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JENSEN HUGHES

TUOLUMNE COUNTY EVACUATION NEEDS ASSESSMENT AND COMMUNICATION STRATEGIES

TUOLUMNE COUNTY, CALIFORNIA

January 22, 2023



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Tuolumne County Evacuation Needs Assessment and Communication Strategies FINAL REPORT

Tuolumne County, California

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Section 1
Introduction

INTRODUCTION

The Tuolumne County Evacuation Needs Assessment and Communication Strategies study identifies locations and communities at higher risk from wildfire and strategies to improve evacuation operations and communication. The report was completed by Kittelson & Associates, Inc. (Kittelson), Jensen Hughes, and Dr. Stephen Wong (University of Alberta) in collaboration with the Tuolumne County Transportation Council (TCTC), Tuolumne County Office of Emergency Services (OES), and local stakeholders. The Tuolumne County Evacuation Needs Assessment and Communication Strategies Report is structured in three sections:

1. **Potential Wildfire Risk** - Identifies relative wildfire risk across Tuolumne County.
2. **Roadway Evacuation Needs Assessment** – Describes potential limits to efficient evacuation based on modeled evacuation scenarios and identifies potential strategies for increasing the resiliency of egress routes.
3. **Communication Strategies** – Identifies potential barriers to effective communication in preparation for and during an evacuation and recommends strategies for improving communication.

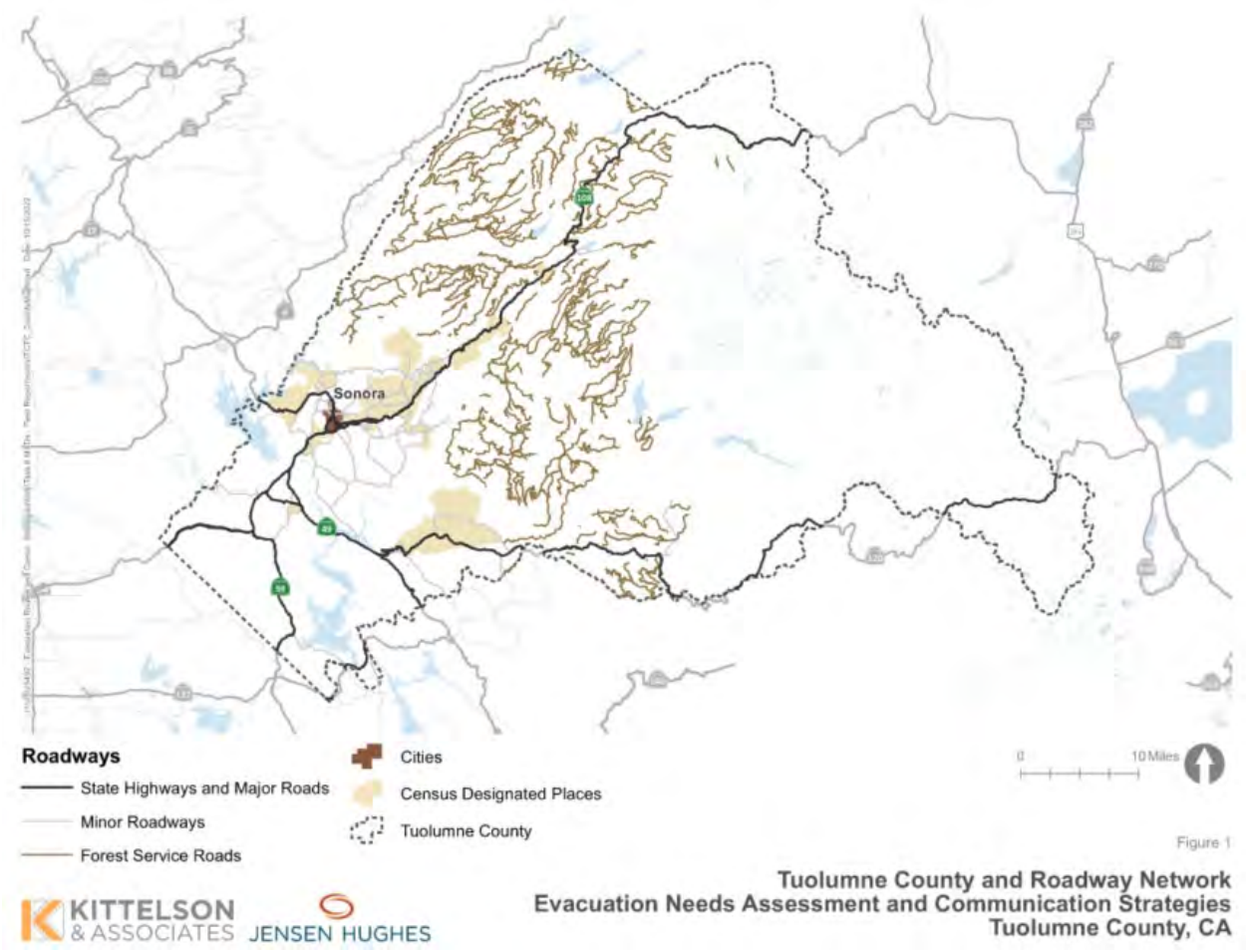
Included at the end of the report are a set of technical memoranda that provide additional detail on methodology and findings summarized in the report. The appendices include the following technical memoranda:

- Tuolumne County Fire Risk Evaluation
- Wildfire Risk Analysis and Design Fire Scenarios
- Identification of Roadway Network Deficiencies
- Strategies for Increasing Capacity and Efficiency
- Vulnerable Populations and Vulnerable Communities – Strategies for Evacuation
- Shelter-in-Place Emergency Planning Considerations
- Communications Strategy
- Community Engagement Strategy

STUDY AREA

Tuolumne County is located centrally in the California Mother Lode along the western slope of the Sierra Nevada range. Figure 1 shows the County and road network. Sonora is the only incorporated city in the Tuolumne County region and is also the County Seat. The County had a population of approximately 55,620 in 2020 and has a projected population of 63,000 by 2040 per the California Department of Finance. The County is approximately 2,217 square miles in area extending from the Sierra Nevada foothills to the mountains' crest and is bordered on the north by Calaveras County, on the south by Mariposa County, on the west by Stanislaus County, and on the east by Alpine and Mono Counties. More than three-quarters of the county is managed by government agencies, including portions of the Stanislaus National Forest and Yosemite National Park.

Figure 1: Tuolumne County Roadway Map with Sonora and Census Designated Places



EVACUATION NEEDS

The majority of the County's residents and visitors live (or stay) within close proximity to the four main state routes traversing the County – CA-49, CA-108, CA-120, and CA-132. However, despite this proximity to state routes, many communities in the County have limited access/egress to these main transportation corridors due to the mountainous terrain. In addition, there are relatively few connections across the County between state routes and major corridors. As a result, a single roadway during an evacuation may serve as both an evacuation route and a primary route for firefighters and emergency personnel.

Further complicating evacuations are difficulties due to limited communication as well as several vulnerable populations and communities, who may require additional support or tailored outreach in the event of a wildfire. For example, the County attracts seasonal visitors and workers who may be less familiar with evacuation procedures. The County is also home to a substantial senior population, residents with limited mobility, and others who may be more difficult to reach during an evacuation.

WILDFIRE HISTORY

Wildfires have historically been a major part of Tuolumne County's natural ecosystem. The Mediterranean-like climate, wide range of challenging topography, windy conditions, and fire-adapted vegetation creates an environment for periodic burns. Historically, and in recent years, the County has experienced significant wildfires including the 2013 Rim Fire, resulting in major physical, social, economic, and environmental impacts. More recently, the potential for fire and wildfire risk has increased with climate change (e.g., extended droughts, elevated heat index, desiccated vegetation, elongated fire seasons) and increased development along the wildland-urban interface.

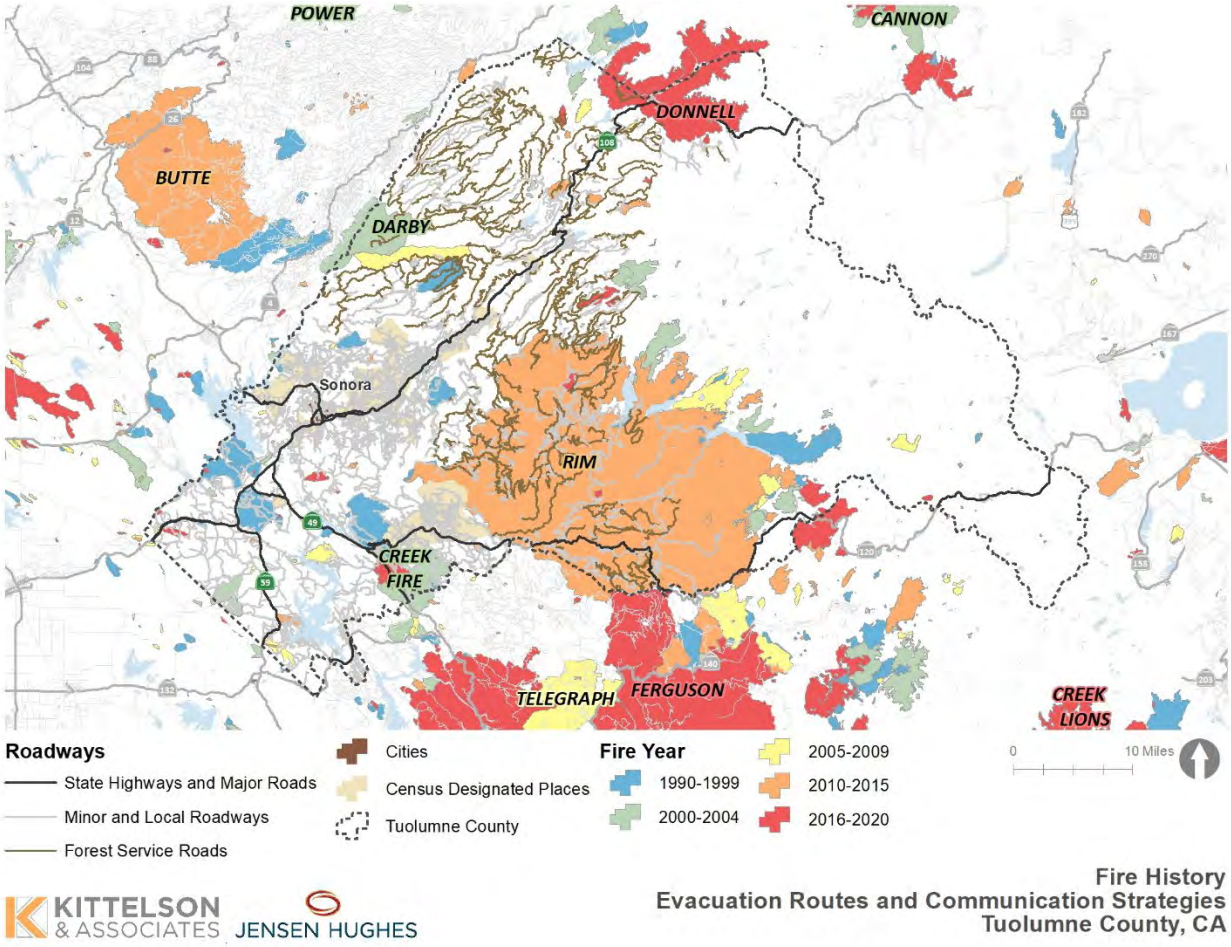
In the past 30 years, California Department of Forestry and Fire Protection (CAL FIRE) has recorded more than 10 wildfires of 300 acres or more in Tuolumne County. The last five wildland fires of historic significance[1] in the County, including approximate acres burned, were:

- 2018 Donnell Fire, 36,450 acres;
- 2017 Creek Fire, 1,750 acres;
- 2013 Rim Fire, 257,300 acres;
- 2009 Knight Fire, 6,100 acres; and,
- 1996 Ackerson Fire, 59,000 acres

Figure 2 presents the County's 30-year fire history from 1990-2020.

[1] WFDSS Disturbance History, accessed December 28, 2019

Figure 2. Recent Wildfire History in Tuolumne County



Section 2
Potential Wildfire Risk

POTENTIAL WILDFIRE RISK

As noted in the Introduction, there is a long history of wildfires in Tuolumne County. This section evaluates relative risk across the County based on four different measures of risk and identifies locations where residential and community infrastructure face specific wildfire-related risks. In addition, the analysis has the potential to inform future planning decisions by indicating where new development would face increased risk from wildfire. Additional detail including sub-area maps are located in Appendix A.

EVALUATING WILDFIRE RISK

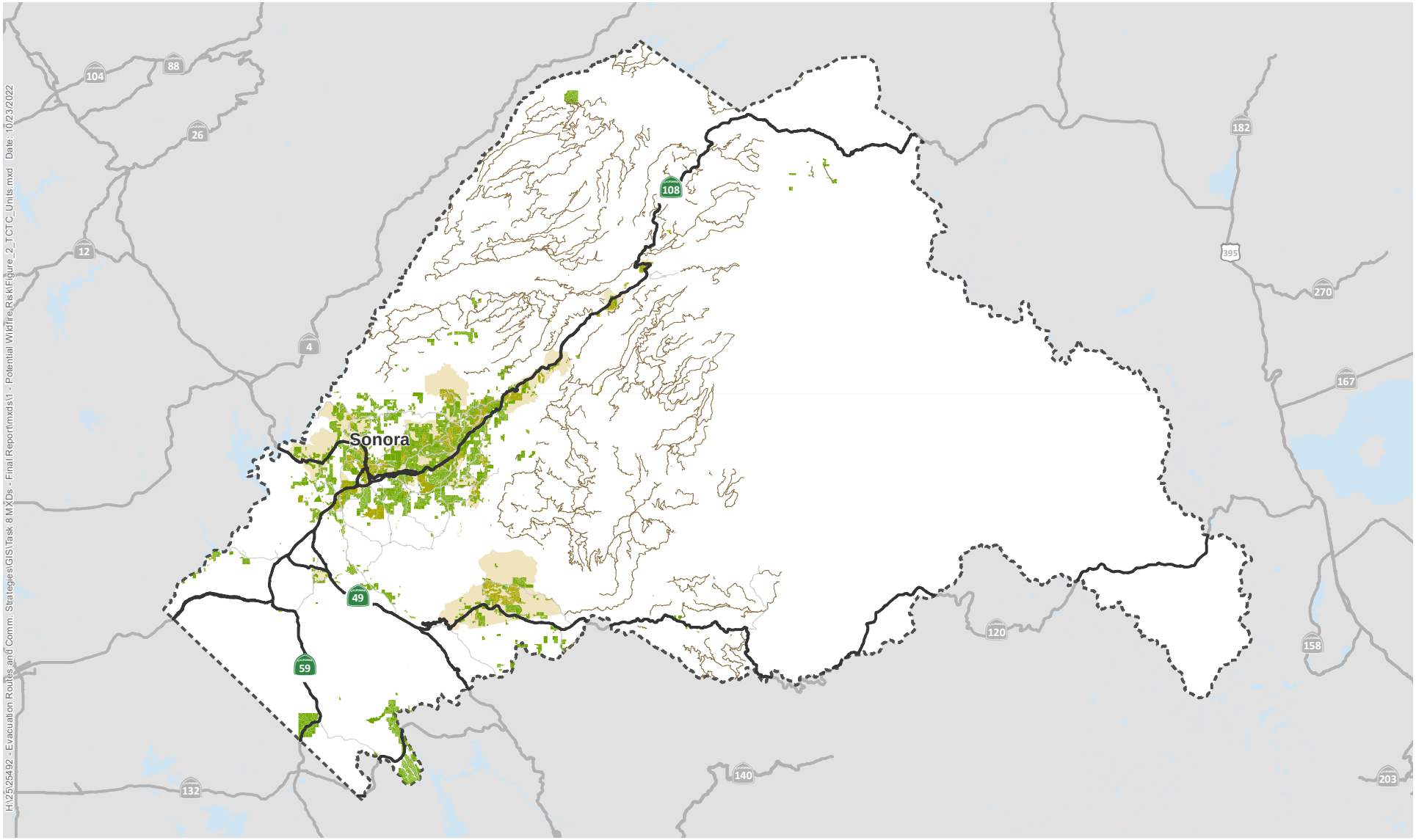
The report considers fire risk as a product of two components. The first considers the potential for the ignition and spread of wildfire. The second measures the degree to which those at-risk areas contain people and infrastructure. The greatest risk is where there is both elevated wildfire risk and a high concentration of people and infrastructure. The section is organized around four wildfire risk factors:

1. Fire Hazard Severity Zones
2. Wildland-Urban Interface
3. Historic Burn Frequency
4. Ignition Hot Spots

For each wildfire risk factor, the degree of exposure for three populations is provided: residential parcels, building structures, and critical infrastructure. The three populations were selected to measure the relative risk exposure to wildfire risk with an emphasis on where people and infrastructure are located.

Critical infrastructure includes a variety of infrastructure types that are of particular concern during a wildfire evacuation, including infrastructure that supports firefighting, operation centers, and locations with concentrations of individuals who are at increased risk during an evacuation, such as schools or senior centers.

Figure 3, Figure 4, and Figure 5 show the distribution of the three reference populations throughout the County. Appendix A includes the calculations of the number of residential parcels, building structures, and critical infrastructure that fall into each risk category. The appendix also provides more detail about the type and location of the different sub-categories of critical infrastructure.



Zoning

- Residential
- Residential Estate

Roadways

- State Highways and Major Roads
- Minor and Local Roadways
- Forest Service Roads

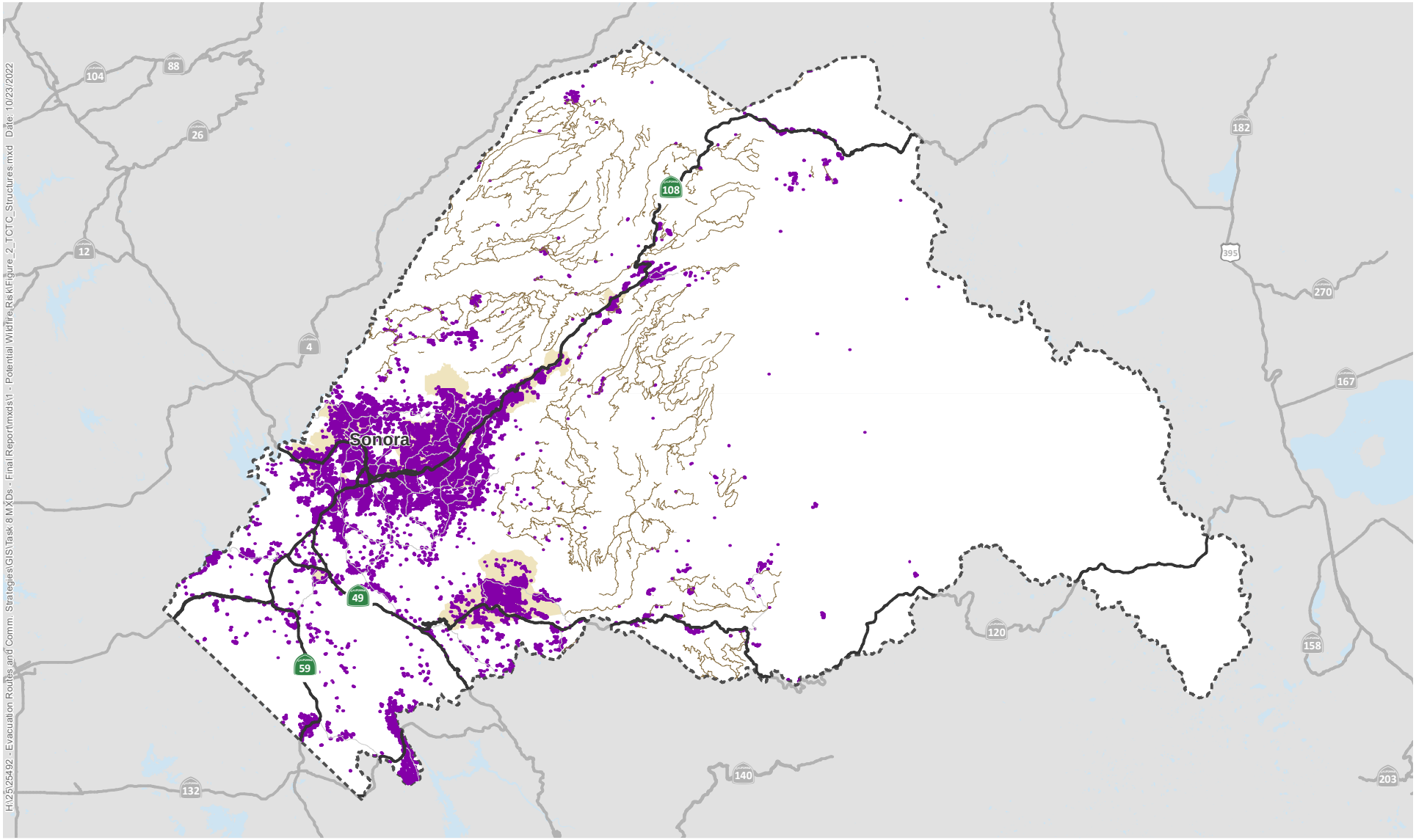
- Cities
- Census Designated Places
- Tuolumne County

0 10 Miles

Figure 3

Residential Zoned Parcels
Evacuation Needs Assessment and Communication Strategies
Tuolumne County, CA

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Structures

Roadways

- State Highways and Major Roads
- Minor and Local Roadways
- Forest Service Roads

- Cities
- Census Designated Places
- Tuolumne County

0 10 Miles

Figure 4

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Structures
Evacuation Needs Assessment and Communication Strategies
Tuolumne County, CA

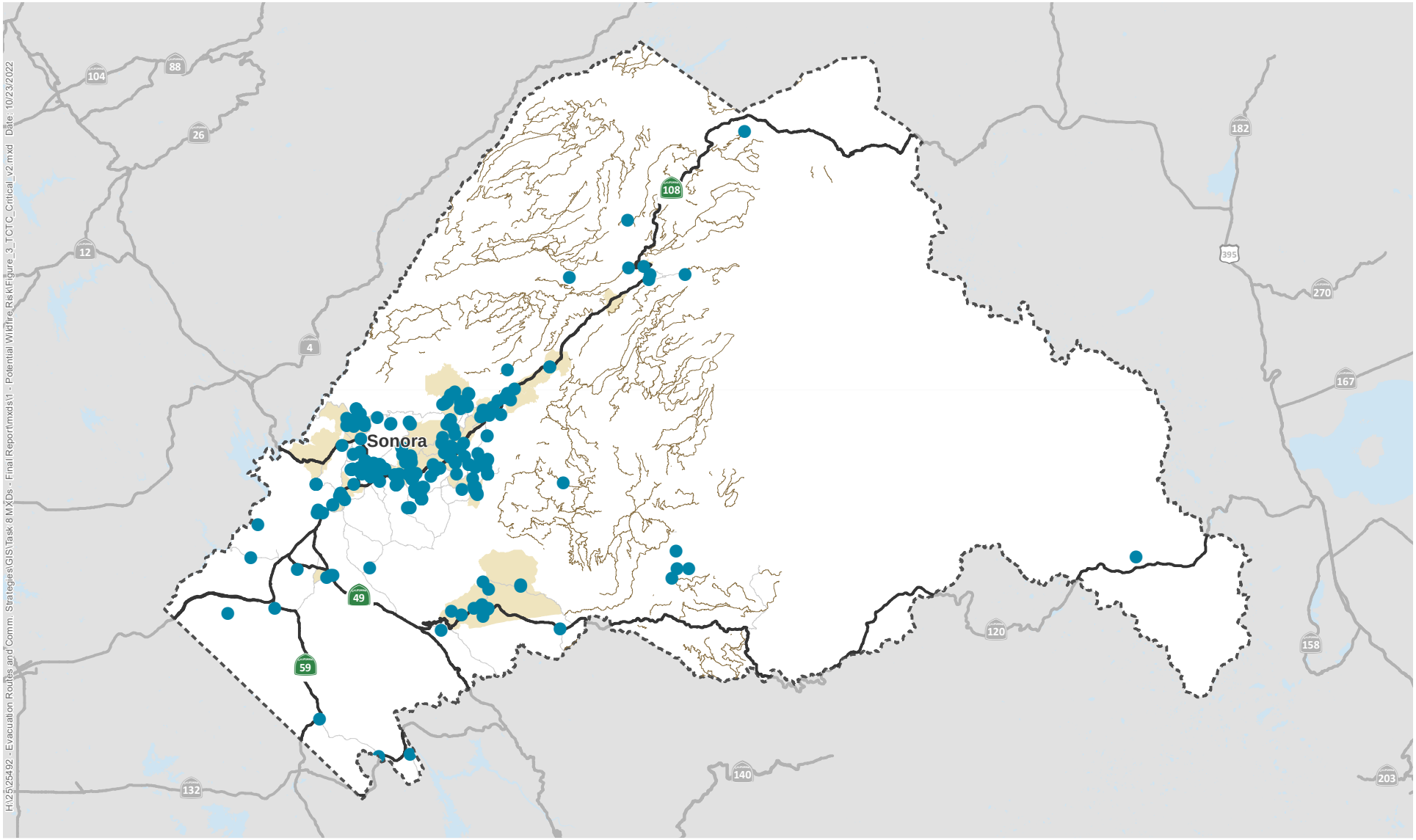


Figure 5

Critical Infrastructure
Evacuation Needs Assessment and Communication Strategies
Tuolumne County, CA

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FIRE HAZARD SEVERITY ZONE

The Fire Hazard Severity Zones (FHSZ) present a composite measure of risk for wildfire occurrence based on factors that influence fire likelihood and fire behavior including fire history, existing and potential vegetative fuel, predicted flame length, ember travel, terrain, and fire weather. The FHSZ measure is used to identify where a fire is likely to occur and how severe fire conditions could be. FHSZ data was developed by CAL FIRE for state responsibility areas (2007) and local responsibility area designations for the City of Sonora (2008). Note that the FHSZ are currently being updated by CAL FIRE with the understanding that the current mapping may underestimate current wildfire risk given climate changes (e.g., drought), and recent more extreme weather events.

POTENTIAL WILDFIRE RISK

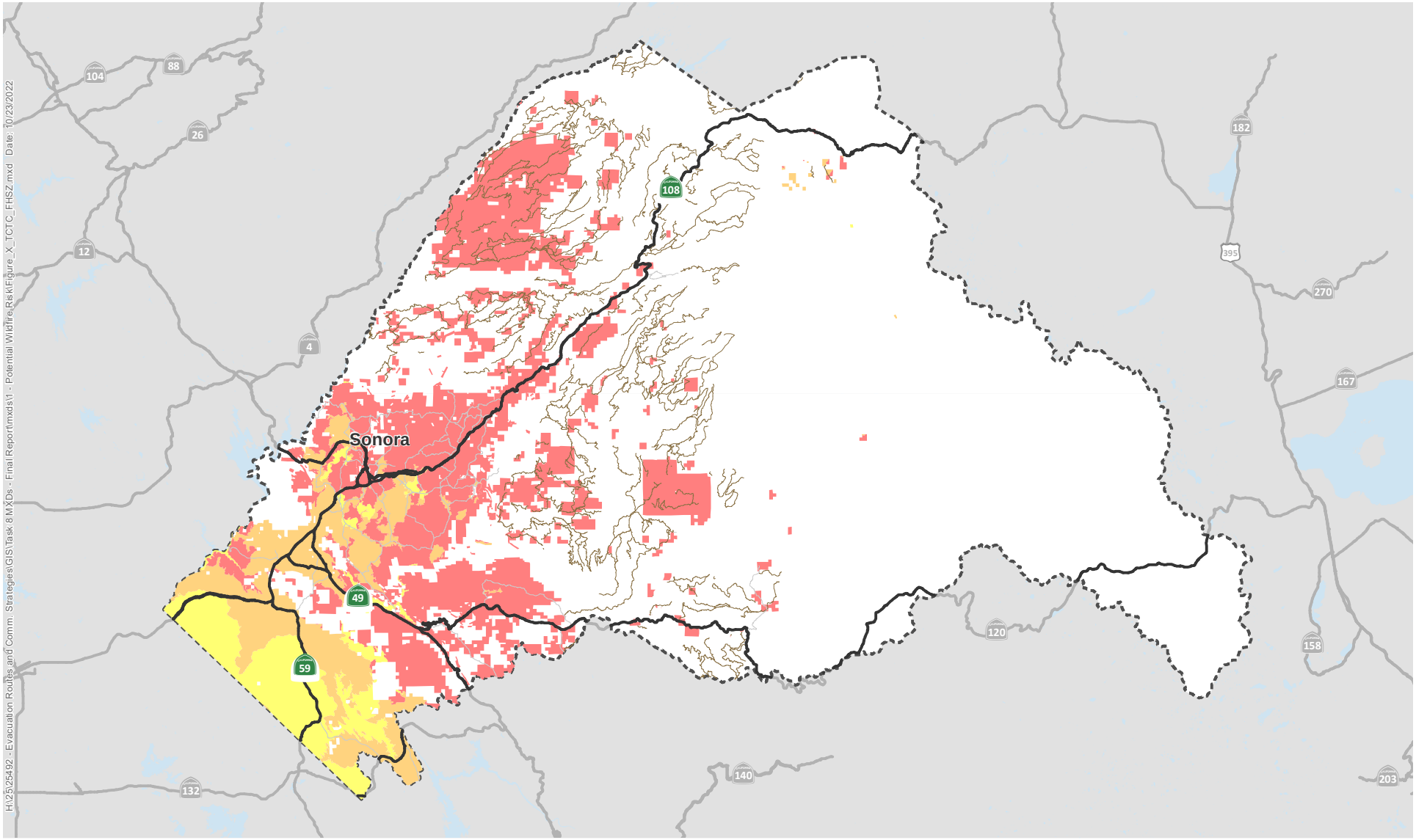
The Fire Hazard Severity Zones are shown in Figure 6. The map indicates risk is present throughout the inhabited areas of the County.

- Risk is lower (though still Moderate) in the western portion of the County along CA-108 and CA-49.
- Risk is higher in the more densely inhabited areas along CA-108, particularly east of Sonora, and in and around Groveland and Pine Mountain Lake along CA-120.
- FHSZs are not present in the higher elevations in the eastern portion of the County.

RISK EXPOSURE

Risk is present across inhabited areas of the County; however, there is variations in risk to residential areas and infrastructure, including:

- The southeast portion of the County has relatively lower risk, with more parcels and structures in a moderate FHSZ zone. In particular, the areas around Sonora, East Sonora, and west of Don Pedro Reservoir County have a lower share of parcels and structures in the high or very high FHSZ.
- Areas east of Sonora along CA-108 are at high risk with areas of the County where over 98% of residential parcels and structures are in high or very high FHSZ zones. 99% of residential parcels and structures in the high risk FHSZ in the area include the communities of Cedar Ridge, Twain Harte, and Sierra Village.
- Relative to the residential parcels and structures, critical infrastructure is located in somewhat lower risk parts of the County. However, almost half (46%) of identified critical infrastructure are still located in a very high FHSZ.



Fire Hazard Severity Zones

- Very High
- High
- Moderate

Tuolumne County

0 10 Miles

Figure 6

Fire Hazard Severity Zone
Evacuation Needs Assessment and Communication Strategies
Tuolumne County, CA

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WILDLAND-URBAN INTERFACE

The wildland-urban interface (WUI) is the area adjacent to or intermixed with forest or other natural vegetation. These locations are a priority for managing fire risk since the presence of human development can increase the potential for fire ignitions and, if started, fires in these locations have greater potential to harm residents and property. New buildings in WUI are often required to comply with additional wildfire building and fire safety code provisions.

Data developed by CAL FIRE for the 2015 Assessment of Forest and Rangelands[2] was used to identify relative risk. Three categories are present in the data: Intermix, Interface, and Influence Zone. The CAL FIRE categories definitions are briefly defined below:

- **Intermix** – Dense housing adjacent to vegetation that can burn in a wildfire.
- **Interface** – Housing interspersed in an area dominated by wildland vegetation.
- **Influence** – Wildfire susceptible vegetation up to 1.5 miles from WUI Interface or Intermix.

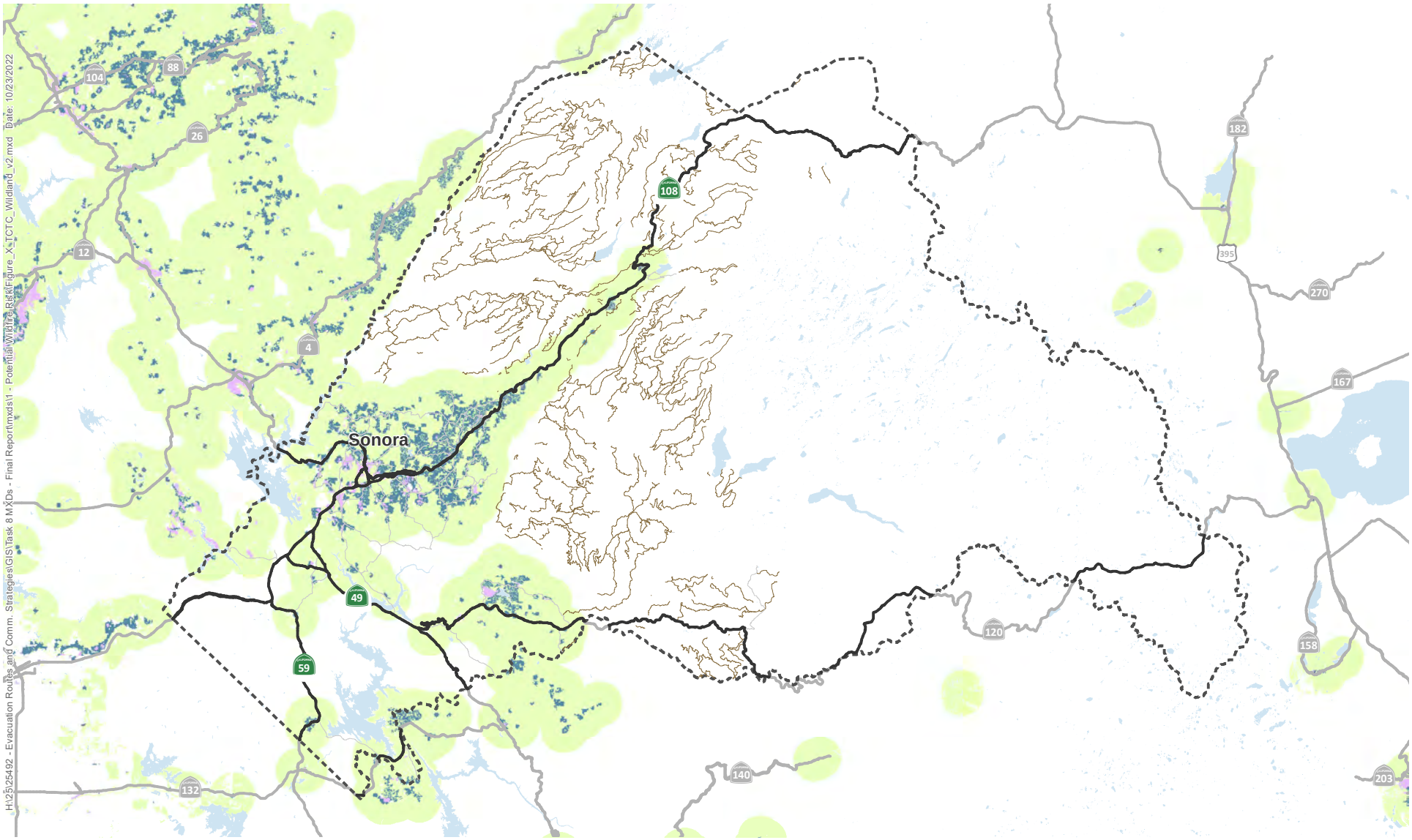
POTENTIAL WILDFIRE RISK

The WUI locations in the County are included in Figure 7. In general, the County has large areas of forest and wildland with relatively smaller areas of concentrated population. As a result, the WUI map shows high degrees of intermixing of wildlands and urban areas that reflect where people live and work. The highest mixing tends to occur on the edges of urban areas. For example, built areas in and around Sonora are intermixed with wildland areas.

SUMMARY OF RISK

- Residential parcels and structures throughout the County tend to be constructed in and adjacent to the WUI. The communities around Cedar Ridge, Twain Harte, Sierra Village have the highest rate of residential parcels and structures in the intermix zone.
- Critical infrastructure appears to be more removed from the WUI on average. However, 4 of 6 urgent care centers and 13 of 19 potential evacuation sites are in an intermix or interface zone.

[2] CAL FIRE, Wildland Urban Interface, 2019. https://frap.fire.ca.gov/media/10300/wui_19_ada.pdf



Intermix

Interface

Influence Zone

Tuolumne County

0 10 Miles

Figure 7

Wildland Urban Interface
Evacuation Needs Assessment and Communication Strategies
Tuolumne County, CA

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HISTORIC BURN FREQUENCY

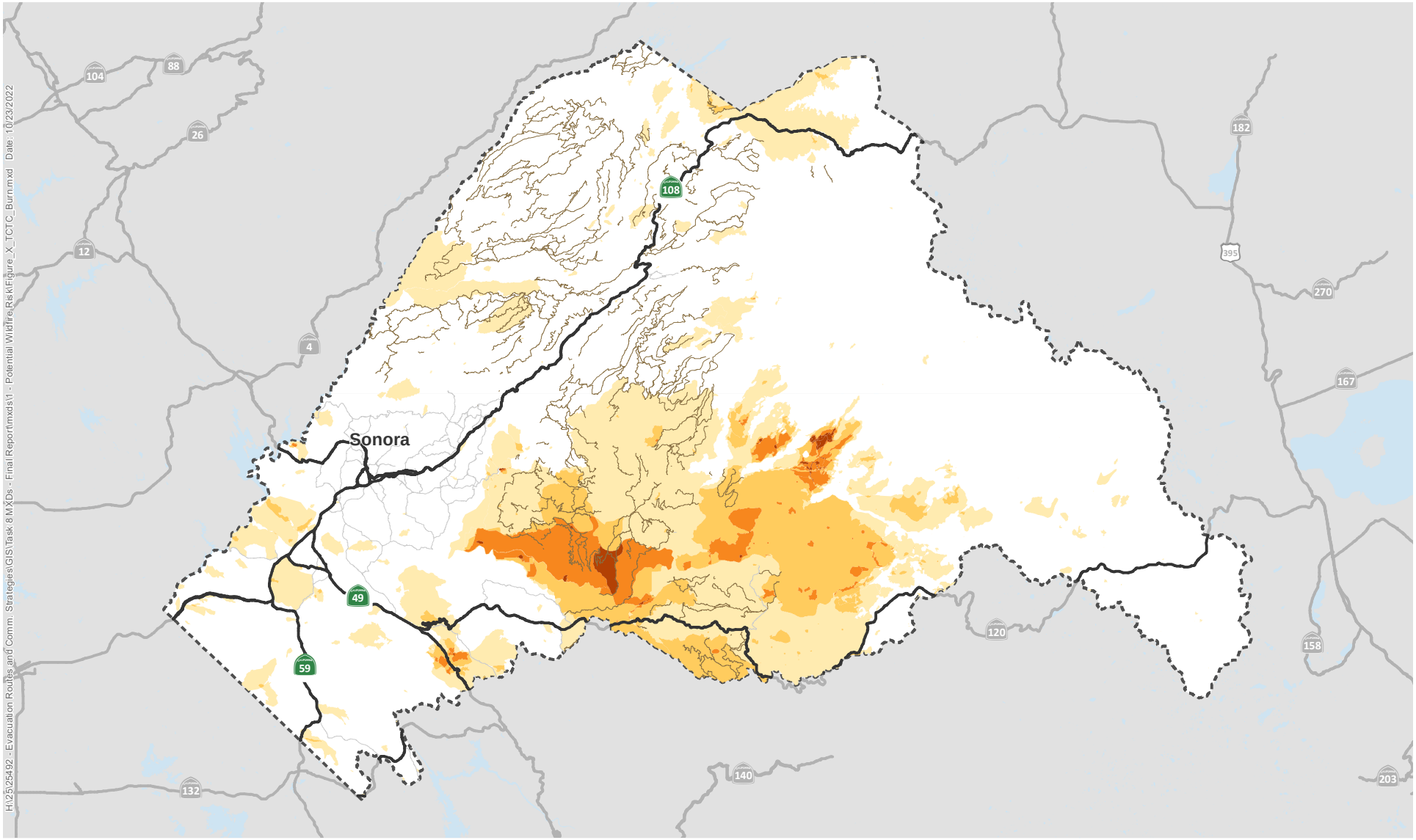
Historic burn frequency data identifies the number of fires that have impacted different areas of the County between 1980 and 2020. It considers the frequency and spread of wildfires. Note that the absence of fire in some locations in the County may reflect increased efforts to put out fires near population areas, rather than an absence of fire potential.

POTENTIAL FIRE RISK

The historic burn frequency for the County is shown in Figure 8. The map shows that to this date, largescale wildfire burns have been contained to less populated areas of the County, such as northeast of Groveland. In contrast, along CA-108, there are multiple instances of a single contained burn, such as south of CA-108 near Twain Harte and Mono Vista. The maps mirror in some ways the WUI maps by showing the proximity of fire near areas at the wildland-urban interface.

SUMMARY OF RISK

- Wildfires spread to a relatively small share of building infrastructure in the County (approximately 5% of all structures and 1% of residential parcels) when considered in context of risk indicated by the FHSZ evaluation. As noted above, this may be a result of increased efforts to put out fires in population areas.
- The critical infrastructure located where wildfires have occurred include powerhouses (4 of 7), wireless communication towers (6 of 32), and water tanks (10 of 82).



Burn Frequency

- 1
- 2
- 3
- 4 or more

Tuolumne County

0 10 Miles

Figure 8

Burn Frequency
Evacuation Needs Assessment and Communication Strategies
Tuolumne County, CA

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IGNITION HOT SPOTS

The ignition hot spot analysis identifies locations in the County with a statistically higher probability of historic fire ignition. The analysis uses the spatial distribution of historic ignitions to identify locations with a higher intensity of ignition events than would be expected if ignitions were randomly distributed. These hot spots can be interpreted as areas where ignitions have historically been clustered. The data presented identify locations in the County with 90%, 95%, and 99% confidence for clustering of past ignitions. The analysis complements the historic burn data by identifying locations where risk of ignition is elevated, but not necessarily where fires have spread substantially.

LOCATIONS OF POTENTIAL RISK

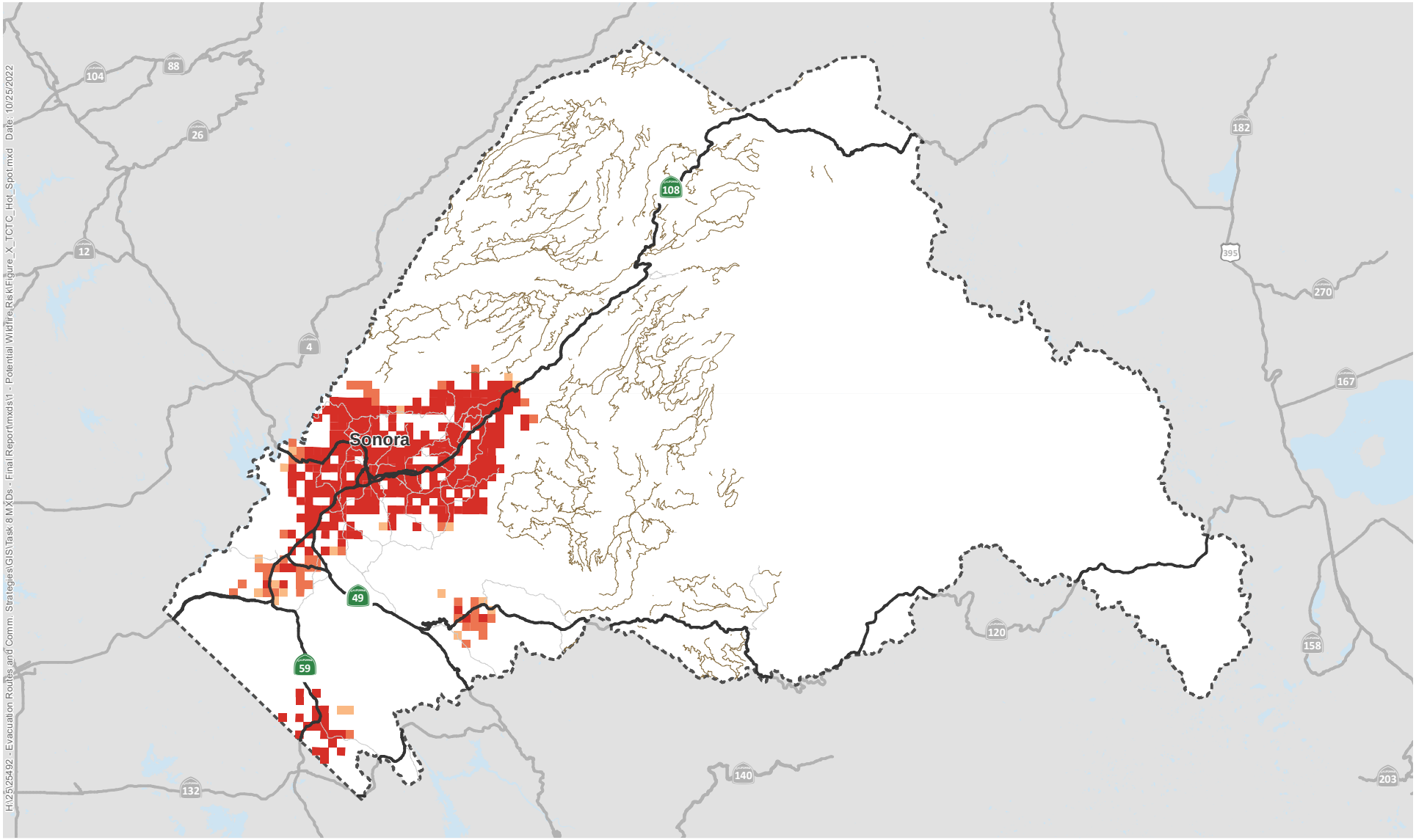
The ignition hot spot analysis is shown in Figure 9. It indicates that there is increased risk of ignition in populated areas of the County:

- Risk of ignition is elevated along CA-108 from Keystone in the West to Sierra Village.
- Risk along CA-120 is elevated south of Groveland.
- High probability of ignition is also identified south of Don Pedro Reservoir.

SUMMARY OF RISK

There is substantial overlap between areas with higher risk of ignition and the three reference populations. This is expected since human activity is a major contributor to fire ignition.

- The locations with the greater number of residential parcels and structures in areas with elevated risk of ignition are along CA-108. In the areas around Cedar Ridge, Twain Harte, Sierra Village, Sonora, East Sonora, Mono Vista, Tuolumne City, and Tuttletown more than 85% of residential parcels are in 99% confidence ignition zones.
- The percent of critical infrastructure in risk zones is greater than for the other wildfire risk types. Together, about three-quarters of senior centers, primary secondary schools, preschools, and large daycare centers are in the 95th confidence ignition category.



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Ignition Hot Spot Analysis - unweighted

- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence
- Tuolumne County

0 10 Miles

Figure 9

Ignition Hot Spots
Evacuation Needs Assessment and Communication Strategies
Tuolumne County, CA

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Section 3
Roadway Evacuation Needs Evaluation

ROADWAY EVACUATION NEEDS EVALUATION

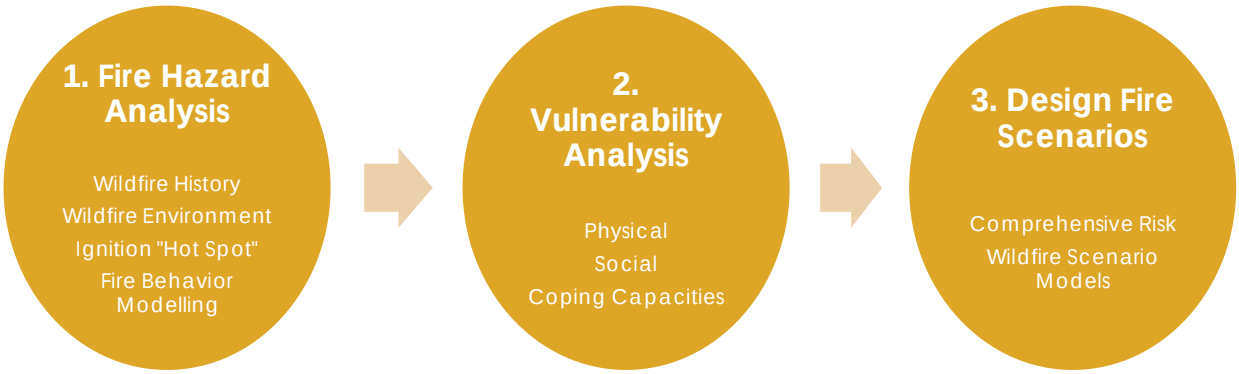
During wildfires, roadway systems can quickly become strained as evacuating vehicles leave an area at the same time. This section evaluates the Tuolumne County roadway system in response to modeled fire scenarios and is organized into two parts. First, it identifies locations in Tuolumne County where potential congestion could hamper evacuations based on an evaluation of several fire scenarios. Second, it presents a set of example treatment plans for nine constrained locations, showing how planning and engineering strategies for increasing capacity and reliability could be applied.

EVALUATION OF EVACUATION SCENARIOS

DEVELOPING FIRE SCENARIOS

Seven fire scenarios were developed to understand the potential for congestion during an evacuation. The scenarios were developed in a three-step process (Figure 10).

Figure 10. General Fire Scenario Development Approach



1. A **fire hazard analysis** was conducted to identify where fires are more likely to occur and likely fire behavior using existing and historical data, including past wildfire history, ignitions, and local environmental settings. This analysis relied on the data and mapping of wildfire risk documented in the prior section of the report.
2. A **vulnerability assessment** was conducted to identify locations with higher risks due to social or physical vulnerabilities, and coping capacity, such as access to firefighting resources.
3. Findings from the fire hazard analysis and vulnerability assessment were used to **identify representative, worst-case wildfire scenarios** that would likely stress the roadway network during evacuations. These wildfire scenarios were selected to identify locations that would have a high impact on the more populated areas of the County, provided geographic diversity in the evacuation scenario, and notably were modeled without the impact of fire abatement activities, and often with atypical, adverse weather conditions to capture worst-case results. Additional detail about the process for the scenario development and selection can be found in Appendix B.

The process resulted in seven fire scenarios that describe hypothetical scenarios. Figures showing the modeled spread of each fire are included on page 31 of Appendix B.

- Apple Colony Fire Scenario
- Cabezut Fire Scenario
- Comp Blue Fire Scenario
- Cedar Ridge Fire Scenario
- Columbia Fire Scenario
- Golden Oaks Fire Scenario
- Groveland Fire Scenario

MODELING TRAVEL BEHAVIOR

For each fire scenario, the Tuolumne County Regional Travel Demand Model was used to evaluate potential for congestion due to evacuating vehicles directly following ignition (0 to 12 hours after ignition) and as the modeled fire spread necessitating a broader evacuation (24 to 36 hours after ignition). For each period, fire spread was used to identify which section of the County would be evacuating and to measure the potential for evacuation routes to become congested.

The number of evacuating trips expected in each scenario was developed based on household units, visitor units, and occupancy rates for the county and survey data[3] collected following previous fires in California. Household and visitor data were based on land use data included in the Regional Travel Demand Model for the 2015 base year. The model also accounted for larger vehicles that would be used in an evacuation, such as trucks, trailers, and RVs. Kittelson selected the 2015 base year for modeling of evacuation conditions after consulting state data indicating minimal population growth since 2015.

Evacuations were modeled assuming background traffic during a typical PM peak hour with evacuation traffic layered on top of typical evening peak hours. As a result, some facilities, like Washington Street in Sonora, that already have a high volume of traffic are more susceptible to result in over-capacity results. Additionally, evacuation traffic was distributed with an emphasis on evacuation travel heading westbound to destinations outside the County. This distribution was selected based on feedback from stakeholders that visitors and others often chose to evacuate along the route that they entered the County and/or toward the larger cities to the west.

A detailed explanation of the modeling process is included in Appendix C.

[3] Wong, S., Broader, J. and Shaheen, P., 2022. *Review of California Wildfire Evacuations from 2017 to 2019*. [online] eScholarship.org. Available at: https://escholarship.org/uc/item/5w85z07g, Wong, S. D., Chorus, C. G., Shaheen, S. A., & Walker, J. L. (2020). A Revealed Preference Methodology to Evaluate Regret Minimization with Challenging Choice Sets: A Wildfire Evacuation Case Study. Travel Behaviour and Society, 20, 331–347. https://doi.org/10.1016/j.tbs.2020.04.003, and Wong, S. D., Broader, J. C., Walker, J. L., & Shaheen, S. A. (2022). Understanding California wildfire evacuee behavior and joint choice making. Transportation. https://doi.org/10.1007/s11116-022-10275-y

EVALUATION RESULTS

Based on the seven fire scenarios, the following locations were identified to be likely locations of congestion during evacuations (see Figure 11 for location in Tuolumne County):

1. **Sonora** Area**.** For the fires that would impact locations along CA-108, the travel model indicates that congestion around the Sonora area is likely whether the fire is occurring in the immediate vicinity or further away. Congestion is partly due to interaction between evacuation trips and usual traffic in the area.
2. **Washington Street** between CA-108 and West School Street through Sonora, including the traffic signals at:
   - Washington Street / Restano Way
   - Washington Street / Golden Chain Highway (CA-49)
3. **CA-108** between Mono Way and where CA-108 and CA-49 split west of Jamestown
4. **CA-120** between Ferretti Road, near Groveland, and Priest Coulterville Road
5. **Arterials/Collectors Streets** connecting to state routes, such as:
   - Phoenix Lake Road
   - Tuolumne Road / Tuolumne Road North
   - Parrotts Ferry Road

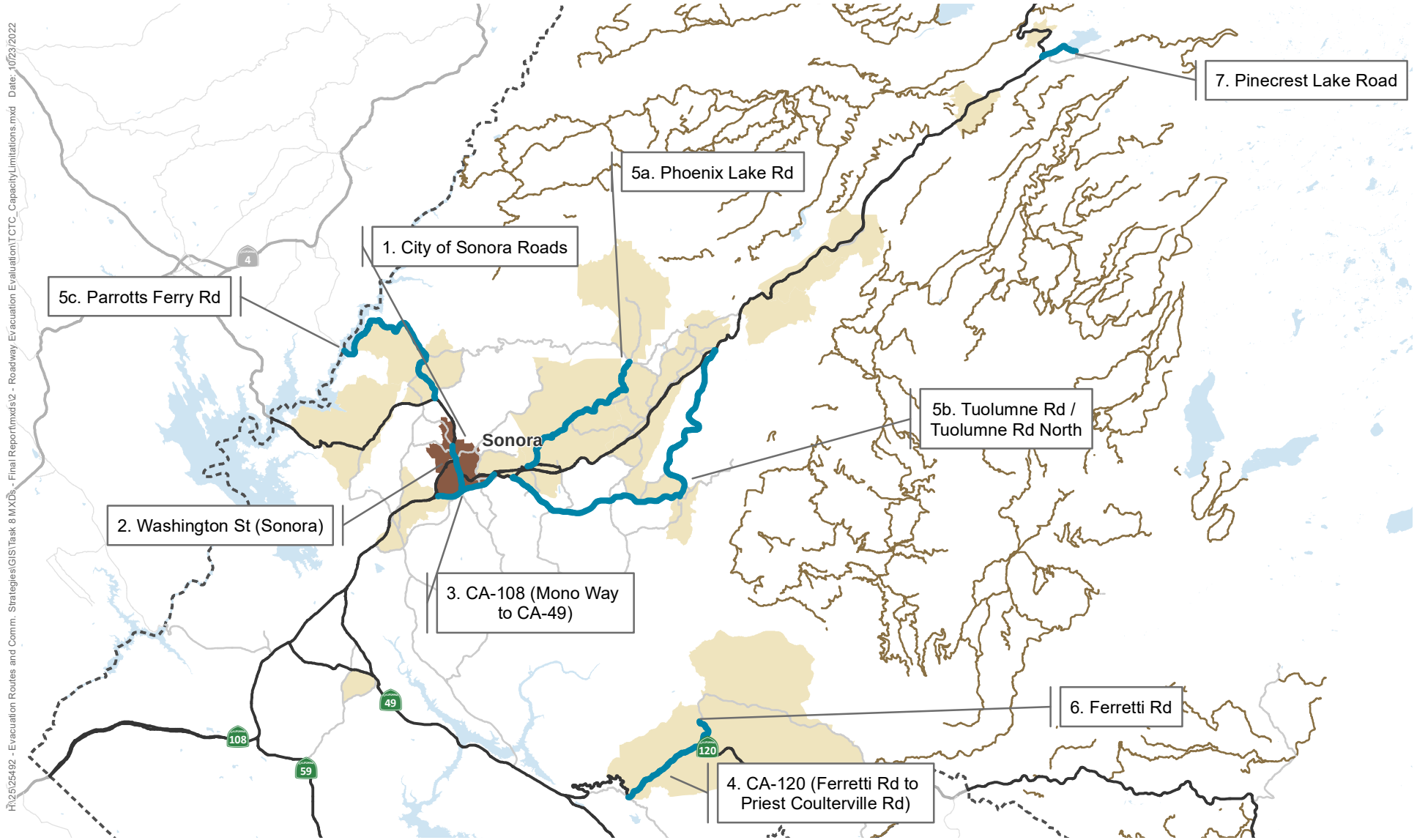
The approach used to model evacuations is less suited for identifying congestion on specific local roads, where evacuation might be expected to spike sharply, such as an entrance to a single community. As a result, the analysis did not identify congestion or over capacity conditions on smaller local roads. However, it did indicate that during evacuations volumes would be expected to grow substantially relative to normal patterns, which could produce operational constraints that interfere with evacuations.

Indicative Local Roads where congestion may occur include:

6. Ferretti Road at CA-120 (Groveland Fire Scenario)
7. Pinecrest Lake Road at CA-108 (Camp Blue Fire Scenario)

Additionally, based on community and stakeholder feedback during the engagement process, the following additional roadways were identified as locations that are expected to have high volumes from evacuating traffic in the modeled scenarios:

- Pinecrest and Strawberry intersections with State Route 108 (Camp Blue Scenario)
- Greenley Road (All Fire Scenarios except Camp Blue and Groveland)
- Lyons Bald Mountain Road (Cabezut Scenario)
- Big Hill Road (Cedar Ridge Scenario)
- Yosemite Road and Algerine Road (Apple Colony Scenario)
- Kewin Mill Road (Cedar Ridge Scenario)
- North Airport Road and Horseshoe Bend Road (Columbia Scenario)
- Campo Seco Road (Community Meeting Input)
- Fraser Flat Road (TCTC Board Meeting Input)
- Mt. Elizabeth Road (TCTC Board Meeting Input)
- Mt. Provo Road (TCTC Board Meeting Input)
- Mono Way (TCTC Board Meeting)



Capacity Limitations

Roadways

State Highways and Major Roads

Minor Roadways

Forest Service Roads

Cities

Census Designated Places

Tuolumne County

0 4 Miles

Figure 11

Potential Capacity Limitations
Evacuation Needs Assessment and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES

NETWORK CAPACITY IMPROVEMENTS

Following the results of the evacuation needs assessment, a set of strategies and treatments were identified for improving the capacity and resilience of the Tuolumne County roadway network to support potential evacuation events. The strategies were identified based on previous congestion and evacuation studies, review of recent evacuation efforts, and staff feedback.

Nine representative locations were then selected to show how the treatments could be applied to locations with a higher risk of congestion during an evacuation. The locations include sites that were congested under multiple future scenarios, such as Washington Street in Sonora, or which were representative of a common location type identified at multiple places in the County.

Table 1: Representative Locations and Treatments

Location	Strategies and Treatments
CA-49/108 West of Sonora	• Reversable Lane / Contraflow • Emergency Shoulder Usage
CA-120 West of Groveland	• Construct Share Use Path that Supports Vehicles • Emergency Shoulder Usage
Washington Street in Sonora	• Close Roads / Prohibit Street Parking • Manage Off-Street Parking at Major Trip Generators • Coordinate Signals – Green Carpet
Phoenix Lake Road	• Maintain Road and Shoulder Clearance Program for Secondary Roads
Pine Mountain Lake	• Add Secondary / Additional Access to Vulnerable Communities
Tuolumne City & Tuolumne Road	• Signal Coordination – Dynamic Flashing Yellow
Pinecrest and Strawberry	• Maintain Road and Shoulder Clearance Program for Secondary Roads • Construct Share Use Path that Supports Vehicles
Mill Villa	• Add Secondary / Additional Access to Vulnerable Communities • Construct Share Use Path that Supports Vehicles
Southwest Tuolumne County	• Build / Upgrade Road to Standard Needed for Evacuation

For each location, cutsheets were developed to show how treatments could be applied at the representative locations. The cutsheets include context for the improvement's selection, a map with potential project extents, and cross sections where applicable. The cutsheets are followed by descriptions of individual treatments. A complete summary of additional potential treatment strategies to enhance roadway network resiliency during evacuations is provided in Appendix D. The appendix provides additional detail for the strategies and treatments, including implementation needs and case studies, where available.

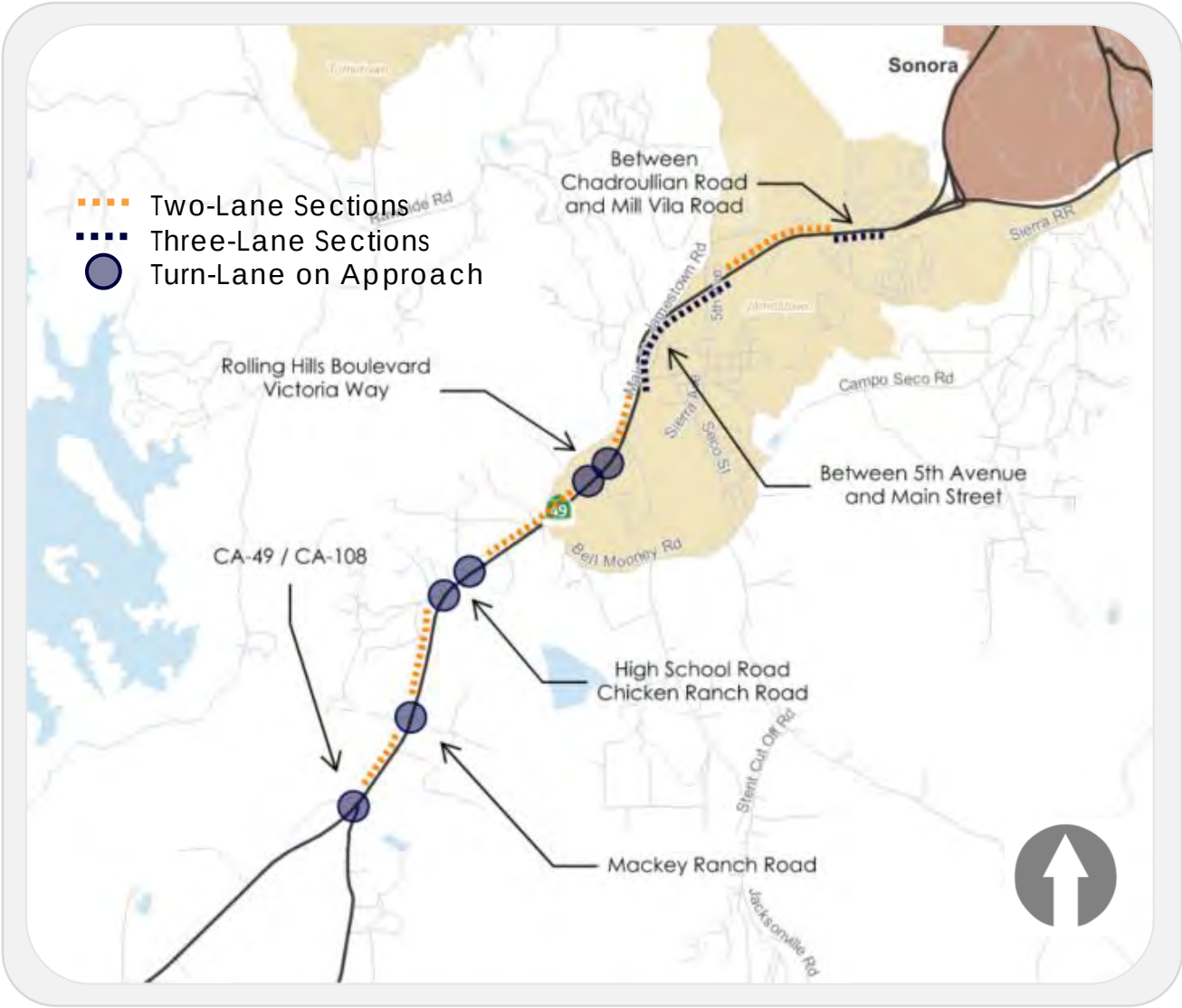
The treatments in Table 1 are recommended since they can be implemented in the near-term (5-10 years), subject to available funding and construction. Long term improvements, such as the Greenley Road extension in Sonora or widening of CA-108 have been identified in the County's long range plans but are currently unfunded. These projects would provide additional evacuation capacity on the County roadway network and support evacuation capacity needs, if constructed. Note that several of the strategies require interagency coordination (e.g., coordination with Caltrans) for implementation and will require additional feasibility studies to determine ultimate implementation.

CA-49/108 West of Sonora
Treatments: Reversible Lane / Contraflow & Expanded Shoulder

Context: Primary egress route for evacuation traffic leaving the County. Modeling indicates operational limits during evacuations. The route currently includes a mix of two-lane cross-sections with shoulders and three-lanes with a turn lane.

Treatment: Consider using coning to convert two-lane sections of the corridor to three lanes using the shoulder. Where necessary, shoulder(s) may need to be expanded to provide sufficient roadway width. Convert left-turn lane to an evacuation lane. Consider maintaining one lane for emergency vehicle inbound access. When applying the treatment, consider closing or managing minor intersections based on roadway alignment, available staffing, and access to alternative routes.

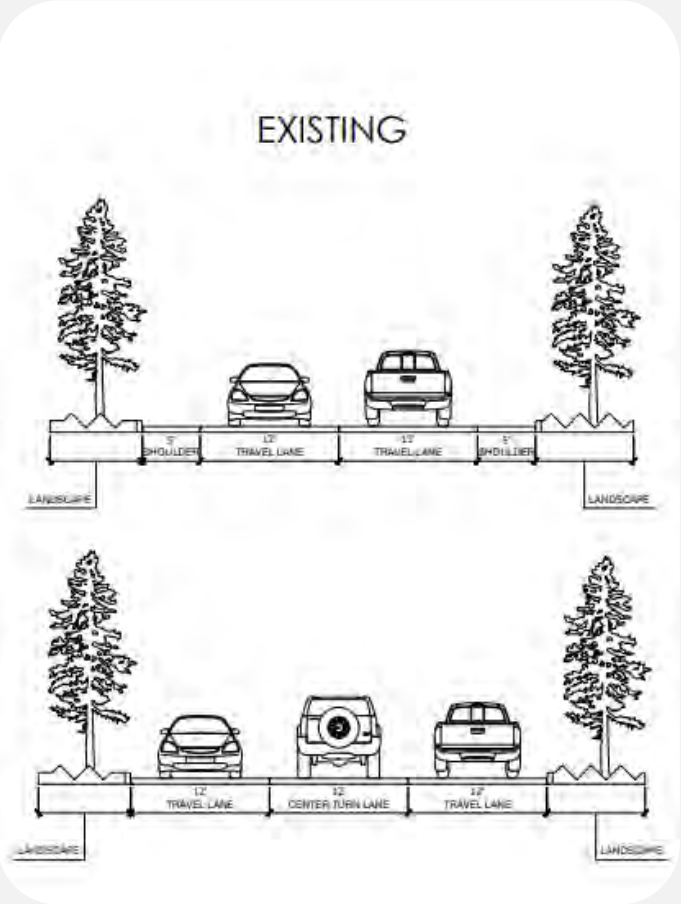
** Cross-section detail provided on next page.*

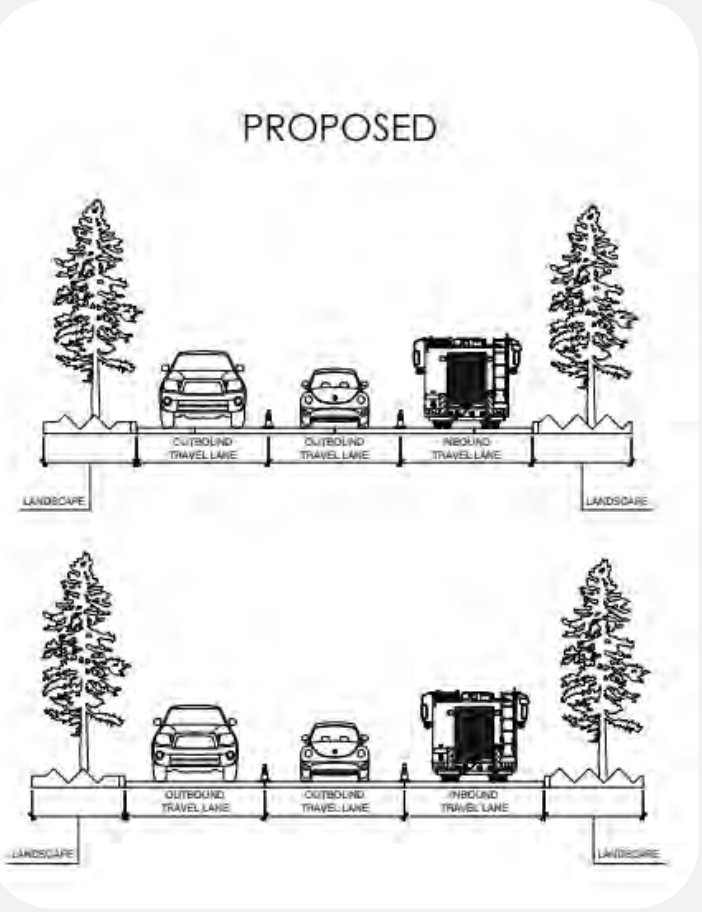


** Note long-term plans to widen CA-49 / CA-108 to five-lanes as noted in the RTP would also increase evacuation capacity. However, portions of the widening are not currently funded.*

CA-49/108 West of Sonora

Treatments: Reversible Lane / Contraflow & Expanded Shoulder







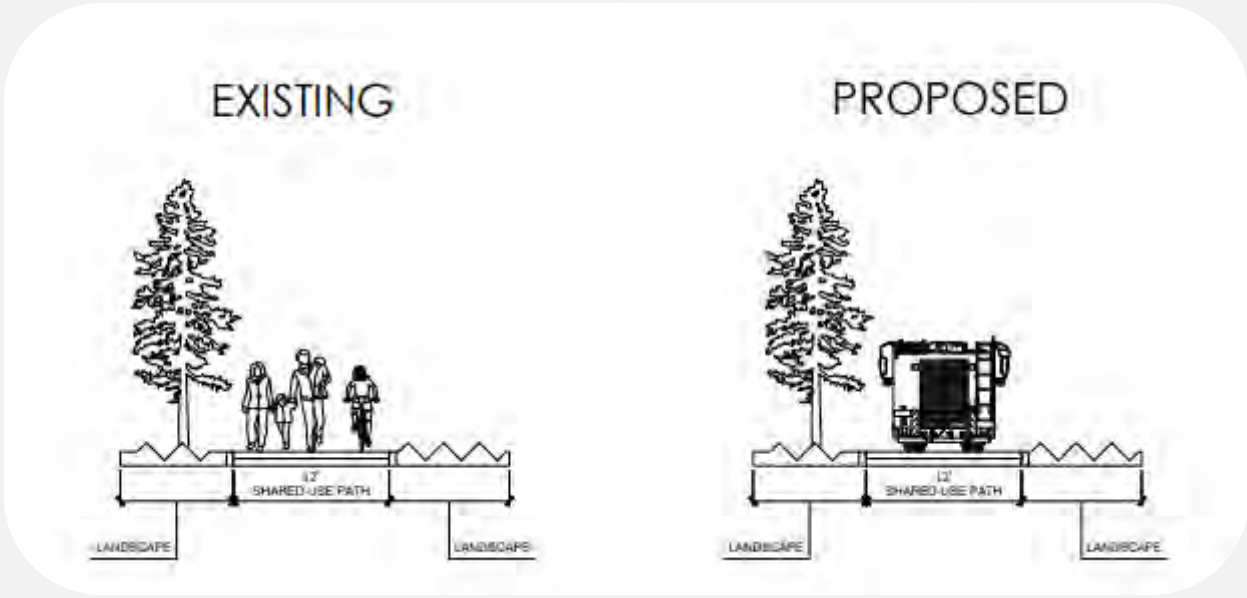


CA-120 West of Groveland
Treatment: Shared Use Path that Supports Vehicles

Context: Primary egress route for traveling west from Pine Mountain Lake and Groveland area. Modeling indicates greatest potential for congestion during evacuations immediately south of Pine Mountain and parallel to Big Oak Flat.

Treatment 1: Consider constructing the Groveland Regional Trail Project to support potential egress or emergency vehicle access.

Treatment 2: Consider construction of traversable shoulders to allow for three-lanes with coning along sections of the corridor.





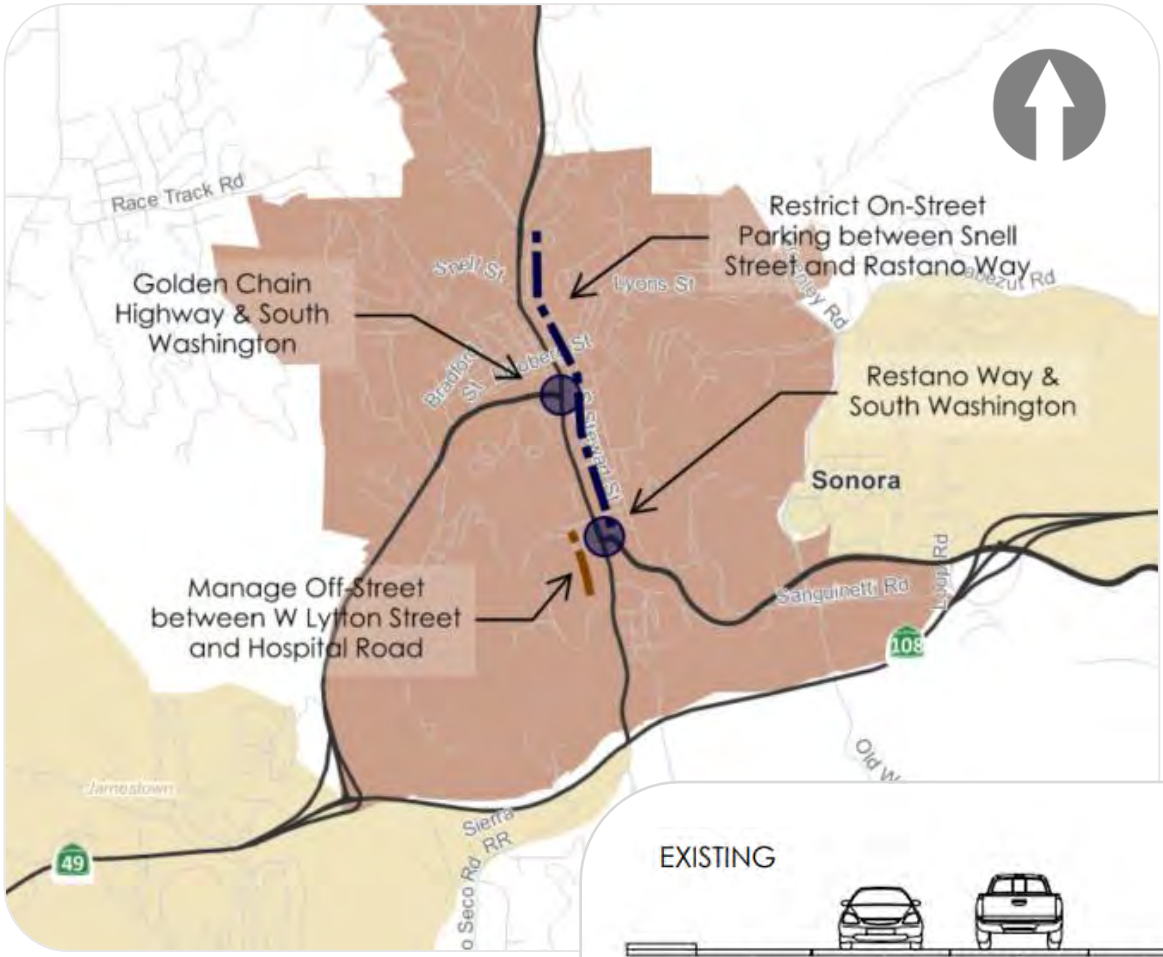
Washington Street, Sonora
Treatments: Prohibit Street Parking, Manage Access, and Coordinate Signal Improvements

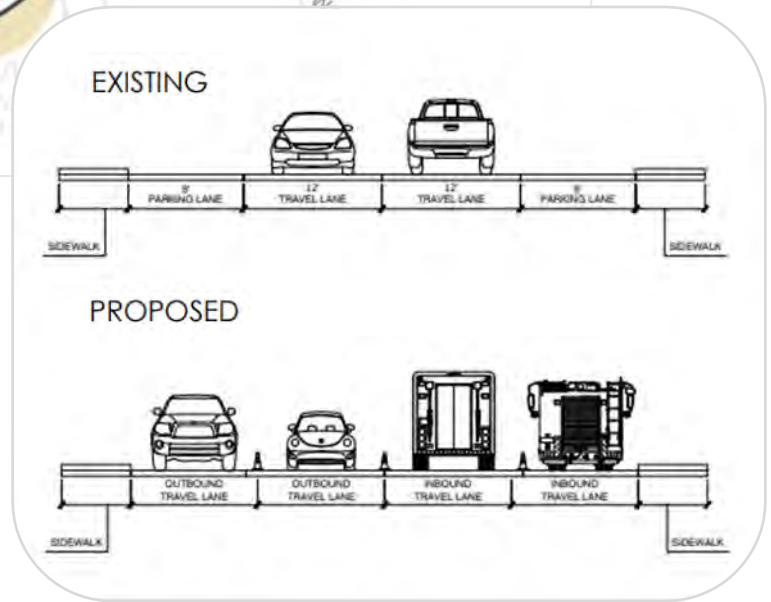
Context: Commercial corridor with on-street parking. County staff experience and modeling indicated likely congestion for evacuating traffic under multiple scenarios.

Treatments for consideration include:

- Restrict street parking between Snell Street and Restano Way to allow coning to create additional egress capacity.
- Manage parking access south of Restano Way to reduce potential delays along Washington Street.
- Coordinate signals to increase green time for evacuating traffic along Washington Street.

** Note that the Greenley Road Extension is a long-term project with the potential to increase evacuation capacity in and around Sonora by providing a bypass between CA-49 and CA-108. However, the project is currently not funded.*



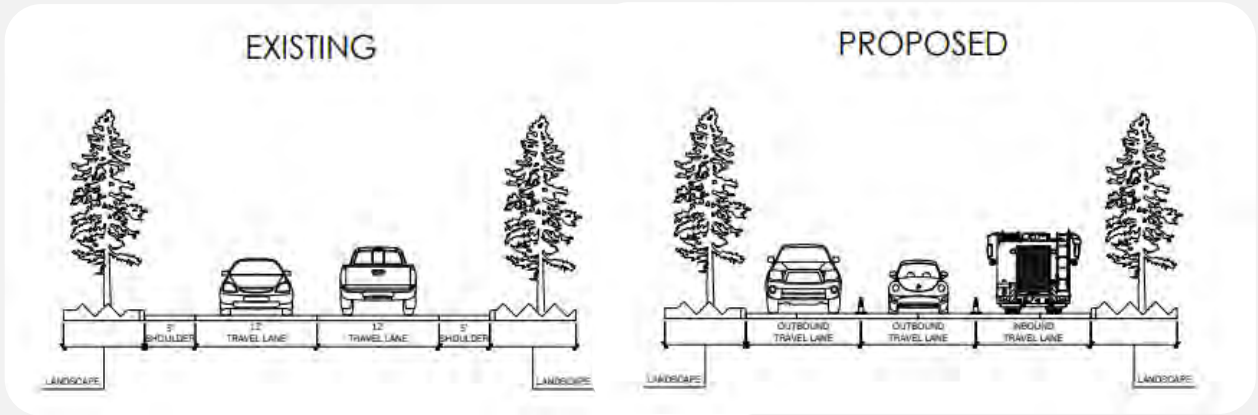


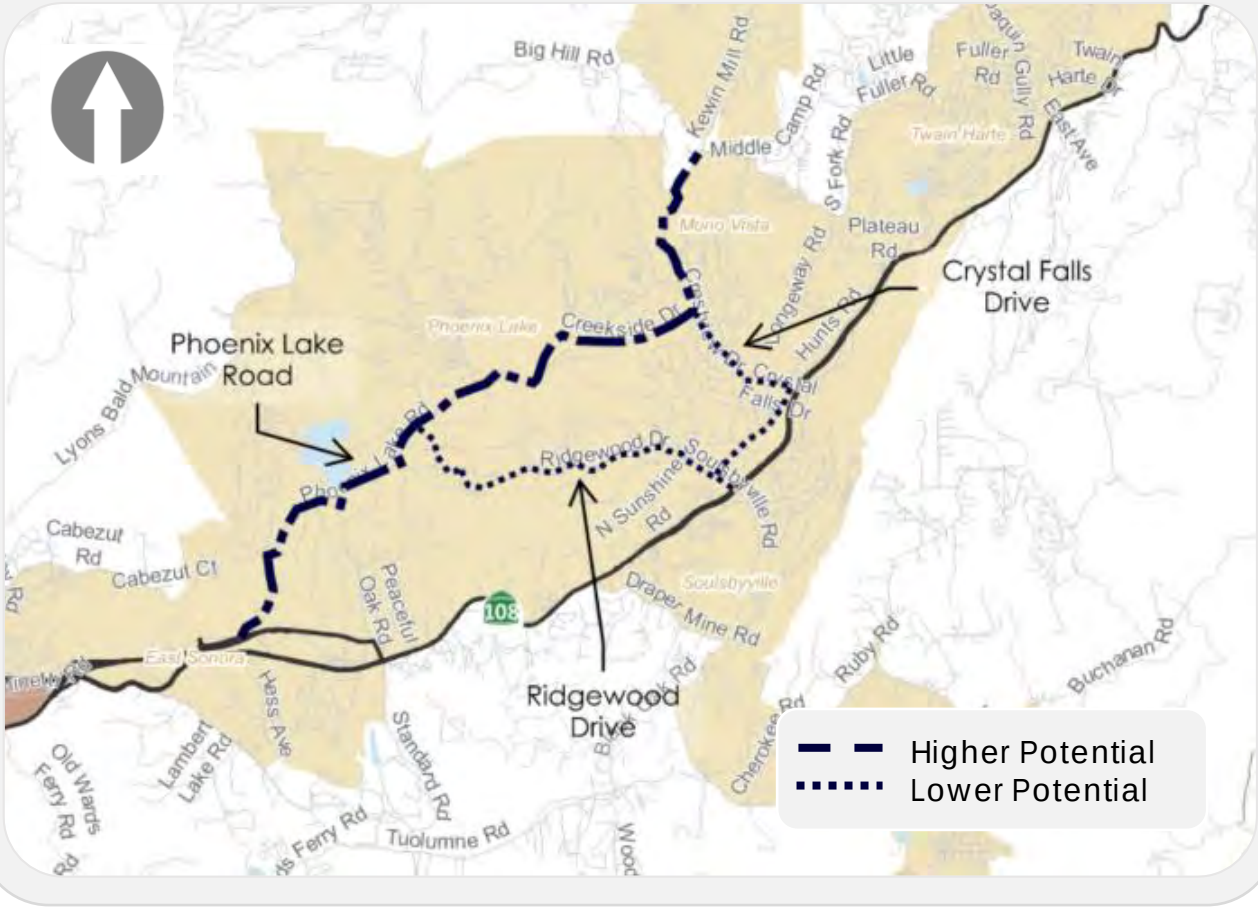
Phoenix Lake Road
Treatments: Shoulder Widening

Context: Two-lane residential corridor traveling through multiple communities north of CA-108. Provides connection to secondary roads with access to CA-108.

Treatment: Where possible, propose widening road with traversable shoulders that could be used in an evacuation to increase roadway capacity and/or emergency vehicle access. With widened shoulders, consider coning an additional lane, using two lanes for evacuation and maintaining one lane for emergency vehicles or other critical traffic.



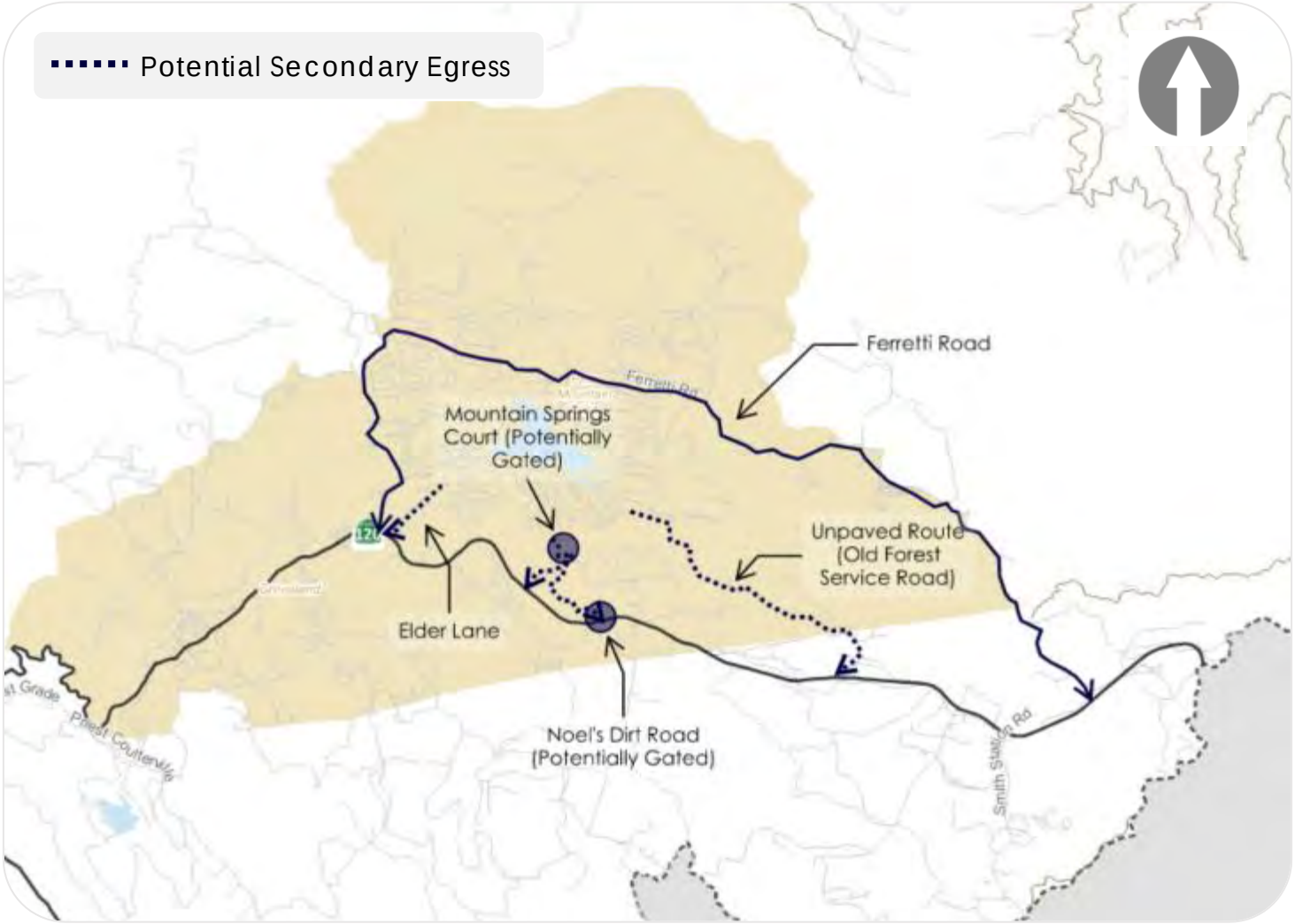




Pine Mountain Lake
Treatment: Access Management for Community

Context: Pine Mountain Lake has two primary access points where Ferretti Road connects to CA-120. Increasing potential egress routes would help to distribute traffic during an evacuation and reduce potential for bottlenecks.

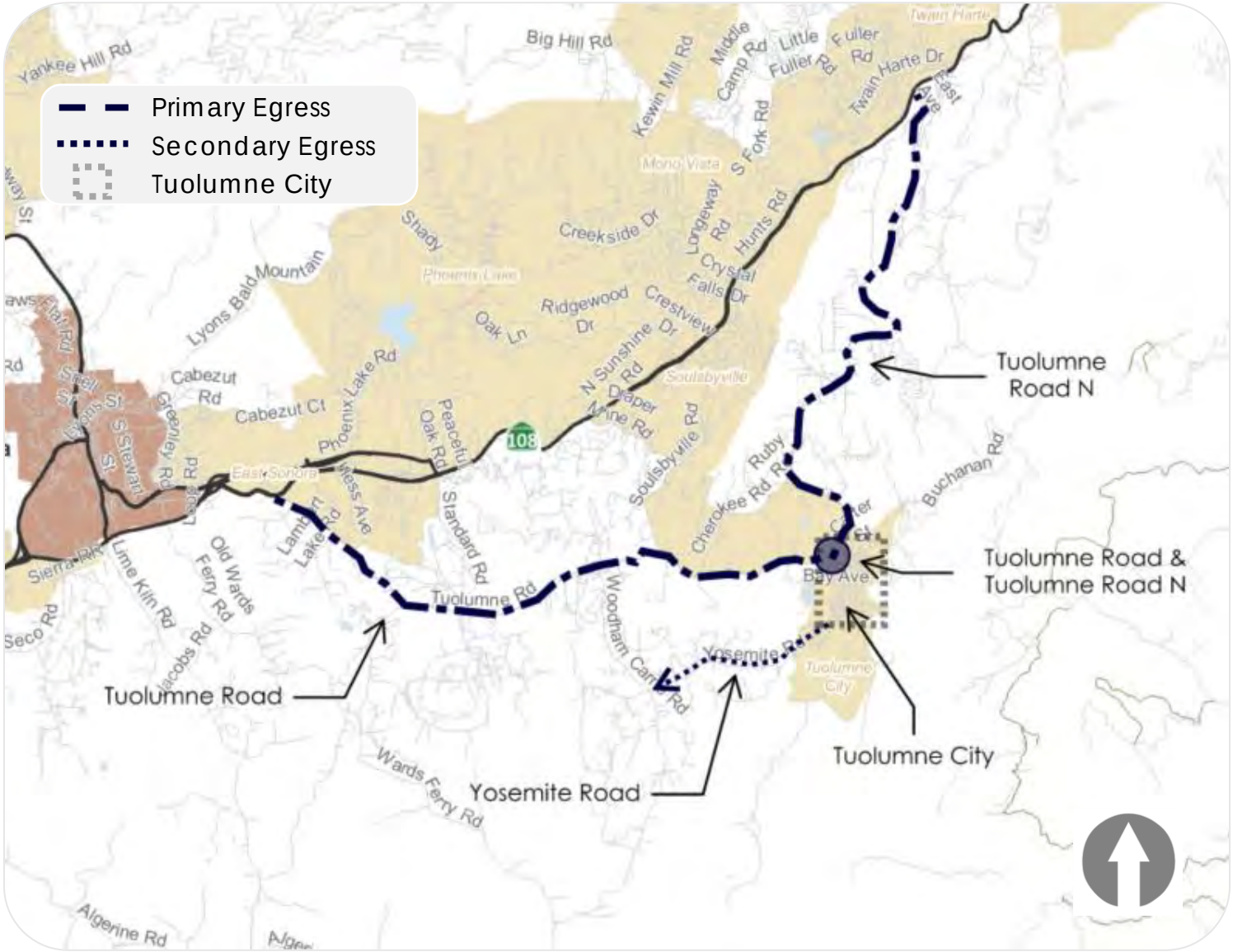
Treatment: Improve secondary egress routes where possible. Consider Mountain Springs Court, Noel's Dirt Road and the unpaved route traveling east as potential egress routes that could be improved and/or opened during evacuation. Improvements could be combined with communication strategies to encourage evacuees to disperse across the possible egress routes.



Tuolumne City & Tuolumne Road
Treatment: Intersection Management and Roadway Treatments.

Context: Tuolumne City is a relatively compact community located about eight miles from CA-108. The two primary routes for evacuees use Tuolumne Road. Tuolumne Road was modeled as having potential for congestion during an evacuation.

Treatment: If staffing permits, active management at the intersection of Tuolumne Road and Tuolumne Road North could improve flow of evacuees and allow for rerouting of traffic if necessary. Consider regular vegetation clearance along Tuolumne Road to reduce fire risk. Similarly, vegetation clearance along Yosemite Road could reduce pressure on the primary evacuation routes by providing a secondary egress route.

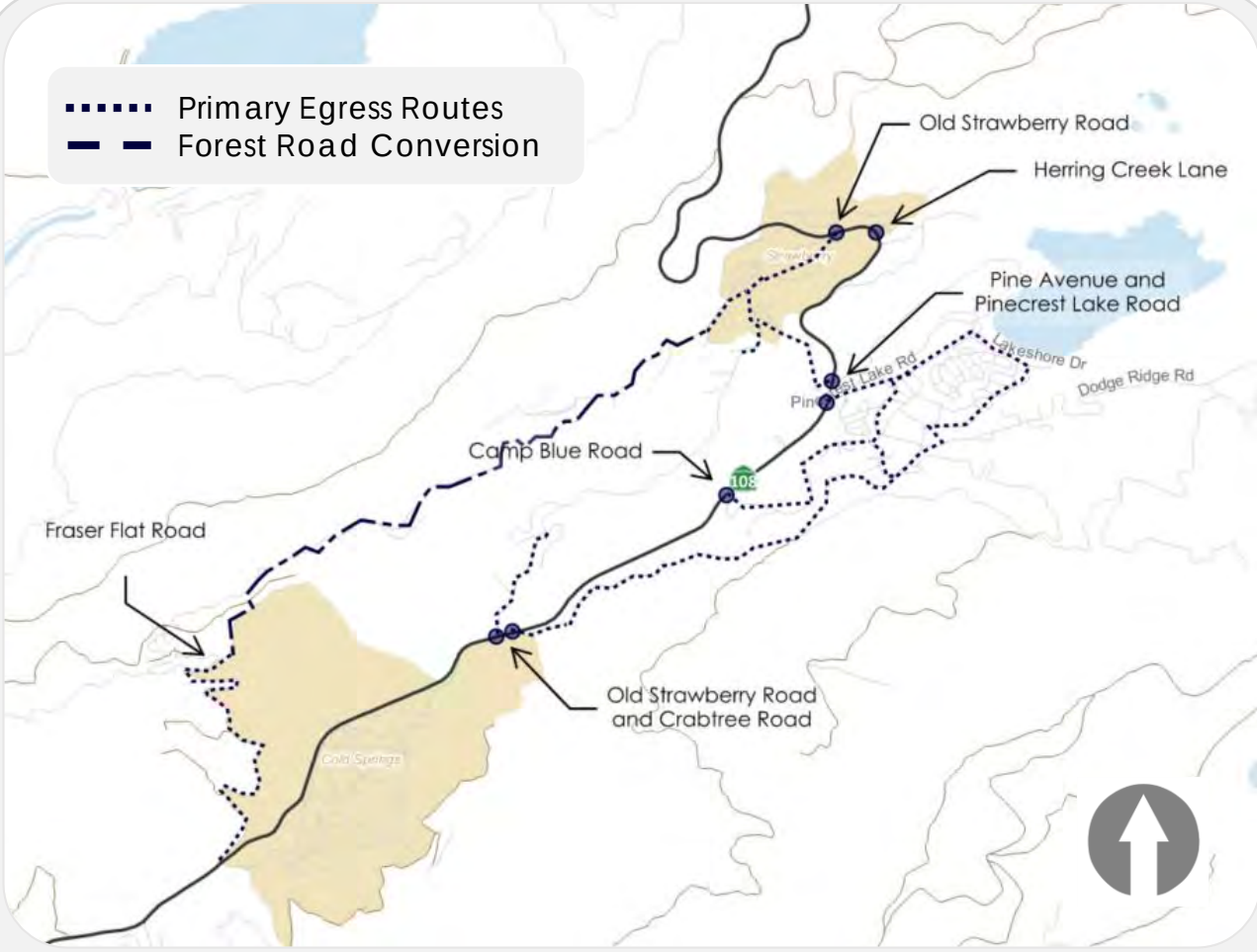


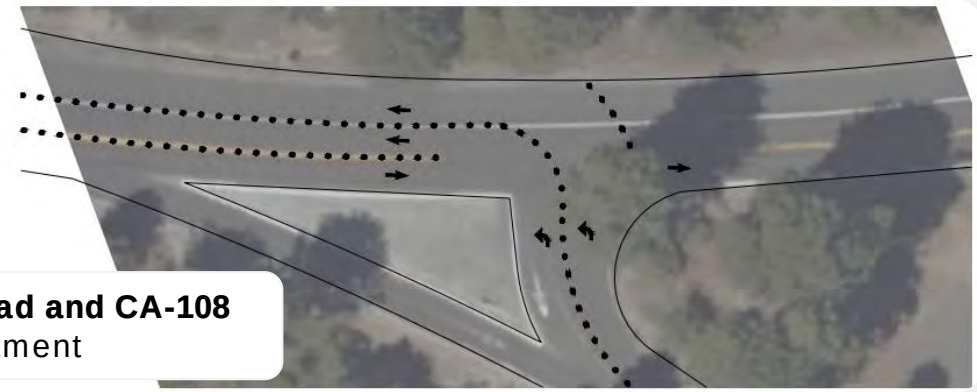
Pinecrest and Strawberry
Treatment: Access Management for Community

Context: Mountain community oriented along CA-108, with limited egress and highly impacted if travel along CA-108 becomes restricted.

Treatment 1: Consider vegetation clearance and traversable shoulder treatments on egress routes, such as Old Strawberry Road including widened shoulders at intersections with CA-108 to allow for the option to provide two lanes of outbound traffic using coning as shown in graphic.

Treatment 2: Consider potential improvement of Forest Route 4N13 between Fraser Flat Road and Old Strawberry Road. This route could be used either for evacuation egress or for emergency vehicles access.





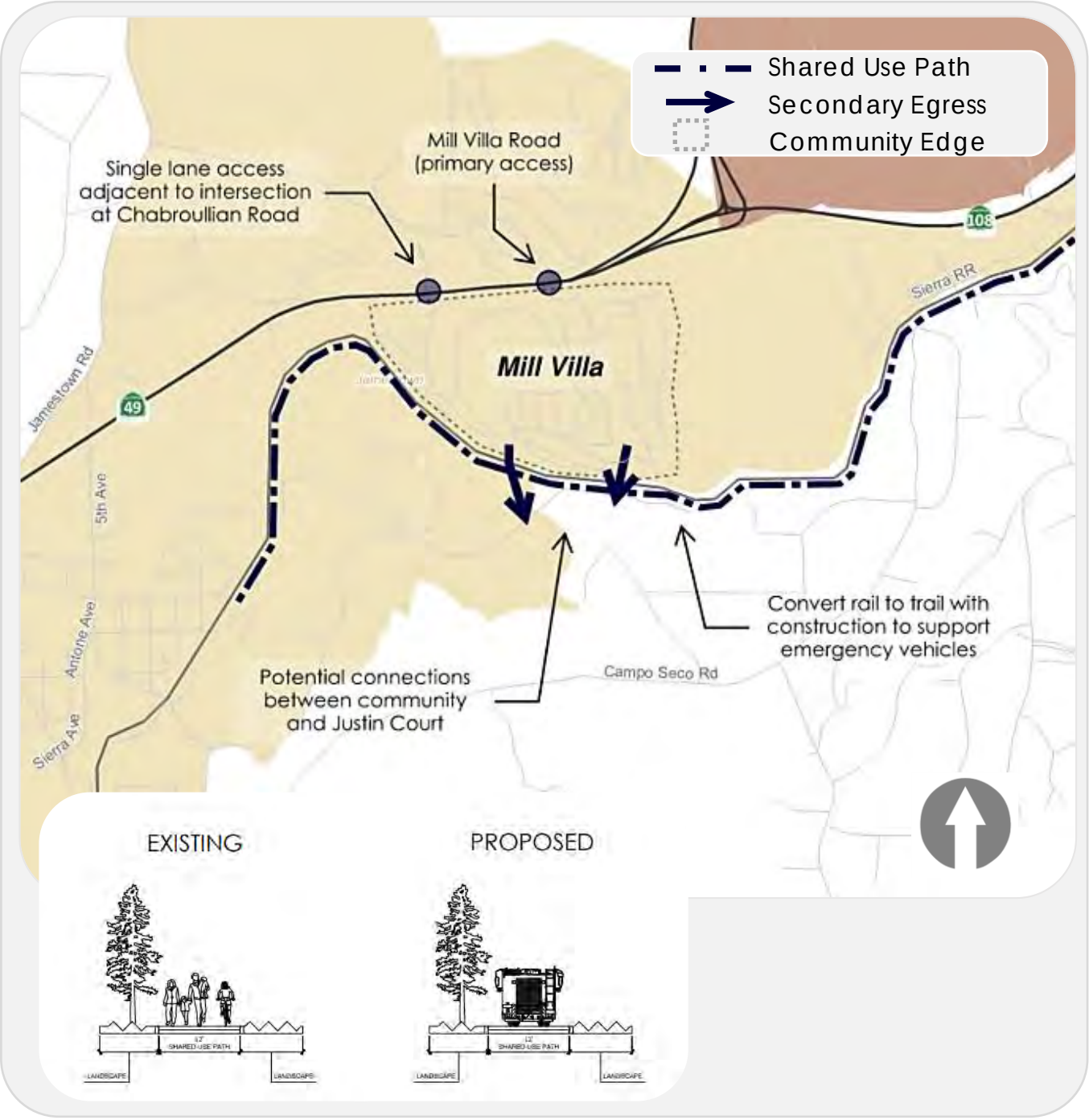
Pinecrest Road and CA-108
Coning treatment

Mill Villa
Treatment: Access Management for Community

Context: Mill Villa is a community located west of Sonora with a primary access at Mill Villa Road. Evacuation modeling identified this section of CA-108 as potentially congested during evacuations. During an evacuation turning left may be difficult and has the potential to disrupt westbound evacuation egress.

Treatment: Consider treatments to create secondary egress route(s) from the south of the community, such as a roadway connection between the community and Justin Court. In addition, the existing rail right-of-way behind the community could be improved as a shared-use path which could support evacuation egress or emergency vehicle access.

** See Vulnerable Populations and Communities Memo for communities where similar treatments may be applicable.*

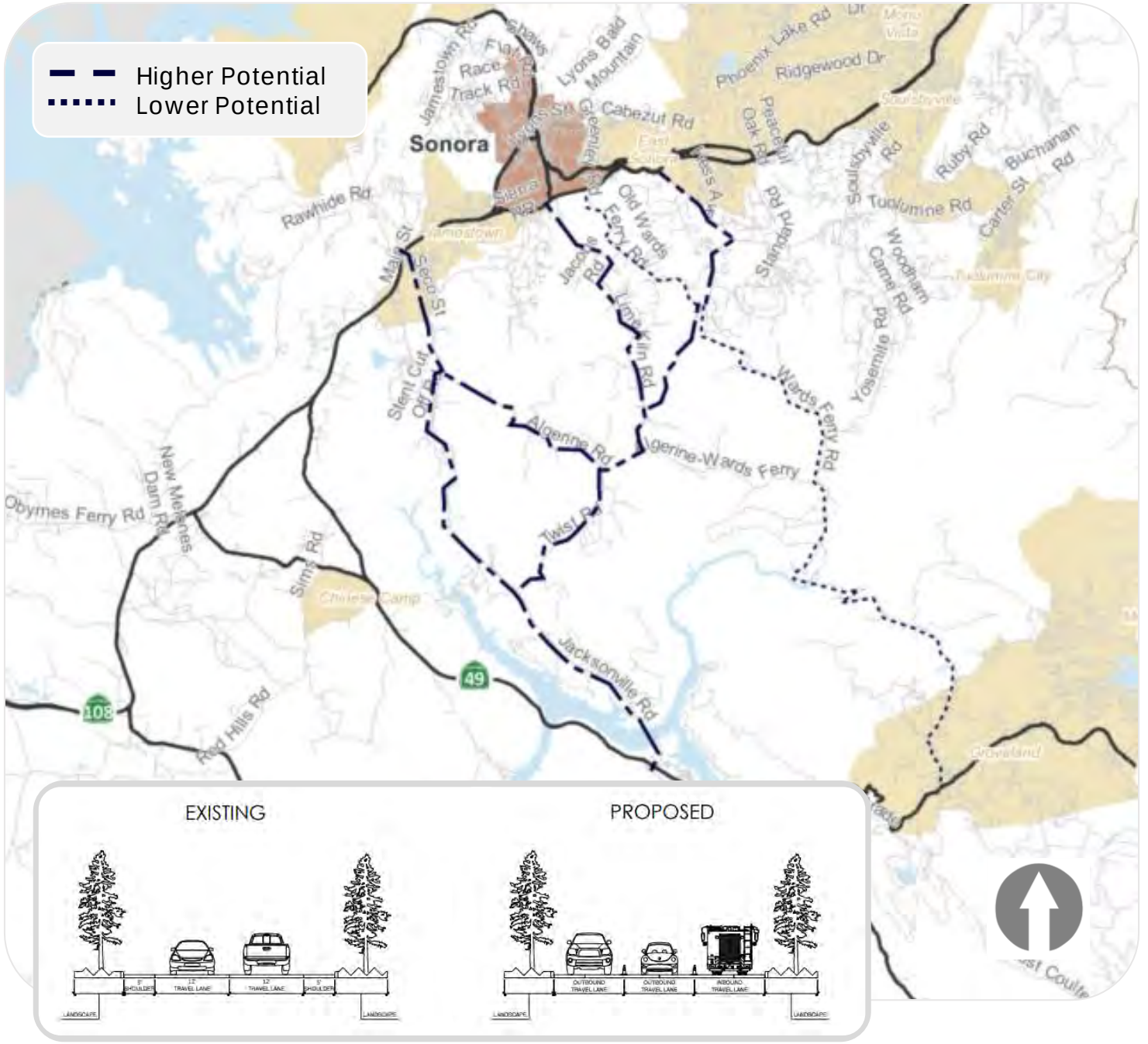


Southwest Tuolumne County
Treatment: Resilient Network with Cross-County Roadways through

Context: Modeling indicates that evacuation traffic would primarily use CA-108 or CA-120. There are relatively few roads that could serve as secondary egress routes if the state highways become congested.

Treatment: Consider potential improvements on secondary roads shown, such as constructing traversable shoulders to support use of coning to create three lanes during an evacuation. Treatment could be applied for full route or along segments of roads where there is greater potential for congestion.

** Additional detailed engineering analysis would be necessary to determine the feasibility for applying treatments to individual roadways.*



STRATEGIES AND TREATMENTS

Reversible Lane/Contraflow

Description: An operational strategy where capacity is added in one direction by reorienting one or more travel lanes to flow in the direction of the evacuation and away from the hazard[4]. This strategy can be attractive since it generally requires minimal infrastructure changes. Reversible lanes can be set up over long distances, such as state routes, or on localized segments, such as in neighborhoods that may only have a single egress route.

The strategy requires staff to implement traffic control at intersections to prioritize evacuation movements and restrict turn movements and lane changing (e.g., on- and off-ramps along grade separated state routes). In particular, intersections must be set up to prevent traffic in the closed direction. Signage and other safety measures need to be implemented on both sides of the roadway to ensure drivers are aware of roadway changes, especially along longer stretches where contraflow is implemented. Existing or new changeable message signs may be used, and consideration should be given as to whether existing signs can be modified where they can be turned around when needed to support the reversible lane or to communicate wrong-way movements when the lane has been reversed.

Managing movements at intersections is critical. As a result, staffing and level of effort to establish the treatment depends on the number of intersections along the roadway, with the treatment being harder to implement on roads with more intersections[5].

For implementation on state routes or facilities that would interact with state routes, a communication plan should be established to connect with the Caltrans Traffic Management Center.

Limitations: One of the primary limitations of the strategy is whether the roadway cross-section and right of way provide sufficient space to allow emergency vehicles to travel against evacuation traffic (either in a travel lane or on the shoulder). Contraflow also requires a large number of staff, enough resources (e.g., cones and signs), and sufficient time to implement. Staffing limitations may delay the implementation of the strategy or limit where the strategy can be implemented.

Emergency Shoulder Usage

Description: This strategy is a variation on Reversible Lane/Contraflow. Under the strategy, the shoulder of a roadway is widened and paved to allow for use as an additional lane of traffic for personal or emergency vehicles during evacuation. Cones or other markers may be used during implementation to identify lanes or reallocate space, as necessary, especially around intersections where the shoulder could conflict with normal turn patterns.

Where possible, the strategy may be preferred over reversible lanes/contraflow because it can be implemented very quickly, does not close the roadways to vehicles that would travel in the opposite direction, and requires less operational support for securing travel lanes and readjusting intersections.

Limitations: In Tuolumne County, most shoulders are not sufficiently wide to currently support the strategy. As a result, this strategy would likely require road widening and removal of trees or other existing infrastructure, resulting in high construction costs. Additionally, the existing shoulder structural section may

[4] For additional information on current resources for contraflow lanes, see Zhao, B., & Wong, S. D. (2021). Developing Transportation Response Strategies for Wildfire Evacuations via an Empirically Supported Traffic Simulation of Berkeley, California. https://escholarship.org/uc/item/70p6k4rf.

[5] For additional information on turn restriction mechanisms see Cova, T. J., & Johnson, J. P. (2003). A network flow model for lane-based evacuation routing. Transportation Research Part A: Policy and Practice, 37(7), 579–604. https://doi.org/10.1016/S0965-8564(03)00007-7

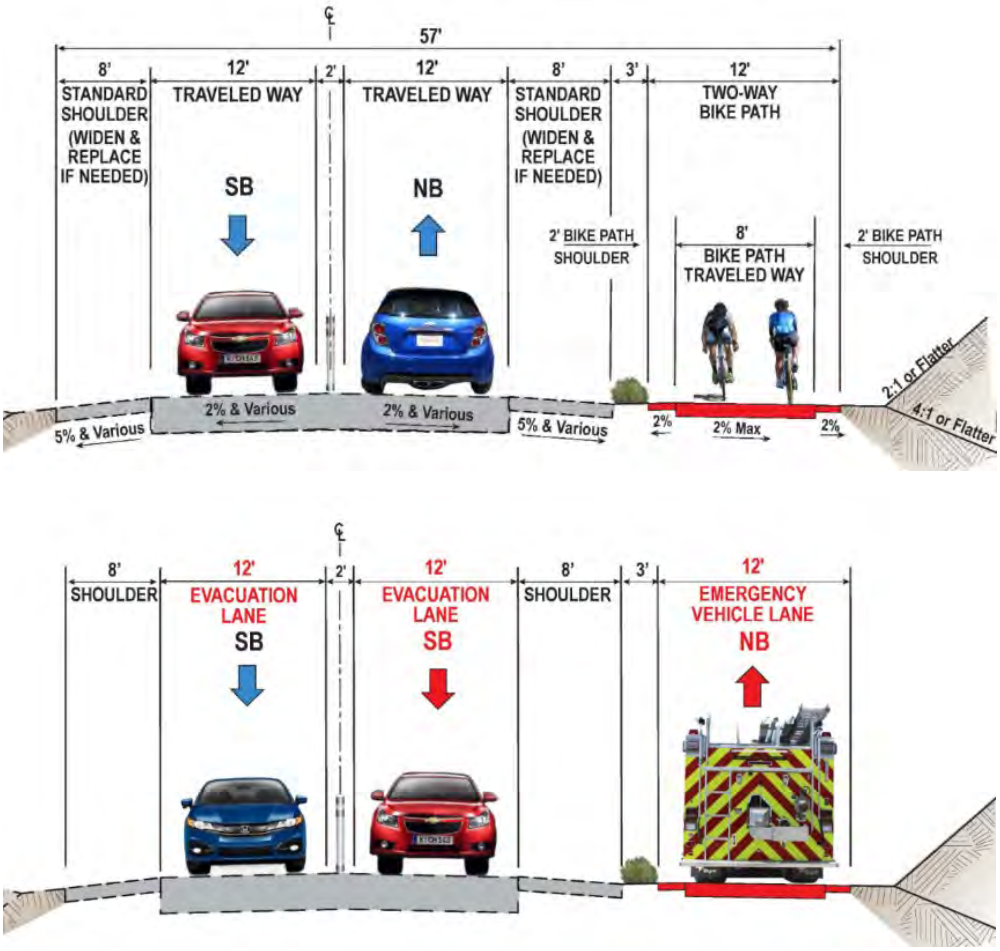
not be suitable for repeated use, especially if heavy vehicles/truck utilize the shoulder area – as a result, the existing shoulder structural section may need to be replaced. Consideration should be given to the presence of trailers, campers, and other wide loads which may complicate required travel widths. Staffing limitations may delay the implementation of the strategy.

