Tahoe Climate Resiliency Dashboard

Draft Metrics

August 2, 2023

Prepared for: Tahoe Regional Planning Agency

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Acknowledgements

ECONorthwest prepared this report for the Tahoe Regional Planning Agency (TRPA). ECONorthwest and TRPA thank those who helped develop the Draft Climate Resiliency Dashboard Metrics.

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Executive Summary

The Tahoe Regional Planning Agency (TRPA), California Tahoe Conservancy (CTC) and many other federal, state, and local public, private, and non-profit organizations are working to reduce GHG emissions and make the Lake Tahoe Region's urban and natural environments resilient to climate change. To advance the region's climate goals, ECONorthwest is leading a team of consultants supporting TRPA in developing a Climate Resilience Dashboard. This will build on the work of the existing Sustainability Dashboard with updates to better track and tell the story of climate resilience in the Lake Tahoe region.

This report provides a summary of takeaways from preliminary research and engagement work as well as an initial analysis of draft metrics selected by the Steering team. Based on the Steering Team's feedback and TRPA staff guidance, the project team will use this initial list of metrics to develop the final recommended resilience metrics to be used in the Dashboard.

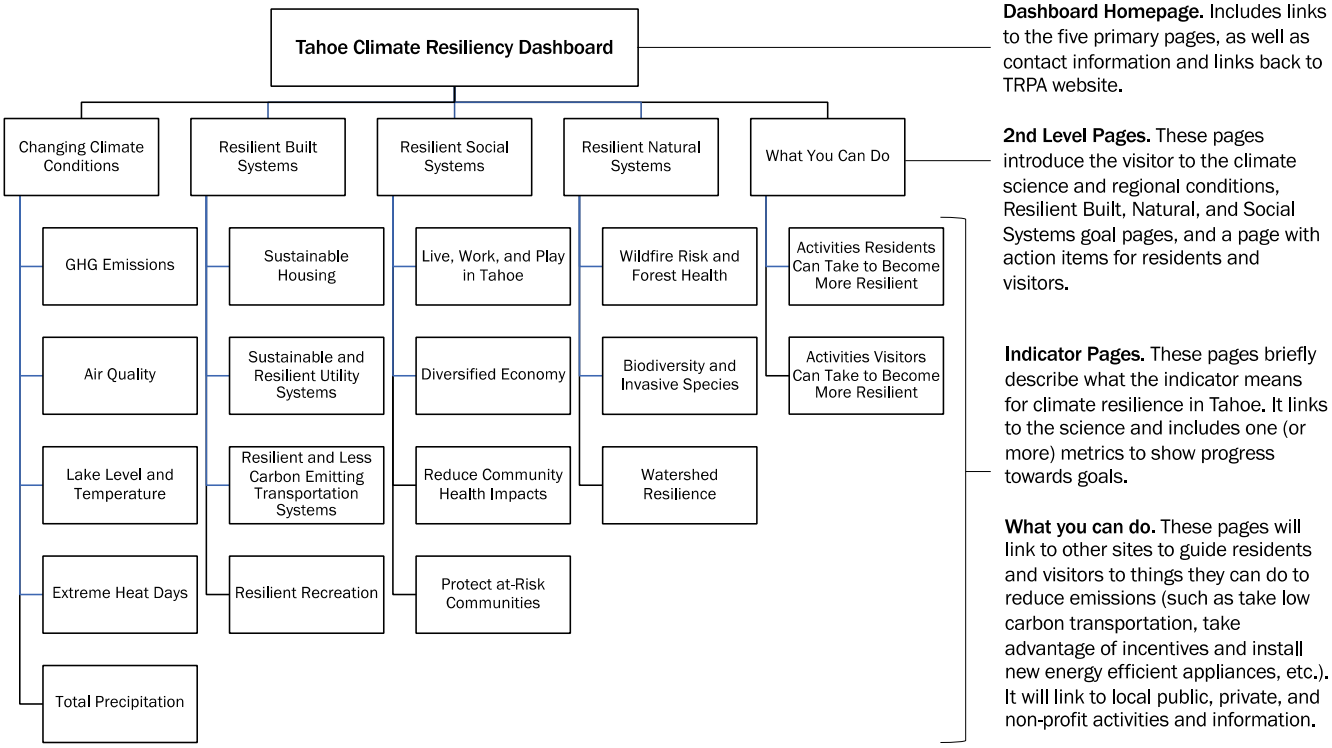
Through this process, the project team recommends identifying regional climate resilience goals, indicators, and metrics as key organizational elements for developing the Dashboard:

- **Goals:** General, high-level aspirations for the Tahoe Region related to climate actions. Goals are general statements on what should be accomplished. They provide direction for community decisions. **Goals should be general, simple, and comprehensively encompassing a set of indicators and metrics.**
- **Indicators:** According to the EPA, an indicator "represents the state or trend of certain environmental or societal conditions over a given area and a specified period of time."[1] **Indicators provide more detail on how to achieve the overarching goals and there is often more than one indicator associated with each goal.** Indicators can include targets or benchmarks. Measuring performance through targets or benchmarks helps evaluate the performance towards achieving established goals. They typically include a start year, length of time, and target. Measures can include quantitative data or qualitative assessments. These should be tied to clear measurable long-term outcomes and should be informed by specific metrics.
- **Metrics: A metric must be understandable and useful for measuring the progress of meeting an indicator (which can be a target) that can be measured with data available over time (can draw from quantitative or qualitative data).** The data should be updated on an ongoing basis, ideally using values that can be compared to past values. Each metric is accompanied by a narrative that describes the purpose of the metric, how it impacts the region, actions being taken to meet regional goals for that metric, and ways the public can get involved. Users can use metrics to assess, plan for, measure, and monitor progress towards desired outcomes and greater resilience.

[1] United States Environmental Protection Agency, "Climate Change Indicators," July 18, 2021, https://www.epa.gov/climate-indicators/frequent-questions-about-climate-change-indicators#q1.

Using best practice guidance, a comprehensive review of existing climate planning documents, and feedback from stakeholders, the project team identified regional goals and indicators for the Lake Tahoe region. This resulted in the following recommended layout for the Climate Resilience Dashboard shown in Exhibit 1.

Exhibit 1. Proposed Storyboard for the Tahoe Climate Resiliency Dashboard
Source: ECONorthwest



Within this proposed structure of the Dashboard, the project team identified and evaluated 51 climate resiliency metrics. These metrics were vetted by the team to ensure that they are relevant in terms of measuring climate goal outcomes and describing the risk or other conditions in the Lake Tahoe region. They were evaluated to ensure that data sources are up-to-date (to the greatest extent possible), credible, and verifiable. The full list of the metrics evaluated is listed in Exhibit 2.

Exhibit 2. Summary of Draft Climate Resiliency Metrics

Goal	Indicator	Metric
Recognize the Changing Climate Conditions	**GHG Emissions**	Total GHG Emissions
		GHG Emissions by Sector
	Air Quality	Poor air quality days per year, number of wildfire smoke days
	Lake Level & Temperature	Lake Tahoe water level
		Annual average water temperature, including surface temperature
	Extreme Heat Days	Number of extreme heat days per year
	Total Precipitation	Total precipitation in water per year, snow as a fraction of annual precipitation

Goal	Indicator	Metric
Resilient Built Systems	**Support Increased Access to Sustainable Housing**	Total number of housing units in town centers
		Share of housing affordable to workforce in town centers
		Participating in (or funding for) energy efficiency programs
		Number of deed-restricted affordable, moderate, and achievable units
		Number of homes hardened
	Support Sustainable and Resilient Utility Systems	Miles of transmission lines hardened (upgraded or undergrounded)
		Number of new hydrants, increased pipe size
		Percent of renewable energy as a share of total energy used
	Upgrade Transportation Systems	Total Transit Ridership, Frequent service (20-minute headways)
		Total Micro-transit Ridership
		Daily per capita Vehicles Miles Traveled (VMT)
		Quantity of alternative fuel stations, EV charging/ hydrogen, Quantity of transit fleet, jurisdictional fleets with zero emission vehicles
		Baseline mode share and weekday or seasonal variation
		Transportation access in priority communities
		Increased lane miles of low-stress bicycle facilities
		Baseline inventory of vulnerable facilities
Resilient Social Systems	**Enhance Access for People to Live, Work, Learn, and Play in Tahoe Sustainably**	Permanent population disaggregated by race and ethnicity, age groups
		Median Household income by jurisdiction and disaggregated by remote and non-remote workers
		Housing costs (median home sales price and rental rates, by jurisdiction)
		Housing tenure (rented full-time, owner-occupied, vacation rental, second home), disaggregated by race, ethnicity, and age
		K-12 public school enrollment data and number of days of school closures due to extreme weather or poor air quality
		Percent of students receiving free or reduced cost lunch
		Percent of workers who commute into the basin on a seasonal basis, origin demographics, distance travelled, and difference in travel time by mode
	Increase Tahoe's Economic Diversity and Resilience, with a Focus on Sustainable Recreation	Number of days public recreation sites, resorts, or ecotourism facilities are closed due to extreme weather or wildfire or the amount of revenue lost
		Number of days recreation facilities are at full capacity
		Transient Occupancy Tax revenue and changes over time
		Total lodging revenues and change over time
		Average annual wages in the tourism industry
		Consistent employment, seasonal workers unemployment rates, and median wages by sector and overall
		Visitor device data as a proxy of visitor frequency and patterns
	Prevent or Reduce Community Health Impacts Associated with Climate Change	Number of days cooling centers or community resiliency centers are open
		Number of Firewise communities in the Tahoe basin
	Equitably Protect At-Risk Communities from Impacts	Number/share of households with access and functional needs (people with disabilities, older adults, children, limited English proficiency, and transportation disadvantaged)
		Map of zero vehicle household concentration, cooling/community resource centers, and a list of the medical support in emergencies

Goal	Indicator	Metric
Resilient Natural Systems	**Reduce Wildfire Risk and Build Forest Health**	Acres of forest fuels reduction treated for wildfire in high-risk areas, map of areas with prescribed fire treatment and project sites
		Tree species diversity and increasing old growth forest
		Wildfire risk metrics such as restoration after, smoke/ash, treatment before
	Increase Biodiversity and Reduce and Control Invasive Species	Acres treated for invasive species
		Watercraft inspections for invasive species
	Increase Watershed Resilience	Acres of restored high-quality wetlands and meadows (also referred to as Stream Environment Zones) helping to store flood waters
		Increase number of parcels with Stormwater Best Management Practices (BMPs) improvements
		Lake Clarity measured by Secchi Depth
		Shared stormwater basin project investment
		Map of carbon sequestration measurement

1. Introduction

1.1 Overview

Project Background

The threats from greenhouse gas (GHG) emissions and climate change call for robust action. While this is a global challenge: the threats of climate change to the Lake Tahoe Region are significant: more frequent forest fires, loss of snowpack, increasing severe storms, flooding, loss of species biodiversity and increased invasives, and increased costs for infrastructure repairs and emergency services. To address these challenges, the Tahoe Regional Planning Agency (TRPA), California Tahoe Conservancy (CTC) and many other federal, state, and local public, private, and non-profit organizations are working to reduce GHG emissions and make the region's urban and natural environments resilient to climate change.

