READY Nevada County

Extreme Climate Event Mobility and Adaptation Plan

Nevada County Transportation Commission

May 2022

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Nevada County Transportation Commission

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Glossary

100-Year Flood

Terminology used in Federal Emergency Management Agency (FEMA) flood mapping to describe a flood event with a 1-in-100 (or 1% probability) of occurring in a given year.

500-Year Flood

Terminology used in Federal Emergency Management Agency (FEMA) flood mapping to describe a flood event with a 1-in-500 (or 0.2% probability) of occurring in a given year.

Adaptation

In the context of this Plan, adaptation involves adjusting to changing climate conditions to minimize negative effects and take advantage of new opportunities. Adaptation is often equated with resiliency planning.

Binder Grade

Pavement binder is a temperature-sensitive "glue" that binds the various materials in asphalt together. Extreme heat may cause the binder to lose structure and deform whereas extreme cold can cause cracking.

Biome

Consists of biological communities comprised of animals and plants adapted to the area's climate characteristics.

Bioretention

Process of naturally filtering stormwater runoff through soils or plant matter in order to remove contaminants.

Buckling

Change in shape of a structure or underlying structural component due to extreme load. In terms of climate stressors, extreme heat can cause pavement or rail lines to buckle.

Climate Change

Long-term changes in weather and temperature patterns. Since the 1800s, humans have been the driving force behind climate change, spurred by the release of greenhouse gas emissions.

Crack Seal

A long-term pavement patching solution, intended to protect pavement from further degradation due to water, plants or other infiltrating materials.

Defensible Space

The creation of a landscaped or natural safety zone surrounding a structure to reduce its susceptibility to wildfire.

Demand Response Transportation Service

Non fixed route service prompted by an individual or group scheduling advanced transportation needs. The service may be provided by a public, private or non-profit entity and/or provide specialized services to people with disabilities.

Emergency Management

An emergency typically refers to a large, unexpected and dangerous event, the management of which encompasses the spectrum of prevention and preparation to response and recovery.

Extreme Weather

Weather occurrence such as a storm, flood or wildfire which is atypical for an area or season and which may cause significant damage to people or the environment. In the context of this Plan, extreme weather events are accelerated by climate change.

Floodplain

Low-lying area adjacent to a river or stream and subject to inundation during flood events.

Fuel (Fire) Break

Strategically engineered strip of land or area with reduced vegetation intended to slow advancing wildfire.

Green Waste

Organic matter that naturally decomposes and which may be collected through curbside collection for composting.

Hardening

Replacement of infrastructure with materials less susceptible to climate stressors to reduce risk and recurring maintenance costs. An example would be the substitution of roadway asphalt for reinforced concrete.

Hydroplaning

Occurs when a vehicle's tires ride on a film of water, losing contact with the pavement and resulting in a loss of control.

Level of Service (LOS)

A term used to describe roadway facility operations, and which is a qualitative description of traffic flow based on factors such as speed, travel time, delay, and freedom to maneuver.

Liquefaction

Loss of soil stability typically prompted by flooding or earthquakes.

Paratransit Service

A supplement to fixed-route services which doesn't follow a defined timetable or route and which may offer specialized access to people with disabilities.

Permeable Pavement

Porous alternative to typical pavement which allows for greater infiltration, reducing runoff. Best applied to lower-volume streets, parking areas, sidewalks and bike facilities, and most effective where shallow slopes (under 5%) are present.

Porosity

Measure of the amount of space or air pockets within a material, and which influences infiltration and drainage.

Representative Concentration Pathways (RCP)

An Intergovernmental Panel on Climate Change (IPCC) adopted series of climate modeling pathways which predict various warming scenarios based on the concentration of greenhouse gas emitted.

Resilience

From a climate change perspective, resilience refers to the process of preparing for, adapting to and recovering rapidly from climate stressors.

Riprap

Human created rock-like material intended to provide support and reduce erosion, such as to protect infrastructure from recurring waves and other repetitive water damage.

Rutting

Pavement depression in the vehicle wheel path which causes an increased risk of hydroplaning during extreme rainfall events or flooding.

Scour

Reduction in a bridge's stability due to erosion around abutments or piers, often caused by fast moving water, and which can compromise long-term foundational integrity.

Sinkhole

Hole in the ground prompted by excessive erosion and water drainage. May be human caused by overextraction of groundwater or naturally caused by water dissolving the rock surface.

Swale

A land depression (natural or artificial) which manages runoff and assists with stormwater infiltration.

Urban Heat Island Effect

Tendency towards higher air temperatures in urban areas due to an abundance of structures like buildings and roads that absorb and re-emit heat.

Washout

Flooding-prompted occurrence where a roadway or railway is significantly eroded, compromising safe travel.

Table of Contents

Introduction **1**
Existing Conditions **2**
Climate Risks and Vulnerabilities 2
Existing Setting 3
Hazard Risks 18
Existing Adaptation Framework 36
Impact Assessment **41**
Temperature and Extreme Heat 42
Precipitation 43
Snowpack 45
Landslides 46
Wildfire 48
Compounding Impacts 50
Conclusions 52
Adaptation Strategies, Policies, and Concepts **53**
Goals 53
Solutions 53
Concepts 68
Implementation **78**
Funding Opportunities 78
References **85**
Appendix A Detailed Risk Assessment Maps **A-1**

Table of Tables

Table 1 Population Projections for Truckee in Eastern Nevada County, 2040 5
Table 2 Employment Projections for Truckee in Eastern Nevada County, 2040 12
Table 3 Summer Intersection Level of Service for Truckee in Eastern Nevada County 14
Table 4 Nevada County Jurisdictional Dams with Extremely High Downstream Hazard Potential 35
Table 5 Temperature and Extreme Heat Impacts Summary 42
Table 6 Precipitation Impacts Summary 43
Table 7 Snowpack Impacts Summary 45
Table 8 Landslide Impacts Summary 46
Table 9 Wildfire Impacts Summary 48

Table of Figures

Figure 1 Population Density in Western Nevada County, 2012 4
Figure 2 Population Density in Western Nevada County, 2035 4
Figure 3 Opportunity Zones in Nevada County 6
Figure 4 Low Income Communities in Nevada County 7
Figure 5 Low Income Communities in Nevada County (Downtown Grass Valley Focus) 7
Figure 6 Low Income Communities (Southern Nevada County Focus) 8
Figure 7 Percent of Population Age 65 Years and Over 9
Figure 8 Percent of Population with a Disability 9
Figure 9 Number of Households with no Vehicle Available 10
Figure 10 Employment Density in Western Nevada County, 2012 11
Figure 11 Employment Density in Western Nevada County, 2035 11
Figure 12 Critical Facilities in Nevada County 13
Figure 13 Level of Service in Western Nevada County, 2012 13
Figure 14 Level of Service in Western Nevada County, 2035 14
Figure 15 Active Transportation Infrastructure in Nevada County 15
Figure 16 Public Transportation Infrastructure in Nevada County 16
Figure 17 Planned Transportation Projects in Nevada County 18
Figure 18 Annual Average Maximum Temperature, Truckee 20
Figure 19 Annual Average Maximum Temperature, Grass Valley 20

Figure 20 Annual Average Minimum Temperature, Truckee 21
Figure 21 Annual Average Minimum Temperature, Grass Valley 22
Figure 22 Annual Extreme Heat Days, Truckee 23
Figure 23 Annual Extreme Heat Days, Grass Valley 23
Figure 24 Maximum One-Day Precipitation, Truckee 25
Figure 25 Maximum One-Day Precipitation, Grass Valley 25
Figure 26 Annual Precipitation, Truckee 26
Figure 27 Annual Precipitation, Grass Valley 27
Figure 28 Maximum Length of Dry Spell, Truckee 28
Figure 29 Maximum Length of Dry Spell, Grass Valley 28
Figure 30 California Snowpack Water Equivalent, Medium Emissions Scenario 30
Figure 31 California Snowpack Water Equivalent, High Emissions Scenario 31
Figure 32 Fire Hazard Severity Zones in Nevada County 32
Figure 33 Annual Average Area Burned, Nevada County 33
Figure 34 Flood Hazard Zones in Nevada County 34
Figure 35 Nevada County Landslide Risk 47
Figure 36 Change in Wildfire Risk (Medium Emissions Scenario, RCP 4.5) 48
Figure 37 Change in Wildfire Risk (High Emissions Scenario, RCP 8.5) 48
Figure 38 The Upper Reach of Wildfires are Shifting Higher in Elevation over Time 49
Figure 39 Ready Nevada County Emergency Alert System 55
Figure 40 Evacuation Route Pre-Planner (3 example routes from Alta Sierra home to library) 56
Figure 41 Town of Truckee Primary Evacuation Routes 56
Figure 42 Roadside Vegetation Management Tracker (tab on Ready Nevada County Dashboard) 60
Figure 43 PG&E's Enhanced Vegetation Management (EVM) Program 61
Figure 44 Santa Monica Big Blue Bus Shade-Covered Seating 65
Figure 45 Caltrans' Pavement Binder Grade Change Given Temperature Rise Scenarios 69
Figure 46 Caltrans' Design Life Considerations for Transportation Infrastructure Assets 69
Figure 47 Permeable Pavement from San Diego Green Infrastructure Guidelines 70
Figure 48 Long Beach culvert 72
Figure 49 ODOT Examples of Horizontal Drain, Blanket Drain and Ground Anchors 73
Figure 50 USAID's Differential Impact of Climate Effects on Materials 74

Introduction

The Nevada County Transportation Commission (NCTC) is the area's Regional Transportation Planning Agency (RTPA). The mission of NCTC is to "plan, communicate and coordinate with the citizens and decision-makers of Grass Valley, Nevada City, Nevada County, the Town of Truckee, and with Caltrans to identify transportation needs, propose solutions, and assist in implementing projects to create a balanced regional transportation system, while protecting the rural qualities and historic character of Nevada County."

NCTC's leadership and coalition-building efforts spearheaded development of this timely Extreme Climate Event Mobility and Adaptation Plan. Nevada County's low-density and prevalence of vulnerable communities (including older adults, persons with disabilities, and households without vehicles) pose geographically relevant risk-factors to consider when mitigating risk and planning for evacuation efforts. The Plan takes a proactive approach to improving the resiliency of Nevada County's transportation infrastructure in the face of increasing climate fueled threats. The Plan will adopt cross-disciplinary approaches that use the best available science to prioritize the most vulnerable people, places, and infrastructure most at risk.

Climate adaptation involves adjusting to changing climate conditions to minimize negative effects and take advantage of new opportunities. Through adaptation planning, the Nevada County Transportation Commission (NCTC) can identify how climate change is likely to impact NCTC's ability to achieve its mission, operate efficiently, and meet its policy and program objectives. By integrating climate change adaptation strategies into planning, NCTC ensures that resources are invested wisely, operations remain effective in current and future climate conditions, and the region is well positioned for any forthcoming regulations or incentives related to climate change.

Existing Conditions

This Existing Conditions chapter broadly assesses the anticipated climate impacts that will affect Nevada County through the middle and end of the 21st century, as well as the local and state adaptation planning framework that is already in place.

Climate Risks and Vulnerabilities

Climate related risks are caused by a range of hazards that are often made more severe or frequent based on climate change. These can be slow in their onset, such as changes in temperature and precipitation leading to droughts, or occur more suddenly, such as tropical storms or floods. These events have the potential to cause injuries or fatalities, operational interruptions, and damage to the environment, property, and infrastructure. Climate risks can be described by a number of characteristics, including:

- Geographic Extent: How localized or wide-ranging is the climate risk across a given area
- Impacts: What are the effects of the climate risk on a given area, and what segments of the population or community are most vulnerable
- Severity: How strongly will the impacts of the climate risk be felt in a given area
- Frequency: How often will the climate risk be felt in a given area and do the impacts change based on seasons or other factors

A climate related event also has the potential to create multiple hazards; for instance, heat is a factor in increased wildfires, and wildfires can lead to increased risk of landslides. Therefore, it is necessary to identify the potential primary and secondary hazards from climate risks.

This chapter provides projections of climate related risks and vulnerabilities in Nevada County for extreme heat, precipitation, snowpack, and other hazards. It also summarizes existing climate adaptation plans and other related programs to provide an overview of the existing regulatory framework in Nevada County.

The findings of this chapter are that Nevada County will be impacted by a number of climate related hazards through the end of the century, including higher temperatures and more variable, intense precipitation events. These impacts are projected to cause higher wildfire risk, lower annual snowpack, and increased risk of floods. The transportation system is thus likely to face more incidents of road washouts, decreases in winter tourism traffic, and a higher probability of transportation delays caused by wildfires along local roadways and rail lines, among other impacts which are highlighted throughout the report.

Methodology

Projections provided in this chapter were developed using Cal-Adapt, a publicly available tool provided by the State of California to help local jurisdictions assess climate-related impacts through the remainder of the 21st century (see the Impact Assessment chapter for more details). Information regarding the direct and indirect effects of these impacts in Nevada County and the Sierra Nevada region were primarily characterized by the Sierra Nevada Region Report as a part of California's Fourth Climate Change Assessment, which was conducted by a number of State agencies in 2018, and the Caltrans Climate Change Vulnerability Assessment for District 3, which was released in 2019.

Existing Setting

Population and Demographics

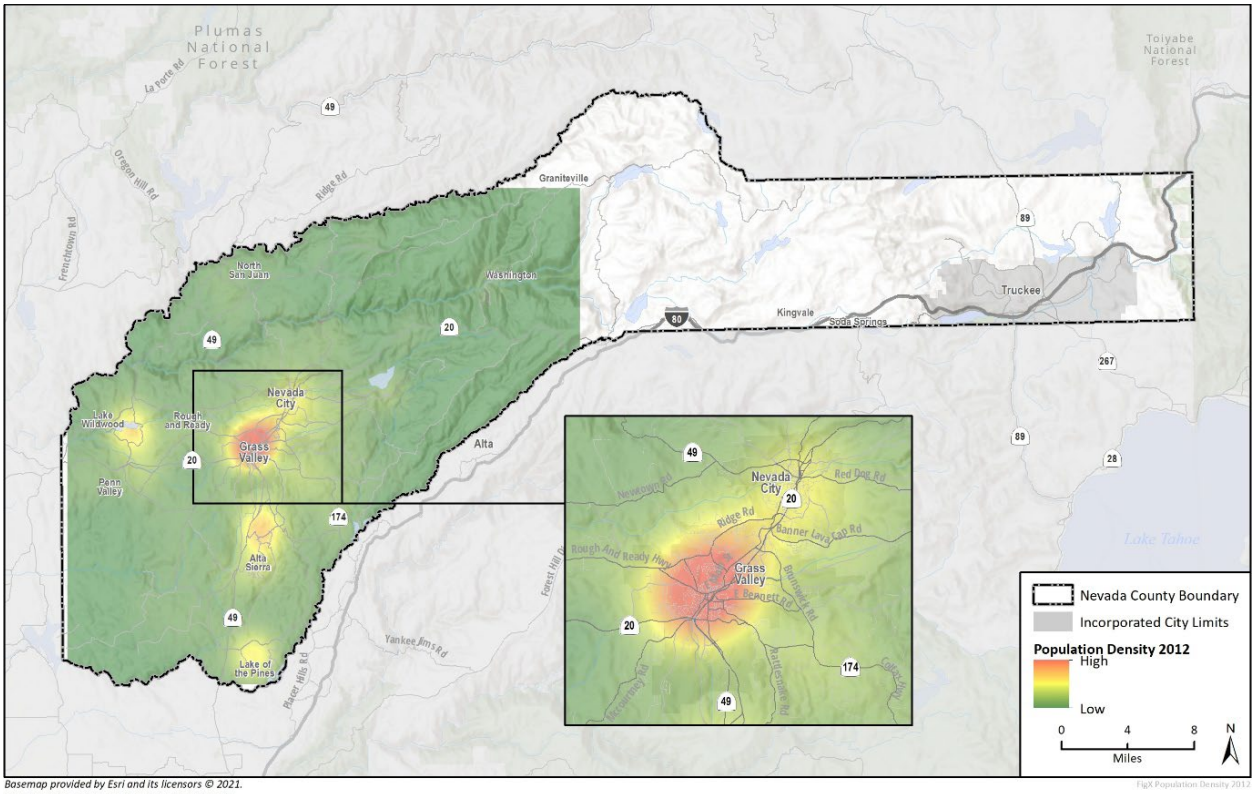
Analyzing the impacts of climate change and existing adaptation strategies are important for NCTC to develop meaningful strategies that build resilience in the local transportation system and protect residents and businesses. It is also important, however, to understand the demographics of the community in Nevada County, as adaptation planning strategies are often highly localized depending on the nature of the unique population and expected climate impacts. This section provides an overview of demographics in Nevada County, highlighting vulnerable populations and other communities that utilize the transportation network, in order to provide additional context for the development of adaptation strategies in the final READY Nevada County Extreme Climate Event Mobility and Adaptation Plan. This includes trends regarding population, households, employment, housing, economic status, and other factors.

POPULATION

In 2020, there were an estimated 98,114 people living in Nevada County. Approximately 33 percent of people live in incorporated cities, mostly in Truckee (17 percent) and Grass Valley (13 percent). Nevada City made up the remaining 3 percent of incorporated residents (DoF, 2020). The population per square mile in 2010 was 103.1 (U.S. Census Bureau, 2021), less than half of the state average of 239.1 people per square mile. The low density of the population could create unique challenges for evacuation efforts during climate related emergencies, increasing the number of roadways and movement corridors that must be maintained for evacuations throughout the County.

Population density for western Nevada County in 2012 is shown in Figure 1, and population density projections for 2035 are shown in Figure 2. These population density figures were developed as a part of the Nevada County 2015-2035 Regional Transportation Plan (RTP) using the Nevada County travel model, which only covers the western portion of the County. Population projections for Truckee, the primary population center in the eastern portion of Nevada County, are shown in Table 1. This data was taken from Truckee's 2040 General Plan Existing Conditions Report, due to the limitations of the data available for eastern Nevada County in the NCTC 2015-2035 RTP.

Figure 1 Population Density in Western Nevada County, 2012



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Additional data provided by Fehr and Peers, 2021.

Figure 2 Population Density in Western Nevada County, 2035

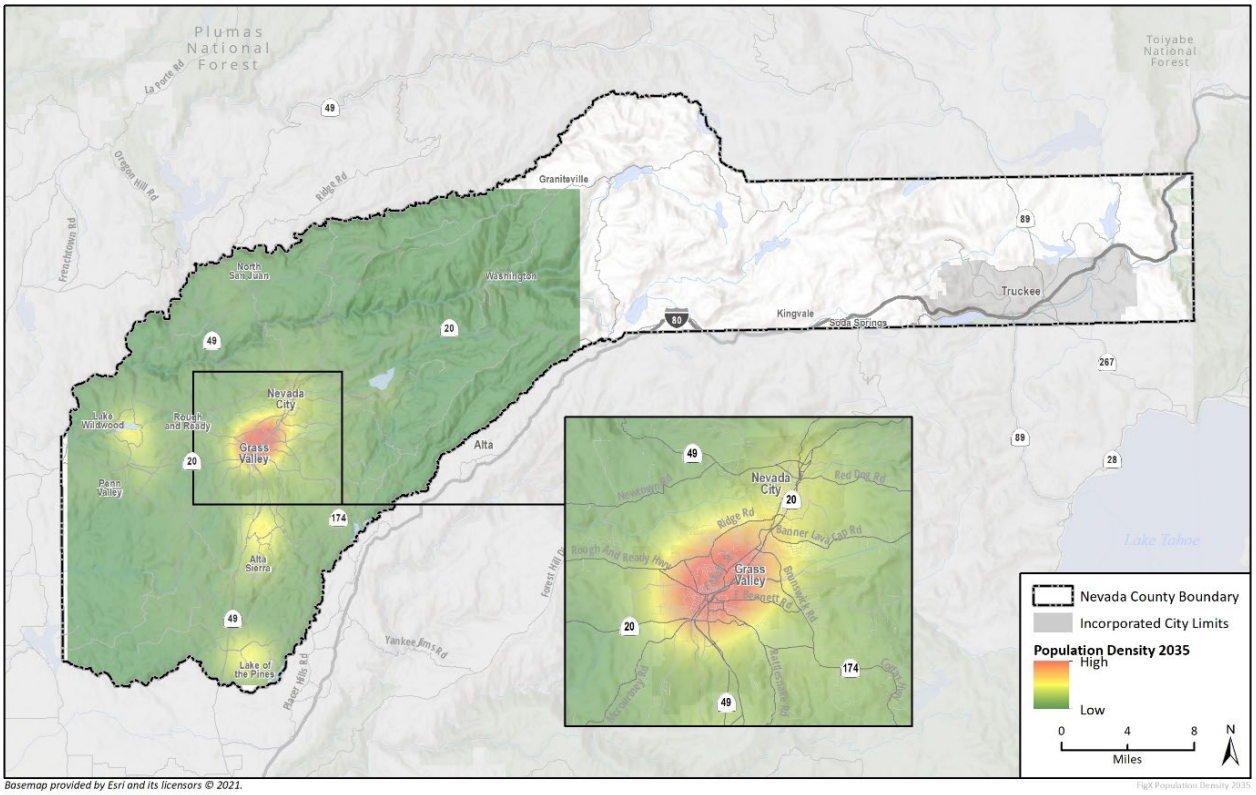

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Table 1 Population Projections for Truckee in Eastern Nevada County, 2040

Year	Town of Truckee		Nevada County
	Low Projected Population (AAGR 0.39%)	High Projected Population (AAGR 1.06%)	Projected Population (AAGR 0.54%)
2018	16,700	16,700	98,757
2030	17,500	18,900	105,318
2040	18,200	21,000	111,007

Note: AAGR = Average annual growth rate.
Sources: Town of Truckee 2040 General Plan Existing Conditions Report; DOF 2018a, 2018b

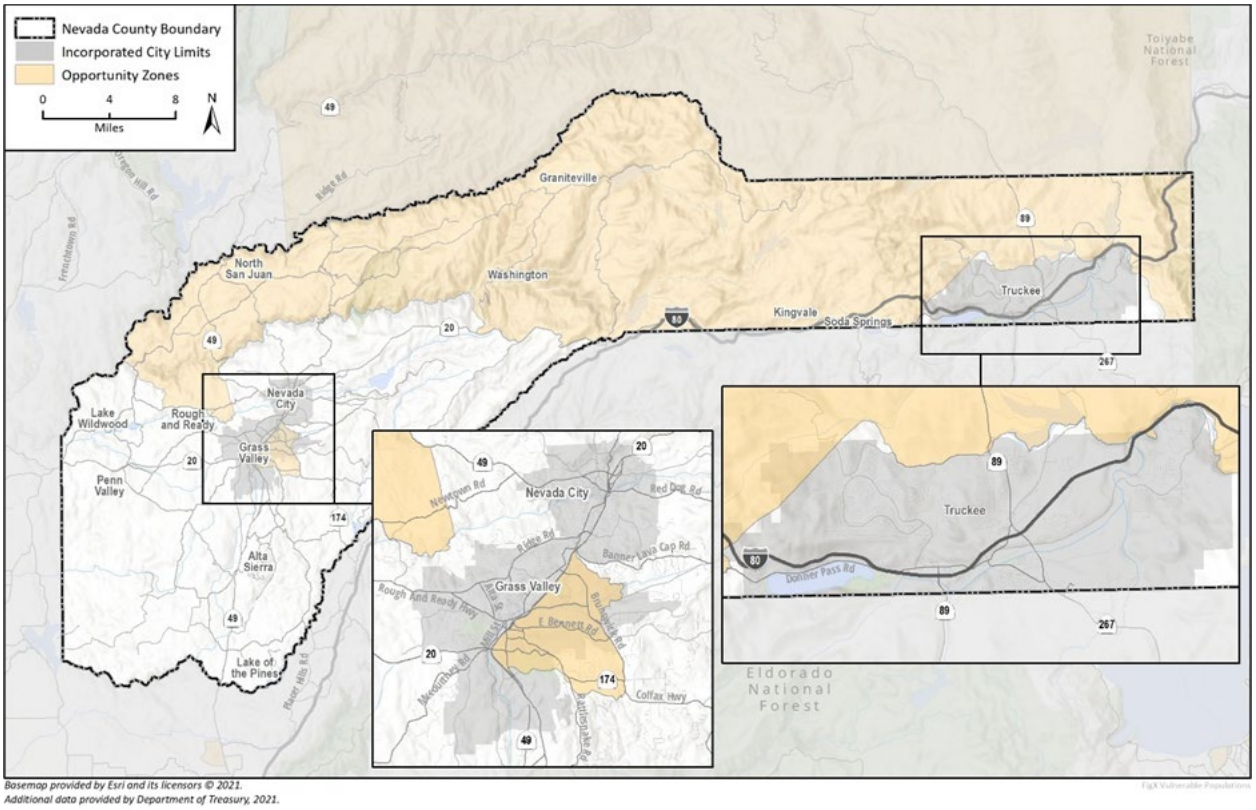
In 2019, the most recent year that data was available for, the median age in Nevada County was 50, indicating a population that skews older. The population was made up of 48.5 percent males, and 51.5 percent females. When looking at race, the largest segment of the population was white (84.7 percent), followed by more than one race (3.1 percent), Asian (1.5 percent), and American Indian or Alaskan Native (1.3 percent) populations. African American and Native Hawaiian or Pacific Islander populations all made up less than 1 percent of the population in Nevada County. In addition, 9.8 percent of the population characterized itself as Hispanic or Latino, while 84.7 percent indicated ethnicity as White alone (U.S. Census Bureau, 2019). When looking at people 25 or older, 94.4 percent of people held a high school diploma, and 37.2 percent held a bachelor's degree. About 6.8 percent of people under 65 years of age were estimated to be without health insurance, lower than the state average of 8.9 percent (U.S. Census Bureau, 2021). Overall, these statistics show a population that is older and relatively monocultural, with average education rates.

VULNERABLE COMMUNITIES

Opportunity Zones are one way to identify the locations of vulnerable communities in Nevada County. Opportunity Zones, defined by the California Department of Treasury, are shown in Figure 3. This can inform agencies on where there is the highest need for resource allocation in the event of a climate related emergency, including adequate transportation during evacuations. Opportunity Zones are census tracts that are defined by the United States Internal Revenue Service (IRS) as economically-distressed communities where new investments, under certain conditions, may be eligible for additional resources. They were added to the tax code by the Tax Cuts and Jobs Act in 2017 (State of California, 2021).

Opportunity Zones in Nevada County include census tract 6057000900 in the northern part of the County, and census tract 6057000600 near Grass Valley. The latter census tract, along with census tract 6057000501 just to the northwest of it, are both highlighted in CalEnviroScreen 3.0 as being in the 65-75 percentile when compared to tracts in the rest of the state, the highest in the County. CalEnviroScreen scores are based on cumulative impacts across twelve pollution burden indicators and eight population characteristics indicators, with higher scores indicating communities which are disproportionately burdened by or vulnerable to pollution sources. Both of these tracts are shown to have an above average number of hazardous material cleanups, groundwater contamination threats, and hazardous waste sites for its population. Rates of asthma, cardiovascular disease, and poverty are also shown to be high in these areas. There are currently no communities designated as Disadvantaged Communities in Nevada County, per Senate Bill (SB) 535 and as informed by CalEnviroScreen 3.0 results (OEHHA, 2018).

Figure 3 Opportunity Zones in Nevada County



However, there is concern with this tool's methodologies accurately capturing concerns present in rural areas. An additional measure of "priority populations" is the definition of low-income communities per Assembly Bill (AB) 1550, which encompasses those census tracts or households which are either:

– At or below 80 percent of the statewide median income, or
– At or below the California Department of Housing and Community Development's low income designated threshold.

There are six Nevada County census tracts defined as low-income priority populations (6057000105, 6057000104, 6057000502, 6057000600, 6057000501 and 6057000900), including a number of neighborhoods along the SR 49 corridor, significant portions of Grass Valley and a substantial tract that extends from north of Rough and Ready through North San Juan, and throughout the eastern portion of the county (minus the Town of Truckee) to the Nevada border. See Figure 4, Figure 5 and Figure 6 for details, where areas highlighted in blue signify low-income census tracts (California Air Resources Board, 2016).

Figure 4 Low Income Communities in Nevada County

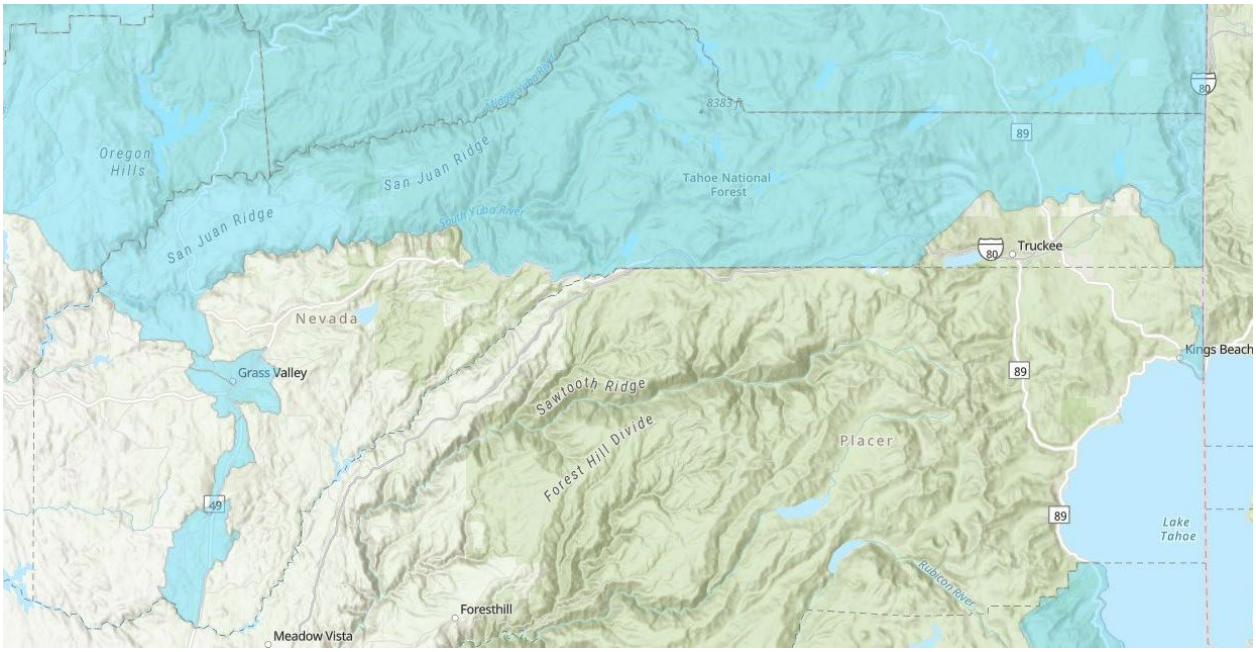


Figure 5 Low Income Communities in Nevada County (Downtown Grass Valley Focus)

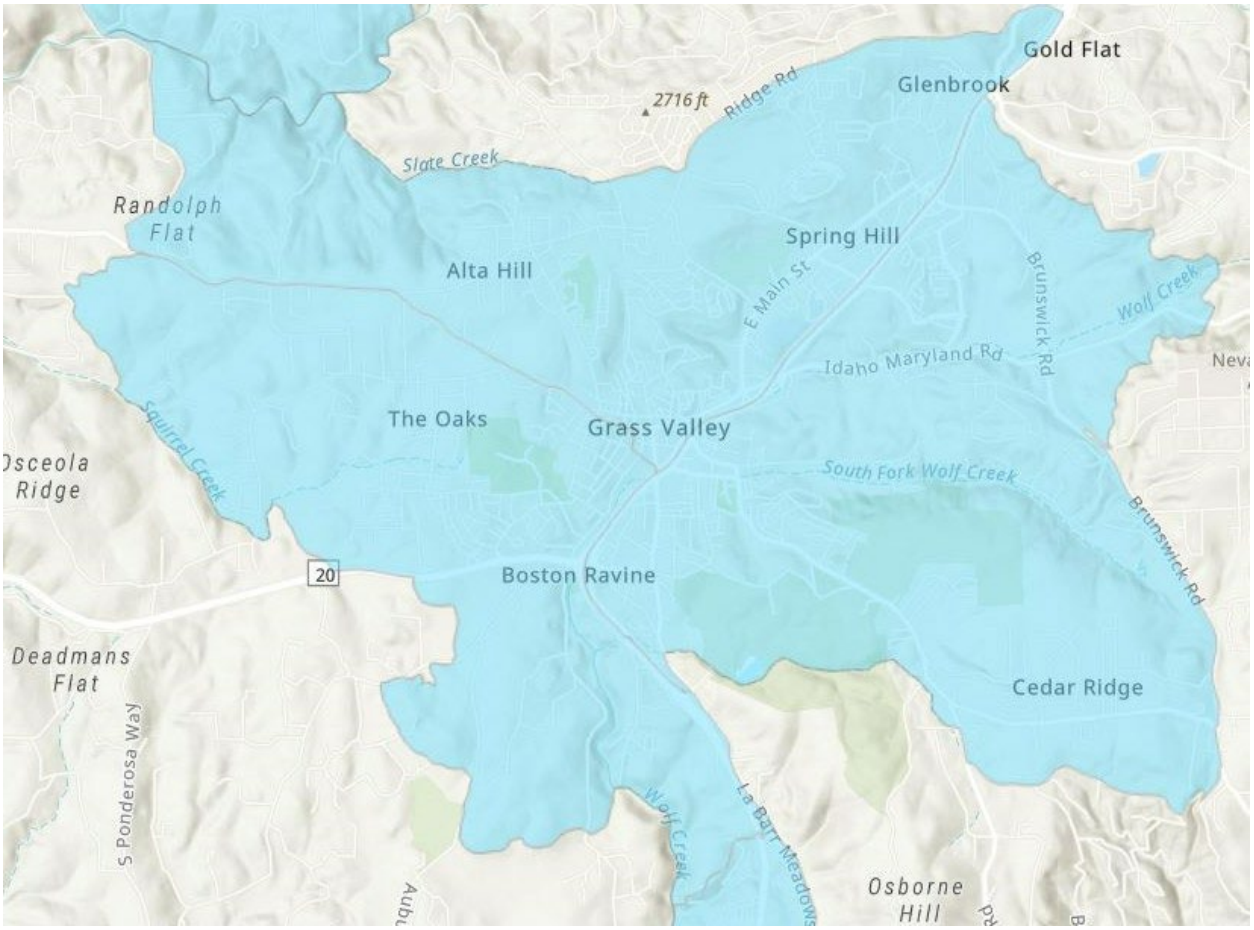
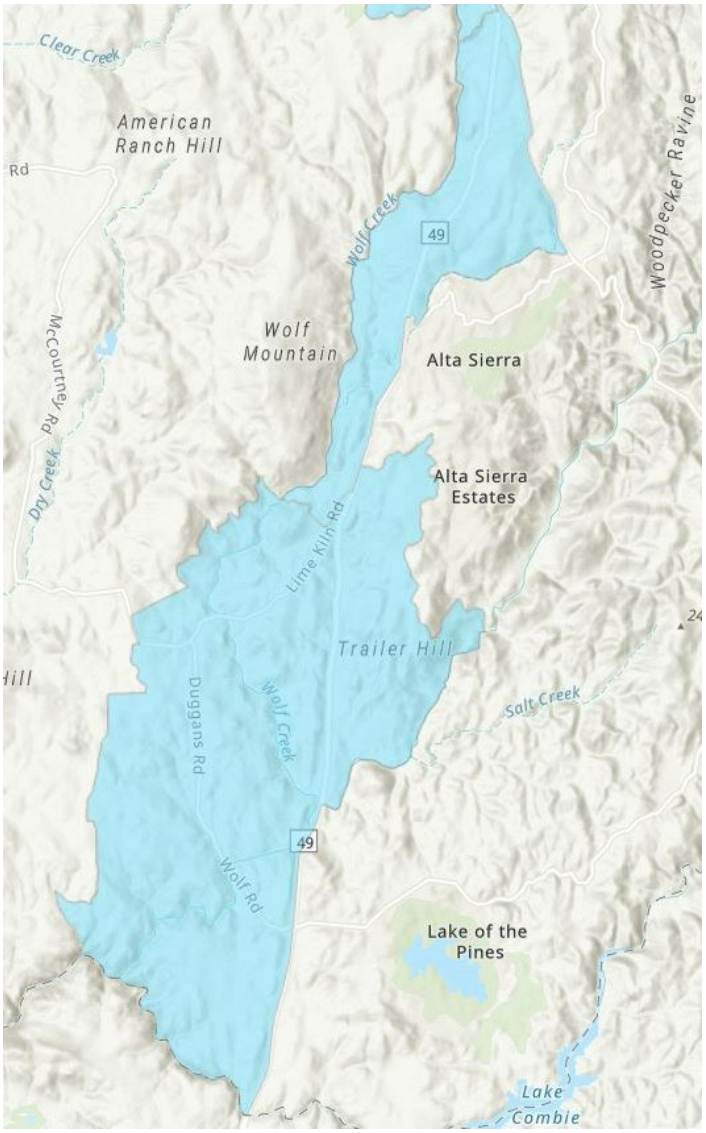


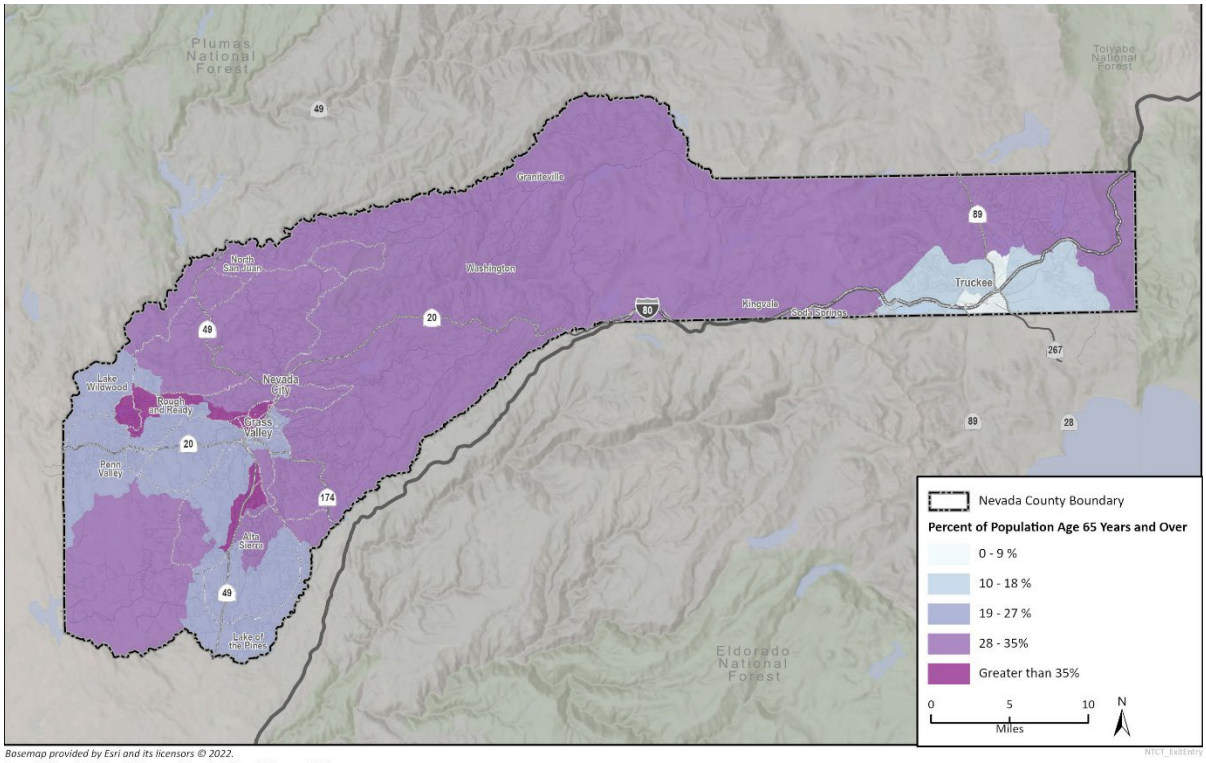
Figure 6 Low Income Communities (Southern Nevada County Focus)



Other vulnerable communities in Nevada County include older adults, persons with disabilities, and households without vehicles. These populations are vulnerable to risks associated with extreme climate events as they may be less mobile or unable to secure transportation during an evacuation or emergency. The distributions of older adults, persons with disabilities, and households without vehicles are provided in Figure 7, Figure 8 and Figure 9. Data was acquired from the 2015-2019 five-year data from the American Community Survey and is displayed at the census tract level.

The areas with the highest number of older adults are located in northern Grass Valley, along SR 49 immediately to the south of Grass Valley, and west of Grass Valley in the area around Lake Wildwood. The areas with the highest number of persons with disabilities are similarly distributed, located in the western part of the county near Grass Valley, Lake Wildwood, and Penn Valley. The areas with the highest number of households without access to a vehicle are also located in northern Grass Valley, with several census tracts around Grass Valley having the second highest number of households without access to a vehicle. The census tract near eastern Truckee also falls within range for the second highest number of households without access to a vehicle. Improvements to the transportation network and evacuation and education programs should be developed to address the unique needs of these vulnerable populations.

Figure 7 Percent of Population Age 65 Years and Over



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Percent of Population Age 65 Years and Over data from US Census; 2022.

Data provided by 2015-2019 American Community Survey. Additional data provided by GHD.
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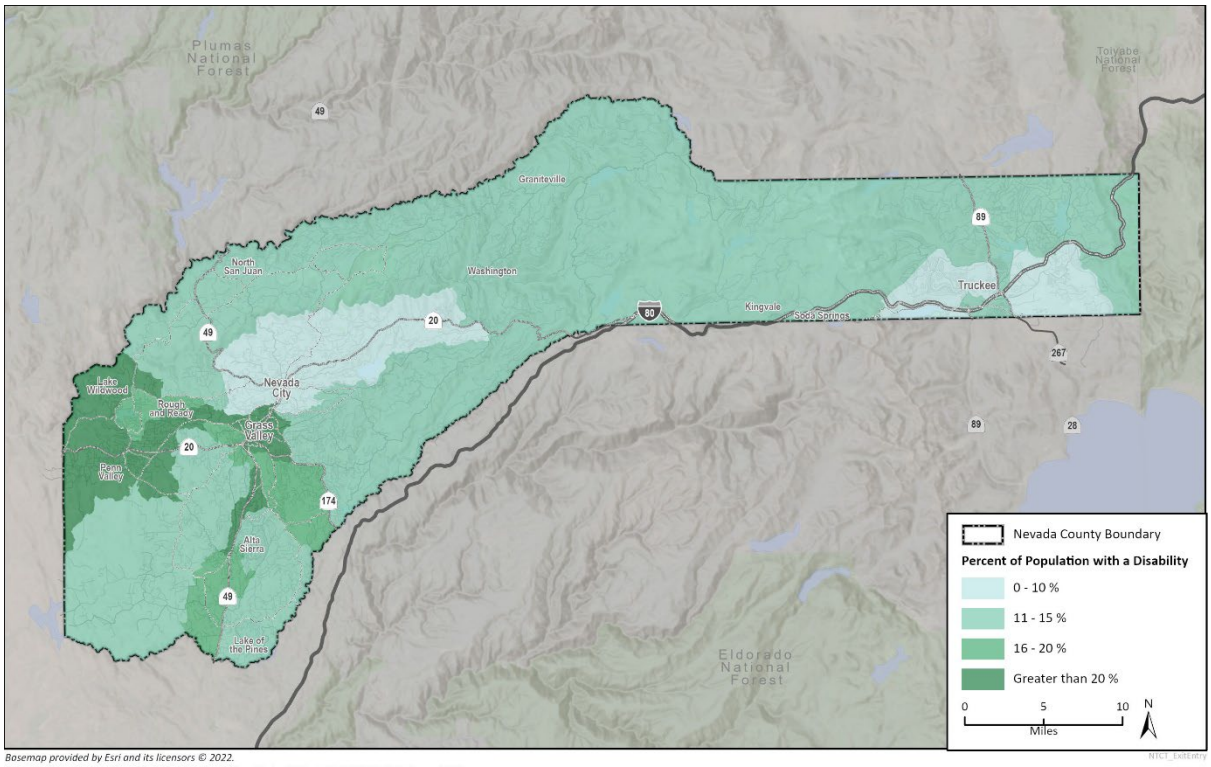
Figure 8 Percent of Population with a Disability



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Percent of Population with a Disability data from, PlaceWorks 2021, ACS 2015-2019, U.S. Census 2019

Data provided by 2015-2019 American Community Survey. Additional data provided by GHD.
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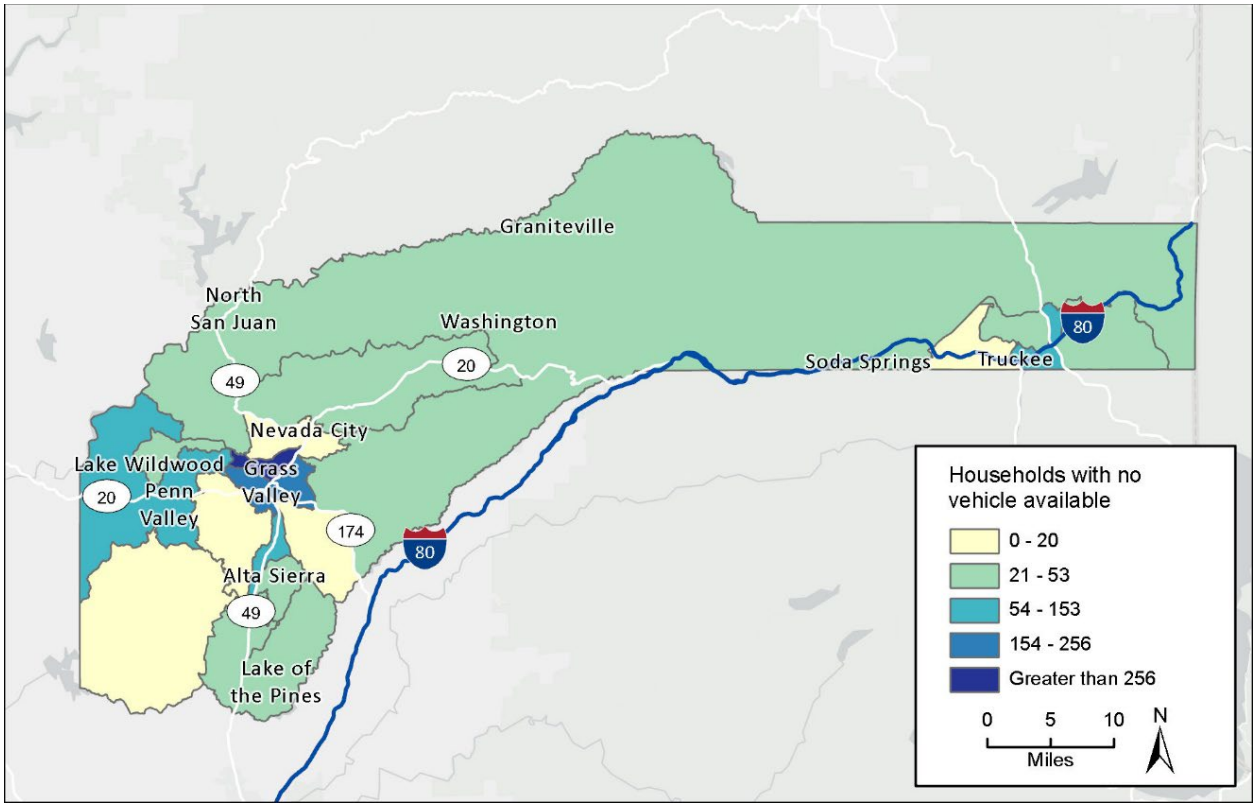
Figure 9 Number of Households with no Vehicle Available



Data provided by 2015-2019 American Community Survey. Additional data provided by GHD.
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HOUSING AND EMPLOYMENT

In 2020, there were an estimated 54,164 housing units in Nevada County. There was a vacancy rate of 21.1 percent, with an average persons per household of 2.27 (DoF, 2020). The average household income was $66,096 in 2019, with approximately 9.4 percent of people living in poverty. The owner-occupied housing unit rate from 2015-2019 was estimated at 74.2 percent. Approximately 92.6 percent of households had a computer from 2015-2019, indicating that digital distribution of emergency information related to the transportation system would be relatively effective (U.S. Census Bureau, 2021). The median price of homes sold was $416,314 in 2019 (EDD, 2021).

