NIST Technical Note
NIST TN 2252

A Case Study of the Camp Fire

Notification, Evacuation, Traffic, and Temporary Refuge Areas (NETTRA)

Alexander Maranghides
Eric D. Link
William "Ruddy" Mell
Steven Hawks
Christopher Brown
William D. Walton

This publication is available free of charge from:
https://doi.org/10.6028/NIST.TN.2252

NIST NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
U.S. DEPARTMENT OF COMMERCE

NIST Technical Note
NIST TN 2252

A Case Study of the Camp Fire

Notification, Evacuation, Traffic, and Temporary Refuge Areas (NETTRA)

Alexander Maranghides
Eric D. Link
Christopher Brown
Fire Research Division
Engineering Laboratory

William "Ruddy" Mell
Fire and Environmental Research Applications
U.S. Forest Service

Steven Hawks
Office of the State Fire Marshal
California Department of Forestry and Fire Protection

William D. Walton
University of Maryland, College Park

This publication is available free of charge from:
https://doi.org/10.6028/NIST.TN.2252

July 2023

U.S. Department of Commerce
Gina M. Raimondo, Secretary

National Institute of Standards and Technology
Laurie E. Locascio, NIST Director and Under Secretary of Commerce for Standards and Technology

NIST TN 2252
July 2023

Publication History
Approved by the NIST Editorial Review Board on 2023-04-14

How to Cite this NIST Technical Series Publication
Maranghides A, Link E, Mell W, Hawks S, Brown C, Walton D (2023) A Case Study of the Camp Fire—Notification, Evacuation, Traffic, and Temporary Refuge Areas. (National Institute of Standards and Technology, Gaithersburg, MD), NIST Technical Note (TN) 2252. https://doi.org/10.6028/NIST.TN.2252

Appendices to this report are contained in a supplemental document that can be accessed at https://doi.org/10.6028/NIST.TN.2252sup.

NIST Author ORCID iDs
Alexander Maranghides: 0000-0002-3545-2475
Eric D. Link: 0000-0002-7784-5023
Christopher Brown: 0000-0002-0426-2249

Cover Page Photos
Left: Evacuation traffic on Skyway, 10:57 (Paradise Police Department)
Right: Civilians at the Optimo TRA, 12:07 (CAL FIRE)

Abstract

The 2018 Camp Fire in Butte County, California quickly impacted the communities of Concow, Paradise, and Magalia, triggering widespread evacuation of 40 000 people. The fire became the most deadly and destructive fire in California history, resulting in 85 fatalities and more than 18 000 destroyed structures. After a preliminary reconnaissance, it was determined that abundant data was available to support an in-depth case study of this devastating wildland-urban interface (WUI) fire, with the goal to learn and increase preparedness for future incidents. This portion of the greater case study focuses on the life safety aspects of the Camp Fire incident: notification, evacuation, traffic, temporary refuge areas, rescues, and fatalities (collectively, NETTRA). Over 2600 NETTRA observations and data points were integrated into a spatiotemporal database. Analysis of this data used the foundation of the previously reconstructed fire progression timeline to provide important context to the NETTRA components. Details and the timeline of requested evacuation notifications are presented with respect to fire progression. The evacuation timeline was assessed via traffic observations throughout the region. The rapid and widespread impact of fire on the communities complicated evacuation efforts due to high traffic volume, road closures due to fire and debris, and direct fire exposures to evacuating civilians in numerous burnover events. A total of 31 temporary refuge areas were implemented during the incident, involving more than 1200 civilians. Further, 198 specific evacuation assistance / rescue events were identified, involving at least 1000 civilians. The unique analysis and reconstruction of the NETTRA components of this WUI fire will help at-risk communities prepare for and respond to future incidents.

Keywords

burnover; California; community hazard reduction; disaster resilience; emergency notification; entrapment; evacuation; fire; Paradise; public safety; TRA; wildfire; wildland-urban interface; WUI

This page intentionally left blank.

Table of Contents

Appendices are included in a supplementary document accessed at:
https://doi.org/10.6028/NIST.TN.2252sup

List of Tables

This page intentionally left blank.

List of Figures

This page intentionally left blank.

List of Symbols, Abbreviations, and Acronyms

AVL
automatic vehicle locator

B-Line
Butte Regional Transit

BCSO
Butte County Sheriff's Office

BO
burnover

CAL FIRE
California Department of Forestry and Fire Protection

CDP
census designated place

CHP
census designated place

CRA
California Highway Patrol

DINS
Damage Inspection Specialist(s)

EA/R
evacuation assistance or rescue

EB
eastbound

ECC
Emergency Command Center

EOC
Emergency Operations Center

FD
fire department

FF
firefighter

FRH
Feather River Hospital

GIS
geographic information system

IC
Incident Commander

ICS
Incident Command System

ICP
Incident Command Post

LE
law enforcement

NB
northbound

NETTRA
notification, evacuation, traffic, and temporary refuge areas

NIST
National Institute of Standards and Technology

OHU
occupied housing unit

PAP
public assembly point

PHL
peak hazard level

PPD
Paradise Police Department

SB
southbound

TD
technical discussion

TRA
temporary refuge area

UoF
urgency of formation

VTD
"virtual" technical discussion

WUI
wildland-urban interface

WB
westbound

This page intentionally left blank.

Acknowledgments

This case study would not have been possible without the collaboration and support of CAL FIRE and the first responders that participated in the incident, including the Paradise Fire and Police Departments. Specifically, the authors would like to acknowledge the support of the California State Fire Marshal, Dennis Mathisen (retired). Chief Mathisen and the CAL FIRE DINS team enabled the NIST/USFS/FEMA Team to effectively access the scene and collect perishable data from the Camp Fire with the help of CAL FIRE damage inspection data. The authors would like to also acknowledge California State Fire Marshal Michael Richwine (retired) for the continuing support of this timeline reconstruction effort.

The authors would like to acknowledge every department/organization that participated in the technical discussions:

- American Medical Response–Shasta County
- B-Line Butte Regional Transit
- BTU Station 35–Paradise
- BTU Station 62–Harts Mill
- BTU Station 63–Oroville
- BTU–Butte Fire Center
- BTU–Unit Headquarters
- Burney Fire District Station 17
- Butte County Emergency Command Center
- Butte County Fire Safe Council
- Butte County Fire Station 33–Upper Ridge
- Butte County Fire Station 42–North Chico
- Butte County Fire Station 44–South Chico
- Butte County Fire Station 55–Bangor
- Butte County Fire Station 73–Biggs
- Butte County Fire Station 74–Gridley
- Butte County Sheriff's Office
- CAL FIRE–Law Enforcement Division
- California Highway Patrol–Chico
- Chico Fire Department–Headquarters
- Del Oro Water Company
- Grass Valley Interagency Emergency Command Center
- Grass Valley Fire Department Station 2
- Linda Fire Protection District
- LNU Station 37–Brooks
- LNU–Konocti Conservation Camp
- Meridian Fire Protection District
- National Weather Service
- NEU Station 61–Loma Rica
- NEU Station 60–Dobbins
- NEU Station 20–Nevada City
- Nevada County Consolidated Fire District
- Northern California Geographic Area Coordination Center
- Olivehurst Fire Department
- Paradise Fire Station 81–Paradise Fire Department
- Paradise Irrigation District
- Paradise Police Department
- Shasta County Fire Station 33–Bella Vista
- Shasta Lake Fire Protection District
- SHU Station 14–Burney
- SHU Station 22–Shingletown
- SHU Station 58–Shasta
- SHU Station 75–Hillcrest
- South Lake County Fire Protection District Station 63–Hidden Valley
- Sutter County Fire Department Station 6–Sutter
- TGU Station 1–Red Bluff
- TGU Station 12–Corning
- TGU–Elk Creek Station
- TGU–Paskenta Station
- Town of Paradise
- Town of Paradise–Department of Public Works
- USFS CA-ENF–Pacific Ranger District, Pollock Pines
- USFS CA-MNF–Stonyford Work Center
- USFS CA-PNF–Beckwourth Ranger District, Blairsden
- USFS CA-PNF–Challenge Visitor Center, Challenge
- USFS CA-PNF–Feather River Ranger District, Oroville
- USFS CA-TNF–Truckee Ranger District, Truckee
- USFS CA-TNF–Yuba River Ranger District, Camptonville
- Wheatland Fire Authority

The authors would also like to specifically acknowledge Paradise Irrigation District and the Del Oro Water Companies for providing important information for the timeline reconstruction.

Additionally, the field data collection would not have been possible without the participation of Engineering Laboratory and Fire Research Division staff, including Ms. Nicole Cooper, Dr. Ryan Falkenstein-Smith, Ms. Lucy Fox, Mr. Cartier Murrill, and Ms. Rebecca Turnbull. Additional data collection support from Ms. Nicole LaRosa of FEMA is also appreciated.

The authors would like to acknowledge CAL FIRE Butte Unit Chief and Butte County Fire Department Fire Chief John Messina, Ms. Karen Ridenour of Texas Forest Service (retired), Ms. Colette Curtis, Paradise Town Council and the town management, Paradise Police Department, Drs. Kathryn Butler and Jiann Yang of NIST, NIST WUI Fire Group Leader Dr. Thomas Cleary, NIST Fire Research Division Chief Dr. Matthew Hoehler, and NIST Engineering Laboratory Director Dr. Joannie Chin for providing input to the report and participating in the review process.

Executive Summary

Thousands of wildland fires ignite in the United States each year. Given the significant extent of the wildland-urban interface (WUI), developed land intermixed or adjacent to wildlands, and the increased ignition potential from human presence, many wildland fires impact WUI communities. Depending on ignition location, fuel characteristics, and weather conditions, the impacts to communities can vary from nuisance smoke to precautionary evacuations, to significant devastation and loss of life. To date, the Camp Fire in 2018 was the most destructive and deadly fire in California state history; the fire destroyed over 18 000 structures, damaged thousands more, and directly claimed 85 lives.

The opportunity to learn from the Camp Fire through a detailed post-fire case study was realized through availability of critical data and collaboration with the local community and first responders. During the nine months following the fire, researchers hosted technical discussions (TDs) with dozens of first responders to collect data related to observations made and actions taken during their involvement in the first 24 hours of the incident. Observation data points were categorized with respect to topic, including fire, evacuation/life safety, and defensive actions/suppression. Analysis of the data is being performed in that order, with each topic providing necessary context for the next. Each observation data point was geotagged and time-referenced. Uncertainties were minimized and inconsistencies were reconciliated as much as possible through an extensive data quality review. The result allowed for the reconstruction of the fire progression timeline, which was then used as the foundation for the data and analysis presented in this report related to evacuations and life safety.

The Camp Fire ignited at approximately 06:20 off Camp Creek Road near the small community of Pulga in the Feather River Canyon in Butte County, California. After immediately impacting Pulga the fire spread southwest over a ridge, spotting and burning into the community of Concow by 07:30, 6.4 km (4 mi) away. By 08:00 spot fires were igniting in Paradise, an additional 6 km (3.75 mi) southwest of Concow. The fire front impacted eastern Paradise forty minutes later.

Mass evacuations were initiated, including over 40 000 people in the communities of Concow, Paradise, and Magalia. The combination of the ignition location, timing, weather, and fuel conditions resulted in little time for communities to evacuate before being impacted by the spreading fire. The heavy traffic volume combined with deteriorating conditions as the fire arrived contributed to the rapid development of widespread gridlock. Routes that took twenty-five minutes in normal traffic took several hours, if they were passable at all. Many people became trapped within the community with no safe egress route. Hundreds of evacuees were exposed directly to hazardous fire conditions in burnover events. These burnover events, in which people were directly exposed to fire conditions that impacted life safety, including entrapments and near-misses, were identified and documented in NIST Technical Note 2135 (Camp Fire – Fire Progression Timeline). The implementation of temporary refuge areas (TRAs), immediately available areas providing temporary shelter and reduced exposures, was widespread as first responders reacted to the situation and focused on civilian life safety.

The catastrophic losses and complex evacuation dynamics that occurred during the Camp Fire have led to the identification of multiple research questions to help understand this WUI fire and to provide lessons learned that may be used to reduce losses in other WUI communities in the

future. This report focuses on the life safety components of Notification, Evacuation, Traffic, and Temporary Refuge Areas (NETTRA).

The research questions addressed in this report include:

- What were the design parameters of the Paradise Evacuation Plan?
- What were the roads and access characteristics of Concow, Paradise, and Magalia?
- How was the notification of civilians in Concow, Paradise, and Magalia achieved?
- When were evacuation notifications and orders issued, and how does this timing relate to fire progression?
- How did fire impact evacuations of Concow, Paradise, and Magalia?
- What were the primary factors that impacted traffic flow during evacuation?
- How did the use of wildfire safety zones and the creation of TRAs impact civilian life safety, and how many civilians utilized TRAs?
- When were TRAs formed and what were the physical characteristics of the TRAs used?
- What were the attributes of the rescues performed and how many civilians were rescued?

Evacuation Plan

Paradise and Butte County had developed an evacuation plan that was communicated to multiple first responder organizations. In planning for a response to a large scale WUI incident, a multiagency training exercise involving over 100 first responders was conducted in Paradise in 2016. While the simulated fire scenario was not similar to the Camp Fire, it was reminiscent of the 2008 Humboldt Fire which burned eastward across the foothills south of and into Paradise. The 2008 fire caused the closure of Skyway, Neal Road, and Clark Road south of Paradise, leaving Pentz Road the only route out of Paradise. Several lessons were learned from the Humboldt Fire, including the need for one-way egress provisions and the utilization of zoned evacuation to reduce/manage congestion. The public information brochure and evacuation plan mailings were developed as a result.

The evacuation plan for Paradise was the most developed component of the Butte County pre-fire evacuation procedures. The Paradise plan included details related to evacuation zones, evacuation routes, traffic direction, contraflow traffic implementation (lane reversal of inbound lanes), and first responder communications. The plan was developed and coordinated with multiple regional first responder agencies and organizations.

The inclusion of contraflow traffic in the 2016 training exercise developed the “muscle memory” of the Paradise Public Works and Police Department, making the implementation of the evacuation plan more efficient and effective. The training exercise provided direct experience for what was needed to implement the traffic control plan in Paradise. While only a relatively small number of residents directly experienced the one-way traffic implementation during the exercise on Skyway, the advertisement of the drill and the public information sharing about the potential implementation in an emergency incident increased public awareness.

Emergency Notifications

A timeline of evacuation notifications was developed based on the integration of data primarily from TDs with incident command staff, radio logs, 911 call recordings, and records of reverse-911 notifications. The presented timeline was based on the initial requests for evacuation warnings and/or orders by the Incident Commander (IC). While these times are not the same as when the notifications were sent to or received by the public, they provide the best foundation for the notification timeline and can be related to the situational awareness of the IC. Evacuation orders flowed from the IC through the law enforcement agencies responsible for the execution/enforcement of the evacuation orders. First responders in the field began immediate execution of the evacuation requests through direct contact with residents. Additional notification methods followed.

No mass notification emergency alert sirens were available in Concow, Paradise, or Magalia; however, multiple tools were used to notify the public including door-to-door notification, announcements via vehicle-mounted speakers, CodeRED reverse-911 call system, and social media. Eight batches of reverse-911 calls were issued to Paradise and Magalia between 07:57 and 09:30, attempting to reach nearly 21 000 registered phone numbers.

The prior establishment of the fire progression timeline (NIST Technical Note 2135) made possible the examination of the notification and evacuation timelines in the context of fire. Overlaying notification data with fire spread data provided an understating of the temporal relationship between notifications, evacuation orders, and fire progression. The analysis was conducted based on the evacuation zones and documented fire in these areas. The analysis highlights that the relationship between notifications and fire can be subdivided into three categories and time periods:

1. Fire was ahead of notification (~06:30 to 07:30)
2. Notifications were approximately simultaneous with the arrival of fire (~07:30 to 08:40)
3. Notifications were ahead of the fire (after 08:40).

These three categories represent the early part of the event (from a notification perspective), when situational awareness was limited; the middle part of the incident, when notifications were catching up to the fire spread and notifications were occurring simultaneously with the arrival of fire; and the later part, where a positive time interval developed providing more time between public notification and fire arrival.

These categories point to three distinct temporal issues associated with community emergency notifications:

1. There is a finite minimum time necessary for situational assessment by the IC.
2. There is finite minimum time between the assessment, deciding that evacuation warnings or orders are needed, and the communication of this information through the chain of command to the participating agencies; specifically, but not limited to, law enforcement.
3. There is a finite amount of time needed to communicate the notification information to the public. The method of communication will impact the minimum time required (e.g., door-to-door notification may take more time than remotely activating a siren system).

These three cumulative times described above can be used to establish minimum temporal thresholds for community notification scenarios. This time is one component of the evacuation timeline, which also includes pre-movement time (for tasks including decision-making, preparation, and packing) and the actual evacuation time. Even without fire it takes a finite amount of time to notify and evacuate a section of a community. The analysis of the temporal relationships between evacuation orders and burnovers highlights the challenges associated with the mass evacuation of civilians in a rapidly progressing fire. The use of the various notification tools described above enhanced public awareness; however, fast spreading fire caused multiple closures of key evacuation roadways and egress arteries, resulting in burnover events which significantly impacted life safety.

The presented data highlights the critical need for effective situational awareness and communication between first responder organizations in order for the notifications and evacuations to rapidly get "ahead" of the fire. A multiagency training exercise held in 2016 was essential to the rapid communication of the IC orders to the participating first responder agencies and to the public.

Evacuations and Traffic Flow

Evacuations during the Camp Fire were a regional-scale event. This study presents an overview of the general evacuation timeline based on traffic flow observations from TDs and supporting information from radio logs, photos, and videos. Inclusion of data from the fire spread timeline shows the impact of fire on egress arteries and provides context of the effects of fire and corresponding road closures on the evacuations.

Evacuation and traffic conditions exhibited significant spatiotemporal variation. Some individuals were able to evacuate early under normal traffic conditions. Others encountered various setbacks and their journeys took 10 or more hours. In many cases, minutes made the difference between getting out early or getting stuck in traffic for hours. The majority of the evacuation of Paradise took place between 08:00 and 14:15.

Pre-planning and training significantly enhanced the life safety of evacuees. The training exercise in 2016 allowed first responders to practice coordinating between agencies and use different traffic management tools like contraflow was effective in building "muscle memory." As the fire arrived in Paradise from the east, channeling the traffic from the Pentz Road corridor through town became time critical. Traffic was pushed to the west and south to stay ahead of the fire. Traffic from Pentz Road was pushed toward Clark Road, and then pushed further west to Neal Road and Skyway. Closures of Clark Road, Neal Road, and Skyway, together with closures on the cross-arteries (Pearson Road, Bille Road, and Wagstaff Road) further complicated civilian evacuations and traffic management in Paradise and beyond. Traffic congestion in Chico along Durham-Pentz Road and CA Highway 99 significantly slowed down the evacuation of Paradise. In some cases, the bottlenecks were located more than 15 km (9 mi) from Paradise.

Much of the evacuation was achieved through individual or small group travel (e.g., families, neighbors) using personal civilian vehicles. The quick onset of the evacuation for the entire town led to widespread gridlock. To enhance life safety, several strategies were implemented by first responders to alleviate jams, facilitate traffic flow, and manage civilians when traffic was gridlocked with fire approaching. Situational awareness was essential to accomplish the above

list of strategies to adapt to the changing fire conditions and availability of safe egress routes. Five key tactics were used to mitigate life safety issues during evacuation, enabling first responders to keep hundreds of civilians out of high hazard areas:

a. Escort civilians to low hazard areas (convoys),
b. Fill up road space in areas that were not burning,
c. Redirect traffic to account for continuously changing conditions (traffic and fire), including intersection traffic management and redirection,
d. Use contraflow to increase traffic flow out of town, and
e. Use parking lots as TRAs to accumulate overflow traffic.

Fire impacted some egress arteries directly (through fire exposures and reduced visibility due to smoke) and others indirectly through downed utility poles and lines and downed/burned trees. Over 230 abandoned vehicles were identified on the major egress arteries, almost 60% of which were burned. Many of these vehicles were involved in burnovers that resulted in partial or complete road closures for hours. Civilians ran to less hazardous areas (~3 km [2 mi] in some instances), a stranger's vehicle, or were rescued by first responders.

The impact of fire on the egress arteries was dynamic; fire impacted traffic directly through smoke, fire, and ember exposures, and indirectly through road blockages (burned and fallen utility lines and poles, trees, and debris). Two or more of the four egress arteries leaving Paradise were simultaneously closed due to fire for 68 % of the time between 08:00 and 14:15.

Closures of egress arteries significantly impacted civilian evacuation and led first responders to create multiple temporary refuge areas (TRAs) to shelter civilians from high fire exposures. The widespread implementation of TRAs led to large groups of civilians staging within Paradise waiting for conditions to improve and roads to become passable again, after which they were escorted out of the fire area. Ultimately, several large convoys of vehicles were escorted out of the fire area. Evacuees in personal vehicles and convoys evacuating Paradise impacted traffic in Chico and CA Highway 99 well into the afternoon of November 8.

Temporary Refuge Areas

There were 18 pre-designated public assembly points and wildfire safety zones located in areas of Butte County affected by the Camp Fire. In total, 31 different TRAs were implemented to meet local life safety needs and to manage the evacuation of civilians, including only four of the 18 pre-designated locations. The rapid fire spread into Concow and Paradise significantly compressed the notification timeline and impacted evacuations. Some civilians started their evacuations before the official orders were announced. Evacuation orders were issued, depending on location, shortly before, concurrently, or shortly after the arrival of fire. This tight timeline resulted in a significant fraction of the evacuating population unable to directly leave the fire area, requiring the use of life saving TRAs.

Eleven TRAs were formed with high urgency, and seven experienced high peak hazard levels from fire exposures. All high peak hazard level TRAs were formed with high urgency. Different types of TRAs were formed based on local conditions, needs, and available spaces. TRA types include 14 parking lots, 7 roadways, 6 structures, 3 maintained natural areas, and 1 unmaintained

natural area. TRAs were formed inside burnovers, as close as practicable outside of burnover areas, or at key access points on or near major arteries. Half of the TRAs occupied by civilians were also defended by first responders.

The estimated number of civilians in TRAs ranges between 1200 and 2100, assuming only one person per vehicle. If the average number of civilians per vehicle was 2, a conservative estimate, the upper estimate of civilians that used TRAs increases to 3300. A limited number of civilians were able to get to designated wildfire safety zones or public assembly areas in Concow and Paradise. A significant level of effort was involved in the coordination of the evacuation of TRAs. Several TRAs were consolidated to help first responders keep track of civilians and to facilitate the formation of evacuation convoys out of the fire area. The presence and availability of transit buses (both large and small) significantly enhanced the evacuation of civilians from the many TRAs.

TRAs were used to accomplish two distinct goals: (1) to address immediate life safety risks, and (2) to manage movement of evacuating civilians to avoid possible high fire exposures and burnovers. The fire rapidly moved into Concow, impacting the community concurrent with notification and evacuation activities. This resulted in the blockage of the main evacuation roadway (Concow Road) and the closure of Hoffman Road, further impacting evacuations. In Paradise, as the fire front impacted the majority of Pentz Road, evacuating traffic became gridlocked on Pentz Road, which also influenced the ability for traffic to flow along the two main east-west cross arteries (Bille Road and Pearson Road). The fire front resulted in multiple burnovers in eastern Paradise that required the utilization of TRAs. As the fire progressed into central and western Paradise, the presence of commercial establishments with large parking lots were leveraged by first responders. These large, paved areas served two purposes; they provided areas of locally reduced exposures (because of their large size) to shelter civilians, and also enabled first responders to use them to manage traffic and keep roadways open for first responder operations.

In Paradise, particularly on the main egress arteries of Skyway and Clark Road, the presence of commercial parking lots significantly facilitated traffic management and reduced the exposures experienced by civilians and first responders. Areas where TRAs experienced high peak hazard levels include locations with fewer parking lots such as upper Skyway, Pentz Road, and east of Clark Road on Bille and Pearson Roads. This was a result of limited options available for traffic management which resulted in rapidly forming gridlocks, particularly early in the incident.

The Butte County and Paradise evacuation plans were developed to address several different partial evacuation scenarios and identified two pre-designated public assembly points in Paradise. The Paradise Auditorium and Performing Arts Center (~150 vehicle capacity) and the CMA Church (~200 vehicle capacity) provided a total Paradise capacity of about 350 vehicles. Parking lots used as TRAs during the Camp Fire contained anywhere from 3 to 550 vehicles each. The availability of these parking areas had a positive impact on life safety. Examples of areas with limited TRA options were the entire Concow area and, in Paradise, Skyway between Wagstaff Road and Clark Road. The limited options available in Concow highlight the need to address the spatial density and size of available safety zones, particularly in low density intermix communities. In Paradise, the limited options along the 3 km (1.8 mi) stretch of upper Skyway during the burnover resulted in civilians abandoning their vehicles and traveling up to 1 km on foot to reach safety. The above information highlights that the number, size, and spatial

distribution of potential TRAs need to be factored into the design of a community-wide system of wildfire safety zones.

Rescues

A total of 198 distinct events were identified in which civilians requested or received Evacuation Assistance or Rescue (EA/R). The identified EA/R events presented in this report likely represent only a fraction of the events that occurred in all three communities. The identified events involved at least 1007 civilians. Uncertainty in the minimum number of civilians involved in EA/R increases the total estimate to 1352. The true head count is likely higher, as this minimum estimate of 1352 assumes only one person per vehicle.

The identified 198 events include 64 requests for evacuation *Assistance*, 82 *Entrapments*, and 14 *Medical* related incidents. Civilians were *Picked-up* in 38 events when they were encountered on the roadside by first responders. The following statistics highlight EA/R across the entire Camp Fire response on November 8 and early November 9:

- 90 % of civilians involved in *Entrapment* events were *Rescued* (659/733).
- 44 % of all civilians in EA/R (443/1007) were involved in TRAs.
- 55 % of civilians *Rescued* (443/809) were involved in TRAs.
- 58 events have no identified response action, with most of them (62 %) being requests for evacuation *Assistance*. Most of the civilians in these events had unknown, but non-fatal, outcomes. Four of the 58 events were associated with seven fatalities.

The analysis provided specific insights into the EA/R events in Concow, Paradise, and Magalia. Events within each community were first analyzed separately to highlight differences between the circumstances in each community, including timing, fire conditions, and number of first responders. Analysis was also carried out for the EA/R activities as a whole.

The statistics highlighting the EA/R in Concow are that:

- 32 % of the civilians living in the selected Concow Rescue Area (CRA) were associated with EA/R events in the first 4.5 hours after the fire reached the CRA,
- 25 % of the estimated population of the CRA were rescued via TRAs,
- 97 % of people involved in EA/R events in Concow were *Entrapments*, and
- 95 out of the 107 civilians *Entrapped* in Concow, were *Rescued*.

Concow EA/R events demonstrate how hazardous and rapidly evolving local conditions can impact life safety and result in entrapments, particularly in situations where there is little time to evacuate or to get to a wildfire safety zone because of the fire ignition location. Additionally, the fact that 92 % of people *Rescued* in Concow were rescued within a 90-minute period demonstrates the need to rapidly engage in life safety operations and highlights the critical need for pre-planning. The large fraction of residents involved in TRAs highlights the need for easily and rapidly accessible safety zones. These community safety zones are necessary when there is not sufficient time to evacuate early.

The EA/R in Paradise involved at least 881 civilians. While Paradise was impacted by fire an hour after Concow, the population size and density, together with egress artery closures and locally high fire exposures, resulted in the *Entrapment* of over 600 civilians. The following statistics summarize the EA/R events in Paradise:

- At least 881 total civilians were involved in known EA/R in Paradise, with a reasonable estimate of 1188 when including potential uncertainty in the data.
- 71 % of people involved in events in Paradise were *Entrapments* (622/881)
- 90 % of people involved in *Entrapments* in Paradise were *Rescued* (560/622)
- 89 % of the people involved in *Entrapment* EA/R in Paradise were in events occurring between 08:00 and 12:00 (556/622)
- 12 % of rescue responses (14/115) were incomplete and therefore are categorized as *Rescue Attempts*—there are no fatalities associated with these 14 events.

EA/R data related to seven fatal events were identified—two in Concow and five in Paradise.

The EA/R data from Paradise illustrate the large number of simultaneous *Entrapments* and *Assistance* requests, and the rapid and effective response by law enforcement and fire department personnel to get civilians to safety. These successful responses are in part attributed to pre-fire planning and joint training exercises that enhanced communication pathways and developed joint response plans between the fire department and law enforcement. The proximity of Paradise to the larger population centers of Chico and Oroville significantly enhanced the EA/R operations in Paradise, as a significant number of law enforcement resources were able to arrive quickly and respond to the large number of simultaneous EA/R events.

The above data highlight the need for additional post-fire studies on these types of EA/R events. Such studies would further assess *Notification*, *Rescue*, *Rescue Attempt*, and *Entrapment* frequency and outcomes in different WUI fire incidents, including interface and intermix locations, suburban and rural/remote communities, and large- and small-loss events.

Technical Findings and Recommendations

The following 64 technical findings (TF) and 26 recommendations (R) were derived from the analysis and interpretation of the data in this report.

Evacuation and Notification Plans (EP)

TF-EP 1. An evacuation plan, developed with input from previous fires and from training exercises, was in place and communicated to first responders and the community before the incident.

TF-EP 2. The evacuation plan included coordination among multiple regional first responder agencies (fire departments, law enforcement, and public works).

TF-EP 3. The Paradise evacuation plan was conceived and designed for a zoned/partial evacuation; it was not designed for a complete simultaneous evacuation of the town.

TF-EP 4. There is a need for streamlined decision-making and communication processes where all the emergency management participants are trained and proficient using the same evacuation zone layout and nomenclature.

TF-EP 5. Including an evacuation component in the 2016 WUI fire training exercise built "muscle memory" of first responders for integrating evacuation into the response component of WUI fire incidents.

TF-EP 6. The 2016 training exercise was used to practice key evacuation elements, including traffic contraflow on Skyway. This served as direct experience to Paradise Public Works and Police Department.

In planning for WUI fire evacuations, communities should consider:

R-EP 1. Developing an evacuation plan in collaboration with nearby first responder organizations/agencies.

R-EP 2. Creating a realistic training exercise that includes fire, rescue, evacuation, and traffic components.

R-EP 3. Practicing training exercises with collaborating fire, law enforcement, emergency medical services, and public works agencies.

R-EP 4. Revising the evacuation plan based on lessons learned from training exercises and other WUI fires.

Emergency Notifications (N)

Pre-Fire

TF-N 1. The Town of Paradise had an established Emergency Operations Plan (EOP).

TF-N 2. The Town of Paradise Emergency Operations Center staffing included town employees and volunteers trained to facilitate notification and evacuation efforts.

TF-N 3. There were no sirens in place for emergency notification in Concow, Paradise or Magalia.

TF-N 4. In preparation for a real wildfire/WUI fire, CAL FIRE and the Town of Paradise worked with multiple local and state jurisdictions to conduct an extensive and detailed evacuation and WUI fire exercise.

TF-N 5. Pre-fire preparations like the evacuation plan and evacuation/WUI fire drill significantly enhanced the first responder notification, evacuation, and firefighting capabilities during the Camp Fire.

During Fire

TF-N 6. During the Camp Fire, public agencies used several modes of communication to alert residents, including door-to-door messaging, vehicle-mounted speakers, CodeRED reverse-911, and social media platforms including Facebook and Twitter.

TF-N 7. Early in the incident, before 08:00, the rapid fire spread outpaced the information flow and the establishment of evacuation boundaries.

TF-N 8. Early in the incident, before 08:00, limited situational awareness (because of rapid fire progression) and the inherent time necessary for communication from the Emergency Command Center (ECC) to Paradise Police Department (PPD) impacted accuracy of information.

TF-N 9. Both 911 call centers (PPD and ECC) provided consistent information to callers based on the changing situational awareness and evacuation orders.

TF-N 10. The initial IC evacuation warning request in Paradise at 07:32 was for "west of Pentz" instead of "east of Pentz." Fourteen minutes elapsed between the initial request and the time the warnings were upgraded to orders and exact zones were specified at 07:46. The "west instead of east" does not appear to have caused any notification delays.

TF-N 11. There is a finite time required to transfer evacuation requests from the incident commander (IC) to first responders to the public.

TF-N 12. It took approximately 10 minutes from the IC request for an evacuation warning for Pentz Road to when law enforcement began door-to-door notifications. The information went from IC to law enforcement dispatch to officers on location.

TF-N 13. PPD 911 began informing residents to evacuate as early as 07:49, just as the first spot fires ignited in Paradise (before evacuation orders were issued for those locations).

TF-N 14. Butte County ECC and PPD accelerated the evacuation of Paradise, communicating complete evacuation at 08:03, ahead of the multi-zone request from the IC at 08:49.

TF-N 15. There was a communication gap between evacuation of "all of Paradise" vs. the IC-selected zones. BCSO and Town of Paradise opted to evacuate more zones than the ones requested by the IC. The communication gap lasted at least 46 minutes.

TF-N 16. Local spot fire ignitions can rapidly spread, leading to burnover events. This rapid fire spread results in limited time for civilian notification, impacting safety during evacuation.

TF-N 17. The use of general directional terms (e.g., east, west, north, and south) relative to specific zones can be a cause of confusion; however, when many zones are involved in a rapidly developing incident there may not be sufficient time to list all zones.

TF-N 18. The Integrated Public Alert and Warning System (IPAWS), including Wireless Emergency Alerts (WEA), was not used.

In planning for WUI fire evacuations, communities should consider:

R-N 1. Developing a notification plan and maintaining a resilient notification system.

R-N 2. Implementing and utilizing a multi-modal notification system that accounts for electricity/internet/infrastructure failures and spans the range of information sources available to residents (e.g., phones, IPAWS, internet, social media, radio, sirens).

R-N 3. Accounting for the cumulative minimum time necessary for situation assessment, information transfer to the incident commander, information transfer between the

incident commander and law enforcement, and communication to the public in the design of a community notification and evacuation plan.

R-N 4. That rapid fire progression and the proximity of a fire's origin to a community may reduce the time available for notification and evacuation. Developing a distributed system of wildfire safety zones for sheltering within the community may provide the safest approach for civilians who may not have sufficient time to safely evacuate.

R-N 5. Using official social media channels to enhance dissemination of real-time information.

R-N 6. That use of advertised and promoted official social media channels to provide updates during an ongoing disaster incident should only be reserved for organizations that can maintain these channels with current information throughout the event. Explicit acknowledgement that information may be incomplete or outdated should be provided.

R-N 7. That advertised use of official social media channels for updates during emergency incidents that do not then provide updated information during an incident can disseminate misleading information to the public. This may result in significant propagation of false information and negatively impact decisions and responses of civilians.

Evacuation and Traffic Flow (ET)

TF-ET 1. Preplanning and training for traffic management and contraflow significantly enhanced life safety of evacuees.

TF-ET 2. The majority of the evacuation of Paradise took place between 08:00 and 14:15.

TF-ET 3. First responders took extensive actions to enhance evacuee life safety, including creating TRAs and escorting civilians to safety in numerous convoys.

TF-ET 4. Five key tactics were used to mitigate life safety issues during evacuation, enabling first responders to keep hundreds of civilians out of high hazard areas:

a. Escort civilians to low hazard areas (convoys)
b. Fill up road space in areas that were not burning
c. Redirect traffic to account for continuously changing conditions (traffic and fire), including intersection traffic management and redirection
d. Use contraflow to increase traffic flow out of town, and
e. Use parking lots as TRAs to accumulate overflow traffic.

TF-ET 5. Burnovers significantly impacted civilian and first responder life safety by exposing evacuees to high hazard conditions and locally closing roadways.

TF-ET 6. Egress arteries blocked by fire significantly impacted civilian evacuation by increasing traffic delays throughout the community.

TF-ET 7. Main egress evacuation arteries experienced a significant number of closures due to fire. One quarter of the intersections/road segments along egress arteries and cross-town arteries experienced one or more closures due to fire.

TF-ET 8. Two or more of the four egress arteries leaving Paradise were simultaneously closed due to fire for 68 % of the time between 08:00 and 14:15.

TF-ET 9. Traffic congestion in Chico along Durham-Pentz Road and CA Highway 99 significantly slowed down the evacuation of Paradise. In some cases, the bottlenecks were located more than 15 km (9 mi) from Paradise.

TF-ET 10. Imbalance in the number of available traffic lanes at potential chokepoints (within or surrounding a community) may not be readily apparent during the design of a plan utilizing a zoned/partial evacuation of a community.

In planning for WUI fire evacuations, communities should consider:

R-ET 1. Preplanning community evacuation scenarios and communicating them to residents and first responder, government, and infrastructure agencies.

R-ET 2. Developing preplanned evacuation scenarios that consider factors including fire history, prevailing winds, proximity of ignition to the community, and road capacity.

R-ET 3. Practicing evacuation scenarios with first responder, government, and infrastructure agencies from the community and associated surrounding jurisdictions.

R-ET 4. Utilizing programs such as "Ready, Set, Go!" to develop and communicate evacuation preparation and timelines.

R-ET 5. Developing alternate plans for situations in which there is insufficient time to evacuate from the fire area.

R-ET 6. Using crosswalks with painted patterns, overhead flashing lights, and/or removable posts to reduce impact on flow instead of immovable fixtures within the roadway.

Temporary Refuge Areas (TRA)

TF-TRA 1. Thirty-one different TRAs were formed during the first 25 hours, 27 of which involved civilians.

TF-TRA 2. Of the 18 pre-designated public assembly areas and wildfire safety zones, only four were used as TRAs during the Camp Fire. Another four were used for incident response staging.

TF-TRA 3. TRAs were selected to leverage natural and/or manmade features. TRA types included 14 parking lots, 7 roadways, 6 structures, 3 maintained natural areas, and 1 unmaintained natural area.

TF-TRA 4. Roadways and natural area TRAs were frequently the only local options (35 % [11/31] of TRAs) during the Camp Fire.

TF-TRA 5. At least 1200 to 2100 civilians were involved with TRAs. If average vehicle occupancy is assumed to be two, the estimated number of civilians increases to 3300.

TF-TRA 6. Individual TRA occupancy ranged from 1 to 550 civilians, including people in vehicles and on foot.

TF-TRA 7. High hazard conditions impacted at least 261 civilians in eight TRAs between 07:55 and 09:35 (100 minutes). Seven of the eight TRAs were formed in direct response to burnover events.

TF-TRA 8. Rapid event evolution prevented residents in Concow from reaching their local safety zone. It took one hour and two TRAs to get from Hoffman Road to the Camelot Meadow Wild Fire Safety Zone, a travel distance of 1 km (0.6 mi) (300 m [0.2 mi] straight-line distance).

TF-TRA 9. First responders and civilians had to wait for the vegetation in Camelot Wild Fire Safety Zone to burn before they could use the meadow as a TRA. This event highlights the need to design and maintain TRAs for ready access. Irrigated and maintained safety zones like Crain Memorial Park or gravel areas may provide additional safety in quickly developing events.

TF-TRA 10. The extensive use of TRAs points to the critical need of developing an evacuation plan that includes scenarios where immediate evacuation out of the fire may not be possible.

TF-TRA 11. TRAs along major evacuation arteries enhanced civilian life safety because in many cases civilians did not have to go out of their way (off the evacuation route) to get to the TRA.

TF-TRA 12. Consolidation of TRAs and groups of civilians facilitated management and evacuation of TRAs by first responders.

Ideally, civilians will have time and ability to safely evacuate before the fire impacts their community. In events where this is not possible, a system of pre-planned wildfire safety zones can be used to enhance life safety to limit civilian exposure to fire during evacuation, especially in intermix communities. The recommendations outlined below focus on the development and implementation of a wildfire safety zone system; however, they also apply to the identification of TRAs. The use of ad hoc TRAs is, by default, a last resort and does not provide the full benefit of a pre-planned wildfire safety zone system.

R-TRA 1. There is a need for a distributed pre-planned wildfire safety zone system in communities that reduces the travel time needed to access these areas so they can be quickly accessed in case a rapidly moving and widespread fire near the community prevents a timely evacuation of the community.

R-TRA 2. The number, size, and spatial distribution of safety zones need to be factored into the design of a community-wide wildfire safety zone system and based on fire exposure consideration, population density in the surroundings, and number and size of other safety zones.

R-TRA 3. Placement of and access to safety zones should consider civilian access pathways and address potential burnover locations, informed by fire history, fuel loading, and dangerous topographical features.

R-TRA 4. Identify high fuel-load areas such as heavily wooded areas, areas of flashy fuels (e.g., unburned tall dry grass), combustible structures, high density residential areas, and

topographical features like chimneys and ravines. Assess civilian egress/transit to safety zones that may traverse these areas.

R-TRA 5. Use wildfire safety zones on major evacuation arteries to enhance civilian life safety.

R-TRA 6. Consider spatial density (and minimum size) of safety zones, as well as their maintenance. The difficulty of getting to Camelot Meadow Wild Fire Safety Zone highlights the need to carefully place and maintain safety zones.

R-TRA 7. Beyond the pre-planned safety zones, first responders should be aware of nearby natural and manmade areas conducive to temporary refuge areas, such as large parking lots, gravel areas, irrigated natural spaces (e.g., parks, cemeteries), roadways/intersections, and other open spaces.

Rescues (R)

Overall

TF-R 1. Rapid fire progression, burnovers, and traffic restrictions significantly impacted rescue actions in Concow and Paradise, by both causing the need for rescues and preventing access to areas in need.

TF-R 2. Over 1000 civilians were involved in 198 identified EA/R events on November 8 and early November 9.

TF-R 3. 61 % of EA/R events are characterized by *Rescue* response actions (121/198).

TF-R 4. 90 % of civilians involved in *Entrapment* events were *Rescued* (659/733).

TF-R 5. Overall, at least 30 % (59/198) of all events involved a civilian with a pre-existing condition that may have caused difficulty in evacuating or prompted a request for assistance or rescue. Five of the 59 EA/R events with pre-existing conditions resulted in fatalities; however, five of the six EA/R events with a fatal outcome involved pre-existing conditions.

TF-R 6. Only 14 % of identified EA/R events involved civilians in vehicles (28/198); however, these events accounted for 40 % of the civilians involved, the same total number as those at a residence (~400/1007).

TF-R 7. The EA/R events involving civilians in their vehicles often resulted in the use of TRAs. This was the outcome 46% of the time (13/28), accounting for 69% of civilians in vehicles (280/406).

TF-R 8. First responders independently found or identified the need for evacuation assistance or rescue without information from 911 or dispatch 37 % of the time (73/198). Coincidentally, events were reported via 911 or dispatch with the same frequency (73/198).

TF-R 9. Only 34 % of *Entrapment* events were reported via 911 or dispatch. First responders encountered *Entrapment* events with the same frequency (34 %).

TF-R 10. 81 % of all EA/R events involved 1 or 2 people (161/198), totaling 21 % of the EA/R head count (210/1007).

Concow – 110 civilians in EA/R

TF-R 11. 92 % of civilians *Rescued* in Concow were rescued in a 90-minute period between 07:45 and 09:15 (88/96), mostly through formation of TRAs (84/88).

TF-R 12. 77 % of civilians in EA/R in Concow were *Rescued* through involvement in TRAs (85/110).

TF-R 13. 18 of 20 events in the selected Concow Rescue Area (CRA) were *Entrapment* events (107/110 civilians).

TF-R 14. Over 25 % of the estimated population of the CRA was *Rescued* (95/342).

Paradise – 881 civilians in EA/R

TF-R 15. 80 % of civilians *Rescued* in Paradise were in *Entrapment* events (560/703).

TF-R 16. 89 % of the people involved in *Entrapment* EA/R in Paradise were in events occurring between 08:00 and 12:00 (556/622).

TF-R 17. 40 % of civilians in EA/R in Paradise were *Rescued* through involvement in TRAs (353/881), including 18 % involved in the immediate formation of TRAs (162/881).

TF-R 18. There is a significant difference between the number of response actions (*Rescues* plus *Rescue Attempts*) to *Entrapments* versus *Assistance* requests. Responses were identified in 83 % of *Entrapments* compared to 44 % of *Assistance* requests. This highlights the effective decision-making by first responders in addressing risk to civilians, prioritizing high hazard situations for rescue by the limited number of available responders.

In planning for WUI fire evacuations, communities should consider:

R-R 1. First responders should plan for partial or complete loss of communications with dispatch.

R-R 2. Additional post-fire studies on these types of evacuation assistance/rescue events should be conducted to further assess *Notification*, *Rescue*, *Rescue Attempt*, and *Entrapment* frequency and outcomes in different WUI fire incidents.

This page intentionally left blank.

1. Introduction

1.1. NIST Wildland-Urban Interface Fire Research Background

Recent years have repeatedly shown that wildland-urban interface (WUI) fires pose a significant threat to life safety and property in the United States. Since 2017, the State of California, in particular, has seen some of the largest, most destructive, and deadliest fires in its history. Five of those fires are among the top 25 largest fire losses (of any fire type) on a list compiled by the National Fire Protection Association (NFPA) [1]. Twelve of the 25 are WUI fires. Thirteen of the top 20 most destructive California fires [2] occurred since October 2017, causing a combined 148 fatalities.

Defined as the zone where structures and communities meet or intermingle with undeveloped wildland, the WUI is extensive in the United States. Analysis of the 2010 U.S. Census data determined that over 44 million homes, housing 32 % of the US population, were located in the WUI [3]. Since 2010, development into wildlands has not slowed, and neither has the number of WUI fires.

In the early 2000s over one thousand structures per year on average were lost to WUI fires in California alone. In the 2010s, seven individual WUI fire events each caused losses of more than one thousand structures. In 2017, the Tubbs Fire destroyed and damaged 5636 structures—double the losses from the 1991 Tunnel Fire (Oakland Hills Fire), which at 2900 structures had been the most destructive California fire to date [4]. One year later, the Camp Fire tripled the mark, destroying 18 804 structures. Eighty-five people perished.

An improved understanding of WUI fire dynamics and structure ignition mechanisms is critical to improving structure and community resistance to WUI fires (the “WUI fire problem”). The National Institute of Standards and Technology (NIST) WUI Fire Hazard Mitigation research effort comprises laboratory and field research projects to address this national fire problem. Additionally, the NIST Disaster and Failure Studies Program provides a platform for research on building and infrastructure performance and emergency response and evacuation procedures.

The Wildland-Urban Interface (WUI) Fire Data Collection on Parcel Vulnerabilities Project is focused on understanding how WUI fire behavior is driven by the interactions among fuel, weather, and topography, and the roles played by heat flux, embers, and direct flame impingement. Building and community vulnerabilities identified through post-fire analysis [5-9] are further investigated through laboratory experiments, e.g. [10-13]. Post-fire analysis also shows how fire behavior is modified by active and passive defensive actions. The WUI Structure/Parcel/Community Fire Hazard Mitigation Methodology [14] considers these interactions and provides mitigation pathways to improve how communities withstand fire and ember exposures during a WUI fire. Additionally, field-scale experiments provide data for development and validation of the NIST-developed Fire Dynamic Simulator (FDS) computer fire model [15].

Research into emergency messaging, evacuation decision-making, and evacuation modeling further support the disaster preparedness, emergency response and management, and community resilience goals of NIST research programs and grants. NIST has also conducted research relating to emergency messaging and evacuations [16], outdoor sirens [17], and messaging content [18]. Recent grant-funded work includes evacuation modeling [19-21], and behavior modeling [22].

NIST WUI research is conducted in partnership with other federal agencies, including the US Forest Service (USFS), Federal Emergency Management Agency (FEMA), US Department of Homeland Security (DHS), and US Fire Administration (USFA); state agencies, including California Department of Forestry and Fire Protection (CAL FIRE) and Texas Forest Service; fire service organizations including Western Fire Chiefs Association, International Association of Fire Fighters (IAFF), and International Association of Fire Chiefs (IAFC); building codes and standards organizations, such as National Fire Protection Association (NFPA) and International Code Council (ICC); and many academic institutions. Research findings are used directly to guide the development of new standards and to provide the scientific basis for new performance-based requirements, with the intent to make structures and communities more resistant to fire and ember exposures.

1.2. The Camp Fire

The Camp Fire started near Camp Creek Road and Pulga Road in Butte County, California, in the Feather River Canyon north of Jarbo Gap, at approximately 06:20 on November 8, 2018. The first report was called in to 911 at 06:25, and the initial response was immediately dispatched to the vegetation fire. The fire quickly became well-established in steep canyon terrain, spreading from the origin toward the small community of Pulga. Shortly after 07:00, the fire crested the ridge west of Pulga and pushed towards Concow. Strong east winds drove the fire 12 km (7.5 mi) from the origin to the Town of Paradise. Within the next five hours, most of the town was destroyed. Fire continued to spread, impacting the foothills south of Paradise to CA Highway 99 (CA-99) and the outskirts of Chico, destroying a large portion of Magalia, and burning communities in Yankee Hill and Cherokee. The location of the Camp Fire is shown by the red shape in Fig. 1, which shows the location of Butte County within the state of California. The map in Fig. 2 provides an overview of the final perimeter of the Camp Fire and highlights selected key locations that are named throughout this report.

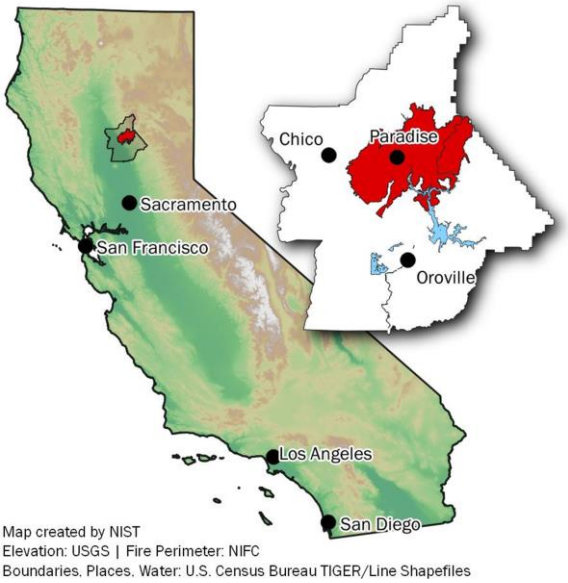


Fig. 1. Location of Butte County, California and the Camp Fire [23].

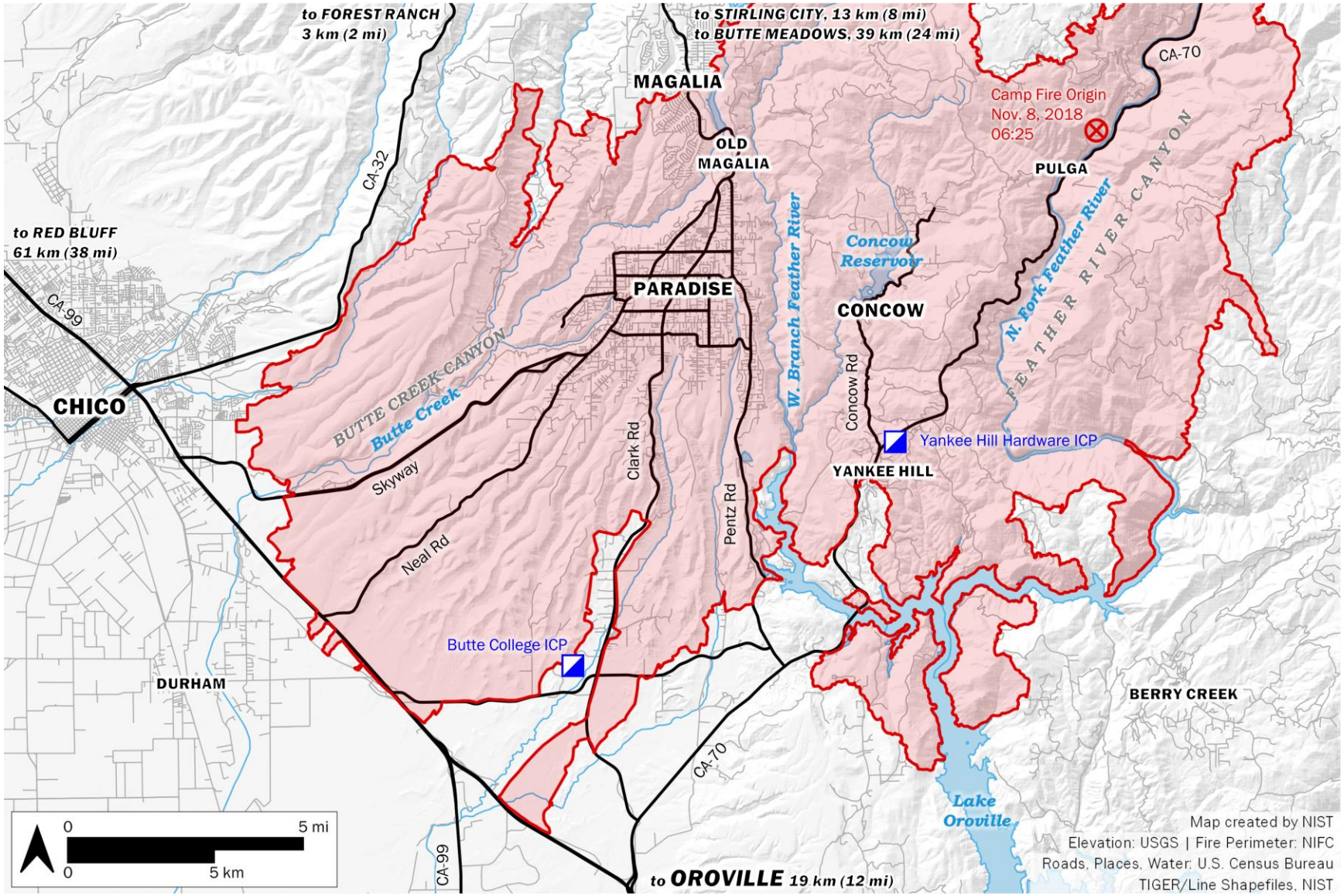


Fig. 2. Overview map identifying selected key landmarks, locations, roadways, and communities in relation to the final perimeter of the Camp Fire. The origin is marked northeast of Pulga. The locations of the two incident command posts (ICP) are also indicated.

The fire burned for 18 days before being declared 100 % contained on November 25, 2018. The Camp Fire encompassed 62 053 ha (153 336 ac) and destroyed 18 804 structures, including 13 696 single-family residences [24]. The fire resulted in 85 civilian fatalities [25-28] and 5 reported major firefighter injuries [29]. After the fire, 3266 missing persons were located after the widespread evacuations [30].

NIST deployed a team to conduct a preliminary reconnaissance of the Camp Fire [31, 32]. The primary objective of the reconnaissance was to determine if the Camp Fire offered unique data that, if collected and analyzed, could provide new technical insight into the US WUI fire problem. After the preliminary reconnaissance, it was determined that this larger case study was warranted.

1.3. Fire Progression Timeline

The first stage of the detailed case study was the development of an event and fire progression timeline to learn about and understand the incident. The fire progression timeline also provides a foundation for additional analysis of other aspects of the incident, including evacuation and notification aspects in this report. The following summary of the progression of the Camp Fire during the first 24 hours is provided here, from the Fire Progression Timeline report (NIST Technical Note 2135) [23], for convenience. For further details of the fire progression, the reader is referred to the previous report. Additional links, references, and data from Ref. [23] are included throughout this document to provide context to the various notification, evacuation, and additional life safety data and observations presented in this report.

Fire Spread Summary

November 8, 06:25 to 10:00

The Camp Fire was first reported via calls to 911 beginning at 06:25. The caller indicated that the fire was burning on the west side of the Feather River near Poe Dam on CA Highway 70 (CA-70). The fire quickly became well-established in the steep canyon terrain, spreading from the origin toward Pulga. Shortly after 07:00, the fire was cresting the ridge and pushing towards Concow. By 07:25 the first structures started burning in Concow, 5 km (3 mi) from the origin.

The fire continued growing in Concow, moving westward and spotting over Concow Reservoir and Sawmill Peak. The first spot fires from the Camp Fire arrived in Paradise at 07:44, 12 km (7.5 mi) from the origin. The main fire front reached Pentz Road around 08:30, resulting in a significant number of distinct spot fires within Paradise. A total of 30 spot fires before 08:30 were identified during the data analysis, with spots reaching as far as 3.4 km (2.1 mi) into the town. Most of these spots (18) were within the first 1 km (0.6 mi) from the wildlands. The fire front reached Pentz Road between Apple View Way and Lowry Lane. Spot fires in and across town before 08:30 were most likely from the wildland fire front and a limited number of structure ignitions in Concow. By 08:45 there were two separate spot fires that had started in the vegetation far ahead of the main fire front. One was burning in the drainage east of Clark Road near American Way, 3 km (1.9 mi) southwest from the Lowry Lane, spotted near Feather River Hospital. The second spot ignited in Honey Run Canyon, located on the west side of Paradise, 6.3 km (3.9 mi) from Lowry Lane.

Between 09:00 and 10:00 in Concow, the head of the fire was hung up on the east side of Concow Reservoir, burning to the north of Ishi Trail. Spot fires were igniting in pine and leaf litter 1.6 km (1 mi) ahead of the fire front. During that same time in Paradise, the fire intensified along both sides of Pentz Road. Initial spot fires deep within town were well established, and the fire was starting to spread to the west impacting Wagstaff, Bille, and Pearson Roads. By 10:00, fire was impacting Pentz, Bille, and Pearson Roads, where civilians were stuck in traffic and trapped in their vehicles. The fire continued to get deep-seated along both sides of Pentz while the earlier spots in town also grew.

November 8, 10:00 to 12:00

Between 10:00 and 11:00 on Pentz Road, peak vegetation fire activity had subsided, but significant fire remained. Most structures and heavy fuels were still burning on both sides of the road. The road was passable with variable visibility. The intersection of Pentz Road and Pearson Road remained fully involved, continuing to impact evacuations.

By 10:00, fire was impacting Clark Road in multiple locations, preventing passage while people were attempting to evacuate. The fire overtook vehicles evacuating on Clark Road at Buschmann Road with wind blowing flames "like a blow torch," and fire jumped to the west side of Clark Road. Clark Road became barely passable again near the town limits for a brief time. However, another flare-up between 11:00 and 11:30 closed the roadway again as 15 m (50 ft) flames crossed Clark Road near Round Valley Ranch Road, and fire again crossed the roadway near American Way. Further down Clark Road at Airport Road, fire also burned over the roadway, delaying access of arriving strike teams as they waited for conditions to abate. The fire continued with high intensity south of the airport into the afternoon, where it paused and hung up for a period of time between about 13:00 and 15:00, before again advancing down into the flats south of Circle J Road.

Between 10:00 and 11:00, the spot fire in Honey Run Canyon, between Russell Drive and Redbud Drive, grew and became well established. Fire ran south up out of the canyon and burned over Skyway. Significant ember showers and fire activity on both sides of Skyway impacted evacuating vehicles.

By noon, intense fire was burning on the ridge and in the canyons near Jordan Hill Road. Flame lengths of 30 m to 45 m (100 ft to 150 ft) were observed. Engines looking for civilians had to drive through fire to escape back to Concow Road. At the same time, the northern flank of the fire was hung up between Coutolenc Road and Pentz Road. In Paradise, the main fire was pushing south down Berkshire Avenue, spreading to structures. Fire spread from structure to structure through Skyway Villa Mobile Home Park. The main fire activity along Pentz Road had passed; structures were burned down, vegetation had burned through, and Pentz Road was passable. Fire was well-established on the west side of northern Pentz Road, burning heavy brush, trees, and structures. Structures began igniting on Sweetbriar Lane, and the fire spread west from structure to structure. Before noon, fire was approaching the Walgreens store and the intersection of Bille Road and Skyway from multiple directions. Structures were burning south and east of Skyway in the area of Almond Street and Fir Street. At the same time, fire activity at the Skyway split was still active on both sides of the roadway, but Skyway was passable. Fire was encroaching on Neal Road and Roe Road from the north, as a large area of fire burned over Skyway.

November 8, 12:00 to 17:00

Between noon and 15:00 in Concow, the southern extent of the fire continued to burn in the Concow Creek canyon northwest of Nelson Bar Road and north of Comfort Lane on both sides of Concow Road. In Paradise, the fire was well established through most of the town and began impacting the downtown area. By 13:00, 10 to 15 structures were burning at the south end of Andover Drive and on Adrian Drive. On the northern end of Paradise, fire was coming toward the Clark Road and Skyway intersection from the canyon to the west. Structures on the east side of Skyway were burning intensely, and fire was coming from the north through residential structures, threatening commercial structures where trapped civilians were taking temporary refuge. Many homes were on fire near Clark Road and Cabernet Lane. To the southwest, fire in Honey Run Canyon was moving down the canyon toward Centerville Road with a moderate rate of spread. On the ridgetops, flames were shooting out of the canyon with 30 m to 60 m (100 ft to 200 ft) flame lengths. In the canyon, flames were 2 m to 3 m (6 ft to 10 ft) long. Ember showers and flames were threatening multiple structures.

Between 14:00 and 17:00, fire was embedded in the structures in the area on the southern end of South Park Drive and Adrian Drive. Fire was burning in Little Butte Creek Canyon, wrapping around to the west, and burning in ravines uphill into the prevailing wind, toward West Park Drive.

By 15:00, heavy fire was burning everything on the west side of Skyway between Black Olive Drive and Jewell Road, including a burning woodpile that was threatening Town Hall. Torching shrubs and junipers were threatening additional nearby structures. Skyway between Pearson Road and Neal Road was being encroached upon from both east and west; fire was spreading uphill and upwind in Honey Run Canyon into structures on the west side of Skyway, and the main fire front was pushing west from Pearson Road. Structures were burning along Pearson Road, Almond Street, and Black Olive Drive, approaching Skyway.

Between 15:00 and 17:00 the fire approached Nelson Bar Road. To the north, the fire remained burning to the south of Magalia. In downtown Paradise, fire was well-established in multiple commercial structures at Skyway on Fir Street, and fire continued to burn structures in the area of Fire Station 81.

November 8, 17:00 to 24:00

Around sunset (16:56) in Concow, an intense fire front with 15 m to 30 m (50 ft to 100 ft) flames burned through the forest into the grasslands, impacting structures along the west side of Nelson Bar Road. Numerous short-range spot fires were observed ahead of the fire front. At the same time in Magalia, fire was backing up out of the canyon, impinging on structures on Andover Drive with creeping fire behind homes. In Paradise, structures continued to burn. Large trees and power poles continued burning and threatened or blocked roadways. Also, around sunset, fire activity at Neal Road and Wayland Road increased, pushing into the area from the northeast. The fire then ran down into the foothills toward CA Highway 99.

Between 18:00 and midnight, the evening was a period of generally reduced fire behavior in the upper part of Little Butte Creek Canyon near Magalia. Different portions of

Andover Drive were threatened throughout the evening period. By 22:00, fire had moved up out of Stilson Canyon and was coming up over Humboldt Road approaching CA Highway 32 (CA-32). Fire had also burned through the Cory Creek area, destroying multiple structures. Residual fire continued to threaten communities along Durham-Pentz Road.

November 9, 00:00 to 08:00

Between midnight and 02:00 on November 9, the fire flared up out of the West Branch Feather River Canyon with 30 m (100 ft) flames pushed by strong winds, estimated at 22 m/s (50 mi/h). Softball-sized embers blew across Coutolenc Road and Skyway into Magalia and Old Magalia. Several spot fires were established on the west side of Magalia Reservoir, and fire was spreading uphill toward Lakeridge Circle. Intense fire blocked Skyway south of the dam.

Between 02:00 and sunrise, at 06:44, the fire became well established in Magalia and consumed hundreds of structures. During the night in Concow fire was between Nelson Bar Road and CA Highway 70. Fire intensity was low to moderate, making local runs and overtaking dozer lines towards Lake Oroville.

The fire activity intensified dramatically at several locations at sunrise. In Concow, fire was burning across Pinkston Canyon Road towards Concow Road. Firefighters were worried about getting hemmed in by fire on both sides on Concow Road. Butte County Fire Station 37 on Concow Road was hit hard by the fire. At the same time in Magalia, a rapid increase in fire activity on the west end of Ponderosa Way impacted the south and west. Firefighters had to drive through fire to reach the safety zone of the parking lot at Pine Ridge School, where fire also approached from the east.

Additional findings from the Fire Progression Timeline of this case study (NIST Technical Note 2135 [23]) include 23 life-threatening burnover events, in which people were directly exposed to fire conditions that impacted life safety, including entrapments and near-misses. References to burnovers throughout this report refer to these specific events. Burnovers involving civilians are directly related to many of the life-safety and evacuation topics and events presented in this report. Nineteen were identified in NIST Technical Note 2135; an additional four are presented in this report based on additional findings related to evacuation/notification/rescue data analyzed for this report. Furthermore, 23 technical findings and nine recommendations associated with the fire progression were presented in Ref. [23].

This page intentionally left blank.

2. Technical Overview

The catastrophic losses from the Camp Fire have led to the identification of multiple research questions to help understand this WUI fire and provide lessons learned that may be used to reduce losses in other WUI communities in the future. A detailed case study of the Camp Fire is being presented through a series of five reports. *Report #1* [31] describes preliminary reconnaissance deployments to the Camp Fire while *Report #2* [32] contains preliminary data collected during those deployments. The additional three comprehensive reports detail various aspects of the fire event:

Report #3 [23]: fire progression and fire behavior (including burnover events),

Report #4 (this report): emergency notification, evacuation, traffic, temporary refuge areas (TRAs), rescues, and fatalities (collectively, NETTRA),

Report #5 (in progress): emergency response, defensive actions, and damaged structures.

The research questions addressed in this report include:

a) What were the design parameters of the Paradise evacuation plan?

b) What were the roads and access characteristics of Concow, Paradise, and Magalia?

c) How was the notification of civilians in Concow, Paradise, and Magalia achieved?

d) When were evacuation notifications and orders issued and how does this timing relate to fire progression?

e) How did fire impact evacuations of Concow, Paradise, and Magalia?

f) What were the primary factors that impacted traffic flow during evacuation?

g) How did the use of wildfire safety zones and the creation of TRAs impact civilian life safety and how many civilians utilized TRAs?

h) When were TRAs formed and what were the physical characteristics of the TRAs used?

i) What were the attributes of the rescues performed and how many civilians were rescued?

This page intentionally left blank.

3. Data Collection and Analysis Methodologies

While much of the data collection was performed within the scope of the methodology presented in the Fire Progression Timeline report [23], a few additional sources and methods were used to collect and analyze the data presented in this current report. More details related to this section are also found in Ref. [23]; some are presented here briefly for convenience or with specific examples or differences relevant to the scope of this report.

3.1. Data Collection

Data collection was accomplished in 11 field deployments, each averaging two weeks long, with two to six personnel on each deployment. Much of the data relies on direct first-hand observation accounts. A total of 151 technical discussions (TDs) with 157 individuals were conducted to collect accounts of first responders and other personnel directly involved in the event. In addition, photos and videos captured during the event provided detail and significant context to the observations. A survey of residents and evacuees was beyond the scope of this case study.

The framework of the approach was to start from the incident command level to build a general understanding of the incident progression and to identify the local first responders who responded in the early hours of the incident. The goal of each TD was to collect technically relevant information about the incident progression and events from first responders and other individuals who had direct involvement in the incident through a detailed chronology of their day. The tools used to define/refine the event(s) timeline for observations presented in technical discussions are listed in Table 1, roughly in the order of spatiotemporal accuracy. Details about the TD methodology are further described in Ref. [23].

Table 1. Tools, "hooks," and methods used to define/refine the event timeline during and after technical discussions.

Tool	Source	Primary Value Added
Automatic Vehicle Locater (AVL)	Electronic database or prepared route of travel summary	Timestamp, location
Pictures and/or videos	Participant	Usually timestamp and location, as well as visual context or audio
Radio communication	Radio log	Timestamp, context
Phone or Text Message	Participant	Timestamp
Meeting with other apparatus that has AVL	AVL (can be used even if TD for that apparatus is not available)	Timestamp, location
Participant's notes taken during event	Participant (frequently from Battalion Chiefs, Division Supervisors and Branch Chiefs)	Possibly timestamp, additional details
Meeting with another first responder	Primary Database – used after the TD	Cross-reference
Unique visual observation[a]	Primary Database – used after the TD	Cross-reference

[a] e.g., traffic conditions, presence or absence of civilians, presence or absence of fire behavior, presence or absence of other first responders.

Notes from each TD were entered into a Primary Database spreadsheet with a specific location and time. Data points were binned into the following categories: fire and fire behavior, evacuation/people, defensive actions, and weather. This report focuses on the *evacuation/people* category of data; data points were coded with subcategories including emergency notification, evacuation, rescue, traffic conditions, blocked roadway, and temporary refuge area.

In addition to the TDs, NETTRA data was collected from several other sources including dashboard camera and audio recordings from Paradise Police Department, "virtual" TDs (VTD) with data points observed from publicly available photos, videos and news reporting, radio log transcript, and 911 call recordings.

Additional data for this report was collected from several other sources. Measurements of roadway width were taken using various GIS tools. The Butte County District Attorney's report [28] was also a critical source of information, particularly related to the incident fatalities. The Butte County Sheriff's Office (BCSO) contributed logs documenting the CodeRED reverse 911-system used for public notifications during the Camp Fire.

3.2. Data Integration and Spatiotemporal Uncertainty

Data integration was conducted in two stages. First, the preliminary data was entered into the master database with corresponding spatiotemporal information. The second stage consisted of integration and quality control, performed by cross-referencing and reconciling different data points so that information was correlated and consistent. Section 7.5 of Ref. [23] provides more detail. Data integration was particularly important to develop the traffic flow component of the data, the TRA sequencing and civilian head counts, and rescue of civilians. Assessment of abandoned and burned vehicles required combination of many data sources and tools, including GIS, satellite and drone imagery, field data, news photos, TD photos, and TD comments to generate the spatial layer of vehicle locations.

Data quality assurance and quality control were accomplished through detailed spatiotemporal cross-referencing of all data points used. When necessary, spatiotemporal adjustments were implemented on individual data points to reconcile differences and improve precision.

An example of data integration and temporal refinement is presented here for context. Data sourced from multiple TDs indicated that a group of civilians took refuge at a Walgreens store in Paradise and were evacuated from that location using firefighting hand crew buses. No precise evacuation time was directly provided from the TD sources. The best estimate of evacuation time from the automatic vehicle locator (AVL) associated with this TD source was 14:00. There was no TD with firefighters from the hand crew; however, the use of AVL data from the hand crew bus showed the exact time of evacuation at 13:22, and enabled refinement of this event's timeline. Additional examples of quality control are presented in Sec. 7.5 of Ref. [23].

Uncertainty and errors associated with the location and time of individual data points are discussed in the following subsections. Uncertainties related to quantities and values are discussed in their relevant sections later in the report.

3.2.1. Potential TD Errors

There are four different types of errors that could occur during TDs as well during the data transfer process into the primary database: temporal, spatial, narration transcription, and coordinate transcription errors. The following descriptions are presented from Ref. [23] for convenience.

Temporal Errors

These errors occurred when a TD participant confused the sequencing of events. The tools identified in Table 1 were used during and after the TD to help identify a number of these errors. There were cases, however, where there were no usable "time hooks" to anchor the TD, and large time windows represented several observations or actions that could not be further pinpointed in time. In these cases, the observation time was assigned the entire time window in which it could have occurred.

Spatial Errors

Misplaced information on the TD maps could result from marking the wrong place (by the TD Lead), from misreading the map (by TD participants), or from getting the location of the event wrong (by TD participants). The documentation and descriptions within the TD were used to identify and rectify this type of error. However, there were cases where there was only a single observer of an event/action at a specific location, meaning that errors might be introduced that could not be tracked and rectified. The tracking and cross-referencing of events during database assembly was intended specifically to reduce the occurrence of these potential errors.

Narration Transcription Errors

Narration transcription errors were a possibility. This issue was addressed by having more than one experienced scribe taking notes during the TDs. Data collection for the previous NIST studies had identified that three is the optimal number of TD scribes. While several TDs were conducted with two scribes, it also should be noted that one scribe was insufficient to capture all the information provided by TD participants. An experienced scribe who had also participated in the field reconnaissance and data collection activities had a better awareness of the locations and could capture TD information more reliably than a person who was unfamiliar with the locations and streets described during the TD.

Coordinate Transcription Errors

The data documented on paper maps from each TD was transcribed into the primary database. Geolocation tools, including Google Earth, Google Maps, Bing Maps, and ArcGIS Online, were used to get the coordinates for each identified point.[1] A number of these tools permitted a seamless "cut-and-paste" of the coordinates while some required manual input, which could result in transcription errors. The visual data integration as part of the Quality Control process could identify this type of error.

[1] Certain commercial entities, equipment, or materials may be identified in this document in order to describe an experimental procedure or concept adequately. Such identification is not intended to imply recommendation or endorsement by the National Institute of Standards and Technology, nor is it intended to imply that the entities, materials, or equipment are necessarily the best available for the purpose.

3.2.2. Spatiotemporal Uncertainties

There is a range of spatial and temporal uncertainties within the data. AVL and geolocated/time-stamped images[2] provided precise time and location references for events. Although many images may be geotagged by cameras or cell phones, care was needed to ensure that an accurate location was recorded, especially in difficult terrain and smoky conditions. All photos used in this study were individually re-geotagged to precise locations based on the contents of the photos. Some photos provided from the TD participants were not geotagged and were not descriptive enough to deduce the location; information from such photos was not captured in the datasets.

Radio log data could also be precise; however, sometimes statements by Division Supervisors and other Incident Command System (ICS) personnel were more general in nature. Defensive actions conveyed to the NIST data collection team by Division Supervisors and Strike Team Leaders were often longer or shorter than what was reported.[3] Cross referencing of these defensive actions was used when available to further refine the temporal component of the statement.

TDs without AVL or accompanying photos had the widest range of temporal and spatial uncertainties of all the data collected. These TD observations could be refined in space and time by utilizing the cross-referencing methodology previously described.

Table 2 lists the range of uncertainties that were expected within the different data types. Further discussion about the variable uncertainties related to TD observations follows.

[2] All images were from cell phones or body/dashboard cameras with accurate times. A few images were copies with altered time and date and were adjusted if possible, otherwise they were not included in the dataset.

[3] This is because the Division Supervisors and Strike Team Leaders frequently traveled between resources and surrounding areas to maintain situational awareness.

Table 2. Uncertainty ranges of various data sources.

Data Source	Data Attributes	Temporal Uncertainty	Spatial Uncertainty
Picture/video	Geolocated Timestamped	±1 min	±5 m
AVL position	Geolocated Timestamped	±1 min	±10 m
Radio log (fire or PPD)	Variable location Timestamped	±1 min – Variable	±0 m – Variable
Picture/video	Geolocated No timestamp	±1 min – Variable	±5 m
TD observation	Location estimated Time estimated	Variable	Variable
TD Inferred time	Time estimated	Variable	n/a
DINS post-fire damage pictures	Geolocated	n/a[a]	Linked to structure
NIST post-fire pictures	Geolocated Timestamped	n/a	±5 m
Drone and satellite imagery	Geolocated	n/a	±(1 m to 100 m)[b]

Note: Values provided are Type B uncertainties as defined in NIST Technical Note 1297 [33].
[a] Data without temporal information (such as DINS, drone, and NIST post fire images) were used as supplemental information to cross-reference and confirm events in time.
[b] For a limited area on the west edge of fire east of Chico, there was an imagery "stitching" offset.

3.2.2.1. Temporal Uncertainty of Observations

The observations with a temporal window fell into two distinct categories. They either encompassed a general action, such as "we were parked here for two hours and during that time defended these five structures," or they described a more specific action such as "we defended this one house for two hours." In the first case, the different structures were defended sometime within the time window without specification of individual duration or sequence, whereas in the second case the action took place over the entirety of the duration.

Large temporal windows were common for locations where the density of first responders was low. This was typical in low population density areas or wildland areas that were not critical to evacuation, life safety, or the containment of the fire. One example was a statement from the heel of the fire, near Pulga, where fire jumped onto the east side of CA Highway 70. The collected data placed the event between 12:35 and 23:30. The large window was associated with the limited available data. In this case there were a limited number of firefighters in the area and limited anchor points to narrow down the event time window. The 11 hour time window was an outlier in the dataset; typical time windows and uncertainties are provided in Table 2 and Sec. 3.3, Data Summary Statistics.