The purpose of this project is to develop a Climate Resilience Dashboard (the Dashboard) that demonstrates the progress of regional partners on climate goals and communicates this to decision makers, regional partners, funders, and regulators (the primary audience), as well as providing transparency and showing progress to stakeholders, residents, and visitors (the secondary audience). ECONorthwest is leading the consulting team that will build on the existing Sustainability Dashboard to develop a local reporting tool that tracks metrics relating to climate resilience in the Lake Tahoe Region. The metrics included in this Dashboard will help tell the story of climate resilience and engage the broader public in the conversation around climate action. It also provides professional staff a consistent source of information to show activities and track progress for reporting and funding requests. The next task of this project will provide the final dashboard metrics (Task 3) which will be part of the dashboard's technical development and final launch (Tasks 4 and 5).

Purpose of this Report

This memorandum presents the goals, metrics, and indicators that the project team identified through initial research and engagement, as well as a logic model that clearly illustrates the relationship between the climate goals, projects, and the draft Dashboard metrics selected for initial evaluation. Multiple organizations are working to increase the resiliency of the Lake Tahoe region to climate change. To begin developing improved metrics for tracking progress towards climate goals, the consulting team led by ECONorthwest convened a workshop of local stakeholders, researched best practices and existing plans, and interviewed twenty individuals at key organizations in the Lake Tahoe area.

This document provides a summary of takeaways from this work as well as preliminary analysis of draft metrics selected by the Steering team. Based on the Steering Team's feedback and TRPA staff guidance, the project team will use this initial list of metrics to develop the final recommended resilience metrics.

1.2 Approach

Dashboard Purpose

The Climate Resilience Dashboard is being developed to serve as a local reporting tool that tracks metrics relating to climate resilience in the Lake Tahoe Region. The metrics will help tell the story of climate resilience and engage regional partners and the broader public in the conversation around climate action, building on previous work including the original Sustainability Dashboard. As the consulting team works with TRPA and the Steering Team to consider a variety of metrics that accurately measure the social, environmental, and economic progress of climate-related goals, the following objectives were identified to guide our work:

Proposed Dashboard Objectives

- Design a new Climate Resilience Dashboard to provide a broad understanding of climate action in Tahoe.
- Focus on metrics of regional significance that are connected to Tahoe Region planning, funding needs, or climate project investment accountability.
- Align climate resilience metrics with existing established goals and metrics, building on information previously developed, and reflecting the best available data, knowledge, and science relevant to the Tahoe Region.
- Provide clear transparent project information to increase stakeholder awareness of and preparation for climate change impacts.
- Promote resilient natural, built, and social systems including sustainable recreation and economy.

Evaluation of Potential Metrics

With these goals in mind, the project team developed a set of criteria to systematically evaluate potential indicators and metrics, as shown in Exhibit 1. These parameters were intended to determine which of the **51 proposed metrics** are the most advantageous to move forward, using guidance from TRPA staff about what aspects of these metrics are most important. Those which were not favorably evaluated were also documented to potentially be used in the future if new information channels become available.

Each of these criteria was assigned a numeric score in order to evaluate metrics on a scale of one through twenty, with higher numbers indicating a better fit for the Climate Resiliency Dashboard. Since some aspects of these metrics are more complex than could be evaluated in this way, we also included a bonus score option for metrics that have direct connections to climate resilience in best practices literature.

Exhibit 1. Criteria and Scoring for Metrics Evaluation

KEY		Maximum Score: 20
Cost ($, $$, $$$)	**Score**	**Description**
Free	4	No cost for purchasing data (agencies will provide data, cost is covered by another budget, or TRPA already has software to analyze data).
$	3	The data would cost less than $500.
$$	2	Cost would be over $500 but less than $1,000
$$$	1	Cost would be over $1,000.
Utility Rating	**Score**	**Description**
Low	1	Low value to decision making processes influencing investment and future action.
Medium	2	The metric provide medium value to decision making processes influencing investment and future action.
High	3	The metric provide high value to decision making processes influencing investment and future action.
Quality of Metric and Data Source	**Score**	**Description**
Low	1	Metric provides limited value in understanding climate change planning progress for the region and adaptation concerns/context. Uncertainty about whether the data is reviewed, accuracy concerns.
Medium	2	Metric provides value in understanding climate change planning progress for the region and adaptation concerns/context. Data is agency sourced (credibility is high) or privately sourced from a credible organization, reviewed (QA/QC).
High	3	Metric provides high value in understanding climate change planning progress for the region and adaptation concerns/context. Metric is well established and has been used by other agencies/organizations. Data is agency sourced (credibility is high) or privately sourced from a credible organization, peer reviewed and science based, and reviewed (QA/QC).
Staff Effort	**Score**	**Description**
Low	3	The metric is anticipated to require minimal staff effort to track and update.
Medium	2	The metric would likely take a routine amount of staff capacity to track and update.
High	1	The metric requires a higher level of staff involvement and likely consultant support to track and update.
Understandable	**Score**	**Description**
Low	1	The metric is hard to understand and highly challenging to describe clearly for the Dashboard audience.
Medium	2	The metric could be understood with additional background information.
High	3	The metric is easy to understand and only requires a minor amount of background information.
Regional Scale	**Score**	**Description**
Yes	1	Data for this metric is available or can be pulled specifically for the Lake Tahoe area.
Somewhat	0	Data for this metric is not available specifically for the Lake Tahoe area, but can be pulled for counties, service areas, or other proximate geographies. (included to preserve details on data during scoring).
No	0	Data for this metric is not clearly available for Lake Tahoe.
Bonus Score	**Score**	**Description**
Direct Climate Resiliency Score	0-3	This metric is highly relevant for climate resiliency, and it generally recognized as an important consideration for meeting climate goals.

Defining Climate Resilience

Climate resilience can have different meanings for different organizations and individuals. To develop a Climate Resilience Dashboard that tracks specific metrics with clear intended outcomes, a consistent definition of climate resilience is critical to ensure that the Tahoe region is working towards shared goals. Conversations with stakeholders highlighted that resilience should cover the capacity to prosper under a wide range of climate-influenced circumstances.

Recognizing the existing Tahoe narrative around climate resilience provides foundational information useful for shaping the focus of the new Climate Resilience Dashboard. TRPA's 2021 Regional Transportation Plan[2] and CTC's 2022 Tahoe Climate Resilience Action Strategy[3] provide insights on how climate resilience is understood in the region but there is no specific definition for climate resiliency recognized in the regional level planning documents reviewed.

TRPA's climate initiative in general focuses on harmonizing the goals of both states and local governments while maintaining the Region's reputation as a global leader in sustainability. The 2021 RTP recognizes climate resilience as a goal and provides a description of climate resiliency and climate change impacts as:

> *"Impacts [that] pose significant and growing risks to the safety, reliability, effectiveness, and sustainability of the Tahoe Basin and its transportation network. Many impacts are already occurring, and Lake Tahoe communities need to adapt to become more resilient to these changes. Higher temperatures, changes in seasonal precipitation, the intensity of rain events, and extreme weather can degrade roadways, damage culverts, and disrupt traffic. Preparing for climate change and extreme weather events is an important element of protecting the integrity of Tahoe's transportation system, the investment of taxpayer dollars, and the achievement of the plan's goals. Additionally, TRPA recognizes the broader need to address climate change in a holistic manner that connects to environmental justice."*[4]

The RTP further recognizes that TRPA has been working with partners to develop a cohesive set of bi-state regional strategies that will result in climate change mitigation, adaptation, and resiliency for the region by building on regional climate action to date and best science and planning practices.[5]

Additionally, the 2022 Tahoe Climate Resilience Strategy published by CTC recognizes an integrated approach to building resilience that focuses on three main systems: the Lake Tahoe water system, the forested upland system, and communities in the Basin.[6] They cite climate

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[2] Tahoe Regional Planning Agency, "Regional Transportation Plan," 2021, https://www.trpa.gov/rtp/.

[3] California Tahoe Conservancy, "Tahoe Climate Resilience Action Strategy," 2022, https://www.laketahoeinfo.org/LocalAndRegionalPlan/Detail/1171.

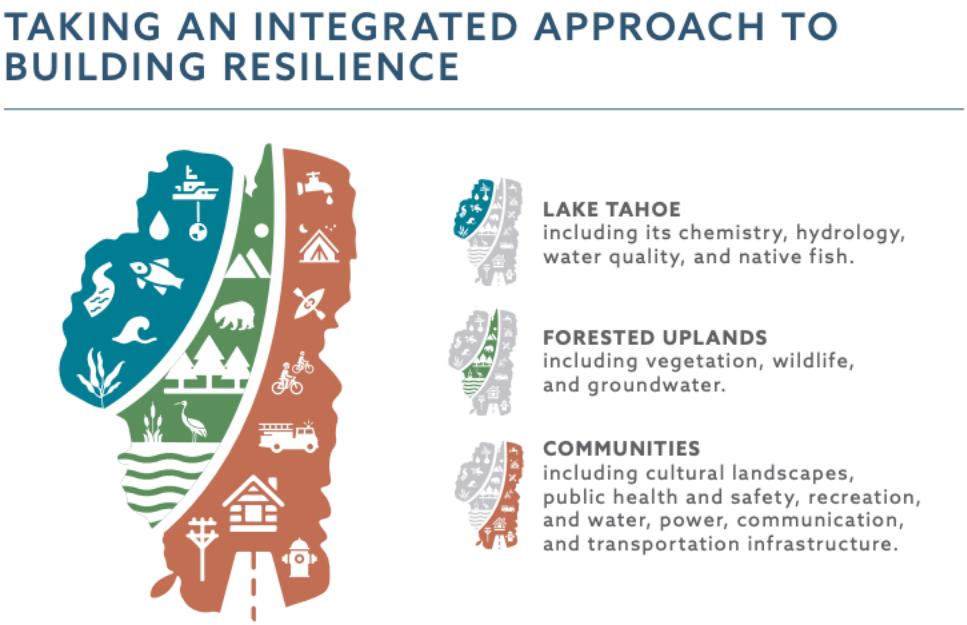
[4] Tahoe Regional Planning Agency, "Regional Transportation Plan,"30.