In 2020, the total labor force was estimated to be 47,420 in Nevada County. The unemployment rate was about 6.8 percent (EDD, 2021). The mean travel time for workers above the age of 16 was 25.5 minutes from 2015-2019, indicating substantial commutes that could be impacted by climate related hazards. Employment density for western Nevada County in 2012 are shown in Figure 10, and projections for 2035 are shown in Figure 11. These employment density figures were developed as a part of the Nevada County 2015-2035 RTP using the Nevada County travel model, which only covers the western portion of the County. Employment projections for Truckee, the primary population center in the eastern portion of Nevada County, are shown in Table 2. This data was taken from Truckee's 2040 General Plan Existing Conditions Report, due to the limitations of the data available for eastern Nevada County in the NCTC 2015-2035 RTP.

Figure 10 Employment Density in Western Nevada County, 2012

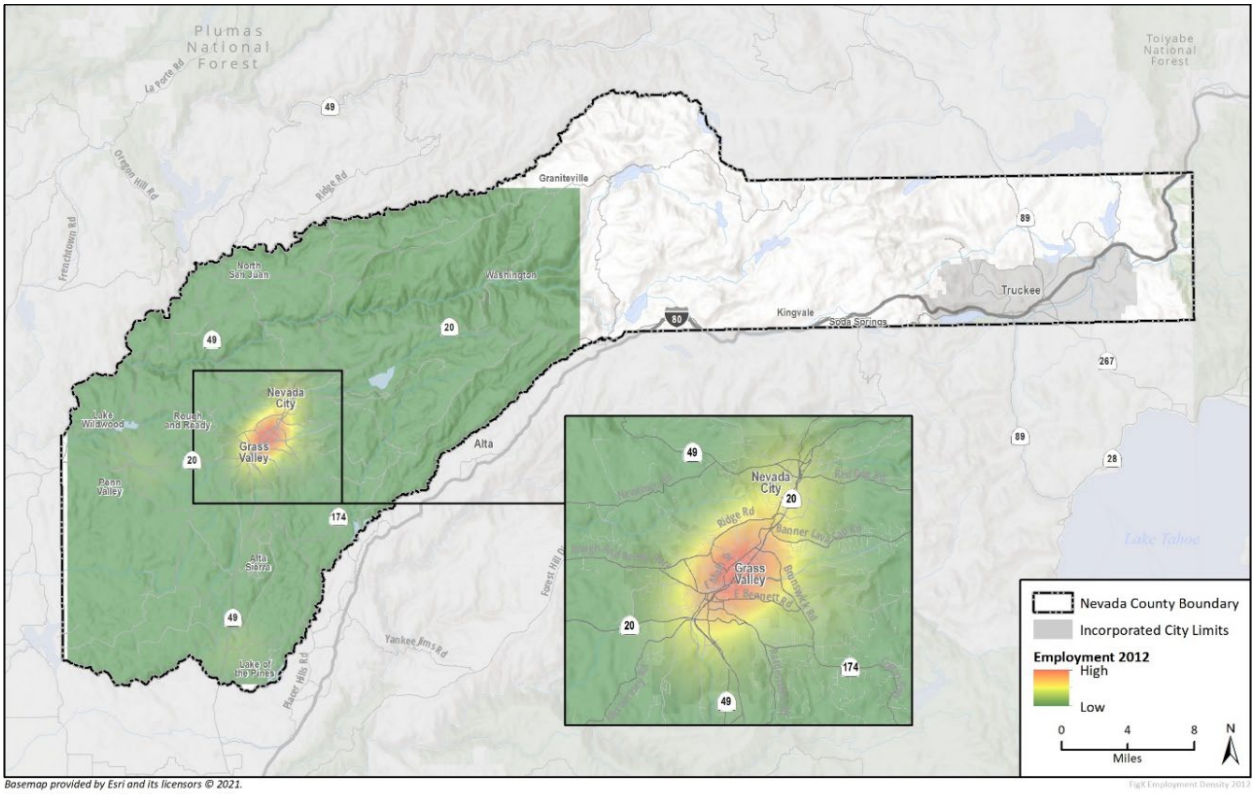

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Figure 11 Employment Density in Western Nevada County, 2035

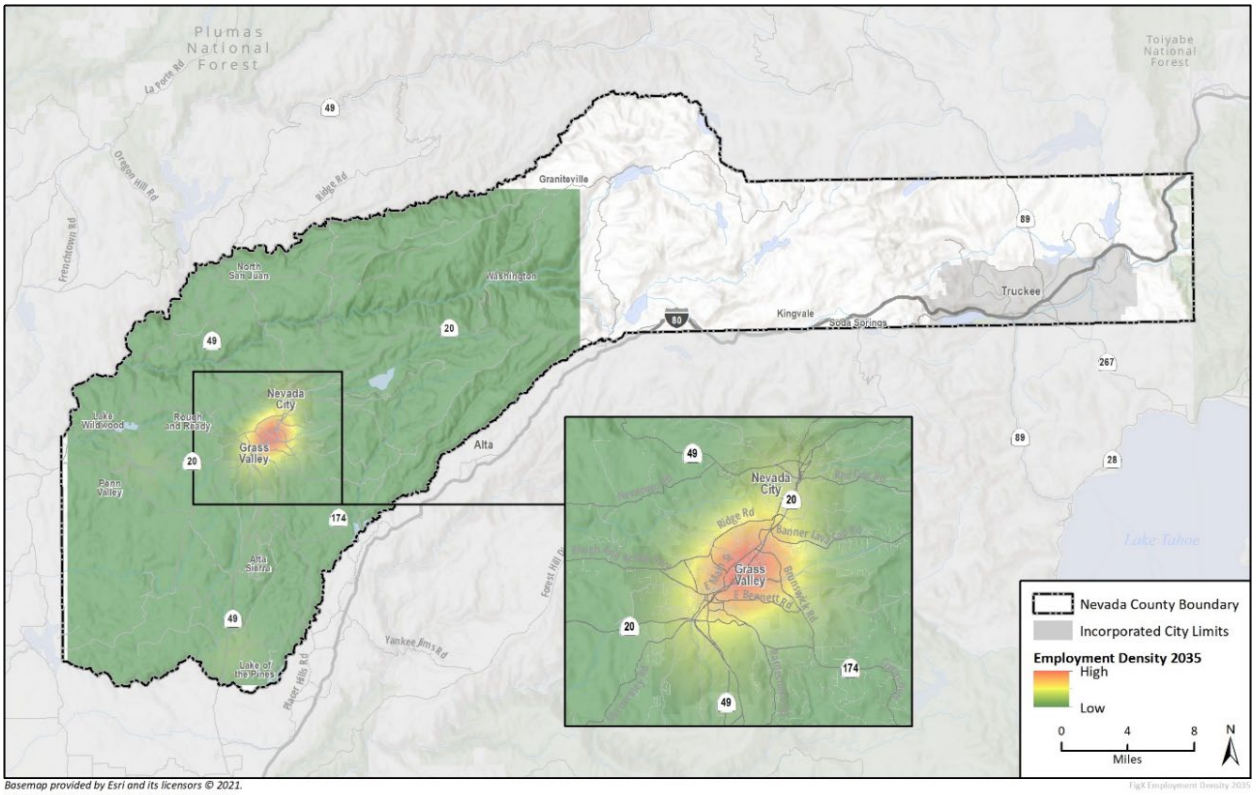

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Table 2 Employment Projections for Truckee in Eastern Nevada County, 2040

Year	Projected Employment Growth (AAGR 0.58%)
2018	7,000
2030	7,500
2040	7,900

Note: AAGR = Average annual growth rate.
Sources: Town of Truckee 2040 General Plan Existing Conditions Report; U.S. Census Bureau, 2017.

Transportation and Mobility

The existing conditions of the transportation system in Nevada County and how it is used are important in determining the strategies, policies, and programs that should be implemented to increase resilience to climate-related events. This includes existing roadways, highways, active transportation infrastructure, and public transit hubs. The location of critical facilities in the County are also important to analyze, including government offices, police stations, fire stations, hospitals, and airports. Critical facilities are vital to maintaining primary community functions, public health, and circulation, making continued access to them for both the general public and public officials a high priority in the event of hazardous events caused by climate change. Critical facilities in the County are shown in Figure 12.

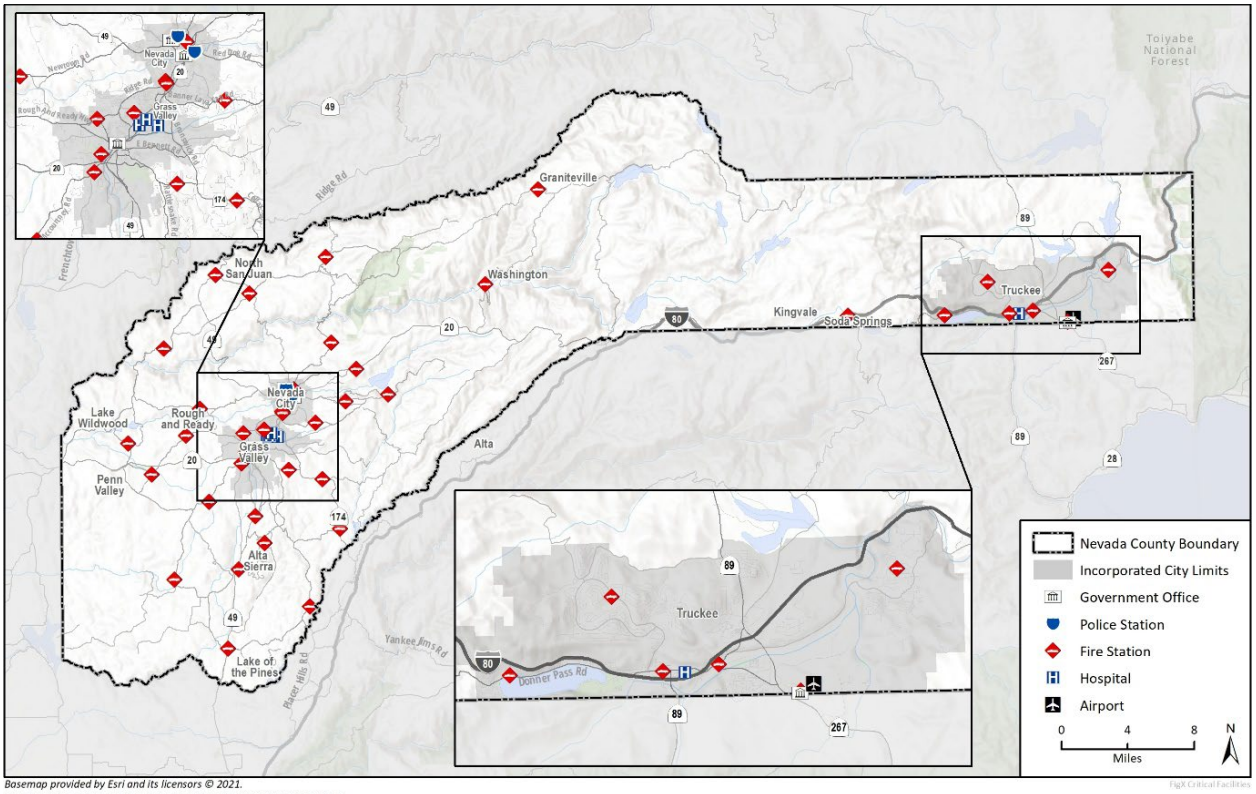
Nevada County has a multimodal transportation system, which includes roadways for passenger and commercial vehicles, active transportation, public transit, Amtrak passenger rail service and thruway busses, commercial rail lines, and two regional airports. The most common modes of travel for commuting in Nevada County are driving alone (75.4 percent) and carpooling (12.7 percent). Walking made up just 2.7 percent of commuter mode share, while public transit made up 0.7 percent and bicycling made up 0.3 percent (NCTC, 2018). These statistics are averaged across the County, and so it is likely that active transportation and transit see higher usage in higher density areas of the County, including Truckee and Grass Valley.

ROADWAY OPERATIONS

Roadway facility operations are often described in terms of Level of Service (LOS), which is a qualitative description of traffic flow based on factors such as speed, travel time, delay, and freedom to maneuver. This metric can be used to determine the most important arterial roadways to maintain access to during hazardous climate related events, and also affect evacuation scenarios based on how quickly or easily residents can travel on County roadways. LOS is categorized into six levels, from LOS A and B, which are uncongested operating conditions, to LOS C and D, which are for moderate levels of congestion. Level E represents at-capacity conditions, while LOS F represents volumes that exceed capacity, resulting in stop-and-go conditions.

LOS for western Nevada County in 2012 and 2035, calculated as a part of the 2015-2035 NCTC RTP using the NCTC travel demand model, is shown in Figure 13 and Figure 14. GIS map data was not available in the 2015-2035 NCTC RTP for the eastern part of the County, including Truckee, and thus is not represented in the figures. LOS data for intersections in Truckee for 2018, taken from the Truckee 2040 General Plan Existing Conditions Report, are shown in Table 3, as the largest population center in eastern Nevada County.

Figure 12 Critical Facilities in Nevada County



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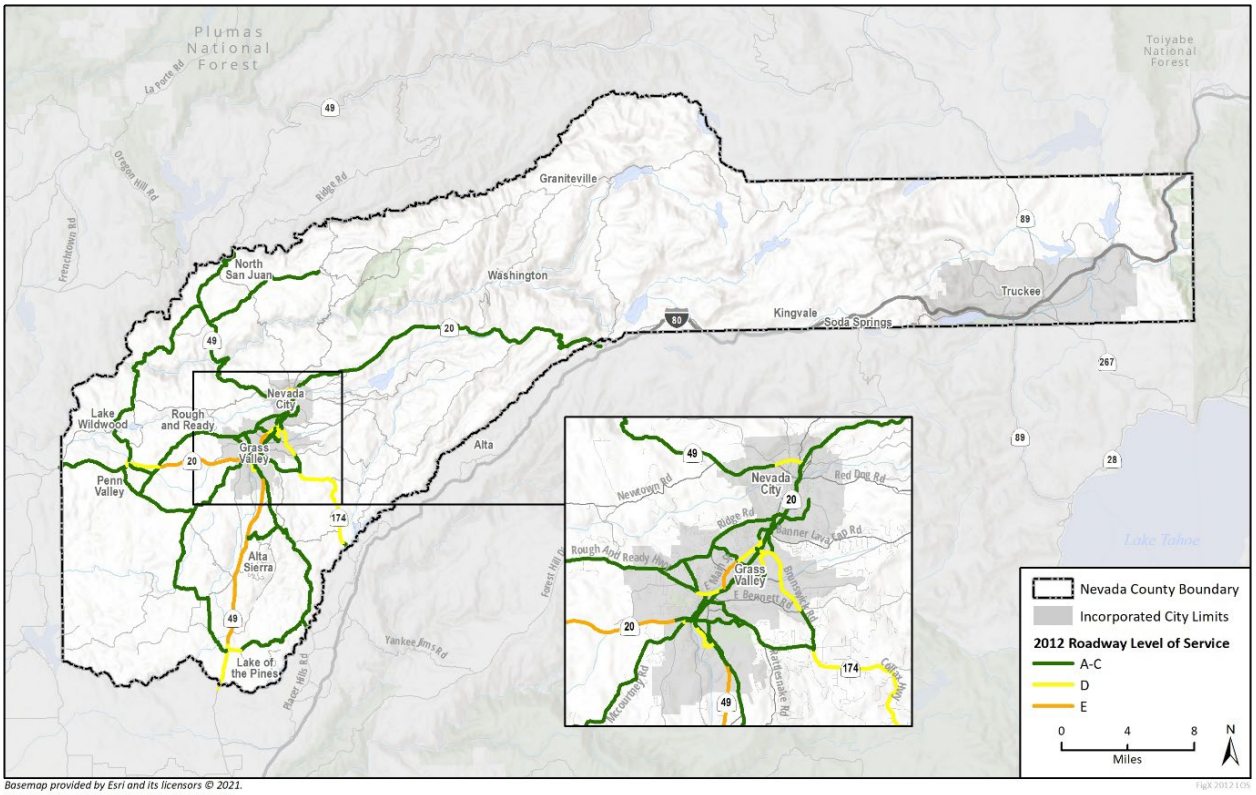
Additional data provided by Fehr and Peers, 2021; Nevada County, 2021.

Figure 13 Level of Service in Western Nevada County, 2012



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Additional data provided by Fehr and Peers, 2021.

Figure 14 Level of Service in Western Nevada County, 2035

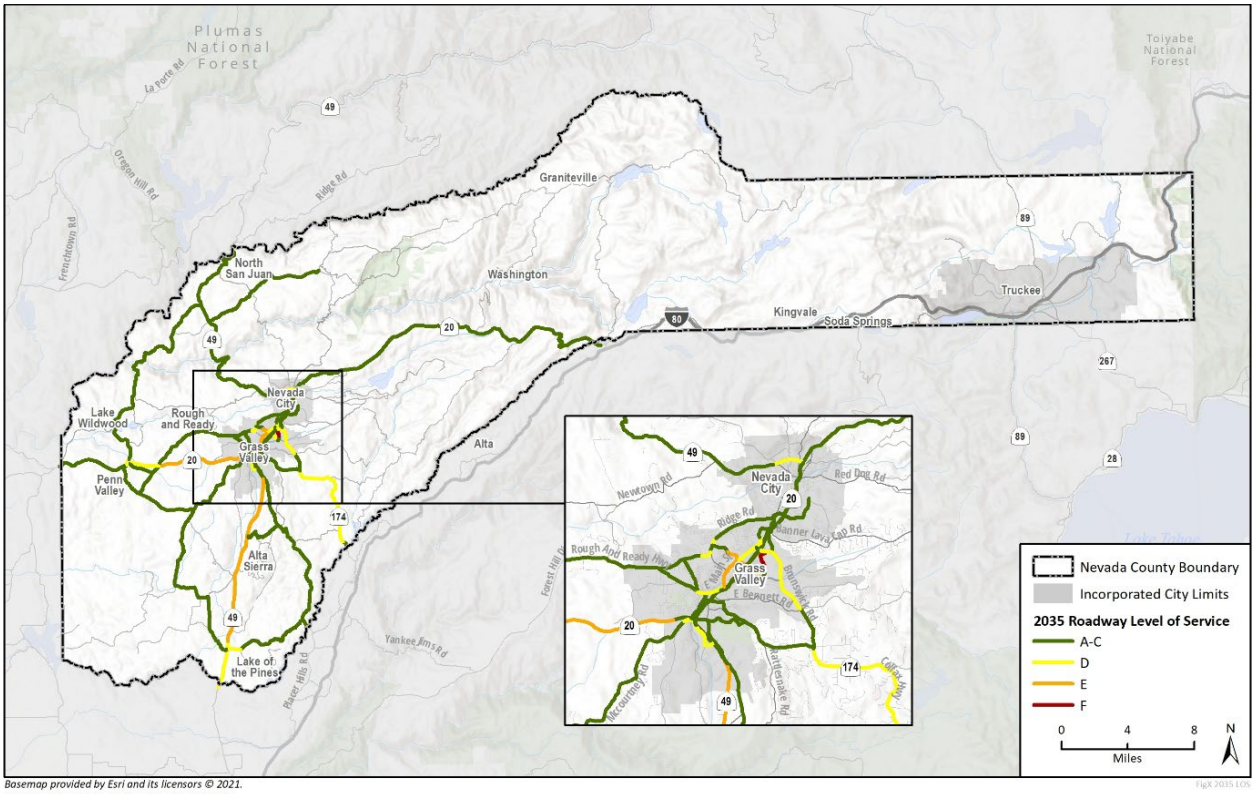


Table 3 Summer Intersection Level of Service for Truckee in Eastern Nevada County

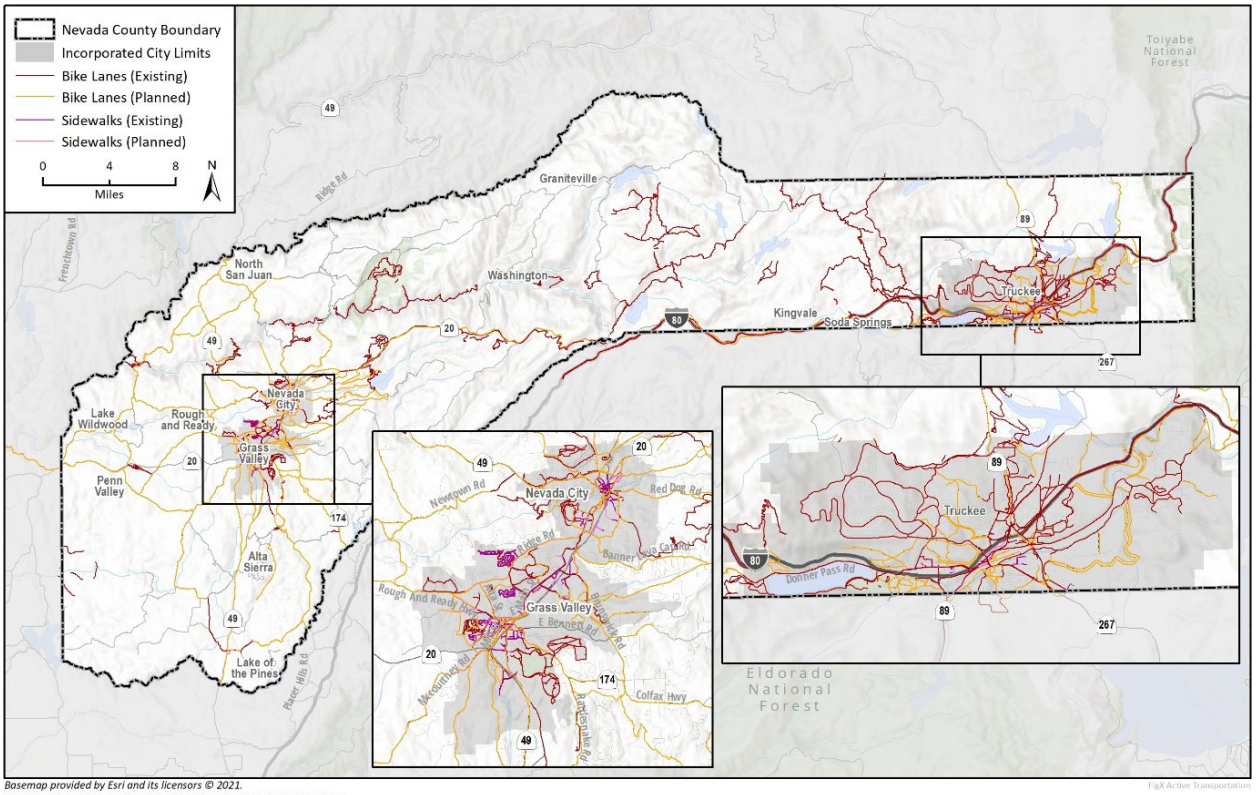
Main Street	Cross Street	Level of Service
Donner Pass Road	Cold Stream Road/I-80 eastbound ramps	E
Donner Pass Road	I-80 westbound western interchange	C
SR 89 South	Donner Pass Road/Frates Lane	D
SR 89 South	I-80 westbound ramps	C
SR 89 South	I-80 eastbound ramps	B
SR 89 South	Deerfield Drive	B
West River Street	Bridge Street	F
Donner Pass Road	Bridge Street	F
Truckee Way	Glenshire Drive	D
SR 267	Brockway Road/Soaring Way	D
SR 89 North/SR 267	I-80 eastbound ramps	E
SR 89 North/SR 267	I-80 westbound ramps	D
Donner Pass Road	SR 89	A

Sources: Town of Truckee 2040 General Plan Existing Conditions Report; modeling conducted by LSC Transportation Consultants, 2018.

ACTIVE TRANSPORTATION

Currently, walking represents about 2 percent and bicycling represents about 0.6 percent of journeys to work in Nevada County. This data does not include trips for other purposes however, such as trips made for shopping, school, or recreation, as these are more difficult to measure (NCTC, 2018). Both of these forms of active transportation provide benefits for reducing passenger vehicle miles traveled (VMT) and improving public health, but also are often the most impacted modes of transportation during disasters, such as when there is poor outdoor air quality due to wildfire smoke. Promoting active transportation can be done by providing more infrastructure for these purposes, such as bicycle facilities and sidewalks. Existing active transportation infrastructure in Nevada County is shown in Figure 15.

Figure 15 Active Transportation Infrastructure in Nevada County



Basemap provided by Esri and its licensors © 2021.
Additional data provided by Fehr and Peers, 2021; Nevada County, 2021.

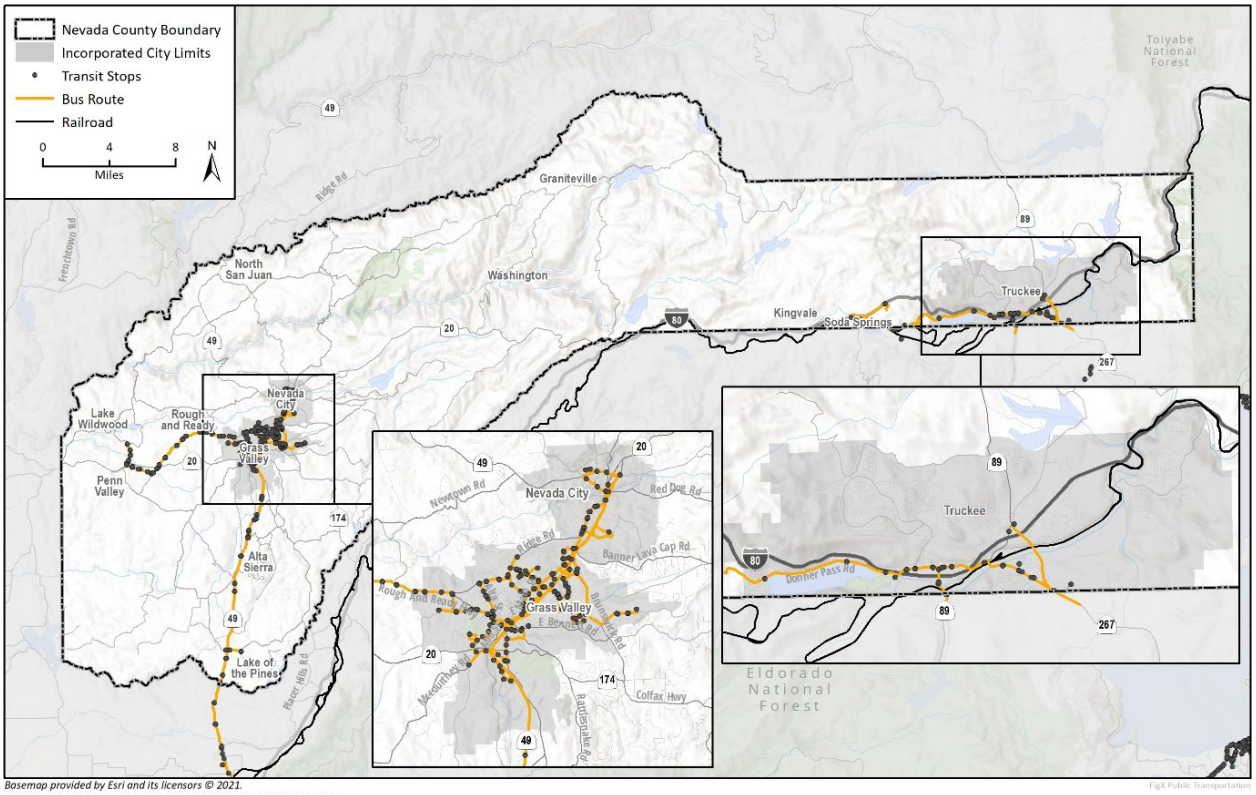
PUBLIC TRANSPORTATION

The public transportation system is an important part of the movement of people throughout Nevada County, especially for vulnerable populations that may not have access to a single passenger vehicle. Public transportation in Nevada County includes a variety of fixed route bus systems, demand response paratransit services, and passenger rail services. With the worsening impacts of climate change, these systems could be adversely affected and put vulnerable communities within the County at risk of losing mobility options.

Transit services in western Nevada County are provided through a Joint Powers Agreement executed between Nevada County, the City of Grass Valley, and Nevada City. The Nevada County Transit Services Division is responsible for the operation and management of the two public transit systems in western Nevada County: Nevada County Connects, which is a fixed route bus system serving the cities of Grass Valley and Nevada City, and Paratransit Services, Inc., which is a nonprofit organization contracted with by the County to provide demand response paratransit service for residents with disabilities in western Nevada County, branded as Nevada County

Now. Nevada County Now also provides paratransit services throughout an outlying defined paratransit area as service hours and resources are available. Eastern Nevada County is primarily served by Tahoe Truckee Area Regional Transit (TART), which is a fixed route transit system serving the Town of Truckee and portions of Placer County. These services are operated collaboratively but separately by each respective jurisdiction. There is also the Truckee Dial-A-Ride, which is a demand response transportation service in the Town of Truckee. Amtrak's California Zephyr serves the San Francisco to Chicago Corridor with a daily train in each direction, through stations in Sacramento, Roseville, Colfax, Truckee, and Reno (NCTC, 2018). Primary public transportation routes and infrastructure are shown below in Figure 16.

Figure 16 Public Transportation Infrastructure in Nevada County



AIRPORT

There are two general aviation airports in Nevada County. The Nevada County Airport, located east of Grass Valley, serves western Nevada County, and the Truckee Tahoe Airport, located southeast of Truckee, serves eastern Nevada County. Both of these airports are included in the National Plan of Integrated Airport Systems as being important to national air transportation and are classified in the California Aviation System Plan as Regional General Aviation airport facilities (NCTC, 2018).

The operational uses at the two airports are similar and the facilities provide a range of services to general aviation customers. The two airports predominantly serve as a base for local personal and recreational flyers, a point of access for personal and recreational visitors to the community, a transportation facility for business/corporate aviation, a place to conduct aviation-related business, and a site for emergency access to the community. The Nevada County Airport also serves as a base for CAL FIRE attack aircraft, which could become more important as more wildfires result in the region due to climate change. Neither of the airports provide commercial airline passenger service, instead emphasizing recreational, business, and emergency needs (NCTC, 2018). Maintaining

services at and access to these airports will be important in the future, especially during hazardous conditions that may occur as a result of climate change.

GOODS MOVEMENT

Goods are primarily moved via trucks in Nevada County. The most significant highways that serve interregional travel and goods movement include Interstate 80, State Route 20, State Route 49 between Interstate 80 and State Route 20, State Route 89, and State Route 267. These are priority interregional highways and are expected to be the focus of future Interregional Transportation Improvement Program investments from Caltrans. As noted in the most recent Regional Transportation Plan, the highest truck volumes occur on Interstate 80 near State Route 89 in the Truckee area, and on Interstate 80 near State Route 20. Freight movement by truck suffers from traffic congestion on the roadway system, negatively affecting overall goods movement within the circulation system. Congestion and delays could be worsened as a result of climate-related hazards, such as landslides or flooding (NCTC, 2018).

In addition to serving as crucial goods movement corridors, State Routes 20 and 49 also serve as emergency detour routes. When emergency detours divert traffic to these routes, goods movement can be delayed by the increase in volume on the roads. During winter detour events, critical goods such as propane for heating may be delayed.

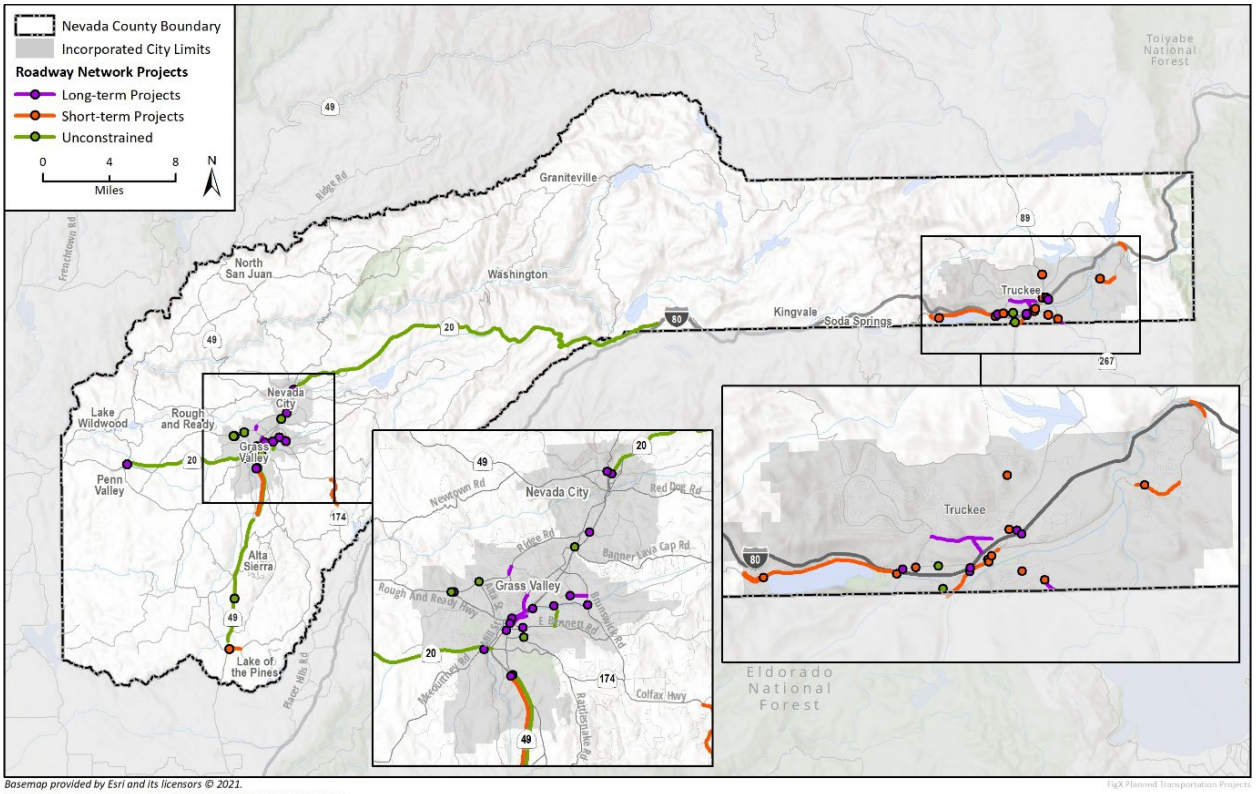
Union Pacific Railroad (UPRR) owns and operates tracks that roughly follow I-80 along the southern and eastern borders of Nevada County. The tracks do not cross into the western portion of the County, and are used heavily for the shipment of goods and also utilized for passenger service. There are sixty-seven miles of track located in eastern Nevada County in total. While there are currently no freight rail loading and unloading facilities in Nevada County, this commercial rail system could still see damage or negative service impacts as a result of climate change (NCTC, 2018).

PLANNED TRANSPORTATION PROJECTS

To determine how best to build resilience into Nevada County's transportation system, it is important to understand what the system will look like and how it will be used in the future. Incorporating climate adaptation measures into construction or development projects makes them more cost-effective than retroactively hardening infrastructure. A map of planned transportation projects in Nevada County through 2035 as outlined in the 2015-2035 RTP is shown in Figure 17. These projects are broken up into three categories:

- Short-term financially constrained projects, which can reasonably expect to be funded and begin construction prior to 2025
- Long-term financially constrained projects that can reasonably be expected to be funded and constructed between 2025 and 2035
- Unconstrained (unfunded) projects that may be constructed prior to the year 2035 if additional revenues are realized or funded by future development (NCTC, 2018)

Figure 17 Planned Transportation Projects in Nevada County



Hazard Risks

Nevada County's transportation infrastructure was developed to accommodate the highly variable climatic conditions of the Sierra Nevada region but is frequently challenged by natural events such as heavy precipitation, heavy snowfall, flooding, and wildfires. Climate changes may result in increased maintenance and repair expenditures, disruptions of economic activity, interruptions of critical lifelines, and ultimately reductions in the overall quality of life for local residents and businesses. Impacts on transportation infrastructure from warming include softening or buckling of road pavement and deterioration of concrete structures, which compromises roadway integrity during heat waves or generally reduces their useful lifetimes. Similarly, bridge joints and other structural elements expand and contract during periods of extreme heat and cold, requiring higher levels of maintenance and reducing their useful lifetimes. Heat waves can also lead to limitations or interruptions to construction activities (Dettinger, 2018).

Heavier rainfall events, including rain on snow, are likely to cause periodic flooding of roadways and railways, and in some areas could cause erosion or mudslides. In addition to flooding and damage, transportation corridors, transmission lines, wastewater treatment facilities, culverts, canals, tunnels, runways, and railways are likely to be challenged, with associated service and business interruptions. As dry spells grow longer, frequencies and risks of forest fires, with attendant transportation disruptions and infrastructure damage, will increase in many parts of the Sierra Nevada region. Wildfire is the predominant risk under climate change to the local transportation-fuel sector (highways, railways, and pipeline infrastructure), due to a combination of direct exposure of the structures to flames, impacts on supporting facilities and agents, and increased competition for help from the State's emergency management systems (Dettinger, 2018).

However, some areas may experience benefits from increased temperatures, like reductions in snow and frost seasons that may reduce the need for removing snow and ice from roadways, railways, and transportation

structures. Earlier thaws and less snowpack and snow cover may increase the accessibility of seasonal mountain passes, although this could increase demands and season-lengths for maintenance and repair.

Cal-Adapt Analysis

Projections of climate hazard risks in Nevada County were primarily analyzed using Cal-Adapt, with information supplemented from the 2017 Nevada County Local Hazard Mitigation Plan and other local sources. Cal-Adapt is an online suite of data visualization tools designed to give the public access to data and information from California's science and research community. It allows users to view how climate change will affect local communities. Projections were modeled for both the eastern and western parts of Nevada County due to their significant variation in topography, elevation, and biomes, allowing for more accurate analysis of climate hazard risks throughout the County. Due to the limitations of the Cal-Adapt tool, projections could not be produced for each separate part of the County. Instead, projections for the Town of Truckee were used as a proxy for analyzing climate hazard risks in the eastern half of the County, and Grass Valley was used as a proxy for the western half of the County.

Cal-Adapt scenarios are all based on Representative Concentration Pathways (RCP) 4.5 and 8.5, which are potential future pathways used by climate scientists to describe different concentration of carbon in the atmosphere. The RCP 4.5 pathway is a medium emissions scenario, which sees global emissions peak around 2040 and then decline, resulting in global temperatures increasing by 1.8°F, generally stabilizing the climate and avoiding the worst effects of climate change. The RCP 8.5 pathway is a high emissions scenario, or business-as-usual, which sees global temperatures increase by 4.3°F, well above the level that scientists say we need to limit climate change to in order to avoid the worst effects of climate change. Based on global trends that still see global GHG emissions increasing today, RCP 8.5 is currently considered the most likely scenario, but both are shown for reference (Mark B., 2020).

RISING TEMPERATURES AND EXTREME HEAT

Temperatures are expected to rise in Nevada County as a result of climate change, particularly at higher elevations, causing extreme heat events to be more severe and to occur more frequently. Extreme heat events pose risks to the public health of vulnerable populations in Nevada County, such as those who work outside or have existing health concerns. Greater fluctuations in temperatures between the summer and winter months will cause infrastructure to expand and contract more, which could lead to more infrastructure repairs being necessary and thus greater disruptions to the circulation system (Dettinger, 2018). This impacts highways through forested areas and other principal arterials in high-risk wildfire areas.

The annual average maximum temperature through the rest of the century, measured in degrees Fahrenheit, is shown for Truckee in Figure 18 and Grass Valley in Figure 19. In Truckee, the annual average maximum temperature is projected to increase from the historical baseline of 58.1°F for 1961-1990, to 62.5°F to 63.4°F by the middle of the century, and 63.7°F to 67.3°F by the end of the century, depending on the emissions pathway scenario. In Grass Valley, the annual average maximum temperature is projected to increase from the historical baseline of 67.8°F for 1961-1990, to 71.7°F to 72.7°F by the middle of the century, and to 72.9°F to 76.4°F by the end of the century, depending on the emissions pathway scenario. These projections show that the annual average maximum temperature in both the eastern and western parts of Nevada County is projected to increase in the future, particularly by the end of the century. A more significant increase is projected for Truckee in the eastern part of the county, likely due to its higher elevation relative to Grass Valley.

Figure 18 *Annual Average Maximum Temperature, Truckee*

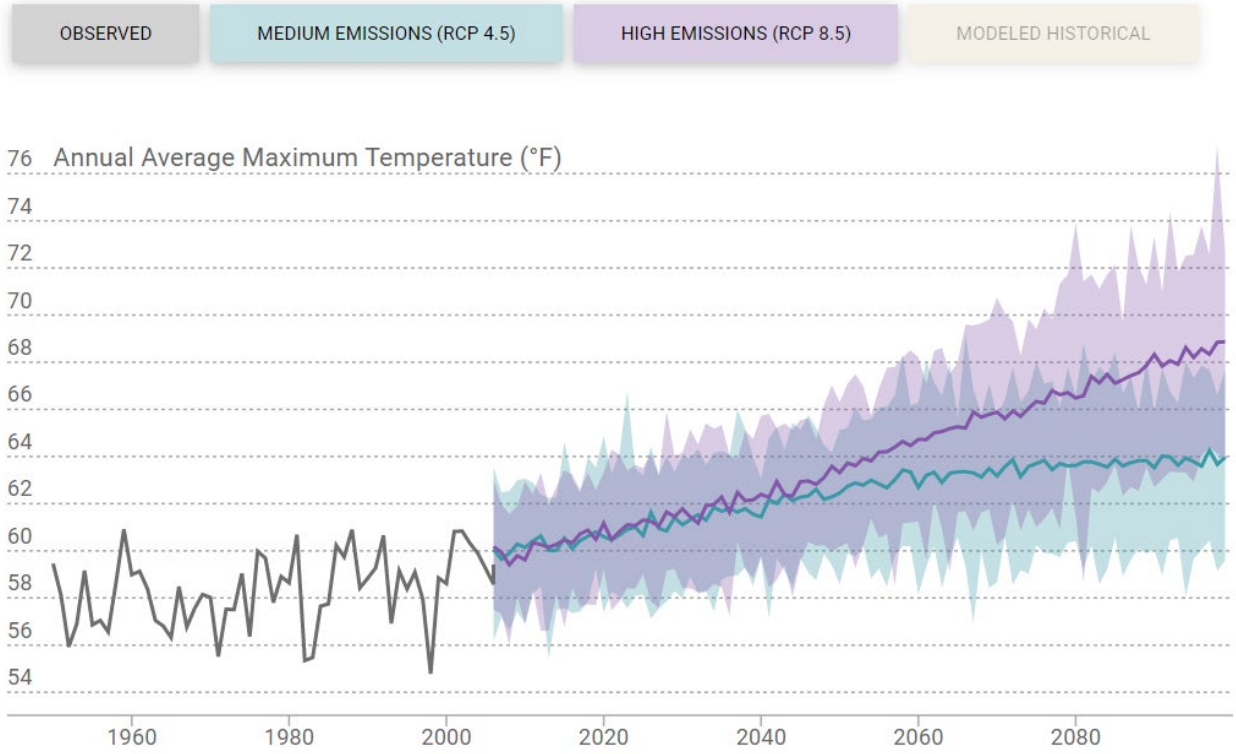
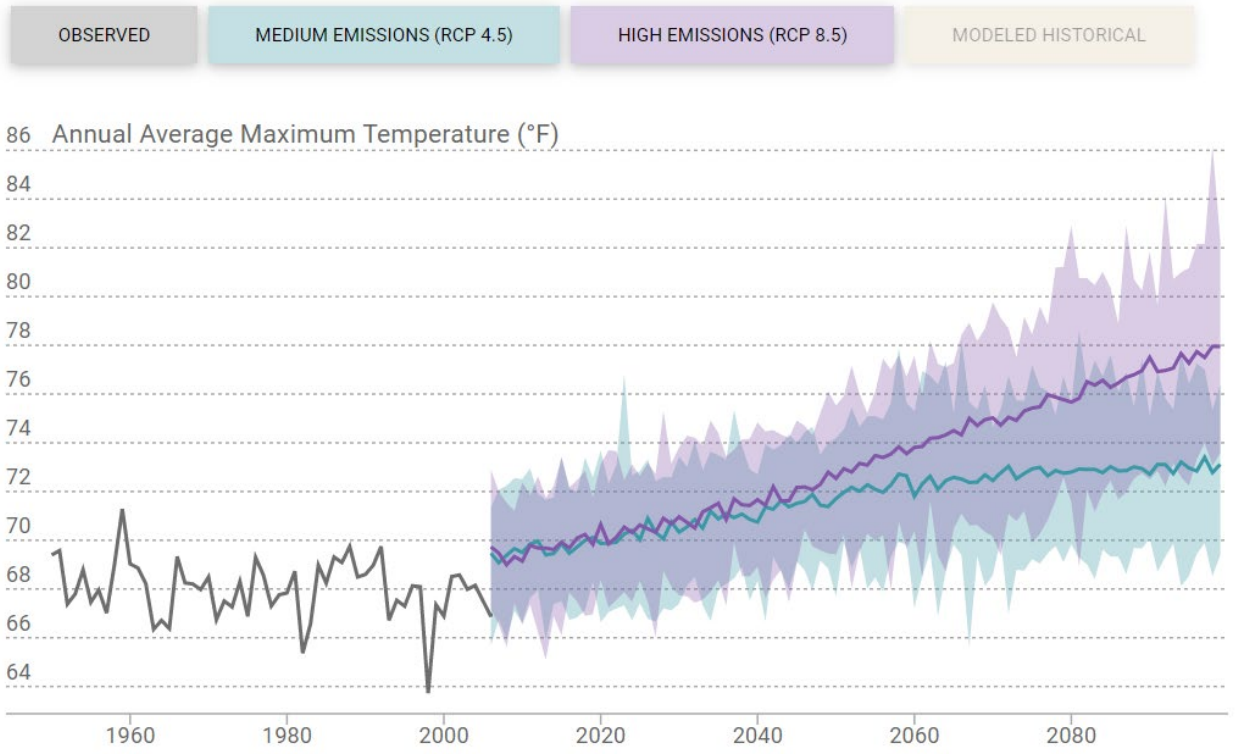


Figure 19 *Annual Average Maximum Temperature, Grass Valley*



Annual average minimum temperature through the rest of the century, measured in degrees Fahrenheit, is shown below for Truckee in Figure 20 and Grass Valley in Figure 21. Increases in annual average minimum temperatures tend to indicate higher occurrences of warm nights. In Truckee, the annual average minimum temperature is projected to increase from the historical baseline of 24.7°F for 1961-1990, to 28.3°F to 29.3°F by the middle of the century, and 29.5°F to 32.9°F by the end of the century, depending on the emissions pathway scenario. In Grass Valley, the annual average minimum temperature is projected to increase from the historical baseline of 41.5°F for 1961-1990, to 44.8°F to 45.8°F by the middle of the century, and to 45.9°F to 49.4°F by the end of the century, depending on the emissions pathway scenario. These projections show that the annual average minimum temperature in both the eastern and western parts of Nevada County is projected to increase in the future, particularly by the end of the century. A slightly more significant increase is projected for Truckee in the eastern part of the county, likely due to its higher elevation relative to Grass Valley.

