heat vulnerable populations	Identifies vulnerable populations that may be affected by heat.	1	1	0
Fact Base	Maps existing heat	Includes a map of areas currently at risk of heat exposure.	0	0	0
Fact Base	Historical heat data	Includes data on past heat.	0	1	0
Fact Base	Heat projections	Includes projections of future heat.	1	1	1
Fact Base	Maps projected heat	Includes map of areas projected to be at risk of heat.	0	0	0
Fact Base	Maps heat vulnerability	Includes a map of heat vulnerability. "'Vulnerability' is the degree to which a population, individual or organization is unable to anticipate, cope with, resist and recover from the impacts of disasters." Examples: CDC's Social Vulnerability Index (SVI), socio-demographic maps.	0	0	0
Fact Base	Vegetation/urban forestry	Includes maps of urban forestry/vegetation. Encompasses maps that depict the estimation of vegation derived from satellite imagery or maps that depict actual locations of known and mapped trees. Examples: urban forestry maps, urban vegetation maps, land cover maps. Note: map(s) must include at least one of these examples (criterion wouldn't include maps of parks only).	1	0	0
Fact Base Total	**12**		**7**	**8**	**5**

Principle	Criteria	Definition of the Criteria	Flagstaff Regional Plan 2030	Coconino County Multi-Jurisdictional Hazard	City of Flagstaff Climate Action & Adaptation
Fact Base Average	**100%**		**58%**	**67%**	**42%**
Strategy Identification	Specific heat strategies	Includes strategies/actions that are explicitly linked to heat.	0	1	1
Strategy Identification	Cost	Estimates the cost of implementing heat strategies/actions.	0	1	1
Strategy Identification	Cost of inaction	States that taking action to adapt to climate change or heat costs less than not acting.	0	0	1
Strategy Identification	Co-benefits	Identifies co-benefits associated with heat strategies/action(s).	0	1	1
Strategy Identification	Maladaptation/Trade-offs	Recognizes trade-offs or maladaptation potential of some heat strategies/action(s).	0	1	0
Strategy Identification Total	**5**		**0**	**4**	**4**
Strategy Identification Average	**100%**		**0%**	**80%**	**80%**
Implementation and Monitoring	Internal Consistency	Actions are tied to specific goals or issues.	1	1	1
Implementation and Monitoring	Strong policies	Actions generally use mandatory (shall/require) as opposed to suggestive (should/may) language.	1	1	1
Implementation and Monitoring	Prioritized actions	Specific actions are prioritized, so some are indicated as higher priority than others.	0	1	1
Implementation and Monitoring	Timetable for implementation	Provides a timetable for when each action will be implemented.	0	1	1
Implementation and Monitoring	Implementation responsibilities	Mentions which organizations or agencies are responsible for actions.	1	1	1

Principle	Criteria	Definition of the Criteria	Flagstaff Regional Plan 2030	Coconino County Multi-Jurisdictional Hazard	City of Flagstaff Climate Action & Adaptation
Implementation and Monitoring	Funding	Identifies sources of funding to implement the plan.	1	1	1
Implementation and Monitoring	Heat specific funding	References heat-specific funding or funding opportunities.	0	0	0
Implementation and Monitoring	Monitoring plan	Includes a process for evaluating the plan, it may include indicators or metrics used.	1	1	1
Implementation and Monitoring	Reporting requirements	Includes requirements for regular reporting of implementation progress (e.g. annual progress report).	1	1	1
Implementation and Monitoring	Monitoring responsibility	Mentions who is responsible for monitoring plan implementation.	1	1	1
Implementation and Monitoring	Plan updates	Includes a method or timeline for updating the plan.	1	1	1
Implementation and Monitoring Total	**11**		**8**	**10**	**10**
Implementation and Monitoring Average	**100%**		**73%**	**91%**	**91%**
Coordination	Local university	States that local universities were engaged in the planning process.	1	1	1
Coordination	Federal agencies	States that national government agencies were engaged in the planning process.	0	1	0
Coordination	State agencies	States that State agencies were engaged in the planning process.	1	1	0