[5] Ibid.

[6] Ibid.

resilience priorities surrounding the need to expand public access to amenities; elevating the role of the natural lands in fighting climate change and advancing biodiversity conservation; restoring natural infrastructure; and safeguarding jobs, rural economies, and vulnerable communities and advancing equity.[7]

Exhibit 2. Tahoe Climate Resilience Action Strategy Approach
Source: TRPA, 2022



Dashboard Organization Elements

While the current Sustainability Dashboard uses a range of indicators to measure different environmental and social data, the Climate Resilience Dashboard will have an expanded scope that consists of several key elements, including **goals, indicators,** and **metrics.** These elements were influenced by our team's best practices research completed as part of this task. In the context of the dashboard, these are defined as:

- **Goals:** General, high-level aspirations for the Tahoe Region related to climate actions. Goals are general statements on what should be accomplished. They provide direction for community decisions. **Goals should be general, simple, and comprehensively encompassing a set of indicators and metrics.**
- **Indicators:** According to the EPA, an indicator "represents the state or trend of certain environmental or societal conditions over a given area and a specified period of time."[8] **Indicators provide more detail on how to achieve the overarching goals and there is often more than one indicator associated with each goal.** Indicators can include targets

[7] California Tahoe Conservancy, "Tahoe Climate Resilience Action Strategy," 3.

[8] United States Environmental Protection Agency, "Climate Change Indicators," July 18, 2021, https://www.epa.gov/climate-indicators/frequent-questions-about-climate-change-indicators#q1.

or benchmarks. Measuring performance through targets or benchmarks helps evaluate the performance towards achieving established goals. They typically include a start year, length of time, and target. Measures can include quantitative data or qualitative assessments. These should be tied to clear measurable long-term outcomes and should be informed by specific metrics.

- **Metrics: A metric must be understandable and useful for measuring the progress of meeting an indicator (which can be a target) that can be measured with data available over time (can draw from quantitative or qualitative data).** The data should be updated on an ongoing basis, ideally using values that can be compared to past values. Each metric is accompanied by a narrative that describes the purpose of the metric, how it impacts the region, actions being taken to meet regional goals for that metric, and ways the public can get involved. Users can use metrics to assess, plan for, measure, and monitor progress towards desired outcomes and greater resilience.

2. What We Learned

2.1 Existing Dashboard Review

The Tahoe Regional Planning Authority (TRPA) is designing a new Climate Resilience Dashboard to **provide a broad understanding of climate action in Tahoe for decision makers and public stakeholders.** The existing TRPA Sustainability Dashboard needs to be revised to better reflect how climate change is impacting the region and what TRPA and other local agencies are doing to reduce greenhouse gas emissions and to build a more resilient region. According to TRPA's recent Climate Resilience Dashboard White Paper developed in 2013 to support the original Dashboard:

> *The current dashboard tracks 31 sustainability metrics across the triple bottom line of environment, community, and economy. The metrics are organized by 11 sub-categories. These metrics are updated on an annual basis as data is available. Since development of the sustainability dashboard, data for some of the metrics has become impossible or highly difficult to collect. The overall dashboard also needs to be refreshed to better reflect current science and action toward climate resilience.*[9]

This project will aim to better reflect updated climate action work in the past ten years, as well as the current regional atmosphere and priorities.

2.2 Best Practice Research Findings

While establishing the draft climate resilience metrics presented in this memorandum, the consultant team reviewed best practices for developing indicators and creating interactive dashboards. The following summary provides an overview of best practices in climate resilience indicator and performance metric development, highlighting key takeaways for suggested next steps for TRPA. Collective Strategies also reviewed existing climate dashboards to identify key dashboard design features relevant for TRPA's project goals and primary dashboard audiences. These example dashboards were chosen to provide examples of climate dashboards created by national, regional, and local agencies with goals and audiences like those of TRPA. Appendix B provides further detail on best practices and relevant example climate dashboards.

Key Takeaways for Indicator and Performance Metric Development

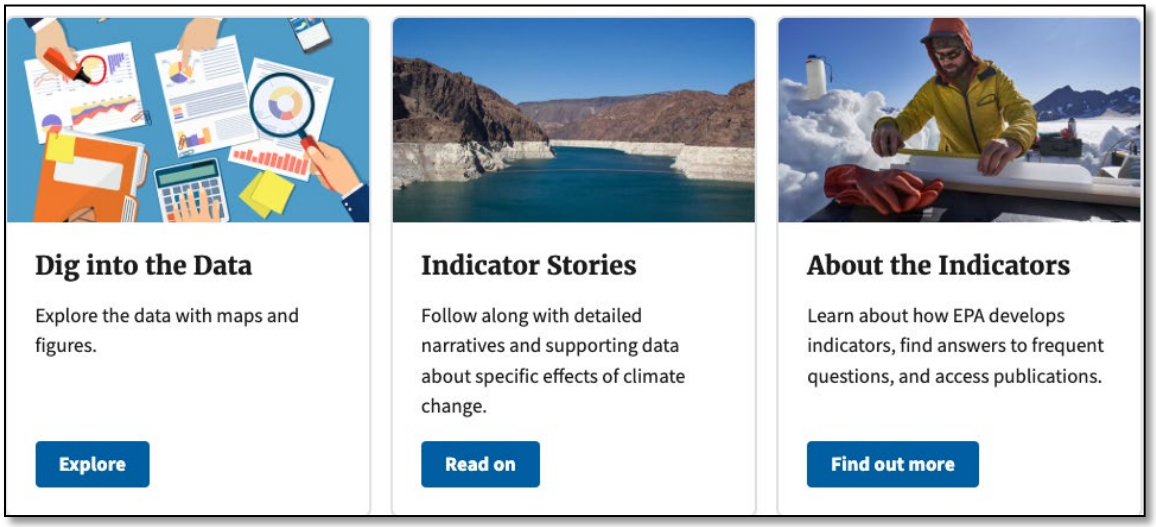
- Agencies at the national, state, and local level struggle to identify and communicate relevant indicators and performance metrics that provide a comprehensive understanding of climate change impacts in specific geographies and regions. These efforts are ongoing and will continue to evolve along with climate action goals.

[9] Tahoe Regional Planning Agency, "Lake Tahoe Climate Resilience Dashboard White Paper," March 23, 2023, 1.

- **TRPA should continue to track best practices at the state and national level and to integrate new resources and data as relevant to ensure that the Dashboard is aligned with and can benefit from these efforts.**

- Agencies tend to use the term "metric" and "indicator" interchangeably or to use just one or the other. For example, the US EPA uses the term "climate change indicator" and does not refer to these data as "metrics." The state of California, in contrast, uses these terms somewhat interchangeably. California created a Resilience "Metrics" Working Group (RMWG) which then developed a list of resilience "indicators" to help track progress and guide decision making across the state. The indicators developed by California's RMWG are high level and require the tracking of multiple specific performance metrics to gage progress towards climate goals.
  - **TRPA should revise their Dashboard to include "indicators" that refer to a trend that provides valuable information on climate action progress that are measured and tracked using specific "performance metrics."**

Exhibit 3. EPA Cliamte Change Indicators Home Page Navigation
Source: US EPA



- Understanding the intended audience for the new Dashboard and how they will engage with the data is key to developing indicators and performance metrics that are meaningful and useful.
  - **TRPA should develop the new Dashboard for use by local and state agency staff to use as a tool to support communication with local Council's and Board's (e.g., decision makers) as well as potential funders.**
- Defining clear, measurable long-term outcomes is critical for tracking progress in building resilience beyond reducing GHG emissions — indicators should be aligned with and relevant to these outcomes.
  - **TRPA should organize the Dashboard based on specific long-term outcomes aligned with the State of California's Adaptation Strategy: Resilient Social**

Systems, Resilient Natural Systems and Resilient Built Systems. TRPA should integrate regional GHG mitigation goals into these three outcome categories.

Exhibit 4. California Adaptation Strategy Priorities
Source: California Climate Adaptation Strategy

- Indicators should be clear and relevant to the intended audience but tied to specific performance measures that directly inform policy and implementation. For example, an indicator of a Resilient Built System could be reduced (or low) physical exposure to climate risks and hazards in residential buildings and the performance metric that help track progress could be percent of residential buildings retrofitted to withstand a 5-year storm with no damage and percent of residential buildings with air conditioning.
  - **TRPA should start to identify indicators by organizing existing regional climate goals under the long-term outcomes identified above and then identifying specific indicators and performance metrics to track progress towards those goals. Once existing goals are integrated, TRPA can identify additional indicators and performance metrics that will provide local and state agency staff with relevant data to communicate progress towards these long-term outcomes and goals.**
- Prioritizing specific indicators to track progress will inevitably involve trade-offs. State agencies in California are working to align the goals, targets, and indicators in various climate related plans such as the state's Adaptation Strategy and the state's Natural and Working Lands Climate Smart Strategy.
  - **TRPA should work with other regional agencies to ensure that any indicators and performance metrics used in the new Dashboard reflect local climate action goals and plans and that potential trade-offs are considered (e.g. prioritizing conservation in a specific area may impede efforts to reduce VMT at a regional level).**