The time of a photo without a timestamp was often determined by the content of the photo. The content could set the photo at a specific time, such as with AVL positioning of a visible

apparatus, or could be set within a time window of possibility. Therefore, these data sources had variable time uncertainties.

Another source of temporal uncertainty was associated with defensive actions performed by residents who stayed behind and defended their property. Specific actions have not been systematically collected from the public in this study; instead, information about civilian structure defense was determined through TDs and VTDs in which such actions were observed. Therefore, to address this temporal issue, generalized defensive actions by civilians (e.g. “a resident defended this property”) were listed with a time window extending all day unless more specific details were known to narrow down the time of the action. While not time-resolved, the location and action were known; the fact that a structure was defended provided critical information to understanding structure survival.

Some times were noted as “inferred” times. While this indicated that a time was not stated or identified for a particular observation, there was data supporting the time window. For example, an observation or sequence of events may have been provided in a TD or VTD without a specific time. By identifying cross-references, time windows could be determined for these observations. Another example was the refinement of a time window by approximating travel time between two known locations. These inferred times may have uncertainties similar to AVL times or videos, which were precise, or may span larger time windows like some TD-provided time estimates.

3.2.2.2. Geolocation Uncertainty of Observations

TDs provided information on notification, evacuation, traffic, temporary refuge areas, and other related life safety activities. The information was provided verbally during the TD, and a large map was annotated with the recalled sequence of events and locations. Further detail of the TD methodology is presented in Sec. 7.3 of Ref. [23]. TD statements and data about fire observations, behavior, and progression are also discussed in Ref. [23]. Defensive actions will be further discussed in NIST Camp Fire Report #5.

Spatial uncertainties associated with NETTRA observations and their respective TD map locations were generally minimal after cross-referencing and quality control. Many data points were associated with roadways and intersections, reducing the spatial uncertainty. There is limited uncertainty associated with specific addresses and landmarks often described in accounts of specific traffic observations, temporary refuge areas, and rescues. Many of the observations were made by first responders on location, in comparison to fire observations which may have been from a distance (e.g., spatial uncertainty of a distant spot fire may be much larger).

The above-described datasets could have uncertainty arising from TD location errors as described in Sec. 3.2.1. Cross-referencing was used to identify and resolve these errors. Photographs and videos further reduced the uncertainty in location of certain data points and events.

3.3. Data Summary Statistics

Sources of NETTRA-related data included TDs, of which approximately one-third were supplemented with photos/videos, VTDs from civilian videos and other news sources, dashboard camera recordings from the Paradise Police Department, and 911 call recordings. Combined, these sources yielded 2664 NETTRA observation data points. Individual data points are listed in Appendix A. Thousands of additional observations related to fire behavior were previously compiled to establish the fire progression timeline [23], and defensive actions will be detailed in a subsequent report.

The distribution of data sources is shown in Fig. 3. Technical discussions comprise a majority of the database, contributing 60 % of all NETTRA observations. Accompanying photos and videos from TD participants yielded 10 % of the data. The instrumental role of law enforcement (LE) in evacuations is evident from the 17 % of data points derived from the PPD video recordings. PPD officers were directly involved with evacuation notifications, traffic management, and TRAs. Data from VTDs includes audio recordings of selected radio traffic, which contributed over half of the data sourced from VTDs. Other VTDs often provided information from a civilian perspective, sometimes providing information from within TRAs or burnovers.

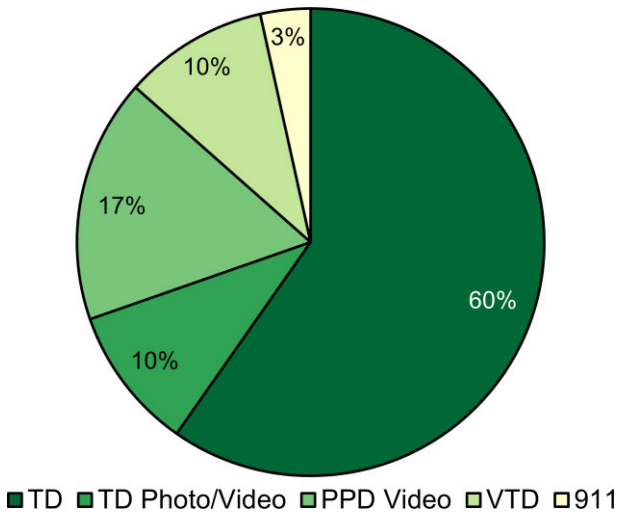


Fig. 3. Distribution of NETTRA observation data sources.

Observation data points were tagged according to eight categories to facilitate searching and analysis: traffic conditions, road blocked, notification, evacuation, rescue, TRA, abandoned vehicle, and fatality. The prevalence of each data category among all NETTRA data is shown in Fig. 4. Note the values do not sum to the total number of data points or 100 %, as multiple categories may apply to individual data points. Data was dominated by observations of traffic conditions, comprising 44 % of all data points. Evacuation actions and observations comprised 23 %, and Rescues were described in 16 %. Few data points in the primary database were

directly associated with fatalities. The fatality data included in this report was primarily sourced from the Butte County District Attorney report [28] and is not reflected in these totals.

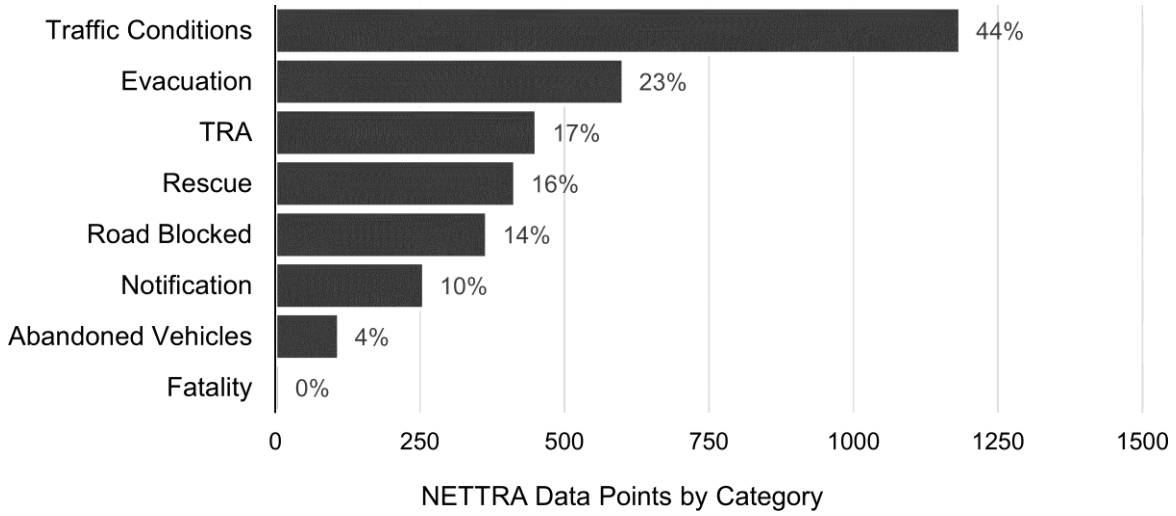


Fig. 4. Distribution of NETTRA data points by topic category. Data may be assigned multiple categories; values do not sum to 100 %.

Figure 5 plots the cumulative fraction of NETTRA observations as a function of time of day (hours greater than 24 indicate time on November 9, e.g., 25 is 01:00), compared to the similar metric for documented fire observations.[4] This plot indicates how quickly fire overtook the town, with over 80 % of recorded fire observations occurring before 18:00, within the first 12 hours of the incident. The overall timing of NETTRA-related observations occurs more quickly than for fire observations, with over 80 % before 14:00. This time shift is attributed to three primary factors: the NETTRA data is dominated by traffic and evacuation observations which occurred mostly before noon, the fire component of the incident was more prolonged compared to the duration of civilian evacuation, and the focus of first responders in the morning was more aligned with civilian life safety and NETTRA topics.

Also shown in Fig. 5 is the distribution of the time source associated with each data point. NETTRA data was linked to directly recorded times via photos, AVL, or radio or 911 call recordings for 69 % of the data points. While the time of the remaining 31 % of data points were inferred, or otherwise not directly linked to a specific time of day, they were all reconciled with the complete data set and most have a low uncertainty or narrow time window in which they could have occurred.

[4] See Fig. 21 in NIST Technical Note 2135 for source of fire observation data.

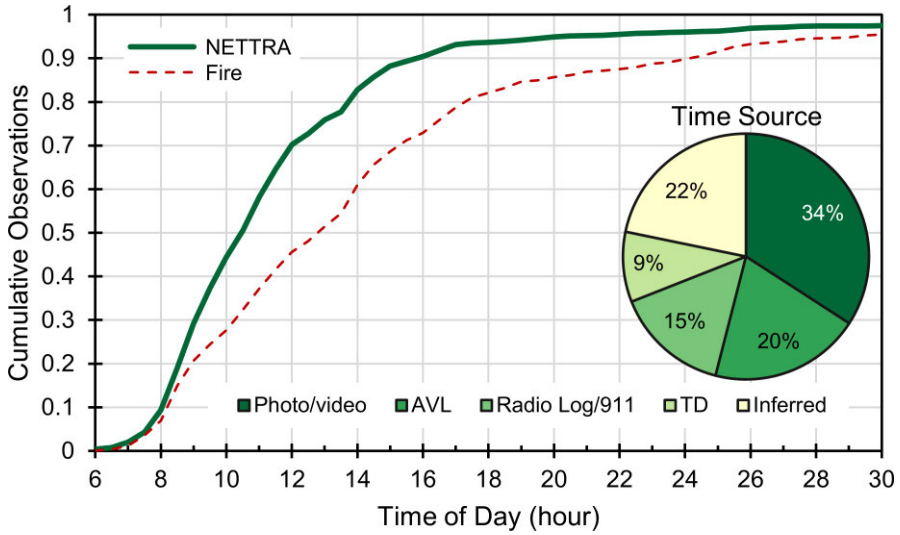


Fig. 5. Cumulative fraction of NETTRA observations compared to fire observations as a function of time (hours greater than 24:00 correspond to November 9) and distribution of time source for NETTRA observations.

Figure 6 shows a breakdown of observations by category in 30-minute windows for the first 12 hours, encompassing the bulk of the NETTRA data. Each bar in Fig. 6a shows the total number of observations in each category within each window (e.g., 187 observations described traffic conditions between 09:00 and 09:30).[5] The peak observation rate was over 300 points each half-hour from 08:30 to 09:30. The individual counts in traffic, evacuation, and rescue categorizations peak during this time. Before 07:30 and after 15:00 there are fewer than 50 total points per window.

Each bar is normalized in Fig. 6b to better highlight the fractional contribution in each time window. While smaller in absolute number than many of the traffic condition observations, the large fraction of observations in the notification category stands out before 08:30. Traffic conditions are the primary observation between 08:30 and 12:30, contributing between 30 % and 40 % of observations in that morning time period, during the peak of evacuations. The proportion of observations related to TRAs also increases as the day progresses; as people evacuate, traffic reduces and becomes less of a focus, but the TRAs continue to be active. Observations related to blocked roads and abandoned vehicles increase in prevalence in the afternoon as traffic clears out and abandoned vehicles become more apparent, and first responders are more mobile throughout town.

[5] some data points were assigned to, and appear in, multiple categories

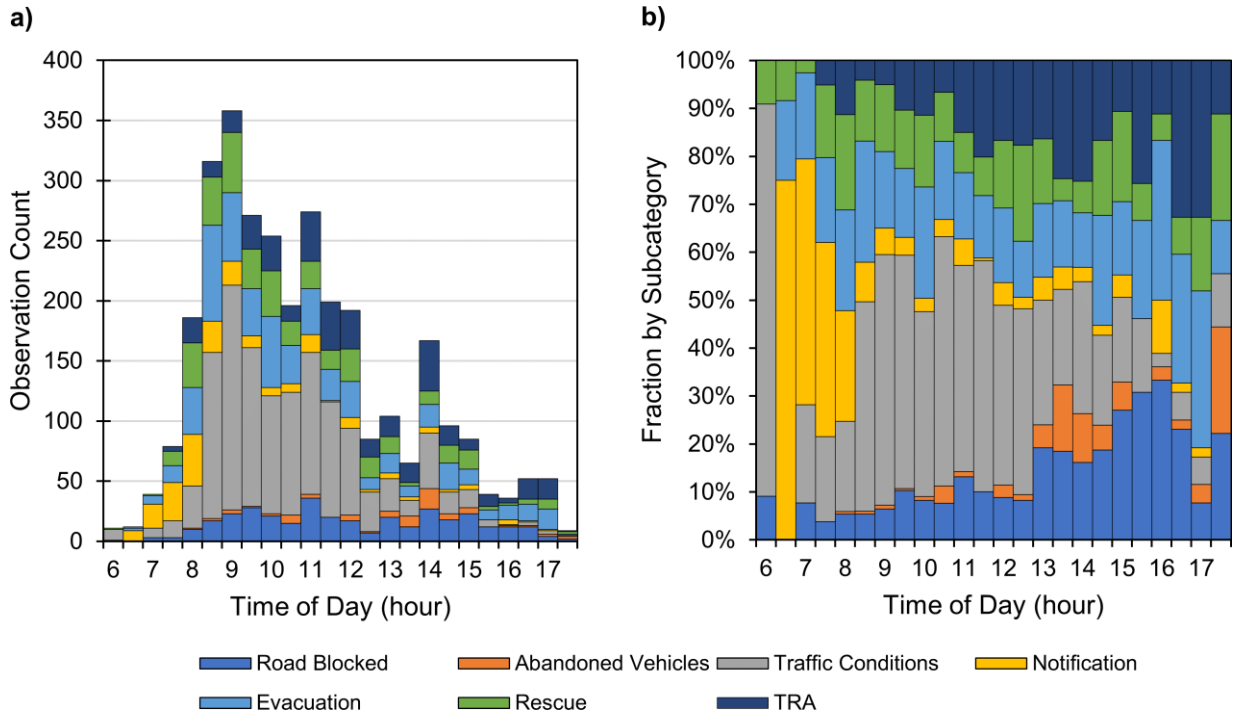


Fig. 6. NETTRA observations as a function of time in 30-minute windows; a) stacked bars indicate the number of data points in each category; some data points were assigned to, and appear in, multiple categories, b) bars are normalized to show contributing fraction of each category.

4. Road and Access Characteristics of Concow, Paradise, and Magalia, CA

The location and topography of the three communities in the foothills of the Sierra Nevada largely dictates their roadway access characteristics. Figure 7 shows a basic map identifying the major roadways around the region, with zoom insets detailing Concow and Paradise. These primary roadways will be mentioned throughout this report. The number of lanes and pavement width of each egress artery are listed in Table 3. Uncertainty (Type B [33]) in roadway width, as measured from aerial imagery using GIS, is estimated to be 0.3 m (1 ft). Maps showing the roadway widths and the total number of travel lanes are shown in Fig. 8 with focus on Paradise, and in Fig. 9 showing the greater fire area. These maps highlight the different widths and capacities of each roadway. The lines vary in thickness based on the nominal roadway width, colors indicate the total number of travel lanes, and black edges indicate the paved shoulder width.

Three state highways pass through the region. CA Highway 70 provides access to Concow via Concow Road. The highway is two lanes north of Clark Road except for a wider four lane segment up the hill between Lake Oroville and Concow Road. While the two-lane highway continues to the northeast up the Feather River Canyon, this section of highway is remote (nearly 100 km [62 mi] to substantial population) and was closed due to the fire and therefore was not a major evacuation route during the Camp Fire. To the south, the highway connects to the city of Oroville, just off Fig. 7a, with two lanes in each direction.

CA Highway 99 is the main north-south route through the city of Chico and directly intersects with two routes into Paradise: Skyway and Neal Road. While CA Highway 99 is a divided highway with two lanes in each direction between CA Highway 70 and Chico, it narrows to two lanes total both north of Chico and south of CA Highway 70, just off the map in Fig. 7a and seen in Fig. 9. CA Highway 149 is a short connector between CA Highway 99 and CA Highway 70.

CA Highway 32, located west of Paradise and passing through Chico, has no direct connection to Paradise. While providing an evacuation route for several communities west and north of Paradise, CA Highway 32 does not have significant focus in this report. Magalia or Paradise residents who were able to evacuate to the north on Skyway likely made their way over to CA Highway 32, although this is a long backroads route. There are limited services to the north on both Skyway and CA Highway 32. Limited data was available to reliably establish the number of civilians who utilized this route, although it was the only remaining option when fire closed the route through Paradise.

With the exception of CA Highway 99 south to CA Highway 70 through Oroville, there are no high-capacity roadways connecting the greater Chico region to areas beyond. Interstate 5 is located approximately 32 km (20 mi) to the west, accessed via two-lane roads.

The smaller rural community of Concow is located in a topographic bowl east of Paradise. A single access/egress route is available via Concow Road, with connection to CA Highway 70 a driving distance of 9.6 km (6 mi) to the south. Concow Road is a winding two-lane road with no shoulder and a nominal total width of 6.7 m (22 ft). Some sections of the road are narrower, and the perceived width is often smaller without a shoulder and due to several blind curves and hills. A detail of the main populated area of Concow around Camelot Lane is shown in Fig. 7b.

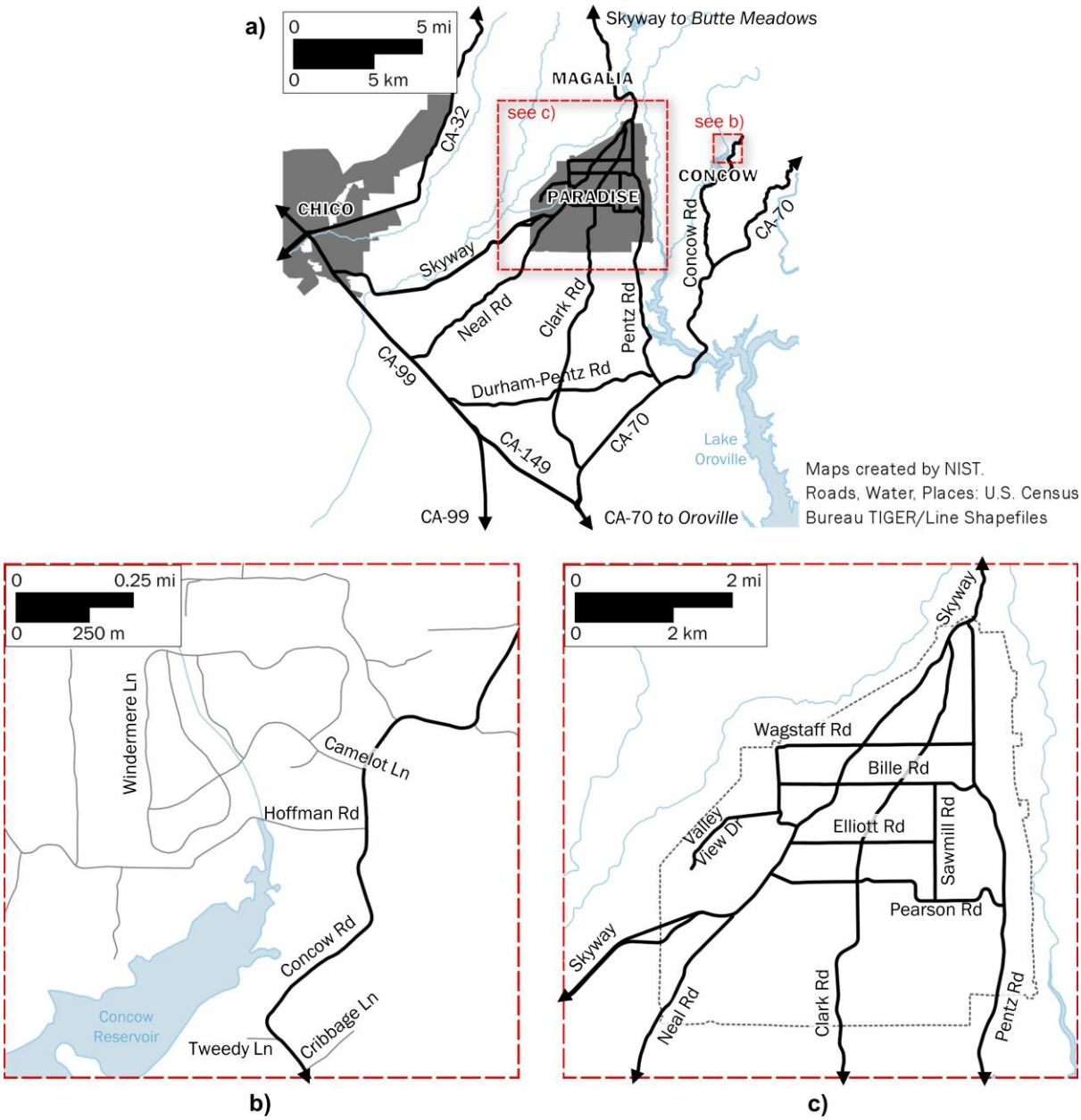


Fig. 7. Primary roadways, a) in Paradise and surroundings, b) detail of Concow, c) detail of Paradise.

Paradise is characterized by its triangular shape with four access/egress routes to the south and one to the north. Within the town limits, there are three primary north-south arteries and four east-west arteries. A map of the primary roadways in Paradise is shown in Fig. 7c.

The primary access to Paradise is via Skyway, the major roadway connecting to CA Highway 99 and Chico. Between Chico and Paradise, Skyway is a divided highway with two travel lanes in each direction. Much of Skyway within the commercial area of Paradise, from the southwest town limits to Bille Road is 5 lanes wide (~18.8 m [62 ft]), including a center turn lane. In the more residential area north of Bille Road, Skyway narrows to two lanes with limited shoulder space except for a 3 km (1.8 mi) segment through the town of Magalia.

Clark Road (maintained by the state as CA Highway 191 [CA-191] south of Paradise) provides a second primary access to Paradise. While only one lane in each direction, there is a more substantial shoulder and a more moderate grade than on Neal Road and Pentz Road. Within Paradise, Clark Road is typically 5 lanes wide through commercial areas of town south of Wagstaff Road. North of Wagstaff Road, Clark Road connects with Skyway via a narrower two-lane segment through intermix (forested) residential areas.

Neal Road and Pentz Road are secondary routes serving Paradise. These two-lane roadways are narrower than Clark Road, and a significant segment of Neal Road has no shoulder. Within Paradise, both roads traverse primarily residential areas and have no shoulder.

The four east-west cross streets are Wagstaff Road, Bille Road, Elliott Road, and Pearson Road. Each of these roads are two lanes and traverse primarily residential areas of town. The exception is Pearson Road between Clark Road and Skyway, which is wider. Elliott Road does not connect all the way across town.

Magalia is accessed through Paradise with connection via Skyway. While Skyway continues north of Magalia and was paved in 2013, this route is remote, the roadway is often narrow and winding, and there are limited services for long distances in this direction. The trip from Magalia to Chico via Skyway, Humboldt Road, and CA Highway 32 is 90 km (56 mi). The trip is 27 km (17 mi) via Skyway through Paradise.

The maps shown in Figs. 8 and 9 indicate the number of total marked travel lanes identified by the color, and the overall width of the roadway by the thickness. Figure 10 shows the number of lanes reasonably available for use by evacuating traffic. The main difference is the reduction of available lanes out of Concow, north of Paradise on Skyway, and on CA Highway 70, CA Highway 99, and CA Highway 32. Within Paradise, all lanes could be utilized for evacuation with feasible traffic control efforts, and therefore is the same as seen in Fig. 8. Data and roadway specifics are included in Appendix B. While examples of capacity reductions or expansions can be identified in both directions, brief discussion here is limited to reductions along the primary direction of travel during the Camp Fire. These transitions can be identified in Figs. 8, 9, and 10 where line thicknesses or colors change. Additional capacity reductions and congestion are encountered at merging at intersections.

A significant “pinch-point” can be identified on Skyway in the area between Elliott Road and Pearson Road, as indicated in Fig. 8 by the yellow and orange segments. In this downtown commercial area, the travel lanes were reduced to calm traffic and improve pedestrian safety. The five lanes between Bille Road and Elliott Road reduce to three lanes with parallel parking along the wide shoulders between Elliott Road and Pearson Road. However, as will be discussed in Sec.7, Evacuation and Traffic Flow, this was not a significant contributing factor in the evacuation process. Further south on Skyway near the town limits, five lanes split into the divided highway segment with a total of four lanes leading to Chico. Additional merging and traffic control is encountered at the bottom of the hill approaching CA Highway 99 and Chico.

Clark Road also has a significant restriction headed southbound from Pearson Road, where five lanes reduce to two lanes and additional merging occurs with traffic from Pearson Road. Pearson Road west of Clark Road is three lanes and wide shoulders, with a paved width similar to the five-lane Clark Road or Skyway. However, a traffic island divides the roadway near Black Olive Drive and briefly reduces the paved width. While still wide enough for four lanes, there are only two marked lanes, one in each direction.

Table 3. Egress routes and primary road arteries leaving Paradise.

Roadway	Total Lanes[a]	Pavement Width, m (ft)	Notes
Skyway (SB)	4	2× 8.5 (28)	Divided roadway, 2 lanes inbound, 2 lanes outbound. Leads through Chico and CA-99.
Clark Road	2	9 to 12 (30 to 40)	Leads to CA-70.
Pentz Road	2	10 (33)	Leads to CA-70.
Neal Road	2	5.8 to 9.4 (19 to 31)	Leads to CA-99.
Skyway (NB)	2	5.5 to 9 (18 to 30)	Leads through Magalia to CA-32 near Butte Meadows (56 km [35 mi]).

Note: SB – southbound, NB – northbound
[a] Total number of lanes in both travel directions.

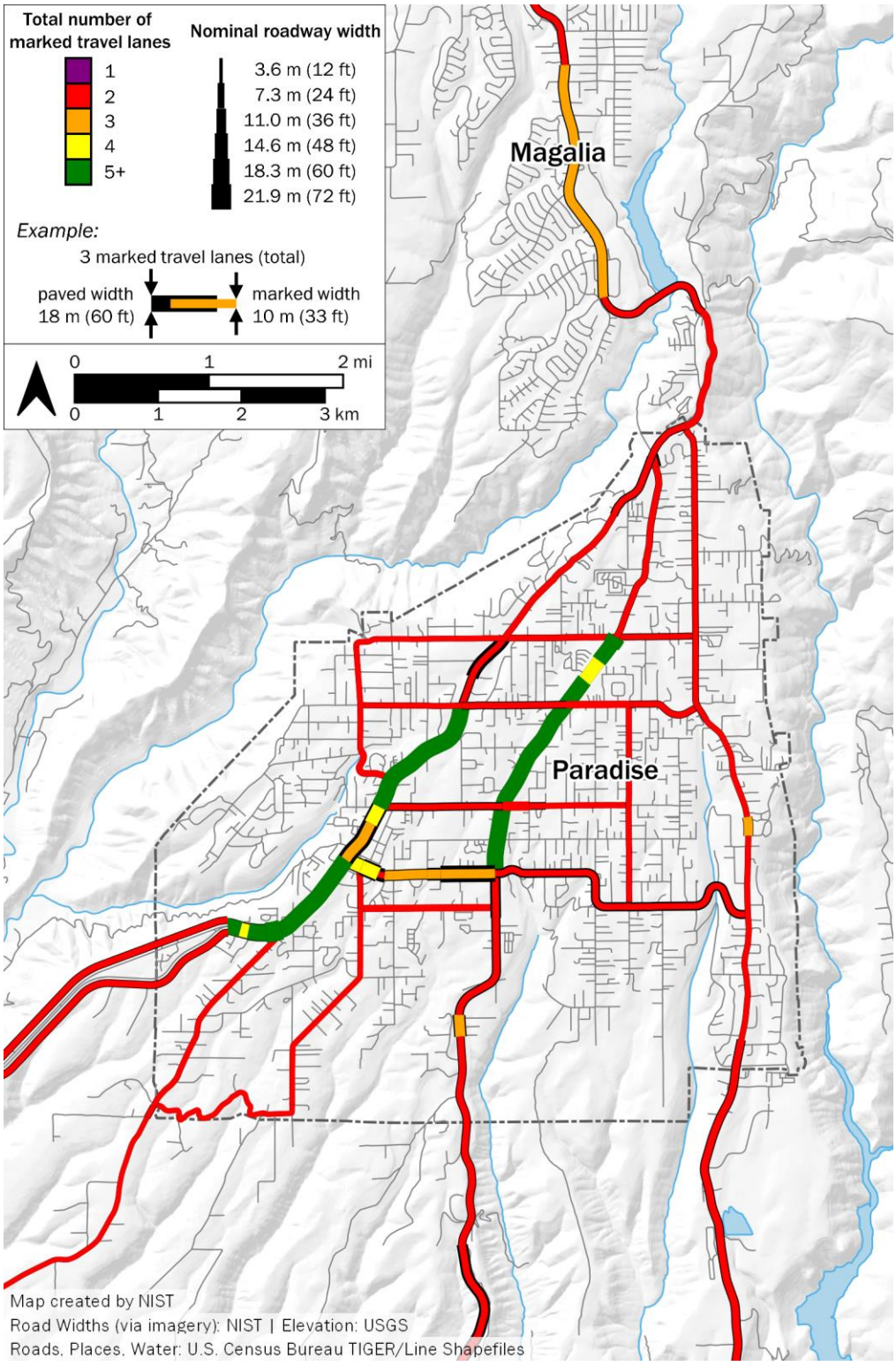


Fig. 8. Total number of travel lanes and lane widths of primary egress arteries and roadways in Paradise.

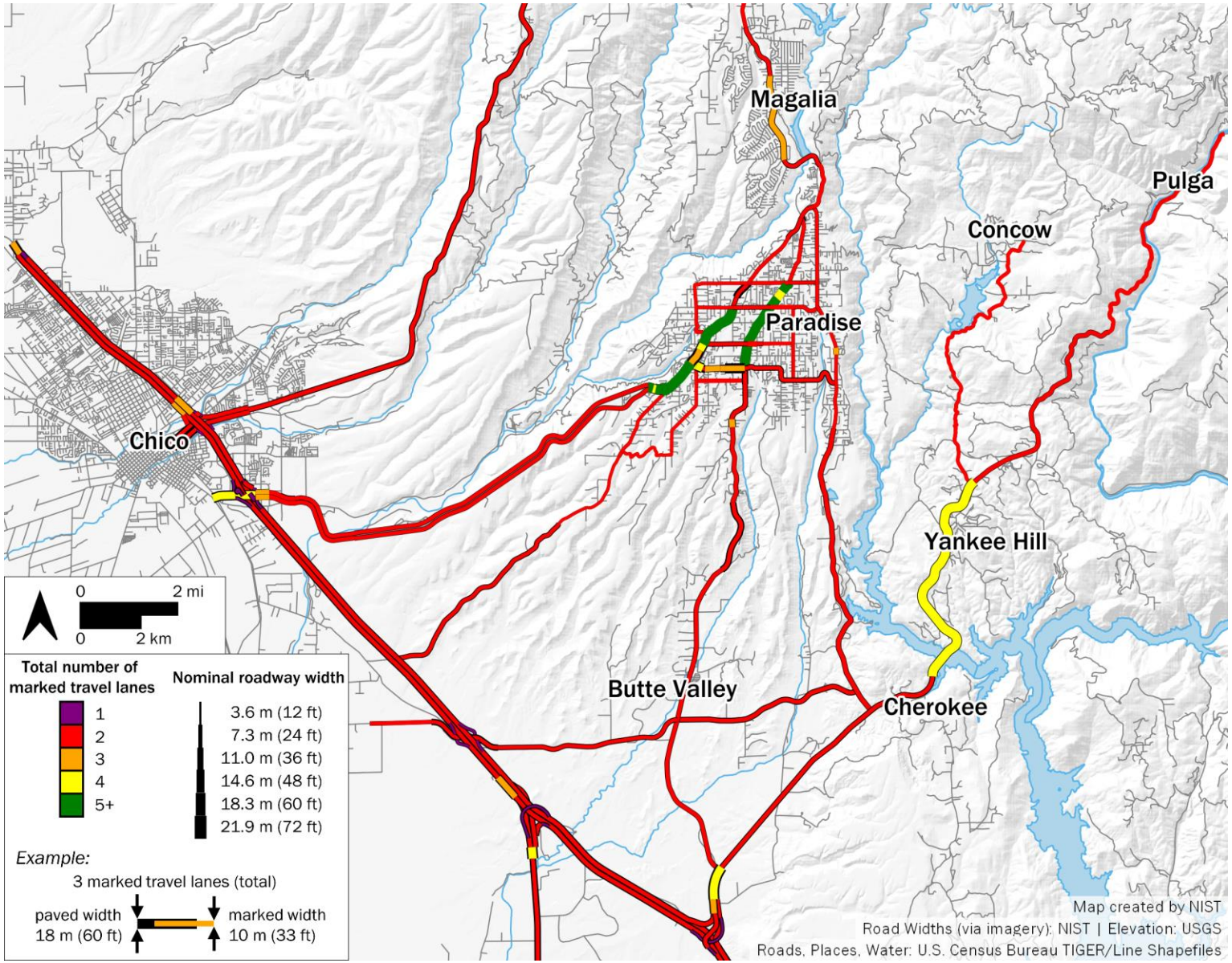


Fig. 9. Total number of travel lanes and lane widths of primary egress arteries and roadways in the Paradise region.

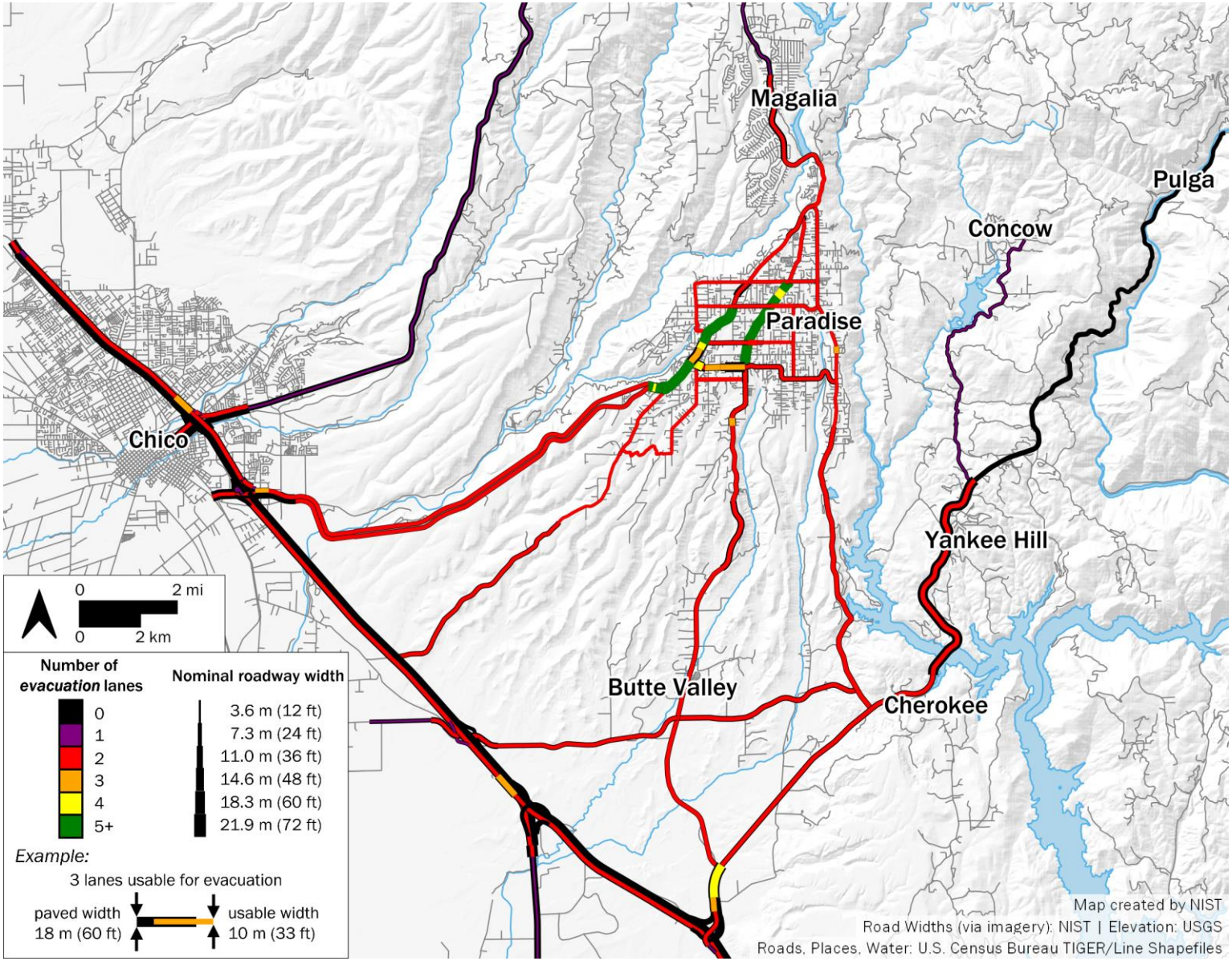


Fig. 10. Total number of travel lanes and lane widths of primary egress arteries and roadways *available for evacuation use* in the Paradise region.

Roadway capacity, roughly indicated by the number of total travel lanes, is examined in the context of population, approximated by the number of occupied housing units (OHU)[6] [34], in Table 4. The table highlights the ratio of the total number of OHU compared to the absolute maximum number of travel lanes. The maximum number of travel lanes accounts for the normal direction of flow plus the full implementation of contraflow lane reversals to allow outbound travel in all lanes and complete access to all existing egress routes. The ratio alone is not an explicit measure of road capacity; however, it does provide a relative sense of potential traffic build up and gridlock. The OHU/Egress Lane ratio for Concow is the smallest, at 164, indicating relatively lower overall potential for congestion, as fewer households use a common egress route. While the Concow ratio is the smallest of the three communities, this number does not reflect the potential limitations of the single egress artery.

In Paradise, the OHU/Egress Lane ratio is 927, over five times the ratio for Concow. This ratio is impacted by the much larger population of Paradise (over 35 times that of Concow), and the non-proportional increase in the number of available egress routes or egress lanes.

While Magalia has a lower population than Paradise, its location on the ridge above Paradise significantly reduces the number of available evacuation route options; one route to the north, and one route to the south, through Paradise. The four southern egress routes out of Paradise could ultimately be used by Magalia residents; however, the single route bottleneck connecting the two communities limits the potential throughput and becomes a significant vulnerability to the overall evacuation of Magalia. Therefore, the OHU/Egress Lane is 36 % higher than for Paradise, at 1264.

The relative impact of a single artery closure has disproportionate impacts on the three communities (e.g., 1/5 arteries in Paradise versus 1/1 artery in Concow). Several egress artery blockages occurred during the Camp Fire and are further discussed in Sec. 7.5.3. These blockages occurred in both Concow and Paradise and highlight that while the information presented in Table 4 may be useful for planning, the impact of fire on egress arteries can dramatically affect the number of available egress lanes during evacuations and needs to be accounted for in evacuation planning.

Table 4. Total population and egress lanes per community.

Location	Pop.	Area, km^2 (mi^2)	Pop. Density, p/km^2 (p/mi^2)	DINS Residential Struct. [35]	Occupied Housing Units (OHU) [34]	Max. Egress Routes	Max. Egress Lanes	OHU / Egress Lane
Paradise	26543	47.5 (18.3)	559 (1450)	12198	11118	5[a]	12	927
Magalia	12671	36.3 (14.0)	349 (905)	2753[b]	5054	2[a]	4	1264
Concow	743	72.0 (27.8)	10 (27)	429	327	1	2	164

[a] The only Paradise egress route to the north must travel through Magalia. The Magalia egress route to the south must travel through Paradise.

[b] Only the fire-impacted southern portion of Magalia was included in structure damage inspection data; the entire structure count is unavailable. Area was truncated at the extent of available data.

[6] The number of occupied housing units sourced from the 2014–2018 ACS 5-Year Data are provided to allow comparisons to the DINS damage inspection data since not all residential structures were necessarily accounted for, particularly in Magalia.

5. Evacuation and Notification Plans (Pre-fire)

Butte County had developed an evacuation plan tailored to the various communities in the county, including specific details for the Town of Paradise and the Upper Ridge area (unincorporated communities north of Paradise, the largest being Magalia). The Butte County Public Safety Agency Emergency Evacuation Plan [36] was in its fifth version in the year before the Camp Fire and included more than 200 professionally-written pages, compiling the plans for eight areas of the county most susceptible to wildland fires. The history of the evacuation plan dates to 1998 when the first modern iteration was developed for Paradise/Magalia. The Paradise/Upper Ridge evacuation plan was the most extensive and detailed portion. Copies of the evacuation plan had been distributed to over 100 emergency officials in more than a dozen agencies. The Town of Paradise also had an emergency notification framework and plan, which was activated and used during the Camp Fire.

5.1. Evacuation Plan

The evacuation plan contained two sets of information: (1) information that was distributed to citizens of the area and (2) more specific implementation and planning details for emergency responders. The plans for the communities surrounding Paradise were much simpler than those for the Town and the Upper Ridge; the populations of the surrounding communities are far smaller than Paradise and there are generally only one or two roads out of each area. These evacuation plans consisted primarily of a public information brochure containing the CAL FIRE "*Ready, Set, Go!*" wildfire evacuation preparation concept [37] along with a detailed map identifying the evacuation route. The maps identified routes not recommended for use in evacuations and locations of locked gates. The plans also included a limited number of pre-designated public assembly areas; locations relevant to the Camp Fire are further discussed in Sec. 5.2. The brochures and maps can be found in Appendix C.

The Paradise and Upper Ridge area plan had more comprehensive planning documentation for emergency officials, including a communications framework, traffic management plan, and a zoned evacuation design. It was acknowledged that the large population with the limited number of egress routes would result in gridlock if everyone attempted to leave town at the same time. Therefore, the town of Paradise was divided into 14 zones (plus 6 zones in the foothills) and the Upper Ridge into 13 zones, as shown in Fig. 11.

Multiple zones that can be evacuated individually or in groups is perhaps the only way to control evacuation but requires significant detailed planning. For example, the plans not only included the identification of evacuation routes, but also locations for flaggers and police officers. Additionally, the plan included the locations and quantities for resources such as barricades, cones, and directional signs, and contained provisions for the staging of tow trucks and other equipment for keeping the roadways open. These details were listed for independent evacuation scenarios for each of the 14 zones in Paradise. Additional specifications were documented for implementation of a northbound evacuation on Skyway to CA Highway 32 via Butte Meadows and Humboldt Road.

The Camp Fire incident highlights the complexities of maintaining and managing the notification/evacuation status of all 33 zones (plus extensive un-zoned area) throughout the entire chain of command. This points to the need for streamlined decision-making and communication

processes where all the emergency management participants are trained and proficient using the same zone layout and nomenclature. Following multiple large WUI fire incidents in Butte County since the Camp Fire, Butte County implemented new county-wide evacuation zones in March 2022, expanding on the existing zones that were present in Paradise and Magalia at the time of the Camp Fire. The updated zone maps can be synced with in-vehicle data systems [38].

One method used to increase egress capacity was to designate major roads in the town of Paradise as one-way during evacuation, specifically Skyway and Pentz Road, reversing the direction of the inbound lanes (also known as contraflow). This requires planning and communication for successful implementation. The contraflow plan did not, however, specifically address the need to move large numbers of emergency responders into town opposing the evacuating traffic.

The evacuation plan also had a few generalized sections for all community areas, including a road closure and re-entry/re-population framework, provisions for special needs individuals, and information on dealing with pets. The first responder plan indicated that the Special Needs Awareness Program (SNAP) through the Butte County In Home Support Services (IHSS) program provided dispatch with a list of individuals who may need help evacuating, updated quarterly.

The successful implementation of an evacuation plan depends in large part on pre-planning, by emergency officials and the public alike, and effective public notification at the time of the event. The principal planning document for the public was a color brochure mailing that promoted the CAL FIRE “Ready, Set, Go!” wildfire evacuation preparation concept [37]. The *Get Ready* portion of the plan describes creating a family evacuation plan and the things one should have on hand in case a rapid evacuation is necessary. The *Get Set* portion of the plan provides a checklist of things to do as the fire approaches. This includes things to do inside and outside the house before leaving, and reminders about evacuation routes and personal belongings to take. The *Go!* section has information on what to do as one evacuates and what to do if trapped in a vehicle, on foot, or in a home. Information was also included about the potential use of one-way contraflow evacuation traffic operations that may be implemented to expedite the process if needed. Plans and maps of the evacuation zones and routes were distributed to residents via residential mailings as recently as April 2018, 6 months before the Camp Fire.

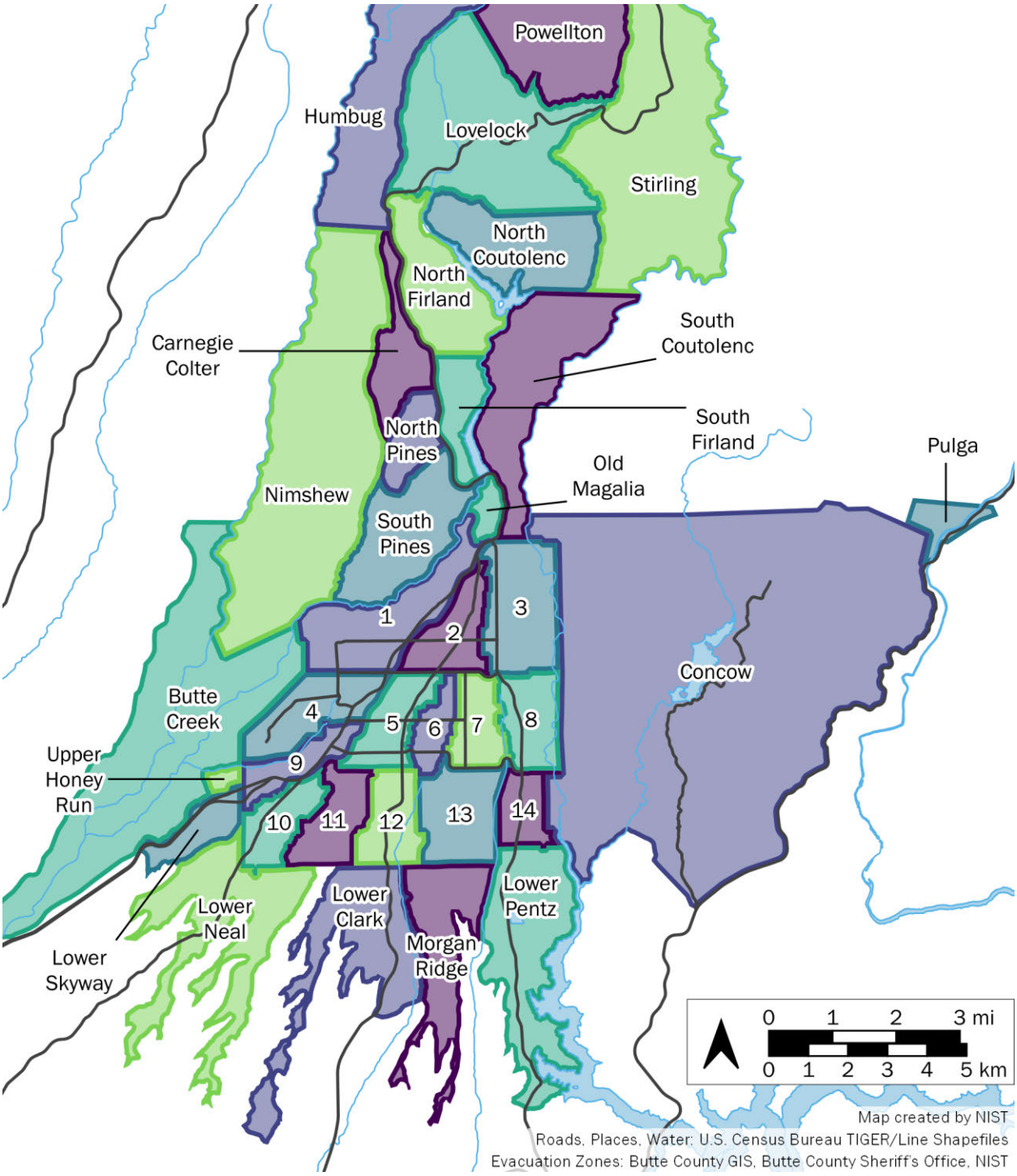


Fig. 11. Paradise and Upper Ridge evacuation zones defined in the Butte County Evacuation Plan. Zone areas for Pulga, Concow, and Butte Creek were adapted from BCSO post-fire zones.

In reviewing the evacuation of the three communities impacted by the Camp Fire, the population of the communities was considered with respect to the number of egress arteries and lanes in order to characterize egress loads and provide context for different evacuation scenarios. Table 5 illustrates the egress load of three different hypothetical evacuation scenarios of multiple Paradise zones. These hypothetical scenarios have been simplified to assume traffic control will prioritize evacuation travel through other non-evacuating zones and do not account for background traffic. The values of the OHU/Egress Lane ratios, ranging from 187 to 316, can be compared to the ratio of 927 for all of Paradise presented in Table 4.

Table 5. Egress capacity for evacuation of selected zones in Paradise via southbound routes only.

Selected Zones/Subregion	DINS Residential Struct. [35]	Potential Egress Routes	Potential Egress Lanes	OHU / Egress Lane
Zones 3, 8, 14	2210	4	7	316
(Pentz Road corridor)		*Pentz Rd*	*(2)*	
		Clark Rd	*(2)*	
		Skyway	*(2)*	
		Neal Rd	*(1)*	
Zones 10, 11, Lower Neal	1391	3	5	278
(southeast Paradise)		*Neal Rd*	*(1)*	
		Skyway	*(2)*	
		Clark Rd	*(2)*	
Valley View and Valley Ridge	560	2	3	187
(part of Zone 4)		*Valley View Dr*	*(2)*	
		Elliott Rd	*(1)*	

Table 6 shows the maximum number of egress routes and lanes used during the Camp Fire evacuation. The table includes number of egress routes and lanes per community and/or subregion within the Camp Fire area. Concow, Magalia, and Paradise are tabulated individually. The last two rows of Table 6 show the cumulative impact of common egress arteries serving multiple communities and the bottleneck that can form many miles away from the initiation of the evacuation. The reduced number of lanes south of Paradise merging into CA Highways 99 and 70 raises the OHU/Egress Lane ratio to over 2500, in stark contrast to the values presented in Table 5 describing partial Paradise evacuation scenarios (e.g., 316 OHU/Egress Lane for Zones 3, 8, 14).

The values in Tables 4 through 6 do not include any reductions of lanes caused by fire or obstructions. Table 6 does not include travel through Chico or account for additional evacuating traffic inflow to CA Highway 70 from Concow and Yankee Hill.[7]

[7] The Concow population is relatively small, and evacuations occurred before the major evacuation traffic built up into Chico. Yankee Hill was not ordered to evacuate until much later in the day.

The comparisons of OHU/Egress Lane values in Tables 4 through 6 highlight the potential value of a nested evacuation assessment for communities. Such an assessment can look at partial or complete community evacuations, as well as the regional impacts of high-volume evacuations. The regional impacts of such evacuations may not become apparent from only partial/zoned evacuation analysis.

Table 6. Maximum number of egress routes and lanes used during the Camp Fire evacuation per community and/or subregion.

Selected Subregion	Occupied Housing Units (OHU) [34]	Egress Routes	Total Lanes Used[a]	OHU / Egress Lane
Concow	327	1 *Concow Rd*	1	327
Magalia	5054	2 *Skyway (NB)* *Skyway (SB)*	2	2527
Paradise	11118	4 *Skyway (SB)* *Clark Rd* *Neal Rd* *Pentz Rd*	7 *(4)* *(1)* *(1)* *(1)*	1588
Paradise and Magalia	16172	5 *Skyway (SB)* *Clark Rd* *Neal Rd* *Pentz Rd* *Skyway (NB)*	8 *(4)* *(1)* *(1)* *(1)* *(1)*	2022
Paradise, Magalia, Butte Valley, and Butte Creek merging into highways south of Paradise	17700[b]	3[c] *Skyway (SB)* *CA-99 (SB)* *CA-70 (SB)*	6 or 7 *(2 or 3)* *(2)* *(2)*	2950 or 2529

[a] Number of lanes used during Camp Fire evacuation accounting for contraflow and open lanes for first responder access and other local conditions.
[b] estimated via OHU and DINS from foothills north of CA-70 and Butte Creek.
[c] majority of civilians evacuating Paradise evacuated south; northern route was blocked by fire early

5.2. Pre-planned Safety Zones and Public Assembly Points

The evacuation plans included a number of pre-designated locations as meeting areas or public assembly points (PAP). These locations were included on the evacuation maps included in the documents and brochures that were periodically mailed and distributed to residents (Appendix C). A listing of PAPs relevant to the Camp Fire is provided in Table 7 including the vehicle or person capacity as listed in the evacuation plan. A description of the site is also provided in the table.

Several of these locations were used during the Camp Fire for various purposes. These include firefighter and first responder staging areas, incident command posts, and temporary refuge areas (TRA) used by both first responders and civilians. The identifiers used in Table 7, e.g., *TRA-A*, indicate a specific PAP was used as a TRA during the Camp Fire. The reader is directed to Sec. 9 for detailed presentation and discussion of TRAs and safety zones.

Table 7. List of pre-designated Public Assembly Points in the Butte County Evacuation Plan.

ID[a]	Name[a]	Description	Capacity[a]		Use During Camp Fire
			Vehicles	People	
Pulga, Concow, Yankee Hill					
1	Shady Rest Area	Widened highway shoulder along river	15	30	No data (inaccessible, outside fire area)
2	Flea Valley	0.8 ha (2 ac) cleared dirt area surrounded by shrubs; via dirt road on ridge above Concow	50	200	No data (inaccessible, inside fire area)
3	Caltrans Pulga Maintenance Yard	Paved area of highway maintenance facility and expanded highway shoulder	50	100	No data (inaccessible, outside fire area)
4	Camelot Meadow Wild Fire Safety Zone	3.3 ha (8 ac) field surrounded by trees and shrubs	400	500	**TRA-A**
5	Crain Memorial Park Wild Fire Safety Zone	0.8 ha (2 ac) field with a gravel parking area, surrounded by trees and shrubs	100	200	No data
6	Concow School Wild Fire Safety Zone	0.8 ha (2 ac) area of small, paved parking lot and athletic field	200	500	FF staging
7	Seventh-Day Adventist Church	0.1 ha (0.25 ac) paved parking lot surrounded by trees and veg.	50	100	No data
8	Pines Yankee Hill Hardware Wild Fire Safety Zone	0.6 ha (1.5 ac) gravel lot	100	200	ICP and FF staging
9	Dome Store (Canyon Lakes Market)	0.26 ha (0.6 ac gravel lot) plus expanded highway shoulder nearby	100	200	FF staging
10	Spring Valley School	0.25 ha (0.6 ac) paved parking area	100	300	FF staging
Paradise					
A	Paradise Alliance Church	Large, paved parking lot	500[b]		**TRA-V**
B	Paradise Auditorium/Senior Center	Large, paved parking lot	250[b]		No data
Upper Ridge (Magalia)					
A	Pine Ridge School	Paved parking lot and school grounds	125[b]		**TRA-DD**
B	Paradise Pines Property Owners' Association	Paved parking lot surrounded by trees, shrubs, nearby structures	150[b]		No data
C	Magalia Community Church	0.5 ha (1.3 ac) gravel parking lot	150[b]		**TRA-U**
D	Old Mill Site/Stirling City	1.3 ha (3 ac) clearing surrounded by trees	250[b]		No data (outside fire area)
Butte Creek Canyon					
	Honey Run Bridge Park	0.1 ha (0.25 ac) gravel parking area within tree covered park	25[b]		No data
Butte Valley					
	Earthwork Soil Factory	Gravel lot surrounding commercial building	100[b]		No data

[a] As listed in the Butte County Evacuation Plan [36].
[b] Approximate number of marked parking spaces or capacity estimated by NIST.

5.3. Notification Plan

Communications for emergency notification were routed from the incident commander to the Butte County Fire Emergency Command Center, then to law enforcement and community agencies. Several notification tools and methods were available to Butte County and the impacted communities (Sec. 6.1).

The Town of Paradise had an established Emergency Operations Plan (EOP) [39] that was developed with support from a FEMA grant and input from the Butte County Office of Emergency Management and the California Emergency Management Agency. The plan was consistent with both the California Standardized Emergency Management Systems (SEMS) and the National Incident Management System (NIMS). As described in the document, the primary accomplishments of the plan were as follows. The plan:

- Establishes the emergency management organization required to mitigate any significant emergency or disaster affecting the Town of Paradise.
- Identifies the roles and responsibilities required to protect the health and safety of Paradise residents, public and private property and the environmental effects of natural and technological emergencies and disasters.
- Establishes the operational concepts associated with a field response to emergencies, the Town of Paradise Emergency Operations Center (EOC) activities and the recovery process.

The established EOC worked with participating agencies to disseminate the necessary notifications. Town employees were trained and prepared for implementation of the EOP, specifically including Paradise Public Works. Training related to WUI fire incidents included basic fire behavior training (similar to NWCG S-190 Introduction to Wildland Fire Behavior).

5.3.1. Emergency Notification Workflow

Workflows to provide emergency notifications to the public are not standardized across the nation and typically involve multiple agencies and jurisdictions. Emergency notifications regarding evacuation are typically classified as orders and warnings [40]. Evacuation orders are intended to inform the public that they need to leave the area immediately. Depending on the jurisdiction, certain law enforcement agencies may have authority to issue mandatory evacuation orders. Warnings are intended to inform the public of the potential of an impending evacuation order and may encourage voluntary evacuation actions, including for those who require more time to evacuate (e.g., for reasons including mobility and health limitations and animal considerations).

A generalized workflow showing the pathway from fire ignition to public notification and subsequent evacuation is shown in Fig. 12. This emergency notification workflow is only one component of the WUI required safe egress time (WRSET) [19] and the overall incident timeline from ignition to evacuation and fire containment. Note that the actual evacuation decision-

making by the public [41-44] and subsequent movement processes [19, 20] are complex, simplistically represented in this diagram, and beyond the scope of this report.

After a fire ignition and the initial response dispatch, the arriving fire department resources assess the situation and establish the incident command. The Incident Commander (IC) determines what evacuations are necessary (warnings/orders) and then must disseminate this request to the relevant participating authorities and impacted communities. There are many potential pathways through this step. Different pathways and procedures may or may not enhance overall communication efficiency depending on authority structure and differences in jurisdiction, situational awareness (i.e., different information streams from fire engines, law enforcement officers, and 911 calls), and specialized knowledge (e.g., fire behavior; notification systems and procedures; and evacuation requirements, authorities, and procedures). Evacuation requests are passed along to first responders in the field to execute the orders. Depending on the authority structure, jurisdiction, and available tools, agencies may issue public mass notifications to alert the population. The IC uses continuous feedback from the progression of the incident to adapt their decision-making, reevaluating evacuation orders and firefighting activities as necessary.

Meanwhile, additional information sources will likely influence an individual citizen's evacuation decisions, such as environmental cues from the fire itself or other notifications from family, neighbors, friends, or the media [16, 45]. This information may shortcut the official notification channels depending on the event timeline. Grajdura et al. [45] conducted a survey of evacuees (397 individuals) in the weeks after the Camp Fire and found that many evacuees became aware of the fire firsthand through observation of flames, embers, or smoke. Many had begun evacuating before receiving official notifications, if they received them at all.

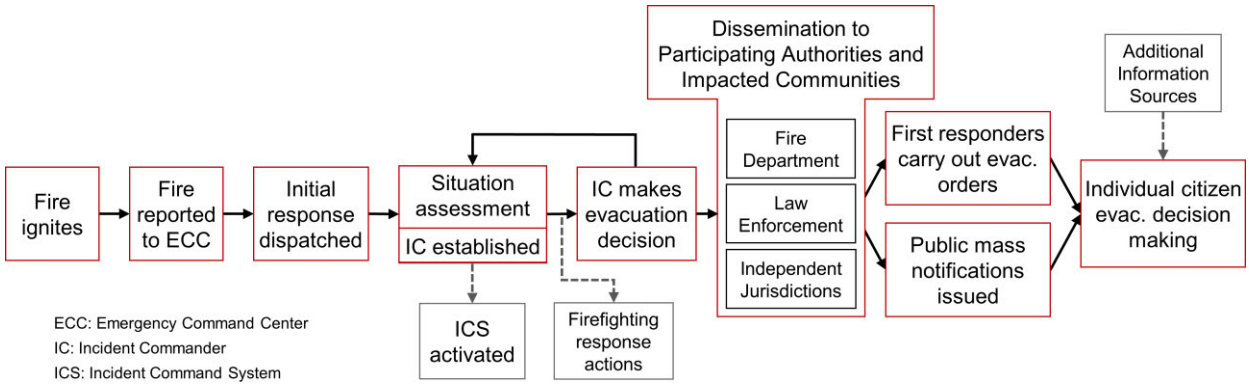


Fig. 12. Generalized flowchart of notification/evacuation information routing.

All of these steps in the communication process take time, ultimately causing a delay in the time that the public receives critical information. Various agencies working in series to communicate the different evacuation and notification requests present more opportunities for miscommunication and delays to develop. An established and practiced communication, authority, and workflow can reduce this delay and enhance efficiency.

As the responding fire department during the Camp Fire, CAL FIRE established the incident command. As will be described in later sections, the first arriving engine requested immediate evacuations for the community of Pulga via the Butte County Fire Emergency Command Center (ECC), who shared this information with the BCSO. As the complexity of the incident rapidly increased, the incident commander position was transitioned from the arriving engine to a dedicated command staff via the ICS. Additional evacuations were requested by the IC as conditions became known. Section 6.2 highlights the evacuation warnings and orders that were requested at the beginning of the Camp Fire, between 06:55 and 09:03 on November 8.

The workflow was complicated by multiple emergency communication hubs, two interconnected reverse-911 (CodeRED) systems, three different 911 systems (Butte County, Paradise, and Chico), and the shutdown of the Town of Paradise 911 system when PPD headquarters was threatened by fire and had to evacuate on the morning of November 8.

5.3.2. Interagency Coordination for Notification and Evacuation

In the case of the Camp Fire, there were multiple jurisdictions involved in the notification process, including Butte County and the Town of Paradise. The notifications and evacuations required the coordination of many different departments including but not limited to: CAL FIRE, BCSO, Town of Paradise (Town Hall, Department of Public Works), Paradise PD (dispatch, officers, and volunteers), Paradise EOC, Butte ECC, Chico PD, Caltrans, B-Line (Butte Regional Transit public transportation), California Highway Patrol, and other agencies/organizations. To expedite communications between the fire department IC and BCSO, a Sheriff's Office representative was on location with the IC beginning at approximately 08:00. Radio logs indicate rapid information exchange among the IC, ECC, and BCSO.

The evacuation notification and coordination process benefited extensively from a previous fire/evacuation training exercise (Sec. 5.4). This exercise, which involved many of the above listed agencies, helped not only to build "muscle memory," wherein training and repetition reduce the conscious effort required to perform a task, but also to identify potential communication challenges [TD-042].

5.4. Preparedness and WUI Fire Response Training Exercise

The Paradise area was identified and used in a training simulation by first responders to run various WUI fire response drills among local and state officials. A comprehensive multi-agency WUI fire response exercise, led by the local CAL FIRE Butte Unit, was conducted in 2016. While wildland fire trainings and drills are often held regularly within individual departments and occasionally with outside collaboration, the magnitude of the 2016 exercise was unique. Participants included local Paradise, Butte County, and state first responders and public works, as well as regional mutual aid departments. Four objectives were successfully executed during the drill:

1. One-way southbound traffic (contraflow) was implemented on Skyway between Elliott Road and Pearson Road between 07:00 and 08:00.
2. A WUI fire exercise of a simulated fire scenario was conducted in the area of Neal Road, including actual dispatch of fire equipment (engines, hand crews, dozers, and aircraft) and a dynamic incident escalation.

3. The Town of Paradise Emergency Operations Center was activated.
4. A simulated activation of one-way southbound traffic on Pentz Road from Pearson Road to CA Highway 70 was conducted.

While the simulated fire scenario was not similar to the Camp Fire, it was reminiscent of the 2008 Humboldt Fire, which burned eastward across the foothills south of and into Paradise. The fire caused the closure of Skyway, Neal Road, and Clark Road south of Paradise, leaving Pentz Road the only route out of Paradise. Several lessons were learned from the Humboldt Fire in 2008, including the need for one-way egress provisions and the utilization of zoned evacuation to reduce/manage congestion. The public information brochure and evacuation plan mailings were developed as a result.

Including the contraflow traffic implementation in the exercise developed the "muscle memory" of the Paradise Public Works and Police Department and provided direct experience for what was needed to implement the traffic control [TD-042]. While only a relatively small number of residents directly experienced the one-way traffic implementation on Skyway, the advertisement of the drill and the public information sharing about the potential implementation in an emergency incident increased public awareness.

5.5. Summary

Paradise and Butte County had developed an evacuation plan that was communicated to multiple first responder organizations. In planning for a response to a large scale WUI incident, a multiagency training exercise involving over 100 first responders was conducted in Paradise in 2016. While the simulated fire scenario was not similar to the Camp Fire, it was reminiscent of the 2008 Humboldt Fire, which burned eastward across the foothills south of and into Paradise. The 2008 fire caused the closure of Skyway, Neal Road, and Clark Road south of Paradise, leaving Pentz Road the only route out of Paradise. Several lessons were learned from the Humboldt Fire, including the need for one-way egress provisions and the utilization of zoned evacuation to reduce/manage congestion. The public information brochure and evacuation plan mailings were developed as a result.

The evacuation plan for Paradise was the most developed component of the Butte County pre-fire evacuation procedures. The Paradise plan included details related to evacuation zones, evacuation routes, traffic direction, contraflow traffic implementation, and first responder communications. The plan was developed and coordinated with multiple regional first responder agencies and organizations.

The inclusion of contraflow traffic in the 2016 training exercise developed the "muscle memory" of the Paradise Public Works and Police Department, making the implementation of the evacuation plan more efficient and effective. The training exercise provided direct experience for what was needed to implement the traffic control plan in Paradise. While only a relatively small number of residents directly experienced the one-way traffic implementation during the exercise on Skyway, the advertisement of the drill and the public information sharing about the potential implementation in an emergency incident increased public awareness.

5.6. Technical Findings

TF-EP 1. An evacuation plan, developed with input from previous fires and from training exercises, was in place and communicated to first responders and the community before the incident.

TF-EP 2. The evacuation plan included coordination among multiple regional first responder agencies (fire departments, law enforcement, and public works).

TF-EP 3. The Paradise evacuation plan was conceived and designed for a zoned/partial evacuation; it was not designed for a complete simultaneous evacuation of the town.

TF-EP 4. There is a need for streamlined decision-making and communication processes where all the emergency management participants are trained and proficient using the same evacuation zone layout and nomenclature.

TF-EP 5. Including an evacuation component in the 2016 WUI fire training exercise built "muscle memory" of first responders for integrating evacuation into the response component of WUI fire incidents.

TF-EP 6. The 2016 training exercise was used to practice key evacuation elements, including traffic contraflow on Skyway. This served as direct experience to Paradise Public Works and Police Department.

5.7. Recommendations

In planning for WUI fire evacuations, communities should consider:

R-EP 1. Developing an evacuation plan in collaboration with nearby first responder organizations/agencies.

R-EP 2. Creating a realistic training exercise that includes fire, rescue, evacuation, and traffic components.

R-EP 3. Practicing training exercises with collaborating fire, law enforcement, emergency medical services, and public works agencies.

R-EP 4. Revising the evacuation plan based on lessons learned from training exercises and other WUI fires.

6. Emergency Notifications

After establishing the fire progression timeline, it is possible to examine the notifications and evacuations within the appropriate context. A timeline of evacuation notifications was developed based on the integration of data primarily from TDs with the incident command, radio logs, 911 call recordings, and records of reverse-911 notifications. Due to the rapid development and spread of the fire in this incident, evacuation orders were the primary official messaging regarding the fire.

As described in Sec. 5.3.1, evacuation orders flowed from the IC through the law enforcement agencies for extended notifications to the public. First responders in the field began immediate execution of the evacuation requests through direct contact with residents. While the time of an emergency alert or evacuation request does not mean the notification was received by the community at that time, it does provide the foundational timeline based on the evolving situational awareness of the IC. Section 6.1 discusses the various notification tools and methods that were used to alert the public of the fire and of the evacuation orders requested by the IC.

The timeline narrative presented in Sec. 6.2 first focuses on the progression of evacuation orders and warnings as they were requested by the incident commander. Evacuation orders requested by the IC do not result in instantaneous notification or departure of civilians. In the case of the Camp Fire, evacuation order requests went from the IC to the ECC, then out to BCSO and other law enforcement agencies responsible for executing evacuations. After that, the message must reach civilians before they decide how to respond to that message and hopefully proceed to evacuate out of the high-risk areas. Additional summaries of the notification timeline are presented in Sec. 6.3 to further analyze the notifications with the context of fire progression.

An in-depth look at the evacuation decision timeline of the IC and how it compares to the fire timeline highlights the temporal component of information transfer as it relates to situational awareness during WUI fire incidents. While a certain amount of “data lag” is known and expected by the IC, the information presented in this section can provide insight into the notification event timeline for incidents with rapid fire spread and complexity changes.

Evacuation zones referred to in this section are those identified in the Butte County evacuation plan and mapped in Fig. 11. Some areas outside of the designated zones were defined based on geographic boundary descriptions and evacuation zones defined by the county after the incident and were interpreted for this case study and analysis.

Based on the nature of the data collection and study approach, the notification timeline from the civilian perspective was beyond the scope of this report which focuses on the relationship between fire progression and IC actions.

6.1. Notification Tools and Methods Used

Various communications tools, systems, and methods were implemented to notify civilians of the fire and the evacuation orders. The utility and success of particular notification tools depends on the fire spread/notification timeline, tool availability, and synergy of multiple tools. The message content itself is also important as it influences the public reception and decision-making [18, 46]. No single notification method will reach every person, and combinations of different tools are necessary to improve the reach and timeliness of alerts. All notifications were impacted by the lack of emergency alert sirens which may increase situational awareness across the community

and engage civilians to actively seek additional information [17]. Emergency notification methods employed during the Camp Fire include:

- Door-to-door notification
- Announcements via vehicle-mounted speakers
- CodeRED reverse-911 call system
- Social media
- Other methods

Discussion of each of these methods follow. Some tools/methods that have been used in other communities during WUI fires and other disasters were not available or implemented during the Camp Fire, including mass notification alerting sirens,[8] local AM radio emergency stations, and the Integrated Public Alert and Warning System (IPAWS) and Wireless Emergency Alerts (WEA). Analysis of why certain methods were used or not used, decision-making processes by the public after receipt of notification, and effectiveness of notifications would require a specific in-depth study which is beyond the scope of this report.

6.1.1. Door-to-door Notification

While a basic notification method, door-to-door notification can be very effective, allowing for in-person communication with first responders. However, it is time and resource intensive. This method can be implemented immediately by first responders (both law enforcement and fire department) in the field, as was the case in Pulga, Concow, and eastern Paradise in the first hours of the event.

Several first responders reported resistance to evacuate. In one example, a first responder [TD-112] knocked on their neighbor's door and advised them to evacuate. The civilian neighbor initially disagreed about the information, despite being told by their neighbor who was a first responder. Eventually the first responder was able to convince their neighbor to evacuate. In some cases, people may be reluctant to evacuate based on information received from other methods, including official channels. A door-to-door notification may provide additional information desired by the civilian to evacuate, as in this example. These types of human psychology, behavior, and warning response are beyond the scope of this report.

Civilians also provided door-to-door notifications to neighbors in several instances, including cases where neighbors were elderly or had medical or mobility limitations. There was anecdotal information regarding civilians being specifically concerned about their neighbors and whether they were awake or would be unlikely to receive a different type of notification.

[8] The Town of Paradise is now in the process of installing a siren system based on lessons learned from the Camp Fire.

6.1.2. Vehicle-Mounted Public Address System

Slightly less intensive than door-to-door notifications, the use of vehicle-mounted speakers can be used while driving along the street. Both law enforcement and fire personnel used their vehicle PA systems to alert residents. While it may not always be possible to include detailed information, the noise and initial alert can make people aware something is going on.

6.1.3. Reverse-911 (CodeRED)

Reverse-911 is a mass notification capability to call all registered phone numbers (cellphone or landline) with a recorded message. Butte County and the Town of Paradise both contracted with a service called CodeRED beginning about one year prior to the fire. This service also had the capability to send text messages and/or emails to registered contacts. The service was opt-in, meaning civilians had to register their contact information with the CodeRED database to receive notifications. The Town of Paradise and Butte County Fire Safe Council had advertised the notification alert service to residents; however, information regarding the number of people who registered for the service was not available. In general, less than 40% of Paradise residents had signed up for the alerts [27].

From 07:57 to 09:30, 8 batches of calls were placed by the BCSO CodeRED system to provide evacuation orders or warnings to zones in Paradise and Magalia. Two of these batches were re-calls to numbers that were not reached during the first attempt. According to system data reports, 28 162 calls were attempted to 14 737 registered phone numbers. Across all the attempted calls, only 4916 (33 % of attempted phone numbers) were directly answered (i.e., delivered calls). The notification was delivered to voicemail to another 4543 (31 % of attempted phone numbers).

The Town of Paradise also issued two CodeRED notification batches, generally overlapping the zones included in the BCSO calls. Specific data from the total number of calls from the second batch from the Town of Paradise was unavailable. The first batch delivered 27 % of calls directly, and an additional 27 % to voicemails. Nearly 3000 registered numbers were not reached. Data totals for each set of CodeRED messages are shown in Table 8. The numbers of emails and text messages are independent of the phone calls and voicemails but may include duplicate contacts if residents registered multiple methods. Additional CodeRED details and data can be found in Appendix D.

Table 8. Selected statistics from CodeRED notifications in Paradise and Magalia, 07:57 to 09:30.

Agency	Primary Call Batches	Email	Text Message	Phone Numbers	Delivered Calls[a]	Voice Mail[a]	Not Reached	Attempted Calls
BCSO	6	2770	2888	14737	4916	4543	7720	28162
Town of Paradise	2[b]	n/d[c]	n/d	6189	1657	1657	2927	10359
Total				**20926**	**6573**	**6200**	**10647**	**38521**

[a] estimated using a rounded percentage and the number of attempted calls
[b] data for the second batch were not available and were not included in the Town of Paradise totals
[c] no data available

The combined BCSO and Town of Paradise CodeRED notifications directly delivered 6573 notifications, or 31 % of the attempted phone numbers. This is only 17 % of the combined population of Paradise and Magalia of approximately 39 000 and represents a maximum fraction of the population which may have directly received a CodeRED notification. This is because multiple phone numbers may have been registered to the same individual or family, and phone numbers may have been contacted more than once when zones were included in repeat notifications. While a similar number of registrants received a voicemail, it is undetermined how many people were able to retrieve the message in a timely manner, and how many were able to do so once power and cell phone services were interrupted. For those residents with landline answering machines, the message may never have been accessible. Similar limitations relate to whether people received emails or text messages.

The low rate of notification compared to the entire population in the warned area, using a voluntary opt-in system, indicates the benefit that may be gained from an opt-out system where phone numbers are automatically enrolled. However, the large fraction of attempted calls that were not connected indicates that this method alone may not be sufficient to reach large fractions of the population.

An inherent limitation of this method is the dependence on phone, internet, and electrical services. Further, systems that heavily rely on Voice Over Internet (VoIP) are reliant on internet system robustness and resiliency. With the loss of cell towers and electrical utilities during the fire, the capability for people to receive the notifications was interrupted.

6.1.4. Social Media

Public safety agencies have implemented, to various extents, the rapid and widespread reach of social media platforms to distribute messages and alerts [47, 48]. During the Camp Fire, both the Town of Paradise and BCSO utilized their official accounts on both Twitter and Facebook to post information and updates regarding evacuations. The fire department utilized these channels less frequently.