Construct Shared Use Path that Supports Vehicles

Description: An engineering strategy that constructs a shared use path that is built to a standard that would allow use by residential or emergency vehicles during an evacuation. Outside of an emergency, the shared use path would be accessible to residents and visitors for walking and biking. This strategy could be implemented separate from or parallel to a primary evacuation route. If constructed parallel to a primary evacuation route, the strategy would have similar operational benefits the emergency shoulder use treatment.

This strategy requires careful access management design that prevents access to personal vehicles during normal periods, but which can be altered to allow emergency vehicle access when necessary. Figure 12 presents an example of a shared use path that can be converted to an evacuation route or emergency vehicle lane. Caltrans is considering an alternative as part for the State Route 67 Improvement Project in Southern California as shown in Figure 12.

Figure 12: State Route 67 Alternative with Two-Way Bike Path / Emergency Vehicle Lane



Source: Caltrans, https://dot.ca.gov/caltrans-near-me/district-11/current-projects/sr67-corridor/improvements

Limitations:

This strategy can be cost-intensive and there is potential for substantial land acquisition costs. The land adjacent to roadways may be owned by an assortment of agencies, including the City of Sonora, Tuolumne County, Chicken Ranch Rancheria of Me-Wuk Tribe, Tuolumne Band of Me-Wuk Tribe, United States Forest Service (USFS), and private owners. Coordination with landowners may be required if shared use paths are constructed through land not owned by the County.

Close Roads/Prohibit Street Parking

Description: This strategy identifies roads and parking locations along major evacuation routes to close or prohibit parking during high-risk conditions or during an evacuation. Closing roads is targeted towards limiting people from visiting high risk areas during evacuations. It could also be used to reserve roadway access for emergency vehicles. Prohibiting parking can support evacuation by limiting travel to a high-risk area or by reducing conflicts created by vehicles leaving or merging into traffic. Parking may also be prohibited where normal parking activity may impede emergency vehicles from reaching critical infrastructure, especially on narrow roadways. The City of Los Angeles maintains a Red Flag Restricted Parking Program for prohibiting parking on specific roads and locations.[6] The program prohibits parking on streets in Very High Fire Hazard Severity Zones during Red Flag alters and allows the City to remove parked cars if they are determined to interfere with evacuations and emergency operators.

Limitations:

- Road closures could impact residents and may need to be established as only applying to visitors.
- Communication of the parking program would need to include a communication plan for visitors in Tuolumne County that may be unaware of roadway and parking restrictions and alternative routes.
- Program could conflict with normal parking behavior near trail heads and other outdoor destinations.
- Staff limitations may reduce the number of locations where the strategy can be implemented.

Manage Off-Street Parking at Major Trips Generator

Description: Large trip-generating land uses can create substantial traffic. If those uses are located along or near a major evacuation corridor, traffic related to the land use could impede evacuation. Closing specific access or actively managing parking entrances to orient traffic away from evacuation routes could reduce potential for congestion, either by reorienting traffic or discouraging evacuees leaving and then reentering flow of traffic.

Limitations:

- Closing parking lots and reorienting traffic may require coordination with local businesses.
- May create confusion or opposition from residents and businesses impacted by changes.
- Staffing limitations may reduce the number of locations where the strategy can be implemented.

Signal Coordination – Green Carpet (Uninterrupted Flow)

Description: An operational strategy where traffic signals along a corridor are set to prioritize the through the movement of evacuation traffic by (1) holding or reducing movement from side streets and (2) restricting left-turn movements. To minimize evacuation time, vehicles leaving the impacted area are prioritized while movements from areas not-yet impacted are restricted. This strategy can also discourage evacuees from detouring from the evacuation route. The strategy can also be applied in small areas where

[6] https://ers.lafd.org/redflag/

there may be a single traffic signal. City of Placerville and Caltrans implemented a green carpet through the city of Placerville during evacuation for the Caldor Fire.[7]

Limitations:

- Tuolumne County has some communities with only one egress route, such that limiting use of the mainline road unacceptably limits local movement.
- May create additional confusion for drivers, either because it (1) prevents evacuees from diverging from through movement or (2) restricts drivers from entering from minor streets.
- Staff limitations may reduce the number of locations the strategy can be implemented at, especially if traffic control is needed.

Maintain Road and Shoulder Vegetation Management and Clearance Program for Secondary Roads

Description: This strategy creates a more resilient evacuation system by annually managing and clearing vegetation on critical secondary roads to reduce fire risk during evacuation. Based on context, specific roads may be identified for engineering treatments such as shoulder widening or tree removal to support use for evacuation. Plans may consider maintaining smaller or more difficult to travel roads exclusively for use by emergency vehicles.

Limitations: Clearing roadways can be expensive and requires targeting of resources.

Add Secondary/Additional Access to Vulnerable Communities

Description: Tuolumne County and CAL FIRE have identified multiple small communities and developments where residents are served by one or two access points. In the event of a rapid evacuation, this could lead to congestion in the development or at locations where vehicles connect with a major roadway. In addition, a fire could more easily block access by closing the available evacuation route.

Moving forward, State Bill 99 (SB 99), signed on August 30, 2019, requires jurisdictions to identify residential developments in hazard areas that do not have at least two evacuation routes upon the next revision of their housing elements.[8] Under the strategy, additional egress routes would be developed to serve evacuation. Where possible, the added access would allow for evacuation in a different direction in case a fire closes an available route.

Limitations

- Geography may limit options for egress, such that secondary access would be to the same evacuation route. This would still add resilience and better distribute trips merging onto the evacuation route.
- Viable routes may require the acquisition of private property.
- Projects may be expensive and provide relatively little county-wide benefit.
- Routes only available during an evacuation may have access limitation that need to be removed during an evacuation, such as gates or bollards.
- Coordination with landowners may be required if secondary access paths are constructed through land not owned by the County (e.g., City of Sonora, Tuolumne County, Chicken Ranch Rancheria of Me-Wuk Tribe, Tuolumne Band of Me-Wuk Tribe, United States Forest Service (USFS), and private owners)

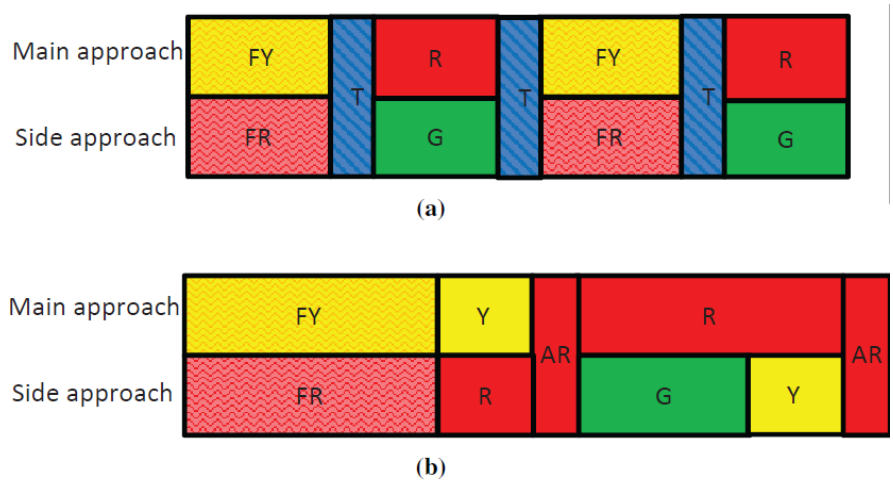
[7] https://www.sacog.org/news/caldor-fire-evacuees-greeted-green-lights-through-placerville
[8] https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201920200SB99

Signal Coordination – Dynamic Flashing Yellow

Description: An operational strategy where traffic signals are set to use a flashing yellow signal on the main evacuation approach and a flashing red on the side street. This strategy may be more appropriate at intersections where a) side streets have significant traffic demand and/or b) there is an absence of available detour routes to serve side street traffic.

In Phase 1, flashing yellow–flashing red (FY/FR), the traffic signals on the main street flash yellow, whereas the side street signals flash red. In Phase 2, green–red (G/R), the main street signal will stay red, and the side street signal will turn green. The goal of using the G/R phase is to quickly clear waiting vehicles on the side streets. Figure 13 shows a signal plan for a dynamic flashing yellow.

Figure 13 Dynamic Flashing Yellow Timing Plan – Two Phases (a) and One Cycle (b)



Source: Asamoah, C. A. (2014). Dynamic flashing yellow for emergency evacuation signal timing plan in a corridor: Semantic scholar. undefined. Retrieved May 4, 2022, from https://www.semanticscholar.org/paper/Dynamic-flashing-yellow-for-emergency-evacuation-in-Asamoah/f896455e97acf37f0cd01cc5f3bbb1ddbb79fc29

Limitations:

- Relatively few traffic signals in Tuolumne County.
- Staff may be needed to assist with managing traffic. In particular, drivers at extended red lights may elect to ignore signals. Staff limitations may reduce the number of signals where strategy can be implemented.

Build/Upgrade Existing Roads to Standard Needed for Evacuation Traffic

Description: An engineering strategy that includes adding new roads or upgrading roadways to support evacuation activities. This strategy is similar to the strategy Maintain Road and Shoulder Clearance program in that the intention is to create a more connected roadway network for evacuations. The difference is that the previous strategies target existing roadways where maintenance would allow for use of the road for evacuation. This strategy is a more capital-intensive strategy to install new or substantially alter existing roads, such as by expanding the width of the road. The Greenley Road extension in the City of Sonora and CA-49/108 are two example projects that have been identified in long-range plans to increase roadway capacity that would support evacuation traffic in the vicinity of Sonora.

Limitations: Cost-intensive strategy and potential for substantial land acquisition costs. May also require coordinating with an assortment of agencies, including the City of Sonora, Tuolumne County, Chicken Ranch Rancheria of Me-Wuk Tribe, Caltrans, Tuolumne Band of Me-Wuk Tribe, USFS, or private owners.

VULNERABLE COMMUNITIES

As part of the Roadway Evacuation Needs Evaluation, additional work was conducted to identify and develop potential strategies and treatments for communities at increased risk due to limited access or egress that could limit fast and efficient evacuations. The report identifies potential access or egress route improvements for evacuations or emergency vehicles access have been identified. Additional detail is available in Appendix E.

Vulnerable communities are defined as community areas with limited access or egress that could limit fast and efficient evacuations. CAL FIRE and Tuolumne County have identified 22 official vulnerable communities within the County. These are communities that only have one access or egress route to the County roadway network and face a risk of not evacuating in time during a wildfire event[9]. Figure 14 shows where these communities are within the County.

Tuolumne County has also developed Community Maps in print[10] and online[11] form for various vulnerable communities throughout the County. These maps are intended to be used by residents to plan for evacuations during emergencies. In communities that lack a secondary egress route, residents and emergency managers may consider earlier evacuation orders than usual if the community are threatened by wildfires.

Potential Access and Egress Improvements

The following section documents potential opportunities for additional egress and emergency access in the case of an emergency evacuation for each vulnerable community. Development of secondary access is largely dependent on funding for planning, design, and construction. These following opportunities for secondary access may be integrated into future planning and project development processes for the community areas to help increase evacuation capacity and resiliency across Tuolumne County. However, no funding has been identified or allocated to these concepts at this time and no detailed feasibility assessment has been performed for implementing the improvements. Coordination with landowners may also be required if secondary access paths are constructed through land not owned by the County (e.g., City of Sonora, Tuolumne County, Chicken Ranch Rancheria of Me-Wuk Tribe, Tuolumne Band of Me-Wuk Tribe, United States Forest Service (USFS), Caltrans and/or private land owners). The recommendations below will require additional coordination and feasibility studies to determine the applicability of the potential improvements.

[9] Note that communities with more than one egress point can be considered vulnerable for a variety of reasons, and should also be evaluated on a case by case basis. Research has identified that indexing communities based on the ratio of households per egress is an effective approach to identifying additional communities that may be vulnerable. See Cova, T. J., & Johnson, J. P. (2003). A network flow model for lane-based evacuation routing. Transportation Research Part A: Policy and Practice, 37(7), 579–604. https://doi.org/10.1016/S0965-8564(03)00007-7

[10] Tuolumne County Community Maps: https://www.tuolumnecounty.ca.gov/1169/Community-Maps

[11] Tuolumne County Community Preparedness Web Map: https://tuolumne.maps.arcgis.com/apps/webappviewer/index.html?id=243823f4378b48cea33ca44c75c120f1

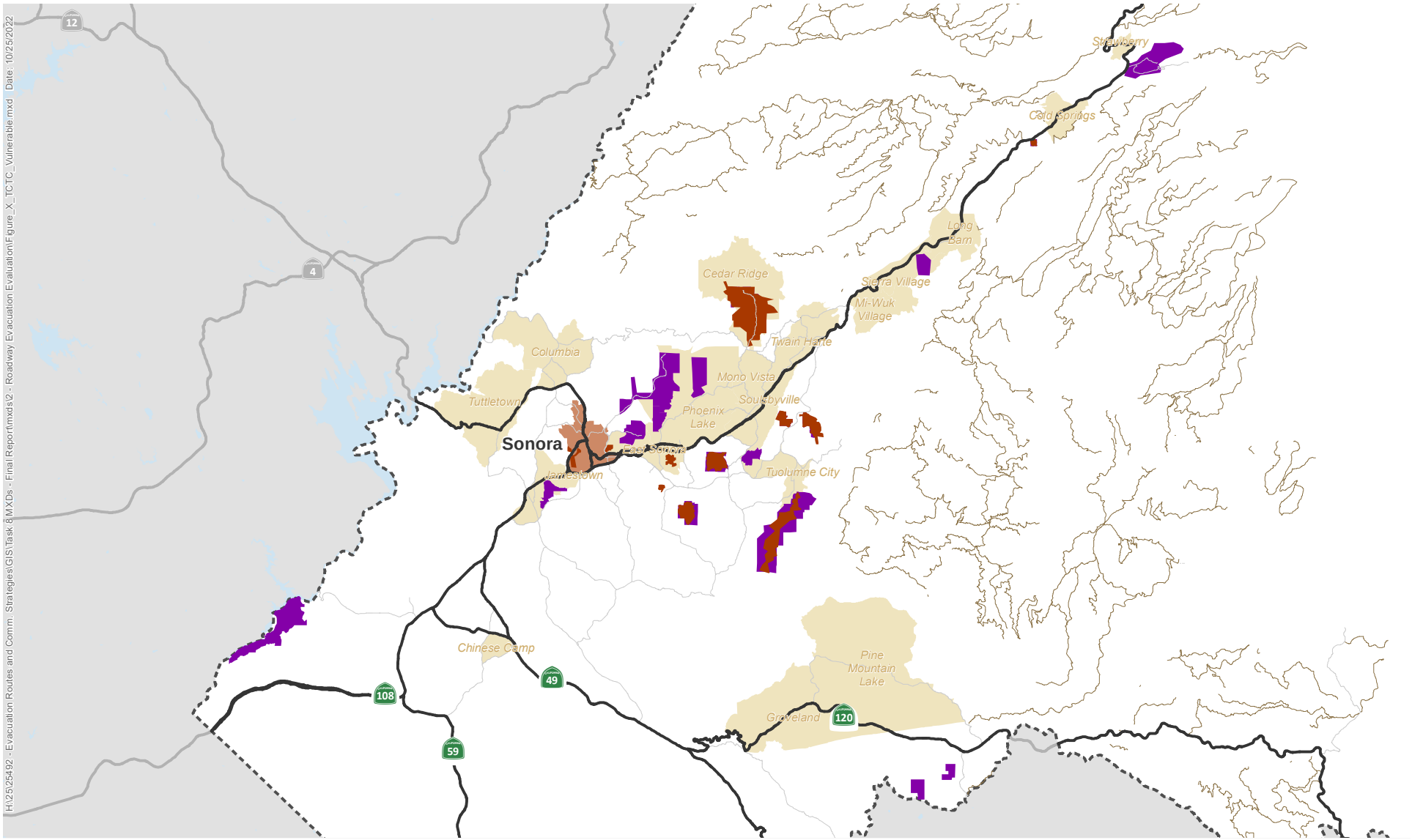


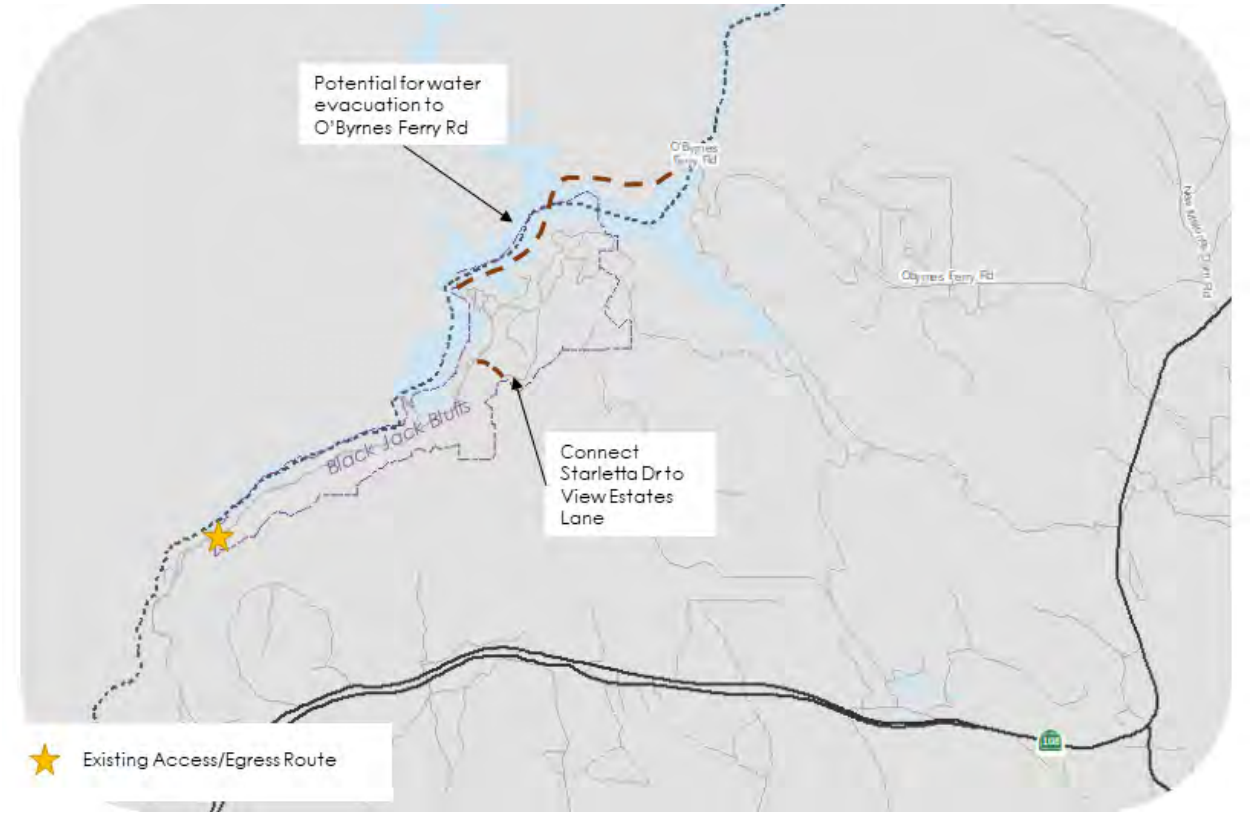
Figure 14

Vulnerable Communities
Evacuation Needs Assessment and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES

Black Jack Bluffs

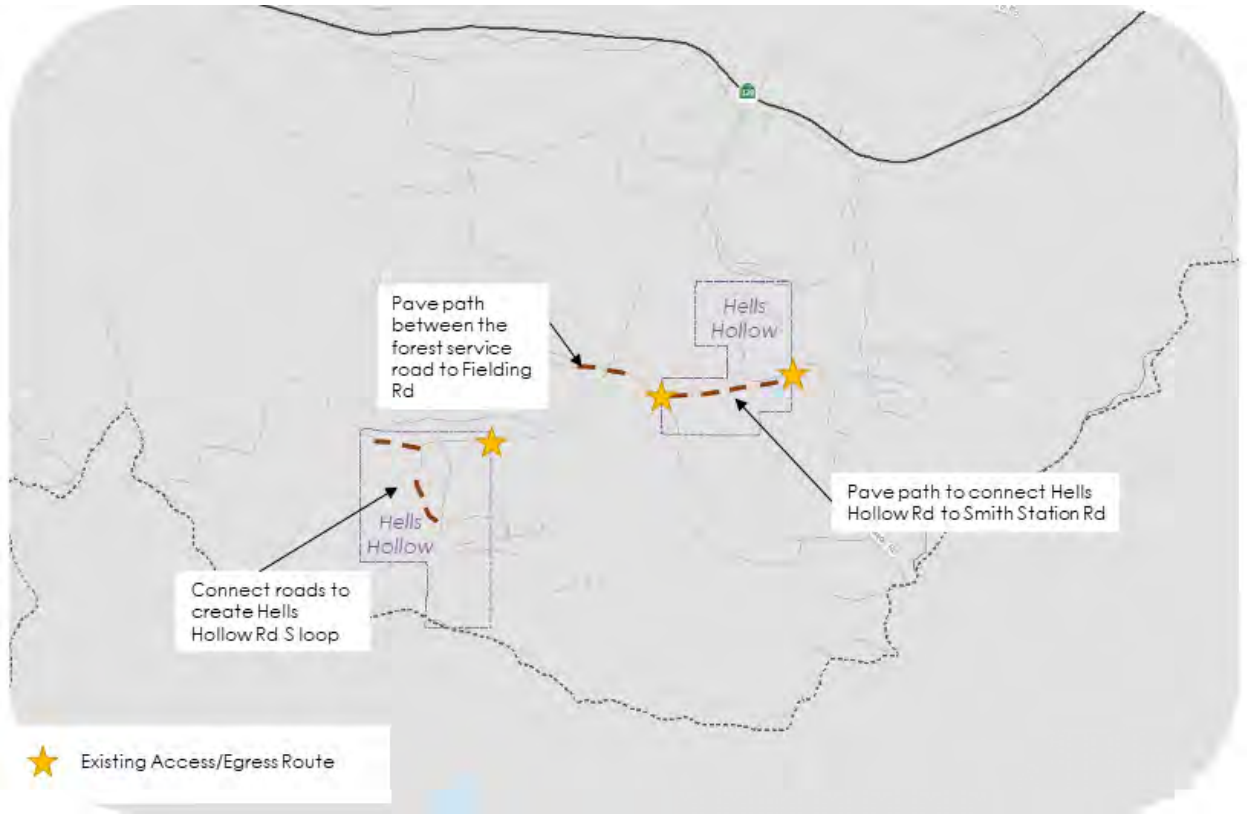
Community	Existing Access/ Egress Routes	Potential Secondary Access/Egress Routes
Black Jack Bluffs	■ Tulloch Road	■ Connect Starletta Drive to View Estates Lane ■ Possibility of a water evacuation to reach O'Byrnes Ferry Road



Source: Kittelson & Associates, Inc., 2022.

Hells Hollow

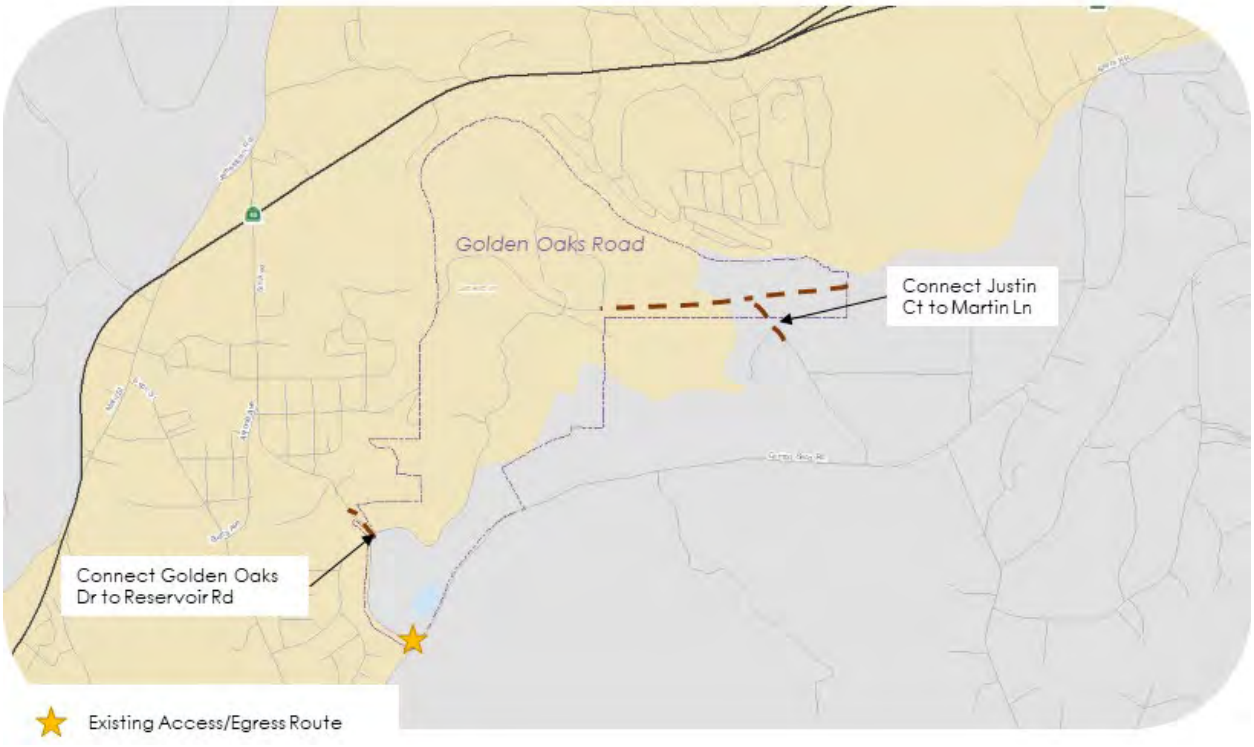
Community	Existing Access/ Egress Routes	Potential Secondary Access/Egress Routes
Hells Hollow (west)	■ Hells Hollow Road	■ Connect roads on the west of the western development to create Hells Hollow Road South loop
Hells Hollow (east)	■ Driveways/dirt paths to Hells Hollow Road	■ Small connection between Forest Service Road 1S17 to Fielding Road. ■ Pave path to connect Hells Hollow Road to Smith Station Road



Source: Kittelson & Associates, Inc., 2022.

Golden Oaks Road

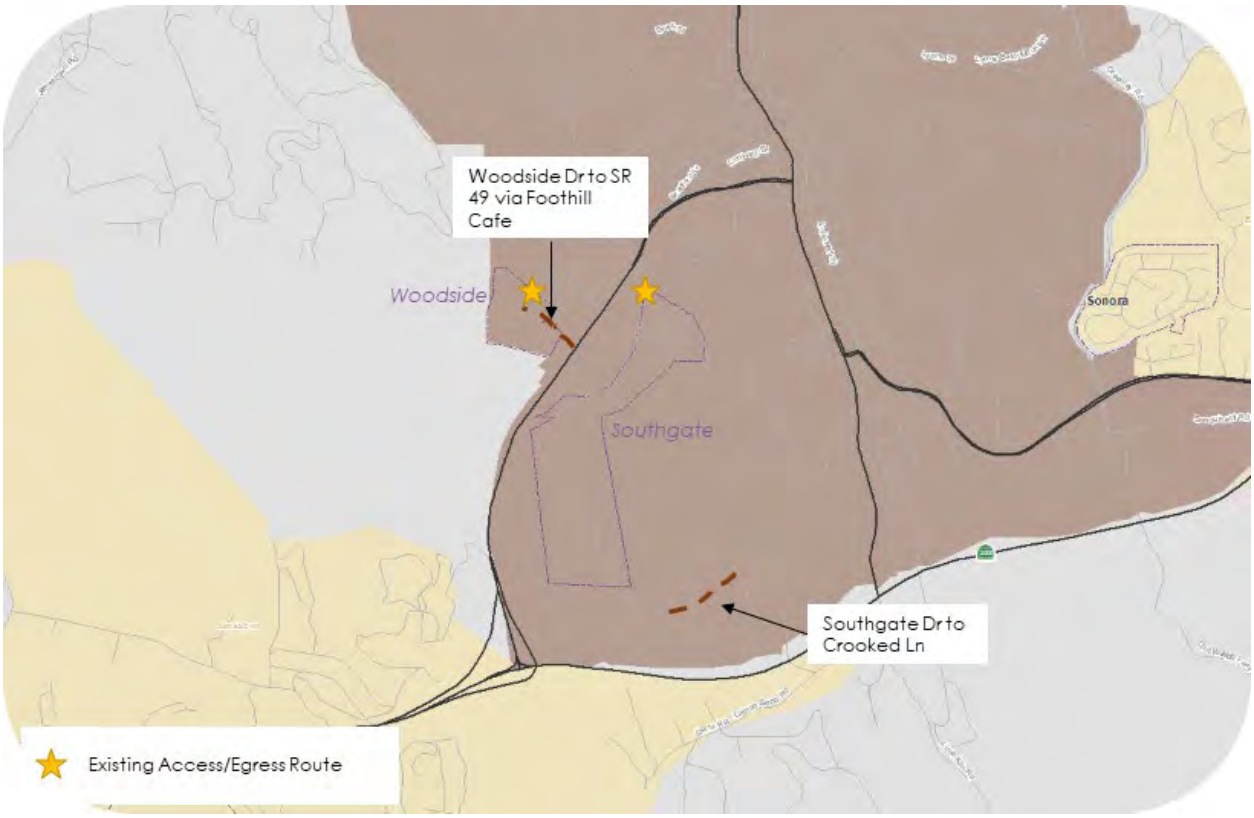
Community	Existing Access/ Egress Routes	Potential Secondary Access/Egress Routes
Golden Oaks Road	■ Golden Oaks Drive	■ Connect Justin Court to Martin Lane ■ Connect Golden Oaks Drive to Reservoir Road



Source: Kittelson & Associates, Inc., 2022.

Woodside/Southgate

Community	Existing Access/ Egress Routes	Potential Secondary Access/Egress Routes
Woodside/Southgate	■ Woodside Drive	■ Connect Woodside Drive to SR 49, via Foothills Cafe
Southgate	■ Southgate Drive	■ Connect Southgate Drive to Crooked Lane



Source: Kittelson & Associates, Inc., 2022.
Note: Proposed secondary access at Woodside Drive is on private property and would require coordination with land owners.

Blue Bell Road

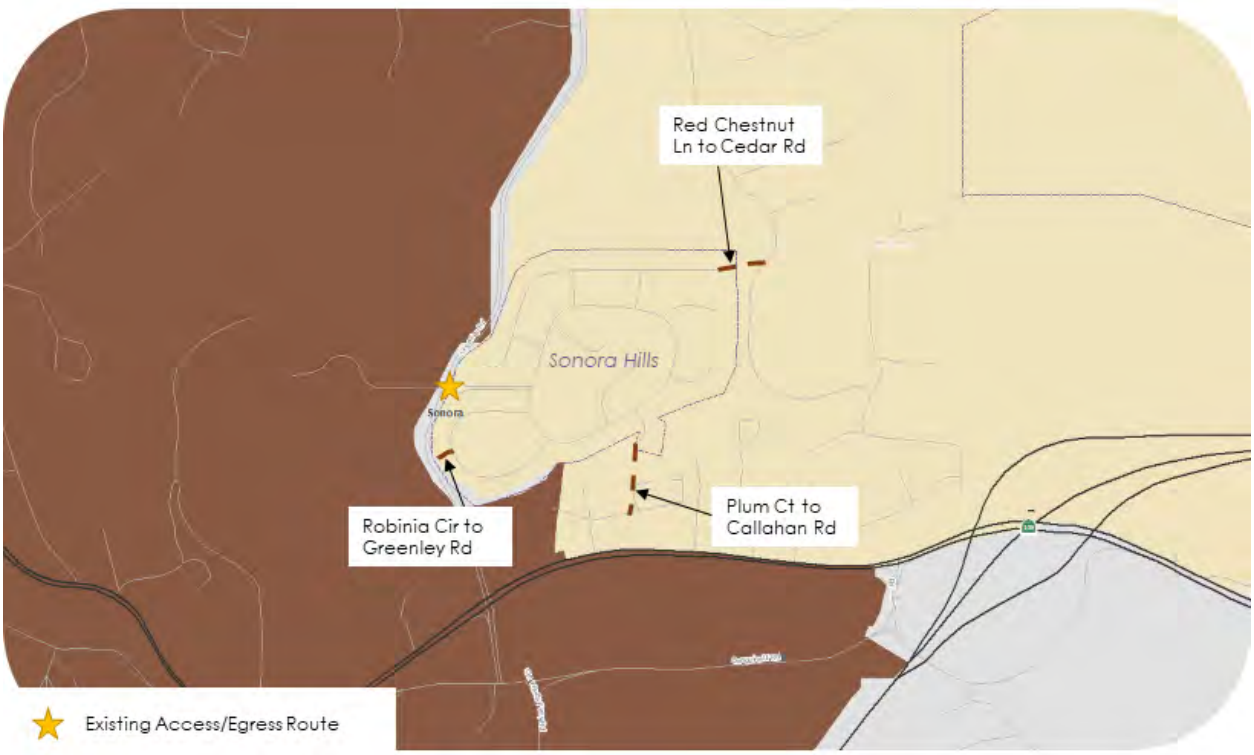
Community	Existing Access/ Egress Routes	Potential Secondary Access/Egress Routes
Bluebell Road	■ Blue Bell Road East	■ Connecting Lupine Lane to Blue Bell Road West ■ Delores Ln to Blue Bell Road East through Buttercup Lane ■ Blue Bell Road East to Delores Road to Aarondale Road



Source: Kittelson & Associates, Inc., 2022.

Sonora Hills

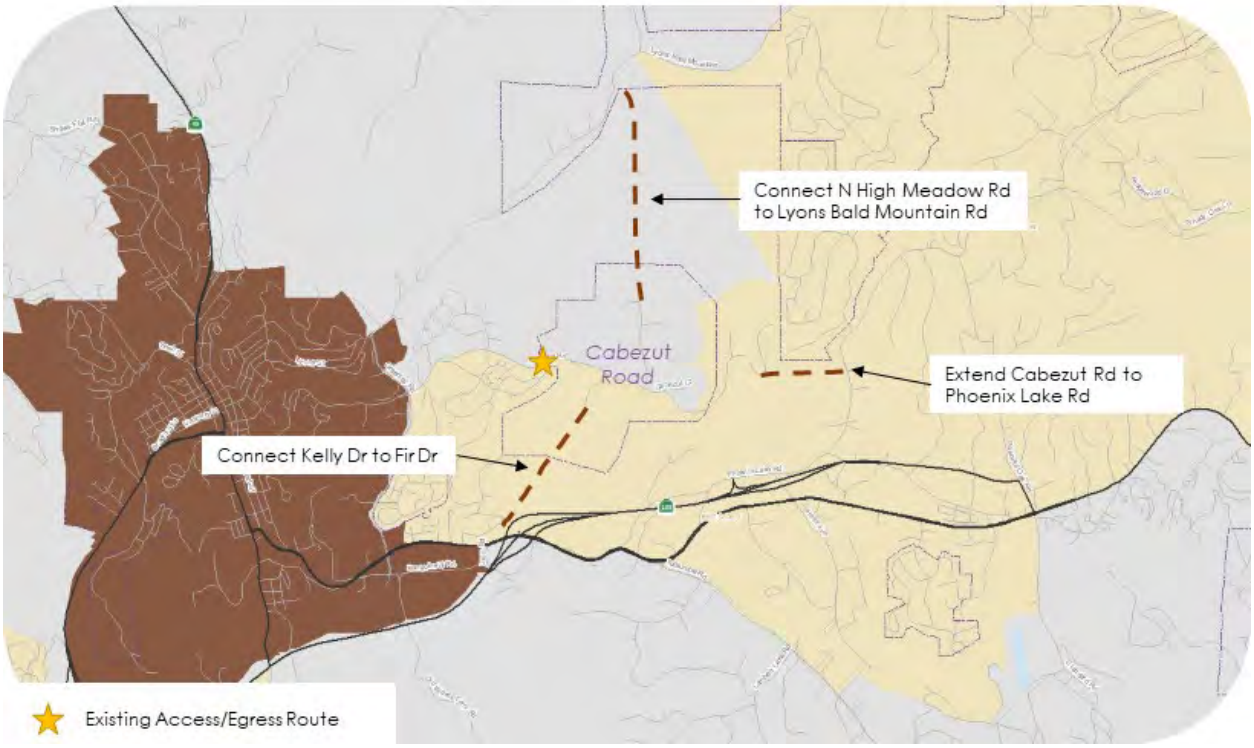
Community	Existing Access/ Egress Routes	Potential Secondary Access/Egress Routes
Sonora Hills	■ Delnero Drive	■ Robinia Circle to Greenley Road ■ Red Chestnut Lane to Cedar Road ■ Plum Court to Callahan Road (across the parking lot) to Mono Way



Source: Kittelson & Associates, Inc., 2022.

Cabezut Road

Community	Existing Access/ Egress Routes	Potential Secondary Access/Egress Routes
Cabezut Road	■ Cabezut Road	■ Connect North High Meadow Road to Lyons Bald Mountain Road ■ Connect Kelly Drive to Fir Drive ■ Extend Cabezut Road to Phoenix Lake Road



Source: Kittelson & Associates, Inc., 2022.

Wards Ferry

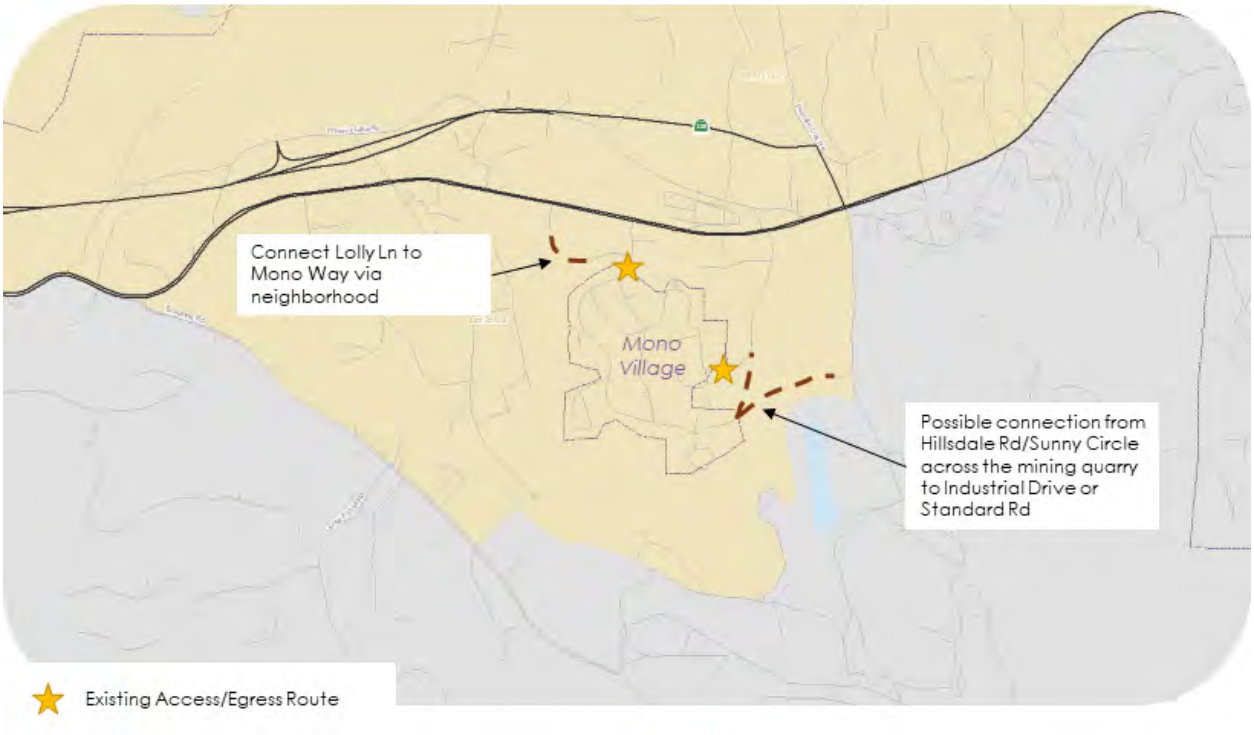
Community	Existing Access/ Egress Routes	Potential Secondary Access/Egress Routes
Wards Ferry	■ White Oaks Drive	■ Southern point of Lakeside Oaks Road to Wards Ferry Road ■ Live Oak Road to Eagle Ridge Drive ■ Shady Oaks Road to Lambert Lake Road



Source: Kittelson & Associates, Inc., 2022.

Mono Village

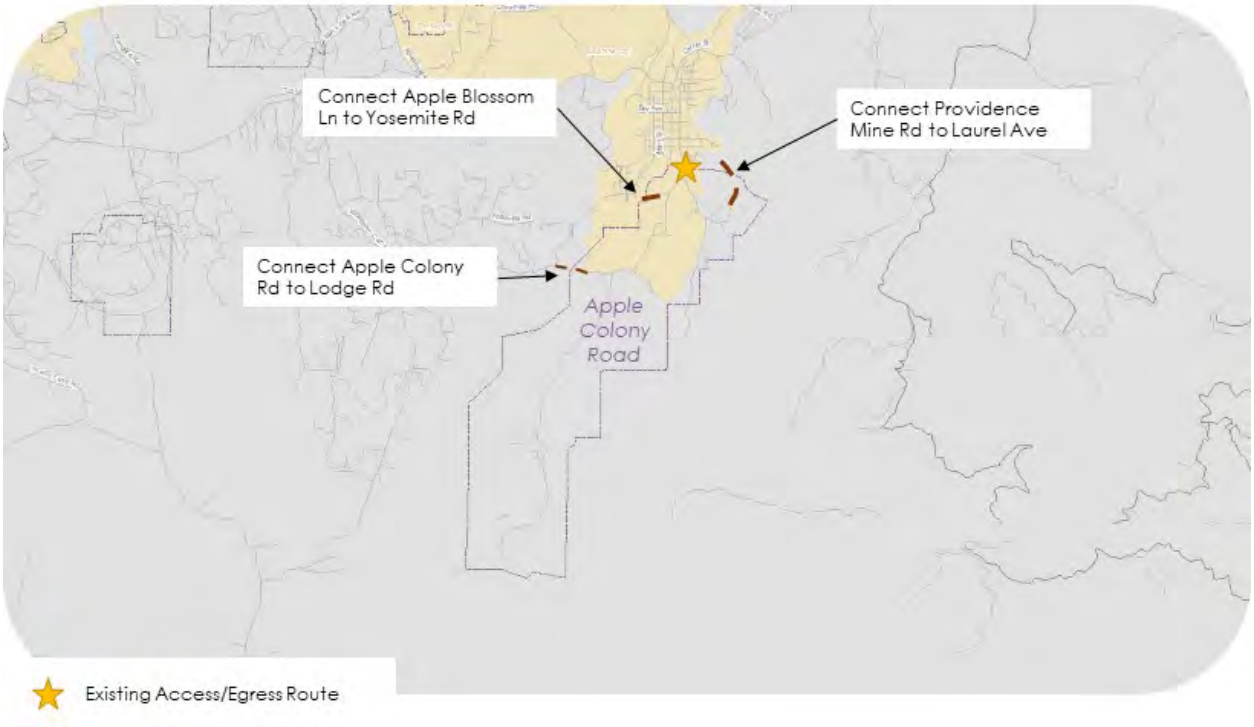
Community	Existing Access/Egress Routes	Potential Secondary Access/Egress Routes
Mono Village	■ Industrial Drive (locked gate) ■ Hillsdale Drive	■ Lolly Lane emergency gate to Mono Way via the neighboring property ■ Possible connection from Hillsdale Road/Sunny Circle across the mining quarry to Industrial Drive or Standard Road



Source: Kittelson & Associates, Inc., 2022.

Apple Colony Road

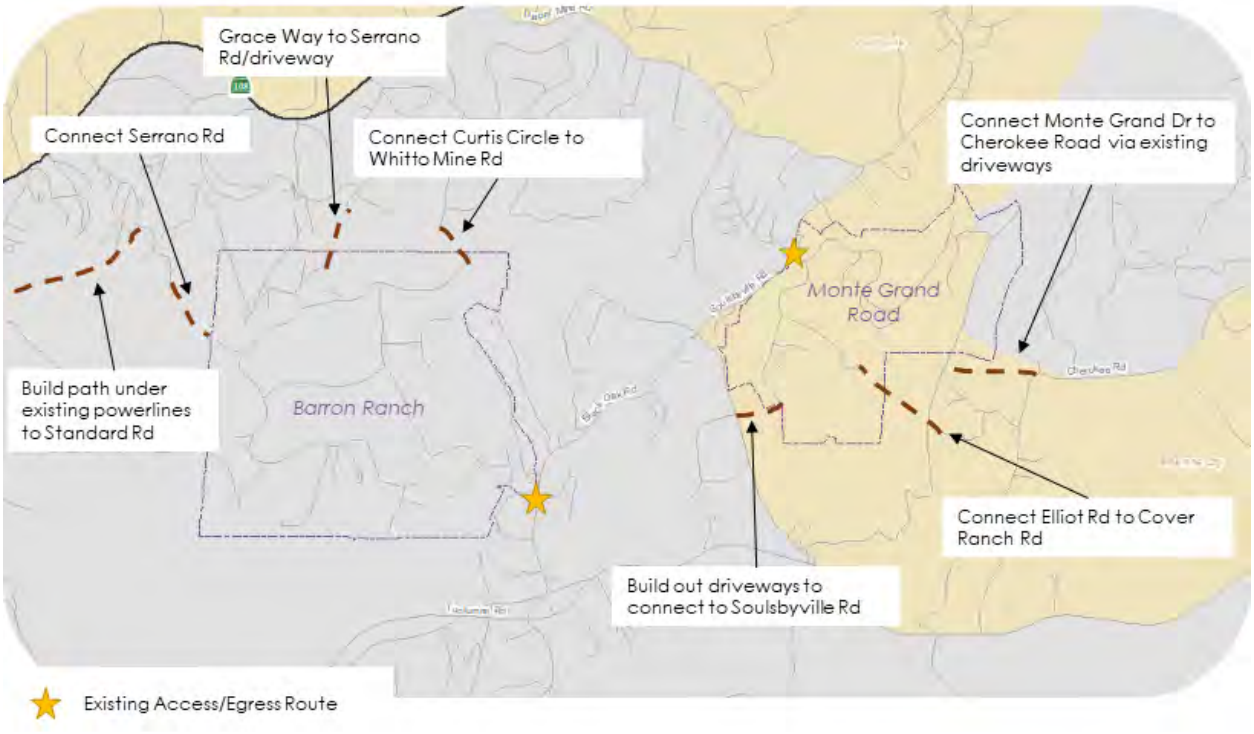
Community	Existing Access/ Egress Routes	Potential Secondary Access/Egress Routes
Apple Colony Road	■ Apple Colony Road	■ Apple Blossom Lane to Yosemite Road ■ Apple Colony Road to Lodge Road ■ Providence Mine Road to Laurel Avenue



Source: Kittelson & Associates, Inc., 2022.

Barron Ranch/Monte Grand Road

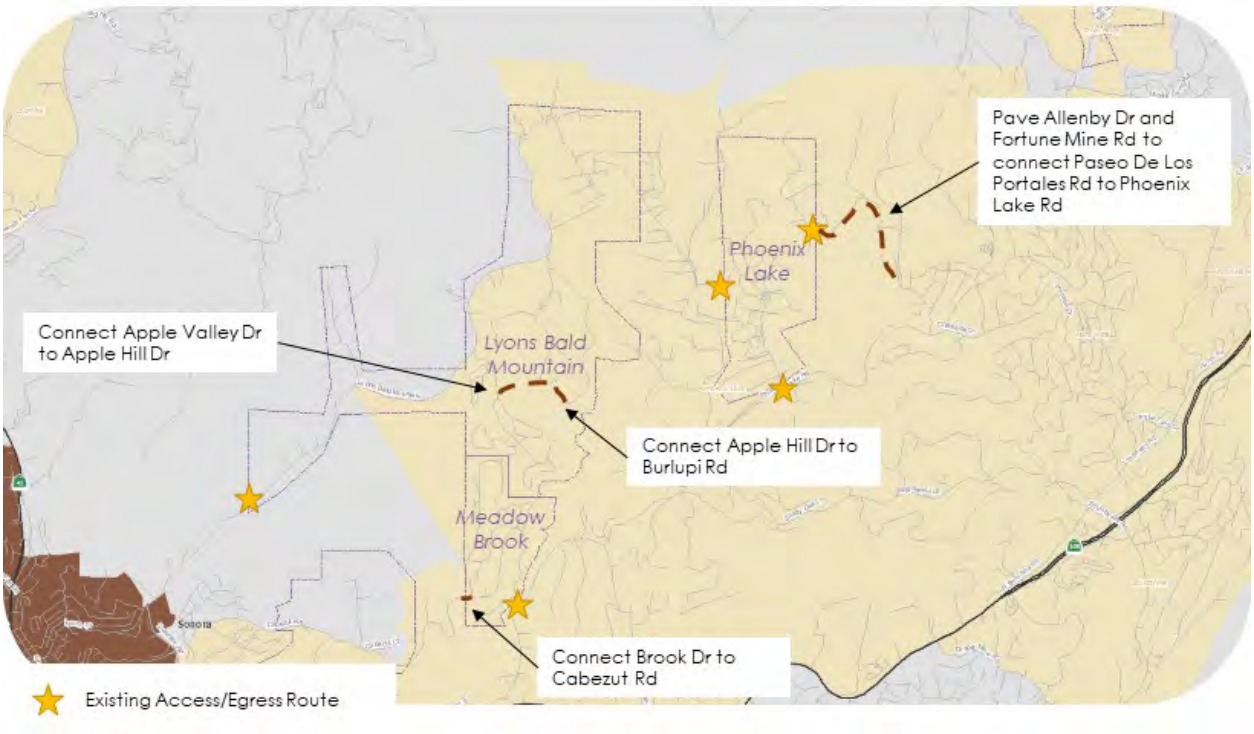
Community	Existing Access/ Egress Routes	Potential Secondary Access/Egress Routes
Barron Ranch	▪ Curtis Circle to Black Oak Road	▪ Connect Curtis Circle to Whitto Mine Road ▪ Connect Serrano Road ▪ Connect Grace Way to Serrano Road ▪ Build path along the power lines to connect to Standard Road
Monte Grand Road	▪ Monte Grande Road/Soulsbyville Road to SR 108 (north) and Tuolumne Road (south)	▪ Connect Monte Grande Drive to the east until Cherokee Road ▪ Connect driveways on the South Soulsbyville Road ▪ Elliot Rd to Cover Ranch Road



Source: Kittelson & Associates, Inc., 2022.

Meadow Brook/Lyons Bald Mountain/Phoenix Lake

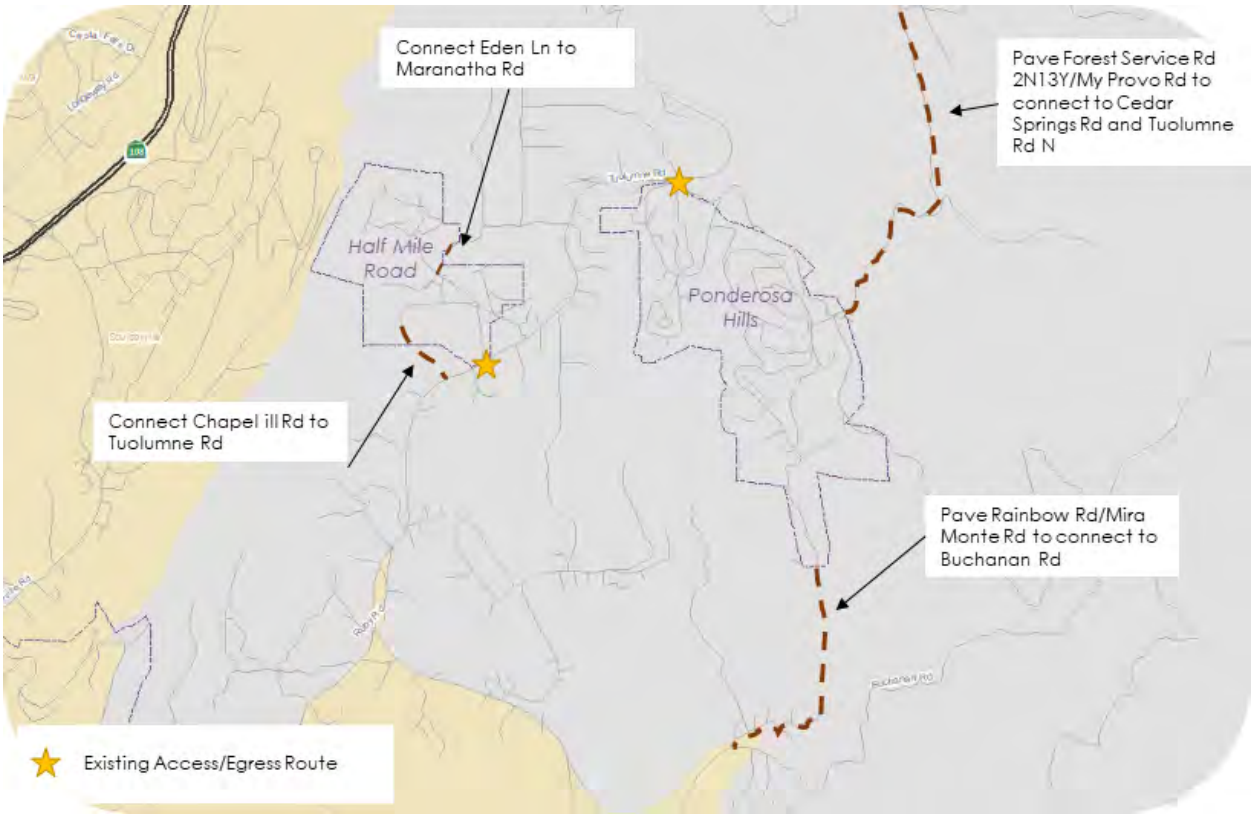
Community	Existing Access/ Egress Routes	Potential Secondary Access/Egress Routes
Meadow Brook	■ Meadow Brook Drive	■ Connect Brook Drive to Cabezut Road
Lyons Bald Mountain	■ Lyons Bald Mountain Road	■ Connection from Apple Valley Drive to Apple Hill Drive ■ Connect over Apple Hill Drive to Burlupi Road
Phoenix Lake Road	■ Paseo De Los Portales Road ■ El Lobo Center ■ Allenby Drive	■ Pave Allenby Drive and Fortune Mine Road to connect Paseo De Los Portales Road to Phoenix Lake Road



Source: Kittelson & Associates, Inc., 2022.

Half Mile/Ponderosa Hills

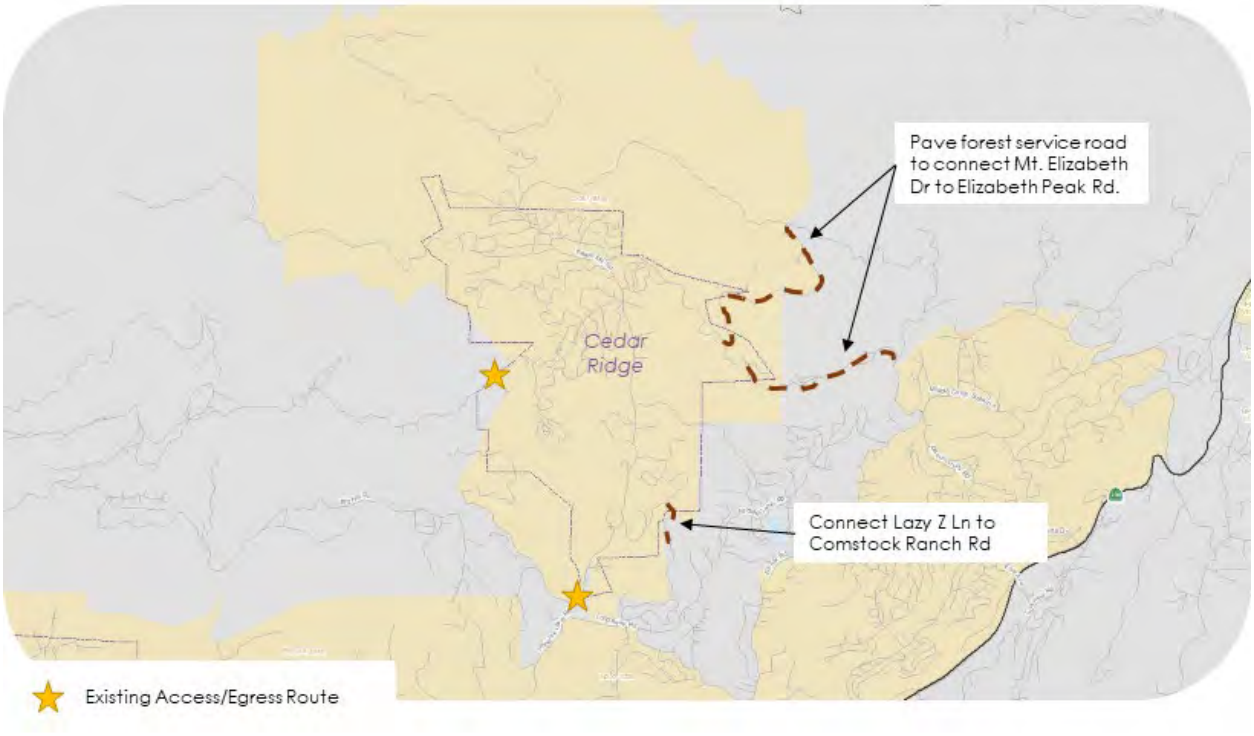
Community	Existing Access/ Egress Routes	Potential Secondary Access/Egress Routes
Half Mile	■ Half Mile Road	■ Eden Lane/Zelensky Road to Maranatha Road ■ Western part of Chapel Hill Road to Tuolumne Road
Ponderosa Hills	■ Gerber Road	■ Pave Rainbow Road/Mira Monte Road ■ Forest Service Road 2N13Y/Mt Provo Road



Source: *Kittelson & Associates, Inc., 2022.*

Cedar Ridge

Community	Existing Access/ Egress Routes	Potential Secondary Access/Egress Routes
Cedar Ridge	■ Kewin Mill Road ■ Old Oak Ranch Road	■ Connect Comstock Ranch Road to Lazy Z Lane ■ Pave forest service road to connect Mt Elizabeth Drive to Elizabeth Peak Road



Source: Kittelson & Associates, Inc., 2022.

Odd Fellows High Sierra

Community	Existing Access/Egress Routes	Potential Secondary Access/Egress Routes
Odd Fellows High Sierra	■ Wheeler Road/Odd Fellows Road	■ Pave and maintain Long Barn Sugar Pine Road ■ Three links Road to Rebekah Road



Source: Kittelson & Associates, Inc., 2022.

Snow White/Peter Pam

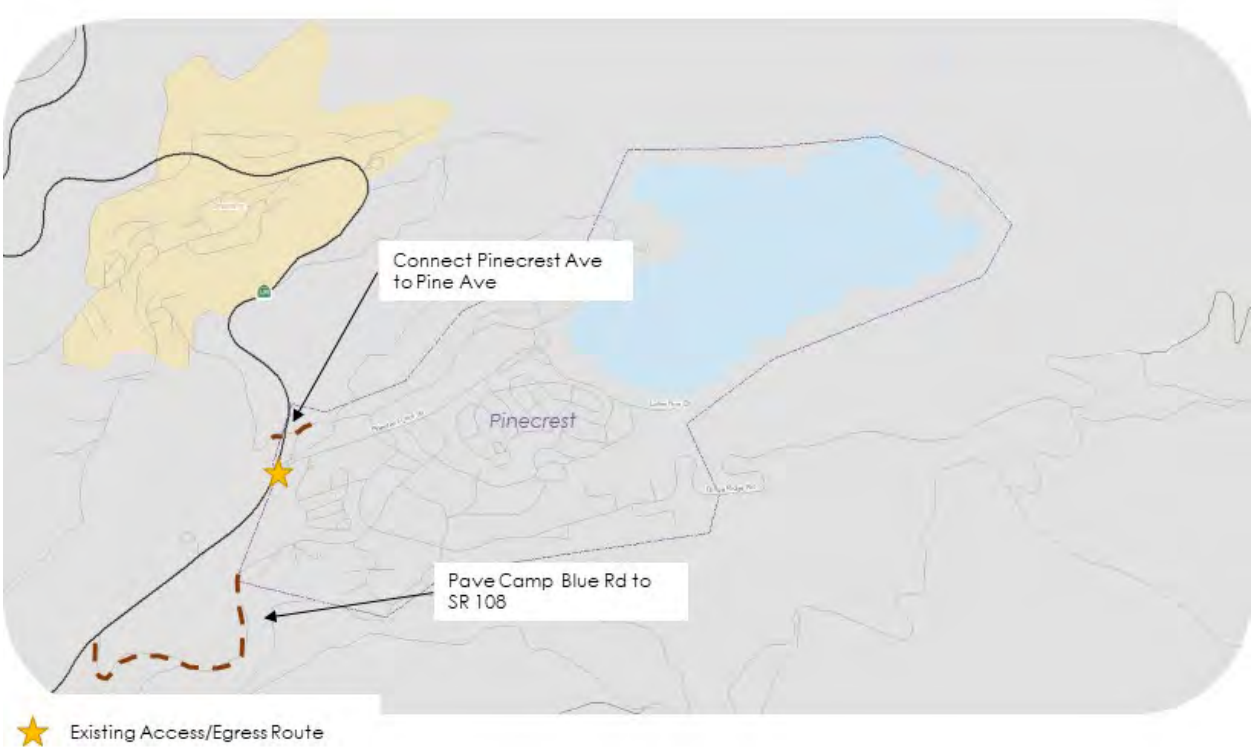
Community	Existing Access/ Egress Routes	Potential Secondary Access/Egress Routes
Snow White/Peter Pam	■ Snowhite Ridge Drive	■ Extending Bambi Lane along the trail to SR 108 ■ Potential to connect Snowhite Ridge Drive via trail/utilities line to SR 108



Source: Kittelson & Associates, Inc., 2022.

Pinecrest

Community	Existing Access/Egress Routes	Potential Secondary Access/Egress Routes
Pinecrest	■ Pinecrest Lake Road	■ Pave Camp Blue Road to SR108 ■ Connecting Pinecrest Avenue to Pine Avenue



Source: Kittelson & Associates, Inc., 2022.

SHELTER IN PLACE

Shelter-in-place (SIP) practices are an important consideration for emergency management operations regardless of the threat or hazard (e.g., flooding, hurricanes, tornados, wildfires). However, in recent years, catastrophic wildfires across the western U.S. (e.g., 2018 Camp Fire, 2017 Thomas Fire) have highlighted a need for a more comprehensive look at fire safety concepts and principles when planning for the use of protection actions such as shelter-in-place. One of the key challenges with the use of SIP practices for wildfires is the need to tailor risk control measures to best address the unique challenges associated with the threat itself, but also the range of local conditions that are critical to ensuring effective implementation (e.g., community demographics, topography, location, infrastructure, resources, authorities, decision-making process).

A SIP facility is a structure used to temporarily separate individuals from a hazard or threat. While evacuation is an organized, phased, and supervised withdrawal, dispersal or removal of civilians from dangerous or potentially dangerous areas. While evacuation remains the preferred management strategy for wildfires, consideration of SIPs may be appropriate in some circumstances when timely evacuation is not possible or achievable. However, current research and policies have evolved to focus on evacuation and shelter-in-place approaches should be approached with caution. For example, when the characteristics of the wildfire threat are extreme, it may be safer for individuals to shelter-in-place than to try to evacuate if an appropriately designed SIP location can be implemented. However, a SIP facility must be desiend to withstand an extreme hazard and home-based SIP actions are generally not recommended. Effective planning and preparation prior to a fire, making informed decisions during the event, providing appropriate public education and training, and providing appropriate risk control features and systems are key to ensuring SIPs are a viable and safe choice of last resort when last minute evacuations are not feasible.

SIP is a last resort option when an evacuation may not be the safest or most feasible action in the event of a wildfire. SIP is assumed to **not** be free from risk for people sheltering. Injuries and deaths may occur at SIPs depending on the extreme nature of the wildfire ana fully safe SIP facility cannot be guaranteed. Facilities used as SIPs are assumed to not be used for the long-term, nor are they assumed to provide the same level of service in sanitation, power supply, and basic human needs that a long-term shelter is designed to provide.

The study evaluated potential feasibility criteria and design standards for shelter-in-place locations. These criteria/standards are documented in Appendix F. TCTC, Tuolumne County OES, and Tuolumne County Sherriff are continuing to explore the possibility of shelter-in-place locations if the identified standards and considerations can be met. However, evacuation is always the primary and preferred action in the event of a wildfire in Tuolumne County at this time. Should appropriate locations for a shelter-in-place site be identified, TCTC, Tuolumne County OES, and partners will explore funding and implementation opportunities to support a more robust emergency response.

Section 4
Communication Strategies

COMMUNICATION STRATEGIES

This section proposes communications strategies for the public in the event of a major wildfire incident and specific strategies for connecting with vulnerable populations. The overall communication strategy focuses on identifying likely wildfire evacuation scenarios, identifying and organizing key audiences and resources, as well as actions and recommendations for activating each of them in the aforementioned scenarios. The intent of this communications assessment, in conjunction with the evacuation analysis, industry standards, and best practices, is to identify areas for improvement and recommendations to help reduce risk to life-safety in future wildfire incidents through communications.

The following documents and information were reviewed as part of development a proposed communication deployment strategy presented hereinafter:

- Tuolumne County Emergency Operations Plan
- Tuolumne County Evacuation Plan Pamphlet
- Tuolumne County Community Wildfire Protection Plan (CWPP), 2004
- Tuolumne County General Plan, Chapter 9, Public Safety Element, 2018
- Tuolumne County Office of Emergency Services (OES), Evacuation Guidelines for Tuolumne County Residents
- Greater Tuolumne City Community CWPP, 2004
- Tuolumne-Calaveras Unit, Strategic Fire Plan, 2020
- Emergency Operations Plan for the City of Sonora, 2014
- Tuolumne County Firewise Communities, 2021
- California Strategic Fire Plan, 2018
- CAL FIRE / Tuolumne County Fire Department, 2021-2025 Strategic Plan, DRAFT
- Pacific Gas & Electric Company (PG&E), 2021 Wildfire Mitigation Plan (WMP), 2021
- PG&E, Community Wildfire Safety Program, Tuolumne County, 2018

For more information on existing conditions for communication, see Appendix G.

COMMUNICATION STRATEGY

FRAMEWORK

The following strategic guidance organizes this strategy into several key components, consisting of scenarios, audiences, resources, and backchannel. A specific sub-strategy accompanies each scenario as it relates to the audiences and resources involved as well as the use of the backchannel to inform decision-making. In the section below, each of the components and their supporting elements are examined, and in the section that follows, how they interact and support a cogent strategy in each of the most likely scenarios is reviewed.

Scenarios

From a functional communications perspective, there are four scenarios of concern for Tuolumne County: pre-evacuation, phased evacuation, total evacuation, and post-evacuation. The simplified distinction is that total evacuation requires outreach to all audiences, whereas a phased evacuation might require certain audiences to be prioritized and reached independently of others. Pre-evacuation represents the entire period before an evacuation is announced and represents opportunity to take proactive

communications measures before any are required. Post-evacuation is the process of reintegrating the public into the previously evacuated area as well as the closure of the communications loop to all external audiences.

- **Pre-evacuation**
- **Phased evacuation**
- **Total evacuation**
- **Post-evacuation**

Audiences

Tuolumne County's functional audiences for communications vary from traditional audiences such as "indigenous tribes" or "school children" because they speak specifically to the actions or strategies required to reach them rather than simply categorial labeling. For example, senior centers and group homes are an audience, but functionally, the traits that make the approach for them different are their propensity to have less mobility or access to and familiarity with digital communications, so focus is on those functional distinctions while providing the associated traditional audiences as examples. In this strategy, the separation of "locals" from "non-locals" is distinguished by the ability to proactively reach, educate, and equip local audiences with resources prior to any emergency event, which is not a reasonable expectation with non-locals.

- **Locals** *(residents, schools, camps, senior centers, group homes, businesses, agencies, etc.)*
  - Urban areas *(higher density, higher potential traffic, high availability, high signage potential, ease of communication)*
    - Specific needs: directed signage
  - In transit *(limited opportunities to reach, highly mobile - may cross various boundaries)*
    - Specific needs: high-visibility signage, mobile/cellular notification
  - Rural or wilderness *(limited cellular network, limited access to signage, potentially longer, more time-consuming egress)*
    - Specific needs: sufficient signage, for peer-to-peer network notification
- **Non-locals** (recreational visitors/tourists, traveling workers, etc.)
  - Urban areas
  - In transit
  - Rural or wilderness
- **Sub-categories** (qualifying each of the above — e.g., local urban business or limited-mobility non-local in wilderness)
  - Vulnerable Populations
    - Limited mobility *(elderly, disabled/chronic conditions/injured, children, transportation disadvantaged)*
      - Specific needs: Physical assistance, peer-to-peer network notification
    - Limited access to communications *(disconnected from digital communications, elderly, young children, homeless, low-income, isolated/remote communities)*
      - Specific needs: Physical signage, peer-to-peer notification
    - *Limited communications comprehension (Limited English proficiency LEF, children, disabled)*
      - Specific needs: Translated communications, multi-lingual assistance and resources, physical assistance
    - Limited reaction time *(all aforementioned groups)*
      - Specific needs: Greater time buffer, peer-to-peer notification

- Businesses and organizations
- Adjacent agencies
- Media

Resources

Tuolumne County resources are separated into two categories—proactive and reactive—representing different opportunities for investment in communications infrastructure. The goal of proactive resources is to empower local populations and businesses with the information to act efficiently in the event of an emergency, and to go one step further in both knowing what to do and how to do it. This relieves pressure on active communications in the event of an emergency and allows emergency response to focus resources on non-local audiences. The goal with all reactive emergency response communications is to be as effective as possible using as few resources as possible. To this end, it is crucial to have a "single source of truth" as a reference for all outbound communications to help manage rumors and potential misinformation. This can be a document, a process, or trained personnel, but the goal is to have the same message "translated" and distributed across multiple formats, media, agencies, etc.

- **Proactive**
  - Planning, education, training
  - Infrastructure
  - Activation
- **Reactive**
  - Digital
  - Physical
  - Relational

Backchannel

The backchannel is the monitoring and information feed that allows for updating and modifying the communications strategy and output of that strategy. For example, when changes occur in the situation or feedback is received on the effectiveness of communications, adjustments can be made accordingly to achieve the desired outcome.

- **Operational feedback**
- **Actionable updates**
  - Situation status changes
  - Audience changes
  - Messaging changes
- **Reintegrating populations**

PRE-EVACUATION

Communications Considerations

This is the complete space of available time for Tuolumne County before an incident. In this period, the full suite of proactive measures that can be accomplished in order to offset the strain on resources during the emergency event is being considered. By spreading out reactive work into the pre-event period, it is effectively "flattening the curve" of resource demand during the event. The pre-evacuation period, therefore, represents an opportunity to set the framework for many of the reactive measures that take place during emergency response—for example, reaching out to local businesses with tools and protocols

for spreading the word about emergencies to their clientele who may be enroute to an affected area or already there.

- Encompasses all proactive resource measures
- Opportunity to offset resource strain during phased- and full-evacuation scenarios
- Opportunity to set framework for managing reactive scenarios

Audiences

For practical purposes, the key audiences in this period include only county locals, because they are the ones reliably available prior to an incident. The county's vulnerable populations are best served through proactive measures taken at this phase, as they are the most dependent on resources already in place during the emergency period. This is an opportunity to test the reach of communications to these populations in a non-critical environment.

- Locals
  - Especially vulnerable populations

Resources

The full suite of proactive resources is being considered. Though depending on the lead time to the event, some may or may not be feasible.

- Proactive

Backchannel

In this scenario, the backchannel serves as feedback from the local audience to build in new resources into measures for both proactive and reactive.

- Local feedback

Actions

The county must first prioritize and assign ownership of the following events in order to get them off the ground. The following actions are recommended in this period, depending on the availability of resources and cooperation of local organizations.

- Planning, education, training
  - Public workshops
  - Staged evacuations, tabletop exercises, and evacuation demonstration events
  - Stakeholder engagements
  - Spokesperson training
  - Social media training
  - Public relations strategies, planning, and proactive outreach
  - Interagency content development and planning (digital templates, etc.)
  - Comms messaging development (templates, etc.)
  - Planning peer-to-peer carpooling
  - Establishing emergency peer-to-peer communications networks
  - Planning resort/camp/hotel shuttles
  - Planning emergency transportation routes and coordination
  - Emergency operations training for local organizations (camps, schools, businesses, centers, etc.)

  - Planning interagency communications, including protocols and directories for coordination
  - Translating planning, education, and training materials
- Infrastructure
  - Road and remote-activated signage
  - PA system
  - Extended/back-up cellular/data network
  - Peer-to-peer communications network
  - Physical communications resource directory
- Activation
  - Dissemination of plans, strategies, and resources
  - Signing up public for push notifications
  - Identifying and connecting associated social media accounts
  - Posting informational signs, posters, flyers

Challenges

One of the biggest operational challenges in this period is establishing a protocol or working rubric for taking pre-event measures with event teams. For example, the PIO who would be assigned in the condition of an emergency, might not have access to resources to accomplish these things in a non-emergency situation. All these actions also require both capital and time expenditures to accomplish, which are finite. Some of these actions rely on the participation of outside agencies and organizations to work effectively, which introduces an element of unpredictability in handoff. Finally, inherent to this period is the consideration of vulnerable populations and how to reach them. It may be a resource challenge to identify and build communications channels that will reach all intended vulnerable audiences reliably in the event of an emergency.

- Availability and continuity of resources in planning vs. emergency phases of operation
- Investment of capital and human resources
- Reliance on outside parties
- Identifying and building communications channels to reach all vulnerable populations

Recommendations

The primary recommendation in this period is to ensure that no audience in Tuolumne County is left behind—especially vulnerable populations. If there are gaps or tenuous connections allowing information to travel to certain audiences, building the infrastructure and system for reaching them should be prioritized in this phase of operation. To that end, laying the groundwork for amplification strategies on top of existing channels such as Everbridge® and Alert Me® that allow a one-to-many approach of sending communications to an intermediary who is responsible for reaching other audiences (such as hotels who will then be responsible for notifying their individual guests) can reduce strain on available resources in particularly demanding communications scenarios. This period also represents the opportunity to actively engage with the public via educational programs such as Firefighters on Your Side and Ready! Go! or consider the reprogramming of such county resources as CERT (Community Emergency Response Team).

- Investment in in-transit signage and communications media to reach vulnerable communication-deficient audiences
- Investment in communications infrastructure such as PA systems and cellular/data network extenders to reach more people in remote areas
- Investment in language translation services to reach non-English speaking audiences

- Investment in amplification strategies that allow one-to-many communications, especially in resource-constrained scenarios
- Establishing protocols and lines of sight for peer-to-peer communications networks
- Activation of city and county educational programs for public emergency preparedness
- Coordination with navigation software companies (e.g., Google Maps, Apple Maps, Waze, etc.) to ensure users are not being directed to travel along routes inadequate for evacuation

PHASED-EVACUATION

Communications Considerations

A phased evacuation is a unique challenge to the county communications strategy because it involves delivering targeted communications to specific audiences to the exclusion of others. The key priority of the communications strategy at this stage is identifying those audiences that require the most time and resources to reach or mobilize. Time is the key driver of priority. As this is a phased activity, it is important to phase audiences as well, prioritizing both those affected by the current situation as well as those who are likely to be next—this is where the feedback channel comes into play in deciding whom the next audiences in line will be.

- Targeted communications and specific audiences
- Prioritizing audiences based on difficulty to reach or mobilize
- Phased or tiered audience categories

Audiences

Functionally, the audience here consists of all audiences until some are labeled as non-priority or non-actionable. That said, vulnerable audiences in particular must be given the requisite time buffer to be notified and evacuated safely and effectively.

- Locals
- Non-locals

Resources

The toolkit for outreach consists of all the county's available resources, though the messaging and targeting will vary depended on the intended audience.

- Digital
  - Press releases
  - EAS, EBS, Everbridge®, Alert Me®, push notifications
  - Social media posts
  - Tweet updates
  - Instagram post updates
  - Sheriff's Office Facebook post updates, groups
  - Interagency and affiliate/partner support
  - Retweets, regrams, reposts, shares, etc.
  - Website page updates
- Physical
  - Road signage

  - Changeable or dynamic message signs
  - Press conferences
- Relational
  - Media relations: TV, radio, web, social
  - Via email, phone, social
  - Interagency relations
  - Peer-to-peer network
  - Real-time translation across media

Backchannel

The backchannel has a large role in this scenario, because it is the gatekeeper for unlocking various audiences and actions as they become necessary. It is also a measurement tool to gauge the effectiveness of communications in achieving the intended goal evacuation of targeted audiences, which should feed back into the use of resources to fill in any gaps as necessary.

- Assigning priority audiences based on operational feedback
- Opening new audiences for communications
- Prioritizing the use of resources in reaching target audiences
- Measuring communications effectiveness

Actions

The communications actions of this scenario involve a phased and multi-pronged activation that include most if not all of the available resources.

- Identifying and developing single source of truth
- Prioritizing and tiering all relevant and potentially relevant audiences
- Codifying evacuation messaging for intended audiences
- Translating and distributing messaging across all available resources to reach necessary audiences
- Employing backchannel to calibrate resource use and identify priority audiences, and to gauge effectiveness of communications

Challenges

The inherent challenge of a phased evacuation is casting too wide or too narrow of a net that either strains resources or egress routes with more people than necessary or does not completely reach the intended audiences. This can be mitigated with information and planning: that is, a well-calibrated pre-event phase and backchannel that minimizes room for error.

- Casting too wide or narrow an audience net

Recommendations

Information and planning are the keys to an effective phased evacuation. By anticipating audience needs, preparing resources, and prioritizing audiences, communications can be both effective and flexible in reaching the intended audiences.

- Prioritizing audiences based on time delay and anticipation of impact
- Real-time relay of developing incident through communications channels—queuing audiences on standby

- Planning and timing communications actions to coincide with event unfolding
- Explore the utility and feasibility of implementing evacuation applications
- Preparing communications messaging and outreach that lays the groundwork for future communications

TOTAL EVACUATION

Communications Considerations

The total evacuation scenario is an exhaustive communications effort that demands engagement of all Tuolumne County resources. While the demands are simple in terms of targeting—all audiences are targeted—it is more complex operationally because of the number of pieces in play and the demands on the communications team to manage the outreach as well as the feedback and response to each of the activated resources. For example, reporters return for a follow-up, social media posts receive questions or criticism.

- Resource strain from activation of all channels and resources at once
- Backchannel from active communications causes additional strain
- More channels to update as scenario evolves

Audiences

This scenario includes all audiences with priority assigned to the most vulnerable.

- Locals
- Non-locals

Resources

This scenario activates the full suite of digital, physical, and relational resources available.

- Digital
  - Press releases
  - EAS, EBS, Everbridge®, Alert Me®, push notifications
  - Social media posts
  - Tweet updates
  - Instagram post updates
  - Sheriff's Office Facebook post updates, groups
  - Interagency and affiliate/partner support
    - Retweets, regrams, reposts, shares, etc.
  - Website page updates
- Physical
  - Road signage
  - Press conferences
- Relational
  - Media relations: TV, radio, web, social
  - Via email, phone, social
  - Interagency relations
  - Peer-to-peer network
  - Real-time translation across media

Backchannel

In the event of a total evacuation, the county backchannel is crucial insight for adjusting the strategy and to adding filters back to the wide-open net cast on resources and audiences. It helps answer the questions: Which audiences are being left behind? How effective is the current communications strategy? And when do we close the loop? We can use it to understand how different audiences may be responding to the same messages delivered across the board—allowing us to adjust messaging and refine methods for meeting audiences where they are.

- Refocusing communications resources and messaging to reach all audiences
- Measuring communications effectiveness
- Deciding when communications resources can be deactivated

Actions

The communications actions of this scenario are the complete and simultaneous activation of all county resources.

- Identifying and developing single source of truth
- Prioritizing vulnerable audiences and refocusing resources to reach those underserved
- Translating and distributing messaging across all resources to reach necessary audiences
- Monitoring the backchannel to enable the effective distribution of updates and gauge the effectiveness of communications
- Deprecating the use of resources as appropriate to manage resource strain

Challenges

Resource strain and resource management is one of the largest challenges in this scenario. Additionally, engaging with an audience this large presents a logistical burden to providing effective updates and feedback across all channels.

- Resource strain
- Logistical considerations of managing feedback and updates to all audiences

Recommendations

Because this scenario requires such a large resource investment from all county communications channels, the communications team should consider the use of amplification methods (i.e., one-to-many) that would've been prepared at the pre-evacuation stage, thereby minimizing the number of channels required to reach the same audience. In addition, designating a single source of truth, such as the Tuolumne County Sheriff Facebook page[12], and referring multiple audiences to it for updates can be an effective way of keeping audiences in the loop with the expenditure of active resources. Audience priorities remain ensuring effective, early, and redundant efforts to reach vulnerable populations who may otherwise be underserved in this scenario.

- Employing amplification methods to maximize reach with minimal resources
- Designating and referring audiences to single source of truth to limit resource strain with updates across all channels
- Prioritization and close monitoring of vulnerable populations to ensure they are effectively reached

[12] Tuolumne County Sheriff Facebook: https://www.facebook.com/tuolumnecountysheriff/

POST-EVACUATION

Communications Considerations

This scenario represents the closing of the loop on county crisis communications. It is the phase marked by the eventual reintegration of both local and visiting populations into the area. That said, the time scale of this phase may vary significantly—in some cases, it may be weeks or days before the public is allowed to return. In all cases, communications channels are expected to stay open to announce updates and finally to announce the terminus of the event. This period also serves as an opportunity to learn from how communications were handled and received during the previous phases and is the ultimate backchannel for refining the process of communications strategy development.

- Reintegrating local and visiting populations
- Updating all communications channels to close out the event
- Feedback opportunity to refine communications strategy going forward

Audiences

This involves all previously reached audiences through either the phased- or total-evacuation scenarios.

- Locals
- Non-locals

Resources

The resource considerations here involve closing the loop with all previously activated resources. Because audiences are physically further afield than they were in the previous activation phases, it may be more challenging to reach them through the same channels.

- Previously activated resources
- Broad-reaching communications channels

Backchannel

As previously noted, this scenario serves as its own backchannel for improving the communications strategy development process. This is an opportunity to seek feedback from various media, partners, and the public. It is valuable to assess which audiences, for example were difficult to reach or to reach effectively to improve future communications strategies.

- Better understanding barriers to communications
- Better understanding difficult-to-reach audiences
- Measuring holistic effectiveness of communications strategy and process

Actions

As with earlier phases, continuity of messaging across all media is crucial in this stage. Coordinating the return of locals and non-locals to Tuolumne County may involve a phased and targeted effort or blanket directions. It is key that these communications are not conflated in mixed messages, so the same priorities of a single source of truth and continuity across resources present in earlier stages is paramount here as well. Finally, as this phase represents the terminus of outbound activity, it involves closing the loop with all open communications channels and ensuring that all audiences reached understand the next steps.

- Identifying and referring to single source of truth

- Translating and distributing messaging across all resources to reach necessary audiences
- Monitoring the backchannel to enable the effective distribution of updates and gauge the effectiveness of communications
- Closing the loop with all audiences and channels

Challenges

As noted in the resources section, one of the primary challenges involved in this stage is reconnecting with all audiences that may have moved further afield in the evacuation phase, and as such are more difficult to reach. Maintaining continuity and an open channel of communication is in itself a resource strain that should not be discounted. Finally, in phased reintegration approaches, it may be necessary to keep lines of connection open with updates and targeted messaging intended for specific audiences—so managing this multi-pronged multi-priority communications tack is resource intensive as well.

- Reconnecting with audiences that have been evacuated and are more dispersed
- Resource strain of open communications for updates
- Resource strain of phased reintegration requiring targeted messaging and audience specificity

Recommendations

The general goal of this phase is to close the loop with all activated resources and evacuated audiences, in Tuolumne County and beyond. To that end, it makes the most sense to limit the resource strain involved with reaching each of them where they are by providing information in one place that they can refer to as the situation unfolds, such as the Tuolumne County Sheriff Facebook page. The latter stages of this phase are also an opportunity to refer audiences to available resources that may be outside the scope of the emergency communications function, such as housing resources, reintegration procedures, safety protocols, etc. so it is recommended to work with partner agencies and resources ahead of time to have systems in place and available. It is also an opportunity to close the loop with local media like KVLM and Tuolumne County Public Access Television who may be able to broadcast the aforementioned resources in their news coverage. Finally, as this is the end phase of communications, it is also an opportunity to leverage the backchannel to refine the communications processes and inform infrastructure and resource investments going forward.

- Referring audiences to single source of truth to limit outbound resource strain in updates and closing the loop
- Preparing referrals to outside resources for reintegration and local area information
- Leveraging open channels to local and broader media to broadcast updates and resource availability
- Leveraging backchannel to refine communications processes and inform future infrastructure and resource investments

COMMUNICATION STRATEGY SUMMARY

Communications strategy is an evolving process. It benefits greatly from the investment of resources into the early, pre-evacuation stage as well as the time taken in the post-evacuation stage to monitor and take stock of both shortcomings and successes in the effectiveness of communications in reaching intended audiences. During an event, having a single source of truth is both strategic from the perspective of communications clarity as it is for minimizing resource strain. And, in all communications phases, employing an active and reliable backchannel for communications and operations is one of the most valuable investments that can be made to improve communications in real-time as well as in the future.

Especially with Tuolumne County's vulnerable and remote populations combined with limited public communications infrastructure, the imperative is that no audience is left behind. There should be a reliable method for reaching everyone, and ideally multiple methods that allow for a quick and coordinated response in the event of a time-sensitive event. The more redundancy that can be built into reaching all audiences, the more investment that can be made in the infrastructure to do so, and the more that those resources can be front-loaded in anticipation of an event, the more successful communications will be in achieving its goals in the case of an emergency. The following subsection discusses specific needs and strategies for reaching vulnerable populations in the county before and during an evacuation.

VULNERABLE POPULATIONS

Vulnerable populations are groups of people with special characteristics that can make evacuations more difficult. Characteristics can be related to lack of transportation (e.g., personal cars or public transportation), socioeconomic factors (e.g., low income, non-English speakers, etc.), communication challenges (households living "off the grid" or without internet access or other means of communication), or physical impairments. These potential vulnerabilities are described below along with the specific needs of the population during an evacuation.

VULNERABLE POPULATIONS

Recreational Visitors/Tourists

There are several popular outdoor destinations that bring visitors and tourists to Tuolumne County. Recreational sites such as Don Pedro Reservoir, Pine Mountain Lake, Pinecrest, and Yosemite National Park bring people from all over the state and country for swimming, boating, camping, and hiking in the summer months. Visitors and tourists staying in Airbnbs and rental cabins are unlikely to know the local roadway network to evacuate in case of an emergency. Activities like camping and hiking can be in areas with poor cell and radio service, making it difficult to provide up to date emergency information to those in the area during evacuations. There are multiple locations popular with visitors and tourists in the Tuolumne County. Five locations where the proportion of visitors and tourists are highest during fire season are:

- Don Pedro Reservoir
- Kennedy Meadows Resort
- New Melones Lake
- Strawberry / Pinecrest
- Yosemite National Park
- Pine Mountain Lake

Populations with Zero Access to Personal Vehicles

According to US Census data, approximately 5% of residents in Tuolumne County do not have a personal vehicle. In the case of an evacuation, these populations would need to find a vehicle to carpool during the evacuation, use public transportation or shuttles, or walk or bike to evacuate in an emergency.

Senior Centers / Group Homes

There are many senior centers/group homes in Tuolumne County, including Sierra Foothill Senior Center, The Gathering Place, Skyline Place, Sonora Senior Living, Adventist Units 6 & 7, Avalon Assisted Living, Sonora Regional Hospital, and many others. Residents of senior centers and group homes can be particularly vulnerable because they may have physical disabilities or medical conditions that prevent them from evacuating themselves in an emergency situation, or they do not have access to personal vehicles for

evacuations. These populations are older and may also be disconnected from digital communication forms.

Populations with Limited Mobility

Populations with limited mobility, which can include seniors and people with disabilities, may experience more difficulty evacuating. Disabled people living on their own and seniors that choose to age in place are usually dependent on family, friends, and public transportation to move around the County. These populations would need to find a vehicle to evacuate in an emergency.

Hispanic and Non-White Populations

According to US Census data, approximately 12% of the population in Tuolumne County identifies as Hispanic or non-white. These populations may suffer discrimination based on physical and cultural traits. These populations may also be limited in their English proficiency and may have difficulties understanding emergency communication or require translated communications.

Tribal Communities

There are two tribal communities in Tuolumne County: the Tuolumne Band of Me-Wuk Indians, and the Chicken Ranch Rancheria of Me-Wuk Indians. Many members of these communities live in more isolated areas where wildfire risks are higher, and communication maybe be more difficult. These populations may also suffer discrimination based on physical and cultural traits.

Evacuation Strategies for Vulnerable Populations

STEPS Transportation Equity Framework for Wildfire Evacuations

The STEPS – Spatial, Temporal, Economic, Physiological, and Social – transportation equity framework looks at different factors for transportation equity and relates them to wildfire evacuations. The STEPS framework was originally crafted to understand deficiencies in identifying barriers to shared mobility but can be adapted and applied to vulnerable populations in emergency events. Table 2 provides an overview of the categories, their definitions, and application to wildfire evacuations. Each evacuation and community strategy presented in the next section will address one or more of the STEPS framework categories. Additional information and guidance can also be found in the Federal Highway Administration's Evacuating Populations with Special Needs document.[13]

Strategies for vulnerable populations in Tuolumne County are guided using the STEPS framework presented in Table 2. Each strategy is described and outlines the STEPS dimension and vulnerable population(s) served.

[13] FHWA Evacuating Populations with Special Needs: https://ops.fhwa.dot.gov/publications/fhwahop09022/fhwahop09022.pdf. Accessed October 2022.

Table 2. STEPS Equity Framework for Wildfire Evacuations

Dimension	Definition	Application to Tuolumne County Wildfire Evacuations
Spatial	Spatial factors that compromise travel needs (e.g., long distances between destinations, lack of public transit)	■ Single ingress/egress routes ■ High risk fire zones ■ Lack of public transportation/carpooling within walking distance ■ Shelters located far away
Temporal	Travel time barriers that inhibit a user from completing time-sensitive trips (e.g., reliable public transit, limited transit operating hours, roadway congestion)	■ Minimal communication notifications for evacuations ■ Travel time along Tuolumne County roadways ■ Rapid fire spread due to weather
Economic	Direct and indirect costs of basic travel that create economic hardships (e.g., vehicle ownership, credit card access)	■ Cost of gasoline, hotels, supplies for evacuation ■ Vehicle ownership
Physiological	Physical and cognitive limitations that make using standard modes of transportation difficult or impossible (e.g., small children, vision/hearing impairments, disabilities)	Vulnerable groups including: ■ Group/senior living residents ■ Disabled residents ■ Schools
Social	Social, cultural, safety, and language barriers that can inhibit a user's comfort with transportation (e.g., lack of multi-language information, perceived safety in neighborhoods)	Vulnerable groups including: ■ Non-English speaking residents ■ Immigrants or undocumented residents ■ Tribal residents ■ Racial and ethnic minorities ■ Visitors/tourists

Source: Can Sharing Economy Platforms Increase Social Equity for Vulnerable Populations in Disaster Response and Relief? A Case Study of the 2017 and 2018 California Wildfires, S. D. Wong et al., 2020; Travel Behavior: Shared Mobility and Transportation Equity, S. Shaheen et al., 2017.

Peer-to-Peer Carpooling

Description: A carpooling system can be developed during an emergency evacuation scenario[14]. Carpooling programs can be done locally (e.g., by a neighborhood or commercial area) or jurisdiction wide (e.g., by the County or CDP). Carpooling can be coordinated with existing transit agencies and infrastructure, such as bus stops, park and ride lots, commercial parking lot, community buildings, etc., can be used for pick-up locations. Personal or commercial vehicles can be used to pick people up and carpool to safe areas within or outside the County. At the local level, a carpooling system can also help with communication efforts and information sharing. Carpooling can help evacuate more people in fewer vehicles, reducing congestion on evacuation routes during an emergency.

STEPS Dimensions Addressed: Spatial, Temporal, Economic, Social, Physiological

Communities Addressed: Populations with zero vehicles, residents of senior centers/group homes, populations with limited mobility, minority populations, tribal communities, communities with limited ingress/egress

Implementation Needs:

- Identify areas that would benefit from a carpooling program (e.g., communities with limited ingress/egress).
- Coordinate with neighbors, local businesses, and Tuolumne TRIP to identify volunteers for carpooling at the local level. For businesses or commercial centers, identify if there are commercial vehicles (e.g., delivery trucks) that can be used for evacuation of people or supplies.
- Coordinate with Tuolumne County Transit/Tuolumne TRIP to identify pick-up and drop-off locations and the frequency of vehicle pick-ups.

Public Transportation in Evacuations

Description: This strategy is similar to a carpooling system, where public transportation is utilized to evacuate residents in emergency situations. Existing transit routes, stops, and vehicles can be utilized during an evacuation for a cost-effective evacuation strategy. Using public transportation can help evacuate more people in fewer vehicles, reducing congestion on evacuation routes during an emergency. The Transportation Emergency Operations Plan[15], developed by Tuolumne County Transit Agency (TCTA), provides guidance for transportation providers to make informed decisions for their operations during emergency evacuation events. TCTA is currently developing a park and ride lot along CA-49/108. This lot could potentially be used as a staging area when evacuating vulnerable populations.

STEPS Dimensions: Temporal, Economic, Physiological

Communities Addressed: Populations with zero vehicles, residents of senior centers/group homes, populations with limited mobility, minority populations, communities with limited ingress/egress

Implementation Needs:

- Coordination with Tuolumne County Transit and school districts. Identify staff that can lead the carpool program during an evacuation.
- Identify pick-up locations along transit routes, school bus routes, and drop-off locations outside the evacuation area.

[14] For additional information facilitating equitable shared mobility for evacuations, see Wong, S. D., Chorus, C. G., Shaheen, S. A., & Walker, J. L. (2020). A Revealed Preference Methodology to Evaluate Regret Minimization with Challenging Choice Sets: A Wildfire Evacuation Case Study. Travel Behaviour and Society, 20, 331–347. https://doi.org/10.1016/j.tbs.2020.04.003

[15] Tuolumne County Transit Authority Transportation Emergency Operations Plan, November 2012. https://www.tuolumnecountytransportationcouncil.org/_files/ugd/fe950e_faa3f90c82b4480a9dfe3362559d02c8.pdf

Resort/Hotel Shuttles in Evacuations

Description: Similar to the carpooling and public transportation strategies but with focus on recreational areas and populations. Visitors to the County are unlikely to know the roadway network and may require additional assistance during an evacuation. Recreational visitors, such as those camping and backpacking, may not have a personal vehicle near-by in the event of an evacuation. Hotel and resort shuttles, such as the SkiBUS, Yosemite Area Regional Transportation System (YARTS) buses, or shuttles in resort areas can be utilized to evacuate residents and visitors in tourist areas.

STEPS Dimensions: Spatial, Temporal, Social

Communities Addressed: Recreational users/visitors

Implementation Needs:

- Coordination with hotels and resorts to identify staffing for evacuations and existing buses/shuttles to evacuate people.
- Identify pick-up and drop-off locations for visitors.
- Create information packages for visitors to share where to go and what to do in an emergency situation.

Translated Communication Materials

Description: To reach non-English speaking populations, all physical and verbal communication materials should be translated into languages that are largely spoken in the County. This may include recreational areas, especially in places in and around Yosemite National Park, which sees many international visitors.

STEPS Dimensions: Social

Communities Addressed: Minority Populations, Recreational users/visitors

Implementation Needs:

- Identify languages most spoken in the County.
- Staff time to create, translate, and distribute evacuation communication materials.
- Identify staff or volunteers who can communicate in the identified languages in the scenario that in-person assistance in needed during an evacuation.

Recreational Visitors Communication Materials

Description: To reach non-residents and visitors in the County, all physical and verbal communication materials should be distributed to hotels, campgrounds, and businesses with large tourist populations. Hotels and Airbnbs can consider adding emergency evacuation guideline pamphlets in each room or welcome book; businesses, campgrounds and other outdoor recreational sites can consider posting evacuation guidelines on notice boards. Staff of hotels, recreation centers, campgrounds, and businesses should also be educated on evacuation guidelines to inform visitors in the case of an emergency evacuation event.

STEPS Dimensions: Social

Communities Addressed: Recreational users/visitors

Implementation Needs:

- Identify recreational areas in the County.
- Staff time to create and distribute evacuation communication materials.
- Identify and educate staff or volunteers who can communicate evacuation orders in the scenario that in-person assistance in needed during an evacuation.

COMMUNITY AND STAKEHOLDER ENGAGEMENT

This report was developed through a collaborative process that engaged multiple stakeholders in three different group settings. The different groups were identified to receive feedback on specific components of the report. This section describes the engagement with the Project Development Team (PDT), the Fire Safety and Advisory Committee (FSAC), and public. The final study will be presented to the TCTC Board for adoption.

PROJECT DEVELOPMENT TEAM

The PDT was established to provide feedback on analysis methodologies, findings from the roadway capacity analysis, and strategies to address roadway capacity issues and evacuate vulnerable populations. The PDT included staff from TCTC, OES, Tuolumne County Sheriff's Office, California Department of Transportation (Caltrans) District 10, Tuolumne County Public Works, City of Sonora Fire Chief, City of Sonora Police Department, and Tuolumne County GIS Department. The project team has presented twice to the PDT throughout the project development process, including:

1. Presenting an overview of the project and discussing and selecting appropriate wildfire scenarios for evacuation assessment [January 27, 2022]
2. Presenting evacuation capacity analysis results and discussing shelter in place considerations [August 1, 2022]

In addition to these three PDT meetings, the project team collected additional feedback from Tuolumne County Public Works and Caltrans on potential infrastructure improvements supporting increased evacuation resiliency to gain input on recommendations and move forward with strategies that could be implemented on the County roadway network.

FIRE SAFETY ADVISORY COMMITTEE

The project team has presented three times to the FSAC throughout the project development process including:

1. Assistance in selecting appropriate wildfire scenarios and parameters for use in the evacuation modeling [December 16, 2021]
2. Presented fire scenario analysis and evacuation analysis approach [February 23, 2022]
3. Presenting and collecting feedback on the evacuation analysis results and draft study recommendations [September 28, 2022]

In addition to these three FSAC meeting presentations, the project team collected additional stakeholder feedback from the Tuolumne County Sherriff's Office to gain input on recommendations and next steps that support emergency operations.

COMMUNITY ENGAGEMENT MEETINGS

The project team conducted two in-person public workshops and one virtual workshop between December 6-8, 2022, as an opportunity to engage with the public to present evacuation analysis results and recommendations and gather public feedback on the study and strategies. The team presented the

fire risk maps, results of the evacuation analysis and potential improvements to address capacity constraints, strategies to assist vulnerable populations and communities in the event of an evacuation, and communication strategies for emergency evacuation events.

Based on the community meetings, a meeting with the Pine Mountain Lakes Association, and stakeholder follow-up from the community meetings, the following summarizes the input received as part of the three engagement meetings for consideration in future evacuation planning efforts and studies and integrated into the final report, where applicable/relevant:

- Identification of additional potentially impacted routes during evacuations including discussions of Ferretti Road and the US Forest Service road serving Evergreen Lodge (maintained by the County) in the Groveland area and Campo Sec Road in the vicinity of Jamestown.
- Support for additional vegetation management to keep roadways clear during evacuations. OES is currently working to prioritize vegetation management projects across the County and identifying funding opportunities to implement priority vegetation management projects.
- Discussion of how to manage evacuation strategies with limited staff availability including the potential for training volunteers to help support in evacuation. OES has been looking into additional funding to assist with implementation as well as exploring new technologies/strategies like dynamic messaging sings that could help reduce staffing requirements while increasing communication in an evacuation. A dynamic messaging sign in Groveland is being piloted in coordination with the Pine Mountain Lakes Association.
- Concerns around navigation applications correctly routing evacuees during an emergency and how to better integrate navigation applications into evacuation plans. OES and County staff hare working with residents to educate them on how and where to evacuate. Staff and community members have also communicated with navigation application companies to try and improve routing in the rural parts of the county.
- Discussion of the limitations of cellular service and cellular data and its implications in reducing communication strategies during and emergency scenario. Strategies for potentially addressing these communication gaps included developing radio communications, using FM radio alerts to reach areas with limited communication server otherwise, and exploring new technologies for more reliable communication across the county including remote communities. OES and the Sheriff's Office also emphasized that the Tuolumne County OES website and the Sheriff's Office's Facebook page is the best location for up to date information during an emergency[16].
- Potential additional areas for consideration for fire and evacuation scenario were identified including the Rawhide/Ridge Flat. The project team discussed the limitations in the number of scenarios that could be modeled within the project and that the locations were chosen in collaboration with stakeholders and the Fire Safety Advisory Committee to determine the fire scenarios that would results in larger-scale evacuations that would support areas of concern and geographic diversity across the County.
- The project team also provided clarifications on the fire and evacuation modeling as well as answering questions regarding the assumptions made in the modeling process. Details for these analyses can be found in the report appendices.
- Questions were raised about the timeline for the strategies and improvements identified in the Needs Assessment. It is anticipated that capital improvements could take 5-10 years to obtain funding and construct while some communication strategies and other strategies identified in the study are already being moved forward or seeking funding for potential implementation, including TCTC

[16] See the Tuolumne County OES Website: https://www.tuolumnecounty.ca.gov/1524/Office-of-Emergency-Services and Tuolumne County Sherriff's Office Facebook page: https://www.facebook.com/tuolumnecountysheriff/

seeking evacuation-related shoulder improvements as part of improvements in development by Caltrans on State Route 49 between the Chicken Ranch Rancheria and East Sonora.

- At the Groveland community meeting, the need to provide rental units and visitors with maps and evacuation information was discussed. In the Pine Mountain Lake community, rental units will be required to have evacuation information and maps. The County geographic information systems (GIS) team is creating community maps for residents and visitors to print and use for evacuations.
- A suggestion was brough forward to consider recommendations for electric vehicle owners to maintain a minimum charge in case of an immediate evacuation. TCTC and OES will review potential opportunities to better account for electric vehicles during evacuations and research potential best practice guidance for these vehicle types and charging during emergencies.
- Concerns were also raised about translated materials being available staged evacuations, as well as whether parking could be limited in areas with limited egress routes. These strategies are included in the Needs Assessment recommendations and are currently being explored by OES for implementation.

Additional feedback from the Community Meetings and other additional meetings during the plan's engagement effort are summarized in Appendix H.

Section 5
Conclusion

CONCLUSION

The Tuolumne County Evacuation Needs Assessment and Communication Strategies study establishes an understanding of wildfire risk across the County, identifies locations where roadways may exceed capacity during an evacuation, and recommends potential strategies and treatments to increase capacity and resiliency of evacuation routes.

Separate sets of strategies were developed for vulnerable communities with limited access and egress and vulnerable populations who face additional barriers during an evacuation. The strategies include potential egress opportunities for residents with limited evacuation routes and communication methods to share real time information and coordinate with residents and visitors before, during, and after evacuations.

Funding Opportunities

This study is the first step of many for identifying ad implementing strategies for a more robust evacuation network in Tuolumne County. While strategies and improvements recommended in this study are generally not funded, the study provides a list of potential projects for pursuing potential funding, including several new funding sources including the CA OES PrepareCA Jumpstart program and the USDOT PROTECT program. The USDOT PROTECT program is a particularly notable opportunity. The program was created as part of the Infrastructure and Investment and Jobs Act and sets aside $631 million for California between 2022 and 2026 for responding to extreme weather events. Eligible projects include highway and transit projects and bicycle and pedestrian facilities that help improve evacuation and disaster relief. Table 3 provides a list of potential funding sources to pursue for future grant funding of evacuation capital improvements or strategies.

Table 3: Funding Opportunities

Program	Description
USDOT PROTECT	Federal program that issues lump sum funding to states to fund planning activities, resilience improvements, community resilience and route activities, and at-risk coastal infrastructure. Funding is issued for period of 2022 to 2026. https://www.fhwa.dot.gov/bipartisan-infrastructure-law/protect_fact_sheet.cfm
USDOT RAISE	Federal program to modernize transportation infrastructure. As part of Infrastructure and Investment and Jobs Act, $7.5 billion was added to the program over five years. Though not targeted specifically towards evacuation projects, projects are evaluated on several categories, including safety and environmental sustainability, that match with goals of this study. https://www.transportation.gov/RAISEgrants
FEMA Hazard Mitigation Grant Program (HMGP)	Federal program that provides funding for mitigation measures that reduce long-term risks from future disasters. Eligible projects can support work rebuilding after a disaster or proactively to reduce potential future disasters. https://www.fema.gov/grants/mitigation
California OES PrepareCA JumpStart	State program that provides technical assistance and State funding to vulnerable and high hazard risk communities to reduce long-term risks from natural disasters. Fundings is intended to focus on mitigation planning and implementation, community education, and recovery planning. https://www.caloes.ca.gov/office-of-the-director/operations/recovery-directorate/hazard-mitigation/prepare-california/

Program	Description
California FireSafe Council (CFSC) Community Capacity Building Grants	Non-profit program that issues grants of up to $20,000 to support community capacity building. Funding can be used towards salary support, volunteer management, and media messaging and communication development. https://cafiresafecouncil.org/grants-and-funding/2022-community-firesafe-capacity-grant/
CFSC County Evacuation Route Grant	Non-profit program that issues funding to support development of clear and resilient evacuation routes. Funding may be used towards evacuation route planning, implementation, public education, construction, signage, and maintenance. https://cafiresafecouncil.org/2021-county-evacuation-route-grant-opportunity/
PG&E Wildfire Ready & Resilient Grant	Funding available through the PG&E Corporation Foundation to fund projects that build community resilience and capacity to withstand climate-related hazards. Eligible applicants include governments, educational institutions, non-profits in partnership with a local or tribal government. Funds are prioritized for applicants with demonstrated exposure to climate hazards and which assist disadvantaged populations and vulnerable communities. https://www.pge.com/en_US/residential/in-your-community/local-environment/resilient-communities/resilient-communities-grant-program.page

Source: Kittelson & Associates, Inc.

Next Steps

The study provides a tool to TCTC, OES, and partners to evaluate opportunities to further enhance emergency response during evacuations and develop capital improvement projects to support a more resilient roadway network during large-scale evacuations. It also provides a status report on existing conditions which can be used moving forward to measure progress made by the County to measure improvements to evacuation operations.



Section 6
Appendices

Appendix A: Tuolumne County Fire Risk Evaluation

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JENSEN HUGHES

TECHNICAL MEMORANDUM

September 1, 2022

Project# 25492

To: Darin Grossi, Shannon Thaggard, Dore Bietz

From: Grace Carsky, Alex Garbier, Darlene Rini, and Amelia Pludow

CC: Matt Braughton

Project TCTC Evacuation Routes and Communication Strategies

RE: Task 2: Tuolumne County Fire Risk Evaluation

INTRODUCTION

Kittelson & Associates, Inc. (Kittelson) and Jensen Hughes are assisting the Tuolumne County Transportation Council (TCTC) and City of Sonora with developing an Emergency Evacuation Routes and Communication Strategies Plan. The Plan focuses on identifying high risk locations, vulnerable populations, and strategies to improve evacuation operations and public communication during emergency evacuations.

This memorandum presents the analysis conducted for Task 2 of the TCTC Emergency Evacuation Routes and Communication Strategies Plan development. The analysis describes how risk varies across Tuolumne County (County) based on several fire risk characteristics identified by Jensen Hughes. For each characteristic, the memo describes the risk and provides a map depicting risk according to the factor. Then the memo summarizes the risk based on its relation to residentially zoned parcels, structures, and critical infrastructure in the County.

The factors included in the memo are:

- Fire Hazard Severity Zones
- Wildland-Unrban Interface
- Vulnerable Communities
- Historic Burn Frequency
- Hot Spot Fire Locations

The goal of the memo is to provide a high-level summary of wildfile risk across the County and highlight locations where residential and community infrastructure face specific wildfire-related risks. In addition, the maps have the potential to support future land use decisions by providing a summary of risk when considering zoning changes or new development. For each factor, the same set of maps is provided regardless of whether the risk is identified in the subarea of the County shown.

REFERENCE POPULATIONS

The memo presents summaries of risk based on three different reference populations: residential parcels, structures, and critical infrastructure. The three populations were selected to measure the relative risk exposure to wildfire risk for different parts of the County with an emphasis on where people and infrastructure are located in the County.

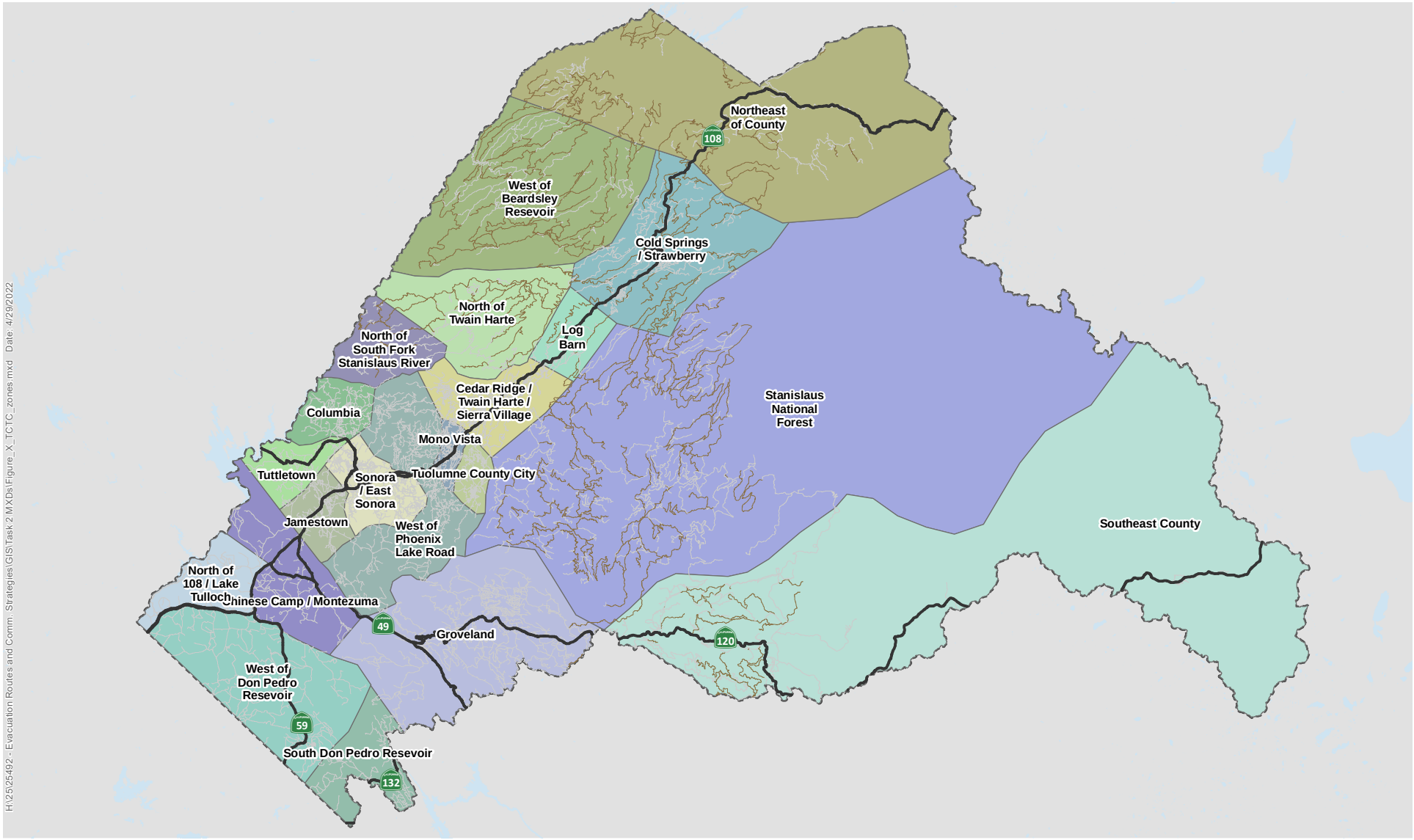
Under each risk section, exposure for the three populations is captured in a set of tables that identify the number and percent of the reference population exposed to the risk. In addition, the residential and structure data is aggregated into contiguous evacuation analysis subareas that were defined based on relative risk, land use, and roadway access. The zones vary in size: larger in areas of the County with fewer people or lower fire risk, and smaller where there are concentrations of people, critical infrastructure, and/or greater fire risk. The zones are shown in Figure 1.