Key Takeaways for Dashboard Design and Maintenance

- Many of the dashboards reviewed were outdated, included broken links and/or disclaimers about data not being updated frequently or just not available.
  - **TRPA should consider setting clear expectations for users about how often the performance metrics will be updated and provide explanations if some metrics will be updated more frequently than others.**
- The US EPA has developed a list of over 50 climate change indicators that provide valuable information on climate change impacts and trends across the US. They have also established a set of 10 criteria to evaluate potential indicators and key considerations to guide any updates to the indicator list.
  - **TRPA should consider developing a similar set of criteria and considerations to help guide the development of a revised set of indicators and performance metrics for the new Dashboard development as well as future updates and revisions.**
- Many climate dashboards are created to communicate progress on a specific plan which helps to organize the dashboard by priorities or goals and illustrate progress in that specific area.
  - **TRPA should consider what programs, goals, plans and actions the agency is already committed to reporting on and consider how to integrate this reporting into regular dashboard updates.**
- Some dashboards include explanations about challenges and barriers like lack of funding, lack of staffing or lack of information that impede progress in certain areas.
  - **TRPA should consider how the new Dashboard can help increase transparency around specific challenges and barriers that limit local and state agency staff member's ability to make progress on specific climate goals.**
- There are key features associated with dashboards that are built for local and state agency staff to support their work to both track and communicate progress towards specific climate goals. These include (but are not limited to) clear explanations of who the dashboard is for, sitemaps and search functions to help the user find the specific information they are looking for and narrative and graphic status updates tied to specific goals and targets.
  - **TRPA should identify specific key features for the new Dashboard that align with their goals for the project. The example dashboards (see the Appendix) provide a starting point to understand which features would be most helpful for local and state agency staff and we recommend TRPA solicit specific input from local and state agency staff on desired dashboard features to ensure that the new Dashboard is useful for this audience.**

2.3 Review of Existing Plans and Guidance

Multiple organizations are working to increase resiliency of the Lake Tahoe region to climate change. This section provides the findings from reviewing key climate resilience documents and plans for the region. The regulatory requirements, plans, programs, projects, and other guiding documents provides foundational grounding and serves as guideposts for the Climate Resilience Dashboard. Appendix C provides a detailed summary of the documents reviewed and further information about their climate goals, indicators, and metrics.

Tahoe Region Climate Planning and Implementation Over the Last Decade

The Tahoe region has several regional climate plans and implementation projects completed over the last decade along with current knowledge on how climate conditions are changing, what is known about defining climate resilience, and major climate action related targets and mandates. Key information related to the update to the Tahoe Climate Resilience Dashboard includes:

- **Climate Related Plans for the Tahoe Region.** Over the last decade, various plans and initiatives have been created for the Lake Tahoe Region communities to address sustainability and the changing climate. The 2013 TRPA Sustainability Action Plan[10] and associated Indicators Reporting Plan[11] was the first official plan outlining a menu of actions in support sustainability. Several of the 2013 Sustainability Plan actions were implemented in subsequent years, and as of 2021, nearly 76 percent of the actions have been implemented.[12] A companion to this plan, the 2013 Indicators Report, provided a blueprint for the existing Sustainability Dashboard.

  Since 2014, various Regional Plan updates and other plans, such as the Tahoe-Truckee Plug-in Electric Vehicle Readiness Plan and the City of South Lake Tahoe Climate Action Plan, included actions, goals, policy provisions, project work, and incentives encouraging sustainability and climate resiliency. For example, updates to the Regional Transportation Plan were made in 2017 and in 2021.

[10] Tahoe Regional Planning Agency, "Sustainability Action Plan: A Sustainability Action Toolkit for Lake Tahoe," December 2013, https://www.trpa.gov/programs/climate-resilience/.

[11] Tahoe Regional Planning Agency, "Sustainability Indicators Report," 2013.

[12] Tahoe Regional Planning Agency, "Climate Resilience," 2021, https://www.trpa.gov/programs/climate-resilience/.

Exhibit 5. Existing Sustainability Dashboard, Lake Tahoe Info
Source: TRPA, accessed at: https://sustainability.laketahoeinfo.org/

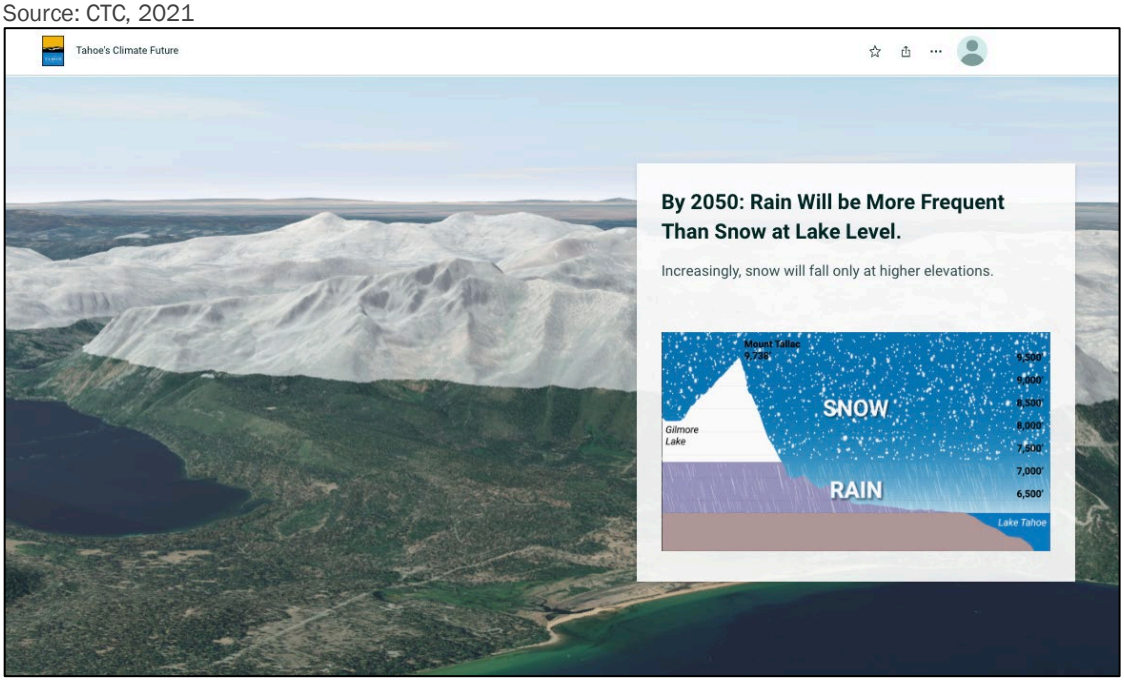
- **Climate Related Projects in the Tahoe Region.** TRPA coordinates the Environmental Improvement Program (EIP) for the region which advances the attainment of environmental threshold standards through partnerships and project work since 1997. Local, state, and federal government agencies, private entities, scientists, the Washoe Tribe, and more have collaborated for many decades to restore the environmental health of Lake Tahoe and serve as the foundation for regional climate adaptation coordination.

  The EIP Dashboard is generally viewed as an effective tool to communicate environmental information to a wide range of public, regulatory, and funding audiences. The EIP project list tracker includes a "Climate Resilience" tag that helps to identify various projects identified as contributing to the Tahoe Climate Resilience Action Strategy.

Exhibit 6. Lake Tahoe Environmental Improvement Program, 2021 Accomplishments
Source: TRPA, August 2022

- **Future Climate Related Work.** As of 2023, TRPA is currently working to update regulations to promote more climate smart development and incentivize resilience. This initiative recognizes the Climate Resilience Dashboard update and the need to measure what matters. This initiative also surveyed 24 stakeholders from local government, nonprofits or community-based organizations, and private organizations to learn about policy updates. Results indicate a need for Tahoe to focus on reducing traffic congestion, promote water efficient landscaping and renewable energy, facilitate the transition to electric vehicles, promote zero waste for temporary events, and continue focusing on workforce housing.
- **Tahoe's Climate Future Story Map.** A story map was created in 2021 by the California Tahoe Conservancy (CTC) to depict how climate change is affecting Lake Tahoe, and how the region is adapting. This story map depicts future climate conditions and the associated impacts through vivid imagery, data, and user-friendly narrative. The site offers an overview of climate change effects and associated adaptation efforts.

Exhibit 7. Tahoe's Climate Future Story Map
Source: CTC, 2021



- **Greenhouse Gas Emissions (GHG) Inventories.** TRPA's webpage covering Climate Resilience provides a summary of the region's GHG Emissions Inventory which has measured an overall decline by almost 39 percent over the last few decades from 2005 to 2018.

Local and Regional Mandates/Targets

At a regional and local level, various existing plans recognize specific targets for achieving climate-related goals. These will inform the Dashboard's narrative around metrics associated with these targets, including the following:

- **TRPA's 2021 RTP includes the following:**
  - By 2045, TRPA's RTP forecasts a reduction of on-road transportation emissions by 13.7 percent.[13]
  - Daily per capita VMT Target: 6.8 percent reduction from 2018 by 2045 (2018 per capita daily VMT is 12.48, goal is 11.63).[14]
  - Non-Auto Mode Share Target: Improve average non-auto mode share calculated from the two most recent TRPA travel survey results; current performance on target at 24.5 percent (2018-20 average) up from 18 percent in 2014-16.[15]
  - Transportation access in priority communities Target: Increase access to each mode from priority communities to 100 percent by 2014 (on target).[16]
  - Pavement Conditions Target: Maintain levels for "good" and "poor" pavement conditions: CA not on target but NV is on target.[17]
- **The 2013 Tahoe Region Sustainability Action Plan established a GHG emission reduction target of 15 percent by 2020 and 49 percent below the 2005 baseline by 2035.** As of 2021, nearly 76 percent of the actions have been implemented.[18]
- The City of South Lake Tahoe has a goal of 100 percent renewable electricity by 2030, at least a 50 percent reduction in GHG emissions by 2030, and an 80 percent reduction in emissions by 2040.[19]

State Level Climate Mandates/Targets

Both the States of California and Nevada have legislative mandates or guidance on measuring and reducing GHG emissions and have set targets for GHG emission reduction, including:

Greenhouse Gas Emissions Targets

- California Senate Bill (SB) 32 (2016) calls for reducing GHG emissions to 40 percent below 1990 levels by 2030, and Executive Order B-55-18 (2018) calls for carbon neutrality by 2045.
- In Nevada, via Executive Order 2019-22 (2019), GHG emissions should be reduced by 2 percent below 2005 levels by 2025 and 45% below 2005 levels by 2030.

[13] Tahoe Regional Planning Agency, "Regional Transportation Plan," 308.

[14] Ibid 123.

[15] Ibid 124.

[16] Ibid 125.

[17] Ibid 82.