Figure 20 Annual Average Minimum Temperature, Truckee

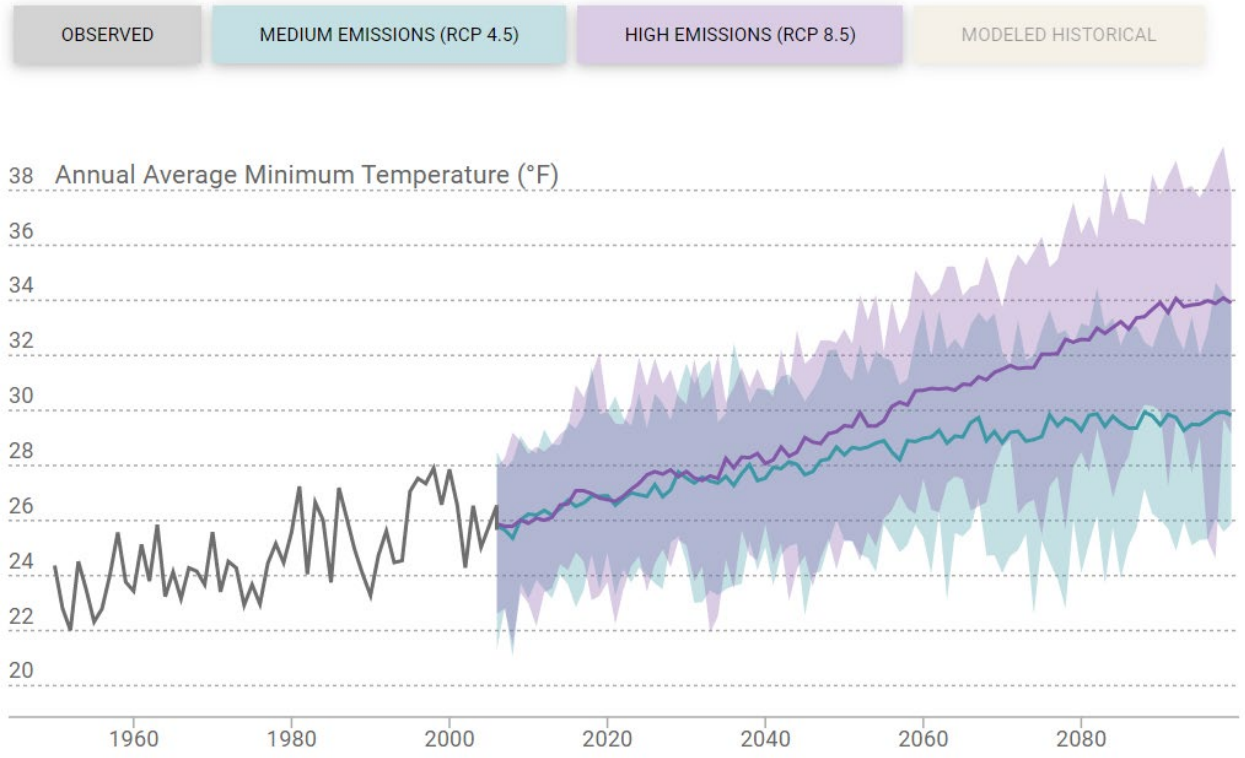
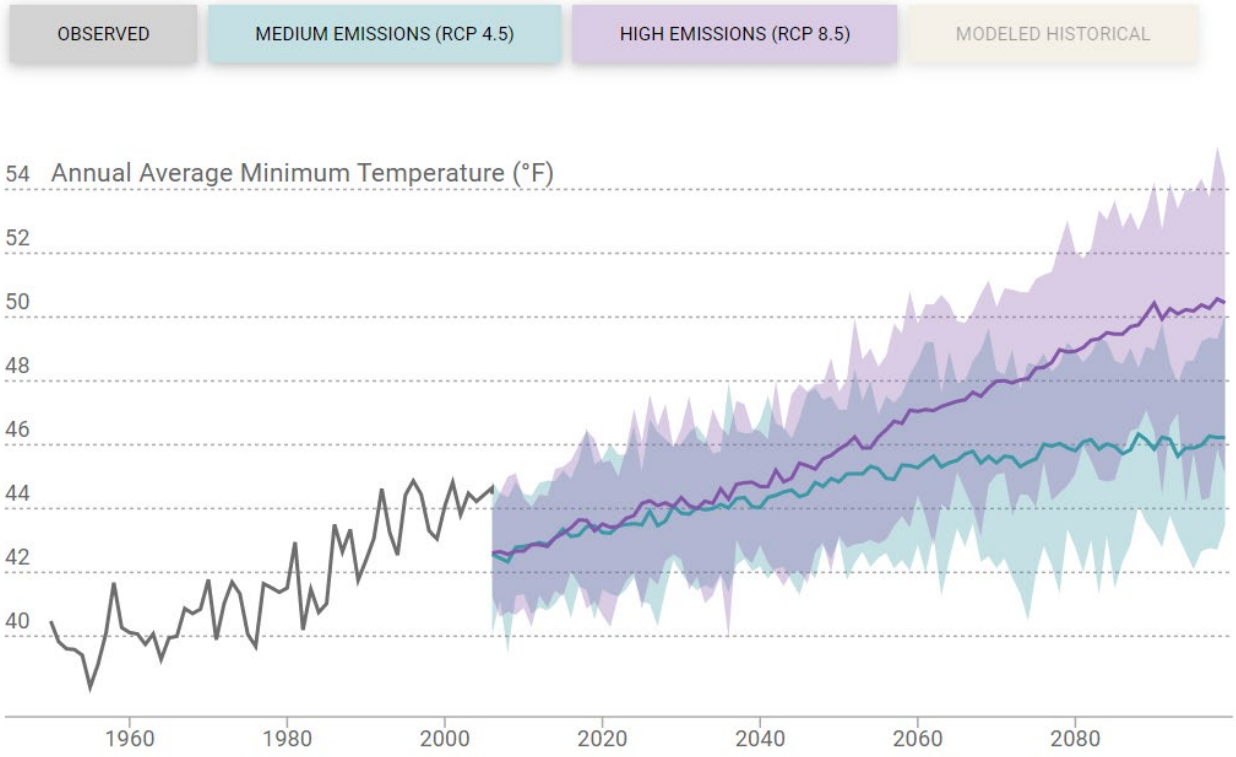


Figure 21 Annual Average Minimum Temperature, Grass Valley



The annual number of extreme heat days through the rest of the century, which is defined as a day with a daily maximum temperature higher than 96.6°F, is shown for Truckee in Figure 22 and Grass Valley in Figure 23. In Truckee, the annual number of extreme heat days is projected to increase from the historical baseline of 4 days for 1961-1990, to 23 to 30 days by the middle of the century, and 31 to 59 days by the end of the century, depending on the emissions pathway scenario. In Grass Valley, the annual number of extreme heat days is projected to increase from the historical baseline of 4 days for 1961-1990, to 24 to 31 days by the middle of the century, and to 33 to 60 days by the end of the century, depending on the emissions pathway scenario. These projections show that the annual number of extreme heat days is projected to increase in both the eastern and western parts of Nevada County, with a slightly greater magnitude in Grass Valley in the western part of the County.

Figure 22 Annual Extreme Heat Days, Truckee

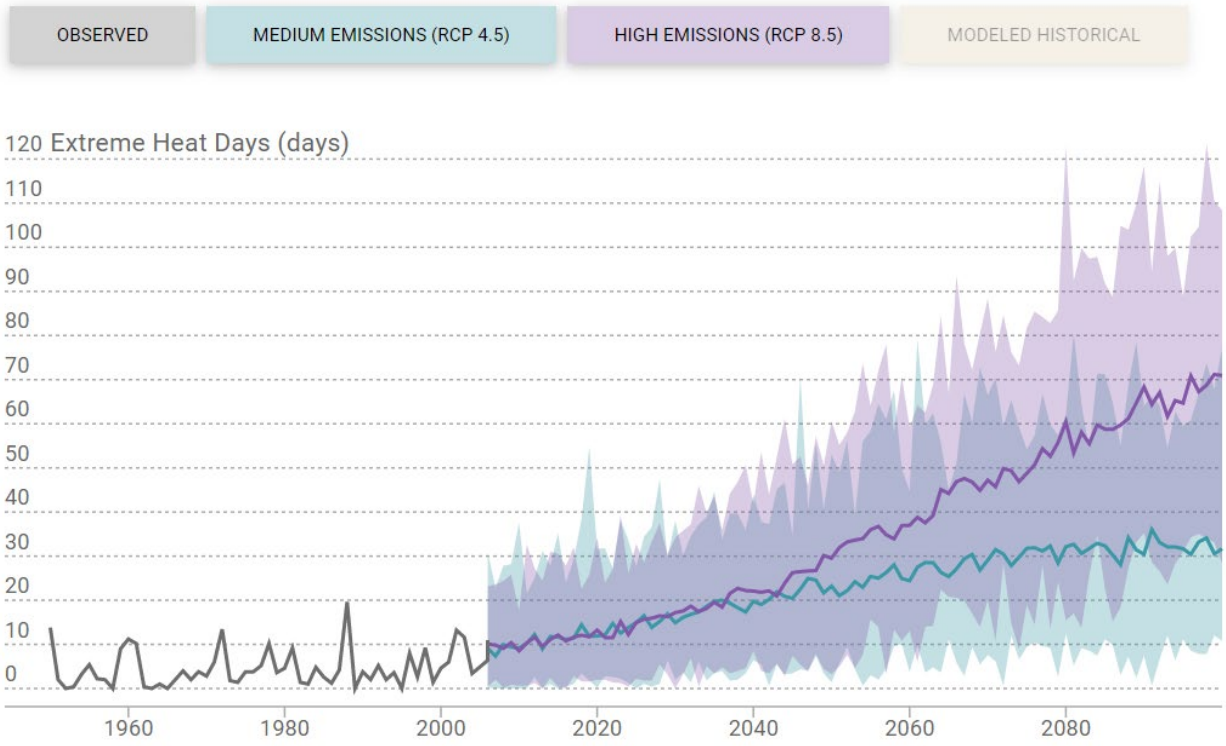
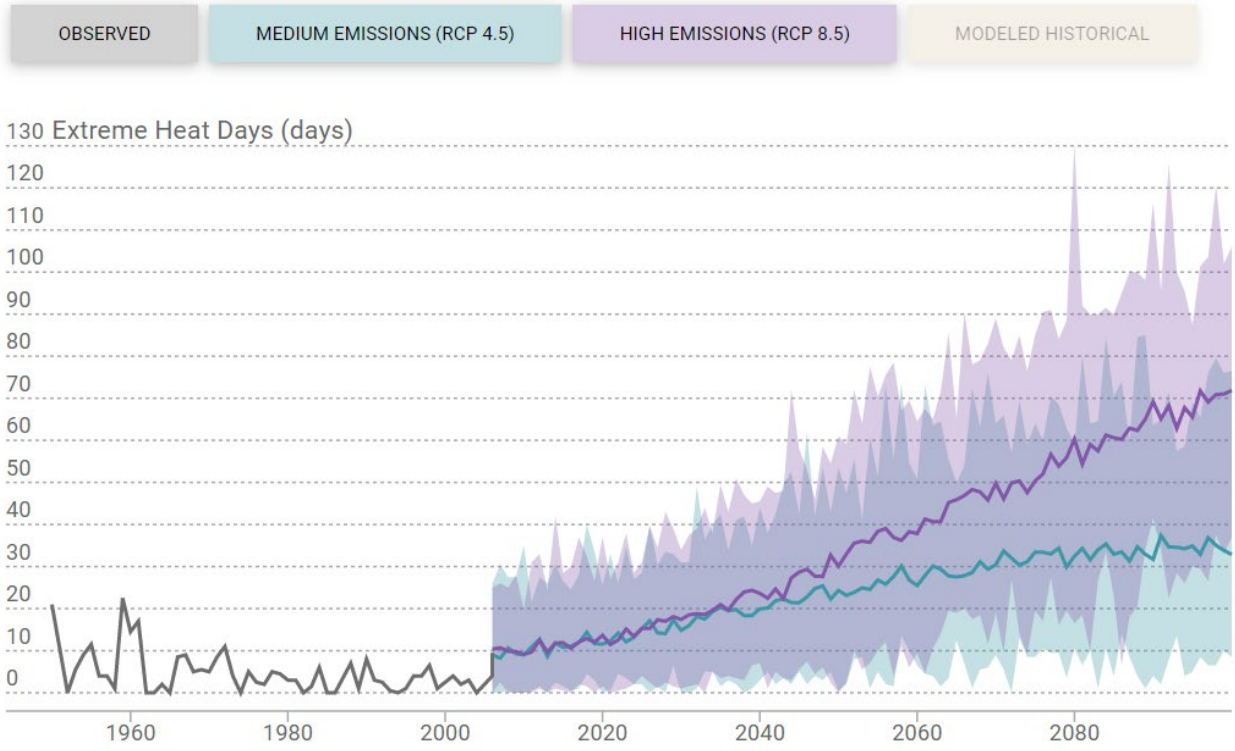


Figure 23 Annual Extreme Heat Days, Grass Valley



PRECIPITATION, DROUGHT, AND SNOWPACK

Precipitation

California's climate varies between wet and dry years. Research suggests that for much of the state, climate change will result in wet years becoming wetter and the dry years will become drier. Dry years will also more likely to be followed by dry years, increasing the risk of drought. While overall average annual precipitation in the state is not projected to change significantly in the next 50 to 75 years, precipitation will likely be delivered in more intense storms and within a shorter wet season. This change in precipitation intensity could create challenges for existing water storage systems in Nevada County as precipitation falls less consistently and overwhelms current maximum capacity, resulting in lost water resources. Small changes in precipitation patterns can have significant impacts on water supplies and agricultural stakeholders, as they depend on the reliability and predictability of precipitation (Dettinger, 2018). Heavy precipitation events can damage transportation infrastructure, causing increased road washouts, potholes, flood events, and mudslides, adversely impacting regular residential and commercial circulation throughout Nevada County.

Maximum one-day precipitation can be used to assess the intensity of precipitation events. Maximum one-day precipitation through the rest of the century, measured in inches, is shown for Truckee in Figure 24 and Grass Valley in Figure 25. In Truckee, maximum one-day precipitation is projected to increase from the historical baseline of 1.97 inches for 1961-1990, to 2.07 to 2.16 inches by the middle of the century, and 2.14 to 2.28 inches by the end of the century, depending on the emissions pathway scenario. In Grass Valley, maximum one-day precipitation is projected to increase from the historical baseline of 3.21 inches for 1961-1990, to 3.31 to 3.40 inches by the middle of the century, and to 3.42 to 3.64 inches by the end of the century, depending on the emissions pathway scenario. These projections show that maximum one-day precipitation in both the eastern and western parts of Nevada County is projected to increase in the future, particularly by the end of the century, indicating precipitation events are likely to become more intense in the future. A slightly more significant increase is projected for Grass Valley in the western part of the county.

Figure 24 Maximum One-Day Precipitation, Truckee

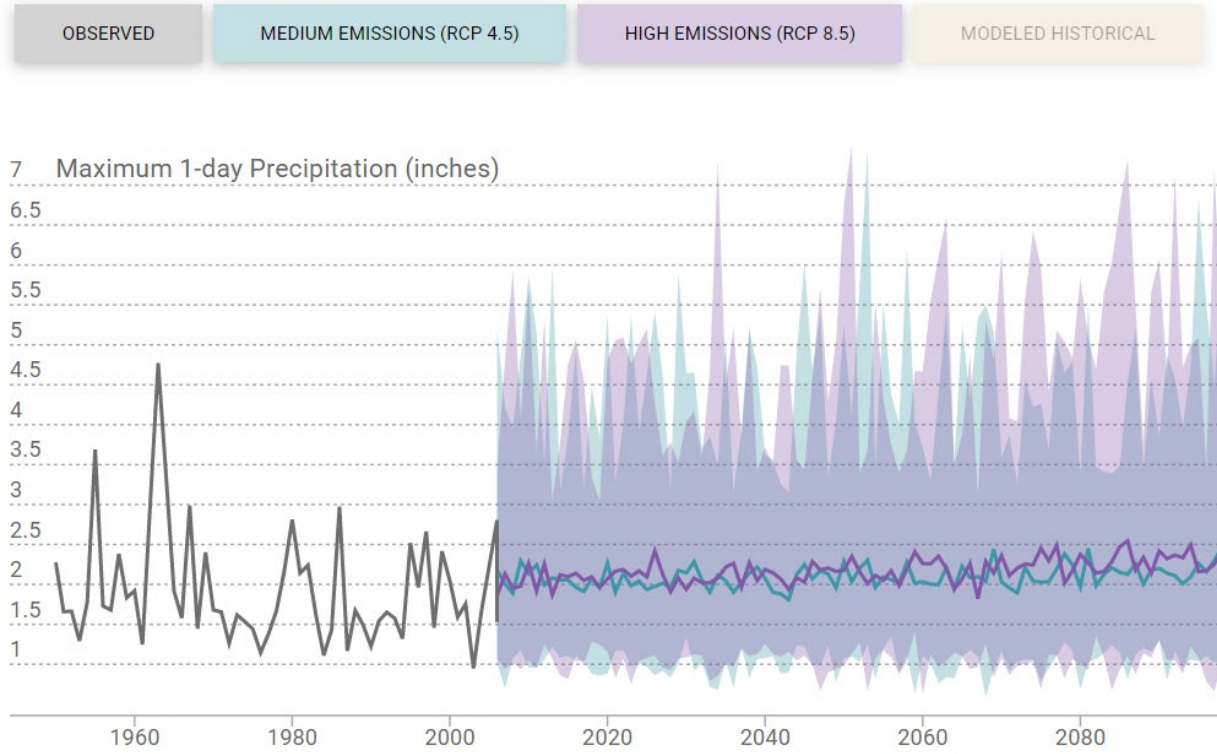
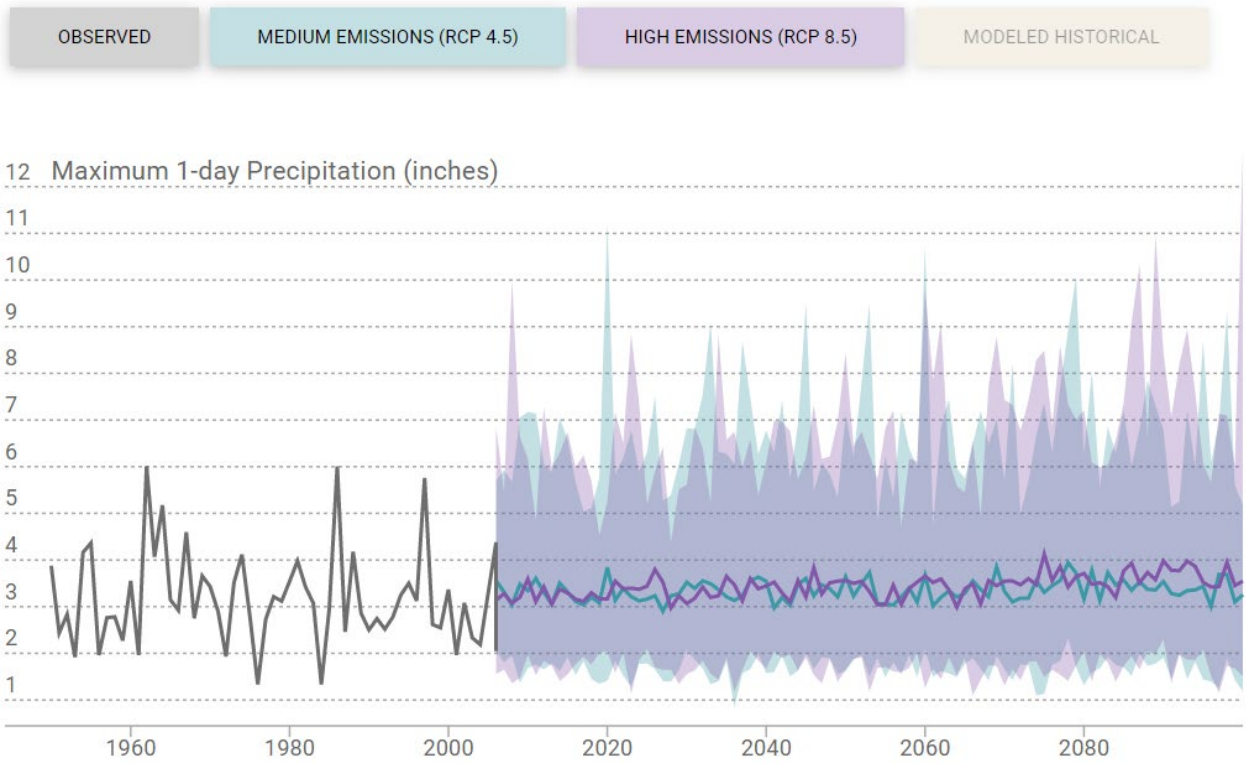


Figure 25 Maximum One-Day Precipitation, Grass Valley



The annual precipitation through the end of the century, measured in inches, is shown below for Truckee in Figure 26 and for Grass Valley in Figure 27. In Truckee, annual precipitation is projected to increase slightly from the historical baseline of 30.9 inches for 1961-1990, to 30.8 to 31.7 inches by the middle of the century, and 31.4 to 32.4 inches by the end of the century, depending on the emissions pathway scenario. In Grass Valley, annual precipitation is also projected to increase slightly from the historical baseline of 54.7 inches for 1961-1990, to 53.8 to 55.0 inches by the middle of the century, and to 54.7 to 55.6 inches by the end of the century, depending on the emissions pathway scenario. These projections show that annual precipitation in both the eastern and western parts of Nevada County is projected to stay about the same in the future, increasing only slightly by the end of the century. This is similar to projections for California statewide, with no clear trend for changes in overall precipitation.

While climate change will not affect average annual precipitation, it is expected to change how it will fall, from increased storm intensity, higher precipitation event variability, and more precipitation falling as rain rather than snow. This will create challenges for existing water supply infrastructure and agricultural industries, which are highly dependent on the predictability of seasonal precipitation, and could stress infrastructure systems not designed to withstand higher intensity precipitation events.

Figure 26 Annual Precipitation, Truckee

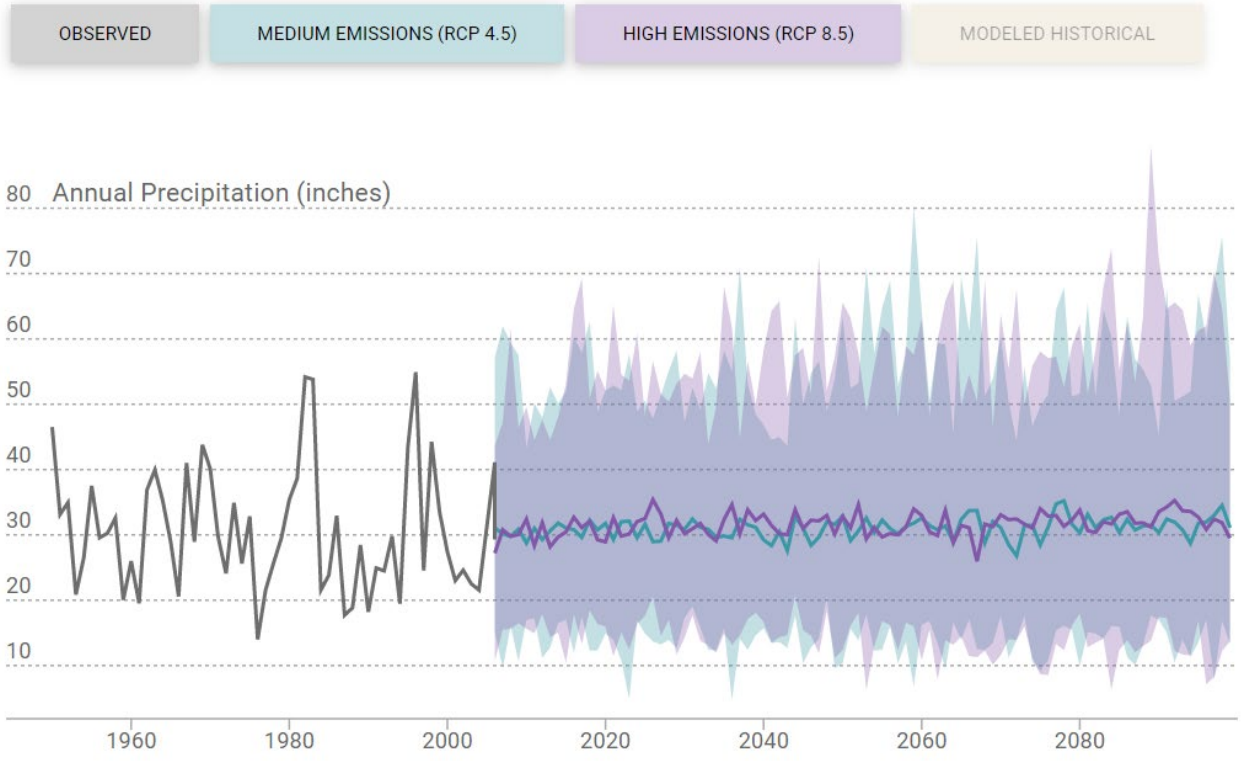
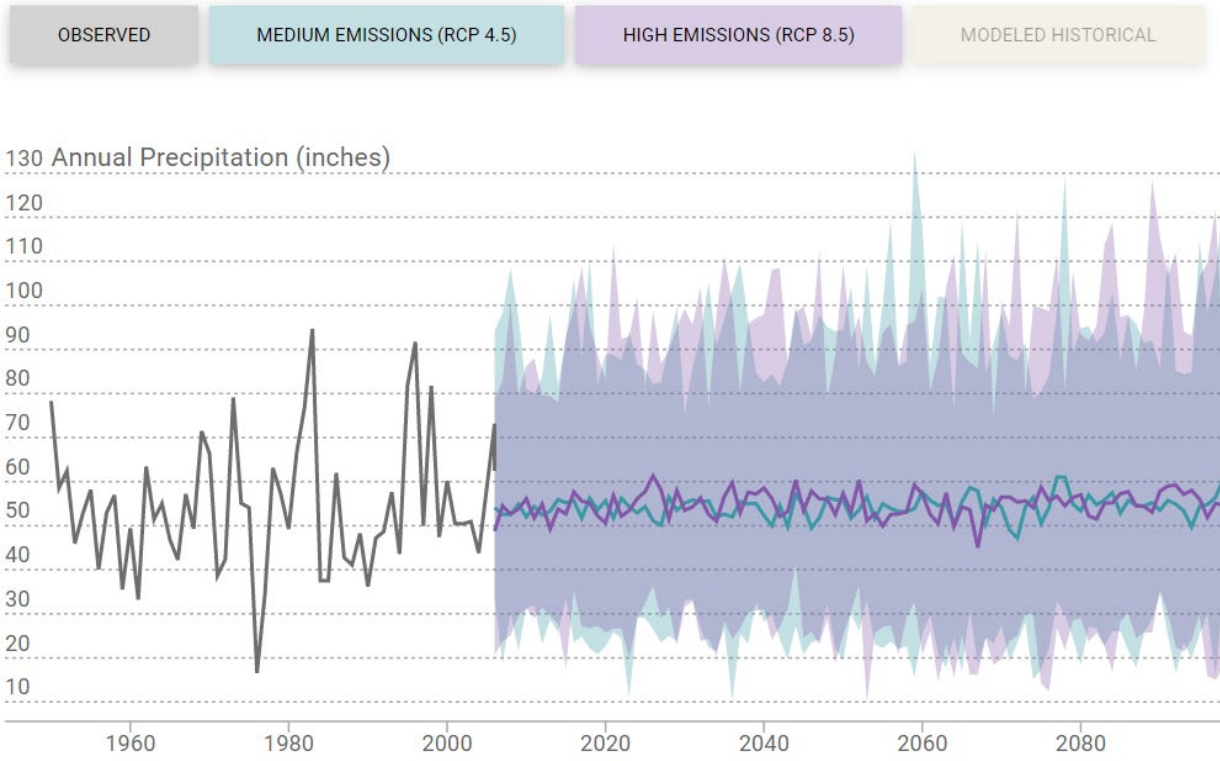


Figure 27 Annual Precipitation, Grass Valley



Drought

Between 2011 and 2017, California experienced its driest and warmest year since records began, the second driest and warmest year, and unprecedented low levels of Sierra Nevada snowpack (Climate Signals, 2018). Recent studies incorporating projected higher temperatures from climate change suggest that droughts like this may become more common if current trends continue (Bedsworth, 2018). One of the most significant impacts of this drought in Nevada County and the surrounding region was a massive tree die-off, resulting in then Governor Jerry Brown to declare a state of emergency, and required Caltrans and local transportation agencies to identify areas throughout California where the trees presented a wildfire and safety hazard and therefore required removal due to safety concerns (Executive Department, 2015). In response, Caltrans District 3 removed dead trees within 100 feet of highway centerlines along SR-20, SR-50, SR-80 and US-89 in Nevada, El Dorado, and Placer Counties from 2015 to 2018. The program ultimately felled over 5,500 trees for an estimated cost of over ten million dollars. As climate change continues to increase the prevalence and duration of droughts, resulting dead trees will continue to pose risks to Nevada County's transportation system.

The maximum length of dry spells can be used to assess the severity and duration of drought events. The maximum length of dry spells through the end of the century, measured in days, is shown for Truckee in Figure 28 and for Grass Valley in Figure 29. In Truckee, the maximum of dry spells is projected to increase from the average historical baseline of 62 days for 1961-1990, to 65 to 67 days by the middle of the century, and 65 to 69 days by the end of the century, depending on the emissions pathway scenario. In Grass Valley, the maximum of dry spells is projected to increase from the average historical baseline of 83 days for 1961-1990, to 87 to 89 days by the middle of the century, and to 86 to 92 days by the end of the century, depending on the emissions pathway scenario. These projections show that the maximum of dry spells in both the eastern and western parts of Nevada County is projected to increase in the future, particularly by the end of the century. A more significant increase is projected for Grass Valley in the western part of the county, with dry spells lasting potentially 9 days longer than they have historically.

Figure 28 Maximum Length of Dry Spell, Truckee

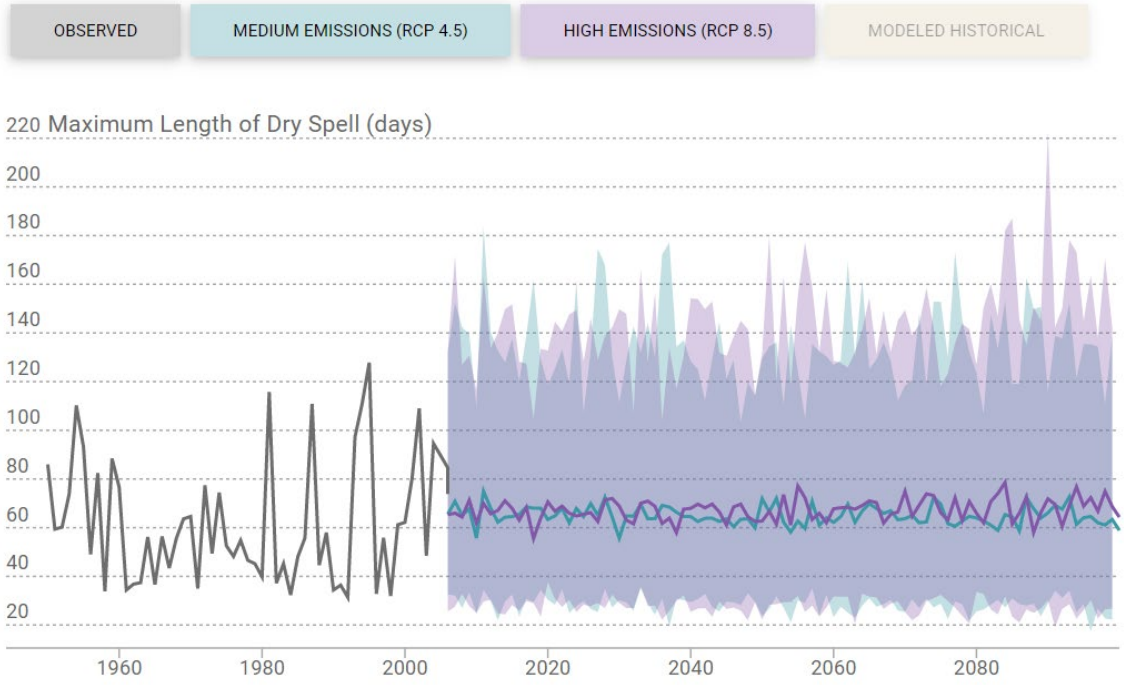
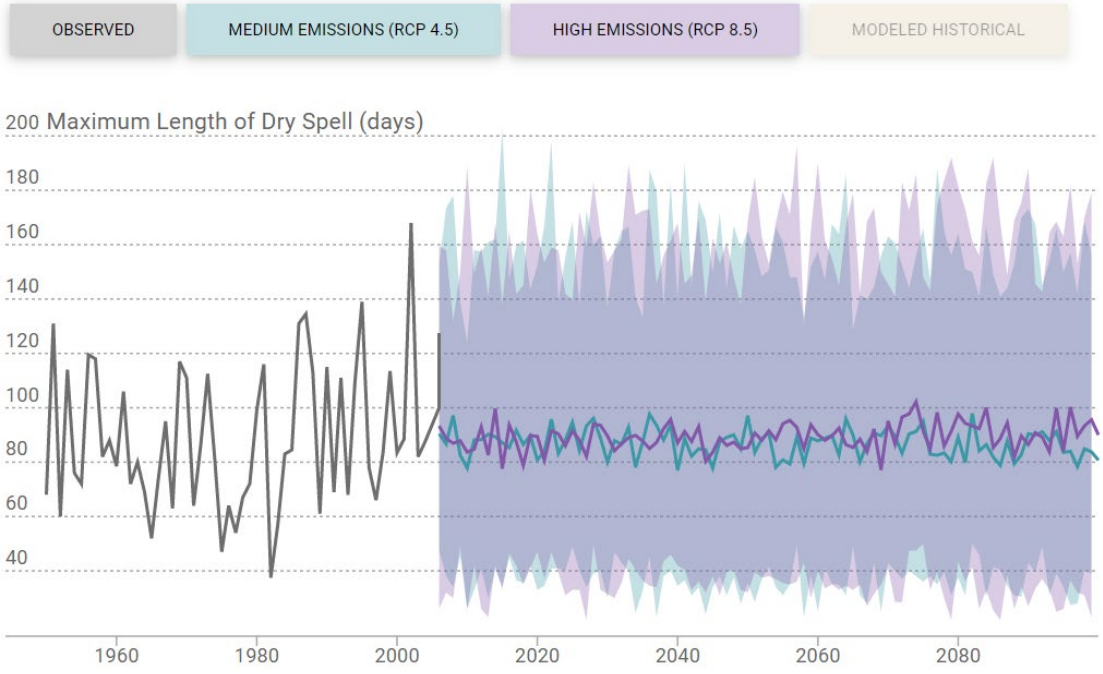


Figure 29 Maximum Length of Dry Spell, Grass Valley



Snowpack

If heat-trapping emissions continue unabated, more precipitation will fall as rain instead of snow, and the snow that does fall will melt earlier. As a result of projected warming, the Sierra Nevada snowpack is expected to cease below 6,000 feet elevation and be reduced overall by more than 60 percent. The snowline is expected to rise anywhere from 1,500 to 3,000 feet by the end of the century, leading to potential impacts to local ecosystems throughout the Tahoe National Forest and affecting the availability of water throughout California. The exact level of snowpack loss will depend on future precipitation patterns, which remain somewhat uncertain, and the potential for loss of snow leading to warmer land surfaces, which could result in a feedback loop which increases warming trends even further (Dettinger, 2018).

The loss of snowpack will combine to dry soils 15 percent to 40 percent below historical norms, depending on elevations, resulting in reduced soil and vegetation moisture, changes in rivers and lakes, and increased stresses on local flora and fauna. High elevation forests and old-growth mixed conifer forests are the most vulnerable to projected changes in climate and wildfire, along with oak woodland areas. Loss of snowpack and overall drying will lead to increased winter stream flows and foods, and to reductions in spring and summer stream flows (Dettinger, 2018). Even under wetter climate projections, snowpack losses will pose challenges to water managers, hamper hydropower generation, and may nearly eliminate skiing and other snow-related recreational activities throughout the region. These impacts could lead to significant economic impacts, which could thus affect traffic levels and commercial transportation activity throughout Nevada County.

Figure 30 shows snow water equivalent across the state in April under a medium emissions scenario (RCP 4.5). In this scenario, the annual mean of snow water equivalent decreases from 4.0 inches for 1961-1990 to 0.1 inches for 2070 to 2090.

Figure 30 California Snowpack Water Equivalent, Medium Emissions Scenario

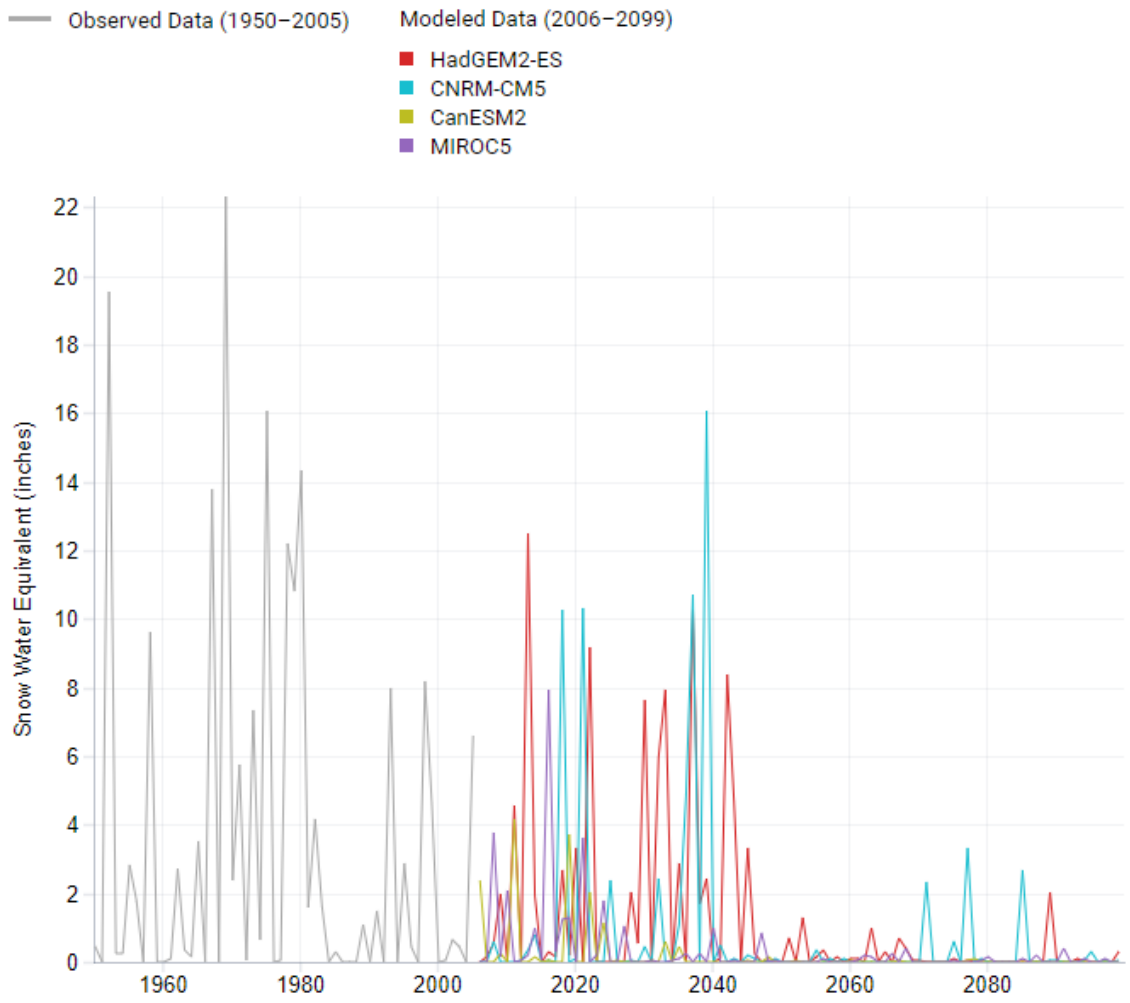
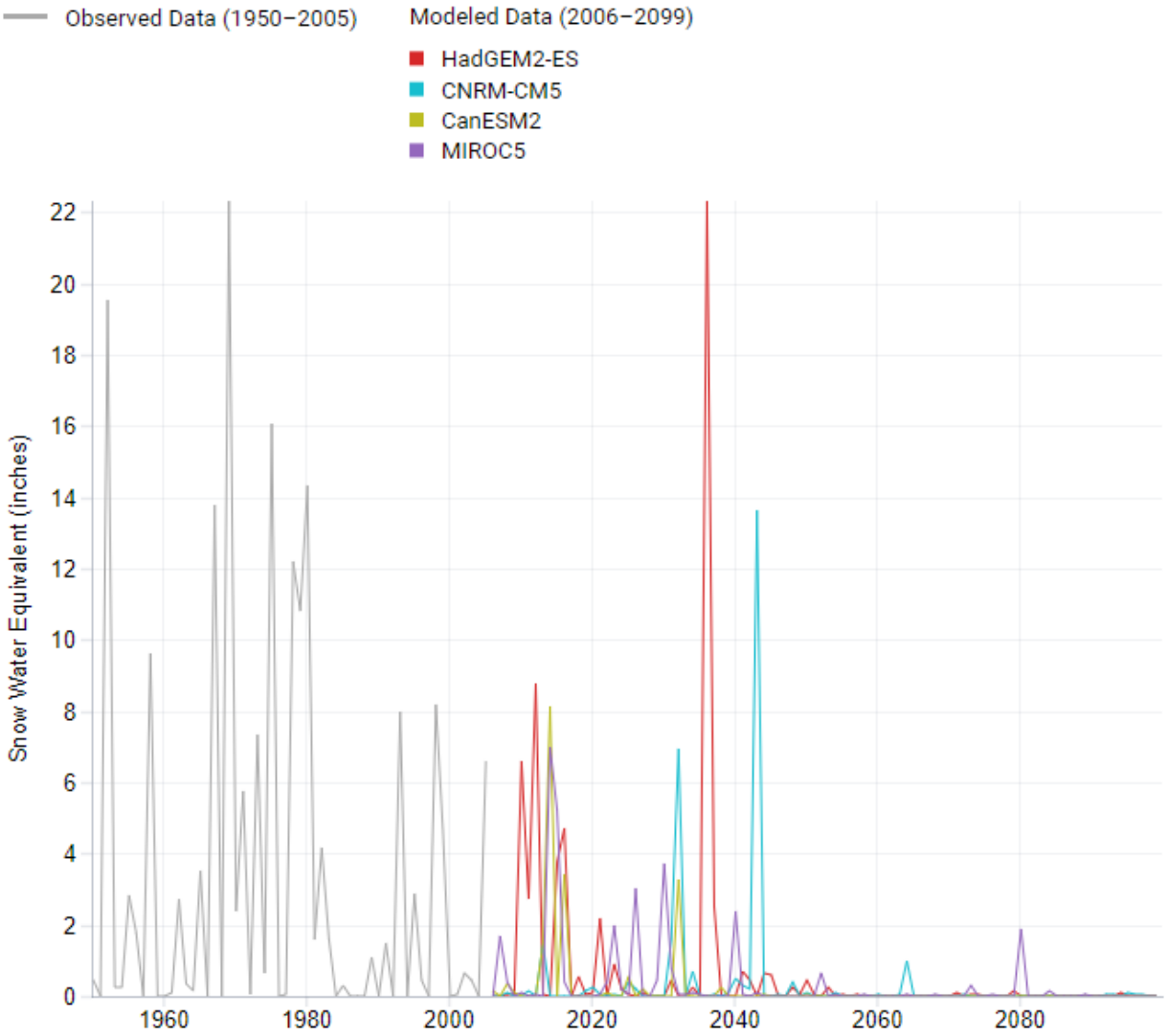


Figure 31 shows snow water equivalent across the state in April under a high emissions scenario (RCP 8.5). In this scenario, the annual mean of snow water equivalent decreases from 4.0 inches for 1961-1990 to 0.0 inches for 2070 to 2090.

Figure 31 California Snowpack Water Equivalent, High Emissions Scenario



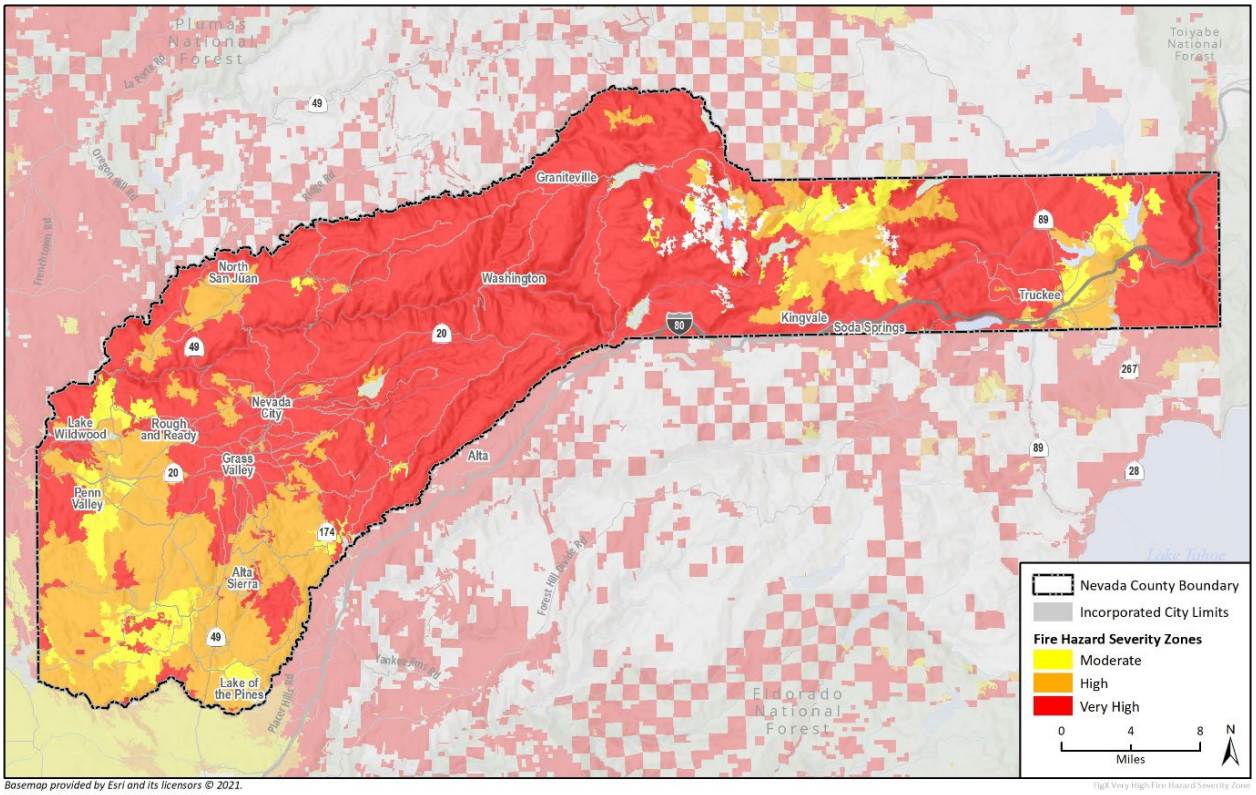
WILDFIRE

The extent and intensity of wildfires increase as temperatures rise, and warming is one of the primary projected impacts of climate change. The National Oceanic and Atmospheric Administration's Fourth National Climate Assessment, released in 2018, reported that climate change factors alone roughly doubled the area burned by wildfire in the western United States between 1984 and 2015. Nevada County has been affected by several wildfires in recent years, such as the Jones Fire in 2020 near Grass Valley. Warming and drying trends in Nevada County as a result of climate change are projected to increase the frequency and severity of wildfires in Nevada County. Increasing wildfires are likely to lead to more transportation disruptions, affecting access to local communities, commerce, tourism and other essential functions throughout Nevada County (Dettinger, 2018). These effects could be particularly acute near bottle necks in the transportation system, such as highways through forested areas and other principal arterials in high-risk wildfire areas.