The CAL FIRE Butte Unit/Butte County Fire Department posted limited updates about the fire on social media (Twitter). The first post at 06:51 was the earliest of any official source and provided information about the initial location and that the fire was estimated to be 10 ac (4 ha) and spreading. The next post was not until 08:02, estimating the size at 1000 ac (405 ha) and that additional resources were en route. Posts at 09:06, 11:15, and 13:02 gave rough acreage updates and urged residents to follow evacuation orders. However, except for generally stating the entire area had been issued evacuation orders at 13:02, no specifics were included in the postings.

The Town of Paradise posted notification of the initial fire ignition and subsequent evacuation notifications to Facebook, as listed in Table 9. Evacuation orders for Paradise Zones 3, 8, and 14 were requested by the IC at 07:46, and for Zones 2, 7 and 13 at 08:01. The Town posted both of these orders on Facebook at 08:13, which was 27 minutes and 12 minutes, respectively, after the IC requests.

The ECC issued evacuation orders for all of Paradise at 08:03 and notified PPD, who began notifying all PPD personnel and dispatchers. However, at 08:14 the Town posted on Facebook that the west half of town was in an evacuation warning, causing potential confusion with a different message from the ECC and the message being directly communicated in the field by

first responders and 911 dispatchers. This information lag highlights the challenges of keeping multiple communication platforms synchronized during a rapidly developing incident.

The first Town of Paradise social media notice that stated that all zones were under evacuation orders was posted at 12:48, 4 hours and 45 minutes after the ECC made the decision to evacuate the entire town. Within this time interval the Paradise Town Hall and EOC had to be evacuated (for safety) to Chico, likely causing interruptions in communications and connectivity to post updates.

Table 9. Town of Paradise Facebook posts between 07:26 and 12:48.

Post Time	Content
07:26	"Cal fire reports a fire in the concow area. Approx. 50 acres. We will update as we get more info"
08:13	"Immediate Evacuation Order: Zones 3, 8, 14, 2, 7 and 13. Shelter will be Oroville Church of Nazarene. Call center [phone number]." An evacuation zone map was also included.
08:14	"[…] Remainder of the Town is on an evacuation warning."
09:04	"UPDATED: 11/8 9:04 am Immediate Evacuation Order: Zones 2, 3, 5, 6, 7, 8, 12, 13, 14."
09:33	Copy of previous post of evacuation orders, with new information regarding an additional evacuation center and school evacuation information.
12:48	"UPDATED: 12:38 Town Hall has been evacuated and the EOC has relocated to Chico. All Paradise Zones are under Immediate Evacuation Order. Please leave as soon as possible. Skyway is under contra-flow so all lanes are headed out of Town." Two shelter addresses were also included (Oroville and Chico).

Starting at 07:23, BCSO posted continual updates of evacuation orders to their Twitter account. Duplicate postings were put on Facebook. Information was posted 17 minutes after the IC requested the evacuation orders for Pentz Road and 40 minutes after the order for Zones 2, 7 and 13. Posting times for announcements by BCSO occurred within an average of five minutes from CodeRED calls to the corresponding zones.

These delays illustrate the operational time lags associated with communicating evacuation information even in conditions/situations where different organizations have worked together before the event to streamline operations.

Additional information is often available from unofficial sources, including "crowdsourced" information such as photos and videos from evacuees. While this information is often available sooner than official channels, often live, one limitation of this information is the availability and accuracy of the time and location associated with the information. This makes it difficult to interpret, verify, and safely utilize in evacuation decisions.

Social media channels can reach wide audiences; however, there are significant potential limitations with the partial use of these platforms during rapidly developing events. Social media channels advertised and promoted as official emergency information sources before incidents which are then not utilized or updated during an incident can result in significant propagation of

false information and negatively impact decisions and responses of civilians. This points to the need for communities and emergency officials to maintain and update these information channels that have been made available and advertised to the public and to provide statements of uncertainty regarding the extent and time of the provided information.

6.1.5. Other Methods

Several other methods providing emergency notifications were utilized during the Camp Fire. Not all methods were used simultaneously or throughout the duration of the evacuation. These methods include

- neighbor-to-neighbor communication,
- direct contact through 911 calls,
- TV and radio news stations, and
- general internet use.

Note that neighbor-to-neighbor communication, if done door-to-door, is the only method that does not directly rely on technology (electricity, internet, phone).

Technical discussions revealed that neighbor-to-neighbor communication was a critical evacuation notification mechanism during this incident. Evidence of this is further shown in 911 calls where the callers mention alerting neighbors and assisting with their evacuation.

Evacuation notification information was passed directly to civilians from 911 operators when civilians called to report fire observations. While the callers were aware of a hazard, several were not aware of the scope of the incident or immediate need for evacuation.

An analysis of radio and TV notification information is beyond the scope of this report. However, one example provides a glimpse at some of the information that may have been broadcast. YouTube video of an evacuating civilian contains audio from a radio broadcast at 08:42 saying “evacuation order now, due to the fire, for areas of Pentz Road in Paradise east to Highway 70…from the Butte County Sheriff’s Office. At last check, the fire over 1000 acres…” While the information in the broadcast may have been provided on-air earlier, at 08:42 the information was communicated 45 minutes after the first BCSO CodeRED notifications for the same area. It is unknown if this information was being re-broadcast or communicated for the first time.

6.2. Notification Timeline Overview

The overall sequence of evacuation notifications in Concow, Paradise, Magalia and surroundings can be divided into four intervals between the fire ignition and when the IC expanded the request for evacuation orders for nearly all zones in Paradise and Magalia.

- 06:25 to 07:31—Evacuation orders and warnings requested for Pulga and Concow
- 07:32 to 07:54—Evacuation orders expanded to Concow, and warnings expanded to Pentz Road in Paradise
- 07:55 to 08:03—Evacuation orders expanded to Pentz Road in Paradise
- 08:04 to 09:03—Evacuation orders expanded to the entire town of Paradise and into Magalia and Butte Creek Canyon

Additional notifications and evacuation orders occurred after 09:03 as the fire continued to spread primarily south and west toward Oroville, Chico, and communities on CA Highway 32 and CA Highway 70. However, those notifications are beyond the scope of this report, which is focused on areas notified and evacuated due to the initial rapid progression of the fire on November 8, when warning time was limited.

A consolidated list of events and data points representing the overall time sequence of notifications and evacuation order requests is presented in Table 10. Localized notification efforts were dictated by fire conditions and actions of first responders in the field. However, evacuation requests from the IC represent the most current incident management information, and therefore provide the backbone of the notification timeline presented here.

The progression of evacuation orders and warnings, along with the locations of individual fire observation data points, are visualized in Figs. 13 and 14, which show the evacuation status of each evacuation zone through the morning of November 8.

Evacuation zones depicted in the maps were defined in the Butte County Evacuation Plan [36] (33 named zones in Paradise and Magalia), with the exception of the specific boundaries of the Pulga, Concow, and Butte Creek Canyon zones. For the purposes of this report, the Concow evacuation zone was interpreted from new evacuation zones [49] developed by the Butte County Sheriff's Office and CAL FIRE in 2020 after the Camp and Dixie Fires [38]. The Concow zone depicted in this report excludes the areas of Nelson Bar and Yankee Hill; these areas were referenced in later evacuation requests by the IC, independent of Concow. The Butte Creek Canyon zone depicts an interpreted zone of the populated area within the canyon, excluding areas of zones otherwise defined in the Butte County Evacuation Plan.

The fire observation data points indicate locations where fire was observed; however, the points alone do not reflect the severity or expanse of fire at each location. Nonetheless, these points provide the highest detail account of fire progression available, as previously presented in the Fire Progression Timeline [23]. Fire progression information is included in the discussion to provide context for the notification/evacuation request timeline.

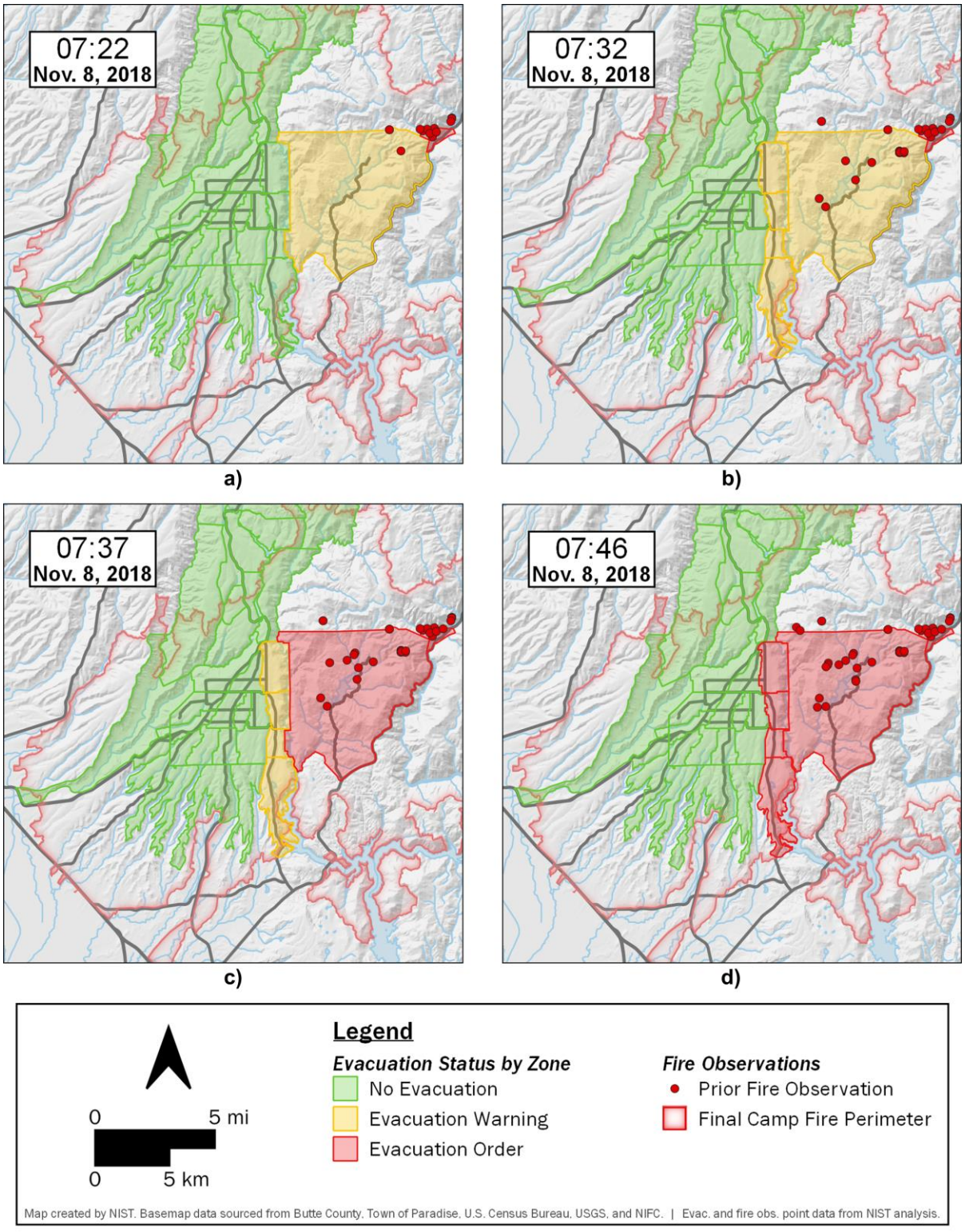


Fig. 13. Evacuation warnings and orders by zone, as requested by the IC, prior to the indicated time, a) 07:22, b) 07:32, c) 07:37, d) 07:46. Prior fire observation data points indicating fire progression are also shown. Evacuation orders included Pulga, Concow, and Pentz Rd in Paradise by 07:46.

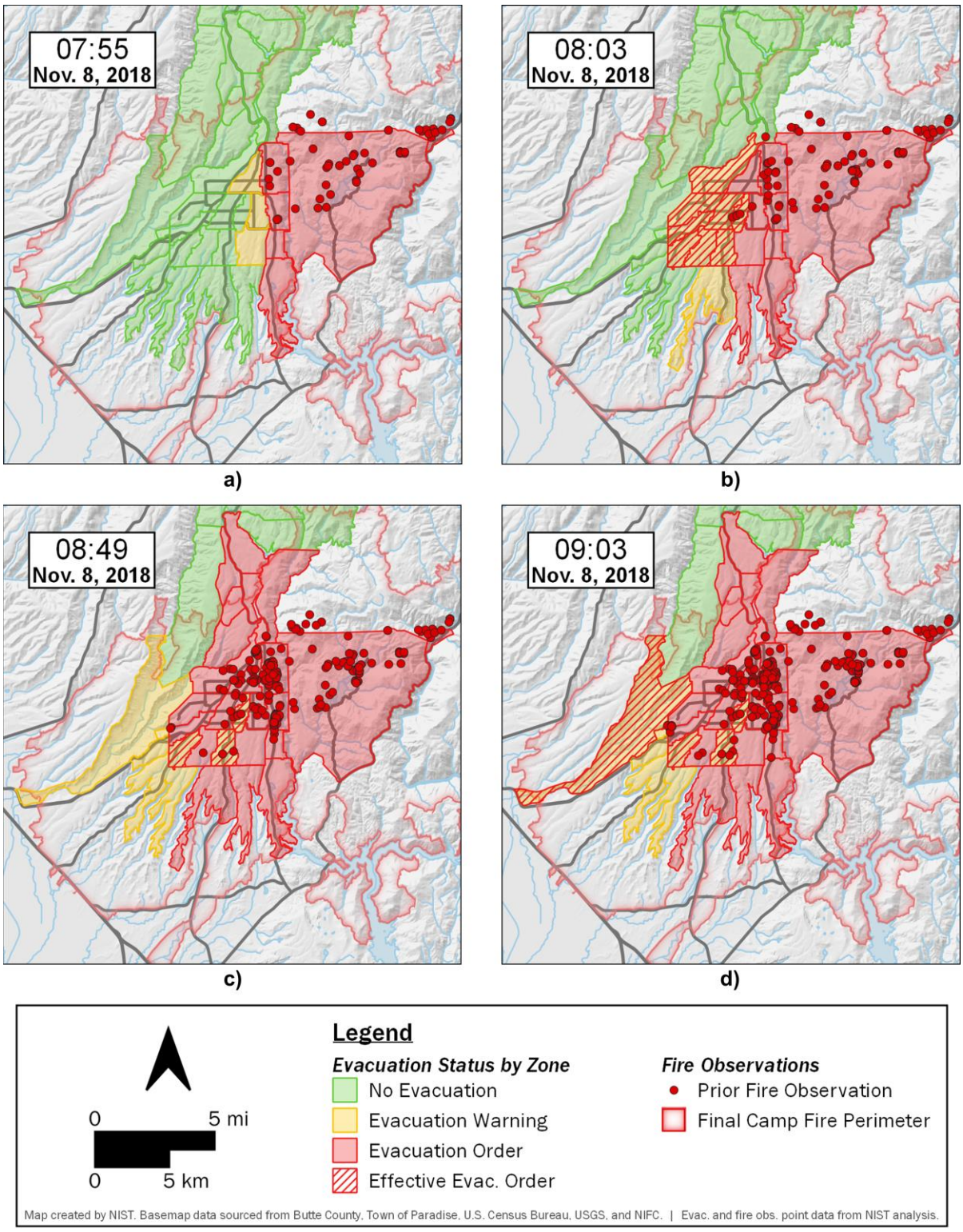


Fig. 14. Evacuation warnings and orders by zone, as requested by the IC, prior to the indicated time, a) 07:55, b) 08:03, c) 08:49, d) 09:03. Effective evacuation orders, denoted by the red hashed areas, were being evacuated in the field but had not yet been specifically requested by the IC. Prior fire observation data points indicating fire progression are also shown. Nearly the entire towns of Paradise and Magalia were under evacuation orders by 09:03.

Notifications from 06:25 to 07:31

The initial time window covering the first hour of the incident was characterized by the initial fire spread and subsequent evacuation order for Pulga, followed by the evacuation warning for Concow, indicated by the red and yellow shaded areas in Fig. 13a.

The first 911 call reporting the fire was received at 06:25. The initial response was dispatched at 06:31 and the first engine was in sight of the fire by 06:44 (essentially driving time from the nearest fire station). After ignition, the fire generally progressed from northeast to southwest, and firefighters immediately began door-to-door evacuations in Pulga. The first notification/evacuation order was made by the IC at 06:55 when they requested an evacuation order for Pulga due to the rapid fire spread towards the community. BCSO immediately confirmed the evacuations for Pulga and was en route to assist. At 07:13, BCSO implemented a "reverse 911" notification in Pulga via the CodeRED communication system.

The fire rapidly spread over the ridge from Pulga and into Concow. An evacuation warning was requested for Concow at 07:22, with the expectation that some areas would receive further evacuation orders pending information updates from personnel in Concow. The current progression of the fire, primarily in the Pulga area but also beginning to burn over the ridge into Concow, can be seen in Fig. 13a, when the evacuation warning was requested for Concow (indicated by the yellow shaded area). Numerous law enforcement officers were en route to Concow to assist with notification and evacuation. No CodeRED notification data have been identified for Concow.

Residents in Paradise had been calling 911 reporting the large smoke column since 07:12. The first documented official public notification in Paradise was posted to Town of Paradise social media at 07:25 (via Facebook) regarding the fire in Pulga, reporting a fire size of 50 ac (20 ha).

Notifications from 07:32 to 07:54

Evacuation requests expanded to include portions of Paradise in this second time interval.

The first evacuation warning for Paradise was requested by the IC at 07:32 for the "west [*sic*] side" of Pentz Road (intending to refer to Zones 3, 8, 14, and Lower Pentz; highlighted yellow in Fig. 13b). That information was communicated to BCSO and PPD, and law enforcement began door-to-door and PA speaker announcements to notify residents along Pentz Road.

Several spot fires and a significant fire front were observed by firefighters along Rim Road (on the ridge between Pulga and Concow) between 07:20 and 07:30; over a dozen were reported and observed throughout Concow by 07:35. Shortly after fire was reported in multiple residential yards in Concow, the IC requested evacuation orders for Concow at 07:37. The ECC advised BCSO, which already had deputies in Concow with more on the way. Figure 13c shows the Concow area in red shading (evacuation order), with numerous spot fires in the Camelot area of Concow and towards Paradise.

Within 14 minutes of the initial evacuation warnings for Paradise, evacuation orders were requested for the zones along Pentz Road at 07:46 (Zones 3, 8, 14, and Lower Pentz, highlighted red in Fig. 13d). The first report of fire in Paradise was reported via 911 at 07:49. CodeRED mass notifications were activated by BCSO for these zones at 07:57.

Within six minutes of the evacuation warning requested by the IC and one minute after the first report of fire in Paradise, at 07:51, Butte County Med contacted the ECC to confirm evacuations including Zone 8, anticipating evacuation of Feather River Hospital located in that zone.

At this time, 911 operators were advising residents in Paradise about the most recent evacuation status for each zone. At 07:49 a 911 caller from Paradise Zone 7 answered by Butte County [911-065-5] was advised to evacuate immediately. Three minutes later, at 07:52, a 911 caller from Zone 6 answered by PPD [911-1027-3] was "advised to stay close to phone for notification." Despite the proximity of the two calls to each other and the apparent contradictory advice, the different agencies were providing the most recent information consistent with the IC requests to citizens in different evacuation zones.

Notifications from 07:55 to 08:03

The 10-minute window around 08:00 was characterized by rapid progression of evacuation requests and widespread spot fires in Paradise.

At 07:55, the IC expanded evacuation warnings to include zones along the west side of Pentz Road (Zones 2, 7, and 13, pictured in Fig. 14a). By this time there were at least five spot fires along the Pentz Road corridor that ignited in a five-minute period. It was not immediately clear to the Battalion Chief in Paradise that the initial fires reported (e.g. Apple View Way) were spot ignitions from the fire spreading through Concow. Communication with the IC clarified the situation and expedited evacuation orders.

Conditions deteriorated rapidly in eastern Paradise. At 08:01, only six minutes after the evacuation warnings were issued, the IC requested expansion of the evacuation area to include Zones 2, 7, 13, and the Morgan Ridge Zone. The IC additionally stated that everything "west of that is to be an evacuation warning," referring to Paradise Zones 1, 4, 5, 6, 9, 10, 11, 12, and the Lower Clark Zone.[9] By this time, available data show that spot fires had ignited in Zones 6 and 7 at 07:57 and 08:00, respectively, nearly concurrent with the evacuation orders issued by the ECC. By 08:01 there were multiple 911 calls reporting fire in Paradise, including Zones 3, 6, 7 and 8. CodeRED notifications for Zones 2, 6, 7, and 13 were implemented by BCSO at 08:32.

Shortly after the IC request for expanded evacuation warnings, the ECC notified PPD dispatch that evacuation orders had been issued for the *entire* town of Paradise—a more widespread evacuation than had just been requested by the IC. This information was immediately relayed to officers in the field. Figure 14b shows the evacuation status of each zone at 08:03. Red shading indicates zones where the IC had requested evacuation orders. The yellow zones with red bars indicate the effective evacuation orders that were being implemented in Paradise, despite the IC request of only a warning at this time. From the perspective of notifications and instructions to civilians throughout Paradise, 08:03 is the time when 911 operators and first responders in the field began instructing and notifying all zones of the town to evacuate. The information was successfully and rapidly communicated to emergency dispatchers and officers within PPD. For example, at 08:04 a 911 caller in eastern Paradise was advised to "…just evacuate. There are mandatory evacuations in effect for all of Paradise."

[9] These warning zones are inferred; they were not explicitly listed by the IC.

Notifications from 08:04 to 09:03

During the following hour, fire overspread significant portions of Paradise.

The Town of Paradise published the evacuation zone map on Facebook at 08:13 and advised of evacuation orders for Zones 3, 8, 14, 2, 7, and 13 (i.e., all zones along Pentz Road). A little over 30 minutes later, at 08:44, the Town of Paradise implemented CodeRED reverse 911 with evacuation orders for all zones on Pentz Road.

At 08:49 the IC requested a significant expansion of evacuation orders now to include a majority of Magalia (from Steiffer Road in the North Firland Zone to the town limits of Paradise), along with Paradise Zones 1, 4, 9, 5, 11, and the Lower Clark Zone. At this time the IC was unaware that the entire town of Paradise had effectively been under evacuation orders since 08:03 and first responders were already evacuating civilians in these zones. Additional zones/regions[10] on the southwest of Paradise, specifically listed by the IC, were put into evacuation warning at this time, including Butte Creek Canyon. Within two minutes, at 08:51, the ECC called PPD about the latest evacuation orders. Figure 14c indicates the expansion of evacuation orders in Magalia with red shading, along with the zones in Paradise that the IC had now specifically named for evacuation.[11]

The final map panel, Fig. 14d, shows an effective evacuation order for Butte Creek Canyon and the remaining zones in Paradise. The information regarding evacuations for Butte Creek Canyon and Paradise Zones 6 and 12 were not specifically mentioned by the IC in the available data. However, evacuation requests for these zones were disseminated by ECC in interagency phone calls.[12]

[10] Not all requests corresponded to defined evacuation zones. Some zones have been interpreted for the purposes of this report.
[11] Note that the map in Fig. 14c highlights the entire North Firland and Carnegie Colter Zones, including north of Steiffer Road. The IC did not specify zones for these Magalia orders, just the northern limit of Steiffer Road.
[12] A recording of such a call at 09:03 was identified in the recorded 911 call log.

Table 10. Notification timeline summary.

Time Range		Notification Action or Event	Source #
06:25		The initial call to 911 is placed, reporting a fire in the Feather River Canyon in the area of Camp Creek Rd and Poe Dam.	911-001-1
06:31		ECC dispatches the initial response.	VTD-32
06:44		The first arriving engine has sight of the fire from CA-70. Another engine accesses Pulga to begin door-to-door evacuations.	TD-028, TD-029 VTD-32
06:51		CAL FIRE announces the fire on social media (Twitter), estimating it is 10 ac and spreading in the Feather River Canyon.	CAL FIRE Butte Unit Twitter
06:55		IC requests evacuation orders for Pulga, and for the surrounding areas to be on alert. BCSO confirms the evacuations and multiple law enforcement are en route to assist.	TD-028, VTD-32
07:06		Engines responding on Rim Rd encounter civilians and advise them to evacuate.	TD-062
07:08	07:20	Multiple 911 calls are coming from Concow. The operator recommends that they should evacuate if they feel threatened.	911-014-1 911-018-1 911-024-1 911-1010-2
07:12	07:42	PPD 911 operators advise residents calling from Paradise that the fire is north of Concow, and they will be notified if they need to evacuate.	911-1006 through 911-1021
07:13		BCSO implements CodeRED reverse 911 for Pulga.	BCSO
07:17		IC maintains the evacuation order for Pulga and anticipates an evacuation warning for Concow. Conditions in Concow are being investigated and IC will provide an evacuation update within 10 minutes.	VTD-32
07:22		IC confirms an evacuation warning for Concow. The exact areas for immediate evacuation vs. warnings are being determined pending information from the field.	VTD-32
07:25		Town of Paradise makes a social media post (Facebook) about a 50-acre fire in Pulga.	Town of Paradise Facebook post
07:30		A 911 caller in Concow reports fire in their yard and is advised to evacuate.	911-037-1
07:30		First documented instance of civilian-to-civilian notification in Paradise/Magalia advising family to evacuate.	TD-058
07:30		All incoming law enforcement units are directed to Concow to assist with evacuations.	VTD-32
07:32		IC requests an evacuation warning for the west [*sic*] side of Pentz Rd in Paradise. This information is passed on to BCSO.	VTD-32
07:37		IC requests an evacuation order for Concow. ECC advises BCSO.	VTD-32
07:39		PPD 911 operators advise residents calling from Paradise that the fire is north of Concow and will be notified if they need to evacuate.	911-1020-5 911-1020-7
07:42		Efforts begin to activate the county EOC to set up call centers and refuge shelters.	TD-007
07:43		Law enforcement begin working down Pentz Rd from Skyway to advise residents of the evacuation warning. Incoming resources are instructed to begin notifications from the south end of Pentz Rd in Paradise.	VTD-32
07:46		IC extends the evacuation orders to include the east side of Pentz Rd in Paradise *[Zones 3, 8, 14, and Lower Pentz]*.	VTD-32
07:49	07:59	People calling 911 from Paradise are being advised of the evacuation orders and are instructed to evacuate immediately. Callers outside of zones with evacuation orders are being advised to remain alert for any future notification.	911-065-1 911-065-5 911-1027-3 911-1032-1

Time Range		Notification Action or Event	Source #
07:51		Butte County Med contacts the ECC to confirm evacuations including Zone 8, anticipating evacuation of Feather River Hospital.	911-072-1
07:55		IC expands evacuation warning to include zones along the west side of Pentz Rd *[Zones 2, 7, and 13]*.	VTD-32
07:57		BCSO implements CodeRED reverse 911 for zones on Pentz Rd.	TD-042, BCSO
08:00		The town manager activates the Paradise EOC.	TD-042
08:01		IC requests expansion of evacuation orders to include Zone 2, 7, 13, and Morgan Ridge. Everything west of that is to be an evacuation warning.	VTD-32
08:03		Butte ECC notifies PPD that they have just issued "mandatory evacuations" for all of Paradise. PPD announces immediately to officers on their radios.	TD-011 VTD-32 911-1035-6
08:03		ECC and PPD 911 operators notify callers that there is a lot of fire and Paradise is under "mandatory evacuations."	911-097-1 911-098-1 911-098-2 911-105-1 911-118-1 911-1037-1 911-1042-1 911-1043-1 911-1046-1 911-1049-1 911-1052-1 911-1053-1
08:00	09:00	Significant evacuation efforts are ongoing in Paradise. First responders are working along Pentz Rd (primarily between Dean Rd and Pearson Rd) and west toward Clark Rd to notify residents (via door-to-door, PA speaker, and sirens) of the evacuations and making rescues in areas fire has already impacted. Some civilians are going door-to-door to alert their neighbors, many of whom are elderly.	TD-005, TD-016 TD-020, TD-022 TD-024, TD-037 TD-040, TD-061 TD-064, TD-067 TD-069, TD-109 TD-112, TD-122 TD-123, TD-124 VTD-32, PPD 911-118-1
08:13		Law enforcement is going door-to-door south of Concow working on evacuations ahead of the fire.	VTD-32
08:13		The Town of Paradise publishes the evacuation zone map on Facebook and advises of evacuation order for Zones 3, 8, 14, 2, 7, and 13 *[i.e., all zones along Pentz Rd]*.	TD-011
08:44		Town of Paradise implements CodeRED reverse 911 for zones on Pentz Rd. Elderly citizens receiving the evacuation call but having difficulty evacuating call 911 for assistance.	911-175-1 KRCR News [50]
08:49		IC expands evacuation orders to include Paradise Zones 1, 4, 9, 5, 11, and Lower Clark, as well as Magalia zones south of Steiffer Rd and Skyway. Butte Creek, Centerville, Upper Honey Run, Lower Skyway, Lower Neal Zones, and Paradise Zone 10 are now all evacuation warnings. At this time the IC was not aware that the ECC and the Town had already issued evacuation orders for all of Paradise.	TD-010 VTD-32 911-209-1
09:03		ECC disseminates evacuation orders for Steiffer Rd to the town limits, Zones 1, 11, 2, 6, 12, 5, 4, Lower Clark, and Butte Creek Canyon.	911-209-1

6.3. Analysis of Notification Timeline

To further illustrate the rapid fire spread, decision-making, and the time necessary for information transfer, the temporal relationships among evacuation notifications can be viewed with respect to the first documented fire observation in each of the designated evacuation zones. This relationship is also discussed with respect to the timing of several burnovers.

Table 11 contains, for each evacuation zone, the time of day of the first fire observation data point (representing the best-known arrival time of fire), the times of evacuation warning and order requests made by the IC, and the times of the corresponding CodeRED notifications. Time differences between the evacuation requests and the first recorded fire observation data point (e.g., 'Δ Warning to Fire'), as well as the time between the initial evacuation warning and evacuation order ('Δ Warning to Order') are also tabulated. The 'Δ CodeRED' values indicate the time duration between the requested evacuation warning or order and the time the CodeRED notification was issued. While evacuation orders were effectively issued for all of Paradise at 08:03 by the ECC, the data in Table 11 lists the time sourced from the IC's requests. Normal text values in Table 11 are times of day, while values in *italics* represent calculated time intervals. The rows of the table are grouped and sorted by zones in the general sequence of fire progression (east to west).

As in the previous map figures and discussion about fire spread, the fire information presented here was compiled from 152 technical discussions with first responders and first-hand accounts and observations [23]. While the data here includes all collected fire observation data, it does not mean that the absence of a data point means there was no fire, and it does not necessarily reflect the same information that the IC had at the time. Due to the rapid development and spread of the fire, difficult access to the area, limited number of resources, and immediate engagement of first responders in life safety tasks, traditional information feedback to the IC was often interrupted [TD-010]. Therefore, the relationship between fire information and the evacuations requested by the IC should be viewed acknowledging the benefit of hindsight and the fact that information transfer from the field to the IC takes a certain amount of time.

Table 11. Time of day of evacuation requests issued by IC and CodeRED notification by zone, grouped and sorted by geographic position with respect to general fire progression (east to west). Italic Δ values indicate time interval (*hh:mm*) between relevant data.

Zone	First Fire Data Point	Δ Warning to Fire	Δ Order to Fire	Warning	Code RED	Δ Code RED	Order	Code RED	Δ Code RED	Δ Warning to Order
Pulga	06:58		*00:03*				06:55	07:13	*00:18*	
Concow	06:45	*-00:37*	*-00:52*	07:22			07:37			*00:15*
Paradise 3	07:50	*00:18*	*00:04*	07:32			07:46	07:57	*00:11*	*00:14*
Paradise 8	07:49	*00:17*	*00:03*	07:32			07:46	07:57	*00:11*	*00:14*
Paradise 14	08:47	*01:15*	*01:01*	07:32			07:46	07:57	*00:11*	*00:14*
L. Pentz	08:54	*01:22*	*01:08*	07:32			07:46	07:57	*00:11*	*00:14*
Paradise 2	08:15	*00:20*	*00:14*	07:55			08:01	08:32	*00:31*	*00:06*
Paradise 6	07:57	*-00:04*		08:01				08:32		
Paradise 7	08:00	*00:05*	*-00:01*	07:55			08:01	08:32	*00:31*	*00:06*
Paradise 13	09:00	*01:05*	*00:59*	07:55			08:01	08:32	*00:31*	*00:06*
Morgan Ridge	n/d						08:01			
Paradise 1	08:31	*00:30*	*-00:18*	08:01	08:43	*00:42*	08:49	16:17	*07:28*	*00:48*
Paradise 5	08:43	*00:42*	*-00:06*	08:01	08:43	*00:42*	08:49	09:09	*00:20*	*00:48*
Paradise 12	08:30	*00:29*		08:01	08:46	*00:45*		16:12		
L. Clark	10:00	*01:59*	*01:11*	08:01	10:07	*02:06*	08:49	13:34	*04:45*	*00:48*
Paradise 4	08:41	*00:40*	*-00:08*	08:01			08:49			*00:48*
Paradise 9	08:41	*00:40*	*-00:08*	08:01			08:49			*00:48*
Paradise 10	10:30	*02:29*		08:01						
Paradise 11	08:30	*00:29*	*-00:19*	08:01	08:46	*00:45*	08:49	16:12	*07:23*	*00:48*
L. Neal	10:30	*01:41*		08:49	10:11	*01:22*				
U. Honey Run	08:41	*-00:08*		08:49	10:11	*01:22*				
L. Skyway	10:44	*01:55*		08:49	10:07	*01:18*		13:34		
Butte Creek	09:11	*00:22*		08:49				10:22		
Old Magalia	08:41		*-00:08*				08:49	09:15	*00:26*	
S. Pines	10:45		*01:56*				08:49	09:15	*00:26*	
N. Pines	26:55		*18:06*				08:49	09:29	*00:40*	
S. Fir.	17:14		*08:25*				08:49	09:29	*00:40*	
N. Fir.	30:21		*21:32*				08:49	09:29	*00:40*	
S. Coutolenc	23:23		*14:34*				08:49	09:15	*00:26*	
Carnegie Colter	no fire						08:49	09:29	*00:40*	
Nimshew	n/d				09:58			13:46		
Humbug	no fire				17:04			25:18		
N. Coutolenc	> Nov 9				17:04		24:53	25:18	*00:25*	
Stirling	> Nov 9							25:18		
Lovelock	> Nov 9				17:04			25:18		
Powellton	no fire							25:18		
Centerville				08:49				10:22		
Foothills								11:46		
Yankee Hill								11:52		

6.3.1. Timing of Evacuation Order Requests with Respect to Arrival of Fire

The progression of evacuation events and general fire observations were presented in the previous section and provide a chronological overview. This analysis presents the same timeline, but with particular focus to highlight the rapid progression of the fire and the temporal relationships with various evacuation requests. Evacuation orders were issued as quickly as possible with the information available to the IC at the time. As the fire progressed, the lead time for evacuations generally increased. This is a function of expansion of the incident command structure, increased number of first responders in the field providing more data feedback, air attack reports beginning at 07:52, and increased concern about the intensity of observed fire behavior leading to more far-reaching evacuation requests in order to be proactive.

Pulga

The community of Pulga was immediately issued evacuation orders at 06:55, as there was no time to issue a warning. The first data point of fire in the immediate Pulga area was recorded 3 minutes later at 06:58 by firefighters who observed fire burning in the hills above Pulga. Data resolution is limited at this location and time; given the proximity to the origin (~800 m, 0.5 mi), it is possible that fire was burning in the community earlier.

The evacuation order was requested 11 minutes after arrival of the first engine at 06:44, 30 minutes after the first report of the fire via 911. At the same time, another engine accessed Pulga and began door-to-door evacuations before the IC broadcasted this request to the ECC and law enforcement partners. CodeRED notifications were sent 18 minutes after the evacuation order was requested by the IC.

Concow

The first data point of fire within the Concow zone was at 06:45 at a second ignition near the ridgeline [28], approximately 1.6 km (1 mi) northeast of the nearest residential structure.[13] Between 07:20 and 07:30 several spot fires were visible in the Concow basin, and a fire front was approaching Rim Road as the fire progressed west/southwest from Pulga. The IC requested an evacuation warning for Concow at 07:22.

The IC requested an evacuation order for Concow at 07:37, 15 minutes after requesting the warning. Intense fire was widespread throughout Concow by 08:00, significantly impacting civilian evacuations and first responder access, and leading to multiple burnover occurrences and forcing the use of multiple temporary refuge areas (detailed in Sec. 9.2).

Fire was burning in the Concow area 52 minutes before the IC requested evacuations. While this is evident in the post-fire collected data, the same information was not available to the IC in real time. The ECC reported the possibility of a second start on Rim Road at 07:04, and the IC re-assigned responding engines to investigate. At this time there was limited information feedback from the field because units were en route and trying to access the fire for more information.

Based on the information feedback to the IC, the first observation of the fire in the Concow zone by firefighters on-scene was from engines responding on Rim Road between 07:20 and 07:30. This reduces the time between fire and the warning to 2 minutes. The first spot fires were being reported via 911 at 07:30, only 8 minutes after the warnings were requested.

[13] This information was relayed from the ECC to the IC via radio at 07:04.

Paradise Zones 3, 8, 14 and Lower Pentz Rd

The IC requested evacuation warnings for eastern Paradise Zones 3, 8, 14, and the Lower Pentz Zone at 07:32 as fire became more widespread in Concow and was spotting closer towards Paradise. Evacuation orders were requested for these four zones 14 minutes later at 07:46, three minutes ahead of the fire's arrival in Zone 8; the first reported spot fire in Paradise was located in Zone 8 at 07:49 near Feather River Hospital. In the next 11 minutes, 9 documented spot fires began in Zones 3 and 8, and all first responders in the area were involved with direct notification and evacuation assistance.

Eleven minutes elapsed between the time the IC requested evacuation of the Pentz Road zones and the activation of the CodeRED system for these zones at 07:57—the quickest CodeRED implementation of the day. The first fire data points in Zone 14 and the Lower Pentz Zone occurred at 08:47 and 08:54 respectively, a little over one hour after the evacuation order was requested.

Paradise Zones 2, 7, 13

At 07:55, evacuation warnings were requested for Paradise Zones 2, 7, and 13. Just six minutes later, at 08:01, the same zones were transitioned to evacuation orders along with the Morgan Ridge Zone. These four zones are contiguous with the initial evacuations along Pentz Road and represent the next lineup of zones anticipated to be impacted by the fire. CodeRED calls to residents in the expanded evacuation area (Zones 2, 6, 7, and 13) began at 08:32 via BCSO.

Note that Paradise Zone 6, located in line north-south with Zones 2 and 14, was not specifically mentioned by the IC for inclusion in any documented requests. The tabulated times refer to the time that additional broad requests were made, such as the 08:01 request for "everything west of that [2, 7, 13] to be a warning," and a 09:03 phone communication from the ECC [911-209-1] which specifically listed Zone 6. It is also noted that the 08:32 BCSO and 09:09 Town of Paradise CodeRED notifications included Zone 6 with Zones 2, 7, and 13. This was likely the intent of the IC given the geographic alignment of the zones.

Remainder of Zones in Paradise, and Magalia

At the same time as the requested evacuation order for Zones 2, 7, and 13 (08:01), warnings were requested by the IC for the remainder of the zones within the town of Paradise, along with the Lower Clark Zone. As described in Sec. 6.1, the ECC upgraded this request and issued evacuation orders for the entire town. Fire observation data indicate that by 08:49, fire had further spread west and north in Paradise and was observed in Zones 1, 4, 5, 9, 11, and the Upper Honey Run and Old Magalia Zones. CodeRED calls to these zones did not start until 08:43 or even much later, as listed in Table 11, perhaps due to the exceedingly large call volume of the previous evacuation orders.

At 08:49 evacuation orders expanded into Magalia and most of the remaining zones in Paradise, which were already being evacuated by first responders in the field. The Lower Clark Zone was also upgraded to an evacuation order. Butte Creek Canyon and the remaining zones on the west side of Paradise were put in evacuation warnings. The request by the IC at 08:49 possibly indicates that the ECC had not communicated back to the IC the evacuation order for all of Paradise was effective at 08:03.

CodeRED notifications for zones in Magalia started between 20 and 40 minutes after the IC evacuation order requests.

Fire was observed burning in Paradise Zones 1, 4, 5, 9, and 11 between 6 minutes and 19 minutes before the IC requested the evacuation order, and 29 minutes to 42 minutes after the evacuation warning was first issued, highlighting the rapid fire spread within Paradise between 08:30 and 08:49. Fire spread into the Lower Clark and South Pines Zones nearly 1 hour and 2 hours, respectively, after the IC requested those zones to evacuate. The remaining Magalia zones (South Firland, South Coutolenc, North Pines, North Firland, and Carnegie Colter) had between 8 hours and 21 hours after the IC evacuation order request before fire arrived within the zones.

Zones That Received Partial or Delayed CodeRED Notifications

Data points regarding evacuation requests and notifications were limited after 09:00 since a majority of the pre-defined evacuation zones and populated areas had been issued evacuation orders. The remaining notification information was sourced from BCSO CodeRED logs.

Zones 6, 12, 10, Lower Neal, Upper Honey Run, Lower Skyway, and Butte Creek Canyon did not get explicit evacuation orders from the IC before 08:50.[14] This may have resulted from a communication discontinuity that may have occurred when all the zones of interest were not explicitly listed/communicated, and an abbreviation was used such as “all zones to the west” or “all zones in Paradise.” Of the seven zones for which the IC did not explicitly request evacuation orders, data indicate that four received CodeRED notifications and three were mentioned by the ECC in interagency phone communications:

- Zone 6 began receiving CodeRED calls at the same time as Zones 2, 7, and 13, at 08:32.
- Butte Creek Canyon began receiving CodeRED calls at 10:22, 1 hour 11 minutes after the first documented fire observation in that zone, and 1 hour 33 minutes after the IC requested an evacuation warning for that area.
- Zone 12 began receiving CodeRED calls at 16:12, at the same time as Zone 11.
- Zone 1 began receiving CodeRED calls at 16:17.
- Evacuation orders for Zones 6, 12, and Butte Creek Canyon were all named in communications from the ECC at 09:03.

The apparent discontinuity in the evacuation order request from the IC did not have an impact on notifications in Zone 6, as the evacuation order information for Zone 6 was included in calls sent to neighboring zones at 08:32. The impact of the delayed notifications on the other zones is beyond the scope of this study and would be difficult to quantify.

CodeRED calls to the Lower Clark Zone began at 13:34, nearly 5 hours after the evacuation order was requested, and after many of the residents had begun evacuating. Paradise Zones 1, 11, and 12 did not start receiving CodeRED calls until after 16:00.

Paradise Zones 4, 9, 10, and Morgan Ridge did not receive any reverse 911 calls (evacuation warnings or orders) based on the available data. The impact of this on evacuations and rescues is beyond the scope of this study and would be difficult to quantify.

[14] There are no additional specific evacuation requests in the radio log or available data after 08:50.

6.3.2. Assessment of Fire-Notification Timing Relationships

The time intervals between evacuation notification (both warnings and orders) and the time of fire arrival in each zone are visualized in Fig. 15. In this figure, the information presented in Table 11 has been plotted to illustrate the amount of time between the fire arrival and the time of evacuation notification for each zone; first with respect to the time of fire arrival, and second with respect to the time the evacuation request was first made.

Figure 15a illustrates the increasing time interval between notification and the time of fire arrival as the event progresses. Points below $y = 0$ indicate fire arrived before the evacuation notification was requested. Zones where the fire arrived later in the morning had a longer lead time from the evacuation notification from the IC. This is a result of increased situational awareness, in part associated with more first responders on scene, and conservative anticipation of fire spread. As the fire entered the more populated area of Paradise, additional data was also provided by more civilians calling 911.

The zones where fire arrived before 08:40 often had less than 30 minutes between when the evacuation was requested and when the fire arrived in the zone. Sometimes the fire was burning within the evacuation zone before the notifications were requested. This shows the impact of the rapid development and early spread rate of the fire that outpaced the transfer of information to the IC.

As seen by the left-most point in Fig. 15 the IC directly issued an evacuation order for Pulga at 06:55, only 3 minutes ahead of the best-known time of fire arrival. There was no corresponding warning time for the Pulga area. While the evacuation request was radioed at 06:55, it is important to note that evacuation activities started there with the first engine on scene at 06:40, just 15 minutes after the initial 911 call and before the IC relayed evacuation information to the ECC and law enforcement partners.

The pair of points at the lower left of Fig. 15a, indicating the fire arrived well before the evacuation warnings, correspond to the Concow zone. Concow was the largest of the zones impacted by fire before 09:00. The time intervals in Table 11 and plotted in Fig. 15 refer to the first fire data point in the entire Concow zone, which occurred with a second fire ignition near the intersection of Concow Road and Rim Road at 06:45. The first 911 calls for fire in Concow from residents there did not begin until 07:03. It was 17 minutes after these calls when the IC issued the Concow evacuation warning. The first observation of fire directly by firefighters in the Concow zone occurred by an engine on Rim Road at 07:32. Limited access roads, complex topography, and long travel distances contributed to the engine not reaching the Rim Road location until 07:32. Within 5 minutes of that observation the IC requested evacuation orders for Concow.

The time between 07:30 and 08:40 can be viewed as the period when evacuation orders occurred nearly simultaneously with the arrival of the fire in the notified zones. This shows up in Fig. 15a as the data cluster at the 00:00 time interval from notification to fire arrival. The Paradise zones where fire arrived an hour after requested evacuation orders were Zones 13, 14, Lower Pentz, and Lower Clark. Magalia had several hours between the evacuation orders and the fire, with the exception of Old Magalia.

Figure 15b shows the time interval between the time of notification and the arrival of fire in each zone depending on the time of notification. The different waves of IC requests are evident in the

vertical alignment of points. The pair of evacuation warning/order sets at 07:32/07:46 (east Pentz zones) and 07:55/08:01 (west Pentz zones) are linked with black lines. Additional lines show corresponding warning/order pairs for other zones.

At 8:01 the IC requested evacuation warnings for Zones 1, 4, 5, 6, 9, 10, 11, 12 and Lower Clark. As listed in Table 11 and indicated by the negative point in Fig. 15b, Zone 4 was the only zone in which fire had already started, with the first fire observation at 07:57. The evacuation order requests for these zones by the IC occurred at 08:49, 8 minutes to 19 minutes after fire was first reported in these zones, except for Zones 6 and 12 which were not specifically identified by the IC.

The 08:49 request also included much of Magalia. With the exception of Old Magalia, where fire first occurred 8 minutes before the evacuation order, the Magalia zones did not see fire for many hours after the notification.

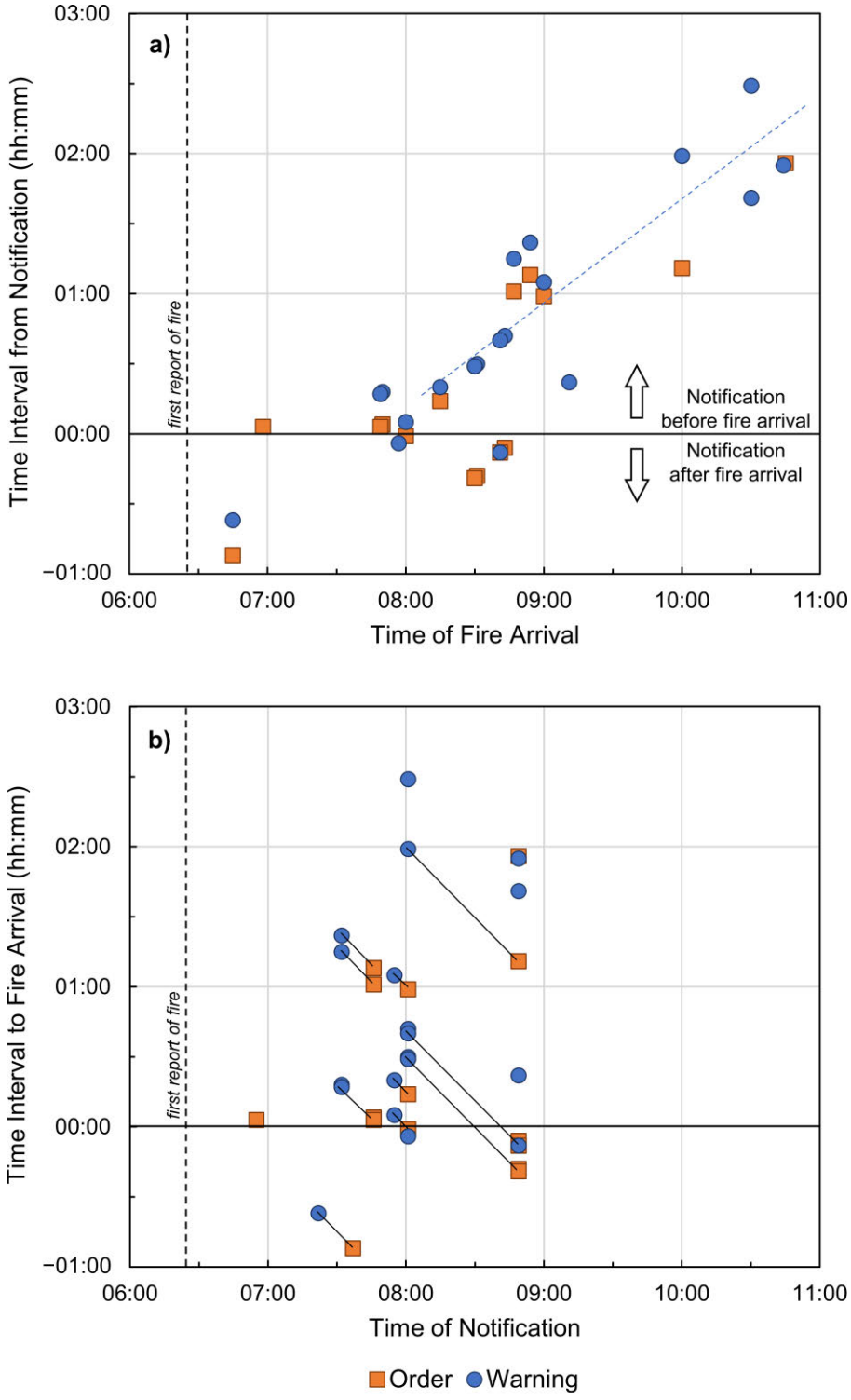


Fig. 15. Graphical representation of the time interval between zone evacuation notification and the arrival time of fire with respect to a) the time of fire arrival, and b) the time of notification. The dashed line in a) illustrates the trend. Solid lines in b) link evacuation warnings and orders for the same zone and indicate a slope of 1:1.

6.3.3. Temporal Relationship between Zone Notification and Burnovers

This section explores the temporal relationships among IC evacuation orders, notifications, first fire observations, and burnovers. Table 12 summarizes the evacuation orders and burnover start times for the burnovers that started at or before 09:25. All notifications were impacted by the lack of emergency alert sirens.

Table 12. Relationship of burnover event times to evacuation notification times.

BO ID	BO Name	BO Start Time t_{BO}	Zone	First Fire Obs. t_f	Evac. Order t_e	Fire to BO $t_{BO}-t_f$ (h:min)	Evac. to BO $t_{BO}-t_e$ (h:min)
1	Hoffman Rd	07:50	Concow	06:45	07:37	1:05	0:13
2	Concow Rd	07:50	Concow	06:45	07:37	1:05	0:13
20	Camelot Ln	07:55[a]	Concow	06:45	07:37	1:10[a]	0:18[a]
4	Skyway (upper)	08:30	2	08:15	08:01	0:15	0:29
5	Windermere Ln	08:35[a]	Concow	06:45	07:37	1:50[a]	0:58[a]
6	Pentz Rd	08:45	8	07:49	07:46	0:56	0:59
7	Pearson Rd	09:15	7	08:00	08:01	1:15	1:14
			8	07:49	07:46	1:27	1:29
			13	09:00	08:01	0:15	1:14
			14	08:47	07:46	0:28	1:29
8	Bille Rd	09:25	2	08:15	08:01	1:10	1:24
			3	07:50	07:46	1:35	1:39
			7	08:00	08:01	1:25	1:24
			8	07:49	07:46	1:36	1:39

[a] Earliest available data point; burnover conditions existed before first recorded observation.

6.3.3.1. Concow Burnovers

By 06:51, BCSO confirmed that multiple law enforcement personnel were en route to Pulga to help with evacuations. The first in-person observation of fire in Concow by first responders was at 07:20 and was reported back to the IC. The evacuation order was requested by the IC at 07:37 and was conveyed to BCSO by the law enforcement (LE) representative at the ICP. There was no CodeRED data identified for Concow. There were no siren notification systems in place. Door-to-door notifications and vehicle PA systems were used to inform the public of the approaching fire. Because of the early hour, it is likely some residents were asleep.

Concow occupies a large geographic area compared to other evacuation zones impacted by the Camp Fire. The first documented fire data point in the Concow area was at 06:45 in the eastern area of the zone; it took less than 45 minutes to spread to or spot into the developed area (i.e., Camelot, Concow Road). The first 911 calls reporting fires burning in yards in Concow were received at 07:30. Multiple spot fire ignitions in Concow, 6 km (4 mi) ahead of the fire front,

grew rapidly and restricted egress. Documented burnovers started at 07:50, approximately 20 minutes after the first reported fires in the developed areas. Civilians and first responders became trapped in burnovers, and TRAs were formed to address immediate life safety needs.

The fire-notification scenario that took place in Concow represents a near-worst-case scenario. The vegetative fuels, fire history, topography, and atmospheric conditions at the time of ignition resulted in very rapid fire intensification and spread. Combined, these resulted in fire spread rates via spotting of 6 km/h to 10 km/h (4 mi/h to 6 mi/h). The Concow burnover/notification event attributes impacting the civilian notification and egress are summarized in the following two lists:

Negative Attributes:

1. Multiple spot fire ignitions (accentuated by fuel receptivity and fuel loading)
2. Early time of impact when some people were asleep
3. No siren notification system
4. No documented CodeRED notifications sent
5. Single egress route
6. Remote location requiring extensive response time for first responders

Positive Attributes:

1. Timely and effective communication between IC and LE
2. Short time span between fire observation information transferred to IC and evacuation request
3. Presence of first responders to form TRAs and lead civilian convoys to Camelot Meadow Wild Fire Safety Zone

6.3.3.2. Upper Skyway Burnover

The first spot fire near Skyway ignited at 08:24 near the boundary of Zones 1 and 2 north of Wagstaff Road, 250 m from Skyway. Multiple additional spot fires subsequently expanded the extent of fire along Skyway, contributing to the burnover event. Evacuation orders for Zone 1 were requested 25 minutes after ignition. CodeRED calls to Zone 1 did not occur until 16:17. The spot fires grew rapidly, giving civilians little time to evacuate before getting trapped by the burnover. The impact of the burnover on upper Skyway locally stopped egress flow and additionally impacted evacuating traffic from northern Paradise and from Magalia, due to Skyway being one of the main north/south road arteries. The fire-notification scenario that took place in Zone 1 is summarized in the two following lists:

Negative Attributes:

1. Spot fire ignition next to egress artery with high fuel load (no fire history)
2. No siren notification system

3. CodeRED notifications were not started until 16:17
4. Limited time to evacuate before burnover
5. Closure of major egress artery impacted flow out of many zones to the north
6. CodeRED was an opt-in system

Positive Attributes:

1. First responders were present to facilitate traffic management and civilian movement to TRAs.

6.3.3.3. Pentz Road Burnover

The evacuation order for Zone 8 was requested by the IC at 07:46. The first report of a fire within the zone was documented three minutes later at 07:49. The first CodeRED call in this zone was placed at 07:57, 8 minutes after the first report of fire.

Civilians evacuating early (07:45–08:00, before the arrival of fire) were slowed by regular rush hour traffic. Evacuation traffic in the Pentz Road corridor was possibly further complicated by parents going back to Ponderosa Elementary School on Pentz Road to pick up their children. Conditions deteriorated as the fire front impacted the eastern side of Paradise, and the burnover on Pentz Road started at 08:45. The situation on Pentz Road between Bille Road and Pearson Road was further complicated by the burnovers at the Bille Road/Pentz Road intersection (to the north) and the burnover on Pearson Road (to the south). All three burnovers significantly complicated local situational awareness, and by extension, evacuation information conveyed to the evacuees.

Review of the available data allows for the identification of several temporal components of the overall evacuation event. Looking at the data for Zone 8, the time for information transfer from the IC to LE is estimated between 1 minute and 3 minutes as a LE representative was at the ICP and conveyed the information directly to BCSO. CodeRED calls were initiated 11 minutes after evacuation orders were given by the IC.

Without rush-hour traffic, fire, or smoke, it takes approximately 22 minutes to travel from upper Pentz Road to Butte College off Durham-Pentz Road, and several minutes longer to get to CA Highway 99 or Chico. Therefore, an evacuee from upper Pentz Road would need at least 33 minutes to get out of the immediate fire area. This estimate is an unrealistic absolute minimum, assuming immediate evacuation action. This minimum time does not include delays that would be added by not being registered for or receiving a CodeRED notification, making the decision and preparations to leave, rush hour traffic, or traffic impacts/delays from smoke, fire, and possible road closures. The above time intervals and unaccounted temporal delays highlight the challenges of evacuating civilians during a rapidly developing fire. The fire-notification scenario that took place in Zone 8 is summarized in the two following lists:

Negative Attributes:

1. Multiple spot ignitions (fuel receptivity and fuel presence)
2. No siren notification system

3. Closure of major egress artery impacted flow out of many zones to the north
4. Limited situational awareness because of extent of fire front and burnovers to the north (Bille Road) and south (Pearson Road)
5. High civilian density areas (e.g., school and hospital)
6. CodeRED was an opt-in system

Positive Attributes:

1. Available mass notification (CodeRED) implemented quickly
2. Presence and large capacity of the parking lot at Feather River Hospital (FRH) on Pentz Road
3. Availability of other parking lots on Pentz Road (see Sec. 9.4.3).

6.3.3.4. Pearson Road Burnover

The Pearson Road burnover occurred near the intersection of four Paradise evacuation zones (7, 8, 13, 14). The intersection of Pearson Road and Pentz Road was critical to the evacuation of all four zones; Pearson Road is a major east/west artery, and Pentz Road allows flow out of Paradise to the south and connects with Magalia to the north. The evacuation orders in these zones were requested by the IC at 07:46 (Zones 13 and 14) and 08:01 (Zones 7 and 8). CodeRED calls began at 07:57 for Zones 8 and 14 and 08:32 for Zones 7 and 13.

The burnover started on Pearson Road at 09:15, between 51 min and 1 h 18 min after the first CodeRED calls in these zones. Traffic on Pearson Road was gridlocked from incoming traffic from all of the connecting side streets in addition to traffic that had originated from Pentz Road and was trying to escape from the fire.

The fire-notification scenario that took place at the Pearson Road burnover is summarized in the two following lists:

Negative Attributes:

1. Multiple spot fire ignitions (fuel receptivity and fuel presence)
2. No siren notification system
3. Traffic on Pearson Road to the west preventing flow of traffic out of the burnover
4. Local topography – drainage possibly contributing to enhanced fire behavior
5. Closure of a major egress intersection between two arteries impacting flow out of many zones to the north
6. CodeRED was an opt-in system

Positive Attributes:

1. Available mass notification (CodeRED) implemented quickly

2. Presence of first responders to create a TRA on Pearson Road and lead the convoy to another TRA at FRH
3. Available undeveloped field for use as TRA
4. Presence of dozer to support TRA and clear roadway
5. Nearby TRA at FRH with capacity to accommodate civilians from Pearson Road and reduce exposures

6.3.3.5. Bille Road Burnover

The Bille Road burnover occurred at the intersection of Bille Road and Pentz Road where evacuation Zones 2, 3, 7, and 8 meet. The earliest identified fire observations within these four zones were at 07:49 (Zone 8) and 07:50 (Zone 7). CodeRED notifications began at 07:57 and 08:32, and the burnover started at 09:25, one to one and a half hours later.

While this burnover occurred at least one hour after the initiation of CodeRED call in the surrounding zones, evacuee traffic was such that gridlock occurred and civilians could not get out of the burnover area. This burnover is similar to the Pearson Road event, as the intersection of Bille Road and Pentz Road is a key evacuation intersection in eastern Paradise. Unlike Pearson Road, however, there was not an open field nearby, and the gridlock at the large intersection limited the traffic management options. The presence of the fire engine and the operational fire hydrant used by the engine to cool the intersection with the deck gun resulted in significant exposure reduction to the trapped civilians and their vehicles.

The fire-notification scenario that took place at the Bille Road burnover is summarized in the two following lists:

Negative Attributes:

1. Multiple spot ignitions (fuel receptivity and fuel presence)
2. High-density of structures in nearby mobile home parks
3. No siren notification system
4. CodeRED was an opt-in system
5. Gridlock of major egress intersection between two arteries impacted flow out of many zones
6. Burning vehicles on Bille Road to the west prevented flow of traffic out of fire

Positive Attributes:

1. Available mass notification (CodeRED) implemented quickly
2. Available and operational fire hydrant
3. Presence of first responders to create TRA, with support of fire engine connected to hydrant to cool trapped vehicles
4. Large intersection and parking area to accommodate number of vehicles.

6.4. Communications Challenges

Large incidents that involve multiple agencies/organizations can experience communication issues among and within the different entities, and this was also reported during the Camp Fire. TDs indicate radio traffic overload; however, these observations were not universal throughout the incident. Several unique communication challenges related to execution of evacuation notifications have been identified beyond those commonly observed during large incidents. Complications specifically with respect to public notifications in Paradise were introduced when both the Town of Paradise EOC and PPD had to be evacuated due to fire.

Communication was complicated, specifically for PPD, by the moving of the PPD operations and dispatch to Chico. Radio coverage from Chico to Paradise was limited to the southern part of Paradise, and officer checks-ins and communications from northern Paradise and Magalia had to be relayed through other officers to the operator in Chico. Additionally, some TDs discussed the ability for field radios to receive communications without the ability to transmit. In some cases, dispatch was able to hear the keying of microphones and used the clicks as a response mechanism to identify that the responding officer was okay.

Cell phone coverage was reported to be “patchy” near FRH and the Pearson Road/Pentz Road intersection on a normal basis before the fire. Cell phone coverage was significantly impacted on the day of the fire due to cell phone tower drop off. Seventeen cell phone towers became non-operational sometime during the Camp Fire [51].

Situational awareness of rapidly deteriorating conditions resulted in disconnects among PPD officers in the field, PPD dispatch, and the EOC. Further complications arose from multiple messaging sources, including two CodeRED Systems (Butte County and Town of Paradise) trying to disseminate rapidly changing information. Communication to residents was likely impacted by the power and internet outages; however, an analysis of such impacts is beyond the scope of this report.

6.5. Summary

A timeline of evacuation notifications was developed based on the integration of data primarily from TDs with incident command staff, radio logs, 911 call recordings, and records of reverse-911 notifications. The presented timeline was based on the initial requests for evacuation warnings and/or orders requested by the IC. While these times are not the same as when the notifications were sent to or received by the public, they provide the best foundation for the notification timeline and can be related to the situational awareness of the IC. Evacuation orders flowed from the IC through the law enforcement agencies responsible for the execution/enforcement of the evacuation orders. First responders in the field began immediate execution of the evacuation requests through direct contact with residents. Additional notification methods followed.

No mass notification emergency alert sirens were available in Concow, Paradise, or Magalia; however, multiple tools were used to notify the public including door-to-door notification, announcements via vehicle-mounted speakers, CodeRED reverse-911 call system, and social media. Eight batches of reverse-911 calls were issued to Paradise and Magalia between 07:57 and 09:30, attempting to reach nearly 21 000 registered phone numbers.

The prior establishment of the fire progression timeline [23] made possible the examination of the notification and evacuation timelines in the context of fire. Overlaying notification data with fire spread data provided an understating of the temporal relationship between notifications, evacuation orders, and fire progression. The analysis was conducted based on the evacuation zones and documented fire in these areas. The analysis highlights that the relationship between notifications and fire can be subdivided into three categories and time periods:

1. Fire was ahead of notification (~06:30 to 07:30)
2. Notifications were approximately simultaneous with the arrival of fire (~07:30 to 08:40)
3. Notifications were ahead of the fire (after 08:40).

These three categories represent the early part of the event (from a notification perspective), when situational awareness was limited; the middle part of the incident, when notifications were catching up to the fire spread and notifications were occurring simultaneously with the arrival of fire; and the later part, where a positive time interval developed providing more time between public notification and fire arrival.

These categories point to three distinct temporal issues associated with community emergency notifications:

1. There is a finite minimum time necessary for situational assessment by the IC.
2. There is finite minimum time between the assessment, deciding that evacuation warnings or orders are needed, and the communication of this information through the chain of command to the participating agencies; specifically, but not limited to, law enforcement.
3. There is a finite amount of time needed to communicate the notification information to the public. The method of communication will impact the minimum time required (e.g., door-to-door notification may take more time than remotely activating a siren system).

These three cumulative times described above can be used to establish minimum temporal thresholds for community notification design scenarios. This time is one component of the evacuation timeline, which also includes pre-movement time (for tasks including decision-making, preparation, and packing) and the actual evacuation time. Even without fire it takes a finite amount of time to notify and evacuate a section of a community. The analysis of the temporal relationships between evacuation orders and burnovers highlights the challenges associated with the mass evacuation of civilians in a rapidly progressing fire. The use of the various notification tools described above enhanced public awareness; however, fast spreading fire caused multiple closures of key evacuation roadways and egress arteries, resulting in burnover events which significantly impacted life safety.

The presented data highlights the critical need for effective situational awareness and communication between first responder organizations in order for the evacuations to rapidly get “ahead” of the fire. The multiagency training exercise highlighted in Sec. 5.4 was essential to the rapid communication of the IC orders to the participating first responder agencies and to the public.

6.6. Technical Findings

Pre-Fire

TF-N 1. The Town of Paradise had an established Emergency Operations Plan (EOP).

TF-N 2. The Town of Paradise Emergency Operations Center staffing included town employees and volunteers trained to facilitate notification and evacuation efforts.

TF-N 3. There were no sirens in place for emergency notification in Concow, Paradise or Magalia.

TF-N 4. In preparation for a real wildfire/WUI fire, CAL FIRE and the Town of Paradise worked with multiple local and state jurisdictions to conduct an extensive and detailed evacuation and WUI fire exercise.

TF-N 5. Pre-fire preparations like the evacuation plan and evacuation/WUI fire drill significantly enhanced the first responder notification, evacuation, and firefighting capabilities during the Camp Fire.

During Fire

TF-N 6. During the Camp Fire, public agencies used several modes of communication to alert residents, including door-to-door messaging, vehicle-mounted speakers, CodeRED reverse-911, and social media platforms including Facebook and Twitter.

TF-N 7. Early in the incident, before 08:00, the rapid fire spread outpaced the information flow and the establishment of evacuation boundaries.

TF-N 8. Early in the incident, before 08:00, limited situational awareness (because of rapid fire progression) and the inherent time necessary for communication from the Emergency Command Center (ECC) to Paradise Police Department (PPD) impacted accuracy of information.

TF-N 9. Both 911 call centers (PPD and ECC) provided consistent information to callers based on the changing situational awareness and evacuation orders.

TF-N 10. The initial IC evacuation warning request in Paradise at 07:32 was for “west of Pentz” instead of “east of Pentz.” Fourteen minutes elapsed between the initial request and the time the warnings were upgraded to orders and exact zones were specified at 07:46. The “west instead of east” does not appear to have caused any notification delays.

TF-N 11. There is a finite time required to transfer evacuation requests from the incident commander (IC) to first responders to the public.

TF-N 12. It took approximately 10 minutes from the IC request for an evacuation warning for Pentz Road to when law enforcement began door-to-door notifications. The information went from IC to law enforcement dispatch to officers on location.

TF-N 13. PPD 911 began informing residents to evacuate as early as 07:49, just as the first spot fires ignited in Paradise (before evacuation orders were issued for those locations).

TF-N 14. Butte County ECC and PPD accelerated the evacuation of Paradise, communicating complete evacuation at 08:03, ahead of the multi-zone request from the IC at 08:49.

TF-N 15. There was a communication gap between evacuation of "all of Paradise" vs. the IC-selected zones. BCSO and Town of Paradise opted to evacuate more zones than the ones requested by the IC. The communication gap lasted at least 46 minutes.

TF-N 16. Local spot fire ignitions can rapidly spread, leading to burnover events. This rapid fire spread results in limited time for civilian notification, impacting safety during evacuation.

TF-N 17. The use of general directional terms (e.g., east, west, north, and south) relative to specific zones can be a cause of confusion; however, when many zones are involved in a rapidly developing incident there may not be sufficient time to list all zones.

TF-N 18. The Integrated Public Alert and Warning System (IPAWS), including Wireless Emergency Alerts (WEA), was not used.

6.7. Recommendations

In planning for WUI fire evacuations, communities should consider:

R-N 1. Developing a notification plan and maintaining a resilient notification system.

R-N 2. Implementing and utilizing a multi-modal notification system that accounts for electricity/internet/infrastructure failures and spans the range of information sources available to residents (e.g., phones, IPAWS, internet, social media, radio, sirens).

R-N 3. Accounting for the cumulative minimum time necessary for situation assessment, information transfer to the incident commander, information transfer between the incident commander and law enforcement, and communication to the public in the design of a community notification and evacuation plan.

R-N 4. That rapid fire progression and the proximity of a fire's origin to a community may reduce the time available for notification and evacuation. Developing a distributed system of wildfire safety zones for sheltering within the community may provide the safest approach for civilians who may not have sufficient time to safely evacuate.

R-N 5. Using official social media channels to enhance dissemination of real-time information.

R-N 6. That use of advertised and promoted official social media channels to provide updates during an ongoing disaster incident should only be reserved for organizations that can maintain these channels with current information throughout the event. Explicit acknowledgement that information may be incomplete or outdated should be provided.

R-N 7. That advertised use of official social media channels for updates during emergency incidents that do not then provide updated information during an incident can disseminate misleading information to the public. This may result in significant propagation of false information and negatively impact decisions and responses of civilians.

This page intentionally left blank.

7. Evacuation and Traffic Flow

Evacuations during the Camp Fire were a regional-scale event. In a complex, dynamic, large-scale event such as this, there are many different evacuation stories based on multiple factors including individual decision-making, local conditions, route of travel, time of departure, and interaction with fire. Some individuals were able to evacuate early under normal traffic conditions. Others encountered various setbacks and their journeys took 10 or more hours. This section presents an overview of the general evacuation timeline based on traffic flow observations from TDs and supporting information from radio logs, photos, and videos. Inclusion of data from the fire spread timeline shows the impact of fire on egress arteries and provides context for the effects of fire and corresponding road closures on the evacuations. Detailed information about departure times, intermediate trips (e.g., to return home first, or to meet family before evacuating), intended and actual routes and destinations, important inputs for evacuation modeling [19, 44], were beyond the scope of this case study. Such information, if available through post-incident surveys or mobile GPS data, such as recent work by Wu et al. [52] and Zhao et al. [53], could further support evacuation modeling research efforts when combined with fire progression data.

Much of the evacuation was achieved through individual or small group travel (e.g., families, neighbors) using personal civilian vehicles. The quick onset of the evacuation for the entire town led to widespread gridlock. Gridlock was further exacerbated by the number of civilians evacuating in large recreational vehicles (RVs) or towing trailers. To enhance life safety, several strategies were implemented to alleviate jams, facilitate traffic flow, and manage civilians when traffic was gridlocked in high hazard areas (i.e., approaching fire). These strategies included:

- traffic direction/management at intersections,
- direction of traffic to roadways with no direct fire exposures,
- traffic re-direction to account for continuously changing conditions (traffic and fire),
- use of roadways, parking lots, and other open spaces as traffic overflow accumulators and TRAs.

Situational awareness was essential to accomplish the above list of strategies for adapting to the changing fire conditions and availability of safe egress routes.

During the course of the evacuations, several roads were impacted by fire and/or other blockages and had to be closed to traffic, causing additional delays and reroutes. These burnover events are described in Ref. [23] and in Sec. 8. Many civilians were unable to evacuate due to these closures and were directed by first responders to TRAs where groups of civilians (3 to ~550) waited for hazardous conditions to abate and for the roads to become passable again. Many others abandoned their vehicles in the traffic or fire and ran to a stranger's vehicle, were rescued by first responders, or in some cases ran several kilometers to a safer location. Section 9 presents the TRAs in more detail. Other civilians were unable to evacuate without assistance or were caught in dangerous fire conditions while evacuating and were rescued by first responders. Many of these rescues are documented in Sec. 10.

The widespread implementation of TRAs led to large groups of civilians staging within Paradise while waiting for conditions to improve. Ultimately, several convoys of vehicles were escorted out of the fire area. The large-scale evacuation also benefitted from the use of buses from the

County's regional public transportation system, Butte Regional Transit (B-Line). B-Line buses played an important role in the eventual evacuation of civilians from TRAs to local emergency shelters and evacuation centers. The evacuation convoys of the B-Line buses are described in further detail in Sec. 9 on TRAs.

In this section, a description of the available evacuation data is presented, along with a general overview of the evacuation progression. The limited available information on the evacuation of schools, FRH, and several other critical care facilities is presented (this information was generally beyond the scope of the collected data and would benefit from a dedicated data collection and analysis effort). This is followed by a detailed reconstruction of traffic flow on egress arteries and other roadways, including discussion of roadway closures and traffic flow restrictions. Due to the significant population difference and the more extensive road network, much of the focus is on Paradise.

7.1. Evacuation and Traffic Data

The data presented in this section is a collection of observations from TDs, radio logs, and photographic data. Fire apparatus AVL data was also used to determine travel times and traffic speeds to help further quantify traffic flow and road closure information. Data from Caltrans traffic sensors in the area that were installed at the time of the fire were also referenced. There were no evacuation surveys conducted to collect the data presented in this section. The traffic observations from all sources were compiled and sorted by roadway and time to facilitate cross-referencing to reconstruct the traffic flow.

The contributions of LE and fire department personnel to redirect and manage traffic to avoid civilian entrapments are demonstrated. The presented data illustrate how the fire dictated road closures and how the road closures impacted evacuation. The data shows why it is essential to document the fire behavior first before attempting to reconstruct the evacuation and traffic details of an event.

Two examples show why it is critical to pull together different data streams to get a complete picture of the event. In one case, the radio log indicates that a group of B-Line transit buses were on their way to help evacuate the Feather Canyon retirement facility on Pentz Road at 08:44. However, technical discussions with B-Line bus drivers and other first responders at Butte College coordinating the response and mass evacuations indicated that the buses had to be turned around due to high fire exposures and never made it to Feather Canyon. Another example of the use of multiple data streams involves the evacuation of the Cypress Meadows Post-Acute transitional care facility. A news article in the Los Angeles Times [54] describes the events that took place between 07:45 and 10:00. TD-067 continued the account after 11:00, beyond what was included in the article, and described the evacuation of patients from Cypress Meadows to a TRA at the intersection of Clark Road and Skyway (the Optimo TRA, see Sec. 9). What is particularly interesting is that neither source referenced the activities recounted in the other, highlighting the need for extensive and comprehensive data collection efforts.

7.2. Evacuation Overview

The following subsections present an overview of the evacuation of civilians from Pulga, Concow, Paradise, and Magalia. Differences in community characteristics, fire progression and notification timing, and traffic impacts contributed to differences in evacuations.

7.2.1. Evacuation of Civilians from Pulga and Concow

There were limited data associated with the evacuation of Pulga. The first engine arrived in Pulga at 06:46; shortly afterwards, at 06:54, they ordered the evacuation of Pulga. Upon arrival, firefighters conducted door-to-door notifications and evacuated four people. It is unknown how many other civilians were in the retreat community at the time and evacuated on their own. The only evacuation route is Pulga Road to CA Highway 70, through Yankee Hill toward Oroville and Chico. Given the limited population of Pulga, it is likely that traffic did not impact the evacuation of civilians; however, the extremely narrow roadway leading to CA Highway 70 and dense vegetation up to the roadbed could have quickly presented hazardous conditions if more people had been present (i.e., summer residents, vacationers, weekenders) or the fire had progressed differently. There is no data of any burnovers in Pulga.