[18] Tahoe Regional Planning Agency, "Sustainability Action Plan," 3-6.

[19] City of South Lake Tahoe, "Climate Action Plan," October 2020, https://www.cityofslt.us/1126/Sustainability.

- California Executive Order N-19-19 (2019) requires every aspect of state government redouble efforts to reduce GHG emissions and mitigate the impacts of climate change while building a sustainable, inclusive economy.

Renewable Energy Production

- The State of California has a goal to switch to 60 percent renewable electricity by 2030 with a goal of 100% carbon free electricity by 2045 from Executive Order B055-18 (2018). California's Assembly Bill (AB) 3232 (2018) also calls for 40 percent GHG emission reductions in buildings by 2030.
- Nevada aims to switch to 50 percent renewable electricity by 2030 with a goal of 100 percent carbon free electricity by 2050 through SB 358 (2019).

Transportation Decarbonization

- California SB 375 (2008), the Sustainable Communities and Climate Protection Act requires that transportation related emission reduction targets be set: Tahoe is responsible for an 8 percent reduction by 2020 and an additional 5 percent by 2035.
- California Executive Order B-16-12 (2012) mandates state agencies facilitate the rapid commercialization of zero-emission vehicles (ZEVs). The Executive Order sets a target for the number of 1.5 million ZEVs in California by 2025. Executive Order B-48-18 (2018) directs state government to meet a series of milestones toward a long-term target of 1.5 million ZEVs on California's roadways by 2025 and 5 million by 2030.
- California Executive Order N-79-20 (2020) establishes that 100 percent of in-state sales of new passenger cars and trucks will be zero-emission by 2035 and 100 percent of medium- and heavy-duty vehicles be zero-emission by 2045, among other emission reduction goals.

Adaptation and Resilience

- California AB 1482 (2015) Safeguarding California prioritizes climate adaptation across state agencies to safeguard California and requires a statewide adaptation plan that is updated every three years.
- California SB 379 (2015) requires all cities and counties to update safety elements of General Plans to include climate adaptation and resiliency strategies.
- California AB 1445 (2022), the Regional Housing Needs Allocation (RHNA), requires Council of Governments to consider emergency evacuation route capacity, wildfire risk and other climate change impacts when developing methodology for distributing RHNA targets.
- California AB 2238 (2022) requires California Environmental Protection Agency to develop statewide extreme heat ranking system by 2025 (ICARP or the Integrated Climate Adaptation and Resiliency Program is required to develop public communication plan for system).

Environmental Justice

- California AB 617 (2017) requires the California Air Resources Board (CARB) and local air districts to develop and implement additional emissions reporting, monitoring, and reduction plans to reduce air pollution exposure in disadvantaged communities.
- California SB 1000 (2016) requires local governments to identify environmental justice communities and address environmental justice in general plans.
- California AB 1384 (2022) requires state level adaptation planning with focus on vulnerable communities.

Resource Management

- California AB 1482 (2015) recognized climate smart land management of our natural and working lands as a critical pillar of our state adaptation efforts.
- California SB 27 (2021) required California Natural Resources Agency (CNRA) to develop the Natural and Working Lands Climate Smart Strategy, and to establish a California Carbon Sequestration and Climate Resiliency Project Registry; it also requires the California Air Resources Board (CARB) to establish carbon dioxide removal targets for 2030 and beyond as part of its Scoping Plan, considering the Natural and Working Lands Climate Smart Strategy, science-based data, cost-effectiveness, and technological feasibility in doing so.
- California SB 1260 (2018) aimed to clear the path for more collaborative wildfire fuel reduction and prescribed burning projects to reduce the risk of catastrophic wildfire.
- California AB 2470 (2018) established the Invasive Species Council of California to coordinate efforts to prevent invasive species introduction and advise efforts to control or eradicate such species.
- California SB 852 (2022) authorizes a city, county or special district to form a climate resilience district for the purpose of raising and allocating funding for projects designed to address climate change mitigation, adaptation, or resilience.

3. What We Heard

3.1 Stakeholder Engagement

As part of this initial dashboard development, the project team engaged with TRPA staff and other key stakeholders in the Tahoe region to gather insight and direction for the Climate Resilience Dashboard. Between April and June 2023, engagement activities included:

- **Two Project Team Meetings** with TRPA staff and the consulting team.
- **One Steering Team Workshop** held in-person in June 2023, with attendance from TRPA, the City of South Lake Tahoe, California Tahoe Conservancy (CTC), League to Save Lake Tahoe, and the Nevada Division of Environmental Protection.
- **16 Interviews with 20 stakeholders** working in housing, transportation, economic development, environment, energy, and local and state governments in the Lake Tahoe region.

This section summarizes the key takeaways from this engagement process that informed our understanding of the priorities, goals, and potential direction for the Dashboard. These activities were also critical for identifying potential data sources, understanding the quality of available metrics, and what needs the Dashboard should fulfill for the Lake Tahoe community.

3.2 Engagement Findings

Stakeholder Interview Findings

The robust stakeholder engagement component of this process yielded a wide range of findings that informed the development of initial goals, indicators, and metrics presented in this memorandum. Individuals working in a variety of fields provided insights which are summarized in this section. Appendix D provides additional detail about these stakeholder interviews.

Overarching Goals and Format

Stakeholders agreed that the Dashboard should provide consistent information for TRPA staff and partners as well as accessible information for public users. Different audiences are likely to use the Dashboard in different ways. For public use, it may be a tool for advocacy, finding resources, and sharing success, while for regional partners, funders, and regulators it may be more regularly used to inform new funding and programmatic initiatives. It is particularly important for the Dashboard to align regional goals and use consistent metrics for storytelling, reporting, planning, and grant applications. Stakeholders also indicated that information on the Dashboard should be condensed, easily consumable, and aligned with the public message and state level goals in order to reach both decision makers and the public.

Well-defined goals are crucial for demonstrating progress, which the Dashboard can aggregate in one place as much as possible. This central resource can help to identify priority strategies and integrate peer-reviewed climate science about ongoing changes to the Basin. Stakeholders also expressed that the Dashboard should present strong narratives, graphics, maps, and accessible data to enhance its usefulness for various audiences. Ultimately, the Dashboard should make climate challenges tangible and inspire action among the public, while streamlining work for decision makers, regional partners, funders, and regulators.

Specific Indicators and Metrics

Track Changes in Local Conditions

Stakeholders agreed that ongoing changes in the Basin should be a central part of the Dashboard. To highlight climate science, the Dashboard can communicate the work being done to track measures like air quality, Lake Tahoe's water level, precipitation, and extreme temperatures. Stakeholders from TRPA and other science-oriented organizations in the Basin indicated that there are a number of these metrics already being tracked which provide vital baseline information about how climate change is affecting the region. These key metrics can be linked with social, built, and natural systems to clearly state the connection between different phenomena and trends in Tahoe with climate change.

Support Resilient Social Systems

Stakeholders across different types of organizations indicated that climate resilience work in the Tahoe Basin requires an assessment of key demographic factors and identification of vulnerable populations to target equitable climate resilience outcomes. Different groups may be more vulnerable to different aspects of climate change, and it is important to acknowledge the variety of challenges based on existing disparities and specific household needs. Access to housing, employment, transportation, outdoor recreation, and emergency services are all important considerations that are linked to climate.

Tracking a range of socioeconomic information in the Dashboard over time such as total population, income, age distribution, race and ethnicity, employment types (such as seasonal workers), cost-burden, limited English proficiency, and persons with disabilities will help to inform a variety of policies. The ability to disaggregate data by demographic groups and across different geographies will make the tool more useful to more audiences. In some cases, state law also requires this to be a consideration for many climate-related efforts. Overall, new climate work needs to be inclusive and have a role for everyone who lives and works in Tahoe.

Stakeholders emphasized that tourism is a critical industry for the region which faces a variety of challenges related to climate which the Dashboard could track. Measuring the impacts of events like wildfires, lack of snow, and extreme weather on tourism facilities and recreation sites can demonstrate important consequences of climate change for the region's economy.

Further, understanding commuting and remote work trends, seasonal employment, changes in tourism indicators, and the ability of businesses to adapt to changing climate are all essential.

Collecting comprehensive data on these aspects allows for informed decision-making and effective climate resilience strategies in the Tahoe Basin, including developing more sustainable tourism, targeting workforce housing initiatives, and connecting businesses with existing programs for energy efficiency and wildfire resilience upgrades.

Support Resilient Natural Systems

Many stakeholders and organizations are aware of and use the current Environmental Improvement Program (EIP) tracker. That work should be linked to this project, but there should be distinct uses for both. EIP thresholds for stormwater, AIS, water infrastructure, sustainable recreation, forest health, water quality, trees per acre, and fire risk are currently being updated. The Dashboard should reflect and link to these updates (as appropriate) and make sure that it is making the specific connection to climate and the broader narrative of increasing natural disasters and resilience work in Tahoe.

Stakeholders working with scientific and environmental data indicated that air and water quality are some of the most important indicators to measure and understand environmental impacts. Interpreting these metrics and making the connection to other impacts of climate change should be an important part of the Dashboard. There are a number of climate-related metrics connected to air and water quality including smoke and ash from wildfires, nutrient loading, forest fuel reduction, vehicle miles traveled (VMT), and economic impacts of tourism. These metrics are often relevant for congressional representatives and funding, so it is important that they can be used to effectively advocate for necessary action.

Measuring forest health is important for stakeholders working in the natural environment, as well as preventing wildfire events. There are several metrics that indicate and warn against changes in forest health including monitoring species migration, tracking the presence of new and existing species, healthy forests (acres treated and wildfire risk), decommissioned forest service roads, and upgrading infrastructure against storms and landslides. Interviewees noted that the new Dashboard should serve as a valuable communication tool to tell the story of forest health and in doing so, should help make the case for additional funding to support forest health efforts. This should communicate the co-benefits like reducing wildfire risk.

Climate resilience work should include protecting biodiversity. Stakeholders indicated specific metrics should consider wildlife habitat, including surveillance and monitoring of invasive species, new species, boat inspections, and water temperature and nutrients that make the Lake more receptive to invasive species to act quickly. As climate change impacts surrounding regions, Tahoe may also see more new species migrating to the region for refuge from extreme heat. Many organizations are starting to think about the future implications of these changes for Tahoe's ecosystems.