Principle	Criteria	Definition of the Criteria	Flagstaff Regional Plan 2030	Coconino County Multi-Jurisdictional Hazard	City of Flagstaff Climate Action & Adaptation
Coordination	Nonprofits	States that nonprofits were engaged in the planning process.	1	0	1
Coordination	Businesses	States that businesses were engaged in the planning process.	1	1	1
Coordination	Neighboring jurisdictions	States that neighboring jurisdictions were given the opportunity to participate in the planning process. Neighboring jurisdictions include regional planning organizations and counties as well as other cities, towns, or villages.	1	1	1
Coordination	Internal support	Describes agency support and involvement from within the local government.	1	1	1
Coordination	Elected official engagement	Mentions involvement of elected official(s) in the planning process.	1	0	1
Coordination Total	**8**		**7**	**6**	**6**
Coordination Average	**100%**		**88%**	**75%**	**75%**
Public Participation	Planning process	Describes the process undertaken to create the plan.	1	1	1
Public Participation	Plan preparation involvement	Describes the stakeholders involved in plan preparation.	1	1	1
Public Participation	Representative Stakeholders	Mentions how stakeholders who were involved represent all the groups affected by proposed policies or how the planning process sought to engage disadvantaged populations. Disadvantaged populations are those that may not traditionally be included in the planning process and may be adversely affected by climate change, such as the poor, elderly, or those for whom English is a second language.	0	0	1
Public Participation	Participation techniques	Mentions participation techniques used to create the plan, such as meetings, surveys, charettes, public comments on drafts, etc.	1	1	1

Principle	Criteria	Definition of the Criteria	Flagstaff Regional Plan 2030	Coconino County Multi-Jurisdictional Hazard	City of Flagstaff Climate Action & Adaptation
Public Participation	Public meetings	States that meetings were used to engage stakeholders and that these meetings were open to the public.	1	1	1
Public Participation	Planning or steering committee	States that a steering committee or advisory committee was used to guide plan creation.	1	1	1
Public Participation	Public participation maintenance	Discusses how public engagement will continue in plan maintenance/evaluation.	1	1	1
Public Participation Total	**7**		**6**	**6**	**7**
Public Participation Average	**100%**		**86%**	**86%**	**100 %**
Uncertainty	Acknowledge uncertainties	The plan acknowledges uncertainties involved in their estimation of vulnerabilities and/or risks.	1	0	0
Uncertainty	Adaptive management	Mentions adaptive management.	0	0	0
Uncertainty	Flexible Strategies	The plan explicitly recognizes the need of flexible adaptation strategies.	0	0	0
Uncertainty	No-regret strategies	No- or low-regrets strategies are discussed as an option to address uncertainty.	0	0	0
Uncertainty	Robust Strategies	Robust strategies are discussed as an option to address uncertainty.	0	0	0
Uncertainty	Scenario Planning	Mention that different scenarios of climate change were considered.	1	0	1
Uncertainty	Multiple time frames	Includes both short-term and long-term strategies.	0	1	1
Uncertainty Total	**7**		**2**	**1**	**2**

Principle	Criteria	Definition of the Criteria	Flagstaff Regional Plan 2030	Coconino County Multi-Jurisdictional Hazard	City of Flagstaff Climate Action & Adaptation
Uncertainty Average	**100%**		**29%**	**14%**	**29%**
OVERALL PLAN QUALITY	**100%**		**61%**	**66%**	**68%**

Appendix B. Heat Strategies Evaluation

Strategy	Definition of the Strategy
HEAT MITIGATION	
Land Use	
Ventilation corridors	An urban area that allows fresh air to flow through a city to "relieve the urban heat island effect, enhance ventilation and protect the land used for climatic and environmental enhancement in a city." Examples: wind corridors, urban canyon
Land conservation	Protecting natural land and returning developed land to its natural form. This also includes the preservation of working agricultural land and natural open space outside of a city. Examples: smart growth, infill development, urban growth boundaries
Urban Development Patterns	Urban development patterns refer to the spacing of buildings and infrastructure in a city. This relationship between urban open spaces, buildings, and urban layout plays a role in urban microclimate.
Roadways and parking lots	Asphalt and concrete have low albedos and high heat absorption, so efforts to reduce or eliminate parking lot requirements, reduce road lanes or narrow roads, and add more complete streets help mitigate heat.
Urban Design	
Built shade structures	Built shade structure designed for pedestrian use and protection from direct sun, which can be either attached to a building or free-standing. Examples: playground shade structures, ramadas, pergolas, awnings, canopies, arbors, and canvas
Cool pavements	Reflective surface coating for streets or sidewalks that store less heat and may have a lower temperature. Examples: cool coatings, cool sidewalks, reflective coating
Building shape and massing	Massing is the overall, basic shape of a building. The more compact a building is, the less amount of roof and wall exposure to the sun, making it easier to cool.
Building and street orientation	Solar, wind, and drainage elements that are considered in the orientation of streets and buildings to alleviate reduce waste heat and mitigate urban heat.
Urban Greening	
Vegetated parks and open spaces	Broadly, the network of planned and unplanned green spaces within a city, spanning both the public and private realms, and managed as an integrated system to provide a range of benefits. Examples: Parks, greenways; passive, active, and/or natural recreation areas
Green roofs and walls	Elements of green infrastructure on buildings that utilize living vegetation to increase the cooling inside and outside and reduce stormwater runoff. Examples: Living roofs and walls
Urban forestry	The planting, maintenance, care and protection of tree populations, such as shading trees, in urban settings. Urban forestry can be found in parks, gardens, landscaped boulevards, greenways, and street-side tree boxes.
Water features	Elements like pools, ponds, fountains, splash parks, natural water features, artificial waterfalls, and streams which can help to decrease the urban heat island effects. Note: does not include green stormwater infrastructure.