- **Residential Parcels** – Parcels zoned to support residential land uses. Data was developed based on County and City of Sonora zoning files. The population includes 30,498 parcels which are shown in Figure 2 and are concentrated in population centers. The data does not differentiate between parcels based on number of units present.
- **Structures** – Structures in the County based on data provided by TCTC. The population includes 52,428 structures which are shown in Figure 3. The data identifies similar concentrations of activity as the residential parcel data. It also identified locations, such as resort areas, where there are buildings but fewer residential parcels.
- **Critical Infrastructure** – Locations of various critical infrastructure as identified by the County. Table 1 presents the different groups and the number of locations in the County. The location of the infrastructure is also shown in Figure 4.

Table 1: Critical Infrastructure in Tuolumne County

Critical Infrastructure Type	Structures
Essential County Operations Buildings	25
Powerhouses	6
Wireless Communication Towers	32
Police Stations	3
Fire Stations	28
TUD Water Tanks	79
Ambulance Stations	4
Hospitals	1
Urgent Care and Clinics	6
Potential Evacuation Shelters	19
Animal Shelters	4
Senior Centers	2
Primary Secondary Schools	28
Preschools	16
Large Daycare Centers	26
Total	**279**

Source: Kittelson & Associates, Inc., based on data from Tuolumne County, 2021



Roadways

State Highways and Major Roads

Minor and Local Roadways

Forest Service Roads

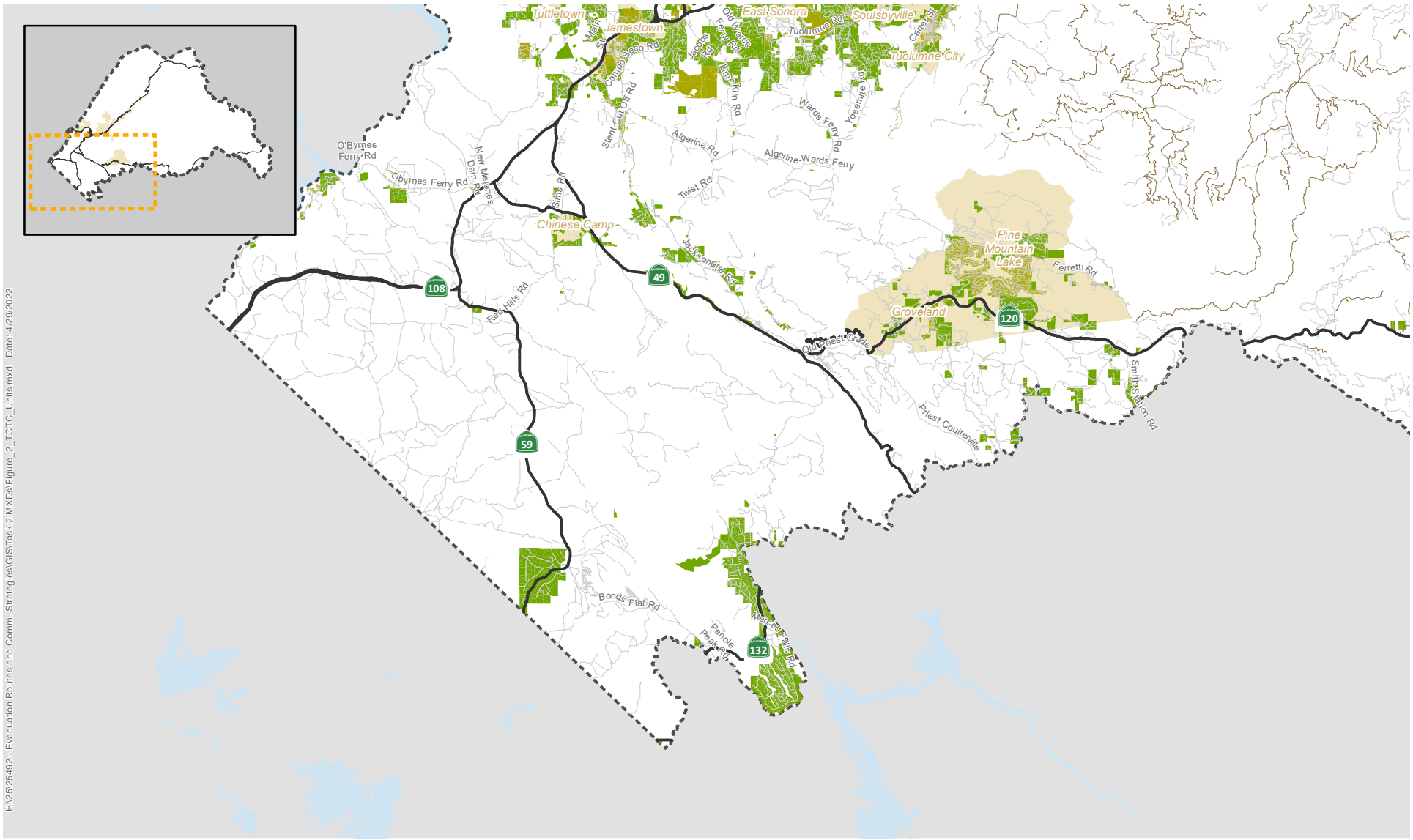
Tuolumne County

0 10 Miles

Figure1

Evacuation Analysis Subareas
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES



Zoning

- Residential
- Residential Estate

Roadways

- State Highways and Major Roads
- Minor and Local Roadways
- Forest Service Roads

- Cities
- Census Designated Places
- Tuolumne County

0 4 Miles

Figure 2.1

Residential Zoned Parcels
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES

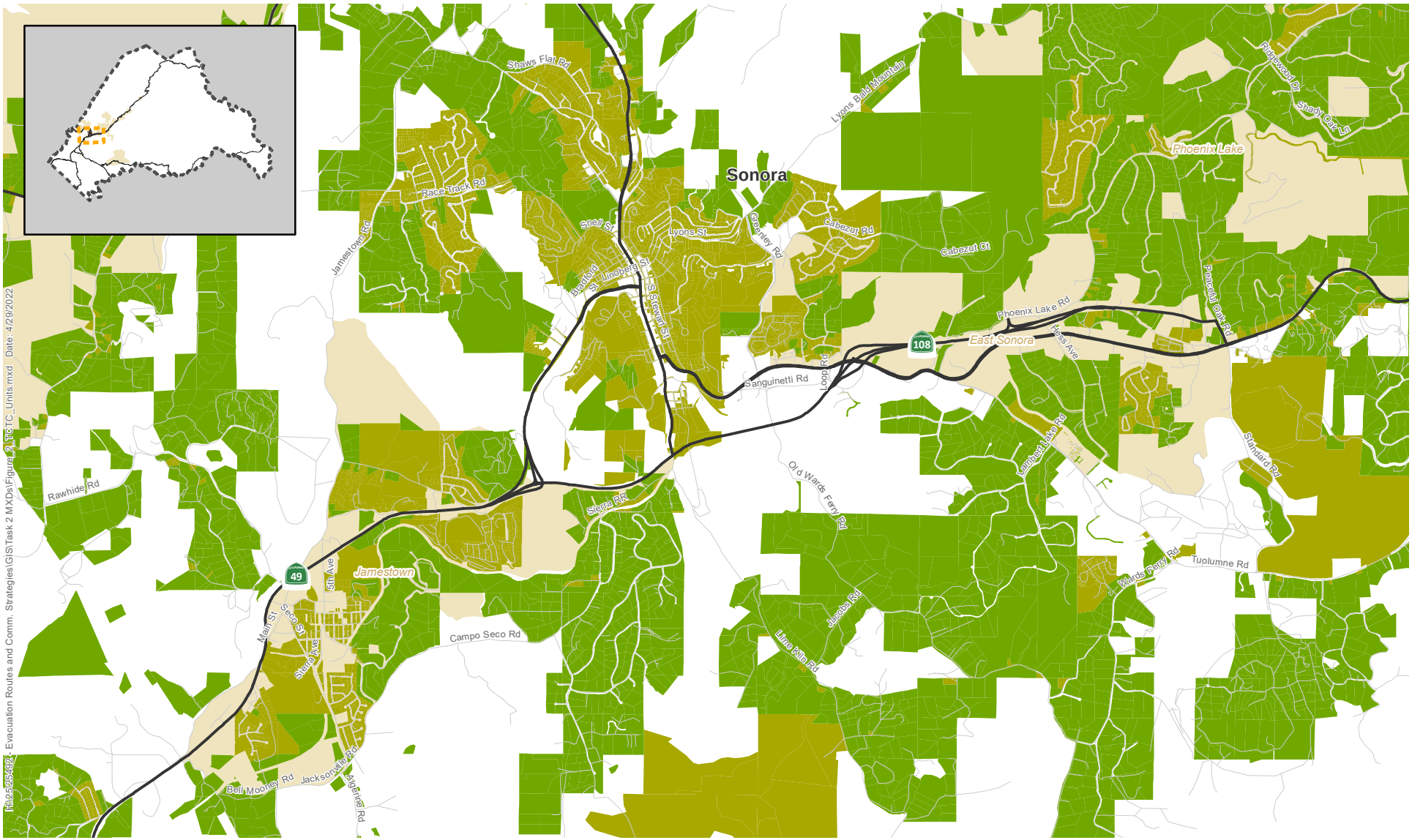
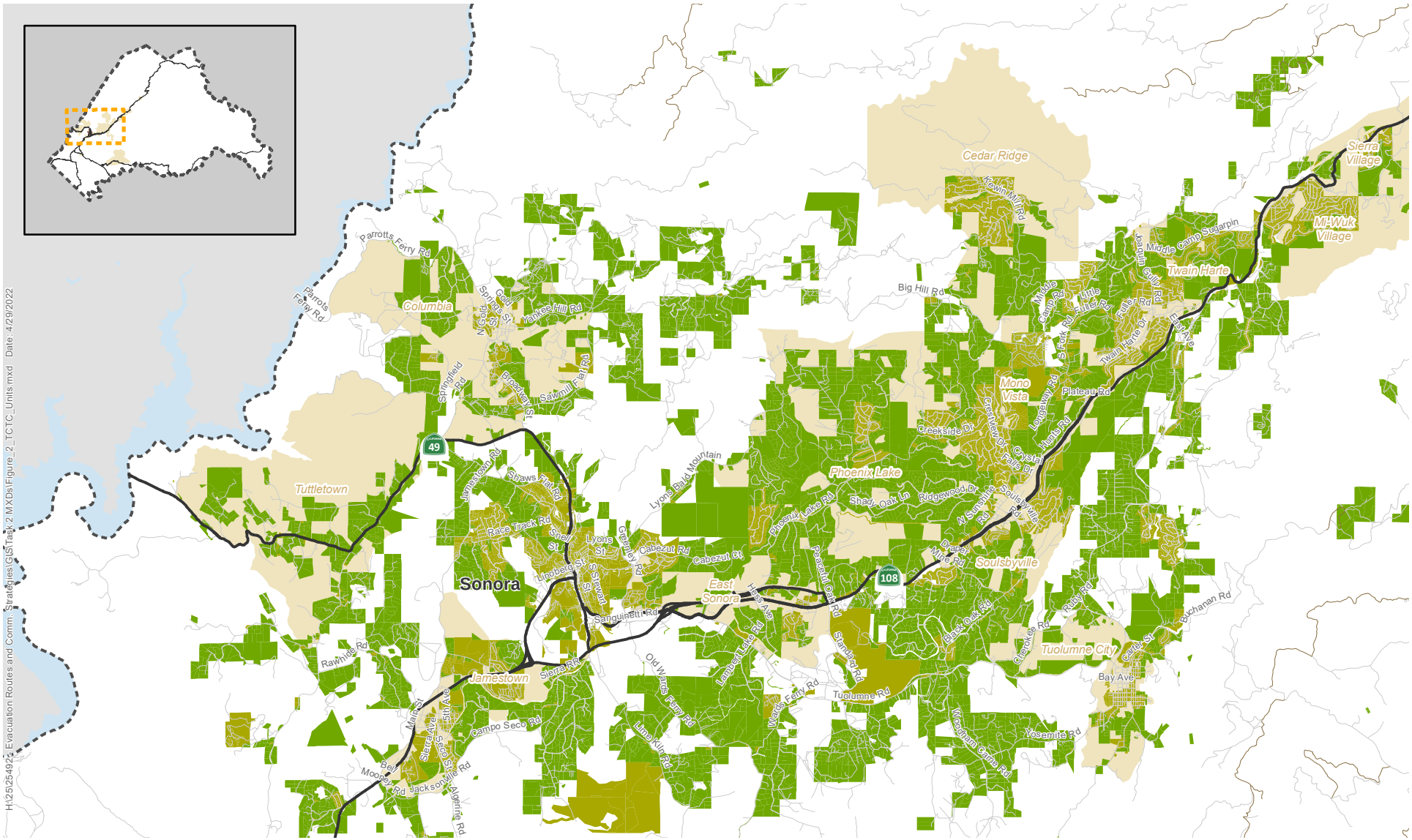


Figure 2.2

Residential Zoned Parcels
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES



Zoning

- Residential
- Residential Estate

Roadways

- State Highways and Major Roads
- Minor and Local Roadways
- Forest Service Roads

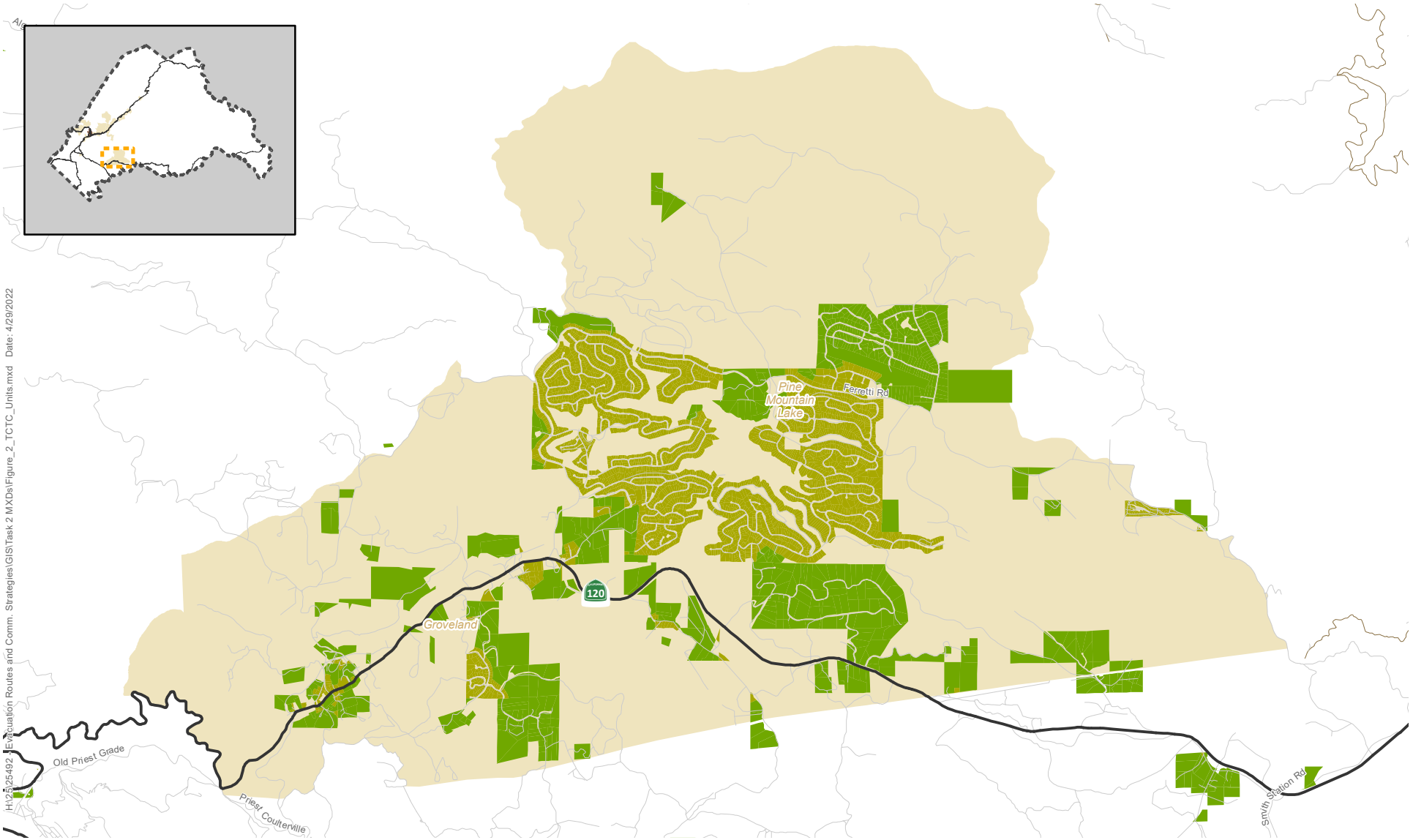
- Cities
- Census Designated Places
- Tuolumne County

0 2.2 Miles

Figure 2.3

Residential Zoned Parcels
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES



Zoning

- Residential
- Residential Estate

Roadways

- State Highways and Major Roads
- Minor and Local Roadways
- Forest Service Roads

- Cities
- Census Designated Places
- Tuolumne County

0 1 Miles

Figure 2.4

Residential Zoned Parcels
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES

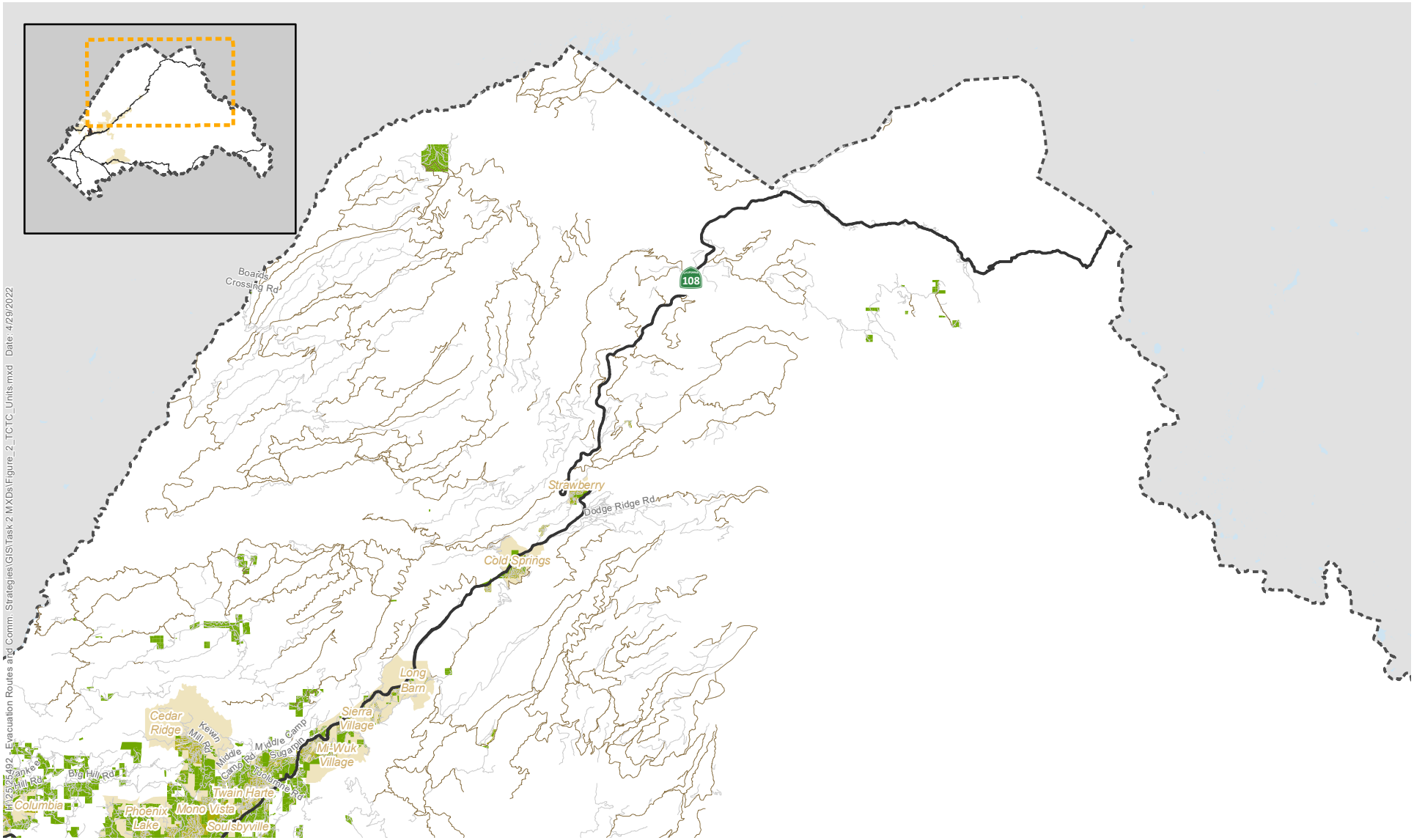
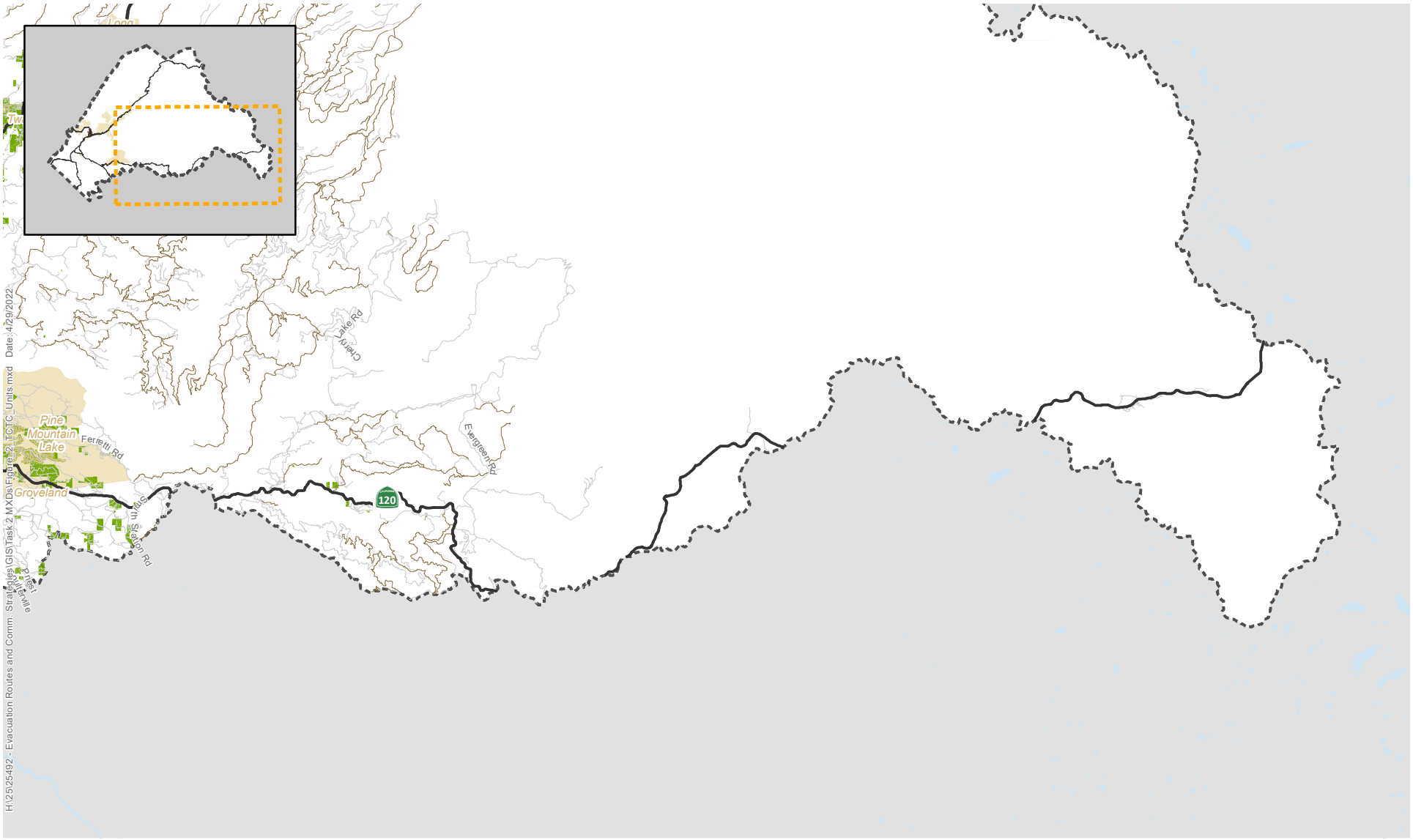


Figure 2.5

Residential Zoned Parcels
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES



Zoning

- Residential
- Residential Estate

Roadways

- State Highways and Major Roads
- Minor and Local Roadways
- Forest Service Roads

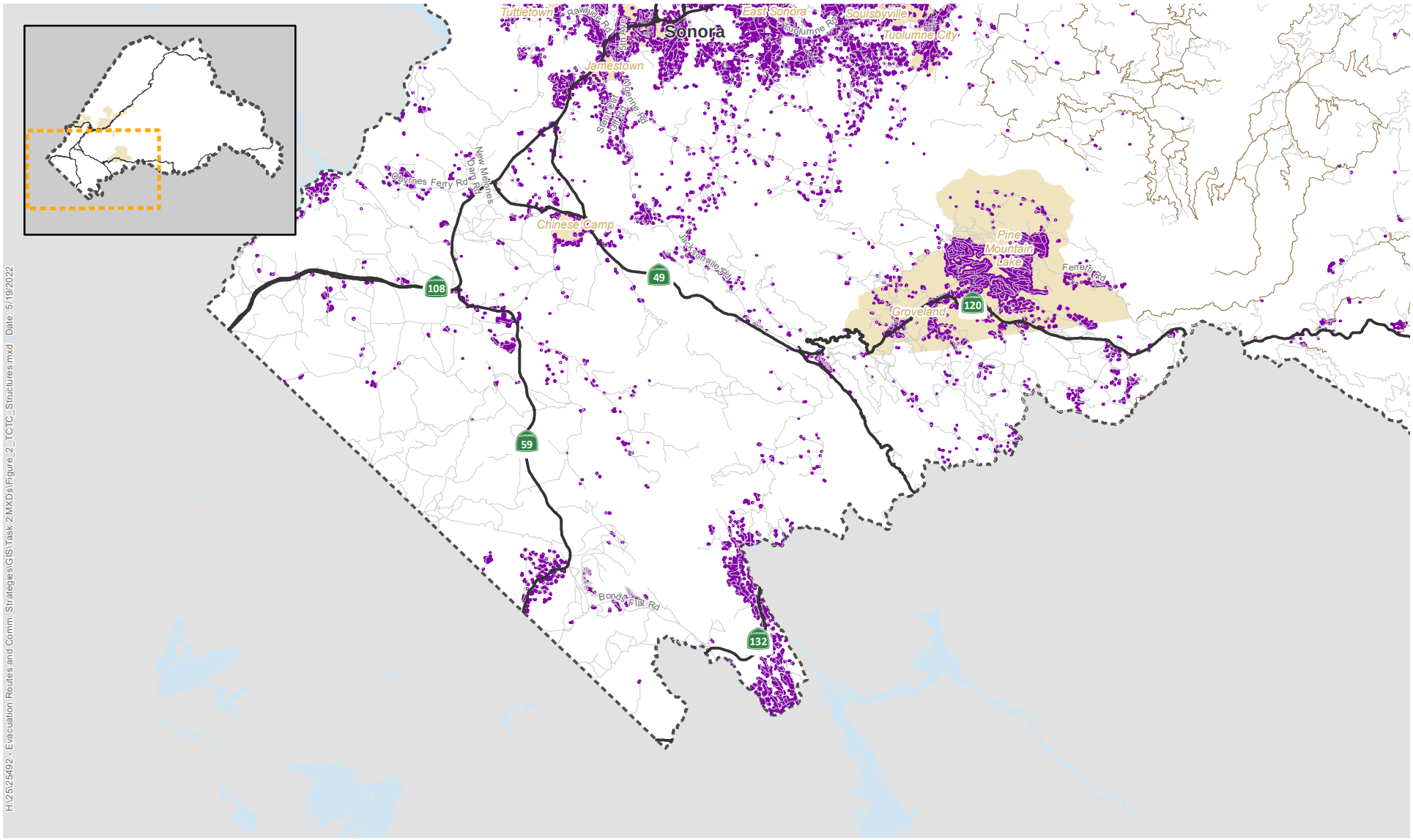
- Cities
- Census Designated Places
- Tuolumne County

0 6 Miles

Figure 2.6

Residential Zoned Parcels
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES



Structures

Roadways

- State Highways and Major Roads
- Minor and Local Roadways
- Forest Service Roads

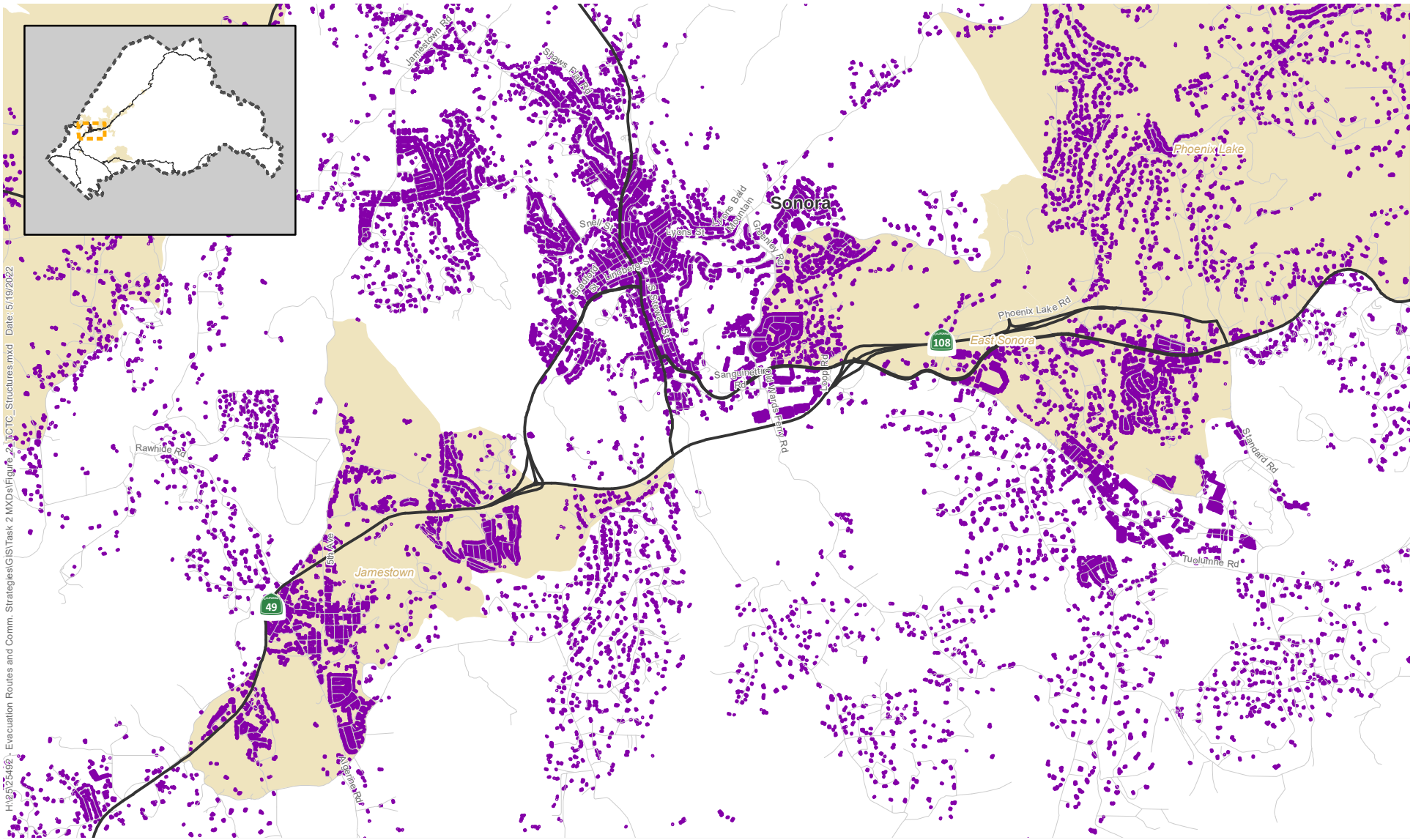
- Cities
- Census Designated Places
- Tuolumne County

0 4 Miles

Figure 3.1

KITTELSON & ASSOCIATES JENSEN HUGHES

Structures
Evacuation Routes and Communication Strategies
Tuolumne County, CA



Structures **Roadways**

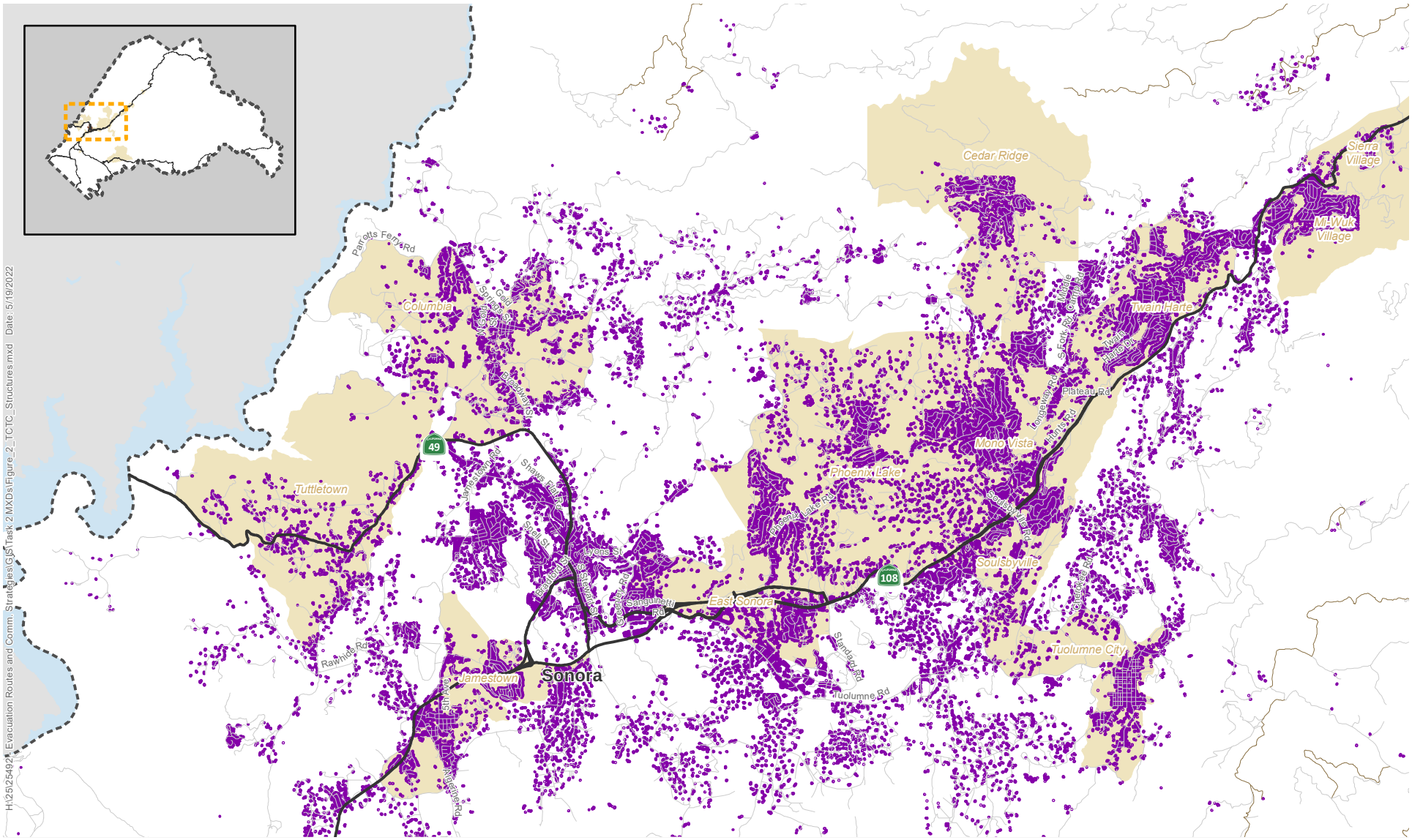
- State Highways and Major Roads
- Minor and Local Roadways
- Forest Service Roads
- Cities
- Census Designated Places
- Tuolumne County

0 0.8 Miles

Figure 3.2

Structures
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES



Structures

Roadways

- State Highways and Major Roads
- Minor and Local Roadways
- Forest Service Roads

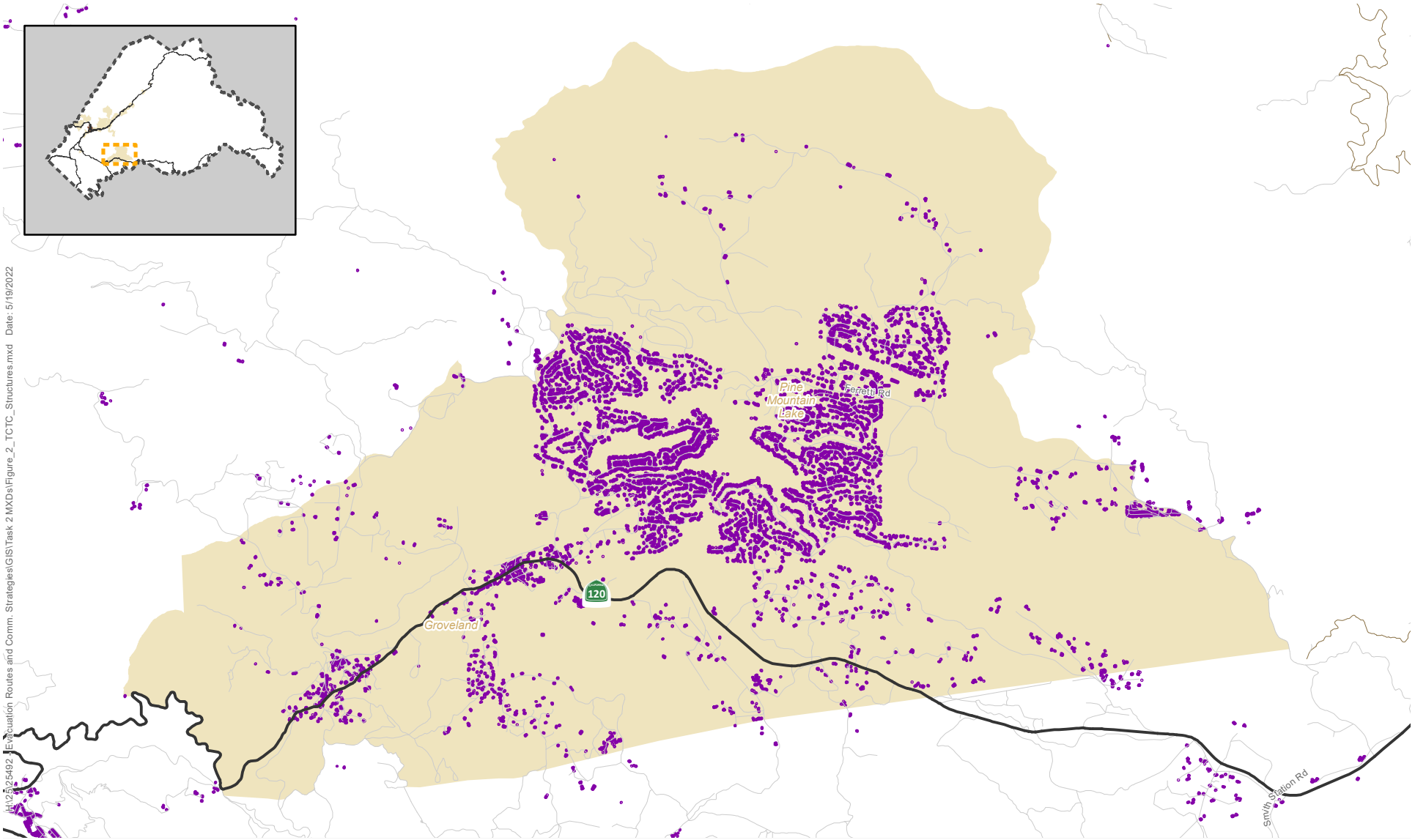
- Cities
- Census Designated Places
- Tuolumne County

0 2.2 Miles

Figure 3.3

Structures
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES



Structures

Roadways

- State Highways and Major Roads
- Minor and Local Roadways
- Forest Service Roads

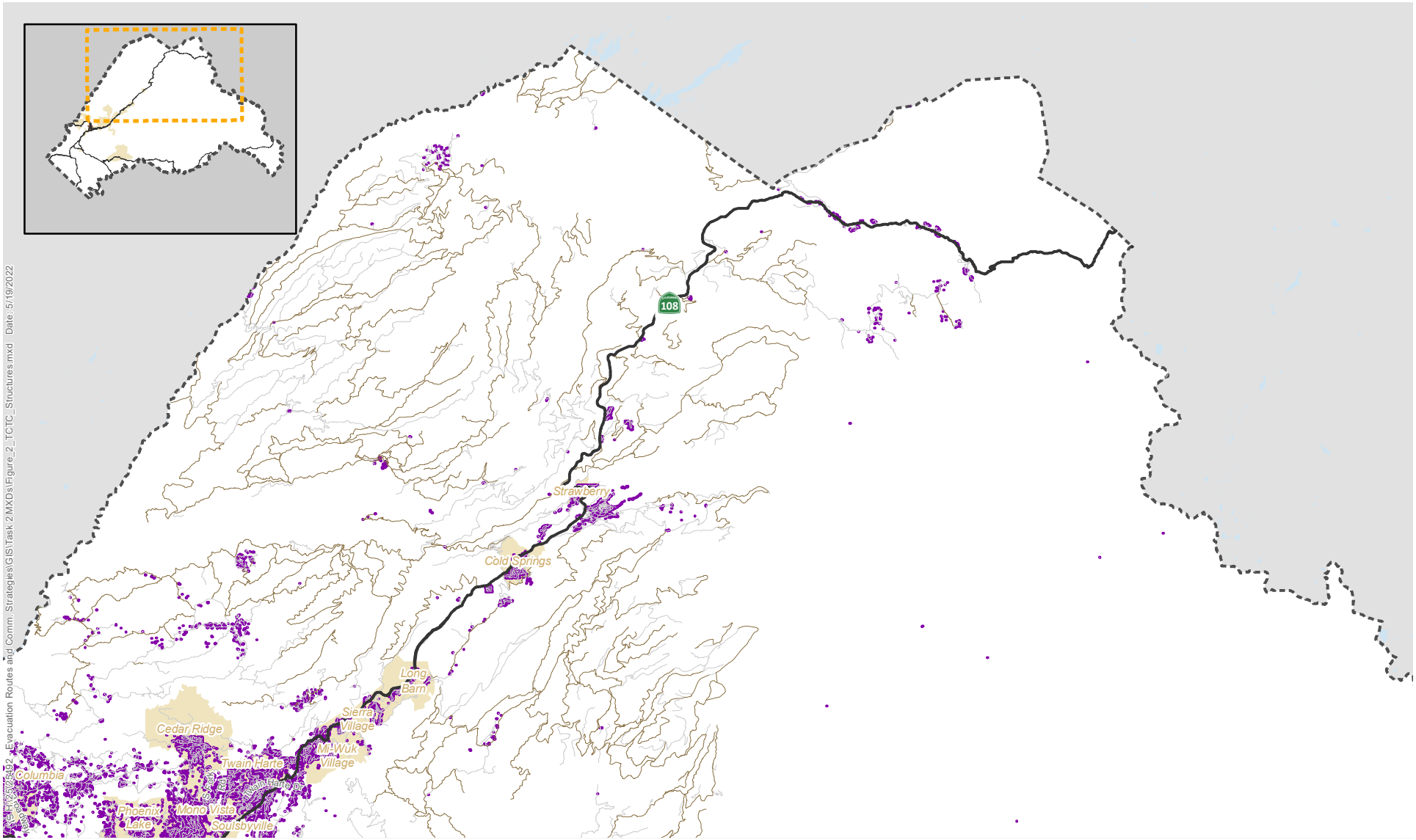
- Cities
- Census Designated Places
- Tuolumne County

0 1 Miles

Figure 3.4

Structures
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES



Structures

Roadways

- State Highways and Major Roads
- Minor and Local Roadways
- Forest Service Roads

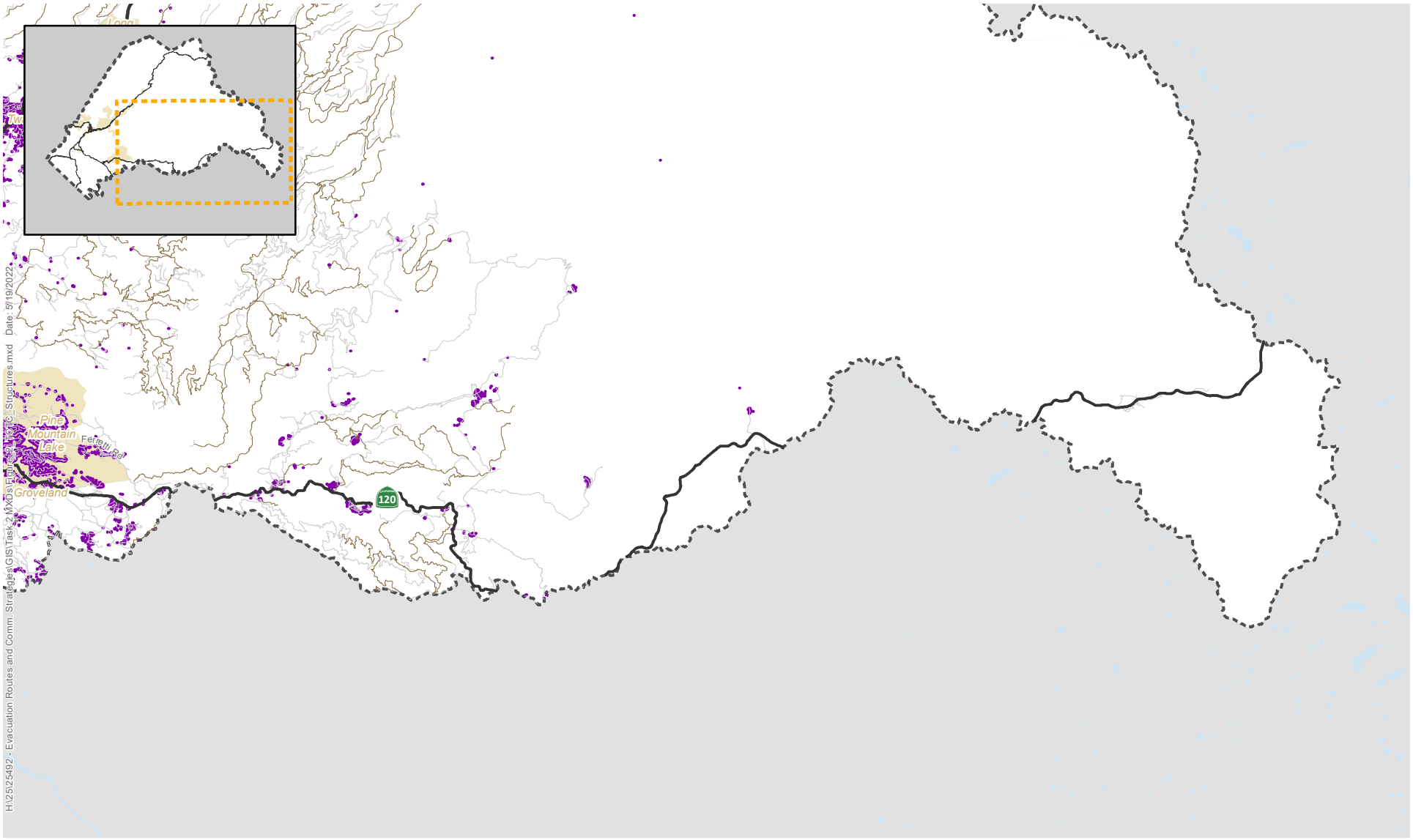
- Cities
- Census Designated Places
- Tuolumne County

0 4 Miles

Figure 3.5

Structures
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES



Structures

Roadways

- State Highways and Major Roads
- Minor and Local Roadways
- Forest Service Roads

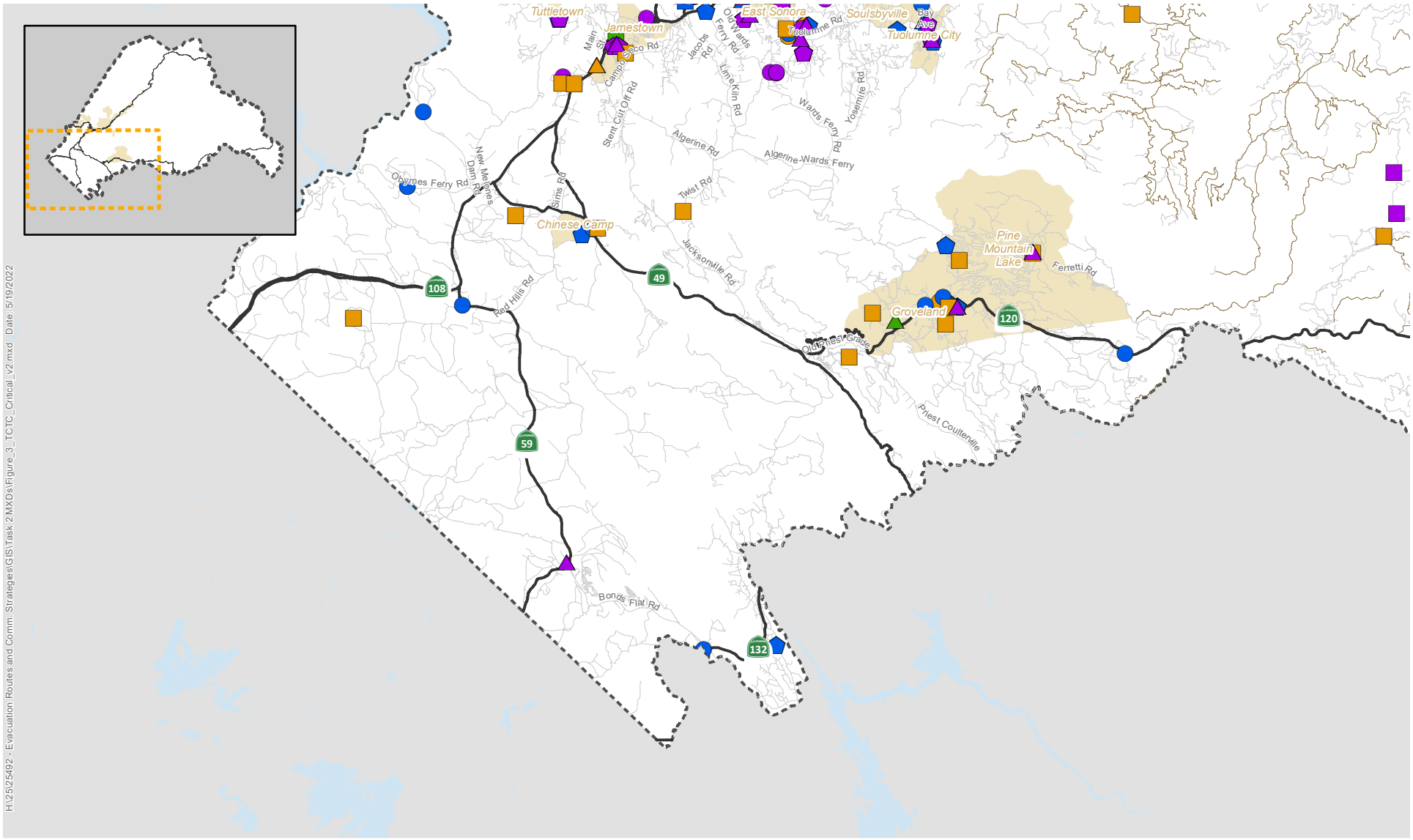
- Cities
- Census Designated Places
- Tuolumne County

0 6 Miles

Figure 3.6

Structures
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES



H:\25\25492 - Evacuation Routes and Comm. Strategies\GIS\Task 2\MXDs\Figure_3_TCTC_Critical_v2.mxd Date: 5/19/2022

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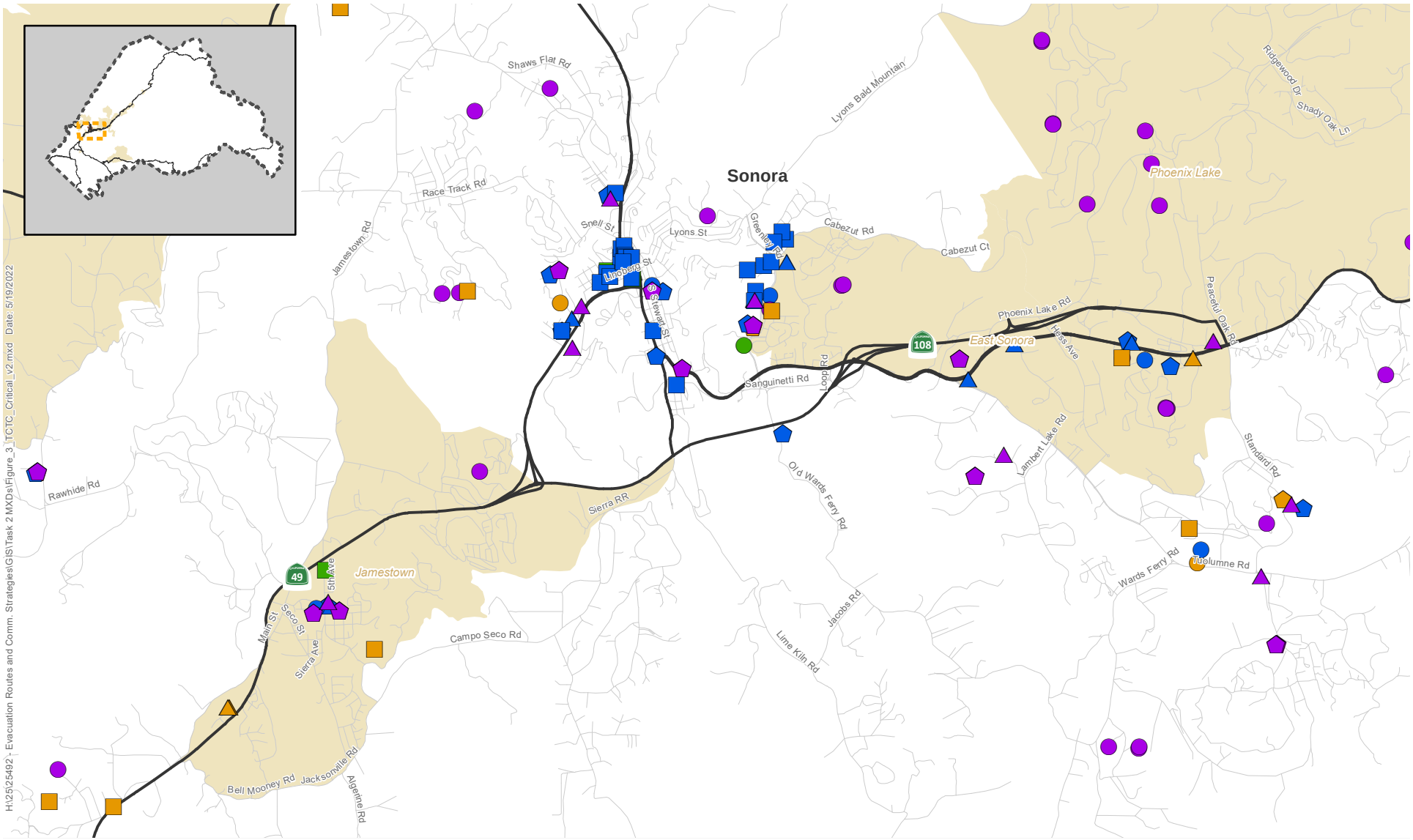
- Essential County Operations Buildings
- Powerhouses
- Wireless Communication Towers
- Police Stations
- Fire Stations
- TUD Water Tanks
- Ambulance Stations
- Hospitals
- Urgent Care and Clinics
- Potential Evacuation Shelters
- Animal Shelters
- Senior Centers
- Primary Secondary Schools
- Preschools
- Large Daycare Centers
- Cities
- Census Designated Places
- Tuolumne County

0 4 Miles

Figure 4.1

KITTELSON & ASSOCIATES JENSEN HUGHES

Critical Infrastructure Evacuation Routes and Communication Strategies Tuolumne County, CA



type

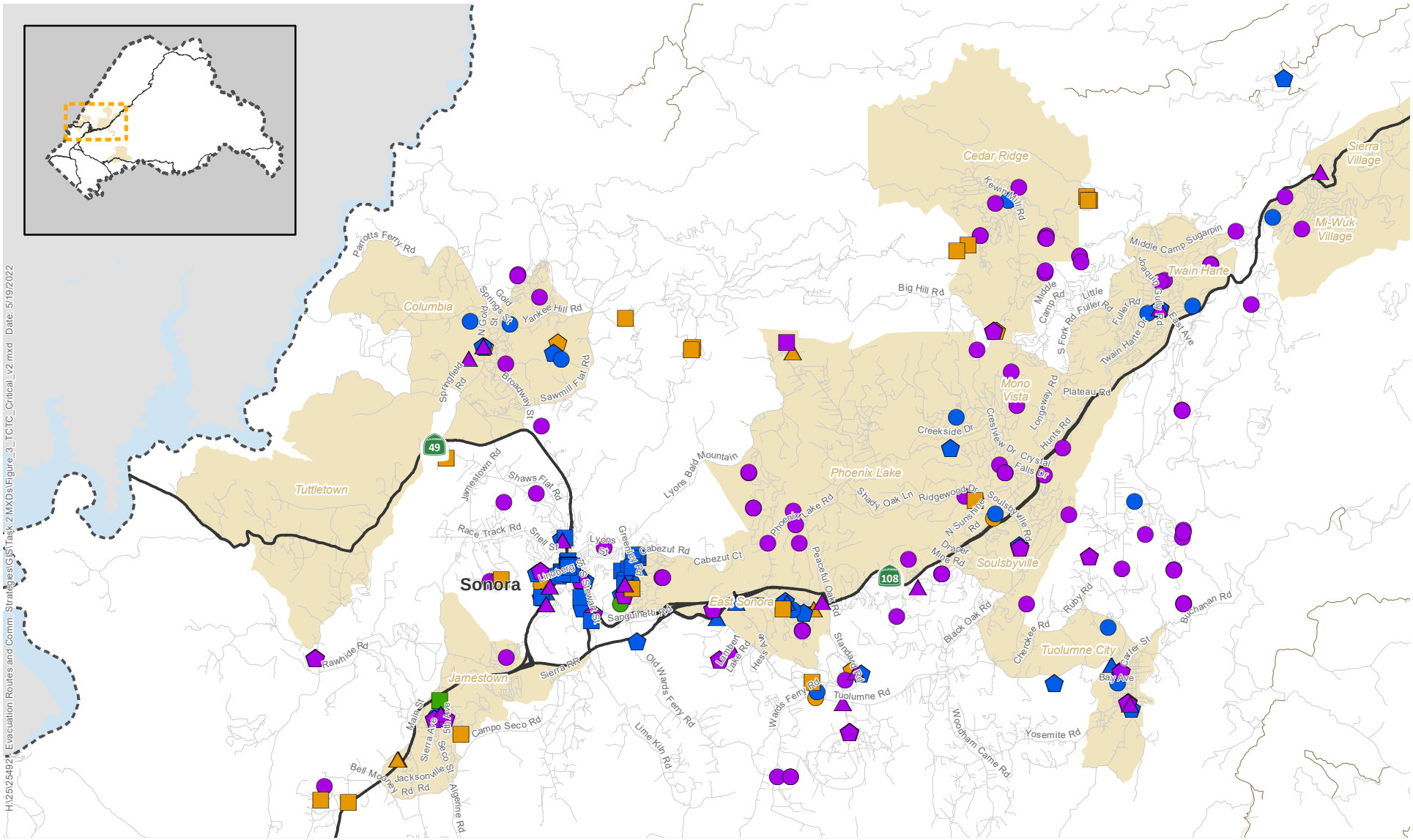
- Essential County Operations Buildings
- Powerhouses
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- Police Stations
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- Potential Evacuation Shelters
- Animal Shelters
- Senior Centers
- Primary Secondary Schools
- Preschools
- Large Daycare Centers
- Cities
- Census Designated Places
- Tuolumne County

0 0.8 Miles

Figure 4.2

KITTELSON & ASSOCIATES JENSEN HUGHES

Critical Infrastructure
Evacuation Routes and Communication Strategies
Tuolumne County, CA



type

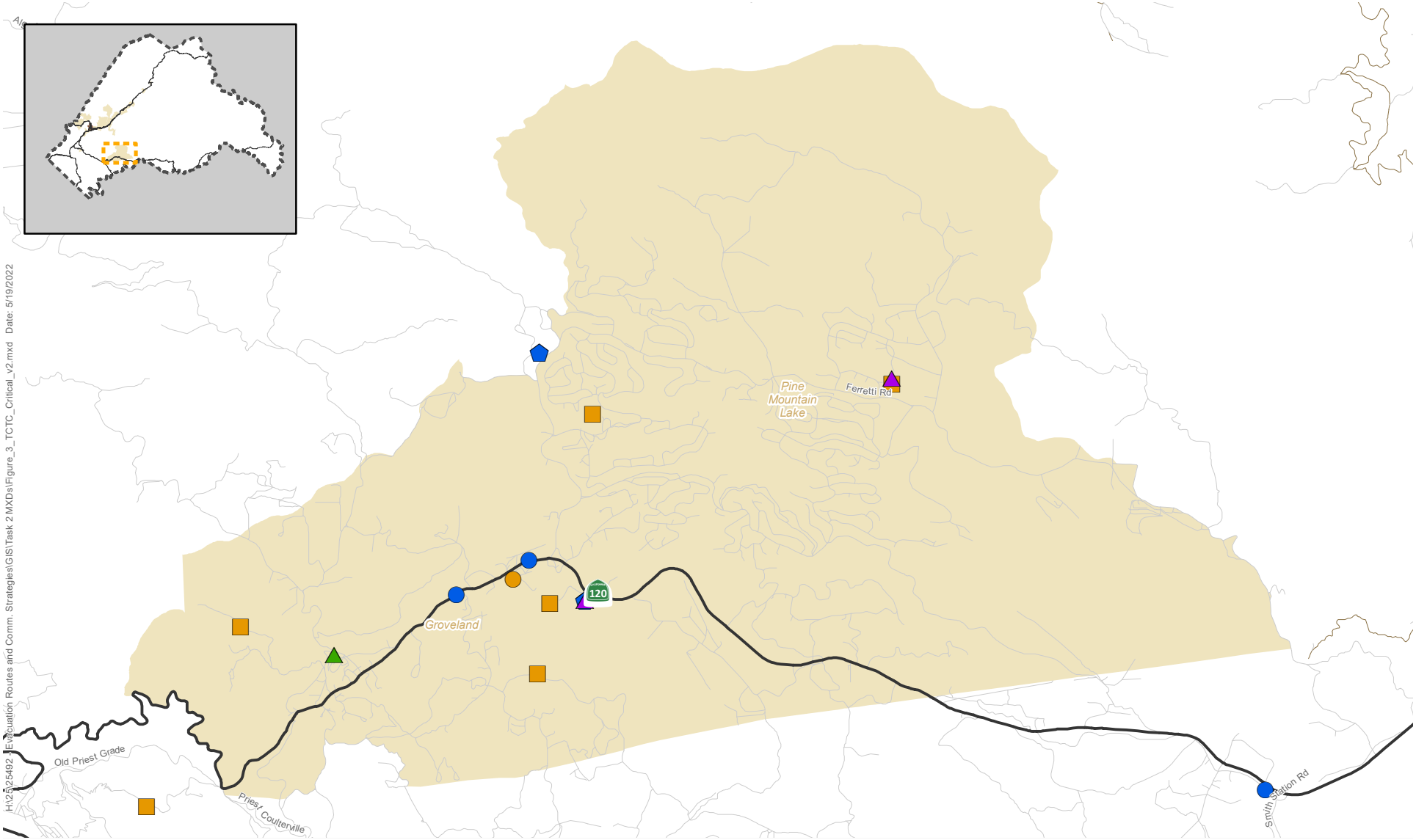
- Essential County Operations Buildings
- Powerhouses
- Wireless Communication Towers
- Police Stations
- Fire Stations
- TUD Water Tanks
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- Urgent Care and Clinics
- Potential Evacuation Shelters
- Animal Shelters
- Senior Centers
- Primary Secondary Schools
- Preschools
- Large Daycare Centers
- Cities
- Census Designated Places
- Tuolumne County

0 2.2 Miles

Figure 4.3

Critical Infrastructure Evacuation Routes and Communication Strategies Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES



type

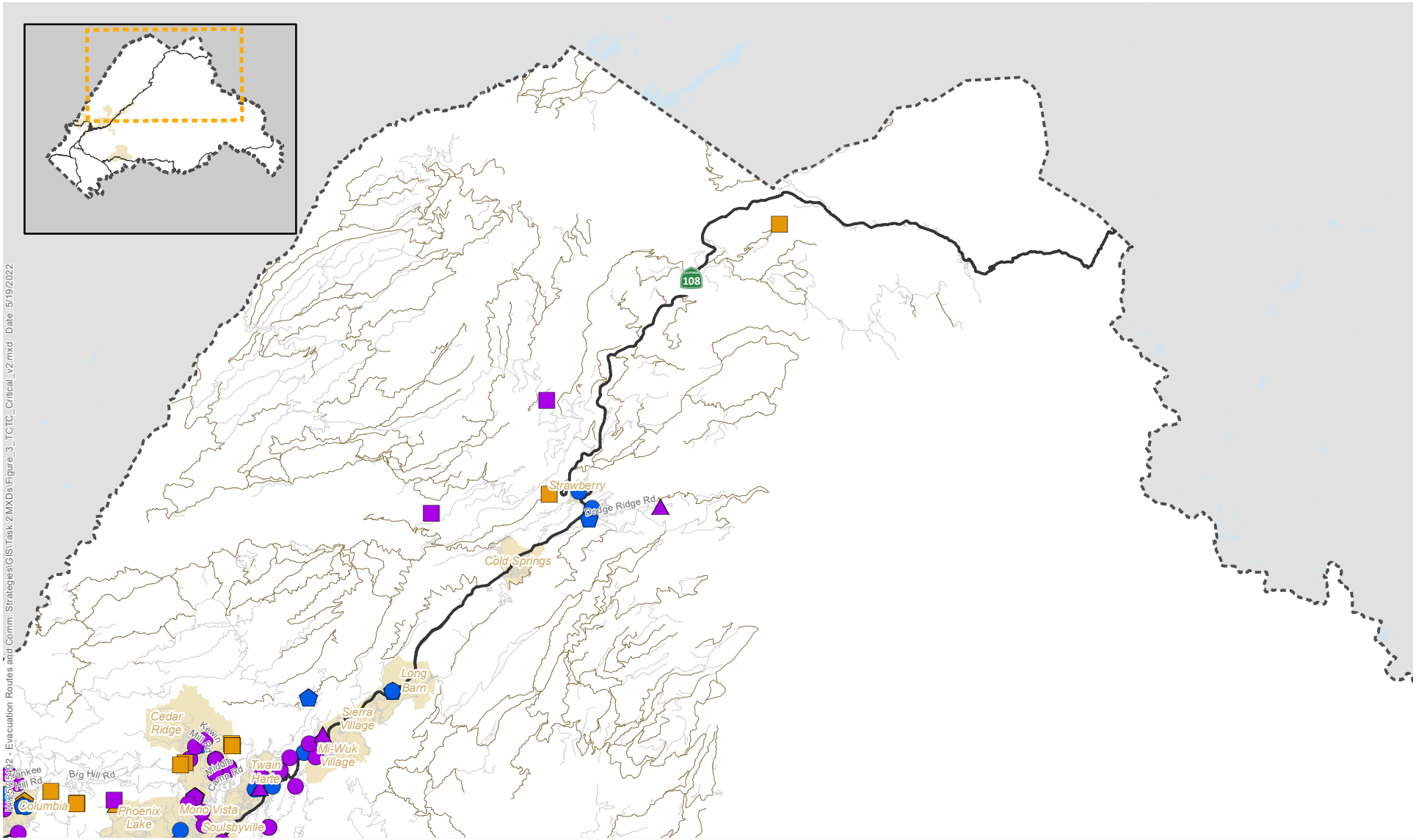
- Essential County Operations Buildings
- Powerhouses
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- Police Stations
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- Potential Evacuation Shelters
- Animal Shelters
- Senior Centers
- Primary Secondary Schools
- Preschools
- Large Daycare Centers
- Cities
- Census Designated Places
- Tuolumne County

0 1 Miles

Figure 4.4

KITTELSON & ASSOCIATES JENSEN HUGHES

Critical Infrastructure
Evacuation Routes and Communication Strategies
Tuolumne County, CA



type

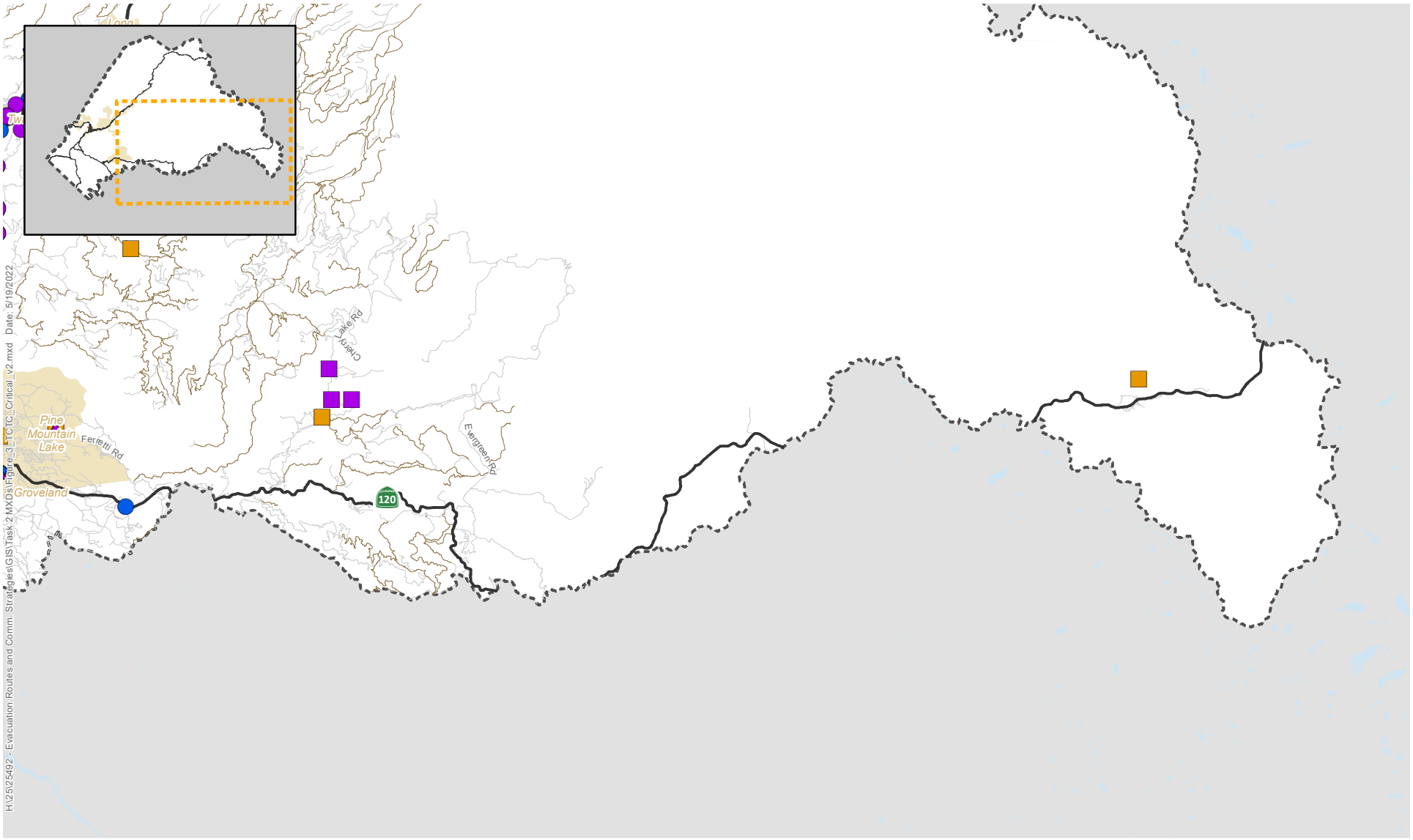
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- Animal Shelters
- Senior Centers
- Primary Secondary Schools
- Preschools
- Large Daycare Centers
- Cities
- Census Designated Places
- Tuolumne County

0 4 Miles

Figure 4.5

Critical Infrastructure Evacuation Routes and Communication Strategies Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES



type

- Essential County Operations Buildings
- Powerhouses
- Wireless Communication Towers
- Police Stations
- Fire Stations
- TUD Water Tanks
- Ambulance Stations
- Hospitals
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- Potential Evacuation Shelters
- Animal Shelters
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- Primary Secondary Schools
- Preschools
- Large Daycare Centers
- Cities
- Census Designated Places
- Tuolumne County

0 6 Miles

Figure 4.6

KITTELSON & ASSOCIATES JENSEN HUGHES

Critical Infrastructure
Evacuation Routes and Communication Strategies
Tuolumne County, CA

FIRE HAZARD SEVERITY ZONES

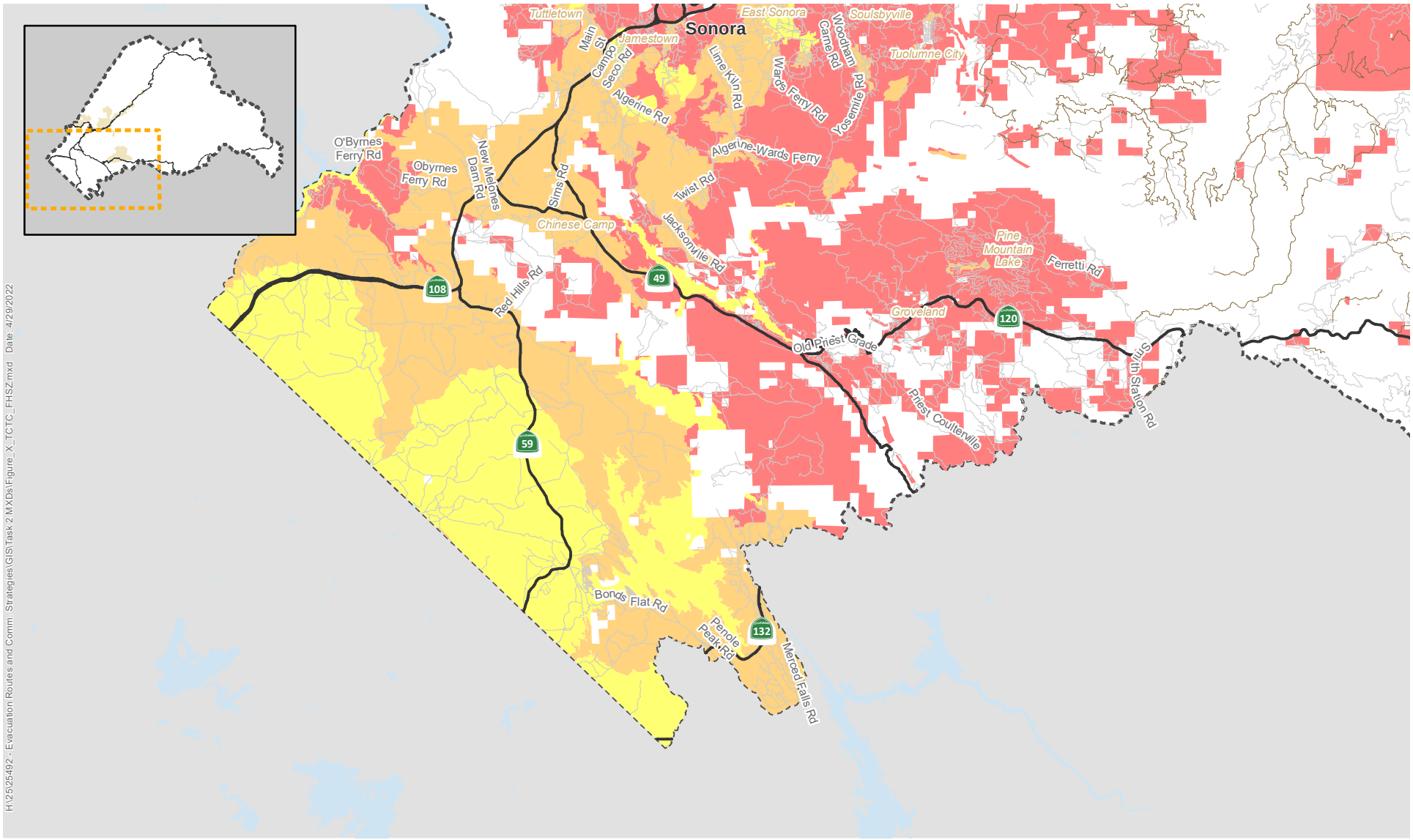
DESCRIPTION

The Fire Hazard Severity Zones (FHSZ) present a composite measure of risk for wildfire occurrence based on factors that influence fire likelihood and fire behavior. The maps categorize locations into three levels of risk: Moderate, High, and Very High. Relative risk is calculated based on several factors (e.g., fire history, existing and potential vegetative fuel, predicted flame length, ember travel, terrain, and fire weather) to help define where a fire is likely to occur and how severe fire conditions could be. The risks presented in the memo are based on California Department of Forestry and Fire Protection's (CAL FIRE) FHSZ data for state responsibility areas (2007) and augmented by the local responsibility area designations for the City of Sonora (2008).

MAP OF RISK

The Fire Hazard Severity Zones are shown in Figure 5. The maps indicate risk is present throughout the inhabited areas of the County.

- Risk is lower (but still Moderate) in the western portion of the County along CA-108 and CA-49.
- Risk is higher in the more densely inhabited areas along CA-108, particularly east of Sonora, and in and around Groveland and Pine Mountain Lake along CA-120.
- FHSZs are not present in the higher elevations in the eastern partion of the County.



Fire Hazard Severity Zones

- Very High
- High
- Moderate

Roadways

- State Highways and Major Roads
- Minor and Local Roadways
- Forest Service Roads

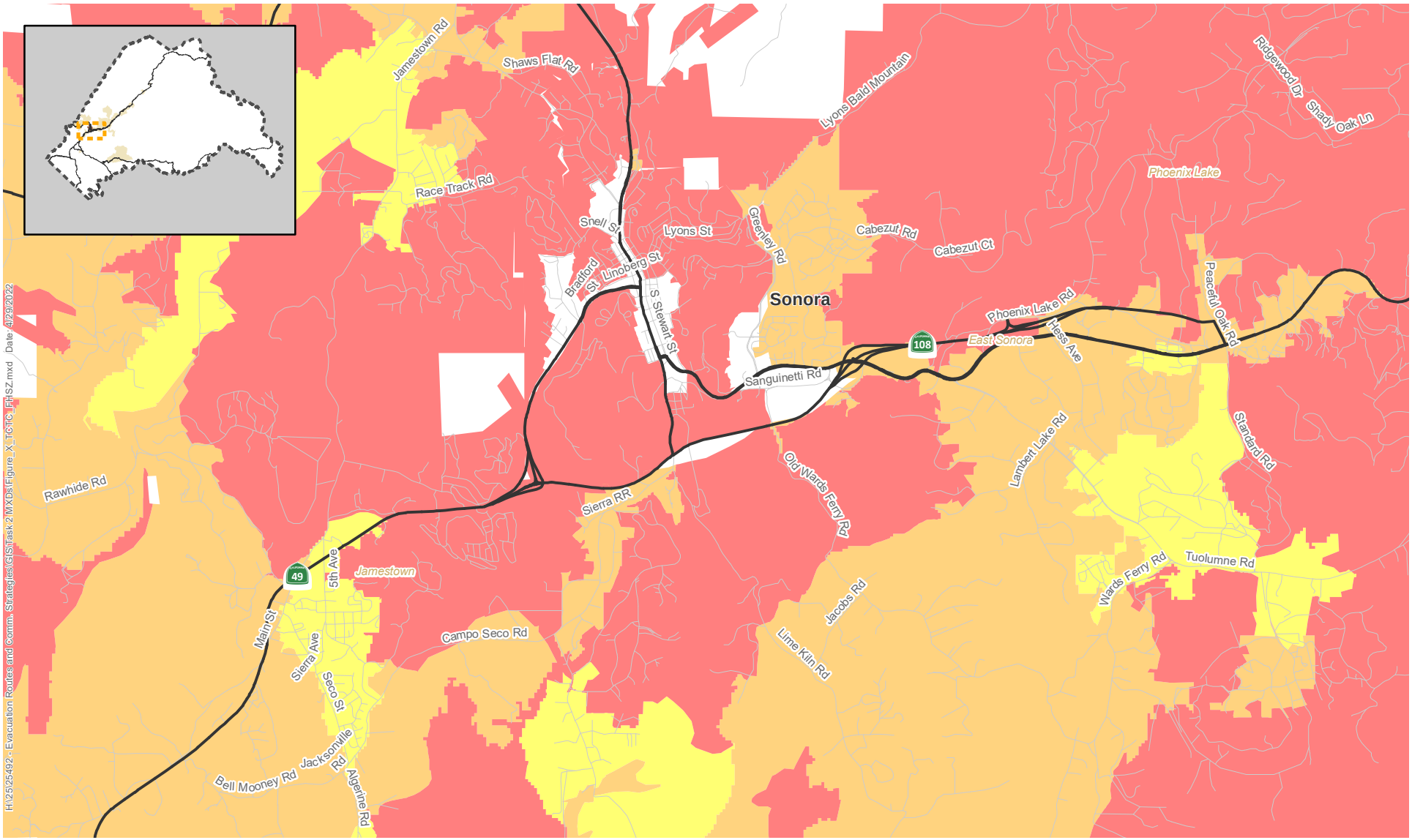
Tuolumne County

0 4 Miles

Figure 5.1

Fire Hazard Severity Zone
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES



Fire Hazard Severity Zones

- Very High
- High
- Moderate

Roadways

- State Highways and Major Roads
- Minor and Local Roadways
- Forest Service Roads

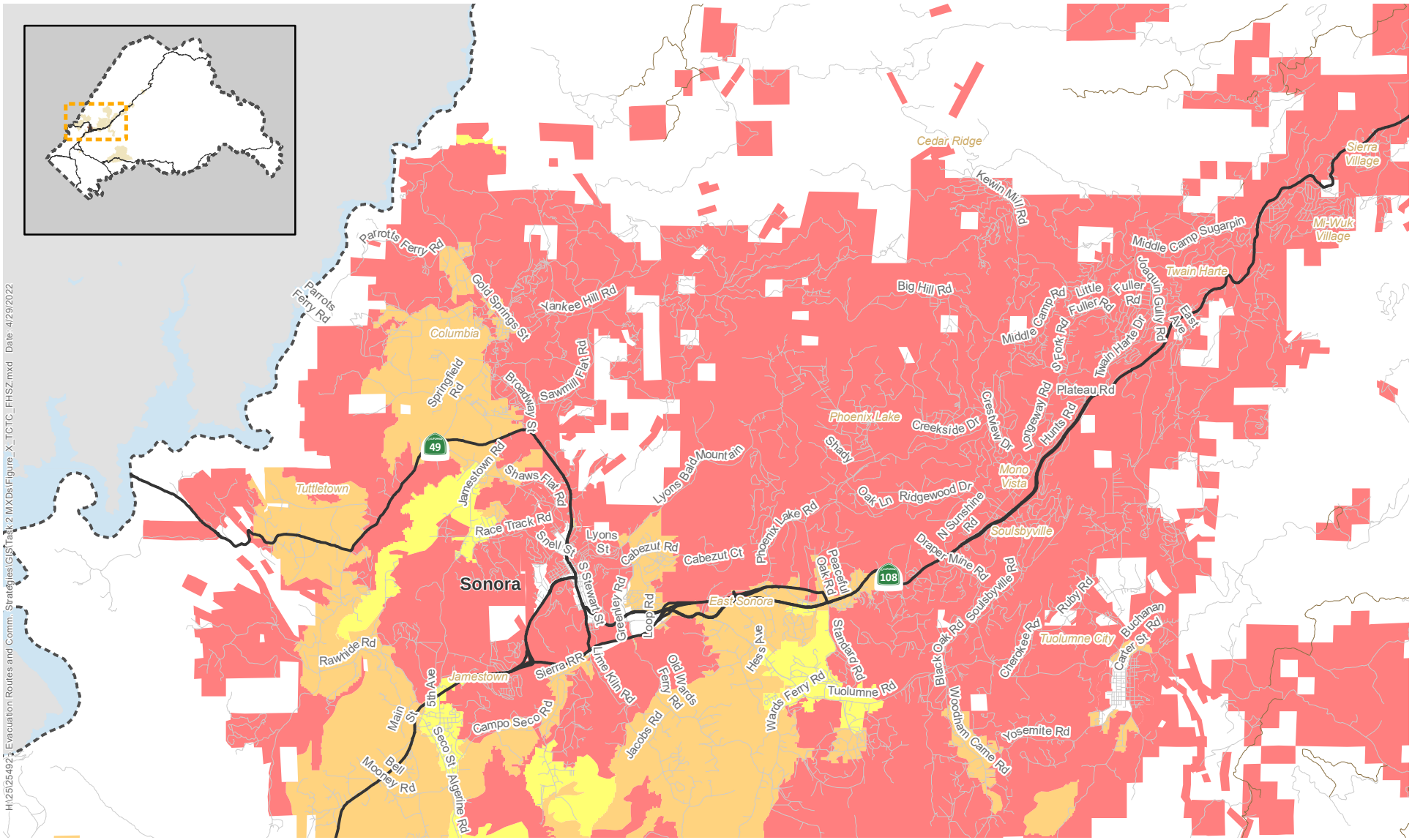
Tuolumne County

0 0.8 Miles

Figure 5.2

Fire Hazard Severity Zone
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES



Fire Hazard Severity Zones

- Very High
- High
- Moderate

Roadways

- State Highways and Major Roads
- Minor and Local Roadways
- Forest Service Roads

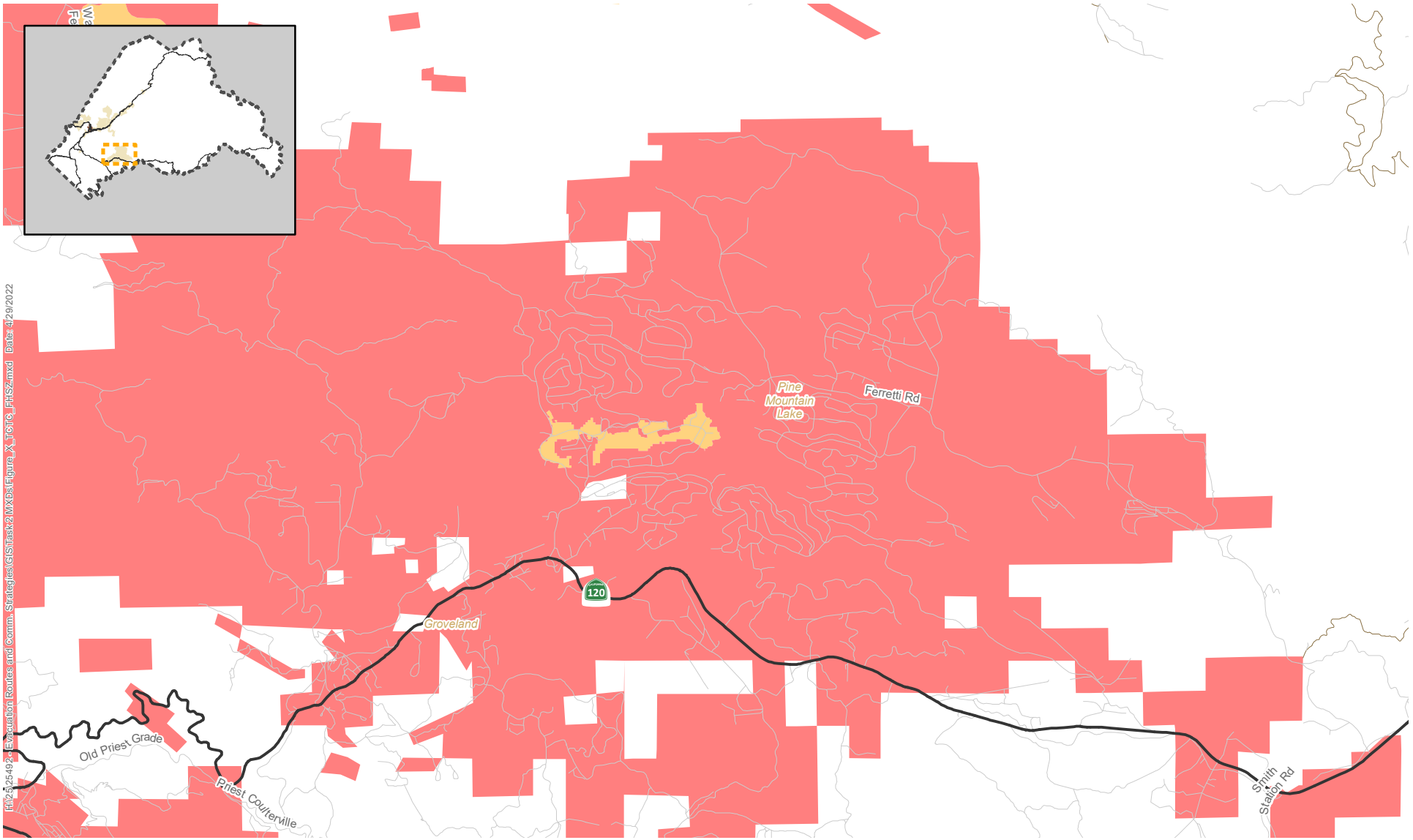
Tuolumne County

0 2.2 Miles

Figure 5.3

Fire Hazard Severity Zone
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES



Fire Hazard Severity Zones

- Very High
- High
- Moderate

Roadways

- State Highways and Major Roads
- Minor and Local Roadways
- Forest Service Roads

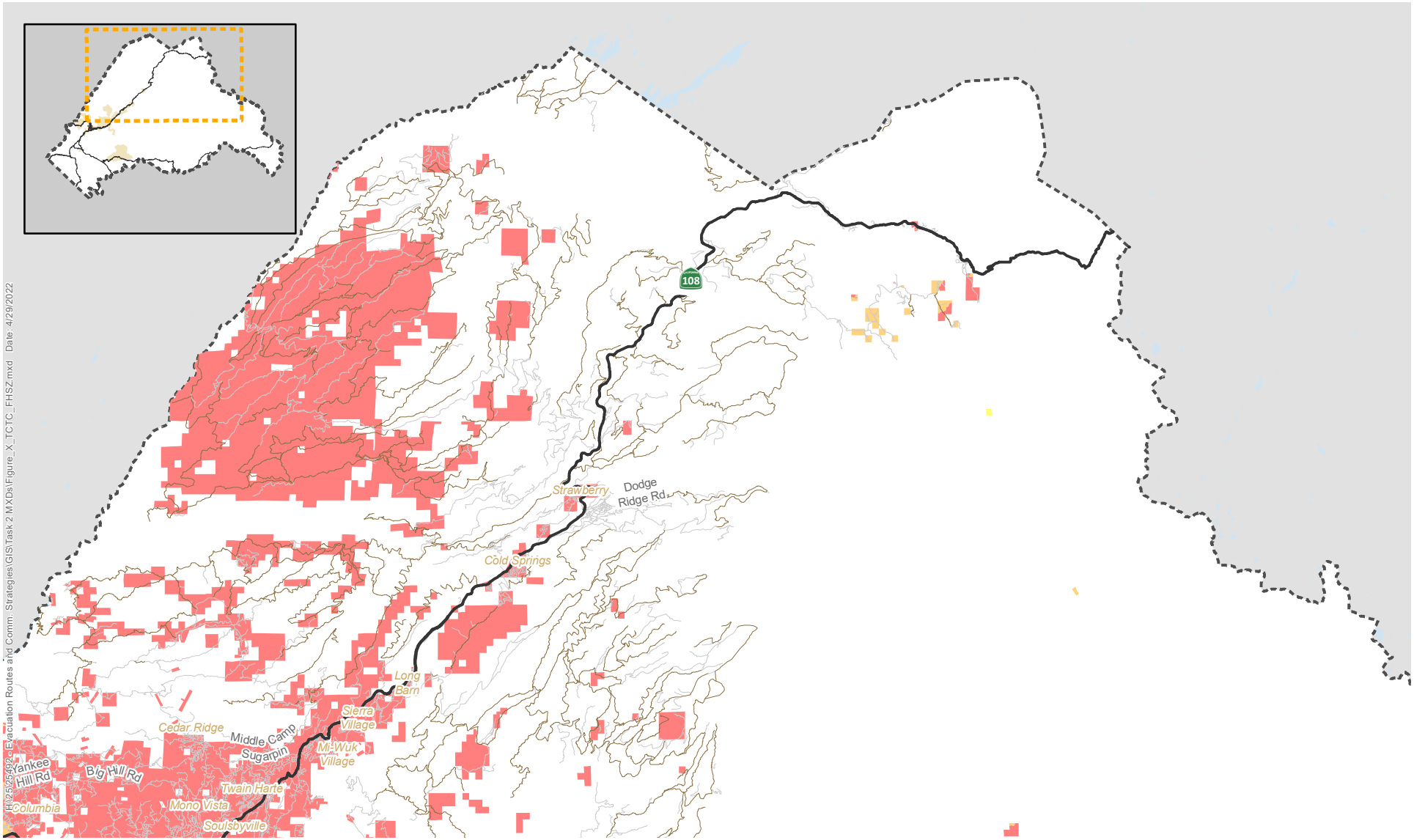
Tuolumne County

0 1 Miles

Figure 5.4

Fire Hazard Severity Zone
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES



Fire Hazard Severity Zones

- Very High
- High
- Moderate

Roadways

- State Highways and Major Roads
- Minor and Local Roadways
- Forest Service Roads

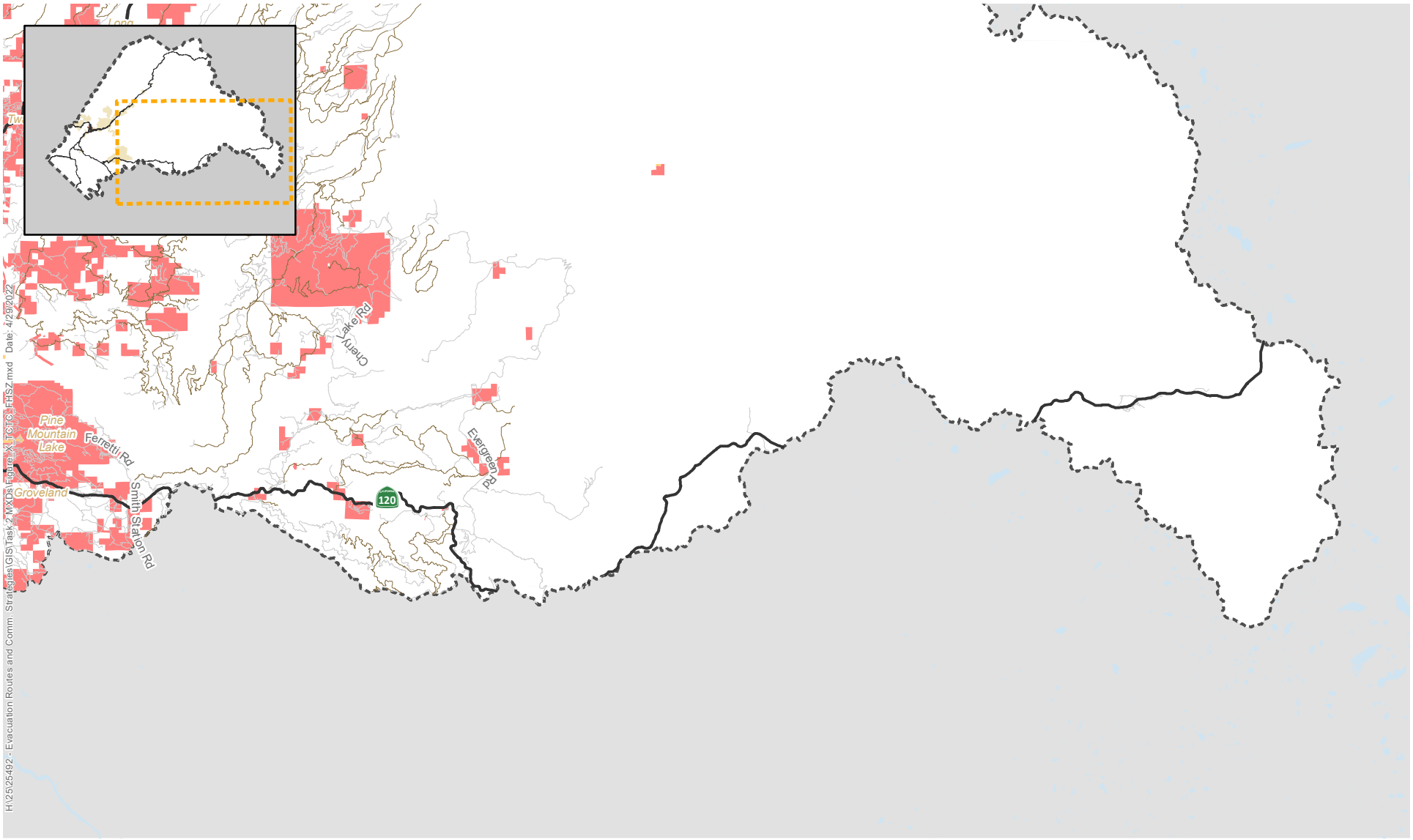
Tuolumne County

0 4 Miles

Figure 5.5

Fire Hazard Severity Zone Evacuation Routes and Communication Strategies Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES



Fire Hazard Severity Zones

- Very High
- High
- Moderate

Roadways

- State Highways and Major Roads
- Minor and Local Roadways
- Forest Service Roads

Tuolumne County

0 6 Miles

Figure 5.6

Fire Hazard Severity Zone
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES

SUMMARY OF RISK

Table 2, Table 3, and Table 4 present the percent of residential parcels, structures, and critical infrastructure that are in moderate high or very high fire hazard severity zones. The analysis shows that for each reference population, risk is endemic with the majority of residential parcels and structures in high or very high FHSZs. Across the zones there is variations in risk:

- Zones in the southeast portion of the County have relatively lower risk, with more parcels and structures in a moderate FHSZ zone. In particular, Sonora / East Sonora and West of Don Pedro Resevoir County subareas have a lower share of parcels and structures in the high or very high FHSZ.
- Zones east of Sonora along CA-108 are at high risk with multiple analysis zones having over 98% of residential parcels and structures in high or very high FHSZ zones. The Cedar Ridge / Twain Harte / Sierra Village subarea has 99% of residential parcels and structures in the high risk FHSZ.
- Relative to the residential parcels and structures, critical infrastructure is located in somewhat lower risk parts of the County. However, almost half (46%) of identified critical infrastructure are still located in a very high FHSZ.

Table 2: FHSZ Risk for Residential Parcels

County Analysis Subarea	Residential Parcels	FHSZ Account					
		Moderate		High		Very High	
Cedar Ridge / Twain Harte / Sierra Village	6,751	0%	-	0%	-	99%	6,716
Sonora / East Sonora	5,153	11%	552	33%	1,687	19%	966
Groveland	4,176	0%	-	4%	180	94%	3,928
West of Phoenix Lake Road	3,465	0%	1	7%	237	93%	3,209
Mono Vista	2,890	0%	-	0%	-	100%	2,889
Jamestown	2,003	26%	518	31%	629	42%	833
Columbia	1,387	0%	-	32%	445	67%	928
Cold Springs / Strawberry	1,250	0%	-	0%	-	100%	1,249
Tuolumne City	1,602	0%	-	8%	125	56%	899
South Don Pedro Reservoir	1,201	0%	1	99%	1,184	1%	16
Tuttletown	717	6%	41	48%	347	44%	319
Log Barn	432	0%	-	0%	-	97%	419
North of Twain Harte	200	0%	-	0%	-	98%	196
West of Don Pedro Reservoir	180	93%	168	7%	12	0%	-
Chinese Camp / Montezuma	155	0%	-	98%	152	2%	3
North of 108 / Lake Tulloch	149	8%	12	27%	40	65%	97
Northeast of County	151	0%	-	30%	46	68%	103
Stanislaus National Forest	119	0%	-	0%	-	50%	59
Southeast County	35	0%	-	0%	-	100%	35
North of South Fork Stanislaus River	35	0%	-	0%	-	100%	35
West of Beardsley Reservoir	2	0%	-	0%	-	100%	2
Total	**32,053**	**4.0%**	**1,293**	**15.9%**	**5,084**	**71.4%**	**22,901**

Table 3: FHSZ Risk for Structures

County Analysis Subarea	Structures	FHSZ Account					
		Moderate		High		Very High	
Cedar Ridge / Twain Harte / Sierra Village	7,393	0%	-	0%	-	99%	7,342
Sonora / East Sonora	8,937	13%	1,146	34%	3,056	19%	1,698
Groveland	5,733	0%	-	4%	233	94%	5,364
West of Phoenix Lake Road	6,669	0%	1	9%	605	89%	5,955
Mono Vista	4,129	0%	-	0%	-	100%	4,129
Jamestown	3,288	24%	783	38%	1,248	37%	1,206
Columbia	3,205	0%	-	33%	1,044	66%	2,125
Cold Springs / Strawberry	1,908	0%	-	0%	-	62%	1,176
Tuolumne City	2,991	0%	-	8%	229	51%	1,528
South Don Pedro Reservoir	1,382	0%	5	97%	1,342	2%	28
Tuttletown	2,074	7%	144	55%	1,145	35%	733
Log Barn	356	0%	-	0%	-	93%	330
North of Twain Harte	368	0%	-	0%	-	99%	365
West of Don Pedro Reservoir	740	63%	469	37%	271	0%	-
Chinese Camp / Montezuma	670	0%	-	87%	581	4%	29
North of 108 / Lake Tulloch	484	5%	24	48%	233	47%	227
Northeast of County	358	0%	-	18%	65	29%	104
Stanislaus National Forest	169	0%	-	0%	-	61%	103
Southeast County	879	0%	-	0%	-	63%	552
North of South Fork Stanislaus River	128	0%	-	0%	-	93%	119
West of Beardsley Reservoir	117	0%	-	0%	-	90%	105
Total	**51,978**	**4.9%**	**2,572**	**19.3%**	**10,052**	**63.9%**	**33,218**

Table 4: FHSZ Risk for Critical Infrastructure

Critical Infrastructure Type	Structures	FHSZ Account					
		Moderate		High		Very High	
Essential County Operations Buildings	25	0%	-	12%	3	0%	-
Powerhouses	6	0%	-	0%	-	33%	2
Wireless Communication Towers	32	3%	1	25%	8	53%	17
Police Stations	3	33%	1	0%	-	0%	-
Fire Stations	28	11%	3	21%	6	50%	14
TUD Water Tanks	79	0%	-	11%	9	77%	61
Ambulance Stations	4	25%	1	0%	-	50%	2
Hospitals	1	0%	-	0%	-	0%	-
Urgent Care and Clinics	6	0%	-	67%	4	0%	-
Potential Evacuation Shelters	19	16%	3	21%	4	32%	6
Animal Shelters	4	25%	1	50%	2	25%	1
Senior Centers	2	0%	-	0%	-	50%	1
Primary Secondary Schools	28	7%	2	18%	5	43%	12
Preschools	16	13%	2	31%	5	19%	3
Large Daycare Centers	26	8%	2	27%	7	35%	9
Total	**279**	**5.7%**	**16**	**19.0%**	**53**	**45.9%**	**128**

WILDLAND-URBAN INTERFACE

DESCRIPTION

The Wildland-Urban Interface (WUI) Fire Areas identify locations where housing and other structures are located adjacent to or intermixed with forest or other natural vegetation. These locations are a priority for managing fire risk since the presence of human development can increase the potential for fire ignitions and, if started, fires in these locations have greater potential to harm residents and property. The WUI is land designated by cities and other local agencies to have an increased risk to wildfires. As such, the exterior design and construction of new buildings in WUI Fire Areas are required to comply with additional wildfire building and fire safety code provisions.

The WUI data presented used for this section was developed by CalFire for the 2015 Assessment of Forest and Rangelands. Three categories are present in the data: Intermix, Interface, and Influence Zone. The categories definitions are available from CalFire.[1]

- Intermix – Dense housing adjacent to vegetation that can burn in a wildfire.
- Interface – Housing interspersed in an area dominated by wildland vegetation.
- Influence – Wildfire susceptable vegetation up to 1.5 miles from WU Interface or Intermix.

MAP OF RISK

The WUI locations in the County are included in Figure 5. In general, the County has large areas of forest and wildland with relatively smaller areas of where population is concentrated. As a result, the WUI maps show high degrees of intermixing of wildlands and urban areas that reflect where people live and work. The highest mixing tends to occur on the edges of urban areas. For example, built areas in and around Sonora are intermixed with wildland areas.