Support Resilient Built Systems

Stakeholders identified a number of metrics related to transportation that are critical for climate mitigation and increased resilience in Tahoe. Metrics related to vehicle miles traveled (VMT) and travel modes are crucial for climate and transportation planning to reduce

automobile emissions and air pollution. Basin residents are increasingly interested in active transportation, particularly traveling on bicycles and e-bikes. These modes should be monitored through metrics like bike lane miles, low-stress network coverage, safety improvements, and uptake of e-bikes as much as possible with other TRPA efforts. Both private electric vehicles (EVs) and electrifying transit systems play a role in reducing emissions. The availability of infrastructure for these vehicles is essential to their utility in the region. However, there are potential tradeoffs between EVs, safety, and reliability due to some data that suggests that these vehicles are more frequently involved in bicycle and pedestrian crashes.[20] Disaggregated transportation data by residents, workers, and visitors may help to connect VMT and travel patterns with specific equity implications.

Transportation system resilience is also vital for natural disaster response, evacuation routes, and increasing wildfire risks. In the Tahoe region, transportation systems need to be able to function as a part of natural disaster response. EVs need to be able to function during emergencies, while evacuation routes from wildfires and snow-blocked roads can create safety issues in the Basin. These are tied to several other critical conversations around density in town centers, stormwater capacity, and electrical grid reliability. There is already some work being done, such as tracking trails and areas that frequently flood.

Decarbonization, transitioning to renewable energy sources like wind and solar, and grid resilience are key metrics for utility providers in the region. Grid reliability and resilience are crucial for consistent service with the shift to renewables, requiring initiatives like pole replacement, vegetation management, and microgrids which are tracked through utility providers. Annual metrics for power generation by type are available and reporting is required by state governments, but more difficult to track at smaller geographies. Current affordability programs offered by utility providers encourage energy efficiency upgrades for homes and businesses, with a growing emphasis on low-income households.

Stakeholders working with housing and land use in Tahoe emphasized the importance of location efficiency, affordability, and accessibility for meeting climate goals. Housing metrics in the Dashboard should track total housing stock, prices, rents, income levels, tenure, and affordability and make the connection with their relevance for climate resilience. Addressing the gap in affordable and workforce housing through moderate density and new housing in town centers can increase quality of life and decrease reliance on automobiles for commuting. Second homes and vacation rentals impact affordability and availability, requiring better monitoring to understand trends for Tahoe residents. Home energy upgrades, weatherization, and electrification enhance climate resilience, but are often less accessible for renters or low-income households. Disaggregated housing data can provide insights into demographic factors over time and help inform strategies for climate-friendly housing and communities.

[20] Pardo-Ferreira MC, Torrecilla-García JA, Heras-Rosas CL, Rubio-Romero JC. New Risk Situations Related to Low Noise from Electric Vehicles: Perception of Workers as Pedestrians and Other Vehicle Drivers. Int J Environ Res Public Health. 2020 Sep 14;17(18):6701. doi: 10.3390/ijerph17186701. PMID: 32938012; PMCID: PMC7558663.

Steering Team Workshop Summary of Findings

In June 2023, ECONorthwest worked with TRPA to convene the Steering Team for an in-person workshop attended by representatives from state and local governments as well as community-based organizations.

General Discussion Takeaways

- **Coordination.** Aligning with California and Nevada state strategies and funding opportunities is important to include in the Dashboard. The Dashboard should also build on existing tools, planning, and initiatives.
- **Audience.** The Dashboard should be designed for use by local and state agency staff, but also be accessible to a wider audience. A key question for the direction of the Dashboard is whether and how the public and visitors will use it. While there is potential to use the Dashboard as a tool for the public, use of the existing Dashboard indicates that it is likely to be primarily used by decision makers, regional partners, funders, and regulators. Engagement with the public should be focused on giving clear calls to action and ways to get involved.
- **Regional Significance.** The Dashboard should be relevant to the entire Lake Tahoe region, with the goal of providing easy access to high-quality, relevant, and comprehensive data.
- **Communication.** Clear definitions of goals, guiding principles, indicators, and metrics are necessary to making the Dashboard successful. Success stories should also be shared with agencies and the public to demonstrate progress through a cohesive narrative.
- **Narrative.** The Dashboard's purpose is to tell a climate-focused story to decision-makers, provide a platform to coordinate regional efforts, position the region for funding and build support and buy-in for climate action. Academia should also be considered as a key stakeholder to ensure efforts and not duplicated and as a source of ongoing feedback. The narrative should acknowledge the role the region plays as a refuge from extreme heat and the potential impacts of this role on Tahoe's resources.

Break-Out Group Takeaways

- Goals for **Resilient Social Systems** should be related to community demographics, health, education, and economy.
  - Examples of **outcomes** include sustainable living and working conditions, prevention of climate impacts on community health, promoting equity, economic resilience, and maintaining high quality of life.
  - **Metrics** could include commuting distances, consistent employment, household demographics, air quality, extreme heat days, disaster preparedness, climate

emergency communication, zero-vehicle households, distance to key services, and the number of days that recreational facilities are closed due to extreme weather conditions.

- Goals for **Resilient Built Systems** should cover transportation, housing, recreation facilities, and tourism.
  - Potential **outcomes** for built systems include resilient land use, water and transportation infrastructure, building decarbonization, and tourism facilities.
  - **Metrics** could include water supply, heat island impacts, parking, housing in flood zones, home hardening, power grid reliability, community resilience centers, vehicle miles traveled (VMT), transit use and ridership, access to evacuation routes, mode shift, and quality and accessibility of tourism opportunities.
- Goals for **Resilient Natural Systems** should consider watersheds, water quality, forest health, and biodiversity.
  - **Outcomes** for natural systems should include forest health, wildfire risk, invasive species, extreme weather events, and water quality/management. While developing the Dashboard narrative, this should also consider the time frame and the concept that change is the new normal.
  - **Metrics** should include forest heterogeneity, increase in old growth forests, wildfire flame length, preservation and restoration of natural areas, biodiversity, temperature and precipitation levels, acres of Stream Environment Zones (SEZ), basin level, nearshore Algae bloom, total maximum daily loads (TMDL), wetlands, stormwater catchment, and carbon sequestration.

4. Climate Resilience Dashboard Goals, Indicators, and Metrics

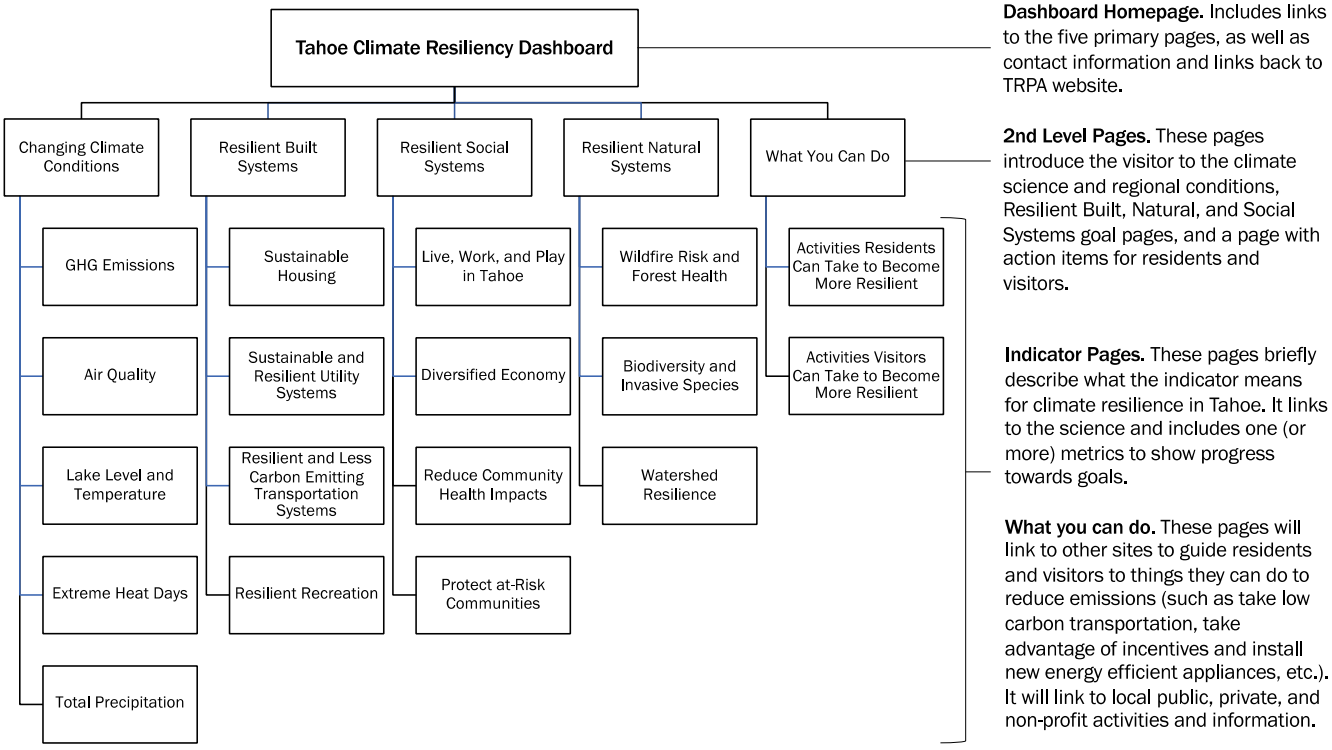
4.1 Proposed Organization of the Dashboard

The Climate Resiliency Dashboard will use three primary elements for organization, including goals, indicators, and performance metrics (described in Section 1.2 of this document). ECONorthwest proposes the following goals and indicators based on our team's technical evaluation, research, and engagement with TRPA and other regional stakeholders, guided by the following proposed organization.

Proposed Storyboard

Using best practice guidance and feedback from stakeholders, we recommend the following layout for the Climate Resilience Dashboard shown in Exhibit 8.

Exhibit 8. Proposed Storyboard for the Tahoe Climate Resiliency Dashboard
Source: ECONorthwest



The project team proposes the following indicator page elements:

- **Title.** The title clearly identifies the indicator being addressed.

- **Introductory paragraph:** What is the challenge and why should we care? How do(es) the metric(s) tell us we are making progress? The introductory paragraph(s) tells the story about what the indicator is and what the metric(s) tell us about the indicator, why we care about it, who it impacts, historical information, where we are now, and how we are trending over time. It will link to important information, either on Lake Tahoe Info or external to the website.