In Nevada County, 92 percent of County residents live within high fire severity zones (Nevada County OES, 2020). Fire Hazard Severity Zones are shown in Figure 32. Many wildfires occur in rural areas, which often have more low-income households than the state average, and disproportionally affect disadvantaged and low-income

communities. Older adult residents and those with disabilities may be unable to quickly evacuate themselves during a wildfire, requiring them to receive additional assistance. Funding transportation improvements to ensure that these households can be effectively evacuated when wildfires threaten them, as well as providing resources for recovery in these areas afterwards, is a challenge to government agencies in Nevada County at all levels.

Figure 32 Fire Hazard Severity Zones in Nevada County

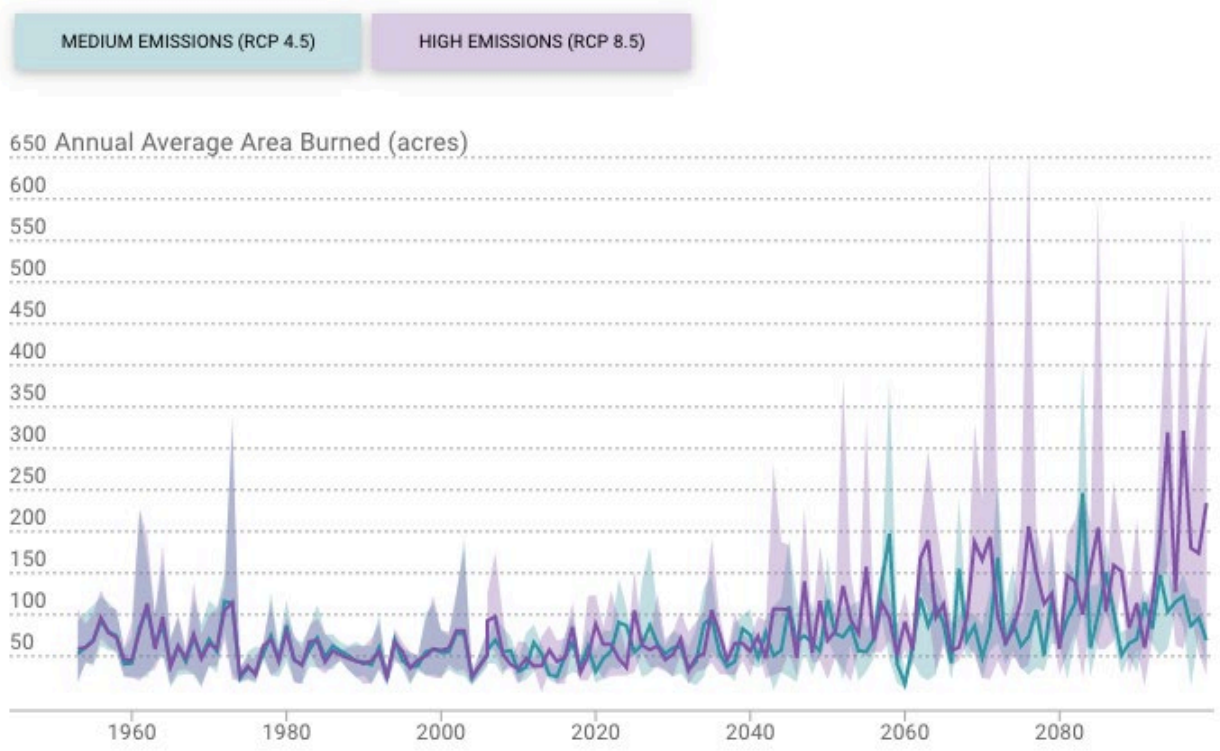


Basemap provided by Esri and its licensors © 2021.
Additional data provided by CALFIRE, 2021.

The frequency, severity and impacts of wildfire are sensitive to many factors, including development patterns, temperature increases, wind patterns, precipitation change, and pest infestations. Therefore, it is more difficult to project exactly where and how fires will burn, and climate models typically estimate increased risk to wildfires. In California, these projections are more robust in Sierra Nevada given model inputs. Projections for annual average area burned are used to broadly assess if wildfire is likely to increase (Dettinger, 2018).

Annual average area burned projections through the end of the century are shown for Nevada County in Figure 33, which generally shows if wildfire is likely to increase. Under a medium emissions scenario, annual average area burned is projected to increase from the historical thirty-year average of 55.2 to 75.6 acres for 1961-1990 to 66.1 to 90.2 acres by the middle of the century, and 81.8 to 114.5 acres by the end of the century. This is a 48.2 percent to 107.4 percent increase from the historical thirty-year average by the end of the century. Under a high emissions scenario, annual average area burned is projected to increase from the historical thirty-year average to 78.9 to 109.0 acres by the middle of the century, and 119.3 to 181.3 acres by the end of the century. This a 116.1 percent to 228.4 percent increase from the historical thirty-year average by the end of the century. These projections show that more area is likely to be burned annually on average in the future throughout Nevada County, particularly by the end of the century. Mountainous, high-elevation areas of the County are likely to see higher wildfire risk than more low-lying areas, due to their higher elevation and large concentration of dense forests.

Figure 33 Annual Average Area Burned, Nevada County



The frequency, severity and location of wildfire events are also influenced by the density of fuel. Fuel is material that feeds a fire, including everything from dead tree leaves, twigs, dead standing trees, live trees, brush, and cured grasses, as well as manmade structures such as homes and other structures. As a result of effective fire suppression since the 1930s, vegetation has continued to grow and accumulate, resulting in an increase in hazardous fuels throughout the County.

Fuels management is critical to mitigating the frequency and severity of wildfires, both within forested areas and along roadways. Several local agencies work to reduce hazardous fuels throughout the County. According to the 2021 Wildfire and Forest Resilience Action Plan, CAL FIRE will expand its fuels management crews, grant programs and partnerships to scale up fuels treatments to 500,000 acres annually by 2025 and expand its fuels reduction and prescribed fire programs to treat up to 100,000 acres by 2025. In addition to the fuels management efforts of the state and local agencies, homeowners also play a role in fuels management and have access to print and online information about home fire safety and creating defensible space. As CAL FIRE seeks to increase its annual acreage of fuels management, grant funding and additional partnerships may provide additional resources to assist with fuels management in the County.

OTHER CLIMATE IMPACTS

There are a number of other climate change impacts that will impact Nevada County, but do not have projections available through Cal-Adapt. While a quantitative analysis could thus not be completed for these climate-related hazards, they could still have significant impacts on Nevada County.

Flooding and Dam Failure

As the source of most of California's water resources, the Sierra Nevada region is also the source of its largest floods. With increased incidence of winter rainfall, cool season snowmelt episodes, and rain-on-snow events, the frequency of winter flooding is projected to increase under climate change in the northern Sierra Nevada. This will pose challenges for existing water infrastructure in local communities, which may have been designed for lower average winter streamflow rates. Flood hazard zones in Nevada County, according to the Federal Emergency Management Agency, is shown in Figure 34. Many communities throughout the Sierra Nevada region and Nevada County do not have the infrastructure in place to manage the enhanced risks and magnitudes of winter floods (Dettinger, 2018). These same floods also stress downstream conveyance, reservoirs, and communities, as exemplified by the Oroville Dam crisis in 2017 (Colgan, 2017). Nevada County currently has 42 jurisdictional dams, with seven rated as having extremely high downstream hazard potential (California Department of Water Resources, 2021). See Table 4 below for a listing of those rated as "Extremely High." Downstream hazard potential measures the potential downstream impacts to life and property should the dam fail while operating with a full reservoir (Cal OES, 2020). Increased flooding or dam failures could lead to more incidents of roads washing out and transportation delays throughout Nevada County, particularly in low-lying areas.

Figure 34 Flood Hazard Zones in Nevada County

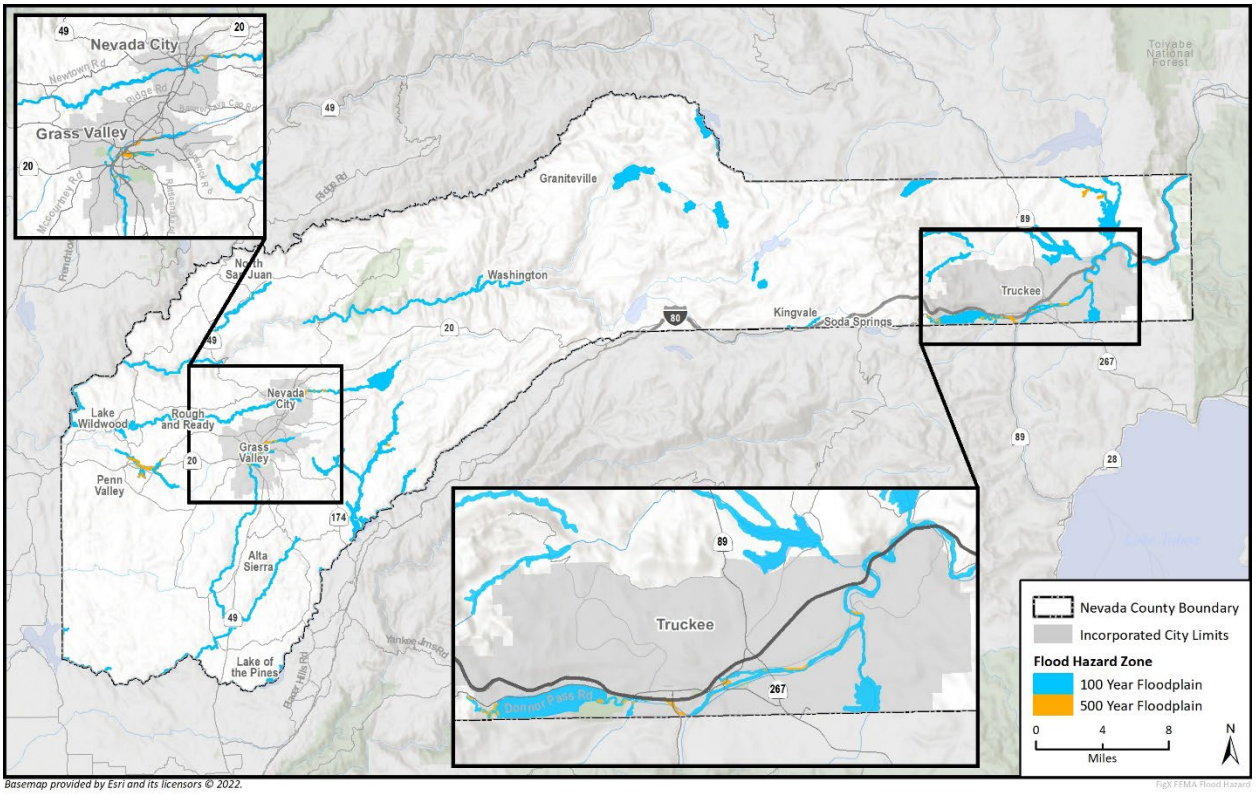


Table 4 Nevada County Jurisdictional Dams with Extremely High Downstream Hazard Potential

Dam Name	Owner Name
Bowman	Nevada Irrigation District
French Lake	Nevada Irrigation District
Jackson Meadows	Nevada Irrigation District
Lake Fordyce	Pacific Gas and Electric Company
Lake Spaulding	Pacific Gas and Electric Company
Rollins	Nevada Irrigation District
Scotts Flat	Nevada Irrigation District

Source: California Department of Water Resources, Division of Safety of Dams. "Dams Within Jurisdiction of the State of California." 2021.

Avalanche

While the direct impact of climate change on avalanches is still not fully understood, it is expected that certain types of avalanche risks will increase throughout mountain ranges in North America, including the Sierra Nevada mountains. Climate impacts that may increase avalanche risk include extreme temperature swings early in the season that make snow layers less cohesive, longer dry spells punctuated by more intense storms, and midwinter rains that can build slick layers and more dust layers to destabilize snow packs (Berwyn, 2021). More wet avalanches are to be expected, with higher risk and activity at higher elevations (Mears and Wilbur, 2019). This puts mountain road segments and those who are traveling along them at higher risk of avalanches.

Geologic Hazards

Landslides and mudslides are known to occur in Nevada County, and indirect impacts of climate change may cause both to occur more often. The risk of landslides and mudslides is known to increase after wildfires, so as wildfires in Nevada County continue to increase as a result of climate change, so too could these geologic hazards in recently burned areas. Both landslides and mudslides are often triggered by large, intense winter storms, which can oversaturate the ground and cause fast moving debris flows (USGS, 2020). The intensity of precipitation events is projected to increase as a result of climate change. Increased landslides and mudslides put mountain roads and other transportation systems near steep grades at risk. This could result in property and infrastructure damage, loss of life, and transportation delays throughout the region, particularly in Grass Valley, Nevada City, Truckee, and the unincorporated communities.

Existing Adaptation Framework

Nevada County has several plans and strategies already in place that identify and mitigate natural hazard risks and the effects of climate change. This section of the Existing Conditions chapter evaluates the existing framework of hazard and adaptation planning, summarizes the relevant regulatory setting, and identifies any gaps that currently exist and can possibly be addressed by the Ready Nevada County Extreme Climate Event Mobility and Adaptation Plan.

State Plans and Regulations

SAFEGUARDING CALIFORNIA PLAN: 2018 UPDATE

The Safeguarding California Plan: 2018 Update is the State's roadmap for everything State agencies are doing and will do to protect communities, infrastructure, services, and the natural environment from climate change impacts (CNRA, 2018). It builds upon the State's previous Adaptation Plans, adopted in 2009 and 2014. This holistic strategy primarily covers state agencies' programmatic and policy responses across different policy areas, but it also discusses the ongoing related work with coordinated local and regional adaptation action and developments in climate impact science. It identifies hundreds of ongoing actions and next steps state agencies are taking to safeguard Californians from climate impacts within a framework of 81 policy principles and recommendations, as well as detailing 33 examples of projects and programs that show how State agencies are investing and taking action to increase resilience to climate change around California. An Environmental Justice chapter highlights how equity is woven throughout California's various adaptation objectives and strategies.

CALIFORNIA ADAPTATION PLANNING GUIDE

The California Adaptation Planning Guide is designed to help local government, regional entities, and climate organizations incorporate best practices and current climate science and research into their adaptation plans (Cal OES, 2020). It provides local governments guidance on local adaptation and resiliency planning, including a step-by-step process that communities can use to plan for climate change. This process is broken down to four steps: Define, Explore, Initiate; Assess Vulnerability; Define Adaptation Framework and Strategies; and Implement, Monitor, Evaluate, and Adjust. This guidance is meant to provide a standard approach to adaptation planning that can be modified to suit the unique needs of each community. The first edition was prepared by the California Governor's Office of Emergency Services (Cal OES) and published in 2012, with an update released in June 2020.

The Adaptation Planning Guide defines the transportation sector as infrastructure assets, including roadways, rail lines, bike paths, sidewalks and walkways, airports, and ports, transportation vehicles themselves, and personnel needed to construct and maintain these systems and provide transportation services. Major vulnerabilities to climate change are described as increased risk of transportation networks being damaged, blocked, or destroyed by natural hazard events, with floods, landslides, severe winds, and wildfires noted as the most significant hazards. These hazards could increase in frequency and severity over time with climate change. In the long-term, sea-level rise is a threat to coastal areas, and extreme heat may become increasingly problematic, melting asphalt on roadways, and buckling rail lines. In areas with a closed section of a transportation network that is the only way in or out of an area, a shutdown could create significant hardships until the network is reopened and pose greater risks during evacuation or emergency response situations. Even if the underlying network is unharmed, vehicle fleets can be harmed by hazards like floods or wildfires (negatively affecting economic activities or community services), and transportation personnel can be harmed by extreme heat events or wildfire smoke.

CALIFORNIA STATE HAZARD MITIGATION PLAN

The California State Hazard Mitigation Plan (SHMP) is the State's primary hazard mitigation guidance document, and was last updated in 2018 (CAL OES, 2018). The 2018 SHMP builds upon the State's commitment to reduce or eliminate potential risks and impacts of natural and human-caused disasters to help communities with their mitigation and disaster resiliency efforts. It includes an updated statewide risk assessment, recent mitigation progress and best practices, updated State hazard mitigation goals and strategies, and updated climate mitigation progress and adaptation strategies.

Climate change adaptation efforts are fully integrated with hazard mitigation throughout the SHMP, which recognizes the relevancy of climate change to the State's disaster and hazard management planning. The 2018 SHMP includes descriptions of projected climate outcomes related to hazard probability, relevant state climate laws and policies, preliminary adaptation strategies, and principles for incorporating climate change into state, local, and regional hazard mitigation planning efforts. Cal-Adapt, California's Adaptation Planning Guide, Safeguarding California Plan: 2018 Update, and the Governor's Office of Planning and Research (OPR) Planning and Investing for a Resilient California technical guidance document are all cited as important resources to help communities assess potential climate change impacts that require adaptation measures, and where additional studies on climate impacts may be necessary.

GOVERNOR'S OFFICE OF PLANNING AND RESEARCH'S PLANNING AND INVESTING FOR A RESILIENT CALIFORNIA

Planning and Investing for a Resilient California: A Guidebook for State Agencies was produced in 2018 by the Governor's Office of Planning and Research, and provides high-level guidance on what future conditions to plan for and how State agencies should approach planning differently in light of a changing climate (OPR, 2018). The Guidebook details how State Agencies can build resilience into a projects, plans, and infrastructure investments, and also includes an Equity Checklist to ensure that resilience projects identify and protect vulnerable populations throughout California. It was developed with input from a Technical Advisory Group comprised of members from State Agencies, local and regional governments, nongovernmental and community-based organizations, and the private sector, formed under direction of Executive Order B-30-15.

CALTRANS CLIMATE CHANGE VULNERABILITY ASSESSMENTS – DISTRICT 3 SUMMARY AND TECHNICAL REPORTS

Caltrans Climate Change Vulnerability Assessments were conducted to better understand the vulnerability of California's State Highway System and other Caltrans assets to future climate change impacts (Caltrans, 2019). The District 3 Technical Report was published in 2019, and summarizes vulnerabilities for the portion of the State Highway System in Caltrans District 3, which includes Nevada County. The Summary Report provides a high-level overview of methodology, potential implications of climate change to Caltrans assets, and how climate data can be applied in decision-making. The Technical Report provides more in-depth discussion primarily written for District 3 staff, including background on the methodology used to develop the reports, information on how to replicate these methods, and a recommended framework for prioritizing potential projects for more detailed assessments in the future. The District 3 reports are organized by climate stressor: temperature, precipitation, wildfire, sea level rise, and storm surge.

Local Plans and Regulations

NEVADA COUNTY LOCAL HAZARD MITIGATION PLAN

The Nevada County Local Hazard Mitigation Plan was updated in 2017 and is designed to reduce or eliminate the long-term risk to people and property from hazards. A risk assessment was conducted as a part of the update process to identify and profile hazards that pose a risk to the county, evaluate the vulnerability of the planning area to these hazards, and examine existing capabilities to mitigate them. Floods, earthquakes, drought, liquefaction, landslides, wildfires, and other severe weather events are among the hazards that can have a significant impact on the county. Climate change was identified as a hazard of critical magnitude and severity, high probability of future occurrences, and extensive geographic extent. Each hazard was also assessed for the influence that climate change would have on increasing its probability. In its findings, the plan asserts that compact, mixed-use and infill developments are likely to increase in popularity in the future, as it will help residents avoid long commutes and vulnerabilities associated with the transportation system.

NEVADA COUNTY EMERGENCY OPERATIONS PLAN

The Nevada County Emergency Operations Plan (EOP) was adopted in 2011, and provides guidelines for emergency response planning, preparation, training, and execution throughout Nevada County. The goal of the plan is to ensure the preservation of life, property, and the environment during natural disasters, emergencies, and manmade incidents. The EOP outlines the procedures and membership of the County's Emergency Services Organization (ESO), initial incident response (with responsibilities assigned to members of the ESO), emergency management phases (which includes preparedness, response, recovery, and mitigation), and other City, County, State, and Federal agency responsibilities during emergencies. It also includes objectives and goals for short and long-term recovery operations (Nevada County, 2011).

In 2017, a supporting document was added to the EOP entitled, "Contingency Plan for Excessive Heat Emergencies". This plan describes County operations during heat related emergencies, and provides guidance for local governments, non-governmental organizations, the private sector, and faith-based organizations in the preparation of their own heat emergency response plans and other related activities. It recognizes the need for Nevada County to identify when extreme heat conditions threaten the health of residents, communicate with both the public and other local agencies, and to mobilize resources and initiate actions to augment local resources when necessary. The plan is divided into three phases of activation, which include pre-seasonal readiness, excessive heat watch/advisory, and excessive heat warning (Nevada County, 2017).

NEVADA COUNTY GENERAL PLAN SAFETY ELEMENT

The Nevada County General Plan Safety Element was last amended in 2020, and addresses both emergency preparedness and potential risk for a variety of hazards in the County. These include geologic hazards and seismic activity, flood hazards, airport and military airspace hazards, hazardous materials and mining hazards, fire hazards and protection, severe weather, climate change resiliency and mitigation, and environmental justice. Climate change is recognized in the Safety Element as posing an immediate and growing threat to California's economy, environment, and public health. Statewide climate-related impacts highlighted include increased likelihood of drought, higher temperatures, flooding, wildfires, landslides, heat waves, snowpack decline, insect pests, and severe weather. The Safety Element update is consistent with SB 379, which requires local jurisdictions to review and update their Safety Element to address climate adaptation and resilience strategies (Nevada County, 2020).

NEVADA COUNTY WILDFIRE EVACUATION PREPAREDNESS ACTION PLAN

The Nevada County Wildfire Evacuation Preparedness Action Plan was adopted in 2019 and developed by the Nevada County Office of Emergency Services (OES). The plan highlights that the County OES partners with local fire districts, CAL FIRE, the Fire Safe Council, Firewise Communities, Truckee, Grass Valley, Nevada City, and other stakeholders to prepare for fires in Nevada County (Nevada County OES, 2020). The plan establishes five initiatives to guide wildfire preparedness in the County, which include:

- Create safer evacuation routes countywide to save lives.
- Improve early warning systems and emergency communications to reach everyone.
- Establish defensible space around our homes and neighborhoods by reducing hazardous vegetation and encouraging voluntary compliance with defensible space standards.
- Provide a coordinated approach to wildfire response preparedness through planning, community engagement, and project implementation.
- Enhance critical infrastructure needed to respond to wildfires such as evacuation route improvements, water storage, fire hydrants, communication systems, and green waste facilities.

NEVADA COUNTY LAND USE AND DEVELOPMENT CODE

The Nevada County Land Use and Development Code establishes the rules and regulations for land development in the County. Chapter XII, Chapter XVI, and Chapter XVII all have relevancy to climate impacts and the transportation system in Nevada County. Chapter XII establishes floodplain management criteria for all developments within unincorporated Nevada County, which includes the construction or alteration of structures, roads, utilities, and other facilities. Chapter XVI sets fire safety and wildfire protection standards for minimizing public safety risks and mitigating the effects of wildland fire exposure to land uses within State Responsibility Areas. Regulations within the Nevada County Code provide measures for emergency access, street name and building address signage, water reserves for emergency fire use, and vegetation modification. Chapter XVII establishes guidelines for the design, plan preparation and construction of roads, drainage, and related improvements within the County's jurisdiction (Nevada County Community Development, 2021).

CITY OF GRASS VALLEY SAFETY ELEMENT

Grass Valley last updated its General Plan Safety Element in 2014. It summarizes the City's goals, objectives, and policies for safety, which include reducing the potential risk of death, injury, property damage, and economic and social dislocation resulting from hazards. While there is no mention of climate change in the element, the plan does discuss related safety issues including slope instability, flooding, structural and wildland fire, airports, and emergency routes and access within the City. Key policies related to transportation include:

- Safety Policy 7 - Identify, maintain, and mark evacuation routes for use in case of disasters or emergencies.
- Safety Policy 10 - Adopt and implement appropriate standards for access roads, on-site driveway standards, fuel reduction and emergency water supply.
- Safety Policy 13 - Continue to implement provisions of the Nevada County Airport Land Use Compatibility Plan, and to coordinate as appropriate with Nevada County, Airport management, and the Nevada County Airport Land Use Commission regarding Airport land use compatibility and safety considerations of major land use actions as listed in Nevada County Airport Land Use Compatibility Plan Policy 1.4.3.

TOWN OF TRUCKEE SAFETY ELEMENT

The Town of Truckee last updated its General Plan Safety Element in 2006. The Safety Element summarizes the goals, policies, and actions for safety in the community, which were developed on the principles of minimizing the potential risk to life and property from natural and induced hazards, ensuring the ongoing safety of operations at the Truckee-Tahoe Airport, and ensuring that residents and emergency services providers are adequately prepared to respond to emergency situations. While there is no mention of climate change in the element, the plan does discuss related safety issues which include steep slopes, hydrology and flooding, avalanches, wildfires, and airport safety. Key policies related to transportation include:

- Safety Policy 4.4 - Require new development to incorporate adequate emergency water flow, emergency vehicle access and evacuation routes.
- Safety Policy 6.1 - Maintain land use and development patterns in the vicinity of the Truckee-Tahoe Airport that are consistent with the adopted Comprehensive Airport Land Use Plan, including setbacks and height requirements.
- Safety Policy 7.1 - Work with Caltrans to coordinate establishment of appropriate emergency access routes through the Town when closure of Interstate 80 is necessitated by weather-related or other emergencies.

More recently (in 2021) the Tahoe Truckee Community Foundation (TTCF) worked with a consultant to develop a blueprint for a Community Organizations Active in Disaster (COAD), which defines how community organizations can best work with emergency services around disaster preparedness and response. TTCF is in the process of implementing these recommendations.

NEVADA CITY PUBLIC SAFETY ELEMENT

Nevada City last updated its General Plan Public Safety Element in 1986. The Public Safety Element summarizes the City's objectives and policies for safety in the community, examining hazards to public safety, including noise exposure, geotechnical and seismic hazards, fire, floods, and health and emergency facilities. There is no mention of climate change in the element. Key policies related to transportation include:

- Fire Hazard Safety Policy – The Nevada City Fire Department, in cooperation with the California Department of Forestry and the relevant Fire Districts, shall maintain high fire protection levels by requiring adequate access and water flow, based on established standards.

Impact Assessment

The preceding Existing Conditions chapter broadly presents a range of anticipated climate conditions for Nevada County according to the best available science. The climate projections cover the middle and end of the 21st century, which encompasses a 30- to 80-year planning timeframe. The purpose of advanced planning at this temporal scale is to familiarize NCTC with the relevant trends in climate factors that it should be prepared to consider for future planning and capital improvement decisions. The primary climate factors presented in the Existing Conditions chapter include:

1. Temperature,
2. Extreme heat,
3. Precipitation,
4. Drought,
5. Snowpack, and
6. Wildfire.

Individually, climate risks can impact transportation infrastructure and services in the county as presented in the following sections. Climate risks can also amplify one another in severity or frequency. Compounding risk relates to the layering of different climate risks. These are the conditions in which one type of climate hazard (the dependent) is modified because of conditions that have been shaped by another climate hazard (the modifier). Understanding these interdependencies may help in the prioritization of investments that address the impacts of climate change.

The purpose of this chapter is to present a high-level overview of potential climate change impacts on Nevada County's transportation infrastructure and services and the community that relies on such services. Impact is defined as the effect that a climate risk can have on a given type of asset or population group. Consistent with best practice as established in recent transportation climate adaptation assessments and Federal Highway Administration guidance, the evaluation relates climate factors to infrastructure facilities (including roadways, rail, bridges, tunnels, and drainage structures), services and functions (including critical facilities, evacuation routes, traffic flows, public transportation, and active transportation), and the community (including commuting and commerce). The evaluation assessed anticipated impacts related directly to the primary climate factors listed above. Drought was included as a compounding factor rather than an individual climate factor because of its indirect impacts on transportation infrastructure and services. Landslide risk is included as an additional climate factor with potential direct impacts (Appendix A provides landslide risk maps).

For each climate factor, potential impacts are organized in the following categories:

- Severity: The level of intensity of the impact
- Frequency: How often the impact will occur
- Geographic Extent: The size of the area the impact will occur

The analysis identifies which types of transportation infrastructure and services within specific key geographies are most vulnerable to projected climate changes, as well as the potential impact to the community. Potential high-level adaptation strategies that relate to each type of climate factor are also provided. This information will be used to inform the next phase of climate adaptation planning which is to identify specific assets within the highest risk geographies and develop targeted conceptual adaptation recommendations for NCTC. Adaptation strategies and

targeted improvement concepts relevant to evacuation routes will be key considerations to assist NCTC with mitigating future extreme climate events.

Temperature and Extreme Heat

Table 5 Temperature and Extreme Heat Impacts Summary

Severity	Frequency	Geographic Extent	Documented Risk Areas
Impacts will include pavement rutting and buckling, railway buckling, increased roadway degradation on heavily used sections.	The likelihood of extreme temperature events that directly cause damage will increase in likelihood, resulting in a faster rate of degradation on transportation infrastructure.	The lower elevations will be most vulnerable, because temperatures will become higher more quickly, particularly the most trafficked routes in and around Grass Valley and Nevada City, including Highways, 20, 49, and 174.	None documented.

The Existing Conditions chapter indicates the following key changes as a result of climate change:

- Average maximum daily temperatures are predicted to increase four to five degrees by mid-century and five to nine degrees by century's end across the county. Higher elevations are predicted to see a slightly greater change in warming compared to the lower elevations, by about half a degree on average.
- Average minimum daily temperatures are predicted to increase three to five degrees by mid-century and four to eight degrees by century's end across the county. Higher elevations are predicted to see a slightly greater change in warming compared to the lower elevations, by about half a degree on average.
- The average number of extreme heat days are predicted to increase by 19 to 27 days by mid-century and 27 to 56 days by century's end. Higher elevations are predicted to see slightly fewer heat days compared to the lower elevations, by about one additional heat day per year.

Transportation infrastructure is designed to perform under a specific temperature range and degrades over time as it is subject to the daily and annual cycle of temperature fluctuations. Pavement materials can soften and expand at higher temperatures, which eventually leads to rutting and potholes. At extreme temperatures, roadways and railways can crack and/or buckle.[1] Railway lines can expand or shift when exposed to extreme heat, which requires operators to slow down or stop rail service under the most severe conditions. Joints in bridges and railways can also be stressed by high temperatures.[2] For example, this behavior was observed recently in the June 2021 Pacific Northwest heatwave.

Routes that are more heavily trafficked are more vulnerable to heat-related impacts because of increased wear.[3] In Nevada County, the lower elevation areas will be exposed to higher temperature averages and extremes. The roadways at lower elevations with the highest Levels of Service are at the greatest risk, including Highway 49 south of Grass Valley, Highway 20 west of Nevada City, and Highway 174 east of Grass Valley. Interstate 80, which already routinely exhibits rutting from heavy truck movements, can also be expected to have increased risk, although perhaps comparatively less so at higher elevations. It is also possible that railway services may be slowed or stopped during extreme heat events, which may inhibit the flow of people and goods.

Increased temperatures will also influence access and demand for transportation services. Public transit providers may be forced to limit or cancel services under extreme heat conditions.[4] People will be less inclined to use public transit and active transportation options if outdoor temperatures exceed their comfort level. Discomfort and heat-

[1] In Portland, roads buckled under extreme temperatures in June 2021.
[2] In Seattle, the Department of Transportation sprayed bridges with water during daylight hours to prevent damage.
[3] USEPA Climate Impacts on Transportation
[4] In Oregon, Amtrak reduced train speeds, and Portland cancelled Streetcar operations during an extreme heat event.

related health risks will be exacerbated in more urban locations due to the urban heat island effect. Since the county is primarily rural, these areas are limited to the downtown portions of Grass Valley, Nevada City, and Truckee. Use of active transportation options (i.e., walking, bicycling, etc.) could be potentially reduced across the county during periods of extreme heat as well. Where use of public transit and active transportation options decreases, vehicle use could increase, which would increase traffic congestion and further contribute to the degradation of roadways. In the case of extreme heat events, there also could be economic impacts if the flow of goods and ability of people to commute is constrained.

Potential Adaptation Strategies

- Key roadway routes to and from Grass Valley should be designed to sustain increased average temperatures and extreme heat conditions. This should include adjusting binder grades based on future temperature projections.
- Key railway routes, particularly below 2,000 feet, where the greatest potential for extreme heat events exists, should be evaluated for potential to sustain operations.
- Conduct a technical vulnerability assessment of exposed metal structures, such as bridges, to increased temperatures and extreme heat events.
- Modify public transit facilities to protect the public from higher temperatures and extreme heat.
- Service providers should prepare for an increasing likelihood of extreme heat events, particularly in the Grass Valley area, which would damage infrastructure or require active mitigation measures during the event to prevent damage and sustain services.
- Operations and maintenance costs for the most trafficked routes, including Highways 49, 20, 174, and Interstate 80 should be expected to increase. This could potentially be mitigated by exploring materials that function under the predicted temperature regime changes.
- Monitor changes in reported infrastructure degradation relative to temperature.
- Review rail operations and maintenance protocols relative to future temperature trends.

Precipitation

Table 6 Precipitation Impacts Summary

Severity	Frequency	Geographic Extent	Documented Risk Areas
Impacts will include washouts, sinkholes, greater damage to unpaved surfaces, roadway obstructions, power outages, flood control infrastructure, and traffic collisions.	Larger extreme precipitation events will be increasingly likely through mid-century and into end-of-century.	The lower elevations, more heavily trafficked roadway segments, and roadway segments associated with flood control structures can be expected to be most impacted.	Increasing frequency of sinkholes reported on and adjacent to SR 49. Washouts have been reported on SR 49 and SR 174. Downtown Truckee, Donner Lake Area and areas along Donner Creek, demonstrating historical flood risk.

The Existing Conditions chapter indicates that precipitation can be expected in fewer but more intense events. Historically, average maximum one-day precipitation is 3.2 inches for Grass Valley and 2.0 inches for Truckee. Historic average annual precipitation is 54.7 inches for Grass Valley and 30.9 inches for Truckee. From the existing conditions assessment:

- Maximum one-day precipitation totals are expected to increase by approximately 0.1 to 0.2 inches by mid-century and about 0.2 to 0.4 inches by century's end. The lower elevations are predicted to have slightly larger increases compared to higher elevations.
- The magnitude and frequency of extreme one-day precipitation events is expected to increase over time.

– There is no appreciable trend in total annual precipitation across the county. However, precipitation events can be expected to be associated with warmer temperatures over time that will produce wetter snow events, particularly at lower elevations, as well as an increase in rain events.

Repeated exposure to precipitation damages transportation infrastructure over time and requires an increase in maintenance activities. There are numerous paved and unpaved roads in the county that will wear at a greater rate because of the predicted increase in extreme precipitation events. Pavement damages can be in the form of potholes, sinkholes, and washouts. Extreme precipitation events can overwhelm or damage flood control structures such as culverts. Overwhelmed or damaged flood control structures can cause erosion and lead to more substantial roadway damage like sinkholes. An increase in snowstorms require additional road clearing activities which also increase pavement wear. There is also an elevated risk of downed tree limbs during extreme precipitation events that can block roadways and railways. Extreme precipitation events also increase the risk of landslide or mudflow events. Figure 51, Figure 52, and Figure 53 in Appendix A show roadway locations in the county that are at elevated landslide risk. More information on Landslide Risk is presented later in this chapter.

Extreme precipitation events are also associated with an increase in traffic collisions and more difficult driving conditions, which could inhibit mobility more frequently. There is elevated risk of collisions for roads that are more heavily trafficked. During the winter, an increase in extreme precipitation could arrive in the form of snowstorms which require increased investments in snow-removal activities, surface conditioning (i.e., salting), and accident response. Mobility disruptions could reduce emergency response time, access to critical services, and commercial transport. Mobility disruptions could also impact evacuation during extreme precipitation events.

Potential Adaptation Strategies

– Key roadway routes to and from Grass Valley should be designed to sustain an increase in extreme rain events.
– Consider expanding the use of bioretention and swales, particularly in Grass Valley and Nevada City.
– Adjust Discharge Projections Based on Confidence Interval and/or Future Precipitation Projections, particularly in West County.
– Consider use of permeable pavements in locations prone to localized flooding
– Key roadway routes above the current snowline (roughly above Grass Valley) should be designed to sustain and increase in snow removal activities in near term.
– An increase in obstruction clearing activities associated with an increase in washouts and downed trees for roadways and railways.
– An increase in repair activities associated with an increase in washouts or sinkholes, particularly in key roadways in West County in an around Grass Valley.
– Key railway routes, particularly below 2,000 feet, where the greatest potential for extreme precipitation events exists, should be evaluated for potential to sustain operations.
– Monitor changes in reported infrastructure degradation relative to precipitation events, including bridge scour.
– Monitor and potentially revisit design criteria for flood control measures, particularly routes associated with critical facility access.

Snowpack

Table 7 Snowpack Impacts Summary

Severity	Frequency	Geographic Extent	Documented Risk Areas (for localized flooding)
Impacts will include roadway obstructions, power outages, localized flooding, inhibited mobility, and traffic collisions, particularly through mid-century	Snow events will become wetter in association with increased temperatures more often.	The lower elevations towards mid-century moving into higher elevations between mid and end-of-century.	– West end of Donner Lake – North side of Donner Lake along Donner Pass Road – Donner Pass Road / Coldstream Road area – Trout Creek / Glenshire Drive area – Downtown corridor – Glenshire subdivision, including the Dorchester Drive / Evensham Place area

The Existing Conditions chapter indicates that a substantial amount of winter precipitation will transition from snow to rain in the county over the coming century. The transition is expected to primarily take place by mid to end of century in the Western part of the county and shift into higher elevations over time. Before the shift occurs, snowstorms will happen at increasingly warmer temperatures, which influence the water content of the snow that falls. Snow becomes heavier as its water content increases, which can place greater strain on trees and structures. Historically, the amount of precipitation that annually falls in the form of snow varies substantially across the county. From the existing conditions assessment:

- The Sierra Nevada snowpack is expected to cease below 6,000 feet elevation and decrease overall by more than 60 percent.
- The snowline is expected to rise anywhere from 1,500 to 3,000 feet by the end of the century.
- The loss of snowpack will dry soils 15 to 40 percent below historical norms, depending on elevations.

As winter precipitation transitions from snow to rain, snowstorms will occur with greater water content. This wetter and heavier snow places greater strain on dead branches on trees and power lines, resulting in more power outages, blocked roadways and railways, and localized flooding. The lower elevations in the Western side of the county will be more likely to experience wetter snow events, particularly towards mid-century. As the transition from snow to rain moves eastward (up-elevation), the major mobility impacts will shift up Highway 20 and Interstate 80.

Towards mid-century, as the transition from snow to rain occurs at lower elevations, the shift to wetter snows will move towards the county's higher elevation. Less road preparation and snow-clearing operations will be needed in the Grass Valley and Nevada City areas.

The potential for traffic collisions and dangerous driving conditions will increase from the changing snow conditions. There is also potential for increased railway maintenance associated with an increase in railway obstructions. An increase in roadway obstructions will result in mobility that could be hindered more frequently, making it more difficult for people to commute and hinder the flow of goods and services.

Potential Adaptation Strategies

- Operations and maintenance costs related to clearing obstructed roadways, railways, and flood control structures, and downed electrical poles starting in areas above the current snowline in the Western County and moving higher in elevation over the course of the century should be expected to increase.
- Monitor changes in reported road and rail maintenance activities relative to snow events.

– Monitor and potentially revisit design criteria for flood control measures, particularly routes associated with critical facility access.

Landslides

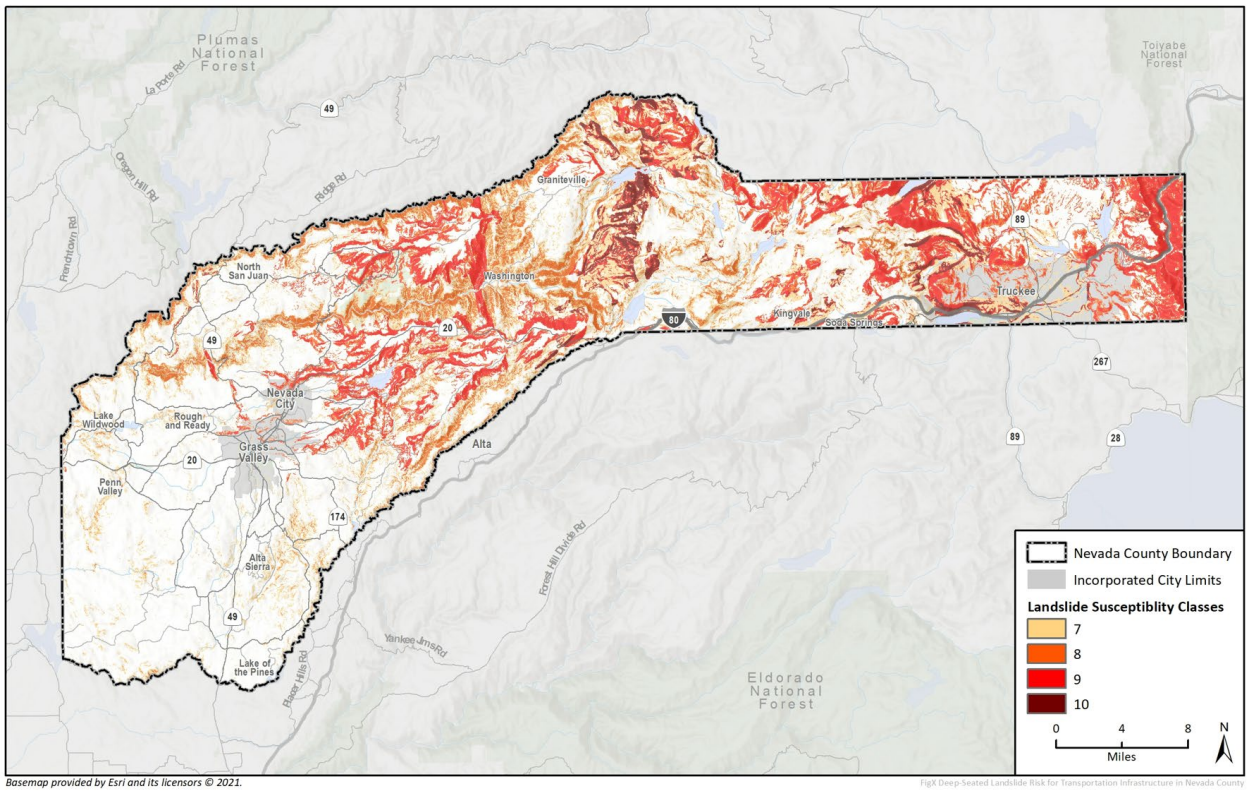
Table 8 Landslide Impacts Summary

Severity	Frequency	Geographic Extent	Documented Risk Areas
Obstructed roadways, potential for collisions, damage to roadways and railways and associated infrastructure, and inhibited mobility.	The number of landslide incidents can be expected to increase over time (see section on compounding and cascading climate risks).	The highest risk locations are shown in Appendix A. The locations with both the highest use and greatest risk include sections of Highway 20 just north of Nevada City just west of Interstate 80 and sections of Interstate 80 just east of Highway 20, near Donner Pass and Truckee.	Specific risk areas for landslides are depicted in Figure 54 to Figure 58 in Appendix A.

Landslide risk was evaluated using a geo-spatial dataset provided by the California Department of Conservation.[5] The Susceptibility to Deep-Seated Landslides dataset covers the entire state of California and was originally published in May of 2011 as CGS Map Sheet 58. It includes several data layers of varying scales and formats, such as Landslide Inventory, Geology, Rock Strength, and Slope. Risk is organized into classes of landslide susceptibility (0 to 10, low to high). These classes express the generalization that on very shallow slopes, landslide susceptibility is low even in weak materials and that landslide susceptibility increases with slope and in weak rocks. Landslide risk is also influenced by climate change factors, including extreme precipitation events, extreme heat and increased temperatures, and wildfire. These factors can increase the frequency and severity of landslide risk and are discussed in the Compounding Impacts section of this report. Landslide risk in Nevada County is presented in Figure 35, with further detailed risk assessment maps in Appendix A.

[5] California Department of Conservation, 2018, Map Sheet 58: Deep Seated Landslide Susceptibility

Figure 35 Nevada County Landslide Risk



For the purposes of this study, the assessment was focused on assessing landslide risk for highways and major roadways proximal to Class 7 Landslide Susceptibility or higher. In general, landslide risk increases in the county northeast of Nevada City and into the higher elevations. The stretches of Highway 20 at elevated risk include locations just northeast of Nevada City and just west of Interstate 80. The stretches of Interstate 80 at elevated risk include locations near Soda Springs and Truckee. There are numerous additional sections of road at elevated risk as shown in Appendix A.

Minor landslides can produce driving hazards and collision risks on roadways and railways. Major landslides can damage roadways, railways, and other transportation infrastructure, presenting clear risks to mobility and the flow of goods in the region. It can take several weeks or months to repair related damages.[6] If bridges or tunnels are damaged, repairs can take longer.

Potential Adaptation Strategies

- Anticipate an increase in maintenance and repair costs and activities for debris clearing and restoring service.
- Implement slope stability measures for roadways and railways at highest-risk locations with a focus on the locations identified in this section and specifically slopes that coincide with drainage.
- Assess landslide risk and potential slope stability measures for bridges and tunnels.
- Monitor high risk areas after significant rain events, particularly rain events that last several days, occur on recently saturated soils, and post-wildfire rainstorms.
- Implement annual inspections of high-risk areas prior to each rainy season (August-September).