[1] CalFire, Wildland Urban Interface, 2019. https://frap.fire.ca.gov/media/10300/wui_19_ada.pdf

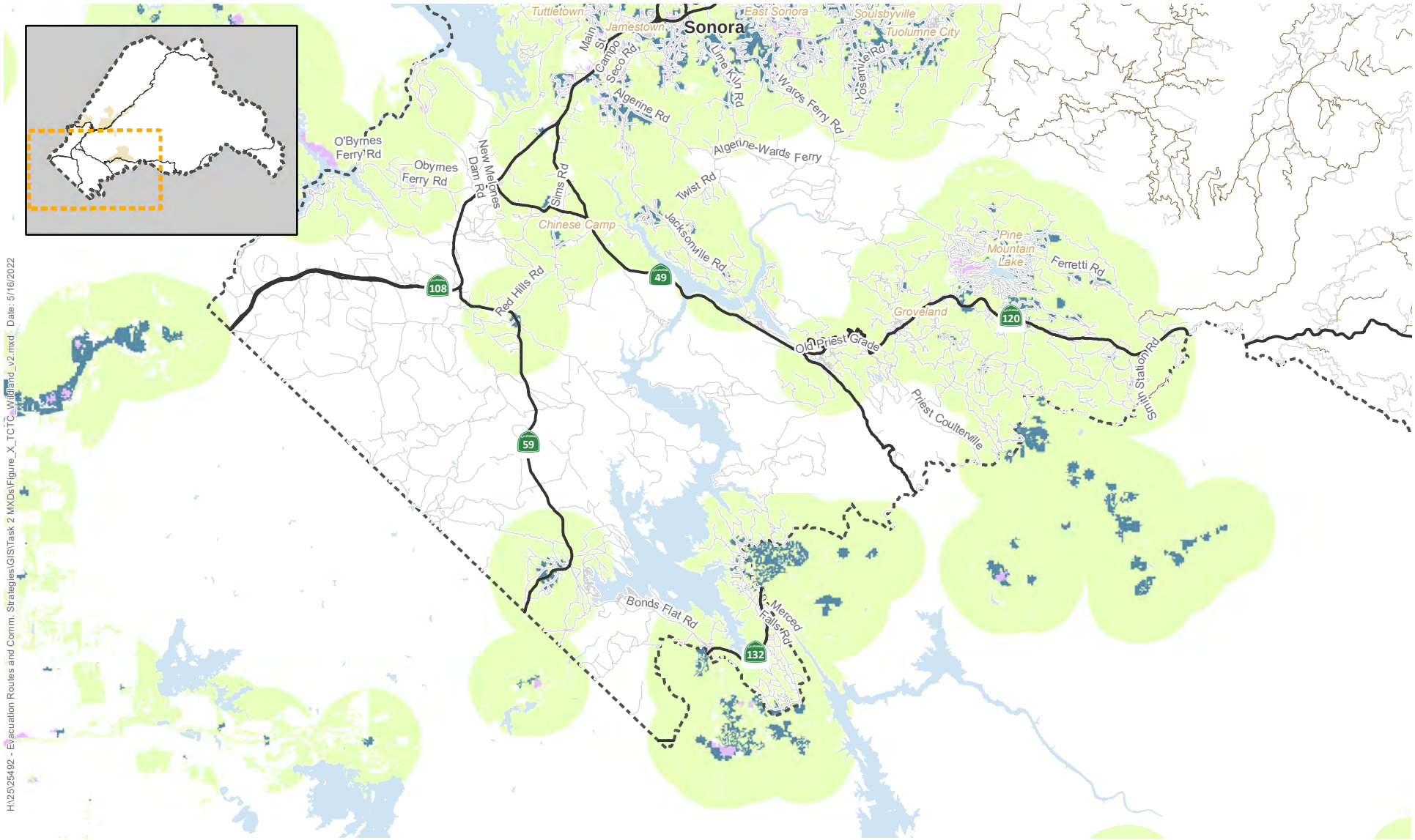


Figure 6.1

Wildland Urban Interface
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES

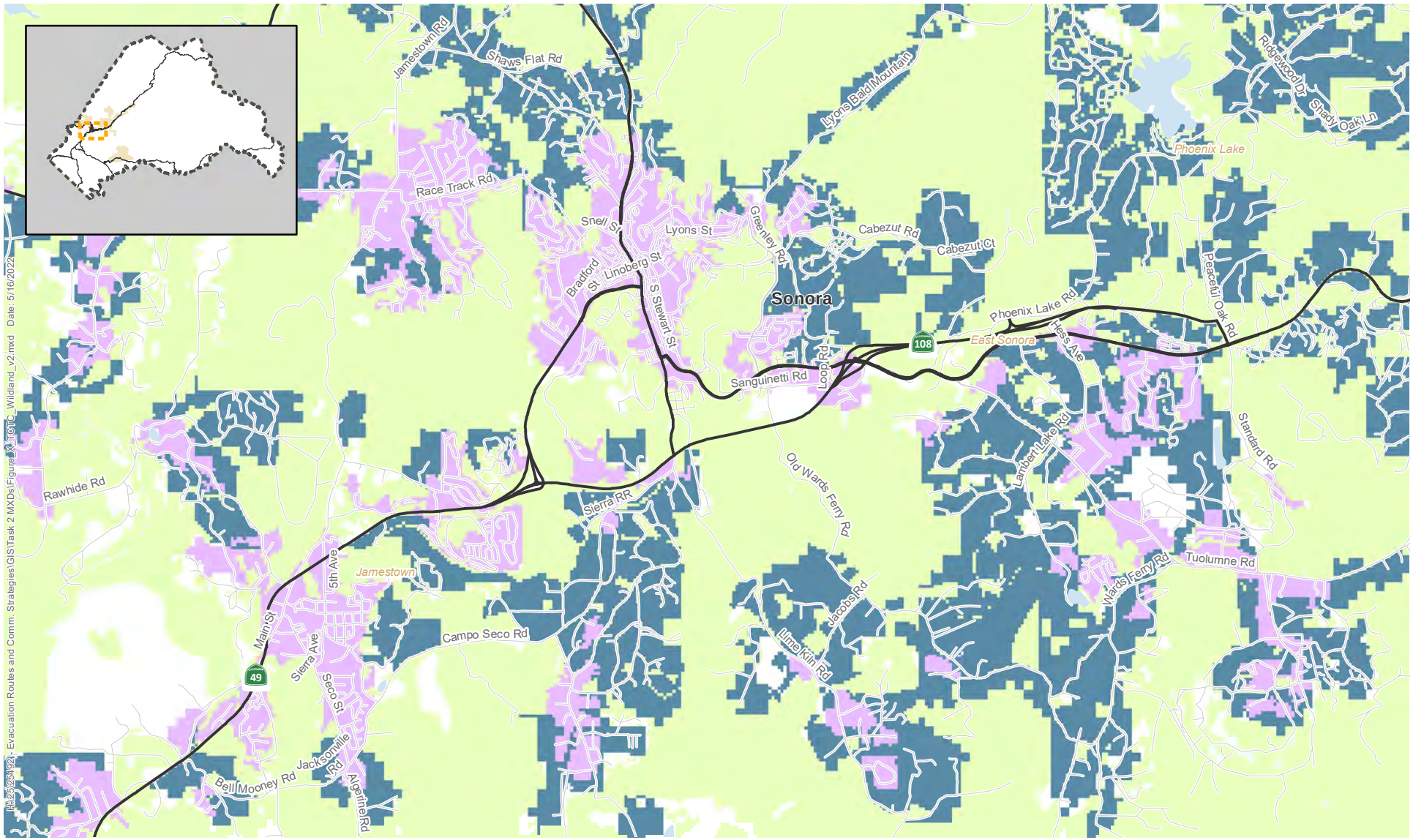


Figure 6.2

Wildland Urban Interface
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES

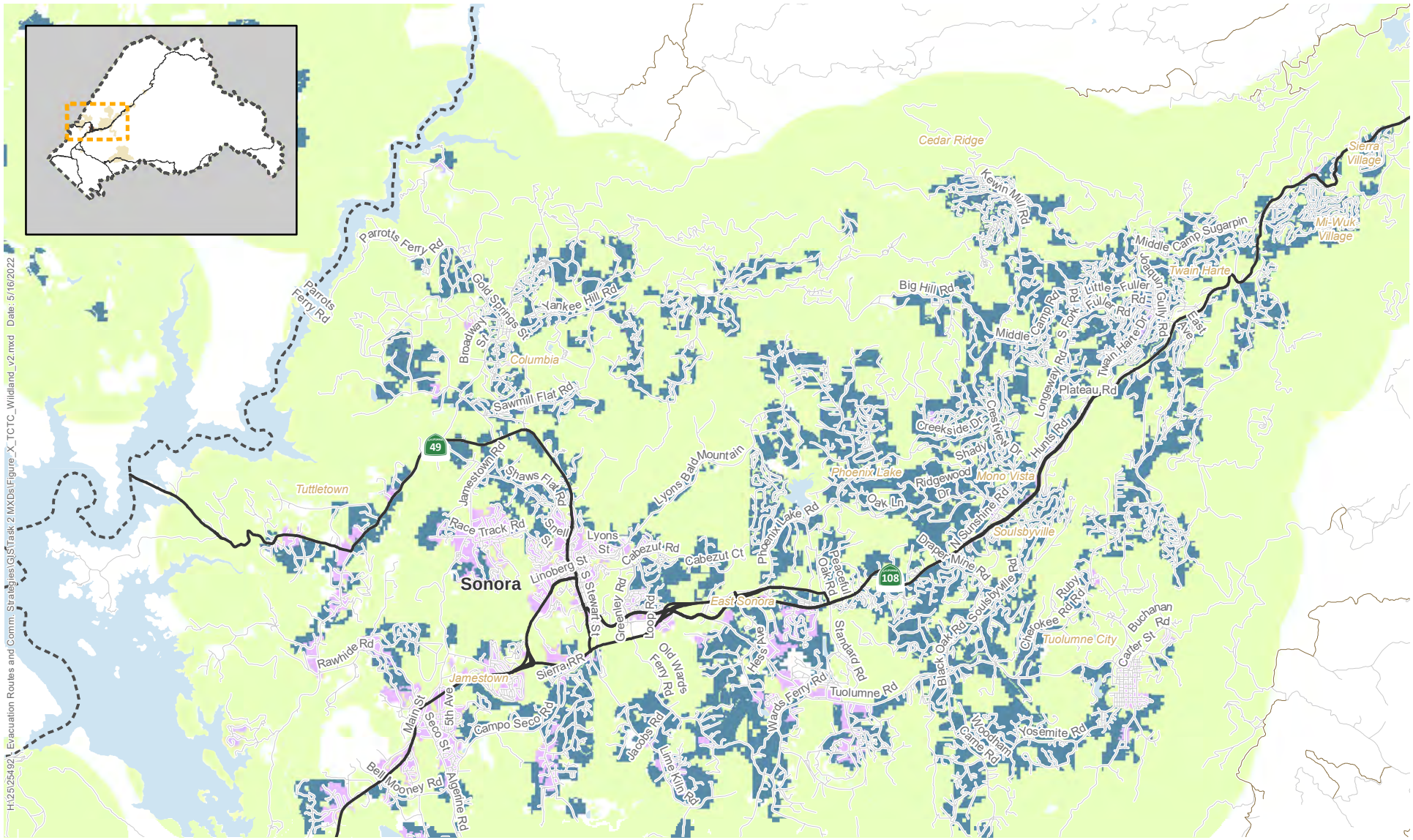


Figure 6.3

Wildland Urban Interface
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES

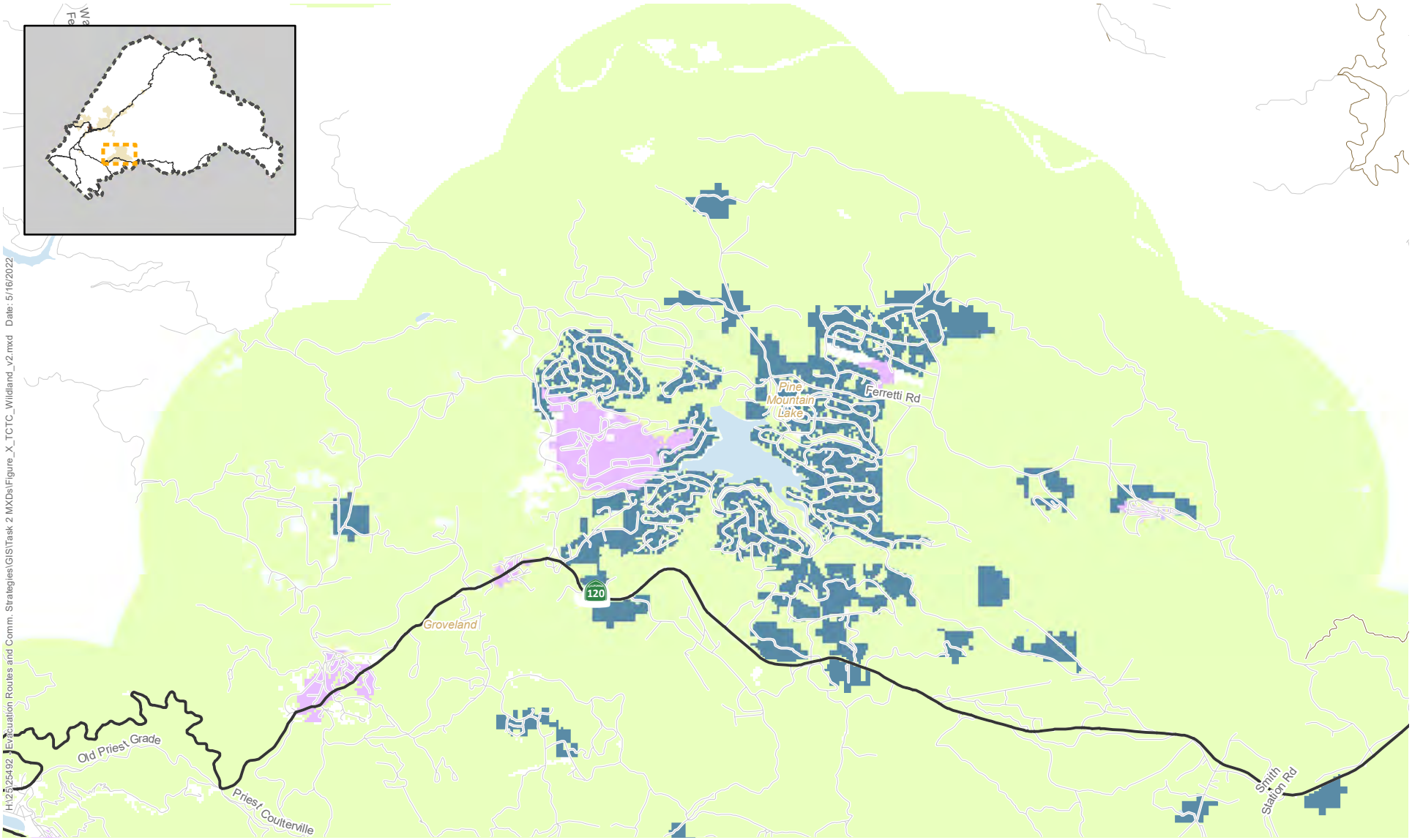


Figure 6.4

Wildland Urban Interface
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES

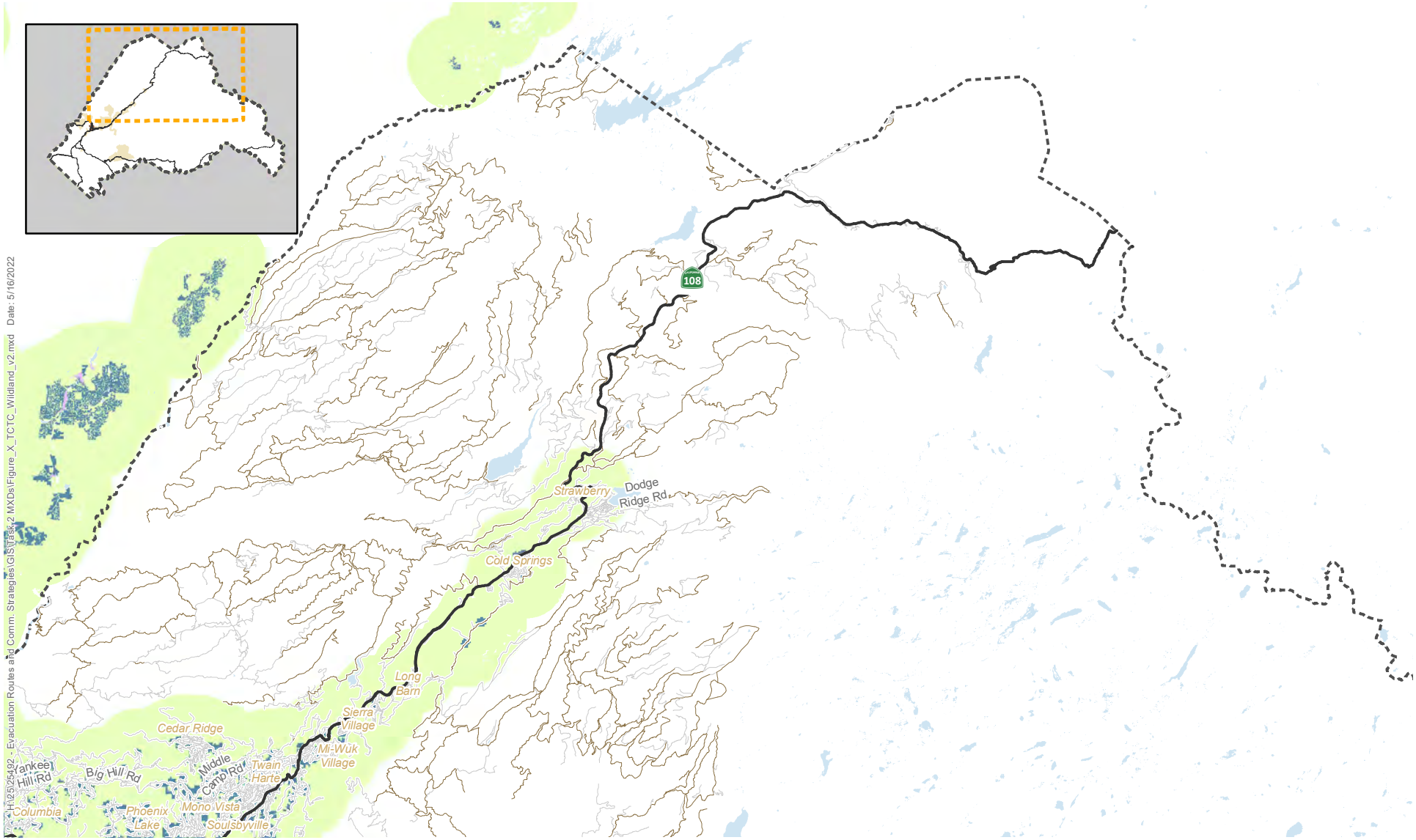


Figure 6.5

Wildland Urban Interface
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES

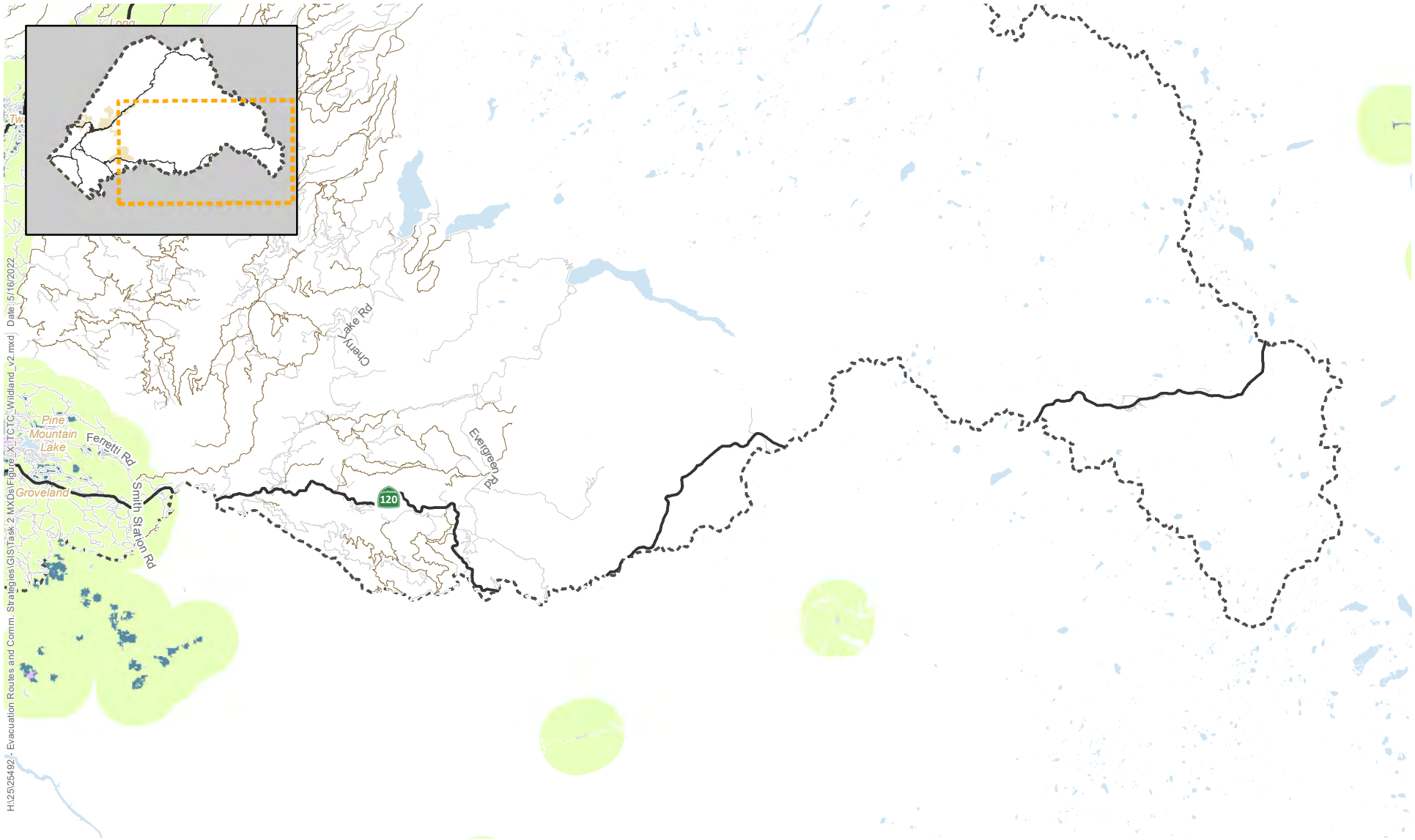


Figure 6.6

Wildland Urban Interface
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES

SUMMARY OF RISK

Table 5, Table 6, and Table 7 indicate the number of residential units that are located in the WUI and the percent of units relative to the total units in that zone. The data indicates:

- The County infrastructure is constructed largely in and adjacent to the WUI. The Cedar Ridge / Twain Harte / Sierra Village subarea has the highest rate of residential parcels and stuctures in the Intermix zone.
- Crtical infrastructure appears to be more removed from the WUI on average than residential parcels and structures. However, 4 of 6 urgent care centers and 13 of 19 potential evacuation sites are in an Intermix or Interface Zone.

Table 5: WUI Risk for Residential Parcels

County Analysis Subarea	Residential Parcels	Wildland Urban Interface					
		Influence		Interface		Intermix	
Cedar Ridge / Twain Harte / Sierra Village	6,751	24%	1,635	0%	3	76%	5,101
Sonora / East Sonora	5,153	18%	910	52%	2,657	29%	1,515
Groveland	4,176	30%	1,250	14%	590	54%	2,257
West of Phoenix Lake Road	3,465	29%	1,014	1%	29	68%	2,369
Mono Vista	2,890	24%	704	1%	41	74%	2,139
Jamestown	2,003	13%	263	68%	1,354	13%	262
Columbia	1,387	32%	438	6%	84	60%	834
Cold Springs / Strawberry	1,250	48%	595	0%	-	45%	565
Tuolumne City	1,602	38%	605	23%	374	38%	604
South Don Pedro Reservoir	1,201	74%	890	1%	8	12%	150
Tuttletown	717	34%	242	25%	181	28%	198
Log Barn	432	97%	417	3%	11	0%	-
North of Twain Harte	200	24%	48	0%	-	0%	-
West of Don Pedro Reservoir	180	68%	122	0%	-	21%	37
Chinese Camp / Montezuma	155	32%	50	37%	58	5%	8
North of 108 / Lake Tulloch	149	44%	65	8%	12	18%	27
Northeast of County	151	0%	-	0%	-	0%	-
Stanislaus National Forest	119	1%	1	0%	-	0%	-
Southeast County	35	0%	-	0%	-	0%	-
North of South Fork Stanislaus River	35	0%	-	0%	-	0%	-
West of Beardsley Reservoir	2	50%	1	0%	-	0%	-
Total	**32,053**	**28.9%**	**9,250**	**16.9%**	**5,402**	**50.1%**	**16,066**

Table 6: WUI Risk for Structures

County Analysis Subarea	Structures	WUI					
		Influence		Interface		Intermix	
Cedar Ridge / Twain Harte / Sierra Village	7,393	19%	1,371	1%	74	80%	5,907
Sonora / East Sonora	8,937	12%	1,077	50%	4,462	35%	3,090
Groveland	5,733	31%	1,750	12%	668	48%	2,747
West of Phoenix Lake Road	6,669	27%	1,814	1%	38	66%	4,395
Mono Vista	4,129	17%	695	3%	142	80%	3,283
Jamestown	3,288	7%	244	63%	2,056	18%	578
Columbia	3,205	36%	1,140	4%	118	57%	1,821
Cold Springs / Strawberry	1,908	62%	1,177	0%	-	27%	520
Tuolumne City	2,991	38%	1,135	25%	762	36%	1,062
South Don Pedro Reservoir	1,382	28%	381	3%	37	20%	277
Tuttletown	2,074	25%	525	21%	426	33%	683
Log Barn	356	96%	340	3%	11	1%	2
North of Twain Harte	368	21%	79	0%	-	0%	-
West of Don Pedro Reservoir	740	10%	76	0%	-	21%	153
Chinese Camp / Montezuma	670	15%	103	23%	152	7%	47
North of 108 / Lake Tulloch	484	23%	111	27%	129	9%	43
Northeast of County	358	1%	3	0%	-	0%	-
Stanislaus National Forest	169	22%	37	0%	-	0%	-
Southeast County	879	0%	-	0%	-	0%	-
North of South Fork Stanislaus River	128	1%	1	0%	-	0%	-
West of Beardsley Reservoir	117	29%	34	0%	-	0%	-
Total	**51,978**	**23.3%**	**12,093**	**17.5%**	**9,075**	**47.3%**	**24,608**

Table 7: WUI Risk for Critical Infrastructure

Critical Infrastructure Type	Structures	WUI Influence		WUI Influence		WUI Influence	
Essential County Operations Buildings	25	24%	6	72%	18	4%	1
Powerhouses	6	17%	1	0%	-	0%	-
Wireless Communication Towers	32	53%	17	9%	3	13%	4
Police Stations	3	0%	-	100%	3	0%	-
Fire Stations	28	54%	15	25%	7	11%	3
TUD Water Tanks	79	68%	54	5%	4	23%	18
Ambulance Stations	4	0%	-	100%	4	0%	-
Hospitals	1	0%	-	100%	1	0%	-
Urgent Care and Clinics	6	33%	2	17%	1	50%	3
Potential Evacuation Shelters	19	16%	3	47%	9	21%	4
Animal Shelters	4	0%	-	75%	3	25%	1
Senior Centers	2	50%	1	50%	1	0%	-
Primary Secondary Schools	28	46%	13	36%	10	4%	1
Preschools	16	25%	4	63%	10	0%	-
Large Daycare Centers	26	31%	8	54%	14	0%	-
Total	**279**	**44.4%**	**124**	**31.5%**	**88**	**12.5%**	**35**

VULNERABLE COMMUNITIES

DESCRIPTION

The Vulnerable Communities risk analysis measures risk based on transportation access and egress. It identifies locations in the County where there is only one access and egress route from the community to the roadway network. People living in these locations may be at greater risk to wildfires because of limited access for first responders to conduct emergency operations and limited number and capacity of egress routes for evacuation. The communities shown in this section were identified either by CalFire (CalFire Vulnerable Subdivision) or County staff (County Vulnerable Communities). The datasets were developed separately and therefore have overlap.

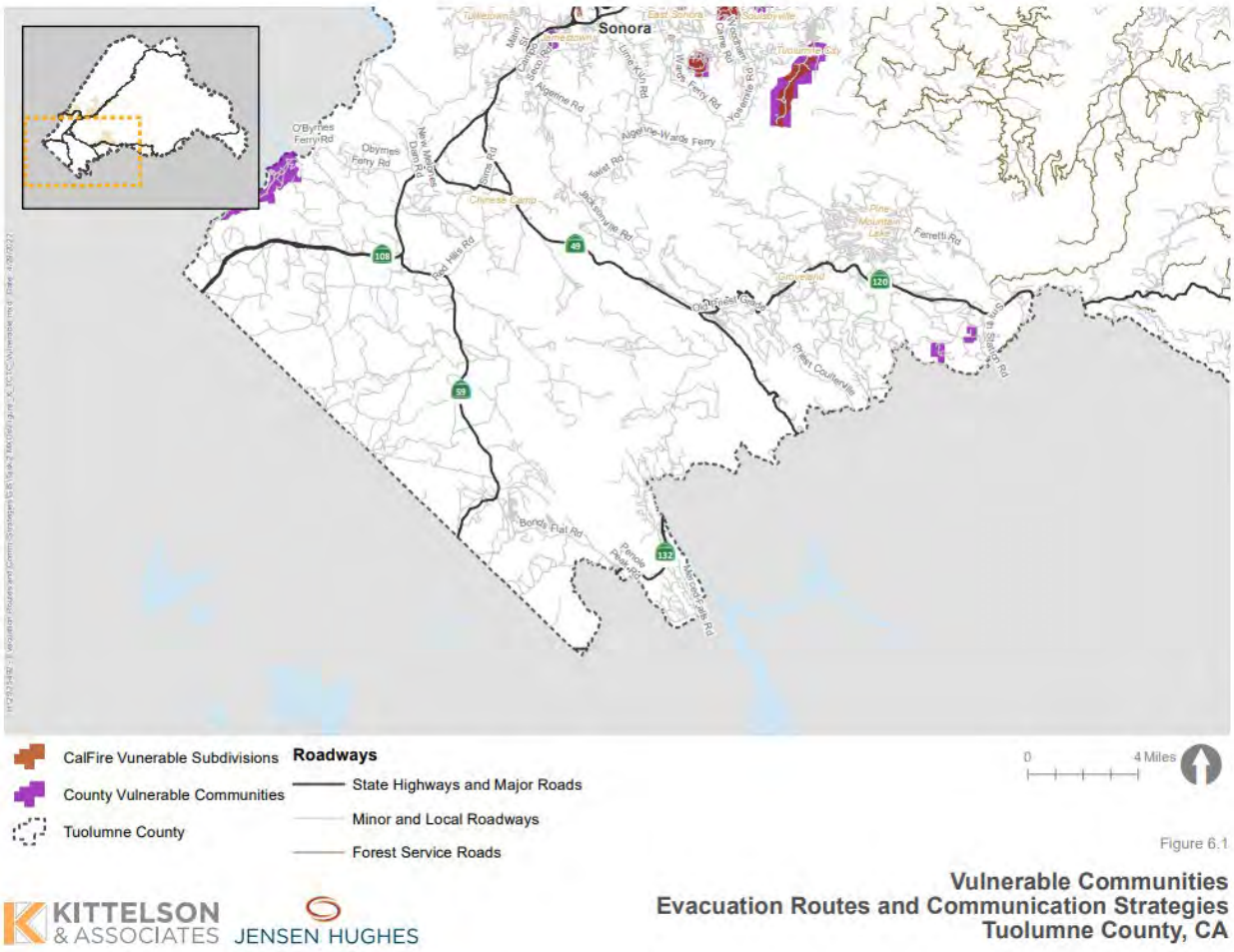
MAP OF RISK

The Vulnerable Communities data is shown in Figure 6. There is a high degree of overlap between the two designations. The areas include communities that are close to a major evacuation route, such as Sonora Village and Mono Village, which are located close to CA-108, as well as locations further from major roadways, such as the community along Apple Colony Road south of Tuolumne City. For these communities, the initial delay in leaving the neighborhood could increase risk of living further from evacuation routes. Note that some of the maps in Figure 6 show areas of the County where no vulnerable communities were identified.

The majority of the communities identified are concentrated along CA-108; however, communities have also been identified near Groveland, Hell Hollow, and further west in the County, Black Jack Bluffs. The communities also vary in size, with some being relatively compact areas inside of more populated areas and others that are spread over larger areas.

Figure 7: Vulnerable

Communities



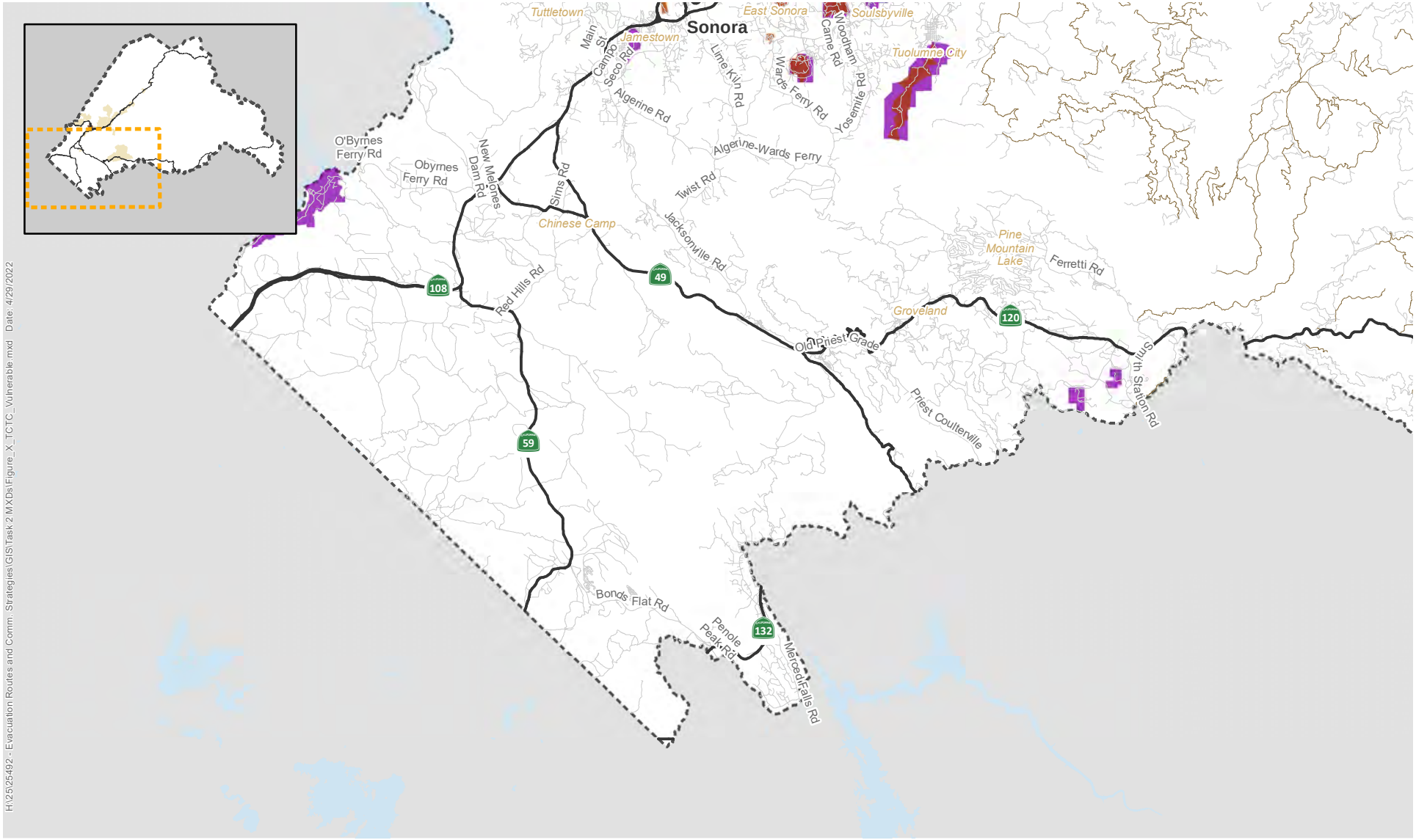


Figure 7.1

Vulnerable Communities
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES

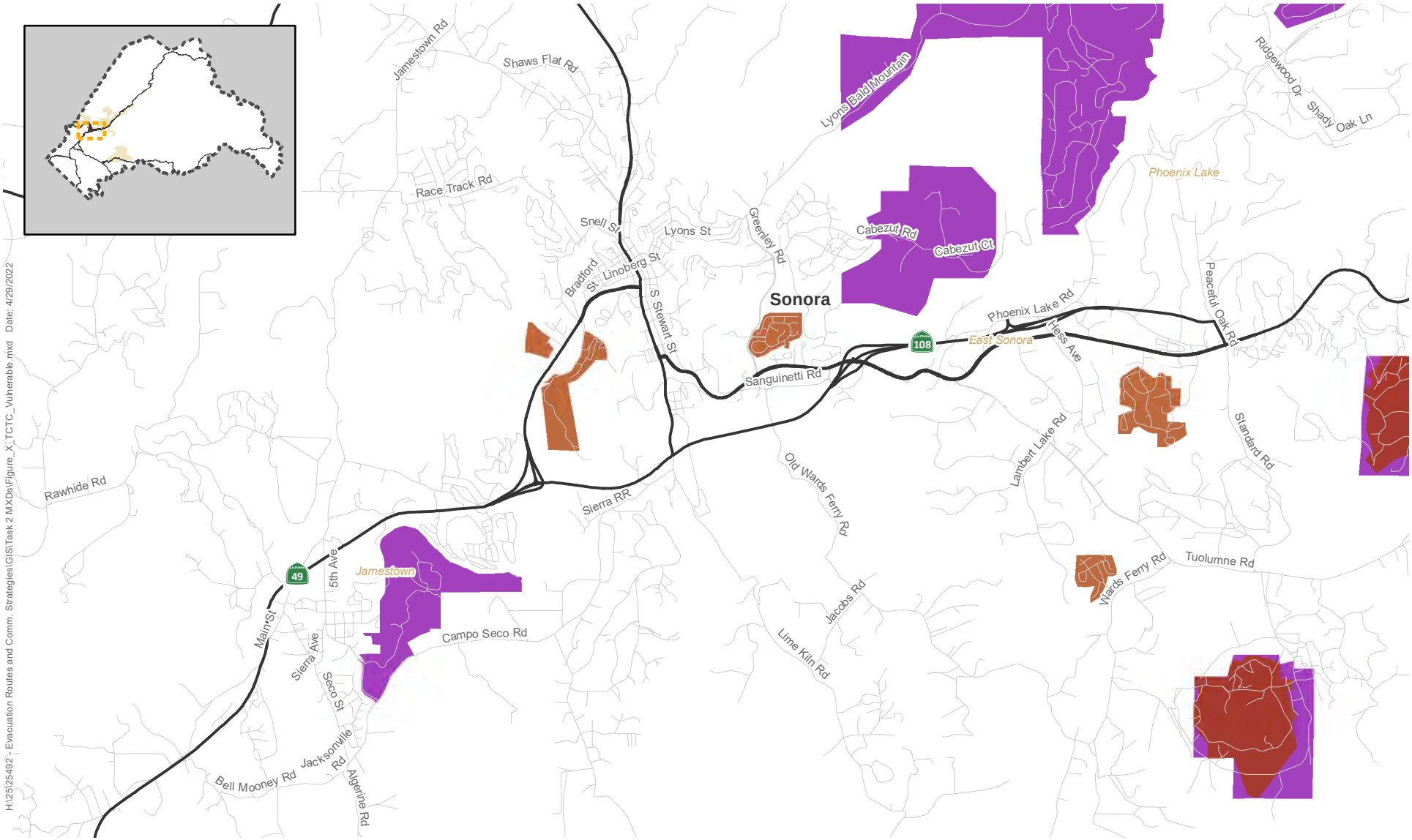


Figure 7.2

Vulnerable Communities
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES

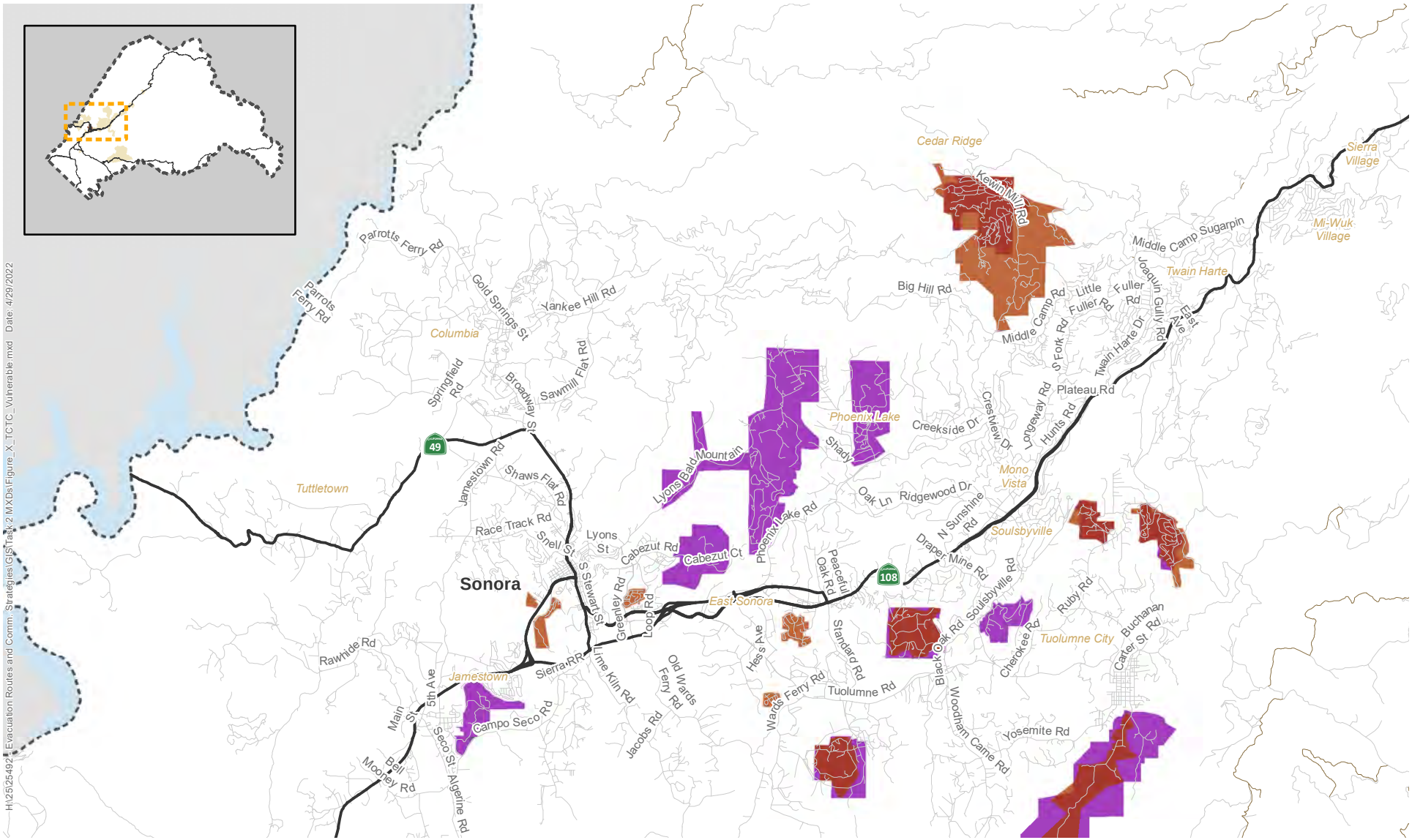
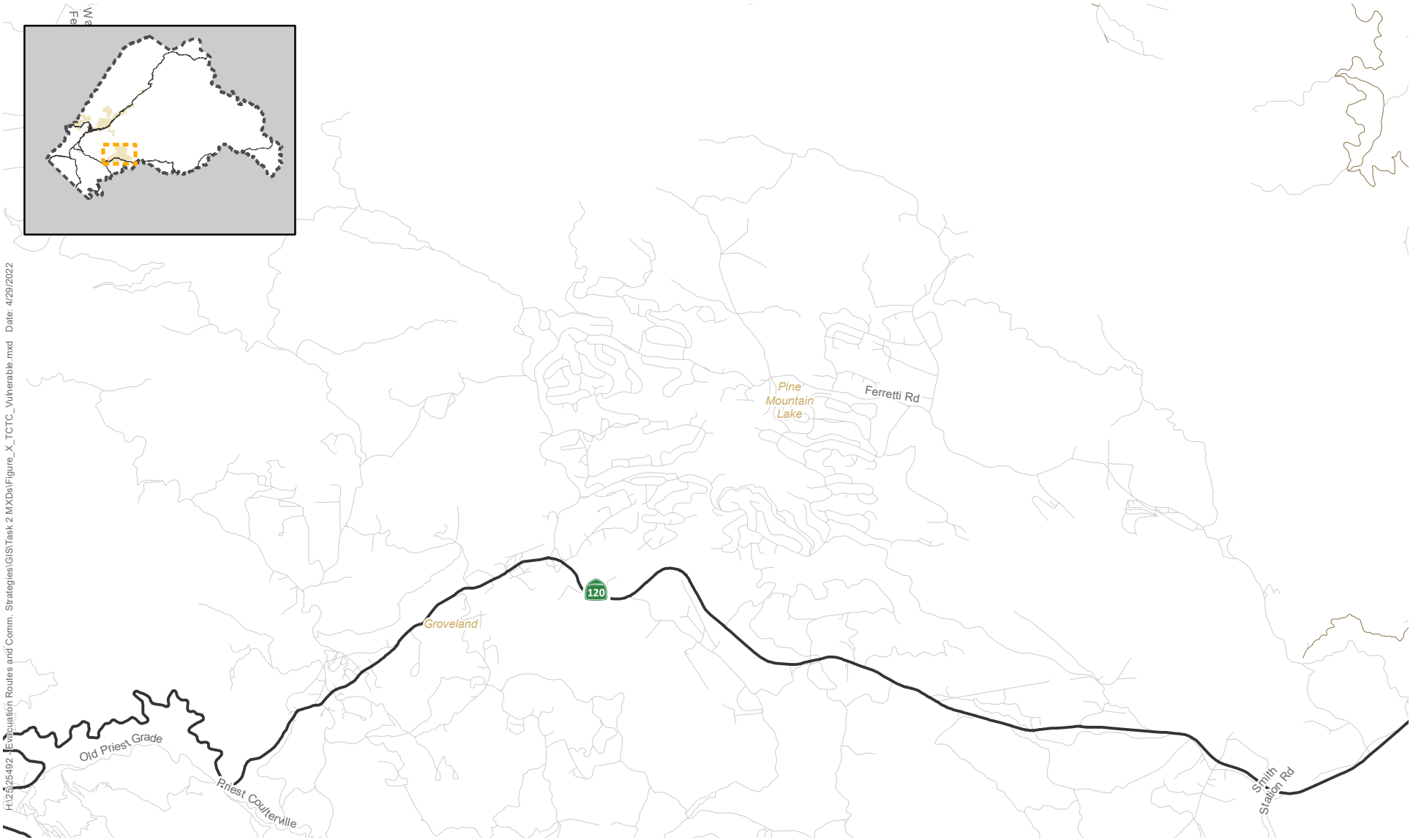


Figure 7.3

Vulnerable Communities
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES



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CalFire Vunerable Subdivisions

County Vulnerable Communities

Tuolumne County

Roadways

State Highways and Major Roads

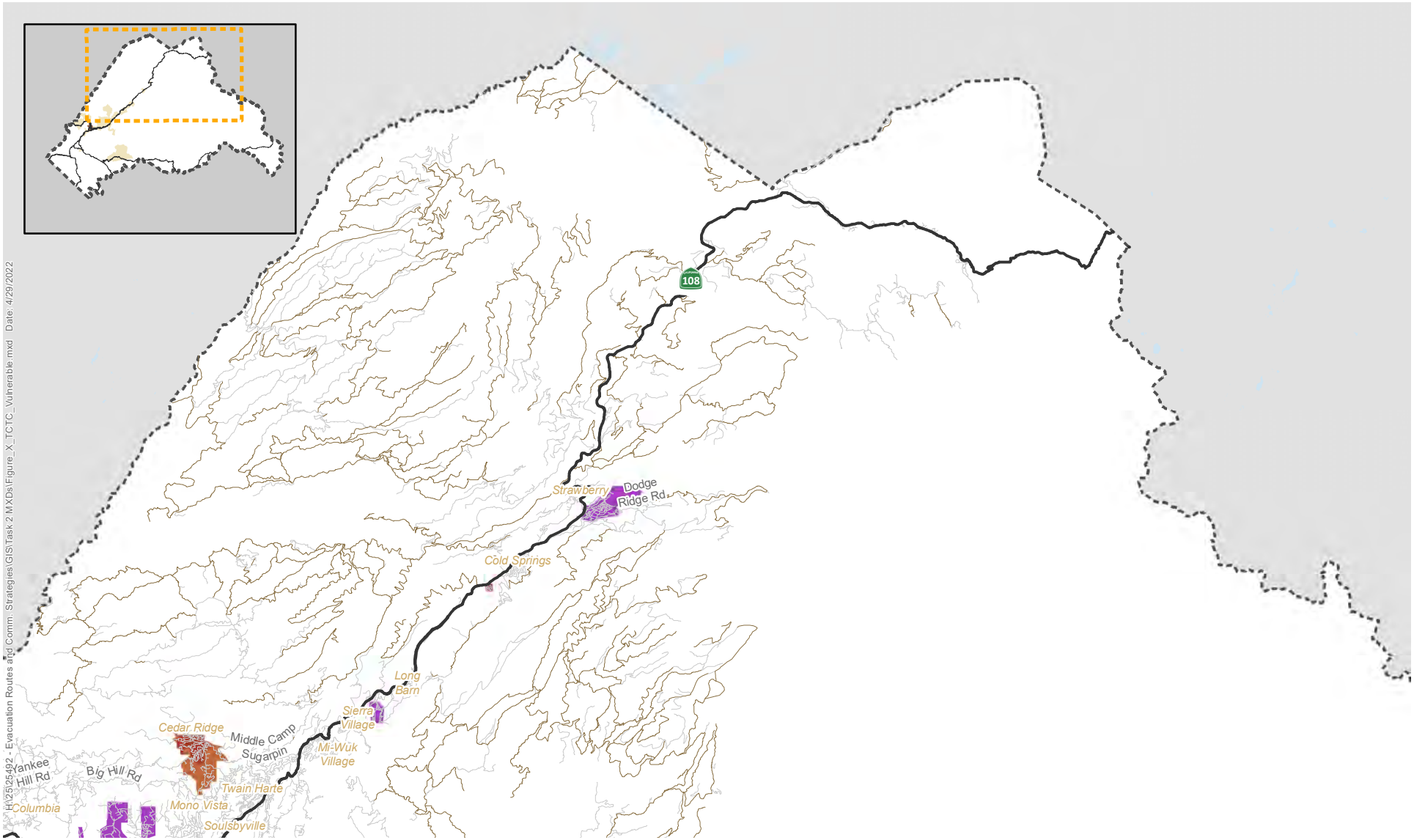
Minor and Local Roadways

Forest Service Roads

Figure 7.4

Vulnerable Communities
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES



CalFire Vunerable Subdivisions

County Vulnerable Communities

Tuolumne County

Roadways

State Highways and Major Roads

Minor and Local Roadways

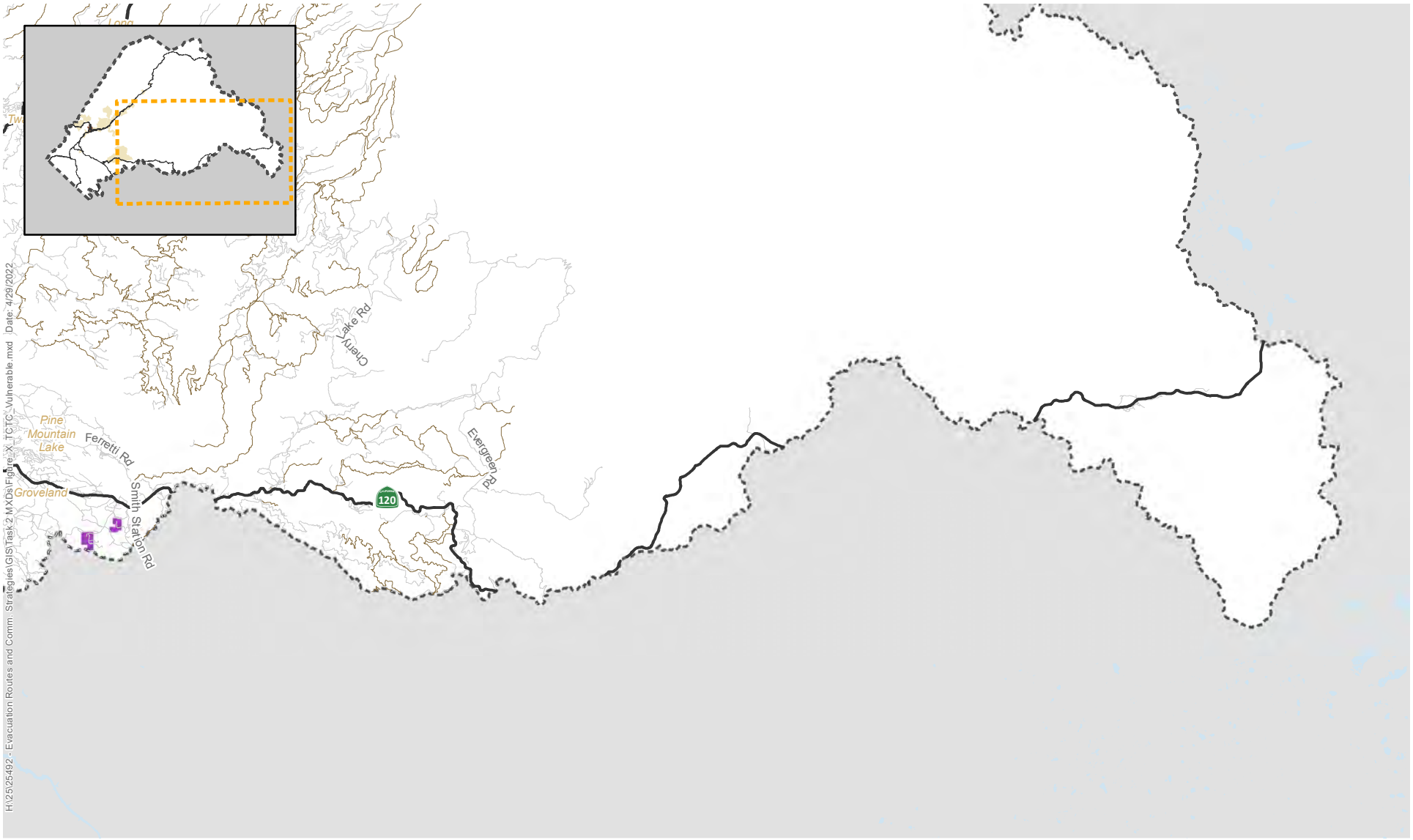
Forest Service Roads

0 4 Miles

Figure 7.5

Vulnerable Communities Evacuation Routes and Communication Strategies Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES



CalFire Vunerable Subdivisions

County Vulnerable Communities

Tuolumne County

Roadways

State Highways and Major Roads

Minor and Local Roadways

Forest Service Roads

0 6 Miles

Figure 7.6

Vulnerable Communities
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES

SUMMARY OF RISK

Table 8, Table 9, and Table 10 present the percent of residential parcels, structures, and critical infrastructure that are located in at least one of the two vulnerable community designations. The analysis shows that relative to the FHSZ risk evaluation, risk applies to a smaller subset of locations and concern varies across the different County Analysis Subareas.

- The subareas of Cedar Ridge / Twain Harte / Sierra Village and West of Phoenix Lake Road have the greatest number of residential parcels and structures that are in vulnerable communities. The impacted areas within those zones are Apple Colony Road, Cedar Ridge, Odd Fellows High Sierra, and Phoenix Lake Country Club Estates.
- The Tuolumne City and North of 108 / Lake Tulloch subareas have fewer residential parcels and structures; however, relative to the other subareas a high percentage of parcels and structures in those subareas have reduced egress.
- In general, critical infrastructure is not located in vulnerable communities. The one exception is that 28% of water tanks are located in vulnerable community locations.

Table 8: Vulnerable Communities Risk for Residential Parcels

County Analysis Subarea	Residential Parcels	Vulnerable Community	
		Percent	Number
Cedar Ridge / Twain Harte / Sierra Village	6,751	19%	1,300
Sonora / East Sonora	5,153	14%	739
Groveland	4,176	1%	47
West of Phoenix Lake Road	3,465	31%	1,072
Mono Vista	2,890	3%	85
Jamestown	2,003	2%	40
Columbia	1,387	0%	-
Cold Springs / Strawberry	1,250	10%	122
Tuolumne City	1,602	33%	525
South Don Pedro Reservoir	1,201	0%	-
Tuttletown	717	0%	-
Log Barn	432	0%	-
North of Twain Harte	200	0%	-
West of Don Pedro Reservoir	180	0%	-
Chinese Camp / Montezuma	155	0%	-
North of 108 / Lake Tulloch	149	83%	124
Northeast of County	151	0%	-
Stanislaus National Forest	119	0%	-
Southeast County	35	0%	-
North of South Fork Stanislaus River	35	0%	-
West of Beardsley Reservoir	2	0%	-
Total	**32,053**	**12.6%**	**4,054**

Table 9: Vulnerable Communities Risk for Structures

County Analysis Subarea	Structures	Vulnerable Community	
		Percent	Number
Cedar Ridge / Twain Harte / Sierra Village	7,393	16%	1,209
Sonora / East Sonora	8,937	11%	992
Groveland	5,733	2%	86
West of Phoenix Lake Road	6,669	22%	1,439
Mono Vista	4,129	4%	167
Jamestown	3,288	2%	61
Columbia	3,205	0%	-
Cold Springs / Strawberry	1,908	32%	615
Tuolumne City	2,991	24%	724
South Don Pedro Reservoir	1,382	0%	-
Tuttletown	2,074	0%	-
Log Barn	356	0%	-
North of Twain Harte	368	0%	-
West of Don Pedro Reservoir	740	0%	-
Chinese Camp / Montezuma	670	0%	-
North of 108 / Lake Tulloch	484	43%	209
Northeast of County	358	0%	-
Stanislaus National Forest	169	0%	-
Southeast County	879	0%	-
North of South Fork Stanislaus River	128	0%	-
West of Beardsley Reservoir	117	0%	-
Total	**51,978**	**10.6%**	**5,502**

Table 10: Vulnerable Communities Risk for Critical Infrastructure

Critical Infrastructure Type	Structures	Vulnerable Community	
		Percent	Number
Essential County Operations Buildings	25	0%	-
Powerhouses	6	0%	-
Wireless Communication Towers	32	6%	2
Police Stations	3	0%	-
Fire Stations	28	7%	2
TUD Water Tanks	79	29%	23
Ambulance Stations	4	0%	-
Hospitals	1	0%	-
Urgent Care and Clinics	6	0%	-
Potential Evacuation Shelters	19	0%	-
Animal Shelters	4	25%	1
Senior Centers	2	0%	-
Primary Secondary Schools	28	4%	1
Preschools	16	0%	-
Large Daycare Centers	26	0%	-
Total	**279**	**10.4%**	**29**

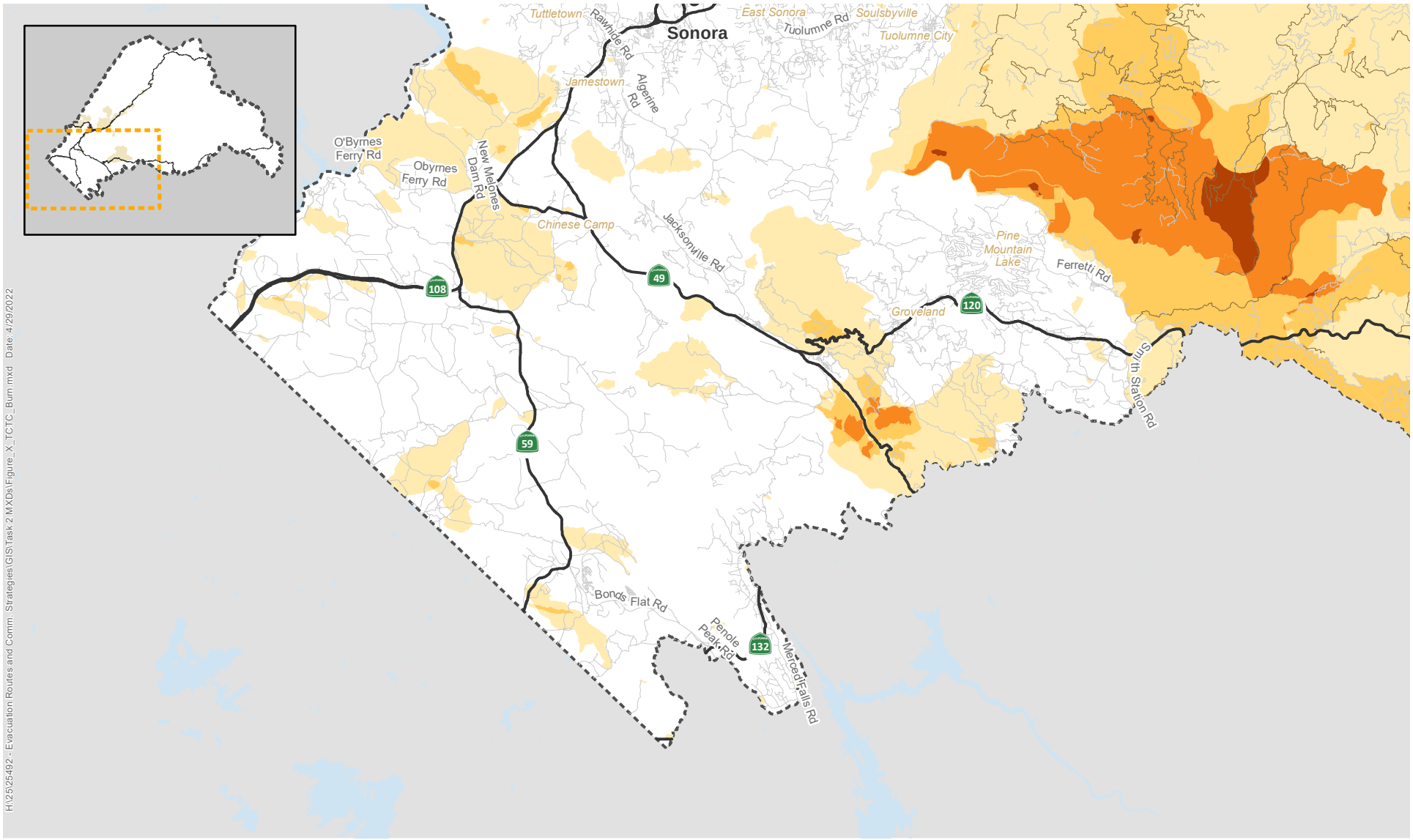
BURN FREQUENCY

DESCRIPTION

The Burn Frequency data identifies the number of fires that have occurred in different areas of the County between 1980 and 2020. In contrast to the other risk data presented, this layer presents historic fire occurrences which is related to, but distinct from, future risk potential. The data also show where fires have historically occurred. It is important to note that absence of fire in some locations in the County may reflect increased efforts to put out fires near population areas, rather than an absence of fire potential.

MAP OF RISK

The burn frequency for the County is shown in Figure 8. The map shows that to this date wildfire burns have been contained to less populated areas of the County. The area of the County that has experienced multiple large fires is northeast of Groveland. The maps indicate the potential for future fires in locations that have not experienced recent wildfires. Along CA-108, there are multiple areas shown with a single contained burn, such as south of CA-108 near Twain Harte and Mono Vista. The maps mirror in some ways the WUI maps by showing the proximity of fire near areas build at the wildland interface.



Burn Frequency

- 1
- 2
- 3
- 4 or more

Roadways

- State Highways and Major Roads
- Minor and Local Roadways
- Forest Service Roads

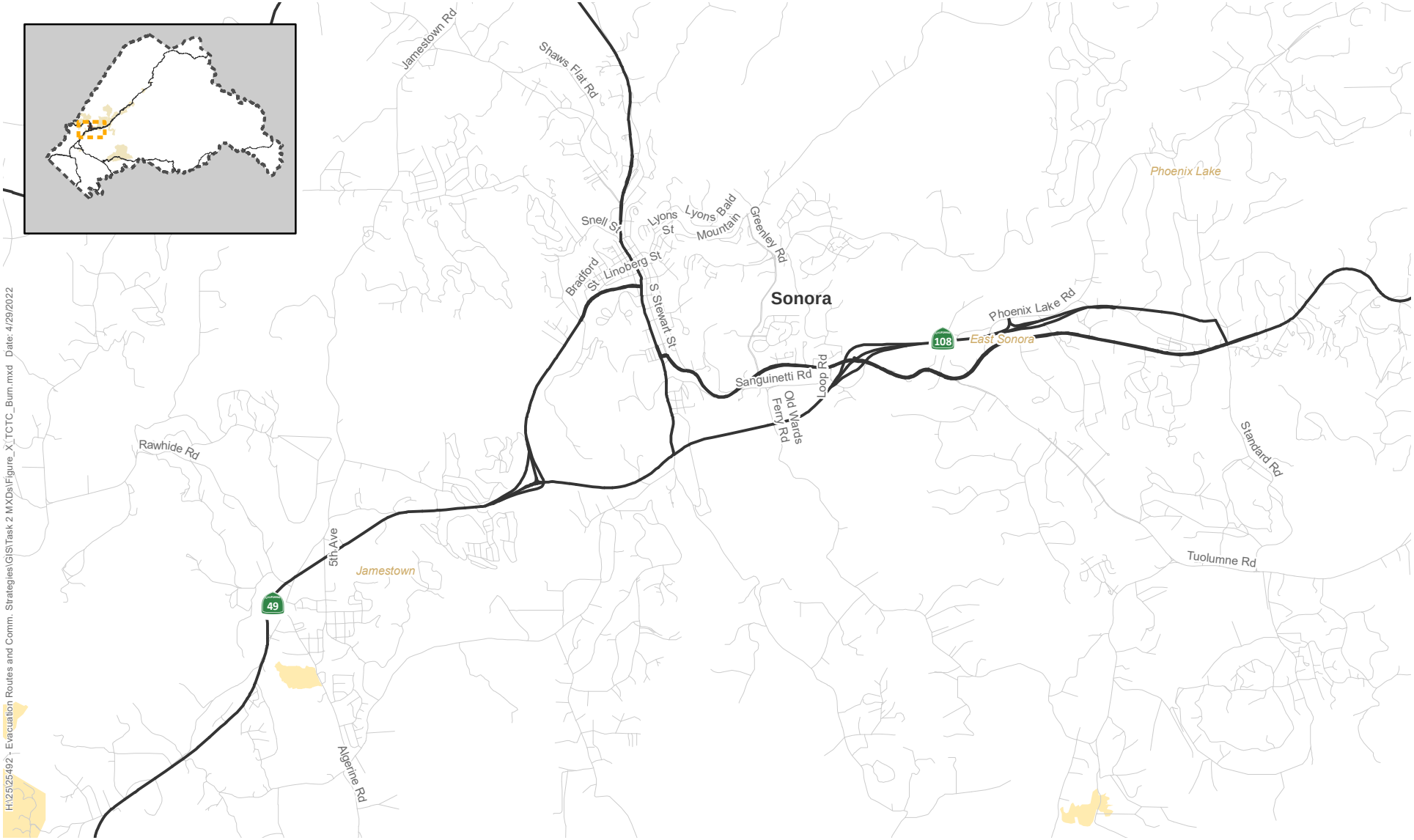
Tuolumne County

0 4 Miles

Figure 8.1

Burn Frequency
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES



Burn Frequency

- 1
- 2
- 3
- 4 or more

Roadways

- State Highways and Major Roads
- Minor and Local Roadways
- Forest Service Roads

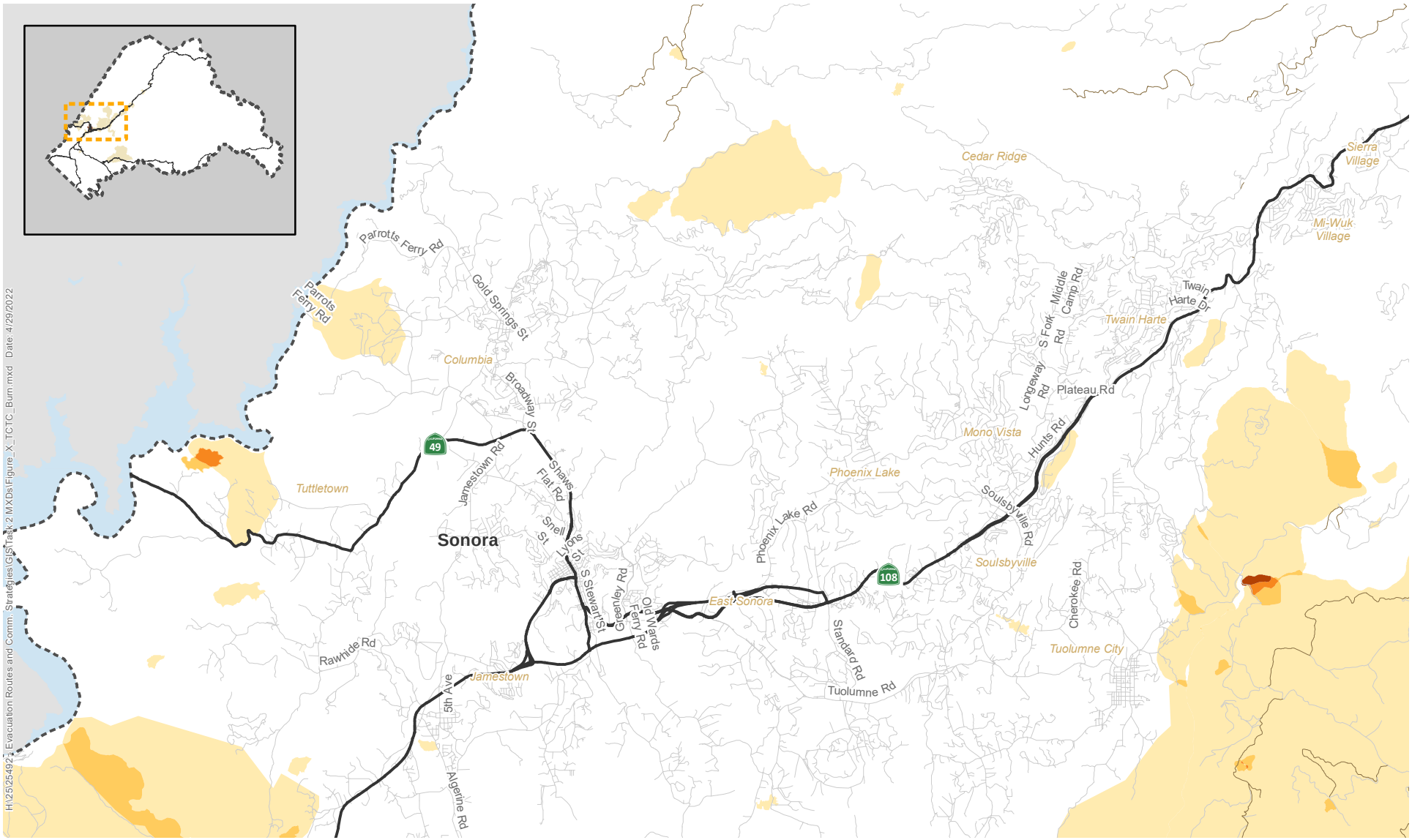
Tuolumne County

0 0.8 Miles

Figure 8.2

Burn Frequency
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES



Burn Frequency

- 1
- 2
- 3
- 4 or more

Roadways

- State Highways and Major Roads
- Minor and Local Roadways
- Forest Service Roads

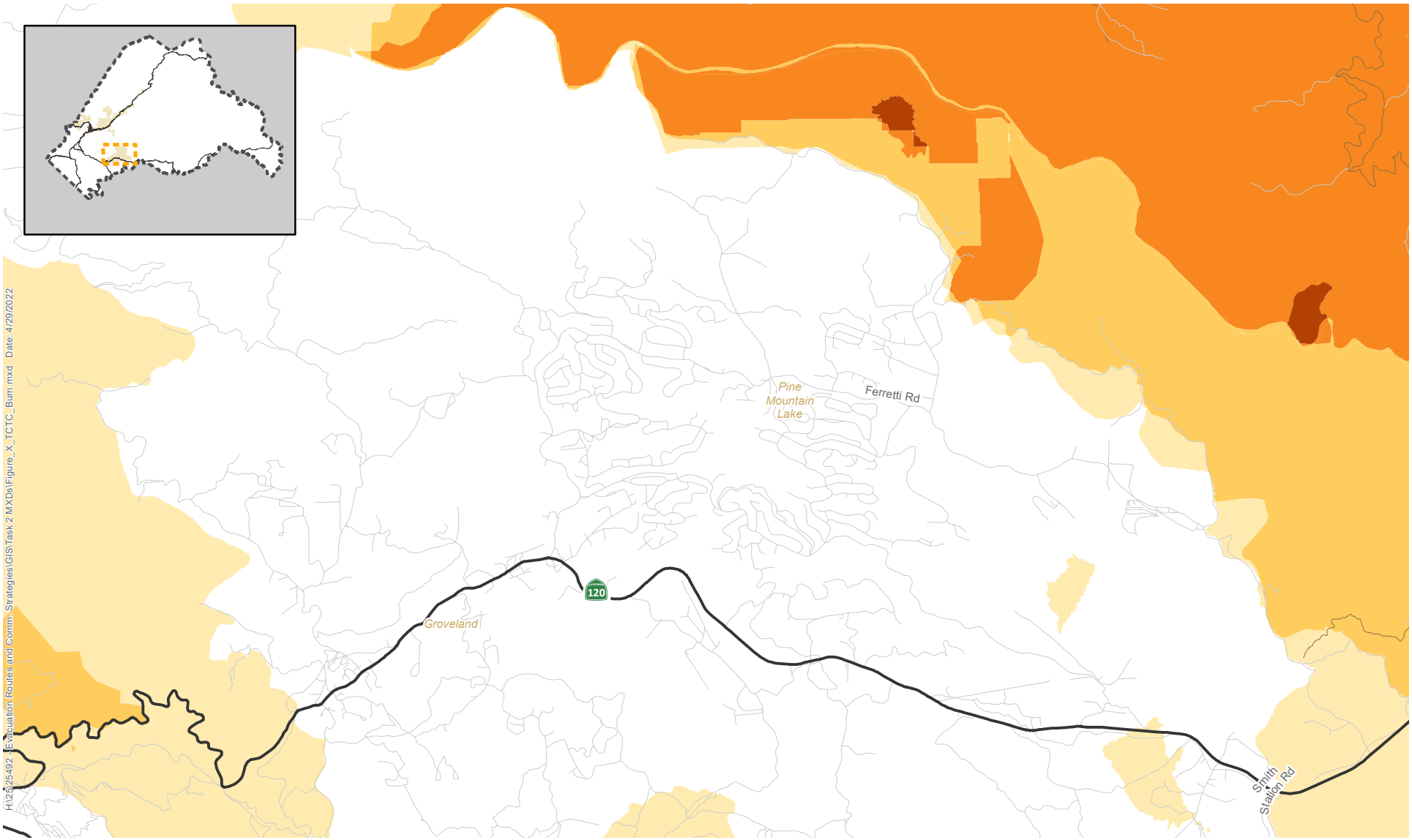
Tuolumne County

0 2.2 Miles

Figure 8.3

Burn Frequency
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES



Burn Frequency

- 1
- 2
- 3
- 4 or more

Roadways

- State Highways and Major Roads
- Minor and Local Roadways
- Forest Service Roads

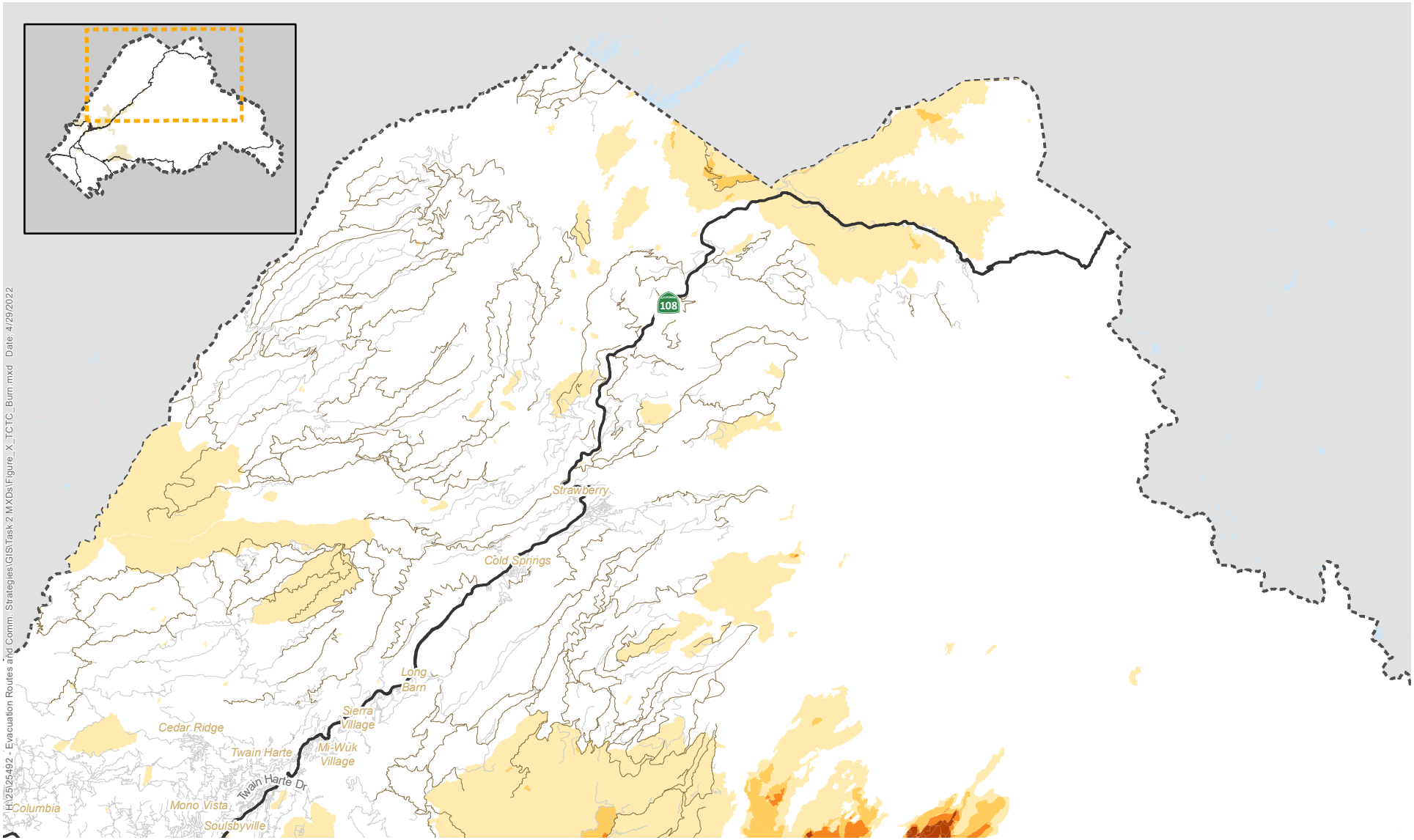
Tuolumne County

0 1 Miles

Figure 8.4

Burn Frequency
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES



Burn Frequency

- 1
- 2
- 3
- 4 or more

Roadways

- State Highways and Major Roads
- Minor and Local Roadways
- Forest Service Roads

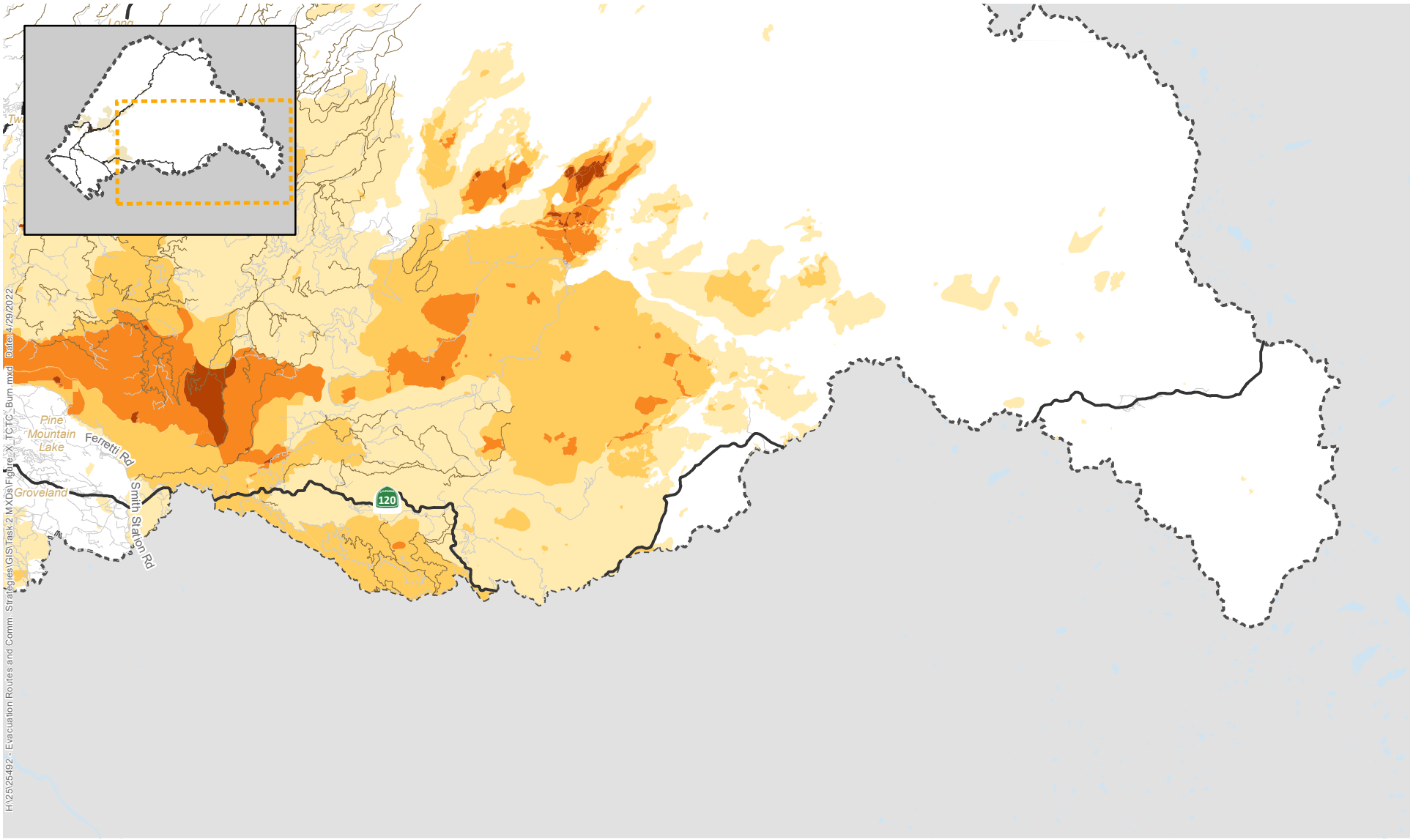
Tuolumne County

0 4 Miles

Figure 8.5

Burn Frequency
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES



Burn Frequency

- 1
- 2
- 3
- 4 or more

Roadways

- State Highways and Major Roads
- Minor and Local Roadways
- Forest Service Roads

Tuolumne County

0 6 Miles

Figure 8.6

Burn Frequency
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES

SUMMARY OF RISK

Table 11, Table 12, and Table 13 summarize the number of burns occurring at the location of residential parcels, structures, and critical infrastructure. The analysis was conducted as a spatial exercise that overlayed burn locations on the reference populations and may not reflect the specific experience of infrastructure (i.e., a structure may have received limited damage despite being in a burn area).

- Wildfires have impacted a relatively small share of infrastructure in the County when considered against the scale of risk indicated by the FHSZ maps.
- A greater percent of structures have been located where wildfires have occurred (5.4%) compared with residential parcels (1.2%).
- The critical infrastructure located where wildfires have occured include powerhouses (4 of 7), wireless communication towers (6 of 32), and water tanks (10 of 82).

Table 11: Burn Frequency for Residential Parcels

County Analysis Subarea	Residential Parcels	Burn Frequency					
		1		2		3	
Cedar Ridge / Twain Harte / Sierra Village	6,751	0%	15	0%	-	0%	-
Sonora / East Sonora	5,153	0%	4	0%	-	0%	-
Groveland	4,176	1%	46	0%	14	0%	-
West of Phoenix Lake Road	3,465	0%	3	0%	-	0%	-
Mono Vista	2,890	1%	37	0%	-	0%	-
Jamestown	2,003	2%	33	0%	-	0%	-
Columbia	1,387	1%	7	0%	-	0%	-
Cold Springs / Strawberry	1,250	1%	8	0%	-	0%	-
Tuolumne City	1,602	6%	92	0%	-	0%	-
South Don Pedro Reservoir	1,201	0%	5	0%	-	0%	-
Tuttletown	717	4%	27	0%	-	0%	-
Log Barn	432	0%	-	0%	-	0%	-
North of Twain Harte	200	0%	-	0%	-	0%	-
West of Don Pedro Reservoir	180	21%	38	0%	-	0%	-
Chinese Camp / Montezuma	155	1%	1	0%	-	0%	-
North of 108 / Lake Tulloch	149	7%	10	0%	-	0%	-
Northeast of County	151	0%	-	0%	-	0%	-
Stanislaus National Forest	119	8%	10	0%	-	0%	-
Southeast County	35	97%	34	0%	1	0%	-
North of South Fork Stanislaus River	35	9%	3	0%	-	0%	-
West of Beardsley Reservoir	2	50%	1	0%	-	0%	-
Total	**32,053**	**1.2%**	**374**	**0.0%**	**15**	**0.0%**	**-**

Table 12: Burn Frequency for Structures

County Analysis Subarea	Structures	Burn Frequency					
		1		2		3	
Cedar Ridge / Twain Harte / Sierra Village	7,393	0%	23	0%	-	0%	-
Sonora / East Sonora	8,937	0%	-	0%	-	0%	-
Groveland	5,733	5%	301	0%	17	0%	1
West of Phoenix Lake Road	6,669	1%	43	0%	-	0%	-
Mono Vista	4,129	1%	44	0%	-	0%	-
Jamestown	3,288	2%	59	0%	-	0%	-
Columbia	3,205	1%	26	0%	-	0%	-
Cold Springs / Strawberry	1,908	0%	5	0%	-	0%	-
Tuolumne City	2,991	4%	126	0%	2	0%	-
South Don Pedro Reservoir	1,382	1%	15	0%	-	0%	-
Tuttletown	2,074	4%	93	0%	-	0%	-
Log Barn	356	0%	-	0%	-	0%	-
North of Twain Harte	368	0%	1	0%	-	0%	-
West of Don Pedro Reservoir	740	10%	73	0%	-	0%	-
Chinese Camp / Montezuma	670	10%	65	0%	-	0%	-
North of 108 / Lake Tulloch	484	11%	52	0%	-	0%	-
Northeast of County	358	32%	115	0%	-	0%	-
Stanislaus National Forest	169	40%	68	0%	12	0%	14
Southeast County	879	72%	635	0%	213	0%	7
North of South Fork Stanislaus River	128	11%	14	0%	-	0%	-
West of Beardsley Reservoir	117	3%	3	0%	-	0%	-
Total	**51,978**	**3.4%**	**1,761**	**0.5%**	**244**	**0.0%**	**22**

Table 13: Burn Frequency for Critical Infrastructure

Critical Infrastructure Type	Structures	Burn Frequency 1		2		3	
Essential County Operations Buildings	25	0%	-	0%	-	0%	-
Powerhouses	6	33%	2	17%	1	0%	-
Wireless Communication Towers	32	13%	4	3%	1	0%	-
Police Stations	3	0%	-	0%	-	0%	-
Fire Stations	28	0%	-	0%	-	0%	-
TUD Water Tanks	79	5%	4	4%	3	0%	-
Ambulance Stations	4	0%	-	0%	-	0%	-
Hospitals	1	0%	-	0%	-	0%	-
Urgent Care and Clinics	6	0%	-	0%	-	0%	-
Potential Evacuation Shelters	19	0%	-	0%	-	0%	-
Animal Shelters	4	0%	-	0%	-	0%	-
Senior Centers	2	0%	-	0%	-	0%	-
Primary Secondary Schools	28	0%	-	0%	-	0%	-
Preschools	16	0%	-	0%	-	0%	-
Large Daycare Centers	26	0%	-	0%	-	0%	-
Total	**279**	**3.6%**	**10**	**1.8%**	**5**	**0.0%**	**-**

HOT SPOT FIRE LOCATIONS

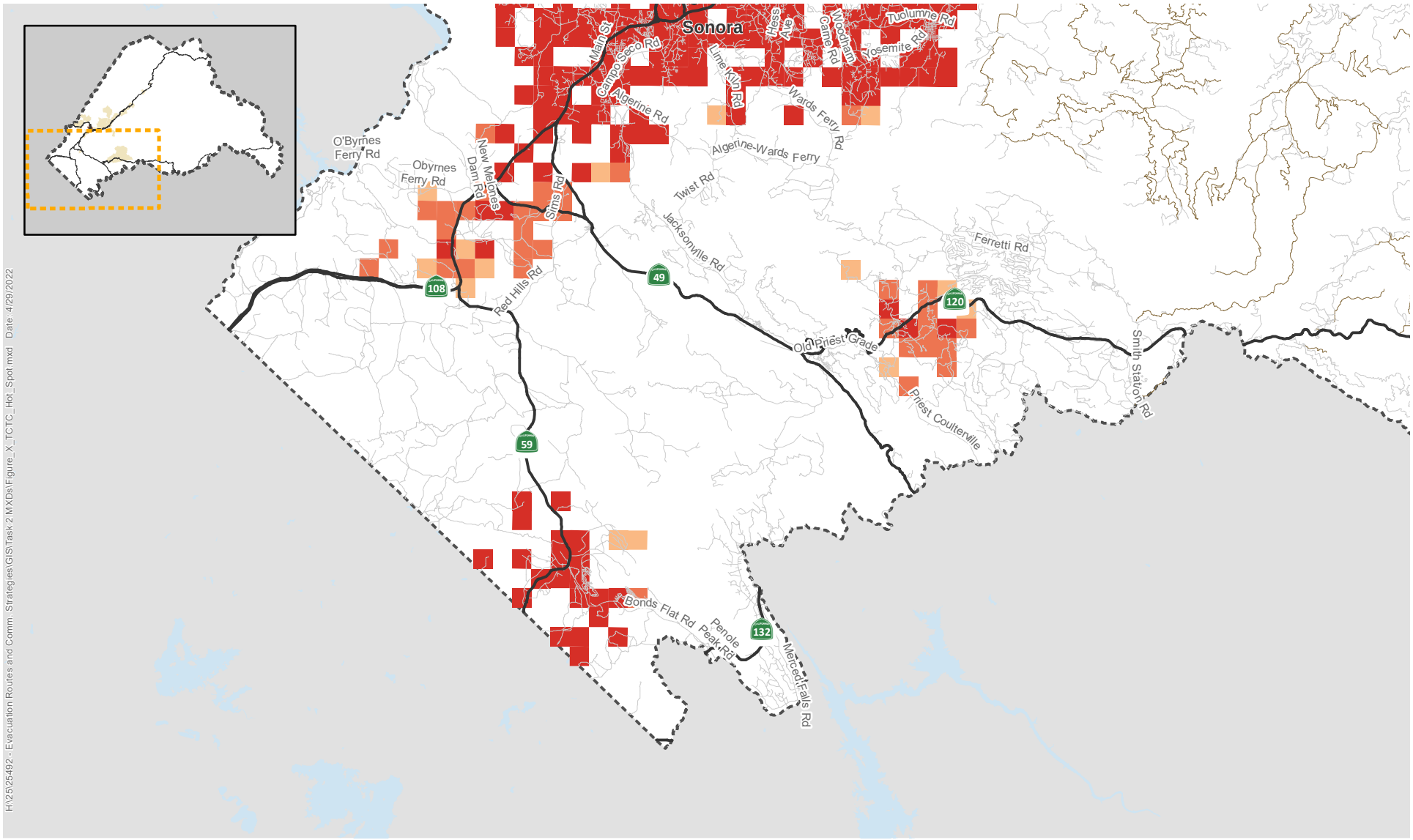
DESCRIPTION

The Ignition Hot Spot analysis identifies locations in the County with a statistically higher probability of historic fire ignition. The analysis uses the spatial distribution of historic ignitions to identify locations with a higher intensity of ignition events than would be expected if ignitions were randomly distributed. These hot spots can be interpreted as areas where ignitions have historically been clustered. The data presented identify locations in the County with 90%, 95%, and 99% confidence for clustering of past ignitions. It is important to note that this analysis is based on number of ignitions, not the size of the burned area that resulted from the ignition.

MAP OF RISK

The Hot Spot Fire analysis are shown in Figure 9. While the burn frequency figures indicate that historically burns area is limited in the populated parts of the County, the hot spot analysis shows that populated areas have a higher probability of ignitions.

- Risk of ignition is elevated along CA-108 from Keystone in the West to Sierra Village.
- Risk along CA-120 is identified south of Groveland.
- High probability of ignition is also identifed South of Don Pedro Resevoir.



Hot Spot Analysis - unweighted

- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Roadways

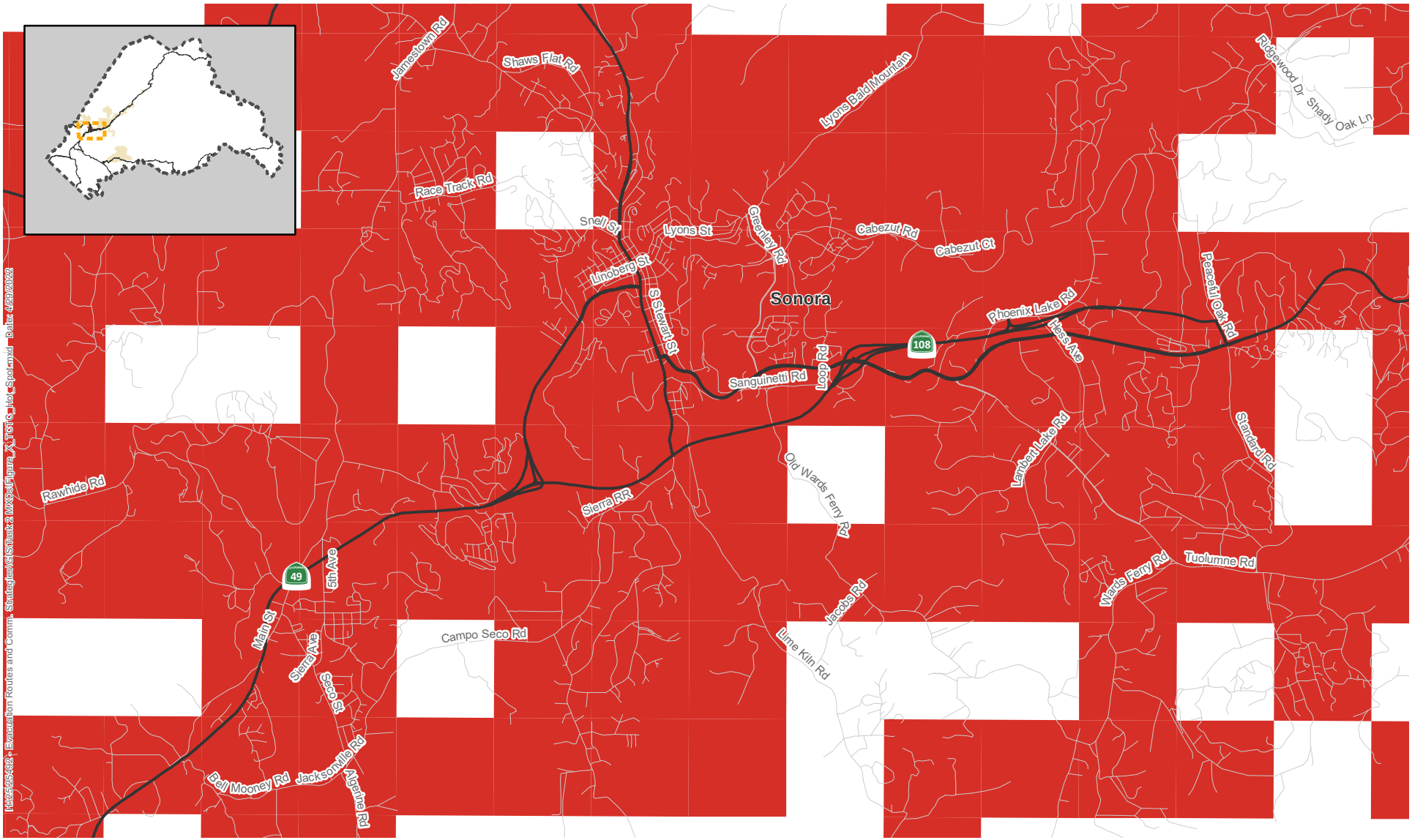
- State Highways and Major Roads
- Minor and Local Roadways
- Forest Service Roads
- Tuolumne County

0 4 Miles

Figure 9.1

Hot Spot Fire Locations
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES



Hot Spot Analysis - unweighted

- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Roadways

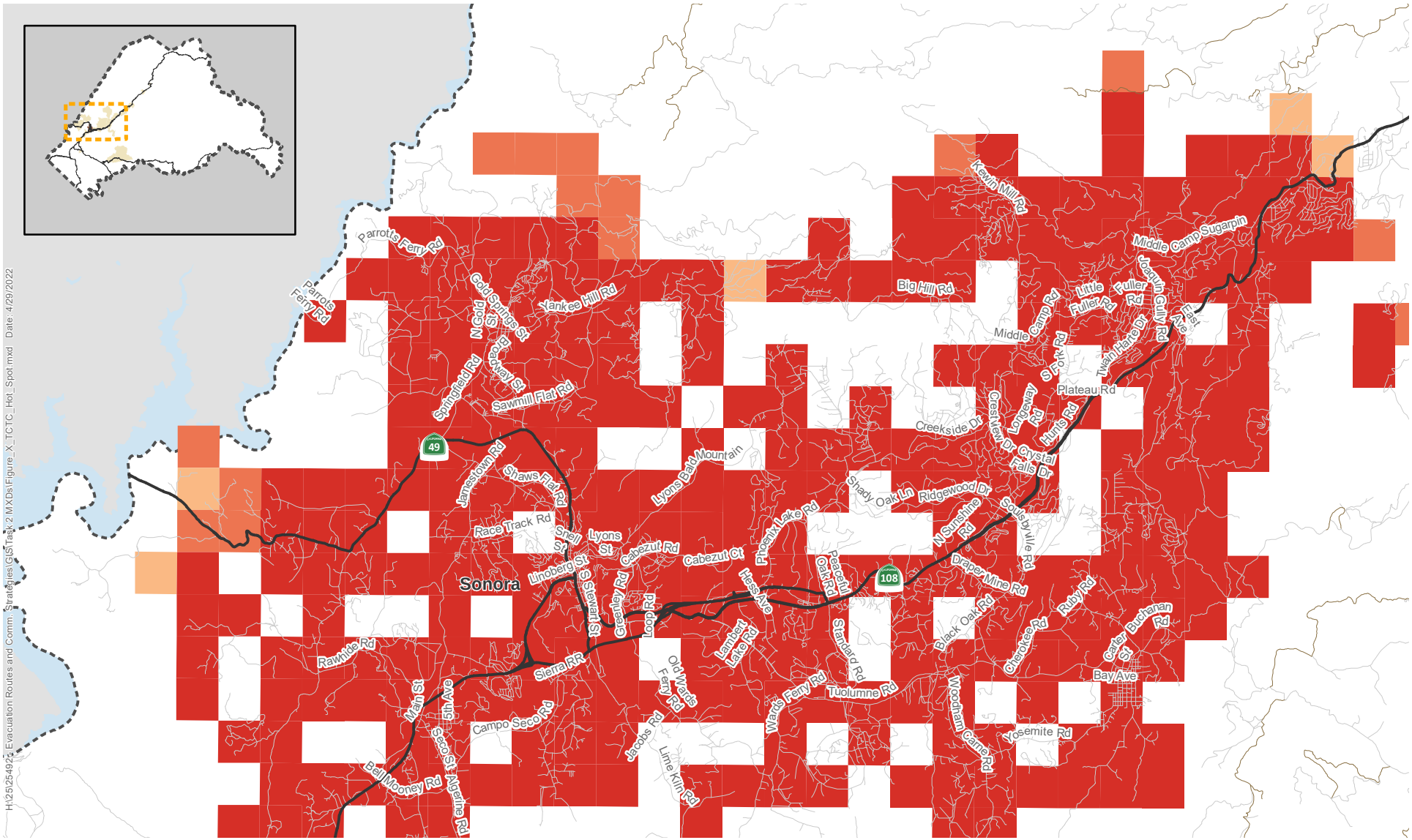
- State Highways and Major Roads
- Minor and Local Roadways
- Forest Service Roads
- Tuolumne County

0 0.8 Miles

Figure 9.2

Hot Spot Fire Locations
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES



H:\25\25492 - Evacuation Routes and Comm. Strategies\GIS\Task 2 MXDs\Figure_X_TCTC_Hot_Spot.mxd Date: 4/29/2022

Hot Spot Analysis - unweighted

- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Roadways

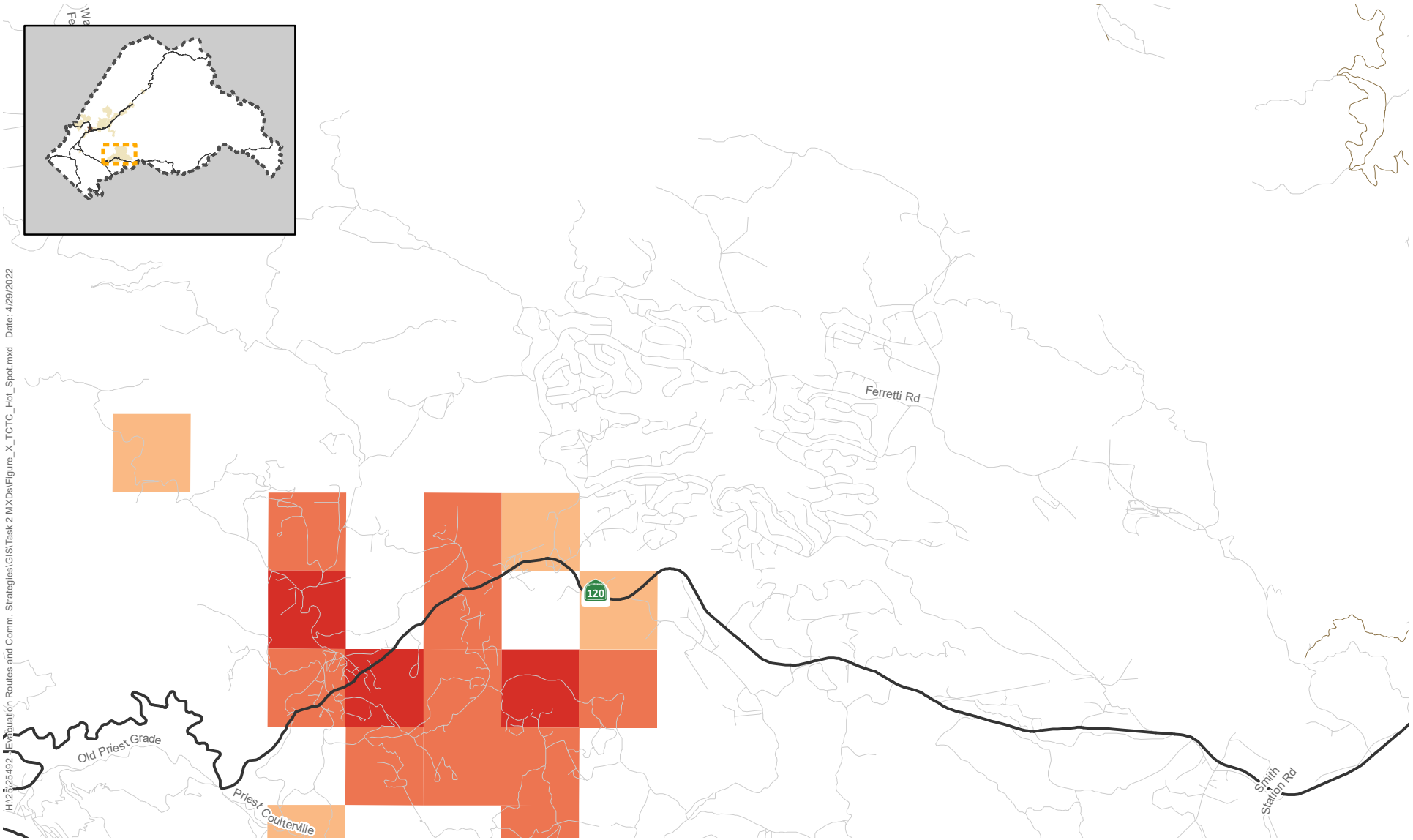
- State Highways and Major Roads
- Minor and Local Roadways
- Forest Service Roads
- Tuolumne County

0 2.2 Miles

Figure 9.3

Hot Spot Fire Locations
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES



Hot Spot Analysis - unweighted

- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Roadways

- State Highways and Major Roads
- Minor and Local Roadways
- Forest Service Roads
- Tuolumne County

0 1 Miles

Figure 9.4

Hot Spot Fire Locations
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES

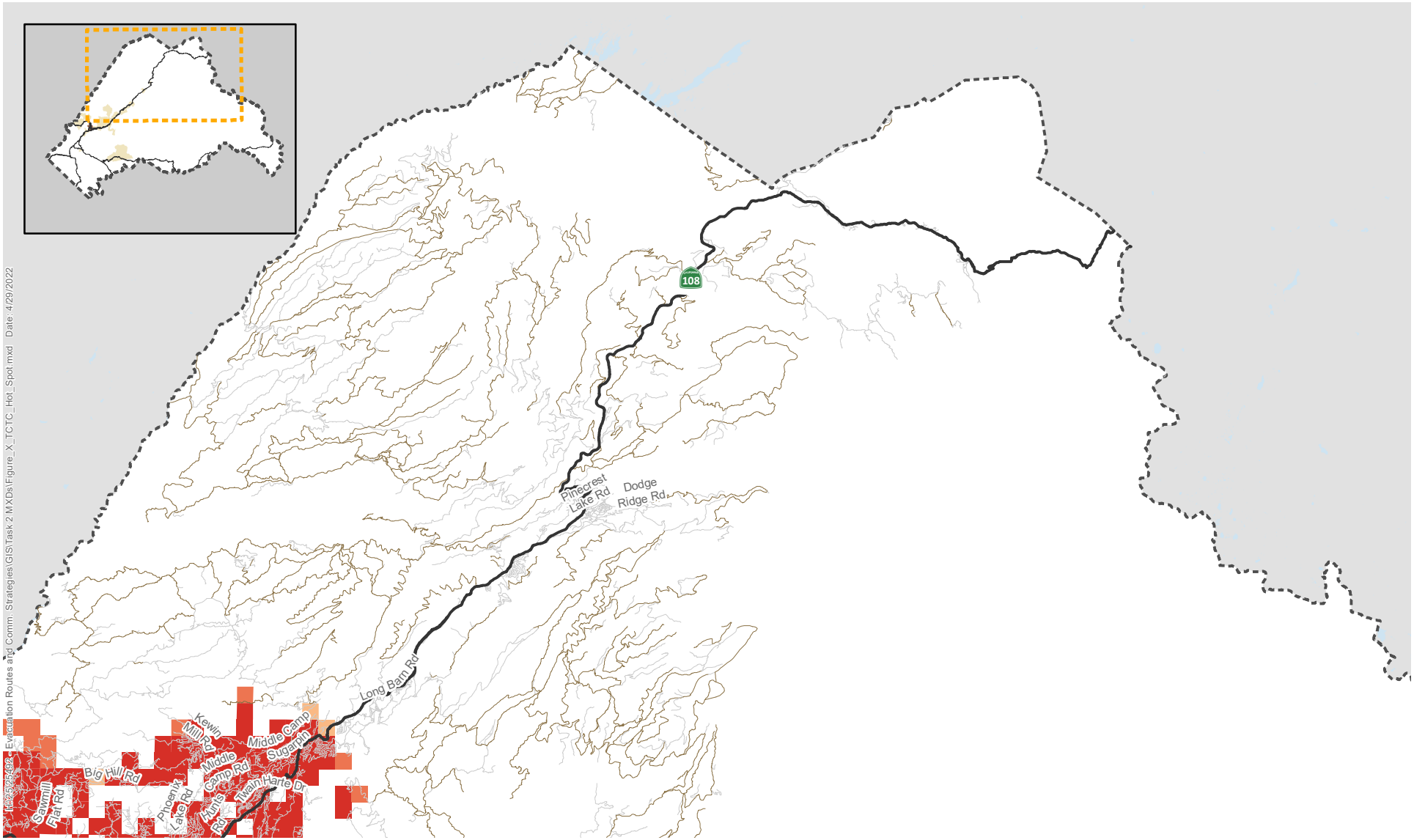
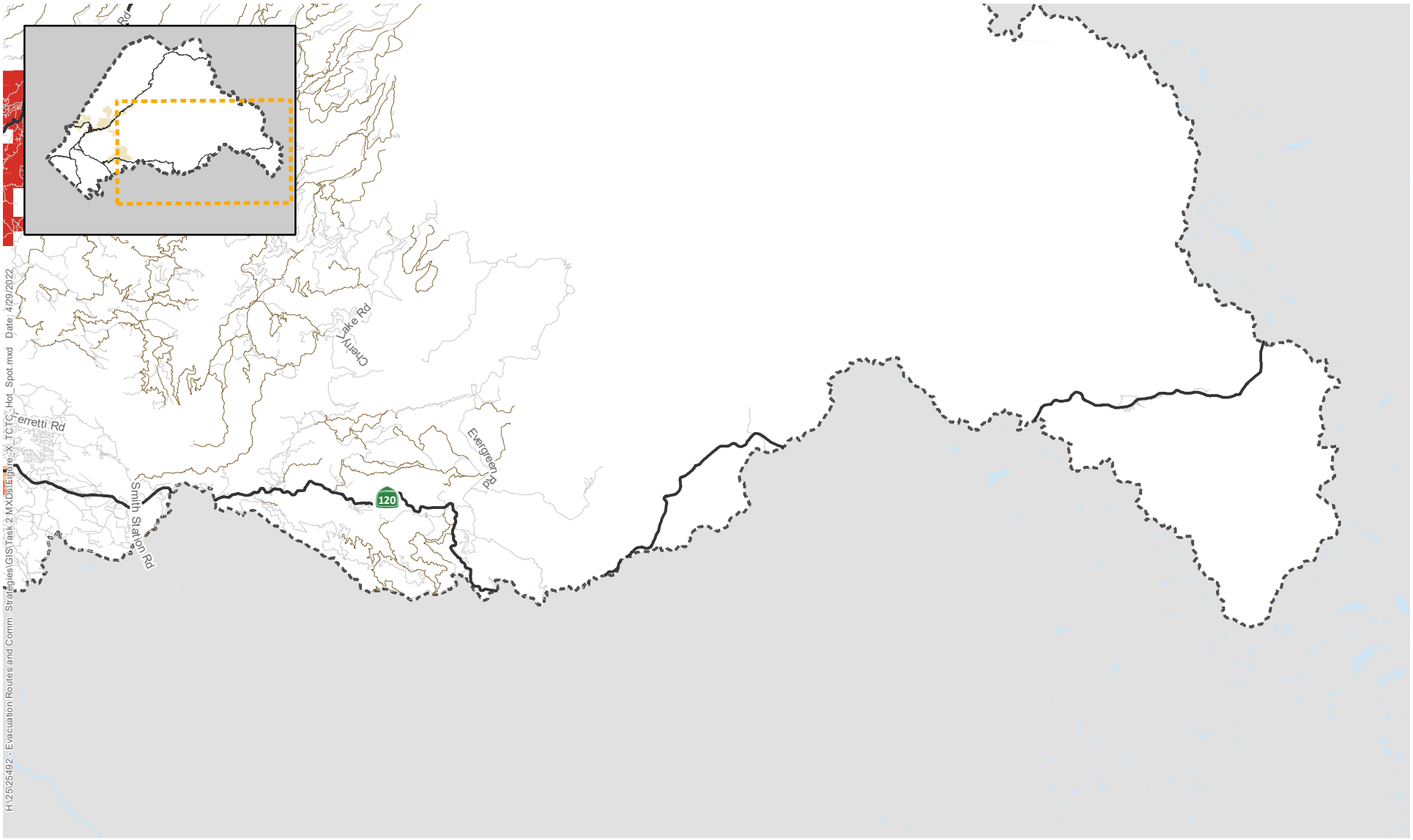


Figure 9.5

Hot Spot Fire Locations
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES



Hot Spot Analysis - unweighted

- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Roadways

- State Highways and Major Roads
- Minor and Local Roadways
- Forest Service Roads
- Tuolumne County

0 6 Miles

Figure 9.6

Hot Spot Fire Locations
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES

SUMMARY OF RISK

Table 14, Table 15, and Table 16 indicate the number of residential units that are located in each of the Hot Spot Fire groups and the percent of units relative to the total units in that zone. The tables identifiy a high degree of overlap between risk of ignition and the reference populations. This is expected since human activity is a major contributor to fire ignition.

- Across the subareas, the locations with the greater number and percent of residential parcels and structures in areas with elevated risk of ignition are alsong CA-108. The Cedar Ridge / Twain Harte / Sierra Village, Sonora / East Sonora, Mono Vista, Tuolumne City, and Tuttletown subareas all have more than 85% of residential parcels in 99% confidence ignition zones.
- Across the critical infrastructure subgroups, the percent of infrastructure in risk zones is greater than in the other risk types evaluated. In particular, 53 of the 72 senior centers, primary secondary schools, preschools, and large daycare centers are in the 95th confidence ignition category.

Table 14: Hot Spot Risk for Residential Parcels

County Analysis Subareas	Residential Parcels	Hot Spot Group					
		90%		95%		99%	
Cedar Ridge / Twain Harte / Sierra Village	6,751	0%	30	0%	21	86%	5,801
Sonora / East Sonora	5,153	0%	-	0%	-	93%	4,772
Groveland	4,176	1%	38	5%	216	1%	46
West of Phoenix Lake Road	3,465	1%	21	0%	1	72%	2,497
Mono Vista	2,890	0%	-	0%	-	87%	2,511
Jamestown	2,003	0%	-	0%	-	91%	1,827
Columbia	1,387	0%	-	2%	28	96%	1,326
Cold Springs / Strawberry	1,250	0%	-	0%	-	0%	-
Tuolumne City	1,602	0%	-	0%	-	94%	1,508
South Don Pedro Reservoir	1,201	0%	-	0%	-	0%	-
Tuttletown	717	2%	13	5%	34	87%	622
Log Barn	432	0%	-	0%	-	0%	-
North of Twain Harte	200	0%	-	0%	-	0%	-
West of Don Pedro Reservoir	180	1%	2	0%	-	56%	100
Chinese Camp / Montezuma	155	1%	1	12%	18	0%	-
North of 108 / Lake Tulloch	149	0%	-	1%	2	0%	-
Northeast of County	151	0%	-	0%	-	0%	-
Stanislaus National Forest	119	0%	-	0%	-	4%	5
Southeast County	35	0%	-	0%	-	0%	-
North of South Fork Stanislaus River	35	0%	-	0%	-	0%	-
West of Beardsley Reservoir	2	0%	-	0%	-	0%	-
Total	**32,053**	**0.3%**	**105**	**1.0%**	**320**	**65.6%**	**21,015**

Table 15: Hot Spot Risk for Structures

County Analysis Subarea	Structures	Hot Spot Group					
		90%		95%		99%	
Cedar Ridge / Twain Harte / Sierra Village	7,393	1%	68	0%	25	86%	6,377
Sonora / East Sonora	8,937	0%	-	0%	-	93%	8,295
Groveland	5,733	3%	149	6%	344	2%	104
West of Phoenix Lake Road	6,669	1%	64	0%	18	64%	4,288
Mono Vista	4,129	0%	-	0%	-	87%	3,610
Jamestown	3,288	0%	-	0%	2	91%	3,001
Columbia	3,205	0%	-	3%	81	93%	2,982
Cold Springs / Strawberry	1,908	0%	-	0%	-	0%	-
Tuolumne City	2,991	0%	-	0%	-	94%	2,810
South Don Pedro Reservoir	1,382	0%	-	2%	23	2%	29
Tuttletown	2,074	1%	28	5%	97	86%	1,781
Log Barn	356	0%	-	0%	-	0%	-
North of Twain Harte	368	0%	-	0%	-	0%	-
West of Don Pedro Reservoir	740	3%	19	0%	-	32%	236
Chinese Camp / Montezuma	670	1%	5	16%	106	7%	49
North of 108 / Lake Tulloch	484	2%	12	5%	23	1%	7
Northeast of County	358	0%	-	0%	-	0%	-
Stanislaus National Forest	169	0%	-	0%	-	0%	-
Southeast County	879	0%	-	0%	-	0%	-
North of South Fork Stanislaus River	128	0%	-	0%	-	0%	-
West of Beardsley Reservoir	117	0%	-	0%	-	0%	-
Total	**51,978**	**0.7%**	**345**	**1.4%**	**719**	**64.6%**	**33,569**

Table 16: Hot Spot Risk for Critical Infrastructure

Critical Infrastructure Type	Structures	Hot Spot Group					
		90%		95%		99%	
Essential County Operations Buildings	25	0%	-	0%	-	100%	25
Powerhouses	6	0%	-	0%	-	0%	-
Wireless Communication Towers	32	0%	-	3%	1	56%	18
Police Stations	3	0%	-	0%	-	100%	3
Fire Stations	28	4%	1	4%	1	54%	15
TUD Water Tanks	79	0%	-	0%	-	97%	77
Ambulance Stations	4	0%	-	0%	-	75%	3
Hospitals	1	0%	-	0%	-	100%	1
Urgent Care and Clinics	6	0%	-	0%	-	100%	6
Potential Evacuation Shelters	19	11%	2	0%	-	74%	14
Animal Shelters	4	0%	-	0%	-	100%	4
Senior Centers	2	0%	-	50%	1	50%	1
Primary Secondary Schools	28	4%	1	0%	-	64%	18
Preschools	16	0%	-	0%	-	88%	14
Large Daycare Centers	26	4%	1	0%	-	77%	20
Total	**279**	**1.8%**	**5**	**1.1%**	**3**	**78.5%**	**219**

CONCLUSION / NEXT STEPS

The analysis shows that risk from wildfire is present in much of the County, particularly along the CA-108 near Sonora and further east. While large scale burns have largely been avoided in populated areas, County population and infrastructure are located in higher risk areas including along the WUI. Within these higher areas, there are communities that may be at greater risk during an evacuation due to roadway access limitation.

The analysis in this memo is intended to be used as a reference for staff and provide context for later steps for developing the Emergency Evacuation Routes and Communication Strategies Plan. For example, the consultant team will be using the analysis to give context to a set of model evacuation for different fire scenarios. Together the work will help inform selection of potential projects to ease congestion around potential chokepoints. In addition, the consultant team will be producing a memorandum that focuses on human characteristics that impact evacuation. The memorandum will describe population characteristics that make evacuation more difficult and identify where those population may be concentrated in the County.

Appendix B: Wildfire Risk Analysis and Design Fire Scenarios

KITTELSON & ASSOCIATES
2510 J Street, Suite 200
Sacramento, CA 95816

JENSEN HUGHES

TECHNICAL MEMORANDUM

June 29, 2022

Project# 25492

To: Matt Braughton, Grace Carsky

From: Darlene Rini, Amelia Pludow, Sid Beckman and Julia Cuendet

CC:

Project TCTC Evacuation Routes and Communication Strategies

RE: Task 8 Draft Report – Wildfire Risk Analysis and Design Fire Scenarios

EXECUTIVE SUMMARY

Kittelson & Associates, Inc. (Kittelson) and Jensen Hughes are assisting the Tuolumne County Transportation Council (TCTC) and City of Sonora with developing an Emergency Evacuation Routes and Communication Strategies Plan. The Plan focuses on identifying high risk locations, vulnerable populations, and potential evacuation routes within Tuolumne County in case of forest fires and will include strategies to maximize roadway capacity and public outreach during emergency evacuations.

This technical memorandum summarizes Jensen Hughes methodology, key assumptions, analysis and results of the wildfire risk assessment portion of the TCTC Evacuation Routes and Communication Strategies Plan development. The wildfire risk assessment is divided into the following sections:

- General Background
- Methodology
- Fire Hazard Analysis
- Vulnerability Analysis
- Design Fire Scenarios
- Results

The results of the wildfire risk assessment served as input and key assumptions for Task 3 (Transit Analysis) and Task 4 (Identifying Vulnerable Populations in Evacuations).