  This is also the place where we can link to federal or state requirements, or other important information.

- **Metric(s) and data sources.** The metric(s) are relevant in terms of measuring climate goal outcomes and describing the risk or other conditions. Data sources should be up-to-date (to the greatest extent practical), credible, and verifiable. The data should be applicable to the Tahoe region (to the greatest extent practical).

- **Other related metrics.** The webpage will also link to other related metrics to make it easy for the reader to find additional information.

- **The science.** The metrics are based on the best available science and data. The Dashboard will make it easy for readers to find additional information about the science if they wish. The Dashboard will be designed to cross-reference existing information in the EIP that is already tracked online.

- **What you can do.** This section of the Dashboard will direct residents and visitors to information they can use to reduce GHG emissions and to become more resilient. Working with TRPA and partners, the Dashboard will link to local, regional, state, national, and international information.

- **What are TRPA and partners doing?** The Dashboard will link to other TRPA and partner organization sites to describe what public agencies are doing to make the Basin more resilient to climate change.

TRPA and the Steering Team will review the findings in this document and the draft metric evaluation and provide feedback to project team. Based on that feedback, the project team will create a Final Metrics Report.

Goal 1: Track Climate Science Related to the Changes in Local Conditions

This goal primarily seeks to advance science, stewardship, and accountability. The indicators and metrics associated with this goal should guide and protect Tahoe climate investments through cutting-edge research, monitoring, and adaptive management.[21] The Dashboard will track key indicators over time relevant to the Lake Tahoe Region that are helpful for comprehending changes in the climate including weather and air quality trends.

- **Recognize the Changing Climate Conditions.** Climate-related trends over time help to understand how climate change is impacting the Tahoe region, including regional GHG

[21] California Tahoe Conservancy, "Climate Resilience Action Strategy," 2022.

emissions, and poor air quality days, Lake Tahoe water level, annual average water temperature, number of extreme heat days, and total precipitation.

Goal 2: Promote Resilient Built Systems (Transportation, Housing, Recreation)

This goal focuses on infrastructure and built systems including transportation, housing, water supply, and recreational facilities. As part of Tahoe's climate can withstand changing conditions and shocks, including changes in climate, while continuing to provide essential services.[22] Suggested Indicators to track progress towards this goal are:

- **Support Increased Access to Sustainable Housing.** Equitable access to sustainable housing can help to support the mitigation of GHG emissions for all households in the Tahoe community and increase the prevalence of resilient housing.
- **Support Sustainable and Resilient Utility Systems.** Switching to renewable energy and investing in water supply infrastructure are important steps to increasing renewable energy generation, responding to wildfires and other climate-related events, and ensuring the resilience of local systems.
- **Upgrade Transportation Systems.** Making transportation systems more sustainable can reduce and mitigate transportation related GHG emissions. Investing in projects that expand equitable access to transit and pedestrian and bike paths can make low-emissions options more accessible. Preparing for the impacts of climate change should also include upgrading transportation facilities to prepare for longer summers, shorter winters, increased precipitation events, fluctuating lake levels, and changes in visitor patterns.

Goal 3: Promote Resilient Social Systems (Demographics, Education, Economy, Health)

All people and communities respond to changing average conditions, shocks, and stresses in a manner that minimizes risks to public health, safety, and economic disruption and maximizes equity and protection of the most vulnerable or at risk to climate impacts. Suggested Indicators to track progress towards this goal are:

- **Enhance Access for People to Live, Work, Learn, and Play in Tahoe Sustainably.** To see results in reducing emissions across the Tahoe community, sustainable lifestyles should be financially accessible to people with a wide range of jobs and incomes that can afford housing, transportation, and other living expenses. Climate-related events like wildfires and extreme temperatures can also have impacts on schools and other public services.
- **Increase Tahoe's Economic Diversity and Resiliency, with a Focus on Sustainable Recreation.** The tourism-related industry with an emphasis on ecotourism and snow sports fosters the prosperity of local businesses and ensures robust employment

[22] Ibid.

opportunities. However, climate change is likely to have impacts on Tahoe's key industries by creating fluctuations in visitor volumes and employment patterns.

- **Prevent or Reduce Community Health Impacts Associated with Climate Change.** Residents can reduce the risk of wildfire by participating in the Firewise program and help to mitigate the impact of climate-related wildfire events. At-risk populations also require access to cooling centers in the summer and warming centers in the winter as extreme temperature and weather events occur more frequently.
- **Equitably Protect At-Risk Communities from Impacts.** To protect vulnerable populations, people with disabilities, older adults, children, people with limited English proficiency, and transportation disadvantaged often require access to community resources in the event of a natural disaster exacerbated by climate change.

Goal 4: Promote Resilient Natural Systems (Environment, Forest Health, Air Quality, Watersheds and Water Quality)

Natural systems including watersheds, forests, and wildlife adjust and maintain functioning ecosystems and natural processes in the face of change. Suggested Indicators to track progress towards this goal are:

- **Reduce Wildfire Risk and Build Forest Health.** Forest restoration projects, restoration of burned forests, and implementation of the Lake Tahoe Forest Action Plan can reduce wildfire risk and build forest resilience to protect communities from wildfire and improve forest health.
- **Increase Biodiversity and Reduce and Control Invasive Species.** Biodiversity plays a major role in our ecosystems and society. Native plants and animals help forests recover after a fire, control flooding and soil erosion, and cycle nutrients. Biodiversity also holds cultural value, including Native American uses, and provides recreational benefits like birdwatching. Greater species diversity as well as preventing and controlling invasive species promotes adaptability and helps ecosystems withstand and recover from disturbances, including those caused by a changing climate.
- **Increase Watershed Resilience.** Resilient wetlands can be net sinks of carbon and can play an important role in reducing greenhouse gas emissions into the atmosphere, thereby mitigating climate change. Forest products also play a role in storing carbon for decades in building materials, thereby delaying emissions. Increase flood water storage capacity (both nature-based and stormwater infrastructure), support carbon sequestration, restore wetlands, streams, and meadows, and improve water clarity all work to increase watershed resilience.

4.2 Draft Metric Review

Draft Metric Findings

Exhibit 9 lists the draft metrics evaluated as part of this project and presents a score for each metric. The full evaluation is described in Appendix B. Note that the score is based on the utility of the metric, staff effort to update, how understandable the metric is, and how closely it is related to climate resiliency.

Exhibit 9. Summary of Draft Climate Resiliency Metrics

Goal	Indicator	Metric	Description/Key Considerations	Source	Final Score (0-20)
Track Changes in Local Conditions	Recognize the Changing Climate Conditions	Total GHG Emissions	Total GHG emissions over time	TRPA	20
		GHG Emissions by Sector	Total GHG emissions by sector (energy, transportation, solid waste, carbon sequestration)	TRPA	20
		Poor air quality days per year, number of wildfire smoke days	Atmospheric conditions worsen with climate hazards like wildfires, which can have impacts to public health, outdoor recreation, and tourism.	AirNow	16
		Lake Tahoe water level	Fluctuating lake levels from periods of flood and drought can impact access to recreation and cause flooding for lakefront properties.	UC Davis, US Geological Survey Water Master	15
		Annual average water temperature, including surface temperature	Long-term water temperature patterns can be good indicators of climate change because the high heat capacity of water bodies makes short-term temperature variability less noticeable.	UC Davis	15
		Number of extreme heat days per year	Increasing heat may increase the chance of heat-related illness; while Tahoe has relatively low-vulnerability to extreme high temperatures, it is a destination for populations escaping intense heat in surrounding communities.	Cal-Adapt, National Weather Service	14
		Total precipitation in water per year, snow as a fraction of annual precipitation	Local ecosystems are extremely sensitive and will become more vulnerable under a warmer climate with altered precipitation patterns. A declining share of snow due to warmer temperatures impacts local hydrologic systems as well as outdoor recreation.	NOAA, UC Davis	14
		Total number of housing units in town centers	Town Centers are areas that allow higher density to encourage mixed use development and efficient	TRPA, local jurisdictions	17

Goal	Indicator	Metric	Description/Key Considerations	Source	Final Score (0-20)
Support Resilient Built Systems Support Resilient Built Systems	**Support Increased Access to Sustainable Housing**		land use that allows for fewer GHG emissions from transportation.		
		Share of housing affordable to workforce in town centers	Housing in town centers that is affordable to Tahoe workers allows more people to live close to places of employment. This can improve quality of life and reduce GHG emissions associated with commuting.	TRPA, local jurisdictions	18
		Participating in (or funding for) energy efficiency programs	The uptake of energy efficiency and electrification rebates for homes and commercial buildings can indicate private sector investments in reducing GHG emissions from buildings.	Liberty Utilities, NV Energy	16
		Number of deed-restricted affordable, moderate, and achievable units	Affordable, moderate, and achievable housing units are relative to household income. The share of these units that are regulated indicates the availability of housing for residents below the area's median income.	TRPA	16
		Number of homes hardened	Home hardening prepares residents to protect their homes against wildfires through upgrades like building materials, ventilation, and defensible space.	CTC, CalFire, Living with Fire	17
	Support Sustainable and Resilient Utility Systems	Miles of transmission lines hardened (upgraded or undergrounded)	Transmission line hardening increases the resilience of the energy grid by upgrading or undergrounding infrastructure to mitigate impacts from wildfires and other climate-related hazards.	Liberty Utilities, NV Energy	13
		Number of new hydrants, increased pipe size	Increased access to water infrastructure helps to better fight wildfires to protect neighborhoods, particularly in high-vulnerability areas.	Local Public Utility Districts (PUDs)	15
		Percent of renewable energy as a share of total energy used	The total share of energy from renewable sources like solar, wind, and hydroelectric power indicates Tahoe's progress towards reducing GHG emissions from power generation.	Liberty Utilities, NV Energy	18
	Upgrade Transportation Systems	Total Transit Ridership, Frequent service (20-minute headways)	A well-functioning public transit system is one of the primary tools for changing local travel patterns to be more efficient and less dependent on automobiles. Transit ridership should be analyzed by stop level ridership, not route or system wide.	Tahoe Transportation District, TART	18
		Total Micro-transit Ridership	Micro-transit increases access to transit systems. Tracking shared rides and program usage can enhance the overall understanding of transit ridership.	Lake Link	12