[6] https://www.mercurynews.com/2021/04/08/highway-1-in-big-sur-to-reopen-two-months-early-after-massive-slide

Wildfire

Table 9 Wildfire Impacts Summary

Severity	Frequency	Geographic Extent	Documented Risk Areas
Impacts include significant damage to transportation infrastructure, power outages, drainage issues, poor air quality, and congestion. Mobility could be compromised for significant periods of time.	Wildfires can be expected to occur with increasing frequency.	Most of the county is in High or Very High Fire Hazard Severity Zones. Fire risk is predicted to increase most in the mid-elevation foothills between 2,000 and 5,000 feet.	While recent fires have occurred in specific locations, the risk areas for wildfire span most of the County.

The county is predominantly in the CalFire Very High Fire Hazard Severity Zone (VHFHSZ), including the most densely populated locations of Grass Valley, Nevada City, and Truckee. Highways 20 and 49, including a wide area around Grass Valley, as well as north and east across the county, are in the VHFHSZ. Interstate 80, starting from Colfax and eastward across the county, are almost entirely in the VHFHSZ. Highways 89 and 267 are also within the VFHSZ.

The modeled probability of wildfire is predicted to increase over the century in specific areas of the county. Currently, modeled data included in Cal-Adapt predicts that the change in wildfire probability will increase most in the mid-elevation foothills between 2,000 and 5,000 feet.[7] There is a similar-modeled increase in decadal probability of wildfire in both RCP 4.5 and 8.5 emissions scenarios for mid-century. However, a significantly higher increase in decadal probability of wildfire is associated in the mid- to late-century period (2050 to 2090) under the High-Emissions Scenario (RCP 8.5). See Figure 36 and Figure 37.

Figure 36 Change in Wildfire Risk (Medium Emissions Scenario, RCP 4.5)

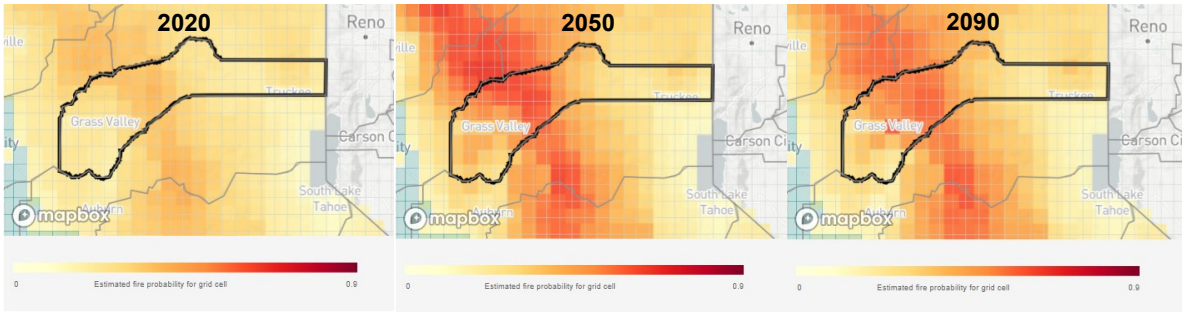
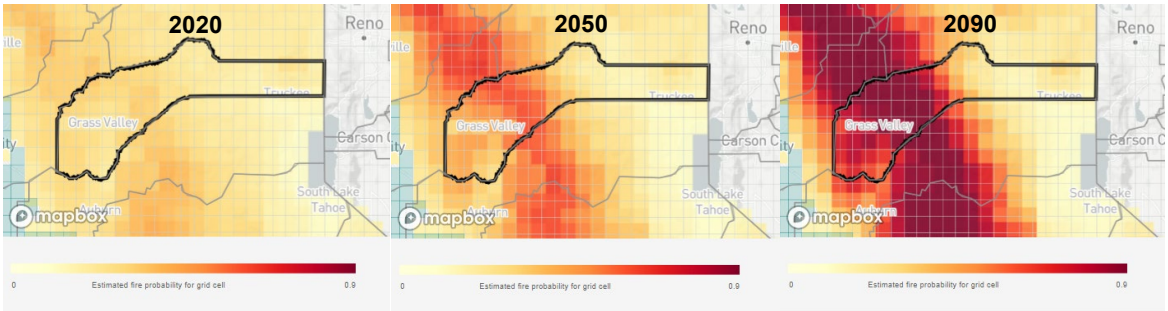


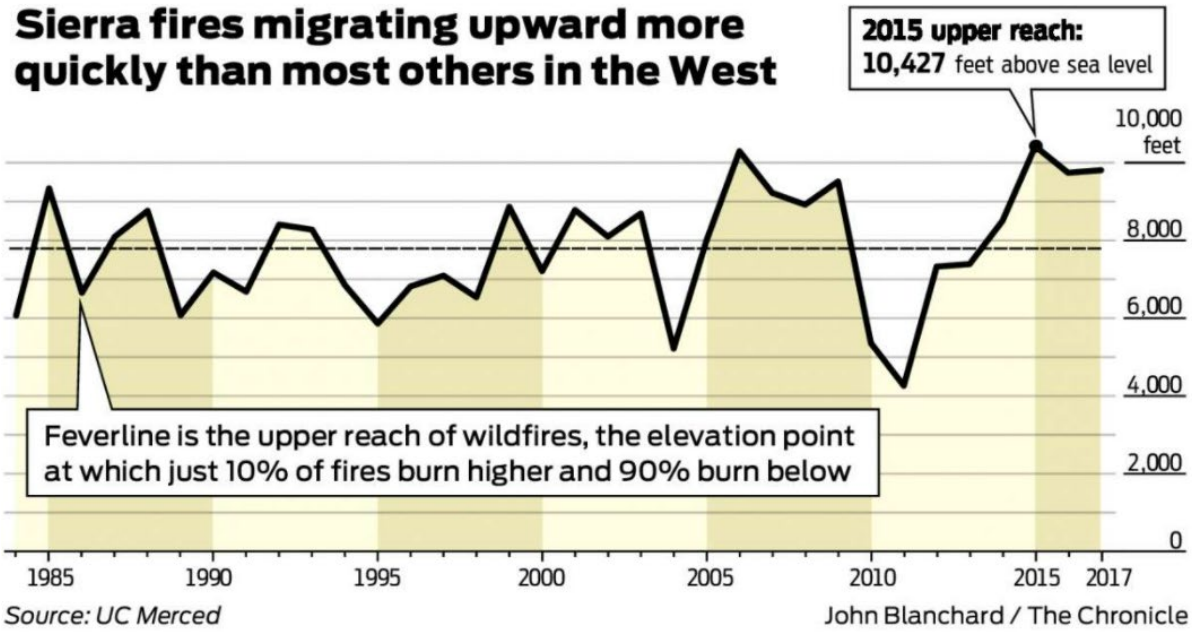
Figure 37 Change in Wildfire Risk (High Emissions Scenario, RCP 8.5)



[7] Wildfire Simulations produced by Dr. Westerling at UC Merced (2018)

Recent data also indicates that wildfires are migrating upward in elevation in the Sierras.[8] As shown in Figure 38, the upper reach of wildfires has increased across the state over the past 35 years. This trend implies that future wildfires may be more likely to spread further into the higher elevations of the county than previously. Higher elevation ecosystems are less equipped to be resilient to wildfires. Wildfires at higher elevations combined with higher temperature are expected to cause shifts in the types of vegetation that grow.

Figure 38 The Upper Reach of Wildfires are Shifting Higher in Elevation over Time



Recent data also indicates that wildfires are increasing in size. During 1972–2018, California experienced a five-fold increase in annual burned area, mainly due to more than an eight-fold increase in summer forest-fire extent.[9] The data indicates an exponential increase in size of summer wildfire area and are associated with a decrease in air moisture (as average temperatures increase, the moisture content in the air decreases).

The primary factors related to wildfire in the county are:

- In general, the county is almost entirely at high or very high wildfire risk. The mid-elevation areas (between 2000 to 5000 feet) are expected to see the greatest increase in the probability of wildfire.
- Historic data indicates that wildfires are already exponentially increasing in size and affecting higher elevation areas.

The county's transportation infrastructure can be damaged by wildfire. Fire can damage pavement, railways, bridges, and lighting. Importantly, wildfire can drastically inhibit mobility when it is critically needed. Roads impacted by wildfire can prevent safe evacuation and inhibit the access of firefighters. Wildfire can significantly damage critical services including water, power, and communications, which can take significant time to repair. Firefighters also have more constrained access to land at higher elevations.

Wildfires can also cause substantial damage to the homes and businesses of county residents. As noted earlier, most people in the county live, work, and travel in very high fire risk areas. Also, as noted, fire risk is expected to increase in and around the Grass Valley and Nevada City area which serves as a commercial hub for much of the

[8] https://www.sfchronicle.com/bayarea/article/California-wildfires-are-climbing-higher-up-16418967.php
[9] William et al. 2019, Observed Impacts of Anthropogenic Climate Change on Wildfire in California

county's population. Fire risk is also predicted to increase most in the mid-elevation foothills between 2,000 and 5,000 feet, including in and around the Town of Truckee.

There are also significant health risks associated with wildfire smoke, especially for those with breathing disorders and those who are immunocompromised. Those who rely on active transportation are also placed at greater risk or their mobility can become limited.

Potential Adaptation Strategies

- Increase defensible space associated with roadways and railways, particularly for West County in and around Grass Valley and Nevada City, with an emphasis on Highways 20, 49 and 174 and other principal arterials. In East County, Highways 89 and 267, and Interstate 80, should also have increased defensible space.
- Increase vegetation clearing activities associated with roadways and railways, particularly for West County in and around Grass Valley and Nevada City with an emphasis on key evacuation routes, including Highways 20, 49 and 174 and other principal arterials. In East County, Highways 89 and 267, and Interstate 80, should also have increased vegetation clearing.
- Major evacuation routes, especially where noted as pinch-points in past extreme weather events and evacuations, should be evaluated for strategic capacity expansion. Use of shoulders and other non-general purpose lanes may be considered.
- Anticipate an increase in maintenance and repair costs activities associated with an increase in obstructed stormwater structures associated with roadways.
- Coordinate with County fire departments to assist in the use and maintenance of roadways as fire breaks.
- Coordinate electrical pole clearing and maintenance activities along key roadways with PG&E, including Highways, 20, 49, 87, 174, and 267.
- Coordinate with PG&E to implement an aggressive electrical undergrounding plan with a focus on key roadways with PG&E, including Highways, 20, 49, 87, 174, and 267.
- Consider changes in drainage material for wildfire the most wildfire prone areas that include the West County.
- Consider adjusting culvert sizing for burned and bulked flows in wildfire prone areas that include the West County.

Compounding Impacts

Individually, the climate risks presented in the preceding sections can each impact transportation infrastructure and services in the county as presented in the preceding sections. Climate risks can also amplify one another in severity or frequency. The following discussion relates to the ways in which different climate factors relate to others in the context of the county's transportation.

Compounding risk relates to the layering of different climate risks on one another. These are the conditions in which one type of climate hazard (the dependent) is modified as a result of conditions that have been shaped by another climate hazard (the modifier). Understanding these interdependencies may be useful for transportation planning because it may help in the prioritization of investments. In this case, it may be possible to modify the impact of a dependent climate hazard by adapting to the modifier one. In addition, any of the factors discussed below could be impacted by constraints in the existing roadway network, especially during extreme climate events and evacuation scenarios. To view detailed maps of limited access areas at elevated risk in Nevada County, see Areas of Limited Ingress/Egress in Appendix A. Access constraints impact both evacuation routing during an emergency and the ability of emergency services personal to reach impacted residents to provide assistance. The following discussion is arranged by modifier and identifies the dependent climate hazards it can be expected to amplify in the county.

Temperature

Higher temperatures are associated with reduced moisture content in the air. Higher temperatures also increase evaporation and transpiration (ET). As a result, as temperatures increase over the century:

- Vegetation will require more water over time in the county. This, coupled with other factors, will contribute to drier vegetation, which could increase wildfire risk.
- Higher temperatures can be associated with increased growth in vegetation, which could increase wildfire fuel load.
- Higher temperatures and drought conditions increase the bark beetle population, causing increase in combustible material available to burn in wildfire.

Snowpack

Most rain falls in California between the months of October and May. The snowpack historically serves as a reservoir for the lower elevations. As the snowpack diminishes, less water will be available as runoff in the May-to-July period. As a result:

- Less water may be available for vegetation in the summer months, which could increase wildfire risk as a result of drier vegetation.
- Heavier snow events coupled with high winds (with higher water content) can cause tree limbs to break and fall thereby increasing wildfire fuel load. As wetter snow events become more common, the volume of downed tree limbs may increase. Increased temperatures and intermittent drought conditions may further increase the vulnerability of trees to be damaged by heavier snow and wind events, thereby further increasing wildfire risk.

Drought

The county is already subject to multi-year drought cycles.

- In recent years, droughts have been associated with massive tree die-offs.[10] Since 2015, the State has felled thousands of trees, some in Nevada County, to reduce the increased fire risk associated with dead trees. Coupled with increased temperatures, an increase in tree die-offs is a significant risk in the county. Faster growing vegetation can grow in places where tree die-offs have occurred, further increasing wildfire fuel loads.
- An increased frequency and duration of drought events in the county is associated with an increase in the potential for catastrophic slope failure.[11] This, coupled with extreme precipitation events, could increase the risk of landslides and mudflows.

As mentioned above, higher temperatures and drought conditions increase the bark beetle population, causing increase in combustible material available to burn in wildfire.

Wildfire

Landscapes that are affected by wildfire can change in association with climate change factors.

- A common effect of wildfire is an increase in sediment loads in surface water, which can clog water intakes.
- More intense wildfires can reduce the porosity of soil, which increases both erosion surface water runoff and reduces groundwater infiltration. An increase in erosion can clog water intakes.
- Post-wildfire landscapes may not regenerate as they were before the fire as temperatures increase and the county continues to experience periods of intermittent drought. In some areas, pine is being replaced by oak.

[10] https://www.smithsonianmag.com/smart-news/why-californias-drought-killed-almost-150-million-trees-180972591
[11] https://www.nature.com/articles/s41598-018-38300-0

Conclusions

Transportation planning in Nevada County can expect hotter and drier conditions through mid-century. If global emissions do not level off by mid-century, the trend will continue through the end of century. These changes will result in more extreme weather events, including more extreme heat days, precipitation events, and wildfires. Snow events will become wetter and heavier, beginning at lower elevations and moving upwards. The snow level is predicted to increase by 1,500 to 3,000 feet by mid-century.

In the lower elevations of the county, below Grass Valley, the primary changes will be an increase in daily minimum and maximum temperatures, the number and magnitude of extreme heat events. These changes are likely to increase the potential for heat-related wear on roadways, particularly those with the greatest use, including Highway 49 South of Grass Valley, Highway 20 West of Grass Valley, and Highway 174 Southeast of Grass Valley, as well as the communities of Lake of the Pines, Alta Sierra, and Lake Wildwood. Wildfire risk is predicted to remain high. It will be important for the transportation network to support evacuations and the ability of firefighters to develop firebreaks and access remote areas of the county to most effectively contain wildfire incidents as they occur.

The middle elevations between 2,000 and 5,000 feet are predicted to undergo the largest climate changes, especially through mid-century. At these elevations, average temperatures will increase and snow events will become wetter (and heavier). Wildfire risk is already classified as Very High Fire Hazard Severity Zones, and the probability of fire is predicted to substantially increase. A coordinated approach to supporting fire prevention and suppression will be necessary. Roadways will need to provide fire suppression access and serve as fire breaks. There are also significant areas with high landslide risk as well, specifically, the stretch of Highway 20 between Nevada City and Interstate 80 which serve as vital corridors for commerce, access to critical services, and evacuation. Special attention should be paid to this stretch to manage risk and enable its use. The vulnerability of tunnels and bridges to wildfire at these elevations should be assessed more closely. The Bridgeport, South Yuba River, Purdon, Edwards, and Washington crossings should receive attention in terms of landslide and wildfire risk. An increase in obstruction clearing activities for road and rail can be anticipated to be related to extreme weather (including heavy snow events) and landslides.

In the higher elevations of the county, above 5,000 feet, the primary change will be an increase in the daily minimum and maximum temperatures. Recent research indicates that wildfires are increasingly affecting higher elevations and that wildfires are crossing into the higher elevations more frequently. There are numerous areas of high landslide risk as well. Notably, the stretches of Interstate 80 near Soda Springs and Truckee stand at the highest-classified risk. Snow is predicted to remain as the predominant form of precipitation during the winter months towards mid to late century.

Adaptation Strategies, Policies, and Concepts

Goals

- NCTC and other partner agencies will mitigate for future extreme climate events impacting Nevada County transportation infrastructure and services through advanced planning, particularly considering this Plan's estimates of severity, frequency and geographic extent of relevant climate factors.
- NCTC and partner agencies will use the adaptation strategies in this plan as a blueprint to guide implementation, with a specific focus on monitoring, evaluating and adjusted as needed.
- NCTC and partner agencies will continue meaningful engagement with Nevada County residents to ensure climate adaptation strategies are responsive to their needs, while honoring the County's historic character.
- NCTC will partner with Nevada County Office of Emergency Services, Nevada County Sheriff's Office and the Nevada County Health and Human Services Agency to ensure the risks to vulnerable communities (such as older adults, persons with disabilities, children, limited English speakers and households without vehicles) are given particular attention, given the reduced mobility and/or transportation access during emergencies and evacuations that these groups may be afforded. Additional critical entities to involve include healthcare networks, assisted living facilities and local organizations that serve seniors and residents with disabilities.
- NCTC will strategize with partner agencies to optimize access to critical facilities in Nevada County, including government offices, police stations, fire stations, hospitals, and airports, recognizing a high priority need for access in the event of future extreme climate events.
- Given that Nevada County is predominantly in the CalFire Very High Fire Hazard Severity Zone, this risk's potency will be particularly prioritized in evacuation planning, vegetation clearance and community outreach efforts, including promoting the recently developed Ready Nevada County Dashboard resource base.

Solutions

Solutions may fall into one of three (or multiple) strategy types.

Planning strategies: Planning strategies ensure future infrastructure design and investment priorities are climate adapted. These actions include the development of plans, updates to design standards, preparedness measures and prioritization processes.

Operational strategies: Operational strategies modify current practices and budget, building in a mitigation framework to adapt in the face of future extreme climate events.

Hardening strategies: Hardening strategies involve modifications and adaptations to ensure infrastructure resiliency, including taking advantage of new opportunities and innovative materials, such as permeable pavement and porous surface mixtures.

Responsible Agencies

For the lead agency (ies) or additional agency (ies) listed below:

- "Public Works Departments" or "Planning Departments" indicates those of Nevada County and of the cities of Grass Valley, Nevada City, and Town of Truckee
- "Emergency Services Departments" includes local (Grass Valley, Nevada City, and Truckee) police departments and fire protection districts

Evacuation Planning & Emergency Preparedness

In the event of an emergency, proactive evacuation planning serves residents as they safely and efficiently leave their homes and emergency personnel as they approach the site of the evacuation-prompting hazard. Proactive measures include both planning strategies (such as conducting studies to understand routing and signage improvements) and operationalizing mitigation and educational tactics. Ready Nevada County's Evacuation Route Pre-Planner and Truckee's evacuation routes by neighborhood map both provide a solid foundation for disseminating routing information to residents, while a number of existing emergency communications tools offer further potential for resident preparedness.

E.1: Solidify evacuation protocols and dissemination of routing information to residents

Strategies for evacuation planning & emergency preparedness are indicated beginning with the letter "E" followed by the strategy number.

Type of Strategy	Proposed Lead Agency	Additional Agencies
Planning, Operational	Nevada County OES	NCTC, Nevada County Sherriff's Department, Emergency Services Departments, local media stations

During an emergency, it's critical that dissemination of vital information, including resident evacuation routing and emergency messaging, is consistent. Boosting resident preparedness prior to an active public safety incident is equally important. There are a number of communication tools and resources available that are either county-wide or city specific. There is opportunity to further clarify and synchronize messaging around these resources.

According to the Nevada County Safety Element, depending on the level of urgency, the community is typically notified of evacuation procedures either via door-to-door notification methods, local media (radio, television, Internet) or as warranted, activation of the emergency alert notification system (CodeRED). See Figure 39 for further details. In order to receive CodeRED alerts, residents must opt-in, at which point they will receive notifications via text, email, landline, cell phone (including a mobile app) or TTY. OES should coordinate with local municipalities to encourage residents to learn about CodeRED and opt-in via the webpage at www.mynevadacounty.com/2713/Emergency-Alerts.

For Truckee residents, the Truckee Police Department and the Fire Protection District use the Nixle Everbridge Emergency Alert System instead of CodeRED as the primary method of communication during critical incidents. Both residents and visitors should be encouraged to subscribe to alerts by registering for the mobile app.

An additional resident preparedness resource available through the Ready Nevada County Dashboard is an "Evacuation Route Pre-Planner" tab, which allows scenario planning and encourages residents to identify a minimum of three evacuation routes from their home (see Figure 40). Residents are encouraged to practice driving alternative routes often to gain familiarity (noting, and as warranted reporting, obstacles such as locked gates or overgrown vegetation). Further promoting this tool will assist with resident evacuation readiness.

The Truckee Police's "Preparing for an Emergency Webpage" (www.truckeepolice.com/disaster-preparedness) also offers an excellent framework for disseminating both seasonally-relevant preparedness information (such as

Winter Weather FAQs) and general resources for emergency planning (including roads and traffic information, emergency alert information, which local radio stations to tune into and evacuation routes – see Figure 41).

A key equity consideration for reaching older adults and/or those with minimal access to technology is to provide print-based emergency planning resources too, rather than rely solely on internet-accessible materials. Should an evacuation-prompting emergency occur, power lines could be impacted too, further necessitating alternative distribution sources.

Figure 39 Ready Nevada County Emergency Alert System

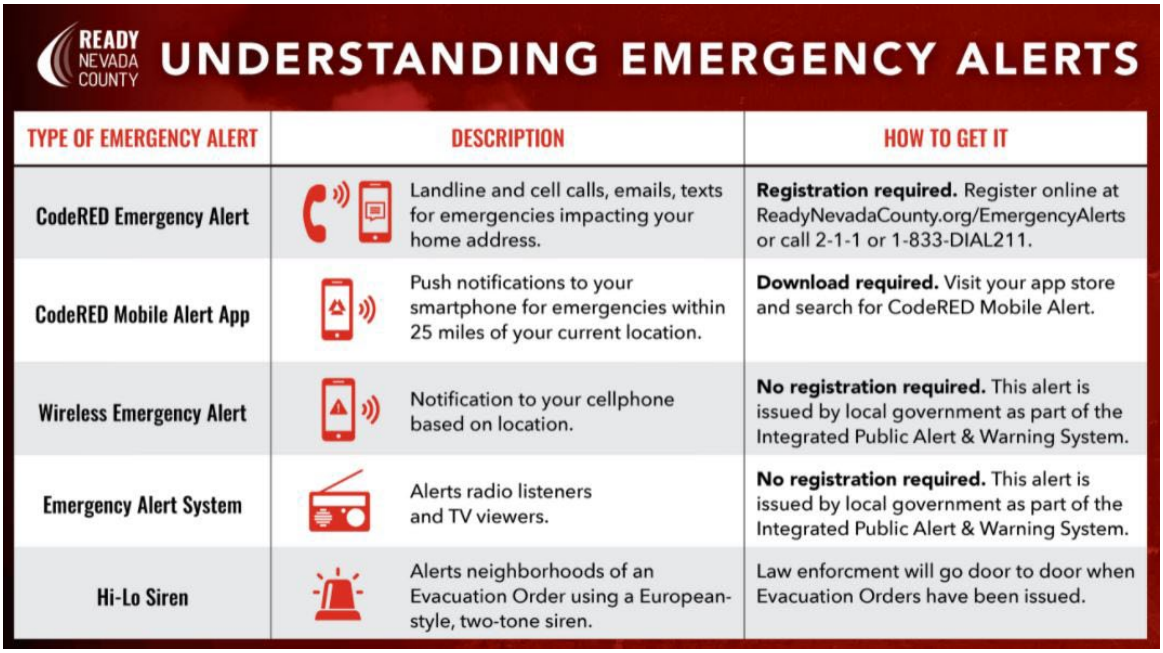


Figure 40 Evacuation Route Pre-Planner (3 example routes from Alta Sierra home to library)

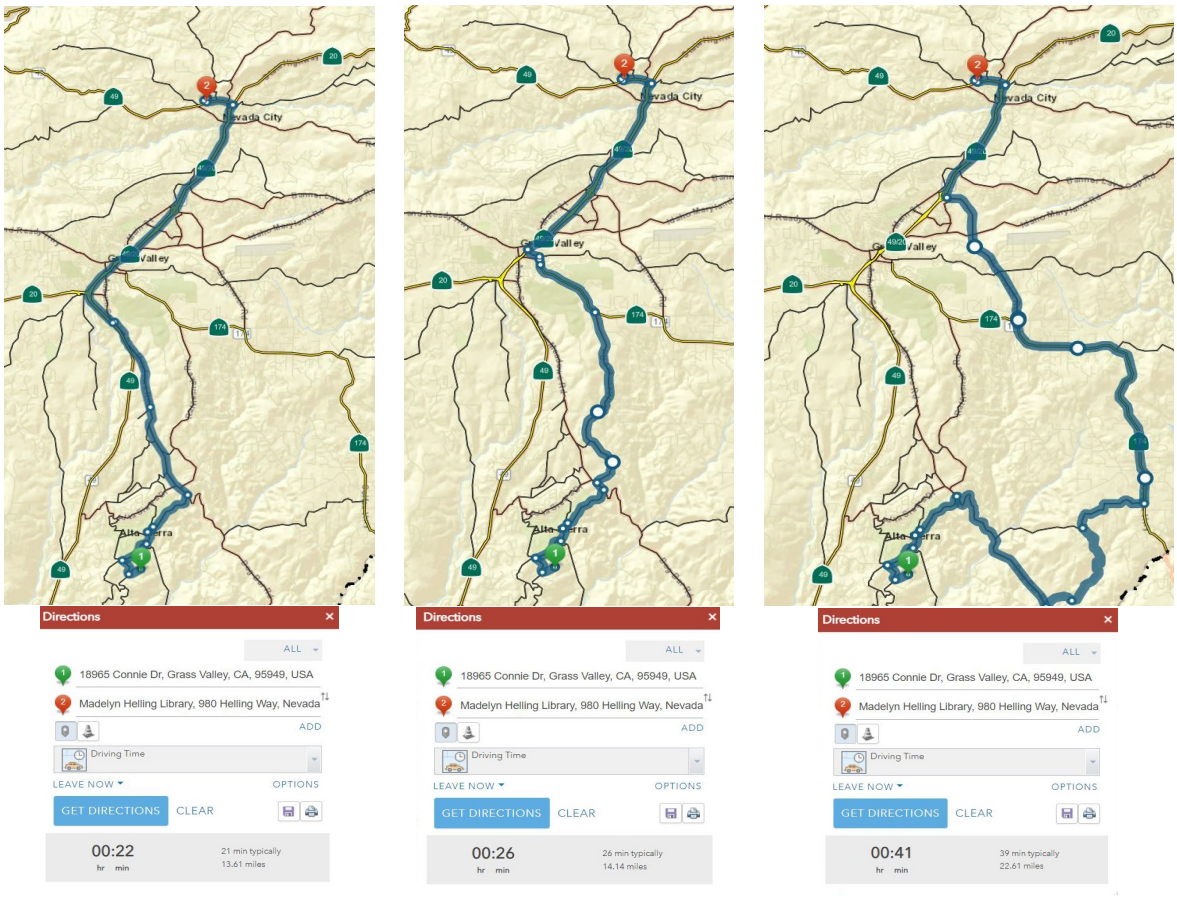
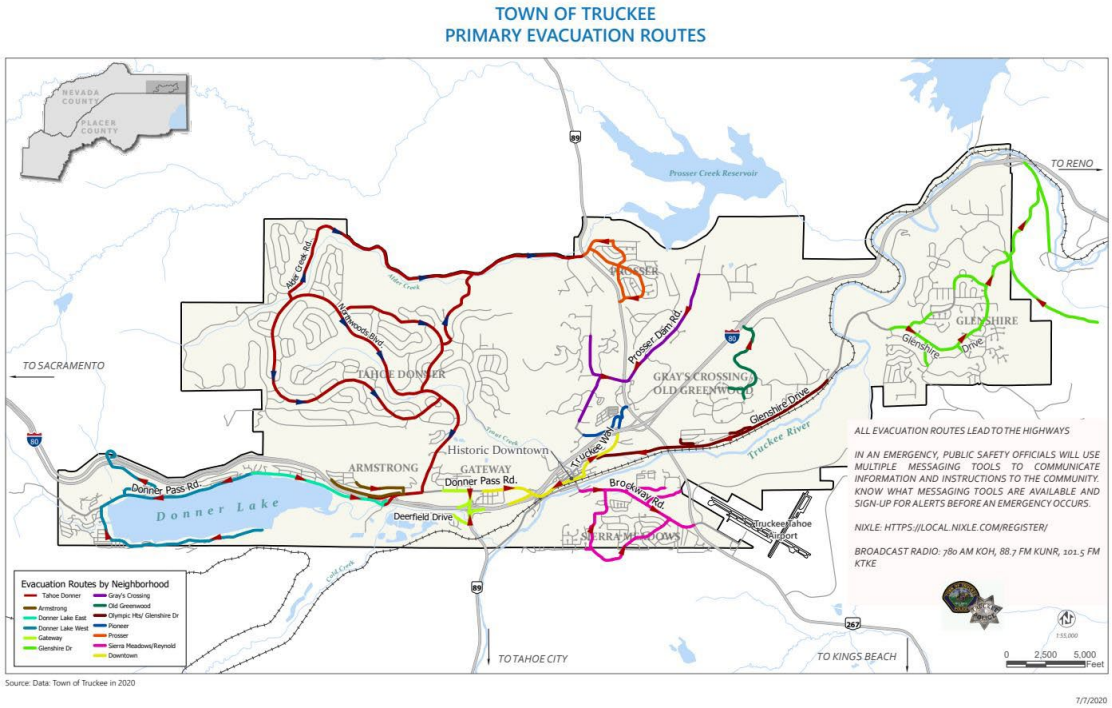


Figure 41 Town of Truckee Primary Evacuation Routes



E.2: Develop microsimulation to identify additional improvements to evacuation routes

Strategies for evacuation planning & emergency preparedness are indicated beginning with the letter "E" followed by the strategy number.

Type of Strategy	Proposed Lead Agency	Additional Agencies
Planning	Nevada County OES	Public Works Departments, Emergency Services Departments, Nevada County Sherriff's Department, CHP, Caltrans, CAL FIRE

Building upon the Nevada County OES's proposal to conduct evacuation planning studies following this Plan's development (as additional funding is obtained), including a microsimulation effort would be beneficial (to visualize whether there is travel time improvements from strategic roadway widening – a proposed example would be SR 49 south of Grass Valley) with the goal of documenting needed improvements to evacuation routes given area conditions. This foundational information could be included in future grant applications and would include regional coordination with Caltrans District 3.

E.3: Develop mitigation strategies to address challenges posed to identified evacuation routes

Strategies for evacuation planning & emergency preparedness are indicated beginning with the letter "E" followed by the strategy number.

Type of Strategy	Proposed Lead Agencies	Additional Agencies
Operational	Nevada County OES, Public Works Departments	Nevada County Sherriff's Department, Emergency Services Departments, CHP, Caltrans

Building on the strong partnership already established (and further solidified during development of this Plan), the partners should utilize this Plan's impact assessments and local knowledge to develop mitigation strategies to address challenges that may be posed to identified evacuation routes (such as bottle necking). Results from the microsimulation effort (see **E.2 Develop microsimulation effort to determine needed improvements to evacuation routes**) will provide further background.

Resident input has already impacted strategic development of these efforts (as submitted via the READY Nevada County Plan interactive map and public comment). The Access Limited Roads and Communities map in Appendix A provides an important foundation, as will the future evacuation planning studies for individual communities.

E.4: Outline emergency procedures and placement of permanent signage to facilitate evacuations

Strategies for evacuation planning & emergency preparedness are indicated beginning with the letter "E" followed by the strategy number.

Type of Strategy	Proposed Lead Agency	Additional Agencies
Planning	Nevada County OES	Public Works Departments, Emergency Services Departments, Caltrans

Oftentimes in subdivisions or rural environments, highway segments act as the primary evacuation route. NCTC should partner with Caltrans to outline emergency procedures and identify placement for permanent signage, as warranted, to help facilitate evacuations, including those routes utilizing the state highway system. As detailed in Caltrans' *Region 3 Vulnerability Assessment Summary Report*, Caltrans has a toolbox at the ready, including additional traffic signals and detour signage to help both evacuees and emergency response personnel navigate hazardous areas. Proactive coordination will streamline the execution process if and when an emergency occurs.

E.5: Upgrade outdated emergency communications infrastructure

Strategies for evacuation planning & emergency preparedness are indicated beginning with the letter "E" followed by the strategy number.

Type of Strategy	Proposed Lead Agency	Additional Agencies
Operational	Nevada County OES	Public Works Departments, Emergency Services Departments, NCTC

The County should continue to push for an upgrade of vital yet currently outdated emergency communications infrastructure, to keep residents apprised of current and changing conditions, through official notification channels.

Given access challenges faced in rural areas with rough topography, consideration should be given to the future of long-range communication planning, including broadband and satellite communications, as well as the new Radio Over Internet Protocol (ROIP) repeater system.

To note, Nevada County has worked with a congressional representative to ensure they are aware of the need, requesting an appropriate funding allocation. Should this request not move forward, the partners should explore other funding outlets to ensure this critical upgrade occurs.

E.6: Develop an emergency evacuation plan

Strategies for evacuation planning & emergency preparedness are indicated beginning with the letter "E" followed by the strategy number.

Type of Strategy	Proposed Lead Agency	Additional Agencies
Planning	Nevada County OES	Public Works Departments, Emergency Services Departments, Nevada County Sherriff's Department, NCTC, Caltrans

A countywide Emergency Evacuation Plan would pull together all updated evacuation protocols and information developed as recommended in other strategies within this document. It would provide a one-stop resource for local agencies and organizations to find relevant and up-to-date material.

E.7: Fund improvements to eliminate evacuation pinch points on major state highways

Strategies for evacuation planning & emergency preparedness are indicated beginning with the letter "E" followed by the strategy number.

Type of Strategy	Proposed Lead Agency	Additional Agencies
Planning	Caltrans	NCTC, California Transportation Commission (CTC)

Key to evacuation preparedness is identifying the appropriate funding sources to strategically eliminate pinch points on evacuation routes, particularly major state highways. As experienced in past fires, human factors pose challenges during an emergency evacuation, further exacerbated by Nevada County's geography and narrow highways. A number of high-risk locations have already been identified by local emergency responders, including:

Along SR 49:

- Lower SR 49 where passing lanes transition back to one lane in each direction, such as the southbound direction north of Alta Sierra, south of Lime Kiln Road.
- The SR 49 merge point south of McKnight Way (a transition from four lanes to two lanes).
- SR 49 northbound north of Nevada City is problematic in an emergency due to the geography and very windy roadway. To note, Caltrans has a project underway in 2022 to straighten the curves, though the issues but won't be eliminated entirely.

Along SR 20:

- Along SR 20 westbound where the road transitions to a two lane highway, including SR 20 east of Ponderosa, SR 20 east of Rex Reservoir, SR 20 east of Rough and Ready Highway and SR 20 east of Cattle Drive.
- SR 20 east of Nevada City, especially in the curves near Lowell Road.

See related strategy **U.8: Identify evacuation route pinch-points to evaluate roadways for strategic capacity expansion** below for additional information.

E.8: Study development of local ordinance to keep rural evacuation routes open

Strategies for evacuation planning & emergency preparedness are indicated beginning with the letter "E" followed by the strategy number.

Type of Strategy	Proposed Lead Agency	Additional Agencies
Planning	NCTC	Public Works Departments, Emergency Services Departments, Nevada County Sherriff's Department

Keeping rural evacuation routes open so they are available in case of an emergency is critical to resident safety. Given concerns that citizens may, for privacy reasons, close off previously available routes and compromise evacuation safety, entities involved in emergency services should study development of a local ordinance to ensure routes remain open. This work will involve investigating the level of required ongoing work to implement and enforce such an ordinance.

Wildfire

Most of Nevada County is in High or Very High Fire Hazard Severity Zones. Wildfires can be expected to occur with heightened frequency and historic data indicates they are already exponentially increasing in size and affecting higher elevation areas. To mitigate the threat of wildfire to Nevada County residents, it's crucial to coordinate existing partnerships at the local, regional and statewide level to maximize the impact of fire-wise planning and operations.

Wildfire focused mitigation strategies seek to operationalize coordinated fuel reduction and maintenance activities alongside infrastructure upgrades in anticipation of future compounding risks.

W.1: Ensure continued coordination of hazardous fuels clearing and defensible space activities

Strategies for wildfire are indicated beginning with the letter "W" followed by the strategy number.

Type of Strategy	Proposed Lead Agency	Additional Agencies
Operational	Fire Safe Council of Nevada County	Public Works Departments, local fire districts, Caltrans, CAL FIRE

Given the Nevada County OES *Wildfire Evacuation Preparedness Action Plan* recognizes that large-scale fuel breaks can offset catastrophic effects, local entities should ensure continued coordination of both hazardous fuels clearing activities and increasing defensible space associated with roadways and railways both in the West County (Highways 20, 49 and 174) and in the East County (Highways 89 and 267, and Interstate 80), including a focus on designated evacuation routes.

The Roadside Vegetation Fuel Clearance Prescription, advanced by the Fire Safe Council of Nevada County and Nevada County Road Department, institutes guidance for fuel reduction treatments by vegetation or fuel type (including specifics for oak/chaparral and conifer forests) along county-maintained roads (560 miles worth).

The Prescription's purpose is to institute "fuel reduction treatments that are more intensive and longer lasting." This includes removing living and dead vegetation to ensure safe access for both residents and emergency response personnel during evacuations and suppression measures. Both Nevada County's Egress/Ingress Fire Safety Project

and the Capital Improvement Plan's Brushing, Shoulder and General Maintenance Project provide further impetus for this effort.

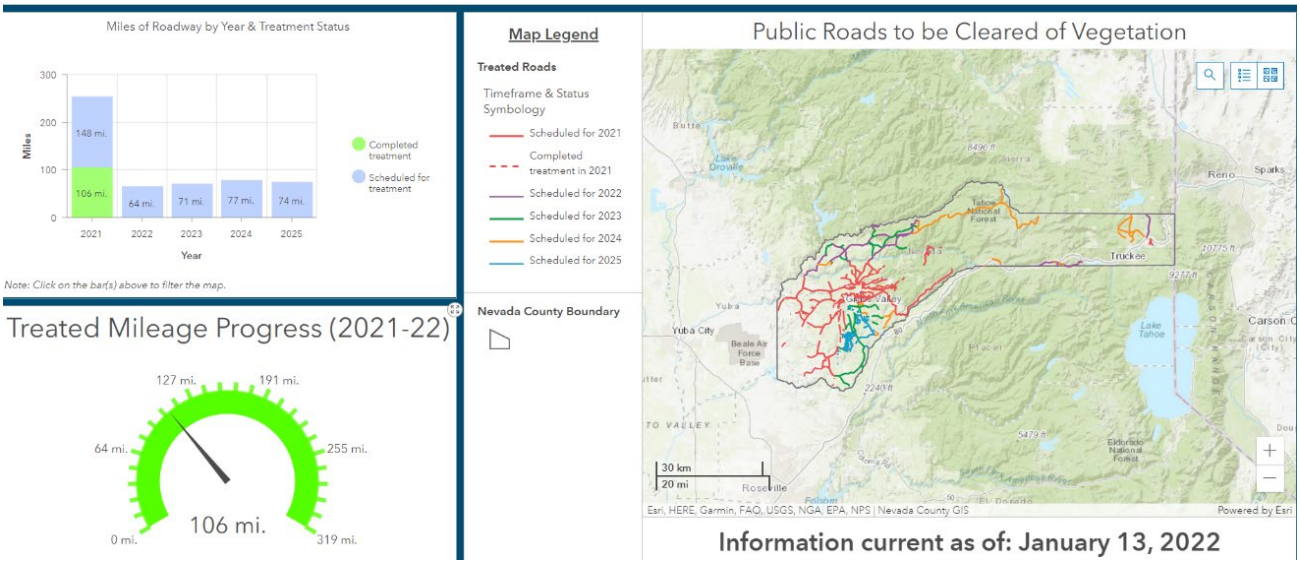
As shown in Figure 42, the Ready Nevada County Dashboard contains a Roadside Vegetation Management Tracker tab, which graphs miles of roadway by year and treatment status, including a 2021-2022 treated mileage progress counter and a map noting public roads to be cleared of vegetation by timeframe. This allows interested community members to search by their address and check the status and schedule of planned work. When community members have requests or concerns regarding vegetation management along non-county-maintained roads, they can work with the Nevada County OES's Defensible Space Inspection Program.

In addition, Truckee Fire Protection District's Measure T (passed in September 2021) provides local prevention funding to reduce fire risk in the wildland urban interface. One of the planned projects for the 2023 season is focused on removing fuels and brush from neighborhood evacuation routes, aiming to keep fire intensity low should it reach these critical roads.

From a regional perspective, the CAL FIRE Nevada-Yuba-Placer Unit (NEU) identifies priority roads annually within its 1,200,000-acre purview for vegetation clearance or thinning. According to the CAL FIRE NEU 2021 Strategic Fire Plan, there are a number of priority projects within Nevada County, including vegetation clearance along a number of historic county fire roads essential for evacuations, a fuel break from Broadway Summit to Glenshire neighborhood in Truckee, fuel breaks between Empire Mine State Park and adjacent landowners in Grass Valley and the South County Fuel Break Lodestar Alta Sierra, which will enhance resident escape routes between Alta Sierra and Lake of the Pines, to give a few examples.

For SRs not within County maintenance purview, Caltrans' Division of Maintenance has prepared a Wildfire Vulnerability Analysis (2020-2030), which highlights highways where fuels reduction is a high priority. Such projects are best initiated when local and state partnerships (with awareness of critical facilities, such as evacuation routes) go hand in hand. Therefore, continued coordination of fuels clearing activities on both county and Caltrans maintained roads will be essential.

Figure 42 Roadside Vegetation Management Tracker (tab on Ready Nevada County Dashboard)



W.2: Prioritize electrical pole clearing and maintenance

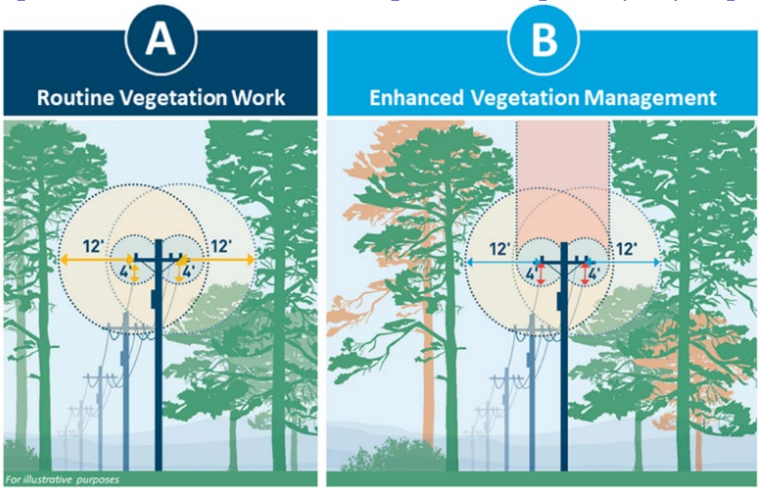
Strategies for wildfire are indicated beginning with the letter "W" followed by the strategy number.

Type of Strategy	Proposed Lead Agency	Additional Agencies
Operational	PG&E	Public Works Departments

As shown in Figure 43, PG&E's Enhanced Vegetation Management (EVM) program performs both routine and enhanced vegetation management. This work also includes removing wood debris from trees cut down in response to previous wildfires through PG&E's Wildfire Wood Management Program. PG&E inspectors and their contractors visit those areas designed as high fire-threat by the California Public Utilities Commission (CPUC) multiple times a year.

PG&E's maintenance priority is those facilities in the top 1-3 percent Circuit Protection Zone (CPZ) risk. Of their six regions, the Sierra region is only second to the North Valley by two CPZ's, and contains 29, for a total of 878 miles. View the CPUC High Fire Threat District Map at bit.ly/CPUCMap.

Figure 43 PG&E's Enhanced Vegetation Management (EVM) Program



W.3: Implement an aggressive electrical undergrounding plan

Strategies for wildfire are indicated beginning with the letter "W" followed by the strategy number.

Type of Strategy	Proposed Lead Agency	Additional Agencies
Hardening	PG&E	Public Works and Emergency Services Departments, Caltrans

Ensure PG&E implements an aggressive electrical undergrounding plan along critical roadways through Nevada County to mitigate for future fire risk to area residents, including along SR's 20, 49, 87, 174, and 267.

PG&E undergrounds approximately 30 miles of overhead powerlines annually. This work is managed through the company's Rule 20A, which is initiated by city, county or municipal agency nominations. The costs for this work are recovered through electric rates post completion.

Nevada County should review PG&E's Electric Undergrounding Program on their webpage (bit.ly/ElectricUndergrounding) to determine local project qualification. As of September 30, 2021, there is one Nevada City and one Nevada County project in the Rule 20A queue, including a project in the engineering phase on Broad Street (city) and a project in the closing phase Combie Road/Magnolia Road Ph 3a (county).

Extreme Precipitation & Flooding

Larger extreme precipitation events will be increasingly likely in Nevada County through mid-century and into end-of-century. Repeated extreme rain can damage transportation infrastructure, increasing maintenance needs and challenging the capacity of flood control structures such as culverts. There are increased risks to roadway users (such as from hydroplaning), which impacts emergency response and efficient evacuations during emergencies. Extreme precipitation and flooding focused mitigation strategies seek to take a proactive approach to infrastructure design and facility upgrades in high-risk areas and following risk-elevating events (like wildfires).

P.1: Incentivize construction of flood control measures through future-thinking design

Strategies for extreme precipitation & flooding are indicated beginning with the letter "P" followed by the strategy number.

Type of Strategy	Proposed Lead Agencies	Additional Agencies
Planning	Public Works and Planning Departments	NCTC

Local planning departments should incentivize flood control measures, including bioretention facilities, swales and permeable pavement, through leveraging the Nevada County Land Use and Development Code, the Land Use Element of the Nevada County General Plan (of which the Comprehensive Site Development Standards were designed to be protective of "prevention and reduction of flood hazards" and "buffering and screening to mitigate adverse effects,") and other relevant planning documents. Additional design focus should be given to those roadways deemed routes for evacuation or critical facility access.

As an example, The National Research Council's *Potential Impacts of Climate Change on U.S. Transportation* special report suggests updating pumping capacity requirements for tunnels and increasing drainage capacity standards for new infrastructure (for example, designing for a 500-year rather than 100-year storm).