Concow also had one evacuation/access route: Concow Road south to CA Highway 70. Rapid fire progression, high vegetative fuel loading, and minimal vegetative clearance along roadways resulted in the multiple burnovers that affected the evacuation of civilians from Concow. In general, heavy traffic did not impact the evacuation of Concow. Despite the two-lane road and incoming first responders, Concow Road south of Cribbage Lane was free of traffic and was not affected by any large-scale or significant duration traffic delays. Additionally, an undetermined number of civilians stayed at their residences, because they could not evacuate (fire or mobility), didn't feel the need to evacuate, or chose to stay and protect their property.

Due to the differences in fire progression, the evacuation of Concow can be divided into three sub-regions within the Concow zone: the structure and population dense area in the vicinity of Camelot Lane and Concow Road north of Cribbage Lane, the area south of Cribbage Lane to CA Highway 70, and Jordan Hill Road west of Concow Road. Other areas within the Concow Census Designated Place (CDP), such as Yankee Hill and Nelson Bar Road, were impacted by fire overnight and into November 9 and are not detailed in this report.

Camelot

The Camelot neighborhood was the first part of Concow impacted by fire, beginning in the 07:00 hour. Potential factors affecting how many residents could evacuate quickly included the likelihood that some residents were still in bed, the lack of mass notifications, and burnovers that occurred on Hoffman Road and Concow Road. Based on data from the U.S. Census Bureau and the number of residential structures accounted for by official DINS post-fire damage inspections, it was estimated that approximately 367 people lived in the area north of Cribbage Lane.

There are limited data on how many residents from the area north of Cribbage Lane were able to evacuate before the fire blocked Concow Road. Most residents that became trapped in the Camelot area sought shelter at the Camelot Meadow Wildfire Safety Zone (see Sec. 9 on TRAs). Many people were in personal vehicles; however, some were rescued and evacuated by first

responders. The people who sheltered in the TRA were escorted out via Concow Road after the fire front passed and the roadway was deemed passable around 10:00.

Concow Road from Cribbage Lane to CA Highway 70

This area was impacted by fire after areas to the north, giving residents time to evacuate via Concow Road to CA Highway 70. First responders conducted door-to-door notifications in this area to advise residents to evacuate. The fire did not progress south of Cribbage Lane and Ishi Trail until later in the morning, and residents could egress without any impacts from fire or roadway burnovers on the morning of November 8 until 10:00. Fire progressed to the south end of the reservoir in the mid-day timeframe, and to Jordan Hill Road at Concow Road in the afternoon, 13:00–14:00. There were several reports of people sheltering in place at their residences. There were no reports of entrapments or fatalities in this section of Concow Road.

Jordan Hill Road

The Jordan Hill Road area west of Concow Road was impacted by spot fires and then the fire front before areas along Concow Road south of the reservoir. Residents in this area reported fire via 911 calls just before 08:00 and began evacuating at that time. Some civilians remained behind after the initial notification/evacuation of Jordan Hill between 7:00 and 8:00. Firefighters accessed the Jordan Hill Road area after reports of trapped civilians around 11:00 and were able to rescue them. However, the late evacuation contributed to added hazards and this rescue developed into a burnover event (*BO #13*) [23]. The fire engine sustained damage and had difficulty navigating downed power lines. They had to drive through fire on Jordan Hill Road to escape.

7.2.2. Evacuation of Civilians in Paradise

As discussed in Sec. 5.1, the Paradise evacuation plan was designed to be implemented for a few zones of Paradise at a time rather than the entire town all at once. The IC initiated evacuation orders for the eastern zones first. However, the ember cast ahead of the fire front and the reports of multiple simultaneous ignitions instigated discussions between the IC, BCSO, PPD, and Paradise Town Hall about the evacuation of all of Paradise as the progressive evacuation approach from east to west was being implemented. There was concern of "breaking the system" if the entire town were to be evacuated at once [TD-010], but based on the fire progression, it was quickly decided that the full immediate evacuation was needed. The Butte ECC notified PPD that they had just issued evacuation orders for the entire town of Paradise; PPD announced the evacuation orders immediately to officers on their radios.

Since the primary evacuation method was by personal vehicles, the town-wide evacuation caused a rapid increase in traffic, resulting in multiple gridlocks on the major arteries. Traffic conditions provided the best available metric to evaluate and analyze the evacuation progression and are detailed in Sec. 7.5. The town-wide evacuation resulted in the simultaneous need to evacuate the hospital and other care facilities, schools, workplaces, civilians in transit, and civilians at home.

Compounding factors impacting the evacuation included:

- daily morning rush hour, as many residents were on their way to work,
- children being dropped off at and in transit to school in school buses,
- the number of large vehicles (e.g., RVs) and towed trailers, and
- rapidly increasing presence of smoke and fire, particularly in the Pentz Road corridor and Skyway just south of Clark Road.

The proximity of Paradise to Chico and Oroville enabled BCSO and other LE first responders to rapidly reach Paradise to help with facilities evacuations and to manage traffic.

The evacuation of Paradise is summarized in Table 13. Section 7.3 describes the available data on the evacuation of schools, FRH, and critical care facilities, while Sec. 7.5 describes traffic flow through the different arteries as a function of time. Table 13 shows the rapid progression between the first spot fire, the first evacuation orders for western Paradise request by the IC, and the evacuation order for the entire town issued by the ECC. The data also illustrate the rapid progression of gridlock associated with increased traffic flow and exacerbated by road closures due to fire.

The progression of burnovers occurring between 09:00 and 09:25, from Pentz Road to the three major east-west arteries of Wagstaff Road, Bille Road, and Pearson Road significantly impacted evacuations. Many civilians were trapped in burnovers, and others were stranded in eastern Paradise due to fire blocking roadways. All traffic was forced westward into Paradise toward Clark Road and Skyway. At 10:00, the closure of Clark Road near American Way, 2 km (1.2 mi) south of Pearson Road, resulted in another significant traffic redirection further to the west. This further increased flow to the already slow-moving traffic on Skyway in Paradise.

The early closure of upper Skyway quickly resulted in gridlock at the intersection with Clark Road before a TRA was formed in the parking lot of the Optimo restaurant (*TRA-S*) (Sec. 9). This closure, as well as smoke and fire north of Pentz Road, completely stopped the evacuation of civilians from Old Magalia and Magalia through Paradise.

While some residents were able to escape early before the traffic gridlock and burnovers, a large number of residents were stuck in traffic for hours. Traffic observations indicate that most civilians were evacuated by 13:45. Additional traffic outside the fire area into Chico, greater Butte County, and beyond continued to impact travel to evacuation shelters and the final destinations of many people.

However, a significant number of people remained in TRAs well after 13:45, waiting for roads to become passable and transportation to arrive for those who did not have vehicles or who had abandoned their vehicles. This was accomplished by several evacuation convoys escorted by first responders, and mass transportation using B-Line transit buses. Details are presented in Sec. 7.4.

Table 13. Paradise evacuation summary timeline.

Time	Fire	Evacuation/Traffic
07:46		*First evacuation orders requested for eastern Paradise (Pentz Rd).*
07:49	First spot fire in Paradise.	
08:03		*Butte ECC and PPD issue evacuation orders for all of Paradise.*
08:30	At least 30 spot fires have ignited throughout eastern Paradise.	
08:30	First burnover starts on major egress artery – upper Skyway.	Major north-south egress artery is gridlocked impacting evacuation of upper Paradise and the evacuation of Magalia. Some vehicles utilize the bike path to head south. Other intersections see increased traffic.
08:45	Burnover starts on Pentz Rd.	Major egress artery is closed, impacting evacuation of upper western Paradise and the evacuation of Magalia.
09:00		Evacuation of FRH and the nearby Feather Canyon retirement community completed.
09:00	Burnover starts on Pearson Rd.	Major east-west artery is closed impacting west to east traffic and evacuations.
09:15	Burnover starts on Bille Rd.	Major east-west artery is closed impacting west to east traffic and evacuations.
09:25	Burnover starts on Wagstaff Rd.	Major east-west artery is closed impacting west to east traffic and evacuations.
10:00	Burnover starts on Clark Rd at American Way.	Major egress artery is closed impacting evacuation of all of Paradise and the evacuation of Magalia.
10:15	Burnover starts on Lower Skyway.	Heavy fire activity impacts Skyway at the lane divide during peak evacuation. Fire is burning structures on both sides of the road. All lanes are being used for SB traffic.
10:45		All traffic is held at Clark Rd and Skyway due to fire conditions on Skyway between Wagstaff Rd and Clark Rd; people stuck in this area are abandoning vehicles and fleeing on foot.
11:30		Clark Rd in Paradise is largely free of traffic. After opening for a short time, Clark Rd recloses due to fire south of town.
12:30	Burnover starts on Neal Rd.	The north-south egress artery Neal Rd is closed. Fuels change beyond the town limits to grassland with few or no structures. Fire and egress problems are confined to within the town limits on Neal Rd.
13:15–13:45		Traffic is clearing out through Paradise. Most traffic on Skyway is now south of Pearson Rd and is slowed by the downed power lines near the lane divide. Neal Rd is clear of Traffic at 13:15.
14:00		A strike team headed to Magalia moves cars and trailers by hand to clear a pathway through the gridlock of abandoned vehicles on Clark Rd at Skyway.

7.2.3. Evacuation of Civilians in Magalia

Data regarding evacuation from Magalia was limited by two primary factors. Due to the progression of the fire that first impacted Concow and Paradise, most emergency personnel responded to those areas, reducing the availability of observations from Magalia. Evacuation traffic and fire blocking routes through Paradise further restricted access to Magalia through the morning hours. Secondly, the evacuation of Magalia occurred over a broader time period, further diluting the density of the data collected from first responders.

Traffic backups and road closures on Skyway restricted evacuation to the south by 10:45. Residents who were able to leave early, either because of a morning commute, from early concerns about the fire, or immediately after the evacuation orders were requested at 08:49, are likely to have evacuated south through Paradise. Routes and travel durations were variable. Once the intersection was closed, southbound passage was blocked until 16:30. For eight hours the only evacuation option for Magalia residents was the longer and more remote northern route.

Firefighters accessing Magalia in the early afternoon encountered a number of civilians still at home or assembled in the street with their neighbors, viewing the fire and smoke plume nearby to the south. Multiple residents on several streets refuted information provided by firefighters and resisted evacuation. A dedicated study of evacuation decision-making was not undertaken; however, several anecdotal statements provide potential insight to why residents may not have evacuated by this time:

- the perceived risk may have been lower due to the direction of the wind blowing fire away
- concern about the long northern evacuation route with limited fuel and services
- waiting for the reduction of heavy traffic delays
- overall desire to stay.

Because of the blocked evacuation route, many people waited for the roads to become passable. This led to the assembly of TRAs and staging areas. Further described in Sec. 9, a number of TRAs were established at parking lots of the church and grocery store.

After fire conditions throughout Paradise improved and emergency officials were able to begin a plan to evacuate civilians sheltering in TRAs, a number of buses and convoys were organized to take people from Magalia to Paradise and then out of the fire area. Buses took multiple trips to Magalia overnight between 17:00 on November 8 and 05:00 on November 9.

7.3. Evacuations of Schools, Feather River Hospital, and Other Care Facilities

The evacuation of schools, hospitals, and other care facilities was generally beyond the scope of the data collection conducted for this current study. Significant findings about widescale emergency evacuation of such facilities with large populations of citizens reliant on transportation and continued care could be learned from in-depth studies of future events focused specifically on this topic.

However, there are some details regarding the evacuation of such facilities in the collected data. Schools were evacuated using an unknown number of school buses, as well as personal vehicles of many staff. There is one account from first responders detailing a number of students without

transportation that were picked up by Paradise Police and taken to the station to await further transportation.

The data on evacuation of FRH is summarized in Table 14. The collected information does not provide sufficient resolution to determine the beginning of the hospital evacuation. The data points describing the arrival of fire provide context for the entire event. Spot fires were first reported on the FRH property at 08:11 via 911. The caller also indicated that evacuation efforts were just beginning. Once it was decided to evacuate the hospital, there was a rapid response of regional law enforcement and EMS to FRH. By 08:36, about one third of the 60 patients had already been evacuated, and less than ten minutes later a first responder arriving at the hospital at 08:45 stated that there were no more patients at the hospital. Patients were evacuated using an unknown number of vehicles, including personal vehicles of hospital staff, law enforcement vehicles, and ambulances.

Several ambulances left the hospital going north on Pentz Road due to fire south of the hospital. Two became entrapped in a burnover on Pentz Road shortly after 09:00 [911-221-2]. Paramedics and hospital staff in the ambulances rescued the patients and sheltered in a nearby residential structure for two hours before they were able to return to the hospital. FRH was heavily defended by multiple fire engines and personnel and became a TRA after the initial evacuation of the facility and the passage of the main fire front. Several patients were returned to the hospital to receive care (outside of the building) until transportation was available. The number of staff and civilians at the hospital at 13:30 is not known. Civilians trapped in other areas of eastern Paradise were also directed or transported to the hospital parking lot TRA. An estimated 160 civilians sheltered at the FRH TRA, and the TRA was occupied for over 6 hours. An evacuation convoy attempted to reach the hospital in the afternoon but was turned around because of fire on Clark Road. The final evacuation details in terms of routes taken and number of vehicles in different convoys are not known.

Table 14. Evacuation timeline of Feather River Hospital.

Time Range		Observation	Source #
07:46		IC requests evacuation orders for Paradise Zones 3, 8, 14, and Lower Pentz (FRH is in Zone 8).	TD-010, VTD-32
07:49		The first spot fire in Paradise ignites off Riverview Drive, ~125 m south of FRH property.	TD-063, PPD 911-064-1 911-066-1 911-071-1 911-084-1
07:51		Butte County Med calls the ECC confirming evacuation orders and is anticipating evacuation of FRH.	911-072-1
08:00		Fire is within feet of residences at the Feather Canyon retirement facility.	911-086-3 911-1035-1
08:11		Spot fires are igniting on FRH campus and evacuations begin.	911-1047-1
08:20	08:40	Fire activity increases on FRH campus; several hospital buildings catch fire.	TD-014, TD-063 VTD-32 911-131-1 911-137-1
08:20		Evacuation of FRH is under way; 10 to 15 BCSO vehicles arrive to help.	TD-063
08:30		Patients are being staged in the ER lobby and being evacuated by buses, medical transports, and law enforcement.	TD-020
08:36		FRH has one third of approximately 60 patients evacuated.	VTD-32, PPD
08:45	09:00	All patients have been evacuated; some staff remain.	TD-020, TD-103 VTD-17, VTD-32 PPD
09:30		Vehicles from Pentz Rd arrive/return to FRH parking lot. The FRH parking lot is now used as a TRA.	TD-020, TD-063 PPD
10:26		A convoy of vehicles is escorted to the FRH TRA from the burnover on Pearson Rd.	TD-122, TD-123
11:00		The ER becomes available in limited capacity for emergency patients only. Some patients are returned to the hospital and staged in the ER and outside.	TD-005, TD-014 TD-020, TD-069 TD-109, TD-111 PPD
11:30	13:30	Transport vans leave the hospital at one point in the early afternoon but soon return when unable to evacuate. Specific route and obstruction details are unknown.	TD-069

Paradise had a number of additional care facilities. A combination of TD data and internet searches compiled a list of at least 20 different facilities ranging from retirement and assisted living communities to transitional care, non-ambulatory care, and hospice facilities. Facilities ranged from small in-home care services with less than 10 beds to large commercial care facilities with over 130 beds. Three examples of care facility evacuations are included to illustrate challenges involved in their evacuation.

Cypress Meadows Post-Acute transitional care facility, located off of Clark Road north of Wagstaff Road, began the evacuation process as early as 07:45, identifying any available beds regionwide to provide continuing care. By 09:30 the first 40 out of the 91 total patients had been moved out. Between 09:30 and 10:00, an order was received to prepare to shelter in place; however, at approximately 10:00 authorities arrived and informed staff that they had to evacuate immediately. Patients were loaded into staff member and law enforcement vehicles. Some patients had been transported north toward Skyway and were stuck in the gridlock, ultimately sheltering at a TRA [TD-067].

The number of different care facilities and mass evacuations triggered assistance from regional ambulance response teams. One such team responded to Paradise to provide evacuation support. They were unable to access the hospital due to fire conditions in the morning. However, in the afternoon, they were flagged down and directed to a care facility that still needed assistance evacuating their residents/patients. In this case, ambulances were needed to transport people due to mobility and medical requirements.

In another case, several patients from Paradise had been previously evacuated to a care facility/assisted living community in Chico. However, as the fire continued to spread down the foothills through the afternoon, concerns about expanded evacuations into Chico triggered evacuation of that facility as a precaution. Several ambulances were utilized to move patients requiring more advanced or specialized care to locations further away.

7.4. Evacuation Escorts/Convoys

Much of the evacuation was accomplished via individuals in personal vehicles on main roadways in heavy traffic, with direction and assistance by first responders. In some cases, additional assistance was needed, and people were escorted from or through a hazardous location individually or in groups. Additionally, evacuation of the many temporary refuge areas was conducted via large convoys led by first responders. These evacuation convoys occasionally included public transit buses. Four categories of evacuation convoys have been identified:

- Convoys escorted to safe egress route or directly out of the fire area
- Convoys escorted to a TRA
- Convoys escorted from TRA to TRA
- Convoys escorted out of the fire from TRAs

Details specific to the last two categories, convoys between TRAs and evacuation of TRAs, including the use of transit buses, is further discussed in Sec. 9.3. Additionally, people were rescued by first responders and were escorted to TRAs or out of the fire area to safety. Individuals who were rescued and taken to TRAs are not included in this discussion of convoys, which focuses on larger groups of civilians. The number of specific rescue events characterized by individual escorts and TRAs are included in Sec. 10 on Rescues.

These convoys occurred throughout the fire area and incident timeline. A few specific examples are listed in Tables 15 and 16 to illustrate the variety of situations and times when escorts and convoys were utilized. It is expected that there are many instances in addition to these specific examples where first responders, particularly LE, rescued/escorted civilians out of the fire area or to a safer location. Limitations in the data collection led to an underrepresentation of LE personnel; however, the available data indicates the significant role LE played in evacuations, escorts, and rescues.

Table 15. Examples of civilian convoys escorted out of the fire area.

Approx. Time Range		Event Description	TD Notes	Fire Exposure[a]	Source
07:45	08:00	Escort civilians out of fire; Concow	Escort 3 civilian vehicles through dense smoke back to flank [of fire, and toward CA-70]	High	TD-110
10:00	12:30	B-Line transit bus convoy into Paradise	Pick up evacuees at multiple locations in southern Paradise. In via Clark Road, out via Neal Road.	Low to High	TD-049 TD-057 TD-059
10:00	11:00	Escort multiple convoys through fire on Skyway; Paradise	BCSO escorts convoys of 20 vehicles down Skyway, including school bus with unknown number of people; several convoys until power line dropped and blocked passage	Moderate, then High	TD-067
13:00	13:15	Escort civilians to safe egress route; Paradise	Locate and escort civilians out. Visibility along Bille Rd is poor; people didn't want to drive [into unknown hazard conditions], weren't sure of way out until escorted	Unknown	TD-112
12:00	14:00	Escort civilians to safe egress route; Concow	Convoy with WT45, an engine, 2 to 3 civilian vehicles; zero visibility	Unknown	TD-027
13:15	13:30	Escort civilian to safe egress route; Paradise	Escort civilian to Wagstaff Rd. No other traffic or cars on Pentz Rd. Cutting power lines with axes; difficult to cut with bolt cutters.	Unknown	TD-045
17:30	17:45	Escort civilians to safe egress route; Paradise	2 residents that were trapped at Twilight Ct [NW Paradise] have been removed and escorted out	Low	TD-014

[a] Relative fire exposure related to conditions during the escort, not necessarily conditions experienced prior to that event.

Table 16. Examples of civilian convoys escorted to shelter at TRAs.

Approx. Time Range		Event Description	TD Notes	Fire Exposure[a]	Source
09:45	10:45	Escort/re-direct traffic to FRH (*TRA-E*)	Directed >50 northbound vehicles to turn around [south on Pentz Rd] to return to the hospital parking lot; pitch black visibility, fire ahead	Low to High	TD-090
10:30	12:45	Escort vehicles to Paradise Baptist Church (*TRA-M*)	Set defensive fire in grass to get safe parking area; start bringing civilians to church; law enforcement present	Unknown	TD-085
11:15	12:15	Escort convoy of vehicles to Paradise Plaza (*TRA-K*)	Skyway and Rocky Ln; traffic is jammed, BCSO advise people to get out of vehicles and walk; advise teens to lead a convoy to Paradise Plaza parking lot	High	TD-042
11:30		Escort vehicles to Best Western (*TRA-T*)	Escort civilians to shelter in Best Western parking lot	Unknown	TD-211
14:30	15:00	Escort/transport vehicles/civilians to Ace Hardware (*TRA-Q*)	EMT advised about a civilian trapped in cemetery; go with engine and two ambulances; find 9 people at cemetery; escort them back to Ace Hardware parking lot	Low	TD-132

Note: TRA identifiers (e.g., *TRA-E*) in the Event Description refer to specific locations detailed in Sec. 9.
[a] Relative fire exposure related to conditions during the escort, not necessarily conditions experienced prior to that event.

7.5. Traffic Flow Along Egress Arteries

Given that the use of individual personal vehicles was the primary means of evacuation, the traffic flow through Paradise and beyond provides the best understanding of the overall evacuation progression.

The traffic in Paradise and points south of town in the foothills was documented by over 1100 individual traffic observation data points. By gridding the town into main north-south egress arteries and east-west cross streets and extending the arteries leading out of town to the egress corridors of CA Highway 99 and Durham-Pentz Road, the traffic, fire, and roadway obstruction conditions were documented at a total of 114 intersections or road segments. Summaries of the traffic conditions on each main roadway are presented here in 11 sections and data tables. Intersections of main egress arteries and cross streets are included in both respective tables for completeness and ease of use.

7.5.1. Traffic Overview

Traffic conditions were categorized into seven levels based on traffic flow and fire exposures along each major roadway. Only the available data is presented; no attempt has been made to fill in data gaps. Conditions were not inferred or interpolated at times and/or locations where explicit observations were not available in the data. Table 17 summarizes the different levels, from (1) no traffic or flowing traffic, to conditions where (5) traffic is very heavy and slow moving or stopped and exposed to fire. The last two categories (6 and 7) were reserved for conditions where the road was closed and no civilians were in the area. This differentiates from Category 5 in which traffic may have been stopped where fire was impacting the roadway.

Table 17. Definition key of traffic flow conditions.

Category	Description	Notes
	no data	
1	no traffic / flowing	Roadway may be smoky and/or dark, but there is no hazard to the roadway from fire.
2	congested / slowed (traffic)	
3	obstructed / slowed (fire-power lines-visibility)	Not all 3's are equal. Some exposures may be more severe, and traffic flow may be light or heavy. May indicate segment is passable by a few individuals not a large convoy. May just indicate an area where passage is obstructed.
4	very heavy / gridlocked / stopped (traffic)	
5	very heavy / stopped (fire-power lines-visibility)	Not all 5's are equal. Exposures may vary, but traffic is stopped (including partial lane closures) and stuck where fire was impacting the roadway.
6	closed / blocked by other (no people)	Roadway is blocked by downed utility lines, trees, debris, or is actively closed by law enforcement.
7	closed / blocked by fire (no people)	Active fire is the primary closure.

The seven categories were defined/created to facilitate data dissemination through general descriptions. As noted in Table 17, even within a specific category not all conditions are identical; hazard levels and flow rates may differ within a single category. The term “passable” is a relative term provided from a first responder perspective and does not imply a fully accessible and functioning egress artery; hazards and debris may be present but do not completely block the road. Additional details on specific conditions can be found in the tables by street (Sec. 7.5.2.1 to 7.5.2.11) and in the NETTRA data listed in Appendix A.

Using the categories described in Table 17, Fig. 16 provides a condensed visualization, in tabular form, of traffic conditions on 13 major roadways between 06:30 and 14:15. Major cross-streets or roadway segments are identified along each major roadway and are listed in each row, in order from north to south or east to west. There are a total of 114 rows representing the main egress arteries and intersections in Paradise and the foothills. Each column represents a fifteen-minute window starting at the listed time. When a route is viewed in its entirety, the information provides an overview of the traffic progression on that road in both space and time. Reading across each row provides a time history of traffic conditions at each road segment. Reading down each column, the table provides an overview of where traffic is flowing or not, and where fire is presenting hazardous conditions or road closures at a given time. Maps illustrating the data at each time window are presented in Appendix E.

Concow Road is listed first (abbreviated to “C Rd”), with two segments detailed: one at Hoffman Road and one at Tweedy Lane, the southern edge of the fire 1 km (0.6 mi) roadway distance south of Hoffman Road. There was limited data available describing conditions on Concow Road south of this point, although it is believed that there were no significant traffic delays. The next ten sections describe traffic in Paradise, covering the four main egress arteries to the south as well as the east-west routes. Foster Road, whose key role is described below in Sec. 7.5.2.9, and Valley View Drive (abbreviated “V”), are also included.

Intersections of major arteries appear in both locations; however, the data represented describes the traffic flow along the primary route, not the cross street. For conditions on the cross street, see the corresponding primary route at the same intersection.

Figure 16 shows the rapid deterioration of traffic conditions throughout Paradise, indicated by the transition from no data or flowing traffic (1) to heavy traffic (4). For example, at 08:00 traffic on Pentz Road was flowing (1) at the intersection with Wagstaff Road; at 08:15 there was heavy traffic/gridlock (4). Pentz Road at Dean Road exhibited a slower transition, with a sequence of 1-2-4-4-1-1 between 08:15 and 09:45. The transition back to no traffic at 09:15 represents the slug of traffic progressing north towards Skyway, away from the fire at Merrill Road and Wagstaff Road. This can also be seen when viewing the columns of Pentz Road between 09:00 and 10:00 showing the different areas which were impacted by gridlock and/or fire. The green Category 1 boxes starting at approximately 10:30 in sections of Wagstaff Road and Clark Road illustrate the beginning of the emptying of Paradise from the north. The progression is seen in Bille and Elliott Roads about an hour later. Skyway and Pearson Road are the last roads to clear at the south end of town.

The first identified conditions of fire directly impacting local evacuation (5) occurred between 08:30 and 08:45 on Skyway in the vicinity of Lofty Lane, south of Clark Road. This was the result of early spot fire activity in the area. No data was available for that location for the 08:45 to 09:00 window; however, at 09:00 Skyway was blocked by fire (7). This event represents the

first road closure in Paradise on November 8. It should be noted that the closure of Skyway occurred approximately one hour after the first reported spot fire in Paradise, merely 30 minutes after the fire front reached Pentz Road, and only ten minutes after the evacuation orders were requested for that part of Paradise (Zone 1) as described in Sec. 6.

The data in Fig. 16 show that there was a total of 29 separate key egress intersections that experienced closures due to fire in a total of 34 events. Thirty-three events occurred in Paradise and the foothills; only one event occurred in Concow. The difference between the two values (29 intersections and 34 events) is associated primarily with Clark Road, where the road opened and closed more than once. These data point to one quarter (28 of 114) of the listed intersections being closed due to fire during the evacuation of Paradise. The remaining event (1 of 29) occurring in Concow closed the only egress route available. While some closures were short (represented in one 15-minute time window), Bille Road, Clark Road, and Skyway each experienced road closures that lasted more than two hours. The closure of upper Skyway required a dozer to clear access for the B-Line bus convoy, and the closure on Bille Road did not get cleared by a dozer until the evening of November 8. Data gaps, such as on Pentz Road at Gate Lane at 11:45, prevent a complete analysis of the average length of closures. All 34 identified road closure events (Categories 6 and 7) impacted civilian egress and many also impacted first responder access and operations.

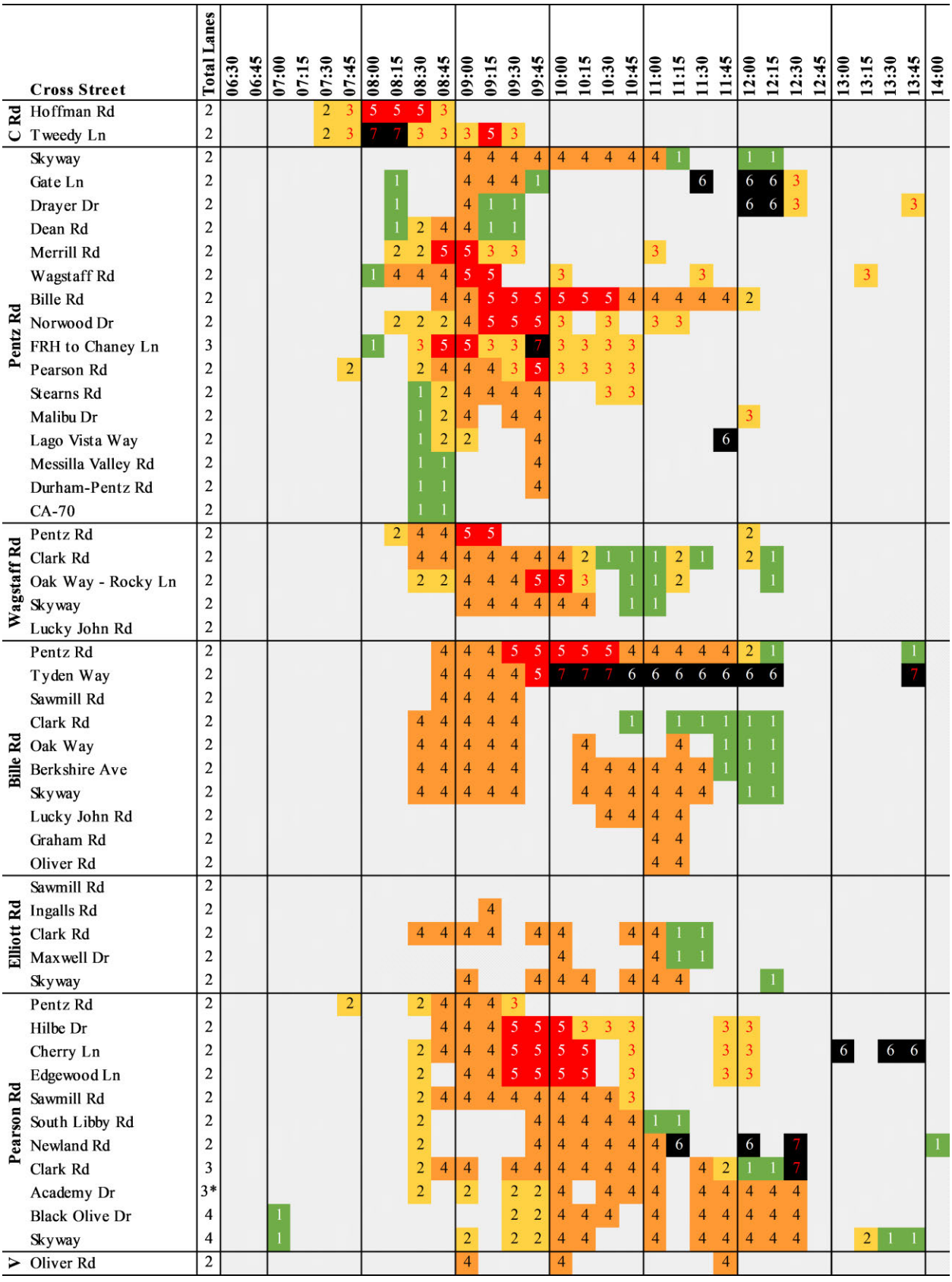


Fig. 16a. Traffic conditions as a function of time along major roadways. See Table 17 for key.

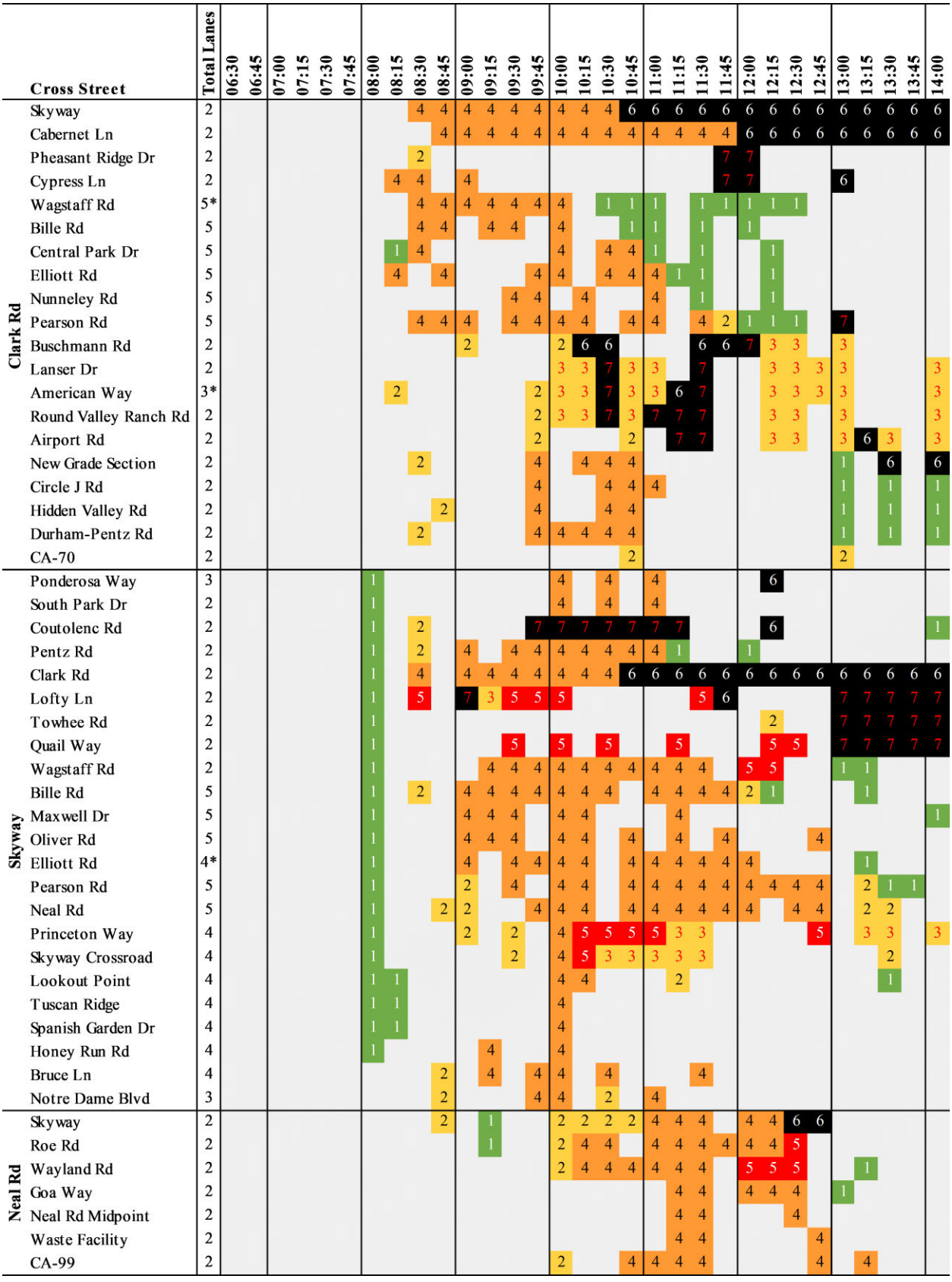


Fig. 16b. Traffic conditions as a function of time along major roadways. See Table 17 for key.

	Cross Street	Total Lanes	06:30	06:45	07:00	07:15	07:30	07:45	08:00	08:15	08:30	08:45	09:00	09:15	09:30	09:45	10:00	10:15	10:30	10:45	11:00	11:15	11:30	11:45	12:00	12:15	12:30	12:45	13:00	13:15	13:30	13:45	14:00
Foster Rd	Buschmann Rd	2																2	4	4			4										
	Roe Rd	2											2					2	2	4			4										
	Wayland Rd	2											2					4	4	4	4		4										
	Neal Rd	2											4					4	4	4	4		4										
Durham-Pentz	Pentz Rd	2								1	1				4	4																	
	Messilla Valley Rd	2									1				4	4																	4
	Clark Rd	2									1				4	4	4	4															4
	Williams Rd	2																			1	1											
	CA-99	2																			1	1											
CA-99	CA-32	2*								2						2		4															
	E 20th St	2*																															
	Skyway	2*																		2		4											
	Neal Rd	2*									4						4			4	6	6	6	6			4						
	Durham-Pentz Rd	2*																		4		4	4	4			4						
	CA-149	2*																	4									6					
	CA-99	2*																										4					

Fig. 16c. Traffic conditions as a function of time along major roadways. See Table 17 for key.

7.5.2. Traffic Flow Details by Roadway

The data presented in Tables 18 through 28 are distilled from TDs, radio logs, videos and photographs, and integrated in space and time using the methodology described in Sec. 3. While Fig. 16 shows an overview of traffic conditions over time, the following sections provide summaries of conditions on each of the major roadways in Paradise, along with two significant roadways beyond: CA Highway 99 and Durham-Pentz Road. Due to the lower population and data sparsity early in the incident, there was not a significant volume of data describing traffic conditions on Concow Road beyond what has been presented in Sec. 7.2.1.

7.5.2.1. Pentz Road

Pentz Road is the north-south egress artery in eastern Paradise. With the exception of FRH, several places of worship, scattered commercial buildings, and a few schools, this is primarily a residential corridor. Pentz Road is one lane in each direction with no shoulder for the entire length. To the east, streets terminate at the edge of the West Branch Feather River canyon. Typically, there is some traffic on Pentz Road with commuters from eastern Paradise and from Magalia. Several schools also impact traffic on Pentz Road, particularly in the morning. The first spot fires in Paradise occurred east of Pentz Road. As the initial spots grew and the fire front arrived at the town's eastern boundary, fire impacted traffic and restricted evacuations.

Conditions and traffic varied locally along Pentz Road as spot fires ignited and the fire front arrived at 08:30. In many cases, early situational awareness was incomplete due to the rapid development of the event, and residents were travelling in both directions (north and south) in attempts to evacuate. Local traffic from side streets backed up quickly as residents evacuating nearly simultaneously from all neighborhoods along Pentz Road had to merge into a single road.

In one example, on Merrill Road at 08:40, where data were available from PPD dashboard video, traffic was backed up with 36 vehicles (and two trailers) in one lane trying to merge onto Pentz Road. The backup increased by 8 vehicles in the next minute. The 36 vehicles represent approximately 23 % of the 158 residences serviced by Merrill Road, assuming one vehicle per residence. The available data illustrate how rapidly conditions can deteriorate and delay evacuation out of high hazard areas.

Evacuating traffic restricted access to first responders entering the fire area. As visibility reduced to zero in many locations, one incoming engine elected to move off Pentz Road and conduct evacuations and firefighting activities on Riverview Drive, a side street to the east just south of FRH. Another engine was able to access the Bille Road/Pentz Road intersection by driving partly off the road and was able to provide critical protection to the civilians that were gridlocked at the intersection (see Sec. 9 on TRAs). The closing of this artery significantly impacted the evacuation of eastern Paradise.

Evacuating traffic, including patients from FRH, were caught in burnovers on Pentz Road, as well as on Pearson Road to the south and Bille Road to the north (see Sec. 8). The burnovers on Pentz Road limited evacuation options, trapping many people in the area of FRH. The complexity of the evacuation was primarily due to the arrival of the broad fire front impacting a 2.5 km (1.5 mi) stretch of Pentz Road north and south of FRH. Additional complicating factors included:

- the need to evacuate the hospital patients and staff for healthcare reasons,
- the need to evacuate all people for life safety reasons (due to fire front and structure ignitions at FRH),
- early fire impacts on Pentz Road south of FRH (e.g., Riverview Drive, Chaney Lane),
- first responder arrival and activity blocking southbound Pentz Road,
- gridlock and arrival of fire north of FRH (north to Bille Road),
- deteriorating visibility with arrival of fire front at FRH (periodically < 2 m), and
- limited situational awareness at FRH of conditions to the north and south.

All of the above factors resulted in significant confusion, with civilians being directed both north and south depending on the information that each first responder knew. Once situational awareness was improved by reports from other responders both north and south of FRH, evacuees with no way out were redirected to the parking lots at FRH where a TRA was formed. First responders used FRH and six other parking lots located along Pentz Road as TRAs to shelter civilians and reduce fire exposures to them. In late morning, after the burnovers on Pentz, Bille and Pearson Roads, fallen power lines along Pentz Road in Paradise further restricted evacuations from the north as well as first responder movements. Pentz Road became passable again in the early afternoon.

Table 18. Pentz Road traffic progression summary.

Time Range		Description
08:15		Traffic is increasing between Merrill Rd and FRH as spot fires ignite and evacuations start; traffic first gridlocks at the Wagstaff Rd intersection.
08:30		Fire exposure to the roadway increases between FRH and Pearson Rd. Traffic volume continues to increase.
08:45		Fire impacts vehicles near Merrill Rd and Chaney Ln. There is heavy traffic between the fire impacted areas. Traffic flow southbound out of Paradise increases.
09:00		There is traffic gridlock throughout Pentz Rd. Heavy traffic evacuates northbound north of Merrill Rd, others are stuck between Wagstaff Rd and FRH. Inbound traffic is blocked by law enforcement.
09:15	09:45	The fire front impacts traffic stuck between Bille Rd and FRH (*BO #6*). Evacuees north of Dean Rd are progressing towards Skyway.
09:30		Evacuees are directed to the FRH parking lot to escape from fire conditions between FRH and Bille Rd. Pentz Rd south of FRH remains blocked by fire.
09:45		Fire, power lines, and emergency response block passage south of FRH and north of Bille Rd. Heavy traffic progresses south of Paradise toward CA-70. Northbound traffic is jammed at Pentz Rd and Skyway.
10:00	11:00	Fire is subsiding at FRH and some civilians evacuate south. The Bille Rd intersection remains gridlocked in high exposures and is being protected by a fire engine (*BO #8*).
11:15		Gridlock at the Skyway intersection has cleared.
12:00		Vehicles from the Bille Rd intersection are escorted to the Kmart TRA.
11:45	12:30	A number of utility lines and utility poles block Pentz Rd north of Wagstaff Rd.
12:30	14:00	Pentz Rd through Paradise is navigable.

7.5.2.2. Clark Road

Clark Road is the central north-south route through Paradise and passes through primarily commercial areas between Pearson Road and Wagstaff Road. This stretch of road is typically 5 lanes wide. The area north of Wagstaff Road is primarily residential and the roadway narrows to one lane in each direction with minimal shoulder space north to Skyway. South of Pearson Road, Clark Road is managed by the state as CA Highway 191, with one lane in each direction and often a wide shoulder. There was a four-way stop at Durham-Pentz Road, approximately 10 km (6 mi) south of Paradise. Further south is the connection to CA Highway 70. As one of the primary roads within Paradise, there is typically traffic on Clark Road during the morning commuting hours.

Spot fires throughout Paradise, together with additional traffic from evacuees arriving from the east, rapidly caused Clark Road to gridlock in many locations. Table 19 presents a chronological summary of traffic progression along Clark Road. Contraflow began at certain locations on Clark Road as early as 08:30 and was fully implemented between Wagstaff Road and Pearson Road for four lanes southbound by 09:00. The contraflow provided more lanes for egress to increase the flow out of northern Paradise.

By 09:00 at the northern end of Paradise, traffic flow from Clark Road onto Skyway southbound was significantly impacted by the gridlock caused by the closures on Skyway. It is possible that some vehicles turned around to attempt to use Clark Road southbound, although heavy traffic

was backed up north of Wagstaff Road and fire was already burning in the area of Kilcrease Cir and Cypress Ln.

The constant flow rate of traffic south on Clark Road, combined with cross traffic on Durham-Pentz Road, could not be readily accommodated at the Durham-Pentz Road intersection four-way stop. Traffic began backing up north of Durham-Pentz Road by 09:45 and resulted in an 8 km (5 mi) backup by 10:50. The tail end of the line was within 800 m (0.5 mi) of the advancing fire burning out of the canyons parallel to the roadway. The arrival of this fire and resulting burnover prevented access of arriving first responders. Had the backup extended further, or had the fire advanced faster, additional civilian exposure to fire would have occurred.

Traffic continued to flow south on Clark Road and out of Paradise; however, the pace was slow. Even with contraflow being used within Paradise, traffic had to be redirected at Pearson Road because the four lanes of Clark Road heading south reduced to only one lane in each direction south of Pearson Road. There were some reports of occasional contraflow on Clark Road for some distance south of the town limits. The extent and duration of the contraflow could not be determined from the data available. Additional traffic was merging from the east on Pearson Road. The traffic on Clark Road was continually fed by evacuees fleeing the deteriorating conditions on Pentz Road corridor and eastern Paradise as the fire continued progressing westward. Traffic flow at the intersection of Clark Road and Pearson Road was improved by directing southbound traffic on Clark Road west onto Pearson Road and westbound traffic from Pearson Road southbound onto Clark Road. This allowed both traffic arteries to flow without delays associated with alternating traffic. Figure 17 shows diagrams of the implemented traffic flow (a), compared to the alternating or cross-traffic arrangement (b). Figure 17c shows an image of the conditions looking north at the intersection at 10:59. This worked to get vehicles off Pearson Road quicker as fire was impacting the end of the line to the east. Note that this approach can work only if there is safe passage in both directions. Otherwise, a slower alternating merge or alternating direction management, or other large scale TRA would be necessary.

As the fire progressed to and burned over Clark Road just to the south of Paradise, several evacuating residents and first responders were caught in hazardous conditions. First responders closed Clark Road twice between 10:00 and 12:00 due to fire conditions. After the burnovers, Clark Road was reopened, and traffic was significantly improved by 13:00. The multiple closures of Clark Road south of Pearson Road to the airport significantly impacted the traffic flow out of Paradise. To manage the outgoing flow and to stay ahead of the fire, PPD, together with other first responders, used three strategies. They:

1. Redirected the southbound flow on Clark Road to flow west on Buschmann Road. Diversion of vehicles to western Paradise, which was not as affected by fire at the time, reduced the fire exposures to evacuees and pushed the flow further to the west. The traffic on Buschmann Road was then directed to Neal Road, via Foster Road and Wayland Road, and also back to Skyway, via Foster Road and Pearson Road. Traffic direction at key intersections facilitated this detour.
2. Utilized TRAs as overflow reservoirs. The parking lots of the commercial facilities on Clark Road were leveraged to remove vehicles from the roadway and stage them for a later evacuation. All four TRAs along Clark Road were utilized in this way.

3. Utilized TRAs to remove evacuees from high exposure conditions. This occurred when civilians egressing Paradise were caught by the advancing fire south of Paradise between American Way and Round Valley Ranch Road; vehicles were turned around and were directed to the TRAs in the parking lots of the Best Western hotel or Ace Hardware store.

Several non-fire obstructions and blockages impacted the usability of Clark Road for later evacuation of civilian convoys and first responder access and operations. Multiple downed utility lines and poles partially or completely blocked Clark Road in several places. To the north, vehicles parked in the roadway near the intersection of Skyway completely blocked passage through the afternoon. At 14:00, a strike team heading for Magalia was able to displace some vehicles by hand to get access and proceed north on Skyway. The intersection was not substantially open until heavy equipment was arranged to clear passage for evacuation convoys after 16:30.

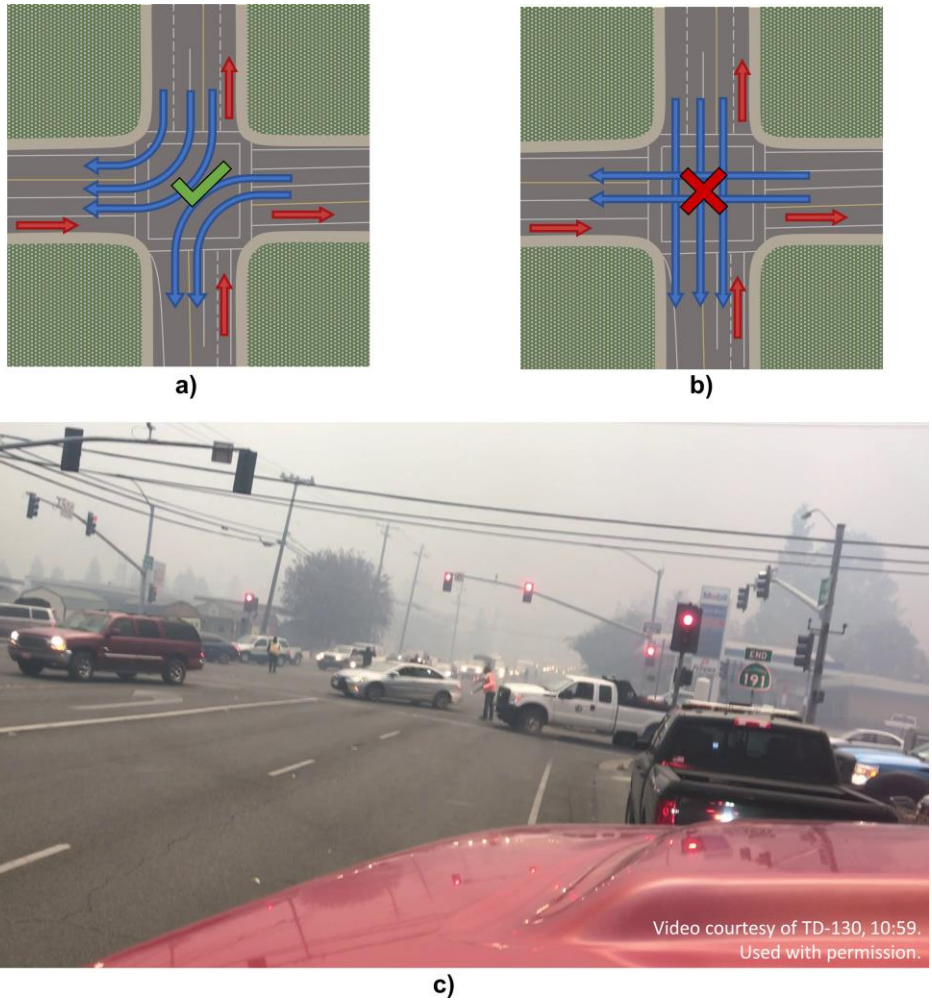


Fig. 17. Stylized diagrams showing a) simultaneous flow and b) alternating flow; red arrows indicate open lanes available for emergency vehicle travel. c) photo of simultaneous flow implemented at the intersection of Clark Road and Pearson Road at 10:59.

Table 19. Clark Road traffic progression summary.

Time Range		Description
08:15	08:45	Traffic is getting locally gridlocked in areas near initial spot fires and local evacuations.
08:30	09:00	Traffic is heading SB on Clark Rd south of Wagstaff Rd. Gridlock at Clark Rd and Skyway significantly limits traffic movement at the northern end, affecting vehicles coming from north of Wagstaff Rd or from Pentz Rd.
08:30	09:15	Arteries feeding Clark Rd from the west are causing local gridlock at major intersections in Paradise. Localized areas in Paradise have contraflow. Clark Rd is flowing southbound out of town.
09:30	10:00	Contraflow is implemented along Clark Rd between Wagstaff Rd and Pearson Rd for all lanes SB.
09:45	11:00	Outbound traffic is backed up to the airport (~8 km [~5 mi]) due to slow downs at the Durham-Pentz Rd intersection.
10:00	10:30	Fire is burning along Clark Rd at the south end of Paradise, impacting traffic.
10:15	10:45	Vehicles drive through fire and Clark Rd is subsequently closed in the vicinity of American Way (*BO #10*). SB traffic is diverted from Clark Rd onto Buschmann Rd. Traffic south of the airport is backed up to Durham-Pentz Rd and occasionally two lanes SB.
10:45		Fire exposures have decreased, allowing for one lane to be re-opened on Clark Rd south of Buschmann Rd. Contraflow of Clark Rd between Durham-Pentz Rd and CA-70 is implemented to alleviate traffic. In Paradise, the backup has cleared north of Bille Rd through Wagstaff Rd.
11:00		Traffic is continuing to clear on upper Clark Rd, now backed up south of Elliott Rd. Southbound Clark Rd is directed WB onto Pearson Rd and traffic from Pearson Rd is directed SB on Clark Rd to Buschmann Rd. Fifty-foot flames are crossing Clark Rd near Round Valley Ranch Rd.
11:15		Traffic is held at Clark Rd and Skyway due to fire blocking Skyway south of Clark Rd and north of Pentz Rd. Heavy fire exposures between American Way and Airport Rd close Clark Rd again, preventing civilian evacuations and first responder ingress.
11:30	12:00	Clark Rd in Paradise is largely free of traffic. A number of civilian vehicles are traveling SB on Clark Rd and sent WB on Pearson Rd. Clark Rd south of Buschmann Rd is still closed due to fire.
11:45		A 1.6 km (1 mi) stretch of Clark Rd is burned over between Cabernet Ln and Wagstaff Rd. There is limited evacuation and first responder activity along this stretch of Clark Rd at this time.
12:00		Fire and power lines continue to impede travel on Clark Rd north of Wagstaff Rd. Fire is also burning across Clark Rd between Pearson Rd and Buschmann Rd. Clark Rd is clear of traffic backups throughout Paradise, except for the closure at the Skyway intersection where civilians have abandoned vehicles in the roadway to seek shelter at the Optimo TRA.
12:15	12:45	Fire south of Pearson Rd has subsided enough to barely allow passage. Vehicles in the backup (from westbound) on Pearson Rd are re-directed toward Clark Rd to leave Paradise.
13:00		There are localized blockages of Clark Rd in Paradise due to power lines and fire exposures to the roadway. Several convoys of are led out of town from points south of Pearson Rd.
13:15		Utility pole/line is blocking access for a strike team just north of the airport.
13:30		The southern edge of the fire is south of the airport and the road is closed to northbound traffic.
14:00		The southern edge of the fire is still south of the airport, north of Circle J Rd, and the road remains closed to northbound traffic. Fire is still burning fuels along Clark Rd south of Buschmann Rd, and power lines and other debris obstruct passage in numerous locations.
14:00		A strike team headed to Magalia moves cars and trailers by hand to clear a pathway through the gridlock of abandoned vehicles on Clark Rd at Skyway.

7.5.2.3. Skyway

Skyway runs through Paradise from the northeast to southwest direction from Magalia to Chico. As the roadway connecting Paradise, Magalia, and the Upper Ridge to the city of Chico, as well as the commercial downtown of Paradise, Skyway is the main route through Paradise. At the northern end of Paradise, Skyway is two lanes surrounded by a combination of commercial and residential lots with significant vegetative fuels. South of Wagstaff Road Skyway is almost exclusively bordered by commercial properties. Between Bille Road and the town limits it becomes five lanes (two northbound, two southbound, and a center turn lane), with an exception between Elliott Road and Pearson Road where it narrows to four and three lanes. In this section of downtown, parking lanes are available on both sides and sidewalk bump outs are present at several crosswalks. From the lane divide to Chico, Skyway is divided with two lanes in each direction.

The early spot fires and approaching fire front quickly impacted the northern end of Skyway, with one of the early spot fires igniting near the intersection with Clark Road. These ignitions and associated fire spread rapidly deteriorate local conditions and caused an initial closure of upper Skyway, just south of the intersection with Clark Road by 09:00. A number of convoys were sent down Skyway until worsening conditions forced the closure of Skyway. This included a burnover of dozens of civilians in their vehicles between Wagstaff Road and Clark Road. Residents that did not get out of this area before the burnover were essentially trapped by the fire and were assembled into a TRA by 11:00. Smoke and fire also blocked Skyway between Pentz Road and Coutolenc Road, cutting off the northern egress route.

The upper Skyway burnover (*BO #4*), described in Sec. 8 and Ref. [23], had significant repercussions on the evacuations of northern Paradise, Old Magalia, and Magalia. The resulting gridlock at the Skyway/Clark Road intersection resulted in limited traffic heading south down Clark Road. The Pentz Road corridor was blocked by fire, and many of the trapped vehicles had already come from that area seeking alternate egress via Skyway. Any direct evacuations of Old Magalia and Magalia through Paradise were no longer possible, and evacuees were forced to wait for fire and roadway conditions to improve.

Further south near the town limits, a spot fire to the west of Skyway in Honey Run Canyon spread west (upslope) and impacted evacuating traffic near the lane divide around 10:15. Fire and subsequent obstructions (utility lines and poles, trees) continued to restrict flow, even with the implementation of contraflow to use a northbound lane for southbound traffic. After implementation of contraflow along Skyway, law enforcement and others directing traffic had to maintain presence to prevent drivers from trying to merge back to the regular southbound lanes and resume typical traffic patterns.

Unlike traffic on Pentz Road that could head west to Clark Road, and further west to Neal Road and Skyway, the evacuees on Skyway had no place to go but south. Traffic from Wagstaff, Bille, Elliott and Pearson Roads continued to merge with southbound traffic on Skyway, avoiding the fire progressing from the east and north. The accumulation of traffic toward southwestern Paradise contributed to the backup all the way to Chico starting as early as 10:00, and gridlock on intersections along Skyway throughout Paradise.

The three primary factors impacting traffic egressing Paradise to the south on Skyway were:

- the total number of lanes from side streets feeding into Skyway (within Paradise),
- the ability of Skyway to flow traffic into/through Chico (backing traffic up the hill into Paradise), and
- the effects of fire, both direct (flaming exposures to traffic) and indirect (downed power lines and utility poles, trees, and other road closures).

The effects of the localized reduction in road capacity through the downtown Paradise area between Elliott Road and Pearson Road had little impact on the overall traffic flow due to the outsized effects listed above. While the reduction in roadway width had limited impact, the presence of a crosswalk "island" on Skyway between Pearson Road and Neal Road (at the Town Hall) limited the use of the center turn lane by responding emergency vehicles entering Paradise via Skyway.

With traffic heading in a southbound direction, officers utilized changing roadway widths to facilitate merging from side streets. For example, Skyway expands from two lanes to five lanes total at the intersection with Bille Road. This allowed traffic from Bille Road to merge directly into a southbound lane without alternating with traffic already on Skyway. Similar conditions facilitated merging of traffic from Pearson Road onto Skyway.

By 13:15 the heavy traffic was south of Pearson Road. Obstructions at the lane divide still restricted traffic, and upper Skyway was closed until the dozer/B-Line bus convoy arrived to clear the road at 16:30.

Table 20 presents a summary of traffic progression along Skyway.

Table 20. Skyway traffic progression summary.

Time Range		Description
04:30	07:45	Several power lines are down on Skyway in Magalia and Stirling City, likely due to high winds.
08:30		The first major spot fire affects Skyway between Lofty Ln and Clark Rd. Traffic is gridlocked at Clark Rd and some vehicles utilize the bike path to head south. Other intersections see increased traffic.
08:45		The traffic light at Neal Rd is manually programmed to hold a green light for Skyway due to increased traffic. Exact volume/speed of traffic is unclear due to conflicting TD statements.
09:00		Fire continues to impact traffic between Lofty Ln and Clark Rd. Law enforcement stops traffic. Skyway becomes very congested north of Pearson Rd. South of Pearson Rd, traffic is flowing out of town with assistance of public works and law enforcement.
09:15		Law enforcement is directing traffic through the spot fire, alternating traffic from Clark Rd and Skyway. Skyway through Paradise is backed up. Additionally, traffic is backed up at the bottom of the hill into Chico, at least as far as Honey Run Rd. NB Skyway is blocked by LE at Bruce Rd.
09:30	10:45	Fire has expanded between Wagstaff Rd and Clark Rd resulting in two localized burnovers that intermittently permit some evacuation traffic (*BO #4*).
09:30		The roadway is again blocked by fire at Lofty Ln, and partially blocked by fire at Quail Way. There is extensive gridlock between Wagstaff Rd and Pearson Rd. Contraflow is implemented, however it is difficult to maintain in some sections.
09:45		A spot fire burns across Skyway between Pentz Rd and Coutolenc Rd, closing the road in both directions. Fire and traffic problems continue in Paradise.

Time Range		Description
10:00		Contraflow is implemented out of Paradise. At least one of the NB lanes is being used by SB traffic.
10:15	11:15	Heavy fire activity impacts Skyway at the lane divide during peak evacuation. Fire is burning structures on both sides of the road. All lanes are being used for SB traffic.
10:45		All traffic is held at Clark Rd and Skyway due to fire conditions between Wagstaff Rd and Clark Rd; people stuck in this area are abandoning vehicles and fleeing on foot.
11:15		Traffic stuck at Pentz Rd is brought to the Optimo TRA at Clark Rd. Traffic continues to be stopped in fire between Wagstaff and Coldren Rd. Traffic is flowing more freely down both sides of Skyway south of the lane divide, although it is still slowed by fire and downed power lines/poles.
11:30		Civilians and law enforcement are still stuck in fire in the area of Coldren Rd. Downed power lines and poles near the lane divide are impeding traffic, forcing all traffic SB down the NB lanes.
11:45		Skyway is still impassable at Clark Rd due to gridlock, abandoned vehicles, and downed power lines. Traffic is still very heavy and slow through Paradise.
12:00		The intersection at Wagstaff Rd is being impacted by fire; civilians are abandoning vehicles and fleeing on foot. Traffic is beginning to clear out at Bille Rd.
12:15		There are multiple road blocks in Magalia preventing SB traffic into Paradise. People stuck in the area of Rocky Ln are cleared out. Wagstaff Rd is still impacted by fire. Skyway at Bille Rd now has no traffic.
12:30		Civilians are rescued from a bus stuck off the road north of Wagstaff Rd as fire burns around the area. There are dozens of abandoned vehicles in the roadway north of Wagstaff Rd.
12:45		A downed utility pole and tree are blocking 3/4 of SB lanes at the lane divide, all but stopping the traffic flow.
13:00		Engines are able to barely pass through Skyway from Wagstaff Rd to Clark Rd. There are dozens of abandoned and burning vehicles and fire along the way. All civilians are clear of this area and traffic is not permitted.
13:15	13:45	Traffic is clearing out through Paradise. Most traffic is now south of Pearson Rd and is slowed by the downed power lines near the lane divide.
13:45	14:15	Skyway between Wagstaff Rd and Clark Rd remains closed due to abandoned vehicles and fire. It will not reopen for civilian traffic. Traffic through Paradise is limited to straggling evacuations. Traffic control continues at the lane divide due to the downed tree and power lines; vehicles are sent SB in the NB lanes.

7.5.2.4. Pearson Road

Pearson Road is the main east-west cross-town artery in southern Paradise, connecting Pentz Road to Skyway. For many streets in southeastern Paradise, connection to Pearson Road is the only way out. The eastern half of Pearson Road is mostly residential between Pentz Road and Clark Road. From Clark Road to Skyway there is a combination of commercial and residential properties. Pearson Road has a total of two lanes from Pentz Road to Clark Road. A third center turn lane is present from Clark Road to Skyway, with additional bike lanes and wide shoulders.

Table 21 summarizes the traffic progression on Pearson Rd. Between 07:00 and 08:00 there was normal commuting traffic on Pearson Road; however, by 08:45 heavy traffic stopped flow in the eastern section from Pentz Road. Initially traffic was in both directions; however, increasing fire activity on Pentz Road led to westbound traffic flow on Pearson Road. The impact of the fire front on eastern Paradise resulted in many civilians using Pearson Road to escape. Contraflow

was occurring in the eastern part of Pearson Road with both lanes heading west, as seen in the Fig. 18 photo taken after the fire. It is unclear if the contraflow occurred organically due to urgency of evacuation or if it was facilitated by first responders in the area. Gridlock extended down side streets, including Stearns Road and Edgewood Lane that feed into Pearson Road. Several fatalities occurred south of Pearson Road.

Between 09:30 and 10:00 the fire impacted the drainage in the area of Hilbe Drive just west of Pentz Road. The rapidly spreading fire impacted the gridlocked traffic east of Edgewood Drive by 10:00. With traffic backed up all the way to Clark Road, vehicles on the eastern end of the line had nowhere to go. A TRA was formed on the south side of Pearson Road to reduce exposures to dozens of vehicles. More details regarding TRAs can be found in Sec. 9. By 10:30, dozens of abandoned and burned vehicles restricted access through eastern Pearson Road. Downed utility lines and utility poles further restricted access through the afternoon.

Pearson Road east of Clark Road cleared of traffic by 11:45 as vehicles were directed south on Clark Road.[15] Pearson Road was clear of traffic by 13:45 after remaining vehicles had merged onto southbound Skyway.

By 15:00 a section of Pearson Road between Clark Road and Skyway became impassable due to severe fire exposures as the fire progressed westward. There are no identified civilian evacuations impacted by this closure; however, the closure impacted first responder access and operations.

Fig. 18. Abandoned and burned vehicles on Pearson Rd indicating contraflow traffic heading west towards Sawmill Rd. Photo taken at 15:28.

[15] Vehicles were initially directed south on Clark Road. Subsequent routing may have sent traffic further west via Buschmann Road due to closure of Clark Road further south. See the Clark Road section (7.5.2.2) for additional details.

Table 21. Pearson Road traffic progression summary.

Time Range		Description
7:00	8:00	Normal morning commute traffic conditions are observed on Pearson Rd.
8:30		There is increased traffic along Pearson Rd with traffic coming from Pentz Rd. The major intersection at Clark Rd is manually directed to manage increased traffic. There is also significant traffic near the schools.
8:45		There is heavy traffic along Pearson Rd, particularly at the major intersection with Clark Rd. Gridlock begins on the east end of Pearson Rd, in the drainage near Hilbe Dr.
9:00	9:30	The eastern portion of Pearson Rd (from Pentz Rd to at least Sawmill Rd) is gridlocked. All cross streets feeding Pearson Rd are trying to head WB using both lanes. For example, there is a line of 10+ vehicles on Stearns Rd and 20+ vehicles on Edgewood Rd waiting to access Pearson Rd.
9:30	10:00	Intense fire overtakes gridlocked traffic on Pearson Rd from Hilbe Dr to Edgewood Ln. Civilian vehicles are directed into an empty grassy lot to reduce exposures on the roadway (Pearson TRA). Traffic is flowing west of Clark Rd due to traffic control at the Clark Rd and Skyway intersections.
10:00		Pearson Rd west of Clark Rd now has heavy traffic volume as evacuating vehicles are directed toward Skyway from Clark Rd.
10:15	10:30	A dozer leads civilian vehicles from the Pearson TRA to FRH around burned, abandoned vehicles and power lines.
10:30		There are over 40 abandoned and burned vehicles between Hilbe Dr and Sawmill Rd. A dozer clears vehicles off the roadway. Pearson Rd has very heavy traffic west of Sawmill Rd. Dispatchers at PPD evacuate.
11:00		A line of 120 vehicles is backed up east of Clark Rd to Newland Rd. There is no traffic east of Newland Rd.
11:15		The roadway is blocked between Newland Rd and Middle Libby Rd; a dozen civilian vehicles attempting to evacuate turn around and wait at Fire Station 82.
11:45		Abandoned vehicles and downed power lines continue to obstruct the eastern section of Pearson Rd as first responders travel through. All traffic from Clark Rd is being directed west over to Skyway; there is no traffic on Pearson Rd east of Clark Rd.
12:00	12:30	Downed power lines are a recurring issue east of Clark Rd requiring multiple actions by first responders to keep the roadway passable. The intersection at Clark Rd is now clear of traffic.
12:30		Conditions deteriorate dramatically east of Clark Rd toward Newland Rd. Everything is on fire making this portion of Pearson Rd closed to all civilian vehicles. A fire engine barely makes passage through flames, debris, and zero visibility.
13:15	13:45	Traffic has cleared from Pearson Rd as the final civilians evacuate down Skyway.
13:30	14:00	A small group of 3 to 6 civilian vehicles are waiting for the road to be cleared. An engine clears power lines and poles in the vicinity of Cherry Ln. Similar incidents occur throughout the afternoon in this area.
15:00		Pearson Rd is impassable due to major fire exposures between Academy Dr and Foster Rd. No civilians were present at this time, although first responder safety and movements were impacted.

7.5.2.5. Bille Road

Bille Road is the east-west cross-town artery connecting Pentz Road to western Paradise through the center of town. Bille Road is a mostly residential two-lane road with minimal shoulder. The residential area west of Skyway is also served by Bille Road.

Like Pearson Road, Bille Road was impacted by the early spot fires and the arrival of the fire front in eastern Paradise. Traffic progression is summarized in Table 22. By 08:30, traffic was heavy at the intersection of Bille and Pentz Roads and contraflow was implemented to accommodate more westbound flow. Vehicles formed a third lane and all three lanes were headed west towards Sawmill Road and Clark Road. Throughput was reduced due to the merging and gridlock at the intersection with Clark Road and traffic was backed up to Pentz Road.

Just before fire began to impact the eastern end of Bille Road, a fire engine gained access to the intersection and hooked up to a hydrant. Between 70 and 100 civilian vehicles were entrapped when fire overtook the intersection. Vehicles that could not be reached by the fire engine deck gun burned and closed off Bille Road for the rest of the day until a dozer was able to clear access through the area.

By 10:45, traffic was cleared from Bille Road east of Clark Road as the eastern part of Paradise was evacuated. Heavy traffic on Bille Road remained between Clark Road and Skyway. Increasing fire activity on Skyway resulted in the redirection of vehicles waiting on Bille Road to turn around and head back to Clark Road.

By noon, the civilians involved in the burnover at the east end of Bille Road were escorted to the large parking lot at the Paradise Plaza shopping center.

West of Skyway, civilians in gridlock were instructed to walk to a TRA that was established at the Walgreens pharmacy building because of the nearby fire activity. Traffic on western Bille Road cleared as Skyway traffic continued to progress south.

Table 22. Bille Road traffic progression summary.

Time Range		Description
08:00		Fire activity is increasing rapidly along Pentz Rd, restricting egress (north at Merrill Rd and south of FRH). Civilians evacuating from Pentz Rd begin to converge on both Bille Rd and Wagstaff Rd.
08:30		Traffic is very heavy on Bille Rd as both lanes are contraflow westbound from Pentz Rd to Skyway.
08:45		Evacuating vehicles are forming 3 lanes westbound east of Sawmill Rd attempting to flee the fire on Pentz Rd. The roadway has 2 marked lanes. Traffic is moving very slowly.
09:00	09:30	Traffic is moving no more than 2 mi/h between Pentz Rd and Clark Rd. Multiple law enforcement officers are attempting to get traffic flowing.
09:15		Heavy ember cast is impacting the area as fire closes in. People are abandoning vehicles in stopped traffic at the east end of Bille Rd in the vicinity of Tyden Way, further restricting traffic flow.
09:30		Fire is in the immediate area of the Pentz Rd intersection. Additional vehicles arrive intermittently as they make their way through fire on Pentz Rd. An engine arrives and hooks to the hydrant; fire fighters use the deck gun to spray and protect between 70 and 100 vehicles within reach.

Time Range		Description
10:00		People are evacuated from their vehicles as fire impacts the traffic jam at Tyden Way beyond the reach of the deck gun. Fire and abandoned vehicles block the roadway.
10:30		Traffic is backed up on the west side of Skyway as civilians try to egress down Skyway. (Note, this is the first data point in this area, however, traffic here has very likely been backed up for a long time).
10:45		The intersection at Clark Rd is cleared and the traffic backup has converged toward Skyway.
10:45	12:00	Fire exposures subside, however, vehicles are still held at the Bille Rd TRA because of the blocked roadways and nowhere to egress.
11:30		Due to congestion and fire issues at the Skyway intersection, vehicles on Bille Rd east of Skyway are turned around and directed back to Clark Rd. Civilians stuck on Skyway are being directed to walk to the Walgreens TRA.
12:00		Vehicles from the Bille Rd / Pentz Rd intersection are escorted to the Kmart TRA.
13:45		Bille Rd near Tyden Way remains impassable due to burning vehicles into the afternoon. AVL indicates first responders are able to drive through by 16:00, and a dozer consolidates burned vehicles around 20:00. One lane is blocked for several days after the fire.

7.5.2.6. Wagstaff Road

Wagstaff Road is the northernmost east-west cross-town artery going from Pentz Road all the way to the western part of Paradise and is primarily residential except for the areas around the intersections of Clark Road and Skyway. It has a total of two lanes and no shoulder.

Like Pearson and Bille Roads, the eastern side of Wagstaff Road (Table 23) was quicky impacted by the rapidly deteriorating conditions as the first spot fires ignited and the fire front arrived to Paradise. Traffic rapidly increased by 08:15, as residents near the initial spot fires in areas such as Dean Road and Merrill Road would have likely taken Wagstaff Road toward Clark Road as the primary route. By 08:45 both lanes were being used westbound towards Clark Road.

Further west, between Clark Road and Skyway, traffic was backed up in both directions at 09:45. As fire conditions deteriorated in that area, an engine protected trapped vehicles and directed or escorted them to the parking lot of the Paradise Plaza shopping center at Clark Road.

Available data indicate that Wagstaff Road was mostly clear by 11:00 as Paradise was evacuated from east to west and north to south. Because of overall reduced fire exposures compared to Pearson Road and Bille Road, Wagstaff Road remained primarily free of burned vehicles and therefore became the default east-west artery for convoys and the movement of civilians across town. Two convoys with a total of 120 vehicles used Wagstaff Road between 11:15 and noon to access the TRA at Paradise Plaza. Downed power lines were present at least once and needed to be cleared by first responders in early afternoon.

Table 23. Wagstaff Road traffic progression summary.

Time Range		Description
08:15		Traffic is quickly increasing from Pentz Rd.
08:30		Traffic is now very heavy east of Clark Rd. Due to heavy traffic on Clark Rd, vehicles on Wagstaff Rd cannot progress further west. Traffic turning west from Clark Rd and traffic originating east of Clark Rd is increasing.
08:45		Traffic from Pentz Rd is using both lanes westbound to escape the fire. Traffic conditions are locally variable, and traffic west of Clark Rd is in both directions.
09:00	09:45	Fire impacts the Pentz Rd intersection where traffic is gridlocked. Traffic is backed up in both directions between Skyway and Clark Rd as people try to access both egress routes.
09:45		Conditions deteriorate locally along Wagstaff Rd between Clark Rd and Skyway. An engine is protecting a line of vehicles as structures and vegetation burn along the roadway. Vehicles are directed to the Kmart parking lot TRA.
10:15		Traffic at Clark Rd is reducing. Fire is still burning between Skyway and Clark Rd, however, most civilians have been evacuated from the area and there is no stopped traffic in the fire.
10:45		Wagstaff Rd between Clark Rd and Skyway is clear of traffic. Conditions are locally smoky, and some fire activity remains. The intersection at Skyway is backed up with traffic on Skyway, however, there are few or no vehicles merging from Wagstaff Rd.
11:15		Convoy of approximately 70 vehicles directed from Skyway to the Kmart TRA via Rocky Ln and Wagstaff Rd.
12:00		Convoy of approximately 50 vehicles directed from Bille Rd TRA on Pentz Rd to the Kmart TRA via Wagstaff Rd.
12:15		No substantial traffic occurs on Wagstaff Rd through the afternoon. There are instances of downed power lines and debris in the roadways. Civilians are advised to stay in the safety of the Kmart parking lot TRA.

7.5.2.7. Elliott Road

Unlike the other primary cross streets of Wagstaff, Bille, and Pearson Roads, Elliott Road does not go all the way east to Pentz Road; instead, it stops at Sawmill Road. However, it remains an important throughway connecting Clark Road and Skyway. On the western side, Elliot Road connects to the residential areas off of Valley View Drive. Elliot Road is a residential two-lane road with no center lane, although it does have several churches, schools, or commercial properties between Skyway and Clark Road.

There is limited data on traffic on Elliott Drive. However, the available data is important for three primary reasons highlighted in Table 24:

- It provides clear information on the challenges encountered in merging east-west cross arteries traffic with evacuating traffic on Skyway. Law enforcement at all the major Skyway intersections facilitated the traffic merging (Fig. 19).
- It provides additional details on traffic and evacuation management in central Paradise. Between 09:45 and 10:00, data shows that traffic at Elliott Road and Clark Road was “balanced” to leverage the faster flowing Skyway compared to the slower moving Clark Road (at that time).
- It adds details to how traffic abated on Skyway in the late morning/early afternoon. Traffic on Elliott Road was clear by 12:15.

Table 24. Elliott Road traffic progression summary.