INTRODUCTION

This report presents a wildfire risk assessment of Tuolumne County, California, as part of the development of an Evacuation Routes and Communication Strategies Plan for the Tuolumne County Transportation Council (TCTC). Due to a variety of concerns including – a highly active and severe wildfire region, limited access and egress routes, limited emergency response resources, large % of lands consisting of undeveloped wildland fuels and a growing population – Jensen Hughes was contracted to evaluate wildfire hazards, vulnerabilities and community-level risks to identify design basis wildfire scenarios for a County-wide evacuation and transit analysis. This included the assessment of the following:

- Fire Hazard Analysis
- Vulnerability Analysis
- Comprehensive Wildfire Risk Assessment

Note: The fire hazard analysis and a vulnerability analysis were combined to develop a comprehensive understanding of wildfire risk across the County as the main basis for identify representative, design fire scenarios for the transit/evacuation analysis.

The intent of this assessment, in conjunction with the evacuation analysis, industry standards and best practices, is to identify areas for improvement and recommendations to help reduce risk to life-safety in future wildfire incidents.

COUNTY DESCRIPTION

Tuolumne County, located centrally in the California Mother Lode along the western slope of the Sierra Nevada range, is approximately 2,217 square miles in area with an estimated population of 55,620 in 2020 and projected population of 63,000 by 2040 per the Department of Finance. The County extends from the foothills to the Sierra crest and is bordered on the north by Calaveras County, on the South by Mariposa County, on the west by Stanislaus County and on the east by Alpine and Mono Counties. Approximately 78 percent of the land within the County is owned by government agencies, which includes portions of the Stanislaus National Forest and Yosemite National Park (~42 percent of the land). Sonora is the only incorporated city in the Tuolumne County region and is also the County Seat.

The majority of the county's population resides in City of Sonora and the unincorporated areas abutting the national forest and national park wildlands. Development in the wildland-urban-interface is only anticipated to grow in the near-/long-term, creating a series of complex challenges. This is further complicated by the millions of visitors and seasonal workers who come to the County for recreational and/or work opportunities increasing the potential for ignitions during the summer months. While the majority of the County's residents and visitors live (or stay) within close proximity to the four main highways – Highway 108, Highway 120, Highway 132 and State Highway 49 – a large portion of the population has limited access/egress to these main transit corridors. This can present several challenges not only for firefighters and other first responders conducting emergency operations, but also for residents (and visitors) who may be evacuating or seeking refuge in an emergency event (wildfire-related or not). The limited access/egress routes, coupled with difficult terrain, can also present communication challenges for both first responders, residents and visiting populations.

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As the County primarily consists of mountainous, forested lands in a dry Mediterranean climate, it is highly susceptible to major wildland fires. Historically, and in recent years, the County has experienced significant and catastrophic wildfires both in the wildland and at the WUI (e.g., 2013 Rim Fire)), leading to major physical, social, economic and environmental impacts.

REFERENCED DOCUMENTS

The following documents and information were reviewed as part of the wildfire risk assessment presented hereinafter:

- Tuolumne County Emergency Operations Plan
- Tuolumne County Evacuation Plan Pamphlet
- Tuolumne County Multi-Jurisdicational Hazard Mitigation Plan
- Tuolumne County Community Wildfire Protection Plan (CWPP), 2004
- Tuolumne County General Plan, Chapter 9, Public Safety Element, 2018
- Tuoumne County Office of Emergency Services (OES), Evacuation Guidelines for Tuolumne County Residents
- Greater Tuolumne City Community CWPP, 2004
- Tuolumne-Calaveras Unit, Strategic Fire Plan, 2020
- Emergency Operations Plan for the City of Sonora, 2014
- Tuolumne County Firewise Communities, 2021
- California Strategic Fire Plan, 2018
- CALFIRE / Tuolumne County Fire Department, 2021-2025 Strategic Plan, DRAFT
- Pacific Gas & Electric Company, 2021 Wildfire Mitigation Plan (WMP), 2021
- PG&E, Community Wildfire Safety Program, Tuolumne County, 2018

METHODOLOGY

GENERAL APPROACH

The wildfire risk assessment for the evacuation and transit analysis consists of three main components as illustrated in *Figure 1* below:



Figure 1 - General approach for the wildfire risk assessment of Tuolumne County

(1) **Fire Hazard Analysis** – To identify and understand the severity and behavior of potential, worst-case wildfire scenarios in the County that may challenge local wildfire evacuation

and transit capacities, a landscape-level fire hazard analysis was first performed based on existing, historical data (e.g., past wildfire history, ignitions and local environmental settings). This part of the analysis provides a baseline understanding of how past incidents behaved and how local environment conditions (e.g., weather, topography and vegetation) can impact fire characteristics (e.g., flame height, rate-of-spread). This also included a hot spot analysis of historical ignitions to help identify where ignitions occurred most often, as well as preliminary fire behavior modelling to provide spatial and temporal distribution of fire at a more localized level. The preliminary spatial and temporal distributions of wildfire are then used as inputs into the wildfire risk assessment.

(2) **Vulnerability Analysis** – To help identify and prioritize high risk communities, a vulnerability assessment was undertaken using a variety of published datasets/tools. Vulnerability was evaluated from three main perspectives: (a) social vulnerabilities (b) physical vulnerabilities and (c) coping capacity vulnerabilities (e.g., access to firefighting resources). The spatial distribution of social, physical and coping capacity vulnerabilities is then used as inputs into the wildfire risk assessment.

(3) **Design Fire Scenarios** – The results of the fire hazard analysis and vulnerability analysis are then evaluated holistically to assess the comprehensive risk posed by a potential wildfire threat. The intent is to use this comprehensive risk as a tool for identifying representative, worst-case wildfire scenarios as key inputs into the evacuation/transit analysis. This included performing detailed wildfire behavior modelling to characterize the extent and timing of 5-6 wildfire scenarios that could potentially impact evacuation/transit capacities during a future wildfire incident.

The following sections describe the key assumptions for the three main components of the analysis.

FIRE HAZARD ANALYSIS

This section presents the results of the wildfire hazard analysis. These results have been used to understand the potential severity and behavior of wildfire threats in the County that may challenge local wildfire evacuation and transit capacities, as well as identify possible mitigation measures to help improve evacuation planning and wildfire resiliency within the transportation system. Note: Recommendations for mitigations measures are pending completion of the evacuation/transit analysis.

KEY ASSUMPTIONS

- **Wildfire History:** To understand landscape-level wildfire potential, severity and general behavior, existing County-wide wildfire datasets (i.e., wildfire history, large fire frequency, ignition frequency) were evaluated. The data were primarilly extracted from CAL FIRE's Fire and Resource Assessment Program (FRAP) database, with modifications for local conditions from Tuolumne County, as well as from the USDA Forest Service datasets.
  - **Ignition Frequency ("Hot Spot" Analysis)** – Using ignition history from CAL FIRE and USDA Forest Service, a hot spot analysis was used to identify statistically significant ignition locations (both weighted and unweighted by total fire area). This was reviewed with

Tuolumne County fire agencies to confirm design basis locations for "match-drop" analyses. ArcGIS Pro was used to perform the hot-spot analysis.

- **Large Fire Frequency Analysis** – Using the historical wildfire perimeter data from CAL FIRE from 1908 to 2018, the frequency of wildfires for each portion of the County was assessed to determine a relative risk ranking. The intent was to identify portions of the County where fire has occurred more frequently than others, and therefore serve as a proxy for higher risk of burning again in the future.

- **Wildfire Environmental Settings Analysis** – The landscape level analysis of existing wildfire datasets was coupled with an evaluation of key wildfire environmental settings (i.e., vegetative fuels, weather and climate, and topography). These settings are fundamental to understanding at a more granular level, potential wildfire severity and behavior.
  - **Weather and Climate Analysis** – The weather analysis was based on locally available Remote Automated Weather Station (RAWS) data during representative core fire season(s) and the associated 90th and 97th percentile conditions. The determination of core fire season(s) was based on an evaluation of fire weather data over the past 20 years, as well as informed by local fire authorities in Tuolumne County. These conditions were evaluated against recent, major wildfire incidents, which may have exceeded the 97th percentile.
  - **Vegetative Coverage** – The spatial distribution of vegetation was based on the dataset for CAL-VEG, as provided by the USDA Forest Service.
  - **Topography** – Topographic data for the County has based on the LANDFIRE dataset from the USDA Forest Service.

- **Preliminary Wildfire Behavior Modelling** – Jensen Hughes ran several preliminary wildfire behavior models (based on the local vegetative cover/fuel models, topography and output from the weather analysis) using FlamMap – a USDA Forest Service tool – to determine potential fire characteristics across the County. Outputs from the models included flame length, rate of spread, burn probability, and maximum spotting distance. Approximately 17 models/scenarios were simulated ranging in fire duration between 6-20 hours. These preliminary runs were intended to provide an rough estimate of which fire locations would be considered to be representative, worst-case scenarios for review by the Fire AHJs prior to evaluating longer duration simluations.

- **Summary of Data Inputs**
  - CAL FIRE Wildfire history data
  - CAL FIRE Fire Hazard Severity Zones (FHSZ) and any modifications from local fire agencies
  - Ignition history data from CAL FIRE and USFS
  - Remote Automated Weather Station (RAWS) data
  - Vegetative land cover from LANDFIRE, CAL FIRE and Tuolumne County
  - Fuel models from LANDFIRE
  - Topography from LANDFIRE

WILDFIRE HISTORY

Wildfires have historically been a major part of Tuolumne County's natural ecosystem. The Mediterranean-like climate, wide range of challenging topography, windy conditions and fire-adapted vegetation creates an environment for periodic burns. The fire environment is made more dangerous by the abundant hazards and risks associated with growing population,

sprawling patterns of development, as well as ongoing impacts of climate change (e.g., extended droughts, elevated heat index risk, desiccated vegetation, elongated fire seasons).

In the past 30 years, CALFIRE has recorded more than 10 wildfires of 300 acres or more. This long history of wildfires is due to the convergence of topography, fire weather and a wide variety of fuels. Chief among fire hazards is the County's weather and climate. The primary driver of large fires in Tuolumne County is weather, particularly due to high winds, which are most frequent during the summer to fall months. These high winds, with the low humidity and high temperatures they create, can prompt the National Weather Service to issue Red Flag Warnings. In Tuolumne County the criteria for the National Weather Service to issue a Red Flag Warning is daytime 10-hour fuel moisture ≤ 6% measured at 1pm, annual grasses are cured, and no wetting rain (greater than 0.10") has fallen in the last 24 hours, and one of the following:

- Sustained winds of **30+ mph**, with daytime minimum relative humidity of **29-42%** and/or Nighttime Maximum Relative Humidity of **60-80%** for eight or more hours.
- Sustained winds of **21+ mph,** with daytime minimum relative humidity of **19-28%** and/or Nighttime Maximum Relative Humidity of **46-60%** for eight or more hours.
- Sustained winds of **12+ mph,** with daytime minimum relative humidity of **9-18%** and/or Nighttime Maximum Relative Humidity of **31-45%** for eight or more hours.
- Sustained winds of **6+ mph,** with daytime minimum relative humidity less than **9%** and/or Nighttime Maximum Relative Humidity of less than **31%** for eight or more hours.

The last wildland fires of historic significance in the County were the 2018 Donnel Fire that burned 36,450 acres; the 2013 Rim Fire, ~257,314 acres; the 2017 Creek Fire, ~1,750 acres; the 2009 Knight Fire, ~6,100 acres, and the 1996 Ackerson Fire, ~59,000 acres. (WFDSS Disturbance History, accessed December 28, 2019). See *Figure 2*.

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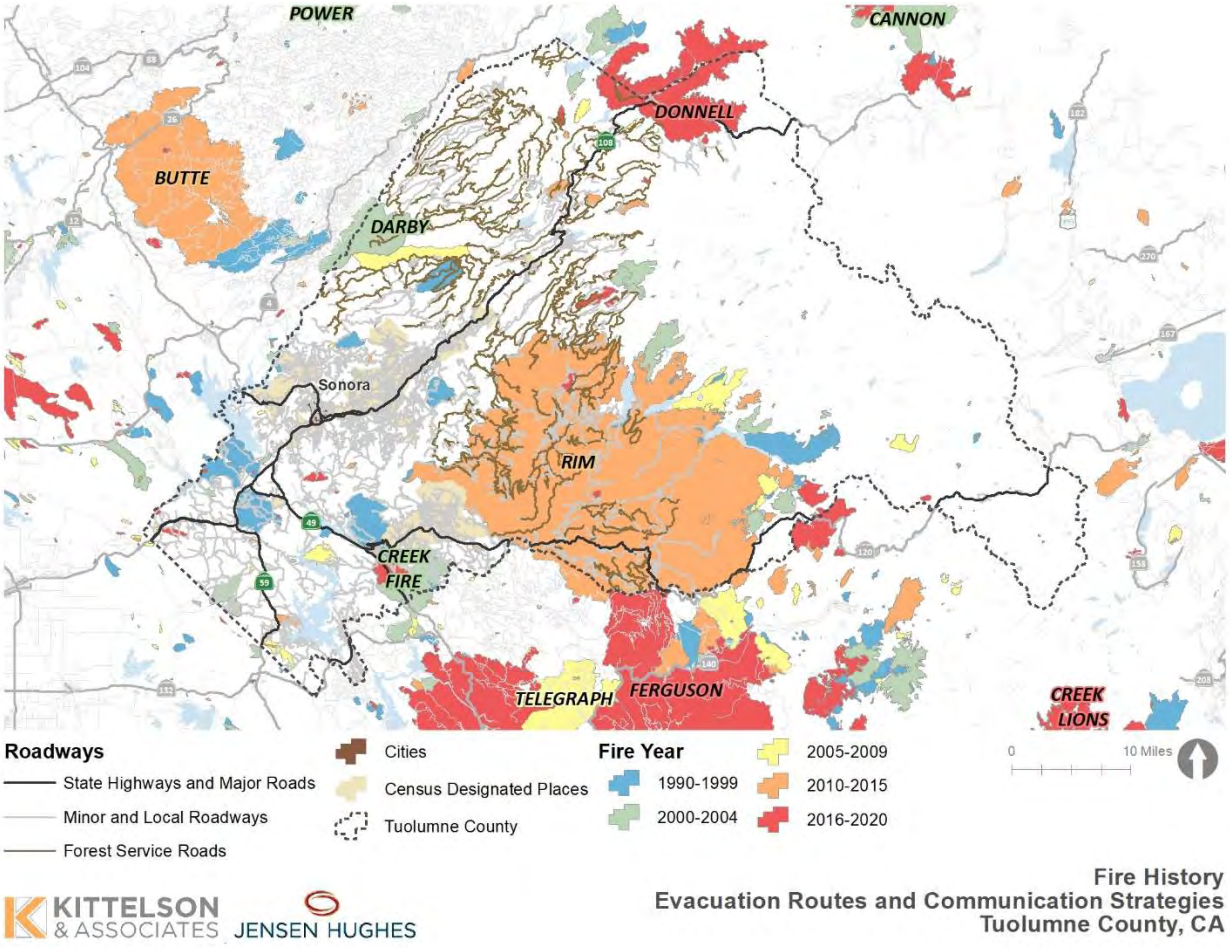


Figure 2 – Recent wildfire history in Tuolumne County

IGNITION FREQUENCY ("HOT SPOT" ANALYSIS)

Wildfire ignitions obtained from the US Forest Service Fire Occurrence database for the period 1992 through 2018 were mapped and analyzed to determine ignition hotspots.

This analysis shows statistically significant clusters of fire ignitions. The hotspot map (Figure 1) shows which areas have had a greater number of ignitions relative to the rest of the county and are likely to see future ignitions. The hotspots are determined using the Getis-Ord Gi* statistic which uses distance between ignitions to identify clusters. The urban areas surrounding Sonora have the highest density of ignitions. Other areas of the county that have a high frequency of ignitions are Groveland, the area near Highway I-49 and Bonds Flat Road and Highway 120 between Ferretti Road and Buck Meadows.

A second hot spot analysis which weights ignitions by the size of the resulting fire was also completed. In *Figure 3* hotspots based only on number of ignitions is indicated by gridding and hotspots based on ignitions weighted by fire size are indicated by dots. This weighted analysis finds clusters of larger fires which are concentrated in the southern area of Tuolumne County along Highway 120.

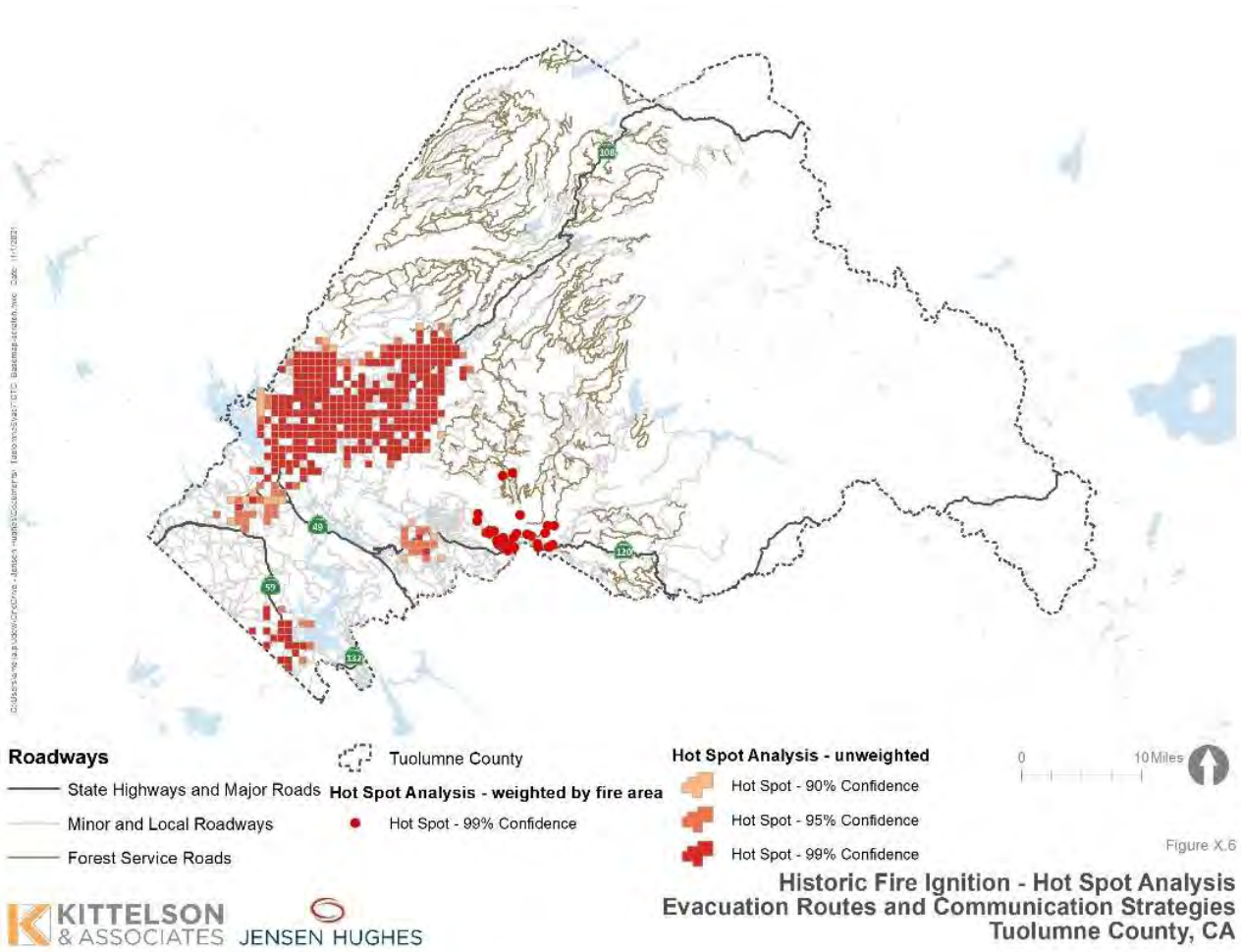


Figure 3 – "Hot Spot" Analysis of Historic Fire Ignitions

LARGE FIRE FREQUENCY

To determine the risk of a wildfire occurring within Tuolumne County, an evaluation of large fire frequency across the landscape between the years 1908 to 2018 was conducted. As part of this evaluation, a risk map was created. For this risk map, a relative risk scale (Table 1) was developed based on the number of times fire burned a particular area. The more frequently an area has burned, the higher the relative risk. *Figure 4* illustrates the relative risk for Tuolumne County.

Table 1 Relative Risk Scale based on Fire Frequency (1908 – 2018)

Frequency of Fire	Relative Risk Classification
>7	Very High
5-6	High
3-4	Moderate
<3	Low

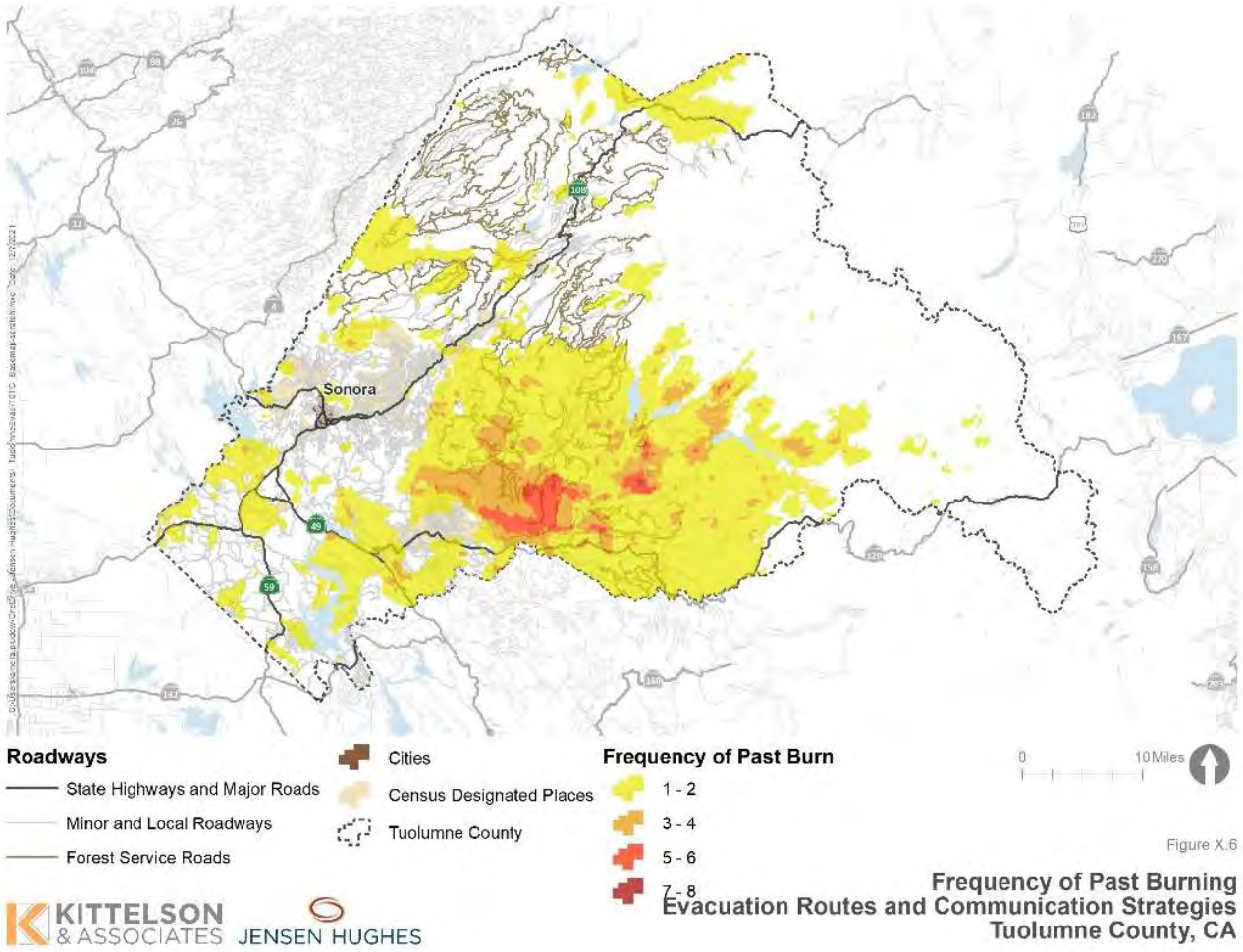


Figure 4 – Frequency of Large Wildfires

As seen in *Figure 4*, wildfire is a common occurrence in Tuolumne County and the region is anticipated to experience large wildfires in the future. Some areas of the county have not seen wildfire within this period but are not without risk of being burned in future wildfires. These unburned locations are generally associated with developed landscapes, where vegetation that supports wildfire spread has been significantly modified over the years. While these areas may not have a fuel complex that will readily support wildfire spread, during wind driven wildfires, ember-cast into these locations puts residences and businesses at risk of burning.

CONCLUSION

These two fire history analyses show that historically wildfire ignitions have been most frequent in the developed areas of the county, while large wildfires have occurred predominately on undeveloped range, commercial forest, and public lands.

WILDFIRE ENVIRONMENTAL SETTINGS

Due to the inherent environmental settings in Tuolumne County – climate, weather, topography and vegetative cover – the vast majority of the County is considered a high wildfire prone area. Per the Fire Hazard Severity Zones maps produced by the California Department of Forestry and Fire Protection (CAL FIRE), 84% of all state responsibility areas and local responsibility areas (SRA and LRA) are within High and Very High Fire Hazard Zones (*Figure 5*). While federal lands are not categorized in the same way as SRA and LRA lands, most of the federal lands across the County are considered to be in high to very high fire hazard zones.

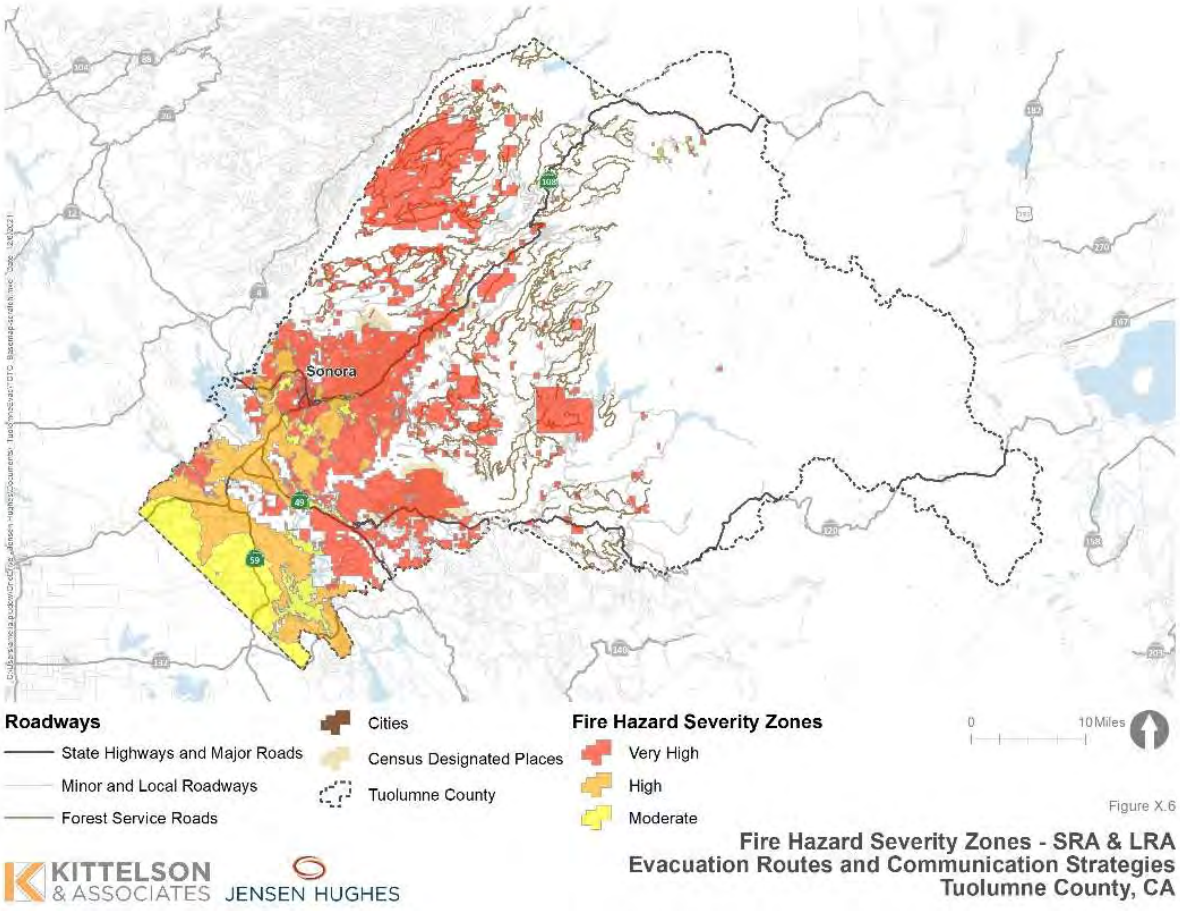


Figure 5 – Tuolumne County Fire Hazard Severity Zones

Fire Hazard Severity Zones (FHSZs) are geographic areas of significant fire hazard in both State and Local lands as identified by CAL FIRE per California Public Resources Code, Sections 4201 through 4204 and Government Code 51175 through 51189. These areas of significant fire hazard are identified based on a number of parameters, such as vegetative fuels, terrain, weather, and other relevant factors, and are categorized into three relative degrees of severity: Moderate, High and Very High FHSZs for State Responsibility Areas (SRAs) or Very High FHSZs for Local Responsibility Areas (LRAs). The FHSZs are based on wildfire hazards over a 30- to 50-year period,

but do not consider how recent wildfire activity or fuel modification actions have influenced potential fire severity. While FHSZs do not predict when or where a wildfire may occur, they are designed to help officials, property owners, and builders better protect structures and infrastructure by identifying areas where the chance for wildfires is moderate to very high.

CLIMATE AND WEATHER

The climate in Tuolumne County is primarily classified as Mediterranean-temperate with dry, warm to hot summers and mild moist to wet winters- according to the Koppen-Geiger Climate Classification System. Weather is the most variable element of the wildland fire environment. Important components of fire weather that influence fire behavior are temperature, relative humidity, precipitation, wind, and atmospheric stability. All of these elements have the potential to enhance or hinder wildfire spread and intensity.

To determine the length of fire season in Tuolumne County, as well as fuel moistures and wind speeds for periods of extreme fire danger that occur during the fire season, a weather analysis using historic weather data collected from National Fire Danger Rating System (NFDRS)-compliant Remote Automated Weather Stations (RAWS) – was performed. The Mount Elizabeth RAWS (*Figure* 6) was utilized due to its proximity to the majority of identified vulnerable communities. The outputs are then used in the fire behavior models.

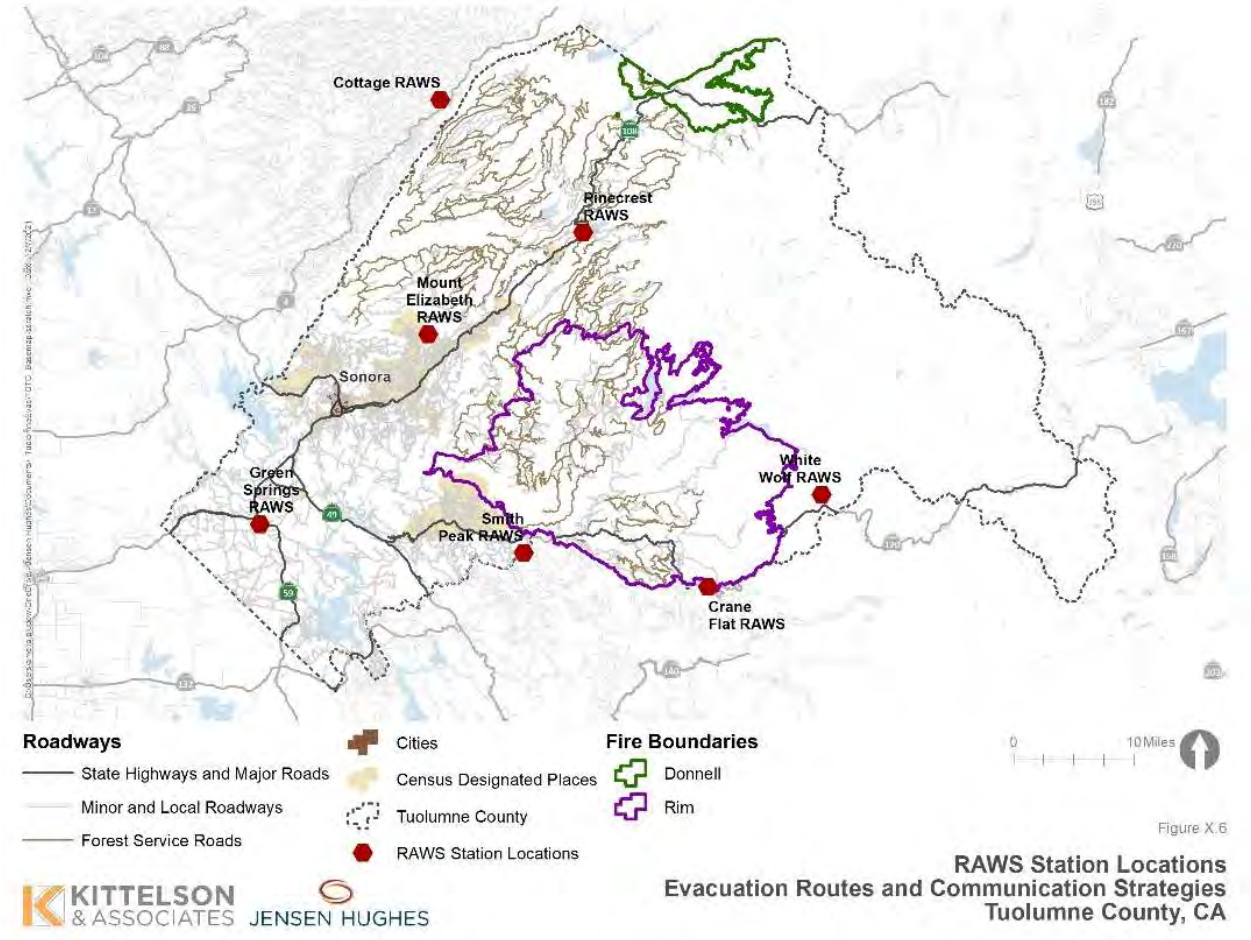


Figure 6 – Remote Automated Weather Station Locations

To determine the length of the fire season, daily weather observations over a 20-year period (i.e., 2002 – 2021) were evaluated using FireFamily Plus, a publicly available software used to calculate percentile break points for fuel moistures and winds. A graph of the Burn Index (BI) was generated from this data for the period between May 1 and November 30 (*Figure 7*). The BI is an estimate of the potential difficulty of fire containment as it relates to the flame length at the head of the fire. For Mount Elizabeth, the BI begins to reach its peak at the beginning of July and declines at the end of September. As such, July 1 to September 30 was selected as the core fire season for this analysis, as these are conditions when fire are the most difficult to control.

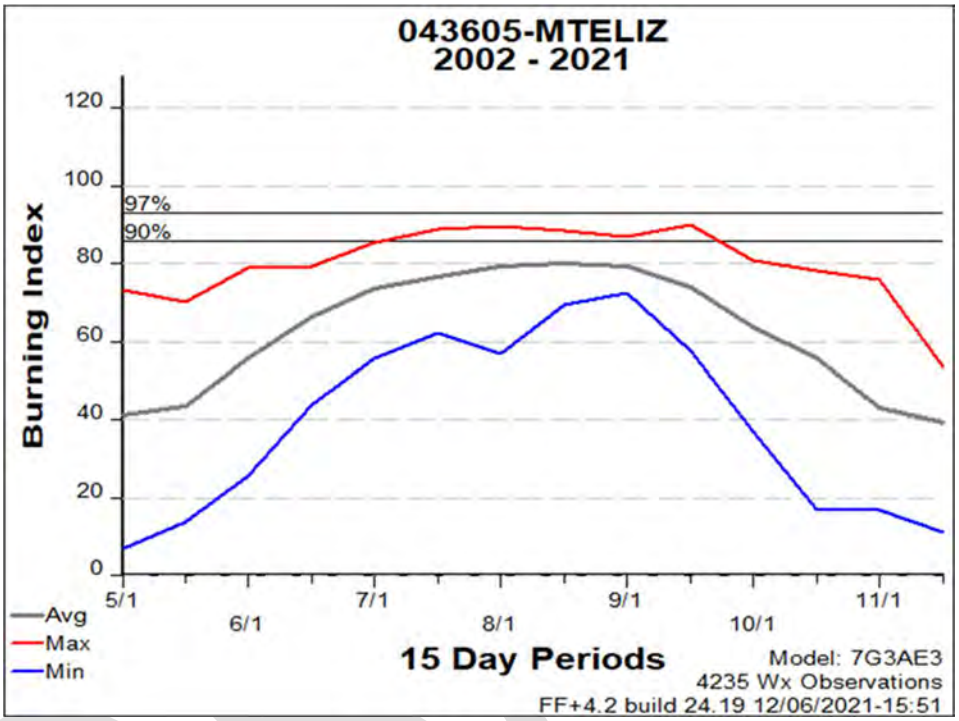


Figure 7 – Burning Index for May 1-November 30 over a 20-year weather period (2002-2022)

Using 20 years of daily weather observations from the Mount Elizabeth RAWS during the identified fire season, Fire Family Plus was used to calculate percentiles for fuel moistures, wind speed and direction, specifically those thresholds at which fire spread is at its maximum (Table 2).

Table 2 Fire Season Fuel Moistures and Wind Speeds under 97th Percentile Conditions

Mount Elizabeth 97th Percentile Fuel Moisture and Wind Speed							
1-hour	**10-hour**	**100-hour**	**1000-hour**	**Herbaceous Moisture**	**Woody Moisture**	**Wind Speed**	**Wind Direction**
3%	3%	5%	6%	3%	70.00%	11mph	247°

Additional weather stations were used to determine hourly wind observations (Table 3) during the peak burning period and their impact on fire spread for two large fires which occurred in Tuolumne County – the 2018 Donnel fire and the 2013 Rim fire (Figure 4). These wind speeds were

compared to Mount Elizabeth. As is industry standard, 97th percentile winds were used for modeling wind impacts on fire spread in the fire behavior analysis.

Table 3 Observed Wind Speeds for Donnel and Rim Fires

Average Hourly Wind Observations (12:00 to 18:00) on Large Fire Growth Days						
Fire	**Dates**	**Average Daily Growth (acres)**	**Average 20' Wind speed (mph)**	**Average Maximum gust (mph)**	**Average Wind direction**	**3-Day Maximum Gust (mph)**
Donnel*	Aug-4/6-2018	3083	8	15	267	23

*Donnel Fire RAWS – Mount Elizabeth, Pinecrest, Cottage

Fire	**Dates**	**Average Daily Growth (acres)**	**Average 20' Wind speed (mph)**	**Average Maximum gust (mph)**	**Average Wind direction**	**2-Day Maximum Gust (mph)**
Rim**	Aug-22/23-2013	44,000	8	17	219	26

**Rim Fire RAWS – Mount Elizabeth, Crane Flat, White Wolf, Smith Peak

VEGETATION AND FUELS

Positioned centrally in the California Mother Lode along the western slope of the Sierra Nevada range, Tuolumne County contains a wide diversity of tree (hardwood and coniferous forests, oak woodlands), shrub (chaparrals), and herbaceous (grasslands) habitat types. Thirty-four habitat types are mapped using the data from CAL FIRE, in corporation with California Department of Fish and Wildlife VegCamp program and extensive use of USDA Forest Service Region 5 remote Sensing Lab (RSP) data. *Figure 8* illustrates the long-term vegetative coverage or habitat systems from approximately 1990 to 2014.

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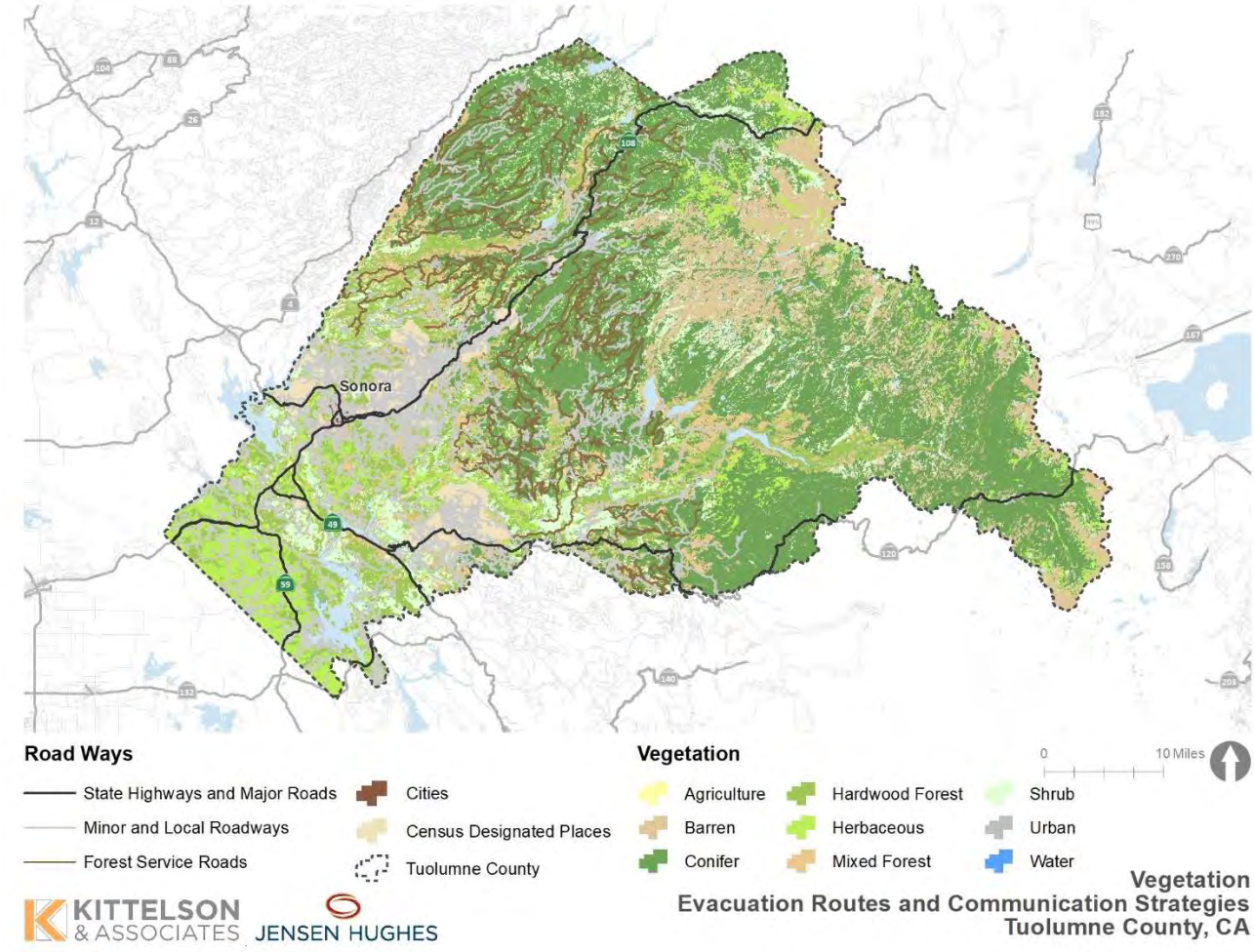


Figure 8 – Vegetative cover in Tuolumne County (CAL-VEG)

Conifer forest/woodlands comprise the largest percentage of the vegetation (~19%), followed by mixed hardwood forest/woodland (9.4%). There is also a substantial amount of barren landscape (10.1%), particularly in the Northeastern part of the County. The western area of the county is made up of plains, which routinely experience extreme summer heat and significant wind events during the spring and fall months. There are brush fields centrally located in the county, which lay over steep hillsides and on top of narrow ridgelines between deepening river canyons. This brush transitions into mixed oak and conifer zones at higher elevations and in deeper and wider canyons.

For mixed-conifer forests, fire is an important element in the ecology. Generally, fire (1) prepares a seedbed; (2) cycles nutrients within the system; (3) adjusts the successional pattern; (4) modifies conditions affecting wildlife; (5) influences the mosaic of age classes and vegetation types; (6) alters the numbers of trees susceptible to disease and insects; and (7) both reduces and creates fire hazards. Natural fire frequency coincides with levels of fuel accumulation that result in burns of relatively low intensity at frequent intervals. This may average 8 years in mixed conifer forests, with frequencies from 4 to 20 years for some particular sites.

Sierra Nevada forest fires vary from the relatively mild surface fires found under natural conditions (e.g., in ponderosa pine, sequoia-mixed conifer, red fir and higher-elevation types) to

extremely intense (e.g., in logged-over country at the brush/timber boundary). In the mixed conifer forest of the Sierras, crowning may occur in individual trees or part of a stand. Prior to intensive fire suppression in the early 1990s, crown fires over significant forest segments were rare due to the uneven-aged, patchy and broken nature of the virgin forest in California. However, with second-growth forests (from logging) and forests with understory shade-tolerant species that have emerged in the absence of regular surface fuels, crown fires are more likely.

Generalized Vegetation/ Land Cover Types	Estimated Acres	Percent (%)
Sierran Mixed Conifer	276,955	19.0
Barren	147,179	10.1
Montane Hardwood	123,301	8.5
Annual Grassland	112,681	7.7
Subalpine Conifer	102,044	7.0
Montane Chaparral	101,641	7.0
Red fir	89,126	6.1
Mixed Chaparral	83,970	5.8
Blue Oak Woodland	68,218	4.7
Ponderosa Pine	66,609	4.6
Lodgepole Pine	45,468	3.1
Jeffrey Pine	40,799	2.8
Montane HW-Conifer	33,744	2.3
Perennial Grassland	32,427	2.2
Lacustrine	31,308	2.1
Juniper	17,783	1.2
CR Chaparral	17,059	1.2
Wet Meadow	14,317	1.0
Blue Oak-Foothill Pine	14,185	1.0
Montane Riparian	12,233	0.8
White fir	11,612	0.8
Alpine Dwarf-Shrub	4,574	0.3
Sagebrush	3,111	0.2
Urban	2,780	0.2
Aspen	1,919	0.1
Riverine	794	0.1
Cropland	645	<0.1
Others	506	<0.1
Total	1,457,499	Total

FUEL CHARACTERISTICS

The key characteristics of vegetative fuels that affect fire behavior include fuel type, fuel moisture, amount of fuel, chemical properties, horizontal continuity, and vertical arrangement.

Fuel types associated with Tuolumne County include grasses, shrubs and the conifer litter and very high load-timber shrub found in forested vegetation types. These fuel types are categorized into specific fuel models which describe the physical properties of the vegetation that support fire. Figure 9 shows the spatial distribution of the fuel models across the County.

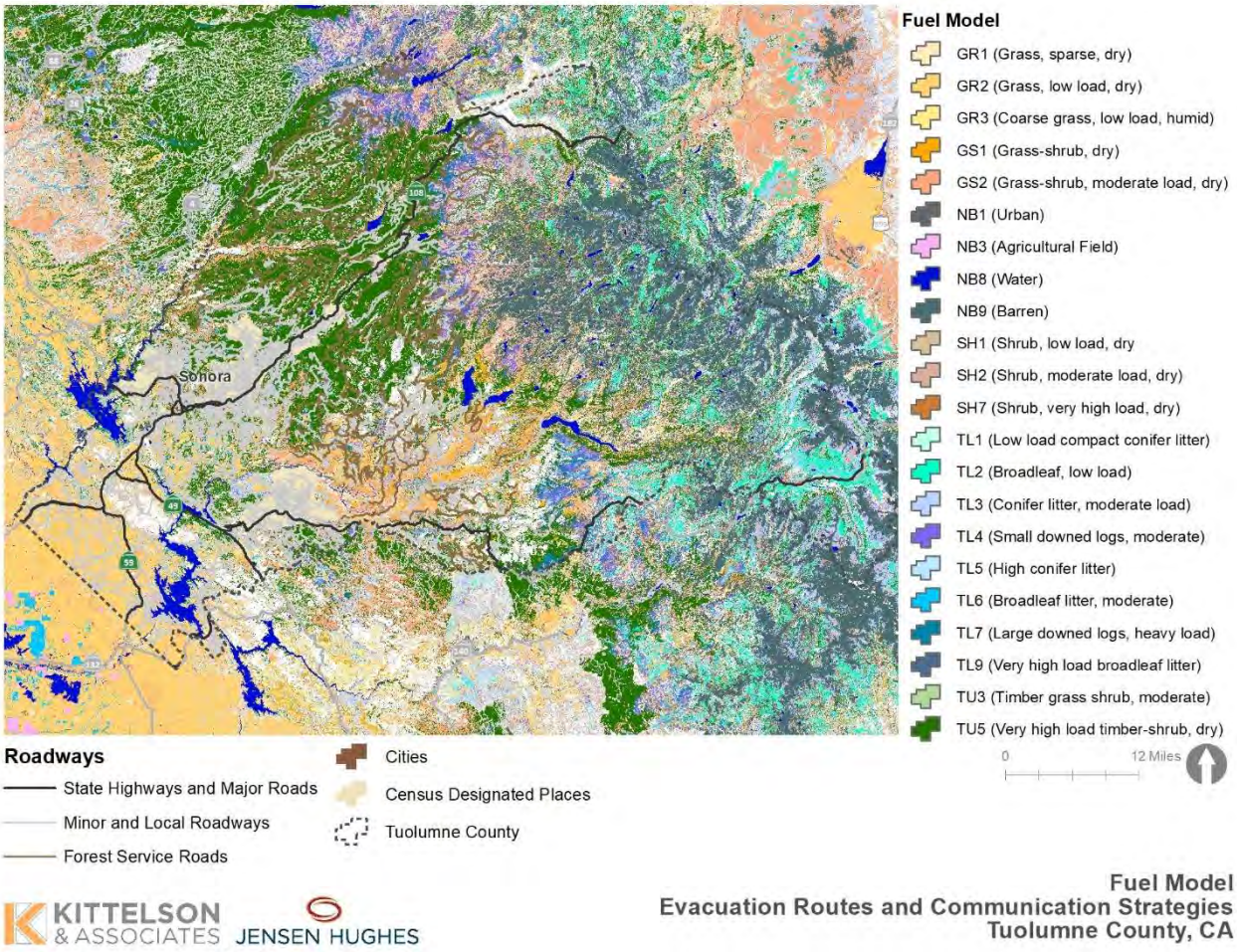


*Figure 9 – Assumed Fuel Models (*FBFM40, *LANDFIRE)*

Note: Urban development, barren land and water, all considered unburnable in the fire behavior models.

TOPOGRAPHY

Topography is the configuration of the earth's surface and is the most stable of the elements in the fire environment. Topography plays a significant role in wildland fire behavior by impacting local winds by sheltering areas from the prevailing wind or by channeling wind through prominent canyons and drainages. Specific elements of topography that affect fire behavior include slope, aspect, terrain features, and elevation with the steepness of slope being the most influential.

Tuolumne County contains several topographical features of significance in the context of this analysis. The western part of the county contains rolling plains. The central part of the county contains steep hillsides atop narrow ridgelines between deepening river canyons. This topography makes the access of motorized firefighting equipment very difficult. Further east of the county, the canyon depth and width increase significantly.

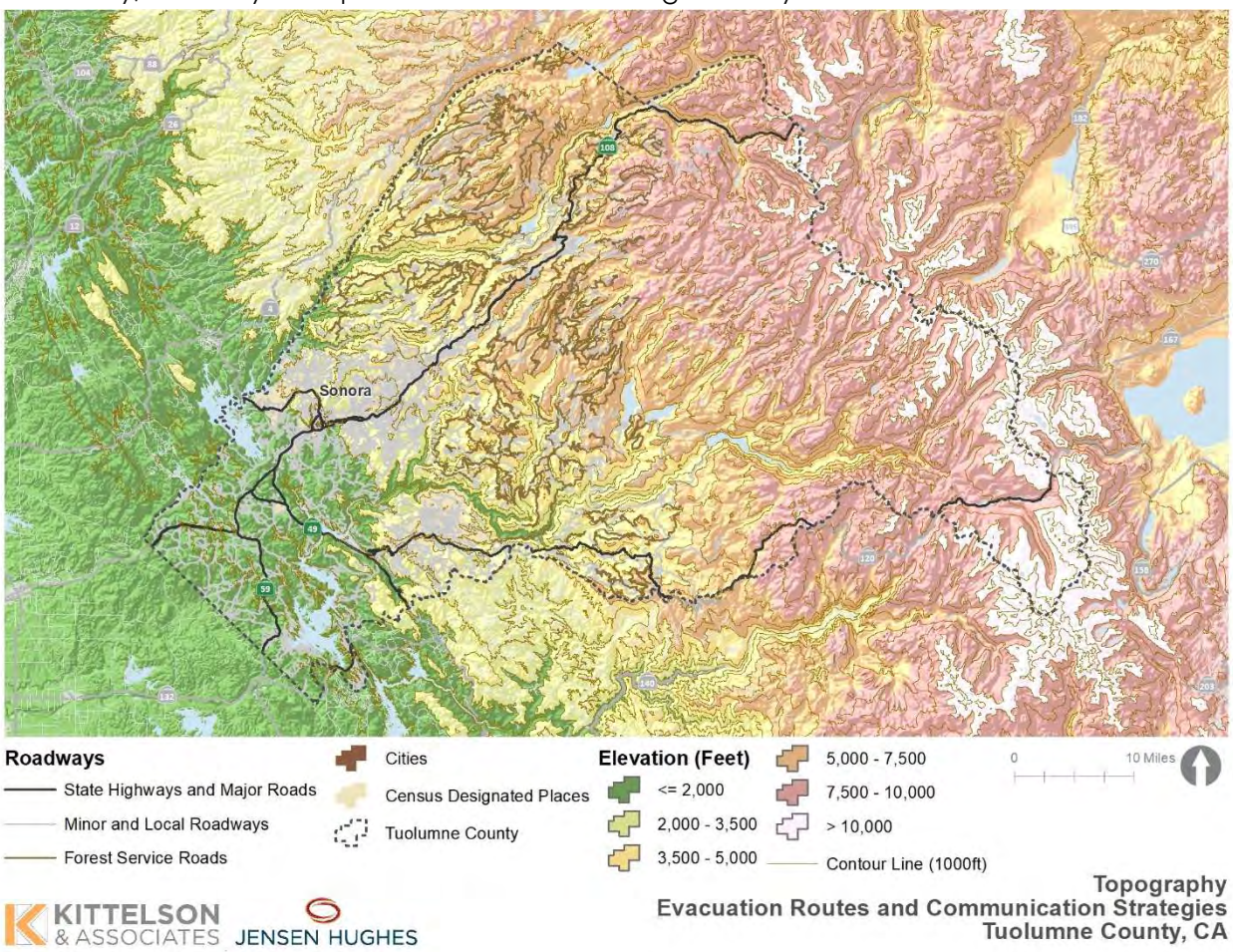


Figure 10 – Elevation Contours across Tuolumne County (LANDFIRE)

PRELIMINARY WILDFIRE BEHAVIOR MODELLING

Given Tuolumne County's wildfire history (e.g., ignition history, past incidents) and wildfire environmental settings (e.g., topography, weather and vegetation) described above, several preliminary wildfire behavior models were performed for 17 ignition points throughout the County. The burn periods for these scenarios ranged from 6-20 hours. These simulations served to understand general wildfire characteristics that could occur across the County, as well as serve as a starting point to select 5-8 representative, worst-case scenarios that would be used as the input for the transit/evacuation analysis. *Figure 11* shows the results of the 17 preliminary wildfire simulations.

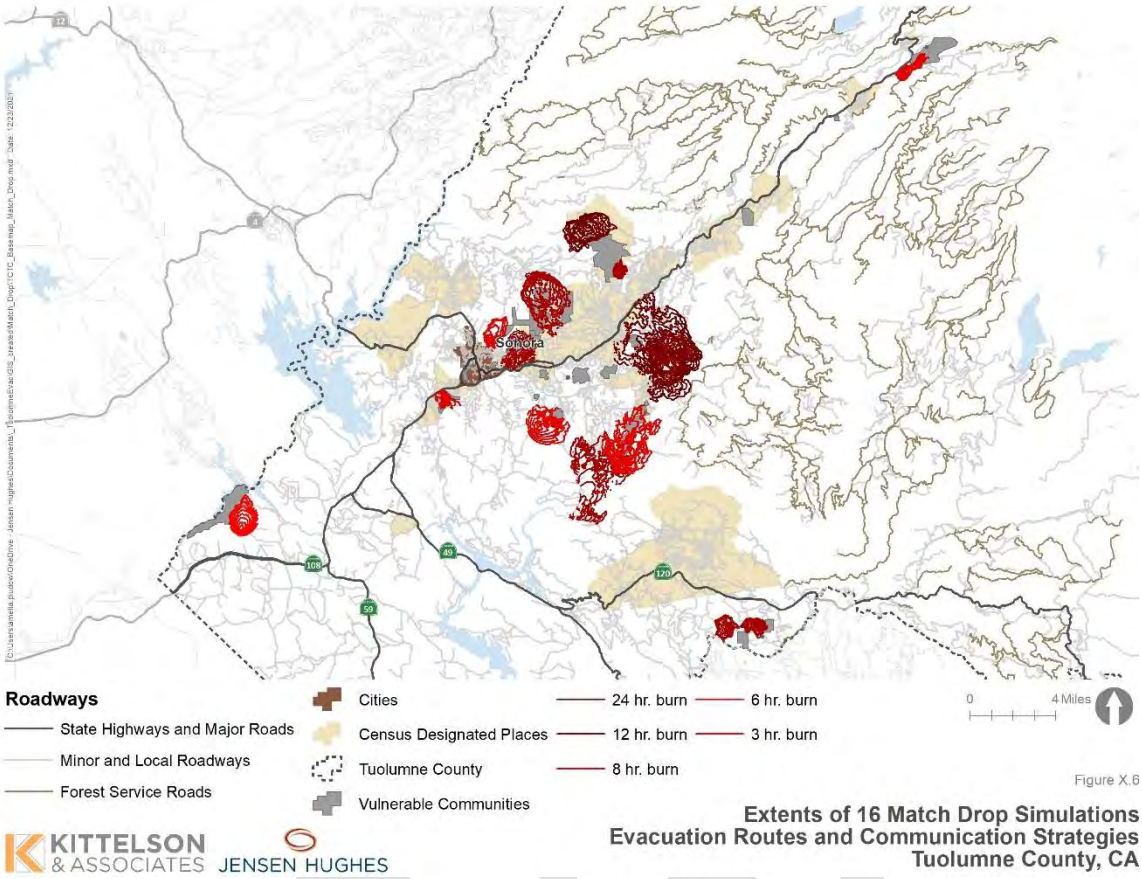


Figure 11 – Results of preliminary wildfire simulations for 17 different scenarios across the County. The figure illustrates extent of fire given varying burn periods and ignition locations.

VULNERABILITY ANALYSIS

To help identify and prioritize high risk communities, a vulnerability assessment was undertaken using a variety of published datasets/tools. Vulnerability was evaluated from three main perspectives: (1) physical vulnerabilities, (2) social vulnerabilities, and (3) coping capacity vulnerabilities (e.g., access to firefighting resources). As vulnerability assessments are often limited by the availability, quality and scale of the datasets, the corresponding analyses were governed by these limitations. Note: Several datasets have been identified to serve as proxies for the various vulnerabilities. The intent is to use these proxies to identify representative, worst-case wildfire risk scenarios for the evacuation/transit analysis.

KEY ASSUMPTIONS

- **Physical Vulnerability Assessment** – Physical vulnerabilty was evaluated based the following existing geospatial datasets: communities at risk, limited access/egress communities, WUI, housing distribution and high value assets. Note: These datasets are intended to only serve as a proxy for the exposure of physical assets in the County to wildfire threats, and where higher concentrations of people and visitors may reside.

- **Social Vulnerability Assessment** – Social vulnerability was evaluated based on the following existing datasets: demographics, locations of high visitor populations and

distribution of access & functional needs. Note: These datasets are intended to only serve as a proxy for social vulnerability, and not a reflection of a full accounting of social, economic and/or other demographic features of the communities in the County.

- **Coping Capacity Vulnerability Assessment** – Coping capacity vulnerabilities was based on a service area analysis of response times from the fire stations across the County. A average travel speed of 31mph was assumed for emergency response vehicles. Note: The service area anslysis was intended to only serve as a proxy for the County's response capacities, and not a reflection of the full extent, breadth and depth of emergency services provided by all government agencies in the County, or that are available from the public, private and civil society sectors.

- **Summary of Data Inputs**
  - Population demographics (e.g., total population, tribal groups/lands, transit dependent population, elderly/child population, non-English speaking population, institutionalized population, high visitor/transient population locations, etc.)
  - CAL FIRE "Communities at Risk"
  - CAL FIRE and Tuolumne County designated vulnerable communities based on access/egress constraints
  - Wildland-Urban Interface from Tuolumne County
  - Housing/building data from the Microsoft Buildings dataset
  - Primary/secondary evacuation routes from Tuolumne County

PHYSICAL VULNERABILITY

COMMUNITIES AT RISK

According to the California Department of Forestry and Fire Protection (CAL FIRE), there are 34 communities within Tuolumne County that are considered "Communities at Risk" (CARs), as listed in the table below and in *Figure 12*.

• Arastraville	• Harden Flat	• Sierra Village No. 1
• Buck Meadows	• Jamestown	• Smith Station
• Bumblebee	• Jupiter	• Sonora
• Chinese Camp	• Kennedy Meadow	• Soulsbyville
• Cold Springs	• Lake Don Pedro	• Standard
• Columbia	• Long Barn	• Stent
• Confidence	• Mather	• Tuolumne City
• Cow Creek	• Mi-Wuk Village	• Tuolumne Rancheria
• Dardanelle	• Moccasin	• Tuttletown
• East Sonora	• Mono Vista	• Twain Harte
• Groveland-Big Oak Flat	• Phoenix Lake-Cedar Ridge	

This designation is based on an evaluation of three main categories of risk: (1) high fuel hazard, (2) probability of a fire, and (3) proximity of intermingled wildland fuels and urban environments that are near wildland fire threats.

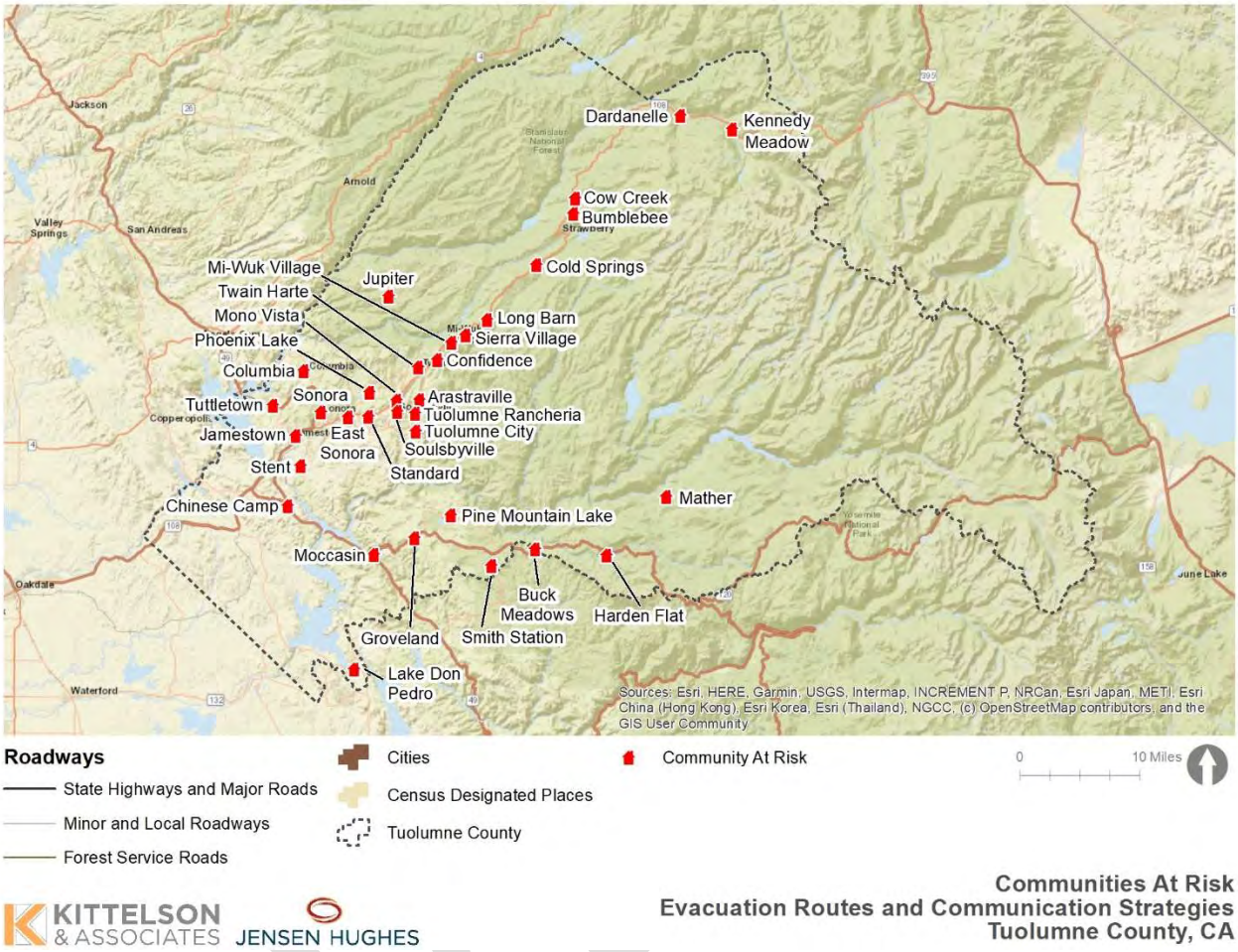


Figure 12 – Communities-at-risk (point data)

Communities and neighborhoods at risk can also be evaluated based on the physical relationship of structures to fuel loads. The wildland-urban-interface (WUI) is defined by the USFS as a place where "humans and their development meet or intermix with wildland fuel". This typically includes communities that are within 0.5 miles of the WUI. WUI is oftentimes divided into two categories: (1) Intermix – Lands that contain at least one housing unit per 40 acres, in which vegetation occupies more than 50% of terrestrial area; and (2) Interface – Land that contain at least one housing unit per 40 acres, in which vegetation occupies less than 50% of terrestrial area. *Figure 13* illustrates the WUI (both intermix and interface) across the County.

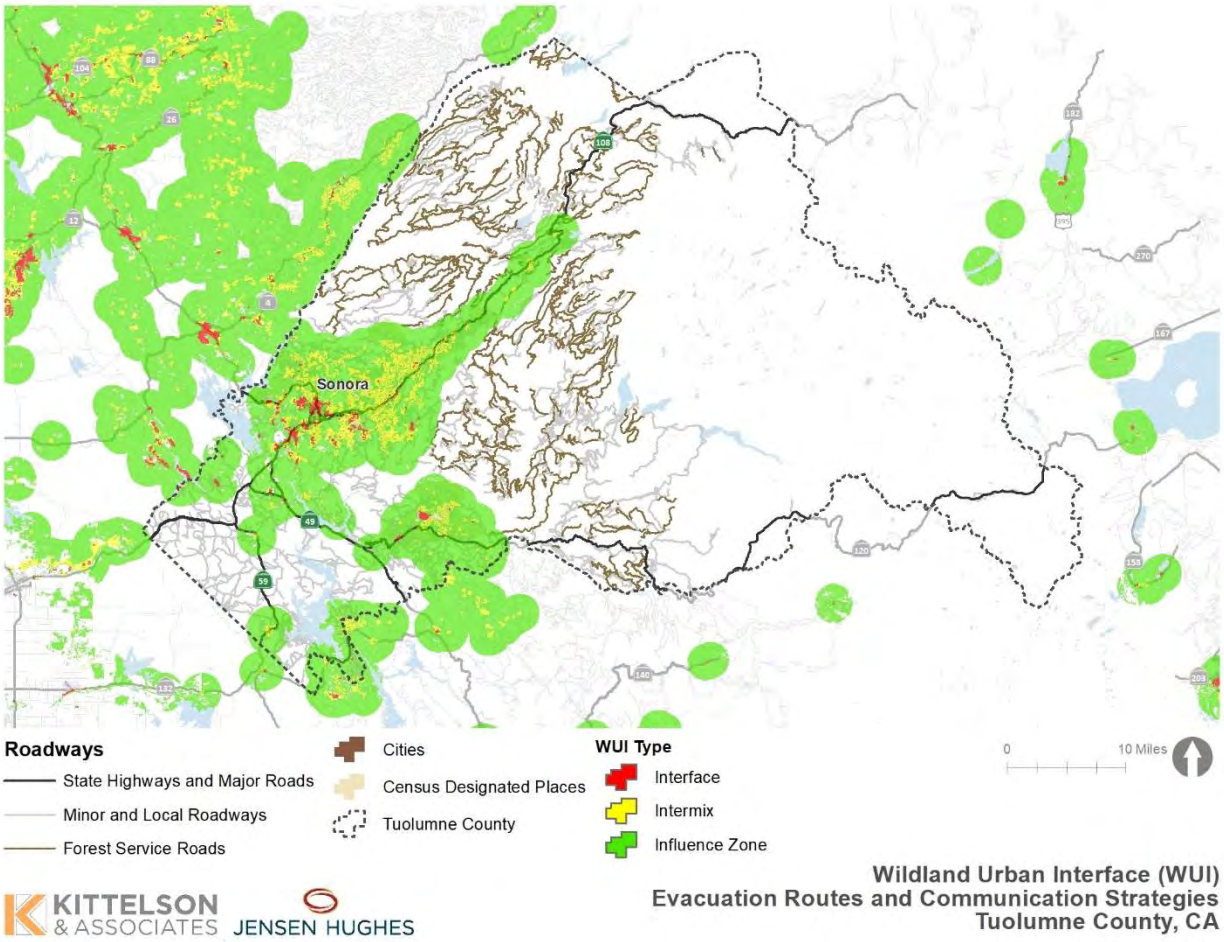


Figure 13 – WUI Map

LIMITED ACCESS/EGRESS COMMUNITIES

Many neighborhoods in the County have limited options for egress with many residences having only a single primary egress route (e.g., Black Jack Bluffs, Cedar Ridge, Apple Colony Road), as shown in *Figure 14*. These "vulnerable" communities are determined via CAL FIRE's Subdivision Review Program with additional communities added by the County.

The existing residential road system is often narrow, creating a potential conflict between incoming emergency equipment and evacuating residents. Many of the structures located along these roads are intermixed with wildland and ornamental fuels and have limited defensible space. These conditions, along with the higher concentrations of residents in these areas, can result in roadways that may become congested from evacuation traffic and incoming emergency response personnel.

There are a total of 22 communities identified by CAL FIRE and Tuolumne County as having limited access/egress.

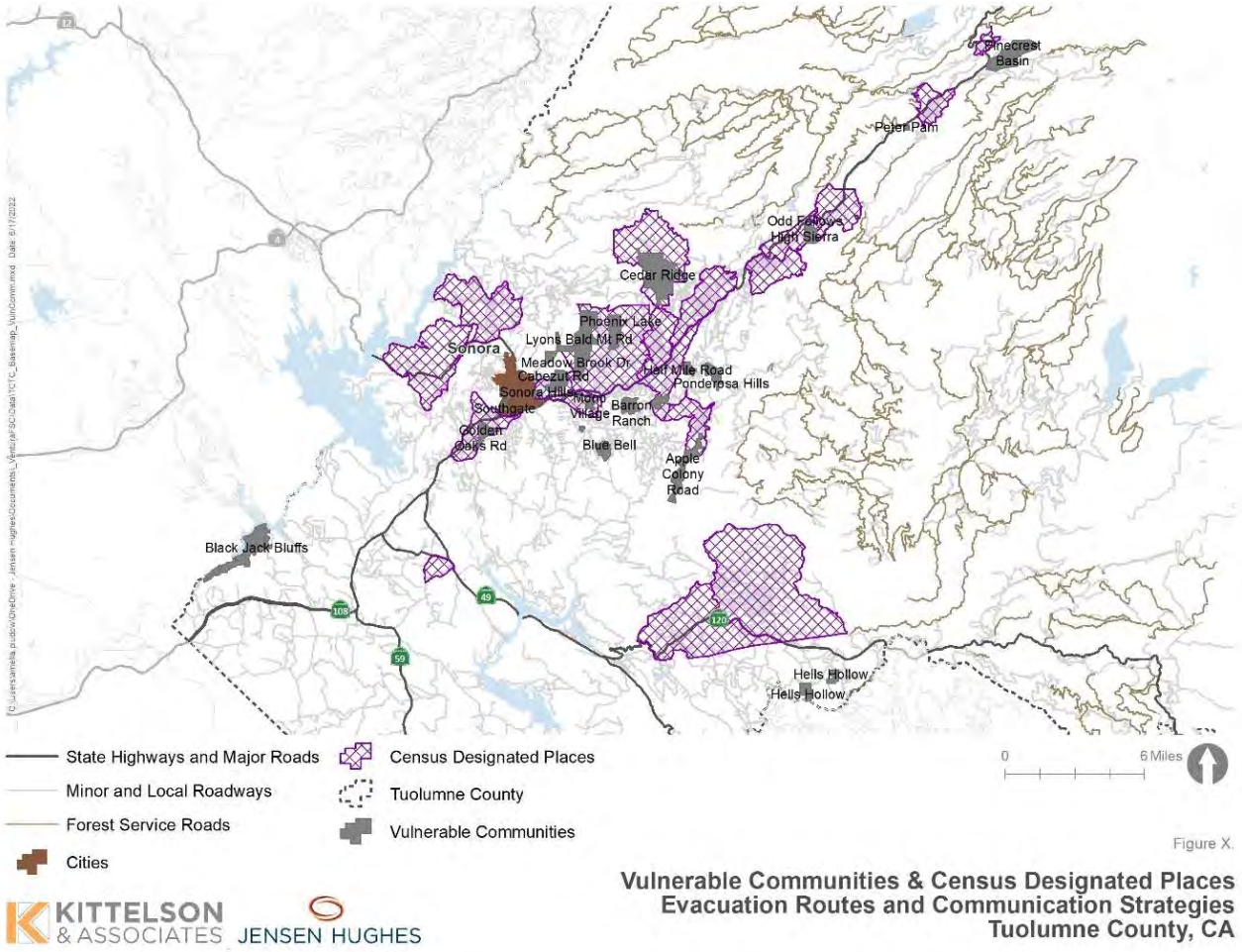


Figure 14 – Limited access/egress communities (grey polygons)

HOUSING

Most housing across the County consists of single-family detached homes on parcels of varying sizes and topographic conditions. Single family homes comprise about 89% of all residential dwellings. As of 2020, the County has an estimated population of 54,039, with the majority of housing density around the City of Sonora, along the Highway 108 corridor and Groveland. See *Figure 15*.

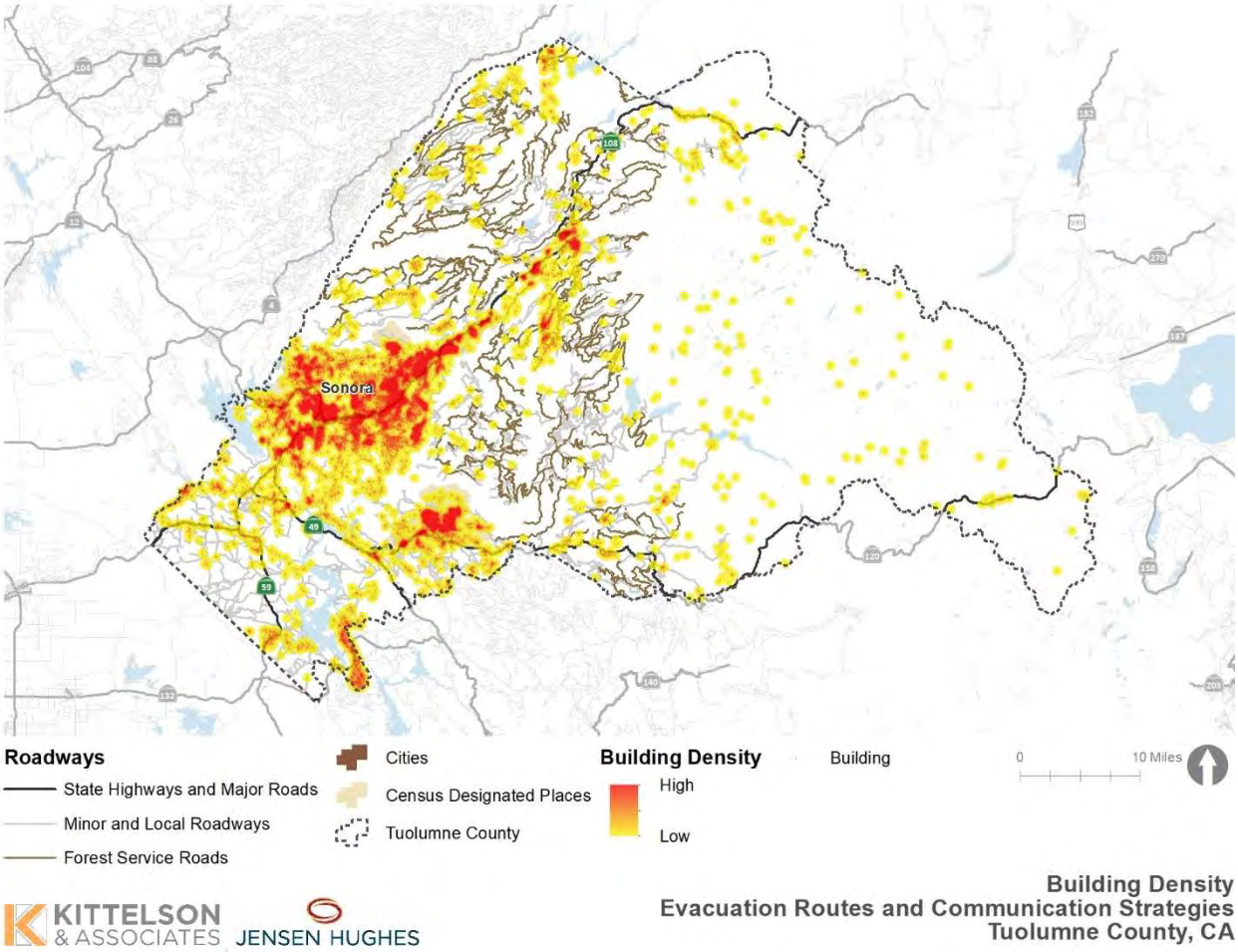


Figure 15 – Housing Density in Tuolumne County

COMMUNITY FACILITIES AND INFRASTRUCTURE

Wildfires can cause significant damage to high-value community facilities and lifeline infrastructure leading to a potential long-term disruption of public services. Electrical services, water facilities, wastewater treatment, transportation networks and police/fire stations comprise just part of the overall critical infrastructure. These major facilities and infrastructure are priority locations for hazard reduction and wildfire hardening projects.

Figure 16 through *Figure 18* depicts community facilities and critical infrastructure in the County.

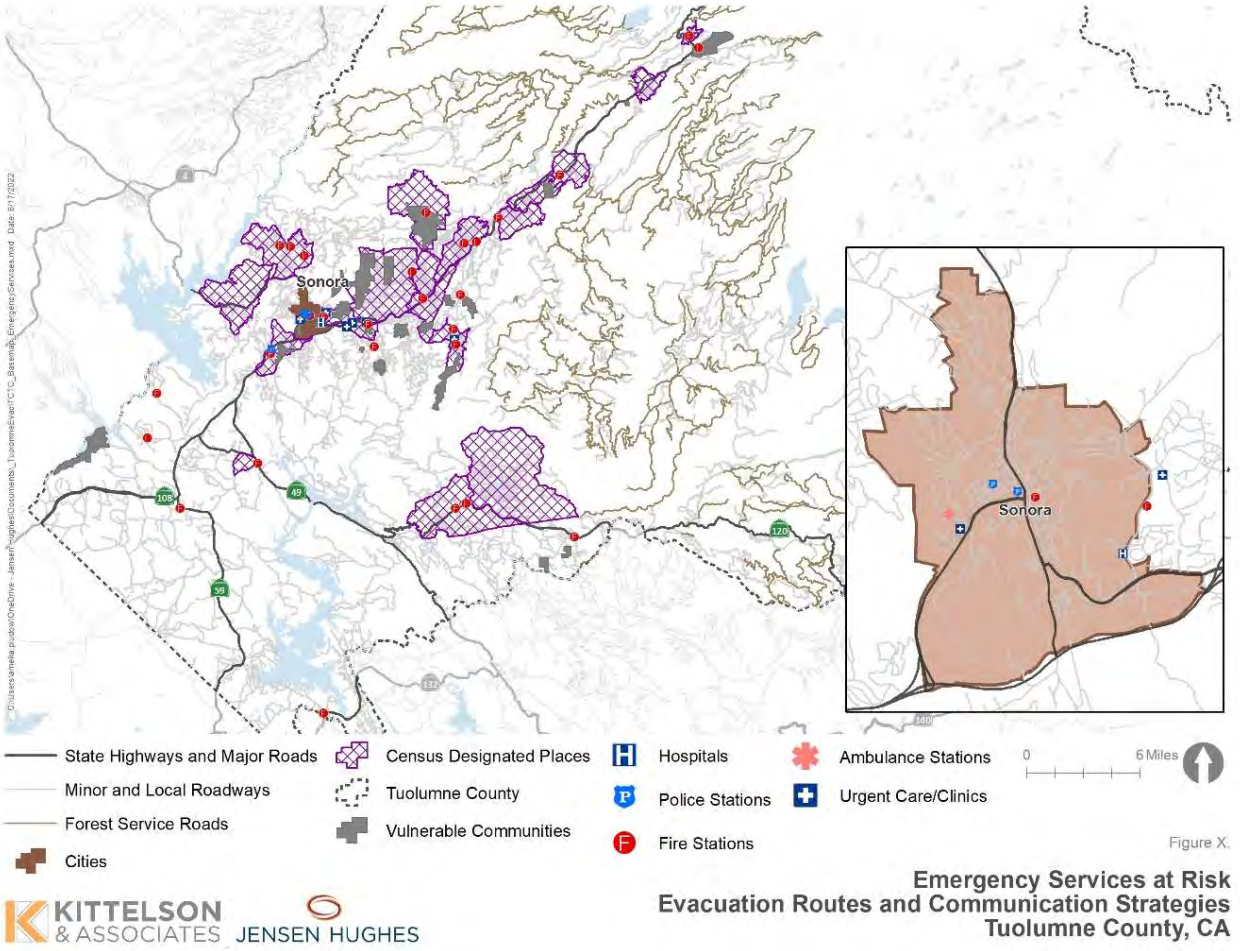


Figure 16 – Community Emergency Facilities at Risk

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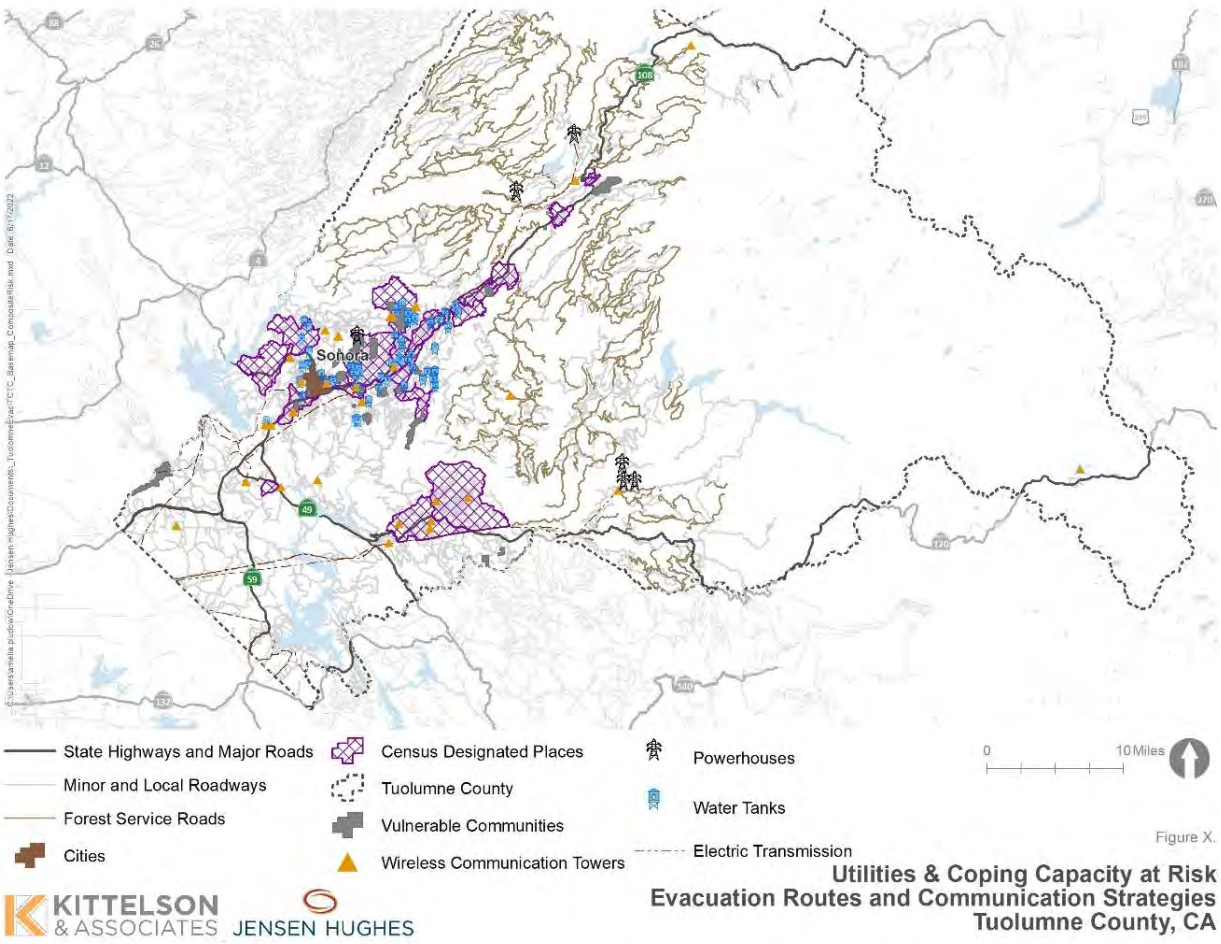


Figure 17 – Critical Infrastructure at Risk

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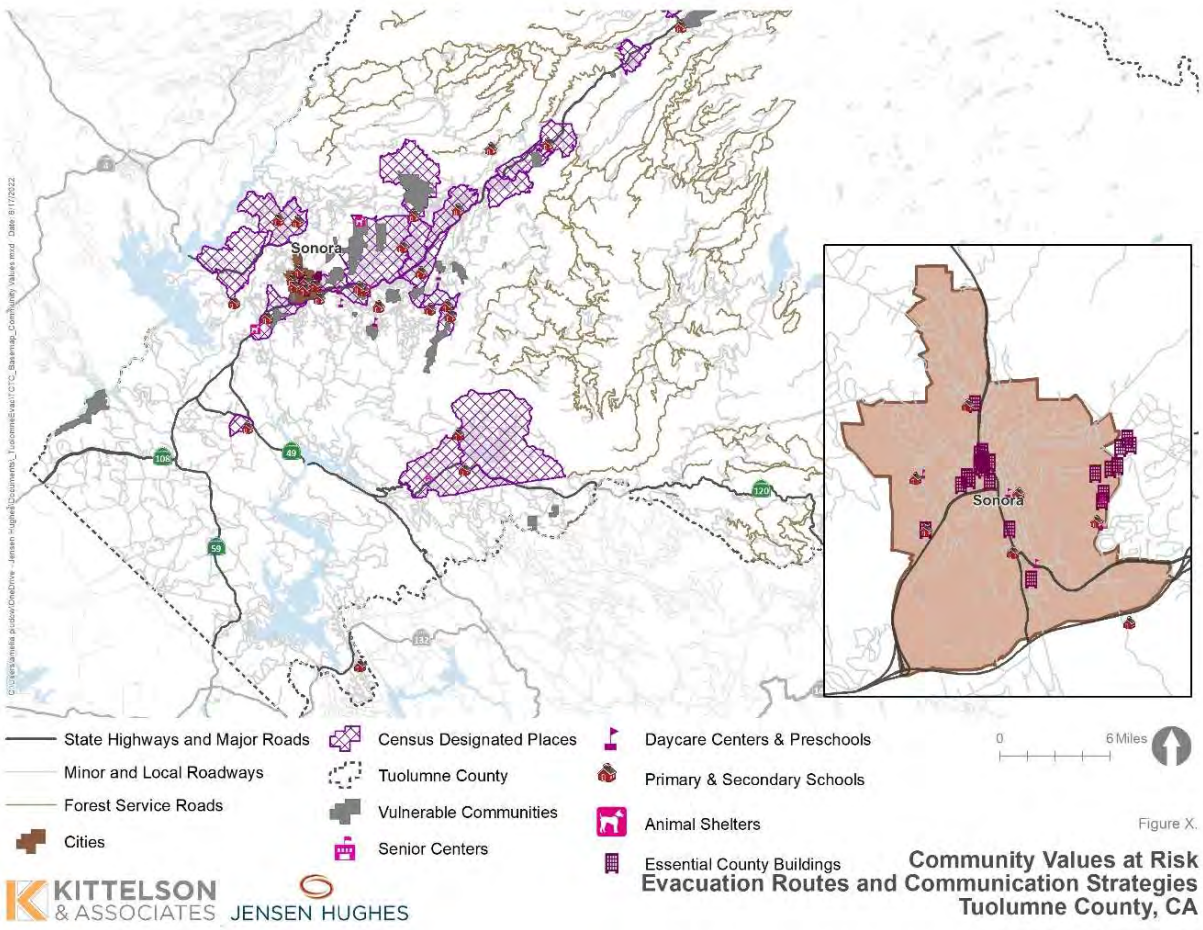


Figure 18 – Other Community Facilities at Risk

SOCIAL VULNERABILITY

Tuolumne County has a population of roughly 55,620 according to the 2020 U.S. Census, with the addition of 100,000s of visitors per month during peak tourism season (e.g., summer). The majority of the population is located in and around the City of Sonora, along the Highway 108 and 49 corridors, with pockets of people near Groveland off Highway 120. However, there can be large number of visitors and vacationers farther east along the Highway 120 corridor, particularly in the Pinecrest area. See *Figure 19*.

While the population of permanent residents may be relatively limited, the influx of large numbers of visitors and other vacationers can further exacerbate the already limited transit infrastructure during emergency (e.g., wildfire incident) and non-emergency periods. The primary access/egress routes are limited by the rugged terrain of the Sierras and associated foothills. This can present several challenges during a major wildfire event, not only for firefighters and other first responders performing emergency services, but also for residents and visitors evacuating or seeking refuge. The difficult terrain can also present emergency communication challenges for first responders, residents and visiting populations.

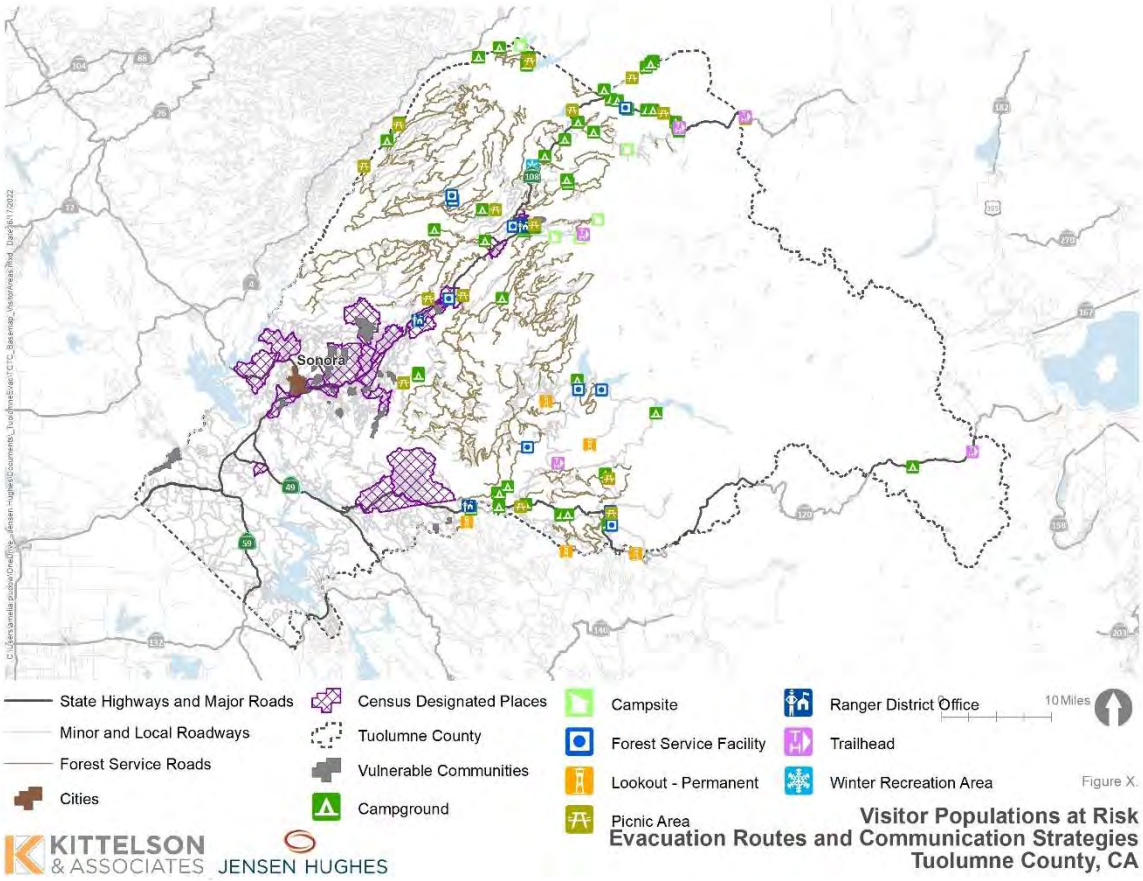


Figure 19 – Distribution of Visitor Populations at Campgrounds and Other Points of Interest

Vulnerable or functional-needs populations may have limited capacities to prepare for, respond to, and/or recover from a major wildfire incident, and are also less likely to get involved in wildfire mitigation activities (Ojerio, 2008). Key demographic and other population statistics for Tuolumne County from the 2020 United States Census (U.S. Census Bureau, http://data.census.gov) were assessed to identify potential vulnerable populations. This data was as follows:

- An estimated 7.7% of the population speaks a language other than English at home
- Approximately 58% of the population have not received a college education
- Approximately 20% of population have some form of disability (i.e., hearing difficulty at 7.0%, vision difficulty at 3.3%, cognitive difficulty at 9.1%, ambulatory difficulty at 9.8%, self-care difficulty at 2.8% and independent living difficulty at 7.6%).
- Vulnerable age groups: 4.4% of population under 5 years; 26.1% of population 65 years and older
- Poverty: 11% of the population live below the poverty line

The statistics for Tuolumne County suggest that a significant segment of the population may have a range of vulnerabilities in preparing, responding to and/or recovering from a wildfire incident that impacts the City. Age, along with physical and mental restrictions can potentially reduce these individual's capacities to efficiently self-evacuate in a disaster. Limited access to financial resources may also hinder the ability for lower-income populations to invest in emergency preparedness, mitigation measures, as well as recover from losses. Language barriers (particularly day-laborers as observed in recent wildfires) can present major barriers to

effectively communicating the need for emergency notifications, evacuation instructions, and/or support services. In addition, visitors to the County can be particularly vulnerable to wildfire incidents, as they are less likely to be familiar with the risks of wildfires, local response management practices, emergency resources, public communication channels and other support services. Planning for vulnerable or functional-needs populations is critical to providing a holistic wildfire mitigation preparedness plan that works for the "whole" community.

COPING CAPACITY VULNERABILITY

The ability of local government and residents to respond to and recovery from wildfire threats is another central component to understanding the risks that wildfires and other hazards present to the County. A service area analysis of response times from the 27 fire stations across the County has been performed as a proxy for the County's coping capacities. *Figure 20* illustrates the results of the response time analysis. As can be seen in the figure, the majority of the fire stations and associated response times cover the Census Designated Places (CDPs), with some locations requiring longer response times. However, a large portion of the County is remote and far from timely first responder coverage. While this may not be an immediate life safety concern, as populations are lower in those areas, it can mean that a wildfire originating in these locations may go unsuppressed for longer periods of time, resulting in larger wildfire incidents.

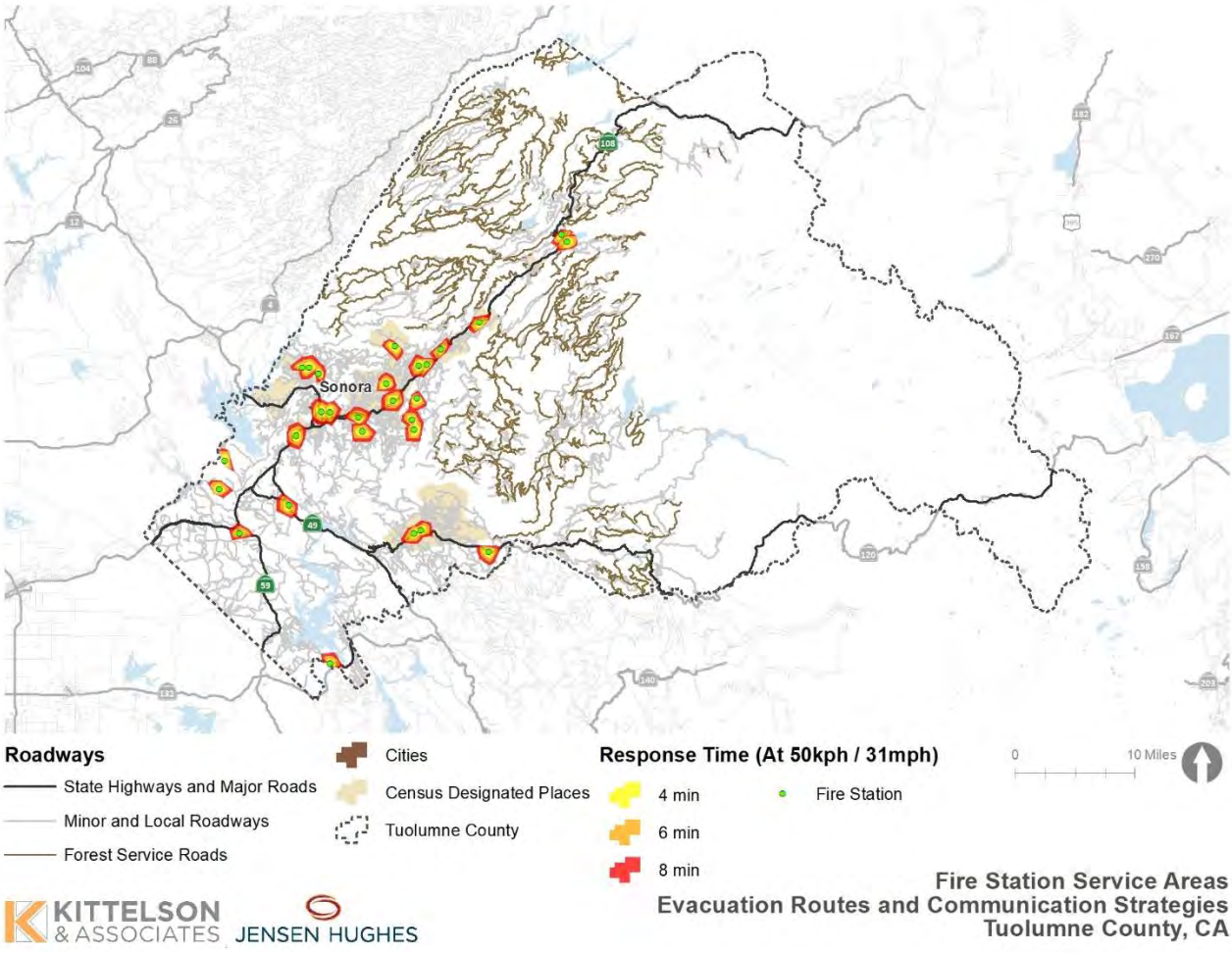


Figure 20 – Firefighter Response Time Capacity

DESIGN FIRE SCENARIOS

Given the results of the fire hazard and vulnerability analyses presented above, this section presents the design basis wildfire fire scenarios as agreed by the Project Development Team (PDT) for the evacuation/transit analysis. The wildfire scenarios are based on a comprehensive evaluation of wildfire risk (i.e., fire hazard, potential impact to community assets and values, and vulnerabilities) to select a set of representative worst-case incidents. In addition to serving as input into the evacuation analysis, the wildfire scenarios and wildfire behavior modelling are also used to identify potential mitigation measures to help improve evacuation planning and wildfire resiliency for the transportation system. Note: Recommendations for mitigations measures are pending completion of the evacuation/transit analysis.

KEY ASSUMPTIONS

- **Comprehensive Risk Assessment** – To identify and priortize representative, worst-case wildfire scenarios (i.e., 5-8 scenarios) for the evacuation analysis, an evaluation of the results of the fire hazard and vulnerabiltiy analyses was performed. The intent is to understand wildfire risk more comprehensively using the following components:

  (1) Review historical wildfire history (e.g., ignition history, location, extent, severity)

  (2) Review wildfire environmental settings (i.e., climate, weather, topography, vegetation)

  (3) Review physical, social and coping capacity vulnerabilities geospatially

  (4) Review results of preliminary wildfire behavior analysis of seventeen (17) ignition locations for a range of burn periods.

  (5) Qualitatively evaluate Items (1)-(4) collectively to select 5-8 representative, worst-case design fire scenarios, based on the following criteria:

    - Fires with a higher likelihood of ignition, spread and severity
    - Fires that represent scenarios across the county and which potentially impact multiple evacuation analysis subareas
    - Fires with the potential to impact multiple vulnerable communities, based on limited access/egress (per CALFIRE) or non-permanent residents (e.g., visitors, vacationers)
    - Fires with the potential to impact large populations
    - Fires with the potential to physically impact roadways

- **Design Fire Scenarios** – Based on the results of the comprehensive risk assessment and input from the local fire chiefs and the PDT, six (6) fire scenarios were selected as worst-case, representative for the evacuation/transit analysis. The six fire scenearios were modeled (based on the local vegetative cover/fuel models, topography and output from the weather analysis presented earlier) using FlamMap to determine the minimum travel times across the landscape given a 72-hour burn period.

- **Summary of Data Inputs**

  - Weather – 97th percentile conditions. Refer to the weather analysis presented earlier
  - Fuel Models per LANDFIRE – 40 Scott and Burgan Fire Behavior Fuel Models (FBFM40)
  - Topography per LANDFIRE

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COMPREHENSIVE RISK

Figure 21 illustrates a range of maps with multiple overlays of various wildfire hazard, risk and vulnerability perspectives based on the results of the fire hazard and vulnerabilities analyses presented earlier. Based on a qualitative evaluation of these "comprehensive" maps, six design fire scenarios were identified and agreed with the local fire chiefs and PDT, as input into the evacuation/transit analysis.

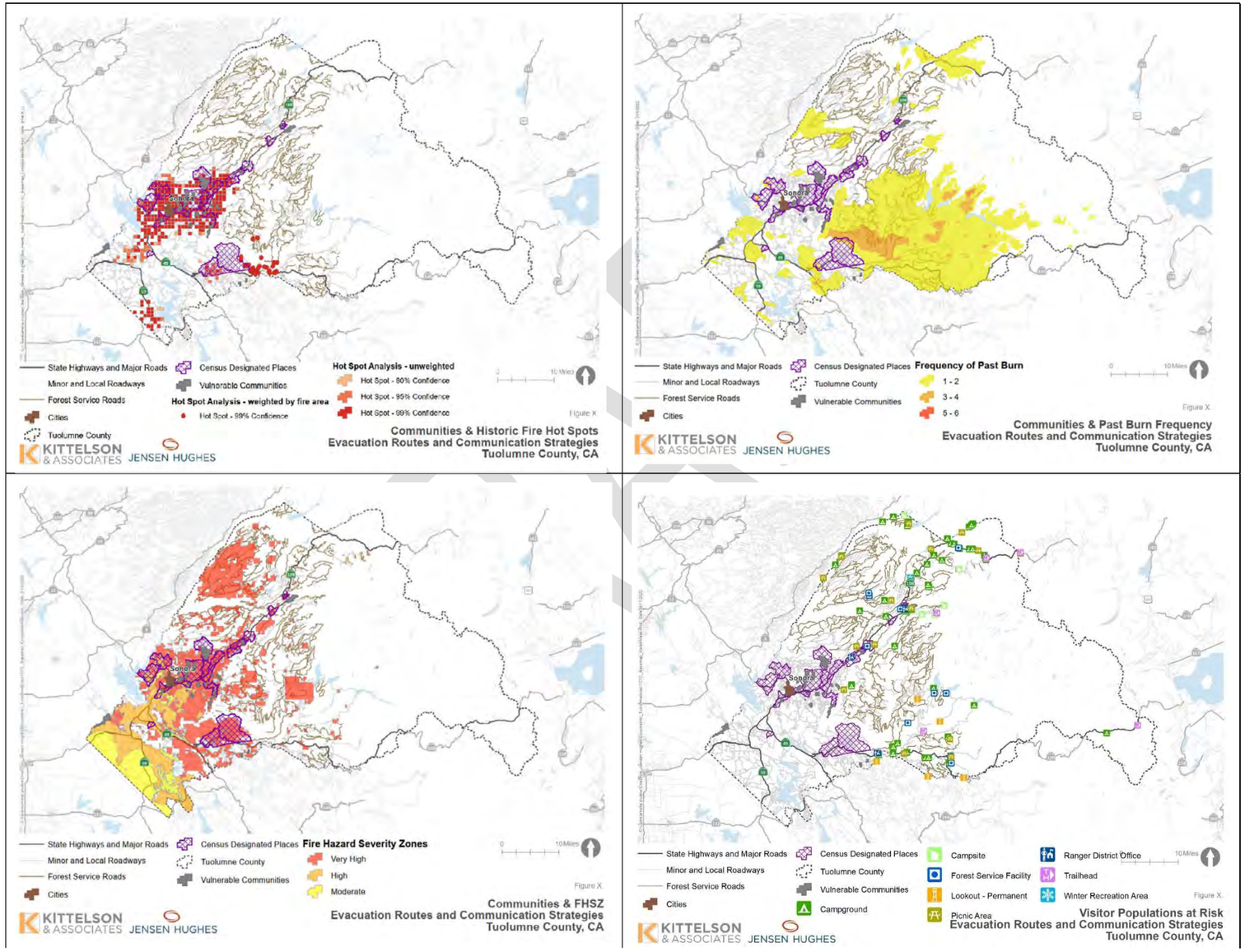


Figure 21 - Comprehensive Evaluation of Wildfire Risk; (top left) – Highest probability of ignition with populated areas; (top right) – Highest fire frequency with populated areas; (bottom left) – Highest severity fires with population (bottom right)- Distribution of residents and visitor locations

Figure 22 shows the six (6) design fire scenarios identified as representative, worst-case wildfire ignition points for the evaluation analysis, based on the comprehensive evaluation of the fire hazard and vulnerability analyses. The six fire ignition points were discussed and agreed upon with the local fire chiefs and PDT.

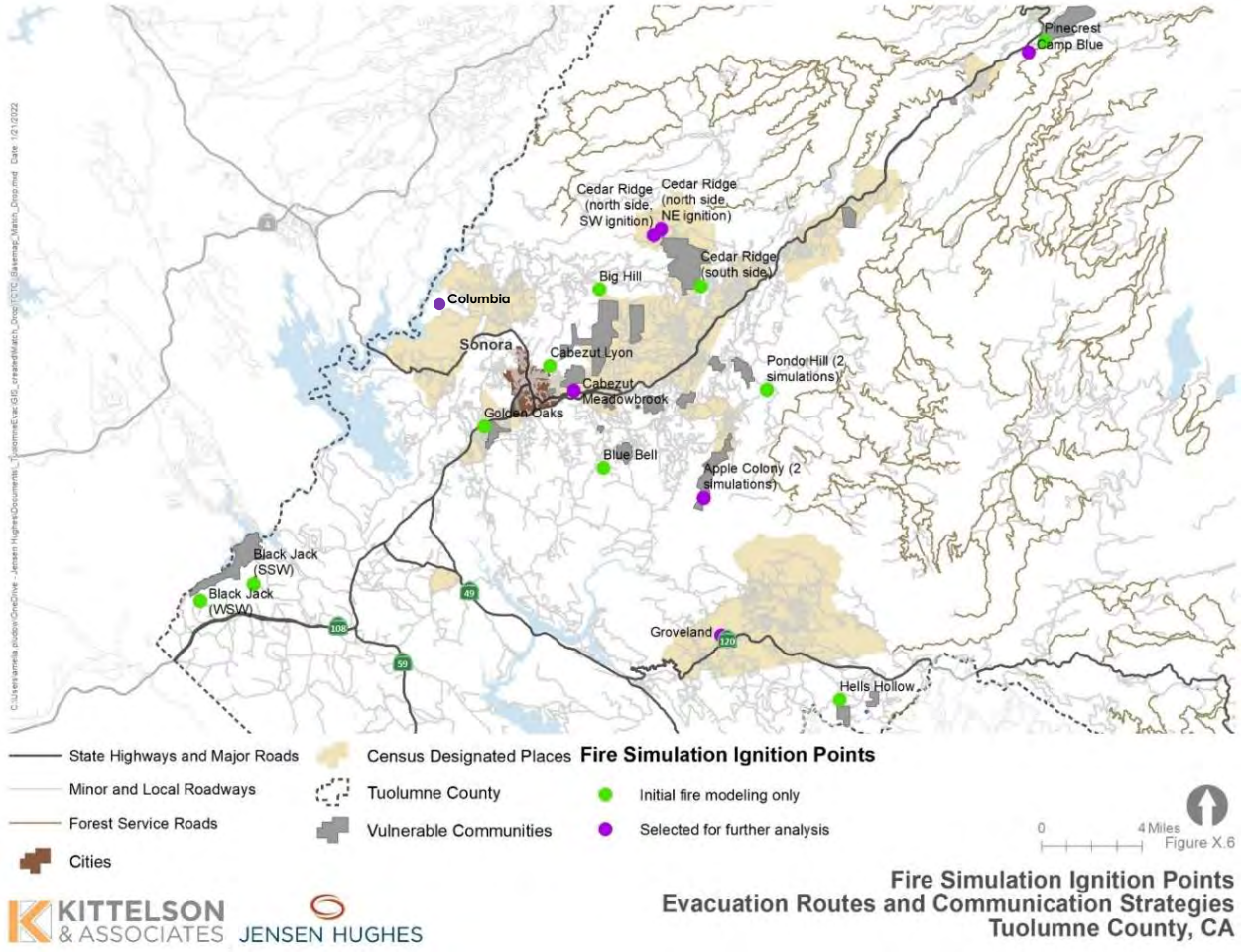


*Figure 22 – Design Fire Scenario Ignition Points **in purple**; Preliminary ignition points **in green**.*

DESIGN FIRE SCENARIOS

Based on the comprehensive wildfire risk assessment, six representative, worst-case wildfire scenarios were developed to inform the evacuation/transit modeling. The six scenarios are as follows:

1. Cedar Ridge Fire
2. Cabezut Ridge Fire
3. Apply Colony Fire
4. Groveland Fire
5. Camp Blue Fire
6. Columbia Fire

For each scenario, a fire simulation model in FlamMap was performed using the Minimum Travel Time (MTT) function to characterize the size and the time required for fire to travel from the

ignition source to a particular point on the landscape. The arrival times are then used in the transportation model to inform the analyst when and where a modeled fire perimeter impacts a community and its associated transit network.

RESULTS

CEDAR RIDGE FIRE SCENARIO #1

This fire scenario incorporates two ignitions at a ridgetop that are pushed downhill into developed areas. See *Figure 23* below for fire arrival times.