P.2: Track Caltrans' progress towards high priority culvert upgrades

Strategies for extreme precipitation & flooding are indicated beginning with the letter "P" followed by the strategy number.

Type of Strategy	Proposed Lead Agency	Additional Agencies
Planning	Caltrans	Public Works Departments

On a regional level, Caltrans' *2020 Adaptation Priorities Report for District 3* identifies the highest priority culverts (both large and small) along state highways that could exceed capacity during localized flooding events. The prioritization matrix assists Caltrans with identifying which culverts qualify for detailed adaptation assessments. Tracking Caltrans' work would assist with determine metrics to track for flagging Nevada County managed culverts (see **P.3: Develop a regional prioritization of culvert upgrades and replacements**).

Large culverts generally have a width of 20 feet or more. Caltrans' flood exposure index found there were no culverts in Nevada County listed as Priority 1, however two were Priority 3, one was Priority 4 and one was Priority 5, as listed in Table 9: Prioritization Of Large Culverts For Detailed Climate Change Adaptation Assessments on page 43 of the report.

Small culverts generally have a width of less than 20 feet. Caltrans' flood exposure index found 24 Priority 1 culverts in Nevada County. In fact, the culvert with the highest overall Cross-Hazard Prioritization Score in District 3 (i.e. the highest priority) is in Nevada County, along I-80 at postmile 29.18 (see Table 6: Priority 1 Small Culverts on pages 27-29 in the report).

P.3: Develop a regional prioritization of culvert upgrades and replacements

Strategies for extreme precipitation & flooding are indicated beginning with the letter "P" followed by the strategy number.

Type of Strategy	Proposed Lead Agencies	Additional Agencies
Planning	Nevada County OES, Public Works Departments, Town of Truckee Emergency Services	CAL FIRE

When a flood event occurs, undersized or blocked culverts may overflow onto roadways or sidewalks, impacting travel. As listed below, the Town of Truckee Emergency Services has started a preliminary identification of problem culverts, based on localized flooding observations during rain or snow events. Nevada County OES and local maintenance agencies should coordinate with the Town of Truckee as well as Cities of Grass Valley and Nevada City to synchronize project lists, factoring in projected increases in heavy rain events. CAL FIRE staff from the Nevada/Yuba/Placer Unit shared that culvert erosion appears to be more at issue on poorly maintained private roadways, with potential to threaten access.

The ultimate goal of this coordinated effort would be to develop a regional prioritization of culvert upgrades and replacements, so as to appropriately budget for these improvements or apply for grants to meet the need.

Preliminary List of Problem Culverts in the Town of Truckee

- West end of Donner Lake
- North side of Donner Lake along Donner Pass Road (where culverts are blocked with snow and water runs off I-80 through and under homes)
- Donner Pass Road / Coldstream Road area (culvert work is already planned here to address this issue)
- Trout Creek / Glenshire Drive area (issues with a small culvert causing back-ups before Trout Creek empties into the Truckee River)
- Downtown corridor (lacks clear path for surrounding storm run-off to travel)
- Glenshire subdivision, including the Dorchester Drive / Evensham Place area (acts a sink, leading the surrounding areas to drain here. Undersized culverts often become blocked with snow, leading to flooding alongside and under houses)

P.4: Explore changes to drainage material and culvert sizing in the most wildfire prone areas

Strategies for extreme precipitation & flooding are indicated beginning with the letter "P" followed by the strategy number.

Type of Strategy	Proposed Lead Agencies	Additional Agencies
Planning	Public Works Departments	None

Area planning departments should explore changes to drainage material and culvert sizing (such as adjusting discharge projections based on confidence interval and/or future precipitation projections) for burned and bulked flows in the most wildfire prone areas, including West County.

Understanding culvert design vulnerabilities could minimize risks associated with heavy precipitation following wildfires. In terms of material, when small culverts made of wood or plastic are exposed to wildfire, they may burn or be deformed, further increasing the risk of flooding following extreme precipitation events. Given this, the Caltrans Cross-Hazard Prioritization Score for culverts (detailed further in **P.2: Track Caltrans' progress towards high priority culvert upgrades**) factored in the construction materials of small culverts within their risk assessment.

Crosscutting Strategies

The strategies below pertain to more than a single hazard and offer enhanced potential to mitigate the impacts of extreme climate events on Nevada County residents and visitors. These mitigating measures range from monitoring planned risk assessments to encouraging proactive planning by both area and regional transportation providers to revamping maintenance priorities and procedures to make climate sensitive decisions.

C.1: Monitor Caltrans's next steps following 2019 Climate Change Vulnerability Assessments

Crosscutting strategies are indicated beginning with the letter "C" followed by the strategy number.

Type of Strategy	Proposed Lead Agency	Additional Agencies
Planning	Caltrans	Nevada County OES, NCTC

To ensure key roadways can be sustained in a changing climate, NCTC will monitor Caltrans's next steps following development of its Climate Change Vulnerability Assessments, including the creation of adaptation plans relevant to Nevada County (for SR's 49, 20, 174, and Interstate 80).

According to the Caltrans' *2020 Adaptation Priorities Report for District 3*, Caltrans plans to undertake detailed adaptation assessments beginning with those assets ranked as Priority 1 (of which there are a number within Nevada County, see **P.2: Track Caltrans' progress towards high priority culvert upgrades** and **U.7: Conduct a technical vulnerability assessment of exposed metal structures to prioritize upgrading the highest need facilities**). These assessments will examine asset exposure using local climate projections and engineering analyses, then develop appropriate adaptations to withstand predicted climate impacts. Caltrans plans to involve key stakeholders in this process and NCTC should be proactive to ensure they and other relevant regional stakeholders have a seat at the table during these discussions.

C.2: Encourage railway entities to consider the impact of extreme climate events on the viability and safety of their operations

Crosscutting strategies are indicated beginning with the letter "C" followed by the strategy number.

Type of Strategy	Proposed Lead Agencies	Additional Agencies
Planning	Union Pacific Railroad (UPRR), Amtrak	NCTC

NCTC will encourage area railway entities to prioritize reviewing both railway operations and maintenance protocols to understand the impact of future temperature trends and major rain events on the viability and safety of their operations.

Per recommendation from the National Research Council's *Potential Impacts of Climate Change on U.S. Transportation* special report, railway mitigation measures for extreme precipitation events include incorporating vulnerability assessments into rail plans (as Caltrans has done for state highway facilities), upgrading railway drainage systems and increasing warning systems to alert crews in case of an emergency. Additionally, the *State of California Hazard Mitigation Plan* suggests building railways on foundations resistant to washouts from floods.

Extreme temperature mitigation measures, designed to reduce the risk of rail buckling include designing new or replacement facilities to withstand higher temperatures, improving sensors and other monitoring systems to understand temperature risks, installing expansion joints to reduce heat damage and increasing maintenance operations. During high-heat events, operators can further lower risk by lowering speeds, shortening trains and lightening loads to reduce the stress on railway tracks.

C.3: Investigate grant applications to enhance alternative transportation options

Crosscutting strategies are indicated beginning with the letter "C" followed by the strategy number.

Type of Strategy	Proposed Lead Agencies	Additional Agencies
Planning	NCTC, Planning Departments	Nevada County Transit Services Division, Tahoe Truckee Area Regional Transit

Recognizing the critical nature of maintaining a viable Level of Service (LOS) on SRs through Nevada County for evacuation purposes, and given Nevada County's goal of shifting travelers to modes other than single-occupancy vehicles, investigate whether submitting a grant application for a passenger rail feasibility study would be a worthy pursuit. This would assist with reducing congestion associated with both winter and summer travel.

As a regional example, Placer County Transportation Planning Agency (PCTPA) plans to submit a Sustainable Transportation Planning Grants (STPG) application through Caltrans for a feasibility study to extend the Capital Corridor route to Truckee/Reno. FY 2022-2023 grant applications are due in October 2022.

C.4: Investigate climate adapted options to buffer transit services from the impacts of future extreme climate events

Crosscutting strategies are indicated beginning with the letter "C" followed by the strategy number.

Type of Strategy	Proposed Lead Agencies	Additional Agencies
Planning	NCTC, Planning Departments	Nevada County Transit Services Division, Tahoe Truckee Area Regional Transit

Given the importance of fostering alternative transportation options and the fact that transit service disruptions can deprive low-income residents of their primary form of transportation, NCTC will partner with area transit agencies to investigate climate adapted options to buffer transit riders from the impacts of extreme heat and plan for alternative routes and stops in the case of roadway failures, evacuation measures or other system-level disruptions.

Heat buffering strategies may include construction of additional shelters or shade devices (see Figure 44) and/or installing water fountains or misters. Additionally, when siting new transit stops, local planning departments should incentivize either siting near existing natural shade cover or installing green infrastructure, which will also buffer against increased risk of flooding due to extreme precipitation events and reduce the heat island effect.

Figure 44 Santa Monica Big Blue Bus Shade-Covered Seating

C.5: Improve communications to re-route travelers in the event of a weather/hazard prompted closure

Crosscutting strategies are indicated beginning with the letter "C" followed by the strategy number.

Type of Strategy	Proposed Lead Agencies	Additional Agencies
Planning, Operational	Caltrans, CHP, Emergency Services Departments	NCTC, Nevada County Sheriff's Office, Nevada County OES

Explore existing tools provided by Caltrans, CHP and local emergency services to ensure appropriate dissemination of updates to the general public (residents, commuters and tourists traveling within and through Nevada County).

One example is Caltrans' regional social media, including the District 3 Facebook page and Twitter (@CaltransDist3), a source for regular updates on chain control, accident prevalence, rerouting and other information tagged as #TrafficAlert. Another is CHP's Truckee and Grass Valley Twitter feeds, which also provide relevant traffic alerts.

Ready Nevada County's social media could establish channels to share this information seamlessly to area travelers.

C.6: Encourage local maintenance agencies to review transportation system asset vulnerabilities to make "climate-sensitive decisions"

Crosscutting strategies are indicated beginning with the letter "C" followed by the strategy number.

Type of Strategy	Proposed Lead Agency	Additional Agencies
Operational	NCTC	Public Works Departments

As the FHWA's *Vulnerability Assessment and Adaptation Framework* reminds us, "The future climate may require different resource allocations and budget planning formulas than today's climate." Local maintenance agencies should holistically review their transportation system assets to understand and prioritize maintenance needs to buffer against vulnerabilities. This involves reviewing local workforce capacity and maintenance needs to understand whether additional personnel are needed, if outsourcing would be beneficial (hiring contractors), or if existing inspectors would benefit from additional training. See "Resources for Incorporating Results into Asset Management" on pages 63-68 of the FHWA framework for further guidance.

C.7: Acquire funding to meet projected design upgrades and repair needs for critical infrastructure

Crosscutting strategies are indicated beginning with the letter "C" followed by the strategy number.

Type of Strategy	Proposed Lead Agencies	Additional Agencies
Planning, Operational	Public Works Departments	NCTC

Given the importance of critical infrastructure connections such as bridges and tunnels, partner agencies will implement the findings from the landslide risk assessment, which determined areas of high risk associated with extreme precipitation (as displayed in Figure 54-58 in Appendix A) in order to anticipate and acquire funding to meet projected design upgrades (such as the addition of slope stability measures) as well as repair needs.

As an example, the National Research Council's *Potential Impacts of Climate Change on U.S. Transportation* special report suggests expanding scour monitoring systems for bridges – a consideration for local entities responsible for asset maintenance to consider. Long-term, scour destabilizing can lead to bridge collapse.

C.8: Establish an annual inspection cycle to both assess high-risk areas prior to the rainy season and establish standards to monitor these locations after events

Crosscutting strategies are indicated beginning with the letter "C" followed by the strategy number.

Type of Strategy	Proposed Lead Agencies	Additional Agencies
Operational	Public Works Departments	NCTC, CAL FIRE, Emergency Services Departments

Establishing an annual cycle to assess targeted areas (such as recent wildfire sites) before the rainy season begins will provide opportunity to catch potential risks before they turn into greater hazardous events. It will be crucial to monitor flagged high-risk areas following significant rain events or wildland fires.

For significant fires, the State of California, in coordination with federal agencies, deploys a post-fire assessment model called The Watershed Emergency Response Team (WERT), which identifies threats by type and location, focused on values-at-risk or VARs. Though this scope and intensity of assessment is typically only warranted with large wildfires or when a federal or state disaster is declared, referring to the model's assessment metrics and end products (such as emergency protection measures, maps and specific findings) could be beneficial to mitigate landslide risk in post-wildfires areas. Here's a sample WERT from the 2018 Camp Fire, which burned 153,336 acres: bit.ly/WERTCamp.

Findings from annual inspections will give implementing agencies tools to proactively integrate slope stability and rockfall protection measures for roadways and railways at high-risk locations. Caltrans recommends soil stabilization tactics such as installing riprap or vegetation, which strengthens embankments.

A first round of projects could be prioritized at those locations identified in Figure 35 Nevada County Landslide Risk, with a focus on steep slopes and those that coincide with drainage.

C.9: Establish budget to meet an increased need for obstruction clearing, general repair and snow removal activities

Crosscutting strategies are indicated beginning with the letter "C" followed by the strategy number.

Type of Strategy	Proposed Lead Agencies	Additional Agencies
Operational	Public Works Departments	Caltrans

Per Caltrans' 2021 *Climate Change Vulnerability Assessment Statewide Summary Report*, evaluating the cost of present-day investments vs. longer term maintenance needs will be crucial to appropriate annual budgeting.

Given the projected impact of extreme climate events on increased obstruction clearing and general repair (such as that necessitated by downed trees, electrical poles, washouts and sinkholes), in addition to snow removal activities at lower elevations, assigning appropriate budget increases to meet this projected need will crucial.

C.10: Coordinate avalanche risk assessments for high-risk areas and high LOS routes

Crosscutting strategies are indicated beginning with the letter "C" followed by the strategy number.

Type of Strategy	Proposed Lead Agencies	Additional Agencies
Operational	Public Works Departments, Caltrans	Emergency Services Departments

It is expected that certain types of avalanche risks will increase throughout mountain ranges in North America, including the Sierra Nevada mountains. To combat this heightened risk, local entities in charge of roadway maintenance should coordinate to conduct risk assessments for the most avalanche-prone areas, especially those routes with a high Level of Service (LOS), like I-80.

Concepts

For When Roadway is Built or Rebuilt

B.1: Replace high-traffic asphalt roadways with concrete to withstand extreme precipitation events

Concepts applicable to when a roadway is built or rebuilt are indicated beginning with the letter "B" followed by the strategy number.

Type of Strategy	Proposed Lead Agencies	Additional Agencies
Hardening	Public Works Departments	Caltrans

Evacuation and emergency response impacts on roadways weakened by flood events can create further hazards and degradation. When designing with flood exposure in mind, replacing asphalt road segments with concrete is an effective hardening strategy. According to the *Resilient Shasta Plan,* upgrading high traffic roadway segments (such as those in the 100-year floodplain) to reinforced concrete reduces long-term maintenance costs.

There may be opportunities during Caltrans' District 3 Climate Change Vulnerability Assessments process to assist with or provide further data to determine key Nevada County roadway segments eligible for hardening projects. Caltrans' Region 3 *2020 Adaptation Priorities Report* identified roadway segments potentially exposed to flooding and extreme temperatures in Table 11: Prioritization of Roadways for Detailed Climate Change Adaptation Assessments on pages 54-65. Though there are no Priority 1 roadways in Nevada County, there is a Priority 2 segment along Hwy 80 at the eastern edge of the County, heading north to the Nevada border.

B.2: Adjust pavement binder grades and/or implement rut-resistant designs on critical routes

Concepts applicable to when a roadway is built or rebuilt are indicated beginning with the letter "B" followed by the strategy number.

Type of Strategy	Proposed Lead Agencies	Additional Agencies
Hardening	Public Works Departments	Caltrans

When designing with future temperatures in mind, there's opportunity to adjust pavement binder grades according to global climate models (see Figure 45 from *Caltrans' Climate Change Vulnerability Assessment Statewide Summary Report* below) to buffer roadways to withstand increased temperatures and extreme heat conditions. Caltrans acts as an information clearinghouse for local governments in this regard, as they have divided the state into nine separate "pavement climate regions" to help determine the performance grade binder specification(s) optimal for road resurfacing projects on state highways, given changing climate conditions, with additional consideration given to the estimated life span of the asset (see Figure 46). As quoted from Caltrans' Region 3 *2020 Adaptation Priorities Report:*

> *Binder can be thought of as the glue that holds the various aggregate materials in asphalt together. Binder is sensitive to temperature. If temperatures become too hot, the binder can become pliable and deform under the weight of traffic. On the other hand, if temperatures are too cold, the binder can shrink causing cracking of the pavement. There are various types (grades) of binder, each suited to a different temperature regime. This study and the Caltrans District 3 Climate Change Vulnerability Assessment considered how climate change will influence high and low temperatures and how this, in turn, could affect pavement binder grade performance (page 6).*

Figure 45 Caltrans' Pavement Binder Grade Change Given Temperature Rise Scenarios

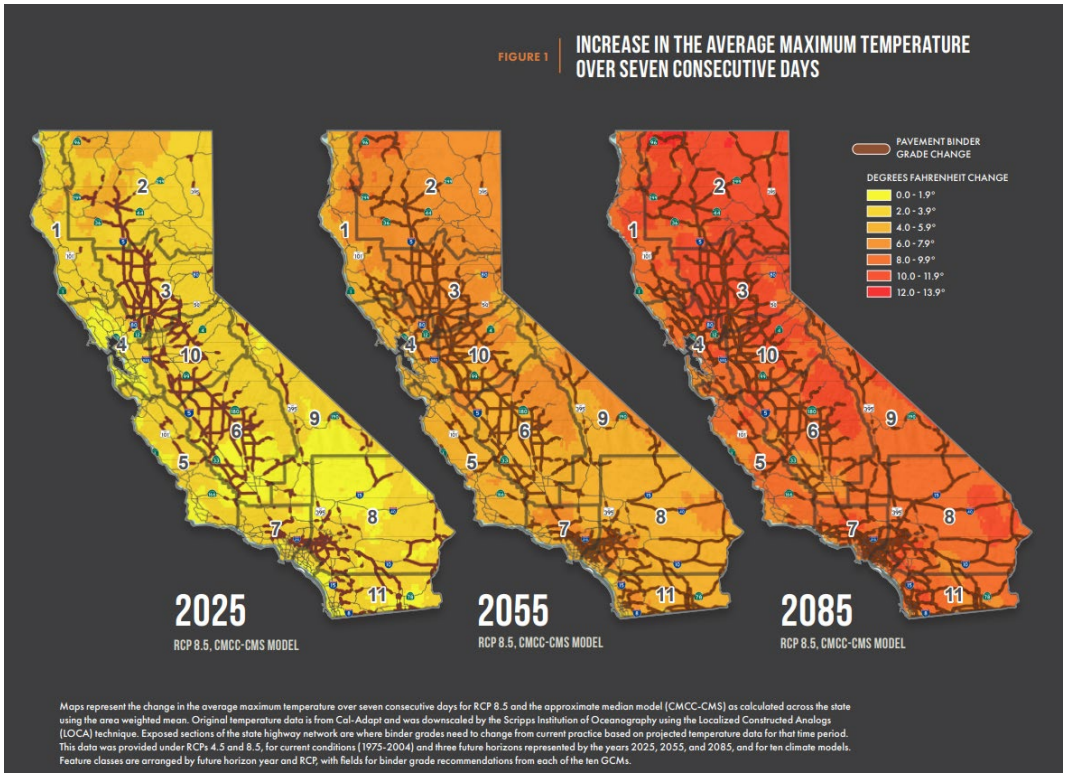
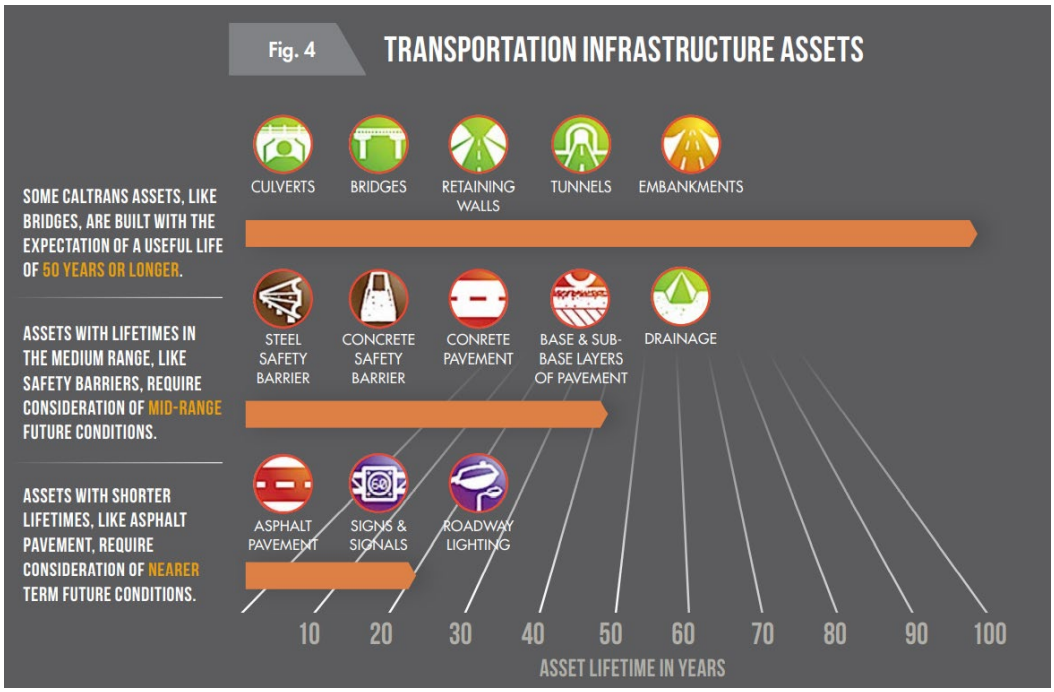


Figure 46 Caltrans' Design Life Considerations for Transportation Infrastructure Assets



B.3: Install permeable pavement in locations prone to localized flooding

Concepts applicable to when a roadway is built or rebuilt are indicated beginning with the letter "B" followed by the strategy number.

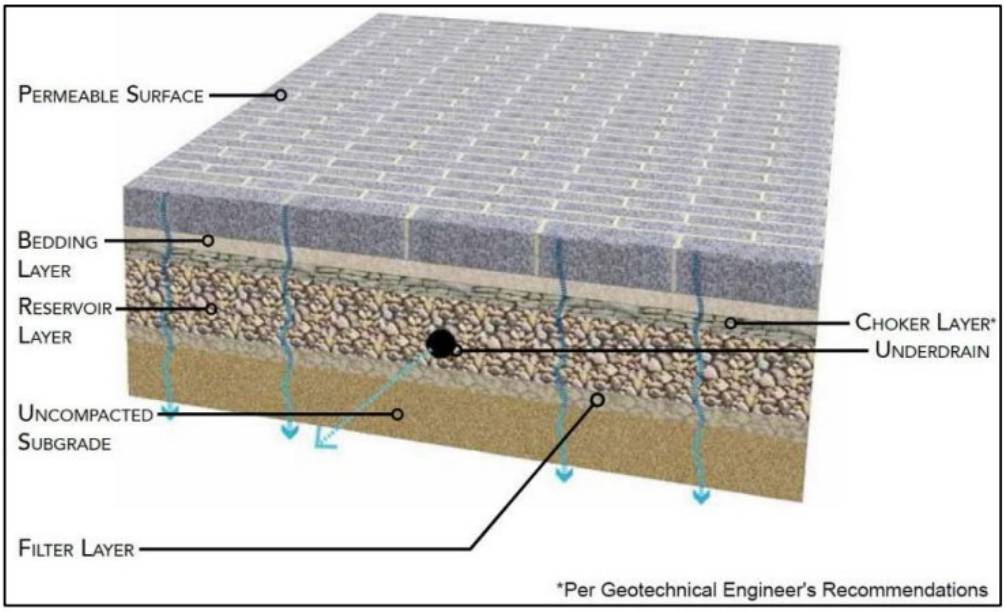
Type of Strategy	Proposed Lead Agencies	Additional Agencies
Hardening	Public Works Departments	Planning Departments

According to the National Association of City Transportation Officials (NACTO), permeable pavement is usually applied to lower-volume streets, parking areas, sidewalks and bike facilities, and is most effective where shallow slopes (under 5%) are present. Permeable pavement allows for greater infiltration which in turn reduces runoff (see Figure 47).

From a maintenance perspective, it is crucial to outline responsibility for sweeping, washing, etc. to maintain the pavement's effectiveness. A related cold-weather benefit discovered from a USGS Upper Midwest Water Science Center study is that permeable pavement functions well in winter conditions, requiring none or as little as 25% of the salt needed to de-ice asphalt, while storing heating within its structure, which promotes thawing of surface snow and ice.

From an equity perspective, maintaining mobility on non-motorized access routes during extreme precipitation events where flooding may occur is crucial to ensure pedestrians, persons with disabilities and transit dependent individuals are still able to safely navigate. Local surveying efforts could assist with identifying critical pathways, sidewalks or other access routes to consider for permeable pavement installation, alongside additional flood-proofing measures.

Figure 47 Permeable Pavement from San Diego Green Infrastructure Guidelines



Upgrades

U.1: Investigate strategic improvements to Highway 49 given its status as the I-80 emergency detour

Concepts applicable to upgrades are indicated beginning with the letter "U" followed by the strategy number.

Type of Strategy	Proposed Lead Agency	Additional Agencies
Operational	Caltrans	NCTC

Given that Hwy 49 experiences congestion issues and serves as both the I-80 emergency detour and an important component of county evacuation routes, encourage Caltrans to continue investigating strategic improvements to ensure an adequate level of service during these events.

Caltrans and NCTC are currently discussing phased improvements for the SR 49 Corridor Improvement Project from La Barr Meadows Road to the McKnight Way Interchange, which intends to improve safety, operations and mobility. This effort offers opportunity to enhance traffic flow should residents be ordered to evacuate. Other strategic improvements of this type could be identified and pursued to alleviate constraints on important evacuation routes.

This effort should also acknowledge that I-80 may be increasingly impacted as the transition from snow to rain moves eastward (up-elevation) and landslide risk increases, which may influence design.

U.2: Employ roadway hardening strategies on critical routes to combat flood exposure

Concepts applicable to upgrades are indicated beginning with the letter "U" followed by the strategy number.

Type of Strategy	Proposed Lead Agencies	Additional Agencies
Hardening	Public Works Departments	Caltrans

For example, to combat exposure to extreme precipitation events and flooding, Caltrans recommends hardening roadways through soil stabilization tactics such as installing riprap or vegetation, which strengthens embankments.

When local planning departments are permitting for projects on routes identified as most susceptible in Figure 35: Nevada County Landslide Risk, these tactics should be prioritized during design.

U.3: To combat vehicle hydroplaning, investigate applying porous surface mixtures

Concepts applicable to upgrades are indicated beginning with the letter "U" followed by the strategy number.

Type of Strategy	Proposed Lead Agencies	Additional Agencies
Hardening	Public Works and Planning Departments	Caltrans

Given that extreme precipitation events can lead to an increased risk of vehicle hydroplaning, investigate applying porous surface mixtures to reduce splashing. In *Climate Change Adaptation for Pavements*, FHWA recommends examining surface texture upgrades to maintain friction.

It's also beneficial if local agencies examine high traffic pavement following significant rain events that result in roadway flooding in order to gauge the impact on the pavement's performance and structural capacity. This effort helps contribute to ongoing asset management monitoring, as detailed in **M.2: Implement an asset management system to monitor the impact of extreme precipitation events on maintenance needs**.

U.4: Investigate upgrading the capacity and/or materials of problem culverts

Concepts applicable to upgrades are indicated beginning with the letter "U" followed by the strategy number.

Type of Strategy	Proposed Lead Agencies	Additional Agencies
Hardening	Public Works Departments	None

Understanding opportunities for retrofitting to allow greater drainage or installing screens/debris cages (as in Figure 48) to reduce blockages would be beneficial. Problem culverts will have been identified through the prioritization process between Nevada County OES and Town of Truckee Emergency Services outlined above in **P.3: Develop a regional prioritization of culvert upgrades and replacements.** The *Climate Resilient Transportation Infrastructure Guidebook* further recommends enhancing inlet design or installing culvert barrel(s).

From a cost perspective, local maintenance agencies may see a cost reduction in blockage-prompted maintenance yet where screens or cages or installed, additional seasonal maintenance needs may apply and should be budgeted for accordingly.

Figure 48 Long Beach culvert

U.5: Repurpose roadway shoulders in flood prone areas for retention functionality

Concepts applicable to upgrades are indicated beginning with the letter "U" followed by the strategy number.

Type of Strategy	Proposed Lead Agencies	Additional Agencies
Hardening	Public Works Departments	Caltrans

Repurposing roadway shoulders or open space adjacent to roadways in flood prone areas to act as retention areas could help mitigate spillover during extreme precipitation events and increase natural infiltration, which in turn reduces roadside wildfire risk. With less standing water on roadways, pavement degradation will also be minimized. Prioritizing shoulder repurposing during planned fuel management or defensible space work could maximize the hazard reduction potential.

U.6: Implement slope stabilization upgrades at high-risk locations

Concepts applicable to upgrades are indicated beginning with the letter "U" followed by the strategy number.

Type of Strategy	Proposed Lead Agencies	Additional Agencies
Hardening	Public Works Departments	CAL FIRE, US Forest Service

According to the *Sacramento Region Transportation Climate Adaptation Plan*, slope stabilization measures fall within three categories: mechanical, hydrogeologic and geometric methods (see Figure 49). Mechanical methods include anchors, nailing, piles or structural wells. Hydrogeologic methods focus on stormwater management, such as employing horizontal or blanket drains, vertical wells or pumps. Geometric methods involve flattening hillside slopes, often including excavation or recompaction.

High risk locations to address within Nevada County include recent wildfire sites, particularly those within flood prone areas. Conversations with CAL FIRE and the US Forest Service will assist with these determinations. Additionally, roadways flagged as high landslide risk (as shown in Appendix A should be a priority for stabilization upgrades.

Figure 49 ODOT Examples of Horizontal Drain, Blanket Drain and Ground Anchors

U.7: Conduct a technical vulnerability assessment of exposed metal structures

Concepts applicable to upgrades are indicated beginning with the letter "U" followed by the strategy number.

Type of Strategy	Proposed Lead Agencies	Additional Agencies
Planning	Public Works Departments	Caltrans

Given that thermal expansion can impact steel bridges and wildfire damage can destroy wooden bridges, it's critical to gain an understanding of county-wide vulnerabilities. Conducting a technical vulnerability assessment of exposed metal structures, such as bridges, to increased temperatures, extreme heat events and wildfires would be beneficial in this effort.

In the short-term, replacing or reconstructing bridge deck expansion joints can help mitigate the impacts of higher temperatures. Long-term, anticipatory design to minimize risk would accommodate higher maximum temperatures so new infrastructure is adapted for future conditions (including heat and rut resistant materials). See Figure 50 from USAID's *A Climate Resilient Infrastructure Methodology* as background for a materials vulnerability index.

Caltrans' *2020 Adaptation Priorities Report for District 3* developed a flood exposure index to outline the threat to all bridges within their purview, considering changes in both flooding and wildfire risk. High scores indicate greater risk, and four in Nevada County were listed as Priority 1 bridges (as shown in Table 4 on pages 22-23 of the *2020 Adaptation Priorities Report for District 3*), meaning these will be within the first batch of Caltrans' assets to receive detailed adaptation assessments and should be noted accordingly on Nevada County infrastructure maps.

Figure 50 USAID's Differential Impact of Climate Effects on Materials

Material	Carbon Dioxide	Cyclones & Storms	Sea Level Rise	Extreme Rainfall & Floods	Annual & Max Temp	Ultraviolet Radiation	Wildfire	Drought
Concrete	M	H	H	M	M	L	M	L-M
Metals	L	H	H	M	M	L	H	L
Mortar	L	M	M	M	L	L	M	H
Timber	L	M	M	M-H	M	L	E	L-M
Coatings	L	M	L	M	M	H	E	L
Polymers	L	M	L	L	M	H	E	L

*Tested on commonly used materials in engineering designs for temperate climates only (©AECOM – Climate sensitivity of materials research, S.E. Australia Region 2007)

L Low M Moderate H High H Extreme

U.8: Identify evacuation route pinch-points to evaluate roadways for strategic capacity expansion

Concepts applicable to upgrades are indicated beginning with the letter "U" followed by the strategy number.

Type of Strategy	Proposed Lead Agencies	Additional Agencies
Operational	Nevada County Operations Division, Caltrans	Public Works and Emergency Services Departments

Building upon the Town of Truckee's primary evacuation routes map (Figure 41 above) and stand-alone evacuation route studies for individual communities which are planned to be developed by NCTC and the Nevada County Office of Emergency Services as additional funding is obtained, identify pinch-points as reported during past extreme weather events, to evaluate these roadways for strategic capacity expansion and other improvements.

For example, the use of shoulders and other non-general-purpose lanes may be considered. During an evacuation, use of shoulders as space for obstruction clearance and as areas for emergency responders should be weighed against repurposing benefits. The microsimulation efforts proposed in **E.2: Develop microsimulation effort to determine needed improvements to evacuation routes** above could be helpful to target locations for widening through elimination of construction features such as merges/lane drops.

U.9: Upgrade cell towers for additional longevity in power outages

Concepts applicable to upgrades are indicated beginning with the letter "U" followed by the strategy number.

Type of Strategy	Proposed Lead Agency	Additional Agencies
Operational	California Public Utilities Commission (CPUC)	Verizon, AT&T and other wireless providers

Past experience in emergency situations has demonstrated that Verizon towers often go offline after just a day of power outages, limiting customers' ability to use 3G and limiting the signal's usefulness to calls only. This impacts the ability of residents accessing the internet, including the county website system, which is a crucial portal for information such as active evacuation orders and projected dates for power to coming back online.

The effort follows the CPUC's decision adopted in July 2020 and developed in response to the increasing prevalence of wildfire-risk prompted public safety power shut-offs (PSPS) and requires California's facilities-based wireless providers to "develop resiliency strategies to prepare for disasters and power outages." The decision gave providers one year (until July 2021) to implement the 72-hour backup power requirement for their facilities, focused on providing coverage to Tier 2 and Tier 3 High Fire Threat Districts during emergencies or power outages (BB&K Attorneys at Law, 2020). Per the CPUC Fire Map, nearly all of Nevada County is within Tier 2 or 3 (see cpuc_firemap2.sig-gis.com).

Local agencies should encourage implementation of CPUC's decision within updates to their permitting and application processes, further encouraging wireless providers to develop resiliency plans and institute the 72-hour backup requirement, to ensure residents aren't left in the dark when an outage occurs.

U.10: Provide generators for electric bus charging in the event of a power outage

Concepts applicable to upgrades are indicated beginning with the letter "U" followed by the strategy number.

Type of Strategy	Proposed Lead Agencies	Additional Agencies
Operational	Nevada County Transit Services Division, Tahoe Truckee Area Regional Transit, Nevada County OES	None

In the event of a power outage, it's crucial to ensure that electric vehicles operated by local transit agencies maintain access to a power source for charging. Transit access is essential in the event of an outage, given the crucial connections these routes provide for transit-dependent riders, who may need to access amenities not available at their homes while power is shutoff.

Maintenance

M.1: Implement an asset management system to monitor the impact of extreme heat on maintenance needs

Concepts qualified as maintenance activities are indicated beginning with the letter "M" followed by the strategy number.

Type of Strategy	Proposed Lead Agencies	Additional Agencies
Operational	Public Works Departments	Caltrans

In keeping with the above recommendation to inventory local bridge assets and monitor Caltrans' upgrade efforts, local entities should monitor the impacts of extreme heat on local assets to ensure they maintain their integrity and/or are flagged for upgrading as needed. For example, there will likely be an increased need for replacement of bridge joints impacted by thermal expansion.

Operations and maintenance costs for the most trafficked routes, including Highways 49, 20, 174, and Interstate 80 should be expected to increase. This could potentially be mitigated by exploring materials (such as adjusted pavement binder) that function under the predicted temperature regime changes.

M.2: Implement an asset management system to monitor the impact of extreme precipitation events on maintenance needs

Concepts qualified as maintenance activities are indicated beginning with the letter "M" followed by the strategy number.

Type of Strategy	Proposed Lead Agencies	Additional Agencies
Operational	Public Works Departments	Caltrans

Local maintenance agencies should implement an asset management system to monitor the impact of extreme precipitation events on maintenance needs of transportation assets (for example, increased repair costs associated with additional obstructed stormwater roadway structures, such as culverts). Ensuring regular maintenance activities are prioritized, and in particular a check of critical facilities such as culverts and storm drains is performed prior to a major rain event, decreases the risk of flooding.

Adaptation concepts discussed such as the installation of a debris racks within culverts can help maintain water flow during extreme participation events and decrease the need for critical maintenance.

M.3: Prioritize maintaining visual roadway cues on critical routes

Concepts qualified as maintenance activities are indicated beginning with the letter "M" followed by the strategy number.

Type of Strategy	Proposed Lead Agencies	Additional Agencies
Operational	Public Works Departments	Caltrans

Local maintenance agencies should prioritize maintaining crucial visual roadway cues (such as centerline and edge line striping) on evacuation routes and routes to critical services. During low visibility conditions such as intense wildfire smoke, these guideposts are crucial. Coordinating these local efforts with maintenance planned for Caltrans facilities will be beneficial.

M.4: Increase pavement maintenance budget to address the impact of extreme climate events

Concepts qualified as maintenance activities are indicated beginning with the letter "M" followed by the strategy number.

Type of Strategy	Proposed Lead Agencies	Additional Agencies
Operational	Public Works Departments	None

Knowing that adjusting pavement binder grade is a longer-term adaptation, in the interim – it is crucial to budget for maintenance needs to maintain critical assets which suffer the impacts of a changing climate. For example, the increasing presence of extreme climate events such as extreme precipitation and extreme heat can lead to pavement wearing, necessitating additional seal coats and crack seals.

M.5: Conduct an analysis of pavement conditions as a part of fire recovery efforts

Concepts qualified as maintenance activities are indicated beginning with the letter "M" followed by the strategy number.

Type of Strategy	Proposed Lead Agencies	Additional Agencies
Planning	Public Works Departments	Caltrans

Roadway damage is typically evaluated using the Pavement Condition Index (PCI). In comparing pre- to post-fire conditions, local agencies can understand maintenance needs prompted by wildfire impacts, ranging from resealing to full reconstruction.

It would be wise for Nevada County to undertake an assessment of maintenance needs, including those previously deferred, to prioritize and fund improvements to evacuation routes that do not meet Pavement Condition Index ratings or the recommended 100-feet of roadside defensible space. Targeting roads that are in poor condition for recovery grants will ensure critical routes are prepared in case of evacuation needs.

M.6: Encourage rail operators to review maintenance protocols to understand risk mitigating potential

Concepts qualified as maintenance activities are indicated beginning with the letter "M" followed by the strategy number.

Type of Strategy	Proposed Lead Agencies	Additional Agencies
Planning, Operational, Hardening	Union Pacific Railroad (UPRR), Amtrak	NCTC

In order to buffer against the impact of extreme climate events, rail operators should outline enhanced maintenance procedures to address the impacts of erosion and landslide risk (as mapped in Appendix A), particularly where rail infrastructure is not protected by tunnels, an increased need for snow clearance at high elevations, and potential route disruptions due to hazardous conditions.

Regular inspections of railway facilities prior to and following extreme climate events can buffer against the predicted impacts of climate vulnerabilities (including extreme heat and precipitation events) on operations.

M.7: Prepare key roadway routes above the current snowline to sustain an increase in snow removal and avalanches

Concepts qualified as maintenance activities are indicated beginning with the letter "M" followed by the strategy number.

Type of Strategy	Proposed Lead Agencies	Additional Agencies
Operational, Hardening	Public Works Departments, Caltrans	Nevada County Transit Services Division, Tahoe Truckee Area Regional Transit, UPRR, Amtrak

Entities responsible for snow maintenance should coordinate and inventory plowing vehicles to understand current and predicted capacity, budgeting for increases in equipment or staffing as needed. In addition, as discussed above, more wet avalanches are to be expected, with higher risk and activity at higher elevations. This puts mountain road segments and those who are traveling along them at higher risk of avalanches.

This effort should also involve alternative transportation providers, to ensure these entities are adapting mitigation strategies to maintain bus and rail service in changing winter conditions.

This effort will also include monitoring high hazard avalanche areas, defined as those where damage to standard wood-frame structures and/or burying of automobiles is likely. According to the Nevada County Safety Element, identified high hazard areas within Nevada County include portions of the Donner Lake, Tahoe-Donner, and Soda Springs areas. This effort is particularly important given the predicted instability of snow conditions below 6,000 feet.

M.8: Coordinate with PG&E to prioritize electrical pole clearing and maintenance

Concepts qualified as maintenance activities are indicated beginning with the letter "M" followed by the strategy number.

Type of Strategy	Proposed Lead Agency	Additional Agencies
Hardening	PG&E	Public Works Departments

Give that the Sierra region is ranked second among all of PG&E's regions for risk, as determined by the number of top 1-3% Circuit Protection Zone (CPZ) (29 within the region), it would be wise to monitor PG&E's planned maintenance activities (as detailed in **W.2: Prioritize electrical pole clearing and maintenance**).

In the near-term, NCTC and partner agencies should monitor the PG&E's Electric Undergrounding Program, including the two Rule 20A queue projects within the County, to understand planned project improvements and any potential local project work that could further buffer against fire risk (see **W.3: Implement an aggressive electrical undergrounding plan**). An added benefit of undergrounding is the minimization of risk associated with changes in snowpack and increased maintenance needs due to downed electrical poles.

Implementation

Funding Opportunities

Many of the adaptation strategies outlined above could be aided or funded by grant opportunities that are currently or recurrently available from federal or state government agencies.

California Agencies

CAL FIRE

Fire Prevention Grants Program

Funding focuses on implementing wildfire prevention projects in fire threatened areas with a focus on protecting people, structures and communities. The grant funds hazardous fuel removal, fire prevention public education, fire prevention and wildfire safety planning and defensible space inspections. Eligible entities include nonprofits, local agencies, Tribal Governments, Fire Safe Councils, and resource conservation districts.

Typical Application Timeline (as funding allows): Annual funding cycle with applications due in the winter.

Details: https://www.caclimateinvestments.ca.gov/fire-prevention-grants

Forest Health Grant

This grant program is focused on active restoration and reforestation activities aimed at providing for more resilient and sustained forests while also mitigating climate change, protecting communities from fire risk, strengthening rural economies and improving California's water and air. The grant funds fuels reduction, prescribed fire, pest management, reforestation and biomass utilization. Eligible applicants include local, state, and federal public agencies, nonprofits, tribal governments, universities, special district and industrial and nonindustrial private forest landowners.

Typical Application Timeline (as funding allows): Annual funding cycle with applications due in the spring.

Details: https://www.fire.ca.gov/grants/forest-health-grants

Rural Fire Capacity Grant

This grant program is focused on funding rural communities (local fire departments serving a population of 10,000 or less). The grant funds firefighting, training, communications and safety equipment for department's volunteer firefighters. Eligible applicants include nonprofits, public agencies and tribal governments.

Typical Application Timeline (as funding allows): Annual funding cycle with applications due in the spring.

Details: https://www.fire.ca.gov/programs/fire-protection/cooperative-efforts

Urban & Community Forestry Grants

This grant program offers up to $23 million for urban forestry programs (including forest expansion, maintenance, and workforce development). Intended project benefits include reduced greenhouse gas emissions, increased water supply, clean air and water, reduced energy use, flood and storm water management, recreation, urban revitalization, improved public health, and producing useful products such as bio-fuel, clean energy, high quality

wood and job creation. Eligible applicants must be city, a county, a qualifying district or a non-profit. The project area must be in an urban area or immediately adjacent to an urban area. For 2021/2022, 75% of grant funding focused on projects meeting the ARB criteria for being located within AB 1550 disadvantaged communities.

Typical Application Timeline (as funding allows): Annual funding cycle with applications due in the summer.

Details: https://www.fire.ca.gov/grants/urban-and-community-forestry-grant-programs

CALIFORNIA FIRE FOUNDATION

Fire Prevention & Preparedness

Funding priority is extended to projects focused on prevention, preparedness, relief or recovery. The 2022 cycle focused on communities in Southern California Edison's service territory. Grant funding categories include: Vegetation Mitigation and Fuels Reduction; Education, Planning or Community Outreach Campaigns; Personal Protective Equipment; Specialized Firefighting Equipment and First Responder Training. Eligible applications include fire departments, firefighter associations, fire safe councils, and other community organizations. The grant request must be $15,000 or less.

Typical Application Timeline (as funding allows): Annual, with applications due in Spring of each year.

Details: https://www.cafirefoundation.org/programs/fireprevention

CALIFORNIA FIRE SAFE COUNCIL

State Fire Assistance Grant

USFS funding of up to $1,175,000 is available for use on non-federal lands. Funding is awarded to non-profit organizations, home/property owners associations, Native American tribes, resource conservation districts, towns, cities and counties, institutions of higher education, joint-powers authorities, special districts, school districts, counties, state agencies and for-profit companies. Grant funding is eligible to assist with fuel hazard mitigation treatments, community hazard mitigation planning, as well as prevention, mitigation and educational programs.

Typical Application Timeline (as funding allows): The call for projects occurs in the spring.

Details: https://cafiresafecouncil.org/grants-and-funding/2022-sfa-grant-opportunity

CALIFORNIA TRANSPORTATION COMMISSION

Active Transportation Program (ATP)

The goals of the ATP include increasing the number of walking and bicycling trips, enhancing safety, assisting agencies with meeting with meeting their climate goals and bolstering public health. ATP funds are distributed as follows: 40% to Metropolitan Planning Organizations (MPO) in urban areas with populations greater than 200,000, 10% to small urban and rural areas with populations of 200,000 or less, 50% to projects competitively awarded by the Commission on a statewide basis, and $4 million per year from the Road Maintenance and Rehabilitation Account to the California Conservation Corps for active transportation projects.

Typical Application Timeline (as funding allows): Funding cycle every two years (even years) with applications due in the summer and funding awards adopted the following spring.

Details: https://catc.ca.gov/programs/active-transportation-program

Local Highway Bridge Program (HBP)

This safety focused program funnels federal aid to local agencies in order to both fix deficient, locally-owned bridges on public highways and perform maintenance. The CTC annually sub-allocates the funds to Caltrans, who produces program lists that are forwarded to MPOs for inclusion in the Federal Statewide Transportation Improvement program (FSTIP).

Typical Application Timeline (as funding allows): The programming of HBP projects is managed through a 15-year plan. This multi-year plan provides 4-years of HBP funding to be programmed in the FSTIP and 11-years of planning.

Details: https://dot.ca.gov/programs/local-assistance/fed-and-state-programs/highway-bridge-program

Local Streets and Roads Program (LSRP)

Funding is awarded annually and eligible to cities and counties that have prepared and submitted a project list to the Commission. Funding is available for basic road maintenance and rehabilitation, safety projects, complete street components, traffic control devices and to satisfy match requirement.

Typical Application Timeline (as funding allows): Project lists are due to the commission in July and the eligible list of cities/counties is adopted in October.