Time Range	Description
08:30	Traffic backs up on Elliott Rd at Clark Rd. Traffic conditions may have backed up as early as 08:00. Law enforcement is present directing traffic by 08:00.
09:00	Law enforcement is guiding traffic at Elliott Rd and Skyway; 5 lanes SB Skyway plus 2 lanes WB Elliott Rd are squeezed to 3 lanes SB on Skyway just south of Elliott Rd.
09:45	Traffic from the eastern section of Elliott Rd is directed to use 2 lanes SB onto Clark Rd and one lane to continue WB toward Skyway; Clark Rd SB is very slow.
10:00	Traffic is heavy on Elliott Rd between Clark Rd and Skyway, but is moving faster than traffic on Clark Rd. More vehicles are sent over toward Skyway.
10:45	A request is made to clear Elliott Rd east of Clark Rd due to the approaching fire. Traffic is still backed up at Clark Rd and Skyway.
11:00	Elliott Rd is backed up from Skyway to Clark Rd. Traffic is only using the westbound lanes.
11:15	The backup on Elliott Rd has reduced to extend from Skyway to Almond St, now using both lanes. No additional traffic is coming from Clark Rd.
12:15	Traffic on Elliott Rd is clear by 12:15.

Fig. 19. View of traffic back up > 300 m on Elliott Rd looking east from Skyway at 10:57. Traffic is mostly single lane heading west.

7.5.2.8. Neal Road

Neal Road is one of the four southern egress arteries from Paradise. Unlike Pentz Road, Clark Road, and Skyway, however, Neal Road does not traverse the entire town. Neal Road branches off of Skyway approximately 700 m (0.4 mi) north of the Skyway split at the southern end of Paradise. Access to Neal Road is from Skyway, via Roe Road, or via Wayland Road. Neal Road is a primarily a two-lane residential road with limited commercial properties. South of Wayland Road, near the town limits, there is a distinct transition from mostly forested residential to grassland fuels.

Traffic on Neal Road began building up after 09:30. Between 09:30 and 10:00 traffic from Skyway began to be diverted to Neal Road. By 10:30 contraflow was implemented to manage the influx of vehicles from Wayland Road and Roe Road. By 11:15 the traffic was backed up over 10 km (7 mi) from CA Highway 99 all the way up to the town limits, restricting overflow from both Skyway and Clark Road.

The delay in utilization of Neal Road for evacuation traffic was due to consideration that this route could have been the dedicated access for incoming first responders. Once it was clear that the fire situation was too urgent and evacuation was the primary goal, contraflow was implemented on Neal Road. However, this did impact incoming first responders. Fire equipment AVL data shows incoming responders had difficulty entering the town due to the oncoming traffic.

Fire activity intensified on upper Neal Road as fire advanced from Skyway, and LE closed off access to Neal Road from Skyway. The Neal Road burnover, not previously reported in Ref. [23], is documented in Sec. 8 and Appendix F. Traffic flow improved between 12:15 and 13:00; Neal Road was clear of traffic within Paradise from Skyway to Wayland Road by 13:15. It took additional time for the remaining traffic to get to CA Highway 99, although the exact time when this occurred is not in the available data. Table 25 summarizes the Neal Road traffic data.

Table 25. Neal Road traffic progression summary.

Time Range		Description
08:45		The traffic light at Neal Rd is manually programmed to hold a green light for Skyway due to increased traffic. Exact volume/speed of traffic is unclear due to conflicting TD statements.
09:15		Law enforcement advises that traffic on Neal Rd is currently light and could accommodate traffic diverted from Skyway.
09:30		Law enforcement indicates on the radio that Neal Rd is clear of traffic [specific location unknown].
09:30	09:45	Law enforcement has discussions about whether to keep Neal Rd two-way traffic to allow inbound emergency vehicles or to contraflow using both lanes outbound to expedite evacuations.
9:45		Law enforcement blocks NB traffic on Neal Rd from CA-99 and begins using both lanes of Neal Rd for evacuation.
10:00		Neal Rd is seeing increased traffic diverted from Skyway. Traffic is also increasing at the intersection with CA-99. Contraflow is used near the intersection.
10:15		Traffic is building on Neal Rd within Paradise limits from Skyway and Wayland Rd.
10:30		Law enforcement is sending both lanes southbound at Neal Rd trying to manage very heavy traffic from both Neal Rd and Wayland Rd.

Time Range		Description
11:00		Skyway south of Neal Rd is blocked by fire. Traffic diverting down Neal Rd gridlocks due to the heavy volume and merging from side streets.
11:15		By 11:15, Neal Rd is bumper to bumper in the southbound lane from CA-99 up to the town limits. Within town, traffic is gridlocked with all lanes used for southbound egress.
11:30	12:30	Heavy, slow and stopped traffic continues on Neal Rd using two lanes for outbound traffic. Traffic is a standstill for the next hour. Incoming first responders struggle to get through the traffic, often driving off the road, averaging 2 mi/h against the flow.
12:00	12:30	Fire impacts the traffic in the area of Wayland Rd and Neal Rd.
12:30		Law enforcement prevents additional traffic from using Neal Rd from Skyway due to the fire burnover. Traffic is caught in heavy fire which now extends from the area of Roe Rd south through the intersection at Wayland Rd.
12:15	13:00	Heavy traffic on Neal Rd is moving approximately 10 mi/h to CA-99.
13:00		There is no traffic on Neal Rd at Goa Way, south of the town limits.
13:15		Neal Rd is clear of traffic at Wayland Rd. There are still two lanes of traffic backed up from CA-99 for at least 1000 m (0.6 mi).

7.5.2.9. Foster Road and Wayland Road

Foster and Wayland Roads are both residential streets servicing neighborhoods in the southern part of Paradise and provide a back route connection from Pearson Road to Neal Road. Access to/from Clark Road is also possible via Buschmann Road. Foster Road is two lanes with no shoulder, similar to many other streets in town; however, Wayland Road is narrower and curvy, without a centerline marking. Because of this, Wayland Road is not a great egress route for heavy through traffic. For the local residents in those neighborhoods, it is a convenient shortcut to Neal Road. Due to the narrow width of the road, combined with the already heavy traffic on Neal Road, lengthy backups and delays were experienced on Wayland Road.

However, because this area was impacted by fire later in the day, it was used to leverage the space available when Clark Road and Skyway were congested and/or affected by fire during evacuation. The route from Clark Road to Neal Road via Foster and Wayland Roads was attractive because it bypassed the busier Pearson Road and Skyway. Table 26 summarizes the traffic data for this road segment.

Table 26. Foster Road and Wayland Road traffic progression summary.

Time Range		Description
09:00	10:00	Traffic on Foster Rd is increasing as people seek a way to egress via Neal Rd. Traffic struggles to turn left from Wayland Rd onto Neal Rd and some vehicles at the end of the line return north on Foster Rd.
10:15	10:45	Traffic is being diverted from Clark Rd to take Buschmann Rd to Foster Rd for access to Neal Rd and Skyway.
10:45		Within a matter of minutes Wayland Rd jams at Neal Rd and traffic backs up on Foster Rd.
11:30		Foster Rd is backed up from Wayland Rd to Buschmann Rd. Traffic from Buschmann Rd is diverted to fill up Black Olive Dr to avoid entrapments at the tail end of the line on Clark Rd.

7.5.2.10. CA Highway 99

CA Highway 99 is one of the main regional roadways in the northeast Sacramento Valley and is the main north-south route passing through the city of Chico. As shown in Figs. 7 and 9, the primary high-capacity regional throughway consists of CA Highway 99 through Chico heading southeast to CA Highway 70 via the CA Highway 149 connector. This freeway is a divided highway with two lanes in each direction.

CA Highway 99 reduces to one lane in each direction both south of CA Highway 149 and 10 km (6.5 mi) northwest of Skyway. While CA Highway 99, in addition to CA Highway 32 and numerous other cross streets, does provide a path of egress out of the Chico region, they are more susceptible to delays from high traffic volume, since only one lane can be available for evacuation.

Two Paradise evacuation routes directly intersect with CA Highway 99: Skyway and Neal Road. The other two, Clark Road and Pentz Road, intersect with CA Highway 70 further south and east, which then merges into the same freeway to Oroville. Once evacuees arrived at CA Highway 99, a decision or desire to go in one direction or the other may have contributed to delays until law enforcement was able to configure appropriate traffic direction. For example, evacuating traffic heading north onto CA Highway 99 toward Chico would have implications on the Skyway intersection, and vehicles directed southbound from Skyway would have implications on the Neal Road intersection. Figure 20 illustrates the convergence of egress routes out of Paradise and the total number of lanes merging into CA Highway 99 and into Chico. The discontinuity between the number of incoming and outgoing lanes illustrated in the figure may not be readily apparent during the design of a plan utilizing a zoned partial evacuation of the town. The complete evacuation of Paradise highlighted this discontinuity by the following three factors:

1. The Skyway intersection with CA Highway 99 is in Chico and required transit through a high-density area with multiple stoplights and background commercial and residential traffic.
2. Continuing to flow through Chico on Skyway west of CA Highway 99 was not a viable high-throughput flow pathway.
3. Neal Road intersects with CA Highway 99 between Chico and Durham-Pentz Road. With the exception of continuing on Durham-Pentz Road (a two-lane road going west with only one lane available for evacuation) there are no major exits from CA Highway 99 to relieve traffic.

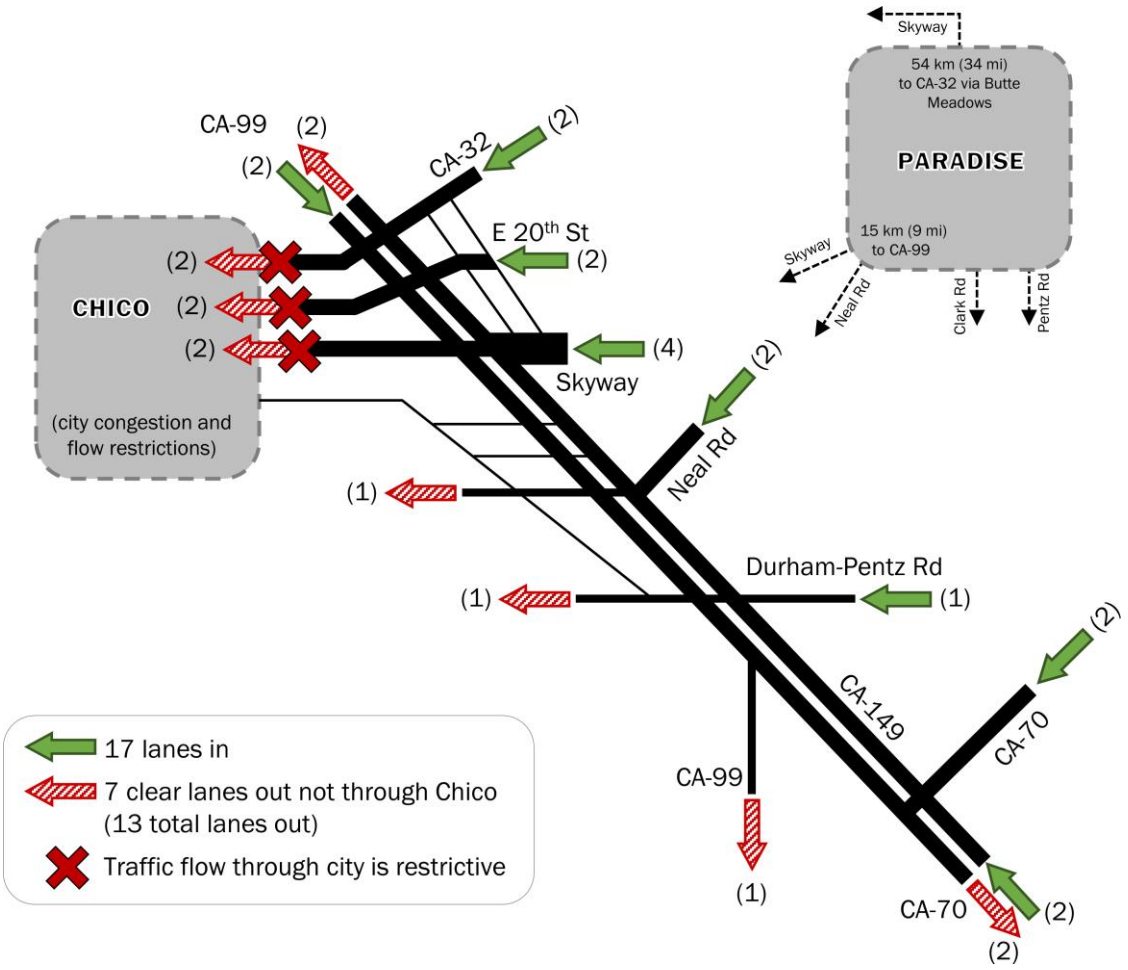


Fig. 20. Stylized diagram of roadway convergence on CA-99 in the vicinity of Paradise and Chico. The difference between the number of incoming lanes compared to the number of outgoing lanes highlights the potential for congestion 15 km from Paradise. Values in parenthesis indicate the number of lanes.

Table 27 contains the traffic data for CA Highway 99 with focus between Chico and CA Highway 149 (CA-149). The data indicates traffic build up and congestion started by 08:30, requiring responding emergency vehicles to travel in the median in some locations. Flow on CA Highway 99 and the routes feeding into it was significantly impacted by merging traffic throughout the morning and early afternoon.

LE was directing access and stopping through traffic on CA Highway 99 into Chico. Closure of northbound CA Highway 99 at Neal Road facilitated the outbound flow of traffic from Paradise. Northbound traffic was also stopped from CA Highway 99 south of the freeway and CA Highway 149 coming from Oroville. This prevented additional background traffic from entering the controlled area.

Because of the large number of secondary routes and intersections involving the interaction between CHP, BCSO, PPD and other LE agencies, the jurisdictional considerations for implementing contraflow, changing the operation of signal lights, and managing background non-evacuee traffic are beyond the scope of this document.

Figure 20 indicates the significant challenges that can occur with the evacuations of large populations over large areas. The analysis identifies the bottlenecks created between 8 km and 15 km (5 mi and 10 mi) away from Paradise that caused traffic to back up all the way into Paradise. This impacted life safety of civilians and first responders as well as first responder operations and should be considered in the future evacuation plans of at-risk communities.

At the time of the fire, the California Department of Transportation (Caltrans) maintained two traffic performance measurement stations on CA Highway 99 near Skyway, one northbound and one southbound. Data recorded from these stations are available through the Performance Measurement System (PeMS) and were reviewed for any additional insight to traffic during the incident. While the data show significant reductions in travel speed and an increase in roadway occupancy, limited conclusions can be drawn about the overall condition of the freeway from a single data station in each direction. Analysis of the available PeMS data is included in Appendix G.

Table 27. CA Highway 99 traffic progression summary.

Time Range		Description
07:45	08:30	SB CA-99 is congested in Chico north of CA-32. This is likely due to typical morning commute traffic as well as visibility of the large smoke plume.
08:00	08:30	CA-99 NB may be closed at or near Durham-Pentz Rd. This data point is unconfirmed with additional information at this time.
08:30		Traffic is heavy on CA-99 near Neal Rd. First responders are driving down the center median.
09:30		LE is blocking northbound traffic onto Neal Rd at CA-99 to prevent civilian access to the fire area and to allow for emergency vehicle access.
09:45		Emergency vehicles are responding from the north and encounter light traffic through Chico.
10:00		Traffic is jammed in both directions at Neal Rd. First responders are driving down the median. SB traffic is backed up 3.8 km (2.3 mi) to Estates Dr.
10:15		SB CA-99 is creeping slowly at CA-32. NB traffic is flowing normally.
10:30		NB traffic is very heavy or stopped at CA-149.
10:45		CA-99 appears to be flowing locally in the area of Skyway. SB traffic is slowed or stopped at Neal Rd. The backup is estimated at 2.4 km (1.5 mi). There is traffic control at Neal Rd. South of Neal Rd AVL indicates that traffic may be moving at normal speeds.
11:00	12:00	CHP shuts down NB CA-99 at Neal Rd. This is likely in order to speed up the flow of the traffic backed up on Neal Rd onto CA-99 SB to direct evacuees away from the fire and congestion in Chico. CA-99 SB south of Neal Rd is flowing. NB CA-99 is stopped and backed up toward Durham-Pentz Rd.
11:15		NB CA-99 is stopped south of Neal Rd, backed up in both lanes to at least Durham-Pentz Rd. First responders are driving up the shoulder.
12:45		Very little NB traffic on CA-99; the ramp to CA-99 is blocked at CA-149. Traffic entering the region on CA-99 NB has been redirected SB onto CA-149.

7.5.2.11. Durham-Pentz Road

Durham-Pentz Road runs east-west in the Sacramento Valley about 10 km (6 mi) south of Paradise town limits and connects Pentz Road to Clark Road to CA Highway 99. Durham-Pentz Road has two lanes and is surrounded by mostly grassy wildland fuels. As discussed in the previous sections, the evacuation traffic from Pentz Road and Clark Road added a significant load to Durham-Pentz Road, particularly as first responders were also trying to access the scene. Due to traffic problems on Skyway and Pentz Road, the best location for the staging area was at the Butte College campus near Clark Road.

The data in Table 28 points to heavy congestion as early as 09:30, with traffic control at Clark Road to allow contraflow. Similar to the traffic control implemented at the Clark Road and Pearson Road intersection, a continuous non-intersecting traffic pattern increased the throughput at the four-way intersection with Clark Road. Traffic remained heavy in areas of Durham-Pentz past 14:00 as traffic slowly progressed onto CA Highway 99 and points to the west.

Table 28. Durham-Pentz Road traffic progression summary.

Time Range		Description
08:15	08:45	Traffic is light.
09:15		Law enforcement responds to the intersection of Clark Rd to block any northbound traffic into Paradise to facilitate possible contraflow.
09:30	10:00	There is heavy, gridlocked traffic between Pentz Rd and Clark Rd (one lane westbound backed up). Two-way traffic is still going on Clark Rd. There is 4-way traffic control at Clark Rd.
10:00		WB traffic on Durham-Pentz Rd is directed SB at Clark Rd. Clark Rd SB is directed WB onto Durham-Pentz Rd.
10:15		Slow moving traffic at the Clark Rd intersection is backing up traffic on Clark Rd into Paradise, with fire impacting the line of traffic at the town limits
11:00	11:30	AVL shows an engine traveling unrestricted between CA-99 and Butte College at Clark Rd.
14:00		Durham-Pentz Rd has heavy traffic west of Wheelock Rd.

7.5.3. Main Egress Roadway Closures

In general, the fire progressed from east to west and, due to the triangular shape of Paradise, from north to south, forcing evacuees to seek egress pathways to the west then south to escape.

There is no data on the number of evacuees that elected to drive out via the northern route (whether via Skyway through Sterling City and Butte Meadows, or the Doe Mill Road shortcut to CA Highway 32). Available data suggests that a majority of evacuees used the southern routes out of Paradise; however, some residents of northern Paradise, Old Magalia, and Magalia may have elected to go north before 09:45 when Skyway was closed due to fire in Old Magalia and south of Coutolenc Road.

Table 29 summarizes the conditions of the four southern egress arteries during the primary evacuation times between 08:00 and 14:15. The information in Fig. 16 shows that heavy traffic impacted evacuation as early as 08:15. Further analysis of Fig. 16 specifically for road closures due to fire (categories 6 and 7) reveals that all four routes were fully open during only six (24 %)

of these 15-minute windows. There were two 15 -minute time windows (8 %) with three routes fully open, 11 (44%) with only two open, and six (24 %) with only one.

Clark Road was the egress artery that experienced the greatest number of closures due to fire exposure between 10:15 and 14:00. Based on available data, 11 out of the 20 main intersections/segments on Clark Road closed at some point due to fire, significantly impacting civilian evacuation and first responder access. The other three egress arteries also experienced closures at several times in this window, as shown in Fig. 16.

Table 29. Summary of southern egress closures in Paradise.

	08:00	08:15	08:30	08:45	09:00	09:15	09:30	09:45	10:00	10:15	10:30	10:45	11:00	11:15	11:30	11:45	12:00	12:15	12:30	12:45	13:00	13:15	13:30	13:45	14:00
Number of southern egress arteries with at least one closure					1			2	1	2	2	2	2	2	3	3	3	3	3	3	2	2	2	2	2
Total intersections blocked [a] (out of 114 [b], not including Concow)	1	1			1			2	2	3	6	4	6	9	10	9	10	8	6	5	8	7	6	8	7
Total intersections blocked along north-south arteries (out of 66 [b])								2							1	1	2	2							
Fraction of main southern egress arteries closed due to fire					¼			½	¼	½	½	½	½	½	¾	¾	¾	¾	¾	¾	½	½	½	½	½

[a] Blocked by fire or other reasons with no civilians present (categories 6 and 7) as defined in Table 17.
[b] Intersections/segments identified in Fig. 16.

7.5.4. Traffic Flow Restrictions

Various traffic flow restrictions were observed to impact civilian evacuation and safety as well as first responder access and operations. Several examples are depicted in Fig. 21. Three different categories and two different types of flow restrictions were identified.

Restrictions were binned into three categories:

Road Closures events where no traffic can safely navigate the local conditions and the road becomes impassable. Such conditions can directly involve civilians and/or first responders.

Reduced Lanes events where the flow disturbance requires physical actions to be resolved and usually involve an obstruction. Restrictions also occur at locations where the roadway width or number of lanes reduce.

Reduced Flow events typically related to traffic flow and increased volume.

The two restriction types are *directly fire related* and *non-fire related*. The distinction between these two types is that while the first will/can only occur when fire is present, the second will/can occur even during an early evacuation before the fire causes additional impacts. The following two lists include traffic-restriction scenarios that occurred during the Camp Fire:

Fire related traffic flow restrictions

- Road closures due to burnovers
    a. Burnovers can occur at or near an approaching fire front or well ahead of it through spotting.
    b. Burnovers in several locations can result in abandoned and burned vehicles that may further extend flow restrictions well after the fire intensity decreases.
    c. Burnovers can entrap local evacuees and limit evacuation options.
- Reduced lanes due to downed electric and utility lines and/or poles
    a. These typically occur several minutes to a few hours after fire impacts an area.
    b. They can occur at a burnover location or at any place where fire impacts above ground utility poles.
- Reduced lanes due to downed trees
- Reduced lanes due to firefighting activities
- Reduced lanes due to burning and burned vehicles
- Reduced flow due to incoming first responder vehicles
- Reduced flow due to heavy smoke impacting visibility

Non-fire related traffic flow restrictions

- Reduced lanes due to road narrowing and/or parked vehicles
- Reduced lanes due to abandoned (unburned) vehicles
- Reduced lanes due to vehicle collisions
- Reduced flow due to traffic merging
    a. Impacts will occur within the evacuating area
    b. Evacuating traffic may have to merge with existing traffic away from the evacuating community
    c. Gridlock many kilometers downstream can result in traffic backups reaching into the evacuating community and/or fire areas
- Reduced flow due to increased space occupied by large vehicles and trailers
    a. RVs and trailers occupy significant space and are more difficult to maneuver, particularly in heavy traffic and merging situations
    b. Improperly connected trailers can become uncoupled and be left abandoned in the roadway, impacting traffic flow and requiring specialized equipment to displace

Restrictions can impact traffic locally or for many miles upstream. The impact of a restriction is a function of the extent of the flow disturbance, the number of lanes fully or partially closed or otherwise rendered unusable, the location of the disturbance, and the time the disturbance occurs. Flow restrictions can impact both civilian evacuations and first responder access and operations. Examples of some of these restrictions are mentioned in the road-by-road summary in Sec. 7.5.2. Several actions were used to address some of the flow restrictions identified above. These included cutting and removing of downed utility lines and trees, use of contraflow to expand traffic capacity, and displacement of abandoned vehicles and other obstructions.

First responder access and operations may be affected by the above-mentioned traffic flow restrictions. During the first 12 hours of the Camp Fire, access to Paradise and Magalia was restricted by:

1. An extended duration burnover on upper Skyway, between Wagstaff Road and Clark Road.
2. Heavy fire activity and additional burnovers on Pentz Road and Clark Road
3. Heavy traffic volume of evacuating civilian vehicles, occasionally using inbound lanes for outbound flow (contraflow)
4. Several restrictions due to power lines and closures due to fire on Clark Road in and to the south of Paradise between 10:00 and 13:00
5. Limited access to the east of Clark Road via Bille Road because of burned vehicles, and
6. Limited access to the east of Clark Road through Pearson Road because of downed utility poles/lines and abandoned/burned vehicles.

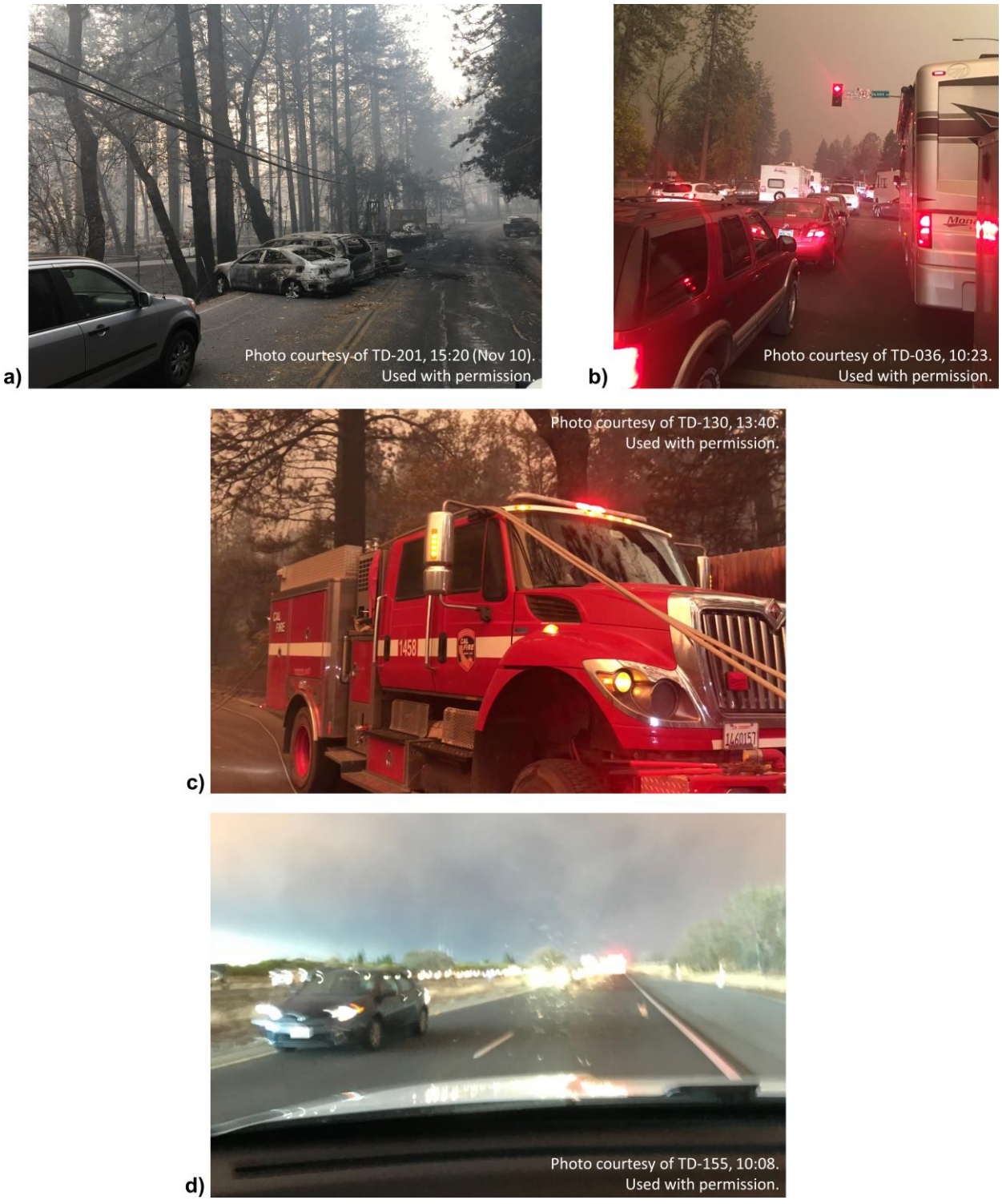


Fig. 21. Examples of traffic flow restrictions; a) burnover resulted in abandoned and burned vehicles in the roadway on Bille Road (photo shows vehicles after displacement to restore access). b) merging cross-streets and numerous large vehicles (RVs) and trailers on Skyway. c) downed utility lines impacting first responder operations on Pearson Road. d) outbound contraflow on Skyway with opposing inbound first responder traffic.

7.5.5. Abandoned Vehicles

One theme of the evacuation that was repeatedly encountered through TDs and first responder observations was the frequency of abandoned vehicles in the roadway, often in conjunction with various burnover events. The aftermath was also frequently documented by news photographers in the days following the fire through compelling images of burned-out abandoned vehicles. Figure 22 shows one such image taken by a first responder on Skyway looking north near Quail Way where dozens of vehicles, ranging from compact cars to a school bus and tractor-trailer were abandoned in and along the roadway.

Fig. 22. Abandoned vehicles in and along the roadway. Post-fire view north on Skyway at Quail Way.

A total of 235 vehicles were identified through analysis of photos and videos, post-fire drone imagery, reporting from the grand jury, and in-person field observation data collection of burn marks and roadway spalling. The location of each[16] identified vehicle is mapped in Fig. 23; burned vehicles are indicated with red points (58 %) while vehicles that did not burn are marked with black points (42 %).[17] The focus of this data collection was to include vehicles in the roadway or immediately along the shoulder, as seen in Fig. 22. Such vehicles would have reduced roadway capacity and obstructed first responder access, especially when burning. It is likely that there were additional cases that were not documented by the available data. Many vehicles located further off the roadway that were likely to have been parked vehicles not involved in evacuation were not included in this data set. Additional details about the data collection and analysis of abandoned vehicles are described in Appendix H. Spatial uncertainty associated with the placement of abandoned and burned vehicles is estimated (Type B uncertainty [33]) to be within 5 m (16 ft).

[16] Four vehicles were in locations beyond the extent of Fig. 23. One in Concow, two on Clark Road, and one on Skyway.
[17] As seen in Fig. 23, burned and unburned vehicles were intermixed. Evaluation of why some vehicles burned or not depends on localized conditions and is beyond the scope of this report.

Vehicles were likely abandoned for various reasons; however, the most probable situation was that it was the action of last resort with no other alternative available to the occupants as fire approached. While the primarily post-fire data collection does not directly indicate when vehicles burned, there are multiple accounts of occupied vehicles igniting or already abandoned vehicles burning during evacuations. Large clusters of abandoned and burned vehicles resulted from five burnovers that impacted traffic on the primary arteries of Skyway, Pearson Road, Bille Road, Pentz Road, and Neal Road. These burnover events occurred in areas with significant traffic gridlock, high density of roadside vegetative fuels with limited to no setback from the roadway, and few parking lots or open areas to use as refuge areas. The reader is directed to Sec. 8 and Ref. [23] for more detail on the burnover events.

The largest number of abandoned vehicles was along a 1.6 km (1.0 mi) stretch of Skyway between Clark Road and Wagstaff Road, where 85 vehicles were located (Fig. 23, Inset A). This stretch of Skyway had extensive vegetation present on both sides and offered few options in the form of parking lots or open areas that could have been used for TRAs. Vehicle abandonments on Skyway significantly impacted evacuations and first responder access for many hours, further restricting access as vehicles burned.

Pearson Road east of Sawmill Road was another stretch of roadway with a high concentration of abandoned vehicles; 39 are shown in Fig. 23 (Inset B) on the 0.8 km (0.5 mi) segment between Sawmill Road and Hilbe Drive. A cluster of four additional vehicles was located in the curve just beyond Inset B, including a law enforcement vehicle. Similar to the events on Skyway, fire impacted gridlocked traffic heading west using both lanes on Pearson Road. With fire approaching and nowhere to go, many civilians abandoned vehicles and ran west on foot or consolidated into other vehicles. More details can be found in the burnover account [23] and Sec. 9 on TRAs.

In the case of Bille Road, a burnover impacting backed up traffic led to an early road closure by 09:15. While the fire progressed westward, the resulting abandoned and burned vehicles continued to block the roadway for many hours. They were not displaced until 20:00, leaving the cross-town route closed for nearly 11 hours during a critical part of the incident.

The impact of abandoned vehicles on traffic on Neal Road occurred later in the evacuation period, beginning around 12:00. Traffic was cleared from the Neal Road and Wayland Road vicinity by 13:00. The later arrival of fire at Neal Road had reduced traffic flow impact on evacuation compared to impacts on Skyway, Pearson, and Pentz Roads. Abandoned vehicles on Neal Road and Pentz Road did not require dozer assistance to facilitate passage, unlike Skyway, Pearson Road, and Bille Road.

Beyond fire exposures to standstill evacuation traffic, two additional causes for vehicle abandonment were specifically identified: running out of fuel and vehicle collisions. While not rigorously documented, there are several accounts of each occurring. Additional civilians were concerned about running out of fuel and delayed or deferred their evacuation in the hopes that they wouldn’t need to evacuate or could avoid traffic, therefore reducing fuel requirements.

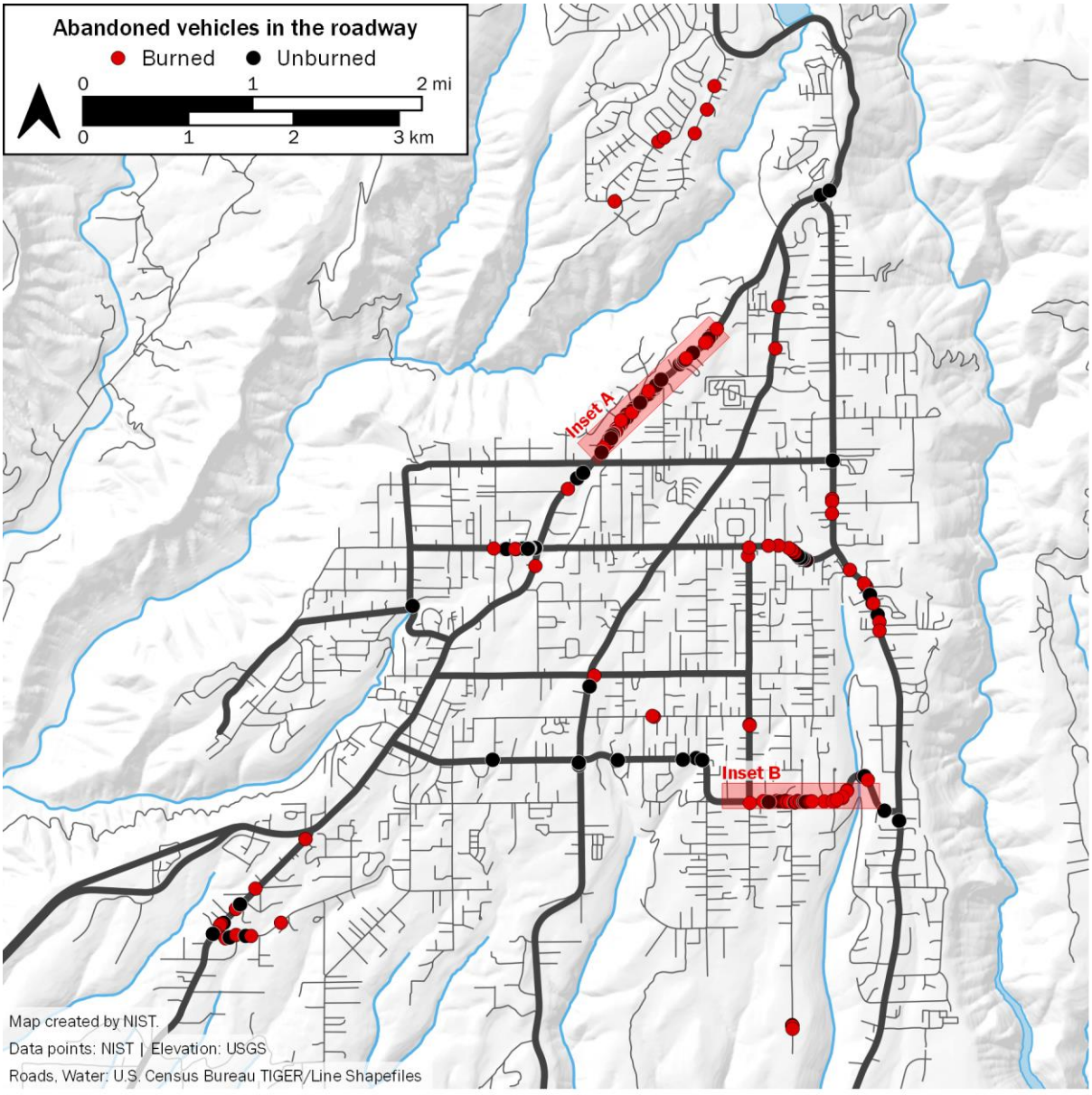


Fig. 23. Locations of vehicles abandoned in the roadway in Paradise.

7.6. Summary

Evacuations during the Camp Fire were a regional-scale event. This section presented an overview of the general evacuation timeline based on traffic flow observations from TDs and supporting information from radio logs, photos, and videos. Inclusion of data from the fire spread timeline shows the impact of fire on egress arteries and provides context for the effects of fire and corresponding road closures on the evacuations.

Evacuation and traffic conditions exhibited significant spatiotemporal variation. Some individuals were able to evacuate early under normal traffic conditions. Others encountered various setbacks, and their journeys took 10 or more hours. In many cases, minutes made the difference between getting out early or getting stuck in traffic for hours. The majority of the evacuation of Paradise took place between 08:00 and 14:15.

Pre-planning and training significantly enhanced the life safety of evacuees. The training exercise in 2016 allowed first responders to practice coordinating between agencies and use different traffic management tools like contraflow was effective in building "muscle memory." As the fire arrived in Paradise from the east, channeling the traffic from the Pentz Road corridor through town became time critical. Traffic was pushed to the west and south to stay ahead of the fire. Traffic from Pentz Road was pushed toward Clark Road, and then pushed further west to Neal Road and Skyway. Closures of Clark Road, Neal Road, and Skyway, together with closures on the cross-arteries (Pearson Road, Bille Road, and Wagstaff Road) further complicated civilian evacuations and traffic management in Paradise and beyond. Traffic congestion in Chico along Durham-Pentz Road and CA Highway 99 significantly slowed down the evacuation of Paradise. In some cases, the bottlenecks were located more than 15 km (9 mi) from Paradise.

Much of the evacuation was achieved through individual or small group travel (e.g., families, neighbors) using personal civilian vehicles. The quick onset of the evacuation for the entire town led to widespread gridlock. To enhance life safety, several strategies were implemented by first responders to alleviate jams, facilitate traffic flow, and manage civilians when traffic was gridlocked with fire approaching. Situational awareness was essential to accomplish the above list of strategies to adapt to the changing fire conditions and availability of safe egress routes. Five key tactics were used to mitigate life safety issues during evacuation, enabling first responders to keep hundreds of civilians out of high hazard areas:

a. Escort civilians to low hazard areas (convoys),
b. Fill up road space in areas that were not burning,
c. Redirect traffic to account for continuously changing conditions (traffic and fire), including intersection traffic management and redirection,
d. Use contraflow to increase traffic flow out of town, and
e. Use parking lots as TRAs to accumulate overflow traffic.

Fire impacted some egress arteries directly (through fire exposures and reduced visibility due to smoke) and others indirectly through downed utility poles and lines and downed/burned trees. Over 230 abandoned vehicles were identified on the major egress arteries, almost 60% of which were burned. Many of these vehicles were involved in burnovers that resulted in partial or

complete road closures for hours. Civilians ran to less hazardous areas (~3 km [2 mi] in some instances), a stranger's vehicle, or were rescued by first responders.

The impact of fire on the egress arteries was dynamic; fire impacted traffic directly through smoke, fire, and ember exposures and indirectly through road blockages (burned and fallen utility lines and poles, trees, and debris). Two or more of the four egress arteries leaving Paradise were simultaneously closed due to fire for 68 % of the time between 08:00 and 14:15.

Closures of egress arteries significantly impacted civilian evacuation and led first responders to create multiple TRAs to shelter civilians from high fire exposures. The widespread implementation of TRAs led to large groups of civilians staging within Paradise waiting for conditions to improve and roads to become passable again, after which they were escorted out of the fire area. Ultimately, several large convoys of vehicles were escorted out of the fire area. Evacuees in personal vehicles and convoys evacuating Paradise impacted traffic in Chico and CA Highway 99 well into the afternoon of November 8.

A number of civilians were unable to evacuate without assistance or were caught in dangerous fire conditions while evacuating and were rescued by first responders. Many of these rescues are documented in Sec. 10.

7.7. Technical Findings

TF-ET 1. Preplanning and training for traffic management and contraflow significantly enhanced life safety of evacuees.

TF-ET 2. The majority of the evacuation of Paradise took place between 08:00 and 14:15.

TF-ET 3. First responders took extensive actions to enhance evacuee life safety, including creating TRAs and escorting civilians to safety in numerous convoys.

TF-ET 4. Five key tactics were used to mitigate life safety issues during evacuation, enabling first responders to keep hundreds of civilians out of high hazard areas:

a. Escort civilians to low hazard areas (convoys)
b. Fill up road space in areas that were not burning
c. Redirect traffic to account for continuously changing conditions (traffic and fire), including intersection traffic management and redirection
d. Use contraflow to increase traffic flow out of town, and
e. Use parking lots as TRAs to accumulate overflow traffic.

TF-ET 5. Burnovers significantly impacted civilian and first responder life safety by exposing evacuees to high hazard conditions and locally closing roadways.

TF-ET 6. Egress arteries blocked by fire significantly impacted civilian evacuation by increasing traffic delays throughout the community.

TF-ET 7. Main egress evacuation arteries experienced a significant number of closures due to fire. One quarter of the intersections/road segments along egress arteries and cross-town arteries experienced one or more closures due to fire.

TF-ET 8. Two or more of the four egress arteries leaving Paradise were simultaneously closed due to fire for 68 % of the time between 08:00 and 14:15.

TF-ET 9. Traffic congestion in Chico along Durham-Pentz Road and CA Highway 99 significantly slowed down the evacuation of Paradise. In some cases, the bottlenecks were located more than 15 km (9 mi) from Paradise.

TF-ET 10. Imbalance in the number of available traffic lanes at potential chokepoints (within or surrounding a community) may not be readily apparent during the design of a plan utilizing a zoned/partial evacuation of a community.

7.8. Recommendations

In planning for WUI fire evacuations, communities should consider:

R-ET 1. Preplanning community evacuation scenarios and communicating them to residents and first responder, government, and infrastructure agencies.

R-ET 2. Developing preplanned evacuation scenarios that consider factors including fire history, prevailing winds, proximity of ignition to the community, and road capacity.

R-ET 3. Practicing evacuation scenarios with first responder, government, and infrastructure agencies from the community and associated surrounding jurisdictions.

R-ET 4. Utilizing programs such as “Ready, Set, Go!” to develop and communicate evacuation preparation and timelines.

R-ET 5. Developing alternate plans for situations in which there is insufficient time to evacuate from the fire area.

R-ET 6. Using crosswalks with painted patterns, overhead flashing lights, and/or removable posts to reduce impact on flow instead of immovable fixtures within the roadway.

This page intentionally left blank.

8. Burnovers

A burnover is defined as "an event in which a fire moves through a location or overtakes personnel or equipment where there is no opportunity to utilize escape routes and safety zones, often resulting in personal injury or equipment damage" [55, 56]. During the Camp Fire, several events occurred where fire temporarily restricted through-access on a major traffic artery or a secondary road, or trapped civilians or first responders amid dangerous conditions. These burnover events were first identified and extensively reported in Ref. [23]. Burnovers varied in intensity and duration. Some impacted civilian evacuation while others impacted first responders only. Others resulted in civilian fatalities, civilian and first responder injuries, and destruction and damage of civilian and first responder vehicles. In several cases, a burnover occurred that did not result in fatalities, injuries, or damage. These were instances in which fire blocked the road and civilians caught in traffic and/or first responders attempting to access the scene waited for fire intensity to subside or opted to take another route, if available. These events could be interpreted as entrapments or "near misses" with respect to the burnover definition but are included in this case study as they have significant impact on civilian and first responder life safety. Identified events are grouped and labeled as burnovers in this report.

Burnovers were identified and documented in 23 different locations. Four burnover events (*BO #20–23*) were identified after the publication of the original 19 events in Ref. [23] during the data analysis of rescue events, which is presented in Sec. 10 of this report. These four burnover events are further detailed in Appendix F.

The first two burnovers during the Camp Fire occurred at approximately 07:50 on November 8 on Hoffman Road and Concow Road in Concow. The last two recorded burnovers occurred at 07:15 on November 9 on Ponderosa Way in Magalia and on Concow Road in Concow. Additional burnovers may have occurred but were not captured during the data collection process because no personnel (first responder or civilian) was present to witness the event; or the event was witnessed by first responders or civilians, but data were not captured because no TD took place with these individuals.

Table 30 summarizes the information of the 23 identified burnovers that occurred throughout the fire area and are mapped in Fig. 24. Timeline details associated with fire behavior for all the burnovers are documented in Ref. [23] and Appendix F of this report, along with pre- and post-fire street view images and overview imagery to convey the range of different conditions under which burnovers occurred.

While all burnovers posed a significant safety hazard to those involved, not all incidents were characterized by the same intensity. In an effort to differentiate, the identified burnovers were divided into two categories with respect to risk of injury or death. Listed in Table 30, fourteen burnovers were identified as "Category 1," representing the highest potential of death/injury (highlighted in red), and seven as less-hazardous "Category 2" events. Of the nine burnovers that occurred before 10:00 on November 8, seven were listed as Category 1, and two as Category 2.

Nearly all of the burnovers on the morning of November 8 significantly impacted evacuating civilians. Nine burnovers were directly related to the formation of TRAs; seven of these involved civilians attempting to evacuate. Fatalities of 7 civilians were linked to three burnover events. Further discussion about the relationships between burnovers and TRAs is presented in Sec. 9, and fatalities are presented in Sec. 11.

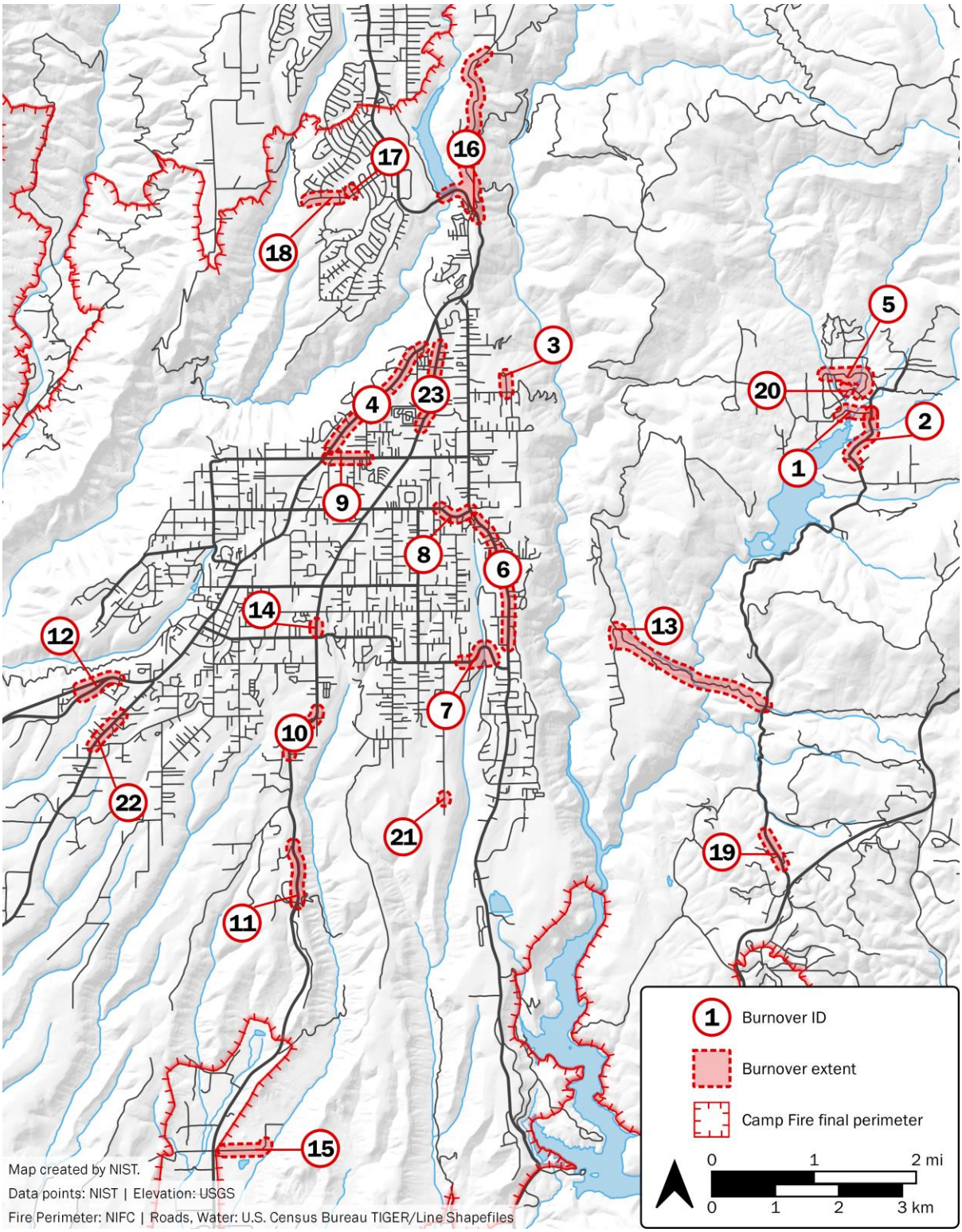


Fig. 24. Map of all identified and documented burnover locations, including 4 newly identified events not previously included in Ref. [23]. The approximate extent of each event is indicated by the shaded areas.

Table 30. Listing of all identified burnovers and basic incident characteristics, including 19 events previously documented in Ref. [23]. Bold locations indicate primary egress roadways.

ID[a]	Location[b]	Community	Severity Category	Burnover Initiation	Burnover Duration (min)	Road Width (m)	Vegetation Setback (m)	Roadway Length Affected[c] (m)	Impacted Civilian Evacuation (Y if yes)	Traffic Gridlock/ Obstruction[d] (Y if yes)	Fire Shelter(s) Deployed (Y if yes)	TRA Formed (Y if yes)	Fatalities
1	Hoffman Rd	Concow	1	07:50	40	3	0–2, more at creek	250	Y		Y	Y	
2	**Concow Rd**	Concow	2	07:50	70	7	0–1	1000	Y				
20	Camelot Ln	Concow	1	07:55 [e]	50	6	0 (in grass)	n/a	Y			Y	
3	Chapman Ln	Paradise	1	08:30	n/d [f]	3	0–3	250					
4	**Skyway** (upper)	Paradise	1	08:30	360	8	0–10	2600	Y	Y		Y	
5	Windermere Ln	Concow	1	08:35 [e]	n/d	4	0–2	1100	Y				1
6	**Pentz Rd**	Paradise	1	08:45	150	8	0–1	1300	Y	Y		Y	
7	**Pearson Rd**	Paradise	1	09:15	60	11	1–3	800	Y	Y	Y	Y	1
8	**Bille Rd**	Paradise	1	09:25	140	8	0–2	500	Y	Y		Y	
21	Edgewood Ln	Paradise	1	09:30	n/d	3	0–3	250	Y				5
9	**Wagstaff Rd**	Paradise	2	09:30	60	8	0–3	500	Y				
10	**Clark Rd** / American Way	Paradise	2	10:00	120	11	1–3	700	Y				
11	**Clark Rd** / Airport Rd	Butte County	2	10:00	90	9	1	1500	Y				
12	**Skyway** (lower)	Paradise	2	10:15	90	7–20	1–3	1000	Y				
13	Jordan Hill Rd / Granite Hill Rd	Concow	1	11:30	n/d	5	0–4	800	Y				

ID[a]	Location[b]	Community	Severity Category	Burnover Initiation	Burnover Duration (min)	Road Width (m)	Vegetation Setback (m)	Roadway Length Affected[c] (m)	Impacted Civilian Evacuation (Y if yes)	Traffic Gridlock/ Obstruction[d] (Y if yes)	Fire Shelter(s) Deployed (Y if yes)	TRA Formed (Y if yes)	Fatalities
22	**Neal Rd**	Paradise	1	11:30	90	6	1–3	800	Y	Y			
23	**Clark Rd** / Cypress Ln	Paradise	2	11:45	n/d	8	0–6	1300	Y				
14	**Clark Rd** / Black Bear Diner	Paradise	2	13:10 [e]	n/d	23	3 (structure)	150					
15	Rattlesnake Flats Rd	Butte County	1	15:15	15	3	0 (in grass)	300					
16	Coutolenc Rd	Magalia	2	00:00 [g]	120	7	0–2	3000				Y	
17	Chestnut Cir	Magalia	1	06:00 [g]	n/a [h]	9	0–1	150					
18	Ponderosa Way	Magalia	2	07:15 [g]	n/d	12	0–3	400	Y			Y	
19	Concow Fire Station 37	Concow	1	07:15 [g]	n/d	9	0–3	600				Y	

[a] Events are listed chronologically. ID #20–23 are out of sequence because they were added in a second round of analysis.
[b] Roadways in bold denote major artery roads significant for evacuation.
[c] The roadway segment affected by each burnover was estimated from the technical discussions.
[d] Traffic was gridlocked or otherwise obstructed before the arrival of fire.
[e] First time of observation. Burnover conditions existed prior to the first recorded observation.
[f] n/d – no data/unknown. There was not enough information to determine duration.
[g] November 9. All other events occurred on November 8.
[h] n/a – not applicable. Event was primarily characterized by a propane tank explosion resulting in firefighter injuries.

9. Temporary Refuge Areas, Safety Zones, and Shelters

The rapid fire spread forced almost immediate evacuation of residents in Concow and Paradise. Most people were unable to evacuate the area before the fire arrived and many were caught by the fire while evacuating, as documented by the identified burnover events (Ref. [23] and Sec. 8). In many cases, first responders were also involved, whether assisting with civilian evacuations or working on fire suppression. Both civilians and first responders were forced to seek shelter in TRAs or pre-planned safety zones or public assembly points (PAPs).

A safety zone is "a pre-planned area of sufficient size and suitable location that is expected to protect personnel and equipment from known hazards without using fire shelters" [57, 58], whereas a TRA is a "pre-planned area where firefighters can immediately take refuge for *temporary shelter* and *short-term relief* without using a fire shelter if emergency egress to an established safety zone is compromised" [59] (emphasis added). Unlike a safety zone, a TRA "may not provide adequate safety and protection for the entire duration of need because of changing fire conditions, especially during periods of extreme fire intensity" [58]. Examples of TRAs include structures (inside or behind), lawns, parking areas, cul-de-sacs, and vehicles—all of which were used during the Camp Fire.

There were a total of 31 identified events during which civilians and first responders sought shelter in TRAs during the first 25 hours of the Camp Fire. There is high confidence that a majority of TRA events have been identified. However, additional locations were likely used for short periods of time by individuals. These locations where individuals took shelter before completely evacuating from or being escorted out of the fire are not included in the list of TRAs established by first responders because these events included a limited number of people per event and comprehensive data for all instances was not identified, such as civilians sheltering at home. Two such events have been identified where civilians sought shelter in open areas (a cemetery and a park).

The range of conditions that impacted the formation of each TRA varied significantly. In order to compare and contextualize the differences between these events, the following definitions have been developed to describe the TRAs.

Urgency of Formation (UoF)

A classification into three levels (low !, moderate ! !, high ! ! !) regarding the need to rapidly establish a TRA to address immediate life safety issues. High UoF implies an urgent need to establish a TRA, such as when people are trapped within a burnover. Low UoF TRAs represent events where the formation of the TRA occurred to address civilian evacuation concerns that were not immediately life threatening. In many cases, Low UoF TRAs were utilized to organize and coordinate the evacuation of civilians.

Peak Hazard Level (PHL)

A classification into three levels (low ▲, moderate ▲▲, high ▲▲▲) regarding the fire exposure experienced by civilians and or first responders when in the TRA. Generally, this is different than the exposures experienced during burnovers. TRAs with High PHL represent cases where the exposures threatened the integrity of the TRA and immediately impacted the life safety of the occupants. TRAs with Low PHL experienced low fire exposures as a result

of limited fire presence in the area, limited surrounding fuels or large buffer areas (e.g., large parking lots), and/or availability of firefighting personnel and equipment. Not all Low PHL TRAs had defensive actions, and not all TRAs with defensive actions had Low PHL.

Relationship of burnover to TRA

More than half of the TRAs had connection to specific burnover events. Connections were classified into two levels:

Burnover caused formation of the TRA— The conditions presented by a burnover (fire exposure) presented a critical need for those involved to take immediate life-saving refuge at their location. In all cases listed in this report, first responders created the TRAs. In most cases, these TRAs were both High UoF and High PHL.

Burnover related to the TRA— Fire conditions from an identified burnover prevented egress, contributing to the need to establish/utilize a TRA to coordinate and organize civilians for evacuation when conditions improved.

Of the 31 TRAs, four utilized pre-planned PAPs.[18] For the purposes of this report, all events/locations are subsequently referred to as TRAs. In 11 of the 31 events, TRAs were formed in response to immediate life safety threats during burnovers. The other 20 TRAs were utilized to prevent/reduce roadway backups or to prevent civilians or first responders from encountering more hazardous conditions and becoming trapped.

The name and a brief description of the location of each TRA are listed in chronological order of formation by a letter identifier in Table 31, along with the relative urgency and peak hazard level. The locations of the TRAs are mapped in Fig. 25.

The following sections provide further detail and analysis of the TRAs, including:

- a temporal summary and brief description of each TRA,
- a detailed summary of the sequence of burnovers in Concow that required a group of civilians to use multiple TRAs,
- estimates of the number of civilians taking refuge in all TRAs,
- analysis of the characteristics of each TRA, such as urgency and exposure levels, location types, and defensive actions, and
- a summary of technical findings.

A complete summary of each TRA can be found in Appendix I.

[18] Pre-planned public assembly points listed in the Butte County Evacuation Plan; whether first responders utilized these locations based on knowledge of this information is unknown.

Table 31. Listing of TRAs in chronological order with urgency of formation (UoF), peak hazard level (PHL), and location information.

ID	Name	UoF	PHL	Location	
A	Camelot Meadow Wild Fire Safety Zone	! ! !	▲ ▲ ▲	Camelot Ln	Concow
B	Hoffman Rd	! ! !	▲ ▲ ▲	Hoffman Rd 350 m (0.2 mi) west of Concow Rd	Concow
C	Concow Rd “dozer zone”	! ! !	▲ ▲ ▲	Concow Rd at Hoffman Rd	Concow
D	Chris Ct	! !	▲ ▲	Chris Ct, east of Pentz Rd north of Wagstaff Rd	Paradise
E	Feather River Hospital	! ! !	▲ ▲	Pentz Rd between Bille Rd and Pearson Rd	Paradise
F	Concow Rd “gravel area”	! !	▲ ▲	Concow Rd near Ishi Tr	Concow
G	Ponderosa Elementary School	! ! !	▲ ▲	Pentz Rd just south of Wagstaff Rd	Paradise
H	Chloe Ct	! ! !	▲ ▲ ▲	Chloe Ct, off Pentz Rd 500 m (0.3 mi) south of Bille Rd	Paradise
I	Bille Rd	! ! !	▲ ▲ ▲	Bille Rd and Pentz Rd	Paradise
J	Pearson Rd	! ! !	▲ ▲ ▲	Pearson Rd near Cherry Ln, 1 km (0.6 mi) west of Pentz Rd	Paradise
K	Paradise Plaza	!	▲	Clark Rd at Wagstaff Rd	Paradise
L	PPD/Fire Station 81	!	▲	Birch St at Black Olive Dr	Paradise
M	Paradise Ridge Southern Baptist Church	! !	▲ ▲	Pentz Rd 1.1 km (0.7 mi) north of Wagstaff Rd	Paradise
N	Wagstaff Rd	! !	▲ ▲	Wagstaff Rd at Skyway	Paradise
O	Fire Station 82	!	▲ ▲	Pearson Rd between Clark Rd and Pentz Rd	Paradise
P	Walgreens	! !	▲ ▲	Skyway at Bille Rd	Paradise
Q	Ace Hardware	!	▲ ▲	Clark Rd at Pearson Rd	Paradise
R	Beyond Fitness	! !	▲ ▲	Pentz Rd 700 m (0.4 mi) north of Wagstaff Rd	Paradise
S	Optimo	!	▲ ▲	Skyway at Clark Rd	Paradise
T	Best Western	! !	▲ ▲	Clark Rd 700 m (0.4 mi) south of Pearson Rd	Paradise
U	Magalia Community Church	! !	▲ ▲	Old Skyway	Magalia
V	CMA Church	!	▲	Clark Rd between Wagstaff Rd and Clark Rd	Paradise
W	Paradise Shopping Center	!	▲ ▲	Skyway near Oliver Rd, 500 m (0.3 mi) north of Elliott Rd	Paradise
X	Firland Dr	! !	▲ ▲	Firland Dr at Skyway, 660 m (0.4 mi) north of Wagstaff Rd	Paradise
Y	Magalia Pines Baptist Church	!	▲ ▲	Lakeridge Cir	Magalia
Z	Magalia Sav-Mor	!	▲	Lakeridge Cir	Magalia
AA	Rite Aid	!	▲ ▲	Skyway at Ponderosa Way	Magalia
BB	Skyway and Coutolenc Rd	! ! !	▲ ▲	Skyway at Coutolenc Rd	Magalia
CC	Magalia Dam	! !	▲	Skyway 600 m (0.4 mi) north of Coutolenc Rd	Magalia
DD	Pine Ridge School	! ! !	▲ ▲	Compton Dr, off Ponderosa Way and W Park Dr	Magalia
EE	Concow Rd and Pinkston Canyon Rd	! ! !	▲ ▲ ▲	Concow Rd at Pinkston Canyon Rd	Concow

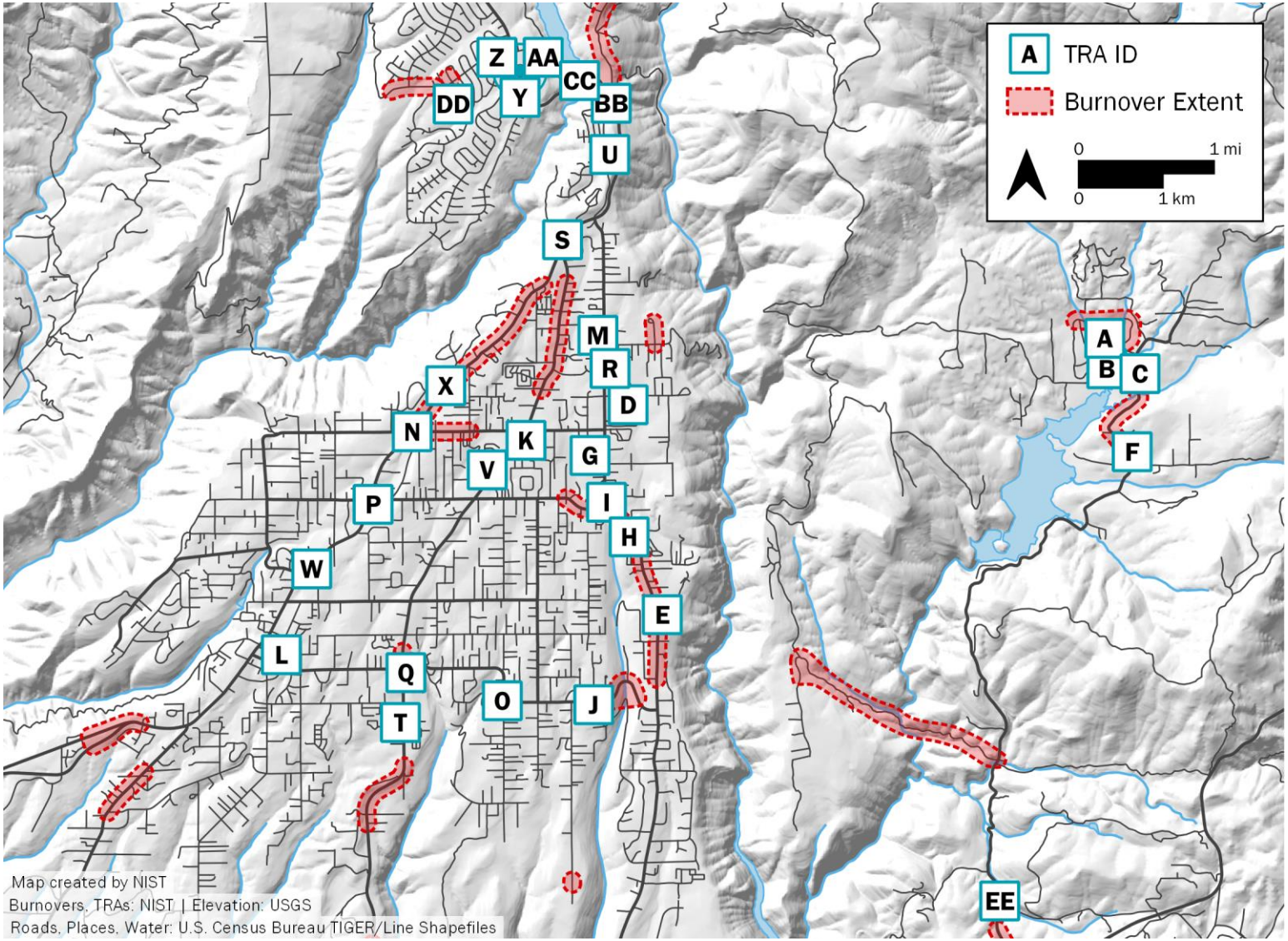


Fig. 25. Map of all identified and documented TRA locations, labeled with letter identifiers in chronological sequence of formation. Burnover event locations are also identified with the red shaded outlines.

9.1. Progression of TRAs and Relationships to Burnovers

The first TRAs were formed in Concow between 07:30 and 08:00 after multiple spot fires quickly distributed fire throughout the community, impacting life safety and evacuation, trapping civilians and first responders. TRAs were continually utilized in response to burnover events and changing fire conditions throughout the day of November 8 as fire then impacted Paradise, reaching a maximum of 12 simultaneously active TRAs. Between 11:15 and 12:45 there were ten or more active TRAs.

Figure 26 shows a timeline of active TRAs and visualizes the temporal relationships between TRAs and their associated burnovers. The figure shows the active duration of each TRA (teal blue), as well as time periods of the burnover(s) that influenced the need for each TRA (red). Statistics provided at the bottom of the figure indicate the total number of active TRAs along with the number and fraction of active TRAs impacted by burnovers for each 15-minute period.

Burnovers directly caused the formation all three TRAs before 08:45 in Concow, and 4 out of 5 (80 %) active TRAs in Paradise at 09:30, highlighting the impacts of rapid fire spread early in the event and the limited safety zone options in Concow and on Pentz Road in Paradise. The maximum number of TRAs concurrently impacted by burnovers was 5 between 11:15 and 11:45 (45 %). During this time there were 11 to 12 active TRAs. There were still a significant number of evacuating civilians, and the fire was well-established in Paradise and Old Magalia.

In many cases, Fig. 26 also shows how quickly TRAs were formed in response to burnover events, particularly before 09:45. However, some notable cases of extended duration burnovers which influenced later-forming TRAs also stand out. For example, the burnover on upper Skyway (*BO #4*) started at approximately 08:30 and continued to impact civilian evacuation and first responder access into the early afternoon. The Firland Drive TRA (*X*) was utilized by firefighters at 13:30, five hours after the burnover started, and highlights the impact of that burnover event on one of the four egress arteries of Paradise and Magalia.

TRA activity decreased after 15:00 to five or fewer active TRAs. After 04:00 November 9 there were no active TRAs until the two burnovers that occurred shortly after sunrise (*BO #18, 19*) that forced firefighters to seek refuge.

Eighteen of the TRAs were caused by or related to specifically identified burnover events. Table 32 lists the relationships between burnovers and the various TRAs and is illustrated by the diagram in Fig. 27. Red solid arrows in the figure denote burnovers that caused the formation of a specific TRA. Gray dashed arrows indicate other relationships between burnovers and TRAs. Due to changing fire and traffic conditions, several TRAs were moved or consolidated. These relationships between TRAs are also highlighted in Fig. 27 by the solid teal arrows.

A comprehensive summary of each TRA can be found in Appendix I. The following sections provide a brief description of the conditions, situation, and timeline of the formation of TRAs in four sequential time windows with specific attention given to the relationship between burnover events and the formation of TRAs:

- 07:50 to 09:35 (*A* through *J*), in Concow and eastern Paradise
- 09:35 to 12:00 (*K* through *T*), in central and western Paradise
- 12:00 to 19:15 (*U* through *AA*), in Paradise and Magalia, and
- 00:00 to 07:45 (*BB* through *EE*), in Magalia and Concow.

This page intentionally left blank.

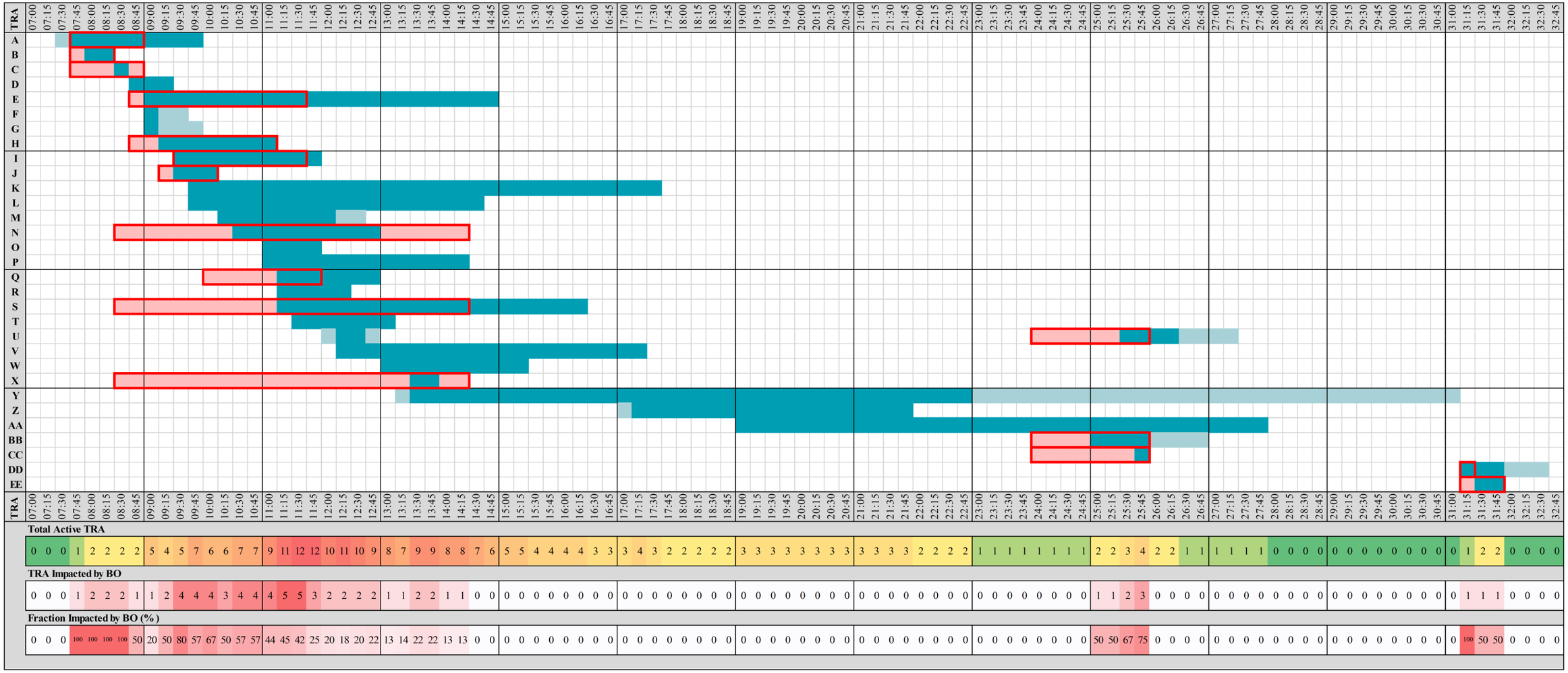


Fig. 26. Timeline of active TRAs and duration of burnover events related to each TRA. Each TRA is active within the dark shaded bars, with uncertainty in the times in lighter shading. The red bars indicate periods of the burnover event(s) which contributed to the formation of each respective TRA. Statistics at the bottom of each column indicate the number of active TRAs and the number and fraction impacted by burnovers within each 15-minute window.

Table 32. Relationships of identified burnover events (BO) and TRAs. Listed in chronological order of burnovers.

BO ID	BO Name	BO Relation to TRA	TRA ID	TRA Name	TRA in BO
1	Hoffman Rd	Cause	B	Hoffman Rd	Yes
2	Concow Rd	Cause	C	Concow Rd “dozer zone”	Yes
20	Camelot Ln	Cause	A	Camelot Meadow Wild Fire Safety Zone	Yes
3	Chapman Ln	None			
4	Skyway (upper)	Related	K	Paradise Plaza	
		Cause/Related	N	Wagstaff Rd	
		Related	P	Walgreens	
		Related	S	Optimo	
		Cause	X	Firland Dr	Yes[a]
5	Windermere Ln	Related	A	Camelot Meadow Wild Fire Safety Zone	
6	Pentz Rd	Cause/Related	E	Feather River Hospital	Yes[a]
		Cause	H	Chloe Ct	Yes
		Related	I	Bille Rd	
7	Pearson Rd	Cause	J	Pearson Rd	Yes
8	Bille Rd	Cause	I	Bille Rd	Yes
21	Edgewood Ln	None			
9	Wagstaff Rd	Related	K	Paradise Plaza	
10	Clark Rd / American Way	Related	Q	Ace Hardware	
		Related	T	Best Western	
11	Clark Rd / Airport Rd	None			
12	Skyway (lower)	None			
13	Jordan Hill Rd / Granite Ridge Rd	None			
22	Neal Rd	None			
23	Clark Rd / Cypress Ln	Related	S	Optimo	
14	Clark Rd / Black Bear Diner	None			
15	Rattlesnake Flats Rd	None			
16	Coutolenc Rd	Cause	BB	Skyway and Coutolenc Rd	Yes
		Related	CC	Magalia Dam	
17	Chestnut Cir	None			
18	Ponderosa Way	Cause	DD	Pine Ridge School	
19	Concow Fire Station 37	Cause	EE	Concow Rd and Pinkston Canyon Rd	

[a] Physical location of TRA was within the identified burnover area but size/location resulted in Moderate peak hazard levels. Exposures were significantly lower than exposures at the other TRAs within burnovers.