Goal	Indicator	Metric	Description/Key Considerations	Source	Final Score (0-20)
Support Resilient Built Systems		Daily per capita Vehicles Miles Traveled (VMT)	Reducing overall VMT indicates lower use of automobiles and a potentially greater uptake of transit and other modes.	RTP, Streetlight or Replica	18
		Quantity of alternative fuel stations, EV charging/ hydrogen, Quantity of transit fleet, jurisdictional fleets with zero emission vehicles	The availability of alternative fuel infrastructure is important for ensuring that Tahoe has the capacity for growth in lower emission travel modes such as individual EVs and electric transit systems throughout the Basin.	USDOT	20
		Baseline mode share and weekday or seasonal variation	Tracking mode share shows the uptake of active forms of transportation such as walking and bicycling recognized in the Active Transportation Plan. These modes have strong co-benefits with climate resilience by reducing emissions. Carpooling is also a potential metric to track but can be difficult data to collect.	TRPA survey, US Census Bureau, Journey to Work, Survey of Income and Program Participation (SIPP)	15
		Transportation access in priority communities	The RTP aims to increase access to transit, bicycle, and pedestrian facilities by 100% by 2045, measured in quarter to half mile distances in priority underserved areas.	TRPA, US Census Bureau - ACS, Justice 40	15
		Increased lane miles of low-stress bicycle facilities	This metric allows TRPA to assess facilities which can benefit the communities who may need low-stress bicycle infrastructure and increase access to sustainable transportation modes.	TRPA, RTP	18
		Baseline inventory of vulnerable facilities	An asset inventory can help the region to manage and prioritize capital improvements for facilities and infrastructure with high vulnerability to climate-change impacts like extreme temperature, flooding, and wildfires.	TRPA, Caltrans, NDOT Asset Inventory	18
Support Resilient Social Systems	**Enhance Access for People to Live, Work, Learn, and Play in**	Permanent population disaggregated by race and ethnicity, age groups	Disaggregating the permanent population by demographic groups can help to identify existing disparities and needs for climate adaptation.	US Census Bureau - ACS	16
		Population at peak periods	Population at peak periods - visitors and seasonal residents	Placer.Ai (or similar location data service -	8

Goal	Indicator	Metric	Description/Key Considerations	Source	Final Score (0-20)
Support Resilient Social Systems	Tahoe Sustainably			Strava Metro, Replica)	
		Median Household income by jurisdiction and disaggregated by remote and non-remote workers	Median household income serves as a key metric of a community's socioeconomic conditions and ability to withstand and recover from climate-related impacts. Differences between remote and non-remote workers also indicate more flexibility for some households and individuals.	US Census Bureau – ACS, LEHD/LODES	16
		Housing costs (median home sales price and rental rates, by jurisdiction)	High housing costs can limit access to safe and resilient housing options, making it challenging for vulnerable populations to relocate, adapt, and invest in sustainable housing.	Redfin, Zillow, Realtor Associations, CoStar	13
		Housing tenure (rented full-time, owner-occupied, vacation rental, second home), disaggregated by race, ethnicity, and age	Housing tenure can indicate a household's ability to implement climate resilience measures such as energy efficiency upgrades, as well as ability to leave during disasters. Disparities by demographic groups can indicate populations for decisionmakers to target with new programs.	US Census Bureau - ACS	1
		K-12 public school enrollment data and number of days of school closures due to extreme weather or poor air quality	School enrollment and closures provides insight on the impacts of climate-related events like wildfires and extreme temperature, as well as changing demographics in Tahoe.	CA and NV Departments of Education, CalMatters	12
		Percent of students receiving free or reduced cost lunch	Free or reduced lunch can be an indicator of income and poverty, although changes to the National School Lunch Program have made FRPL status a less reliable measure of student economic disadvantage in recent years.	CA and NV Departments of Education	12
	Increase Tahoe's Economic Diversity and Resilience, with a Focus on Sustainable Recreation	Percent of workers who commute into the basin on a seasonal basis, origin demographics, distance travelled, and difference in travel time by mode	Understanding commuting patterns provides information about transportation-related emissions associated with automobile travel. It also indicates whether there are economic opportunities for workers in Tahoe year-round and seasonally.	TRPA, Streetlight or Replica, US Census Bureau (LEHD/LODES)	13
		Number of days public recreation sites, resorts,	Recreation closures from climate-related events may increase in coming years. The number of days that	Tahoe Science Advisory	13

Goal	Indicator	Metric	Description/Key Considerations	Source	Final Score (0-20)
Support Resilient Social Systems		or ecotourism facilities are closed due to extreme weather or wildfire or the amount of revenue lost	private, local, state, and federal sites are closed and the amount of revenue lost from closures or lower volume days can show the impact of these events on one of Tahoe's key industries.	Council, Recreation Agencies	
		Number of days recreation facilities are at full capacity	As residents of surrounding areas may come to Tahoe during periods of extreme heat, the days that facilities are at full capacity can be an important metric for tracking increased demand in the Basin.	Tahoe Science Advisory Council, Strava Metro or Replica	13
		Transient Occupancy Tax revenue and changes over time	TOT revenue data are one way to quantify the impacts of climate change on the tourism industry through changes in overnight visitation. These may not be in effect in all communities in the Basin.	State of California, Douglas County, Washoe County	14
		Total lodging revenues and change over time	Total lodging revenues may be more difficult to obtain but can provide an understanding of impacts of climate change to the tourism industry throughout the region.	Smith Travel Reports	12
		Average annual wages in the tourism industry	Annual wages in the tourism industry specifically can show the strength of Tahoe's economic opportunities and how climate-related events may impact wages in this key sector.	Smith Travel Reports, Bureau of Labor Statistics (BLS)	12
		Consistent employment, seasonal workers unemployment rates, and median wages by sector and overall	Employment patterns can have implications for residents' and workers' vulnerability to climate change and climate-events. Understanding the types of industries that are growing in the region and workforce characteristics can help Tahoe to adapt and diversify its economy and target strategies for workers in the area.	BLS/State Economic Development Agencies (California EDD and the Nevada DETR), EMSI	14
		Visitor device data as a proxy of visitor frequency and patterns	GPS-tracked device data can indicate the rate of visitors coming to Tahoe and the way that it fluctuates in response to climate change.	Streetlight, TRPA travel survey	12

Goal	Indicator	Metric	Description/Key Considerations	Source	Final Score (0-20)
Support Resilient Social Systems	Prevent or Reduce Community Health Impacts Associated with Climate Change	Number of days cooling centers or community resiliency centers are open	This metric reflects the frequency and intensity of extreme heat or other climate-related events and can help to identify gaps in available resources.	CTC, Offices of Emergency Services	14
		Number of Firewise communities in the Tahoe basin	Firewise communities are a metric of wildfire education and community-led efforts to mitigate and prevent impacts of climate-related events.	CalFire, Living with Fire	13
	Equitably Protect At-Risk Communities from Impacts	Number/share of households with access and functional needs (people with disabilities, older adults, children, limited English proficiency, and transportation disadvantaged)	The population with access and functional needs may require specific considerations for climate resilience and response during climate-related events. This metric can help to indicate the need for certain facilities and resources in response to climate change.	US Census Bureau - ACS	19
		Map of zero vehicle household concentration, cooling/community resource centers, and a list of the medical support in emergencies	Zero-vehicles households can face challenges with evacuation during wildfires or other events. Mapping where this population is concentrated and distance to resources/supplies can help to equitably prepare communities to respond to these scenarios.	US Census Bureau – ACS or LEHD/LODES, CTC, Offices of Emergency Services	13
Promote Resilient Natural Systems	Reduce Wildfire Risk and Build Forest Health	Acres of forest fuels reduction treated for wildfire in high-risk areas, map of areas with prescribed fire treatment and project sites	Implementing projects to support forest thinning and restoration projects to protect communities from wildfire. This could be measured with acres of forest fuels reduction treated for wildfire in high-risk areas, mapping showing areas with prescribed fire treatment and project sites.	TRPA	19
		Tree species diversity and increasing old growth forest	Species diversity metrics could include measurements of tree density, basal area, large/tall tree density, clump/gap structure, seral stage, large snag density; drought vulnerability, disturbance such as dead trees.	TRPA	15
		Wildfire risk metrics such as restoration	These metrics can help track the risk of high and moderate-severity fire, identify threats to infrastructure, high-intensity patch size, and	Unknown (TRPA currently exploring)	15

Goal	Indicator	Metric	Description/Key Considerations	Source	Final Score (0-20)
Promote Resilient Natural Systems		after, smoke/ash, treatment before	proportion of high severity fires, and inform community wildfire protection and egress/ingress plans.		
	Increase Biodiversity and Reduce and Control Invasive Species	Acres treated for invasive species	Acres treated helps to track progress for preserving and protect biological resources in the Region and protecting against invasive species increasing with climate change.	TRPA	20
		Watercraft inspections for invasive species	Watercraft inspections are an important way to prevent new invasive species from entering the area which may flourish with changing climate conditions.	TRPA	17
	Increase Watershed Resilience	Acres of restored high-quality wetlands and meadows (also referred to as Stream Environment Zones) helping to store flood waters	Wetlands and meadows restored are a measure that helps to track increased flood water storage capacity in Tahoe and provide a number of co-benefits for water clarity and carbon sequestration.	TRPA	16
		Increase number of parcels with Stormwater Best Management Practices (BMPs) improvements	Tracking parcels that implement BMPs also demonstrates progress for managing stormwater which is expected to increase with climate change and higher volumes of precipitations.	TRPA	16
		Lake Clarity measured by Secchi Depth	Clarity metrics can be indicative of environmental health in Lake Tahoe and show the impacts of increased stormwater runoff on the aquatic ecosystem.	UC Davis	11
		Shared stormwater basin project investment	Tracking shared investment shows how the region is cooperating on increasing watershed resilience and could help to identify gaps to be addressed.	TRPA	16
		Map of carbon sequestration measurement	Mass measurement or percent change in soil organic matter and/or increase in soil water holding capacity can indicate carbon sequestration, which will be critical for mitigating climate change impacts in Tahoe.	TRPA	16

5. Appendices

A. Draft Metric Review Results Table

B. Best Practice Research Findings

C. Existing Document Review Summary

D. Interview Summary