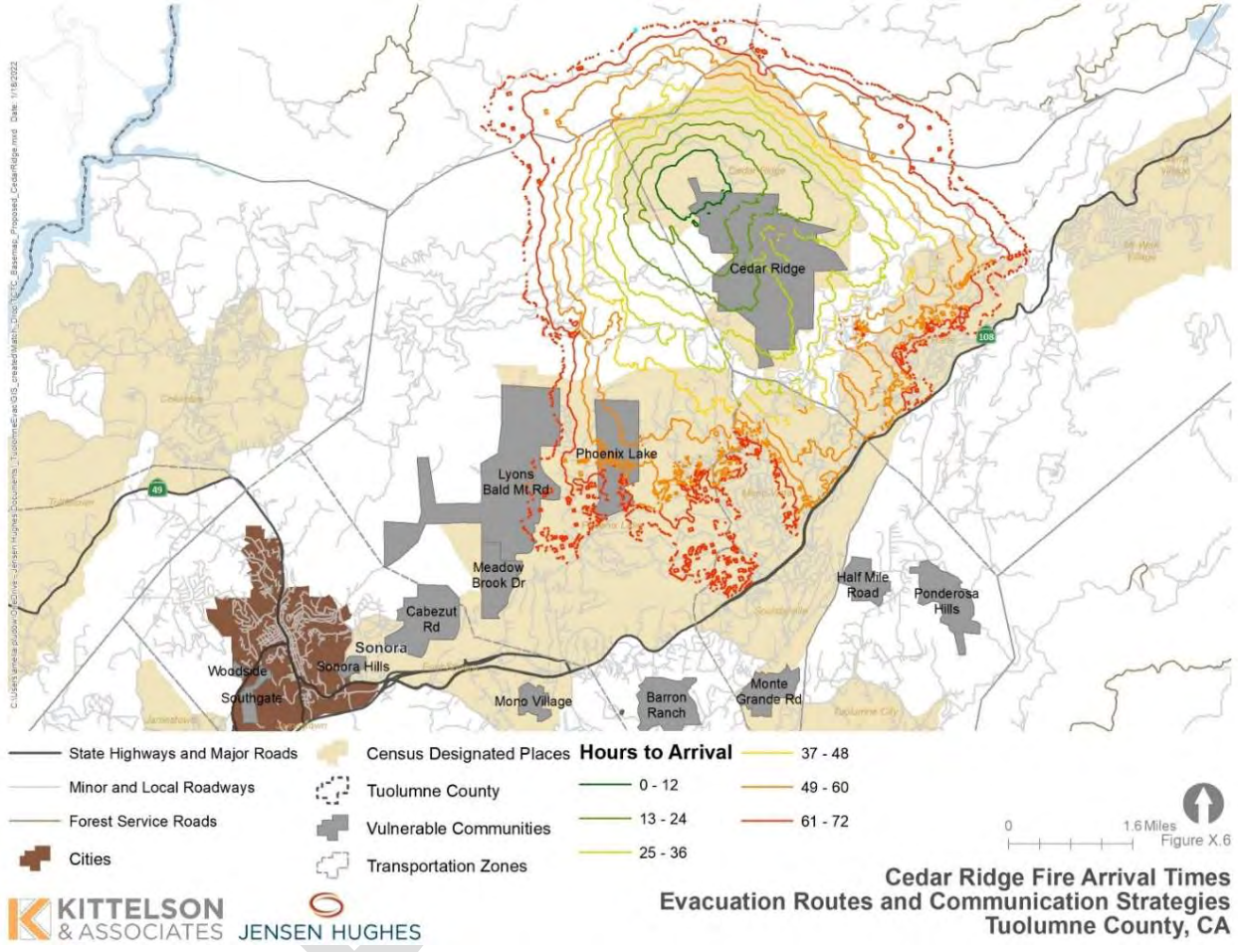


Figure 23 – Cedar Ridge Fire Scenario Arrival Times

Historically, this area of the County has had high ignition likelihood, which can be assumed to continue in the future due to proximity to human development. A fire in this area could potentially impact multiple vulnerable communities including Cedar Ridge, Phoenix Lake, Lyons Bald Mt. Rd., and Meadow Brook Dr.

CABEZUT FIRE SCENARIO #2

This fire scenario incorporates a single ignition point off Cabezut Road, which results in fire spreading north, northeast and into Sonora. See *Figure* ***24*** below for fire arrival times.

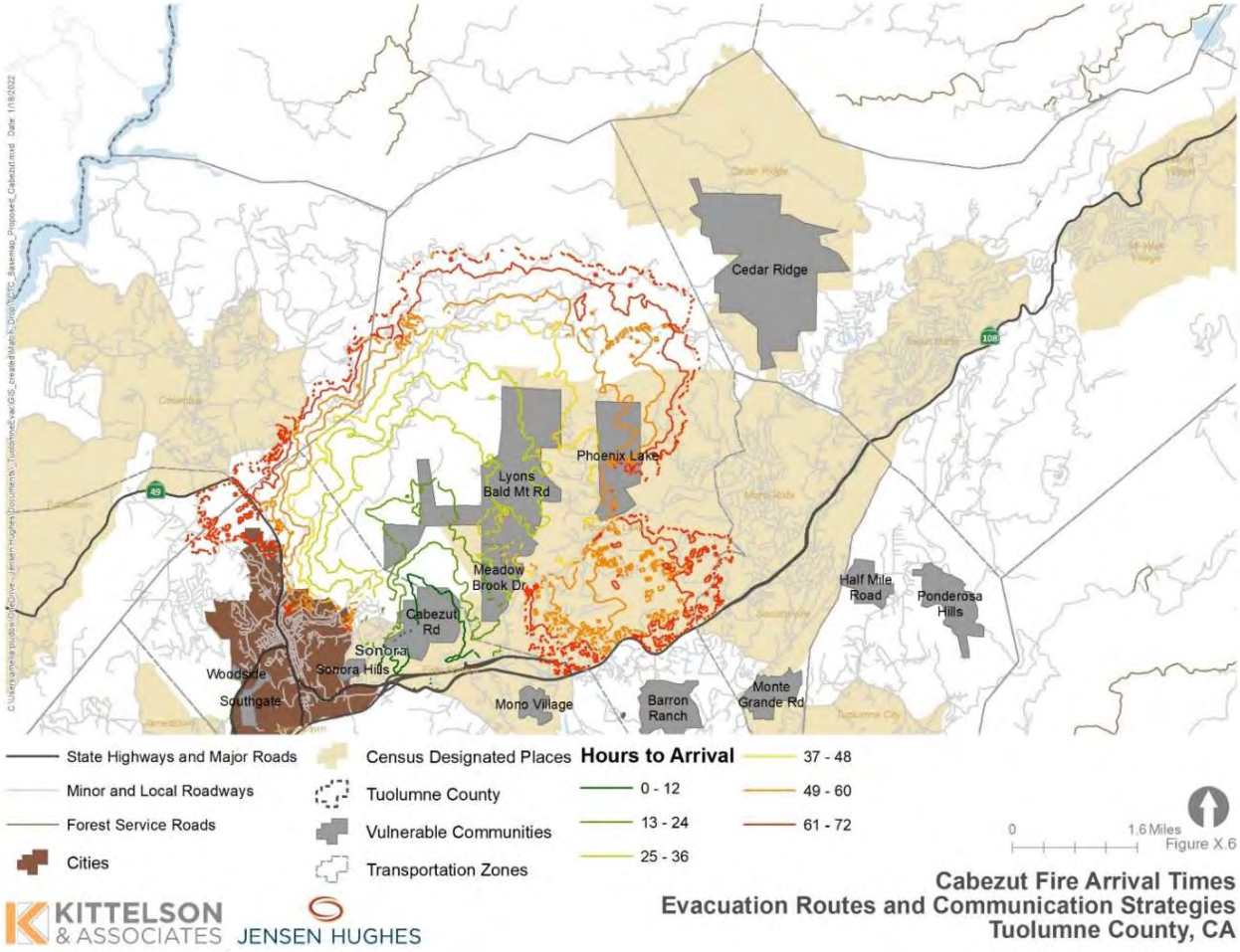


Figure 24 – Cabezut Fire Scenario Arrival Times

Historically, this area of the County has had high ignition likelihood, which can be assumed to continue in the future due to human development. A fire in this area could potentially impact several vulnerable communities, including Cabezut Rd, Meadow Brook Dr., Lyons Bald Mt. Rd., and Phoenix Lake. It is also likely that this scenario would have a significant impact on the center of Sonora, CA.

APPLE COLONY FIRE SCENARIO#3

This scenario models a wind-driven canyon fire. This fire type has historically been difficult to control in Tuolumne County due to access and fire behavior. See *Figure* ***25*** below for fire arrival times.

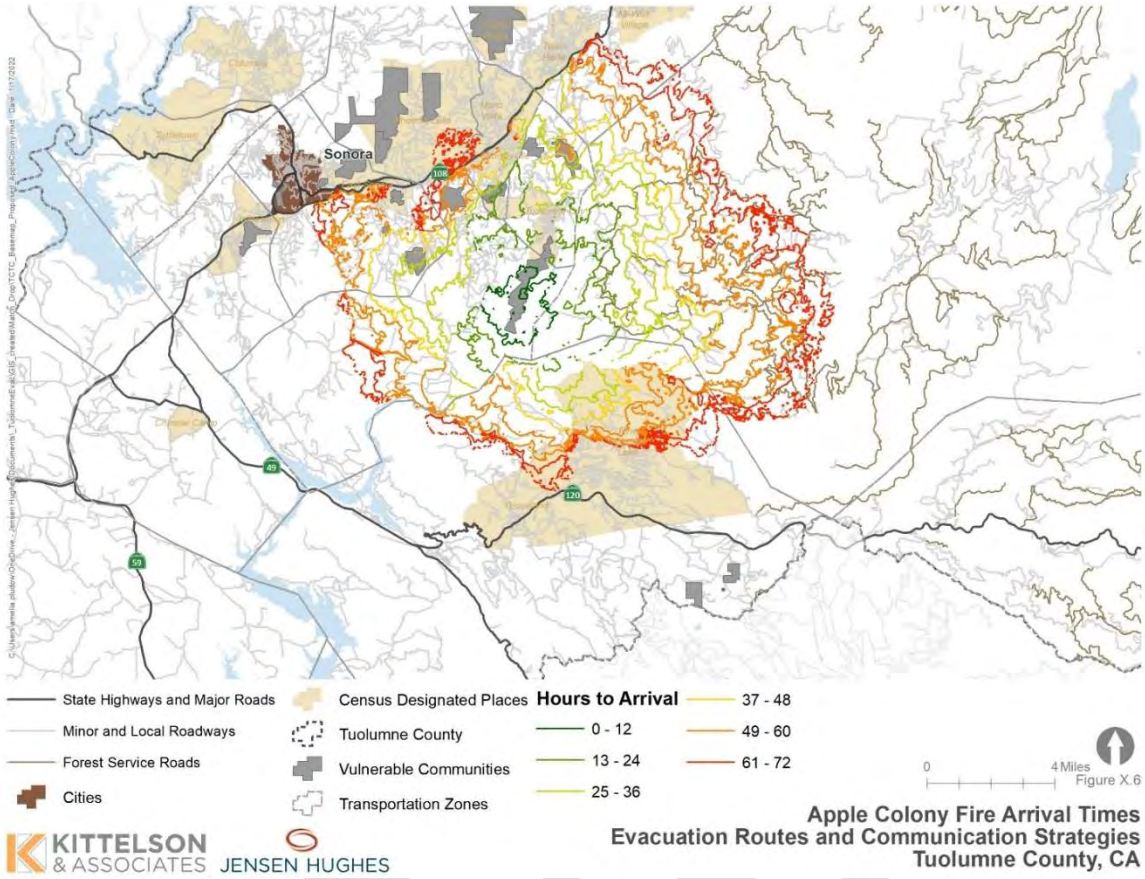


Figure 25 – Apple Colony Fire Scenario Arrival Times

Historically, this area of the County has had high ignition likelihood, which can be assumed to continue in the future due to human development. A fire in this area could potentially impact several vulnerable communities including Apple Colony Rd., Blue Bell, Lambert Lake, Mono Village, Barron Ranch, Monte Grande Rd., Half Mile Rd., and Ponderosa Hills.

GROVELAND FIRE SCENARIO #4

This fire scenario incorporates a single ignition point off Highway 120 in Groveland, which results in rapid fire spread primarily north and northeast. See *Figure* **26** below for fire arrival times.

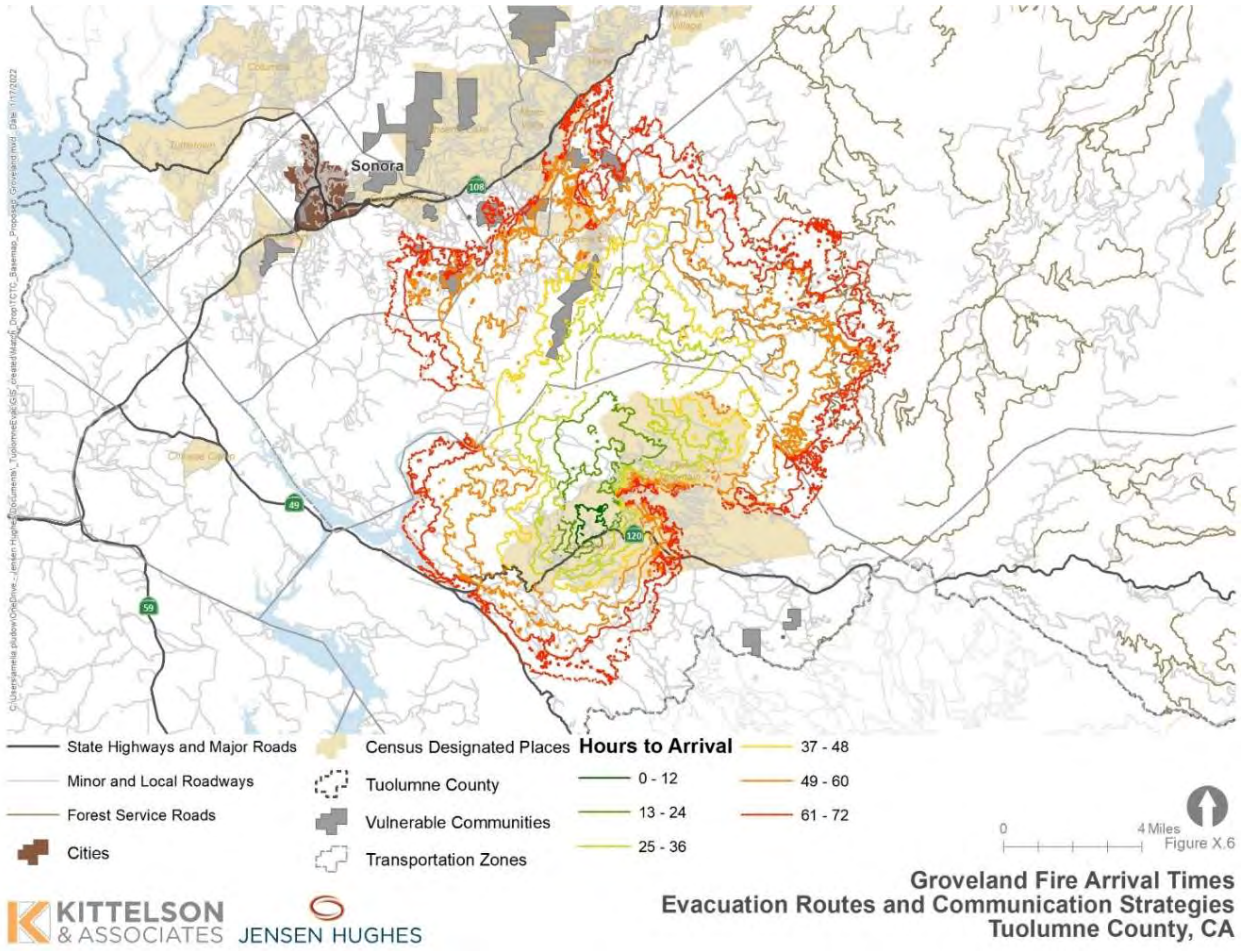


Figure 26 – Groveland Fire Scenario Arrival Times

Historically, this area of the County has had high ignition likelihood, which can be assumed to continue in the future due to human development. Groveland has been evacuated multiple times in the last two decades. A fire in this area would impact several vulnerable communities including Apple Colony Rd., Blue Bell, Lambert Lake, Barron Ranch, Monte Grande Rd., Half Mile Rd., and Ponderosa Hills.

CAMP BLUE FIRE SCENARIO#5

This scenario models a single ignition point starting in a recreational camping area along the eastern part of the Highway 108 corridor and shares many similarities with the historic reality of the 2018 Donnel Fire. See *Figure* **27** below for fire arrival times.

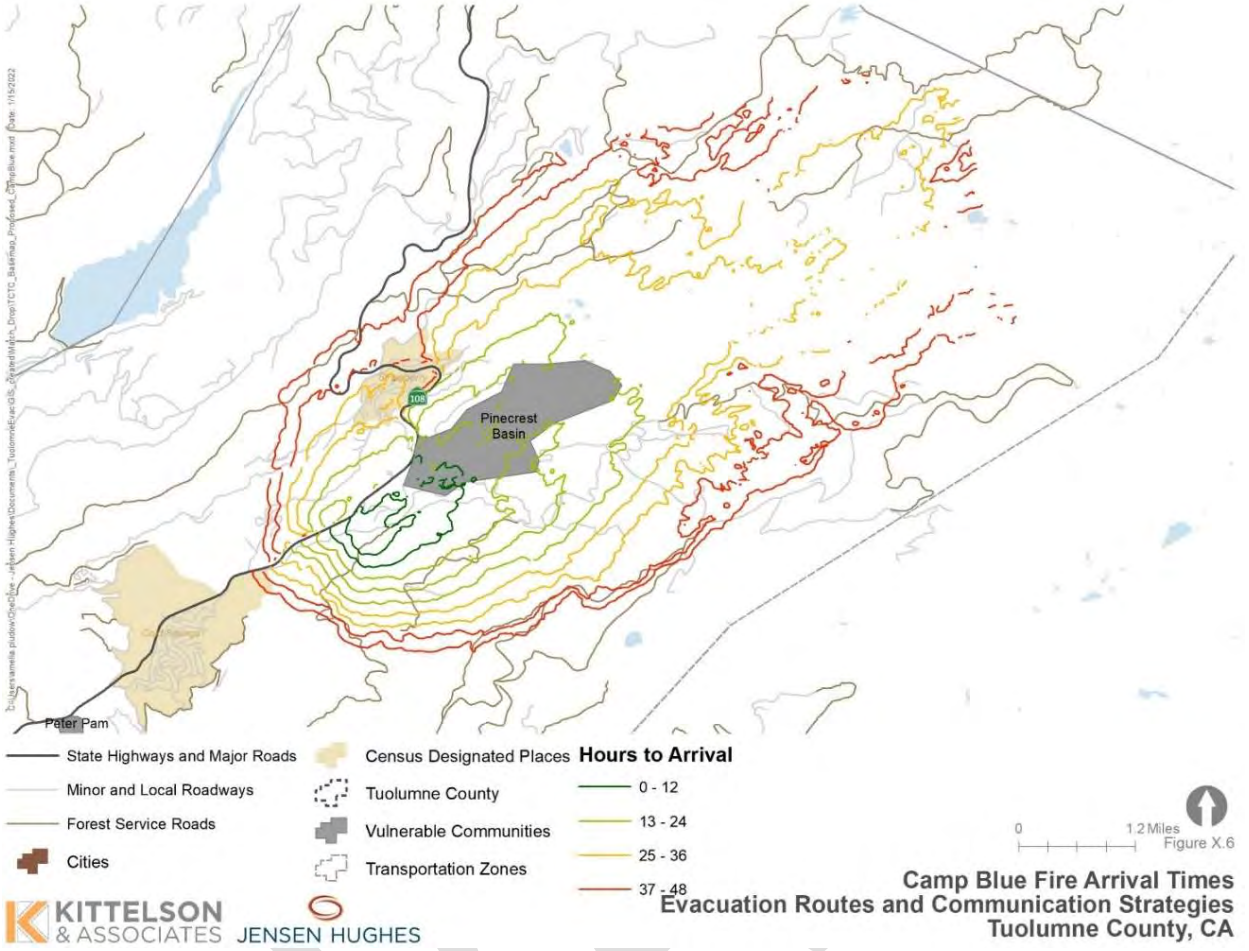


Figure 27 – Camp Blue Fire Scenario Arrival Times

A fire in this area would impact the vulnerable community of Pinecrest Basin. This area has a high density of second homes and recreational use. This leads to an evacuation challenge because of individuals unfamiliar with transportation routes and other emergency services.

COLUMBIA FIRE SCENARIO #6

This scenario models a fire in the Columbia area coming out of the river canyon. See *Figure 28* below for fire arrival times.

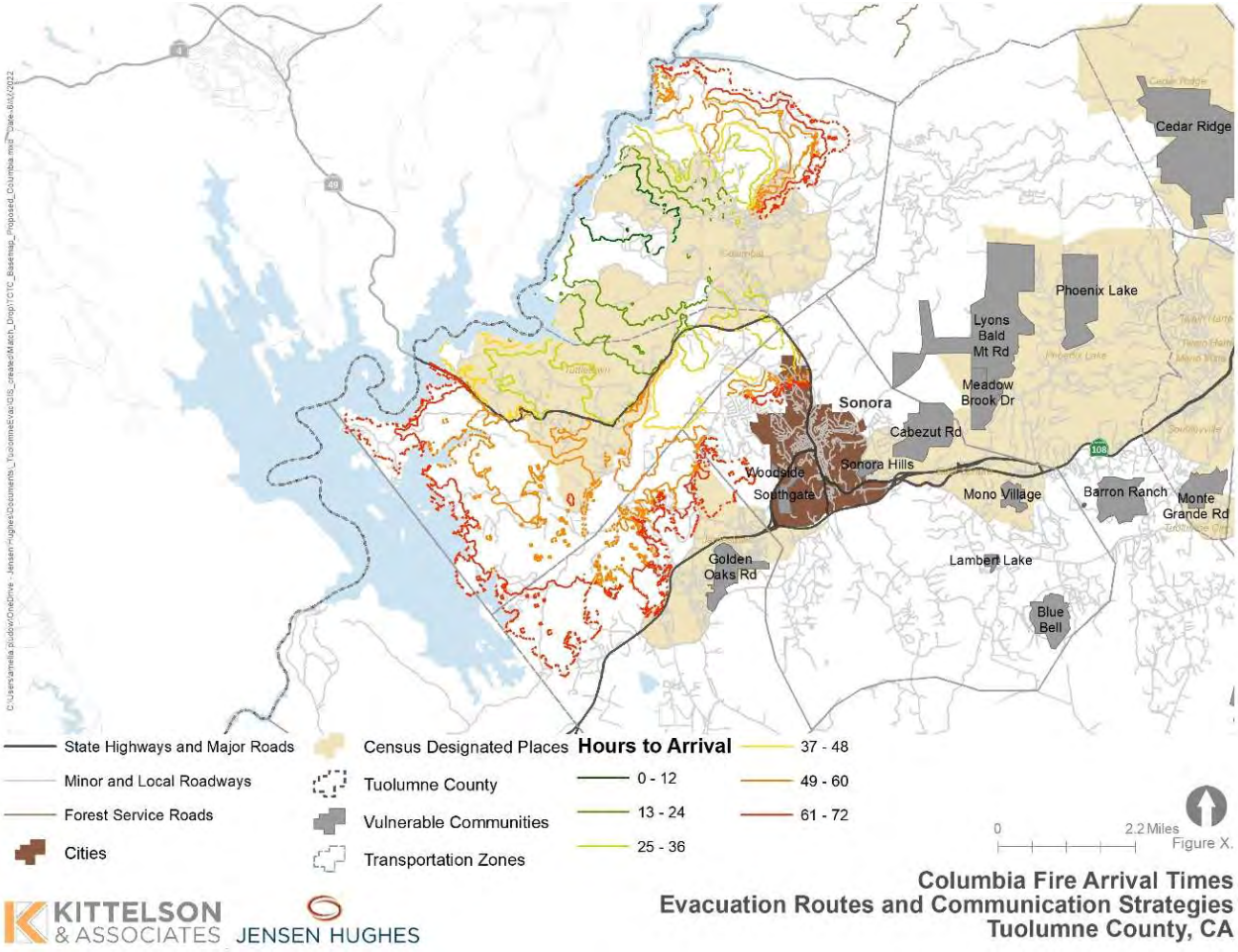


Figure 28 – Columbia Fire Scenario Arrival Times

Historically, this area of the County has had high ignition likelihood, which can be assumed to continue in the future due to human development. A fire in this area would impact the Census Designated Places of Columbia and Tuttletown, as well as the City of Sonora.

Appendix C: Identification of Roadway Network Deficiencies

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2510 J Street, Suite 200
Sacramento, CA 95816

JENSEN HUGHES

TECHNICAL MEMORANDUM

January 21, 2023

Project# 25492

To: Darin Grossi, Dore Bietz, Shannon Thaggard

From: Grace Carsky, Alex Garbier, Matt Braughton, RSP, Mike Aronson, PE, Darlene Rini, and Amelia Pludow

Project TCTC Evacuation Routes and Communication Strategies

RE: Task 3: Identification of Roadway Network Deficiencies

INTRODUCTION

This memorandum presents the fire scenario evacuation results of seven modeled fire scenarios for Tuolumne County. The analyses were conducted to help identify locations where there is a greater potential for traffic congestion in the event of an evacuation. These include locations identified as having congestion during a modeled evacuation scenario, as well as locations with similar characteristics.

The document is organized into three sections:

1. The first section describes the roadway network and baseline conditions;
2. The second describes how the evacuation scenarios were conducted and evaluated; and,
3. The final section reports findings from the seven evacuation scenarios, including locations where congestion might occur.

LIMITATIONS

The results of the memo are intended to show potential locations of congestion based on a subset of possible fire scenarios. The scenarios were developed based on assumptions and modeling techniques that reflect current understanding for evacuations and wildfire modeling. These scenarios are intended to model a potential range of evacuations and wildfires but not all possible scenarios. Actual wildfire and evacuation events will vary based on a variety of factors. As a result, the identified wildfires and evacuation constraints represent informed estimates of the most likely potential wildfire footprints and capacity constraints based on available data, but not all possible fire and evacuation scenarios.

ROADWAY NETWORK & BASELINE CONDITIONS

Tuolumne County is shaped by the significant elevation changes and natural features present in the County. Communities are oriented along several state highway facilities. If evacuation trips are to occur, they will generally consist of traveling along the shortest route to one of the three state highways that cross the County: CA-108, CA-120, and CA-49. While there are some secondary roads that (1) connect between state routes (such as Rawhide Road south of Sonora), and/or (2) run roughly parallel to state highways (such as Tuolumne Road and Mono Way), these facilities are relatively limited in number or may not be ideal for evacuation purposes due to roadway widths or grades.

The assessment of congestion with different traffic patterns is based on the Tuolumne County Regional Travel Demand Model. The travel model represents all land uses in the county grouped into transportation analysis zones (TAZs) and includes a representation of important road connections (generally all streets except very local residential streets). Each road segment is coded with functional classification, number of lanes, uncongested speed, and an estimate of typical hourly capacity. The model estimates the vehicle trips generated by each land use, distributes the trips to a variety of likely destinations, and assigns each origin-destination pair to the best route. The model also assesses congestion and will iteratively divert some traffic to alternative routes until congestion is balanced between all available routes.

The individual fire scenario analyses compare results to baseline weekday PM peak hour conditions to identify locations where traffic during evacuation might be expected to result in substantial congestion. The travel model estimates of baseline conditions indicate that congestion is relatively rare in Tuolumne County, with most roads operating below capacity. The only roads where congestion is indicated in the model in the baseline scenario are around Sonora. Figure 1 shows the conditions for the area around Sonora where the highest baseline PM peak hour volume to capacity conditions are estimated.

The model indicates two additional locations where volumes exceed capacity; however, based on feedback from staff and review of the model, the results are a product of conservative modeling approaches and do not reflect normal congestion:

1. **CA-108 east of the Mono Way Intersection** – The PM peak hour model is calibrated to high reported Caltrans peak hour volumes estimated at 1,400 vehicles/hour, which exceeds the segment capacity of 1,100 vehicles/hour. This estimate is more reflective of a period with peak recreational/tourist activity, rather than a typical weekday. Specific count data reports a typical weekday peak hour as closer to 1,000 vehicles/hour.
2. **Phoenix Lake Road** – The road is classified as a "Low Capacity Arterial" with an hourly capacity of 550 vehicles/hour. Looking at the roadway conditions, this appears to be a reasonable estimate for the "desirable" maximum volume on the road, but a conservative estimate for the actual operational capacity, which is possibly closer to 1,000 vehicles/hour. As a result, the road typically operates without congestion.

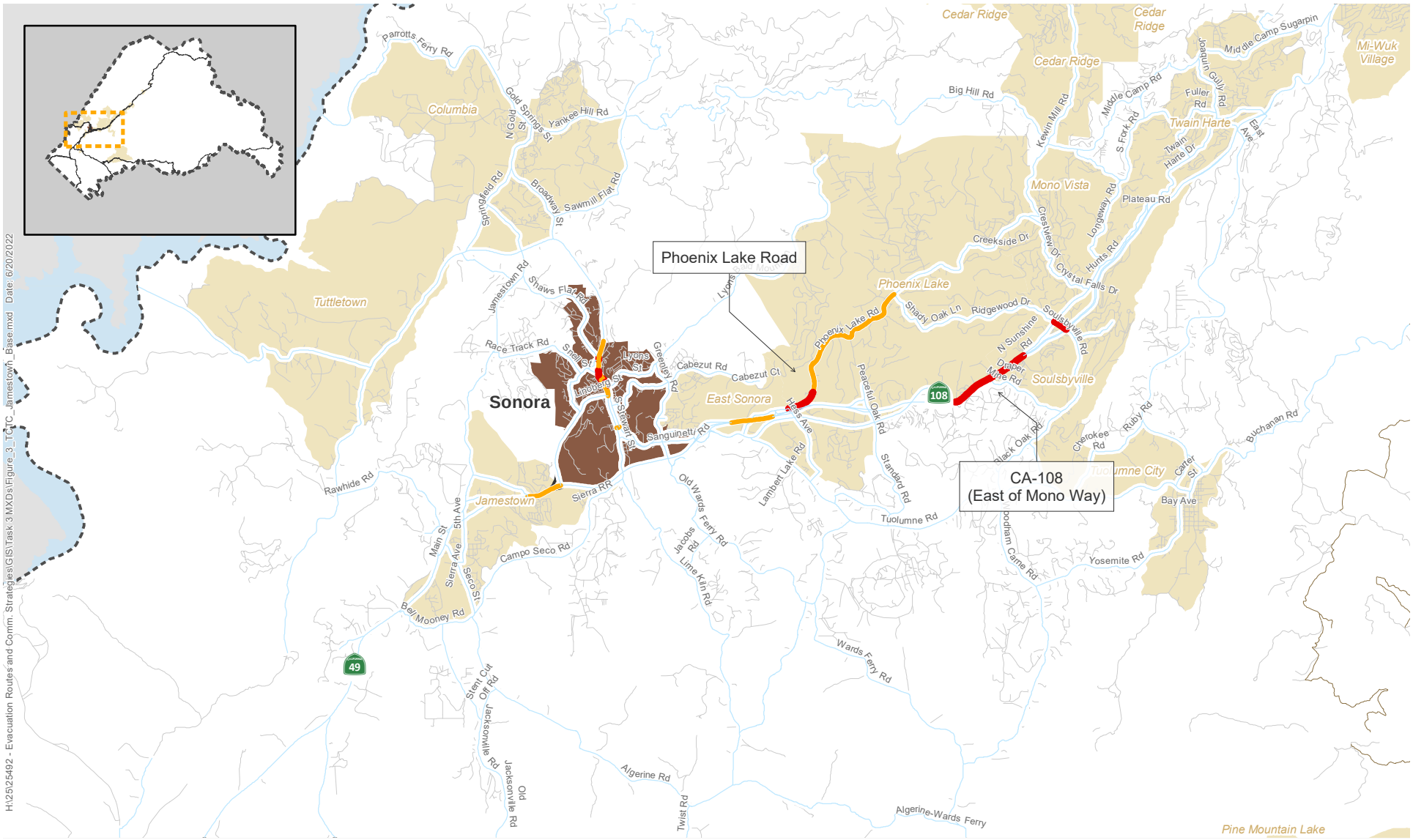


Figure 1

Baseline Model Volume to Capacity
PM Peak Hour
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES

EVACUATION EVALUATION

Kittelson and Jensen Hughes modeled evacuations for seven fire scenarios selected based on staff and stakeholder input. For each fire, a three-step process was conducted to create the scenario. Note that the scenarios represent potential fire ignition, spread, and evacuation behavior. Fire ignition could occur at other locations and the specific conditions of an emergency evacuation could result in evacuation behavior that diverges from the definitions and assumptions used for this analysis.

STEP 1 – FIRE SCENARIO MODELING

Jensen Hughes created the fire model scenarios based on input from TCTC staff, stakeholders, and an understanding of local conditions. Figure 2 through Figure 8 show the fire arrival times for each of the scenarios. The fires are modeled representing potential fire ignition and spread for the purposes of assessing where congestion may occur. These scenarios were selected to provide representative, worst-case wildfire scenarios that would likely stress the roadway network during evacuations. They were focused in locations that would have a high impact on the more populated areas of the County while also providing geographic diversity across the County, and were notably modeled **without** fire abatement activities and often with atypical, adverse weather conditions to capture worst-case results.

STEP 2 – IDENTIFYING TRAVEL PATTERNS

Time Period: Kittelson modeled transportation activity in two time periods after ignition for each fire evacuation scenario – 0 to 12 hours, and 24 to 36 hours after ignition. The 0 to 12 hour scenario was selected to understand evacuation immediately following the start of a fire. The 24 to 36 hour time period was then selected to show a broader evacuation involving a larger area of the county. For each period, Kittelson reviewed the travel model TAZs and assigned each TAZ a combination of Baseline Travel and Evacuation Travel based on its proximity to the fire line for each of the two time periods.

Travel Type: Baseline travel represents normal travel patterns during the PM peak hour as included in the travel model. Evacuation travel represents estimated evacuation trips from each TAZ which replace the normal travel patterns (discussed in Step 3 below). Kittelson modeled travel for each TAZ to shift from primarily baseline travel (“No Action”), to a mix of baseline and evacuation travel (“Standby”), and finally to primarily evacuation travel as the fire becomes closer (“Evacuation”). As a result, some facilities that are already near capacity during PM peak hours (e.g., Washington Street in Sonora), aremore susceptible to result in over-capacity results with the addition of evacuation traffic.

Roadway Capacity: Kittelson modeled the transportation using the default travel model capacities for each road. The scenarios represent conditions without implementation of any evacuation strategies, such as contraflow lanes, which could increase roadway capacity.

STEP 3 – ESTIMATING EVACUATION TRIPS AND ROUTING

Number of Evacuation Trips: Kittelson estimated the number of evacuation trips based on household units, visitor units, and occupancy rates for the county and survey data[1] collected following previous fires in California. Household and visitor data were based on land use data included in the county travel model for the base year, 2015. Kittelson selected the 2015 base year for modeling of evacuation conditions after consulting state data indicating minimal population growth since 2015. Occupancy rates for housing were based on input assumptions in the travel model. Visitor units were assumed to have an occupancy of 90% to represent a busy visitor season.

The evacuation survey data were used to identify when and if households tended to evacuate and the number of vehicles per household used during an evacuation. For modeling, Kittelson assumed that evacuating households would generate an average of 1.725 vehicle trips per household. Then, to account for the presence of trailers and oversized vehicles, Kittelson increased the number of trips by 13.4% based on reported rates of oversized vehicles and trailers used in evacuations.

Table 1 and Table 2 identify the number of occupied households and visitor units and total evacuation trips for the 12 hour period for each fire scenario. The data is organized to show the trips for evacuation and standby areas separately. Note that the trips are for the full 12 hour period. A peak hour trip estimate is used for the traffic modeling.

Table 1: Modeled Evacuation Trips for 0 to 12 hour Period

Scenario	Evacuation TAZs			Standby TAZs		
	Households	Vacation Units	Trips	Households	Vacation Units	Trips
Apple Colony	250	0	500	1,590	0	2,740
Cabezut	90	0	150	830	0	1,430
Camp Blue	70	380	410	0	0	0
Cedar Ridge	0	0	0	550	0	950
Columbia	100	0	200	730	20	1,280
Golden Oaks	200	0	390	1,010	0	1,730
Groveland	10	20	20	240	50	470

Source: Household and vacation units are for occupied units in county travel model for the base year, 2015

[1] Wong, S. D., Broader, J. C., Walker, J. L., & Shaheen, S. A. (2022). Understanding California wildfire evacuee behavior and joint choice making. Transportation. https://doi.org/10.1007/s11116-022-10275-y

Table 2: Modeled Evacuation Trips for 24 to 36 hour Period

Scenario	Evacuation TAZs			Standby TAZs		
	Households	Vacation Units	Trips	Households	Vacation Units	Trips
Apple Colony	950	0	1,850	2,340	100	4,140
Cabezut	510	0	990	1,750	0	3,030
Camp Blue	*Modeled as Single Period*					
Cedar Ridge	170	10	340	2,690	10	4,650
Columbia	680	20	1,350	1,450	0	2,510
Golden Oaks	430	0	840	950	0	1,640
Groveland	220	40	4,990	2,650	80	130

Source: Household and vacation units are for occupied units in county travel model for the base year, 2015

Trip Peaking: Kittelson first estimated total evacuation trips occurring during each 12 hour period. Because the transportation model estimates traffic patterns for a peak hour, Kittelson identified a peak factor to translate the trips into an hourly estimate to use in the transportation model.

Table 3 shows the peaking rates applied. The rates reflect an expectation that peaking will be higher for TAZs in the evacuation stage and lower for TAZs in the "Standby" stage. Note that peak evacuation travel may be higher in a specific location than the aggregate number used for transportation modeling. Kittelson is using a lower figure because behavior is being modeled across multiple TAZs that would reach the evacuation stage at different times within the given time period. Table 4 includes a summary of the peak hour evacuation trips for each scenario.

Table 3: Trips Estimation Methodology

Stage	0 to 12 Hours	24 to 36 Hours
No Action	NA	NA
Standby	20%	25%
Evacuation	80%	75%
Post-Evacuation	NA	NA

Table 4: Modeled Evacuation Trips in Peak Hour

Stage	0 to 12 Hours		24 to 36 Hours	
	Total Trips	Peak Hour	Total Trips	Peak Hour
Apple Colony	3,240	950	5,990	2,310
Cabezut	1,580	430	4,020	1,400
Camp Blue[1]	410	410	*NA*	
Cedar Ridge	950	190	4,990	1,200
Columbia	1,480	410	3,860	1,580
Golden Oaks	2,120	660	2,480	1,000
Groveland	490	120	5,120	1,300

1. Camp Blue was modeled with all trips leaving in the peak hour due to potential of modeled fire to quickly limit all available exit on CA-120.

Evacuation Destination and Route Choice: For each TAZ, Kittelson assigned likely evacuation destinations based on feedback from staff and stakeholders with a goal of identifying where trips would be likely to concentrate to evaluation potential for congestion. The distribution is not intended to reflect a precise distribution of the exact routes that would be taken. Evacuation trips include a mix of destinations outside the county and traveling to Sonora, depending on the location and direction of the modeled fire. Table 5 and Table 6 shows the net distribution of modeled evacuation trips by destination for each scenario.

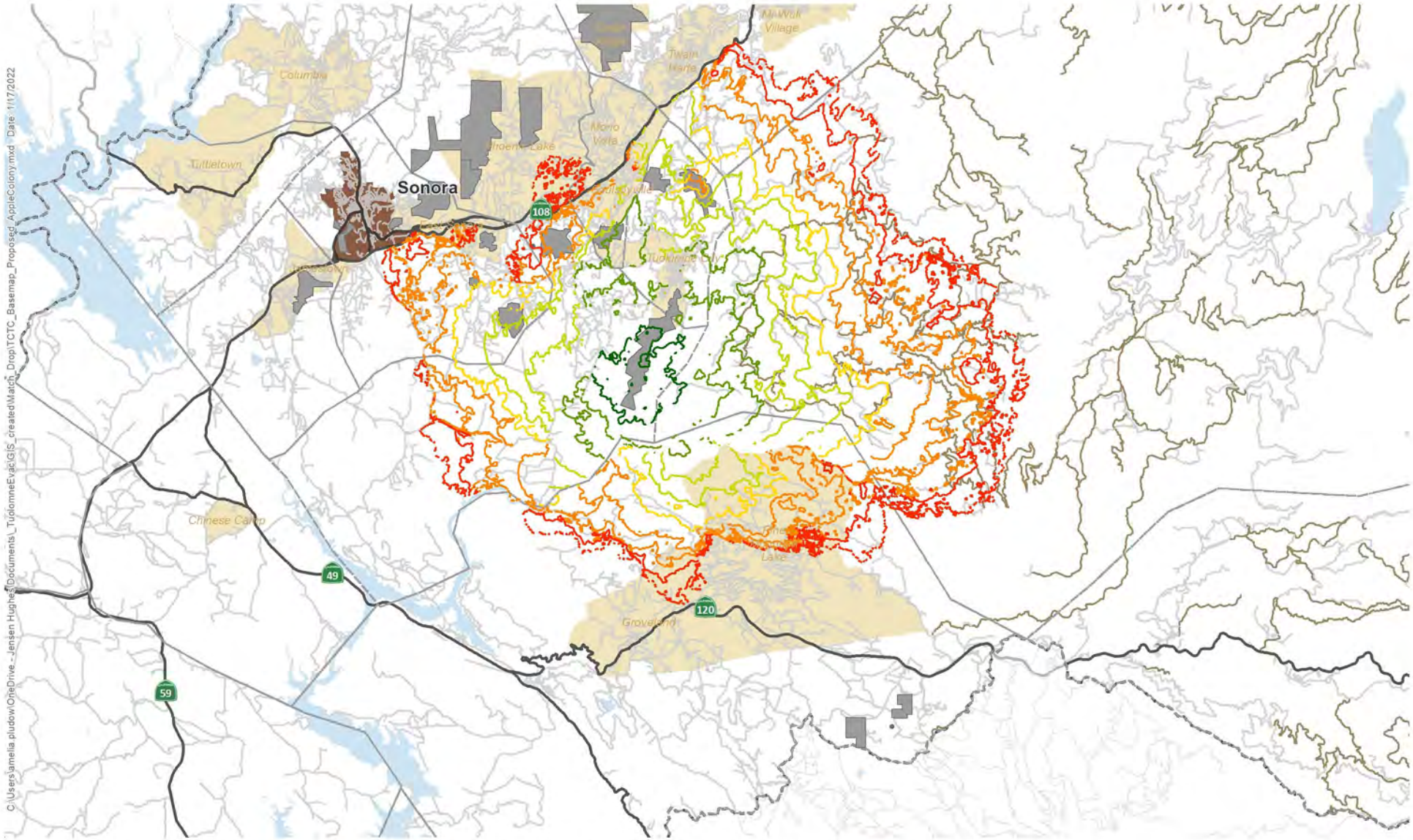
Table 5: Distribution of Evacuation Trips in 0 to 12 Hours

Destination	Apple Colony	Cabezut	Camp Blue	Cedar Ridge	Columbia	Golden Oaks	Groveland
Sonora	18%	5%	35%	35%	25%	5%	34%
CA-108/120 towards Modesto	65%	70%	40%	40%	22%	70%	31%
CA-132 towards Modesto	1%						21%
CA-49 towards Angels Camp	16%	25%	15%	15%	36%	25%	
CA-49 towards Coulterville			5%	5%			14%
CA-120 towards Mono City			5%	5%			
Parrotts Ferry Rd towards Vallecito					17%		

Table 6: Distribution of Evacuation Trips in 24 to 36 Hours

Destination	Apple Colony	Cabezut	Camp Blue	Cedar Ridge	Columbia	Golden Oaks	Groveland
Sonora	62%	70%		53%	33%	70%	42%
CA-108/120 towards Modesto	1%						14%
CA-132 towards Modesto	16%	25%		18%	46%	25%	5%
CA-49 towards Angels Camp	1%		*NA*	3%			10%
CA-108 towards Sonora Junction				3%			
CA-120 towards Mono City							
Parrotts Ferry Rd towards Vallecito	18%	5%		24%	21%	5%	28%

Fire Closures: Kittelson treated all roads in the travel demand model as available for the first time period where transportation is being modeled (0 to 12 hours). For the second time period (24 to 36 hours), Kittelson assumed that some roads would be closed. The closed road segments were identified by reviewing highway and secondary roads relative to each fire scenario's time of arrival contour maps. As necessary, Kittelson altered the evacuation destinations or evacuation time period for a TAZ if a road closure would preclude that destination. The evacuation result descriptions identify any assumed road closures.



State Highways and Major Roads
Minor and Local Roadways
Forest Service Roads
Cities
Census Designated Places
Tuolumne County
Vulnerable Communities
Transportation Zones

Hours to Arrival

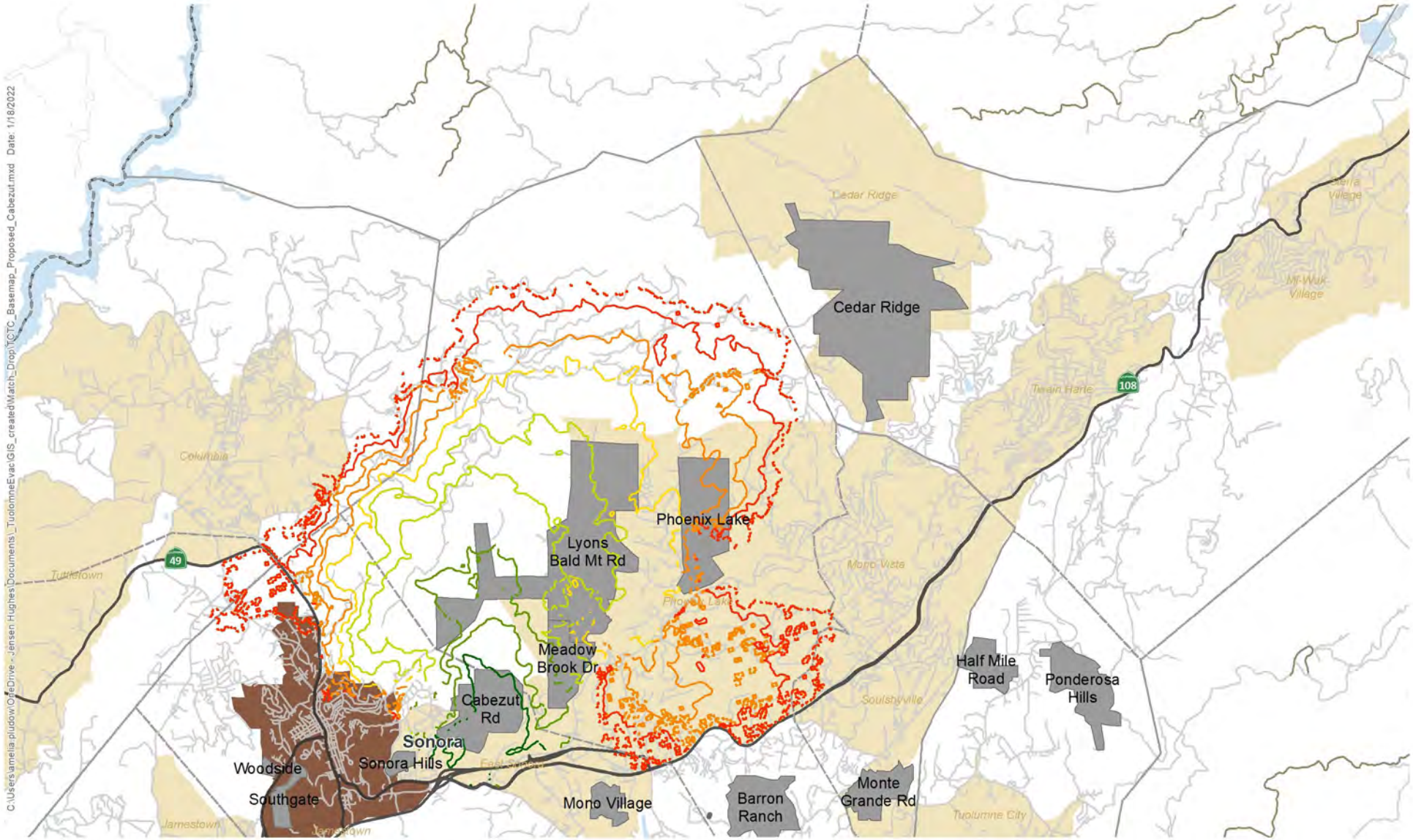
0 - 12
13 - 24
25 - 36
37 - 48
49 - 60
61 - 72

0 4 Miles

Figure 2

Apple Colony Fire Arrival Times
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES



State Highways and Major Roads

Minor and Local Roadways

Forest Service Roads

Cities

Census Designated Places

Tuolumne County

Vulnerable Communities

Transportation Zones

Hours to Arrival

0 - 12

13 - 24

25 - 36

37 - 48

49 - 60

61 - 72

0 1.6 Miles

Figure 3

Cabezut Fire Arrival Times
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES

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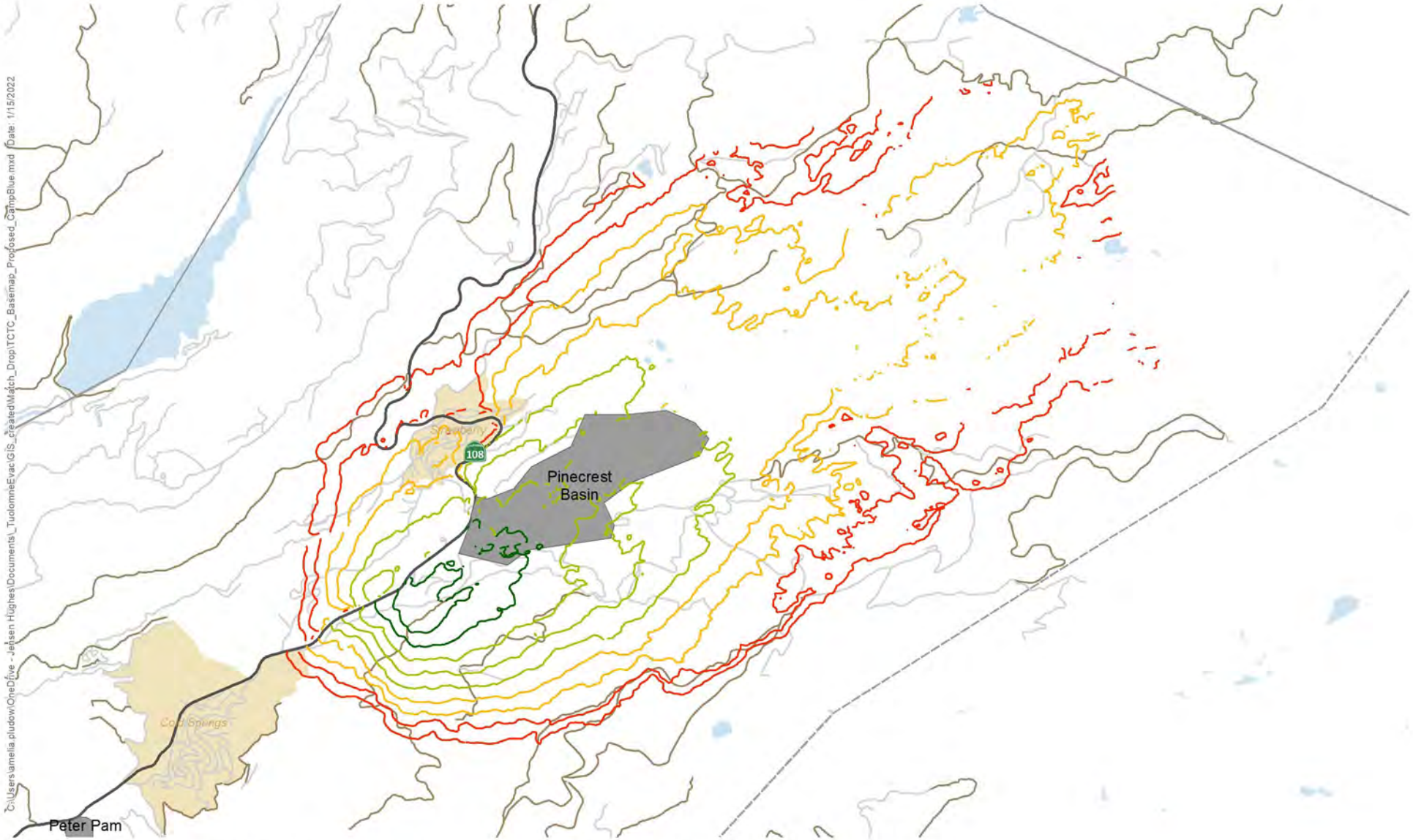
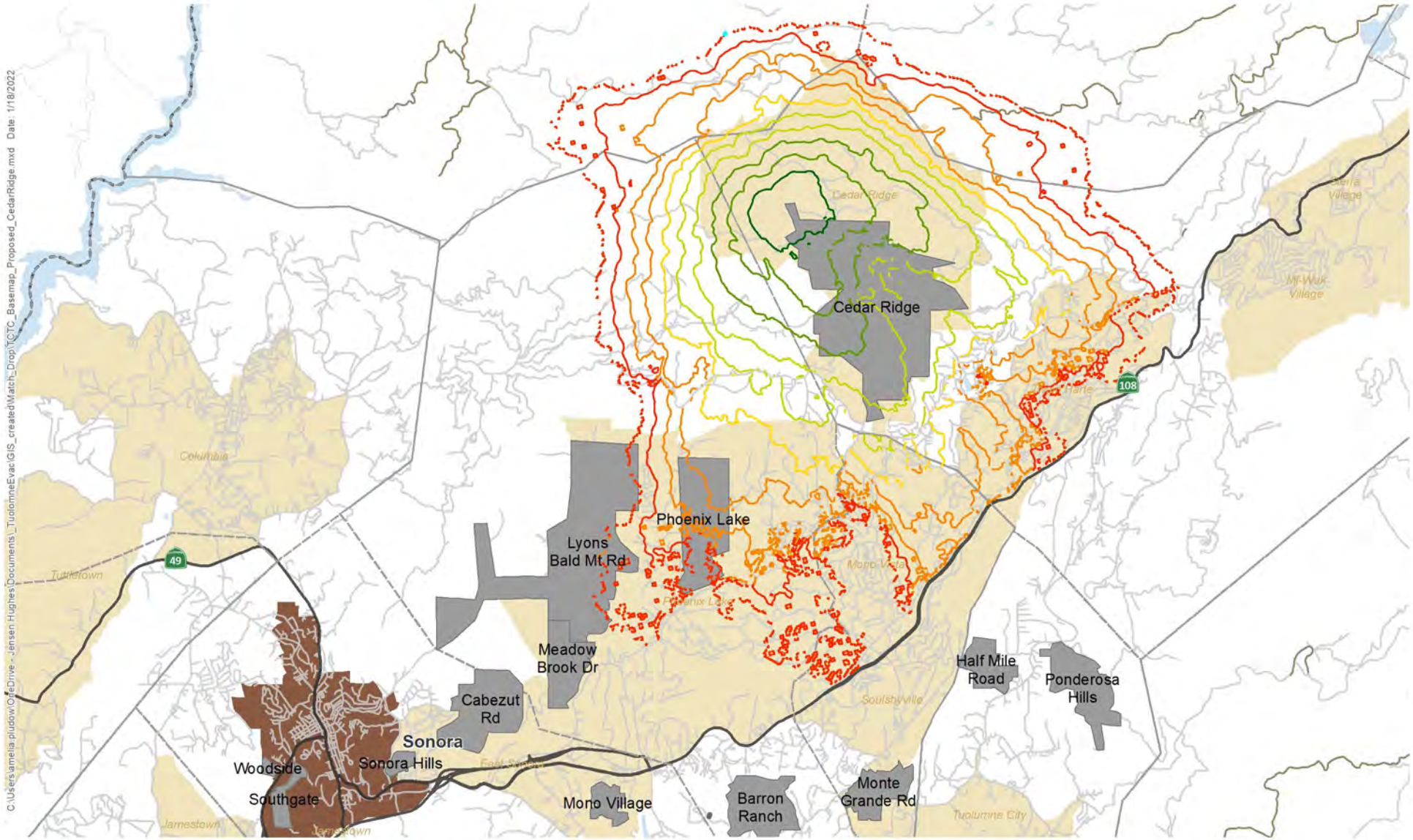


Figure 4

Camp Blue Fire Arrival Times
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES



State Highways and Major Roads
Minor and Local Roadways
Forest Service Roads
Cities
Census Designated Places
Tuolumne County
Vulnerable Communities
Transportation Zones

Hours to Arrival

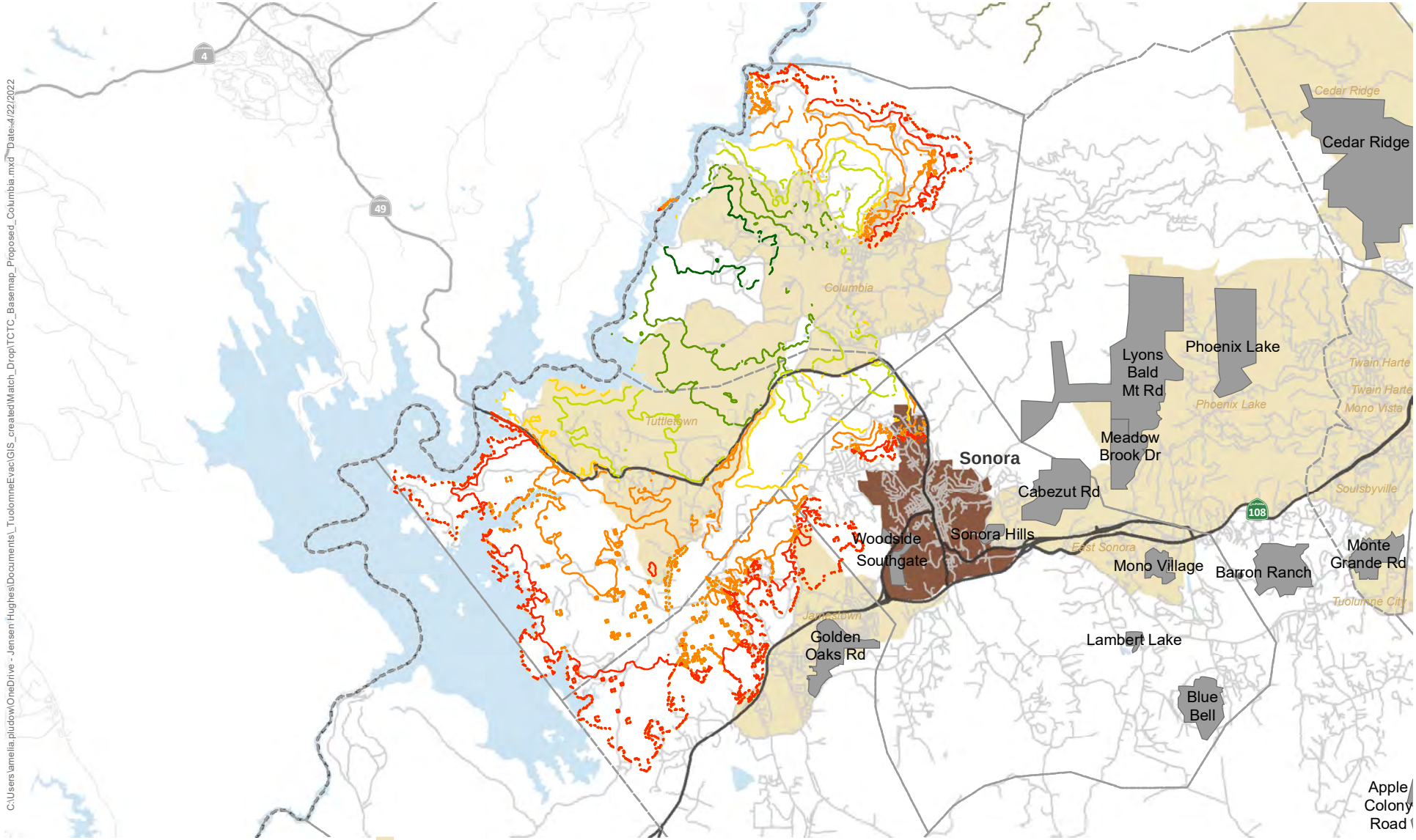
0 - 12
13 - 24
25 - 36
37 - 48
49 - 60
61 - 72

0 1.6 Miles

Figure 5

Cedar Ridge Fire Arrival Times
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES



State Highways and Major Roads

Minor and Local Roadways

Forest Service Roads

Cities

Census Designated Places

Tuolumne County

Vulnerable Communities

Transportation Zones

Hours to Arrival

0 - 12

13 - 24

25 - 36

37 - 48

49 - 60

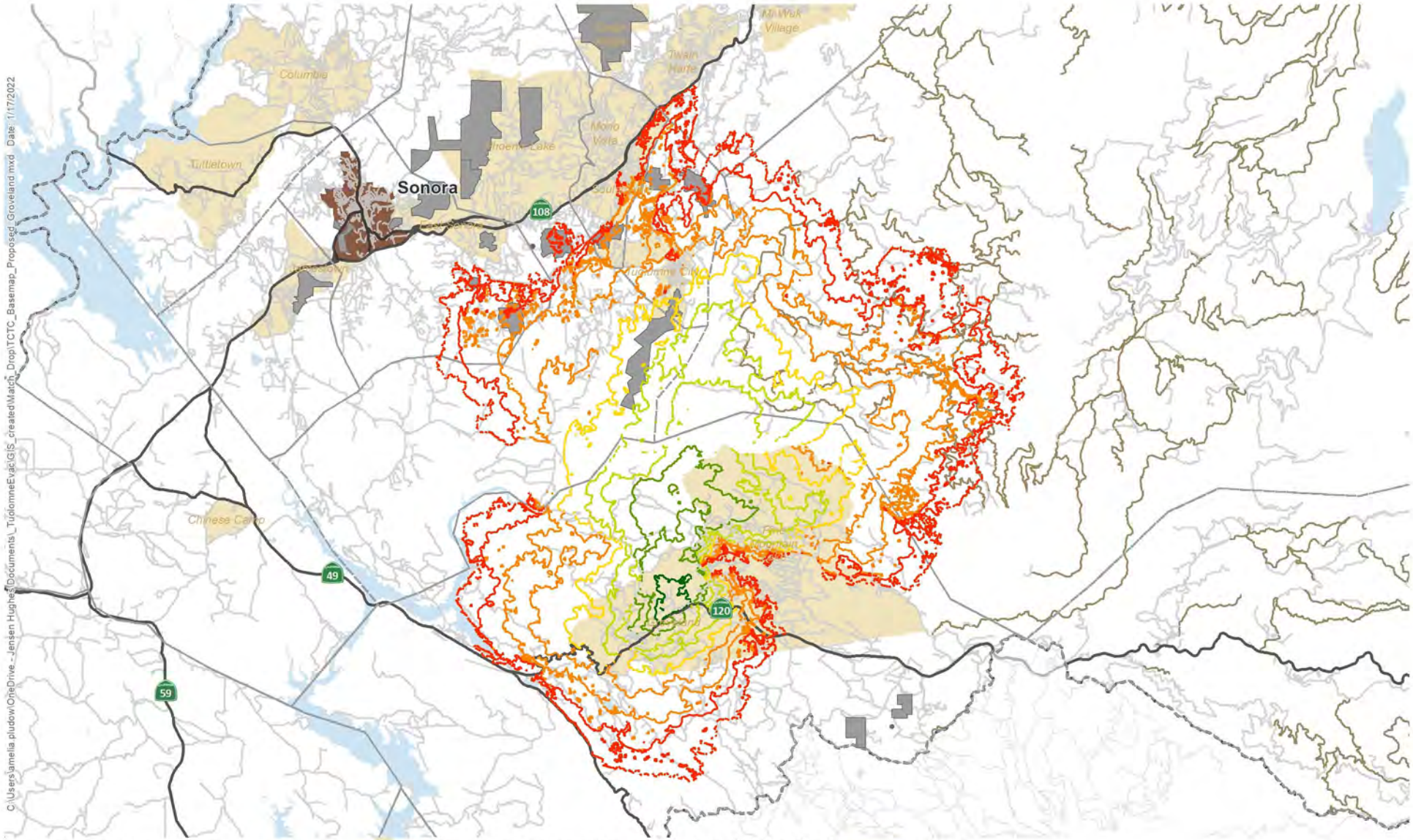
61 - 72

0 2.2 Miles

Figure 6

KITTELSON & ASSOCIATES JENSEN HUGHES

Columbia Fire Arrival Times
Evacuation Routes and Communication Strategies
Tuolumne County, CA



State Highways and Major Roads
Minor and Local Roadways
Forest Service Roads
Cities
Census Designated Places
Tuolumne County
Vulnerable Communities
Transportation Zones

Hours to Arrival

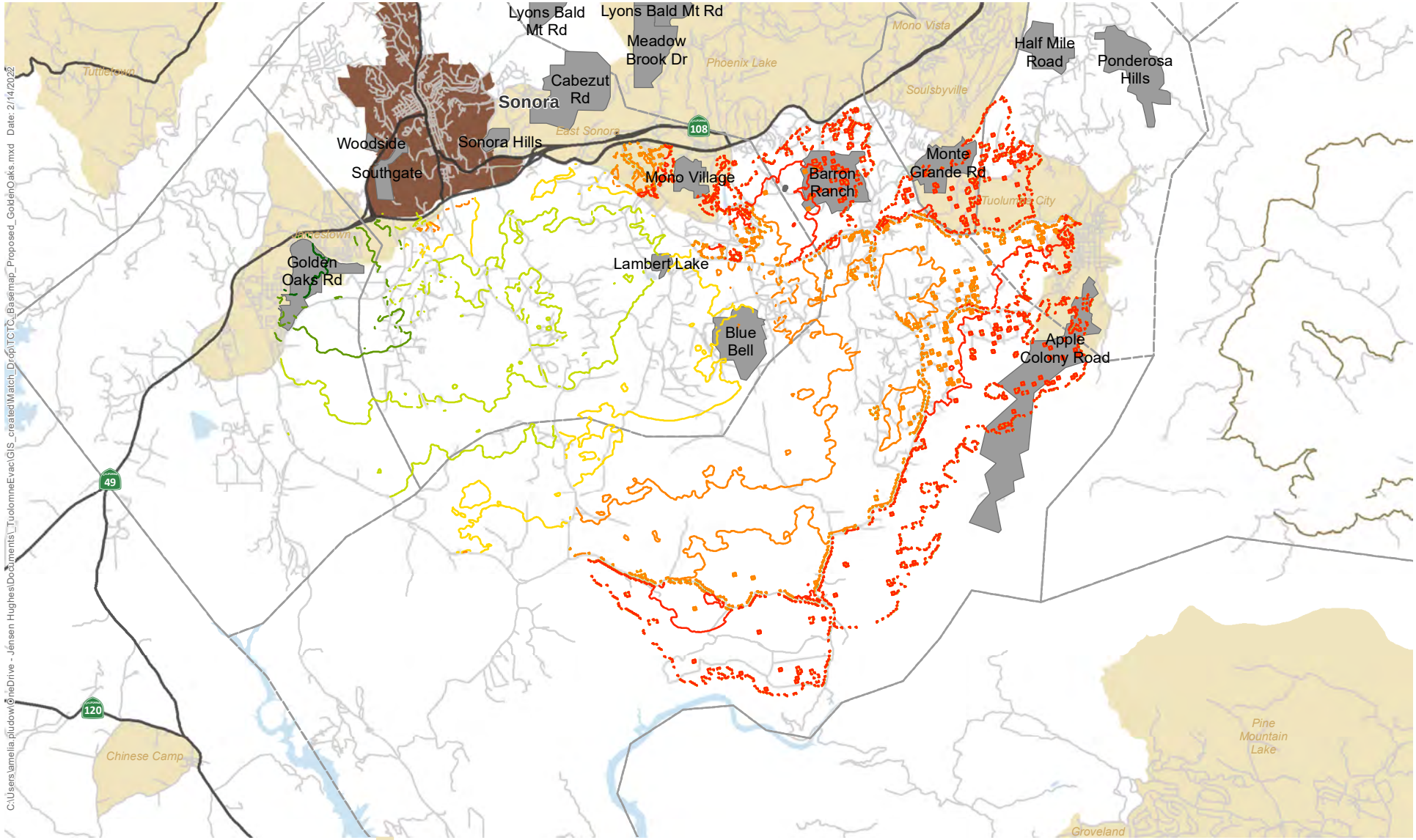
0 - 12
13 - 24
25 - 36
37 - 48
49 - 60
61 - 72

0 4 Miles

Figure 7

Groveland Fire Arrival Times
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES
JENSEN HUGHES



State Highways and Major Roads

Minor and Local Roadways

Forest Service Roads

Cities

Census Designated Places

Tuolumne County

Vulnerable Communities

Transportation Zones

Hours to Arrival

- 0 - 12
- 13 - 24
- 25 - 36
- 37 - 48
- 49 - 60
- 61 - 72

0 1.8 Miles

Figure 8

KITTELSON & ASSOCIATES JENSEN HUGHES

Golden Oaks Fire Arrival Times
Evacuation Routes and Communication Strategies
Tuolumne County, CA

EVACUATION RESULT FINDINGS

Evacuation capacity analysis was conducted for two time periods for each of the seven fire scenarios. The results represent the peak hour conditions for an evacuation when non-evacuation traffic would be at its highest levels.

Based on an analysis of the seven fire scenarios, Kittelson found the following to be likely locations of congestion during evacuations:

1. **Sonora Area.** For the fires that would impact locations along CA-108, the travel model indicates that congestion around the Sonora area is likely whether the fire is occuring in the immediate vicinity or further away. Evacuation trips would travel through the area and interact with baseline non-evacuation traffic creating capacity constraints.
2. **Washington Street** between CA-108 and West School Street through Sonora, including the traffic signals at:
    - Washington Street / Restano Way
    - Washington Street / Golden Chain Highway (CA-49)
3. **CA-108** between Mono Way and where CA-108 and CA-49 split west of Jamestown
4. **CA-120** between Ferreti Road, near Groveland, and Priest Coulterville Road
5. **Arterials/Collectors Streets connecting to State Highways**, such as:
    - Phoenix Lake Road
    - Tuolumne Road / Tuolumne Road North
    - Parrotts Ferry Road

The approach used to model evacuations is less suited for identifying congestion on specific local roads, where evacuation might be expected to spike sharply, such as an entrance to a single community. As a result, the analysis did not identify congestion or over capacity conditions on smaller local roads. However, it did indicate that during evacuations volumes would be expected to grow substantially relative to normal patterns, which could produce operational constraints that interfere with evacuations.

Indicative Local Roads where congestion may occur include:

- Ferreti Road at CA-120 (Groveland Fire Scenario)
- Pinecrest Lake Road at CA-08 (Camp Blue Fire Scenario)

Additionally, based on community and stakeholder feedback during the engagement process, the following additional roadways were identified as locations that are expected to have high volumes from evacuating traffic in the modeled scenarios:

- Pinecrest and Strawberry intersections with State Route 108 (Camp Blue Scenario)
- Greenley Road (All Fire Scenarios except Camp Blue and Groveland)
- Lyons Bald Mountain Road (Cabezut Scenario)

- Big Hill Road (Cedar Ridge Scenario)
- Yosemite Road and Algerine Road (Apple Colony Scenario)
- Kewin Mill Road (Cedar Ridge Scenario)
- North Airport Road and Horseshoe Bend Road (Columbia Scenario)
- Campo Seco Road (Community Meeting Input)
- Fraser Flat Road, Mt. Elizabeth Road, Mt. Provo Road, Mono Way (TCTC Board Meeting)

APPLE COLONY FIRE

Under this scenario, the fire starts near Tuolumne City (see Figure 2 for the potential fire extents). Tuolumne City can be accessed by Tuolumne Road and Tuolumne Road North. Tuolumne Road connects to CA-108 near East Sonora, while Tuolumne Road North connects to CA-108 at Twain Harte. Evacuation is expected to be primarily in the direction of Sonora, rather than on Tuolumne Road North. The fire would result in evacuation of residents along Apple Colony Road, who have a single access, and Tuolumne City, which is also limited to a small set of evacuation routes.

0 TO 12 HOUR SCENARIO

Figure 9 shows the volume to capacity ratio for 0 to 12 hours. The peak hour evacuation would be 950 vehicles per hour. The model indicates substantial and immediate over capacity conditions adjacent to Tuolumne City and along major routes heading west:

1. **Tuolumne Road** is the primary access road to the Tuolumne Ciy area and is projected to be largely over capacity.
2. **CA-108** is over capacity from near East Sonora to the where CA-49 and CA-108 split east of Sonora.
3. **Washington Street** through Sonora would exceed capacity.

24 TO 36 HOUR SCENARIO

Figure 10 shows the volume to capacity ratio for 24 to 36 hours. Under the scenario, the peak hour evacuation would be 2,310 hourly vehicles. Tuolumne Road, Yosemite Road, and Cherokee Road would be closed because of fire spread. The model indicates similar locations with congestion and over capacity conditions as during the 0 to 12 hour scenario. In addition, the model identifies that some secondary evacuation routes would be congested and have over capacity conditions:

1. **Wards Ferry Road** is an alternative route for vehicles leaving on Tuolumne Road that would be congested in this scenario and is overcapaity due to a low base capacity for the road.
2. **Red Hill Road** out of Chinese Camp is a local road connecting to CA-120. It shows as over capacity due to trips diverging from CA-108 to find another way west and a low base capacity.

In addition, the road closures at Tuolumne Road, Yosemite Road, and Cherokee Road would limit evacuation routes traveling southwest. In response evacuation trips would be diverted onto **Tuolumne Road North** which is projected to be over capacity in this scenario.

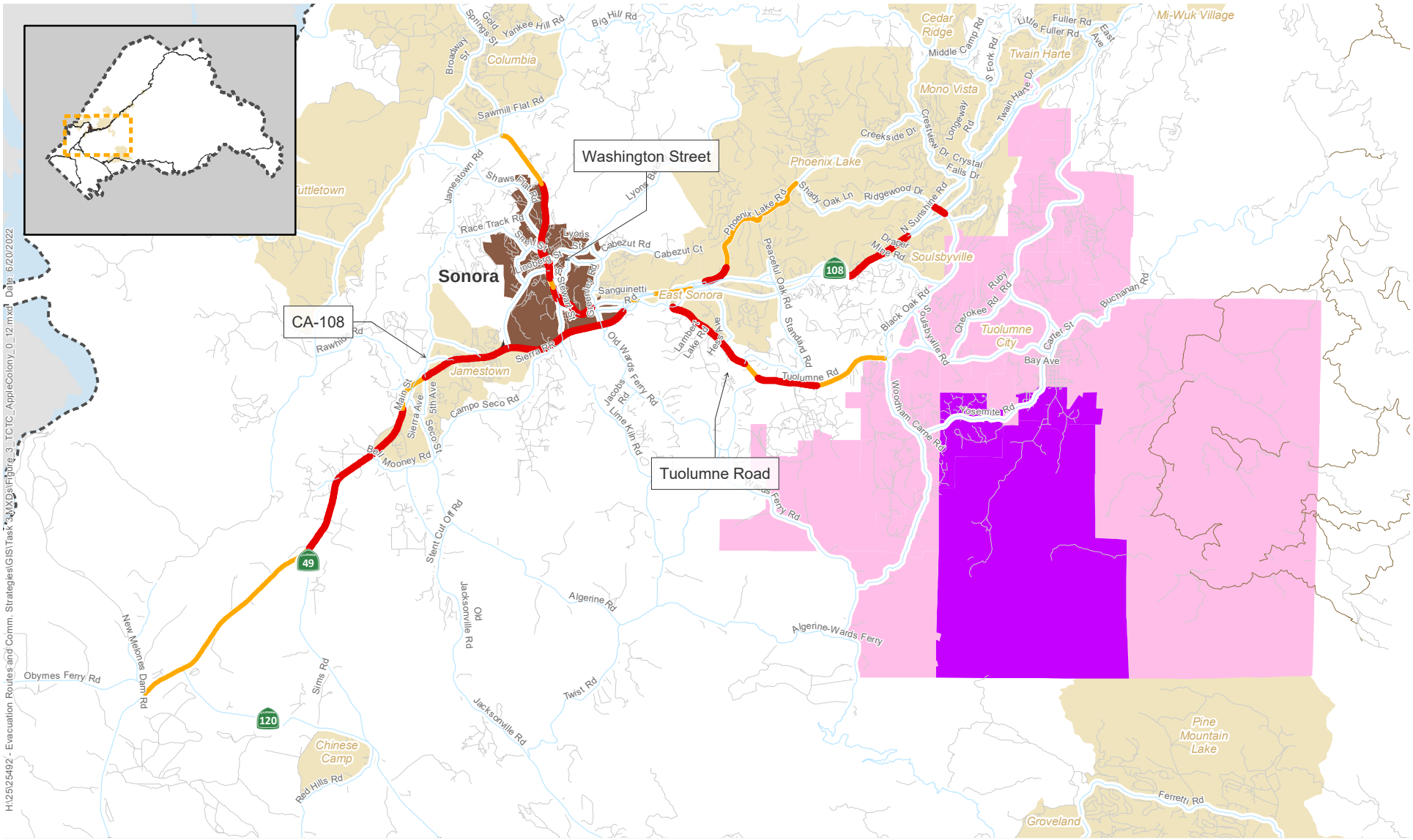


Figure 9

KITTELSON & ASSOCIATES JENSEN HUGHES

Apple Colony Fire Scenario - 0 to 12 Hours
Tuolumne County, CA

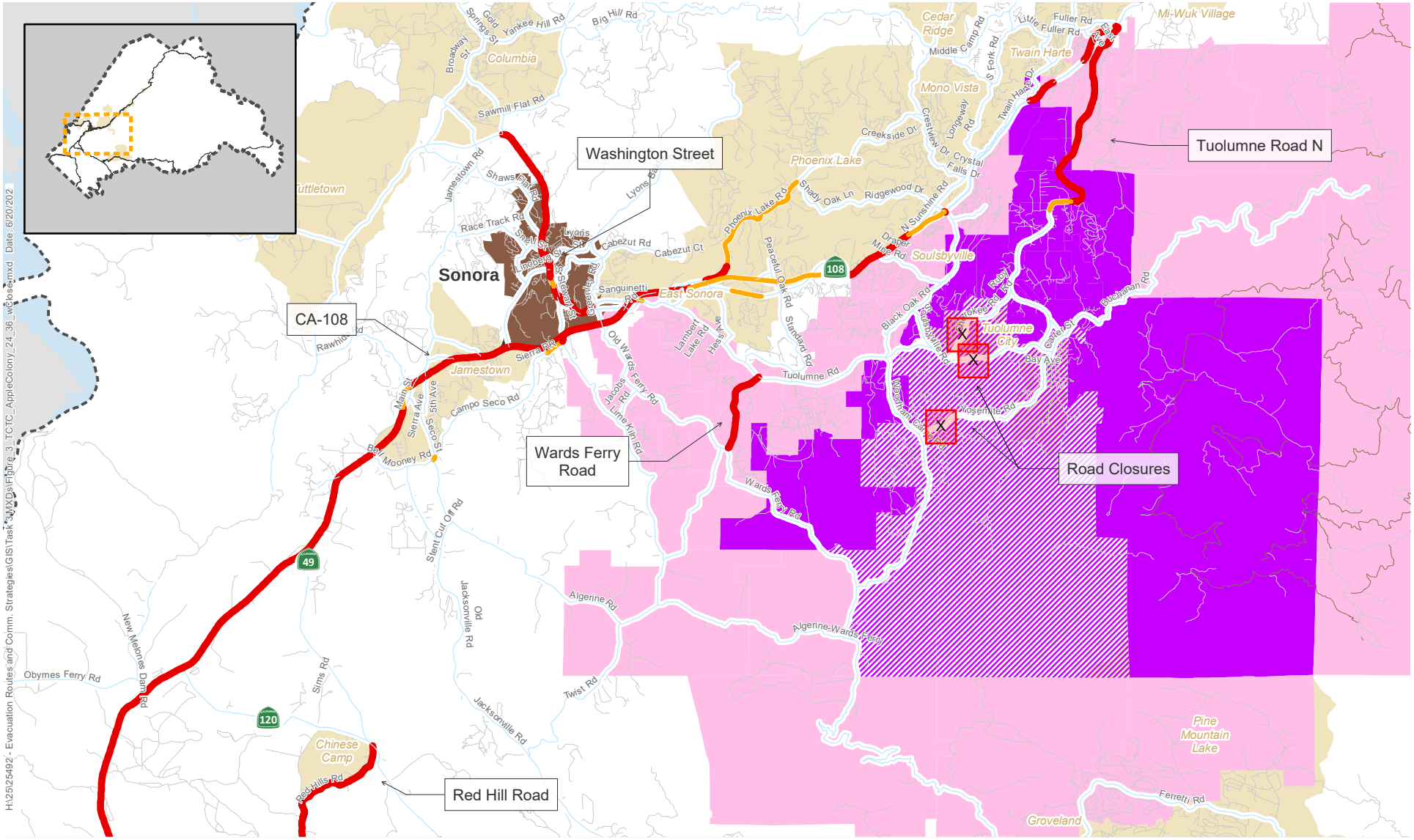


Figure 10

KITTELSON & ASSOCIATES JENSEN HUGHES

Apple Colony Fire Scenario - 24 to 36 Hours
Tuolumne County, CA

CABEZUT FIRE

Under this scenario, evacuation is concentrated northeast of Sonora on the north side of CA-108 (see Figure 3 for the potential fire extents). The primary evacuation routes are along CA-108 to Sonora, and north of CA-49. The fire would result in evacuation trips from multiple vulnerable communities with limited access and egress including neighborhoods along Cabezut Road, Meadow Brooks Drive, and Lyons Bald Mountain Road.

0 TO 12 HOUR SCENARIO

Figure 11 shows the volume to capacity ratio for 0 to 12 hours. Under the scenario, the peak hour evacuation is 430 vehicles. The model indicates that there is potential congestion and overcapacity conditions at three locations serving evacuation trips:

1. **CA-108** west of the Mono Way interchange would be over capacity.
2. **Mono Way** towards Sonora would be congested.
3. **Washington Street** through Sonora would exceed capacity.

Note that evacuation for residents along Lyons Bald Mountain Road may not be fully captured as full evacuation for the TAZs along the road would primarily occur between the two modeled periods.

24 TO 36 HOUR SCENARIO

Figure 12 shows the volume to capacity ratios for 24 to 36 hours. Under the scenario, the peak hour evacuation is 1,400 vehicles. The model indicates that the locations showing congestion and overcapacity conditions become worse in the later period as a greater number of evacuation trips travel out of the area, including:

1. **CA-108** shows as overcapacity from near Phoenix Lake Road to CA-120.
2. **Mano Way and Washington Street** show as overcapacity between CA-108 through Sonora.

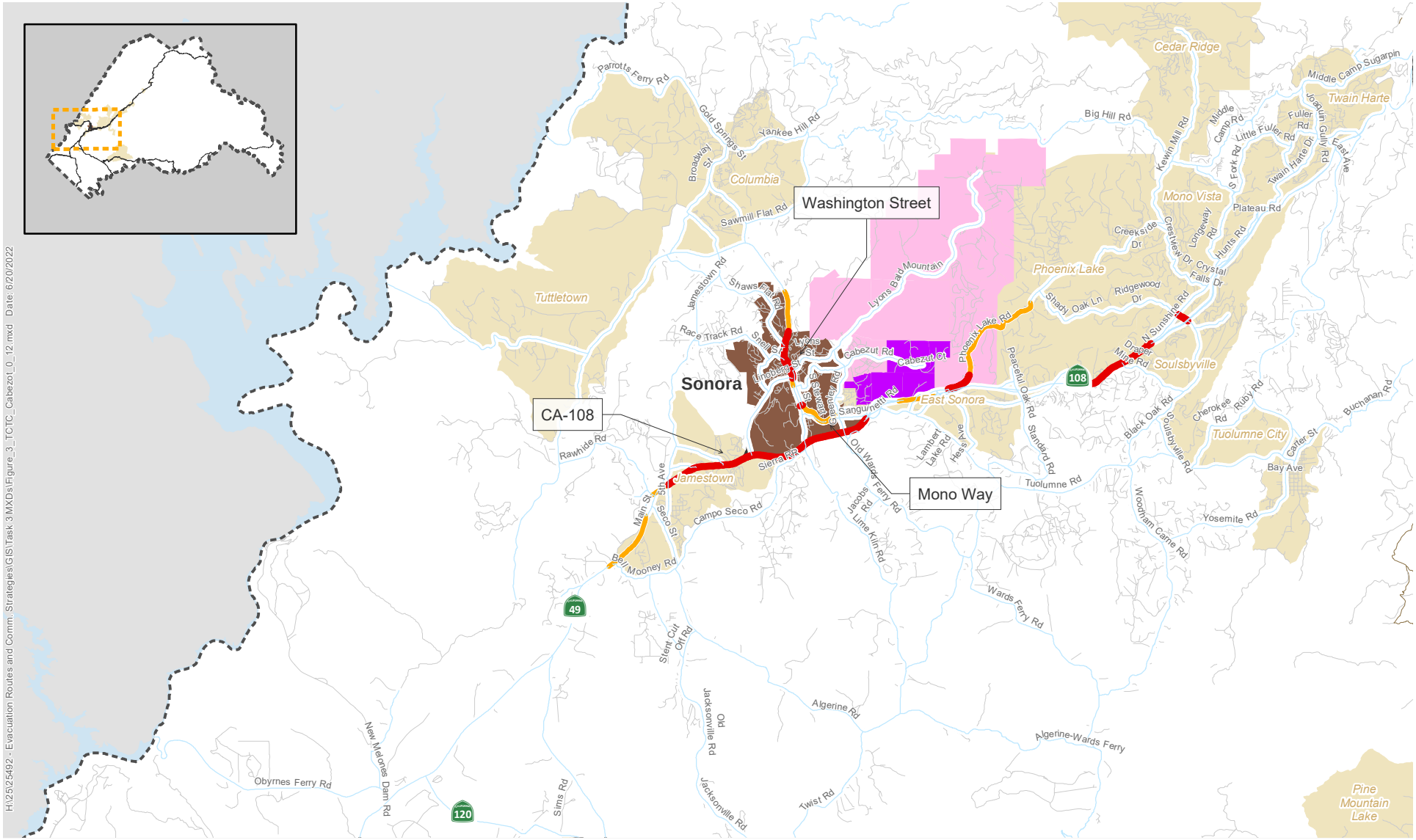
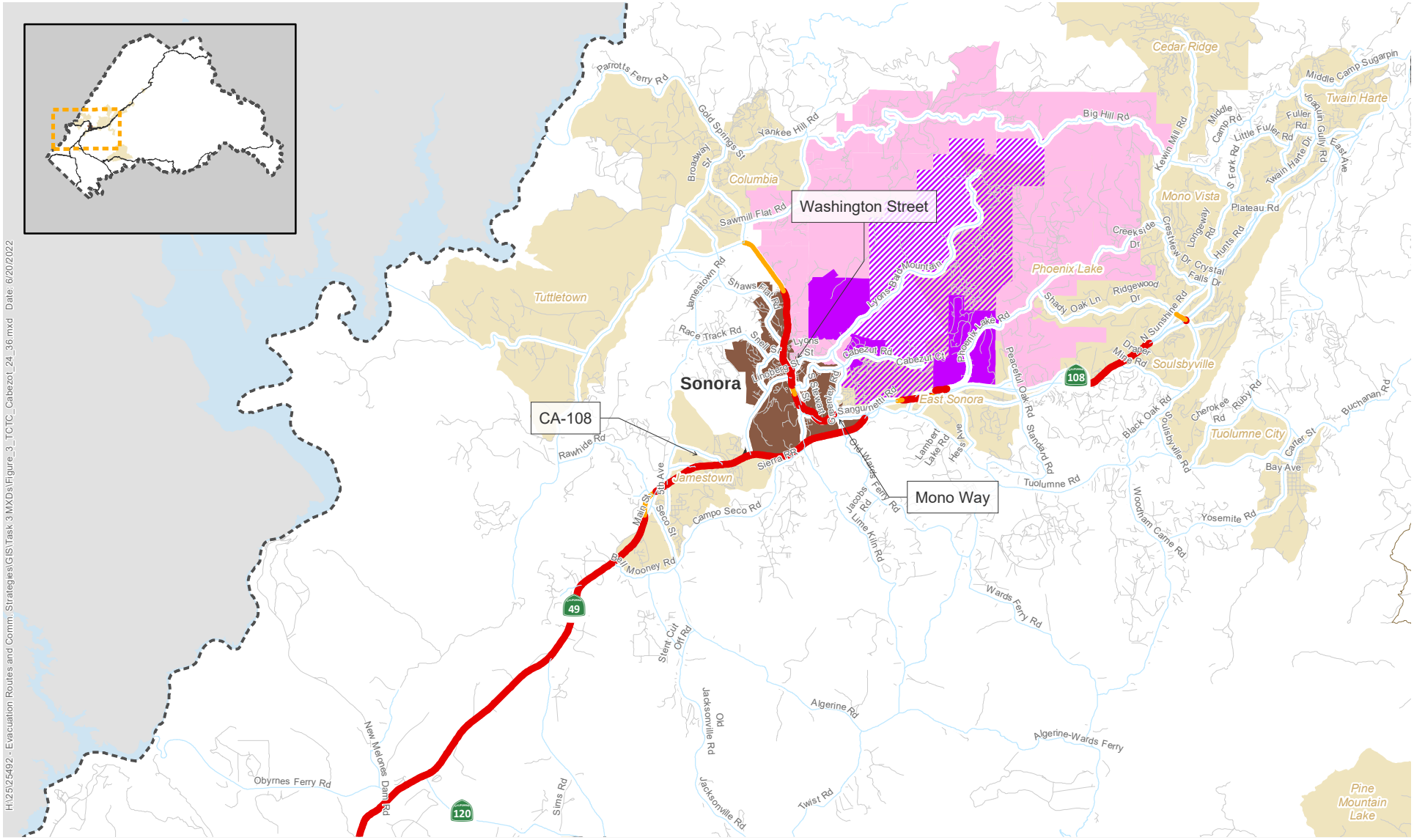


Figure 11

KITTELSON & ASSOCIATES JENSEN HUGHES

Cabezut Fire Scenario - 0 to 12 Hours
Tuolumne County, CA



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Figure 12

KITTELSON & ASSOCIATES JENSEN HUGHES

Cabezut Fire Scenario - 24 to 36 Hours
Tuolumne County, CA

CAMP BLUE

Under this scenario, the fire starts near CA-108 near the communities of Pinecrest and Strawberry (see Figure 4 for the potential fire extents). Kittelson modeled the evacuation for the area with the full population evacuating during the 0 to 12 hour time period and all TAZs modeled as "Evacuation" zones. There is no 24 to 36 hour scenario. This approach was selected to reflect the concentrated population of the area and the potential for the fire spread to cut off available evacuation routes. Evacuation is modeled with evacuation trips traveling primarily towards Sonora and further west.

0 TO 12 HOUR SCENARIO

Figure 13 shows the volume to capacity ratio for 0 to 12 hours. Under the scenario, the peak hour evacuation is 410 vehicles. Congestion in the scenario is not identified in the immediate area around the fire. Instead, congestion appears closer to Sonora when the evacuating trips meet busier county roadways.

A look at the roads in the immediate areas around the fire indicates that the volumes on the roads would grow substantially during a fire. This could create operational impacts which are not captured in the model by generating traffic that substantially exceeds usual operations. In addition, the area includes several outdoor destinations that during peak-of-peak periods might have more visitors than are assumed for the evaluation scenario. The locations that appear to be most at risk from congestion are:

1. **CA-108** where traffic volumes double relative to normal PM conditions traveling towards Sonora.
2. **Pinecrest Lake Road** where volumes towards CA-108 are shows as increasing by 85%.

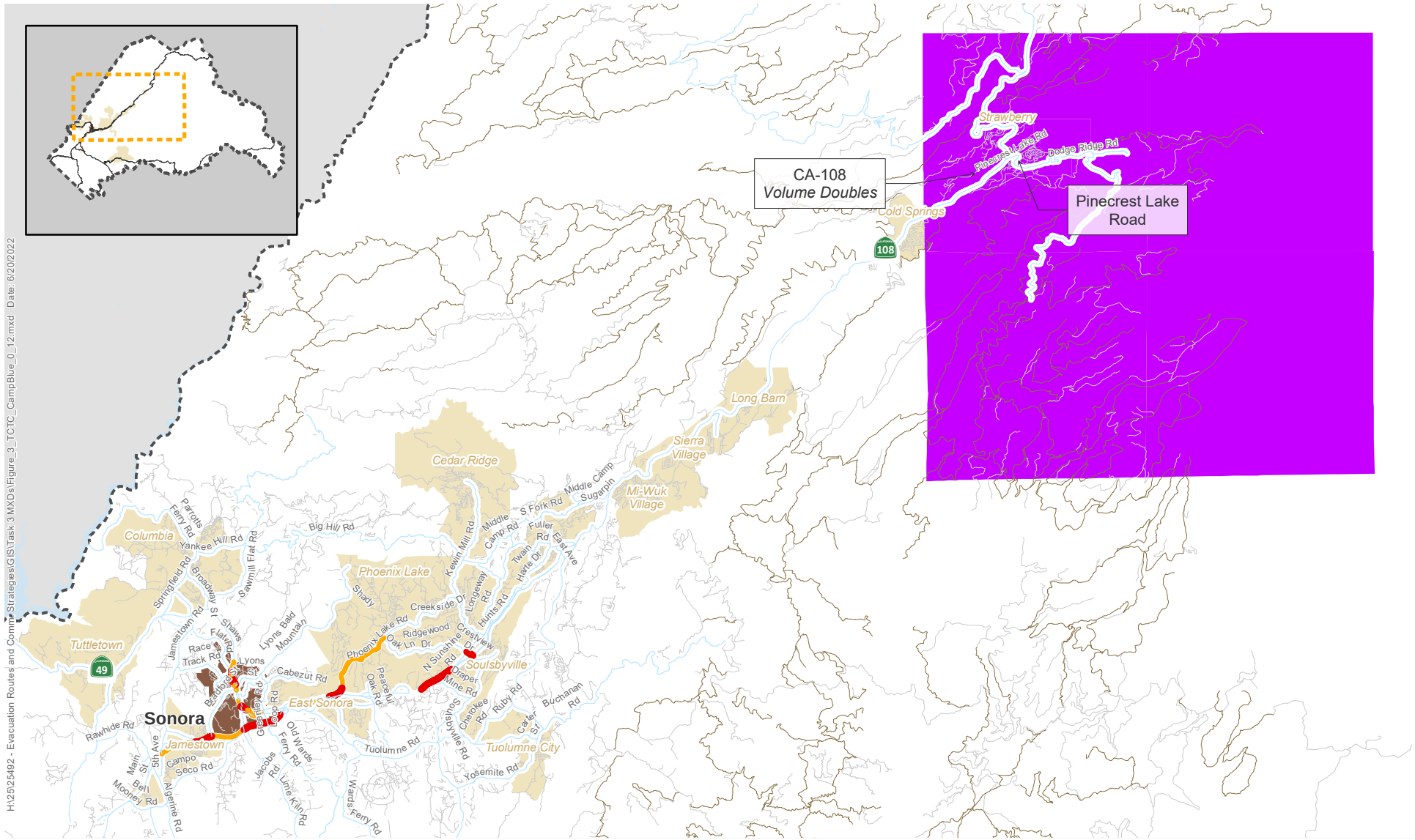


Figure 13

KITTELSON & ASSOCIATES JENSEN HUGHES

Camp Blue Fire Scenario - 0 to 12 Hours
Tuolumne County, CA

CEDAR RIDGE

Under this scenario, the fire starts around the Cedar Ridge community, progressing primarily southward towards CA-108 (see Figure 5 for the potential fire extents). The evacuation trips primarily exit the Cedar Ridge area along Kewin Mill Road. In the second time period, there are more evacuation trips starting in the populated areas near CA-108. Note that in the baseline conditions the travel model indicates that there will be congestion on Phoenix Lake Road and this congestion should not be attributed to evacuation.

0 TO 12 HOUR SCENARIO

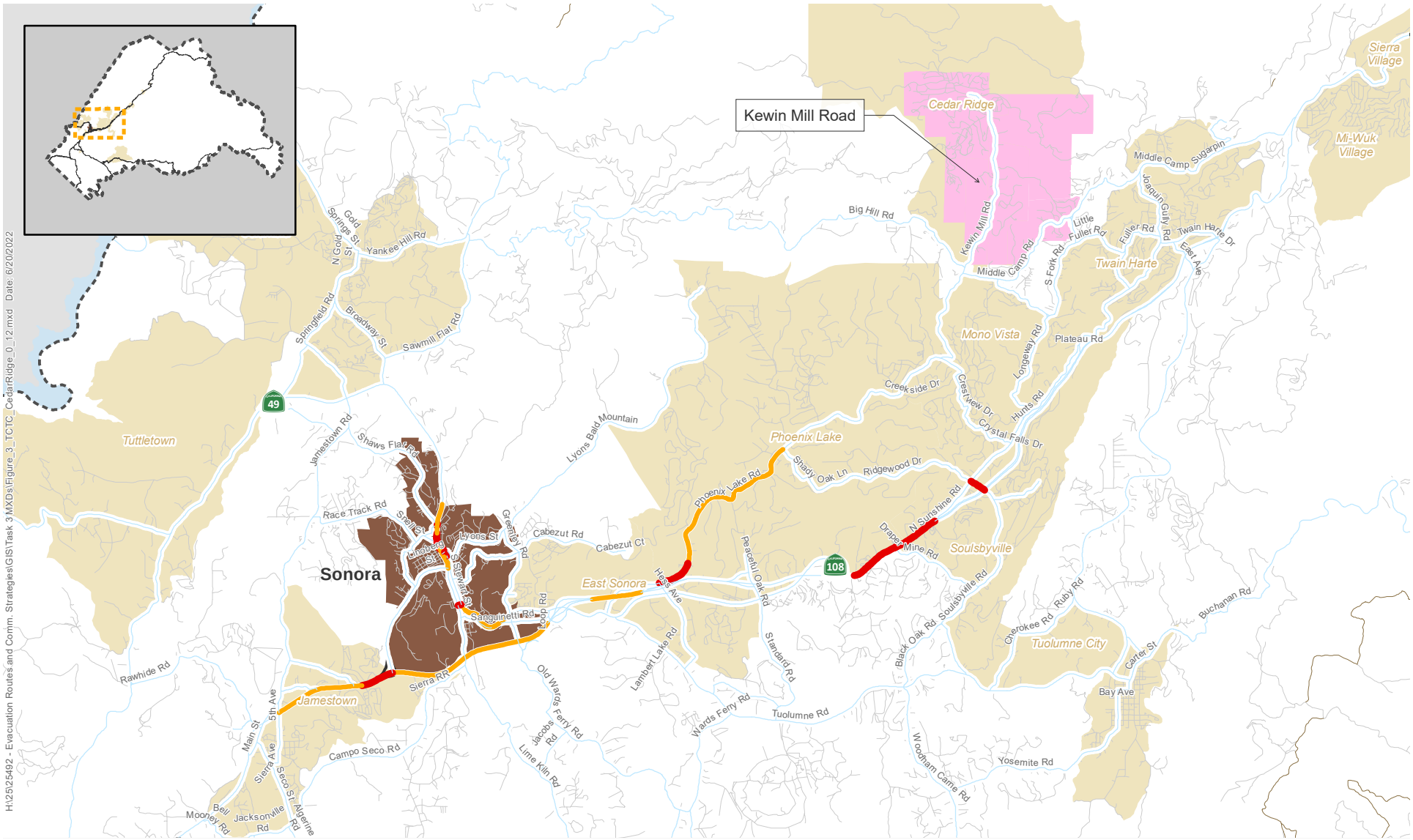
Figure 14 shows the volume to capacity ratio for 0 to 12 hours. Under the scenario, the peak hour evacuation is 190 vehicles. In contrast to the other scenarios included in this memo, the initial ignition impacts relatively fewer residents in the 0 to 12 hour scenario. As a result, the model does not indicate substantial congestion or over capacity conditions related to the fire evacuation.

1. **Kewin Mill Road** is the primary evacuation route for the first areas impactd by the fire. As shown in the figure, the scenario does not include TAZs adjacent to CA-108 in the initial evacuation. However, if evacuation begins during the early period from areas closer to CA-108 could generate congestion along Kewin Mill Road that impacts those needing to leave immediaately from Cedar Ridge.

24 TO 36 HOUR SCENARIO

Figure 15 shows the volume to capacity ratio for 24 to 36 hours. Under the scenario, the peak hour evacuation is 1,200 vehicles. The model indicates that congestion and over capacity conditions are likely to occur west of the fire. Evacuation trips are distributed over several collector roads north of CA-108, reducing the potential for local collectors to show congested conditions. The locations where new congestion and overcapacity conditions are identified relative to baseline conditions are:

1. **CA-108** is projected to be over capacity starting in east Sonora, near where Phoenix Lake Road merges with CA-108.
2. **Washington Street** is projected to be over capacity through Sonora.



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Figure 14

KITTELSON & ASSOCIATES JENSEN HUGHES

Cedar Ridge Fire Scenario - 0 to 12 Hours
Tuolumne County, CA

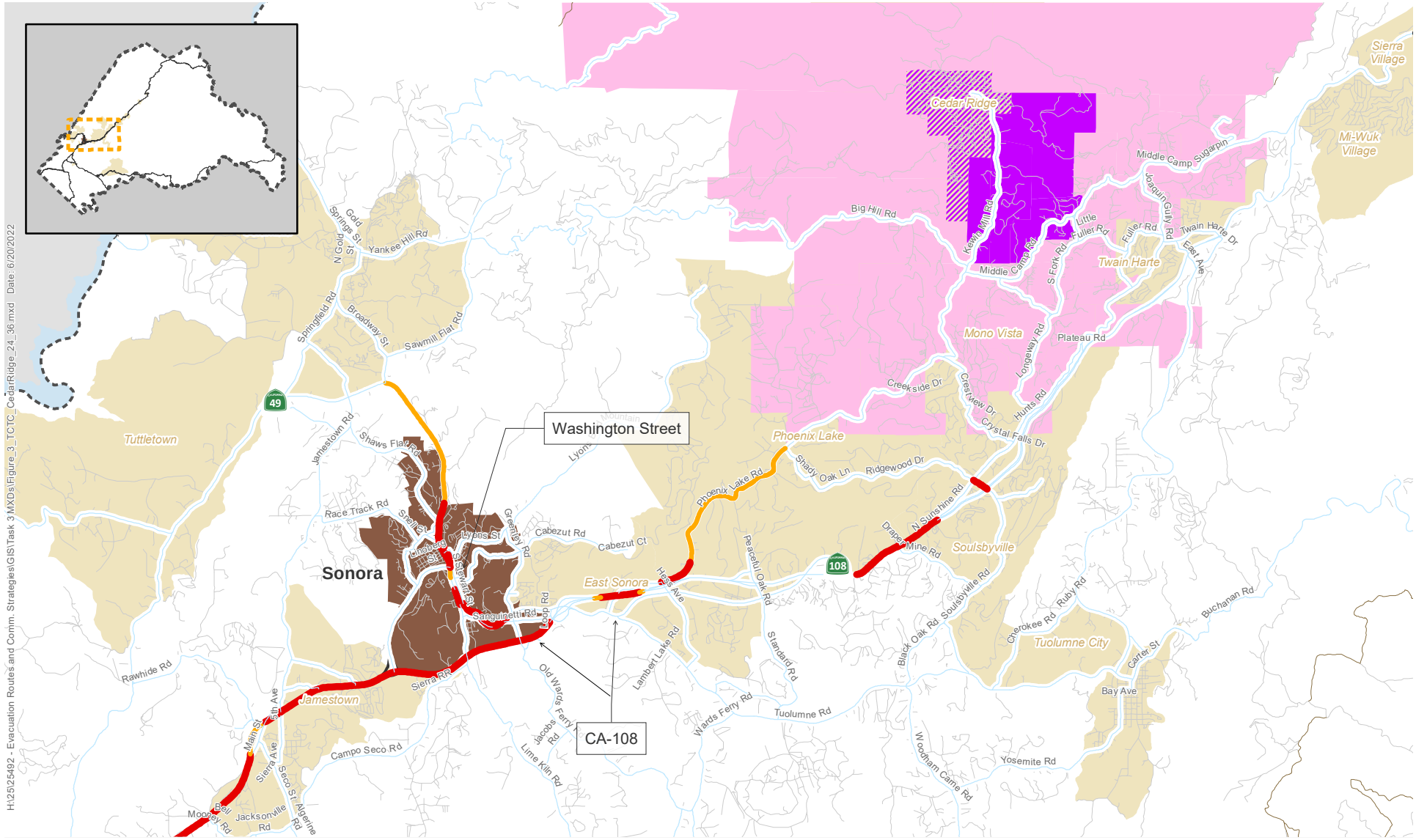


Figure 15

KITTELSON & ASSOCIATES JENSEN HUGHES

Cedar Ridge Fire Scenario - 24 to 36 Hours
Tuolumne County, CA

COLUMBIA

Under this scenario, the fire starts northwest of Columbia, east of the bridge on Parrotts Ferry Rd. The fire progresses north and south through Columbia and Tuttletown. The evacuation trips are modeled as evacuating north across the County line along CA-49 or Parrotts Ferry Rd, or towards Sonora or west along CA-108. In the second time period, Parrotts Ferry Road is closed, and trips are rerouted to CA-49 towards Angels Camp.

0 TO 12 HOUR SCENARIO

Figure 14 shows the volume to capacity ratio for 0 to 12 hours. Under the scenario, the peak hour evacuation is 410 vehicles. While some roads experience substantial increases in volumes, congestion related to the evaluation is not identified. One potential mitigating factor for evacuation in the area is that relative to other areas of the County there are more alternative routes for evacuating from the impacted area. The locations that appear to be most at risk from congestion are:

1. The area west of the Columbia Airport has two access roads, **N Airport Road** and **Horseshoe Bend Rd** that connect to the larger road network. While both roads appear to have sufficient capacity in the model, any operational issues or impacts from fires could limit efficient evacuation.

24 TO 36 HOUR SCENARIO

Figure 15 shows the volume to capacity ratio for 24 to 36 hours. Under the scenario, the peak hour evacuation is 1,580 vehicles. Parrott Ferry Road is closed near the County border, blocking evacuation in the direction of CA-4. The model indicates that there is congestion and over capacity conditions during the scenario. The locations where new congestion and overcapacity conditions are identified relative to baseline conditions are:

1. **Parrotts Ferry Road/Springfield Road** are projected to be over capacity or congested from a little north of Yankee Hill Road to Horseshoe Bend Road.
2. **Washington Street** is projected to be over capacity through Sonora.
3. **CA-49 / CA-108** is projected to be a mix of over capacity and congested south of Sonora.

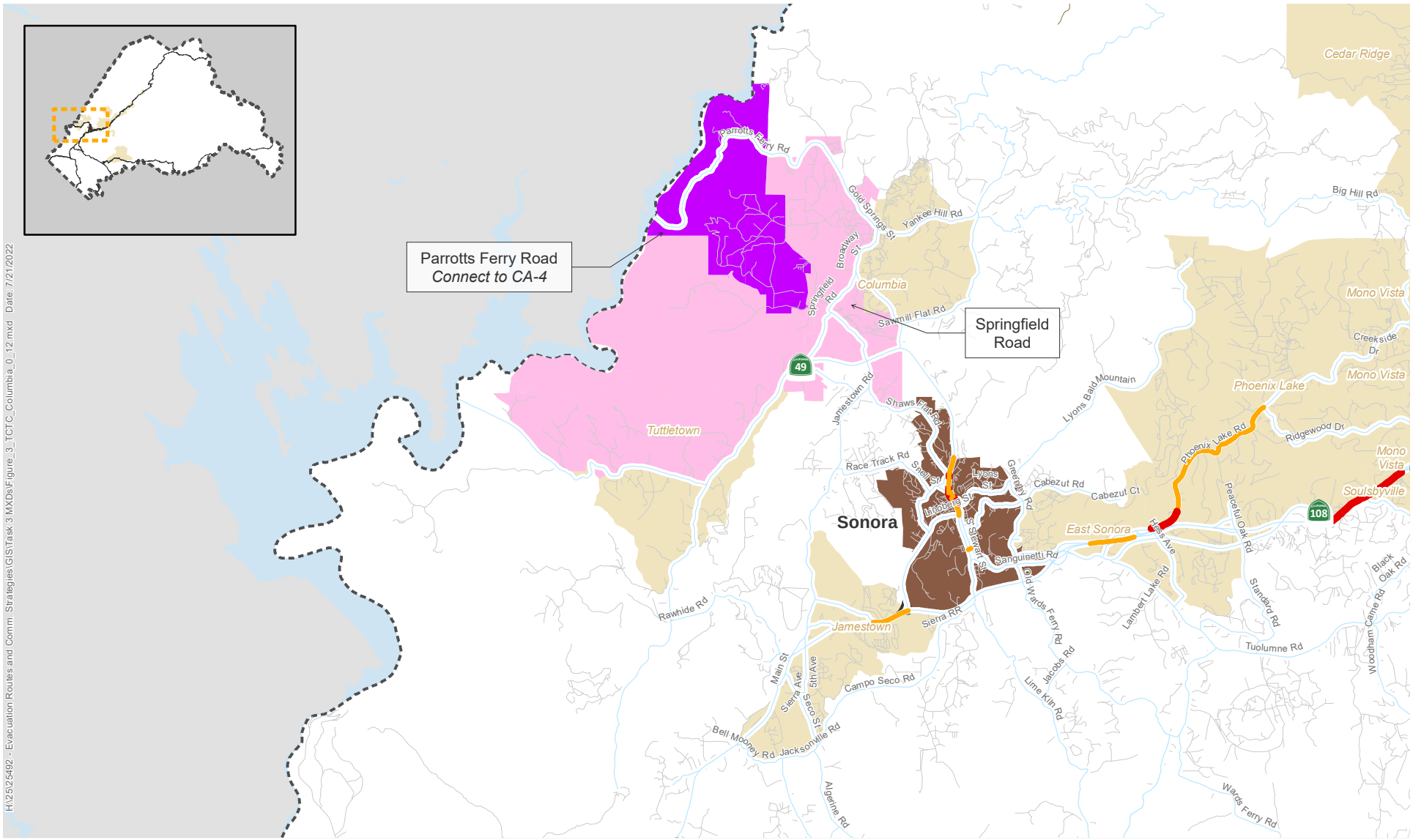
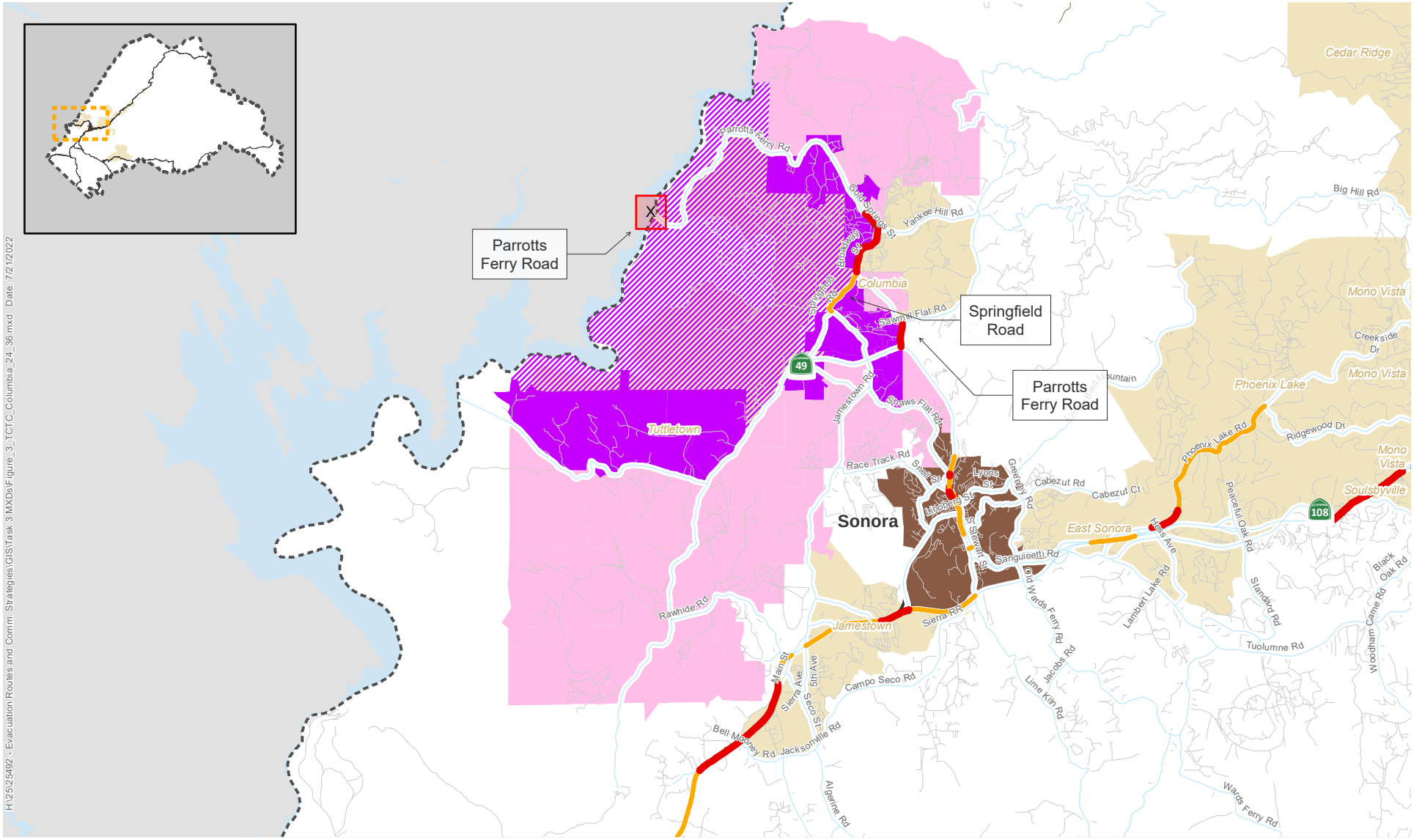


Figure 16

KITTELSON & ASSOCIATES JENSEN HUGHES

Columbia Fire Scenario - 0 to 12 Hours
Tuolumne County, CA



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Figure 17

KITTELSON & ASSOCIATES JENSEN HUGHES

Columbia Fire Scenario - 24 to 36 Hours
Tuolumne County, CA

GOLDEN OAKS

Under this scenario, the evacuation is concentrated in areas southeast of CA-108 near Jamestown (see Figure 7 for the potential fire extents). The primary evacuation routes are along CA-108, to Sonora, and north of CA-49. The fire would result in evacuation trips from Golden Oaks (both time periods), Lambert Lake, and Blue Bell (in the second time period).