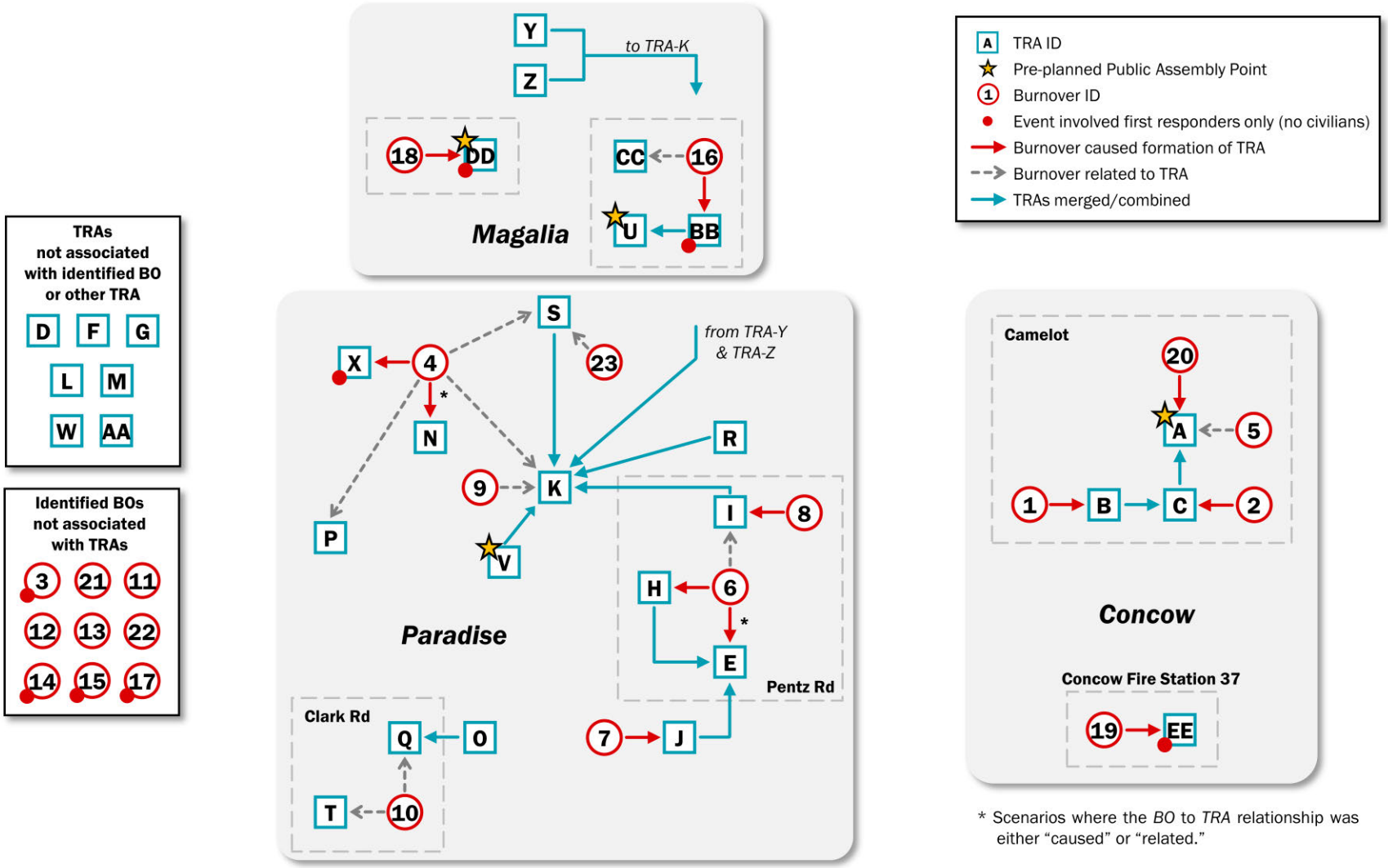


Fig. 27. Flowchart diagram showing the relationship between burnovers and TRAs. Arrows indicate the impact of a burnover on a TRA and the merging of multiple TRAs.

9.1.1. Concow and Eastern Paradise, 07:50–09:35, November 8, 2018

One third (10/31) of the TRAs were formed between 07:55 and 09:35; four in Concow and six in Paradise. This time window is characterized by numerous complex and rapidly developing life-threatening situations. During this time, a total of 10 burnovers had occurred or started in Concow and Paradise. As listed in Table 32, all 10 of the TRAs formed during this period were directly in response to fire conditions and had high or moderate urgency and peak hazard levels. Six of the 10 TRAs were located directly within burnover areas and experienced high peak hazard levels (*TRA-A*, *B*, *C*, *H*, *I*, *J*). Each of the six burnovers affecting these TRAs were classified as presenting a high risk of injury or death due to the severity of the fire exposure (*BO #1*, *20, 5*, *6*, *7*, *8*) [23]. The TRAs in this time window are listed with their associated burnover events in Table 33.

Fire moved into Concow with reports of spot fires burning in yards by 07:15; conditions deteriorated in Concow as the fire spread. The Camelot Meadow Wild Fire Safety Zone (*TRA-A*) was used by civilians and law enforcement starting no later than 07:55, when they waited for the meadow to burn before taking refuge in the burned area inside vehicles. Nearby, the Hoffman Road TRA (*B*) was formed at 08:00, where 24 civilians took refuge in the creek at the low water crossing with two firefighters for approximately 20 minutes. After moving from the creek, another TRA (*C*) was necessary at the intersection of Hoffman Road and Concow Road by 08:27 before everyone was able to consolidate at the Camelot Meadow. The flowchart in Fig. 27 visualizes the burnover events that precipitated each TRA and the consolidation/movement of TRAs into other TRAs. A more detailed discussion of this sequence of events is provided in Sec. 9.2. The last TRA in Concow on November 8 began at approximately 09:05 as the fire conditions on Concow Road prevented approximately 20 civilians from evacuating. They took refuge in a gravel area near a residence and were accompanied by a water tender (*TRA-F*).

The first reports of fire in Paradise occurred between 07:50 and 08:00 to the east of Pentz Road, followed by the main fire front at approximately 08:30. The significant fire impact caused a huge disturbance in evacuations and forced a set of cascading TRA formations early in the incident. Six TRAs were formed between 08:45 and 09:35 (*TRA-D*, *E*, *G*, *H*, *I*, *J*). Of the six, five were formed with high urgency and four were needed directly in response to burnover events (*BO #6, 7, 8*).

Traffic on Pentz Road was significantly impacted by fire between the east-west cross-arteries of Bille Road and Pearson Road, trapping hundreds of civilian vehicles in the area (*BO #6*). The TRA at Feather River Hospital (*E*) first developed organically as civilians trying to evacuate from the area encountered fire north and south of the hospital. Some were able to return to the parking lot. First responders at the hospital had limited information about conditions beyond the immediate area and were attempting to direct traffic away from the fire, not knowing the extent of traffic backup and fire beyond the FRH property. The intersection of Bille Road and Pentz Road was completely gridlocked and many vehicles were stuck on Pentz Road in zero visibility.

Ambulances evacuating patients from the hospital were fighting traffic to get north to Bille Road when one ambulance ignited. The paramedics and hospital staff were able to take refuge inside a nearby residential garage (*TRA-H*) for two hours with the assistance of other first responders. Many vehicles were directed back to the parking lot at Feather River Hospital by first responders on Pentz Road. Traffic was still gridlocked at Bille Road when the fire front impacted the intersection with Pentz Road at 09:30. A fire engine was able to use the water supply from a

hydrant to spray and protect the area where 70 to 100 vehicles were crowded (*TRA-I*). Figure 28 shows a photo of the intersection looking southwest from Pentz Road. Aerial imagery of all TRAs can be found in Appendix I.

Fig. 28. Photo of the intersection of Pentz Rd (left) and Bille Rd (right) looking southwest (*TRA-I*). The fire hydrant used by firefighters to protect the TRA is visible in the center of the photo.

At the same time, traffic on Pearson Road was also backed up when a spot fire began in the drainage near Hilbe Drive. As the spot fire grew and the main fire front also pushed westward, dozens of vehicles were impacted by a significant firestorm on the east end of Pearson Road between Cherry Lane and Hilbe Drive (*BO #7*). First responders were able to move vehicles into a grassy empty residential lot to reduce exposure levels (*TRA-J*). The group of 30 to 70 civilian vehicles were ultimately led to Feather River Hospital when a dozer was able to clear the roadway of burning vehicles and other debris.

The two other TRAs within this time window were at Chris Court (*TRA-D*), off Pentz Road and Merrill Road, and at Ponderosa Elementary School (*TRA-G*) on Pentz Road. First responders in the area of Chris Court were able to protect civilians in six vehicles in the cul-de-sac that could not evacuate due to the surrounding fire activity. First responders also conducted defensive actions at nearby surrounding parcels. At Ponderosa Elementary School, six vehicles of civilians sought refuge in the outdoor paved basketball courts, located behind (west of) the school buildings, attempting to escape fire and traffic. A 911 call was made by one of the civilians and the 911 dispatcher advised them “There's no one to come help you right now. If you need to drive through a fence, then do it.” While the outcome was undetermined, there are no reported fatalities in this location and there were no burned or abandoned vehicles remaining in the basketball courts during the data collection.

Table 33. Relationships between TRAs and burnovers (BO), 07:50–09:35 (*TRA-A* to *TRA-J*).

ID	Name *Temporary Refuge Area* Burnover	UoF	PHL	BO Category	Start
A	***Camelot Meadow Wild Fire Safety Zone***	! ! !	▲▲▲		***07:55***
1	Hoffman Rd			1	07:50
2	Concow Rd			2	07:50
20	Camelot Ln			1	07:55
5	Windermere Ln			1	08:35
B	***Hoffman Rd***	! ! !	▲▲▲		***08:00***
1	Hoffman Rd			1	07:50
C	***Concow Rd "dozer zone"***	! ! !	▲▲▲		***08:27***
1	Hoffman Rd			1	07:50
2	Concow Rd			2	07:50
D	***Chris Ct***	! !	▲▲		***08:45***
E	***Feather River Hospital***	! ! !	▲▲		***09:00***
6	Pentz Rd			1	08:45
7	Pearson Rd			1	09:15
8	Bille Rd			1	09:25
F	***Concow Rd "gravel area"***	! !	▲▲		***09:05***
G	***Ponderosa Elementary School***	! ! !	▲▲		***09:07***
H	***Chloe Ct***	! ! !	▲▲▲		***09:20***
6	Pentz Rd			1	08:45
I	***Bille Rd***	! ! !	▲▲▲		***09:30***
8	Bille Rd			1	09:25
J	***Pearson Rd***	! ! !	▲▲▲		***09:35***
7	Pearson Rd			1	09:15

9.1.2. Central and Western Paradise, 09:35–12:00, November 8, 2018

Ten more TRAs were formed between 09:35 and 11:30 on November 8, all in Paradise, as the fire spread westward through the town. Six (*TRA-K*, *N*, *P*, *Q*, *S*, *T*) were related to burnovers occurring on the egress arteries of Skyway and Clark Road and the cross-arteries of Bille Road and Wagstaff Road; however, they were not formed with the same high urgency as many of the earlier TRAs. None of the TRAs formed in this time window were located within burnover areas. Two experienced low peak hazard levels (*TRA-K*, *L*) and the remaining eight had moderate peak hazard levels.

The long duration burnover on upper Skyway (*BO #4*) occurred in multiple stages beginning as early as 08:30. This burnover ultimately extended 2.5 km (1.6 mi), affecting most of Skyway between Wagstaff Road and Clark Road. The road was intermittently passable despite the fire conditions, and many vehicles were evacuated through this route. As the fire continued to spread through northern Paradise, increased fire intensity impacted evacuees in the area between Wagstaff Road and Rocky Lane from both east and west, in a time period estimated between 09:30 and 11:00. *BO #9* on Wagstaff Road at and west of Rocky Lane additionally impacted evacuees. Because of the spatial extent of these burnovers (*BO #4*, *9*) and the gridlocked traffic, many civilians were forced to abandon their vehicles and walk to TRAs, in some cases with young children, pets, and possessions. Some civilians were able to squeeze into other vehicles.

Some traffic was redirected east on Wagstaff Road toward Clark Road, where first responders at Paradise Plaza shopping center formed a TRA (*K*) beginning as early as 09:45. The Wagstaff Road TRA (*TRA-N*) was formed in the roadway intersection at approximately 10:30. First responders also planned to utilize the inside of a small stucco-constructed commercial building for refuge. The estimated travel distance between *BO #4* and *TRA-N* ranged from 150 m to 1 km.

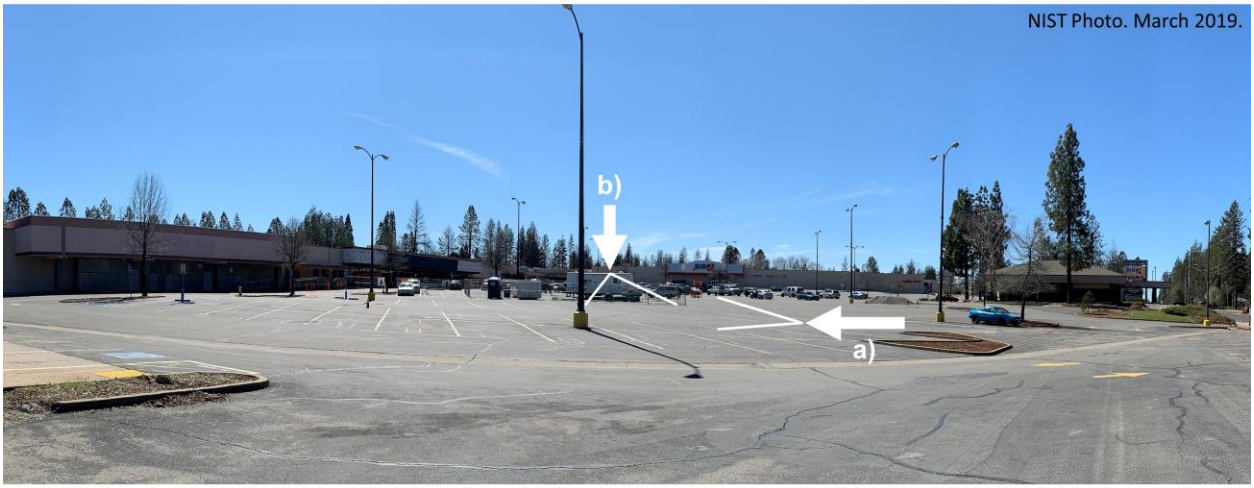
Gas stations located on two corners of the *TRA-N* intersection contributed to the decision that the area was not a good TRA. Fire impacted the intersection around 12:00 and first responders shoved abandoned vehicles from the roadway to facilitate passage. First responders were trying to collect the many civilians on foot and bring them to safety as the area was impacted by fire. Some civilians continued south down Skyway toward the Walgreens (*TRA-P*, described later) and Bille Road, and east to Clark Road. The Wagstaff Road TRA (*N*) had a vehicle occupancy estimated between 100 and 200 vehicles.

The parking lot of the Paradise Plaza shopping center (*TRA-K*), at the intersection of Clark Road and Wagstaff Road, was the largest occupancy TRA used during the Camp Fire. Peak occupancy is estimated to be 350 to 550 vehicles based on information from TDs and video data. There were approximately 600 marked parking spaces in this large lot. First responders began directing civilians into the parking lot around 09:45 because of the extensive traffic backups and the approaching fire east of the shopping center (< 50 m to the commercial buildings, < 200 m to the intersection of Wagstaff Road and Clark Road). Some of the early arriving vehicles were directed to this TRA from areas on Skyway near Rocky Lane where *BO #4* was occurring.

Ultimately, several other TRAs were consolidated into this location (indicated in Fig. 27), and the Paradise Plaza TRA became a central staging area for civilians to wait for roadway conditions to improve before being assisted out of town in convoys or on transit buses. This is further discussed in Sec. 9.3. Figure 29 shows two pictures from within the TRA at 12:00 just prior to peak TRA occupancy. Most civilians were evacuated from the Paradise Plaza TRA and out of the fire area by 17:45.

a)

b)



c)

Fig. 29. Paradise Plaza TRA (*K*) at 12:00. Photos a) and b) show views from within the parking lot from the locations indicated in the post-fire photo c). The estimated number of vehicles at the TRA ranges from 350 to 550 at maximum occupancy.

Due to the fire intensity and gridlocked traffic conditions on Skyway between Clark Road and Wagstaff Road, law enforcement completely stopped traffic at the intersection of Skyway and Clark Road between 10:45 and 11:00, contributing to the formation of *TRA-S*. The Optimo TRA, in the parking lot near the "Optimo" restaurant, was formally established at 11:15 because Skyway was impassable both north and south. Additionally, Clark Road experienced a burnover along a 1.3 km (0.8 mi) stretch around Cypress Lane (*BO #23*), further preventing evacuations and indirectly contributing to the TRA formation, as indicated by the flowchart in Fig. 27. The TRA sheltered between 180 and 220 civilians, estimated based on TDs, pictures, and videos, and remained operational until 16:30. The TRA was used by civilians stuck at the intersection and backed up onto neighboring side streets, including Gate Lane. Because of the gridlock, some civilians had to walk over 400 m (0.25 mi) to get to the TRA. Civilians initially took refuge in the parking lot before moving inside buildings—under construction with unfinished interiors, metal roofs, and cinderblock walls—after first responders gained access when fire exposures increased. Figure 30 shows the TRA at 12:07, when civilians were gathered in the parking lot with first responders as fire burned nearby. Several engines provided protection during the afternoon. Civilians were evacuated/escorted out of the Optimo TRA by 16:30 via Clark Road. Skyway remained impassable due to burned vehicles and power lines.

Fig. 30. Civilians and first responders in the Optimo parking lot (*TRA-S*).

Earlier in the incident, shortly before 11:00, firefighters determined a TRA was necessary at the intersection of Bille Road and Skyway in western Paradise as the fire was approaching the gridlocked traffic. A battalion chief established a TRA at the Walgreens and three engines helped to gain access to the building and direct civilians. The primary goal was to direct civilians to continue evacuating in their vehicles to reduce the total number of people trapped. The Walgreens TRA (*TRA-P*) was formed at 10:55 and supported between 100 and 140 civilians. At 12:20, two school buses were used to transport civilians from the TRA. Visibility was so poor that first responders used glow sticks to lead 98 people to the buses. About 15 to 20 people

remained at the TRA after the buses left and were evacuated using a hand crew bus between 12:55 and 13:22.

At the south end of Paradise, the primary egress artery of Clark Road experienced burnovers at two locations (*BO #10*, *11*), preventing evacuation travel and requiring traffic to be diverted and sent to TRAs. Vehicles were turned around and directed back to the parking lots at the Ace Hardware (*TRA-Q*) and the Best Western (*TRA-T*) to wait for fire to subside and for the road to become passable again. At 11:14 a firefighter redirected the traffic flow headed south on Clark Road to turn around and head to the parking lot at Ace Hardware (*TRA-Q*) because Clark Road was closed due to fire. Vehicles were also escorted to the Best Western parking lot around the same time, located between the burnover and the hardware store, 500 m (0.3 mi) south of the Ace Hardware. Both areas were defended by engines, and the Ace Hardware parking lot was used as a staging/meeting area by first responders throughout the afternoon. It is unclear how many civilians/vehicles used the Ace Hardware; however, it was used as a staging area for consolidation of other TRAs prior to further evacuation. At 12:00, civilians from the TRA at Fire Station 82 (*TRA-O,* see below) were escorted to the Ace Hardware parking lot to await further instruction from law enforcement. A total of 15 to 20 vehicles took shelter at the Best Western while firefighters protected the property. By 12:00 firefighters also identified the larger neighboring parking lot of the bowling alley to the south as an additional TRA if necessary. At 13:11, engines escorted the civilian vehicles from the Best Western down Clark Road to Durham-Pentz Road and out of the fire.

Four additional TRAs that were not directly connected to a specifically identified burnover event were also formed between 08:30 and 11:30. These were located at Paradise Police Department (PPD)/Fire Station 81 (*TRA-L*), Paradise Baptist Church (*TRA-M*), Fire Station 82 (*TRA-O*), and the parking lot of the Beyond Fitness gym on Pentz Road (*TRA-R*).

The TRA at PPD/Station 81 was formed as a low urgency TRA with several civilians being dropped off there between 09:45 and 14:41, a few having been previously rescued or picked up by PPD officers or other first responders. The TRA was defended by various first responders throughout the day, including two occasions when the roof of the PPD was cleaned of pine needles. Between 30 and 60 civilians are estimated to have used this TRA, primarily as a stopover point waiting for further transportation.

The parking lot at Paradise Baptist Church (*TRA-M*) on Pentz Road was utilized by 4 to 6 civilian vehicles directed there by first responders. Firing operations were conducted on the surrounding vegetation, along with other defensive actions, to enhance the tenability.

Fire Station 82 (*TRA-O*) was used by 10 to 20 civilians between 10:55 and 12:00, while conditions on Pearson Road were impassable to Pentz Road because of abandoned vehicles and toward Clark Road due to fire. Firefighters were then able to lead a convoy of 10 to 12 civilian vehicles down Pearson Road to Clark Road to evacuate. The station was also used intermittently as a staging point for first responders and rescues through the afternoon.

The small TRA at the parking lot of Beyond Fitness (*TRA-R*) on Pentz Road was formed between 11:15 and 11:33 when three civilian vehicles took shelter there at the direction of a battalion chief. No defensive actions took place, and it is believed that the peak hazard level was moderate. They were subsequently escorted to Paradise Plaza (*TRA-K*) at 12:30, where more resources and evacuees were located.

9.1.3. Paradise and Magalia, 12:00–19:15, November 8, 2018

Fire continued to fill in unburned areas in Paradise between 11:30 and 19:00 on November 8, while at the same time further spreading into Old Magalia and the southern parts of Magalia (e.g., Andover Drive). Seven additional TRAs were formed and utilized in this time window; four were located in Paradise, one in Old Magalia, and three in Magalia.

Only one of the seven was directly caused by a burnover event—Firland Drive (*TRA-X*). This TRA was formed and utilized by firefighters heading north through Paradise attempting to reach their assignment in Magalia. After encountering significant fire and numerous vehicles blocking passage on Skyway north of Rocky Lane, the engines parked at Firland Drive at 13:34 and waited for 24 minutes for fire conditions on Skyway to abate. Five hours after starting, the upper Skyway burnover (*BO #4*) was still impacting first responder access through the area.

While not in response to specifically identified burnover events, one other TRA in this time window was formed with moderate urgency in response to fire conditions at the gravel parking area of the Magalia Community Church (*TRA-U*). The Magalia Community Church was reported to be populated by civilians between 12:15 and 12:41 after fire had become well-established in Old Magalia. It is likely that *TRA-U* was used before and after the reported times; spot fires began in the Old Magalia area before 08:41. While some civilians may have been able to evacuate immediately, the church was denoted as a pre-planned evacuation assembly point in the county evacuation plan, and it is possible that residents utilized this space prior to the first data point from TDs. There is little information available on the number of civilians that used this TRA. Note that the church parking area was used again later in the night and is also reported in the next time window (Sec. 9.1.4).

The remaining five TRAs formed during this time window were of relatively low urgency. These TRAs were identified as safe places away from direct fire exposures where civilians could be dropped off to await further transportation or stage in their vehicles to be escorted out when roads were safe. In Paradise, the CMA Church (*TRA-V*) on Clark Road and the Paradise Shopping Center (*TRA-W*) on Skyway were used as TRAs beginning in the early afternoon.

While the CMA Church was a pre-designated safety zone/public assembly area in the Butte County evacuation plan, the first civilians documented to be using the parking lot for this purpose were noted at approximately 12:20. At this time, firefighters identified the safe location and dropped off a woman that they had previously rescued to join other civilians located at the church. The parking lot was used as a companion TRA to the Paradise Plaza parking lot just 500 m (0.3 mi) north on Clark Road. Between 16:35 and 17:25, vehicles from the church were moved to the shopping center before a large convoy was formed and people were evacuated.

The TRA formed at the Paradise Shopping Center (*TRA-W*) was formally occupied starting at 13:00, and an estimated 20 to 40 civilians used the parking lot as a TRA awaiting further transportation. Civilians with pets, and even some livestock, were present until 15:30, when fire was closely approaching the commercial buildings, the hazard level increased to moderate, and law enforcement determined that it would no longer be safe to stay there. Civilians were transported out of Paradise using law enforcement vehicles.

Three TRAs were formed in Magalia between 11:30 and 19:00. The first was at the Magalia Pines Baptist Church (*TRA-Y*) between Skyway and Lakeridge Circle. The first data point places

civilians at the TRA at 13:37; however, it is likely that the TRA was in use for some time before that. *TRA-Y* is estimated to have been used by 80 to 130 civilians.

TRAs in the parking lots at the Sav-Mor grocery (*TRA-Z*) and at the Rite Aid in Magalia (*TRA-AA*) were formed at 17:15 and 19:00 respectively. The Sav-Mor was the TRA in Magalia with the fewest documented number of civilians, used by 10 to 40 civilians between 17:15 and 22:00. Civilians were evacuated by B-Line and other Paratransit buses via Clark Road to Paradise Plaza (*TRA-K*) to join a larger convoy out of the fire. The Rite Aid was used as a TRA starting at 19:00; however, civilians drove, and possibly walked, there in the early afternoon and used the parking lot as a staging/waiting area. The fire front arrived from the Coutolenc Road area in the early morning hours of November 9. During this time the TRA was defended by several engines. TDs and video indicate that 40 to 60 civilians were present taking refuge in the parking lot and inside the store. At 03:48 on November 9, a convoy of civilian vehicles was escorted out of Magalia through Paradise. TDs indicate that the Rite Aid continued being used as a staging area in Magalia, and additional civilians were brought there throughout the morning of November 9.

Out of the seven TRAs in this time window, the CMA Church (*TRA-V*) and Magalia Sav-Mor (*TRA-Z*) experienced low peak hazard levels during the active periods, while the remaining five experienced moderate peak hazard levels. Most TRAs were used by both civilians and first responders; however, the Firland Drive TRA was occupied only by first responders.

9.1.4. Paradise and Concow, 00:00–07:27, November 9, 2018

The last four documented TRAs occurred on November 9 and were all formed directly due to burnovers. Three were created with high urgency to escape hazardous fire behavior. These were at Skyway and Coutolenc Road (*TRA-BB*) and the Pine Ridge School (*TRA-DD*) in Magalia, and at the intersection of Concow Road and Pinkston Canyon Road in Concow (*TRA-EE*). The other TRA in this period was slightly less urgent and was utilized to avoid travelling into fire, by parking on the Magalia Dam (*TRA-CC*).

TRA-BB and *TRA-CC* are linked to the Coutolenc Road burnover (*BO #16*) which occurred between 00:00 and 02:00. The burnover event forced first responders operating along Skyway and Coutolenc Road to seek refuge at the cleared intersection of the two roadways. Several engines parked on Skyway relocated to the gravel area at the Magalia Community Church (*TRA-U*) at 01:30. Additional firefighters working in the Old Magalia area also took refuge at the church as the fire intensified in the Little Butte Creek Canyon. During this same time, a first responder driving from Magalia towards Paradise stopped on the Magalia Dam (*TRA-CC*) along with a civilian vehicle for 11 minutes between 01:48 and 01:57, waiting for fire intensity to decrease before they were able to continue.

The final two linked TRA/burnover events occurred shortly after sunrise on November 9 in Magalia and Concow. Notifications and search and rescue operations continued into the morning of November 9 in Magalia. Between 07:10 and 07:20, firefighters were going door to door on Ponderosa Way evacuating remaining residents. At the same time, the fire was flanking through the South Park Drive area toward Pine Ridge School and Ponderosa Way. Firefighters were evacuating a civilian as fire pinched Ponderosa Way and Compton Drive from the east and west (*BO #18*). The strike team drove through fire to return to the Rite Aid staging area with the rescued civilian; however, some units were not able to pass through the fire and took refuge at

the Pine Ridge School, a pre-designated public assembly point (*TRA-DD*). A fuel treatment around the school property reduced direct fire exposures, and firefighters were able to conduct successful defensive actions to save the main school building. No civilians were present.

In Concow, firefighting operations continued through the night of November 8 and early into November 9. At 06:40 on November 9, fire was burning across Pinkston Canyon Road towards Concow Road. Firefighters working on Concow Road were worried about getting pinched between areas of fire. The fire intensified shortly after sunrise and visibility dropped to zero on Concow Road at Fire Station 37 (*BO #19*). Engines attempted to retreat to the safety zone at the Concow Pool but were unable to make it through the fire. They took refuge at the intersection of Concow Road and Pinkston Canyon Road (*TRA-EE*) between 07:27 and 07:45. Two additional engines attempted to drive south on Concow Road to CA Highway 70 but also could not make it through and returned back to the intersection to wait. The peak hazard level was categorized as high, since firefighters with dedicated apparatus (fire engines) could not drive through. No civilians were involved in *TRA-FF*, and the burnover (*BO #19*) did not impact any civilian evacuations. This was the last documented TRA activity.

9.2. Detailed TRA Progression in Concow

The Hoffman Road, Concow Road "dozer zone," and Camelot Meadow Wild Fire Safety Zone TRAs are considered separately in much of the analysis of this report. However, during the fire they were all linked together in a convergence of events, depicted in the flowchart in Fig. 27. The following summary is intended to provide greater perspective of the interconnection between the different TRAs and fire progression. An annotated map is shown in Fig. 31.

Fire moved into Concow with reports to 911 of fire burning in yards by 07:15 on November 8. The IC requested evacuations of Concow at 07:22. At 07:50, while scouting out the fire and announcing evacuations on Hoffman Road, firefighters observed multiple spot fires along the road. At 07:55, law enforcement officers in Camelot informed the ECC via radio that they may not be able to escape Camelot due to fire conditions. The pre-designated Camelot Meadow Wild Fire Safety Zone (*TRA-A*) was the only option and was on fire (*BO #20*). Officers planned to park all vehicles in the field after the grass burned. Conditions deteriorated in the Concow area, and by 08:00 the firefighters returning eastward on Hoffman Road encountered 4 civilians running westbound from Concow Road toward the low water crossing. Their clothing was burned, and their hair was on fire. The road ahead had been blocked by fire, and they could not make it out to Concow Road. Visibility was less than 3 m (10 ft).

Between 08:00 and 08:17, 10 to 15 civilian vehicles were blocked by fire on Hoffman Road (*BO #1*) along with the firefighters. Two firefighters extracted all the civilians (n=24) from their vehicles and took shelter in the creek (*TRA-B*). Fire shelters were deployed to protect against radiation as the fire burned through dense vegetation. Several homes and vehicles were also burning, and propane tanks were exploding. At 08:17, while civilians and firefighters were trapped at the Hoffman Road TRA, there were approximately 15 civilian vehicles and additional law enforcement vehicles at Camelot Meadow. Visibility there was less than 100 m.

Several responding engines, crews, and dozers encountered heavy fire conditions on Concow Road at 07:45 and had to wait to gain access beyond Tweedy Lane. At 08:10, a dozer was able to progress further on Concow Road, and between 08:15 and 08:23 was able to clear Hoffman Road

from Concow Road to the creek to find the trapped group. Civilians packed into 8 unburned civilian vehicles and the firefighter's pickup truck and were led to the Concow Road intersection.

On Concow Road, the burnover (*BO #2*) that started at 07:50 was continuing and there were downed power lines just north of the intersection, indicated in Fig. 31. The Hoffman Road convoy was trapped again, along with additional civilian vehicles and fire engines attempting to get to the Camelot Meadow Wild Fire Safety Zone. To provide additional space for the Hoffman Road convoy and the other vehicles at the intersection, the dozer operator pushed out an area on the east side of Concow Road, the "dozer zone" (*TRA-C*). The dozed area was approximately 0.15 ha (0.37 ac), about 50 m × 30 m. At 08:31 a fire engine managed to drive from the intersection to Camelot but reported that it was not yet safe to escort the civilian convoy through. The civilians were finally able to leave the intersection at 08:47 and were in the Camelot Meadow Wild Fire Safety Zone (*TRA-A*) by 08:55. Civilians that sheltered in the creek were involved in two high peak hazard level exposure TRAs for over one hour before they were escorted to safety.

A number of search and rescue activities extended through the morning in Camelot between 07:45 and 12:00. Severe exposures significantly impacted some of these operations (*BO #5*). Civilians were escorted out of the Camelot Meadow TRA around 10:00.

Figure 32 shows a view of the Camelot meadow looking north from Camelot Lane, taken approximately one year after the fire.

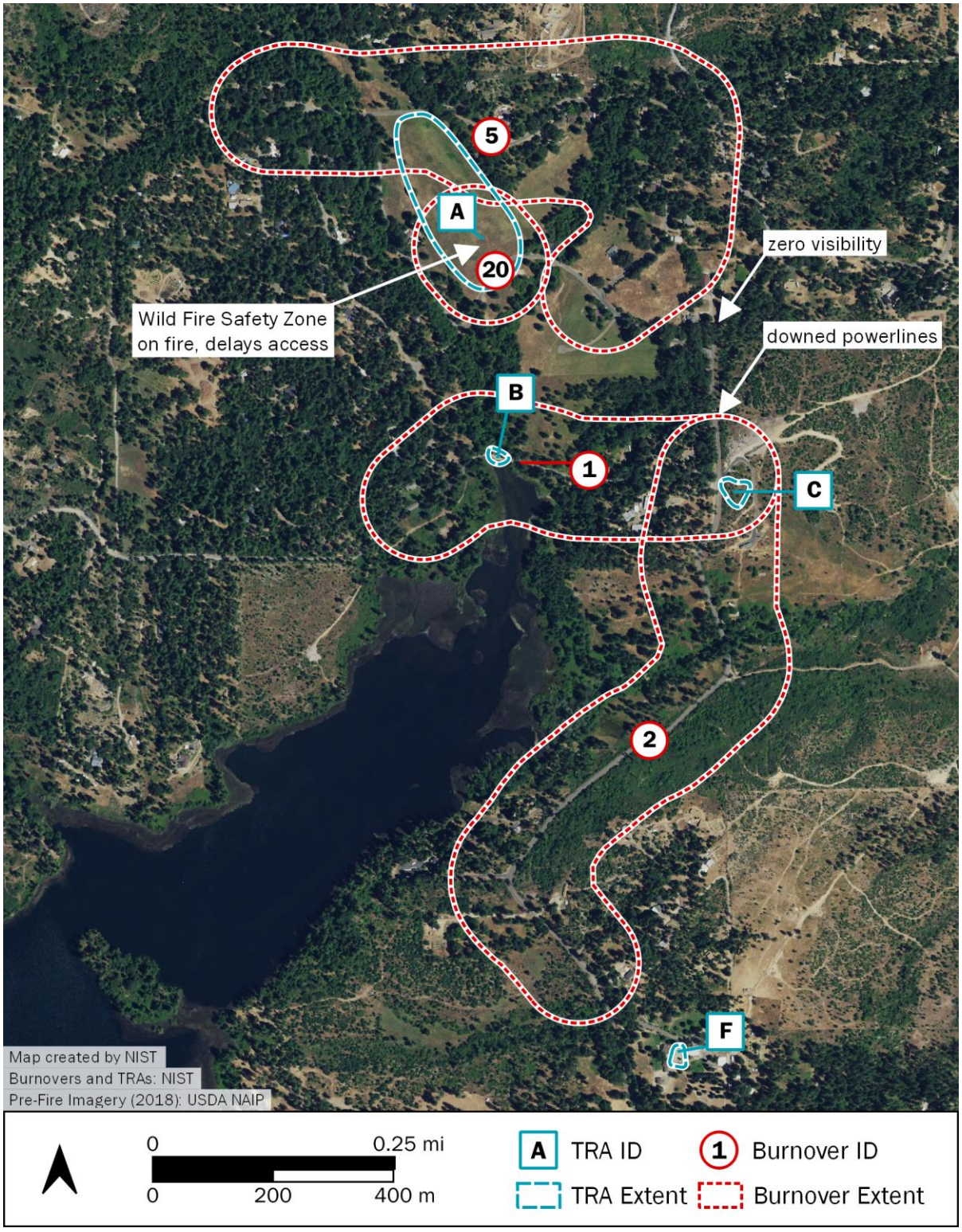


Fig. 31. Map showing the geographic relationship between the burnovers and TRAs in Concow, overlaid on pre-fire satellite imagery from 2018.

Fig. 32. NIST photos of the Camelot Meadow Wild Fire Safety Zone looking north from Camelot Ln, October 29, 2019 (~1-year post-fire).

9.3. Evacuation of TRAs

As described in Sec. 0, many civilians were unable to evacuate directly and were directed to TRAs. TRAs were used as immediate life-saving areas of refuge as well as locations where civilians were assembled to wait until further evacuation was possible after fire conditions improved and debris was cleared from the road. While most people were able to evacuate directly, over 1000 people first partially evacuated to TRAs. When fire exposures abated and safe egress was possible, subsequent evacuation of TRAs was coordinated by first responders. In some cases, improvement in conditions was localized and prohibited complete evacuation from the fire area, resulting in consolidation and merging of multiple TRAs.

Overall, evacuation convoys of TRAs were successfully executed. In a few documented cases, convoys were unable to evacuate due to fire conditions, and a few inbound convoys of transport vehicles (i.e., ambulances and buses) were unable to reach their intended destination due to fire and road obstructions. These events are listed in Table 34.

Table 34. Identified unsuccessful evacuation convoy attempts.

Time Range	Convoy Description	Intended Destination	Reason for Abort
before 10:00	Transit buses convoy from Butte College staging up Clark Road	Unknown	Fire conditions
10:00 10:30	A regional ambulance response team arrives to Butte County and attempts to enter Paradise via Skyway	Feather River Hospital (*TRA-E*)	Fire conditions
11:00 16:00	Various groups of civilians and civilians led by first responders attempt to evacuate from the hospital (*TRA-E*) multiple times	Out of the fire area	Fire and roadway conditions
14:00	Two transit buses were escorted toward the hospital but were turned around	Feather River Hospital (*TRA-E*)	Fire conditions

The connection between various TRAs is illustrated in Fig. 27. Table 35 lists the primary evacuation outcome of each TRA. Six TRAs have limited data regarding the specific evacuation outcome; however, the primary outcome for 90 % of civilians involved with TRAs is accounted for.

Evacuation of many TRAs was accomplished through vehicle convoys. A total of 18 different TRA convoys have been identified between 08:30 and 04:00 on November 9. The identified convoys were categorized as:

a) Convoys to move civilians from TRA to TRA

b) Convoys for the evacuation of TRAs (out of the fire)

Table 35. Primary evacuation outcome of each TRA.

ID	Name	Primary Outcome
A	Camelot Meadow Wild Fire Safety Zone	Escorted out
B	Hoffman Rd	Escorted to TRA-C
C	Concow Rd “dozer zone”	Escorted to TRA-A
D	Chris Ct	Drove out
E	Feather River Hospital	Drove out / escorted out
F	Concow Rd “gravel area”	n/d
G	Ponderosa Elementary School	n/d
H	Chloe Ct	Transported to TRA-E
I	Bille Rd	Escorted to TRA-K
J	Pearson Rd	Escorted to TRA-E
K	Paradise Plaza	Escorted out
L	PPD/Fire Station 81	Transported out
M	Paradise Baptist Church	n/d
N	Wagstaff Rd	n/d
O	Fire Station 82	Escorted to TRA-Q
P	Walgreens	Transported out
Q	Ace Hardware	Escorted out
R	Beyond Fitness	Escorted to TRA-K
S	Optimo	Escorted to TRA-K
T	Best Western	Escorted out
U	Magalia Community Church	n/d
V	CMA Church	Escorted to TRA-K
W	Paradise Shopping Center	Escorted/transported out
X	Firland Dr	n/a
Y	Magalia Pines Baptist Church	Transported to TRA-K
Z	Magalia Sav-Mor	Transported to TRA-K
AA	Rite Aid	Escorted out
BB	Skyway and Coutolenc Rd	n/a
CC	Magalia Dam	n/d
DD	Pine Ridge School	n/a
EE	Concow Rd and Pinkston Canyon Rd	n/a

Note: n/d represents no data, n/a indicates that only first responders, not civilians, used the TRA

9.3.1. TRA Consolidation Convoys

Eleven separate TRA to TRA convoy/civilian transfer events were identified: two in Concow, seven in Paradise and two in Magalia. The events in Concow were previously described in detail in Sec. 9.2. First, those involved in the Hoffman Road burnover and subsequent TRA (*BO #1*, *TRA-B*) were escorted in a convoy by a dozer and firefighter to *TRA-C* on Concow Road, where they joined additional civilians and first responders. When conditions allowed, people were further escorted to the Camelot Meadow Wild Fire Safety Zone (*TRA-A*). Both of these escorted convoys experienced intense fire exposures.

Several TRAs in Paradise were consolidated. The first was the Pearson Road TRA (*J*). After the burnover event forced first responders to form a TRA in the empty residential lot, fire conditions abated and conditions permitted travel to the larger parking lot at FRH (*TRA-E*) where there were more first responder resources and other civilians already sheltering. Following a dozer in the lead to clear burned vehicles and other debris, first responders escorted a convoy of civilian vehicles to the hospital. The hospital staff and patients using the TRA at the residence on Chloe Court (*TRA-H*) also returned to the hospital when conditions permitted.

Through the afternoon and into the evening, the Paradise Plaza TRA (*K*) became the centralized hub for many other TRAs in Paradise, since it was both one of the largest parking lots in town and centrally located. After the Bille Road burnover and TRA (*BO #8*, *TRA-I*), conditions on Bille Road and Pentz Road (southbound) were still impassable due to fire, abandoned vehicles, downed utility lines, and other debris. First responders coordinated a convoy of the vehicles from Bille Road to consolidate into the parking lot at Paradise Plaza around midday. The three vehicles who were directed into the parking lot at the gym (*TRA-R*) were also directed to Paradise Plaza.

Shortly prior to the final evacuation of many civilian vehicles from *TRA-K*, they were also joined by vehicles from the Optimo (*TRA-S*) and the CMA Church (*TRA-V*) between 16:30 and 17:00. Consolidation of TRAs improved the safety of civilians by improving situational awareness and enhanced the ability of first responders to keep track of them and manage their evacuation. Managing and guiding one large convoy facilitated the evacuation of this large number of vehicles in an orderly manner. People from the TRAs in Magalia (*Y* – Magalia Pines Baptist Church, *Z* – Magalia Sav-Mor) were also transported to Paradise Plaza for evacuation with the larger convoy or for transportation on waiting buses.

In one other case, just before noon, a convoy between Fire Station 82 on Pearson Road (*TRA-O*) and the Ace Hardware (*TRA-Q*) led nine civilian vehicles toward Clark Road so that they would be closer to the main evacuation route and in a larger parking lot area.

9.3.2. TRA Evacuation Convoys

In addition to the convoys that evacuated some TRAs via transfer or consolidation into other TRAs, seven TRAs were directly evacuated out of the fire area via convoys of civilian vehicles.

Once fire conditions abated in Concow, the group of civilians that had consolidated at the Camelot Meadow Wild Fire Safety Zone (*TRA-A*) were escorted out Concow Road to CA Highway 70. Similarly, several convoys were used during the afternoon/evening to evacuate the civilians and remining employees who sheltered at the hospital in Paradise (*TRA-E*). Specific times and details of how many convoys and their routes of travel were not determined.

Multiple convoys were used to evacuate TRAs once the fire had burned through large parts of Paradise and the egress arteries had re-opened after the burnovers on Skyway and Clark Road and debris had been cleared enough to allow passage of civilian vehicles. Several convoys were escorted down Clark Road to evacuate civilians sheltering at the Best Western (*TRA-T*) shortly after 13:00, when passage on Clark Road south of Paradise and past the airport was deemed safe again. Those at the Ace Hardware TRA (*Q*) were also escorted at some time in the early afternoon, although specific details of how many vehicles and exactly what time are unclear. On Skyway, civilian vehicles were escorted out of the fire area and other civilians were transported in law enforcement vehicles via Skyway when the Paradise Shopping Center (*TRA-W*) was no longer safe to occupy around 15:00.

The evacuation of civilians from the Paradise Plaza (*TRA-K*) occurred in the late afternoon/evening after the other major TRAs at the Optimo (*S*) and CMA Church (*V*) had been consolidated into one large group. A convoy of B-Line transit buses was escorted into Paradise and Magalia to transport civilians without vehicles, arriving around 17:00. Details about the B-Line bus involvement are described in the following section.

The final documented convoy left the Rite Aid (*TRA-AA*) in Magalia between 03:30 and 04:00 on the morning of November 9, 21 hours after the fire ignition, 20 hours after the fire front reached Paradise, and 3 hours after the midnight blowup of the fire from Coutolenc Road into Magalia. Civilians were given instructions from first responders before leaving the TRA and were given a specified safe route down Skyway to Clark Road and back over to Skyway. Instructions were clear to not deviate from the route because of unknown hazardous conditions on other roadways.

9.3.3. Use of B-Line Transit Buses

Butte Regional Transit (B-Line) provided valuable support during evacuation operations on November 8 into November 9, and continued operational support in the following days. Thirteen B-Line public transit buses involved in evacuations during the Camp Fire on November 8 were identified and documented. Information presented here was collected through technical discussions with B-Line personnel, including managers and drivers. Table 36 contains a summary timeline of B-Line bus engagement in evacuations; Appendix J contains additional details.

Normal operations involved transit buses on two fixed routes from Chico, plus seven Paratransit buses stationed in Paradise. Buses were operating in normal weekday service when the fire occurred; these buses continued to transport passengers out of Paradise among the evacuating traffic. Additional evacuation support was coordinated through the BCSO. Around 09:00, B-Line dispatched the first group of three large transit buses and two small Paratransit buses to the Incident Command Post staging area located at Butte College. The buses arrived around 10:00. Communication between B-Line management and the BCSO was well-established at the time of the Camp Fire after previous collaboration in 2017 during the Oroville Dam crisis.[19]

The largest organized bus convoy was coordinated with the goal of evacuating TRAs in Paradise. Five transit buses and two Paratransit buses were escorted by first responders, along with heavy

[19] High water levels and damage to the Oroville Dam spillway threatened to flood the city of Oroville downstream of the dam, triggering evacuations.

equipment to clear debris and obstructions. Leaving from the Butte College staging area at 15:30, the convoy traveled up Skyway to Clark Road, then south to the Paradise Plaza TRA (*K*) at the intersection of Clark Road and Wagstaff Road, arriving at approximately 17:15. The trip through Paradise was slow, as the roadway was being cleared to allow passage of the buses and intense fire conditions were present in the downtown commercial area along Skyway.

The primary evacuation was conducted over the next two hours. The large transit buses were loaded with passengers waiting at the Paradise Plaza TRA while the smaller, more maneuverable, Paratransit buses were used to ferry additional pedestrians to the larger buses. The smaller buses were taken to Magalia (*TRA-Z*), and transported several people to Paradise Plaza, including some in wheelchairs. Three of the five large buses and one Paratransit bus departed the TRA at 19:30 and transported people to evacuation shelters in Chico. Drivers estimate that each bus was full of approximately 50 passengers. Additional civilian vehicles accompanied this evacuation convoy as people left the TRAs. After several more hours waiting to gather as many civilians as possible, the remaining buses departed the TRA by 23:00 and took evacuees to the established shelters.

Table 36. B-Line transit bus evacuation engagement timeline summary.

Approx. Time Range		Description
08:00		Bus on Route 41 in Paradise, with passengers
08:00	11:00	Paratransit bus in service in Paradise; driver parks bus, evacuates passenger in personal vehicle
09:00	12:00	Bus on Route 41 is stuck in traffic; deviates from fixed route to evacuate with passengers
09:00	09:30	Attempt to send a Paratransit bus on an evacuation mission with law enforcement [a]
09:30	10:00	Buses dispatched to staging area at Butte College
10:00	12:30	Two transit buses with Paratransit bus go on rescue mission to Buschmann Rd area [a]
14:00		Attempt to send buses to FRH via Clark Rd [a]
15:30		Convoy departs staging area for Paradise TRA evacuations [a]
17:15		Convoy arrives at Paradise Plaza TRA
17:15	20:30	Buses load passengers; Paratransit buses ferry people from TRAs in Magalia
19:30		First group of buses depart Paradise Plaza with >100 evacuees; additional vehicles join convoy
23:00		Final buses depart Paradise Plaza
01:00		All buses have returned to the depot.
—		B-Line provided additional support to operations over the following days.

[a] Convoys departed from Butte College staging area

9.4. Analysis

9.4.1. Number of Civilians Utilizing TRAs

The number of civilians in TRAs was compiled using the best available information sourced from TDs, radio logs, photos, and videos. Tracking of TRA relocations and merging of individuals and groups allows for an estimate of the total number of people involved. At least 1222 civilians are estimated to have utilized at least one TRA.

Table 37 presents a range of the total number of civilians who were involved in TRAs based on the estimated numbers of vehicles and pedestrians (i.e., people not in vehicles). In some cases, exact counts of individuals were obtained. For example, the head count of 24 civilians at the Hoffman Road TRA was announced on the radio. In other instances, only an estimate of the total number of vehicles was possible, and the most likely range of the number of people and/or vehicles was calculated. For a minimum count, assuming a single person per vehicle (the driver), the estimated number of civilians is between 1222 and 2116, equivalent to between 5 % and 9 % of the population of Paradise. Estimates assuming up to 2.5 persons per vehicle are also shown in Table 37, resulting in a reasonable maximum count of 3889 people involved in TRAs (12 % of the population of Paradise).

The counts of civilians and/or vehicles at each individual TRA are listed in Table 38, along with the range of each estimated head count. TRAs that merged/combined are indicated as such and show the total number of people in each TRA. In most cases, the number of civilians and vehicles are additive. In four cases, the number of civilians was known independently of the number of vehicles, and the number of vehicles they used is provided in parenthesis for completeness. Individual TRA occupancy ranged from 1 to 550 civilians including people in vehicles and on foot.

Since not all TRAs were utilized simultaneously, Figure 33 illustrates the temporal component of the number of civilians in TRAs. The figure assumes that the full occupancy of each TRA was a step function at the formation of the TRA. The shading represents the potential range of the number of civilians based on two levels of vehicle occupancy: 1 person and 2 persons per vehicle. The bottom plot in Fig. 33 shows the number of simultaneously active TRAs. The figure shows that 25 of 31 TRAs had been populated by 14:00, accounting for nearly all of the civilians in TRAs.

Table 37. Estimated range of individual civilians based on different vehicle occupancy levels.

	Low Count	High Count
Pedestrians	622	934
Vehicles	600	1182
Total		
1.0 person/vehicle	1222	2116
1.5 persons/vehicle	1522	2707
2.0 persons/vehicle	1822	3298
2.5 persons/vehicle	2122	3889

Table 38. Estimated head count of civilians in each TRA, assuming one person per vehicle.

		Civilians		Vehicles [a]		Total Civilians [b]		
ID	**Name**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Includes**
A	Camelot Meadow Wild Fire Safety Zone	70	85	*(24)*	*(30)*	70	85	B + C
B	Hoffman Rd	24	24	*(10)*	*(15)*	24	24	
C	Concow Rd “dozer zone”	30	45	—	—	30	45	B
D	Chris Ct	—	—	6	6	6	6	
E	Feather River Hospital	65	115	50	110	115	225	H + J
F	Concow Rd “gravel area”	15	25	—	—	15	25	
G	Ponderosa Elementary School	—	—	6	6	6	6	
H	Chloe Ct	7	14	*(2)*	*(2)*	7	14	
I	Bille Rd	—	—	70	100	70	100	
J	Pearson Rd	—	—	30	70	30	70	
K	Paradise Plaza	—	—	350	550	350	550	I + R
L	PPD/Fire Station 81	30	60	*(0)*	*(0)*	30	60	
M	Paradise Ridge Southern Baptist Church	—	—	4	6	4	6	
N	Wagstaff Rd	—	—	100	200	100	200	
O	Fire Station 82	10	20	20	30	30	50	
P	Walgreens	100	140	—	—	100	140	
Q	Ace Hardware	—	—	—	—	—	—	
R	Beyond Fitness	—	—	3	3	3	3	
S	Optimo	180	220	—	—	180	220	
T	Best Western	—	—	15	20	15	20	
U	Magalia Community Church	—	—	—	—	—	—	
V	CMA Church	—	—	50	250	50	250	
W	Paradise Shopping Center	20	40	—	—	20	40	
X	Firland Dr	0	0	0	0	0	0	
Y	Magalia Pines Baptist Church	80	130	—	—	80	130	
Z	Magalia Sav-Mor	10	40	—	—	10	40	
AA	Rite Aid	40	60	—	—	40	60	
BB	Skyway and Coutolenc Rd	0	0	0	0	0	0	
CC	Magalia Dam	—	—	1	1	1	1	
DD	Pine Ridge School	0	0	0	0	0	0	
EE	Concow Rd and Pinkston Canyon Rd	0	0	0	0	0	0	

Note: The min and max values reflect uncertainty in the number of pedestrians and vehicles.
[a] ( ) indicate non-additive values; the indicated civilians were within those allotted vehicles.
[b] Total head count assumes only 1 person per vehicle.

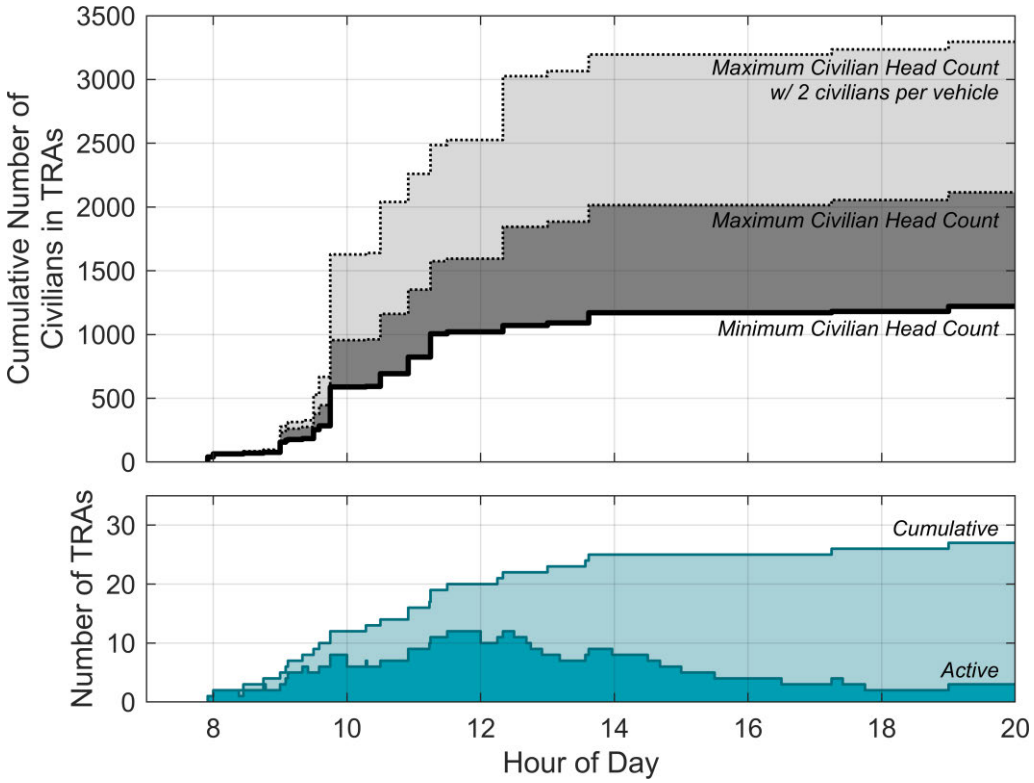


Fig. 33. Cumulative head count of civilians and TRAs over time on November 8. Maximum civilian head count values show the uncertainty in the number of people or vehicles, as well as the uncertainty in vehicle occupancy.

9.4.2. High Urgency of Formation and High Peak Hazard TRAs

TRAs were characterized by two qualities: the urgency of formation and the peak hazard level (Sec. 9). The urgency of formation (high, moderate, or low) represents how rapidly the individuals present needed to get to safety. Examples of the two extremes represent civilians and/or first responders caught in a burnover seeking immediate shelter (high urgency) versus utilizing a TRA in the absence of fire exposures to wait for the traffic or roadway conditions to improve (low urgency).

The peak hazard level describes the maximum exposure level experienced by civilians and/or first responders while in the TRA, in three categories classified as high, moderate, and low. High peak hazards were experienced when the TRA was formed in a burnover. Moderate conditions were defined as significant fire and/or ember exposures that did not pose an immediate danger to life, while low exposures described scenarios where the combination of local fire activity and the size of the TRA resulted in little danger to life safety. Table 32 lists the relationships between TRAs and associated burnovers and whether a TRA was created within the burnover area.

Eleven TRAs were deemed in this analysis to have been formed with a high urgency. Eight were created between 07:55 and 09:35 and involved a minimum total of 261 civilians—70 in Concow and 191 in Paradise. Head counts in each TRA, assuming one person per vehicle, are listed in

Table 39. With the exception of Ponderosa Elementary School[20] (6 civilian vehicles present), each of these high urgency TRAs were formed in direct response to burnovers and were coordinated by first responders on location. The remaining three high urgency TRAs involved first responders only and took place on November 9.

Out of the eight High Urgency of Formation TRAs involving civilians (*A* - Camelot Meadow Wild Fire Safety Zone, *B* - Hoffman Road, *C* - Concow Road "dozer zone", *E* - Feather River Hospital, *G* - Ponderosa Elementary School, *H* - Chloe Court, *I* - Bille Road, and *J* - Pearson Road), six experienced high peak hazard conditions. The fire front hit Paradise at approximately 08:30, impacting the eastern parts of town—first east of Pentz Road between 08:30 and 09:00, then further west between 09:00 and 09:30. There was significant fire activity along nearly the entire Pentz Road egress corridor from Apple View Way (north of Ponderosa Elementary School) to Pearson Road, a distance of 5 km (3 mi).

Table 39. Head count of civilians involved in high urgency of formation TRAs, assuming one person per vehicle.

				Civilian Head Count	
	ID	**TRA Name**	**PHL**	**Min**	**Max**
Concow					
	A	Camelot Meadow Wild Fire Safety Zone	▲▲▲	70	85
	B	Hoffman Rd	▲▲▲	24[a]	24[a]
	C	Concow Rd "dozer zone"	▲▲▲	30[a]	45[a]
Paradise					
	E	Feather River Hospital	▲▲	115	225
	G	Ponderosa Elementary School	▲▲	6	6
	H	Chloe Ct	▲▲▲	7[b]	14[b]
	I	Bille Rd	▲▲▲	70	100
	J	Pearson Rd	▲▲▲	30[b]	70[b]
Total				**352**	**569**
				(261 individuals)	**(416 individuals)**

Note: The tabulated civilian head count assumes only 1 person per vehicle. The min and max values reflect uncertainty in the number of pedestrians and vehicles. The true maximum is likely higher than 1 person per vehicle. Total is the (person × exposure) count. Some individuals were located in multiple locations, as follows:
[a] Consolidated into *TRA-A*.
[b] Consolidated into *TRA-E*.

9.4.3. TRA Type, Size, and Location

Different types of location settings were used for TRAs based on local conditions, needs, and available spaces. TRAs were formed within burnovers, as close as practicable outside of burnover areas, and at key access points on, or near, major roadways. TRA locations were

[20] There was a 911 call from the outdoor basketball courts at Ponderosa Elementary School, and civilians were provided with evacuation instructions.

characterized into 5 types, consisting of 14 parking lots, 7 roadways, 6 structures, 3 natural areas (e.g., roadside creek), and 1 maintained natural area (e.g., ballfield, maintained meadow). The physical size of TRAs varied significantly depending on the type, ranging from small intersections of narrow roads to over 3 ha (8 ac) at the Camelot Meadow Wild Fire Safety Zone. Table 40 lists the type and size of each TRA.

This analysis contains a data bias for TRAs formed by first responders. It is possible that other civilian-only TRAs were formed, particularly in Concow and eastern Paradise (e.g., like the Chris Court situation but without first responders present). Two known examples include civilians taking refuge in maintained natural areas at Bille Park (a few vehicles) and Paradise Cemetery (9 civilians). Vehicles in both locations were escorted out of the area.

Three pre-designated wildfire safety zones or public assembly points (PAPs) were used.

- Camelot Meadow Wild Fire Safety Zone: maintained natural area
- Paradise CMA Church PAP: parking lot, and
- Pine Ridge School PAP: parking lot.

There is limited information available on the extent of fuel present at the Camelot TRA; however, radio logs indicate that fuel was sufficient to carry fire and delay the use of the TRA for some time until the meadow had burned. In Paradise and Magalia, the pre-planned PAPs were all parking lots.

TRA size varied significantly. The largest TRA was the Camelot Meadow Wild Fire Safety Zone, greater than 3.2 ha (8 ac). Parking lots varied from 2.4 ha (6 ac) with 500 to 600 marked parking spaces at the CMA Church and Paradise Plaza, to as small as the 0.08 ha (0.2 ac) “gravel area” used at a residence on Concow Road. Large area TRAs, including Camelot Meadow Wild Fire Safety Zone (*TRA-A*), FRH parking lot (*TRA-E*), and Paradise Plaza (*TRA-K*), were sufficiently large to accommodate the number of civilians present. For TRAs that were formed within burnovers, the size of the TRA was limited by the available locations, therefore creating high congestion areas with high exposures, frequently leading to ignition of civilian vehicles. Examples of these TRAs include Hoffman Road (*TRA-B*), Bille Road (*TRA-I*), and Pearson Road (*TRA-J*).

Parking lots were used for 45 % (14/31) of TRAs and generally provided reduced exposure levels. Most parking lot TRAs were used to park civilians until egress roadway conditions improved. They played a key role in traffic management to limit civilians from being exposed to highly hazardous conditions. No parking lot TRAs experienced high peak hazard levels; eleven experienced moderate and three experienced low peak hazard levels.

Only three of the 14 parking lot TRAs were established with high urgency. The TRA at Feather River Hospital (*TRA-E*) was necessary to address the immediate needs of hospital patients and staff, as well as to accommodate civilian vehicles exposed to advancing fire along Pentz Road. Similarly, the basketball courts[21] behind Ponderosa Elementary School (*TRA-G*) were used by civilians in six vehicles to shelter from rapidly deteriorating conditions on Pentz Road. The parking lot at Pine Ridge School (*TRA-DD*) in Magalia was also accessed with high urgency by firefighters in the morning on November 9.

[21] The basketball courts were categorized as a parking lot.

Of six structures used, only the residence on Chloe Court (*TRA-H*) was located within a burnover, formed with high urgency in high hazard conditions. Four of the remaining five structures used as TRAs experienced moderate peak hazard levels, and one, PPD/Fire Station 81 (*TRA-L*), had low PHL during its use as a TRA. Several structures were commercial businesses surrounded by parking lots, which provided additional buffer and reduction of hazard levels. Like the parking lot TRAs, the majority of the structures were used to shelter civilians from moderate exposures.

Traffic gridlock, combined with rapidly spreading fire, forced first responders to establish roadway or natural area TRAs that experienced high exposures. In these events, the size of the TRA was influenced by the number of civilians trapped there. The gridlock and subsequent burnover that resulted in establishment of a TRA at Bille Road is an example of such an event. Other similar TRA scenarios include Pearson Road, Hoffman Road and the Concow Road "dozer zone." Roadways and natural area TRAs had proportionally higher instances of high urgency—43 % (3/7) and 100 % (4/4), respectively—and high hazard—29 % (2/7) and 100 % (4/4). Roadways were used when civilians and/or first responders were trapped in a location because of fire in the vicinity and escape was not possible due to fire and/or traffic conditions. The Hoffman Road and Bille Road burnover/TRA combinations are examples of such events. Roadway TRAs were often setup at intersections to provide as much space as possible from the surrounding roadside fuels, with people sheltering inside vehicles.

Out of the 4 natural area TRAs, only one was a maintained area—the pre-planned wildfire safety zone at Camelot. In Concow, the area around the Hoffman Road creek crossing was not designed to be a safety zone, and the roadside vegetation along the road was not maintained. Another natural TRA was physically created by a dozer during the Concow Road burnover event, pushing out the approximately 50 m × 30 m area of tall shrubs as described in Sec. 9.2. In Paradise, the one natural area TRA, on Pearson Road, was semi-maintained as a grassy unbuilt residential lot. Roadways and natural area TRAs were frequently the only local options (35 % [11/31] of TRAs during the Camp Fire) and were used out of necessity in quick response to local high exposure conditions.

In Paradise, particularly on the main egress arteries of Skyway and Clark Road, the presence of commercial parking lots significantly facilitated traffic management, as they were used to reduce the exposures experienced by civilians and first responders. Locations where the frequency of large parking lots was lower, such as upper Skyway (north of Wagstaff Road), Pentz Road, and Bille and Pearson Roads east of Clark Road were areas where traffic management options were limited, and gridlocks formed rapidly early in the evacuation. Pentz Road, a heavily vegetated egress artery, was primarily residential with limited commercial facilities. Along Pentz Road between Skyway and Feather River Hospital, a distance of 5 km (3.1 mi), six parking lots were readily visible and accessible from Pentz Road. In all six cases the parking capacity was at least 36 marked spaces. Three of the six were used as TRAs, shown in Fig. 34. Traffic and fire conditions limited movement and forced the local formation of TRAs; three additional TRAs were formed immediately along Pentz Road utilizing non-parking lot areas.

Table 40. List of TRAs with location types and general areas.

ID	Name	Type	Area	
			ha	ac
A	Camelot Meadow Wild Fire Safety Zone	Natural (Maintained)	3.37	8.33
B	Hoffman Rd	Natural	0.06	0.16
C	Concow Rd “dozer zone”	Natural	0.15	0.37
D	Chris Ct	Roadway	0.30	0.74
E	Feather River Hospital	Parking Lot	1.38	3.40
F	Concow Rd “gravel area”	Parking Lot	0.08	0.20
G	Ponderosa Elementary School	Parking Lot	0.28	0.70
H	Chloe Ct	Structure	0.31	0.77
I	Bille Rd	Roadway	0.31	0.77
J	Pearson Rd	Natural	0.29	0.71
K	Paradise Plaza	Parking Lot	2.32	5.74
L	PPD/Fire Station 81	Structure	0.37	0.92
M	Paradise Ridge Southern Baptist Church	Parking Lot	0.21	0.52
N	Wagstaff Rd	Roadway	0.49	1.22
O	Fire Station 82	Structure	0.11	0.26
P	Walgreens	Structure	0.55	1.37
Q	Ace Hardware	Parking Lot	0.53	1.30
R	Beyond Fitness	Parking Lot	0.34	0.83
S	Optimo	Structure[a]	0.34	0.83
T	Best Western	Parking Lot	0.70	1.74
U	Magalia Community Church	Parking Lot	0.57	1.41
V	CMA Church	Parking Lot	2.56	6.34
W	Paradise Shopping Center	Parking Lot	0.75	1.86
X	Firland Dr	Roadway	0.11	0.28
Y	Magalia Pines Baptist Church	Parking Lot	0.93	2.31
Z	Magalia Sav-Mor	Parking Lot	0.39	0.95
AA	Rite Aid	Structure	0.55	1.37
BB	Skyway and Coutolenc Rd	Roadway	0.32	0.78
CC	Magalia Dam	Roadway	0.17	0.43
DD	Pine Ridge School	Parking Lot	1.25	3.09
EE	Concow Rd and Pinkston Canyon Rd	Roadway	0.06	0.16

[a] The parking lot was used initially, but civilians were moved into structures for increased protection.

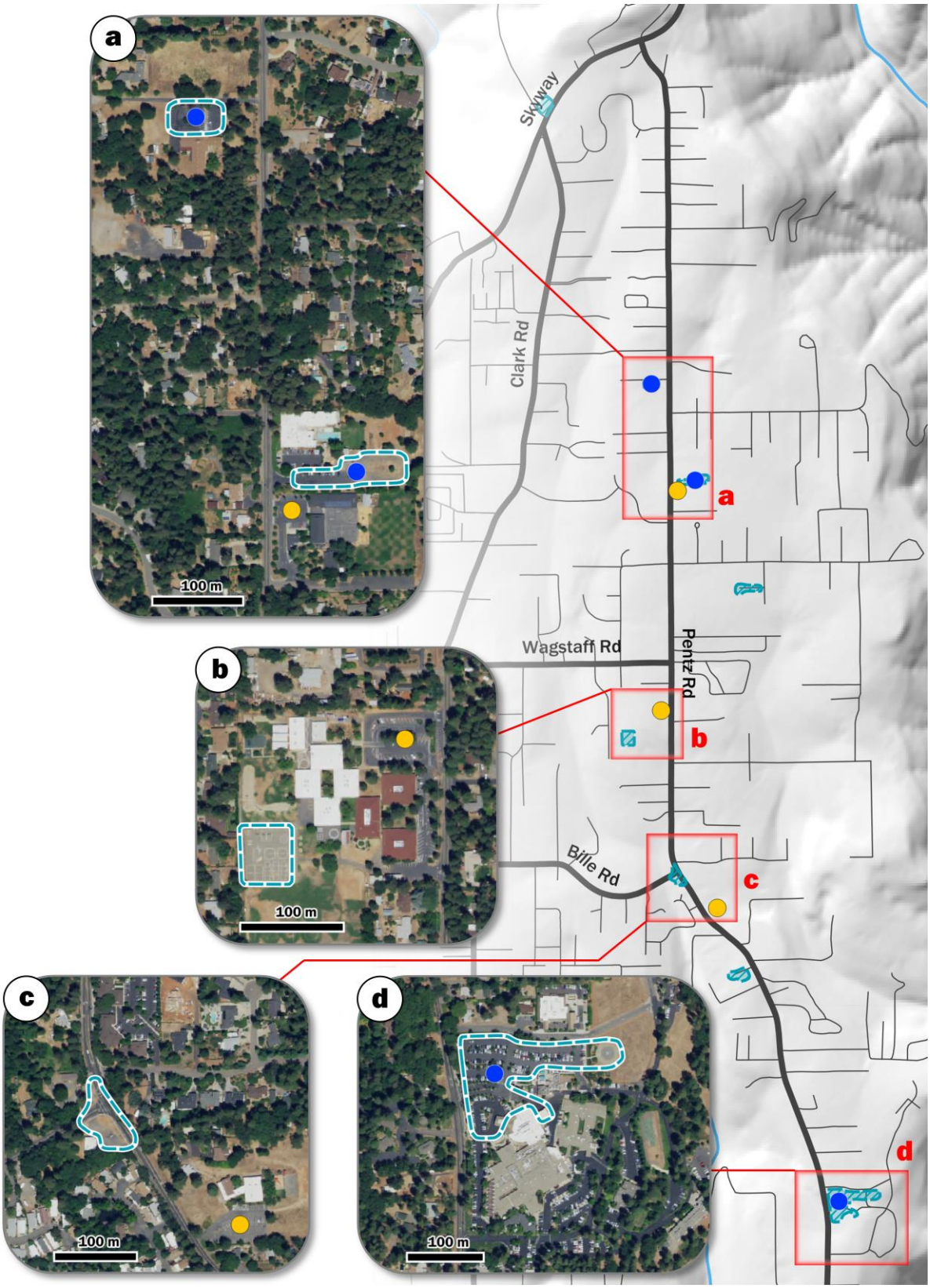


Fig. 34. TRAs (teal blue outline and shading) along Pentz Rd utilized many of the readily visible and accessible parking lots, highlighted by blue dots. Additional parking areas are indicated by yellow dots.

9.4.4. Fuels Around TRAs

The types, quantity, and location of combustible fuels around TRAs varied significantly. The timing with respect to TRA occupation and the burning duration also influenced the exposure levels experienced at each TRA. All TRAs in Paradise and Magalia were in locations that had not experienced significant fire history in over 100 years. In Concow, the TRAs (and wildfire safety zones) had not experienced significant fire in the last 10 years.

In situations like Hoffman Road (*TRA-B*), people became trapped in a forested area with relatively thick understory vegetation extending all along the narrow one lane roadway. The TRA was established at the location with the most cleared space—at/in the low water crossing at Concow Creek. These conditions were very different from those experienced at Paradise Plaza—a 2.3 ha (5.7 ac) paved parking lot surrounded on two sides by main traffic arteries and commercial structures on the other sides. In cases where commercial structures did not ignite, these large structures provided distance between TRAs and the hazard, shielding occupants from radiation and potentially from embers. However, these structures represent a serious hazard if ignited. For example, a similar commercial parking lot was present at the Old Town Plaza (the shopping center with Safeway et al.) on Clark Road at Elliott Road, where the burning commercial building resulted in hazardous exposures to the parking area, making the area unusable as a TRA.

The potential influence of surrounding roadways as fuel breaks is also variable, depending on the width of the roadway, roadside fuels, and whether abandoned vehicles in the roadway were burning. Road widths in and around each TRA are presented in each summary in Appendix I. Also in the Appendix, satellite and/or aerial imagery before and after the fire show the fuels around each location.

9.4.5. TRA Duration

The time duration over which each TRA was utilized depended primarily on the local conditions. A second factor was often the fire and traffic conditions between the TRA and a complete evacuation from the fire area; long-duration but low peak hazard level TRAs were implemented to keep civilians in a relatively safe location until fire and roadway conditions allowed for safe evacuation. TRA use was kept to an absolute minimum in the cases when TRAs were within burnover areas and high exposures were present (e.g., Hoffman Road, *TRA-B,* 23 minutes), while TRAs used as assembly locations, such as Paradise Plaza *TRA-K*, were often utilized for several hours. Tables 41 to 43 divide the TRAs into three groups based on the duration of TRA occupation and summarize the minimum head count of civilians involved in each location.

The majority of civilians, a minimum count between 955 and 1675, or 78 %, took refuge in one of nine TRAs for between 3 and 9 hours, tabulated in Table 41. None of these long-duration TRAs experienced high peak hazard levels, indicating the relative safety of the locations utilized for staging and waiting for conditions to permit safe evacuation. FRH was the only long-duration TRA formed with high urgency due to the early onset of severe fire conditions, its location on Pentz Road, and the vulnerable population at the hospital. Out of the 1000-plus civilians involved in these long-duration TRAs, only 13 % were at FRH (*TRA-E*).

There were 12 moderate duration TRA events (Table 42). Three TRAs (highlighted) were both high urgency and high peak hazard level. The remaining nine experienced moderate peak hazard

level. Out of the minimum estimated head count of 1222 civilians who were in at least one TRA, 319 (26 %) were in TRAs active between 1 and 3 hours. Out of the 319, 147 (46%) were in high urgency of formation and high peak hazard level TRAs.

While 10/31 TRAs (32 %) were active for less than one hour (Table 43), they only account for ~10 % of the number of civilians in TRAs. However, most of these people were exposed to high peak hazard levels and urgent life-threatening scenarios, emphasized in the highlighted rows. Between 90 and 145 people (80%) were in high urgency TRAs, and 84 to 139 (75 %) were in TRAs with high peak hazard levels.

Table 41. TRA duration and minimum civilian head count, t ≥ 3 hours.

ID	TRA	Urgency	Peak Hazard	Active Duration (h:mm)	Civilian Head Count [a]	
					Min	Max
Y	Magalia Pines Baptist Church	!	▲▲	9:23	80	130
AA	Rite Aid	!	▲▲	9:00	40	60
K	Paradise Plaza	!	▲	8:00	350	550
E	Feather River Hospital	! ! !	▲▲	6:00	115	225
S	Optimo	!	▲▲	5:15	180	220
V	CMA Church	!	▲	5:05	50	250
L	PPD/Fire Station 81	!	▲	4:56	30	60
Z	Magalia Sav-Mor	!	▲	4:45	10	40
P	Walgreens	! !	▲▲	3:35	100	140
	Total (person × TRA)				**955**	**1675**

[a] Tabulated civilian head count assumes only 1 person per vehicle. The min and max values reflect uncertainty in the number of pedestrians and vehicles. The true maximum is likely higher than 1 person per vehicle.

Table 42. TRA duration and minimum civilian head count, 1 ≥ *t* > 3 hours.

ID	TRA	Urgency	Peak Hazard	Active Duration (h:mm)	Civilian Head Count [a]	
					Min	Max
I	Bille Rd	! ! !	▲▲▲	2:30	70	100
W	Paradise Shopping Center	!	▲▲	2:30	20	40
M	Paradise Baptist Church	! !	▲▲	2:28	4	6
N	Wagstaff Rd	! !	▲▲	2:25	100	200
A	Camelot Meadow	! ! !	▲▲▲	2:05	70	85
H	Chloe Ct	! ! !	▲▲▲	1:55	7	14
Q	Ace Hardware	!	▲▲	1:46	n/d	n/d
T	Best Western	! !	▲▲	1:41	15	20
DD	Pine Ridge School	! ! !	▲▲	1:20	0	0
R	Beyond Fitness	! !	▲▲	1:15	3	3
O	Fire Station 82	!	▲▲	1:05	30	50
BB	Skyway and Coutolenc Rd	! ! !	▲▲	1:00	0	0
	Total (person × TRA)				**319**	**518**

Note: n/d indicates no data.

[a] Tabulated civilian head count assumes only 1 person per vehicle. The min and max values reflect uncertainty in the number of pedestrians and vehicles. The true maximum is likely higher than 1 person per vehicle.

Table 43. TRA duration and minimum civilian head count, *t* < 1 hour.