Details: https://catc.ca.gov/programs/sb1/local-streets-roads-program

Solutions for Congested Corridors Program (SCCP)

State-wide competitive program amounting to $250 million in funding annually. Eligible agencies include regional transportation planning agencies, county transportation commissions, and the California Department of Transportation (Caltrans). Projects must be part of a comprehensive corridor plan and include elements such as improvements to state highways, local streets and roads, rail facilities, public transit facilities and bicycle and pedestrian facilities.

Typical Application Timeline (as funding allows): Two years of funding are programmed at a time. The last program closed in Summer 2020.

Details: https://catc.ca.gov/programs/sb1/solutions-for-congested-corridors-program

State Highway Operation and Protection Program (SHOPP)

Caltrans is tasked with preparing the SHOPP, which is a "fix-it-first" program focused on preservation, emergency repairs, safety improvements on operations enhancements on state highways. Caltrans shares a draft project list with Regional Transportation Planning Agencies (RTPA's) for their review before final submittal.

Typical Application Timeline (as funding allows): The 2022 SHOPP will be adopted in April and cover four years of programmed projects.

Details: https://catc.ca.gov/programs/sb1/solutions-for-congested-corridors-program

State Transportation Improvement Program (STIP)

STIP is a multi-year capital improvement program of transportation projects on and off the State Highway System. Caltrans and regional planning agencies prepare transportation improvement plans after the amount of funding is decided. Local agencies work through their Regional Transportation Planning Agency, County Transportation Commission, or Metropolitan Planning Organization to nominate projects.

Typical Application Timeline (as funding allows): STIP programming occurs every two years, with the cycle beginning in the summer of odd numbered years and the STIP adopted in the spring of even numbered years.

Details: https://dot.ca.gov/programs/local-assistance/fed-and-state-programs/state-transportation-improvement-program

CALTRANS

FTA Section 5310 - Enhanced Mobility of Seniors and Individuals with Disabilities Program

The goal of this program is to improve the mobility of seniors and individuals with disabilities by removing barriers to transportation services and expanding mobility options available. The amount of available funding is approximately $18 Million. It provides grant funds for capital (vehicles and related equipment such as cameras, radios, scheduling software), mobility management (travel training, one stop call center) and operating expenses. Eligible public agencies include agencies where no private non-profits are readily available to provide service and agencies that have been approved by the State to coordinate transportation services.

Typical Application Timeline (as funding allows): The call for Projects is held every two to three years.

Details: https://dot.ca.gov/programs/rail-and-mass-transportation/enhanced-mobility-of-seniors-and-individuals-with-disabilities-program-fta-5310

Rural Transit & Intercity Bus - FTA Section 5311

Funding is focused on those public transit services in non-urbanized areas with populations under 50,000. The program supports both maintenance of existing public transportation and the expansion of those services.

Typical Application Timeline (as funding allows): The FTA apportions formula funds to each state on an annual basis. The California Department of Transportation, Division of Rail and Mass Transportation (DRMT) is the designated grantee for California.

Details: https://dot.ca.gov/programs/rail-and-mass-transportation/rural-transit-intercity-bus-fta-section-5311-and-5311f

State of Good Repair

This program's goal is to "rehabilitate and modernize California's existing local transit systems." Annual funding is approximately $105 million and is made available for eligible transit maintenance, rehabilitation, and capital projects. Eligible applications include transportation planning agencies, county transportation commissions, and Metropolitan Transit Systems.

Typical Application Timeline (as funding allows): First, regional entities establish their own deadlines by which local transit operators must submit projects. Final project lists are due to Caltrans September 1.

Details: https://dot.ca.gov/programs/rail-and-mass-transportation/state-transit-assistance-state-of-good-repair

NCTC

Transportation Development Act (TDA)

Funding sourced through this act focuses on public transportation, in compliance with regional transportation plans (RTPs). The TDA includes two funding sources: the Local Transportation Fund (LTF) and the State Transit Assistance (STA) fund. The TDA funds a wide variety of transportation programs, including planning and programming activities, pedestrian and bicycle facilities, community transit services and public transportation projects.

Typical Application Timeline (as funding allows): Distribution occurs each fiscal year.

Details: https://dot.ca.gov/programs/rail-and-mass-transportation/transportation-development-act

Federal Agencies

FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA)

Assistance to Firefighters Grants Program

Includes grants of three varieties: Assistance to Firefighters, Staffing for Adequate Fire and Emergency Response and Fire Prevention & Safety Grants. Funded items include firefighting equipment, protective gear, emergency vehicles, training, recruitment and retention activities and safety-focused projects. Eligibility is limited to fire departments, state fire training academies and emergency medical service organizations.

Typical Application Timeline (as funding allows): The call for projects occurs in December of each year.

Details: https://www.fema.gov/grants/mitigation/post-fire

Building Resilient Infrastructure and Communities (BRIC)

BRIC is a pre-disaster hazard mitigation program for projects that reduce the risks posed by disasters and natural hazards. BRIC focuses on proactive investments that showcase design innovation and creative partnerships. Funding is available to states, local communities, tribes and territories, with a requirement that applicants have a FEMA-approved State or Tribal Hazard Mitigation Plan. For FY 2021, FEMA distributed up to $1 billion through the program.

Typical Application Timeline (as funding allows): The call for projects occurs in the Spring.

Details: https://www.fema.gov/grants/mitigation/building-resilient-infrastructure-communities

Hazard Mitigation Grant Program (HMGP)

Provides funding to state, local, tribal, and territorial governments to rebuild, increase resilience and reduce risk. The HMGP funds a variety of relevant mitigation projects, such as utility retrofits to increase resistance to disasters, flood risk reduction projects and slope stabilization projects. Funding was recently allocated with a focus on climate change and the impacts of the COVID-19 pandemic.

Typical Application Timeline (as funding allows): Funding is only available after a presidentially declared disaster.

Details: https://www.fema.gov/grants/mitigation/hazard-mitigation

HMGP Post Fire

Post Fire funding focuses on reducing secondary hazards following wildfire. States, tribes and territories affected by fires which resulted in a Fire Management Assistance Grant (FMAG) declaration on or after October 5, 2018, are eligible. There are five mitigation project types which are the grant's focus – wildfire mitigation (defensible space, fuels reduction burned tree removal, etc.), 5-percent initiative (installing warning signs), infrastructure retrofits (hardening water systems), soil and slope stabilization (erosion barriers, reseeding, installing debris traps, etc.) and flood prevention (modifying culverts, adding emergency spillways, etc.).

Typical Application Timeline (as funding allows): The application period opens with the state or territory's first FMAG declaration of the fiscal year and closes six months after the end of that fiscal year. Application extensions may be requested.

Details: https://www.fema.gov/grants/mitigation/post-fire

FEDERAL HIGHWAY ADMINISTRATION (FHWA)

California Federal Lands Access Program (FLAP)

Funds improvements to state, county, tribal, and local government owned or maintained transportation facilities that provide access to, are adjacent to, or are located within federal lands. Applications are competitive and require local funding matching.

Typical Application Timeline (as funding allows): The Programming Decision Committee will meet in 2022 to determine when to hold the next call for projects.

Details: https://highways.dot.gov/federal-lands/programs-access/ca

US DEPARTMENT OF TRANSPORTATION

Rebuilding American Infrastructure with Sustainability and Equity (RAISE) Discretionary Grant Program

The RAISE Discretionary Grant program provides an opportunity for US DOT to invest in road, rail, transit and port projects that promise to achieve national objectives. The grant program is a competitive discretionary fund for multi-modal, multi-jurisdictional projects that are more difficult to support through traditional DOT programs. State, local, and regional agencies are eligible.

Typical Application Timeline (as funding allows): The call for projects occurs in the spring.

Details: https://www.transportation.gov/RAISEgrants/about

US FOREST SERVICE (USFS)

Community Forest Program (CFP)

The CFP Program provides financial assistance to tribal entities, local governments, and qualified conservation non-profit organizations to acquire and establish community forests that provide community benefits. Community benefits include economic benefits through active forest management, clean water, wildlife habitat, educational opportunities, and public access for recreation.

Typical Application Timeline (as funding allows): The call for projects occurs annually, with applications due to State Foresters or equivalent Tribal officials in January.

Details: https://www.fs.usda.gov/managing-land/private-land/community-forestv

Landscape Scale Restoration (LSR) Competitive Grant Program

The LSR Program is a grant program focused on collaborative, science-based restoration of priority forest landscapes, furthering priorities identified in State Forest Action Plans. Desired outcomes include reduced wildfire risk; improved fish and wildlife habitats, including for threatened and endangered species; maintained or improved water quality and watershed function; mitigated invasive species, insect infestation, and disease; improved important forest ecosystems; and improved measures of ecological and economic benefits, including air quality, and soil quality and productivity. Eligible applicants include state forestry agencies/appropriate State agencies, units of local government, Indian tribes, non-profits, universities and Alaska Native Corporations.

Typical Application Timeline (as funding allows): The call for projects occurs annually opening in the summer and closing in the fall.

Details: https://www.thewflc.org/landscape-scale-restoration-competitive-grant-program/fy-2022-landscape-scale-restoration

Urban and Community Forestry Program

The program's cost share grant awards focus on challenges identified in the National Ten Year Urban and Community Forestry Action Plan (2016-2026). The most recent cycle amounted to $1,000,000 in available funding. Eligible entities include tribal organizations, State governments, County governments, Independent school districts, Public and State controlled institutions of higher education, Special district governments, Private institutions of higher education, City or township governments and Nonprofits.

Typical Application Timeline (as funding allows): The call for projects occurs at the end of the year with application due in Spring of the following year.

Details: https://www.fs.usda.gov/managing-land/urban-forests/ucf

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Appendix

Appendix A
Detailed Risk Assessment Maps

Landslide Exposure

Figure 51 Major roadways exposed to Class 7 or Higher Landslide Susceptibility, West

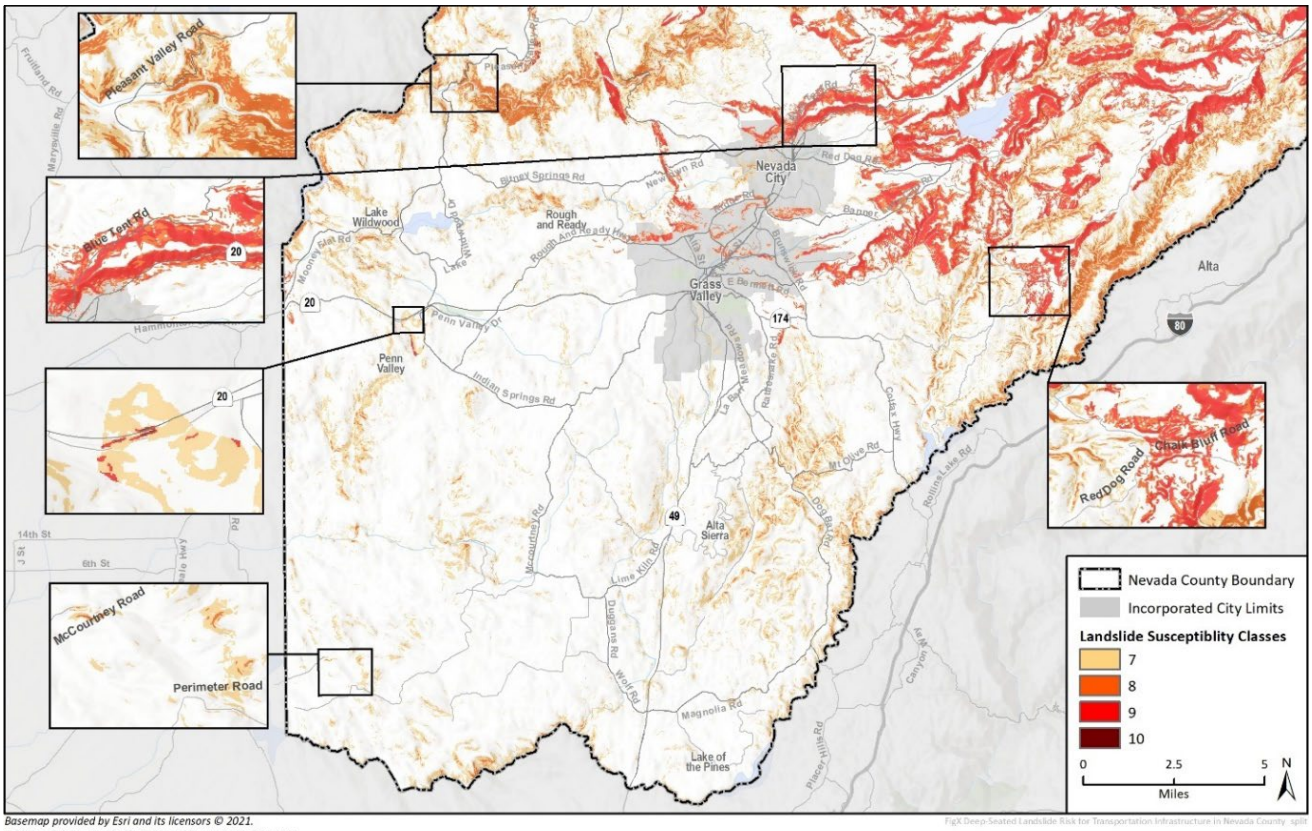
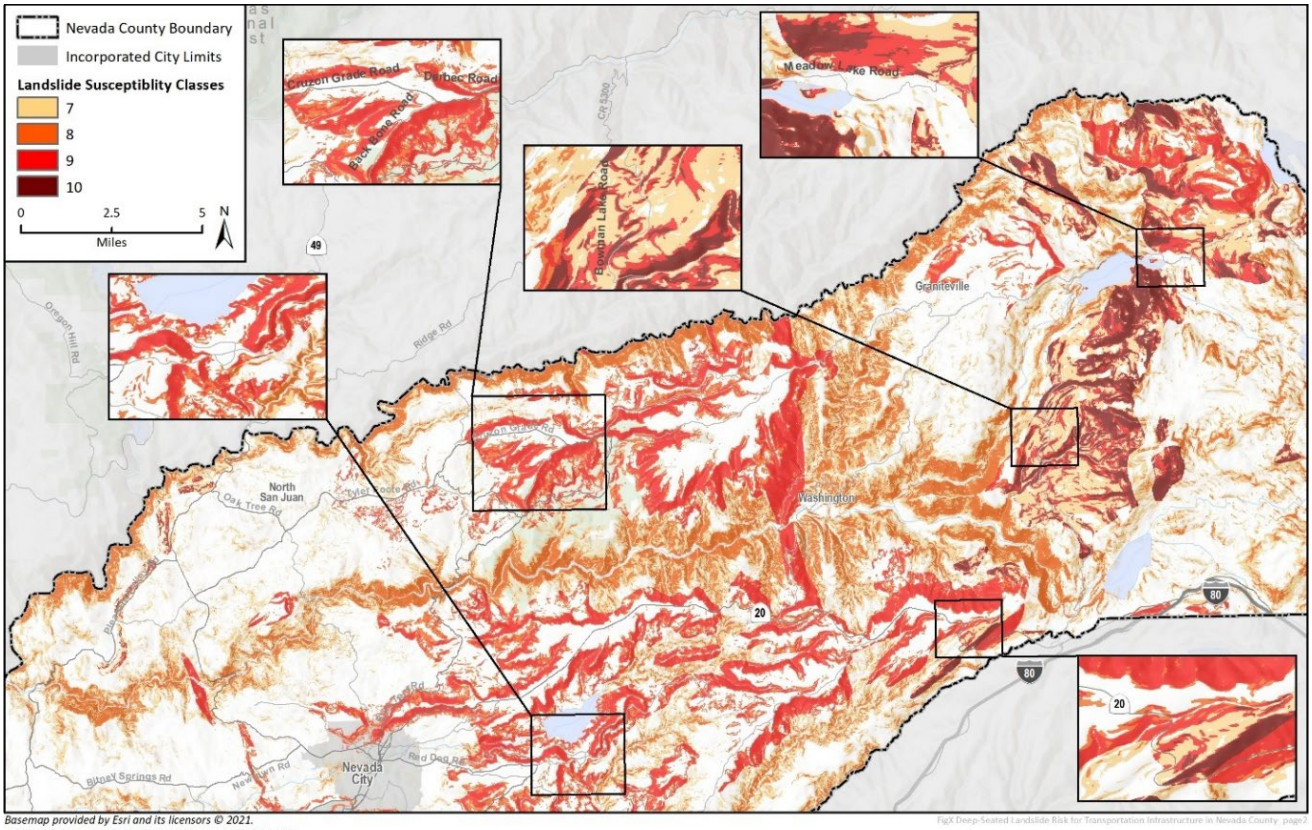
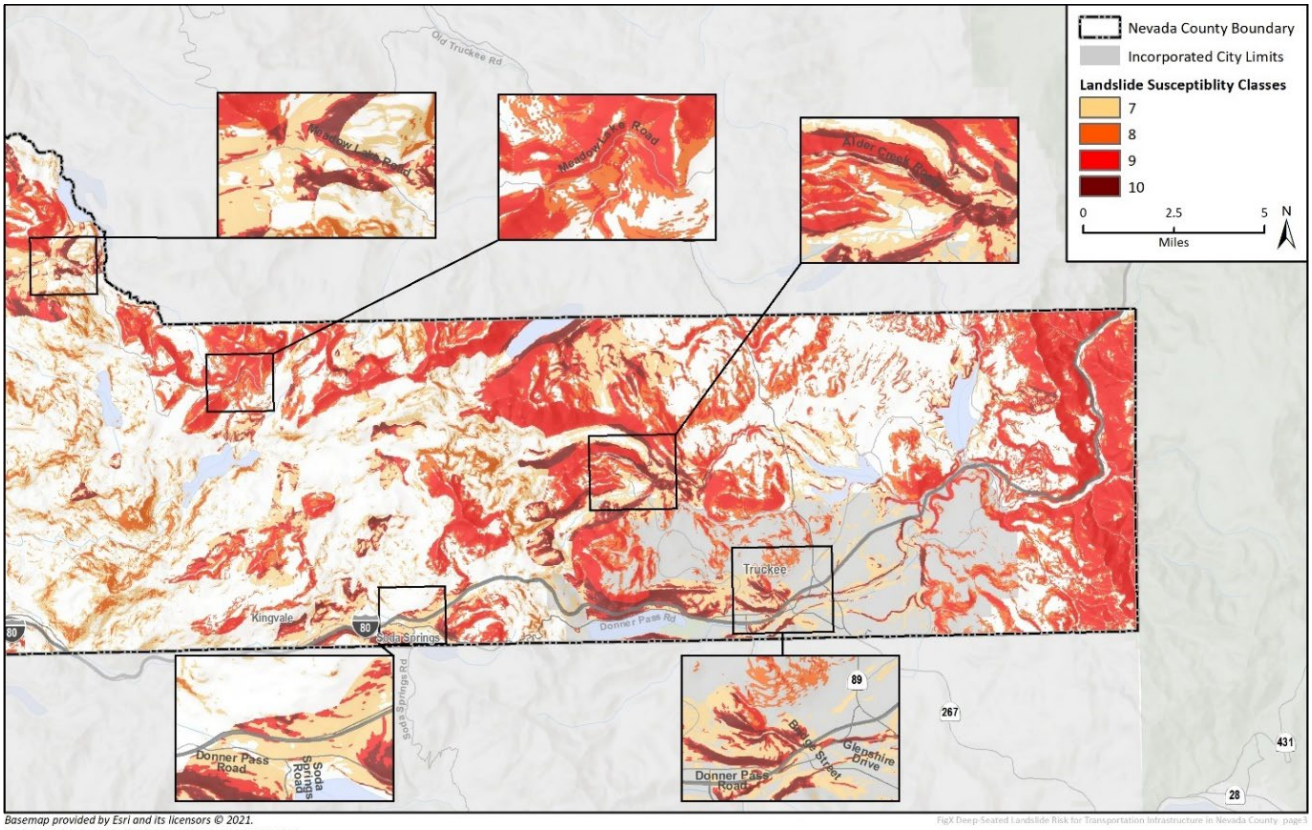


Figure 52 Major roadways exposed to Class 7 or Higher Landslide Susceptibility, Middle



Basemap provided by Esri and its licensors © 2021.
Additional data provided by Fehr and Peers, 2021; CGS,2021.

Figure 53 Major roadways exposed to Class 7 or Higher Landslide Susceptibility, East



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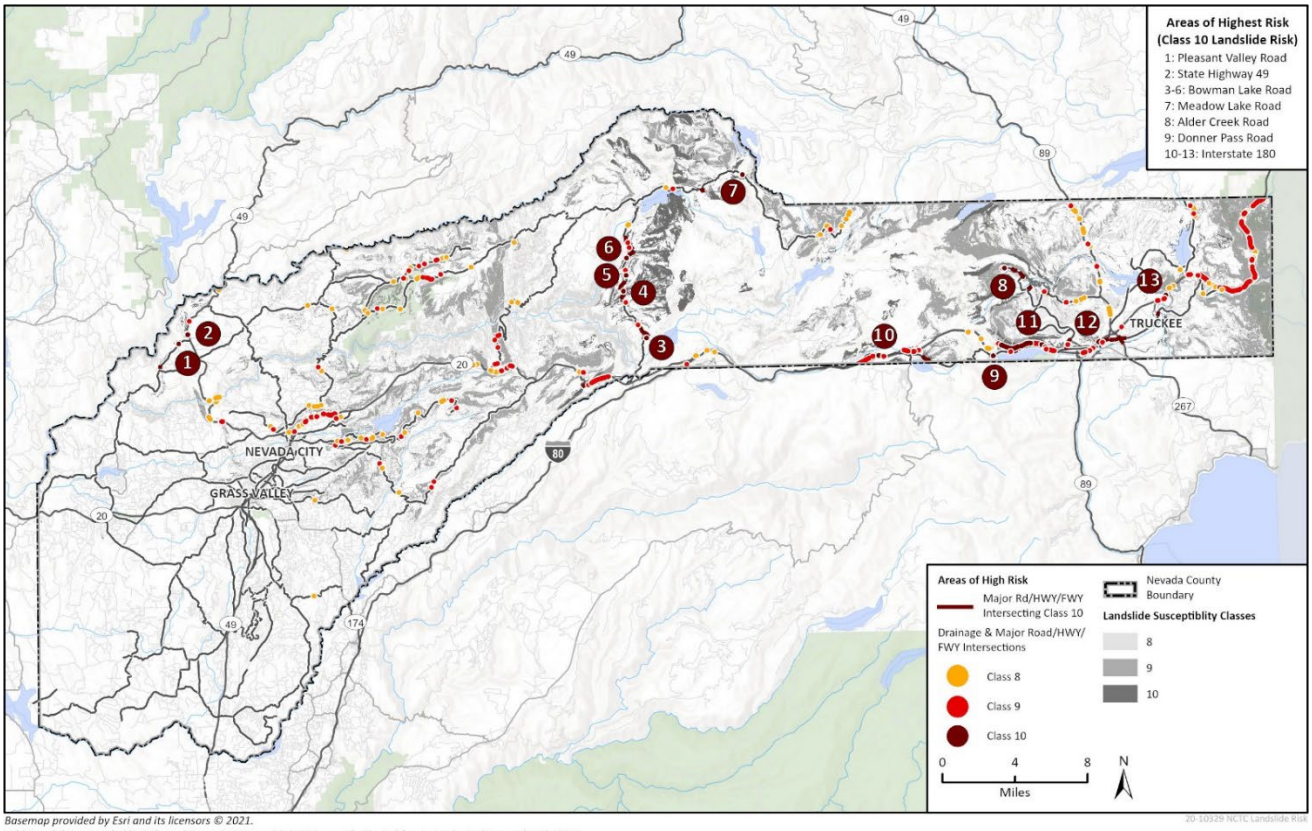
Additional data provided by Fehr and Peers, 2021; CGS,2021.

Landslide Risk Detailed Maps

Figure 54 Landslide Risk Associated with Extreme Precipitation in Nevada County



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Additional data provided by Fehr and Peers, 2021; Landslide Risk provided by California Geological Survey (CGS), 2021.

Figure 55 Pleasant Valley Rd Class 10 Landslide Risk

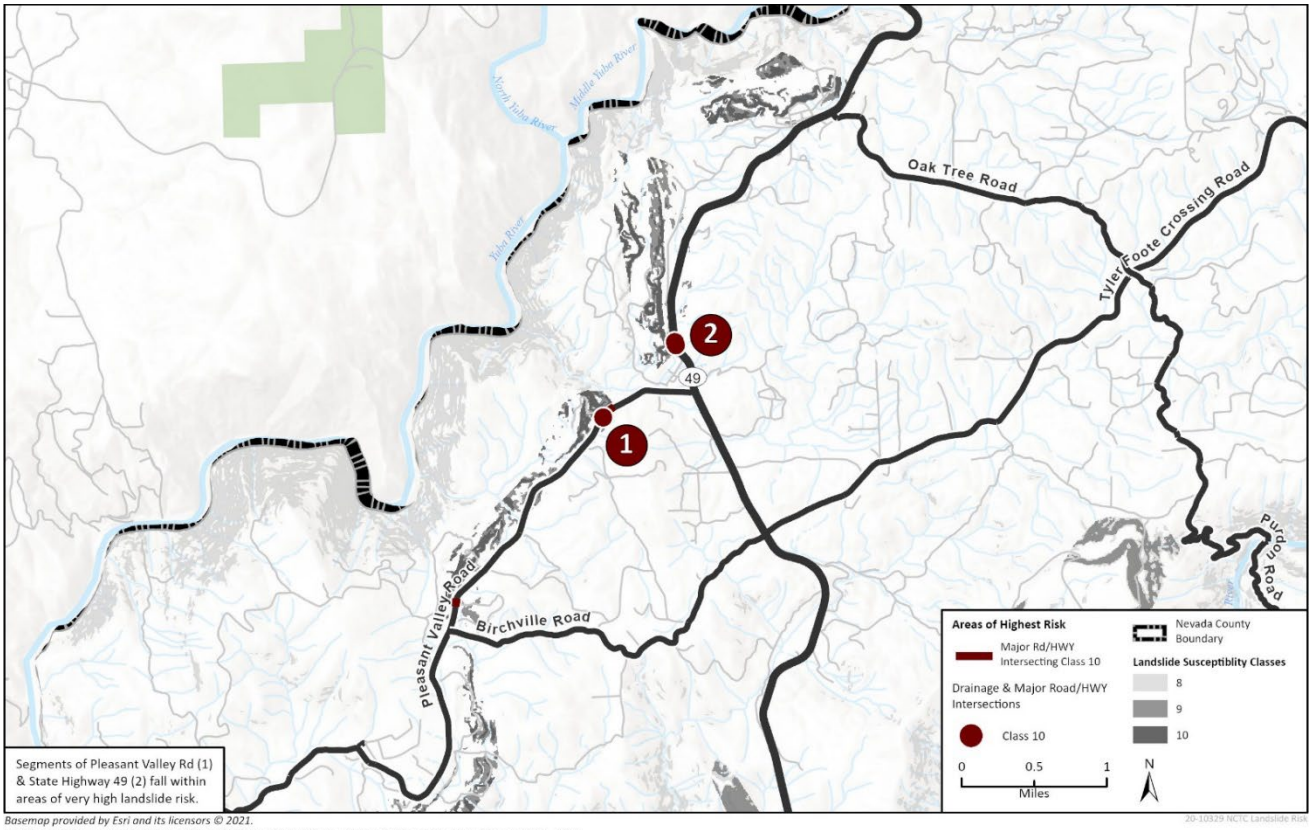
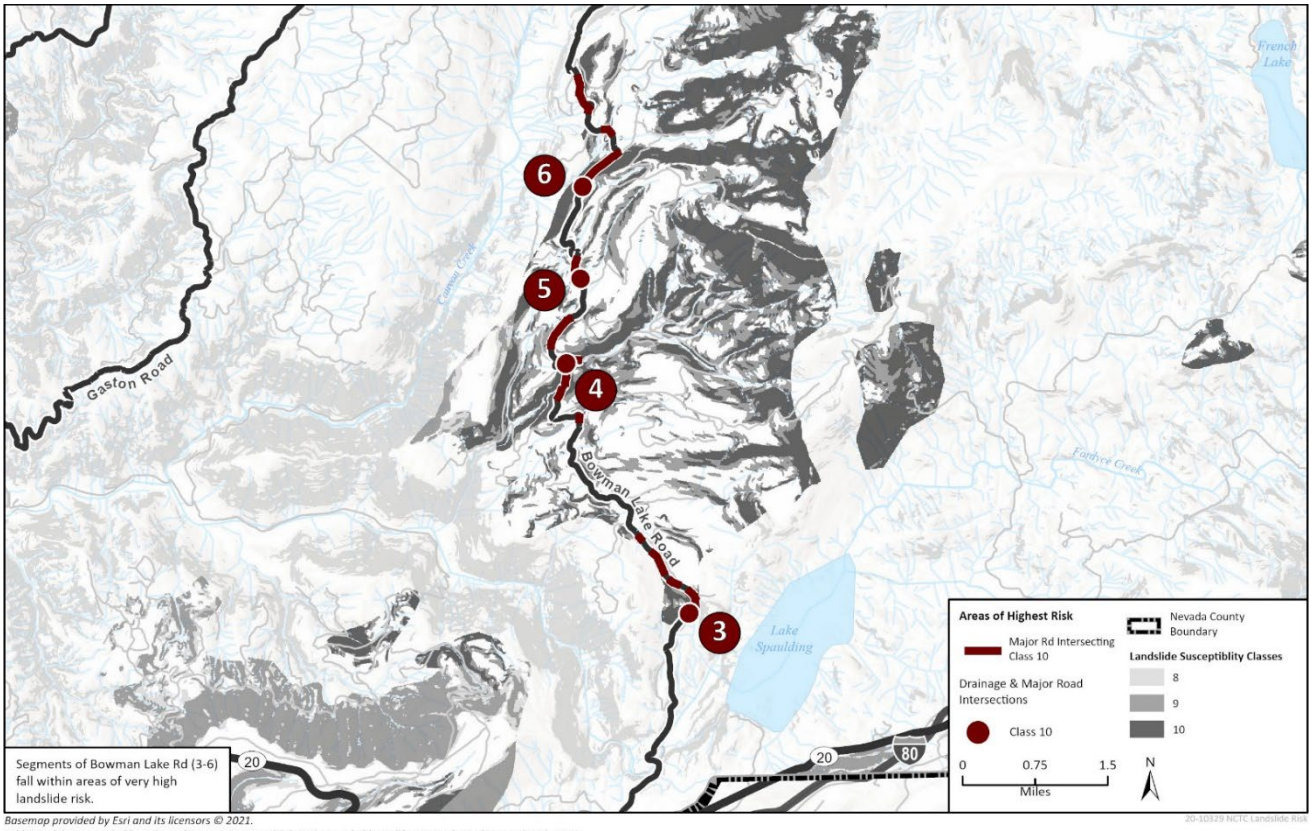
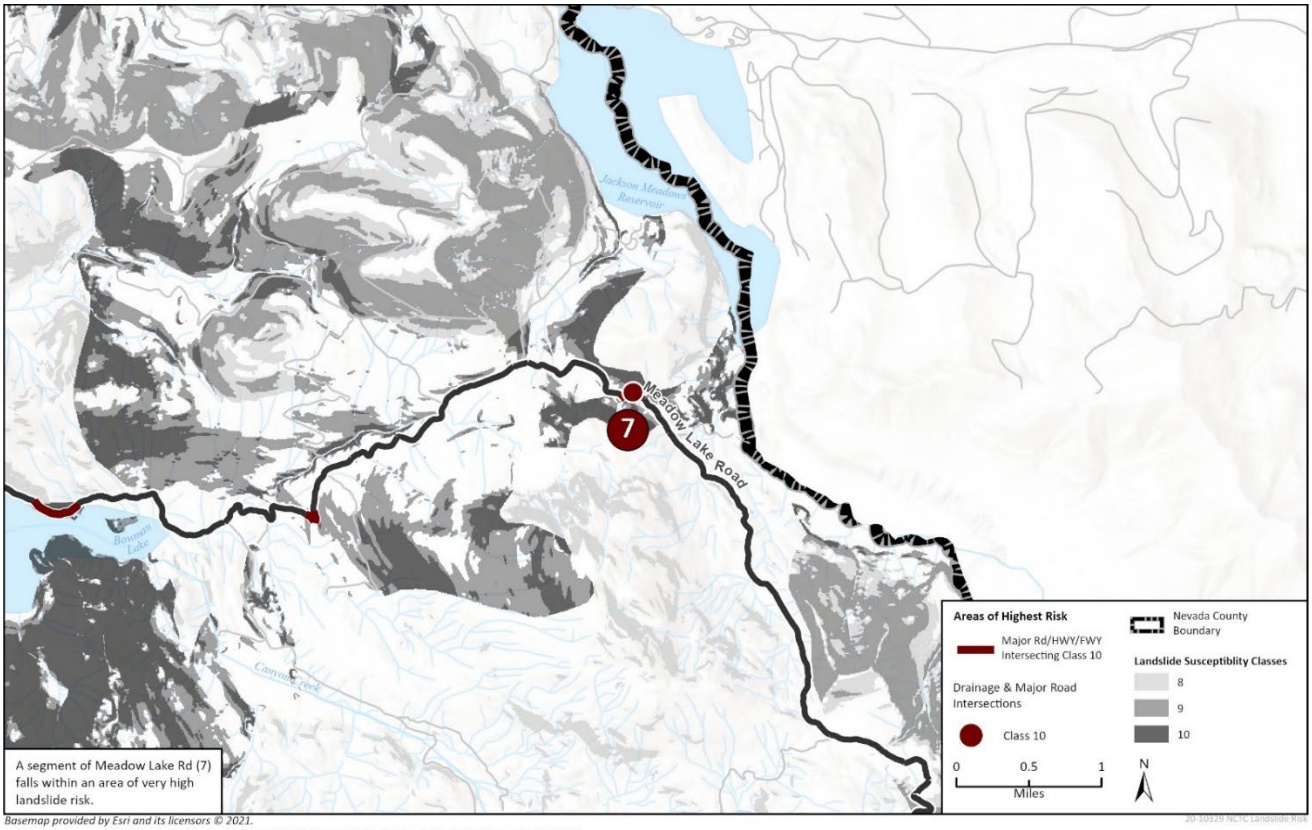


Figure 56 Bowman Lake Rd Class 10 Landslide Risk



Basemap provided by Esri and its licensors © 2021.
Additional data provided by Fehr and Peers, 2021; Landslide Risk provided by California Geological Survey (CGS), 2021.

Figure 57 Meadow Lake Rd Class 10 Landslide Risk



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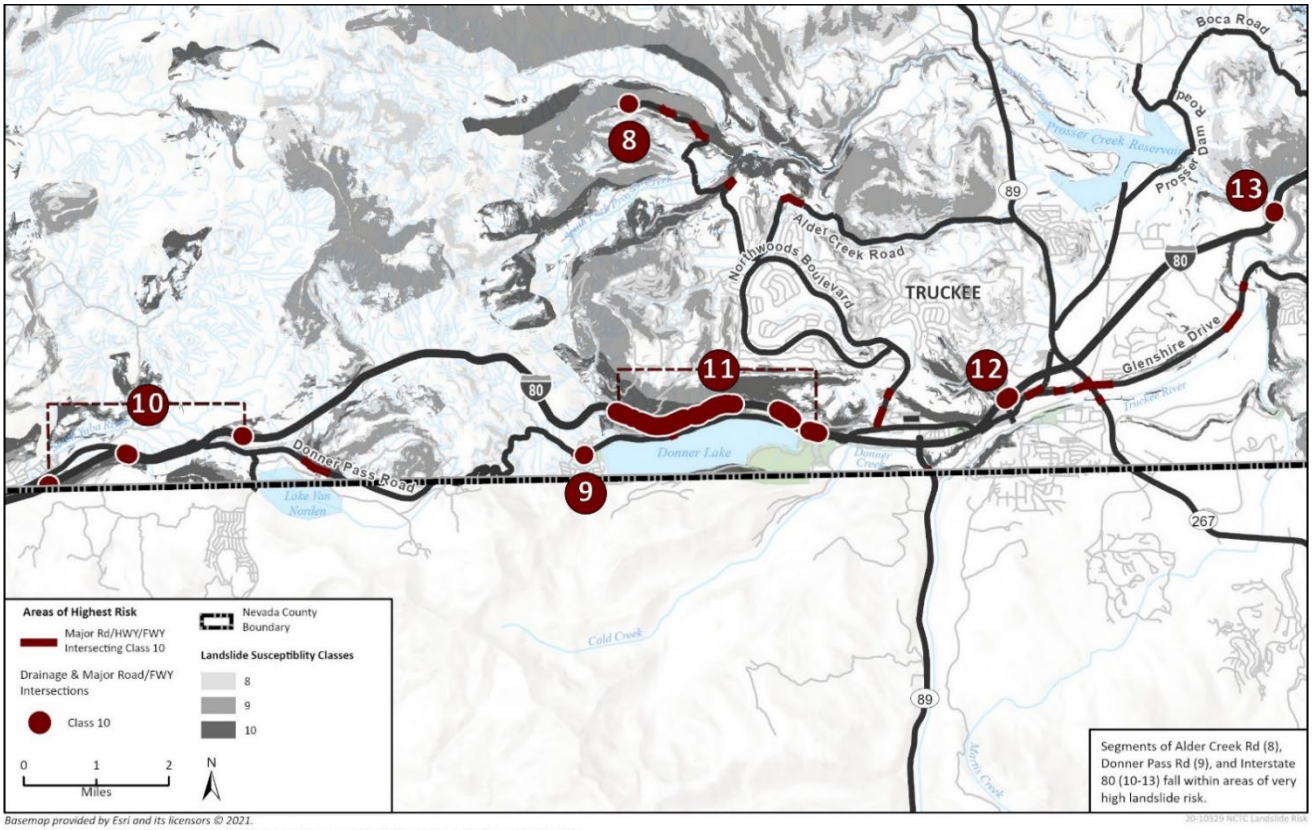
Additional data provided by Fehr and Peers, 2021; Landslide Risk provided by California Geological Survey (CGS), 2021.

Figure 58 Alder Creek, Donner Pass, I-80 Class 10 Landslide Risk



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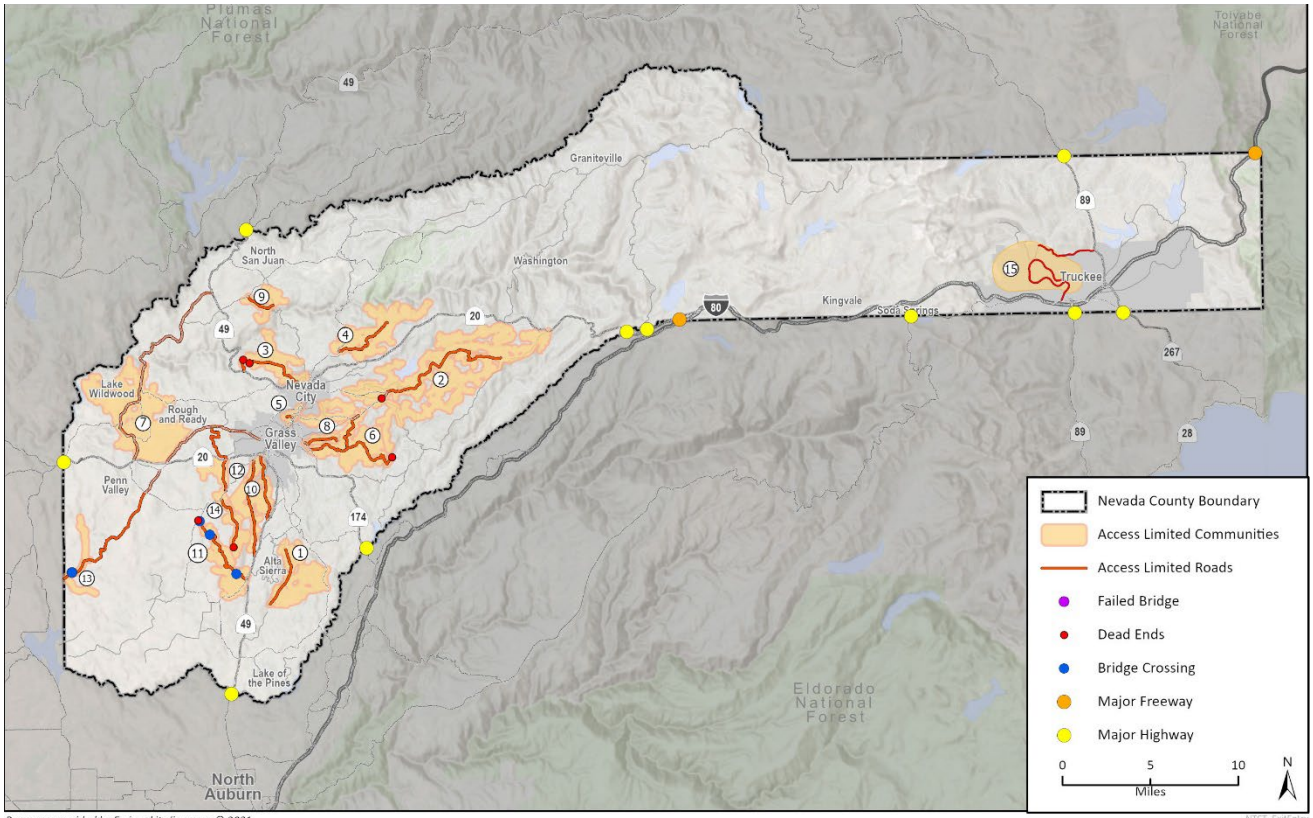
Additional data provided by Fehr and Peers, 2021; Landslide Risk provided by California Geological Survey (CGS), 2021.

Areas of Limited Ingress/Egress

Figure 59 Access Limited Roads and Communities



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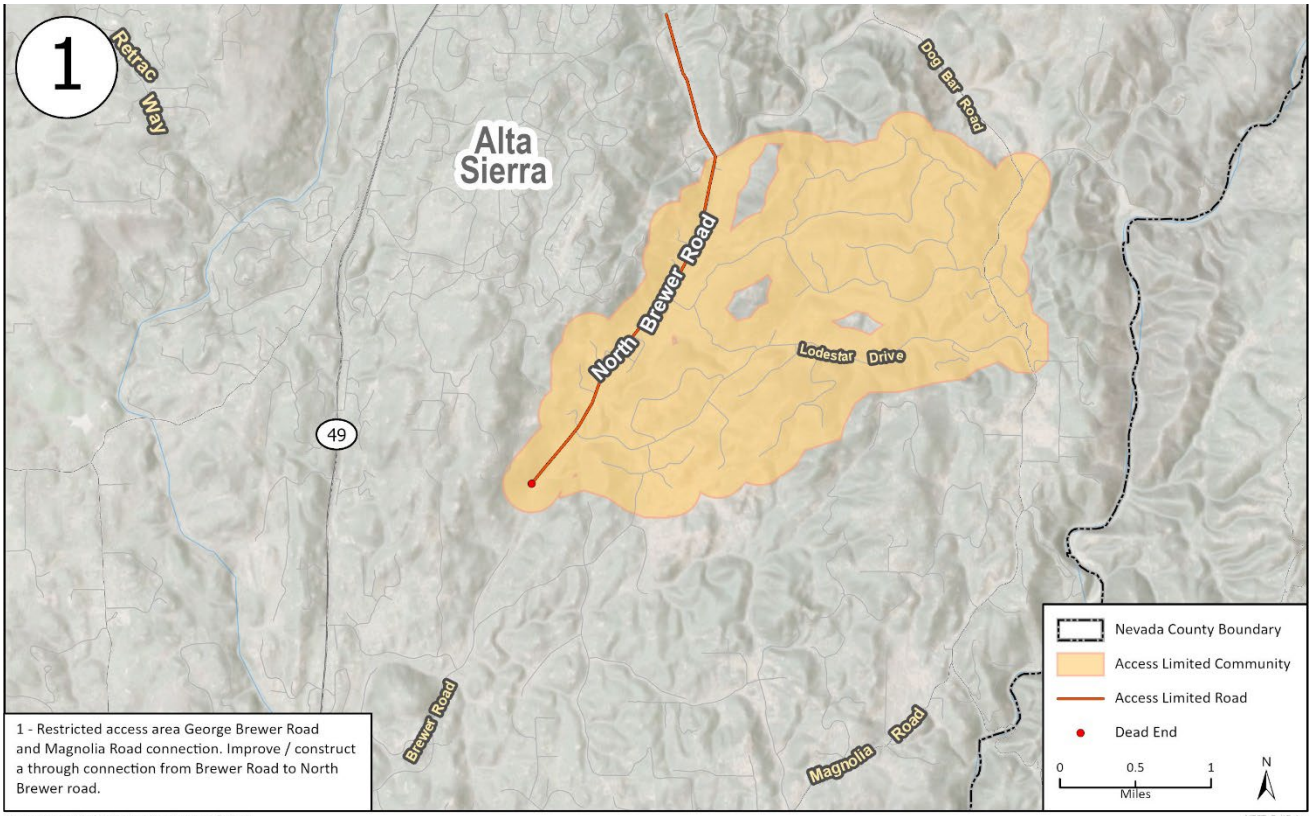
Additional data provided by Fehr and Peers, 2021.

Figure 60 Access Limited Community: North Brewer Road



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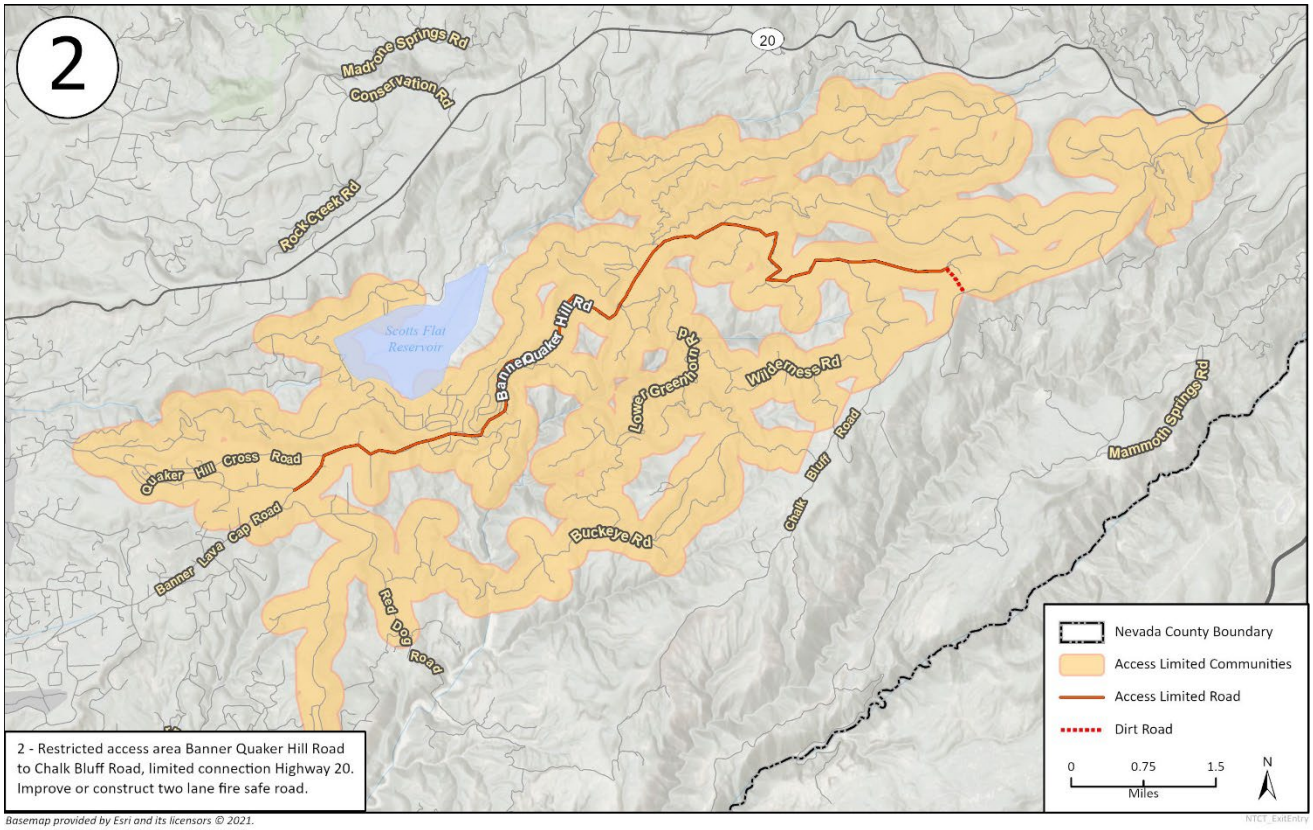
Additional data provided by Fehr and Peers, 2021.