Green stormwater infrastructure	The "range of measures that use plant or soil systems, permeable pavement or other permeable surfaces or substrates, stormwater harvest and reuse, or landscaping to store, infiltrate, or evapotranspirate stormwater and reduce flows to sewer systems or to surface waters" Examples: sidewalk cutouts, street cutouts, bioswales, cisterns, and basins.
Waste Heat	
Building waste heat reduction programs	Policies and programs that incentivize or require more insulated and efficient buildings. Weatherization is the installation of building materials and utilities that make homes and buildings more comfortable and energy efficient, which also reduces energy costs. Weatherization assistance programs, which are through local governments and/or power companies and are for low-income residents, are different than weatherization projects (Houston CAP, 2020). Example: LEED requirements, sustainable and/or green building requirements/assistance
Vehicle waste heat reduction	Anything that reduces the use of traditional gasoline-powered vehicles. Examples: transit, active transportation, walkability, electric vehicles
Cool roofs and walls	A cool roof is a roofing system that delivers higher reflectance and absorbs lower amounts of solar radiation, compared to conventional materials, to reduce surface temperature. Cool walls are exterior walls with high albedo which helps to keep the inside cooler and decrease the urban heat island effect due to the exterior walls of the building. Examples: White painted roofs and walls, reflective roofs and walls
HEAT MANAGEMENT	
Emergency Preparedness	
Early warning systems	An early warning system is a communication system that will notify the general public about heat-health safety as a precaution to an extreme heat event. Examples: heat-health warning system, emergency heat warning system, heatwave warning system
Heat response plan	"A coordinated plan that describes and organizes activities to prevent heat-related morbidity and mortality in a community." Examples: Extreme heat emergency plan, heat wave emergency plan
Cooling centers and resilience hubs	"A cooling center is a location, typically an air-conditioned or cooled building that has been designated as a site to provide respite and safety during extreme heat." Examples: cooling shelters, resilience hubs
Public Health	
Education and awareness	The communication of heat safety and information. Examples: education campaigns, local news outreach
Personal Heat Exposure	
Transit systems operations	Transit systems are designed or operated to minimize heat exposure for passengers or to increase their thermal comfort. Examples: Bus or transportation stops be equipped with shading or water features so as to increase the thermal comfort of the people using them. Systems should operate with frequent and reliable service, and alerts for delays should be easily findable by the public.
Parks and trails operations	Parks and trails are managed to reduce heat exposure to users. Examples: Parks and trails that are closed during periods of extreme heat, signs warning about heat at a park entrance, informational campaigns for park and trail users.
School operations	Schools are designed or operated to minimize heat exposure or to increase thermal comfort. Examples: Rules about temperatures at which students can be outside and for how long, adjusting recess or physical education times, and adding shade to playground equipment.

Occupational safety regulations	Policies by a local government, beyond existing state and federal regulations, to ensure the thermal comfort and heat/health safety of workers exposed to unsafe heat conditions such as outdoor or warehouse workers. Examples: shifting work to early morning and late evening, frequent breaks, hydration, shade, other cooling tactics.
Energy	
Indoor cooling	Updating or introducing regulations and requirements for indoor cooling for institutions such as schools, child or elder-care facilities, or for landlords.
Grid resilience	The addition of decentralized, redundant power with renewable energy microgrids, or establishing smart demand-side management programs that incentivize or remotely implement reduced power use by certain customers during high-demand periods. Building code updates that allow and account for emerging technologies.
Accessible and affordable energy	Grants, loans, or programs that reduce the cost of heating or cooling a home, which are typically funded through electric companies, governments, or local organizations. Note: these are most commonly targeted at seniors and low-income households.