0 TO 12 HOUR SCENARIO

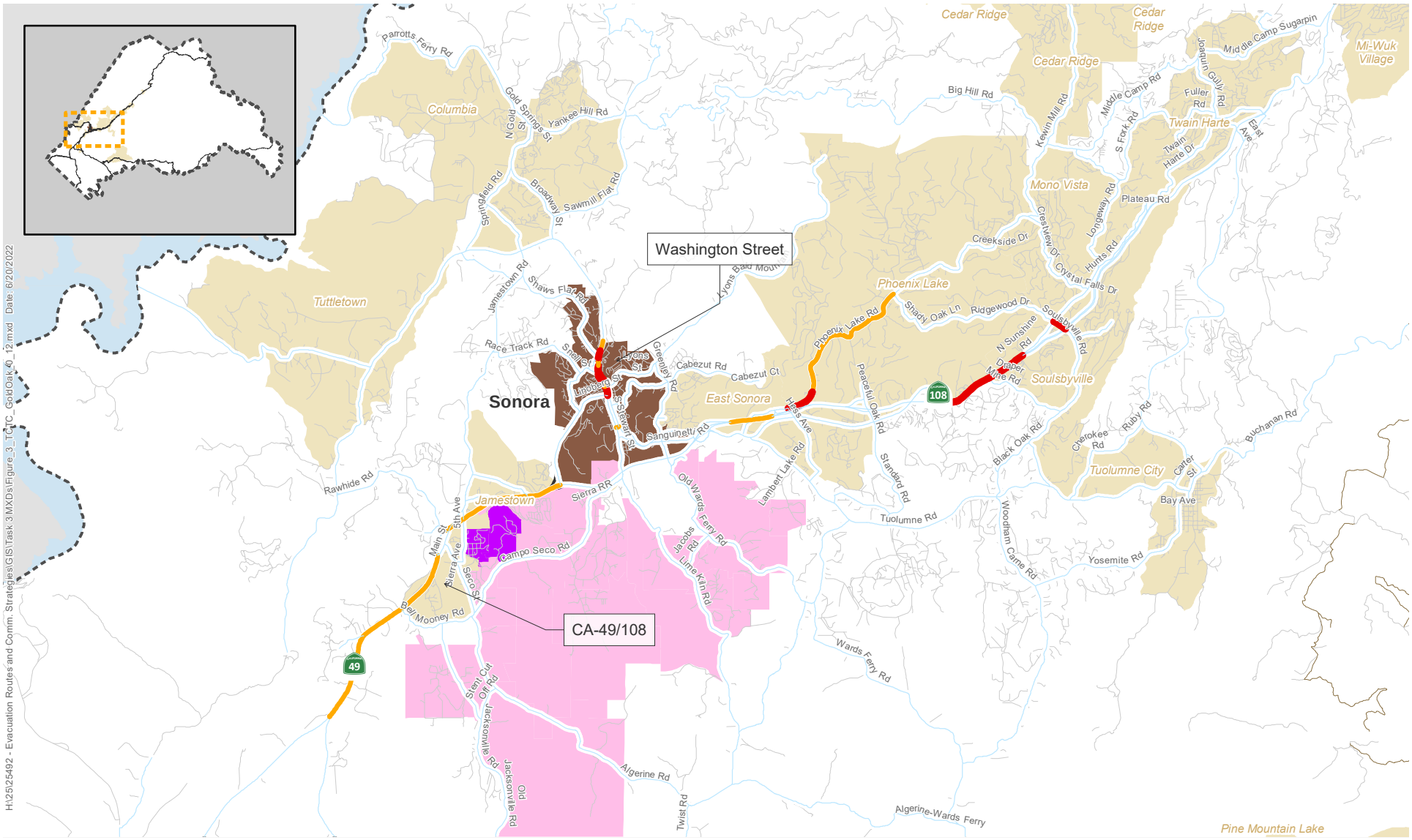
Figure 18 shows the volume to capacity ratio for 0 to 12 hours. Under the scenario, the peak hour evacuation is 660 vehicles. The travel model indicates congestion and over capacity conditions at two locations serving evacuation trips:

1. **CA-108** east of the CA-49/108 juction would be congested.
2. **Washington Street** through Sonora would exceed capacity.

24 TO 36 HOUR SCENARIO

Figure 19 shows the volume to capacity ratio for 24 to 36 hours. Under the scenario, the peak hour evacuation is 1,000 vehicles. In the scenario, Camp Seco Road would be closed east of Seco Street in response to fire spread. The model indicates that as the fire travels southeast there would be increased congestion in and around Sonora.

1. **CA-108** transitions from congested to over capacity from Washington Street to the split between CA-49 and CA-108 near the Caltrans Sonora Maintenance Station.
2. **Washington Street** remains overcapacity with the highest volume to capacity ratio observed at the north end of the city and at the intersections with Mono Way and CA-49.



H:\25\25492 - Evacuation Routes and Comm. Strategies\GIS\Task 3 MXDs\Figure_3_TCC_GoldOak_0_12.mxd Date: 6/20/2022

Figure 18

KITTELSON & ASSOCIATES JENSEN HUGHES

Golden Oaks Fire Scenario - 0 to 12 Hours
Tuolumne County, CA

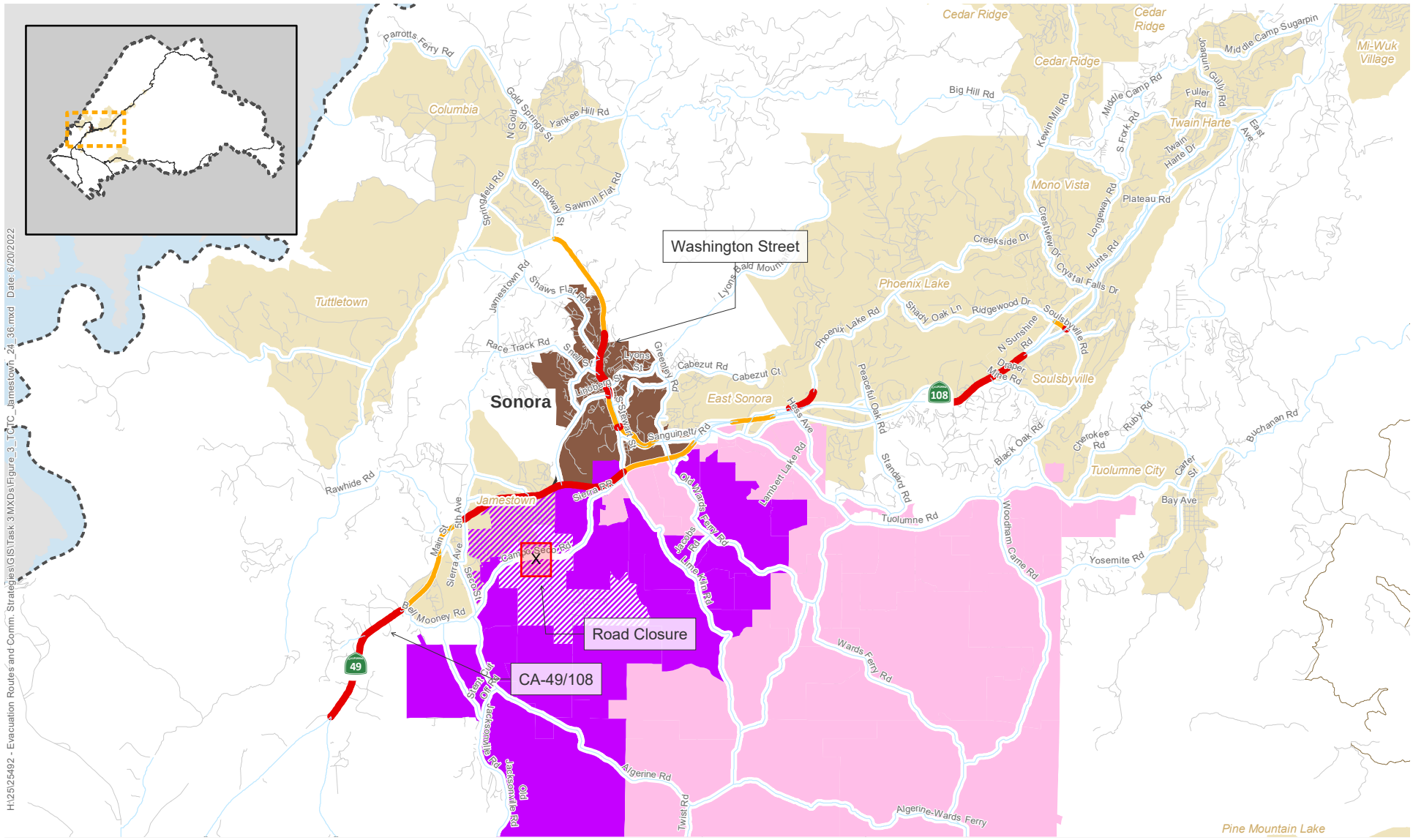


Figure 19

KITTELSON & ASSOCIATES JENSEN HUGHES

Golden Oaks Fire Scenario - 24 to 36 Hour
Tuolumne County, CA

GROVELAND

Under this scenario, the fire would begin northwest of Groveland and encroach quickly on CA-120 and the Pine Mountain community (see Figure 8 for the potential fire extents). Evacuation is concentrated along CA-120. The Pine Mountain community is served by one road, Ferretti Road with an exit in the east and west. In the later period, the fire would spread closer to Tuolumne City and communities that are oriented to travel to and from CA-108. In the second time period, the scenario assumes closure of roadway access to Wards Ferry Road and CA-120 east of Ferretti Road due to fire spread.

0 TO 12 HOUR SCENARIO

Figure 20 shows the volume to capacity ratio for 0 to 12 hours. Under the scenario, the peak hour evacuation is 120 vehicles. The model indicates that there is relatively little potential for congestion compared with the other scenarios. This is partly due to the absence of evacuation from the more heavily populated Pine Mountain area.

24 TO 36 HOUR SCENARIO

Figure 21 shows the volume to capacity ratio for 24 to 36 hours. During this scenario, Wards Ferry Road and CA-120 east of Ferretti Road are closed due to fire spread and evacuating trips were reassigned based on available exit routes. The peak hour evacuation is 1,300 vehicles. The model indicates potential congestion on:

1. **CA-120** between Ferreti Road and CA-49 is shown as congested or over capacity.

Evacuation from locations at the north end of the projected fire spread have the potential to create congestion similar to what is shown for the Apple Colony fire scenario.

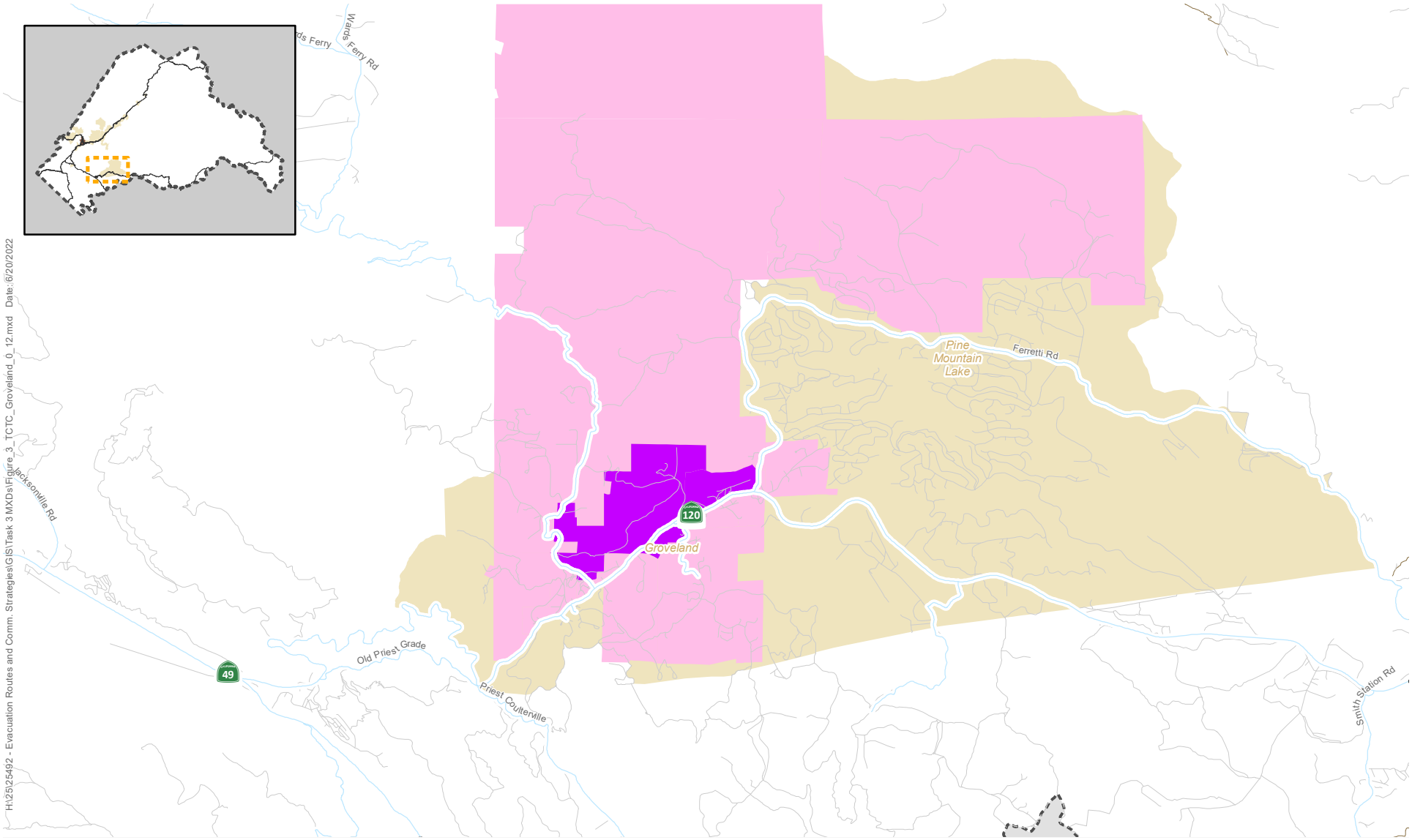


Figure 20

KITTELSON & ASSOCIATES JENSEN HUGHES

Groveland Fire Scenario - 0 to 12 Hours
Tuolumne County, CA

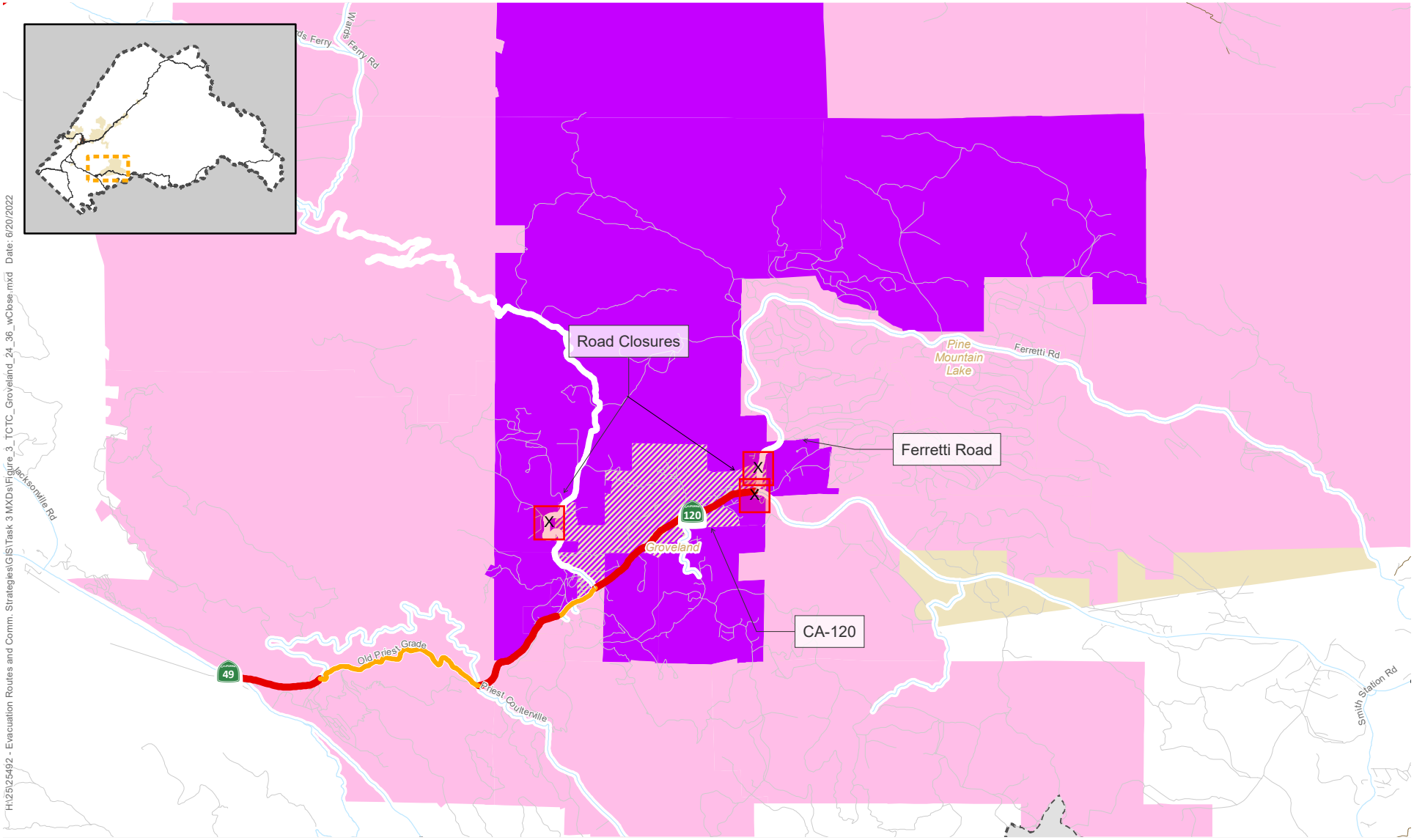


Figure 21

KITTELSON & ASSOCIATES JENSEN HUGHES

Groveland Fire Scenario - 24 to 36 Hours
Tuolumne County, CA

NEXT STEPS

Based on the results of the analysis, Kittelson will begin developing example treatment concepts for selected locations that are anticipated to experience congestion or over capacity conditions during an evacuation. These treatment concepts will also serve as models for implementing similar strategies at other locations throughout the county. Kittelson will work with TCTC staff to identify and select the locations best suited for the treatment concepts based on the results from the evacuation capacity analysis documented in this memorandum.

Appendix D: Strategies for Increasing Capacity and Efficiency

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JENSEN HUGHES

TECHNICAL MEMORANDUM

January 21, 2023 Project# 25492

To: Darin Grossi, Dore Bietz, Shannon Thaggard

From: Matt Braughton, RSP, Grace Carsky, Alex Garbier, Leyi Zhang

CC: Dr. Stephen Wong

Project TCTC Evacuation Routes and Communication Strategies

RE: Task 3: Strategies for Increasing Capacity and Efficiency

INTRODUCTION

This memorandum describes a set of strategies identified for improving the capacity and resilience of the County roadway network to support potential future evacuation events. The strategies were identified based on previous congestion and evacuation studies, review of recent evacuation efforts, and staff feedback. The strategies are organized into six groups:

1. Roadway Capacity and Resilience
2. Intersection Capacity and Resilience
3. Added Routes for Evacuation Planning
4. Improve Development and Vulnerable Community Access
5. Evacuation Management Guidance
6. Additional Demand Management

For each individual strategy, the following is identified:

- **Description** – Describes the strategy and desired outcomes. For example, while some strategies will increase capacity to meet projected needs, other strategies may seek to more efficiently conduct evacuations within available roadway capacity. It also identifies if the strategy is primarily an engineering or design project, an operational strategy, or a communication strategy.
- **Implementation Needs** – Identifies steps for planning for and implementing the strategy.
- **Limitations** – Notes considerations and potential drawbacks that could limit effectiveness or proclude use of the strategy in specific locations.
- **Case Studies** – Where there are applicable examples, case studies, or research, identifies where the strategy has been implemented and high-level notes.

At the end of the memorandum is a list of additional research and references that support or provide additional examples for the strategies. Following the modeling of the evacuation network, the strategies will provide a basis for developing concepts for potential evacuation

resiliency improvements at priority locations identified as having limited capacity during one of the evacuation scenarios. Note that interagency coordination will be needed in order to implement these strategies on state routes (Caltrans) or on other lands (e.g., US Forest Service).

The strategies presented in this memorandum are new and evolving and were chosen based on relevance to Tuolumne County. Appropriate case studies were chosen where possible; in some cases, no applicable examples could be identified.

GROUP 1 – ROADWAY CAPACITY AND RESILIENCE

This group includes strategies and treatments to improve vehicle flow and capacity along roadways. For each of these treatments, it is necessary to consider downstream capacity limitations and identify if those limits nullify potential benefits of the treatment.

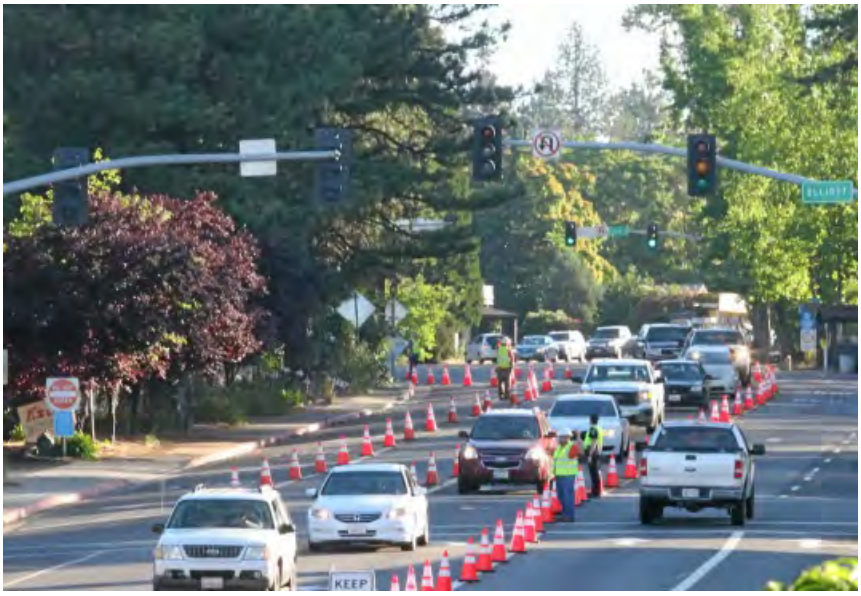
1.1 REVERSIBLE LANE/CONTRAFLOW

Description: Operational strategy where capacity is added in one direction by reorienting one or more travel lanes to flow in the direction of the evacuation and away from the hazard. This strategy can be attractive since it generally requires minimal infrastructure changes. Reversible lanes can be set up over long distances, such as highways, or on localized segments, such as in neighborhoods that may only have a single egress route.

The strategy requires staff to implement traffic control at intersections to prioritize evacuation movements and restrict turn movements and lane changing (e.g., on- and off-ramps along highways). In particular, intersections must be set up to prevent traffic in the closed direction. Signage and other safety measures need to be implemented on both sides of the roadway to ensure drivers are aware of roadway changes, especially along longer stretches where contraflow is implemented. Existing or new changeable message signs may be used to help communicate changes to the typical roadway traffic patterns. Additionally, opportunities to modify existing signs to be turned around when needed, or to indicate wrong way movement when the lane has been reversed, should be considered and evaluated.

Managing movements at intersections is critical. As a result, staffing and level of effort to establish the treatment depends on the number of intersections along the roadway, with the treatment being harder to implement on roads with more intersections.

Figure 1: Reversible Lane Test – Paradise, CA



Source: Paradise Post, Rick Silva

Implementation Needs:

Prior to Implementation:

- Staffing plan, including an implementation leader, a communication leader, and number of staff to be deployed to evacuation areas.
- Plans for reorienting traffic, including (1) ensuring available routes for emergency vehicles to travel against traffic, and (2) altering intersection operations to avoid conflict at sites where roadways connect with the evacuation route with reversible lanes.
- Timeline for implementing the strategy, including time needed to clear traffic from the lane that will be reversed and time to reroute traffic from connecting roadways.
- *Potential Construction Needs* – Implementation may require roadway or shoulder expansion to provide sufficient space for emergency vehicles to travel against traffic. Reversible LED lane signs can also be considered to visually communicate the change in direction of traffic during an evacuation.
- Establish communication plan to include contact with the Caltrans Traffic Management Center

During Implementation:

- Contact Caltrans Traffic Management Center
- Staff to be deployed to intersections to manage vehicle flow and prevent vehicles from entering the reversible lanes from connecting roadways.
- A communication plan for staff during implementation.

- Signs, cones, and/or bollards for road closures and detour routes.

Limitations: One of the primary limitations of the strategy is whether the roadway cross-section and right of way provide sufficient space to allow emergency vehicles to travel against evacuation traffic (either in a travel lane or on the shoulder). Contraflow also requires a large number of staff, enough resources (e.g., cones and signs), and sufficient time to implement. Staffing limitations may delay the implementation of the strategy or limit where the strategy can be implemented.

Case Study:

- Pacific Coast Highway Contraflow during the 2018 Woolsey Fire[1]

1.2 EMERGENCY SHOULDER USAGE

Description: Engineering and operational strategy that is a variation on Reversible Lane/Contraflow. Under the strategy, the shoulder of a roadway is widened and paved to allow for use as an additional lane of traffic for personal or emergency vehicles during evacuation. Cones or other markers may be used during implementation to identify lanes or reallocate space, as necessary, especially around intersections where the shoulder could conflict with normal turn patterns.

Where possible, the strategy may be preferred over reversible lanes/contraflow because it can be implemented very quickly, does not close the roadways to vehicles that would travel in the opposite direction, and requires less operational support for securing travel lanes and readjusting intersections.

See Strategy 3.2 for a related option. Under the strategy, a shared use path could be constructed along a roadway which could function as an emergency path during an evacuation.

Implementation Needs:

Prior to Implementation:

- Implementation plan, including signage, cones or other barriers, and timeline for implementation.
- Staffing plan, including an implementation leader, a communication leader, and number of staff to be deployed to evacuation areas.
- *Potential Construction Needs* – Review existing shoulders and available shoulder width and appropriate shoulder structure for candidate sites. Design and construct wider, paved shoulders where possible, and upgrade shoulder structure where needed to account for expected repeated use and/or heavy vehicle/truck use. Shoulders along evacuation routes could be marked with evacuation signs in advance to reduce the number of staff needed to place signage during an evacuation event.

[1] https://la.curbed.com/2018/12/13/18131163/wildfire-earthquake-evacuations-cars

During Implementation:

- Staffing to set up signage and cones/flex posts/bollards for shoulders.
- A communication plan for coordinating staff during implementation.

Limitations: In Tuolumne County, most shoulders are not sufficiently wide to currently support the strategy. As a result, this strategy would likely require road widening and removal of trees or other existing infrastructure, resulting in high construction costs. Consideration should be given to the presence of trailers, campers, and other wide loads which may complicate required travel widths. Staffing limitations may delay the implementation of the strategy.

Case Study:

- Florida DOT (FDOT) Emergency Shoulder Use[2] - Florida uses the strategy to increase traffic capacity during hurricane evacuations on highways. FDOT is replacing contraflow and lane reversal plans with emergency shoulder use since they do not require blocking traffic and securing and moving traffic across crossover sections of the interstate.
    - Note that this strategy may not be directly applicable to Tuolumne County due to the scale of the strategy and different evacuation scenarios (i.e., evacuations due to hurricanes and flooding). This strategy may be scaled down to certain areas in the County or along shorter segments of the roadway where shoulders are already wide enough for vehicles

GROUP 2 – INTERSECTION CAPACITY AND RESILIENCE

This group includes strategies and treatments to limit bottlenecks at intersections and reduce the potential for conflict. For each of these treatments, it is important to determine downstream intersection capacity limitations (i.e., are benefits dependent on intersection treatments?).

2.1 SIGNAL COORDINATION – GREEN CARPET (UNINTERRUPTED FLOW)

Description: Operational strategy where traffic signals along a corridor are set to prioritize the through the movement of evacuation traffic by (1) holding or reducing movement from side streets and (2) restricting left-turn movements. To minimize evacuation time, vehicles leaving the impacted area are prioritized while movements from areas not-yet impacted are restricted. This strategy can also discourage evacuees from detouring from the evacuation route. The strategy can also be applied in small areas where there may be a single traffic signal.

Implementation Needs:

Prior to Implementation:

- Identify corridors or locations where traffic signals are present and treatment is appropriate (e.g., holding movement from side streets does not prevent people from evacuating).

[2] https://www.fdot.gov/emergencymanagement/esu/default.shtm

- Create implementation and staffing plan to facilitate evacuation, including training staff to manually change signals if necessary.
- Develop local circulation plans (e.g., Tuolumne County Community Maps[3]) for communities where traffic might be held from major road. For example, develop plans to allow continued movement of people in Sonora if evacuation is prioritizing locations east of the city.
- Establish requirements for integrating new traffic signals into the system. If signals require manual changes, develop plan for implementing changes.

During Implementation:

- Track evacuation needs to ensure priority is given to areas most in need of evacuation (e.g., roadways with exisiting capacity issues).
- Staff at intersections where side-street traffic will be held to explain the situation and discourage illegal movements or to set up detour signage.
- A communication plan for staff to coordinate strategy implementation along the green carpet corridor.

Limitations:

- Strategy is likely not appropriate if evacuation is necessary from the communities impacted by the side-street red light. Tuolumne County has some communities with only one egress route, such that limiting use of the mainline road unacceptably limits local movement.
- May create additional confusion for drivers, either because it (1) prevents evacuees from diverging from through movement or (2) restricts drivers from entering from minor streets.
- Relatively few traffic signals in Tuolumne County for the strategy to be implemented at. The strategy does not provide Countywide benefits.
- Staff limitations may reduce the number of locations the strategy can be implemented at, especially if traffic control is needed.

Case Study:

- City of Placerville and Caltrans implemented a green carpet through the city of Placerville during evacuation for the Caldor Fire.[4] The green carpet was used to support evacuation of people residing east of Placerville. Caltrans District 3 deployed operators to implement signal changes and Placerville city staff put up signage for temporary closures supporting the green carpet and shared maps for local detours. Figure 2 shows the detour maps that the city of Placerville distributed for local detours.

[3] https://www.tuolumnecounty.ca.gov/1169/Community-Maps
[4] https://www.sacog.org/news/caldor-fire-evacuees-greeted-green-lights-through-placerville

Figure 2 Downtown Placerville Example



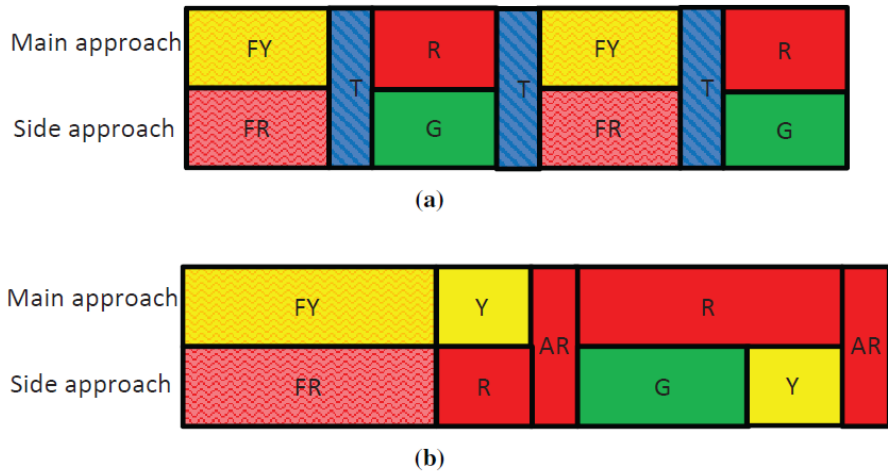
Source: El Dorado County

2.2 SIGNAL COORDINATION – DYNAMIC FLASHING YELLOW

Description: Operational strategy that is an alternative to the green carpet strategy. Under the strategy, traffic signals are set to use a flashing yellow signal on the main evacuation approach and a flashing red on the side street. This strategy may be more appropriate than a green carpet at intersections where a) side streets have significant traffic demand and/or b) there is an absence of available detour routes to serve side street traffic.

In Phase 1, flashing yellow–flashing red (FY/FR), the traffic signals on the main street flash yellow, whereas the side street signals flash red. In Phase 2, green–red (G/R), the main street signal will stay red, and the side street signal will turn green. The goal of using the G/R phase is to quickly clear waiting vehicles on the side streets. Figure 3 shows a signal plan for a dynamic flashing yellow.

Figure 3 Dynamic Flashing Yellow Timing Plans – Two Phase (a) and One Phase (b)



Source: Asamoah, C. A. (2014). Dynamic flashing yellow for emergency evacuation signal timing plan in a corridor: Semantic scholar. undefined. Retrieved May 4, 2022, from https://www.semanticscholar.org/paper/Dynamic-flashing-yellow-for-emergency-evacuation-in-Asamoah/f896455e97acf37f0cd01cc5f3bbb1ddbb79fc29

Implementation Needs:

Prior to Implementation:

- Identify corridors or locations where traffic signals are present and treatment is appropriate.
- Create an implementation plan for the strategy to facilitate evacuation, including staffing and communication plans.
- Establish requirements for integrating new traffic signals into the system.

During Implementation:

- Track evacuation needs to ensure priority is given to areas most in need of evacuation (e.g., roadways where capacity issues are already present, areas with no available detour routes for evacuations).
- Staffing potentially needed for managing side-street queues if there is concern of significant back-up under the alternative timing.

Limitations:

- Relatively few traffic signals in Tuolumne County.
- Staff may be needed to assist with managing traffic. In particular, drivers at extended red lights may elect to ignore signals. Staff limitations may reduce the number of signals where strategy can be implemented.

2.3 PREPARE FOR SIGNAL OPERATION DURING POWER OUTAGE

Description: Traffic signals may lose power prior to or during an evacuation due to a disruption caused by a fire or utilities shutting off power to avoid causing fires. New battery technology can substantially increase the time signals can operate on back-up power. If a traffic signal is not working, it can result in reduced throughput and increased crash risk.

In addition, during a power-outage, signals may default to an all-way stop. This prioritizes safe operation of the signal, but results are lower overall throughput. In the case of an evacuation, lower throughput could substantially reduce the efficiency of an evacuation. As a result, staff could evaluate whether to use an alternative timing during an outage, such as the flashing-yellow timing plan, or deploy staff to manage intersections instead of the default outage signal plan.

Implementation Needs:

Prior to Implementation:

- Review default signal timing behavior during power outages.
- Identify locations for setting specific evacuation timing in the case of a power outage.
- Identify how long a power outage may occur to understand need for battery backup.
- Identify where staff may need to be deployed for traffic control in the case of signal failure.

Implementation:

- Update batteries based on technology best able to meet evacuation needs.
- Identify signals where power outages may exceed existing battery power.
- Plan for power-outages during a evacuation, by either setting default signal operations or by planning for deployment of staff to manage intersections.
- Establish a battery check schedule to ensure batteries are always ready for an emergency.

Limitations:

- In the scenario where staff are needed at intersections for traffic control, staff limitations may delay strategy implementation or reduce the number of intersections where the strategy can be implemented.

Case Study:

- San Diego County began updating their traffic signals to replace existing lead, acid-based backup battery to nickel-zinc batteries. The change is projected to increase how long signals can run on back-up energy from four to six hour to more than 24 hours.[5]

[5] https://timesofsandiego.com/politics/2021/10/08/county-begins-to-place-long-life-batteries-in-traffic-signals-as-prep-for-outages-emergencies/

GROUP 3 – ADDED ROUTES FOR EVACUATION PLANNING

Group 3 includes strategies and treatments to increase the number of potential routes available for evacuation. These strategies will be further evaluated in subsequent work where trail data, forest service roads, and fire routes are evaluated for appropriateness.

3.1 MAINTAIN ROAD AND SHOULDER CLEARANCE PROGRAM FOR SECONDARY ROADS

Description: Creates a more resilient evacuation system by annually clearing critical secondary roads to reduce fire risk during evacuation. Based on context, specific roads may be identified for engineering treatments such as shoulder widening or tree removal to support use for evacuation. Plans may consider maintaining smaller or more difficult to travel roads exclusively for use by emergency vehicles.

Implementation Needs:

Prior to Implementation:

- Identify non-State roadways that provide primary or secondary evacuation routes.
- Identify roadways for clearing programs or additional treatments (e.g., shoulder widening).

During Implementation:

- Conduct clearing program for secondary roads

Limitations:

- Clearing roadways can be expensive and requires targeting of resources.

Case Study:

- The District of Makenzie, British Columbia was awarded grant funding to reduce flammable fuel along Highway 39, the only major egress route for evacuations. Fuel reduction treatments were applied on 120 hectares of high-risk areas along the corridor and fuel management prescriptions are planned for another 70 hectares.[6]

3.2 CONSTRUCT SHARED USE PATH THAT SUPPORTS VEHICLES

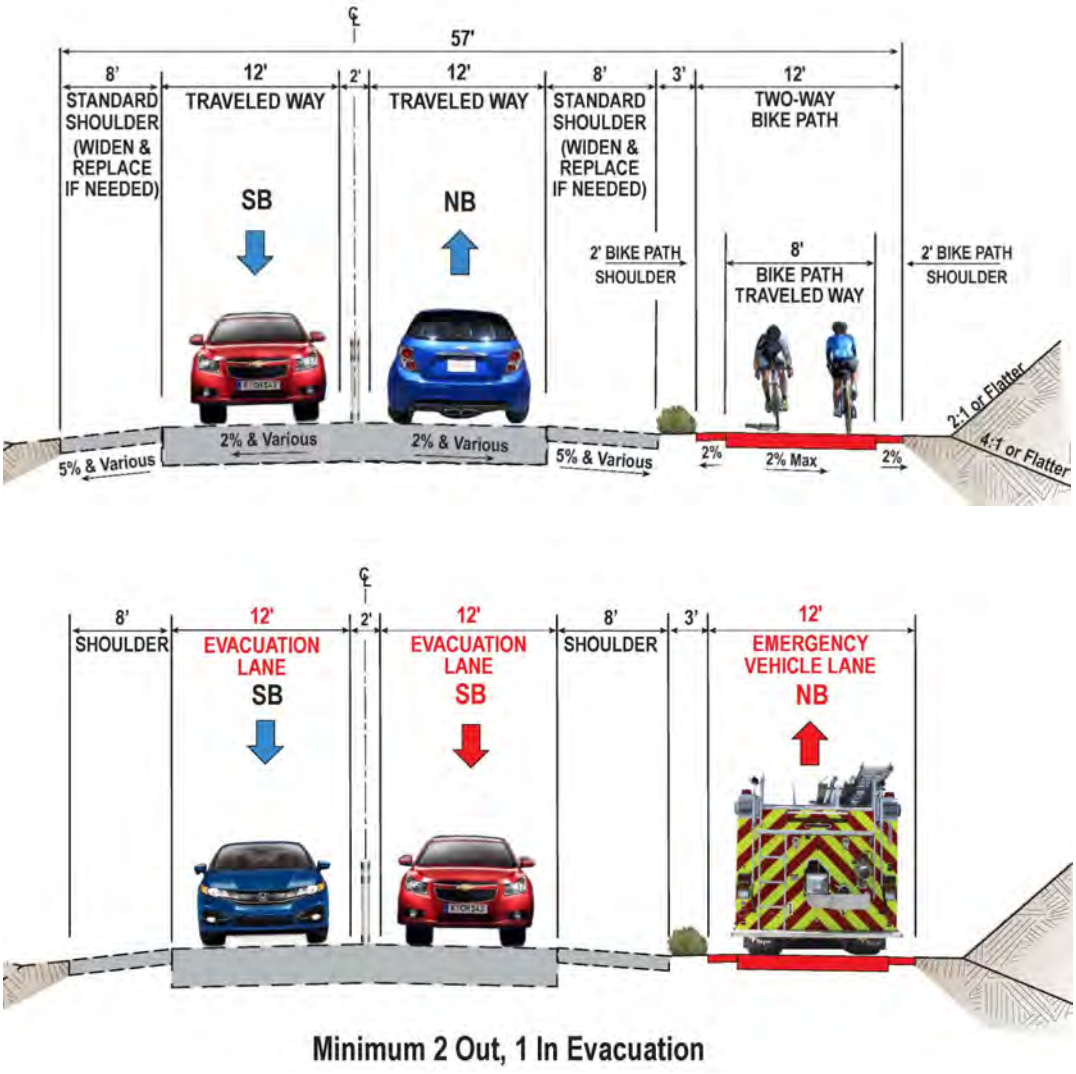
Description: An engineering strategy that constructs a shared use path that is built to a standard that would allow use by residential or emergency vehicles during an evacuation. Outside of an emergency, the shared use path would be accessible to residents and visitors for walking and biking. This strategy could be implemented separate from or parallel to a primary evacuation route. If constructed parallel to a primary evacuation route, the strategy would have similar operational benefits to Strategy 1.2 Emergency Shoulder Use.

This strategy requires careful access management design that prevents access to personal vehicles during normal periods, but which can be altered to allow emergency vehicle access

[6] https://www.fesbc.ca/community-of-mackenzie-now-has-a-safe-emergency-evacuation-route/

when necessary. Figure 4 presents an example of a shared use path that can be converted to an evacuation route or emergency vehicle lane.

Figure 4: State Route 67 Alternative with Two-Way Bike Path / Emergency Vehicle Lane



Source: Caltrans, https://dot.ca.gov/caltrans-near-me/district-11/current-projects/sr67-corridor/improvements

Implementation Needs:

Prior to Implementation:

- Identify zoning and land uses where shared use paths can be constructed.
- Review characteristics of the land to identify if the route would be appropriate for construction, including:
  - Provides a substantial benefit for emergency vehicles or evacuees.

- Grade change is either appropriate for vehicles or could be accomplished through reasonable efforts (e.g., can be constructed on a short timeline, through available funding, etc.).
- Maintenance is manageable (e.g., appropriate staff and funding is available).

During Implementation:

- Construct shared use path, including gates, bollards or flex posts that can be removed for vehicle access during evacuations.

Limitations:

- Cost-intensive strategy and potential for substantial land acquisition costs.
- Land adjacent to roadways may be owned by an assortment of agencies, including the City of Sonora, Tuolumne County, Chicken Ranch Rancheria of Me-Wuk Tribe, Tuolumne Band of Me-Wuk Tribe, USFS, and private owners. Coordination with landowners may be required if shared use paths are constructed through land not owned by the County.

Case Study:

- Caltrans is considering an alternative as part fo the State Route 67 Improvement Project in Southern California that would construct a two-way bike-path parallel to the road that could be redeployed for emergency vehicles.[7]

3.3 CONVERT PATH OR FIRE-ROAD TO POTENTIAL VEHICLE ACCESS ROUTE

Description: Identify locations where a new evacuation route or service road for emergency vehicles could be developed by modifying or converting a bike lane, path, or fire-road to serve potential evacuation routes. Depending on characteristics of the route, the bike lane, path, or fire road may only be viable as a route for emergency vehicles and inappropriate to use for evacuees. The strategy is envisioned as building off existing paths and fire roads rather than constructing a brand-new route.

Similar to the prior strategy, this strategy requires careful access management design that prevents access to personal vehicles during normal periods, but which can be removed to allow emergency vehicle access, as necessary.

Implementation Needs:

Prior to Implementation:

- Identify existing bike lanes, path, and fire trails that have potential for emergency vehicles to access and travel on.
- Review characteristics of the facility to identify if the route would be appropriate for conversion, including:

[7] Caltrans, "State Route 67 Highway Improvement Projects", https://dot.ca.gov/caltrans-near-me/district-11/current-projects/sr67-corridor/improvements

- Provides a substantial benefit for emergency vehicles or evacuees.
- Width of facility can accommodate emergency vehicles.
- Grade change is either appropriate for vehicles or could be accomplished through reasonable efforts (e.g., can be modified on a short timeline, through available funding, etc.).
- Maintenance is manageable (e.g., appropriate staff and funding is available).

During Implementation:

- Convert path or fire road into evacuation route (e.g., widening, paving, gates, etc.) for emergency vehicles. Adding, as necessary, additional access management to prevent personal vehicles from using facilities during normal periods.

Limitations:

- Cost-intensive strategy and potential for substantial land acquisition costs.
- Existing facilities may be managed by an assortment of agencies, including the City of Sonora, Tuolumne County, Chicken Ranch Rancheria of Me-Wuk Tribe, Tuolumne Band of Me-Wuk Tribe, USFS, and private owners. Coordination with land owners may be required if routes need to be modified or land needs to be acquired.

Case Studies:

- The District of Makenzie Community Wildfire Protection Plan notes that recreation trails can be constructed to support fire ground crews by building trails to a standard that support ATVs and installing gates and other barriers to manage access to unauthorized uses.[8]
- A cycletrack installed in London, UK was constructed to create a safe route for cyclists on the roadway. Although not designed for emergency access, the facility was sufficiently wide to support use by emergency vehicles to avoid congestion on the parallel road. [9]

3.4 BUILD / UPGRADE EXISTING ROAD TO STANDARD NEEDED FOR EVACUATION

Description: An engineering strategy that includes adding new roads or upgrading roadways to support evacuation activities. This strategy is similar to the strategy Maintain Road and Shoulder Clearance program in that the intention is to create a more connected roadway network for evacuations. The difference is that the previous strategies target existing roadways where maintenance would allow for use of the road for evacuation. This strategy is a more capital-

[8] District of Makenzie Community Wildfire Protection Plan 2017 Update: https://districtofmackenzie.ca/wp-content/uploads/2018/11/Mackenzie_2017_CWPP_Update-optimized.pdf
[9] *Think of Protected Cycleways as Priority Lanes for Ambulances.* https://www.forbes.com/sites/carltonreid/2020/07/07/think-of-cycleways-as-priority-lanes-for-ambulances/?sh=56b6f4a6e121

intensive strategy to install new or substantially alter existing roads, such as by expanding the width of the road.

Implementation Needs:

Prior to Implementation

- Identify locations with limited egress routes where improved maintenance or shoulder clearance is not sufficient to create alternative routes.

During Implementation:

- Select existing route or potential new route where roadway could be constructed.
- Design and construct route.

Limitations:

- Cost-intensive strategy and potential for substantial land acquisition costs. May also require coordinating with an assortment of agencies, including the City of Sonora, Tuolumne County, Chicken Ranch Rancheria of Me-Wuk Tribe, Tuolumne Band of Me-Wuk Tribe, USFS, and private owners.

GROUP 4 – IMPROVE DEVELOPMENT AND VULNERABLE AREA ACCESS

Group 4 includes strategies and treatments to reduce potential bottlenecks on roads serving residential developments and, as possible, increase the efficiency of evacuation routes.

4.1 ADD SECONDARY / ADDITIONAL ACCESS TO VULNERABLE COMMUNITIES

Description: Tuolumne County and CalFire have identified multiple small communities and developments where residents are served by one or two access points. In the event of a rapid evacuation, this could lead to congestion in the development or at locations where vehicles connect with a major roadway. In addition, a fire could more easily block access by closing the available evacuation route. Figure 5 shows the locations of communities along CA-108 that have been identified by CalFire or the County as having limited egress points.

Moving forward, State Bill 99 (SB 99), signed on August 30, 2019, requires jurisdictions to identify residential developments in hazard areas that do not have at least two evacuation routes upon the next revision of their housing elements.[10] Under the strategy, additional egress routes would be developed to serve evacuation. Where possible, the added access would allow for evacuation in a different direction in case a fire closes an available route.

Implementation

Prior to Implementation:

- Identify communities and locations with limited access and egress.

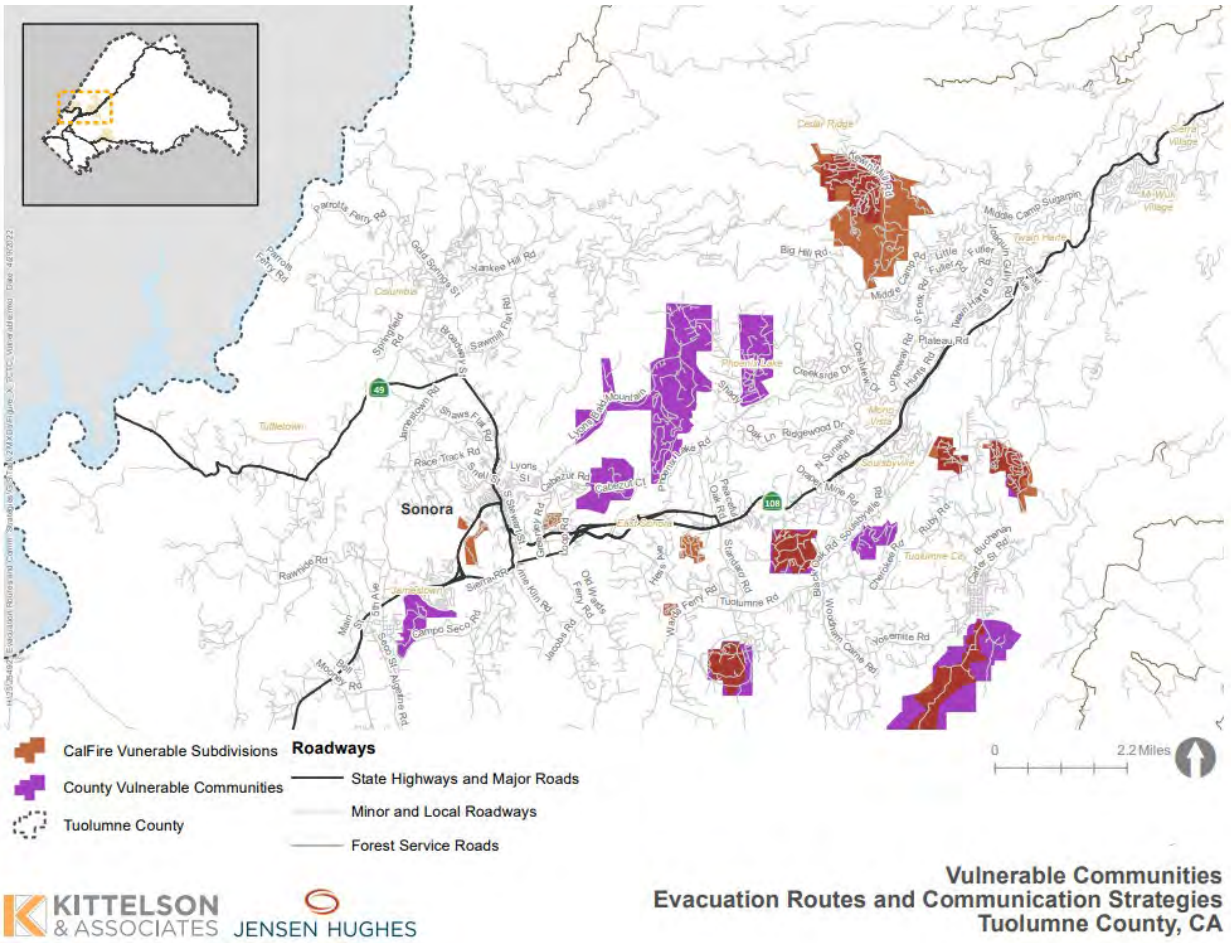
[10] https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201920200SB99

- Review potential locations where additional egress could be developed.

During Implementation:

- Option 1 – Construct new roadway access.
- Option 2 – Create a private access that would be available only in the event of a fire.
- Option 3 – Prepare a trail or other pathway that connects to locations where pick-up is possible.

Figure 5: Vulnerable Community Locations



Source: Kittelson & Associates, Inc. with data from CalFire and Tuolumne County

Limitations

- Geography may limit options for egress, such that secondary access would be to the same evacuation route. This would still add resilience and better distribute trips merging onto the evacuation route.
- Viable routes may require the acquisition of private property.
- Projects may be expensive and provide relatively little county-wide benefit.

- Routes only available during an evacuation may have access limitation that need to be removed during an evacuation, such as gates or bollards.

Case Studies:

- Debris blocked a road that serves as a single exit for a community during the 2017 Northern California Fire which resulted in residents being helicoptered to safety.[11]
- Access could be completed as pedestrian access. High Knob, a subdivision in the mountains of Virginia, developed an evacuation map that includes an evacuation route used as a defined trail. The evacuation route is for foot access only.[12]
- Kensington, CA has an designated evacuation route through a cemetary. Normally the route is blocked by bollards that must be removed during an evacuation.[13]

GROUP 5 – GUIDANCE TO REDUCE ROADWAY DEMAND

Group 5 includes strategies to manage roadway capacity and communicate roadway conditions. Both strategies will be discussed in more detail as part of the communication and outreach tasks.

5.1 PHASED EVACUATION

Description: During an evacuation from a fire, it is critical to prioritize use of available roadway capacity for households who need additional time to evacuate and who are closest to the fire. In contrast, it is important to reduce congestion generated by individuals who are not in immediate risk. A survey of evacuees in three recent California fires found that 29% to 75% of households evacuated even though they did not receive a mandatory evacuation order.[14] These households include those that failed to receive an order due to a communication failure and those that chose to leave despite a relatively low risk. For the latter choice, these trips can generate downstream congestion that limit the movement of highest risk individuals.

Phasing an evacuation can help to optimize the use of available roadway capacity for serving the highest needs. Phasing can be implemented through communication strategies and through roadway operations, such as holding side-street access or routing non-critical evacuation through alternative routes where possible. In addition, the strategy could employ a "pre-stage" evacuation, encouraging visitors to leave before capacity must be marshalled for critical needs.

Implementation

Prior to Implementation:

- Develop communication plan with evacuation zones for staging evacuations. Include communcation to zones to identify a) zones that need to evacuate immediately, b) zones

[11] Wong, S., Broader J., Shaheen, S. (2020) "Review of Wildfire Evacuations from 2017 to 2019." 1-76. Available at: https://escholarship.org/content/qt5w85z07g/qt5w85z07g_noSplash_a1016d9a321138365ab7e2311309a373.pdf?t=q7c4sj
[12] https://www.hkoai.com/evacuating-to-safety
[13] https://www.kensingtonfire.org/files/66a907ac3/Kensington+Evacuation+Research+Project+Final.pdf
[14] https://escholarship.org/uc/item/5w85z07g

that need to be ready to evacuate with notice (i.e., zones on "stand-by"), and c) zones that do not need to evacuate.

- Develop an outreach plan to explain when to evacuate and potential restrictions to travel on side-streets.
- Identify locations with multiple evacuation routes, that could be rerouted to reserve capacity to maintain capacity for high-risk evacuees.
- Identify locations or populations where additional evacuation time is needed (e.g., medical facilities, low-car ownership areas, and elderly communities).

During Implementation:

- Communicate mandatory evacuation by evacuation zone.
- Limit or reroute non-critical evacuation by evacuation zone.
- Observe known bottlenecks to understanding ongoing capacity (ITS Strategies).

Limitations:

- Fast moving fires could overwhelm phased evacuation.
- Visitors may be less aware of the communication plan for evacuation and may be more likely to evacuate prior to mandatory evacuation.
- A strong desire of some visitors and residents to evacuate towards the Central Valley and avoid non-direct evacuation routes (e.g., travel east out of Tuolumne County) can add congestion to the roadway network.
- Power outages or limited cell signals that hamper ability to communicate quickly.

Case Studies:

- Sonoma County assigns every area of the County to a pre-planned evacuation zone and then uses three emergency orders to manage evacuations.[15] One of the orders is "Shelter-in-Place" which is used both for when evacuation is impossible *and* if evacuation is unnecessary.
- Paradise Fire – Report found that due to a failure of communication systems, residents evacuated at the same time rather than a planned phased evacuation, leading to increased congestion that was exacerbated by fire impacting evacuation routes.[16]

[15] Know Your Zone – Sonoma County - https://sonomacounty.maps.arcgis.com/apps/instant/lookup/index.html?appid=58500b81c61148279263bed52403c81a

[16] (St. John and Serna, 2018; Serna et al., 2018)

5.2 INTELLIGENT TRANSPORTATION SYSTEM

Description: Good communication is critical during a fire, both for outreach to residents and visitors, and for coordinating activities among staff and emergency personnel. Real-time monitoring of travel conditions and disseminating travel information to evacuees (Highway Advisory Radio Systems (HAR), Dynamic Message Signs (DMS)) can be used during evacuations. The most common area of ITS application can be used for real-time monitoring of travel conditions. Several states, including South Carolina, Florida, and Louisiana, were either using or are planning to use remote traffic detection systems. Additionally, fiber technology can enhance the capability to detour routes, guide the traveling public, and assist in using changeable message signs and/or signals during emergency scenarios. Consideration should also be given to the use of cellular data and text message to assist with communication.

ITS are also planned to disseminate travel information to evacuees. Two of the systems planned for use are HAR and DMS. In contrast to traffic counter and CCTV systems that bring data in, HAR and DMS systems get information out. To make the most effective use of these tools (HAR has a limited range of about 3–5 miles), states were planning to use them in advance of exits and interchanges where services and alternative routes were available. The type of information conveyed through HAR and DMS included shelter locations, alternative evacuation routes, congestion, incident information, and services such as gas station, rest area locations, lodging availability, among others.

Implementation Needs:

Prior to Implementation:

- Implementation plan, including identifying roadways and intersections for ITS improvements.
- Available communication network connection.

During Implementation:

- Communicate updates through the system.
- Observe known bottlenecks to understanding ongoing capacity (ITS Strategies).

Limitations:

- Costs to implement ITS equipment is high and may be a barrier.
- Potential for equipment to be damaged by fire.

GROUP 6 – DEMAND MANAGEMENT

Group 6 includes strategies and treatments to manage demand and potential conflicts by closing or prohibiting use of roads or parking.

6.1 CLOSE ROADS / PROHIBIT STREET PARKING

Description: Identify roads and parking locations along major evacuation routes to close. This strategy could be implemented during high-risk conditions or during an evacuation. Closing

roads is targeted towards limiting people from visiting high risk areas during evacuations. It could also be used to reserve roadway access for emergency vehicles. Prohibiting parking can support evacuation by limiting travel to a high-risk area or by reducing conflicts created by vehicles leaving or merging into traffic. Parking may also be prohibited where normal parking activity may impede emergency vehicles from reaching critical infrastructure, especially on narrow roadways.

Implementation Needs:

Prior to Implementation:

- Identify conditions needed to close a road to the public and determine if there are unintended consequences from the closure. Identify roadways that could be closed without negatively impacting evacuees and emergency vehicles.
- Identify locations where prohibiting parking would support evacuation and post signs identifying potential parking restrictions.

During Implementation:

- Communicate which closures and prohibitions are in effect.
- Staff support to set up temporary closure of roads and on-street parking, including traffic control signs and gates.
- Communication and outreach to locations where visitors may be concentrated (e.g., campsites, resorts).

Limitations:

- Road closures could impact existing residents and may need to be established as only applying to visitors.
- Communication of the parking program would need to include a communication plan for visitors in Tuolumne County that may be unaware of roadway and parking restrictions and alternative routes.
- Program could conflict with normal parking behavior near trail heads and other outdoor destinations.
- Staff limitations may reduce the number of locations where the strategy can be implemented.

Case Studies:

- The City of Los Angeles maintains a “Red Flag” program for prohibiting parking on specific roads and locations.[17]
- The City of Oakland has previously closed multiple narrow high fire risk roads over the July 4th weekend to limit potential for fire ingition.

[17] https://ers.lafd.org/redflag/

6.2 MANAGE OFF-STREET PARKING AT MAJOR TRIPS GENERATOR

Description: Large trip-generating land uses can create substantial traffic. If those uses are located along or near a major evacuation corridor, traffic related to the land use could impede evacuation. Closing specific access or actively managing parking entrances to orient traffic away from evacuation routes could reduce potential for congestion, either by reorienting traffic or discouraging evacuees leaving and then reentering flow of traffic.

Implementation Needs:

Prior to Implementation:

- Identify large trip generating land uses and determine if specific parking plans could be developed that orient traffic away from known congestion points.
- Create a staffing plan to assist with parking and access management. This can include training staff at local businesses to manage parking and access.

During Implementation:

- Deploy staff to help implement closures or management processes.

Limitations:

- Closing parking lots and reorienting traffic may require coordination with local businesses.
- May create confusion or opposition from residents and businesses impacted by changes.
- Staffing limitations may reduce the number of locations where the strategy can be implemented.

6.3 TOW TRUCK AVAILABILITY

Description: Crashes or other vehicle breakdowns quickly impede the flow of traffic. As a result, having tow-trucks or other support vehicles strategically located is greatly beneficial for quickly identifying and responding to evacuation events. In Tuolumne County, roadways are already often limited to two lanes, such that road blockages must be resolved quickly. This strategy can be combined with ITS and other communication plans to ensure information about events is communicated rapidly.

Implementation Needs:

Prior to Implementation:

- Identify locations where tow trucks can be stationed to easily access evacuation routes (e.g., parking lots, pull outs, rest stops).
- Identify locations where capacity issues are more likely to occur or where it is more difficult for teams to access stopped vehicles.

During Implementation:

- Deploy tow truck teams proactively to cover evacuation routes and respond to issues as they arise.

Limitations:

- Roadways in Tuolumne County are often only two lanes without a shoulder, such that vehicles are difficult to pass once stopped. Additional lanes may need to be constructed or adjacent roadways identified for tow trucks to travel.

Case Study:

- Bulldozers were used to remove abandoned vehicles during the Camp Fire.

CONCLUSION AND NEXT STEPS

This memorandum describes a set of strategies identified for improving the capacity and resilience of the county roadway network to support potential future evacuation events. The strategies were identified based on previous congestion and evacuation studies, review of recent evacuation efforts, and staff feedback. A list of additional research and references that support or provide examples for the strategies begins on the following page. After completing the modeling of the six evacuation scenarios, the strategies will provide a basis for developing concepts for potential evacuation resiliency improvements at priority locations identified as having limited capacity during one of the evacuation scenarios.

ADDITIONAL REFERENCES

This section lists additional research and references for operational, engineering, and communication strategies for evacuation scenarios.

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3.1 MAINTAIN ROAD AND SHOULDER CLEARANCE PROGRAM FOR SECONDARY ROADS

- Caltrans Roadside Fire Fuels Reduction: https://dot.ca.gov/programs/maintenance/roadside-fire-fuels

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Appendix E: Vulnerable Populations and Vulnerable Communities – Strategies for Evacuation

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TECHNICAL MEMORANDUM

January 21, 2023

Project# 25492

To: Darin Grossi, Dore Bietz, Shannon Thaggard

From: Matt Braughton, RSP1, Grace Carsky, Sravya Kamalapuram

CC: Dr. Stephen Wong, Alex Garbier

Project: Tuolumne County Evacuation Needs Assessment

RE: Task 4: Vulnerable Populations and Communities – Strategies for Evacuation

INTRODUCTION

This memorandum describes the vulnerable populations and communities in Tuolumne County that are at increased risk during a wildfire evacuation. The memo identifies a set of strategies to support evacuation for each vulnerable population and presents opportunities for additional access and egress routes in an emergency evacuation for vulnerable communities.

The strategies were identified based on best practices, case studies, and current research. Each vulnerable population or community is described and mapped (where data is available). Each potential strategy is presented with a description of the strategy, the needs prior to and during implementation, and the vulnerable populations that benefit from the strategy.

VULNERABLE POPULATIONS AND COMMUNITIES IN TUOLUMNE COUNTY

This section identifies and describes the vulnerable populations and communities in Tuolumne County that face increased barriers to evacuating quickly and safely during a wildfire or other emergency scenario.

Vulnerable populations are groups of people with special characteristics that can make evacuations more difficult. Note that California Office of Emergency Services uses the Access and Functional Needs (AFN) Populations to capture similar populations. Characteristics can be related to lack of transportation (e.g., personal cars or public transportation), socioeconomic factors (e.g., low income, non-English speakers, etc.), or physical impairments. Each of these potential vulnerabilities are described below. Note that populations who live "off the grid" or lack access to means of communication are also vulnerable during evacuation – the strategies for communication with the vulnerable populations noted above can be adapted to coordinate with these populations for evacuation communication strategies.

Vulnerable communities are defined as community areas with limited access or egress that could limit fast and efficient evacuations. The California Department of Forestry and Fire Protection (CalFIRE), Tuolumne County Office of Emergency Services (Tuolumne County OES), and members of the project development team (PDT) have identified several vulnerable communities with limited ingress/egress routes. For each of these communities, one or more additional routes has been identified as a potential access or egress route for evacuations or emergency vehicles. Note that all of these new connections are subject to additional study and may require coordination with and approval from private or public land owners to construct.

VULNERABLE POPULATIONS

RECREATIONAL VISITORS/TOURISTS

There are several popular outdoor destinations that bring visitors and tourists to Tuolumne County. Recreational sites such as Don Pedro Reservoir, Pine Mountain Lake, Pinecrest, and Yosemite National Park bring people from all over the state and country for swimming, boating, camping, and hiking in the summer months. Visitors and tourists staying in Airbnbs and rental cabins are unlikely to know the local roadway network to evacuate in case of an emergency. Activities like camping and hiking can be in areas with poor cell and radio service, making it difficult to provide up to date emergency information to those in the area during evacuations. Figure 1 highlights some key recreational areas within the County where the proportion of visitors and tourists are highest during fire season.

POPULATIONS WITH ZERO ACCESS TO PERSONAL VEHICLES

According to US Census data, approximately 5% of County residents do not have a vehicle. In the case of an evacuation, these populations would need to carpool during the evacuation, use public transportation or shuttles, or walk or bike to evacuate in an emergency.

SENIOR CENTERS / GROUP HOMES

There are many senior centers/group homes in Tuolumne County, including Sierra Foothill Senior Center, The Gathering Place, Skyline Place, Sonora Senior Living, Adventist Units 6 & 7, Avalon Assisted Living, Sonora Regional Hospital, and many others. Residents of senior centers and group homes can be particularly vulnerable because they may have physical disabilities or medical conditions that prevent them from evacuating themselves in an emergency situation, or they do not have access to personal vehicles for evacuations. These populations are older and may also be disconnected from digital communication forms.

POPULATIONS WITH LIMITED MOBILITY

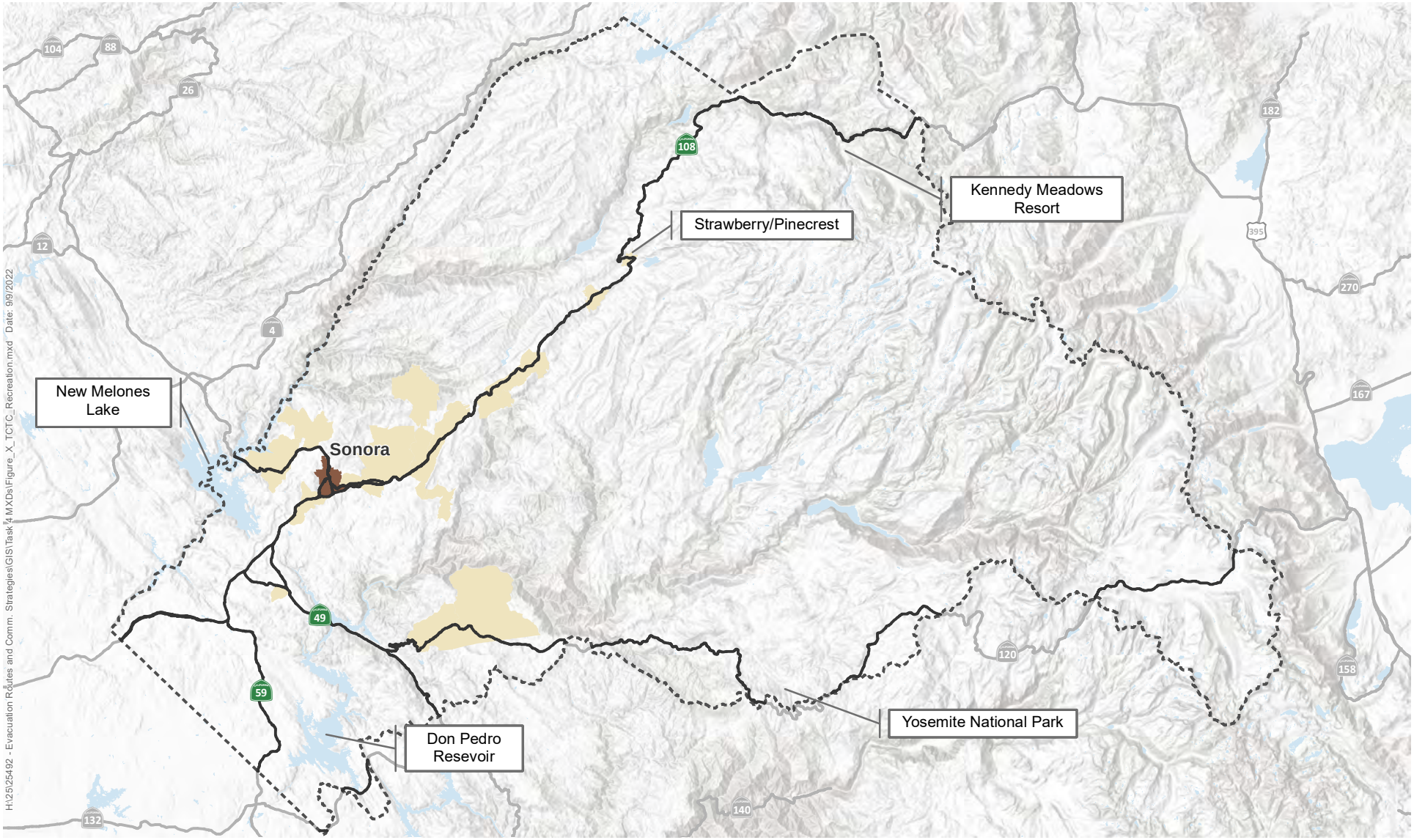
Populations with limited mobility, which can include seniors and people with disabilities, may experience more difficulty evacuating. Disabled people living on their own and seniors that choose to age in place are usually dependent on family, friends, and public transportation to move around the County. These populations would need to find a vehicle in order to evacuate.

HISPANIC AND NON-WHITE POPULATIONS

According to US Census data, approximately 12% of the population in Tuolumne County identifies as Hispanic or non-white. These populations may suffer discrimination based on physical and cultural traits. These populations may also be limited in their English proficiency and may have difficulties understanding emergency communication or require translated communications.

TRIBAL COMMUNITIES

There are two tribal communities in Tuolumne County: the Tuolumne Band of Me-Wuk Indians, and the Chicken Ranch Rancheria of Me-Wuk Indians. Many members of these communities live in more isolated areas where wildfire risks are higher and communication maybe be more difficult. These populations may also suffer discrimination based on physical and cultural traits.



Roadways

State Highways

Cities

Census Designated Places

Tuolumne County

0 10 Miles

Figure 1

Recreational Areas
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES

EVACUATION STRATEGIES FOR VULNERABLE POPULATIONS

STEPS TRANSPORTATION EQUITY FRAMEWORK FOR WILDFIRE EVACUATIONS

The STEPS – Spatial, Temporal, Economic, Physiological, and Social – transportation equity framework looks at different factors for transportation equity and relates them to wildfire evacuations[1]. The STEPS framework was originally crafted to understand deficiencies in identifying barriers to shared mobility but can be adapted and applied to vulnerable communities in emergency events. Table 1 provides an overview of the categories, their definitions, and application to wildfire evacuations. Each evacuation and community strategy presented in the next section will address one or more of the STEPS framework categories. Additional information and guidance can also be found in the Federal Highway Administration's Evacuating Populations with Special Needs document.[2]

Table 1. STEPS Equity Framework for Wildfire Evacuations

Dimension	Definition	Application to Tuolumne County Wildfire Evacuations
Spatial	Spatial factors that compromise travel needs (e.g., long distances between destinations, lack of public transit)	▪ Single ingress/egress routes ▪ High risk fire zones ▪ Lack of public transportation/carpooling within walking distance ▪ Shelters located far away
Temporal	Travel time barriers that inhibit a user from completing time-sensitive trips (e.g., reliable public transit, limited transit operating hours, roadway congestion)	▪ Minimal communication notifications for evacuations ▪ Travel time along Tuolumne County roadways ▪ Rapid fire spread due to weather
Economic	Direct and indirect costs of basic travel that create economic hardships (e.g., vehicle ownership, credit card access)	▪ Cost of gasoline, hotels, supplies for evacuation ▪ Vehicle ownership
Physiological	Physical and cognitive limitations that make using standard modes of transportation difficult or impossible (e.g., small children, vision/hearing impairments, disabilities)	Vulnerable groups including: ▪ Group/senior living residents ▪ Disabled residents ▪ Schools
Social	Social, cultural, safety, and language barriers that can inhibit a user's comfort with transportation (e.g., lack of multi-language information, perceived safety in neighborhoods)	Vulnerable groups including: ▪ Non-English speaking residents ▪ Immigrants or undocumented residents ▪ Tribal residents ▪ Racial and ethnic minorities ▪ Visitors/tourists

Source: Adapted from *Can Sharing Economy Platforms Increase Social Equity for Vulnerable Populations in Disaster Response and Relief? A Case Study of the 2017 and 2018 California Wildfires*, S. D. Wong et al., 2020; *Travel Behavior: Shared Mobility and Transportation Equity*, S. Shaheen et al., 2017.

[1] Wong, S. D. et al (2020). A Revealed Preference Methodology to Evaluate Regret Minimization with Challenging Choice Sets. Travel Behaviour and Society, 20, 331–347. https://doi.org/10.1016/j.tbs.2020.04.003

[2] FHWA Evacuating Populations with Special Needs: https://ops.fhwa.dot.gov/publications/fhwahop09022/fhwahop09022.pdf. Accessed October 2022.

VULNERABLE POPULATION EVACUATION STRATEGIES

PEER-TO-PEER CARPOOLING

Description: A carpooling system can be developed during an emergency evacuation scenario. Carpooling programs can be done locally (e.g., by a neighborhood or commercial area) or jurisdiction wide (e.g., by the County or CDP). Carpooling can be coordinated with existing transit agencies and infrastructure, such as bus stops, park and ride lots, commercial parking lot, community buildings, etc., can be used for pick-up locations. Personal or commercial vehicles can be used to pick people up and carpool to safe areas within or outside the County. At the local level, a carpooling system can also help with communication efforts and information sharing. Carpooling can help evacuate more people in fewer vehicles, reducing congestion on evacuation routes during an emergency.

STEPS Dimensions Addressed: Spatial, Temporal, Economic, Social, Physiological

Communities Addressed: Populations with zero vehicles, residents of senior centers/group homes, populations with limited mobility, minority populations, tribal communities, communities with limited ingress/egress

Implementation Needs[3]:

- Identify areas that would benefit from a carpooling program (e.g., communities with limited ingress/egress).
- Coordinate with neighbors, local buisnesses, and Tuolumne TRIP to identify volunteers for carpooling at the local level. For businesses or commercial centers, idenitfy if there are commerical vehicles (e.g., delivery trucks) that can be used for evacuation of people or supplies.
- Coordinate with Tuolumne County Transit/Tuolumne TRIP to identify pick-up and drop-off locations and the frequency of vehicle pick-ups.

PUBLIC TRANSPORTATION IN EVACUATIONS

Description: This strategy is similar to a carpooling system, where public transportation is utilized to evacuate residents in emergency situations. Existing transit routes, stops, and vehicles can be utilized during an evacuation for a cost-effective evacuation strategy. Using public transportation can help evacuate more people in fewer vehicles, reducing congestion on evacuation routes during an emergency. The Transportation Emergency Operations Plan[4], developed by Tuolumne County Transit Agency (TCTA), provides guidance for transportation providers to make informed decisions for their operations during emergency evacuation events.

[3] For additional information, Wong et al. (2020) provides extensive recommendations for agencies to facilitate equitable shared mobility.
[4] Tuolumne County Transit Authority Transportation Emergency Operations Plan, November 2012. https://www.tuolumnecountytransportationcouncil.org/_files/ugd/fe950e_faa3f90c82b4480a9dfe3362559d02c8.pdf

TCTA is currently developing a park and ride lot along SR-49/108. This lot could potentially be used as a staging area when evacuating vulnerable populations.

STEPS Dimensions: Temporal, Economic, Physiological

Communities Addressed: Populations with zero vehicles, residents of senior centers/group homes, populations with limited mobility, minority populations, communities with limited ingress/egress

Implementation Needs:

- Coordination with Tuolumne County Transit and school districts. Identify staff that can lead the carpool program during an evacuation.
- Identify pick-up locations along transit routes, school bus routes, and drop-off locations outside the evacuation area.

RESORT/HOTEL SHUTTLES IN EVACUATIONS

Description: Similar to the carpooling and public transportation strategies but with focus on recreational areas and populations. Visitors to the County are unlikely to know the roadway network and may require additional assistance during an evacuation. Recreational visitors, such as those camping and backpacking, may not have a personal vehicle near-by in the event of an evacuation. Hotel and resort shuttles, such as the SkiBUS, Yosemite Area Regional Transportation System (YARTS) buses, or shuttles in resort areas can be utilized to evacuate residents and visitors in tourist areas.

STEPS Dimensions: Spatial, Temporal, Social

Communities Addressed: Recreational users/visitors

Implementation Needs:

- Coordination with hotels and resorts to identify staffing for evacuations and existing buses/shuttles to evacuate people.
- Identify pick-up and drop-off locations for visitors.
- Create information packages for visitors to share where to go and what to do in an emergency situation.

TRANSLATED COMMUNICATION MATERIALS

Description: To reach non-English speaking populations, all physical and verbal communication materials should be translated into languages that are largely spoken in the County. This may include recreational areas, especially in places in and around Yosemite National Park, which sees many international visitors.

STEPS Dimensions: Social

Communities Addressed: Minority Populations, Recreational users/visitors

Implementation Needs:

- Identify languages most spoken in the County.
- Staff time to create, translate, and distribute evacuation communication materials.
- Identify staff or volunteers who can communicate in the identified languages in the scenario that in-person assistance in needed during an evacuation.

RECREATIONAL VISITORS COMMUNICATION MATERIALS

Description: To reach non-residents and visitors in the County, all physical and verbal communication materials should be distributed to hotels, campgrounds, and businesses with large tourist populations. Hotels and AirBnbs can consider adding emergency evacuation guideline pamphlets in each room or welcome book; businesses, campgrounds and other outdoor recreational sites can consider posting evacuation guidelines on notice boards. Staff of hotels, recreation centers, campgrounds, and businesses should also be educated on evacuation guidelines to inform visitors in the case of an emergency evacuation event.

STEPS Dimensions: Social

Communities Addressed: Recreational users/visitors

Implementation Needs:

- Identify recreational areas in the County.
- Staff time to create and distribute evacuation communication materials.
- Identify and educate staff or volunteers who can communicate evacuation orders in the scenario that in-person assistance in needed during an evacuation.

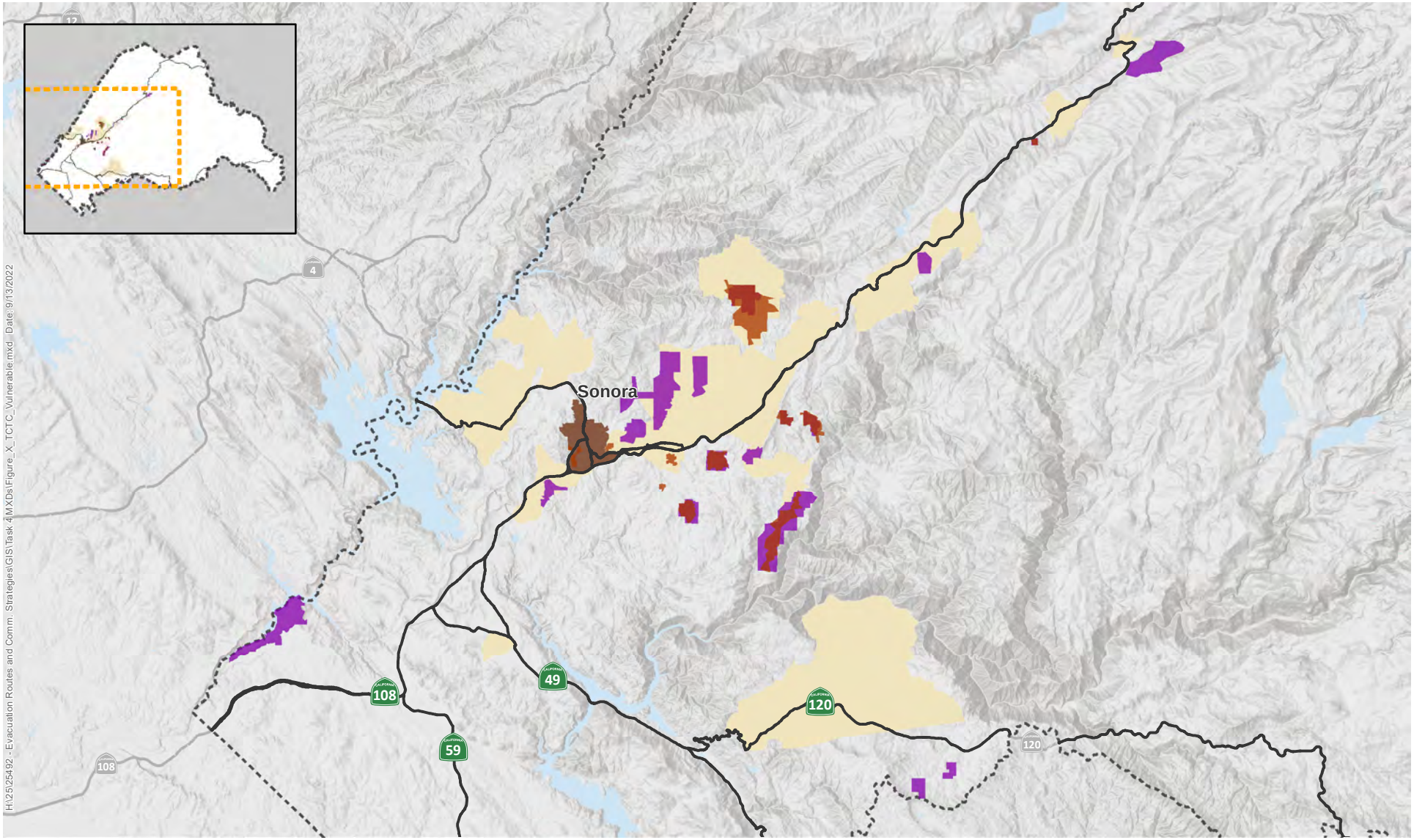
VULNERABLE COMMUNITIES

CalFire and Tuolumne County have identified 22 vulnerable communities within the County. These are communities that only have one access or egress route to the County roadway network and face a risk of not evacuating in time during a wildfire event. Figure 2 shows where these communities are within the County.

Tuolumne County has developed Community Maps in print[5] and online[6] form for various vulnerable communities throughout the County. These maps are intended to be used by residents to plan for evacuations during emergencies. In communities that lack a secondary egress route, residents and emergency managers may consider earlier evacuation orders than usual if the community are threatened by wildfires.

Kittelson reviewed the existing access and egress for each identified vulnerable community. The following section documents potential opportunities for additional egress and emergency access in the case of an emergency evacuation for each vulnerable community. Development of secondary access is largely dependent on funding for planning, design, and construction. These following opportunities for secondary access may be integrated into future planning and project development processes for the community areas to help increase evacuation capacity and resiliency across Tuolumne County. However, no funding has currently been identified or allocated to these concepts.

[5] Tuolumne County Community Maps: https://www.tuolumnecounty.ca.gov/1169/Community-Maps
[6] Tuolumne County Community Preparedness Web Map: https://tuolumne.maps.arcgis.com/apps/webappviewer/index.html?id=243823f4378b48cea33ca44c75c120f1



CalFire Vunerable Subdivisions

State Highways and Major Roads

County Vulnerable Communities

Tuolumne County

0 6 Miles

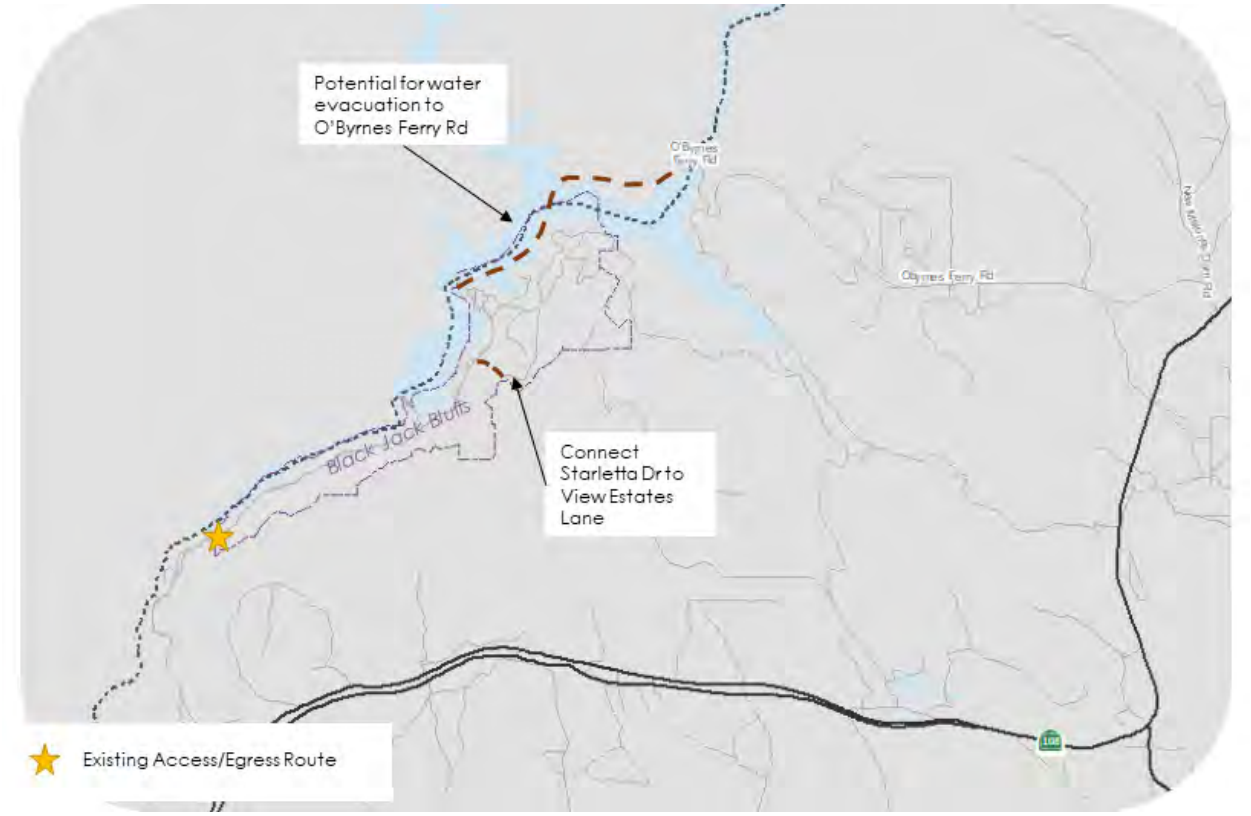
Figure 2

Vulnerable Communities
Evacuation Routes and Communication Strategies
Tuolumne County, CA

KITTELSON & ASSOCIATES JENSEN HUGHES

BLACK JACK BLUFFS

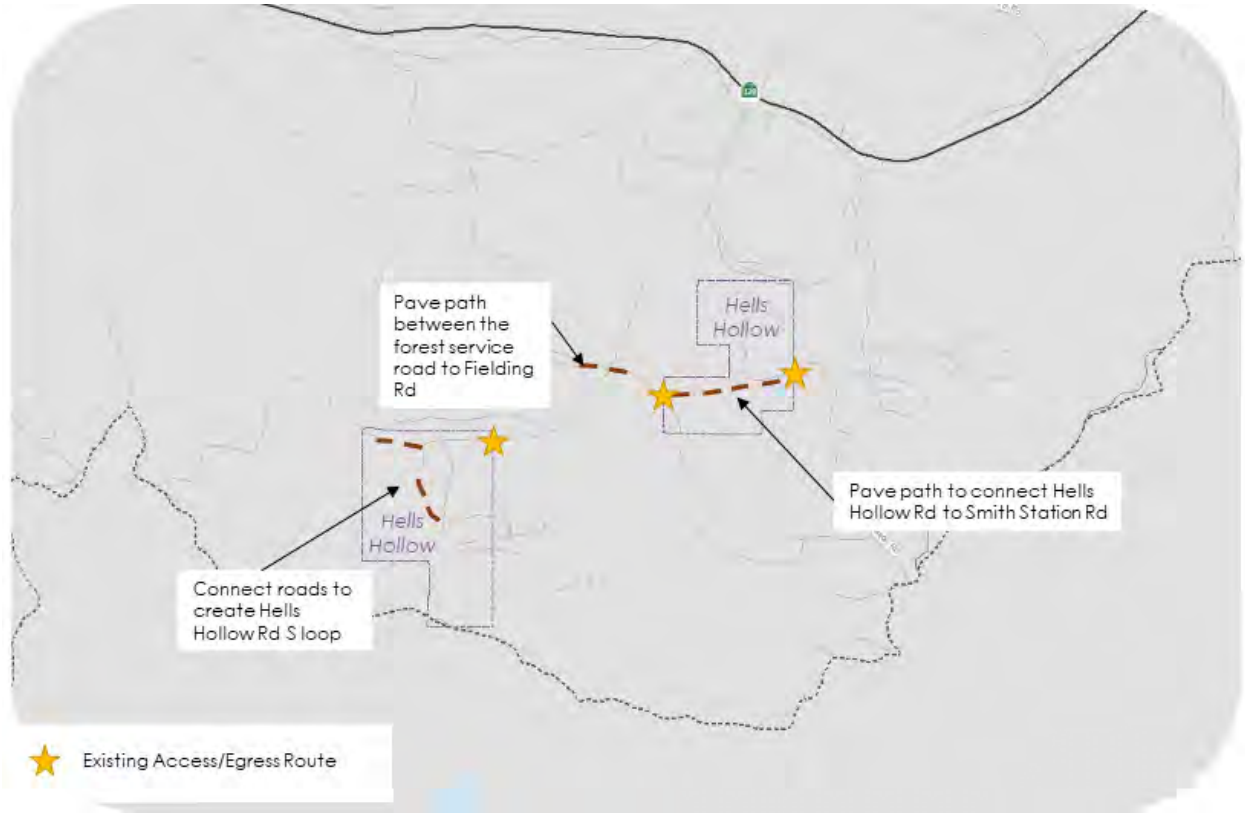
Community	Existing Access/Egress Routes	Potential Secondary Access/Egress Routes
Black Jack Bluffs	• Tulloch Road	1. Connect Starletta Drive to View Estates Lane 2. Possibility of a water evacuation to reach O'Byrnes Ferry Road



Source: *Kittelson & Associates, Inc., 2022.*

HELLS HOLLOW

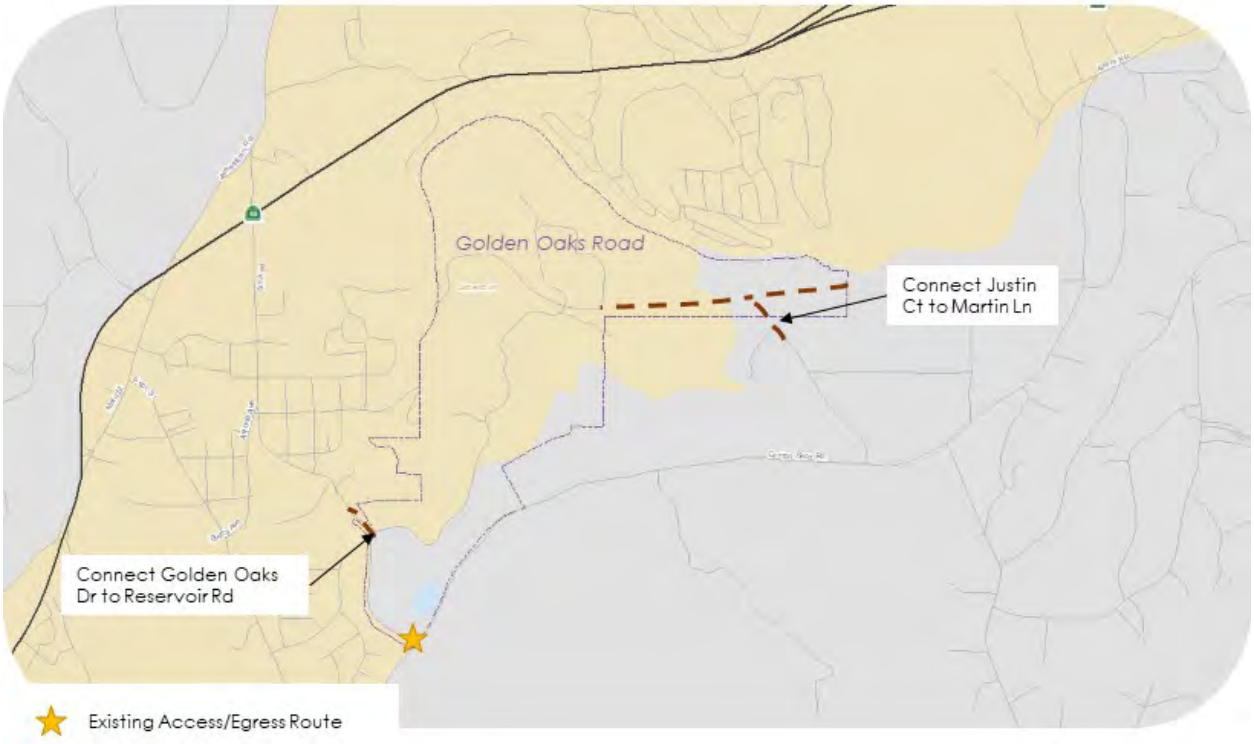
Community	Existing Access/Egress Routes	Potential Secondary Access/Egress Routes
Hells Hollow (west)	• Hells Hollow Road	1. Connect roads on the west of the western development to create Hells Hollow Road South loop 2. Small connection between Forest Service Road 1S17 to Fielding Road. 3. Pave path to connect Hells Hollow Road to Smith Station Road
Hells Hollow (east)	• Driveways/dirt paths to Hells Hollow Road	



Source: *Kittelson & Associates, Inc., 2022.*

GOLDEN OAKS ROAD

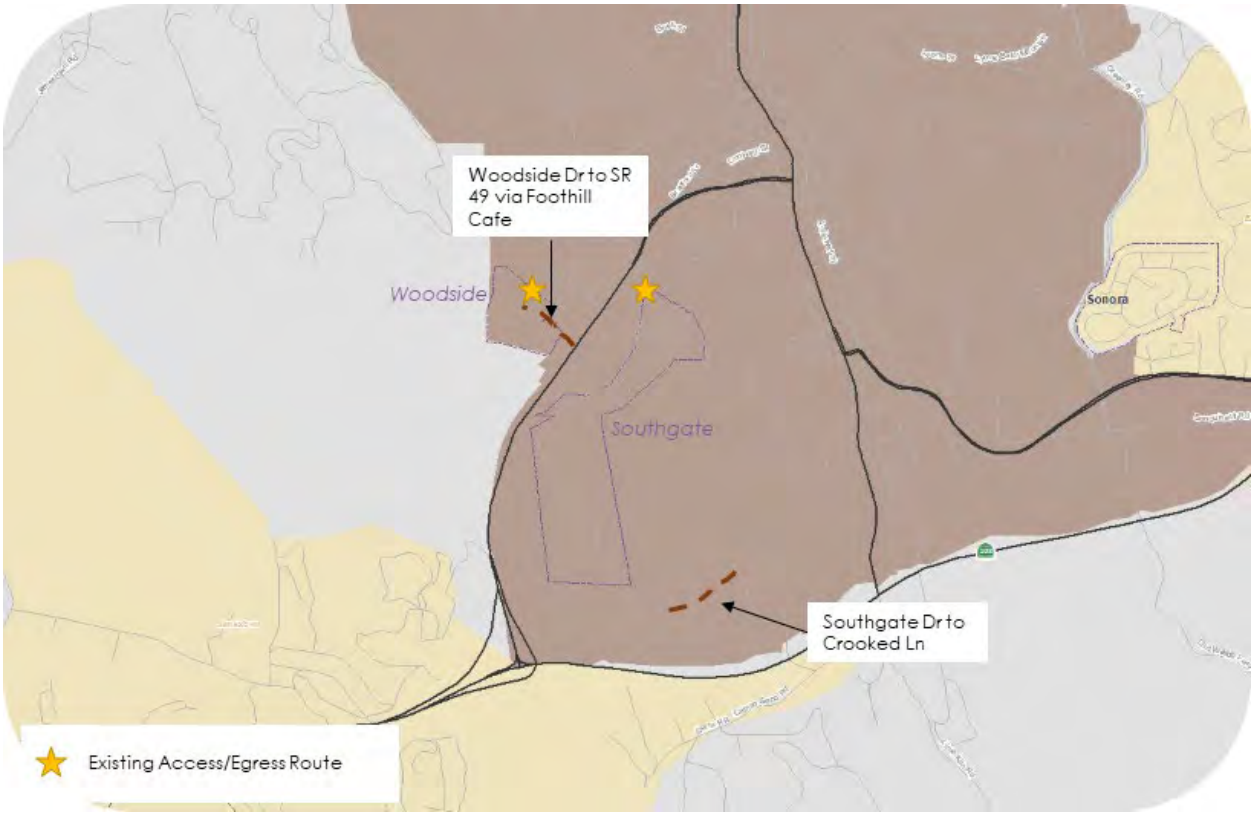
Community	Existing Access/Egress Routes	Potential Secondary Access/Egress Routes
Golden Oaks Road	• Golden Oaks Drive	1. Connect Justin Court to Martin Lane 2. Connect Golden Oaks Drive to Reservoir Road



Source: *Kittelson & Associates, Inc., 2022.*

WOODSIDE/SOUTHGATE

Community	Existing Access/Egress Routes	Potential Secondary Access/Egress Routes
Woodside/Southgate	• Woodside Drive	1. Connect Woodside Drive to SR 49, via Foothills Cafe 2. Connect Southgate Drive to Crooked Lane
Southgate	• Southgate Drive	



Source: *Kittelson & Associates, Inc., 2022.*

BLUE BELL ROAD

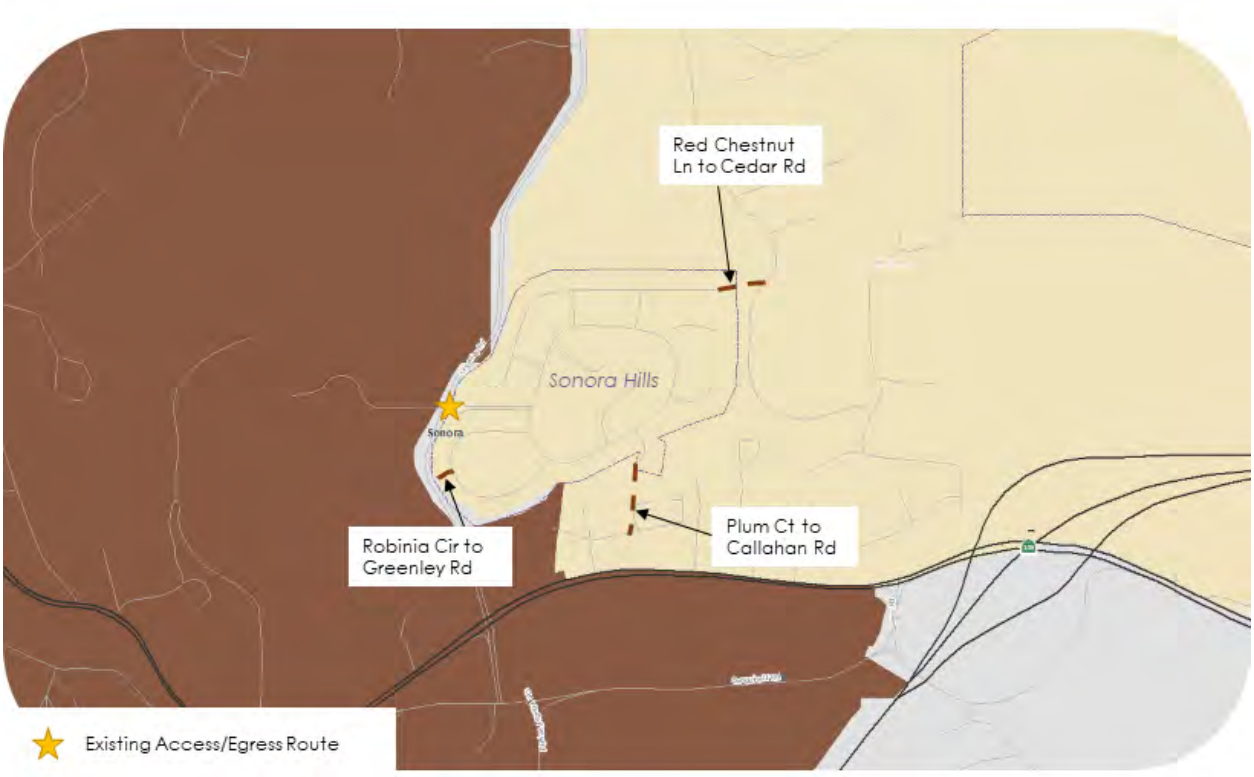
Community	Existing Access/Egress Routes	Potential Secondary Access/Egress Routes
Bluebell Road	• Blue Bell Road East	1. Connecting Lupine Lane to Blue Bell Road West 2. Delores Ln to Blue Bell Road East through Buttercup Lane 3. Blue Bell Road East to Delores Road to Aarondale Road



Source: *Kittelson & Associates, Inc., 2022.*

SONORA HILLS

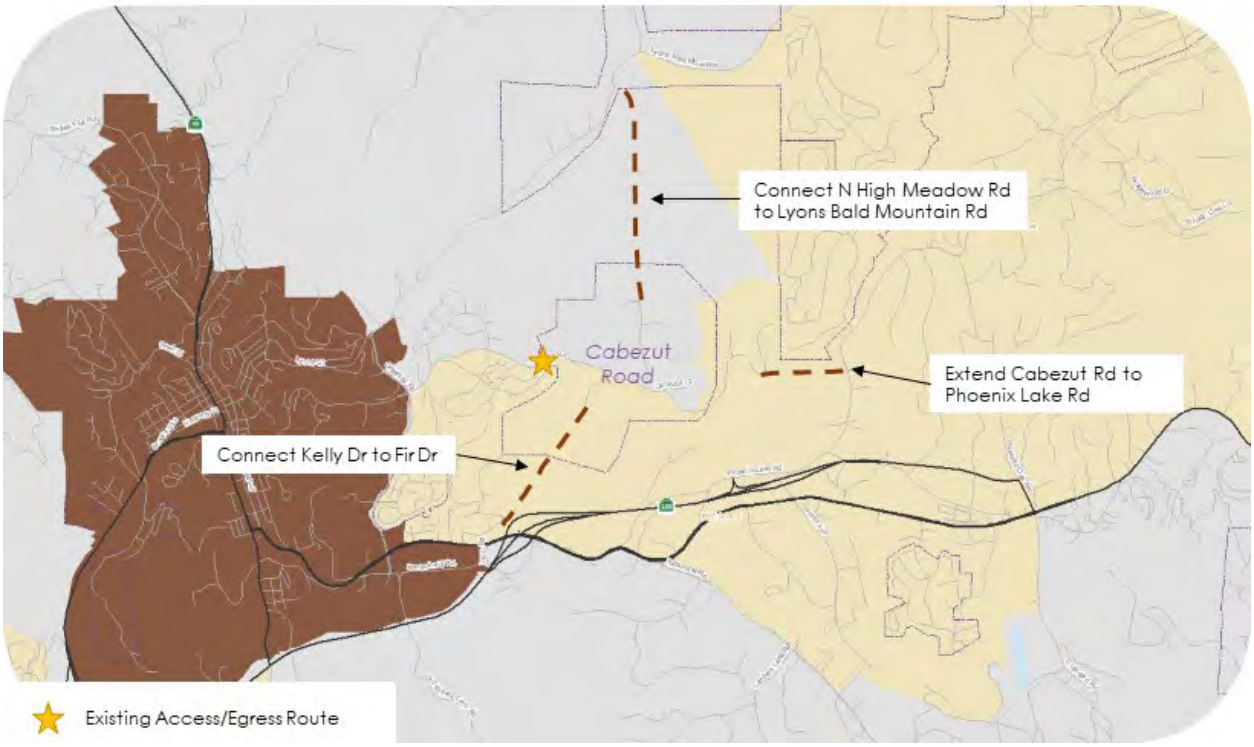
Community	Existing Access/Egress Routes	Potential Secondary Access/Egress Routes
Sonora Hills	• Delnero Drive	1. Robinia Circle to Greenley Road 2. Red Chestnut Lane to Cedar Road 3. Plum Court to Callahan Road (across the parking lot) to Mono Way



Source: *Kittelson & Associates, Inc., 2022.*

CABEZUT ROAD

Community	Existing Access/Egress Routes	Potential Secondary Access/Egress Routes
Cabezut Road	• Cabezut Road	1. Connect North High Meadow Road to Lyons Bald Mountain Road 2. Connect Kelly Drive to Fir Drive 3. Extend Cabezut Road to Phoenix Lake Road



Source: *Kittelson & Associates, Inc., 2022.*

WARDS FERRY

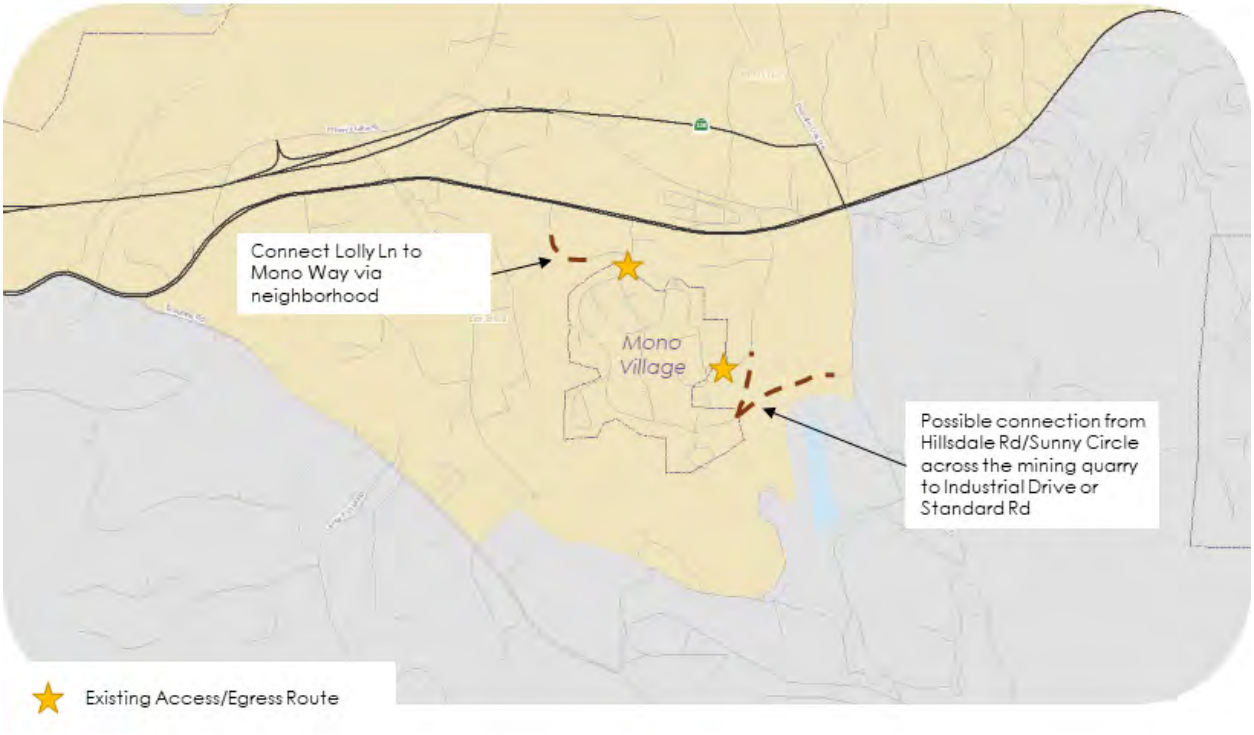
Community	Existing Access/Egress Routes	Potential Secondary Access/Egress Routes
Wards Ferry	• White Oaks Drive	1. Southern point of Lakeside Oaks Road to Wards Ferry Road 2. Live Oak Road to Eagle Ridge Drive 3. Shady Oaks Road to Lambert Lake Road



Source: *Kittelson & Associates, Inc., 2022.*

MONO VILLAGE

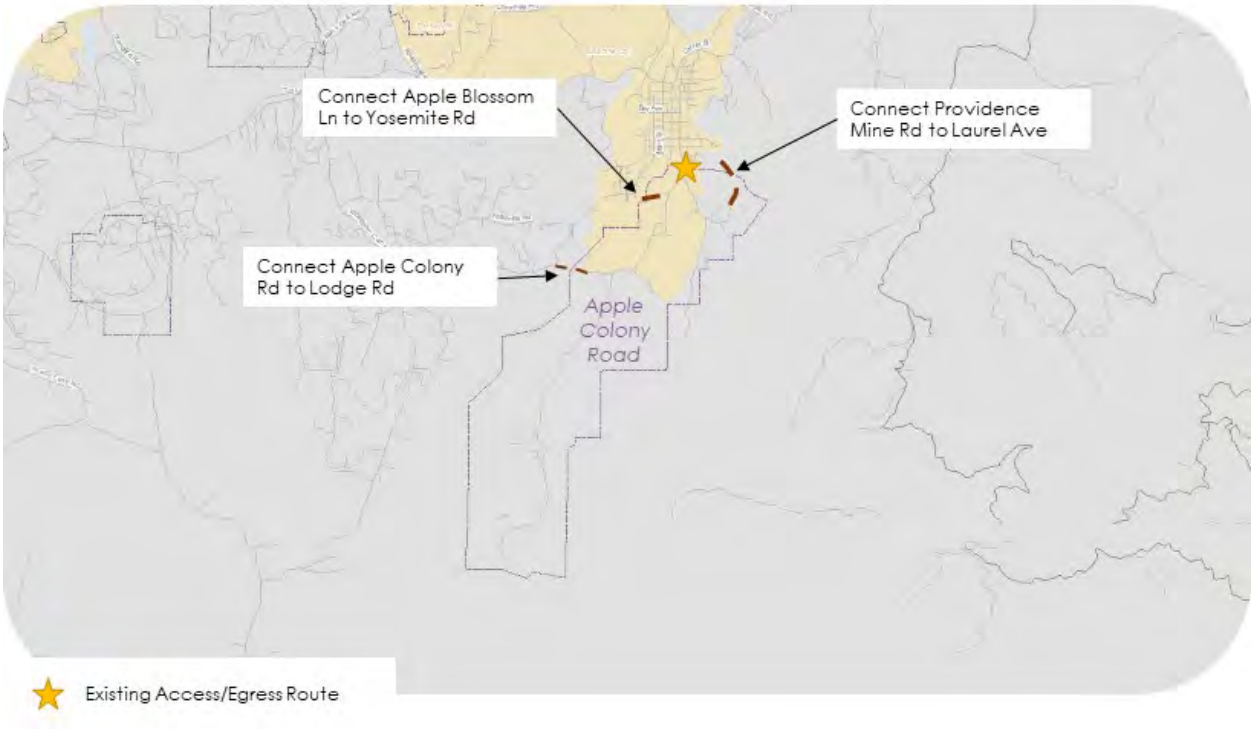
Community	Existing Access/Egress Routes	Potential Secondary Access/Egress Routes
Mono Village	• Industrial Drive (locked gate) • Hillsdale Drive	1. Lolly Lane emergency gate to Mono Way via the neighboring property 2. Possible connection from Hillsdale Road/Sunny Circle across the mining quarry to Industrial Drive or Standard Road