Figure 61 Access Limited Community: Banner Quaker Hill Road



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Additional data provided by Fehr and Peers, 2021.

Figure 62 Access Limited Community: Cement Hill Road & Cedar Song Road

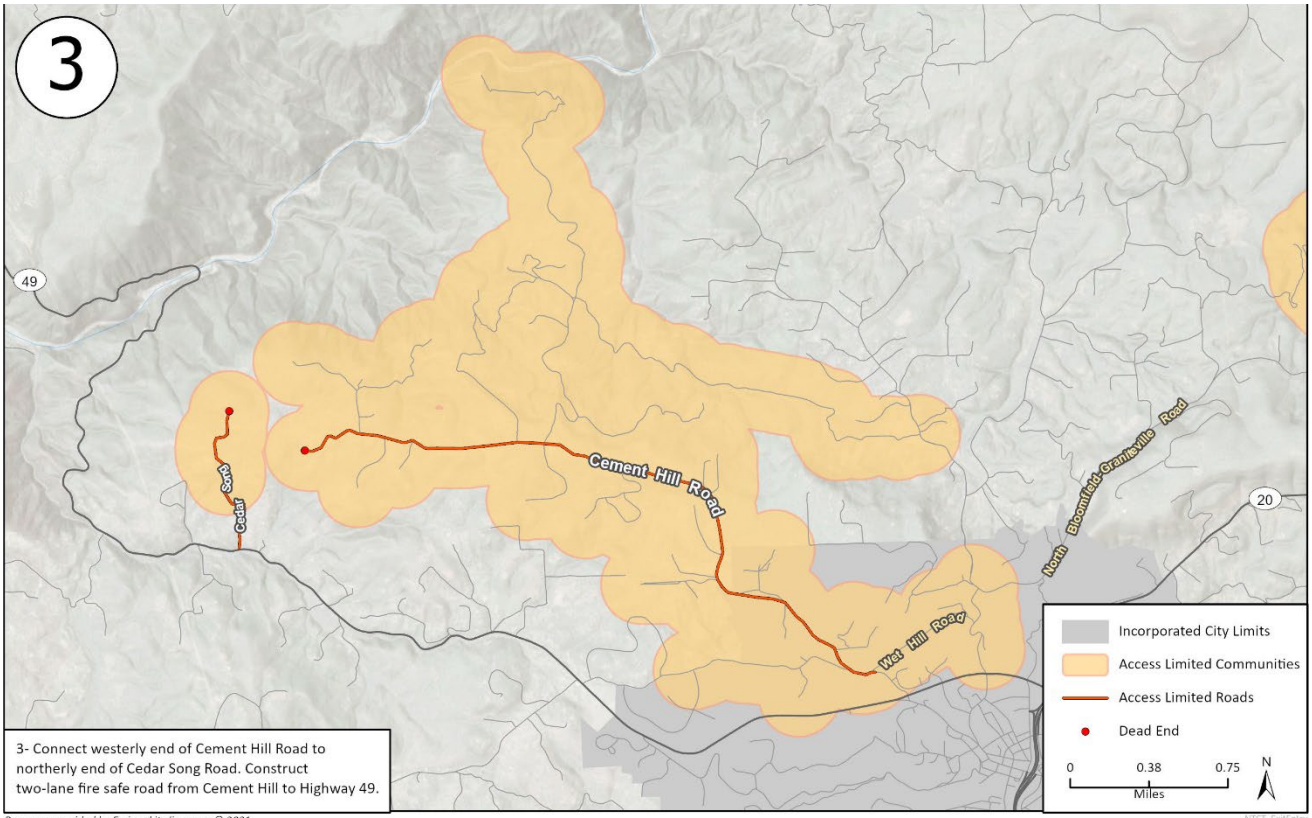

Figure 63 Access Limited Community: Cooper Road

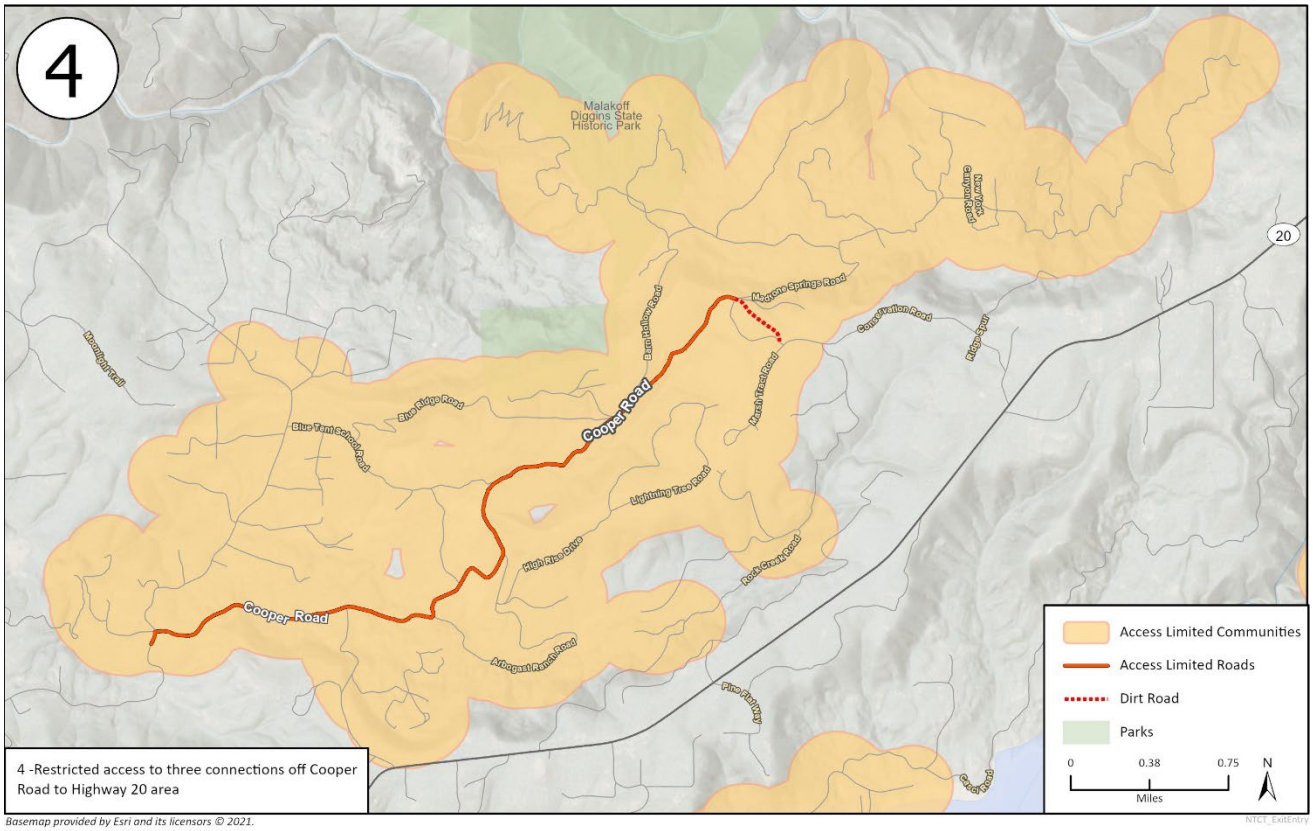

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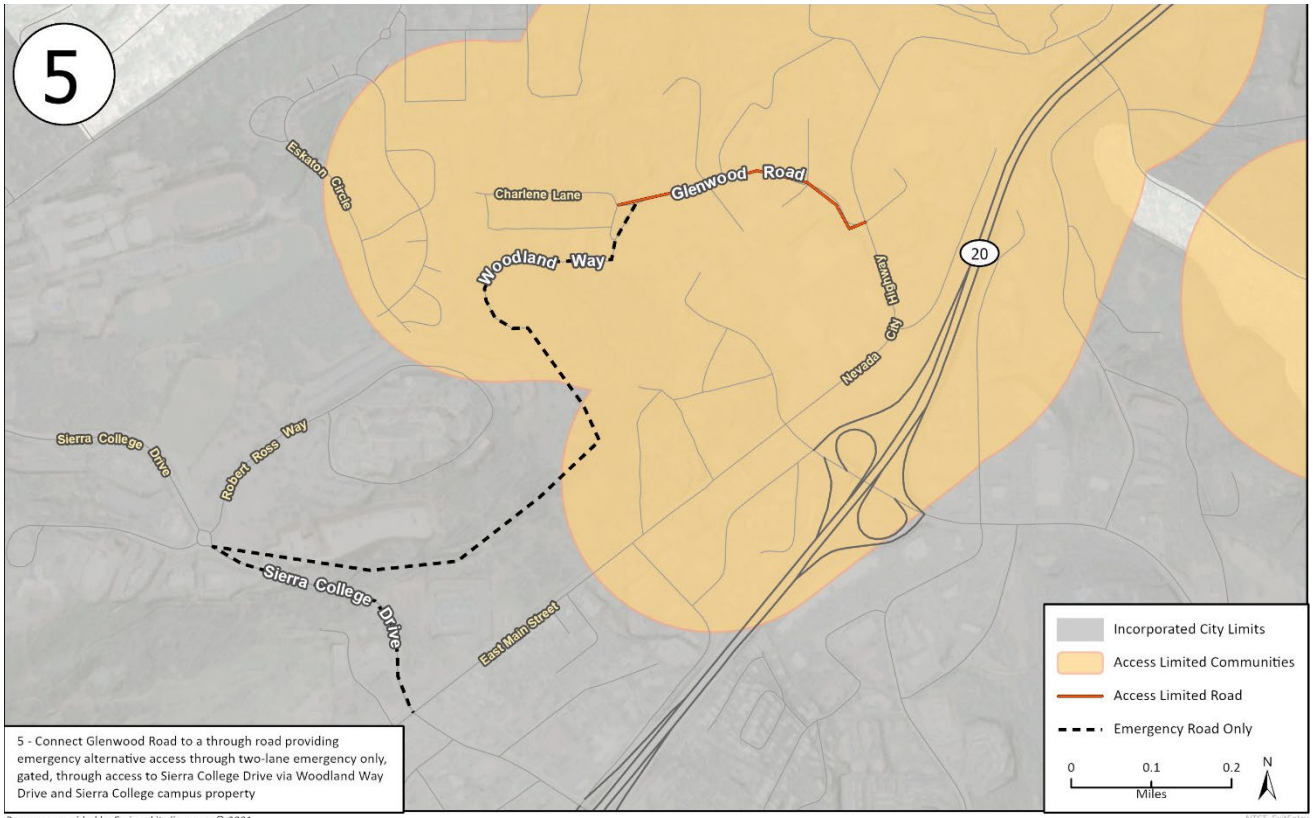
Figure 64 Access Limited Community: Glenwood Road



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Additional data provided by Fehr and Peers, 2021.

Figure 65 Access Limited Community: Greenhorn Road

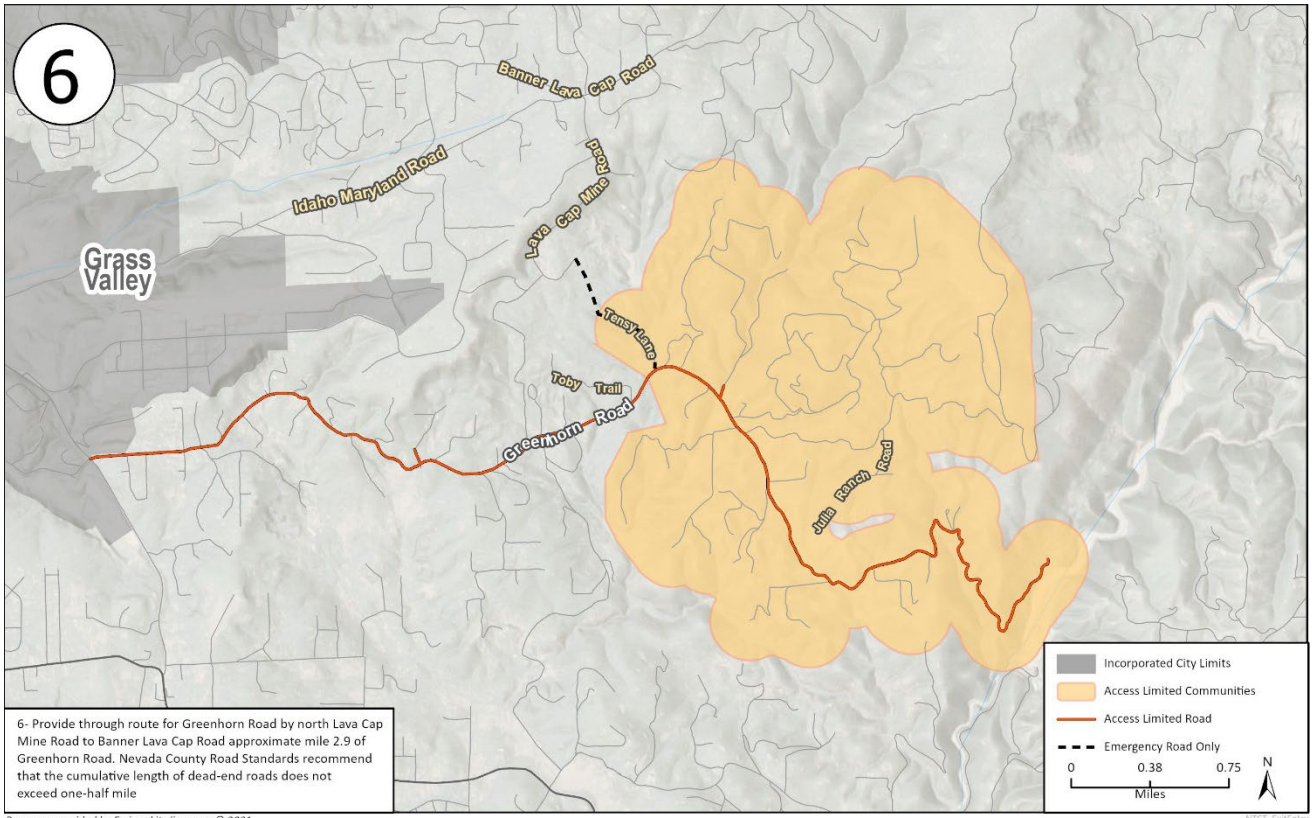

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Figure 66 Access Limited Community: Pleasant Valley Road & Rough and Ready Highway

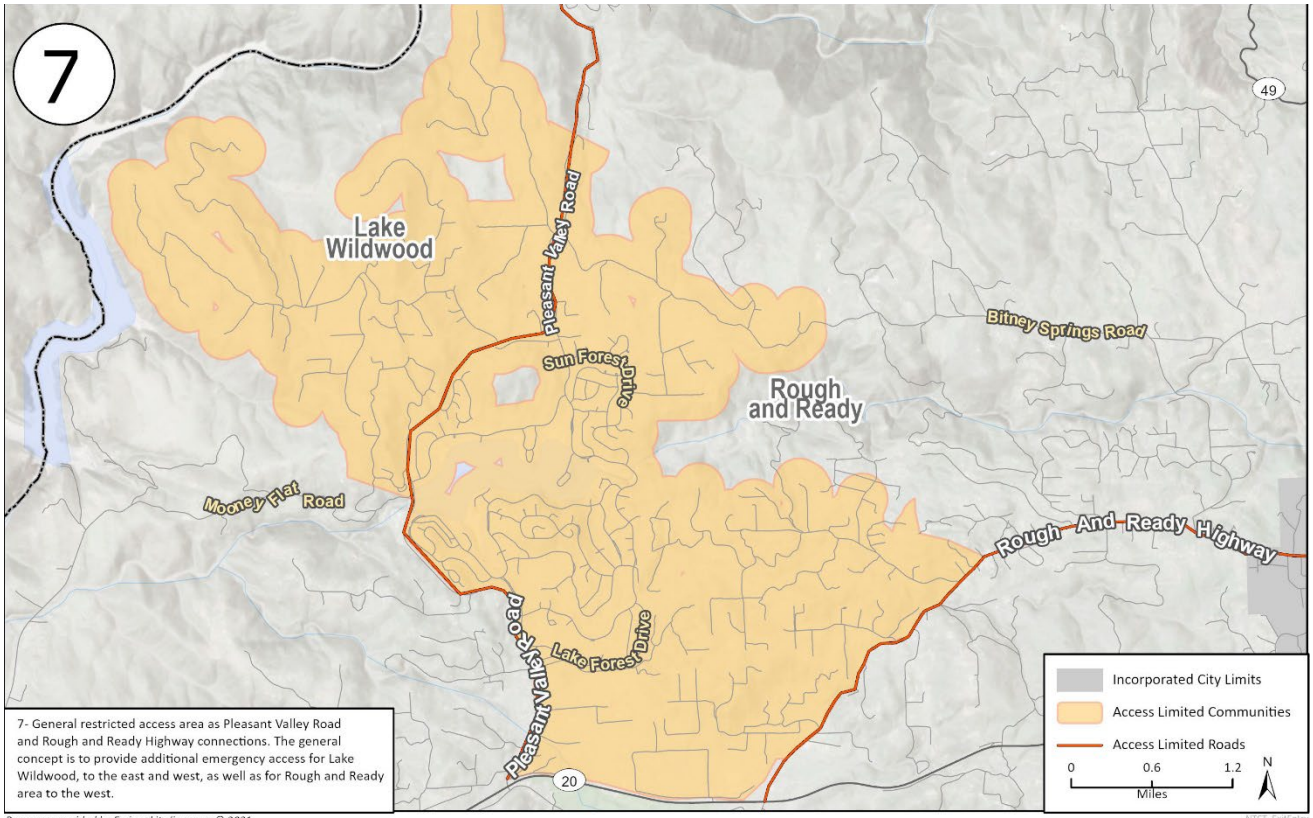

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Figure 67 Access Limited Community: Loma Rica Drive

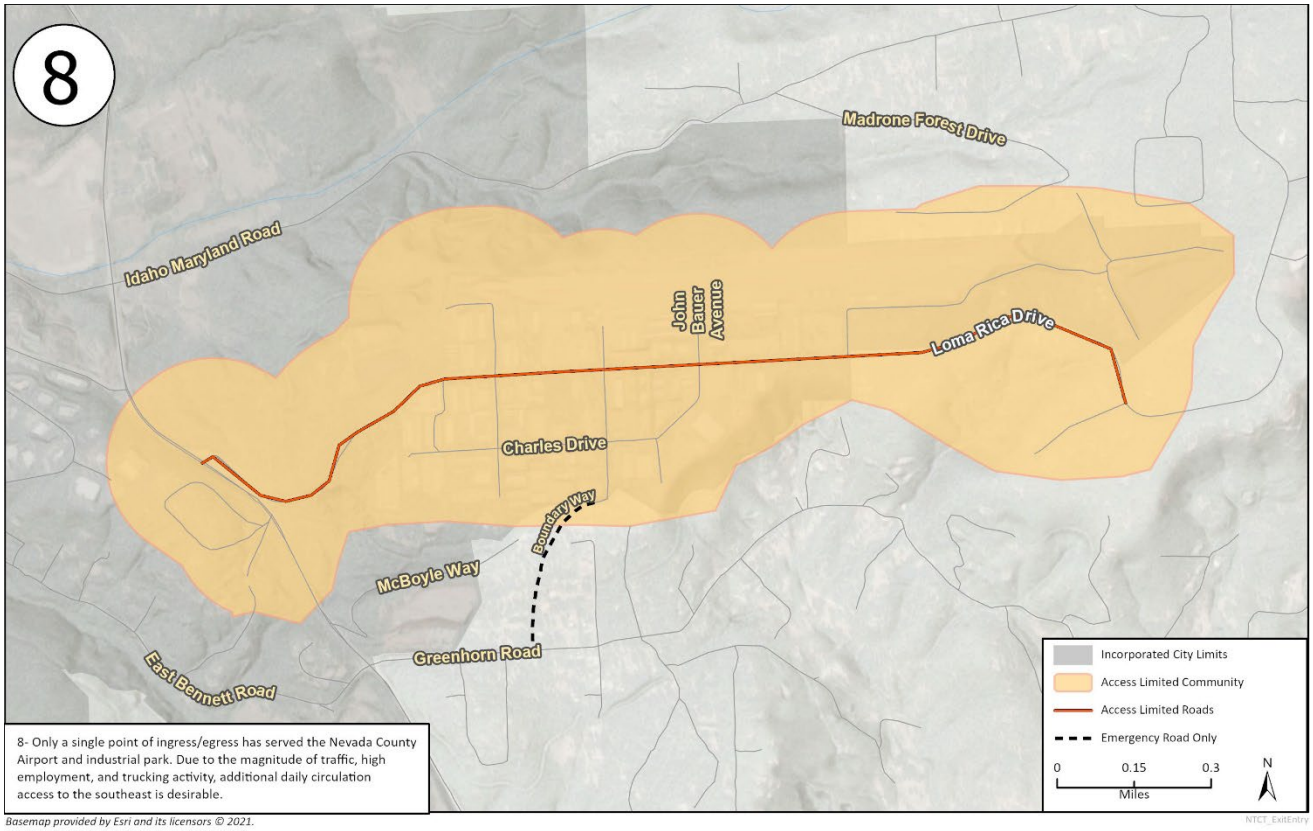

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Figure 68 Access Limited Community: Murphy Road

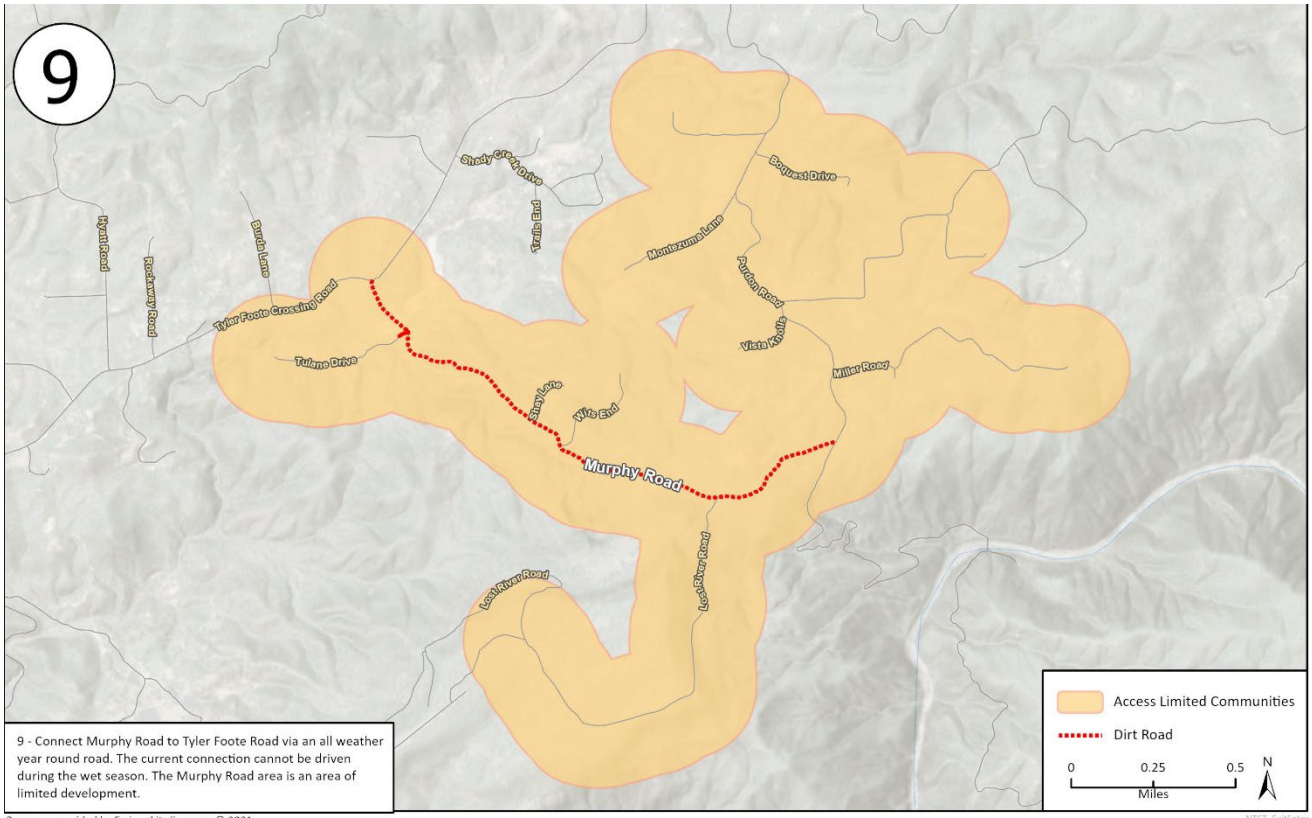

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Figure 69 Access Limited Community: Auburn Road & Allison Ranch Road

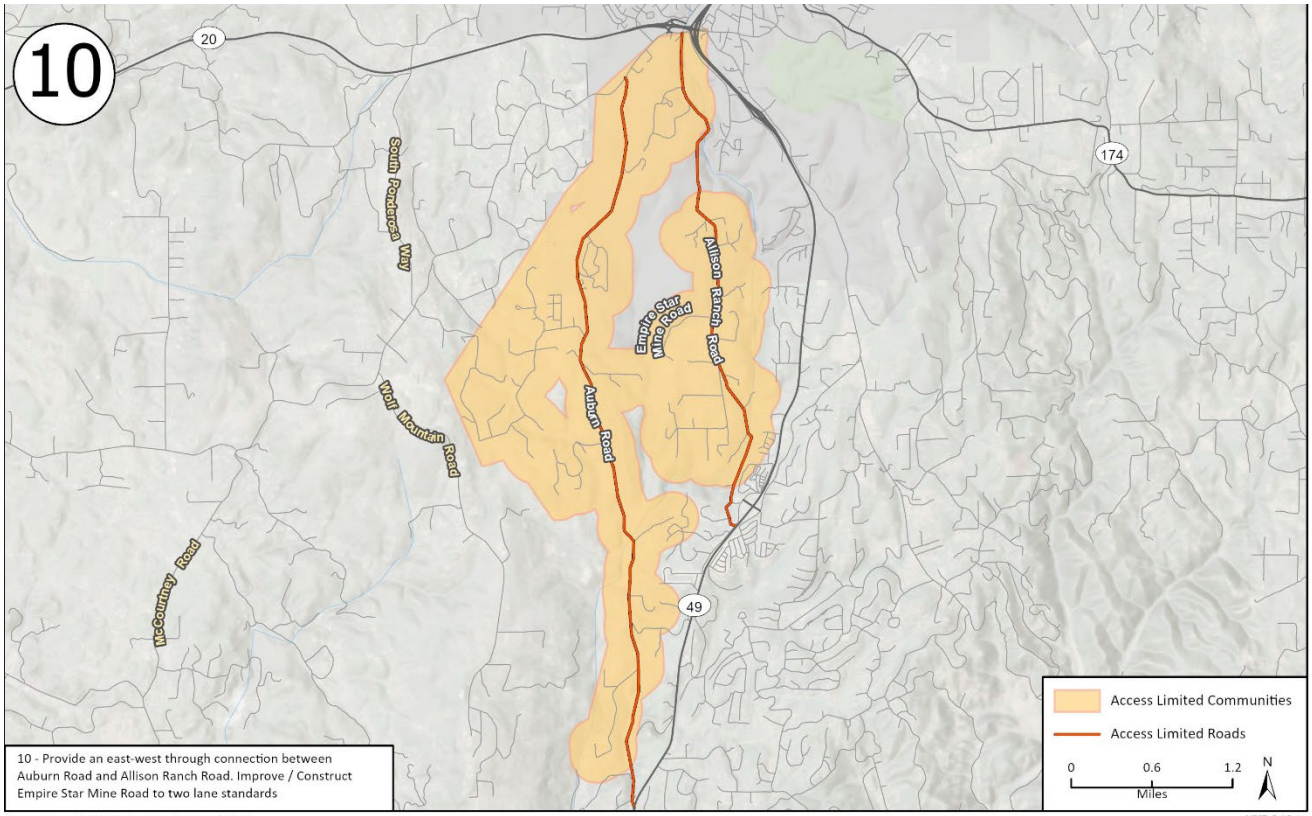

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Figure 70 Access Limited Community: Retrac Way

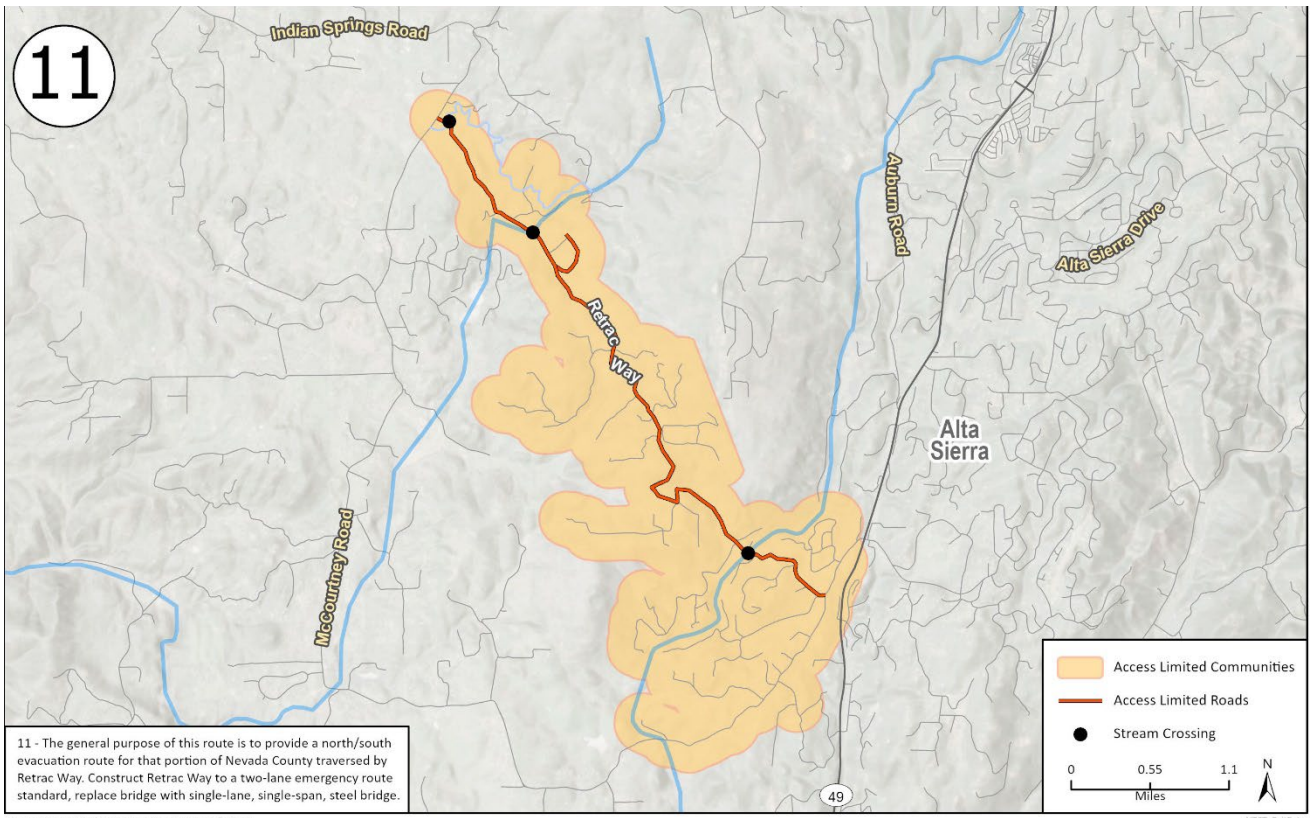

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Figure 71 Access Limited Community: South Ponderosa Way

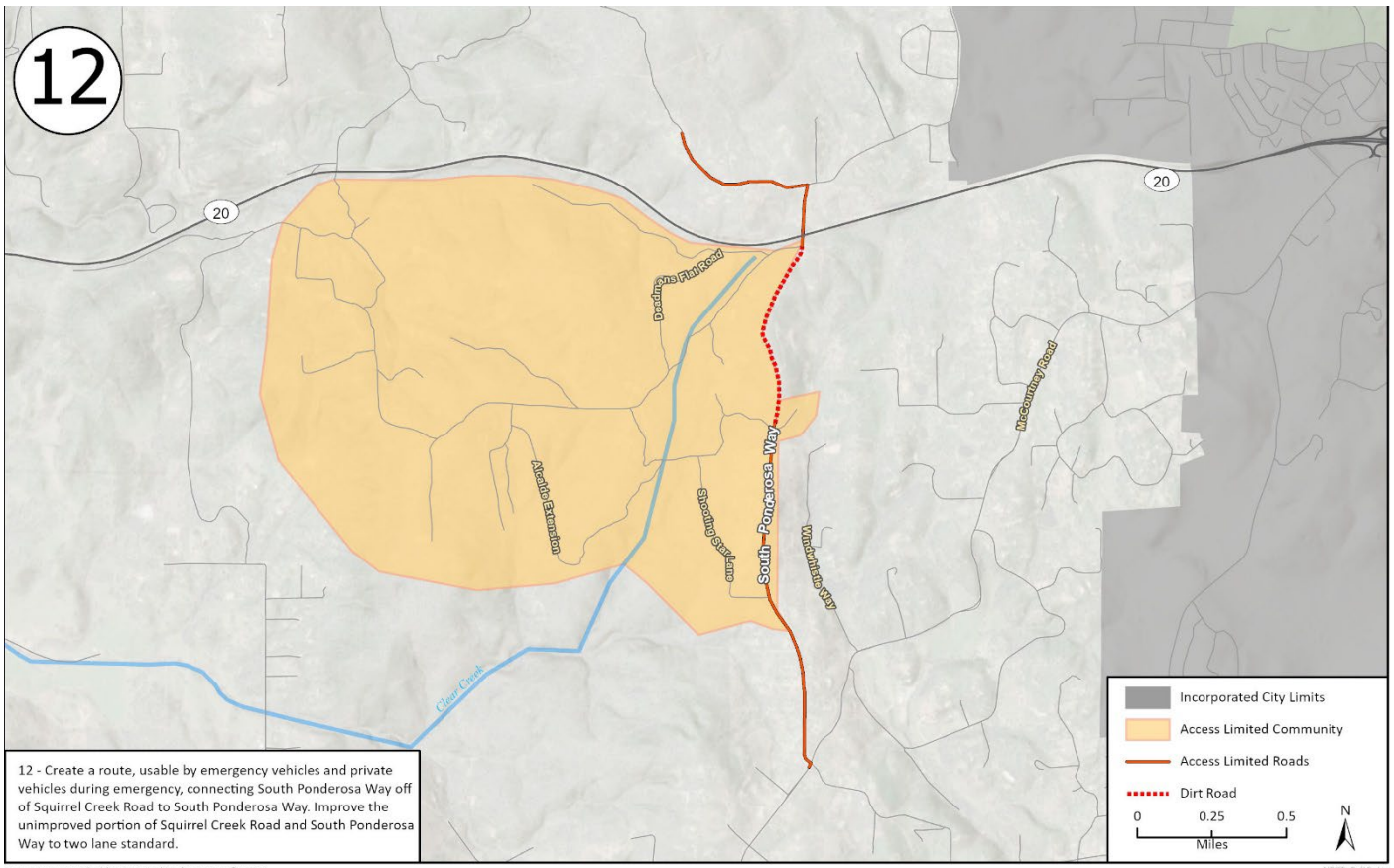

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Figure 72 Access Limited Community: Spenceville Road

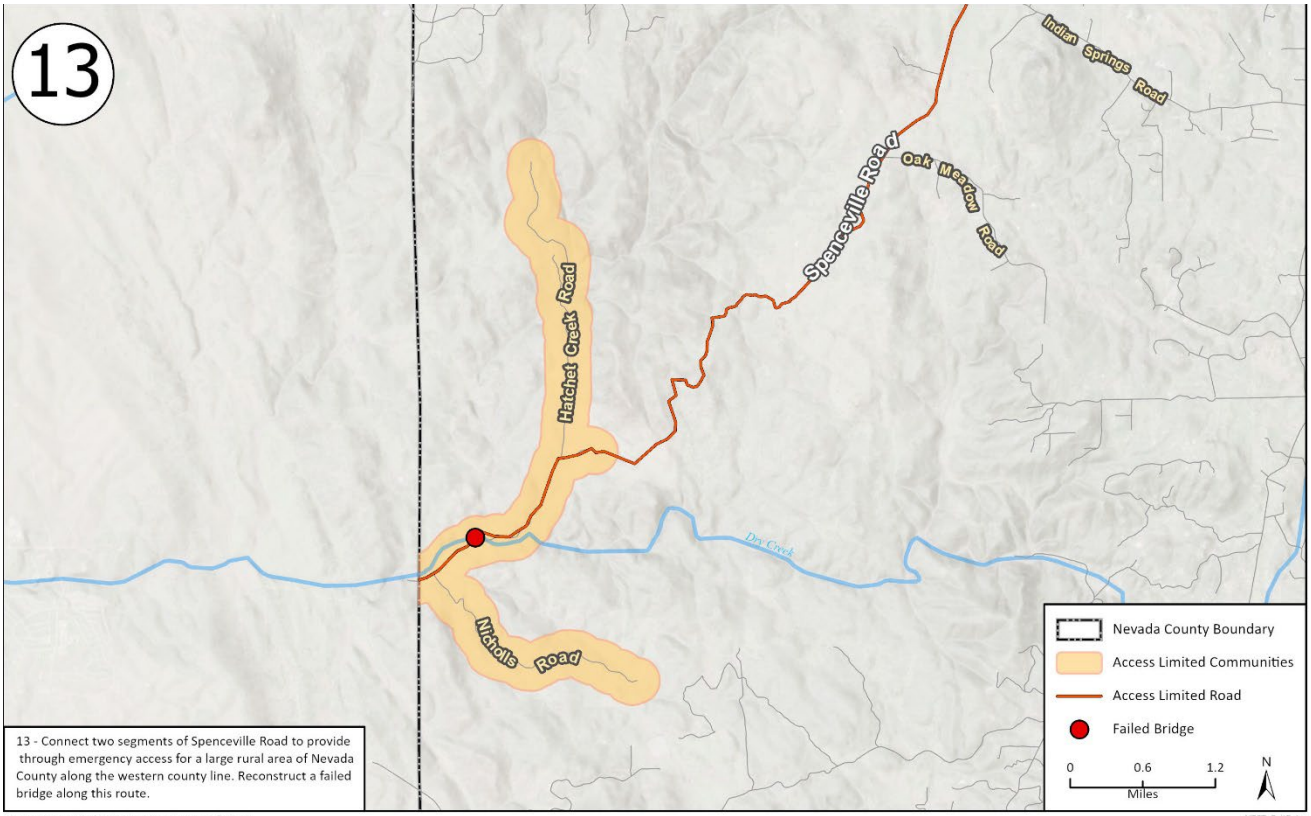

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Figure 73 Access Limited Community: Wolf Mountain Road

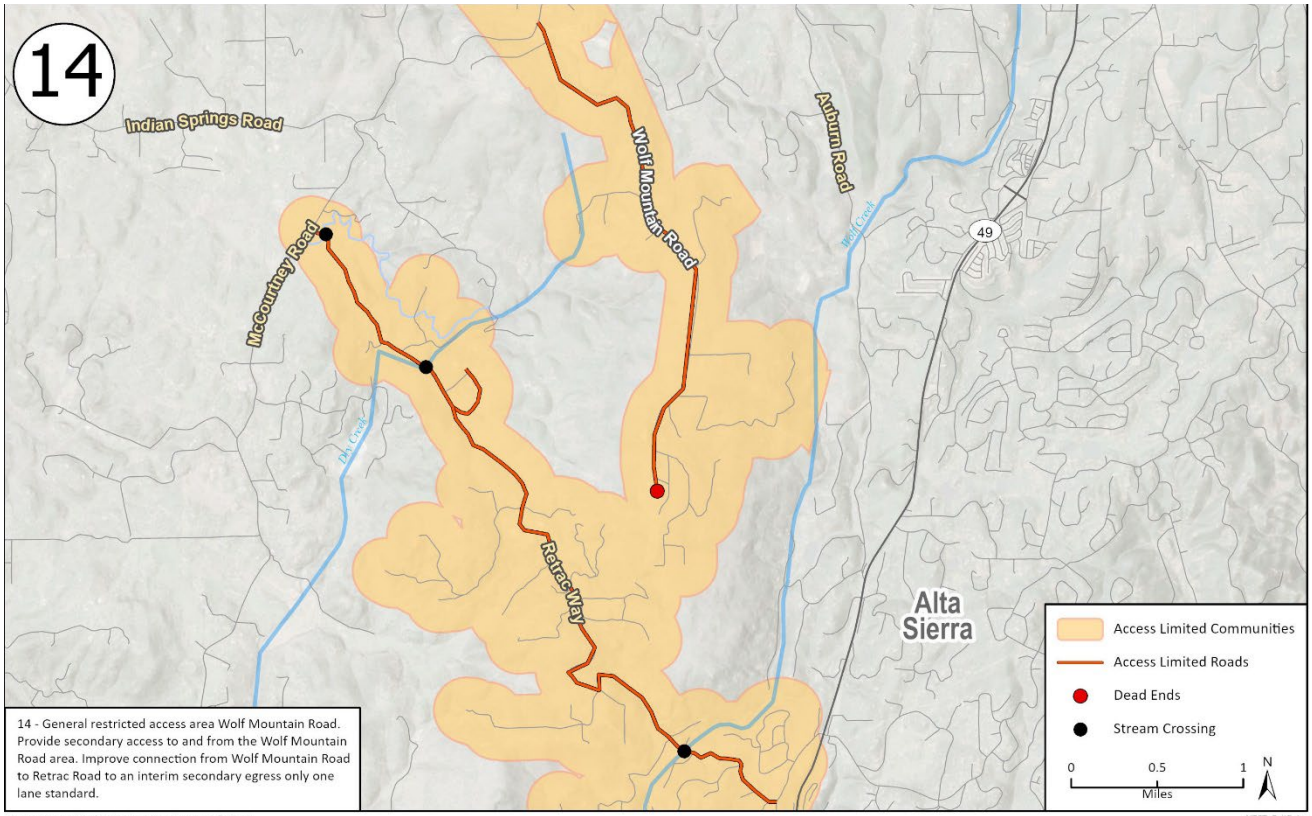

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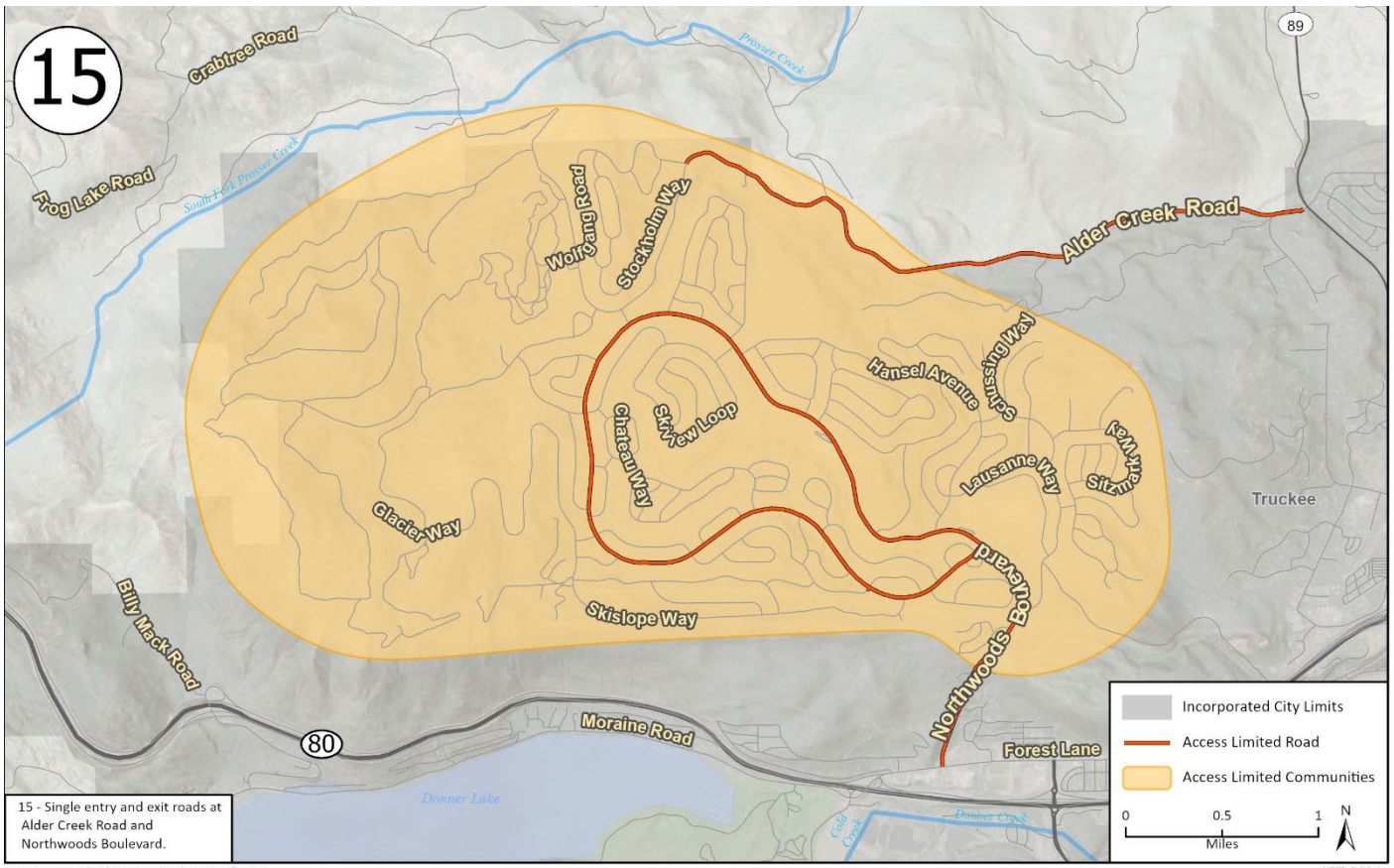
Figure 74 Access Limited Community: Northwoods Boulevard & Alder Creek Road



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