ID	TRA	Urgency	Peak Hazard	Active Duration (h:mm)	Civilian Head Count [a]	
					Min	Max
G	Ponderosa Elementary School	! ! !	▲▲	0:53	6	6
J	Pearson Rd	! ! !	▲▲▲	0:43	30	70
D	Chris Ct	! !	▲▲	0:40	6	6
U	Magalia Community Church[b]	! !	▲▲	0:26	n/d	n/d
C	Concow Rd “gravel area”	! !	▲▲	0:25	15	25
X	Firland Dr	! !	▲▲	0:24	0	0
B	Hoffman Rd	! ! !	▲▲▲	0:23	24	24
C	Concow Rd “dozer zone”	! ! !	▲▲▲	0:20	30	45
EE	Concow Rd and Pinkston Canyon Rd	! ! !	▲▲▲	0:18	0	0
CC	Magalia Dam	! !	▲	0:09	1	1
	Total (person × TRA)				**112**	**177**

[a] Tabulated civilian head count assumes only 1 person per vehicle. The min and max values reflect uncertainty in the number of pedestrians and vehicles. The true maximum is likely higher than 1 person per vehicle.

[b] TRA was also used a second time by first responders only, not included in this table.

9.4.6. TRA Occupant Type

TRAs were typically occupied by both civilians and first responders, on foot and/or inside vehicles. First responders were present at 25 TRAs to provide sheltering and evacuation information to civilians, often while taking shelter themselves. In several cases first responders conducted defensive actions to protect TRAs and civilians, further described in Sec. 9.4.7.

Only the Ponderosa Elementary School TRA is known to have been used by civilians without first responders present. At Ponderosa Elementary School (*TRA-G*), a civilian called 911 indicating they were trapped at the basketball courts; the dispatcher provided emergency evacuation guidance.

Five TRAs were used exclusively by first responders. These were Firland Drive (*TRA-X*), Skyway and Coutolenc Road (*TRA-BB*), Magalia Community Church (*TRA-U*)[22], Pine Ridge School (*TRA-DD*), and Concow Road and Pinkston Canyon Road (*TRA-EE*). These TRAs were utilized primarily during burnover events encountered during fire suppression activities after the bulk of civilian evacuations had occurred.

9.4.7. Defensive Actions at TRAs

Defensive actions by first responders took place at half of the TRAs and are identified in Table 44. Defended TRAs are subdivided into three categories:

1. TRAs where defensive actions were conducted to directly enhance the life safety of civilians,
2. TRAs where the defensive actions were aimed at protecting infrastructure and commercial buildings that were used intermittently to shelter civilians,
3. Defensive actions in the area within or surrounding the TRA to reduce losses, enhance access to the TRA, and keep exposures low. In these situations, the civilians sheltering in the TRA were not in immediate danger.

There are four TRAs in Category 1. The first was the TRA at the cul-de-sac of Chris Court (*TRA-D*), where firefighters protected civilians from surrounding burning structures. On Chloe Court (*TRA-H*), a residential structure was used as a TRA and was defended as civilians and first responders took shelter in the garage. On Bille Road (*TRA-I*), the fire engine connected to the hydrant used the deck gun to cool down the gridlocked traffic at the intersection during the Bille Road burnover (*BO #8*), preventing an estimated 70 to 100 vehicles from catching on fire. Lastly the Rite Aid in Magalia (*TRA-AA*) was heavily defended from nearby exposures of burning buildings using multiple fire engines while sheltering between 40 and 60 civilians.

Eight TRAs were defended in Category 2, including Feather River Hospital (*TRA-E*), the PPD/Fire Station 81 (*TRA-L*) and Fire Station 82 (*TRA-O*), Paradise Ridge Southern Baptist Church (*TRA-M*) and the CMA Church public assembly point in Paradise (*TRA-V*), and two churches (Magalia Community Church (*TRA-U*) and Magalia Pines Baptist Church (*TRA-Y*)) and the Pine Ridge School public assembly point (*TRA-DD*) in Magalia.

[22] Between 01:00 and 03:30 on November 9. The first use of this location involved both civilians and first responders.

The remaining five TRAs in Category 3 (Paradise Plaza [*TRA-K*], Walgreens [*TRA-P*], Ace Hardware [*TRA-Q*], Optimo [*TRA-S*], and Best Western [*TRA-T*]) were defended, but there was no direct hazard to the civilians taking shelter at these TRAs. Out of these five, only at the Optimo were civilians placed inside buildings as exposures to the parking lot increased. In the four other cases, civilians were sheltered in the parking lots or other open areas (e.g., the helipad at FRH).

With the exception of Bille Road, Chris Court, and Chloe Court, all defended TRAs were commercial or public buildings, including fire stations, schools, churches, hospitals, and businesses. Bille Road and Chris Court TRAs were located on roadways, and defensive actions were aimed at exposure reduction. The Chloe Court TRA was the only residential structure used as a TRA and was defended to maintain life safety. Figure 35 shows photos of three examples of defensive actions at TRAs.

Fig. 35. Examples of defensive actions taken at TRAs. a) Feather River Hospital, Category 2. b) Rite Aid, Category 1. c) Optimo, Category 3.

Table 44. Defensive actions taken at active TRAs.

ID	TRA Name	Defensive actions during active TRA
Category 1: Life Safety		
D	Chris Ct	Firefighters engaged in defensive action of multiple structures in the area. Fire hydrants were utilized.
H	Chloe Ct	First responders (paramedics and medical staff) cleaned debris from around the structure, roof, and gutters of a residence. Garden hoses were used to put out nearby spot fires. A fire engine also arrived to defend the area.
I	Bille Rd	A fire engine utilized the fire hydrant water supply to spray the intersection area during the fire exposure. Additional engines conducted rescue and defensive action operations on Bille Rd.
AA	Rite Aid	Multiple fire engines protected against radiation exposure from nearby burning commercial structures and from embers.
Category 2: Infrastructure Protection		
E	Feather River Hospital	There was significant suppression effort dedicated to stopping fire spread through the hospital building and suppressing spot fires in the landscaping vegetation.
L	PPD/Fire Station 81	Various defensive actions were taken to protect the structures, including clearing debris from the roof and patrolling with garden hoses.
M	Paradise Baptist Church	Firefighters conducted defensive burning operations and utilized the fire hydrant on Pentz Rd.
O	Fire Station 82	Firefighters cleared debris from the roof and from around the structure and defended against embers and fire exposures to station.
U	Magalia Community Church	Defensive actions were taken in the area near the Community Church.
V	CMA Church	Defensive actions were taken at the church.
Y	Magalia Pines Baptist Church	Firefighters patrolled the area and conducted unspecified defensive actions.
DD	Pine Ridge School	Firefighters suppressed ignitions on temporary classroom buildings and patrolled the school campus to defend from embers and exposures.
Category 3: Exposure Reduction		
K	Paradise Plaza	Firefighters patrolled the area around the shopping center, protected the back of the buildings from exposures, and put out spot fires in vegetation in the parking lot.
P	Walgreens	Defensive actions were taken to protect the Walgreens structure from fire exposures from nearby burning vehicles, structures, and vegetation. Fire on the roof was suppressed using fire extinguishers from the store.
Q	Ace Hardware	Firefighters conducted defensive actions to protect the main commercial structure from the nearby burning vegetation and stored materials.
S	Optimo	Firefighters put out spot fires and suppressed a structure ignition at the TRA. Additional firefighting operations were conducted on surrounding commercial structures to prevent fire from encroaching on the TRA.
T	Best Western	Firefighters defended the hotel structure from vegetation fire and also suppressed fire on the roof of the hotel.

9.4.8. Decision-making and Evacuation Intent

TRAs were formed to meet situational life safety needs and to manage the evacuation of civilians. This section contains information collected from TDs and other data sources such as radio logs and pictures/videos—no surveying of civilians was conducted. While most information about the decision-making and evacuation intent of civilians during the Camp Fire remains unknown, the following examples from the collected information can provide useful insight. These examples summarize a few known events and likely intentions regarding TRAs.

Civilian intentions in the context of TRAs can be divided into the following categories:

1. Civilians sought shelter in a wildfire safety zone or TRA by themselves.
2. Civilians became trapped by fire in a burnover. In many cases civilians in burnovers were redirected to TRAs.
3. Civilians were trying to leave the area (either for evacuation purposes or other reasons), and fire forced their redirection to a TRA.
4. Civilians were directed to a TRA because of traffic flow and fire exposures but were not in any immediate danger from fire exposures.

The following cases demonstrate the complexities of these evacuation events and provide possible insight into the civilian evacuation intents. All events described below took place on November 8.

Concow between 07:55 and 10:00

There were a number of civilians that made it to the Camelot Meadow Wild Fire Safety Zone before 08:00, likely from points north of the Concow Road/Hoffman Road intersection where the majority of residences are located. It is possible that some people were instructed to go there by law enforcement officers working on direct emergency notifications.

On Hoffman Road, civilians leaving the area were led by first responders. It is not known if any of them intended to go to the Camelot Meadow Wild Fire Safety Zone rather than evacuating to CA Highway 70 via Concow Road; however, they ended up being escorted there after enduring TRAs on Hoffman Road and Concow Road (see Sec. 9.2).

On Concow Road, a number of civilians in their vehicles were trying to get to (or return to) the Camelot Meadow (in the opposite direction of evacuating Concow) and were caught in the burnover there along with the civilians from Hoffman Road. It is unknown if these civilians were forced to turn around due to road/fire conditions or if they were entering from outside the fire area to return to their homes or other reasons.

Paradise and Magalia between 08:45 and 11:30

At 08:45, shortly after the fire front reached the eastern part of Paradise, civilians getting ready to evacuate from Chris Court were told by firefighters to stay there until conditions improved. Firefighters formed a TRA and they conducted defensive actions around the Chris Court cul-de-sac. This TRA remained active for at least 40 minutes before civilians were able to drive out of the area.

> Around 09:00 on Pentz Road, civilians trying to evacuate the FRH area became trapped between the Bille Road burnover to the north and the Pentz Road and Pearson Road burnovers to the south. Rapidly deteriorating conditions contributed to limited situational awareness during the early part of the burnovers, resulting in civilians driving in both directions attempting to get out of the area. A few were able to go south on Pentz Road, and many sought shelter at the FRH TRA. Two ambulances leaving FRH headed north towards Bille Road to evacuate[23] and one caught fire near Chloe Court, 1 km (0.6 mi) north of the hospital. The Fire Chief present in the area accessed a residential garage, forming the Chloe Court TRA. Patients and paramedics remained there for 2 hours before returning to FRH.
>
> Also on Pentz Road, six civilian vehicles sought shelter on the basketball courts of Ponderosa Elementary School, likely because of local high exposures and heavy/standstill traffic conditions. A recording of their 911 call indicated that they were intending to escape but encountered fencing blocking their progress. They were advised by the operator to drive through the fence if necessary. There was no evidence that such actions were taken.
>
> At 11:30, the burnover on Clark Road at American Way resulted in a stream of evacuating traffic being redirected northward to parking lots at the Ace Hardware and Best Western TRAs. The closure of Clark Road forced traffic redirection by PPD and other LE westward through Paradise toward Skyway.

The above event descriptions illustrate evacuation complexities that arise particularly for scenarios that are locally impacted by fire and traffic. These events occurred where there was limited time between the arrival of fire and the time needed to inform and evacuate the public. Another example of civilian decision-making and intent is illustrated in VTD-31 in the late morning, in which civilians in Magalia attributed their decision to delay their evacuation because of heavy traffic and gridlock, saying "the streets are just too full to go anywhere, so we're just waiting. Where else can you really go? Streets are packed. Can't drive anywhere. I've got a quarter tank of diesel, so I'm not trying to sit around in traffic. The wind is blowing south, so that's good. We're just going to wait it out here…if the wind changes, we're going to get out of here." In the afternoon, these civilians staged at the Rite Aid before it became a formal TRA. Ultimately, they were escorted out of the fire with other civilians who had assembled at, or were sent to, the TRA. This illustrates some of the external factors that can influence the personal decisions made by civilians during complex WUI fire events.

Unlike the civilian examples, intended destinations and actions of some first responders that formed and utilized TRAs are known via technical discussions. In the case of the Firland Drive TRA, first responders were trying to go north on Skyway to their assignment to protect the Optimo TRA (*S*) when they encountered numerous abandoned and burning vehicles in the roadway, heavy fire conditions, and near-zero visibility. The expanded area at the intersection of Firland Drive enabled them to wait for conditions to improve on Skyway before proceeding north.

In the case of the Pine Ridge School TRA on November 9, first responders were conducting a search and rescue operation in Magalia when conditions dictated use of a TRA/safety zone. The

[23] Pentz Road south of the hospital was visibly impacted by heavy fire at the time. From FRH, one cannot see north up to Bille Road to know there was fire that way too.

school had been previously identified, and firefighters were able to retreat there. In Concow, also on November 9, firefighters became concerned about the changing fire behavior observed during fire suppression activities along Concow Road and attempted to leave the area. Some engines were able to make it out while others had to turn around and take shelter in the roadway intersection of Concow Road and Pinkston Canyon Road.

9.5. Summary

There were 18 pre-designated public assembly points and wildfire safety zones located in areas of Butte County affected by the Camp Fire. In total, 31 different TRAs were implemented to meet local life safety needs and to manage the evacuation of civilians, including only four of the 18 pre-designated locations. The rapid fire spread into Concow and Paradise significantly compressed the notification timeline and impacted evacuations. Some civilians started their evacuations before the official orders were announced. Evacuation orders were issued, depending on location, shortly before, concurrently, or shortly after the arrival of fire. This tight timeline resulted in a significant fraction of the evacuating population unable to directly leave the fire area, requiring the use of life saving TRAs.

Eleven TRAs were formed with high urgency, and seven experienced high peak hazard levels from fire exposures. All high peak hazard level TRAs were formed with high urgency. Different types of TRAs were formed based on local conditions, needs, and available spaces. TRA types include 14 parking lots, 7 roadways, 6 structures, 3 maintained natural areas, and 1 unmaintained natural area. TRAs were formed inside burnovers, as close as practicable outside of burnover areas, or at key access points on or near major arteries. Half of the TRAs occupied by civilians were also defended by first responders.

The estimated number of civilians in TRAs ranges between 1200 and 2100, assuming only one person per vehicle. If the average number of civilians per vehicle was 2, a conservative estimate, the upper estimate of civilians that used TRAs increases to 3300. A limited number of civilians were able to get to wildfire safety zones or public assembly areas in Concow and Paradise. A significant level of effort was involved in the coordination of the evacuation of TRAs. Several TRAs were consolidated to help first responders keep track of civilians and to facilitate the formation of evacuation convoys out of the fire area. The presence and availability of transit buses (both large and small) significantly enhanced the evacuation of civilians from the many TRAs.

TRAs were used to accomplish two distinct goals: (1) to address immediate life safety risks, and (2) to manage movement of evacuating civilians to avoid possible high fire exposures and burnovers. The fire rapidly moved into Concow, impacting the community concurrent with notification and evacuation activities. This resulted in the blockage of the main evacuation roadway (Concow Road) and the closure of Hoffman Road, further impacting evacuations. In Paradise, as the fire front impacted the majority of Pentz Road, evacuating traffic became gridlocked on Pentz Road, which also influenced the ability for traffic to flow along the two main east-west cross arteries (Bille Road and Pearson Road). The fire front resulted in multiple burnovers in eastern Paradise that required the utilization of TRAs. As the fire progressed into central and western Paradise, the presence of commercial establishments with large parking lots were leveraged by first responders. These large, paved areas served two purposes; they provided areas of locally reduced exposures (because of their large size) to shelter civilians, and also

enabled first responders to use them to manage traffic and keep roadways open for first responder operations.

In Paradise, particularly on the main egress arteries of Skyway and Clark Road, the presence of commercial parking lots significantly facilitated traffic management and reduced the exposures experienced by civilians and first responders. Areas where TRAs experienced high peak hazard levels include locations with fewer parking lots such as upper Skyway, Pentz Road, and east of Clark Road on Bille and Pearson Roads. This was a result of limited options available for traffic management which resulted in rapidly forming gridlocks, particularly early in the incident.

The Butte County and Paradise evacuation plans were developed to address several different partial evacuation scenarios and identified two pre-designated public assembly points in Paradise. The Paradise Auditorium and Performing Arts Center (~150 vehicle capacity) and the CMA Church (~200 vehicle capacity) provided a total Paradise capacity of about 350 vehicles. Parking lots used as TRAs during the Camp Fire contained anywhere from 3 to 550 vehicles each. The availability of these parking areas had a positive impact on life safety. Examples of areas with limited TRA options were the entire Concow area and, in Paradise, Skyway between Wagstaff Road and Clark Road. The limited options available in Concow highlight the need to address the spatial density and size of available safety zones, particularly in low density intermix communities. In Paradise, the limited options along the 3 km (1.8 mi) stretch of upper Skyway during the burnover resulted in civilians abandoning their vehicles and traveling up to 1 km on foot to reach safety. The above information highlights that the number, size, and spatial distribution of potential TRAs need to be factored into the design of a community-wide wildfire safety zone system.

9.6. Technical Findings

TF-TRA 1. Thirty-one different TRAs were formed during the first 25 hours, 27 of which involved civilians.

TF-TRA 2. Of the 18 pre-designated public assembly areas and wildfire safety zones, only four were used as TRAs during the Camp Fire. Another four were used for incident response staging.

TF-TRA 3. TRAs were selected to leverage natural and/or manmade features. TRA types included 14 parking lots, 7 roadways, 6 structures, 3 maintained natural areas, and 1 unmaintained natural area.

TF-TRA 4. Roadways and natural area TRAs were frequently the only local options (35 % [11/31] of TRAs) during the Camp Fire.

TF-TRA 5. At least 1200 to 2100 civilians were involved with TRAs. If average vehicle occupancy is assumed to be two, the estimated number of civilians increases to 3300.

TF-TRA 6. Individual TRA occupancy ranged from 1 to 550 civilians, including people in vehicles and on foot.

TF-TRA 7. High hazard conditions impacted at least 261 civilians in eight TRAs between 07:55 and 09:35 (100 minutes). Seven of the eight TRAs were formed in direct response to burnover events.

TF-TRA 8. Rapid event evolution prevented residents in Concow from reaching their local safety zone. It took one hour and two TRAs to get from Hoffman Road to the Camelot Meadow Wild Fire Safety Zone, a travel distance of 1 km (0.6 mi) (300 m [0.2 mi] straight-line distance).

TF-TRA 9. First responders and civilians had to wait for the vegetation in Camelot Wild Fire Safety Zone to burn before they could use the meadow as a TRA. This event highlights the need to design and maintain TRAs for ready access. Irrigated and maintained safety zones like Crain Memorial Park or gravel areas may provide additional safety in quickly developing events.

TF-TRA 10. The extensive use of TRAs points to the critical need of developing an evacuation plan that includes scenarios where immediate evacuation out of the fire may not be possible.

TF-TRA 11. TRAs along major evacuation arteries enhanced civilian life safety because in many cases civilians did not have to go out of their way (off the evacuation route) to get to the TRA.

TF-TRA 12. Consolidation of TRAs and groups of civilians facilitated management and evacuation of TRAs by first responders.

9.7. Recommendations

Ideally, civilians will have time and ability to safely evacuate before the fire impacts their community. In events where this is not possible, a system of pre-planned wildfire safety zones can be used to enhance life safety to limit civilian exposure to fire during evacuation, especially in intermix communities. The recommendations outlined below focus on the development and implementation of a wildfire safety zone system; however, they also apply to the identification of TRAs. The use of ad hoc TRAs is, by default, a last resort and does not provide the full benefit of a pre-planned wildfire safety zone system.

R-TRA 1. There is a need for a distributed pre-planned wildfire safety zone system in communities that reduces the travel time needed to access these areas so they can be quickly accessed in case a rapidly moving and widespread fire near the community prevents a timely evacuation of the community.

R-TRA 2. The number, size, and spatial distribution of safety zones need to be factored into the design of a community-wide wildfire safety zone system and based on fire exposure consideration, population density in the surroundings, and number and size of other safety zones.

R-TRA 3. Placement of and access to safety zones should consider civilian access pathways and address potential burnover locations, informed by fire history, fuel loading, and dangerous topographical features.

R-TRA 4. Identify high fuel-load areas such as heavily wooded areas, areas of flashy fuels (e.g., unburned tall dry grass), combustible structures, high density residential areas, and topographical features like chimneys and ravines. Assess civilian egress/transit to safety zones that may traverse these areas.

R-TRA 5. Use wildfire safety zones on major evacuation arteries to enhance civilian life safety.

R-TRA 6. Consider spatial density (and minimum size) of safety zones, as well as their maintenance. The difficulty of getting to Camelot Meadow Wild Fire Safety Zone highlights the need to carefully place and maintain safety zones.

R-TRA 7. Beyond the pre-planned safety zones, first responders should be aware of nearby natural and manmade areas conducive to temporary refuge areas, such as large parking lots, gravel areas, irrigated natural spaces (e.g., parks, cemeteries), roadways/intersections, and other open spaces.

10. Rescues

The information presented in this section describes 198 rescue events derived from 406 data points identified through analysis of data sourced from TDs, emergency calls, and radio logs. These events involved over 1000 civilians and ranged from well-documented efforts to rescue entrapped civilians to chance encounters of civilians walking in the street by first responders who then transported them to a safer location. Forty-four percent of those rescued were associated with TRAs described in the previous section; however, these individuals represent only 36 % of civilians involved in TRAs. While the documented events occurred throughout the time period from fire ignition to midnight on November 8, 50 % occurred before 10:30, and 85 % occurred before 15:00.

Each rescue event was classified into a hierarchy of event types based on the situation and documented first responder action. Various aspects of each event were characterized, including the time and location, number of civilians involved, agency of participating first responder(s), outcome, and other circumstances of the event including injuries, pre-existing conditions, and presence of animals. The following sections provide analysis of these different aspects. A listing of each individual event is provided in Appendix K.

The documented events include completed rescues, attempted rescues, and notifications/communications of requests for rescue or evacuation assistance. In the remainder of this section, the term *Rescue* takes on a specific meaning regarding the actual action of responding to an incident. For reference to the general terminology “rescue events,” the acronym EA/R is introduced (meaning **E**vacuation **A**ssistance or **R**escue) to differentiate between the specific *Rescue* term.

10.1. Data Sources and Limitations

These data represent a significant new body of knowledge associated with EA/R during a WUI fire. While the data are extensive, there are limitations to acknowledge.

The majority of the EA/R data was collected from TDs, during which the primary purpose was to obtain fire behavior/fire progression and first responder actions (response) data. The data collection limitations associated with post-incident field collection dictated the number of TDs and the hierarchy of TDs that were conducted. Data were collected in 151 TDs over the course of six months after the fire. Data from TDs were frequently cross-referenced with radio log transcripts and recordings, AVL tracks, and photos and videos.

The proportionally high fraction of first responder activities accounted for in Concow, in addition to the focused geographic area and rapid onset of fire, likely allowed identification of the majority of EA/R in that community. In Paradise, the primary multi-civilian rescues associated with TRAs and burnovers have most likely been documented; however, there is likely a significant fraction of EA/R that have not been documented due to the larger population, geographic area, and prolonged duration of the event. Additionally, EA/R that occurred after 07:30 on November 9 were not captured because most of the emphasis of the data collection focused on the first 24 hours after the Camp Fire ignition.

The completeness of each EA/R account varied depending on the information source, the level of involvement of the source, and the level of detail and number of data points associated with each event. In some cases, only the emergency call or radio transmission indicating the situation

needing a response was identified, without detail or knowledge of how the incident was resolved. Nonetheless, these cases were resolved in some way, whether by undocumented first responder actions or by the ability of the civilian to self-rescue or receive assistance from a neighbor, and further illustrate the scale of EA/R events.

Table 45 lists the data sources used to identify the EA/R events. The significantly larger portion of TDs with fire service personnel compared to LE personnel is notable (100 vs. 19, respectively). Also note that there were time limitations to the available 911 recordings—the fact that PPD dispatch had to relocate to Chico when the station in Paradise was threatened by fire influenced the available EA/R data.

Table 45. Sources of EA/R data.

Source	Number with EA/R	Notes
Firefighters	55 of 100 TDs	
Law Enforcement	9 of 19 TDs	
Other	5 of 33 TDs	
911 Calls	49 of 502 calls	PPD 911 from 07:07 to 08:20 BC ECC 911 from 06:25 to 09:22
PPD	Dashboard and body cameras	Select footage provided by PPD
VTD	6 of 32 VTDs	Including 1 radio recording
Other supporting data sources	CAL FIRE AVL CAL FIRE DINS Butte County DA Report Google Maps and Earth	Used for data cross-referencing

10.2. Definitions and Data Types

EA/R events were categorized based on the type of situation (Event Class) and on the action taken by first responders (Response Action) that were documented in the available data. Combined, the Event Class and Response Action result in one of ten Event Types. Attributes for each event were also documented and are listed with definitions in Table 46.

Event Classes

The events were classified into four separate types of situations and assigned one of the following Event Class designations.

Entrapment Designation for circumstances where a person/reporting party was trapped by fire in the immediate proximity; in an immediate life-threatening situation (may include burn injuries); indicated fire was an issue; or required some sort of protective action beyond transportation or general assistance.

Assistance Designation for when a person needed help evacuating due to pre-existing conditions (e.g., mobility impairment) or lack of transportation. Fire was not considered an imminent threat, although there may have been fire in the area. If data indicated fire became a threat before completion of the response, the event was classified as an *Entrapment*. Assistance requests that were unresolved in the data may have turned into entrapments by our definition, although available data suggested that the local conditions were non-life threatening.

Medical Designation for events where the primary issue was a medical concern unrelated to fire exposure (although it may have been exacerbated by fire issues or stress).

Pick-up Defined when a person was encountered outside (i.e., on foot or in vehicle) by first responders who were not responding to a specific location or report of someone needing assistance, who then took that person to a safer area or handed them off to other transportation. In general, fire conditions were unspecified or not specifically identified as immediately life threatening. If available data indicated conditions were hazardous, those encounters were assigned to the *Entrapment* classification. If data was unclear but the person was potentially a chance encounter rather than the specific target of a rescue/assistance request, the event was categorized as a *Pick-up*.

Response Action

Rescue Data includes response actions taken to rescue, guide, protect, assist, and/or transport a person to a safer location. EA/R in this category also include events where civilians elected not to leave with the responding emergency personnel.

Rescue Attempt Data indicates response action was taken; however, a *Rescue* was not completed, or transportation was not provided, due to a number of potential reasons. Reasons may include that the responder was not able to access the location (fire conditions or blocked roadway); or that upon accessing a specified location, the person was unable to be located. Additionally, incomplete data may have prevented categorization as a *Rescue*.

No Data (Notification) No data represents events where records show that first responders were notified of a request for evacuation assistance or rescue but no data was available to determine whether a response was sent or initiated.

It is important to note that neither the *Rescue Attempt* nor *No Data (Notification)* EA/R instances indicate a failure by a first responder. In a majority of these cases there was simply no data to further categorize the event. In a few cases, various situations prevented the completion of the rescue, including fire conditions, bad location information, and previously evacuated people.

Table 46. Definitions of EA/R attributes.

EA/R Attribute	Definition
Time of Notification / Direct Observation	Earliest time rescue request is communicated to or observed by first responders
Time of Rescue / Response Attempt	Time of the start of rescue activity/response (including travel time)
Time of Conclusion	Time when civilians reach a safe location such as a TRA, or when they are transferred to other first responders to be further transported (e.g., by helicopter)
Rescue Response Time (min)	Time between notification of emergency services and the start of rescue response/action; difference between Time of Rescue and Time of Notification
Rescue Duration (min)	Duration of first responder involvement; difference between Time of Rescue and Time of Conclusion
Event Duration (min)	Total duration; difference between Time of Conclusion and Time of Notification
Head Count	Known minimum head count of civilians involved in the incident (assuming one person per vehicle unless otherwise specified)
Est. Min. Reasonable Additional Head Count	Best estimate of the total number of civilians involved in addition to the absolute minimum Head Count (assuming one person per vehicle unless otherwise specified).
Notification/ Encounter Source	Source of how emergency services became aware of the need for assistance or rescue (911, FD Dispatch, LE Dispatch, Civilian, FD, LE, Other, Unknown Source)
Participating First Responder	Type of first responder performing the rescue/assistance (FD, LE, FD to LE, LE to FD, LE to Civilian, LE and FD, Civilian, Other, Unknown)
Rescue Circumstance	Situation of the civilian needing rescue (Vehicle, On foot, Residence, Structure, Other, Unknown)
Outcome	The outcome of the event (Formation of TRA, Transport to TRA, Transport to Other, Escort to TRA, Escort to Other, Medical Transport, Civilian Transport, Not Present, Fatality, Other, Unable to Access, Refuse to Leave, Unknown)
Injury	Was there a fire-related injury (burn or other injury inflicted during evacuation)?
Pre-X	Whether pre-existing conditions (not fire related) may have impacted civilian evacuation capabilities (e.g., mobility impairment or medical condition)
Animals	Whether animals (i.e., pets, livestock) were also rescued or accompanied civilians
Burnover ID	Indicates if the EA/R was associated with or the result of an identified burnover event (see Sec. 8 and Ref. [23])
TRA ID	Indicates if a TRA was utilized as part of the EA/R sequence of events (see Sec. 9)
Location	The community of the EA/R event (Concow, Paradise, Magalia, Other)
Source	The contributing data sources (TD, VTD, 911, PPD)
Complete	Indicates whether the available data describes a complete rescue sequence from notification through resolution, or is incomplete
Encounter	Indicates if the EA/R was an Encounter (i.e., unplanned meeting between first responder and civilian needing assistance), a Response (i.e., a *Rescue* or *Rescue Attempt* in response to a known request for EA/R), a Notification Only (no Response Action), or Undetermined
Data Points	The number of data points associated with the event

10.3. Overview of Identified Evacuation Assists and Rescues

Tables 47 and 48 break down the Event Types of the identified EA/R in each community by Event Class and Response Action, respectively. *Entrapments* and *Assistance* classifications represent 74 % (146/198) of all EA/R. Sixty-one percent (121/198) of EA/R are characterized by *Rescue* response actions. The bulk of identified EA/R events occurred in Paradise, including 163 of the 198 (82 %).

Figures 36 and 37 show the approximate locations of the 198 identified EA/R events which occurred across the fire incident. Data points are located on the parcel of interest (if associated with a specific address) or at the general location specified by first responders. Locations do not imply specific resolution with respect to location within the parcel or around/inside a residence. The data points are mapped in two ways to highlight the spatial component of each Event Class and Response Action. Figure 36 shows the different events colored by Event Class with different shapes corresponding to Response Action. It is notable that in the area north and east of the reservoir in Concow, 18 of the 20 EA/R were of the *Entrapment* class, indicated by the orange data points. Other notable observations from Fig. 36 show that requests for evacuation assistance occurred throughout Paradise and in Magalia (yellow points). Nearly all of the *Pick-up* class events occurred in Paradise, identified by the black stars.

Figure 37 shows the data colored by Response Action. First to note is the prevalence of yellow-colored points indicating the EA/R events characterized by a completed *Rescue* action. The *Rescue Attempts* and *Notification Only* points are scattered throughout the fire area.

Further in-depth analysis is discussed in the following sections.

Table 47. EA/R event frequency by community, organized by Event Class / Response Action.

Event Type **Class** / Action	**Concow**	**Paradise**	**Magalia**	**Other**	**Total**
Assistance	**1**	**55**	**6**	**2**	**64**
Notification	1	31	2	2	36
Rescue Attempt		5	1		6
Rescue		19	3		22
Entrapment	**20**	**58**	**3**	**1**	**82**
Notification	4	10			14
Rescue Attempt	4	9			13
Rescue	12	39	3	1	55
Medical	**1**	**13**			**14**
Notification	1	6			7
Rescue		7			7
Pick-up	**1**	**37**			**38**
Notification		1			1
Rescue	1	36			37
Total	**23**	**163**	**9**	**3**	**198**

Note: "Other" events occurred in Yankee Hill, Stilson Canyon, and an undetermined location.

Table 48. EA/R event frequency by community, organized by Response Action / Event Class.

Event Type **Action** / Class	**Concow**	**Paradise**	**Magalia**	**Other**	**Total**
Notification	**6**	**48**	**2**	**2**	**58**
Assistance	1	31	2	2	36
Entrapment	4	10			14
Medical	1	6			7
Pick-up		1			1
Rescue Attempt	**4**	**14**	**1**		**19**
Assistance		5	1		6
Entrapment	4	9			13
Rescue	**13**	**101**	**6**	**1**	**121**
Assistance		19	3		22
Entrapment	12	39	3	1	55
Medical		7			7
Pick-up	1	36			37
Total	**23**	**163**	**9**	**3**	**198**

Note: "Other" events occurred in Yankee Hill, Stilson Canyon, and an undetermined location.

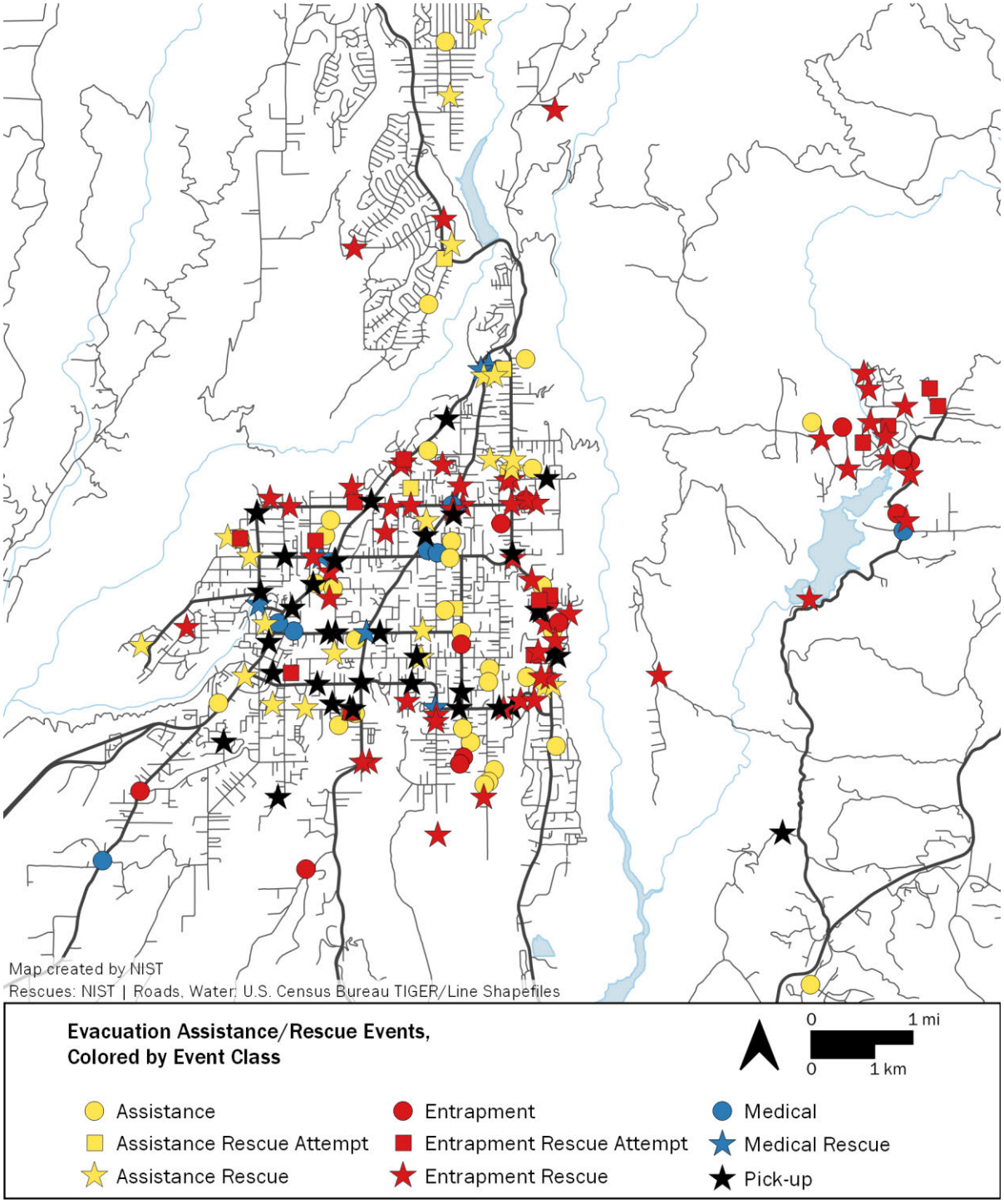


Fig. 36. Map of all identified EA/R events. Data points colored by Event Class.

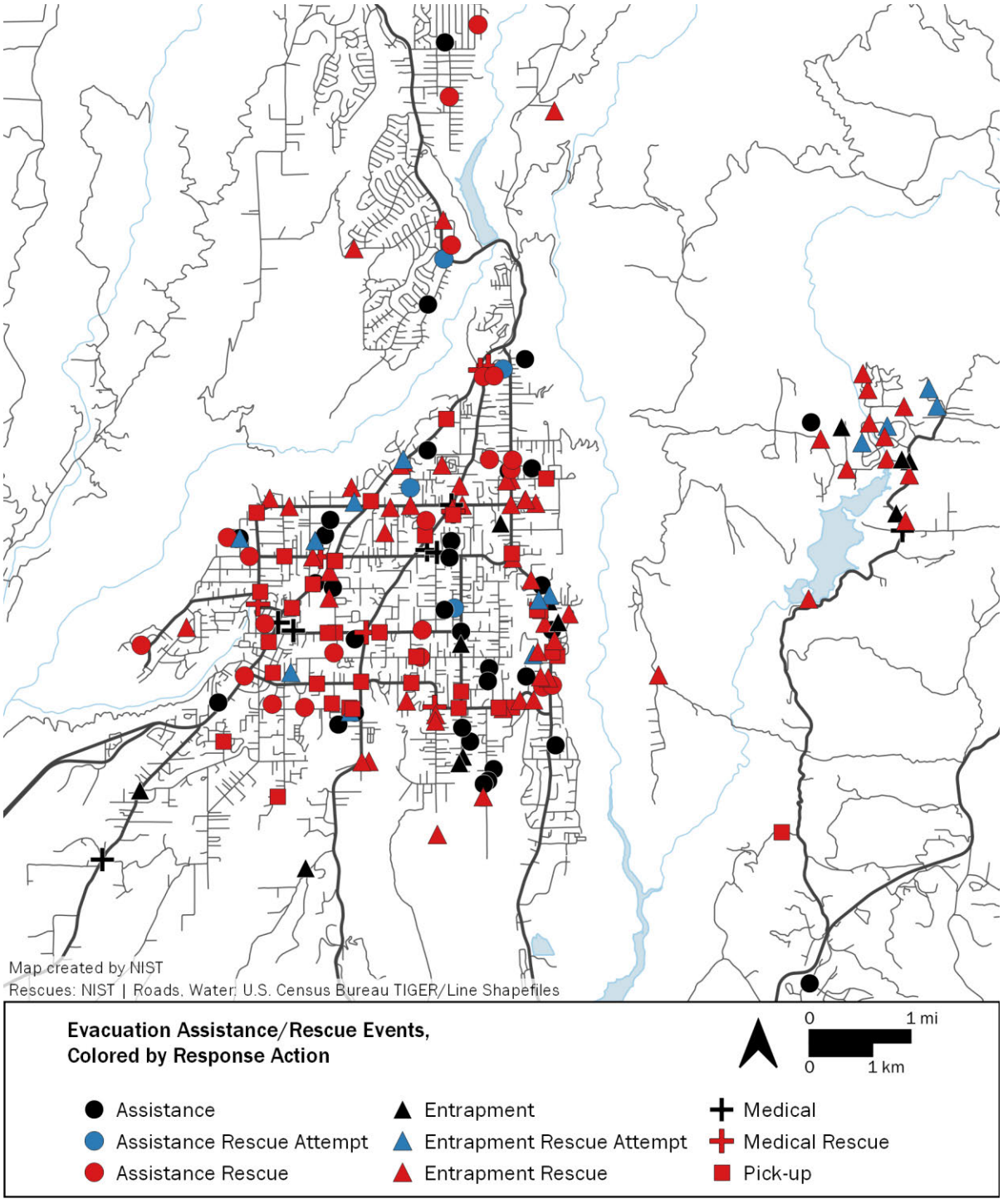


Fig. 37. Map of all identified EA/R events. Data points colored by Response Action.

10.4. Analysis by Community

This section presents analysis of the identified EA/R within each of the three communities, Concow, Paradise, and Magalia. Communities are presented in that order reflecting the general fire and EA/R progression. Half of all EA/R events in Concow started before the first fire-related event in Paradise at 08:00. There are contextual differences in the EA/R occurring in each community due to the different nature of fire timing, first responder resource availability, population, and evacuation progress.

Different key concepts and findings are described based on the differing situations in each of the communities. For example, the documented events in Concow represent a large fraction of actual EA/R because of the significant number of TDs with first responders in the area and the relatively small geographic area of interest. In contrast, while 164 EA/R events have been identified in Paradise, it is likely the true number of events was significantly higher because of the number of first responder resources present and the extended event timeline. These factors combine to result in a lower fraction of first responders included in TDs.

Further analysis is provided on the overall statistics of EA/R events regarding the total number of civilians rescued, the outcome of each event, the time of day of EA/R events, and other aspects of EA/R events in Sec. 10.5.

10.4.1. Concow

Concow represents a special case in the analysis of rescues during the Camp Fire. This is because the community is isolated, has a single egress route, and is not in the evacuation path of other communities (like Magalia egressing through Paradise). Additionally, due to the rapid onset of fire early in the morning, a significant fraction of the Concow population was involved in EA/R events. There were 23 distinct EA/R events identified occurring in Concow between 07:25 and 13:00, involving a minimum total of 110 civilians.

Concow includes an expansive geographic area with a large fraction of undeveloped land. The Concow CDP covers 72 km^2 (27.8 mi^2); however, there is a significant population concentration in a much smaller area of the community centered around the Camelot neighborhood near the intersection of Camelot Lane and Concow Road. Most EA/R events in Concow (20/23) occurred in this area where the initial emergency response was focused (due to both fire and rescue needs). For the purposes of analysis in this section, this area is referred to as the "Concow Rescue Area" (CRA). Areas south of the CRA were not directly impacted by fire until much later in the morning or afternoon. Areas north of the CRA were inaccessible to first responders due to fire conditions, and furthermore, were generally unpopulated wildlands. Figure 38 shows the CRA and the distribution of residential structures within the Concow CDP.

The CRA was defined by a 200 m buffer around roadways involved in EA/Rs or that were otherwise known to have been patrolled or accessed by first responders. The buffer provides an estimate of the area that could have been reached by vehicle-mounted loudspeakers and sirens alerting residents to the fire. The CRA covers 4.65 km^2 (1.80 mi^2) and contains 21.8 km (13.5 mi) of roadways. While the CRA represents only 6 % of the Concow CDP administrative land area, it included 46 % of residential structures in the CDP.[24]

[24] Inclusion of all structures results in a similar fraction (48 %) within the CRA. Structures were identified in CAL FIRE DINS data.

The estimated population at the time of the fire for Concow was 743 [34]. All identified EA/R activities involved a total of 110 civilians, or 15 % of the entire Concow population. If the population is assumed to be evenly distributed among residential structures, approximately 342 residents lived within the defined CRA. This suggests that 32 % of residents in the CRA were involved in some type of EA/R activity in the first four and a half hours after the fire arrived.[25]

[25] Determined using the 106 rescued civilians in the CRA, not the 110 total in Concow CDP.

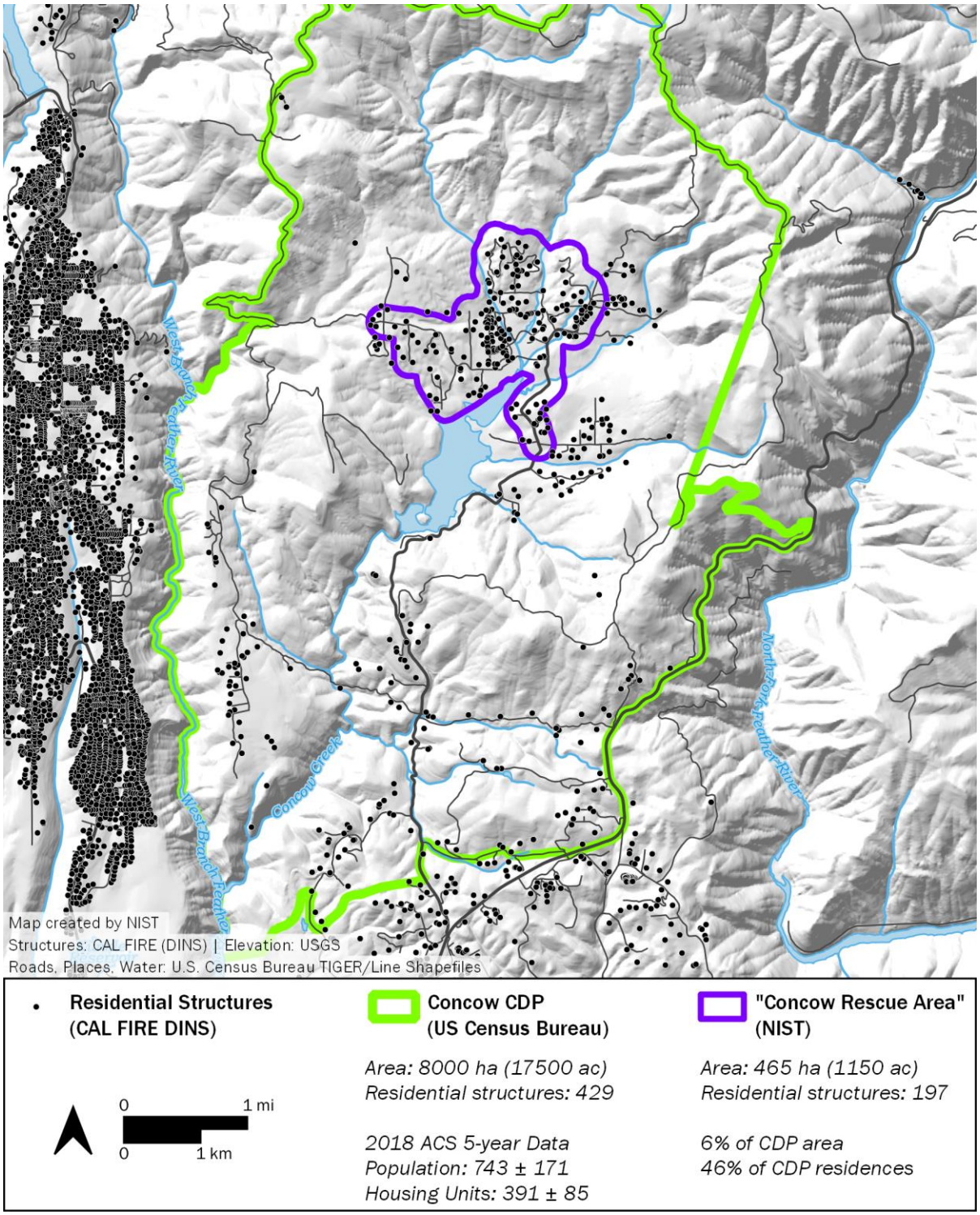


Fig. 38. Map of the Concow community showing locations of residential structures and the CDP boundary. Twenty documented EA/R events occurred within the densely populated portion of Concow indicated within the purple boundary denoting the “Concow Rescue Area.”

10.4.1.1. EA/R in Concow

EA/R events in Concow were overwhelmingly classified as *Entrapment* (20/23), with only one each of *Assistance*, *Medical*, and *Pick-up* class events (illustrated previously in Fig. 36). This is a notable distinction compared to the variety of events occurring in Paradise, primarily influenced by the early and rapid onset of severe fire conditions across the entire CRA. Of the 107 people involved in *Entrapments*, 89 % were directly accounted for in the data as being *Rescued*.

Table 49 lists the number of events and people involved in each EA/R Event Type. A response was documented in 16 of the 20 *Entrapment* events in Concow. There was no identified response to four of the events. Out of the 16 EA/R responses, 12 (75 %) were completed (i.e., *Rescue*), involving 95 civilians, over 25 % of the estimated population of the CRA. The remaining 4 rescue attempts were incomplete (i.e., *Rescue Attempt*) due to restricted access caused by burnovers and fire conditions. Only one of these 4 incomplete rescues is associated with a fatality. While data show that actions were being taken to access the location, it is likely the rescue was not accomplished due to several reasons, including traffic congestion, fire conditions, and because the limited number of first responders in the area were concurrently dealing with several burnovers, TRAs, and other EA/R events.

Nine out of ten events with no documented rescue (i.e., *Notification* and *Rescue Attempt*) did not result in fatalities. This reinforces that the presented data is likely incomplete and additional actions to complete each incident may have occurred that were not identified/documented.

Table 49. EA/R events in Concow by Event Type, organized by Event Class / Response Action.

Event Type **Class** / Action	**Event Count**	**Civilian Head Count**
Assistance	**1**	**1**
Notification	1	1
Entrapment	**20**	**107**
Notification	4	7
Rescue Attempt	4	5
Rescue	12	95
Medical	**1**	**1**
Notification	1	1
Pick-up	**1**	**1**
Rescue	1	1
Total	**23**	**110**

There were 7 separate *Entrapment Rescue* events between 07:45 and 09:15 (90 min) during a period of very intense fire exposures. These 7 events involved a total of 88 people—92 % of all the people *Rescued* in Concow (88/96). Out of the 88, 84 were *Rescued* through the formation of a TRA; the other 4 were transported directly out of the fire area. Ultimately, 85/110 (77 %) civilians were *Rescued* involving TRAs, representing one in four residents living in the CRA (85/342). The above data highlights the need for easily and rapidly accessible safety zones when there is not sufficient time for an early evacuation.

Table 50 lists the number of different EA/R by outcome. Four percent of civilians could not be accessed because of burnovers. Two EA/R events were linked to fatalities; one event involved multiple civilians with different outcomes and is categorized as "Other" in Table 50.

Table 50. Concow EA/R events and civilian head count by outcome.

	Event Count		Civilian Head Count	
Outcome	***n***	**%**	***n***	**%**
Formation of TRA	3	13	82	75
Transport to TRA	1	4	1	1
Transport to Other	6	26	9	8
Unable to Access	3	13	4	4
Fatality	1	4	1	1
Other Outcome	3	13	4	4
Unknown Outcome	6	26	9	8
Total	**23**	**100**	**110**	**100**

10.4.1.2. Fatalities in Concow

While more discussion of fatalities throughout the Camp Fire is given in Sec. 11, the fatalities occurring in Concow are also briefly discussed here in connection to identified rescue attempts.

Eight fatal incidents occurred in Concow involving nine fatalities. Out of the eight fatal incidents, only two have been directly linked with EA/R data. Table 51 summarizes the timeline information of EA/R events in Concow that involved fatalities. One was linked to a partially documented rescue attempt identified by a single data point indicating first responders were trying to find and access the location. The other event was a partially successful rescue where the fatality occurred before first responders were able to reach the two entrapped people. One person was rescued and transported for medical care.

The remaining six fatalities were not linked to any identified dispatch, rescue request (i.e., 911 call), or rescue action identified in the available data. There may or may not have been emergency calls or rescue attempts from these remaining cases. One TD noted that the ECC was receiving reports of people trapped in Concow before 07:25, although further details were not available (EA/R ID #002). Additionally, several other identified but incomplete EA/R accounts did not result in fatalities, indicating that a specific rescue action is missing from the data (whether conducted by a first responder or civilian), or that person was able to self-evacuate. The rescue complexities and life-threatening conditions encountered by first responders and evacuating civilians in Concow were previously discussed and highlighted in the TRA analysis in Sec. 9.

Table 51. Concow EA/R events with fatalities.

EA/R ID	Time of Awareness	Response	Initial Time of Response	Notes
005	n/d	Yes (*Rescue Attempt*)	< 07:50	LE radio communication at 07:50, still attempting to find access due to fire, poor signage and possibly wrong street number; traffic on Concow Rd getting plugged up with emergency vehicles and people trying to evacuate
081	n/d	Yes (*Rescue*)	09:38	FD response to multiple burn victims; one fatality, one transported by engine to meet with helicopter

10.4.1.3. First Responders in Concow

Both law enforcement and the fire service played significant roles in EA/R in Concow. Firefighters were the predominant rescuer for 52 people in 10 events (52/95=55 %) and LE rescued 40 people in one event (40/95=42 %). Note that this single event was the formation of the Camelot Meadow Wild Fire Safety Zone TRA (*TRA-A*). It is undetermined how civilians arrived there or if additional rescues by the LE officers in Concow further contributed to this event or other undocumented EA/R.

AVL data, TDs and radio communication logs were used to identify LE and firefighters in Concow between 07:30 and 10:00. Firefighting equipment in the Concow Rescue Area (CRA) before 10:00 included 4 engines, 2 pickup trucks, 2 dozers, 2 water tenders, and 3 hand crews. Several law enforcement vehicles and personnel were also present in this time period and helped with the Camelot TRA and with evacuations throughout Concow; however, this number is difficult to estimate.

10.4.1.4. Summary

The fact that at least one in four residents in the CRA were rescued through the implementation of TRAs highlights the life safety hazards in intermix communities with high fuel loadings during wind events that occur when fuel moistures are low. These severe hazards can be particularly impactful when there is little time to evacuate or to get to a safety zone, further highlighting the need for easily and rapidly accessible safety zones

Most rescue actions occurred in a condensed time period; 95 % of people rescued in Concow were rescued within a 90-minute window. These rescues were made possible by the rapid and effectively coordinated response of emergency personnel, including both LE and fire service, who were in the community performing evacuation notifications before and during the arrival of the fire. This demonstrates the need to quickly engage in life safety operations and highlights the critical need for pre-planning.

10.4.2. Paradise

Paradise had a population of approximately 26 500 at the time of the Camp Fire. A total of 163 EA/R events (82 % of all identified) occurring in Paradise were documented, involving at least 881 civilians. While the overall number of civilian rescues is higher than in Concow, several factors contributed to a significantly lower fraction of the Paradise population being involved in rescues compared to Concow.

The arrival of the fire front in Paradise later that morning gave civilians more time to prepare and begin evacuating. The fire first reached the eastern part of Paradise at 07:50 and spread and spotted westward into town. The fire reached the center and western part of town when most residents were awake. As discussed in the notification section (Sec. 6.3), with the exception of Zone 6 and Upper Honey Run, evacuation warning notifications to Paradise initiated ahead of the fire. This gave residents more time to begin evacuating before smoke and fire impacted egress arteries and entrapped civilians.

Secondly, Paradise had a number of multilane roads and multiple large parking lots associated with commercial buildings, places of worship, schools, and municipal buildings along with multiple egress arteries.

Lastly, while Paradise, like Concow, did not have emergency alert sirens, the opt-in reverse-911 call system was activated in Paradise. This is a critical tool for evacuation information dissemination that enhances public evacuation awareness.

It is worth noting the high potential for unrecorded rescues in Paradise due to several factors. Both the population and the area were much larger for Paradise compared to the Concow Rescue Area. Both of these factors resulted in lower data density in Paradise; therefore, multiple individual events may not be captured. Also, because the rescues in Paradise occurred later in the incident than in Concow, additional mutual aid resources had responded and were more prevalent. This was particularly the case for LE, of which there were numerous responding units from more than half a dozen nearby agencies. Units from Chico and Oroville may have been on scene early contributing to emergency notifications and rescues. Larger numbers of fire department mutual aid arrived later from further away. While many TDs took place with fire department personnel, the primary data objective of collecting fire progression data was accomplished without having TDs with every engine of every strike team—the data resolution required to understand the fire progression was coarser than the detail required to identify individual EA/R events. While a TD with a strike team leader may have provided enough detail regarding fire progression observed by the entire strike team, individual EA/R events are less likely to be remembered or relayed.

As a result, it is highly likely that the documented EA/Rs in this section represent only a fraction of all the individual rescues that occurred in Paradise. However, like the data coverage of burnover events and TRAs, the majority of large group rescues and first responder interventions is believed to be reflected in the data.

10.4.2.1. EA/R in Paradise

Analysis of the EA/R in Paradise by Event Type (Table 52) show that *Evacuation Assistance* and *Entrapment* events occurred in similar numbers, each approximately one third of EA/R events. This is significantly different than Concow, where 20 of 22 EA/R events were *Entrapments*. This difference was influenced by several factors compared to Concow, including generally increased awareness of the fire due to the fire's arrival later in the morning and the variability in the arrival time of fire across Paradise, allowing for more time for notifications and evacuations to begin. However, while the number of *Assistance* and *Entrapment* events are comparable, the number of civilians involved in *Entrapments* was significantly greater, comprising 71 % of all people involved in EA/R in Paradise. This skew of headcount toward the *Entrapment* events can be attributed to two main factors: several entrapment rescue events are associated with burnovers and TRAs involving a large number of people at the same time, while calls for evacuation assistance often consisted of individuals or small groups at home.

Fewer people were involved in *Pick-up* event types, which totaled 23 % of events but only 7 % of the EA/R population (66 people). These events were characterized by spontaneous encounters, typically involving only one or two civilians at a time. By definition, almost all *Pick-up* events (97 %) were categorized as *Rescues*. The one exception was an event in which a dozer encountered two civilians on the roadside and could not transport them. The operator alerted other units on the radio to arrange for them to be picked up. The documented *Pick-ups* represent a fraction of the expected actual number for two reasons. Firstly, there were multiple first responders in Paradise in the morning of November 8 that are not in the current Camp Fire data set and secondly, because of several reports from first responders describing multiple *Pick-ups* that could not be pinpointed in space and time.

As expected, *Medical* event types were the fewest in number and total civilian count. While not directly related to the WUI fire incident, these events were included in the analysis and discussion because they still require emergency aid and draw from the same pool of available first responders. Only 13 of the identified events were classified as *Medical* and 7 of 13 resulted in documented rescue response, including 11 of 17 people.

It is notable that 67 % of *Entrapments* were classified as *Rescues*, indicating a documented successful response resulting in the rescuing of at least 560 civilians, or 90 % of the people involved in *Entrapment* events. The remaining *Entrapment* events are evenly distributed among *Rescue Attempts* and *Notified Only* (*No Data*) response actions. Nine events were *Rescue Attempts,* representing 16 % of *Entrapment* events and involving 14 civilians. Forty-eight entrapped civilians requested evacuation assistance in 10 separate events that were not linked to any identified rescue or rescue attempts.

Assistance requests represented 34 % of all identified EA/R events in Paradise and were classified as *Rescues* 35 % of the time. Nine percent had attempted rescues, and 56 % had no identified response action.

There is a significant difference between the number of response actions (*Rescues* plus *Rescue Attempts*) to *Entrapments* versus *Assistance* requests. Responses were identified in 83 % of *Entrapments* compared to 44 % of *Assistance* requests. This highlights the effective decision-making by first responders in addressing risk to civilians, prioritizing high hazard situations for rescue by the limited number of available responders.

There are also indications of the effective communication of local life safety conditions between 911 dispatch and civilians calling for help. This is essential in situations where the number of requests for help from the public outnumber the available first responders on the scene. An example of this is demonstrated in several 911 dispatch communications where civilians were advised by dispatch that "…I don't have anybody to send to you, so if you can flag down one of your neighbors and hop in a car with them, I would recommend that" [911-183-1], and "get in [a neighbor's] car and leave the area immediately" [911-183-3].

Table 52. Event and civilian counts by EA/R Event Type in Paradise, organized by Event Class / Response Action.

Event Type **Class** / Action	**Event Count**		**Civilian Headcount**	
	n	**%**	***n***	**%**
Assistance	**55**	**34**	**176**	**20**
Notification	31	56	102	58
Rescue Attempt	5	9	6	3
Rescue	19	35	68	39
Entrapment	**58**	**36**	**622**	**71**
Notification	10	17	48	8
Rescue Attempt	9	16	14	2
Rescue	39	67	560	90
Medical	**13**	**8**	**17**	**2**
Notification	6	46	6	35
Rescue	7	54	11	65
Pick-up	**37**	**23**	**66**	**7**
Notification	1	3	2	3
Rescue	36	97	64	97
Total	**163**	**100**	**881**	**100**

Note: Percentages are listed for each Event Class, e.g., 56 % (31/55) of *Assistance* events were *Notification Only*.

Table 53 presents the EA/R Event Types in Paradise organized by Response Action. While Tables 52 and 53 contain the same data, both tables are necessary to understand the complexity and implications of EA/R events. For example, the number of events within each type is not sufficient to tell the story of all EA/R events. As more clearly seen in Table 53, the number of *Rescues* from *Entrapments* and *Pick-ups* were similar (39 and 36, respectively). However, the number of civilians involved is dramatically different. Civilians *Rescued* from *Entrapments* account for 560 people, or 80 % or all civilians *Rescued*, in contrast with the 64 persons in *Pick-up* class events.

Table 53. Event and civilian counts by EA/R Event Type in Paradise, organized by Response Action / Event Class.

Event Type	**Event Count**		**Civilian Headcount**	
Action / Class	***n***	**%**	***n***	**%**
Notification	**48**	**29**	**158**	**18**
Assistance	31	65	102	65
Entrapment	10	21	48	30
Medical	6	13	6	4
Pick-up	1	2	2	1
Rescue Attempt	**14**	**9**	**20**	**2**
Assistance	5	36	6	30
Entrapment	9	64	14	70
Rescue	**101**	**62**	**703**	**80**
Assistance	19	19	68	10
Entrapment	39	39	560	80
Medical	7	7	11	2
Pick-up	36	36	64	9
Total	**163**	**100**	**881**	**100**

Note: Percentages are listed for each Response Action, e.g., 65 % (31/48) of *Notification Only* events were *Assistance* type events.

10.4.2.2. EA/R Outcomes

Paradise EA/R events involved a total of at least 881 civilians, 40 % of which were involved with TRAs (353/881). Analysis reveals that Escort to TRA and Formation of TRA each represent 3% of events while they collectively represent 30% of civilians involved in EA/R; 162 people (18 %) were involved in the immediate formation of a TRA, and 107 (12 %) were escorted to a TRA. The remaining 84 (9 %) were transported to a TRA in 31 events, highlighting that *Rescues* of this method were often performed by individual units (e.g., LE cruiser or fire engine) typically transporting small groups of two or three civilians at a time. Twenty-six percent of civilians in EA/R in Paradise (229 civilians) were transported to non-TRA locations.

The 18 % fraction of civilians rescued via the immediate formation of TRAs in Paradise (162/881) is significantly smaller than the 75 % in Concow. The 162 people in rescues involving the formation of TRAs were primarily associated with the Pearson Road and Bille Road burnovers (*BO #7, 8; TRA-J, I*) and the Walgreens TRA (*TRA-P*). These burnovers occurred in residential areas on two-lane roads and in an intersection where the roadways were larger than those in Concow at Hoffman Road or Concow Road. However, the local fuel densities, together with limited time to evacuate, resulted in high urgency rescues under very hazardous conditions for the above-mentioned Paradise and Concow burnover/TRA rescues.

The outcomes associated with one third of the events (55/163), including 169 civilians (19 %), are unknown. Most of these events (44/55) were of the *Notification Only* (*No Data*) response action, for which no response details were determined. Only three out of the 881 civilians involved with the identified EA/R in Paradise refused to leave, representing a tiny fraction of instances. While only 5 events resulted in the persons not being present at the described location, this is likely an undercounting of these instances. First responder TD comments indicated various non-specific occasions where this occurred. It is unknown if the person was able to self-evacuate, gain assistance from civilians, or if another first responder previously completed the rescue.

10.4.2.3. Civilians Rescued — Head Count and Uncertainty

Overall, the rescue or assistance of 1007 civilians was accounted for in the data of 198 EA/R events. There is uncertainty in the number of civilians involved in 27 % of all EA/R events, totaling a potential increase in head count of 33 %, or an additional 332 civilians. Therefore, the range of the minimum number of civilians in the identified EA/Rs is between 1007 and 1352. The true maximum is likely higher since these minimum estimates assume only one person per vehicle.

Forty-four out of 53 events with uncertain head counts occurred in Paradise. These events accounted for 307 of the 332 additional civilians potentially involved, representing 92 % of the uncertainty in all EA/R events. The events in Concow and Magalia account for the remaining 8 % of uncertainty in the number of additional civilians involved in EA/Rs, a total of 25 civilians, with a maximum individual event uncertainty of eight people.

The following analysis of uncertainty in the number of civilians involved in EA/R includes only those events in Paradise, due to the more complete dataset and higher fraction of incidents. This provides insight into the source of the majority of the uncertainties in the data. Table 54 presents the number of events with uncertain head counts and the estimated minimum reasonable additional head count of civilians in each Event Type in Paradise.

The number of civilians involved in EA/R is conservatively presented as a minimum count of 881 in Paradise. However, there is uncertainty in the head count of about one quarter of the EA/R events in Paradise. The estimated reasonable additional head count includes 307 people, a 35 % increase, for a total of 1188 civilians in Paradise. It should be noted that all data tables use the absolute minimum civilian count of 881 and not the potential minimum number of 1188.

Out of the 44 events with uncertain head counts in Paradise, 35 contribute less than 10 additional persons each, 24 of which add only one or zero people.[26] Three events have an undetermined uncertainty due to incomplete information. The remaining 6 events add 20 or more persons each, accounting for 75 % of all added persons in Paradise. The largest head count uncertainty of an individual EA/R event is related to the Walgreens TRA (*TRA-P*). It was assumed that a baseline of 10 people were rescued and brought to the TRA. However, if the minimum estimate of 100 civilians present at the TRA had all been *Rescued* and directed there to escape fire exposures on Bille Road near Skyway, 90 more would need to be accounted for in the EA/R total.[27]

The uncertainty in head count largely impacts the *Entrapment Rescue* event type. An estimated reasonable minimum uncertainty in this event type includes 196 additional civilians, or 64 % of the added people in Paradise.

While the number of events with a headcount uncertainty are similar between *Notification* and *Rescue* Event Classes (18 and 19, respectively), the number of civilians they correspond to is dramatically different. Uncertainty in the *Rescue* Event Class accounts for 81 % of the total number of additional civilians who may have been involved in EA/R. Even when the adjusted uncertainty is included, *Rescue Attempts* involved only a small number of people involved in EA/Rs (28/1188); most people were *Rescued*.

Table 54. Estimated minimum reasonable additional head count of civilians in EA/R in Paradise by Event Type, organized by Response Action / Event Class.

Event Type **Action** / Class	**Event Count**	**Events with Additional Head Count**	**Head Count**	**EMRA Head Count**[a]	**Fraction of Added Head Count**	**Adjusted Total Head Count**	**Increase**
Notification	**48**	**18**	**158**	**49**	**16%**	**207**	**31%**
Assistance	31	13	102	21	7%	123	21%
Entrapment	10	4	48	28	9%	76	58%
Medical	6	1	6	0	0%	6	0%
Pick-up	1	0	2	0	0%	2	0%
Rescue Attempt	**14**	**7**	**20**	**8**	**3%**	**28**	**40%**
Assistance	5	2	6	3	1%	9	50%
Entrapment	9	5	14	5	2%	19	36%
Rescue	**101**	**19**	**703**	**250**	**81%**	**953**	**36%**
Assistance	19	4	68	44	14%	112	65%
Entrapment	39	9	560	196	64%	756	35%
Medical	7	0	11	0	0%	11	0%
Pick-up	36	6	64	10	3%	74	16%
Total	**163**	**44**	**881**	**307**	**100%**	**1188**	**35%**

[a] Estimated Minimum Reasonable Additional Head Count of civilians, assuming 1 person per vehicle

[26] Seven events were identified with uncertain head counts but the most reasonable estimate was that there were no additional civilians involved.
[27] See Table 38 for the listing of TRA occupancy.

10.4.2.4. EA/R with Respect to Time of Day

The various EA/R events corresponded to the progression of fire through Paradise. Spot fires began just prior to 08:00, followed by the fire front at 08:30. The rapid progression of fire spread into Paradise, generally from east to west, resulted in significant road closures and burnovers and caused difficulty in civilian evacuation, resulting in many requests for evacuation assistance or rescues. Significant EA/R activity occurred in the first few hours of the event. While most civilians were out of Paradise by 14:00, EA/R activities continued through the afternoon and evening. The EA/R data available was impacted by the evacuation and shut down of the PPD dispatch center. The available data from PPD covered emergency calls until 08:20. Call records from the Butte County ECC dispatch were available until 09:22. After PPD evacuated, no 911 records were available from Chico PD.

Requests for *Assistance* were almost exclusively listed before 10:00, before fire impacted civilians and need for evacuation assistance developed into need for rescue from entrapments. Most *Entrapments* in Paradise, 60 % (35/58), occurred between 08:00 and 12:00. In 4 hours, over 556 people in Paradise were trapped, based on known, documented *Entrapment* EA/R events. These events accounted for 89 % (556/622) of the civilians involved in *Entrapments*.

Additional statistics are summarized below:

- The identified EA/R before noon account for 85% (752/881) of all the civilians involved and 65% of all events.
- 83% of all civilians (293/353) involved in EA/R before noon were either directed to, escorted to, or involved in the formation of a TRA. *Entrapments* peaked in the 09:00 hour, with 14 separate EA/R *Entrapment* events, including the TRAs that occurred on Pentz, Bille and Pearson Roads.
- There were 55 total *Assistance* requests in Paradise. Between 08:00 and 10:00, 29 of 36 *Assistance* requests were categorized as *Notification Only* and have no identified Response Action. Of the remaining 19 *Assistance* requests between 10:00 and 19:00, only 2 were *Notification Only*.
- Of the 31 total *Assistance* requests with no documented Response Action (i.e., *Notification Only*), one event is related to a fatality. Thirty events did not result in a fatality; this highlights the potential for additional EA/R actions to have been performed by first responders or neighboring civilians not identified in TDs and radio logs.
- Before 15:00, 25 % of EA/R events (36/144) were responses to specific requests for assistance or rescue. After 15:00, when the frequency of EA/R events slowed, the percentage of EA/R events for responses to specific requests for help increased to 53 % (10/19). This is in contrast to the percentage of events where first responders encountered civilians without having been notified of their location/situation, which remained at 32 % of events in both time windows (47/144 and 6/19, respectively). This shows how first responders were able to catch up after 15:00 and provide responses to incoming requests for help. This was possible because most civilians had evacuated Paradise, traffic was reduced enabling better and quicker access, and more first responders were present as additional mutual aid arrived. After this time, only one EA/R event did not have an identified Response Action; the remaining were either direct responses or encounters.

10.4.2.5. Fatalities in Paradise

Five EA/R events in Paradise were associated with a total of 9 civilian fatalities. Four of the five instances included no information about a response and were classified as *Notification Only*. Two events had documented calls to 911 for assistance, while the other two were announced on the radio by law enforcement dispatch. The two without documented 911 calls occurred after noon, beyond the available 911 recordings. It is undetermined how dispatch became aware of the need for assistance.

There were 48 identified EA/R in Paradise with no documented response after notification to first responders. Four out of the 48 resulted in a total of seven fatalities in Paradise (EA/R ID #052, 075, 138, 170) and are listed in Table 55. The civilians in all four events had pre-existing conditions that may have impacted their ability to evacuate or self-rescue (mobility or health related). It should be noted that during the 09:00 hour, when two of the five EA/R notifications that resulted in fatalities are shown with no associated identified response data, there were 38 separate identified concurrent EA/R events involving 299 people. These 38 events initiated within the 09:00 hour and do not include events that began before and extended past 09:00, highlighting the significant need for evacuation assistance and rescues, and the extent of the response and rescue operations occurring in that time window.

Out of the five EA/Rs in Paradise linked to fatalities, four are categorized as *Entrapments* due to the high hazard conditions at these locations at the time of the emergency calls. Event ID #052 was categorized as *Assistance* because at the time of the call there was no indication of entrapment. Of the five events, people in four events were found located inside their homes.

The fifth event, EA/R ID #137, was classified as an *Entrapment Rescue*. In this additional event, two fatalities were found upon arrival of first responders. Engines responding to a specific address arrived at a nearby residence on a neighboring street due to low visibility and poor signage. They found 2 deceased residents at this location. These victims were apparently not included in the incident total of 85 fatalities and no documented fatality location from Ref. [28] matched the descriptions provided by first responders related to EA/R ID #137. A civilian involved in a later EA/R event (#154), in what appears to be the first location sought by the engines, was found by another first responder and refused to leave.

Table 55. Paradise EA/R events with fatalities.

EA/R ID	**Event** Type	Time of Notification	Notification Source	Notification Details	Situational Context
052	Assistance	09:00	911	Caller requested evacuation assistance on Edgewood Ln.	Burnovers (*BO #7, 21*) and fire occurring in the area. Heavy traffic on Pearson Rd with dozens of people trapped blocked access and consumed resources.
075	Entrapment	09:19	911	Caller requested rescue from entrapment in burning house on Norwood Dr.	Burnovers (*BO #6, 7, 8*) and fire in the area. Heavy traffic on Pentz Rd with dozens of people trapped blocked access and consumed resources.
137	Entrapment Rescue	12:10	FD Dispatch	Dispatch advised units of possible entrapment.	Resources responded to area and encountered poor visibility and signage. Possibly arrived at neighboring location where victims were found.
138	Entrapment	(12:11)	LE Dispatch	Dispatch requested welfare check of elderly resident.	Unknown time and source of first notification. Area had burned before 12:11.
170	Entrapment	(14:52)	LE Dispatch	Dispatch requested welfare check of handicapped citizen.	Unknown time and source of first notification. Note was made prior to PPD evacuation. Area had burned before 14:52.

10.4.2.6. EA/R by First Responder

Both fire department and law enforcement personnel were instrumental in Paradise EA/R events. Fire personnel were identified as the primary responders for 41 % of the events in Paradise, involving 30 % of the total civilian head count. Law enforcement personnel were the primary responder for 23 % of events, and 24 % of civilians. Combinations of LE/fire personnel were identified operating together in 7 % of the events, involving 22 % of civilians. These EA/R events may have been jointly executed by mixed teams, or the initial rescuer may have transferred civilians to the other agency to continue the rescue/transport. These events highlight the effective real-time collaboration of first responders.

Primary involvement in *Assistance* EA/R events was evenly distributed between LE and Fire personnel. However, *Entrapment*-class events were addressed primarily by fire personnel in 30 EA/Rs (with 195 civilians) compared to 10 events by LE (162 civilians). This difference is likely attributable to the specific fire-rescue training, fire-specific personal protective equipment (PPE), and other tools/equipment, including the ability of fire engines to operate in more hazardous fire environments. The significant number of civilians involved in the 10 LE rescue events is

dominated by the evacuation of the Feather Canyon senior living facility near FRH, where 140 civilian residents were urgently evacuated/rescued just before and during the arrival of the fire front.

Additional *Entrapment Rescues* may have been conducted by law enforcement personnel that were not identified in the data. Regardless, the identification of several *Entrapment Rescue* events, in addition to the other actions of law enforcement officers during the Camp Fire incident, exemplifies that LE personnel can often encounter high-hazard fire conditions where they would benefit from additional fire training and PPE.

In addition to first responders, there were five EA/R where civilians were involved in the *Rescue* or *Rescue Attempt* of 7 other civilians. These identified events are almost certainly an underrepresentation of the true scope of civilian rescues, given the urgency of evacuations, significant traffic, and numerous instances of civilians getting rides from strangers. A survey of the affected population was not conducted.

10.4.3. Magalia

A relatively small number of EA/R events occurring in Magalia were documented in the available data. The nine events involved 12 civilians. Rescues in Magalia occurred at the beginning of the Camp Fire incident and continued into the following day on November 9. These numbers represent only a small fraction of likely EA/R for four primary reasons:

1. Fire reached the core of Magalia (i.e., north of West Park Drive) several hours after it impacted Paradise and Old Magalia. Because of this, more firefighting personnel were present beyond those included in the data collection process, where the primary focus was the fire progression over the first 18 hours to 24 hours. The later arrival of fire and limited areas of fire activity provided more time for civilians to evacuate. Combined with the overall less severe fire behavior, this resulted in a lower number of burnover events in Magalia. This is in contrast to the fire behavior/burnover/evacuation sequencing that contributed significantly to EA/R in Paradise.
2. Hazardous conditions began on Andover Drive and Adrian Drive (southwest Magalia) late in the morning and into early afternoon on November 8. Because there was more time to evacuate, a significant fraction of the population was out of the area before the fire arrived.
3. To collect fire behavior, defensive actions, and response data, there were significantly more TDs conducted with fire personnel compared to LE. Available data indicates that dozens of additional LE personnel were on scene beyond those accounted for in TDs. This is evident in multiple TDs, and video footage and still images show LE in both marked and unmarked vehicles. This factor also applies to Concow and Paradise.
4. Because fire reached parts of Magalia later in the incident, additional time was available for more mutual aid resources to arrive. There were several fire department mutual aid strike teams from which fire behavior data was collected only from the strike team leader rather than from individual engine captains. In these cases, EA/R activities performed by individual engines may not have been communicated during the TDs since the strike team leader may not have remembered specific details pertaining to each of the five engines in the team.