Source: *Kittelson & Associates, Inc., 2022.*

APPLE COLONY ROAD

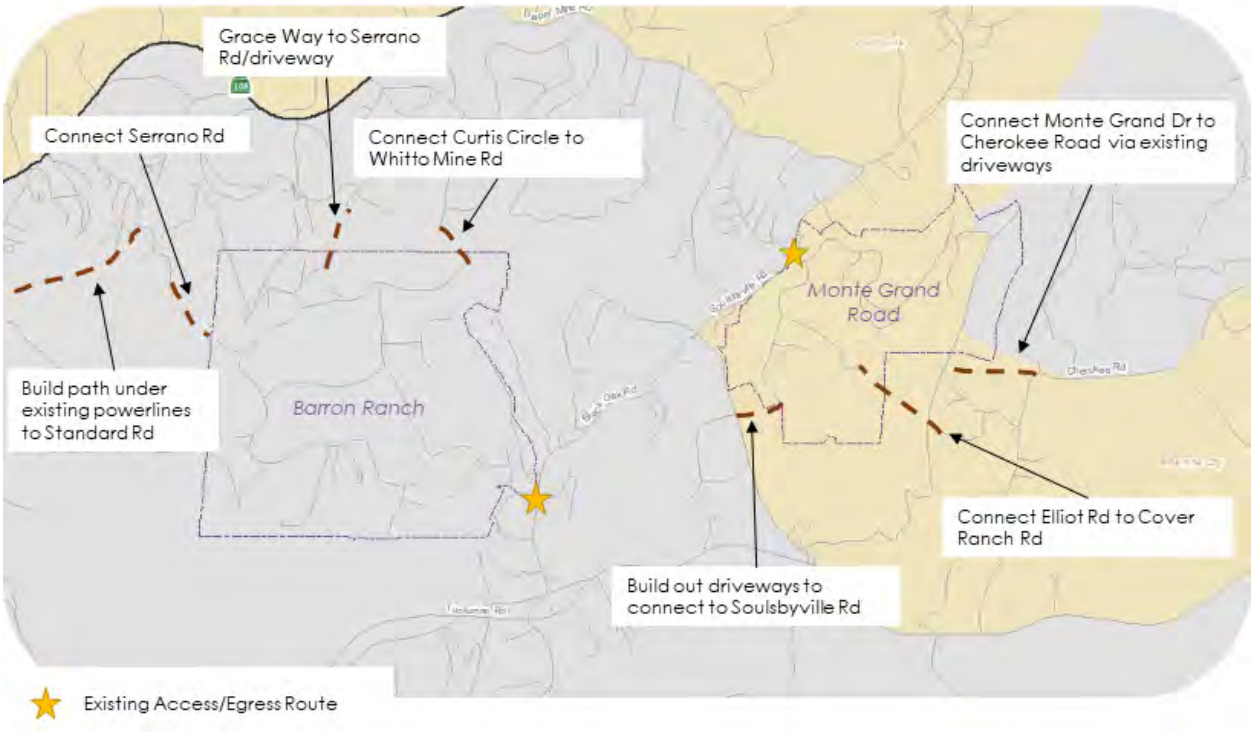
Community	Existing Access/Egress Routes	Potential Secondary Access/Egress Routes
Apple Colony Road	• Apple Colony Road	1. Apple Blossom Lane to Yosemite Road 2. Apple Colony Road to Lodge Road 3. Providence Mine Road to Laurel Avenue



Source: *Kittelson & Associates, Inc., 2022.*

BARRON RANCH / MONTE GRAND ROAD

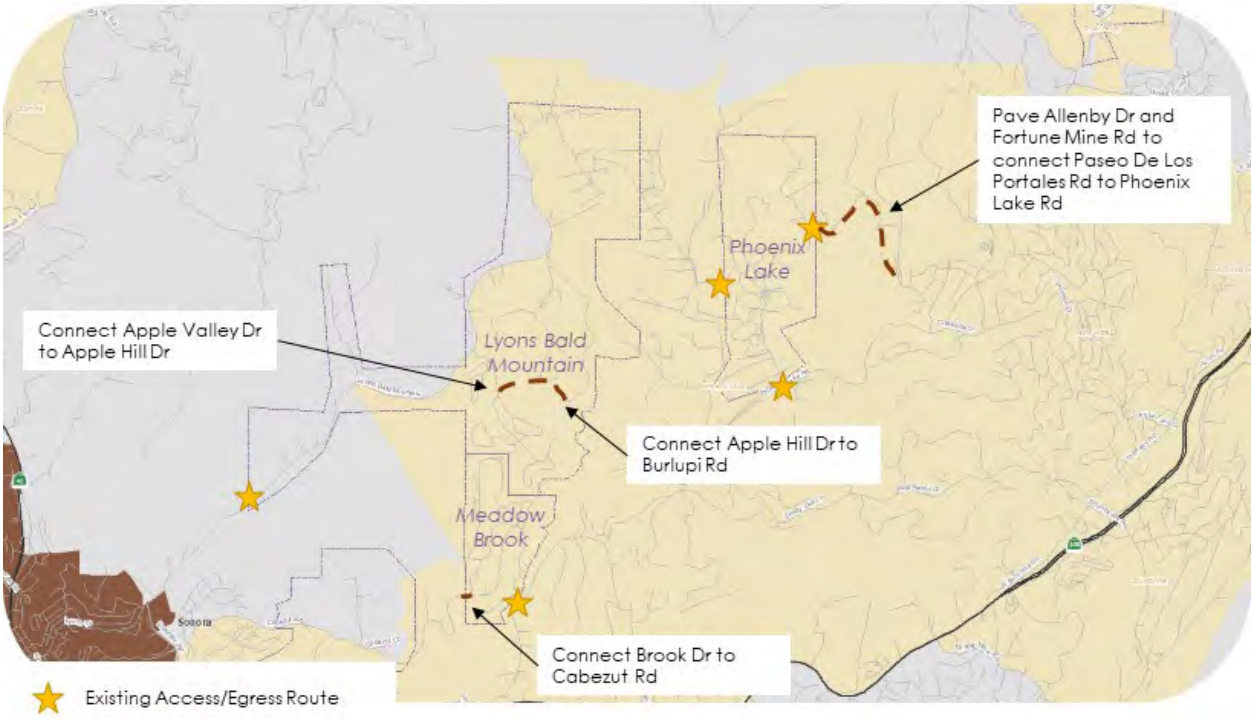
Community	Existing Access/Egress Routes	Potential Secondary Access/Egress Routes
Barron Ranch	• Curtis Circle to Black Oak Road	1. Connect Curtis Circle to Whitto Mine Road 2. Connect Serrano Road 3. Connect Grace Way to Serrano Road 4. Build path along the power lines to connect to Standard Road
Monte Grand Road	• Monte Grande Road/Soulsbyville Road to SR 108 (north) and Tuolumne Road (south)	5. Connect Monte Grande Drive to the east until Cherokee Road 6. Connect driveways on the South Soulsviville Road 7. Elliot Rd to Cover Ranch Road



Source: *Kittelson & Associates, Inc., 2022.*

MEADOW BROOK/LYONS BALD MOUNTAIN/PHOENIX LAKE

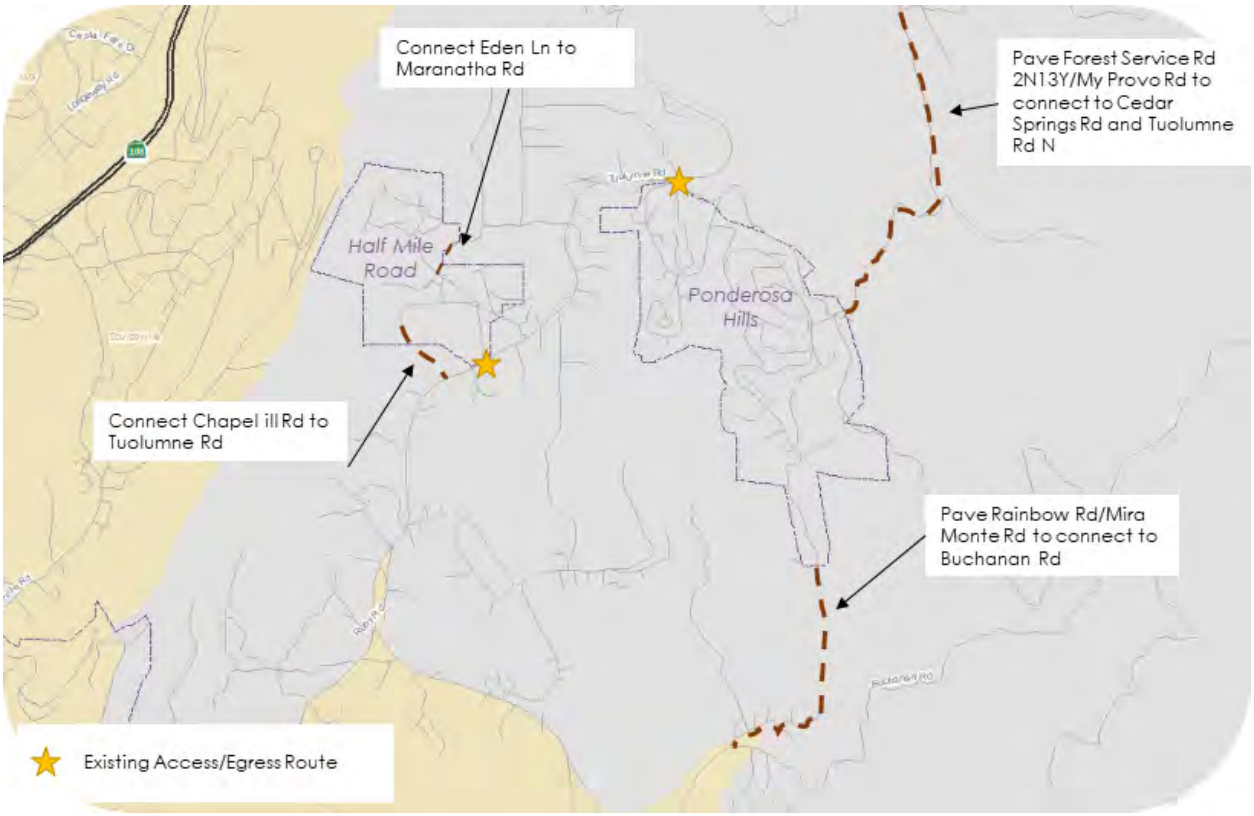
Community	Existing Access/Egress Routes	Potential Secondary Access/Egress Routes
Meadow Brook	• Meadow Brook Drive	1. Connect Brook Drive to Cabezut Road
Lyons Bald Mountain	• Lyons Bald Mountain Road	2. Connection from Apple Valley Drive to Apple Hill Drive 3. Connect over Apple Hill Drive to Burlupi Road
Phoenix Lake Road	• Paseo De Los Portales Road • El Lobo Center • Allenby Drive	4. Pave Allenby Drive and Fortune Mine Road to connect Paseo De Los Portales Road to Phoenix Lake Road



Source: *Kittelson & Associates, Inc., 2022.*

HALF MILE/PONDEROSA HILLS

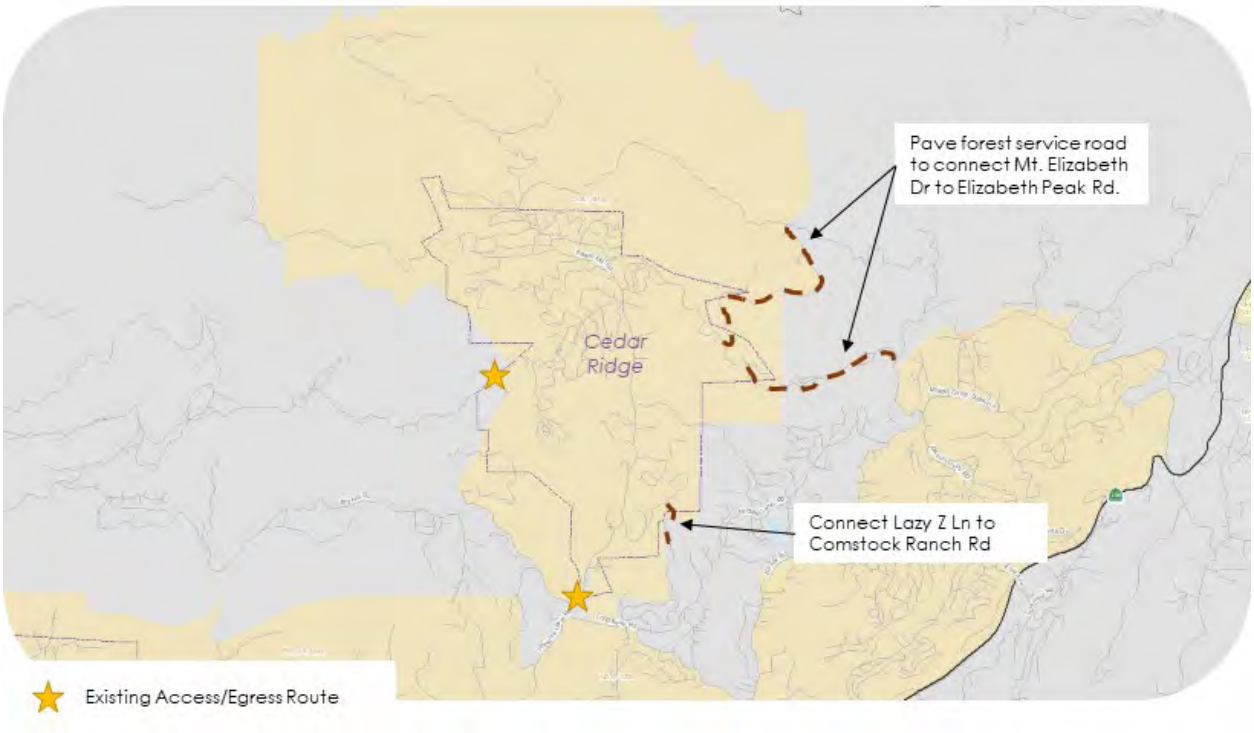
Community	Existing Access/Egress Routes	Potential Secondary Access/Egress Routes
Half Mile	• Half Mile Road	1. Eden Lane/Zelensky Road to Maranatha Road 2. Western part of Chapel Hill Road to Tuolumne Road
Ponderosa Hills	• Gerber Road	3. Pave Rainbow Road/Mira Monte Road 4. Forest Service Road 2N13Y/Mt Provo Road



Source: *Kittelson & Associates, Inc., 2022.*

CEDAR RIDGE

Community	Existing Access/Egress Routes	Potential Secondary Access/Egress Routes
Cedar Ridge	• Kewin Mill Road • Old Oak Ranch Road	1. Connect Comstock Ranch Road to Lazy Z Lane 2. Pave forest service road to connect Mt Elizabeth Drive to Elizabeth Peak Road



Source: *Kittelson & Associates, Inc., 2022.*

ODD FELLOWS HIGH SIERRA

Community	Existing Access/Egress Routes	Potential Secondary Access/Egress Routes
Odd Fellows High Sierra	• Wheeler Road/Odd Fellows Road	1. Pave and maintain Long Barn Sugar Pine Road 2. Three links Road to Rebekah Road



Source: *Kittelson & Associates, Inc., 2022.*

SNOW WHITE/PETER PAM

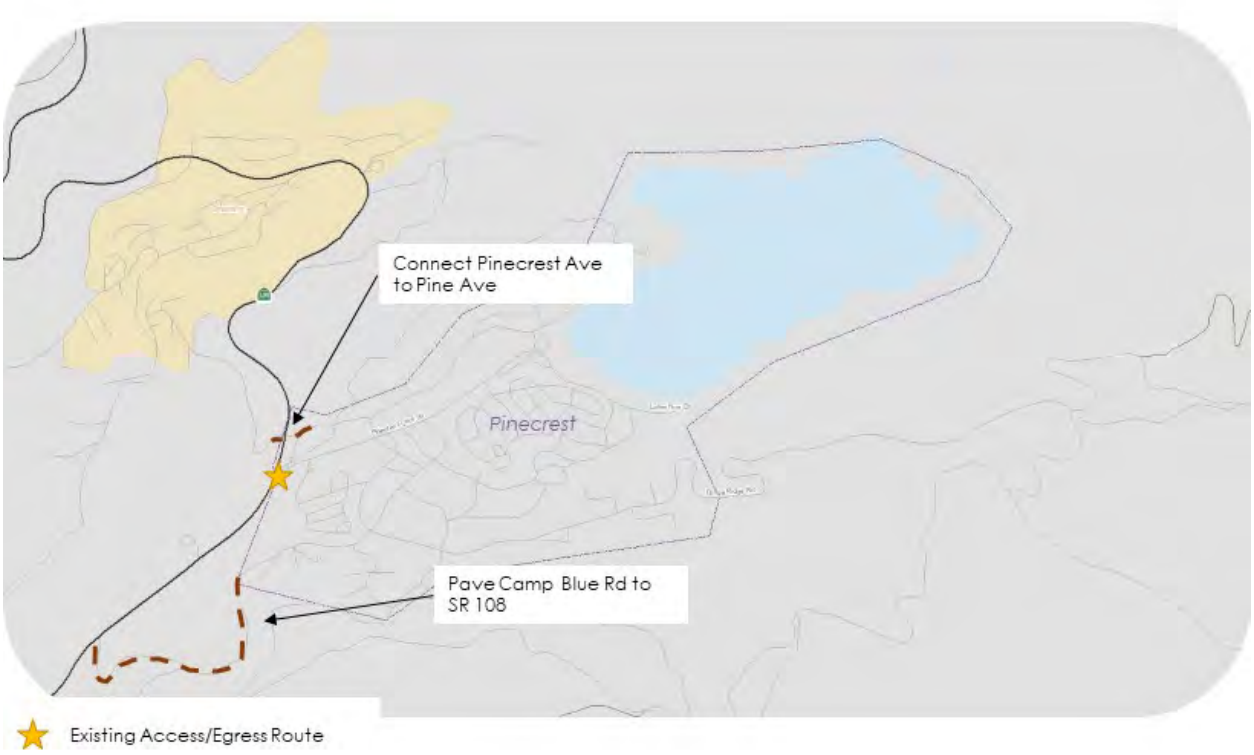
Community	Existing Access/Egress Routes	Potential Secondary Access/Egress Routes
Snow White/Peter Pam	• Snowhite Ridge Drive	1. Extending Bambi Lane along the trail to SR 108 2. Potential to connect Snowhite Ridge Drive via trail/utilities line to SR 108



Source: *Kittelson & Associates, Inc., 2022.*

PINECREST

Community	Existing Access/Egress Routes	Potential Secondary Access/Egress Routes
Pinecrest	• Pinecrest Lake Road	1. Pave Camp Blue Road to SR108 2. Connecting Pinecrest Avenue to Pine Avenue



Source: *Kittelson & Associates, Inc., 2022.*

CONCLUSION/NEXT STEPS

This memo provides several strategies and opportunities for additional egress to assist vulnerable populations and communities during an emergency evacuation in Tuolumne County. Many of the strategies presented utilize existing infrastructure to keep starting costs low once strategies are implemented. Opportunities for secondary access and egress routes in vulnerable communities range from low to high cost and complexity. These opportunities may be integrated into future planning and project development processes for the community areas to help increase evacuation capacity and resiliency across Tuolumne County.

Appendix F: Shelter-in-Place Emergency Planning Considerations

JENSEN HUGHES
Advancing the Science of Safety

Memo

October 18, 2022

To:	Darin Grossi Executive Director Tuolumne County Transportation Council
From:	Darlene Rini
cc:	Shannon Thaggard, Dore Bietz, Matt Braughton, Grace Carsky, Sid Beckman, Julia Cuendet
Subject:	TCTC – Task 5 Shelter-in-Place Emergency Planning Considerations

Introduction

The purpose of this memo is to provide Tuolumne County Transportation Council (TCTC) with various risk control components and features to consider in the event shelter-in-place facilities, as a last resort measure for first responders, is adopted by TCTC for future wildfire planning needs. As determined in our January project development team meeting, we understand that the project management team no longer wishes for the Consultants (Kittelson/Jensen Hughes) to identify specific shelter-in-place facilities, as part of Task 5 for the Evacuation Routes and Communication Strategies Plan. Recommendations in this report are based on the assumption that SIPs are NOT to be used for the long-term or to provide the same level of services in sanitation, power supply and basic human needs that a long-term shelter is designed to provide. Jensen Hughes has been directed to prepare a detailed list of risk control considerations and fire life safety features. These should be considered in the event that the County wishes to adopt the use of shelter-in-place facilities in future wildfire incidents across the County.

Currently, there are no U.S. codes, standards, or guidance documents for the design of shelter-in-place facilities to major wildfire threats. Thus, the recommendations in this memo are based on traditional fire safety concepts, best practices in wildland firefighting operations, building fire safety codes and standards, and international references. It is on this basis that the following risk control categories have been identified as key components for wildfire safety in shelter-in-place facilities:

- Item(s) A – Topographic Location
- Item(s) B – Construction Type and Fire separation
- Item(s) C – Occupant Loads/Capacity
- Item(s) D – Means of Access and Accessibility
- Item(s) E – Structural hardening
- Item(s) F – Defensible space
- Item(s) G – Vegetation management (long-term)
- Item(s) H – Communication systems
- Item(s) I – Suppression systems
- Item(s) J – Smoke control measures
- Item(s) K – Firefighting water supplies
- Item(s) L – Fire department access
- Item(s) M – Firefighter personnel & operations
- Item(s) N – Emergency power supplies
- Item(s) O – Essential disaster supplies
- Item(s) P – Ignition sources
- Item(s) Q – Fire safety signage

Background

Shelter-in-place (SIP) practices are an important component of emergency management operations regardless of the threat or hazard (e.g., flooding, hurricanes, tornados, wildfires). However, in recent years, catastrophic wildfires across the western U.S. (e.g., 2018 Camp Fire, 2017 Thomas Fire) have highlighted a need for a more comprehensive look at fire safety concepts and principles when planning for the use of protection actions such as shelter-in-place. One of the key challenges with the use of SIP practices for wildfires is the need to tailor risk control measures to best address the unique challenges associated with the threat itself, but also the range of local conditions that are critical to ensuring effective implementation (e.g., community demographics, topography, location, infrastructure, resources, authorities, decision-making process).[1]

Shelter-in-Place: The use of a structure to temporarily separate individuals from a hazard or threat.

Evacuation: Organized, phased, and supervised withdrawal, dispersal, or removal of civilians from dangerous or potentially dangerous areas, and their reception and care in safe areas.

A shelter-in-place (SIP) facility is a structure used to temporarily separate individuals from a hazard or threat. While evacuation is an organized, phased, and supervised withdrawal, dispersal or removal of civilians from dangerous or potentially dangerous areas and remains the dominant management strategy for wildfires, there's growing consideration of SIPs in some circumstances when timely evacuation is not possible or achievable. For example, when the characteristics of the wildfire threat are extreme (e.g., fast moving, high winds), there's limited notification infrastructure, land-use planning and development limit adequate egress times, physical or medical limitation of citizens, insufficient transit capacity for mass evacuations or other transit/evacuation barriers. In these circumstances, it may be safer for individuals to shelter-in-place than to try to evacuate.[2] However, effective planning and preparation prior to a fire, making informed decisions during the event, providing appropriate public education and training, and providing appropriate risk control features and systems are key to ensuring SIPs are a viable and safe choice when last minute evacuations are not feasible.

Shelter-in-Place Considerations

OVERVIEW

As Tuolumne County is located in the heart of the central Sierra Nevada range, it's faced with a wide range of challenging wildfire environmental settings (e.g., topography, fuels and weather), history of large/damaging fires, population characteristics (e.g., increasing growth, high transit/visitor populations) and built environment conditions (e.g., limited access/egress, pre-wildfire code building stock). Due to these local conditions, mass evacuation during a major, fast-moving wildfire incident may not be a feasible option. Thus, considering the use of SIPs, in future incidents, may be a possible emergency management tool.

Based on meetings with the project management team, the use of SIPs is currently not the preferred emergency management option for wildfire incidents in the County. However, at the direction of the project management team, a detailed list of risk control considerations and fire life safety features are presented in Table 1 for consideration in the event the County wishes to adopt the use of SIPs in the future. As there are currently no U.S. codes, standards, or guidance documents for the design of SIP to major wildfire threats, the recommendations and/or considerations in Table 1 are based on traditional fire safety concepts, best practices in wildland firefighting operations, building fire safety codes and standards, and international references.

The recommendations have also been developed based on the assumption that the use of SIPs is a last resort option when evacuation may not be the safest or most feasible, and will likely consist of existing buildings (e.g., a high school, city hall, church) that can provide temporary places of relative safety. **The**

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SIPs are assumed to NOT be used for the long-term or to provide the same level of services in sanitation, power supply and basic human needs that a long-term shelter is designed to provide.

SIPs are also assumed to NOT be free from risk for people. Injuries and fatalities may occur at SIPs depending on the extreme nature of the wildfires. A fully safe SIP facility cannot be guaranteed

RECOMMENDATIONS

This section provides a summary of recommendations for consideration in the event, the County wishes to adopt the use of shelter-in-place facilities in future wildfire incidents. Table 1 summarizes recommended actions to help reduce wildfire safety risk factors where SIPs maybe used as an emergency management option in future wildfire incidents in Tuolumne County. It is understood that there may not be any existing locations in the County that will meet all of the listed planning considerations for SIP facilities. The intent is to provide a list of recommendations with priority rankings to aid the County in the evaluation and long-term development of potential SIP facilities (if desired in future). Table 1 categorizes a range of identified actions based on several key risk categories that impact exterior fire hazards:

+ Item(s) A – Topographic Location
+ Item(s) B – Construction Type and Fire separation
+ Item(s) C – Occupant Loads/Capacity
+ Item(s) D – Means of Access and Accessibility
+ Item(s) E – Structural hardening
+ Item(s) F – Defensible space
+ Item(s) G – Vegetation management (long-term)
+ Item(s) H – Communication systems
+ Item(s) I – Suppression systems
+ Item(s) J – Smoke control measures
+ Item(s) K – Firefighting water supplies
+ Item(s) L – Fire department access
+ Item(s) M – Firefighter personnel & operations
+ Item(s) N – Emergency power supplies
+ Item(s) O – Essential disaster supplies
+ Item(s) P – Ignition sources
+ Item(s) Q – Fire safety signage

Priority Ranking of Recommendations

To assist the County in planning and implementing various risk reduction measures, a priority rating has been provided for each recommendation from a fire life-safety perspective (i.e., where life safety for the public and first responders is prioritized above other performance objectives). The following is an explanation of each rating:

+ **High:** Greatest benefit for limiting fire life safety risks
+ **Medium:** Moderate benefit for limiting fire life safety risks.
+ **Low:** Lowest benefit for limiting fire life safety risks.

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Table 1 – Recommended Shelter-in-Place Risk Control Measures and Other Fire Safety Considerations

Risk Category	Item	Guidance / Recommendations	Priority Ranking	Reference
A. TOPOGRAPHIC LOCATION	A.1	When possible, the selected SIP should not be located on or adjacent to negative topographical features such as ravines, on saddles of ridge tops, close to the top of a steep slope, dead ends or box canyons, or the mid-point of a slope.	**HIGH**	FEMA Home Builder's Guide to Construction in Wildfire Zones
	A.2	Increased risk of fire severity and damage to a structure can oftentimes be a result of the structure's location relative to specific topographical features such as slope, aspect, and position. For example, where located on a ridgetop, the selected SIP structure should have a minimum 50-foot setback from wildland vegetation on the downslope side. This setback should be increased in areas with heavier fuels, such as a forested environment.	**HIGH**	FEMA Home Builder's Guide to Construction in Wildfire Zones
B. CONSTRUCTION TYPE	B.1	The selected SIP structure should meet Type IIA or higher construction (i.e., non-combustible, fire-rated). Building materials, systems, and/or assemblies used in the exterior design and construction should meet the requirements detailed in CBC Section 707A.	**HIGH**	FEMA Home Builder's Guide to Construction in Wildfire Zones CBC Sec. 707A
	B.2	The use of non-combustible or fire-resistant materials should be considered for exterior components. This includes but is not limited to roofing, vents, exterior coverings, exterior windows, skylights, doors, decking, and any accessory structures.	**HIGH**	FEMA Home Builder's Guide to Construction in Wildfire Zones CBC Sec. 707A
C. OCCUPANT LOADS	C.1	***Occupant Load*** – An occupant load factor of 5 square feet per person is recommended where shelter-in-place use is anticipated for 2 hours or less.	**HIGH**	FEMA P-453
D. MEANS OF ACCESS & ACCESSIBILITY *Consider the means of access to shelter-in-place facility(s) carefully, taking into consideration general access to the site, as well as access for persons with mobility, visual, or hearing disabilities*	D.1	***Primary Access –*** Street or access driveways should at a minimum, meet applicable design criteria for fire apparatus access roads from CFC Section 503. Refer to Item L recommendations.	**HIGH**	IWUIC Sec. 403 CFC Sec. 503
	D.2	***Secondary Access*** – The best practice is to select a facility that has a secondary means of access/egress. The secondary access should meet the same specifications as the primary means of access/egress except for the requirement to have an all-weather surface if approved by the AHJ.	**MEDIUM**	CFC Sec. 503
	D.3	***Directional Signage –*** Consult with the local Authority Having Jurisdiction (AHJ) to determine if signage is required. If required, approved notices or markings should include the words NO PARKING-FIRE LANE. The means by which fire lanes are designated shall be maintained in a clean and legible condition at all times. Size of letters, numbers, and symbols for street and road signs should have a minimum 4-inch letter height and 1/2-inch stroke, be reflective, and contrast with the background color of the sign. The sign and sign support should be constructed of non-combustible materials.	**MEDIUM**	CFC Sec. 503.3 FEMA Home Builder's Guide to Construction in Wildfire Zones
	D.4	***Accessibility –*** The selected SIP should meet minimum accessibility requirements detailed in California Building Code (CBC) Sec. 11B. Accessible routes should comply with CBC Sec. 11B-402. General building elements should comply with CBC Sec. 11B-501-505.The ADA Checklist for Emergency Shelters should be utilized to evaluate the SIP's conformance to ADA requirements.	**MEDIUM**	CBC Sec. 11B ADA Checklist for Emergency Shelters

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Risk Category	Item	Guidance / Recommendations	Priority Ranking	Reference
E. STRUCTURAL HARDENING *In the event of a major, rapid on-set wildfire, firefighting resources in the County will be quickly overwhelmed. This means that active structure defence by firefighters may not be available for most structures. In some cases, it may not be safe for firefighters to engage in structure protection due to a variety of factors (e.g., intensity of the fire, weather conditions, access issues, lack of water supplies, etc.). Thus, the survivability of a structure in a major wildfire event can dramatically depend on the structural hardening provisions provided and maintained.*	E.1	***Roof*** – The selected SIP structure should have a roof that is intact, well maintained and Class A rated per ASTM E108. The facility owner should have a maintenance plan established to maintain the roof in good condition. This includes replacing any broken, damaged, or missing roof materials, plugging openings in roofing materials, such as the open ends of barrel tiles ("bird nest" stopping), keeping it free of bird's nests, fallen leaves, needles and branches, and removing all tree limbs within 10 feet of the chimney, or that overhang the roof.	**HIGH**	FEMA Home Builder's Guide to Construction in Wildfire Zones CBC Sec. 705A
	E.2	***Chimneys*** – If the selected SIP structure has chimneys and/or stovepipe openings, they should be provided with an approved spark arrestor cap with a 1/2-inch screen.	**HIGH**	IWUIC Sec 605
	E.3	***Eaves*** – The soffit areas of the selected SIP structure should be provided with a non-combustible material such as fibre-cement panels. The selected SIP structure should also be provided with proper soffit vent protection, where present. A 1/16-inch metallic screen mesh or ASTM E2886 certified vent is the best method to accomplish this. Note: All gaps and voids should be inspected on an annual basis and provided with appropriate caulking material as needed.	**MEDIUM**	FEMA Home Builder's Guide to Construction in Wildfire Zones ASTM E2886 CBC Sec. 706A
	E.4	***Exterior Wall Finish –*** The selected SIP structure should have exterior wall coverings of non-combustible materials. Any material used for exterior wall covering should have any damaged areas repaired and voids or gaps filled to prevent the intrusion of embers. Should the opportunity arise to change siding material the Fire AHJ and Building Official should be consulted for improved fire resistance to meet current codes.	**MEDIUM**	FEMA Home Builder's Guide to Construction in Wildfire Zones CBC Sec. 707A
	E.5	***Windows and Skylights*** The selected SIP structure should be equipped with windows that are double-glazed that utilize tempered glass for the exterior pane. Skylights should be flat skylights constructed of double-pane glass and kept free of vegetation. The selected SIP structure should have non-combustible shutters to protect large window and glass doors from radiant heat, where windows are facing dense vegetation.	**MEDIUM**	FEMA Home Builder's Guide to Construction in Wildfire Zones CBC Sec. 708A NIST Note 1910
	E.6	***Vents –*** All vent openings (e.g., attic vents, crawl space vents, soffit/eave vents, foundation vents) should be covered with 1/16-inch wire mesh. An available option is to install ember-resistant vents meeting ASTM E2886 certification. Keep vents free of debris, litter, etc. Dormer-face vents should be replaced with low-profile vent.	**HIGH**	FEMA Home Builder's Guide to Construction in Wildfire Zones CBC Sec. 706A NIST Note 1910 ASTM E2886 IWUIC Sec. 505
	E.7	***Gutters*** – The selected SIP structure should have gutters of non-combustible materials such as aluminium, copper, or galvanized metal. A gutter protector should be installed, where possible, to reduce collection of leaves and combustible debris. The SIP structure should have periodic inspection and cleaning of the gutters.	**HIGH**	FEMA Home Builder's Guide to Construction in Wildfire Zones IWUIC Sec. 506.4 Firewise NIST Note 1910

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Risk Category	Item	Guidance / Recommendations	Priority Ranking	Reference
	E.8	***Decks*** – If the selected SIP structure has a deck(s), it should be comprised of fire-resistant, fire-rated materials or heavy timber construction. Decks should be in good repair. This includes routinely removing combustible debris (e.g., pine needles, leaves, twigs, and weeds) from the gaps between deck boards and under the deck.	**MEDIUM**	FEMA Home Builder's Guide to Construction in Wildfire Zones IBHS Guide – Decks CBC Sec. 709A
	E.9	***Combustible Items*** – The facility owner of the selected SIP structure should have a plan in place to keep all porches, decks, and other areas of the building free of flammable materials (e.g., baskets, newspapers, pine needles, and debris). This plan should also include keeping firewood, bales of hay or straw, plastic trash/recycle bins, and other combustible/flammable materials a minimum of 30-feet away from a structure.	**HIGH**	FEMA Home Builder's Guide to Construction in Wildfire Zones Firewise IBHS Fire Safety Guide Sheet
	E.10	***Fences*** – Where fences attach to the selected SIP structure, the initial 5 feet of fence or gate should be comprised of a non-combustible material such as metal. Combustible fences, particularly those in close proximity to the SIP, should have a space of approximately 2 inches at the lowest point to the ground to prevent ember collection and/or ignition.	**HIGH**	FEMA Home Builder's Guide to Construction in Wildfire Zones IBHS Fire Safety Guide Sheet NIST Note 1910
	E.11	***Garage*** – Any loading dock openings or other large roll-down doors should be tight fitting and kept closed in a fire event.	**MEDIUM**	FEMA Home Builder's Guide to Construction in Wildfire Zones
F. DEFENSIBLE SPACE *Defensible space provides a buffer between the building and the wildland that surrounds it. It protects a structure from direct flame impingement, radiant heat, and ember cast, and is essential for structure survivability during wildfires.* *Defensible space also allows room for tactical fire-fighting operations. At a minimum, the defensible space should extend 100 feet from all sides of any structure but not beyond the property line except when adverse conditions exist.*	F.1	***Fuel Modification Zones*** – Fuel modification zones should be provided around all buildings/structures on the property. For fire resistant plants and shrubs consult with local fire department and/or Firewise listings of appropriate plants. Otherwise, refer to California's comprehensive "Fire Resistant Plan List" (http://firesafesdcounty.org/wp-content/uploads/2017/05/Comprehensive-Fire-Resistant-Plant-List.pdf) **Zone 0 (0-5 feet from the building)** – This is considered the most important defensible space zone, and includes areas immediately surrounding a structure/ building, as well as areas under any attached decks or overhangs. Establishing a five-foot ember-resistant zone around the SIP to eliminate materials that will likely be ignited by embers provides important new protection measures that enhance a structure's chance of surviving a wildfire. These protection measures include: - Remove anything combustible including vegetative and "urban" type fuels (e.g., woody plants, mulch, woodpiles, combustible trellises, trash bins, vehicles, woodpiles, and other stored combustible items). - Move any trash, recycling, or compost bins further than 5' from the SIP (in Zones 1 or 2) or store them within a hardened garage or outbuilding - Relocate woodpiles to Zone 2 or within a well-sealed, protected structure (e.g., hardened garage or shed), with a minimum of 10' separation from other fuels; 40' if adjacent to multiple woodpiles. - Remove any dead/dying vegetative debris (e.g., leaves, pine needles) - Consider replacing existing landscaping in zone 0 with hardscaping such as pavers, concrete, rock mulch, pea gravel or non-combustible mulch.	**HIGH**	FEMA Home Builder's Guide to Construction in Wildfire Zones Firewise (NFPA) Guide Sheets IWUIC Code Sec 603 NIST Note 1910 CA Bill 3074

Risk Category	Item	Guidance / Recommendations	Priority Ranking	Reference
		- Consider replacing the bottom six inches of the exterior wall with noncombustible materials (e.g., brick, stone veneer, exposed concrete, stucco) from the foundation to the exterior siding. - Trim back all trees, shrubs and any other vegetation so that it's not within this zone, particularly around chimney and stovepipe outlets. - Limit combustible items (e.g., outdoor furniture, grills) on top of decks and balconies. Remove combustible fencing, gates and arbors attached to the structure with non-combustible materials. **Zone 1 (5-30 feet from the building) –** This zone is considered critical to creating defensible space and limiting structure-to-structure fire spread. Note: This designation also applies to the area within 10' of driveways, access roads, or public roads adjacent to the property - From 5 to 30 feet there should be low growing, well-irrigated, fire-resistant, drought-resistant plantings. Ornamental and wildland vegetation should be carefully spaced, low growing, well-watered, and free of resins, oils, and waxes that burn easily. There should be no dead vegetation, firewood, or stacks of flammable material in this zone. Lawns and native grasses should be mowed to maintain a maximum height of 4 inches. - Ladder fuels (vegetation under trees) should be regularly removed. Trees should be located at least 15 feet from a structure and spaced so that canopies don't touch, at least 30 feet apart. Trees and shrubs should be limited to small clusters of a few each to break up continuity of fuel across the landscape. **Zone 2 (30 to 100 feet from the building) –** The goal in this zone is to interrupt the path of a wildfire, minimize flame length, and keep fires on the ground. - Vegetation in this zone should be low growing, well irrigated and less flammable. - There should be at least 30 feet between clusters of two to three trees. - There should be a mixture of deciduous and coniferous trees with breaks in vegetation, such as driveways, gravel walkways and lawns. - Separate auxiliary structures such as a detached garage, pump house, pergola, and utility shed from the home by at least 50 feet. Increase the distance if the structure is used for the storage of combustible materials - Where the property lines restrict achieving 100 feet of defensible space and at the discretion of the fire department, it may be prudent to increase hardscaping to offset the reduced width. In some jurisdictions, the full 100 feet is achieved through community defensible space, where neighbors on adjacent properties maintain the portion of the 100 feet that falls within their land.		
	F.2	**Additional Clearances –** As the slope angle increases (percent increase or degrees of increase) around the SIP, a corresponding increased distance of managed fuels needs to be provided to reduce the threat of an impinging fire on the structure. For a flat to mild slope (less than 20%), clearance should be double the vegetation height for shrubs, and a minimum clearance of 10 feet should be provided for trees. For a mild to moderate slope (20-40%), clearance should be	**HIGH**	Firewise Guidance FEMA Home Builder's Guide to Construction in Wildfire Zones IWUIC Section 202 and 603.2 NIST Note 1910

Risk Category	Item	Guidance / Recommendations	Priority Ranking	Reference
		the vegetation height multiplied by 4 for shrubs, and a minimum clearance of 20 feet should be provided for trees. For a moderate to steep slope (greater than 40%), clearance should be multiplied by 6, and a minimum clearance of 30 feet should be provided for trees.		PRC 4291
G. LONG-TERM VEGETATION MANAGEMENT	G.1	**Fuel Management –** A vegetation management plan increases the probability of survivability during a fire event. The owner of the selected SIP should have a vegetation management plan established. This plan should include a copy of the site plan, methods, and timetables for controlling, changing, or modifying areas on the property, and a plan for maintaining the proposed fuel-reduction measures. Elements of the plan should include removal of slash, snags, vegetation that may grow into overhead electrical lines, other ground fuels, ladder fuels, dead trees, and the thinning of live trees. This plan should be submitted to the code AHJ for review and approval.	HIGH	IWUIC Code Appendix A102 IWUIC Appendix B
H. COMMUNICATION SYSTEMS	H.1	***Communication Equipment*** – The following communications equipment should be located and maintained in good condition in the selected SIP structure: (1) National Oceanic and Atmospheric Administration (NOAA) weather radios or receivers for commercial broadcast, (2) if NOAA broadcasts are not available, Ham radios or emergency radios connected to the police or the fire and rescue systems, (3) Cellular and/or satellite telephones (may not operate during an event and may require a signal amplifier to be able to transmit within the shelter), (4) Battery-powered radio transmitters or signal emitting devices that can signal local emergency personnel, (5) Portable generators with uninterruptible power supply (UPS) systems and vented exhaust systems, (6) Portable computers with modem and internet capabilities, ax/copier/scanner, (7) Public address systems, and (8) Standard office supplies (paper, notepads, staplers, tape, whiteboards and markers, etc.).	HIGH	FEMA P-453
I. SUPPRESSION SYSTEMS	I.1	***Fire Sprinkler System (NFPA 13)*** – The SIP location should be equipped with a fire sprinkler system in accordance with code requirements. The system should be tested and maintained according to NFPA Standards.	MEDIUM	NFPA 25 CFC Chapter 9
		Exterior Sprinkler Protection – Where possible, an exterior sprinkler system should be installed to provide enhanced protection to a SIP. However, there is currently no official design standards, performance specification or verified fire tests to demonstrate the effectiveness and/or reliability of exterior sprinkler systems	LOW	FEMA Home Builder's Guide to Construction in Wildfire Zones
	I.2	***Hydrants –*** The facility should be provided with fire hydrants spaced accordingly with CFC Sec. 507.5 and Appendix C.	MEDIUM	CFC Chapter 5
J. SMOKE CONTROL MEASURES	J.1	***Structure HVAC Systems*** – The selected SIP structure should have procedures in place to shut off the HVAC System and any exhausting mechanisms to reduce the intrusion of smoke and embers into the structure.	HIGH	FEMA P-453 and American Red Cross Shelter Guidance Handbook.
	J.2	**Air Filtration** – The selected SIP structure should be equipped with a means of air filtration to protect occupants from toxic gases that may leak into the building. This can be provided by a combination of HEPA filters and high-efficiency gas adsorbers.	MEDIUM	FEMA P-453

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Risk Category	Item	Guidance / Recommendations	Priority Ranking	Reference
	J.3	**Smoke-Tight Construction –** The selected SIP structure should have smoke-tight construction where applicable in the CBC and CFC. All penetrations should be appropriately sealed. Weather stripping around doors should be provided in the SIP structure.	**HIGH**	FEMA P-453 CBC Sec. 7 CFC Sec. 7
K. FIREFIGHTING WATER SUPPLIES	K.1	**Water Supply -** The selected SIP structure should have an approved water supply (and fire pump, if applicable) capable of supplying the required fire flow for fire protection according to Appendix B of the CFC. Water supply should comply with CFC Sec. 507.2 and can include private cisterns, ponds, pools, and water systems to suppress fires and protect a structure. Water supply should also meet requirements of Sec. 404 of the IWUIC. Secondary water storage could provide enhanced firefighting operations. Depending on the size of facility and anticipated number of people using the SIP, additional water storage could range from 5,000 up to 200,000 gallons. This should be reviewed with the local fire department for guidance.	**HIGH**	Wildland Urban Interface Operating Principals – Cal Fire, 2014 NFPA 1142 CFC Sec. 5 IWUIC Sec. 404
L. FIRE DEPARTENT ACCESS (These are in addition to Item D, and specific to fire department access needs).	L.1	***Primary Access –*** Street or access driveways should at a minimum, meet applicable design criteria for fire apparatus access roads from CFC Section 503. AHJ approval should also be obtained. At a minimum, the selected SIP should have an unobstructed width of not less than 20 feet exclusive of shoulders, a vertical clearance of not less than 13 feet 6 inches, a driving surface capable of maintaining the imposed loads of fire apparatus and provide all-weather driving capabilities and be provided with approved signage.	**HIGH**	IWUIC Sections 403.2, 403.3, 403.7 CFC Sec. 503 Wildland Urban Interface Operating Principals, Cal Fire 2014 FEMA Home Builder's Guide to Construction in Wildfire Zones
	L.2	**Access Turnaround** – Where necessary, the turning radius of the fire apparatus access road should comply with CFC Sec. 503.2.4. Consult with local fire department.	**HIGH**	CFC Sec. 503
	L.3	**Personnel Access –** Personnel access should meet the requirements of CFC Sec. 504. Exterior doors and openings of the selected SIP structure should be maintained readily accessible for emergency access by the fire department. An approved access walkway leading from fire apparatus access roads to exterior openings should be provided.	**HIGH**	CFC Sec. 504
M. FIREFIGHTER PERSONNEL & OPERATIONS	M.1	***Firefighter Personnel and Equipment –*** Where possible, each SIP should be provided with at least one fire truck with 3 personnel to provide spot fire protection and help defend the SIP from ember ignition.	**MEDIUM**	n/a
	M.2	***Pre-Plans/Maps*** – If possible, a designated Fire Command Center should be located within the SIP. Otherwise, pre-plans/maps should be provided at a central lobby or non-combustible lockbox on the exterior of the property. The intent is to provide firefighters or other first responders who are not familiar with the County and its' SIPs to quickly understand the key fire safety features of the SIP (e.g., location of sprinkler control value, secondary water supplies, HVAC system, hydrants, emergency communication systems/equipment)	**MEDIUM**	Wildland Urban Interface Operating Principals, CAL FIRE IWUIC Sec. 405 CFC Sec. 508
N. EMERGENCY POWER SUPPLIES *During planned (e.g., PSPS) and unplanned power outages, fire protection systems requiring power will need to rely on*	N.1	***Emergency/Standby Power Source –*** The selected SIP structure should be equipped with an emergency/standby power system in accordance with CFC Sec. 1203. It should be designed to provide secondary power within 10 seconds after primary power is lost, for a minimum duration of 2 hours without being refuelled or recharged.	**LOW**	CFC Sec. 1203

Risk Category	Item	Guidance / Recommendations	Priority Ranking	Reference
emergency and/or back-up power supplies to maintain continuity of service. This will be an essential component to achieving a resilient fire protection system design and other critical life safety systems.				
O. ESSENTIAL DISASTER SUPPLIES	O.1	The selected SIP structure should be equipped with FEMA recommended shelter equipment and supplies. See Table 4-1 of FEMA-453.	**LOW**	FEMA P-453
P. IGNITION SOURCES *Identify any sources of ignition, from heat or flame. All premises will contain ignition sources, some will be obvious such as cooking equipment, open flames, overhead electrical lines, welding, whilst others may be less obvious such as heat from mechanical and/or electrical equipment.*	P.1	***Power Distribution*** - Tree trimming and vegetation should be maintained 10 feet clear around distribution poles on-site. Coordination with the local energy provider is necessary to maintain fuel modification around their equipment.	MEDIUM	IWUIC Sec. A102.3
	P.2	***High Fire Risk Ignition Sources or Fuels*** – The selected SIP structure should have procedures in place to control high fire risk ignition sources or fuels. This includes maintaining clearance from ignition sources, prohibiting smoking and equipment and devices that generate heat, sparks, or open flames, fireworks, restricting the use of outdoor fires and incinerators, outdoor fireplaces, barbecues, and grills, and preventing the planting of vegetation under or adjacent to energized electrical lines.	**HIGH**	IWUIC Sec. A104, A105
	P.3	***Propane Storage*** – There should be no vegetation under large stationary propane tanks located near the selected SIP structure. The distance requirements for propane tank locations are dependent upon the LP Gas tank size as well as whether the installation is above ground or underground and should comply with CFC Table 6104.3. Fuel storage vessels should be located at least 30 feet away from the facility and away from downhill slopes. They should be located behind a non-combustible masonry wall.	**HIGH**	NFPA 58, Appendix I IWUIC Sec. 606 FEMA Home Builder's Guide to Construction in Wildfire Zones CFC Sec. 6104
Q. FIRE SAFETY SIGNAGE *Fire safety signage forms an integral part of the overall fire safety strategy of a building/property and is fundamental to the communication of good fire safety management information. Clearly visible and unambiguous signage is essential for speedy escape, particularly on large properties where people may not be familiar with the premises*	Q.1	***Road Signage*** – Signage to clearly define which road junctions to follow to access the SIP. Road identification signs should be of non-combustible materials and have minimum 4-inch-high reflective letters with 1/2-inch stroke on a contrasting 6-inch-high sign. Road identification signage shall be mounted at a height of 7 feet from the road surface to the bottom of the sign. Signage should be approved by the AHJ. Education and raising awareness are key parts of effective communication of the access routes and location of the SIP structure.	**MEDIUM**	IWUIC Sections 403.4/403.4.1
	Q.2	***Building Identification*** **-** Ensure SIP facilities are provided with identification that is plainly legible and visible from the street from both directions of travel. Addressing and identification should meet or exceed the minimum requirements of the Building Official and the local Building Code, found in CFC Sec. 505. Consult the local Fire AHJ, Law Enforcement AHJ and OEM concerning signage indicating a SIP sign or designation. If a sign is to be made visible to the public a uniform format should be used throughout the county to avoid confusion.	**MEDIUM**	IWUIC Sections 402.3, 403.6 CFC Sec. 505

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Risk Category	Item	Guidance / Recommendations	Priority Ranking	Reference
	Q.3	***Water Supplies Signage*** **-** On-site water sources available for firefighting purposes should be clearly identified. Identification should comply with CFC Sec. 509.	**MEDIUM**	IWUIC Section 404.8 CFC Sec. 509

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[2] R. Blanchi *et al.*, "Sheltering practices during bushfire," no. November, pp. 1–76, 2015.

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[5] FEMA, "Design Guidance for Shelters and Safe Rooms: FEMA 453," *Fed. Emerg. Manag. Agency,* no. May, 2006, [Online]. Available: https://www.fema.gov/pdf/plan/prevent/rms/453/fema453.pdf

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[13] IBHS, "Protect Your Property from Wildfire." Online: May 2019. https://disastersafety.org/wp-content/uploads/2020/03/WF_California_IBHS.pdf

[14] CAL FIRE, "Defensible Space," *California Department of Forestry and Fire Protection,* [Online]. Available: https://www.fire.ca.gov/programs/communications/defensible-space-prc-4291/

[15] National Fire Protection Association (NFPA) 25, "Standard for Inspection, Testing and Maintenance of Water-Based Fire Protection Systems with California Amendments". 2013 Edition

[16] "Sheltering Handbook, Disaster Services," *American Red Cross,* no. May, 2012, [Online]. Available: https://crcog.org/wp-content/uploads/2017/12/American-Red-Cross-Sheltering-Handbook.pdf

[1] The currently adopted Edition of all building codes and standards for Tuolumne County should be utilized. As new codes are adopted by the AHJ, referenced codes and standards in this document should also be updated. Where a code is referenced in this document is not specified an edition by the AHJ, the newest edition should be utilized.

[17] CAL FIRE, “Wildland Urban Interface Operating Principles,” *California Department of Forestry and Fire Protection*, no. 2014, [Online]. Available: https://www.iaff.org/wp-content/uploads/2019/05/CAL-FIRE-Wildland-Urban-Interface-Book.pdf

[18] NFPA 1142, “Standard on Water Supplies for Suburban and Rural Firefighting”, 2022 Edition.

[19] NFPA 58, “Liquefied Petroleum Gas Code”, 2017 Edition.

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Appendix A

Table 4-1 of FEMA P-453 contains a list of recommended shelter equipment. See below:

FEMA P-453 Table 4-1

Type	Equipment/Supplies
Communications Equipment	National Oceanic and Atmospheric Administration (NOAA) weather radios or receivers for commercial broadcast if NOAA broadcasts are not available
	Ham radios or emergency radios connected to the police or the fire and rescue systems
	Cellular and/or satellite telephones (may not operate during an event and may require a signal amplifier to be able to transmit within the shelter)
	Battery-powered radio transmitters or signal emitting devices that can signal local emergency personnel
	Portable generators with uninterruptible power supply (UPS) systems and vented exhaust systems
	Portable computers with modem and internet capabilities
	Fax/copier/scanner
	Public address systems
	Standard office supplies (paper, notepads, staplers, tape, whiteboards and markers, etc.)
Emergency Equipment	A minimum of two copies of the Shelter Operations Plan
	Flashlights and batteries, glow sticks
	Fire extinguishers
	Blankets
	Pry-bars (for opening doors that may have been damaged or blocked by debris)
	Stretchers and/or backboards
	Trash receptacles
	Automated External Defibrilator (AED)
	First aid kit
	Trash can liners and ties
	Tool kits

Type	Equipment/Supplies
	Heaters
	Megaphones
First Aid Supplies	Adhesive tape and bandages in assorted sizes
	Safety pins in assorted sizes
	Latex gloves
	Scissors and tweezers
	Antiseptic solutions
	Antibiotic ointments
	Moistened towelettes
	Non-perscription drugs (e.g., asprin and non-asprin pain-relievers, anti-diarrhea medications, antacids, syrup of ipecac, laxatives)
	Smelling salts for fainting spells
	Petroleum jelly
	Eye drops
	Wooden splints
	Thermometers
	Towels
	Fold up cots
	First aid handbooks
Water	Adequate quantities for the duration of the expected event(s)
Sanitary Supplies	Toilet paper
	Moistened towelettes
	Paper towels
	Personal hygiene items
	Disinfectants
	Chlorine bleach
	Plastic bags
	Portable chemical toilet(s), when regular toilets are not contained in the shelter

Type	*Equipment/Supplies*
Infant and Children Supplies	Disposable diapers
	Powders and ointments
	Moistened towelettes
	Pacifiers
	Blankets

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Appendix G: Communications Strategy

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JENSEN HUGHES

TECHNICAL MEMORANDUM

January 21, 2023

Project# 25492

To: Darin Grossi
Executive Direction
Tuolumne County Transportation Council

From: Darlene Rini, Meagan Joy, and Jonathan Lai

CC: Shannon Thaggard, Dore Bietz, Matt Braughton, RSP, Grace Carsky, Mike Aronson, PE

Project: TCTC Evacuation Needs Assessment

RE: Task 7 Draft Memo – Communication Deployment Strategy

EXECUTIVE SUMMARY

The purpose of this memo proposes a Communications Deployment Strategy (Strategy) for the public in the event of a major wildfire incident, as part of the Evacuation Needs Assessment and Communications Strategy project for Tuolumne County Transportation Council (TCTC) and Tuolumne County Office of Emergency Services (OES). The Strategy focuses on identifying and organizing key audiences and resources, as well as actions and recommendations for activating each of them in the likely wildfire scenarios.

The Strategy is divided into the following sections:

- Introduction
- Existing Conditions
  - Area Notification Systems
  - Social Media and Media Programs
  - Educational and Planning Resources
- Communications Deployment Strategy
  - General Strategy
    - Scenarios
    - Audiences
    - Resources
    - Backchannel
  - Scenario-Specific Strategies
    - Pre-Evacuation
    - Phased Evacuation
    - Total Evacuation
    - Post-Evacuation
- Conclusion

INTRODUCTION

This memorandum presents the proposed Strategy for the public in the event of a major wildfire incident in Tuolumne County, California. Due to a variety of concerns— including a highly active and severe wildfire region, limited access and egress routes, limited emergency response resources, a large percentage of lands consisting of undeveloped wildland fuels, and a growing population—Jensen Hughes was contracted to identify and enhance existing communication strategies in the development of a countywide Communications Deployment Strategy. The Strategy is intended to support decision-making for a range of potential evacuation scenarios during a major wildfire incident. This includes the following main sections:

- Existing Communication Conditions
  - Area Notification Systems
  - Social Media and Media Programs
  - Educational and Planning Resources
- Communications Deployment Strategy
  - General Strategy
  - Scenario-Specific Strategies

The intent of this assessment, in conjunction with the evacuation analysis, industry standards, and best practices, is to identify areas for improvement and recommendations to help reduce risk to life-safety in future wildfire incidents.

COUNTY DESCRIPTION

Tuolumne County, located centrally in the California Mother Lode along the western slope of the Sierra Nevada range, is approximately 2,217 square miles in area with an estimated population of 54,039 in 2020 and projected population of 63,000 by 2040 per the Department of Finance. The county extends from the foothills to the Sierra crest and is bordered on the north by Calaveras County, on the South by Mariposa County, on the west by Stanislaus County and on the east by Alpine and Mono Counties. Approximately 78 percent of the land within the county is owned by government agencies, which includes portions of the Stanislaus National Forest and Yosemite National Park. Sonora is the only incorporated city in the Tuolumne County region and is also the county seat.

The majority of the county's population resides in the City of Sonora and the unincorporated areas abutting the national forest and national park wildlands. Development in the wildland-urban-interface is only anticipated to grow in the near- and long-term, creating a series of complex challenges. This is further complicated by the millions of visitors and seasonal workers who come to the County for recreational and/or work opportunities increasing the potential for ignitions during the summer months. While the majority of the County's residents and visitors live (or stay) within close proximity to the four main highways: Highway 108, Highway 120, Highway 132, and State Highway 49—a large portion of the population has limited access/egress to these main transit corridors. This can present several challenges not only for firefighters and other first responders conducting emergency operations, but also for residents (and visitors) who may be evacuating or seeking refuge in an emergency event (wildfire-related or not). The limited

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access/egress routes, coupled with difficult terrain, can also present communication challenges for both first responders, residents, and visiting populations.

As the County primarily consists of mountainous, forested lands in a dry Mediterranean climate, it is highly susceptible to major wildland fires. Historically, and in recent years, the County has experienced significant and catastrophic wildfires both in the wildland and at the wildland urban interface (WUI) (e.g., 2013 Rim Fire)), leading to major physical, social, economic, and environmental impacts.

REFERENCED DOCUMENTS

The following documents and information were reviewed as part of development a proposed communication deployment strategy presented hereinafter:

- Tuolumne County Emergency Operations Plan
- Tuolumne County Evacuation Plan Pamphlet
- Tuolumne County Community Wildfire Protection Plan (CWPP), 2004
- Tuolumne County General Plan, Chapter 9, Public Safety Element, 2018
- Tuolumne County Office of Emergency Services (OES), Evacuation Guidelines for Tuolumne County Residents
- Greater Tuolumne City Community CWPP, 2004
- Tuolumne-Calaveras Unit, Strategic Fire Plan, 2020
- Emergency Operations Plan for the City of Sonora, 2014
- Tuolumne County Firewise Communities, 2021
- California Strategic Fire Plan, 2018
- CALFIRE / Tuolumne County Fire Department, 2021-2025 Strategic Plan, DRAFT
- Pacific Gas & Electric Company, 2021 Wildfire Mitigation Plan (WMP), 2021
- PG&E, Community Wildfire Safety Program, Tuolumne County, 2018

In Progress

EXISTING CONDITIONS

As part of the development of a Communication Deployment Strategy, an evaluation of existing communication strategies with respect to large-scale wildfire evacuations across the County was undertaken. This included the assessment of the following:

- Traffic Management
- Area Notification Systems
- Social Media and Media Programs
- Educational Resources

TRAFFIC MANAGEMENT

PHYSICAL SIGNAGE

Hurdles to evacuation can include challenging road characteristics, limited access/egress routes independent of fire hazards, vegetation encroachment on roads, security gates, unlit roads and intersections, and unlit street signage.

Tuolumne County utilizes functional Incident Management Organization groups and sections. The Operations Section is responsible for providing and coordinating public works services, including providing and placing barricades and signs for traffic management activities. The current type and use of digital technologies for signage during emergency incidents in Tuolumne County is unclear. However, this is one of many different approaches for communicating critical information before, during, and after a major wildfire incident, and thus is discussed in greater detail later in this report.

AREA NOTIFICATION SYSTEMS

Operational Area (OA) coordination refers to the multi-agency coordination under the California Standardized Emergency Management System (SEMS). Tuolumne County OES provides preparedness before, and coordination during, large-scale emergencies and disasters across the County. This includes serving as the OA coordinator with partner agencies, special districts, and key private agencies in providing planning, response, recovery, and mitigation activities due to fire and non-fire-related incidents. During an emergency, their primary role is to facilitate priority setting, interagency cooperation, and the efficient sharing and flow of information and resources.

California's Office of Emergency Services coordinates overall state agency response to major disasters in support of local government. The office is responsible for assuring the state's readiness to respond to and recover from both natural and human-made disasters, and for assisting local governments in their emergency preparedness, response, and recovery efforts.

In Progress

The following is a list of various area notification systems and/or emergency communication services to the public:

- The Everbridge® Citizen Alert System
  - All residents and visitors are able to receive alerts issued by the Tuolumne County Sheriff's Office of imminent threats and emergency warnings via the Everbridge Citizen Alert syste. The system has the option to enter one or multiple addresses that any registrant requests in the event of an emergency (e.g., primary residence, vacation property, child's school, daycare facilities, pet sitter, etc.). The system also allows for multiple methods of notificaiton – home or work phones, or email addresses to receive time-sensitive emergency messages on multiple devices, no matter where you are.



Link to register: https://member.everbridge.net/index/1332612387832200#/login

- Notify Me®
  - Tuolumne County provides an alert center that enables residents and visitors to subscribe to a number of emergeny event alerts (e.g., emergency alerts via Everbridge, press releases, public health) in Tuolumne County.

    Link to subscribe: https://www.tuolumnecounty.ca.gov/list.aspx
- National Weather Service (NWS)
  - The NWS transmits continuous weather information on 146.425 and 146.525 MHz frequencies. NWS severe weather broadcasts are preceded with a 1050 Hz tone that activates weather monitor receivers equipped with decoders. The NWS can also access the National Warning System to announce severe weather information

SOCIAL MEDIA AND MEDIA PROGRAMS

SOCIAL MEDIA

Tuolumne County is actively connected with social network programs including Facebook, Twitter, and Instagram. Local agencies use social media in an effort to keep stakeholders up to date on events, advisories, and alerts. The following table summarizes some of the primary social network links and websites for emergency preparedness in Tuolumne and surrounding areas.

Source	Weblink
Tuolumne County	
Tuolumne County Facebook	https://www.facebook.com/tuolumnecountygovernment
Tuolumne County Twitter	https://twitter.com/TuolumneCountyC
Tuolumne County Office of Emergency Services Facebook	https://www.facebook.com/TuolumneCountyOES

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Tuolumne County Fire Department Facebook	https://www.facebook.com/people/Tuolumne-County-Fire-Department
Tuolumne County Fire Department Twitter	https://twitter.com/tuolumnecofire
Tuolumne County Fire Department Instagram	https://www.instagram.com/tuolumnecountyfire/?hl=en
Tuolumne County Sheriff Facebook	https://www.facebook.com/tuolumnecountysheriff
Tuolumne County Sheriff Twitter	https://twitter.com/tuolumnesheriff
Tuolumne County Sheriff Instagram	https://www.instagram.com/tuolumnesheriff/?hl=en
Tuolumne County Notification Registration page	https://member.everbridge.net/index/1332612387832200#/login
Tuolumne County Animal Control	https://www.facebook.com/tuolumnecountyanimalcontrol/
CAL FIRE	
CAL FIRE Tuolumne-Calaveras Unit Facebook	https://www.facebook.com/CALFIRETCU
CAL FIRE Tuolumne-Calaveras Unit Twitter	https://twitter.com/CALFIRETCU
Independent Entities	
My Mother Lode*	https://www.mymotherlode.com/
* Provides information on evacuation advisories, warnings, and orders for Calaveras and Tuolumne counties.	

TUOLUMNE COUNTY RADIO BROADCAST

Area radio stations monitor emergency broadcasts and provide updated information on the following stations:

- 93.5 KKBN
- 92.7 KZSQ FM Sonora (Star)
- AM 1450 / FM 102.7 KVLM (News Talk)
- KOSO 93.1 FM (Modesto-Local EAS Station)

TUOLUMNE COUNTY PUBLIC ACCESS TELEVISION

Access Tuolumne is a Tuolumne County non-profit, community media organization. Access Tuolumne provides airtime on the local TV channels and online and offers media production training, facilities, and equipment. The content is a mix of local government and community programming, programs from other public access stations, items of interest found in the Public Domain, and emergency updates.

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EDUCATIONAL AND PLANNING RESOURCES

Community collaboration and engagement are central to any effective emergency preparedness program. Communicating accurate and timely information before, during, and after a wildfire is a challenge that communities are addressing through a variety of programs before an event escalates.

The following is a list of preparedness actions and measures at the city, county, and regional levels.

CITY AND LOCAL COMMUNITY PROGRAMS

- City of Sonora – Firefighters On Your Side campaign
  - The latest Firefighters On Your Side campaign – Prepare For Wildfire – brings critical wildfire preparedness tools to communities across California. This program offers materials in English and Spanish. Available at: https://firefightersonyourside.org/wildfire
- City of Sonora – Defensible Space Program
  - This program developed for the City of Sonora provides requirements and recommendations for defensible and reduced fuel zones to offer solutions to improve resistance of structures to wildfire loss for developed properties by improving management by homeowners of their defensible space zone. Available at: https://www.sonoraca.com/wp-content/uploads/2020/06/CITY-OF-SONORA-DEFENSIBLE-SPACE-INFORMATION.pdf
- Pine Mountain Lake Association – Ready! Go!
  - Fire emergency preparedness action plan for the Pine Mountain Lake area. Provides information for residents to prepare for wildfire events. Available at: https://www.pinemountainlake.com/wp-content/uploads/2020/11/PML-Emergency-Preparedness_FINAL.pdf
- Pine Mountain Lake Association – Fire Safety
  - Resource that provides many guidance documents including preventing home ignition, defensible space requirements and recommendations, tree removal requests, and emergency preparedness plans for the area. Available at: https://www.pinemountainlake.com/fire-safety-2/

COUNTY AND REGIONAL PROGRAMS

- Tuolumne County – Wildland Fire Evacuation Pamphlet
  - The County offers a wildfire evacuation pamphlet providing residents, business and visitor with information regarding various wildfire evacuation preparedenss and planning before, during and after a major wildfire incident. This includes identification of primary travel routes, emergency communication media outlets, sheltering options, etc. Available at: https://www.tuolumnecounty.ca.gov/DocumentCenter/View/19395/Tuolumne-County-Wildland-Fire-Evacuations-Pamphlet?bidId=

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- Tuolumne County GIS Mapping Tool
  - Tuolumne County provides a GIS mapping tool of active evacuation advisories. Available at: https://experience.arcgis.com/experience/d309d5b7f81a46adbb0a1ae627967633/?fbclid=IwAR1_2ViLZG0-PETElLFA6tX0D-MZBnb2mH4iQiXcl8YPe6SC3lA6pwlpZ80
- Tuolumne County – Firewise USA program
  - Offered through the National Fire Protection Association for the purpose of empowering community members to reduce their wildfire risk and encouraging neighbors to work together to take action against loss caused by wildfire. Available at: https://www.tuolumnecounty.ca.gov/1242/Firewise-Communities
- Tuolumne County – Defensible Space and You! program
  - Tuolumne County provides information on recommended defensible space for property owners to reduce the threat of wildfire loss. Available at: https://www.tuolumnecounty.ca.gov/1260/Defensible-Space#:~:text=Most%20areas%20of%20the%20County,the%20risk%20of%20structural%20fires
- Tuolumne County – Emergency Services Plan
  - County procedures and policies for response to significant disasters. This plan encompasses all significant disasters, including wildland fires. Available at: https://www.tuolumnecounty.ca.gov/DocumentCenter/View/6165/Tuolumne-County-EOP?bidId=
- Tuolumne County – Community Emergency Response Team (CERT)
  - Community Emergency Response Training is a 36-hour course designed for the average citizen so that they can be valuable to their community during a time of disaster. The County of Tuolumne encourages local citizens to participate in and learn essential emergency procedures to enhance emergency response by local public agencies through citizen preparedness. Available at: https://www.tuolumnecounty.ca.gov/1558/CERT---Community-Emergency-Response-Team
- Tuolumne Firesafe Council
  - The Tuolumne Fire Safe Council (FSC) is a grassroots, nonprofit organization that works to reduce wildfire hazard and the effects of wildfires in the north Tuolumne County community. Throughout California, FSCs educate homeowners about community wildfire preparedness activities, typically working directly with local fire officials to design and implement projects that increase wildfire preparedness and response efforts. Available at: https://tuolumnefiresafe.org/
- Tuolumne County – Hazardous Vegetation Management Ordinance
  - County Hazardous Vegetation Management Ordinance. Provides for the removal of hazardous vegetation situations in unincorporated areas of the county to reduce the potential for fire and to promote the safety and welfare of the community. The current ordinance pending Board of Supervisors adoption is available at:

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https://legistarweb-production.s3.amazonaws.com/uploads/attachment/pdf/1680092/Hazardous_Vegetation_Management_Ordinance_20221206_BOS.pdf

- Tuolumne County – Hazardous Fuel Reduction Program
  - Large scale fuel reduction and vegetation clearance on roads in Tuolumne County and provide defensible space assistance to low-income homeowners through grant funding. Available at: https://www.tuolumnecounty.ca.gov/DocumentCenter/View/14288/CCI2018GrantAgreementandMod1
- American Red Cross California Gold Country Region
  - The Gold County Region Chapter of the American Red Cross seeks to help people prevent, prepare for, and respond to natural and human-caused disasters through immediate mobilization of people and resources and the provision of community, workplace, and school-based training. In addition to disaster relief, the Region delivers Community-Disaster Education, First Aid/CPR, and other types of life-saving health & safety training to people across the region. Available at: https://www.redcross.org/local/california/gold-country/about-us/locations/sierra-delta-chapter.html
- Tuolumne County Amateur Radio Emergency Services (ARES)
  - ARES is a nationwide organization of licensed radio amateurs who have volunteered their expertise and equipment to provide emergency communications when disaster strikes. Available at: https://tcares.net/about-tuolumne-county-amateur-radio-emergency-services/

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COMMUNICATIONS DEPLOYMENT STRATEGY

GENERAL STRATEGY

The primary goals of this Communications Deployment Strategy are to:



The following strategic guidance organizes this Strategy into several key components, consisting of scenarios, audiences, resources, and backchannel. A specific sub-strategy accompanies each scenario as it relates to the audiences and resources involved as well as the use of the backchannel to inform decision-making. In the section below, each of the components and their supporting elements are examined, and in the section that follows, how they interact and support a cogent strategy in each of the most likely scenarios is reviewed.

SCENARIOS

From a functional communications perspective, there are four scenarios of concern for Tuolumne County: pre-evacuation, phased evacuation, total evacuation, and post-evacuation. The simplified distinction is that total evacuation requires outreach to all audiences, whereas a phased evacuation might require certain audiences to be prioritized and reached independently of others. Pre-evacuation represents the entire period before an evacuation is announced and represents opportunity to take proactive communications measures before any are required. Post-evacuation is the process of reintegrating the public into the previously evacuated area as well as the closure of the communications loop to all external audiences.

- **Pre-evacuation**
- **Phased evacuation**
- **Total evacuation**
- **Post-evacuation**

AUDIENCES

Tuolumne County's functional audiences for communications vary from traditional audiences such as indigenous tribes or school children because they speak specifically to the actions or strategies required to reach them rather than simply categorial labeling. For example, senior centers and group homes are an audience, but functionally, the traits that make the approach for them different are their propensity to have less mobility or access to and familiarity with digital communications, so focus is on those functional distinctions while providing the associated traditional audiences as examples. In this strategy, the separation of locals from non-locals is distinguished by the ability to proactively reach, educate, and equip local audiences

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with resources prior to any emergency event, which is not a reasonable expectation with non-locals.

- **Locals** *(residents, schools, camps, senior centers, group homes, businesses, agencies, etc.)*
  - Urban areas *(higher density, higher potential traffic, high availability, high signage potential, ease of communication)*
    - Specific needs: directed signage
  - In transit *(limited opportunities to reach, highly mobile - may cross various boundaries)*
    - Specific needs: high-visibility signage, mobile/cellular notification
  - Rural or wilderness *(limited cellular network, limited access to signage, potentially longer, more time consuming egress)*
    - Specific needs: sufficient signage, for peer-to-peer network notification
- **Non-locals** (recreational visitors/tourists, traveling workers, etc.)
  - Urban areas
  - In transit
  - Rural or wilderness
- **Sub-categories** (qualifying each of the above — e.g., local urban business or limited-mobility non-local in wilderness)
  - Vulnerable Populations
    - Limited mobility *(elderly, disabled/chronic conditions/injured, children, transportation disadvantaged)*
      - Specific needs: Physical assistance, peer-to-peer network notification
    - Limited access to communications *(disconnected from digital communications, elderly, young children, homeless, low-income, isolated/remote communities)*
      - Specific needs: Physical signage, peer-to-peer notification
    - *Limited communications comprehension (Limited English proficiency LEF, children, disabled)*
      - Specific needs: Translated communications, multi-lingual assistance and resources, physical assistance
    - Limited reaction time *(all aforementioned groups)*
      - Specific needs: Greater time buffer, peer-to-peer notification
  - Businesses and organizations
  - Adjacent agencies
  - Media

RESOURCES

Tuolumne County resources are separated into two categories—proactive and reactive—representing different opportunities for investment in communications infrastructure. The goal of proactive resources is to empower local populations and businesses with the information to act efficiently in the event of an emergency, and to go one step further in both knowing what to do and how to do it. This relieves pressure on active communications in the event of an emergency and allows emergency response to focus resources on non-local audiences. The goal with all reactive emergency response communications is to be as effective as possible using as few resources as possible. To this end, it is crucial to have a "single source of truth" as a reference for all outbound communications. This is especially in helping to control rumors or misinformation

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before, during, and after evacuations, especially given uncertainties via social media and other new communication platforms. This can be a document, a process, or trained personnel, but the goal is to have the same message translated and distributed across multiple formats, media, agencies, etc.

- **Proactive**
  - Planning, education, training
  - Infrastructure
  - Activation
- **Reactive**
  - Digital
  - Physical
  - Relational

BACKCHANNEL

The backchannel is the monitoring and information feed that allows for updating and modifying the communications strategy and output of that strategy. For example, when changes occur in the situation or feedback is received on the effectiveness of communications, adjustments can be made accordingly to achieve the desired outcome.

- **Operational feedback**
- **Actionable updates**
  - Situation status changes
  - Audience changes
  - Messaging changes
- **Reintegrating populations**

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PRE-EVACUATION

COMMUNICATIONS CONSIDERATIONS

Pre-evacuation is the complete space of available time for Tuolumne County before an incident. In this period, the full suite of proactive measures that can be accomplished in order to offset the strain on resources during the emergency event is considered. By spreading out reactive work into the pre-event period, it is effectively flattening the curve of resource demand during the event. The pre-evacuation period, therefore, represents an opportunity to set the framework for many of the reactive measures that take place during emergency response. For example, reaching out to local businesses with tools and protocols for spreading the word about emergencies to their clientele who may be enroute to an affected area or already there.

- Encompasses all proactive resource measures
- Opportunity to offset resource strain during phased- and full-evacuation scenarios
- Opportunity to set framework for managing reactive scenarios

AUDIENCES

For practical purposes, the key audiences in this period include only county locals, because they are the ones reliably available prior to an incident. The county's vulnerable populations are best served through proactive measures taken at this phase, as they are the most dependent on resources already in place during the emergency period. This is an opportunity to test the reach of communications to these populations in a non-critical environment.

- Locals
    - Especially vulnerable pouplations

RESOURCES

The full suite of proactive resources is being considered. Though depending on the lead time to the event, some may or may not be feasible.

- Proactive

BACKCHANNEL

In this scenario, the backchannel serves as feedback from the local audience to build in new resources into measures for both proactive and reactive.

- Local feedback

ACTIONS

County staff and/or partners must first prioritize and assign ownership of the following events in order to get them off of the ground. The following actions are recommended in this period, depending on the availability of resources and cooperation of local organizations.

- Planning, education, training
    - Public workshops

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  - Stakeholder engagements
  - Spokesperson training
  - Social media training
  - Public relations strategies, planning, and proactive outreach
  - Interagency content development and planning (digital templates, etc.)
  - Comms messaging development (templates, etc.)
  - Planning peer-to-peer carpooling
  - Establishing emergency peer-to-peer communications networks
  - Planning resort/camp/hotel shuttles
  - Planning emergency transportation routes and coordination
  - Emergency operations training for local organizations (camps, schools, businesses, centers, etc.)
  - Planning interagency communications, including protocols and directories for coordination
  - Translating planning, education, and training materials
- Infrastructure
  - Road and remote-activated signage
  - PA system
  - Extended/back-up cellular/data network
  - Peer-to-peer communications network
  - Physical communications resource directory
- Activation
  - Dissemination of plans, strategies, and resources
  - Signing up public for push notifications
  - Identifying and connecting associated social media accounts
  - Posting informational signs, posters, flyers

CHALLENGES

One of the biggest operational challenges in this period is establishing a protocol or working rubric for taking pre-event measures with event teams. For example, the public information officer (PIO) who would be assigned in the condition of an emergency, might not have access to resources to accomplish these things in a non-emergency situation. All of these actions also require both capital and time expenditures to accomplish, which are finite. Some of these actions rely on the participation of outside agencies and organizations in order to work effectively, which introduces an element of unpredictability in handoff. Finally, inherent to this period is the consideration of vulnerable populations and how to reach them. It may be a resource challenge to identify and build communications channels that will reach all intended vulnerable audiences reliably in the event of an emergency.

- Availability and continuity of resources in planning vs. emergency phases of operation
- Investment of capital and human resources
- Reliance on outside parties
- Identifying and building communications channels to reach all vulnerable populations

RECOMMENDATIONS

The primary recommendation in this period is to ensure that no audience in Tuolumne County is left behind—especially vulnerable populations. If there are gaps or tenuous connections

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allowing information to travel to certain audiences, building the infrastructure and system for reaching them should be prioritized in this phase of operation. To that end, laying the groundwork for amplification strategies on top of existing channels such as Everbridge® and Alert Me® that allow a one-to-many approach of sending communications to an intermediary who is responsible for reaching other audiences (such as hotels who will then be responsible for notifying their individual guests) can reduce strain on available resources in particularly demanding communications scenarios. This period also represents the opportunity to actively engage with the public via educational programs such as Firefighters On Your Side and Ready! Go! or consider the reprogramming of such county resources as CERT (Community Emergency Response Team).

- Investment in in-transit signage and communications media to reach vulnerable communications-deficient audiences
- Investment in communications infrastructure such as PA systems and cellular/data network extenders to reach more people in remote areas
- Investment in language translation services to more effectively reach non-English speaking audiences
- Investment in amplification strategies that allow one-to-many communications, especially in resource-constrained scenarios
- Establishing protocols and lines of sight for peer-to-peer communications networks
- Activation of city and county educational programs for public emergency preparedness

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PHASED-EVACUATION

COMMUNICATIONS CONSIDERATIONS

A phased evacuation is a unique challenge to the Strategy because it involves delivering targeted communications to specific audiences to the exclusion of others. The key priority of the communications strategy at this stage is identifying those audiences that require the most time and resources to reach or mobilize. Time is the key driver of priority. As this is a phased activity, it is important to phase audiences as well, prioritizing both those affected by the current situation as well as those who are likely to be next—this is where the feedback channel comes into play in deciding whom the next audiences in line will be.

- Targeted communications and specific audiences
- Prioritizing audiences based on difficulty to reach or mobilize
- Phased or tiered audience categories

AUDIENCES

Functionally, the audience here consists of all audiences until some are labeled as non-priority or non-actionable. That said, vulnerable audiences in particular must be given the requisite time buffer to be notified and evacuated safely and effectively.

- Locals
- Non-locals

RESOURCES

The toolkit for outreach consists of all the county's available resources, though the messaging and targeting will vary depended on the intended audience.

- Digital
    - Press releases
    - EAS, EBS, Everbridge®, Alert Me®, push notifications
    - Social media posts
    - Tweet updates
    - Instagram post updates
    - Facebook post updates, groups
    - Interagency and affiliate/partner support
        - Retweets, regrams, reposts, shares, etc.
    - Website page updates
- Physical
    - Road signage
    - Press conferences
- Relational
    - Media relations: TV, radio, web, social
    - Via email, phone, social
    - Interagency relations
    - Peer-to-peer network
    - Real-time translation across media

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BACKCHANNEL

The backchannel has a large role in this scenario, because it is the gatekeeper for unlocking various audiences and actions as they become necessary. It is also a measurement tool to gauge the effectiveness of communications in achieving the intended goal evacuation of targeted audiences, which should feed back into the use of resources to fill in any gaps

- Assigning priority audiences based on operational feedback
- Opening new audiences for communications
- Prioritizing the use of resources in reaching target audiences
- Measuring communications effectiveness

ACTIONS

The communications actions of this scenario involve a phased and multi-pronged activation that include most if not all of the available resources.

- Identifying and developing single source of truth
- Prioritizing and tiering all relevant and potentially relevant audiences
- Codifying evacuation messaging for intended audiences
- Translating and distributing messaging across all available resources to reach necessary audiences
- Employing backchannel to calibrate resource use and identify priority audiences, and to gauge effectiveness of communications

CHALLENGES

The inherent challenge of a phased evacuation is casting too wide or too narrow of a net that either strains resources or egress routes with more people than necessary or does not completely reach the intended audiences. This can be mitigated with information and planning: that is, a well-calibrated pre-event phase and backchannel that minimizes room for error.

- Casting too wide or narrow an audience net

RECOMMENDATIONS

Information and planning are the keys to an effective phased-evacuation. By anticipating audience needs, preparing resources, and prioritizing audiences, communications can be both effective and flexible in reaching the intended audiences.

- Prioritizing audiences based on time delay and anticipation of impact
- Real-time relay of developing incident through communications channels—queuing audiences on standby
- Planning and timing communications actions to coincide with event unfolding
- Preparing communications messaging and outreach that lays the groundwork for future communications
- Targeted evacuation orders to reluctant individuals can increase evacuating behavior[1]

[1] Wong, S. D., Broader, J. C., Walker, J. L., & Shaheen, S. A. (2022). Understanding California wildfire evacuee behavior and joint choice making. Transportation. https://doi.org/10.1007/s11116-022-10275-y

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TOTAL EVACUATION

COMMUNICATIONS CONSIDERATIONS

The total evacuation scenario is an exhaustive communications effort that demands engagement of all Tuolumne County resources. While the demands are simple in terms of targeting—all audiences are targeted—it is more complex operationally because of the number of pieces in play and the demands on the communications team to manage the outreach as well as the feedback and response to each of the activated resources. For example, reporters return for a follow-up, or social media posts receive questions or criticism.

- Resource strain from activation of all channels and resources at once
- Backchannel from active communications causes additional strain
- More channels to update as scenario evolves

AUDIENCES

This scenario includes all audiences with priority assigned to the most vulnerable.

- Locals
- Non-locals

RESOURCES

This scenario activates the full suite of digital, physical, and relational resources available.

- Digital
    - Press releases
    - EAS, EBS, Everbridge®, Alert Me®, push notifications
    - Social media posts
    - Tweet updates
    - Instagram post updates
    - Facebook post updates, groups
    - Interagency and affiliate/partner support
        - Retweets, regrams, reposts, shares, etc.
    - Website page updates
- Physical
    - Road signage
    - Press conferences
- Relational
    - Media relations: TV, radio, web, social
    - Via email, phone, social
    - Interagency relations
    - Peer-to-peer network
    - Real-time translation across media

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BACKCHANNEL

In the event of a total evacuation, the county backchannel is crucial insight for adjusting the strategy and to adding filters back to the wide-open net cast on resources and audiences. It helps answer the questions: Which audiences are being left behind? How effective is the current communications strategy? And when do we close the loop? Staff can use it to understand how different audiences may be responding to the same messages delivered across the board—allowing adjustments to messaging and methods to meet audiences where they are.

- Refocusing communications resources and messaging to reach all audiences
- Measuring communications effectiveness
- Deciding when communications resources can be deactivated

ACTIONS

The communications actions of this scenario are the complete and simultaneous activation of all county resources.

- Identifying and developing single source of truth
- Prioritizing vulnerable audiences and refocusing resources to reach those underserved
- Translating and distributing messaging across all resources to reach necessary audiences
- Monitoring the backchannel to enable the effective distribution of updates and gauge the effectiveness of communications
- Deprecating the use of resources as appropriate to manage resource strain

CHALLENGES

Resource strain and resource management is one of the largest challenges in this scenario. Additionally, engaging with an audience this large presents a logistical burden to providing effective updates and feedback across all channels.

- Resource strain
- Logistical considerations of managing feedback and updates to all audiences

RECOMMENDATIONS

Because this scenario requires such a large resource investment from all county communications channels, the communications team should consider the use of amplification methods (i.e., one-to-many) that would have been prepared at the pre-evacuation stage, thereby minimizing the number of channels required to reach the same audience. In addition, designating a single source of truth, such as the Tuolumne County Facebook page, and referring multiple audiences to it for updates can be an effective way of keeping audiences in the loop with the expenditure of active resources. Audience priorities remain ensuring effective, early, and redundant efforts to reach vulnerable populations who may otherwise be underserved in this scenario.

- Employing amplification methods to maximize reach with minimal resources
- Designating and referring audiences to single source of truth to limit resource strain with updates across all channels
- Prioritization and close monitoring of vulnerable populations to ensure they are effectively reached

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POST-EVACUATION

COMMUNICATIONS CONSIDERATIONS

Post-evacuation represents the closing of the loop on county crisis communications. It is the phase marked by the eventual reintegration of both local and visiting populations into the area. That said, the time scale of this phase may vary significantly—in some cases, it may be weeks or days before the public is allowed to return. In all cases, communications channels are expected to stay open to announce updates and finally to announce the terminus of the event. This period also serves as an opportunity to learn from how communications were handled and received during the previous phases and is the ultimate backchannel for refining the process of communications strategy development.

- Reintegrating local and visiting populations
- Updating all communications channels to close out the event
- Feedback opportunity to refine communications strategy going forward

AUDIENCES

This involves all previously reached audiences through either the phased- or total-evacuation scenarios.

- Locals
- Non-locals

RESOURCES

The resource considerations here involve closing the loop with all previously activated resources. Because audiences are physically further afield than they were in the previous activation phases, it may be more challenging to reach them through the same channels.

- Previously activated resources
- Broad-reaching communications channels

BACKCHANNEL

As previously noted, this scenario serves as its own backchannel for improving the communications strategy development process. This is an opportunity to seek feedback from various media, partners, and the public. It is valuable to assess which audiences, for example were difficult to reach or to reach effectively to improve future communications strategies.

- Better understanding barriers to communications
- Better understanding difficult-to-reach audiences
- Measuring holistic effectiveness of communications strategy and process

ACTIONS

As with earlier phases, continuity of messaging across all media is crucial in this stage. Coordinating the return of locals and non-locals to Tuolumne County may involve a phased and targeted effort or blanket directions. It is key that these communications are not conflated in

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mixed messages, so the same priorities of a single source of truth and continuity across resources present in earlier stages is paramount here as well. Finally, as this phase represents the terminus of outbound activity, it involves closing the loop with all open communications channels and ensuring that all audiences reached understand the next steps.

- Identifying and referring to single source of truth
- Translating and distributing messaging across all resources to reach necessary audiences
- Monitoring the backchannel to enable the effective distribution of updates and gauge the effectiveness of communications
- Closing the loop with all audiences and channels

CHALLENGES

As noted in the resources section, one of the primary challenges involved in this stage is reconnecting with all audiences that may have moved further afield in the evacuation phase, and as such are more difficult to reach. Maintaining continuity and an open channel of communication is in itself a resource strain that should not be discounted. Finally, in phased reintegration approaches, it may be necessary to keep lines of connection open with updates and targeted messaging intended for specific audiences—so managing this multi-pronged multi-priority communications tack is resource intensive as well.

- Reconnecting with audiences that have been evacuated and are more dispersed
- Resource strain of open communications for updates
- Resource strain of phased reintegration requiring targeted messaging and audience specificity

RECOMMENDATIONS

The general goal of this phase is to close the loop with all activated resources and evacuated audiences, in Tuolumne County and beyond. To that end, it makes the most sense to limit the resource strain involved with reaching each of them where they are by providing information in one place that they can refer to as the situation unfolds, such as the Tuolumne County Facebook page. The latter stages of this phase are also an opportunity to refer audiences to available resources that may be outside the scope of the emergency communications function, such as housing resources, reintegration procedures, safety protocols, etc. It is recommended to work with partner agencies and resources ahead of time to have systems in place and available. It is also an opportunity to close the loop with local media like KVLM and Tuolumne County Public Access Television who may be able to broadcast the aforementioned resources in their news coverage. Finally, as this is the end phase of communications, it is also an opportunity to leverage the backchannel to refine the communications processes and inform infrastructure and resource investments going forward.

- Referring audiences in to single source of truth to limit outbound resource strain in updates and closing the loop
- Preparing referrals to outside resources for reintegration and local area information
- Leveraging open channels to local and broader media to broadcast updates and resource availability
- Leveraging backchannel to refine communications processes and inform future infrastructure and resource investments

In Progress

CONCLUSION

Communications strategy is an evolving process. It benefits greatly from the investment of resources into the early, pre-evacuation stage as well as the time taken in the post-evacuation stage to monitor and take stock of both shortcomings and successes in the effectiveness of communications in reaching intended audiences. During an event, having a single source of truth is both strategic from the perspective of communications clarity as well as for minimizing resource strain. Further, in all communications phases, employing an active and reliable backchannel for communications and operations is one of the most valuable investments that can be made to improve communications in real-time as well as in the future.

Given Tuolumne County's vulnerable and remote populations combined with limited public communications infrastructure, the imperative is that no audience is left behind. There should be a reliable method for reaching everyone, and ideally multiple methods that allow for a quick and coordinated response in the event of a time-sensitive event. The more redundancy that can be built into reaching all audiences, the more investment that can be made in the infrastructure to do so, and the more that those resources can be front-loaded in anticipation of an event, the more successful communications will be in achieving its goals in the case of an emergency.

In Progress

Appendix H: Community Engagement Summary

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PUBLIC ENGAGEMENT AND COMMENT NOTES

Community Events: December 6-8, 2022 Board Meeting: January 11, 2023	Project# 25492
Project Name:	TCTC Evacuation Needs Assessment
Meeting Location:	Sonora, CA; Groveland, CA; Virtual Meeting
Submitted by: Grace Carsky, Matt Braughton, RSP$_1$	

SONORA COMMUNITY EVENT:

Sonora Opera Hall, December 6, 2022, 5:30-7pm

- Question: Any considerations for Campo Seco Road? The route was gridlocked during the Sonora Fire and is the only other access if SR-108 is closed.
    - The priority roadways were selected based on the results the travel model analysis and how often they came up in the evacuation analysis results as overcapacity, as well as through discussions with the stakeholder team.
- Question: Are there any plans for vegetation management to clear roadways for evacuations?
    - Yes, our recommendations include discussion of vegetation management. For example, Phoenix Lake is discussed as a location where vegetation management could help keep an important evacuation egress route open longer to increase evacuation capacity.
    - Tuolumne County Office of Emergency Services (OES) is also working on prioritizing vegetation management projects and identifying funding for projects.
- Question: Are there any plans for extending Greenley Road?
    - City of Sonora has identified this as an important evacuation route (and overall project), and it is included in our report as opportunity to increase evacuation capacity to help address expected evacuation congestion through Sonora. However, the project is currently unfunded.
- Question: Are there any strategies for addressing congestion on Washington Street?
    - We have identified signal coordination and "green wave" signal timing strategies related to help prioritize evacuation traffic during emergencies. These changes/preparations will require coordination with Caltrans and further study.
    - We also identified the potential to remove street parking to increase roadway capacity – similar strategies have been implemented in rural Los Angeles County during red flag warnings
- Question: How has active traffic management been planned for the strategies (e.g., in-person traffic control, cars breaking down, etc.)
    - We acknowledge that there are staff limitations for some of the strategies and have identified implementation needs for each.

- Question: Can we integrate navigation systems (e.g., Google Maps, Apple Maps, Waze) into the evacuation plans?
    - County & OES are working with residents to educate them on how and where to evacuate.
    - Navigation applications are not always reliable and may direct people down the wrong path or cell service may be limited in certain parts of the county.
    - OES is also researching additional communication technologies like radio communication, FM alerts, and transceiver alerts to provide additional communication layers during emergencies.
    - The most up to date information will always on the OES website and Sheriff's Office Facebook page
- Question: Was there any consideration for the Rawhide/Ridge Flat area?
    - The project had limited scope to choose fire scenarios, this area was not selected as one of the highest priority due to it not being located in what has been identified as a high fire hazard area and the lower residential density of the area.
- Comment: Recommend that residents get ATVs for evacuating since they are more nimble than vehicles
- Question: Why was evacuation traffic direct to the west?
    - Based on research and prior experience, many people choose to evacuate towards their homes or other populated areas (e.g., Central Valley, Bay Area, etc.). Our analysis used this assumption when choosing where people would evacuate but does not necessarily reflect what could be recommended as part of evacuation operations (subject to Sheriff's Office direction and spread of the wildfire).
    - OES/County is educating people to **NOT** do this, but to evacuate wherever is the best and safest place to do so based on current conditions.
- Question: What is the general timeline for these strategies/projects?
    - This is the first of many steps in implemented the work and projects can take 5-10 years to get funding and construct
    - TCTC is working on getting the funding for several recommended projects including actively working with Caltrans on improvements to SR-49 from Chicken Ranch Rancheria to East Sonora
- Question: If we are talking about increasing capacity on the roadways, how are we handling the new roundabout on SR-108 (one travel lane, reduced speeds)?
    - TCTC did not have this information when the roundabout was planned and constructed and that may have influenced the design.
    - There is the potential to reconstruct in the future and add capacity to support evacuations or additional capacity as appropriate.

GROVELAND COMMUNITY EVENT

Groveland Community Center, December 7, 2022, 5:30-7pm

- Question: Does the modeling include visitors and tourists?
  - Yes, the model includes resorts and visiting residents, so this was incorporated into the evacuation analysis. The assumption assumed peak occupancy of housing units and high visitation at recreation sites as part of the analysis. The analysis also accounted for planned future growth using the TCTC's future land use projects.
  - We also incorporated population growth into the analysis.
- Question: Why was only a small segment of SR-120 (Ferretti to Priest Coulterville) identified when the roadway does not have lane changes until Chinese Camp?
  - There are limitations to the model – this is a starting point to looking at capacity strategies that would be refined through more detailed feasibility studies.
  - Comment: at SR-120 and Priest Coulterville, the speed limit increases to 65 mph and people may choose to take Priest Coulterville to evacuate
    - Priest-Coulterville Road is typically closed for emergency vehicles to assist in evacuations
- Question: Can the model incorporate adjacent counties (e.g., Mariposa County, Calaveras County, Mono County, etc.) in the analysis?
  - We can route people into these counties, but the model only uses Tuolumne County roadways as part of the network. We do understand travel patterns into and out of the County but cannot evaluate roadways outside the County network.
    - The model uses anonymized cellphone tower data to understand how people travel in and out of the County and is calibrated to account for those trips into and out of the County.
  - From an operations and communications standpoint, the County does coordinate with adjacent counties in emergencies.
  - Important to note that Yosemite Park opens their gates to allow for evacuation traffic during emergencies.
- Comment: How will the SR-108 roundabout affecting evacuation?
  - Currently one travel lane each way, but may be expanded during capital improvement projects in the future, if needed for capacity.
- Question: Would the County consider private shuttles for evacuations?
  - Public transit and school buses are currently utilized as part of evacuations.
  - Casinos and other transit agencies already offer vehicles in support, as needed
  - County has established an evacuation operations document on how to work with transit operators in evacuations
- Recommendation: We need to prioritize improvements to the Evergreen Lodge roadway
  - Roadway is a US Forest Service road that the County currently maintains
  - There is a federal grant to improve the road conditions and increase travel lanes (estimated work in 2025)
- Recommendation: Pine Mountain Lake rental units will include evacuation information and maps to educate people on where and how to evacuate, does the County have similar plans?

  - County GIS has community maps available for people to print and use for evacuations and the County and OES are exploring additional ways to communicate and distribute materials to the public on a countywide scale.
- Question: Are there any plans to make translated materials?
  - Translated materials are included as a recommendation for communication outreach that will be explored as a future consideration.
- Question: Does the communication strategy recommend any use of technology (e.g., variable message signs)? Pine Mountain Lake has funded the purchase of one variable message sign for emergencies.
  - No current plans, but will add changeable message signs as a potential strategy into the study.
  - OES is constantly reviewing opportunities to integrate new technologies into their approach to emergency operations and communications and has been exploring new technologies to reduce communication barriers during evacuations.
- Question: Is there any guidance on best practices for electric vehicles in evacuations?
  - We appreciate the comment and will add this as a topic to explore as part of the report. There is not much guidance on this topic yet. The current recommendation is to keep electric vehicles charged, just as people are encouraged to keep their gas tanks full in case of an immediate evacuation.
- Recommendation: In communities with only one egress route, can we limit street parking to increase capacity out?
  - This approach has been integrated in the plan as a recommended strategy and has been implemented by other jurisdictions (Los Angeles County) during red flag days and emergencies.
- Question: Would the County stage an evacuation exercise in Groveland?
  - OES currently discussing how this could be done in vulnerable communities (like Groveland). It would likely be voluntary but hoping to move forward with an approach after determining needs and funding.
- Question: How can residents find the information on how and where to evacuate?
  - OES & County GIS have community maps for residents so they can identify evacuation routes in their neighborhoods.
  - Pine Mountain Lake recently launched their own community maps that highlight egress routes in the area.

VIRTUAL COMMUNITY EVENT

Zoom Virtual Meeting, December 8, 2022, 5:30-7pm

- Comment: Under current and evolving fire regime, we cannot use historical fire data to help with fire scenario predictions.
    - Historical data was used as a framework for developing an understanding of historic fire risk. This data was then used in discussions with the Fire Safety Advisory Committee and follow-up discussions with County fire chiefs and other stakeholders to arrive at locations that would best represent high-impact scenarios for the evacuation transportation analysis (i.e., a high potential to result in a larger scale evacuation). As an example, the Columbia scenario was added not based on historic fire risk for the area but based on concern for a larger scale evacuation near Sonora.
- What software is used for the fire modeling and evacuation analysis?
    - FlamMap – fire modeling
    - TransCAD – evacuation capacity analysis
- Comment: Build three lanes so two can be used for evacuations and one for emergency operations
    - Larger scale roadway capacity improvement projects have been identified for several roadways within the County but are currently awaiting funding. Given the limited funding available for roadway capacity increasing projects, alternative nearer-term improvements were reviewed. We will add additional documentation to support that roadway capacity improvements do allow for greater evacuation capacity.
- Comment: Groveland multi-use path is funded from Flint Court to Deer Creek Road. Can we maintain the rest of the route to Vassar Road, and add the recommendation to the plan?
    - We will review the current funded portion versus the remainder of the route and update the recommendation to better reflect the current funding status of the project.
- Comment: Many fire scenarios/evacuation analysis results mention Washington Street as over capacity – why? Fires come from the valleys and eastern part of County, how is Washington Street impacted?
    - The evacuation analysis was set up to route people west (e.g., Central Valley, Bay Area) during an evacuation, so vehicles are evacuating through Sonora/along Washington Street. Washington Street is also already highly utilized, so the addition of evacuating traffic can quickly lead to the road operating over capacity (experiencing extreme congestion).
    - The study recommends potential improvements along Washington Street to add capacity through Sonora.
- Question: Are there any plans to conduct tabletop exercises/staged evacuation to practice out the plan or identify issues?
    - No plans currently but OES is exploring the possibility of implementing an evacuation exercise in vulnerable communities as well as tabletop exercises.
- Comment: How are RVs/trailers being considered for evacuation? Can secondary egress routes accommodate larger vehicles?

  - Alternate routes may not accommodate larger vehicles, but we understand that many people evacuate with larger vehicles and part of our analysis integrated the addition of more large vehicles into the capacity calculations. Designs for future improvements on primary evacuation routes should consider larger vehicles being used for evacuations.
- Question: How is public transit being utilized in evacuations?
  - Bus operators are on call to help evacuate if needed but are never told to go into active fire/hazard areas. They regularly help evacuate populations without access to a vehicle.
- Question: Are there any plans to create an evacuation app (e.g., Mariposa County Alter Center?)
  - No plans to create an app. All information is on the Tuolumne County Sheriff's website and Facebook page

PINE MOUNTAIN LAKE ASSOCIATION BOARD MEETING

Groveland Community Center, December 7, 2022, 4:00-5:00pm

- There are 400 short-term rentals in the community area with 68% of the owners living outside the community.
- Most evacuees want to go out on Ferretti Road and go westbound on State Route 120
- Approximately 2,000 visitors in the area six months out of the year – these visitors often do not necessarily know where they are or how to evacuate.
- South Side Senior Connection – helps keep track of vulnerable populations and their needs. Coordination with OES and TCTC to get buses to help people get out. During the Moc Fire, the buses sat empty because they did not have direction of where to go for pick ups.
- Different communication techniques are important for different populations.
- There is a need for alternate routes in the Pine Mountain Lake community – there are nine entrances with 14 gates/access points. Three potential evacuation routes have been identified by the association:
  - Mountain Springs Road to allow access to State Route 120 on the east end of the lake.
  - Big Creek connecting to Big Creek Shaft Road using a former US Forest Service road that was abandoned. Exploring possibility of acquiring right of way and ownership.
  - Hetch Hetchy Railroad Grade – a portion of the right of way is being acquired by Groveland Community Services District through a grant to build a pave walkway. This route would connect out to State Route 120 between Groveland and Big Oak Flat to provide a potential exit for evacuating vehicles or entry for emergency vehicles
- Feedback from Moc Fire:
  - Evacuation traffic was sent westbound on State Route 120 but then sent back, as well as traffic from people who live off the hill coming up to their property.
  - Yosemite National Park opened their gates to allow evacuating traffic when notified.

  - Primary evacuation routes: State Route 120 (west and east), Smith Station Road, Cherry Lake Road, and Wards Ferry Road.
  - Consider blocking Wards Ferry Road on the north end to prevent inbound traffic.
- Desire for evacuation signs at "T" intersections to direct traffic on appropriate evacuation direction.
  - PMLA have worked with Tuolumne County to get approved signs for evacuation, working through approvals
- Evacuation routes to be posted in any rental.
- Desire for changeable message signs at Pine Mountain Lake Road and Ferretti Road to direct which way to evacuate. Needs to be coordinated with OES and the Sheriff's Office.
- Consider putting up barricades to indicate direction of evacuation travel. This would require staffing.
- Concerns about how to provide evacuation communications regarding when to evacuate and which way to go.
  - IPAWS – able to reach those that do not sign up (e.g., EverBridge) – instead linked to cellphone tower signal connection to send critical messages
  - Social Media Misinformation – how to best tackle and get a single point of information
  - Bulletins and testing frequently to raise awareness and provide regular communication on where people should go to get information.
  - Alternatives to cell service since previously cell service has gone down, reliant on fiber connection through AT&T.
  - GrovelandNet & TCares – Radio amateur program that could help share local knowledge back to the Sheriff/OES during an emergency (e.g., a downed tree that needs removal).
  - Starlink (with a generator for power) as another option
- PMLA exploring procedures for PML employees and conducting evacuation exercises.

ADDITIONAL COMMENTS/QUESTIONS

- Thomas Hernandez (via email, 12/9/2022):
  - Make the next presentation focused on the Groveland area only (too much time spent on areas we have no interest in as we do not live there). Information on Sonora, Twain Harte...can be back up slides if anyone is interested.
  - I have mentioned this before to PML and Cal Fire, there has to be a focus on Ferretti Rd, during fire season if that road is used for evacuations-there are several areas of high grass, it catches on fire and you won't be able to see clearly due to smoke-keep in mind, most full time residents are 70 and above. Then you have the younger generation that drive at high speeds regardless of the conditions. One accident and you have effectively shut down a main artery of exit.
  - During fire season, there should be signs at each charging station, keep batteries charged to xxx% during Fire Season.

  - Partner with CERT and or have a plan to close access to Old Priest Grade prior to an evacuation notice. We only need one panicked RV person to head down the grade and block it as they cannot maneuver the turns.
  - Look at the various tour companies that cater to non-English speaking tourist, can we get them engaged in sharing evacuation steps...like being on a cruise ship, they cover that on day one.
  - Get "wind socks" installed in various locations to help determine which way the smoke/fire is headed, to help better suggest exit routes.
  - Partner with the Red Cross-get a deal on emergency to go bags and publish to help people be prepared.
  - Suggest some of the latest and greatest gadgets; I have some magnetic circular lights that blink, flash, stay lit....for easy visibility.
  - Perhaps draft a simple flow chart that folks can carry with them, in their car, in their home that gives some simple steps on how to get your things together, what to load, who to contact (family, friends...) they are on their way out.
  - Consider pre made signs that can be put up or taken down to identify exit routes
  - NOW reverse the process, what to do when you get the all clear to return, do's and don'ts
  - Set up special phone number, or radio station to focus on nothing but the emergency, folks can program that number into their phones, car radios.
  - Set date for next review, note all the questions and comments made in the Dec 7th meeting and show status of each one. This tells the audience, you listened and ideas and thoughts that were not previously captured are now in the design of the program.
  - Perhaps consider streaming the next one, I was disappointed that there were not more people interested in our community and I do not know if it is because we didn't advertise enough (via Chamber, PML newspaper, Flyers posted....)
- Margaret Willits (via email, 12/8/2022):
  - From the virtual event chat: In other cases, described as "Shelter In Place" These principals were proven to save lives during the "Camp Fire" in the Paradise area... 85 people died, with roughly half of them dying while trying to escape
  - From Wikipedia: However, 70 of the 84 fatalities listed in the Butte County District Attorney's Camp Fire investigation summary[84] occurred inside or immediately outside the victim's residences, indicating that failure to evacuate contributed to many more deaths (70) than occurred while evacuating (8).
  - Question: What was your information source? Are there places to find out what people are learning from these fires?
  - Response (via David Goldemberg):

    Good Morning Margaret,

    Thanks for reaching out, which I really do appreciate.

    You may not be aware, but Wikipedia is driven by user input, which to my knowledge has NO official verification process other than the people who manage the Wikipedia "platform" do have an acceptance criterion in order for

something to be put up on their site. I know this from personal experience, as my Stepmother, Rose Goldemberg was accepted for content regarding her personal achievements, but the process was pretty arduous.

That said, it is not hard to "go back in time" to look at the incredible amount of "footage" that was presented by people trying to escape the "Camp Fire", media sources, and documentaries that were put up from various official agencies. This includes information from CAL FIRE, Butte County Fire Department (under contract with CAL FIRE), Media, and I believe some from various Federal agencies.

The footage that I personally observed which was well documented included pleas for help, and quite honestly, prayers were being asked for. A number of segments involved on the scene first responders who directed people to areas where they could, and did survive. In some cases, it was an intersection of roadways, where perhaps a single fire engine deployed hoses to protect the people. In other cases, emergency responders helped to lead people to areas such as a shopping center or large parking lot where they could go to in order to survive.

In other cases, and most unfortunately, the people who were trying to escape (and half by what I saw from CAL FIRE reports, which I value much more than Wikipedia) literally died either inside of their vehicles, or if they exited their vehicles, were found on the ground in the adjacent vicinity.

Thus, people were burned to death in their vehicles or close to them, and yest, they died in their homes or close to their homes. Car tires on fire due to intense conditions where there was not adequate clearances to the sides of the roads, which is something that our Fire Safety Advisory Committee (FSAC) looked closely at when developing our Vegetation Management Ordinance… Car engines failed causing "stalls" due to heavy smoke conditions rendering them stuck in the road. When vehicles could not move dure to such conditions, all of the vehicles behind them were "stuck" thus could not escape, and this caused many, many deaths…

I am available to discuss all of this in greater detail, and you should also conduct proper research with CAL FIRE and the Butte County Fire Department, and the Butte County Sheriff Office to get the most accurate facts.

In closing, when we look at our local roads, and reference Washington Street as a consideration from people being evacuated from Cedar Ridge area, it makes no sense at all. Probably 8 miles or more from Cedar Ridge to downtown Sonora, and no reason what so ever to show Washington Street as there are many, many areas to go to without going downtown Sonora… I am aware of the impacts from the "Washington" fire, but not applicable here…

Jumping off now for a scheduled call…

Thanks,

David

- Margaret Willits (via email, 12/8/22): When asked about models tonight you said that you were using Cube. From what I see online, Cube is software to link GIS and a model, but that still leaves the question of what model was used, how much it has been tested and whether it has been tested in areas like this one.
    - Response (via Matt Braughton, 12/8/2022):

Margaret –

Thank you for the follow-up question that Grace passed along. Cube is the travel demand modeling software but also provides a visualization platform that you are referencing to allow for links between input data, the travel demand model, and outputs. However, we misspoke in the meeting and the software for the Tuolumne County model is actually based in TransCAD which is a similar modeling software (Cube and TransCAD are the most common travel demand modeling software packages used in California and nationally). The Tuolumne County Regional Travel Demand Model is a four-step, trip-based model which is used by Tuolumne County for travel demand modeling for transportation plans and projects within the county – these type of travel demand models are commonly used by many public agencies in California.

The model was most recently updated in 2020 to update and calibrate the model to current conditions within the County including how trips are generated and assigned, updates to trip origins and destinations, as well as the roadway network to better reflect existing conditions within the County. The calibration process uses existing data to confirm that the model is predicting reasonable travel patterns and volumes. I am cc'ing Mike Aronson who is our lead modeler should he wish to correct anything I've stated or add additional detail. The model has been regularly updated (major updates approximately every five years) and calibrated to ensure they are reasonably reflecting travel demand in the County for TCTC's planning efforts.

As mentioned, the travel demand model is only used for the transportation analysis component where the FlamMap software was used to model the 72-hour wildfire scenarios whose burn areas were used as inputs for determining the areas that were modeled as evacuating in the travel demand model. I am cc'ing Darlene Rini from Jensen Hughes who developed those wildfire scenarios for our team if you have questions regarding that software process.

All of the wildfire scenarios and evacuation transportation analysis results were brought to our project management team, key stakeholders, and the Fire Safety

Advisory Council to confirm the approach and results as reasonable to Tuolumne County conditions and help identify and provide input on where the modeling may not fully capture expected congestion - a few of which I noted in our presentation last night (e.g. Ferretti Road in Groveland and Pinecrest Lake Road in Pinecrest).

Best,

Matt Braughton

TCTC BOARD MEETING

Zoom Meeting, January 11, 2023, 3-6:30pm

- Kathleen (TCTC/TCTA, District 4): Would evacuees not use Old Priest Grade to evacuate?
    - Kittelson: We are not recommending any specific route for an evacuation. Residents of Groveland and Sonora brought up that Old Priest Grade is not a preferred route for evacuation, especially for larger vehicles, RVs, trailers, etc.
- Correction: Old Wards Ferry Rd (not Wards Ferry Road)
- Shared Use Paths: Groveland Community District is working on getting grants to pave their shared use path in the area.
- Sonora City/Greenley Road: TCTC thinks it would be useful as an evacuation route for Cabezut/East Sonora
    - Kittelson: we received feedback on the extension and will add it into the report
- How can we use the report to secure funding for shoulder treatments, road widening, etc.?
    - We have identified some funding sources (CAL FIRE, State agencies, Federal PROTECT grant, etc.) in the report. Some of these projects will overlap/be included in the Regional Transportation Plan. The list of projects in these plans can be prioritized to help decide where efforts to secure funding should go. There is current funding to add shoulders and widen roadways in some parts of the County and evacuation considerations are being integrated with that prioritization process.
- Additional Critical Roadways: Frasier Flat Rd (Strawberry) as an emergency vehicle route; add Mt. Elizabeth Rd (for Twain Harte & Cedar Ridge communities) and Mt. Provo Rd (out of Ponderosa Hills).
- We should think about how we can help the Forest Service with maintenance of their roadways for use during evacuations.
- Road expansion seems unlikely/impossible in some areas of the County.
    - The study will be helpful to understand how to prioritize evacuations and communicate impacts to the community. For example, evacuating senior living homes before evacuating everyone else in a vulnerable community
- Widening roads/other capital improvements will likely be shot down by environmental groups. Need to think about the political side of suggested improvements, not just the technical/analytic side.

  - Yes, environmental concerns are a consideration though there has been some changes in terms of how evacuation capacity is considered as part of projects (versus adding capacity general).
- Question: What is driving this needs assessment process? Are we simply more aware of the conditions of an evacuation and what we could do to improve operations? We have not seen any increase in population in the region – with a lower population, do we not have adequate infrastructure for evacuations? There is an increase in fire risk – is that the driving force?
  - The recent emphasis on evacuation understanding is a reaction to what has happened elsewhere in the state. We are looking at the County systematically to understand what worst case scenarios could occur and how the roadways and communities would be impacted.
  - There are a lot of aspects the study touches on that TCTC cannot implement, but we can coordinate with OES, USFS, Sheriff's Office, etc. to help prepare and improve our emergency evacuation planning.
  - We ca also use the study to help inform the public about what is at stake during evacuations – what they should plan for, what they should not do during an evacuation, and pointing them to other planning resources in the County