While the residents in Magalia had more time to evacuate in general, TDs indicate that there was not a sense of urgency throughout the community. For example, around 12:30, TD-040 described their activity in the area as “on the PA through Magalia, instruction to evacuate north; block party-type atmosphere, people all outside chatting and filming” and that people had the impression that the fire would stay in Paradise because of the current wind direction.

Approximately half of the documented EA/Rs in Magalia occurred on the first day, November 8. The remaining five occurred on the morning of November 9. Additional EA/R activities and support of resident evacuations occurred through November 9 beyond the time window of data collection. First responders used fire engines to evacuate civilians to TRAs, making back and forth trips ferrying residents to the Rite Aid and retrieving medications and pets from homes.

An example of a significant life safety event occurring more than 24 hours after the Camp Fire ignition is presented here for context. At 07:10 on November 9, firefighters were conducting door-to-door evacuations along Ponderosa Way. A rescue of an elderly civilian that stayed behind was successfully accomplished. The fire engine, with the elderly civilian in the engine, drove through fire to get to safety (*BO #18*). Additional engines on the scene retreated to safety at the Pine Ridge School TRA (*TRA-EE*). As described in Sec. 8, these hazardous events can occur hours after a community is initially impacted by fire. This rescue demonstrates the impact on life safety of civilians who opt to stay (or may not be able to evacuate) and the first responders who save them.

10.5. Overall EA/R Analysis

The following sections explore different characteristics of all documented EA/R events, listed in Table K-1. Overall EA/R event analysis is provided in the context of the population of the different affected communities, documented response actions, EA/R outcome, time of event occurrence, and the source of notification alerting first responders of a need for evacuation assistance or rescue.

Further analysis is provided on characteristics of the civilians involved in EA/R events, including group size of civilians involved in EA/R, the circumstances of civilians being rescued (e.g., on foot, in vehicles, in residences), and whether the involved civilians had pre-existing health or mobility conditions affecting their ability to evacuate.

10.5.1. Population Fraction

The estimated minimum fraction of the population involved in the 197 identified EA/R is presented in Table 56. The data in the table does not include the uncertainty in the number of civilians; the numbers presented are the minimum count of civilians present. In general, the civilian count could be at least 33 % higher, as described in Sec. 10.4.2.3.

The data indicates that even without adjusting for the Concow Rescue Area, identified in Sec. 10.4.1, nearly 15 % of the entire population of Concow was involved in EA/R events. While the relative percentages are lower for Magalia and Paradise, there were almost 900 civilians involved in EA/R in Paradise. As presented in Sec. 10.4.2.3, a reasonable estimate of the minimum number is likely at least 1200 in Paradise, not accounting for any additional unidentified EA/R activities.

Table 56. Fraction of community population involved in EA/R.

Location	Event Count		Civilian Head Count		Community Population	Pop. Fraction in EA/R
	n	%	*n*	%		
Concow	23	12	110	11	743	14.8 %
Paradise	163	82	881	88	26543	3.3 %
Magalia	9	5	12	1	12671	0.1 %
Other	3	2	4	0		
Total	**198**	**100**	**1007**	**100**		

[a] Population statistics from U.S. Census Bureau 2014–2018 5-year ACS [34].

10.5.2. Response Action

Previously, Tables 47 and 48 presented the number of different events of each Event Type to provide context to the overall EA/R efforts within each community. Overall, 61 % of all events (121/198) are characterized by completed *Rescue* actions. The following analysis provides further insight to the relationship of Response Action and Event Class that is not evident in the previous data tables.

Tables 57 and 58 present the number of events and number of civilians involved, respectively. Sub-tables, located to the right of the raw number values, indicate the relative fractions of each Event Type in two ways. In the center, values are presented as a fraction of each Event Class. On the right, values are presented as a fraction of each Response Action. An example of how to read the tables is as follows: looking at the right third of Table 57, under "% of Event Count by Response Action"—of the *Rescue Attempts*, 68 % were for *Entrapment*-class events. However, by Event Class, only 16 % of *Entrapment*-class events were *Rescue Attempts*.

One of the most significant findings from this analysis is that 90 % of civilians involved in identified *Entrapment*-class events were *Rescued*. This is seen in the center portion of Table 58. This means that 10 % of people in *Entrapment* events were involved in events characterized by no identified response action or an attempted rescue. Three percent of people in *Entrapment* events were associated with *Attempted Rescues*; 95% of those civilians survived (i.e., 1 fatality in *Entrapment Rescue Attempts*). Overall, 90% of civilians in *Entrapment* events with no identified response action (*Notification Only*) and *Attempted Rescues* survived. Among 27 events, there were 4 events totaling 7 fatalities.

Furthermore, of the people *Rescued*, 81 % were involved in *Entrapment*-class events. A similar analysis with *Notification Only* events shows that most of those civilians (63 %) were related to *Assistance* events. Most of these civilians had unknown, but non-fatal outcomes. This is further discussed in the next section.

All told, this shows how first responders were able to prioritize events and were able to *Rescue* a significant number of people from life-threatening situations.

Table 57. Response Action by Event Class – event count.

	Event Count				% of Event Count by Event Class				% of Event Count by Response Action			
Event Class	**Notification**	**Rescue Attempt**	**Rescue**	**Total**	**Notification**	**Rescue Attempt**	**Rescue**	**Total**	**Notification**	**Rescue Attempt**	**Rescue**	**Total**
Assistance	36	6	22	**64**	56%	9%	34%	**100%**	62%	32%	18%	**32%**
Entrapment	14	13	55	**82**	17%	16%	67%	**100%**	24%	68%	45%	**41%**
Medical	7	0	7	**14**	50%	0%	50%	**100%**	12%	0%	6%	**7%**
Pick-up	1	0	37	**38**	3%	0%	97%	**100%**	2%	0%	31%	**19%**
Total	**58**	**19**	**121**	**198**	**29%**	**10%**	**61%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 58. Response Action by Event Class – civilian head count.

	Civilian Head Count				% of Head Count by Event Class				% of Head Count by Response Action			
Event Class	**Notification**	**Rescue Attempt**	**Rescue**	**Total**	**Notification**	**Rescue Attempt**	**Rescue**	**Total**	**Notification**	**Rescue Attempt**	**Rescue**	**Total**
Assistance	108	7	74	**189**	57%	4%	39%	**100%**	63%	27%	9%	**19%**
Entrapment	55	19	659	**733**	8%	3%	90%	**100%**	32%	73%	81%	**73%**
Medical	7	0	11	**18**	39%	0%	61%	**100%**	4%	0%	1%	**2%**
Pick-up	2	0	65	**67**	3%	0%	97%	**100%**	1%	0%	8%	**7%**
Total	**172**	**26**	**809**	**1007**	**17%**	**3%**	**80%**	**100%**	**100%**	**100%**	**100%**	**100%**

10.5.3. Outcome

The outcomes of individual EA/R events were assigned into one of 13 categories. These categories include aspects about the result of the immediate EA/R action and how the result was achieved. All possible outcomes are listed in Table 59 along with the event frequency and the number of civilians associated with each outcome.

The most frequent known outcome of EA/R events was that civilians were transported in first responder vehicles to a safe location, either to a TRA or other location (within or outside of the fire area), occurring a combined 35 % of the time. These events account for at least 300 civilians.

The most common outcome among all civilians in EA/R was the direct formation of a TRA. While this outcome occurred only 4 % of all events (8/198), these events include nearly one quarter of all civilians in the documented EA/R (244/1007). While these EA/R constitute a small fraction of events, the critical life safety situations presented by intense fire exposures to large groups of people with limited evacuation options meant that immediate formation of a TRA was required.

An Unknown Outcome was also common in the data and was the most frequent result (33 % of events). However, 82 % of these events, accounting for 90 % of civilians with unknown outcomes, are classified as *Notification Only* events with no documented rescue action; by default, these events have unknown outcomes due to lack of data unless they are associated with a documented fatality.

The Other Outcome category includes complex or mixed outcome events that do not fit into the other defined categories. Several people in Concow were *Rescued* and then subsequently involved in an entrapment. These civilians then joined others at the Hoffman Road, Camelot Road, and Camelot Meadow TRAs (*TRA-B, C,* and *A*). Many civilians on Pentz Road were directed to the TRA at the FRH, although they were not directly transported or escorted there and were not included in those respective categories. One event had a complex outcome. Civilians in their vehicles on Skyway were trapped north of Wagstaff Road. To escape, several people abandoned their vehicles and walked down the road to reach the TRA at the intersection of Wagstaff Road (*TRA-N*). Others were able to get rides from other civilians or first responders.

Additional, less frequent, outcomes include specific medical transportation of certain individuals, instances when other civilians provided transportation rather than first responders, and events where the civilians were not present or first responders were unable to access the location.

Table 59. Distribution of Event Outcomes for all EA/R events.

	Event Count		Civilian Head Count	
Event Outcome	***n***	**%**	***n***	**%**
Formation of TRA	8	4	244	24
Transport to TRA	36	18	92	9
Escort to TRA	5	3	107	11
Transport to Other	34	17	208	21
Escort to Other	4	2	8	1
Civilian Transport	10	5	15	1
Medical Transport	5	3	9	1
Refuse to Leave	3	2	3	0
Fatality	6	3	10	1
Not Present	5	3	9	1
Unable to Access	8	4	11	1
Other Outcome	8	4	107	11
Unknown Outcome	66	33	184	18
Total	**198**	**100**	**1007**	**100**

Outcome by Location

Tables 60 and 61 further differentiate the various outcomes by community (Concow, Paradise, and Magalia), both by number of civilians and by number of events, respectively.

Table 59 above shows that overall, 44 % of people in EA/R were involved in TRAs (top 3 lines). However, as seen in Table 60, this overall percentage is not uniform across the three communities. In Concow, the majority of civilians in EA/R (76 %) were involved in the direct formation of TRAs, or were transported to TRAs (Hoffman Road, Concow Road, and Camelot Meadow Wild Fire Safety Zone). This is in contrast to Paradise, where 40 % of those in EA/R had outcomes related to TRA activities. This difference is a result of multiple factors and is likely a result of the short time between fire ignition and the impact to Concow compared to the additional 60 minutes available before the fire impacted Paradise evacuations.

The primary outcome of civilians in EA/R events in Concow was Formation of TRA. In contrast, the TRA outcomes in Paradise were more frequently Transport or Escort to TRA, with 36 events and 191 civilians, each coincidentally representing 22 % of both the events and head count in Paradise. While only 5 EA/R events in Paradise had the outcome of directly forming a TRA, 162 civilians were involved in these few events. This shows that transport and escort to TRAs were major components of first responder activities relating to EA/R in Paradise, due to the:

- prolonged fire event duration impacting sequential areas of town,
- larger number of TRAs throughout the town, and
- long duration of active TRAs, providing several locations for civilians to be dropped off.

In addition to TRAs, many civilians (206, 23 %) were transported or escorted to other locations, either completely out of the fire area, or to safe egress routes or other transportation in Paradise. These EA/Rs were conducted primarily by first responders, although there are a few events where civilians provided the transportation. Combined, Formation of TRAs and Transport/Escort to TRAs or other safe locations account for 50 % of all EA/R events and 65 % of the civilians involved in Paradise.

Table 60. Number of civilians by outcome of all EA/R events.

	Concow		Paradise		Magalia		Other		Total	
Event Outcome	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Formation of TRA	82	74.5	162	18.4					**244**	**24.2**
Transport to TRA	1	0.9	84	9.5	7	58.3			**92**	**9.1**
Escort to TRA			107	12.1					**107**	**10.6**
Transport to Other	9	8.2	198	22.5	1	8.3			**208**	**20.7**
Escort to Other			8	0.9					**8**	**0.8**
Civilian Transport			14	1.6	1	8.3			**15**	**1.5**
Medical Transport			9	1.0					**9**	**0.9**
Refuse to Leave			3	0.3					**3**	**0.3**
Fatality	1	0.9	9	1.0					**10**	**1.0**
Not Present			9	1.0					**9**	**0.9**
Unable to Access	4	3.6	7	0.8					**11**	**1.1**
Other Outcome	4	3.6	102	11.6			1	25.0	**107**	**10.6**
Unknown Outcome	9	8.2	169	19.2	3	25.0	3	75.0	**184**	**18.3**
Total	**110**	**100.0**	**881**	**100.0**	**12**	**100.0**	**4**	**100.0**	**1007**	**100.0**

Table 61. Number of events by outcome for all EA/R events.

	Concow		Paradise		Magalia		Other		Total	
Event Outcome	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Formation of TRA	3	13.0	5	3.1					**8**	**4.0**
Transport to TRA	1	4.3	31	19.0	4	44.4			**36**	**18.2**
Escort to TRA			5	3.1					**5**	**2.5**
Transport to Other	6	26.1	27	16.6	1	11.1			**34**	**17.2**
Escort to Other			4	2.5					**4**	**2.0**
Civilian Transport			9	5.5	1	11.1			**10**	**5.1**
Medical Transport			5	3.1					**5**	**2.5**
Refuse to Leave			3	1.8					**3**	**1.5**
Fatality	1	4.3	5	3.1					**6**	**3.0**
Not Present			5	3.1					**5**	**2.5**
Unable to Access	3	13.0	5	3.1					**8**	**4.0**
Other Outcome	3	13.0	4	2.5			1	33.3	**8**	**4.0**
Unknown Outcome	6	26.1	55	33.7	3	33.3	2	66.7	**66**	**33.3**
Total	**23**	**100.0**	**163**	**100.0**	**9**	**100.0**	**3**	**100.0**	**198**	**100.0**

Outcome by Response Action

Looking at all of the EA/R data with respect to Response Action, 80 % of civilians were *Rescued*, 3 % were involved in *Rescue Attempts*, and 17 % had no identified response action (*Notification Only*). The following highlights describe the EA/R event outcomes depending on the identified Response Action.

Rescue outcomes (121 events)

- 55% of civilians *Rescued* went to TRAs (40% of *Rescue* events),
- 26% were transported to other locations (28% of *Rescue* events), and
- 13% had Other outcomes (7% of *Rescue* events).

Rescue Attempt outcomes (19 events)

- 42% of the time, first responders were unable to access civilians requesting assistance or rescue (also corresponding to 42% of civilians in *Rescue Attempts*)
- 26% of the time, civilians were not present at the reported location when first responders arrived (35% of civilians in *Rescue Attempts*)
- 5% of the time (1 event), *Rescue Attempts* were associated with a fatality (1 individual, representing 4% of civilians in *Rescue Attempts*)

Notification Only outcomes (58 events)

- 7% of events with no identified response action are associated with fatalities (7 individuals in 4 events)
- By definition, the other 93% of events with no identified response action have unknown outcomes (165 individuals in 54 events)
- *Notification Only* events include 82% of all events with unknown outcomes (90 % of civilians with unknown outcomes).

The above statistics highlight the critical contribution of TRAs to the enhancement of civilian life safety in the *Rescue* events and describe the specifics of the *Rescue Attempts,* providing insight as to why they were incomplete. A small fraction of the 58 *Notification Only* events were associated with fatalities. This indicates that the civilians were able to evacuate unassisted or to shelter in place, or that additional response actions (by first responders or other civilians) were not identified.

10.5.4. Time of Day

Temporal analysis of the EA/Rs shows that 85 % (167/198) occurred in the first 18 hours after the first reported Camp Fire ignition, and that 74 % (147/198) occurred in the seven hours between 08:00 and 15:00 on November 8. Figure 39a shows the temporal distribution of EA/R events between 6:00 and 24:00 on November 8. Figure 39b shows the cumulative number of events by type. Each plot is broken down by Event Class. The data show the initial slew of entrapments in Concow in the 07:00 hour followed by a significant number of entrapment and assistance activities between 08:00 and 09:30 as the fire arrives in Paradise. In these early hours, requests for *Assistance* and *Entrapments* dominate. *Pick-up* class events are pronounced between 10:00 and 15:00. The figure illustrates the falloff of EA/R activities between 14:00 and 16:00.

Identified EA/R rapidly escalated from 9 events between 07:00 and 08:00 to 38 between 08:00 and 09:00, peaking at 42 EA/R per hour between 09:00 and 10:00. Seven hundred and fifty-two civilians were involved in EA/R in Paradise between 08:00 and 12:00, representing 85 % of all civilians involved in EA/R in Paradise. This four-hour time window includes the evacuation of the Canyon View retirement facility and the high-occupancy TRAs at FRH (*TRA-A*), Bille Road (*TRA-I*), Pearson Road (*TRA-J*), Paradise Plaza (*TRA-K*) and Wagstaff Road (*TRA-N*).

Even if the 108 civilians involved in EA/R in Concow are not included because of the proximity to the ignition, 85 % (752/881) of civilians involved in EA/R in Paradise occurred in the four hours between 08:00 and 12:00, again highlighting the critical need for rapid activation and engagement of search and rescue operations.

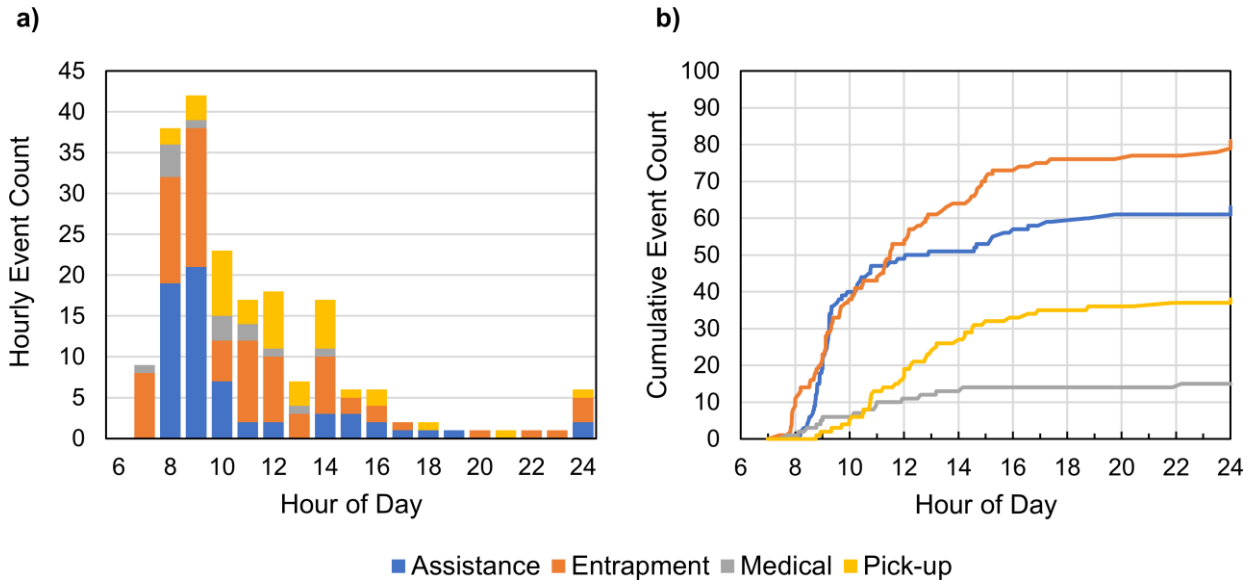


Fig. 39. Distribution of EA/R events by time of day on November 8, by Event Class. a) hourly event counts. b) cumulative event counts.

10.5.5. Notification Source

The information source notifying first responders about each EA/R incident was recorded according to the available data. The frequency of each source is shown in Fig. 40.

The traditional source of information alerting emergency services to a need for evacuation assistance or rescue is via a civilian call to 911; the dispatcher then assigns resources to respond. This was the documented information path in 37 % of EA/R events.[28] The "Dispatch" notification source refers to EA/R events that do not have an associated 911 call record; however, it is assumed that dispatchers were notified of these events either via 911 or other emergency reporting method.

However, in rapidly developing and dynamic incidents, the first responders often discover or encounter EA/R events themselves, without input from 911 or dispatch. Among all EA/R events identified in the Camp Fire, the first responder independently found or identified the need for evacuation assistance or rescue 37 % of the time.

- Half of these incidents (34/73) involved first responders encountering civilians on the roadside and picking them up.
- Many times (38%, 28/73), first responders encountered entrapped civilians.
- Approximately one third of *Entrapments* (28/82) were identified directly by first responders in the field (i.e., without information from 911 or dispatch).

Civilians provided information directly to first responders 10 % of the time, bypassing 911. Such information pathways are only possible with a significant number of first responders out in the community working on evacuation and notification.

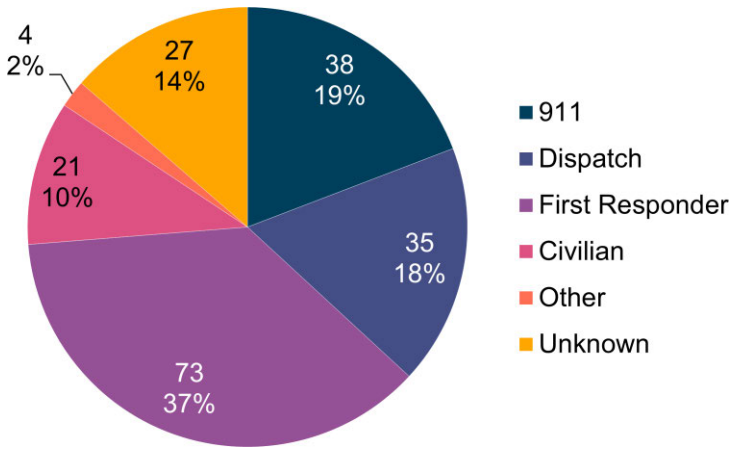


Fig. 40. Frequency of each notification source alerting first responders of the need for evacuation assistance or rescue for all documented EA/R events.

[28] The combined total of 911 and dispatch sources (both LE and FD dispatch).

While 63 % of *Assistance* events were reported via 911 or dispatch and 14 % were found via first responder, only 34 % of *Entrapment* events were reported via 911 or dispatch. First responders encountered *Entrapment* events with the same frequency (34 %). The remaining 32 % of *Entrapment* events are evenly divided between notification directly by civilians to first responders and unknown sources.

In events resulting in a *Rescue*, only 12 % were reported via 911 or dispatch; over half were encountered by first responders (58 %).

10.5.6. Group Size

Figure 41 illustrates the number of events involving a given group size of civilians per event (a) and the total number of civilians accounted for by events of each group size (b). Eighty-one percent of all EA/R events involved 1 or 2 people, totaling 21 % of the EA/R head count. Ninety percent involved less than 10 people.

The largest group size event was the urgent evacuation of the Canyon View retirement living facility near FRH as the fire front was impacting Paradise. While the event included the estimated 140 residents, the actual evacuation and rescue of that group was accomplished in smaller subgroups and individuals.

This indicates that a significant number of mobile resources are needed to execute these EA/R events. This is particularly important for more remote areas, where critical time will be needed for first responders to transit to the community.

In the particular events of the Camp Fire, BO and TRA events involved a significant fraction of the overall number of EA/R civilians. Forty-two percent of civilians involved in EA/Rs were in groups of more than 50 people. While this is a minority of the events, they represent a significant life-safety outcome.

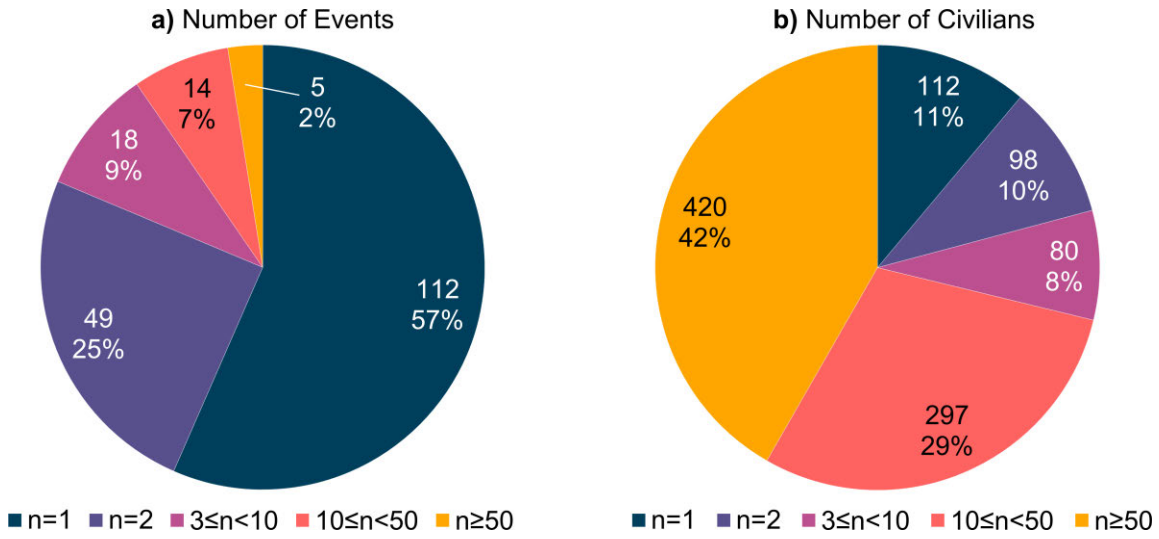


Fig. 41. Distribution of group size for each EA/R event. a) number of events by group size. b) total number of civilians by group size.

10.5.7. Circumstance

Table 62 describes the number of civilians in identified EA/Rs in each circumstance, whether in a residence, vehicle, on foot, or other. The Other Circumstance category includes events with mixed circumstances, such as civilians both in vehicles and on foot after abandoning vehicles. The categories in Table 62 focus on the originating circumstance, not the means to the outcome.

Table 62. Circumstance of civilians involved in EA/R events.

	Event Count		Civilian Head Count	
Circumstance	***n***	**%**	***n***	**%**
Residence [a]	110	56	404	40
Vehicle	28	14	406	40
On foot	42	21	67	7
Other Circumstance	6	3	97	10
Unknown Circumstance	12	6	33	3
Total	**198**	**100**	**1007**	**100**

[a] Residence category includes 2 events and 3 civilians in non-residential structures.

An analysis of the data based on the circumstance of civilians in each EA/R shows that over half (110/198) of the identified events involved civilians in/at their residences. Approximately half of the EA/Rs occurring at residences were direct responses to specific locations requested by emergency callers. The other half had no identified response. Occasionally, first responders encountered civilians at their residence and provided EA/R assistance. This highlights the need for the availability of multiple first responder units. While an engine with 4 firefighters may provide the ability to cover more ground for door-to-door evacuations and searches, the transport capacity of a single vehicle is limited.

An additional 21 % of events involved people on foot, often encountered on the roadside. While the group size of these events was generally 1 or 2 people, these events still present a large use of resources, and transported 67 people in 42 unique events during the Camp Fire.

Only 14 % of identified EA/R events involved civilians in vehicles; however, these events accounted for 40 % of the civilians involved, the same percentage as those at a residence. Most of the EA/R events involving civilians in vehicles were in two categories: Formation of TRA or Escort to TRA. The latter subcategory does not by default imply highly hazardous conditions. This is further described and analyzed in the TRA section, Sec. 9.

Outcomes of EA/R varied with respect to the circumstances. The following statistics highlight important findings.

- From residences, 10% of civilians were transported to TRAs and 44% were transported to other locations, often out of the fire area. The outcome is unknown for 35% of civilians in these EA/Rs.
- The EA/R events involving civilians in their vehicles often resulted in the use of TRAs. This was the outcome 46% of the time, accounting for 69% of civilians in this

circumstance. The EA/R outcome for 39% of people in their vehicles was the formation of a TRA. An additional 24% were escorted to an existing TRA. The remaining 6% were transported by first responders to an existing TRA.

- A smaller, yet substantial, number of civilians (67) in EA/Rs were on foot. Sixty-nine percent of them were transported, in equal numbers, to TRAs or other locations.
- All but one of the civilians in the Other Circumstance category were involved in TRAs. Many of these civilians were on foot, while some were in vehicles. The outcome of these events was primarily the formation of TRAs. It should be noted that the travel range of civilians on foot is significantly reduced compared to civilians in vehicles. This impacts not only their ability to travel to reach safety, but also the intensity of received exposures. Therefore, these situations often resulted in the expedited formation of TRAs.

10.5.8. Pre-existing conditions

Overall, at least 30 % (59/198) of all events involved a civilian with a pre-existing condition that may have caused difficulty in evacuating or prompted a request for assistance or rescue. Pre-existing conditions that were identified in the data include medical limitations, mobility impairments, and lack of transportation (e.g., no vehicle or couldn't drive). This is a lower bound figure; pre-existing condition information was not available for all events and was only recorded if specific details indicated the existence of such conditions. It is likely that more events and people were impacted by such conditions, but the information was not available in the data.

Only five of the 59 EA/R events with pre-existing conditions resulted in fatalities; however, five of the six EA/R events with a fatal outcome involved pre-existing conditions.

10.5.9. Complete EA/R Accounts

Out of the identified 198 EA/R events, a subset of 52 were detailed with specific start-to-finish data, providing complete accounts of the event cycle. Half of the events were characterized as *Encounters*, meaning there was no documented call for help or dispatch of first responders to rescue those specific people; they were spontaneous encounters. The remaining 26 cases with complete data, spanning from the notification of first responders to the response and resolution, were characterized as *Responses*.

Out of the 208 civilians involved in the identified complete *Response* EA/R, 173 were involved in *Entrapments*, 34 were involved in requests for *Assistance*, and 1 was a *Medical* emergency. The rescue response time[29] for complete *Response* events (n=26) was less than 5 minutes with the exception of 3 outliers—EA/R events #017, 059, and 099. The specifics of these events are summarized below:

EA/R #017 (08:11, 93 min): The timeline of this event is complete; however, details may be missing. The first call to 911 was placed at 08:11 and the first documentation of a response already in progress at 09:44. Because the location in Concow was blocked by high fire exposures, there may have been undocumented attempts to respond to this address before the radio transmission at 09:44 indicating such.

[29] The time between when first responders were notified of the request for assistance and the time when a unit resolved the incident.

EA/R #059 (09:07, 18 min): This event possibly reflects a true response time of 18 minutes. This event occurred during the initial mass evacuation, high fire exposure period along Pentz Road with limited first responder resources and restricted access. Despite this potential delay, the rescue was successful (i.e., no fatality) at 09:31. Another first responder arrived at 10:06 in response to the earlier rescue request, highlighting that multiple first responders are attempting rescues and that the notification/rescue coupling is fluid.

EA/R #099 (10:26, 229 min): In this case, there was no fire exposure at the care facility when the request for assistance was first received. However, fire spread through town and the building ignited while being evacuated. The indicated time when residents were being evacuated using multiple wheelchairs and medical transport vans may indicate the lead time required to assemble the necessary transportation team, and the time required for the resources to arrive on location, traveling in the opposite direction of evacuating traffic. This delay may also highlight the prioritization of rescue efforts to focus on critical entrapment events first. The need to evacuate many other care facilities in Paradise, using specialized vehicles, likely contributed to the time gap between the initial assistance request and evacuation.

The total event duration (first notification to completion) of the 52 complete EA/Rs ranged from 3 minutes to 269 minutes. With the exclusion of the three events with durations over 100 minutes, the average duration of complete events was 25 minutes, with a standard deviation of 23 minutes. The rapid response to the numerous requests for assistance and rescue shows the impact of first responders' efforts to prioritize and respond to rapidly changing conditions.

Of the complete response events, 19 of 26 were *Rescues* (196 people) and 7 were *Rescue Attempts* (12 people). The *Rescue Attempts* were classified as such because first responders were unable to access the location due to fire, power lines, or other obstructions, the person was not present at the specified location, or the outcome was unknown. There were no fatalities associated with these events.

10.6. Summary

The information presented above was collected from TDs, VTDs, dashboard cameras, radio logs, and 911 recordings. A total of 198 distinct events were identified in which civilians requested or received Evacuation Assistance or Rescue (EA/R). The identified EA/R events presented here likely represent only a fraction of the events that occurred in all three communities. The identified events involved at least 1007 civilians. Uncertainty in the minimum number of civilians involved in EA/R increases the total estimate to 1352. The true head count is likely higher, as this minimum estimate of 1352 assumes only one person per vehicle.

The identified 198 events include 64 requests for evacuation *Assistance*, 82 *Entrapments*, and 14 *Medical* related incidents. Civilians were *Picked-up* in 38 events when they were encountered on the roadside by first responders. The following statistics highlight EA/R across the entire Camp Fire response on November 8 and early November 9:

- 90 % of civilians involved in *Entrapment* events were *Rescued* (659/733).
- 44 % of all civilians in EA/R (443/1007) were involved in TRAs.

- 55 % of civilians *Rescued* (443/809) were involved in TRAs.
- 58 events have no identified response action, with most of them (62 %) being requests for evacuation *Assistance*. Most of the civilians in these events had unknown, but non-fatal, outcomes. Four of the 58 events were associated with seven fatalities.

The analysis provided specific insights into the EA/R events in Concow, Paradise, and Magalia. Events within each community were first analyzed separately to highlight differences between the circumstances in each community, including timing, fire conditions, and number of first responders. Analysis was also carried out for the EA/R activities as a whole.

The statistics highlighting the EA/R in Concow are that:

- 32 % of the civilians living in the selected Concow Rescue Area (CRA) were associated with EA/R events in the first 4.5 hours after the fire reached the CRA,
- 25 % of the estimated population of the CRA were rescued via TRAs,
- 97 % of people involved in EA/R events in Concow were *Entrapments*, and
- 95 out of the 107 civilians *Entrapped* in Concow, were *Rescued*.

Concow EA/R events demonstrate how hazardous and rapidly evolving local conditions can impact life safety and result in entrapments, particularly in situations where there is little time to evacuate or to get to a wildfire safety zone because of the fire ignition location. Additionally, the fact that 92 % of people *Rescued* in Concow were rescued within a 90-minute period demonstrates the need to rapidly engage in life safety operations and highlights the critical need for pre-planning. The large fraction of residents involved in TRAs highlights the need for easily and rapidly accessible safety zones. These community safety zones are necessary when there is not sufficient time to evacuate early.

The EA/R in Paradise involved at least 881 civilians. While Paradise was impacted by fire an hour after Concow, the population size and density, together with egress artery closures and locally high fire exposures, resulted in the *Entrapment* of over 600 civilians. The following statistics summarize the EA/R events in Paradise:

- At least 881 total civilians were involved in known EA/R in Paradise, with a reasonable estimate of 1188 when including potential uncertainty in the data.
- 71 % of people involved in events in Paradise were *Entrapments* (622/881)
- 90 % of people involved in *Entrapments* in Paradise were *Rescued* (560/622)
- 89 % of the people involved in *Entrapment* EA/R in Paradise were in events occurring between 08:00 and 12:00 (556/622)
- 12 % of rescue responses (14/115) were incomplete and therefore are categorized as *Rescue Attempts*—there are no fatalities associated with these 14 events.

EA/R data related to seven fatal events were identified—two in Concow and five in Paradise. Additional data on the 85 fatalities can be found in Sec. 11.

The EA/R data from Paradise illustrate the large number of simultaneous *Entrapments* and *Assistance* requests, and the rapid and effective response by LE and fire department personnel to

get civilians to safety. These successful responses are in part attributed to pre-fire planning and joint training exercises that enhanced communication pathways and developed joint response plans between the fire department and law enforcement, as described in Sec. 5.4. The proximity of Paradise to the larger population centers of Chico and Oroville significantly enhanced the EA/R operations in Paradise, as a significant number of LE resources were able to arrive quickly and respond to the large number of simultaneous EA/R events.

The above data highlight the need for additional post-fire studies on these types of EA/R events. Such studies would further assess *Notification*, *Rescue*, *Rescue Attempt*, and *Entrapment* frequency and outcomes in different WUI fire incidents, including interface and intermix locations, suburban and rural/remote communities, and large- and small-loss events.

10.7. Technical Findings

Overall

TF-R 1. Rapid fire progression, burnovers, and traffic restrictions significantly impacted rescue actions in Concow and Paradise, by both causing the need for rescues and preventing access to areas in need.

TF-R 2. Over 1000 civilians were involved in 198 identified EA/R events on November 8 and early November 9.

TF-R 3. 61 % of EA/R events are characterized by *Rescue* response actions (121/198).

TF-R 4. 90 % of civilians involved in *Entrapment* events were *Rescued* (659/733).

TF-R 5. Overall, at least 30 % (59/198) of all events involved a civilian with a pre-existing condition that may have caused difficulty in evacuating or prompted a request for assistance or rescue. Five of the 59 EA/R events with pre-existing conditions resulted in fatalities; however, five of the six EA/R events with a fatal outcome involved pre-existing conditions.

TF-R 6. Only 14 % of identified EA/R events involved civilians in vehicles (28/198); however, these events accounted for 40 % of the civilians involved, the same total number as those at a residence (~400/1007).

TF-R 7. The EA/R events involving civilians in their vehicles often resulted in the use of TRAs. This was the outcome 46% of the time (13/28), accounting for 69% of civilians in vehicles (280/406).

TF-R 8. First responders independently found or identified the need for evacuation assistance or rescue without information from 911 or dispatch 37 % of the time (73/198). Coincidentally, events were reported via 911 or dispatch with the same frequency (73/198).

TF-R 9. Only 34 % of *Entrapment* events were reported via 911 or dispatch. First responders encountered *Entrapment* events with the same frequency (34 %).

TF-R 10. 81 % of all EA/R events involved 1 or 2 people (161/198), totaling 21 % of the EA/R head count (210/1007).

Concow – 110 civilians in EA/R

TF-R 11. 92 % of civilians *Rescued* in Concow were rescued in a 90-minute period between 07:45 and 09:15 (88/96), mostly through formation of TRAs (84/88).

TF-R 12. 77 % of civilians in EA/R in Concow were *Rescued* through involvement in TRAs (85/110).

TF-R 13. 18 of 20 events in the selected Concow Rescue Area (CRA) were *Entrapment* events (107/110 civilians).

TF-R 14. Over 25 % of the estimated population of the CRA was *Rescued* (95/342).

Paradise – 881 civilians in EA/R

TF-R 15. 80 % of civilians *Rescued* in Paradise were in *Entrapment* events (560/703).

TF-R 16. 89 % of the people involved in *Entrapment* EA/R in Paradise were in events occurring between 08:00 and 12:00 (556/622).

TF-R 17. 40 % of civilians in EA/R in Paradise were *Rescued* through involvement in TRAs (353/881), including 18 % involved in the immediate formation of TRAs (162/881).

TF-R 18. There is a significant difference between the number of response actions (*Rescues* plus *Rescue Attempts*) to *Entrapments* versus *Assistance* requests. Responses were identified in 83 % of *Entrapments* compared to 44 % of *Assistance* requests. This highlights the effective decision-making by first responders in addressing risk to civilians, prioritizing high hazard situations for rescue by the limited number of available responders.

10.8. Recommendations

In planning for WUI fire evacuations, communities should consider:

R-R 1. First responders should plan for partial or complete loss of communications with dispatch.

R-R 2. Additional post-fire studies on these types of evacuation assistance/rescue events should be conducted to further assess *Notification*, *Rescue*, *Rescue Attempt*, and *Entrapment* frequency and outcomes in different WUI fire incidents.

This page intentionally left blank.

11. Fatalities

Eighty-five fatalities were identified as the direct and immediate result of the Camp Fire [25, 28]. This number does not include potential morbidity and mortality due to delayed exposure effects in the months and years after, either from direct exposure within the incident or indirect exposure from dispersed smoke and pollutants [60-62]. This section is intended to provide overall context and insight into the immediate fatalities. Many of the individual circumstances are included in the summary report [28] of the investigatory grand jury on behalf of the Butte County District Attorney's Office, which includes 84 fatalities. An additional 85th victim was included in information statements from the Butte County Sheriff's Office [25, 30] and additional news reporting after the fire [63].

Data presented in this section was compiled from three sources: the grand jury report, BCSO press releases, and general news reporting. Of the 85 fatalities, 10 fatalities (7 events) were associated with the 198 EA/R events detailed in Sec. 10. Of these, two were unable to be rescued in time, while one was *Rescued* and did not recover from their injuries. Four fatalities (2 events) were documented in 911 calls but were unable to be rescued. The remaining 3 events were known to law enforcement dispatch at undetermined time from an undetermined source. Some fatalities may be linked to rescue actions that are not reflected in the available data, including the 4 events that are documented as notification only. However, in many cases, emergency services may not have been aware of a victim's need for rescue, such as cases in which the victim did not call 911. Seven of the nine fatalities in Concow are not linked to any documented notification, rescue request, or rescue action. While the EA/R data included 58 instances where the only data point was notification of emergency personnel, only 4 of these events (7 people) are linked to the 85 fatalities. Two additional fatalities were identified through TDs. The described location of this event could not be related to the reported 85 fatalities, as described in Sec. 10.4.2.5.

Several characteristics of victims were documented from the available data sources, including age and location, and whether there was evidence indicating the person was attempting to evacuate. Known mobility impairments or medical conditions that may have impacted the ability to evacuate was occasionally documented. However, reporting of such information was inconsistent; the absence of this information does not necessarily mean that there were no pre-existing conditions.

The average and median age of the victims was 72 years old, ranging from 20 to 99. Only 16 individuals were under age 65.

Most fatalities (87 %) were found at home. A smaller number were located with their vehicles, attempting to evacuate. The distribution of locations is listed in Table 63, along with the count of people who had mobility and/or medical conditions. Pre-existing mobility or medical conditions may impede one's ability to effectively evacuate. Several victims were reported to have lacked access to a vehicle or were unable to drive. Others had medical conditions that may have made evacuating difficult or slow and may have required additional help to move equipment or wheelchairs. At least 42 % of the victims were reported to have a mobility or medical condition, and it was less likely that they were attempting to evacuate. Nearly everyone with an identified pre-existing mobility and/or medical condition was found at home. Only 11 % of victims in the pre-existing condition category were believed to be evacuating, compared to 30 % of victims without a disclosed condition.

Based on available reporting of the circumstances of each victim, officials believed [28] that at least 19 of the 85 people (22 %) were attempting to evacuate when they were overcome by the fire. They were found outside their homes, or in or around their vehicles. Of the 19, only four had a mobility or medical limitation. Victims who were not believed to be evacuating were more likely to have a mobility or medical condition. Of the 66 people (78 %) not evacuating, at least half had a pre-existing condition. Counts are presented in Table 64.

Nearly all of those who were overcome by fire while attempting to evacuate were located in Concow or eastern Paradise (Pentz Road and Edgewood Lane) where the fire impacted the communities early and rapidly. Evidence cited by the District Attorney report [28] indicated that 5 of 9 fatalities in Concow were attempting to evacuate.

Table 63. Summary of fatalities with respect to location found and pre-existing (Pre-X) conditions.

Location	Count	Any Pre-X Condition	Pre-X Mobility Impairment	Pre-X Medical Limitation
Home – inside	59	29	19	16
Home – outside	15	6	3	5
Vehicle – inside	7	1	0	1
Vehicle – outside	3	0	0	0
Unknown	1	0	0	0
Total	**85**	**36**	**22**	**22**

Table 64. Summary of fatalities with respect to evacuation and pre-existing (Pre-X) conditions.

Evacuation Circumstance	Count	Any Pre-X Condition	No Known Pre-X Condition
Attempting evacuation	19	4	15
Undetermined/Not attempting evacuation	66	32	34
Total	**85**	**36**	**49**

12. Analysis of First Responder Comments

Technical discussions (TD) often included statements or comments about the Camp Fire incident or WUI fire in general that were not directly related to establishing the incident timeline or linked to a specific observation. The comments came from a broad range of perspectives and contain valuable observations from a range of different first responders. Documentation of these comments may provide insight, ideas, and perspectives to consider by communities and emergency personnel. Keywords categorizing each comment were developed as needed to encompass the comments; for clarity, only one category was assigned to each comment. The frequency count of each primary keyword is listed in Table 65. A listing of the 143 NETTRA-related comments is presented in Appendix L.

The most prevalent keyword was “egress,” which was tagged 40 times in comments provided by 28 unique contributors. Most comments related to general observations that have been explored in previous sections of this report. Nearly half of the comments in this category related to the limited number of egress routes available and the bottlenecks (in and outside of Paradise) that were experienced due to merging lanes, abandoned cars, downed trees, and downed utility poles. The large number of civilians that were trying to use the same limited number of evacuation routes at the same time also contributed to the bottlenecks. Finally, additional bottlenecks occurred at the very end of the evacuation routes, at stop signs and stop lights on the edge of Chico. Some comments provided thoughts for egress improvements, such as widening the major evacuation routes, and including neighboring towns in evacuation plans to prepare them to handle the evacuation traffic and to prevent additional congestion at the end of the route.

The second most frequent keyword category was “plan,” referring to the evacuation plan that was in place at the time of the fire or other aspects of the incident that should be considered in an evacuation plan.

Several TDs highlighted the important role public transit buses played in the general evacuation, even though the bus system (B-Line) was not involved in the evacuation plans. Pre-existing collaboration between the B-Line management and the BCSO initiated the support during the early stages of the incident. Several comments related to the performance of the transit vehicles may highlight factors to consider in development of future evacuation plans. Smaller-sized buses were able to navigate roadway hazards, such as downed trees, utility lines, and abandoned vehicles, better than larger buses. However, it was demonstrated that both large and small buses can play an important role in future evacuations. Smaller buses can more easily get to locations closer to a hazardous area to relocate civilians towards TRAs and areas where larger buses can collect them and transport groups out of the fire area. Smaller buses may also have more specialized capability for wheelchair access.

Limited public awareness/engagement was also observed in Magalia during the late morning/early afternoon of November 8. Anecdotal information from multiple TDs indicates that many residents did not appreciate the fire hazard and that there was a sense that the fire was “just in, and was going to stay, in Paradise.” First responders indicated the difficulty of getting many residents to appreciate the urgency and the need to rapidly evacuate. In some cases, residents reportedly responded to urgent in-person evacuation instructions with sentiments like, “yeah, yeah, we’re packing up and will leave in an hour,” much slower than indicated by first responders.

Finally, even though some categories have smaller numbers of comments, they can still have significant implications for planning and responding to future events. For example, the single "animal" comment was a suggestion that there needs to be a framework to support animal evacuations from long-term evacuation areas that are no longer immediately threatened by the fire. Much of the Camp Fire area was closed to entry for 37 days. Programs like the one suggested would ensure care for pets and livestock and support the community during fire containment and community repopulation and recovery.

Table 65. List of topic keywords and frequency counts of NETTRA comments noted from technical discussions.

NETTRA Keyword	Count
Egress	40
Plan	28
Notification	13
B-Line buses	12
Special needs	8
Coordination	6
Drill	6
Zone	5
Contraflow	4
TRA	4
Traffic	4
Rescue	3
Hazards	2
Response	2
Utilities	2
Vegetation	2
Animals	1
Communication	1
Total	**143**

13. Summary

The path and timing of the 2018 Camp Fire through communities in Butte County, California presented a significant threat to life safety. The fire progression timeline [23] was used as the technical foundation to analyze, interpret, and contextualize the life safety aspects of the incident, including notification, evacuation, traffic, the formation and use of TRAs, and rescues conducted during the first 24 hours of the fire.

This case study report examined the pre-fire preparations, notification, and evacuation activities in Concow, Paradise, and Magalia, the three communities initially impacted by the Camp Fire. The report identified the relationship between the notification timeline and the time of fire arrival as a function of evacuation zones. The subsequent evacuation was documented and analyzed, primarily via observation and tracking of traffic conditions throughout the communities. The integration of the fire progression data was instrumental in understanding the dynamic evacuation process, highlighting the effects of fire on evacuees, traffic, and road closures.

The creation and widespread use of TRAs in response to fire exposures experienced by evacuating traffic was assessed and analyzed, as was the use of convoys to manage traffic and escort civilians to safety. A total of well over 1200 civilians were involved in 31 TRAs, including over 200 civilians in high-risk environments. Additionally, 198 distinct evacuation assistance/rescue (EA/R) events were identified and classified. The unique dataset was analyzed with respect to response actions, outcomes, and circumstances of each rescue. At least 1000 civilians were involved in EA/R events, many independent of the civilians included in TRAs. A limited analysis was performed on the available information regarding the 85 fatalities suffered in the fire.

The three impacted communities, Concow, Paradise, and Magalia experienced the Camp Fire very differently.

Concow

This community was very close to the fire origin (6.5 km, 4 mi) and was impacted within 1 hour of ignition. As a result, there was little time for widespread community notification. Door-to-door notification activities by first responders and neighbors were instrumental in informing residents. A large fraction of the population in the Concow Rescue Area (CRA, the area surrounding Camelot and near the reservoir) was caught in high hazard situations. One-hundred ten civilians, representing approximately 32 % of the CRA, were involved in EA/R events. Multiple TRAs in close proximity to each other had to be formed to maintain life safety of both civilians and first responders. Rescue activities were impacted by the intensity of the rapidly moving fire. Evacuation was constrained by burnovers that closed the main egress artery.

Paradise

Spot fires began impacting Paradise 35 minutes after Concow. The fire front arrived approximately 40 minutes later at around 08:30. The fire significantly impacted evacuations along the Pentz Road corridor where multiple burnovers occurred, trapping and endangering dozens of civilians.

Evacuation notifications caught up with the fire progression, and by 09:00 CodeRED reverse 911 evacuation notifications were sent to the public ahead of the fire. Traffic was pushed to the west, first to Clark Road then to Skyway as the fire generally progressed southwest. Traffic leaving Paradise gridlocked in Chico and the valley, and the backup extended all the way up Skyway into Paradise. Traffic management by first responders was used to shuffle vehicles and evacuating civilians away from fire exposures as much as possible. Rescues and the use of TRAs occurred throughout the morning of November 8 as burnovers entrapped civilians and closed many of the egress arteries. Mutual aid responders were instrumental in conducting numerous rescues. First responder access was restricted by fire, road closures, and heavy evacuating traffic. Most civilians had evacuated by 14:00.

Magalia

The southern extent of Magalia and the Old Magalia neighborhood also experienced fire the morning of November 8. The closure of Skyway through Paradise prevented civilians from evacuating using the southern routes after 10:00. Many residents in Magalia felt that the fire was not going to reach their community. The southern evacuation route reopened after 17:30 and was passable with an escort through Paradise. However, intense fire pushed deeper into Magalia overnight after fire flared up along Coutolenc Road and progressed west. The delayed arrival of the fire to parts of Magalia enabled the communication of notification information to the public well ahead of the fire. Most civilians had evacuated by that time; however, there were evacuations and rescues into the night and through the morning of November 9.

The above information provides a high-level overview of the notification, evacuation, traffic and TRA data collected and analyzed for the first 24 hours of the Camp Fire. The information presented in the report together with the fire protection timeline data can be used to understand the events that unfolded on November 8. This information can also serve other WUI intermix communities to better prepare for future WUI fires.

A number of research questions were answered through detailed analysis presented throughout this report. The often complex and interconnected aspects of each question can be found in the related sections of the report identified in bold below.

a) What were the design parameters of the Paradise Evacuation Plan?
(Sec. 5)

b) What were the roads and access characteristics of Concow, Paradise, and Magalia?
(Sec. 4)

c) How was the notification of civilians in Concow, Paradise, and Magalia achieved?
(Sec. 6)

d) When were evacuation notifications and orders issued, and how does this timing relate to fire progression?
(Sec. 6.2 and 6.3)

e) How did fire impact evacuations of Concow, Paradise, and Magalia?
(Sec. 7.5, 8, and 9)

f) What were the primary factors that impacted traffic flow during evacuation?
(Sec. 7.5, 8, and 9)

g) How did the use of wildfire safety zones and the creation of TRAs impact civilian life safety and how many civilians utilized TRAs?
(Sec. 9)

h) When were TRAs formed and what were the physical characteristics of the TRAs used?
(Sec. 9 and Appendix I)

i) What were the attributes of the rescues performed and how many civilians were rescued?
(Sec. 10)

This page intentionally left blank.

14. Technical Findings and Recommendations

The technical findings and recommendations have been compiled here for ease of access. Lists are numbered *TF-* for technical findings and *R-* for recommendations, followed by a code for the topic (e.g., *TF-EP* for technical findings related to evacuation plans).

In total, 64 technical findings related to the different life safety components of the Camp Fire incident were highlighted in the previous sections of this report: evacuation plans (EP), emergency notifications (N), evacuation and traffic flow (ET), temporary refuge areas (TRA), and rescues (R). Additionally, 26 recommendations present mitigating concepts for consideration by at-risk communities.

14.1. Evacuation and Notification Plans

TF-EP 1. An evacuation plan, developed with input from previous fires and from training exercises, was in place and communicated to first responders and the community before the incident.

TF-EP 2. The evacuation plan included coordination among multiple regional first responder agencies (fire departments, law enforcement, and public works).

TF-EP 3. The Paradise evacuation plan was conceived and designed for a zoned/partial evacuation; it was not designed for a complete simultaneous evacuation of the town.

TF-EP 4. There is a need for streamlined decision-making and communication processes where all the emergency management participants are trained and proficient using the same evacuation zone layout and nomenclature.

TF-EP 5. Including an evacuation component in the 2016 WUI fire training exercise built "muscle memory" of first responders for integrating evacuation into the response component of WUI fire incidents.

TF-EP 6. The 2016 training exercise was used to practice key evacuation elements, including traffic contraflow on Skyway. This served as direct experience to Paradise Public Works and Police Department.

In planning for WUI fire evacuations, communities should consider:

R-EP 1. Developing an evacuation plan in collaboration with nearby first responder organizations/agencies.

R-EP 2. Creating a realistic training exercise that includes fire, rescue, evacuation, and traffic components.

R-EP 3. Practicing training exercises with collaborating fire, law enforcement, emergency medical services, and public works agencies.

R-EP 4. Revising the evacuation plan based on lessons learned from training exercises and other WUI fires.

14.2. Emergency Notifications

Pre-Fire

TF-N 1. The Town of Paradise had an established Emergency Operations Plan (EOP).

TF-N 2. The Town of Paradise Emergency Operations Center staffing included town employees and volunteers trained to facilitate notification and evacuation efforts.

TF-N 3. There were no sirens in place for emergency notification in Concow, Paradise or Magalia.

TF-N 4. In preparation for a real wildfire/WUI fire, CAL FIRE and the Town of Paradise worked with multiple local and state jurisdictions to conduct an extensive and detailed evacuation and WUI fire exercise.

TF-N 5. Pre-fire preparations like the evacuation plan and evacuation/WUI fire drill significantly enhanced the first responder notification, evacuation, and firefighting capabilities during the Camp Fire.

During Fire

TF-N 6. During the Camp Fire, public agencies used several modes of communication to alert residents, including door-to-door messaging, vehicle-mounted speakers, CodeRED reverse-911, and social media platforms including Facebook and Twitter.

TF-N 7. Early in the incident, before 08:00, the rapid fire spread outpaced the information flow and the establishment of evacuation boundaries.

TF-N 8. Early in the incident, before 08:00, limited situational awareness (because of rapid fire progression) and the inherent time necessary for communication from the Emergency Command Center (ECC) to Paradise Police Department (PPD) impacted accuracy of information.

TF-N 9. Both 911 call centers (PPD and ECC) provided consistent information to callers based on the changing situational awareness and evacuation orders.

TF-N 10. The initial IC evacuation warning request in Paradise at 07:32 was for “west of Pentz” instead of “east of Pentz.” Fourteen minutes elapsed between the initial request and the time the warnings were upgraded to orders and exact zones were specified at 07:46. The “west instead of east” does not appear to have caused any notification delays.

TF-N 11. There is a finite time required to transfer evacuation requests from the incident commander (IC) to first responders to the public.

TF-N 12. It took approximately 10 minutes from the IC request for an evacuation warning for Pentz Road to when law enforcement began door-to-door notifications. The information went from IC to law enforcement dispatch to officers on location.

TF-N 13. PPD 911 began informing residents to evacuate as early as 07:49, just as the first spot fires ignited in Paradise (before evacuation orders were issued for those locations).

TF-N 14. Butte County ECC and PPD accelerated the evacuation of Paradise, communicating complete evacuation at 08:03, ahead of the multi-zone request from the IC at 08:49.

TF-N 15. There was a communication gap between evacuation of "all of Paradise" vs. the IC-selected zones. BCSO and Town of Paradise opted to evacuate more zones than the ones requested by the IC. The communication gap lasted at least 46 minutes.

TF-N 16. Local spot fire ignitions can rapidly spread, leading to burnover events. This rapid fire spread results in limited time for civilian notification, impacting safety during evacuation.

TF-N 17. The use of general directional terms (e.g., east, west, north, and south) relative to specific zones can be a cause of confusion; however, when many zones are involved in a rapidly developing incident there may not be sufficient time to list all zones.

TF-N 18. The Integrated Public Alert and Warning System (IPAWS), including Wireless Emergency Alerts (WEA), was not used.

In planning for WUI fire evacuations, communities should consider:

R-N 1. Developing a notification plan and maintaining a resilient notification system.

R-N 2. Implementing and utilizing a multi-modal notification system that accounts for electricity/internet/infrastructure failures and spans the range of information sources available to residents (e.g., phones, IPAWS, internet, social media, radio, sirens).

R-N 3. Accounting for the cumulative minimum time necessary for situation assessment, information transfer to the incident commander, information transfer between the incident commander and law enforcement, and communication to the public in the design of a community notification and evacuation plan.

R-N 4. That rapid fire progression and the proximity of a fire's origin to a community may reduce the time available for notification and evacuation. Developing a distributed system of wildfire safety zones for sheltering within the community may provide the safest approach for civilians who may not have sufficient time to safely evacuate.

R-N 5. Using official social media channels to enhance dissemination of real-time information.

R-N 6. That use of advertised and promoted official social media channels to provide updates during an ongoing disaster incident should only be reserved for organizations that can maintain these channels with current information throughout the event. Explicit acknowledgement that information may be incomplete or outdated should be provided.

R-N 7. That advertised use of official social media channels for updates during emergency incidents that do not then provide updated information during an incident can disseminate misleading information to the public. This may result in significant propagation of false information and negatively impact decisions and responses of civilians.

14.3. Evacuation and Traffic Flow

TF-ET 1. Preplanning and training for traffic management and contraflow significantly enhanced life safety of evacuees.

TF-ET 2. The majority of the evacuation of Paradise took place between 08:00 and 14:15.

TF-ET 3. First responders took extensive actions to enhance evacuee life safety, including creating TRAs and escorting civilians to safety in numerous convoys.

TF-ET 4. Five key tactics were used to mitigate life safety issues during evacuation, enabling first responders to keep hundreds of civilians out of high hazard areas:
   a. Escort civilians to low hazard areas (convoys)
   b. Fill up road space in areas that were not burning
   c. Redirect traffic to account for continuously changing conditions (traffic and fire), including intersection traffic management and redirection
   d. Use contraflow to increase traffic flow out of town, and
   e. Use parking lots as TRAs to accumulate overflow traffic.

TF-ET 5. Burnovers significantly impacted civilian and first responder life safety by exposing evacuees to high hazard conditions and locally closing roadways.

TF-ET 6. Egress arteries blocked by fire significantly impacted civilian evacuation by increasing traffic delays throughout the community.

TF-ET 7. Main egress evacuation arteries experienced a significant number of closures due to fire. One quarter of the intersections/road segments along egress arteries and cross-town arteries experienced one or more closures due to fire.

TF-ET 8. Two or more of the four egress arteries leaving Paradise were simultaneously closed due to fire for 68 % of the time between 08:00 and 14:15.

TF-ET 9. Traffic congestion in Chico along Durham-Pentz Road and CA Highway 99 significantly slowed down the evacuation of Paradise. In some cases, the bottlenecks were located more than 15 km (9 mi) from Paradise.

TF-ET 10. Imbalance in the number of available traffic lanes at potential chokepoints (within or surrounding a community) may not be readily apparent during the design of a plan utilizing a zoned/partial evacuation of a community.

In planning for WUI fire evacuations, communities should consider:

R-ET 1. Preplanning community evacuation scenarios and communicating them to residents and first responder, government, and infrastructure agencies.

R-ET 2. Developing preplanned evacuation scenarios that consider factors including fire history, prevailing winds, proximity of ignition to the community, and road capacity.

R-ET 3. Practicing evacuation scenarios with first responder, government, and infrastructure agencies from the community and associated surrounding jurisdictions.

R-ET 4. Utilizing programs such as “Ready, Set, Go!” to develop and communicate evacuation preparation and timelines.

R-ET 5. Developing alternate plans for situations in which there is insufficient time to evacuate from the fire area.

R-ET 6. Using crosswalks with painted patterns, overhead flashing lights, and/or removable posts to reduce impact on flow instead of immovable fixtures within the roadway.

14.4. Temporary Refuge Areas

TF-TRA 1. Thirty-one different TRAs were formed during the first 25 hours, 27 of which involved civilians.

TF-TRA 2. Of the 18 pre-designated public assembly areas and wildfire safety zones, only four were used as TRAs during the Camp Fire. Another four were used for incident response staging.

TF-TRA 3. TRAs were selected to leverage natural and/or manmade features. TRA types included 14 parking lots, 7 roadways, 6 structures, 3 maintained natural areas, and 1 unmaintained natural area.

TF-TRA 4. Roadways and natural area TRAs were frequently the only local options (35 % [11/31] of TRAs) during the Camp Fire.

TF-TRA 5. At least 1200 to 2100 civilians were involved with TRAs. If average vehicle occupancy is assumed to be two, the estimated number of civilians increases to 3300.

TF-TRA 6. Individual TRA occupancy ranged from 1 to 550 civilians, including people in vehicles and on foot.

TF-TRA 7. High hazard conditions impacted at least 261 civilians in eight TRAs between 07:55 and 09:35 (100 minutes). Seven of the eight TRAs were formed in direct response to burnover events.

TF-TRA 8. Rapid event evolution prevented residents in Concow from reaching their local safety zone. It took one hour and two TRAs to get from Hoffman Road to the Camelot Meadow Wild Fire Safety Zone, a travel distance of 1 km (0.6 mi) (300 m [0.2 mi] straight-line distance).

TF-TRA 9. First responders and civilians had to wait for the vegetation in Camelot Wild Fire Safety Zone to burn before they could use the meadow as a TRA. This event highlights the need to design and maintain TRAs for ready access. Irrigated and maintained safety zones like Crain Memorial Park or gravel areas may provide additional safety in quickly developing events.

TF-TRA 10. The extensive use of TRAs points to the critical need of developing an evacuation plan that includes scenarios where immediate evacuation out of the fire may not be possible.

TF-TRA 11. TRAs along major evacuation arteries enhanced civilian life safety because in many cases civilians did not have to go out of their way (off the evacuation route) to get to the TRA.

TF-TRA 12. Consolidation of TRAs and groups of civilians facilitated management and evacuation of TRAs by first responders.

Ideally, civilians will have time and ability to safely evacuate before the fire impacts their community. In events where this is not possible, a system of pre-planned wildfire safety zones can be used to enhance life safety to limit civilian exposure to fire during evacuation, especially in intermix communities. The recommendations outlined below focus on the development and implementation of a wildfire safety zone system; however, they also apply to the identification of TRAs. The use of ad hoc TRAs is, by default, a last resort and does not provide the full benefit of a pre-planned wildfire safety zone system.

R-TRA 1. There is a need for a distributed pre-planned wildfire safety zone system in communities that reduces the travel time needed to access these areas so they can be quickly accessed in case a rapidly moving and widespread fire near the community prevents a timely evacuation of the community.

R-TRA 2. The number, size, and spatial distribution of safety zones need to be factored into the design of a community-wide wildfire safety zone system and based on fire exposure consideration, population density in the surroundings, and number and size of other safety zones.

R-TRA 3. Placement of and access to safety zones should consider civilian access pathways and address potential burnover locations, informed by fire history, fuel loading, and dangerous topographical features.

R-TRA 4. Identify high fuel-load areas such as heavily wooded areas, areas of flashy fuels (e.g., unburned tall dry grass), combustible structures, high density residential areas, and topographical features like chimneys and ravines. Assess civilian egress/transit to safety zones that may traverse these areas.

R-TRA 5. Use wildfire safety zones on major evacuation arteries to enhance civilian life safety.

R-TRA 6. Consider spatial density (and minimum size) of safety zones, as well as their maintenance. The difficulty of getting to Camelot Meadow Wild Fire Safety Zone highlights the need to carefully place and maintain safety zones.

R-TRA 7. Beyond the pre-planned safety zones, first responders should be aware of nearby natural and manmade areas conducive to temporary refuge areas, such as large parking lots, gravel areas, irrigated natural spaces (e.g., parks, cemeteries), roadways/intersections, and other open spaces.

14.5. Rescues

Overall

TF-R 1. Rapid fire progression, burnovers, and traffic restrictions significantly impacted rescue actions in Concow and Paradise, by both causing the need for rescues and preventing access to areas in need.

TF-R 2. Over 1000 civilians were involved in 198 identified EA/R events on November 8 and early November 9.

TF-R 3. 61 % of EA/R events are characterized by *Rescue* response actions (121/198).

TF-R 4. 90 % of civilians involved in *Entrapment* events were *Rescued* (659/733).

TF-R 5. Overall, at least 30 % (59/198) of all events involved a civilian with a pre-existing condition that may have caused difficulty in evacuating or prompted a request for assistance or rescue. Five of the 59 EA/R events with pre-existing conditions resulted in fatalities; however, five of the six EA/R events with a fatal outcome involved pre-existing conditions.

TF-R 6. Only 14 % of identified EA/R events involved civilians in vehicles (28/198); however, these events accounted for 40 % of the civilians involved, the same total number as those at a residence (~400/1007).

TF-R 7. The EA/R events involving civilians in their vehicles often resulted in the use of TRAs. This was the outcome 46% of the time (13/28), accounting for 69% of civilians in vehicles (280/406).

TF-R 8. First responders independently found or identified the need for evacuation assistance or rescue without information from 911 or dispatch 37 % of the time (73/198). Coincidentally, events were reported via 911 or dispatch with the same frequency (73/198).

TF-R 9. Only 34 % of *Entrapment* events were reported via 911 or dispatch. First responders encountered *Entrapment* events with the same frequency (34 %).

TF-R 10. 81 % of all EA/R events involved 1 or 2 people (161/198), totaling 21 % of the EA/R head count (210/1007).

Concow – 110 civilians in EA/R

TF-R 11. 92 % of civilians *Rescued* in Concow were rescued in a 90-minute period between 07:45 and 09:15 (88/96), mostly through formation of TRAs (84/88).

TF-R 12. 77 % of civilians in EA/R in Concow were *Rescued* through involvement in TRAs (85/110).

TF-R 13. 18 of 20 events in the selected Concow Rescue Area (CRA) were *Entrapment* events (107/110 civilians).

TF-R 14. Over 25 % of the estimated population of the CRA was *Rescued* (95/342).

Paradise – 881 civilians in EA/R

TF-R 15. 80 % of civilians *Rescued* in Paradise were in *Entrapment* events (560/703).

TF-R 16. 89 % of the people involved in *Entrapment* EA/R in Paradise were in events occurring between 08:00 and 12:00 (556/622).

TF-R 17. 40 % of civilians in EA/R in Paradise were *Rescued* through involvement in TRAs (353/881), including 18 % involved in the immediate formation of TRAs (162/881).

TF-R 18. There is a significant difference between the number of response actions (*Rescues* plus *Rescue Attempts*) to *Entrapments* versus *Assistance* requests. Responses were identified in 83 % of *Entrapments* compared to 44 % of *Assistance* requests. This highlights the effective decision-making by first responders in addressing risk to civilians, prioritizing high hazard situations for rescue by the limited number of available responders.

In planning for WUI fire evacuations, communities should consider:

R-R 1. First responders should plan for partial or complete loss of communications with dispatch.

R-R 2. Additional post-fire studies on these types of evacuation assistance/rescue events should be conducted to further assess *Notification*, *Rescue*, *Rescue Attempt*, and *Entrapment* frequency and outcomes in different WUI fire incidents.

15. NIST Camp Fire Case Study Reports

The set of reports on the NIST Camp Fire Case Study, including two follow-on reports and a web-based data visualization tool, are outlined below:

Camp Fire Report #1: Camp Fire Preliminary Reconnaissance [31]

NIST Camp Fire Report #1 focused on the initial reconnaissance deployment and field data collection and includes:

- NIST Disaster and Failure Studies Preliminary Reconnaissance Decision Criteria worksheet
- Preliminary Reconnaissance objectives
- Field deployment timeline
- Initial data collection summary
- Initial findings

Camp Fire Report #2: Preliminary Data Collected from the Camp Fire Reconnaissance [32]

NIST Camp Fire Report #2 focused on data collected from the Preliminary Reconnaissance and includes:

- NIST Damage Assessments of 132 damaged residential structures
- Photographs of structure damage
- Automatic vehicle location (AVL) data
- Radio transcripts
- Incident-related maps

Camp Fire Report #3: Fire Progression Timeline [23]

NIST Camp Fire Report #3 focused on the methodology and the fire progression details, and includes:

- Introduction to the Camp Fire and affected WUI communities
- Pre-fire hazard and preparation
- Data collection and analysis methodology details
- Fire progression details and timeline
- First responder comments
- Technical findings summary
- Recommendations

Camp Fire Report #4: Notification, Evacuation, Traffic and Temporary Refuge Areas *(this report)*

NIST Camp Fire Report #4, this report, focuses on notification, evacuation, and TRAs. Specifically, the report includes:

- Pre-fire evacuation and notification plan
- Notification timeline and relation to fire progression
- Evacuation and traffic timeline
- Summary of each TRA
- Relationship between TRAs and burnovers
- Summary of known rescues
- First responder comments
- Technical findings summary
- Recommendations

Camp Fire Report #5: Emergency Response and Defensive Actions

NIST Camp Fire Report #5 will focus on Fire and Law Enforcement response and infrastructure response, including water systems. The report will include:

- An overview of Fire and LE resources on the scene
- Infrastructure response
- Defensive actions: ground operations
- Defensive actions: aerial operations
- Defended structures
- Exposures to NIST-documented damaged structures
- First responder comments
- Technical findings summary
- Recommendations

Camp Fire Case Study Data Visualization Tool

A web-based tool will be provided that will enable users to navigate the Camp Fire in both space and time. All the data presented in NIST Camp Fire Reports #3, #4 and #5 will be included in the tool.

References

[1] National Fire Protection Association (2019) *Largest fire losses in the United States*. (Updated September 2019). Available at https://www.nfpa.org/News-and-Research/Data-research-and-tools/US-Fire-Problem/Large-loss-fires-in-the-United-States/Largest-fire-losses-in-the-United-States.

[2] CAL FIRE (2022) *Top 20 Most Destructive California Wildfires*. (Updated October 24, 2022). Available at https://www.fire.ca.gov/our-impact/statistics.

[3] Martinuzzi S.*, et al.* (2015) The 2010 wildland-urban interface of the conterminous United States. *NRS-RMAP-8*. (U.S. Department of Agriculture, Forest Service, Newtown Square, PA). https://doi.org/10.2737/NRS-RMAP-8

[4] CAL FIRE (2019) *Top 20 Most Destructive California Wildfires*. (Updated August 8, 2019). Available at https://web.archive.org/web/20190821170646/fire.ca.gov/media/5511/top20_destruction.pdf.

[5] Maranghides A., Mell W. (2009) A Case Study of a Community Affected by the Witch and Guejito Fires. *NIST Technical Note 1635*. (National Institute of Standards and Technology, Gaithersburg, MD). https://doi.org/10.6028/NIST.TN.1635

[6] Maranghides A., McNamara D., Mell W., Trook J., Toman B. (2013) A Case Study of a Community Affected by the Witch and Guejito Fires Report: #2 – Evaluating the Effects of Hazard Mitigation Actions on Structure Ignitions. *NIST Technical Note 1796*. (National Institute of Standards and Technology, Gaithersburg, MD). https://doi.org/10.6028/NIST.TN.1796

[7] Maranghides A., Mell W., Ridenour K., McNamara D. (2011) Initial Reconnaissance of the 2011 Wildland-Urban Interface Fires in Amarillo, Texas. *NIST Technical Note 1708*. (National Institute of Standards and Technology, Gaithersburg, MD). https://doi.org/10.6028/NIST.TN.1708

[8] Maranghides A., McNamara D. (2016) 2011 Wildland Urban Interface Amarillo Fires Report #2 – Assessment of Fire Behavior and WUI Measurement Science. *NIST Technical Note 1909*. (National Institute of Standards and Technology, Gaithersburg, MD). https://doi.org/10.6028/NIST.TN.1909

[9] Maranghides A., McNamara D., Vihnanek R., Restaino J., Leland C. (2015) A Case Study of a Community Affected by the Waldo Fire – Event Timeline and Defensive Actions. *NIST Technical Note 1910*. (National Institute of Standards and Technology, Gaithersburg, MD). https://doi.org/10.6028/NIST.TN.1910

[10] Maranghides A.*, et al.* (2021) Structure Separation Experiments Phase 1 Preliminary Test Plan. *NIST Technical Note 2161*. (National Institute of Standards and Technology, Gaithersburg, MD). https://doi.org/10.6028/NIST.TN.2161

[11] Maranghides A., *et al.* (2022) NIST Outdoor Structure Separation Experiments (NOSSE): Preliminary Test Plan. *NIST Technical Note 2199*. (National Institute of Standards and Technology, Gaithersburg, MD). https://doi.org/10.6028/NIST.TN.2199

[12] Maranghides A., *et al.* (2022) Structure Separation Experiments: Shed Burns without Wind. *NIST Technical Note 2235*. (National Institute of Standards and Technology, Gaithersburg, MD). https://doi.org/10.6028/NIST.TN.2235

[13] Butler K., *et al.* (2022) Wind-driven Fire Spread to a Structure from Fences and Mulch. *NIST Technical Note 2228*. (National Institute of Standards and Technology, Gaithersburg, MD). https://doi.org/10.6028/NIST.TN.2228

[14] Maranghides A., *et al.* (2022) WUI Structure/Parcel/Community Fire Hazard Mitigation Methodology. *NIST Technical Note 2205*. (National Institute of Standards and Technology, Gaithersburg, MD). https://doi.org/10.6028/NIST.TN.2205

[15] National Institute of Standards and Technology (2023) *Fire Dynamics Simulator (FDS) and Smokeview (SMV)*. Available at https://pages.nist.gov/fds-smv/.

[16] Walpole E.H., Kuligowski E.D., Cain L., Fitzpatrick A., Salley C. (2020) Evacuation Decision-Making in the 2016 Chimney Tops 2 Fire: Results of a Household Survey. *NIST Technical Note 2103*. (National Institute of Standards and Technology, Gaithersburg, MD). https://doi.org/10.6028/NIST.TN.2103

[17] Kuligowski E.D., Wakeman K. (2017) Outdoor Siren Systems: A review of technology, usage, and public response during emergencies. *NIST Technical Note 1950*. (National Institute of Standards and Technology, Gaithersburg, MD). https://doi.org/10.6028/NIST.TN.1950

[18] Kuligowski E.D., Doermann J. (2018) A Review of Public Response to Short Message Alerts under Imminent Threat. *NIST Technical Note 1982*. (National Institute of Standards and Technology, Gaithersburg, MD). https://doi.org/10.6028/NIST.TN.1982

[19] Ronchi E., *et al.* (2017) e-Sanctuary: Open Multi-Physics Framework for Modelling Wildfire Urban Evacuation. *FPRF-2017-22*. (Fire Protection Research Foundation, Quincy, MA). Available at https://www.nfpa.org//-/media/Files/News-and-Research/Fire-statistics-and-reports/WUI/RFWUIEvacuationModelingFramework.pdf.

[20] Ronchi E., *et al.* (2020) WUI-NITY: a platform for the simulation of wildland-urban interface fire evacuation. *FPRF-2020-11*. (Fire Protection Research Foundation, Quincy, MA). Available at https://www.nfpa.org//-/media/Files/News-and-Research/Fire-statistics-and-reports/WUI/RFWUINITY.pdf.

[21] Ronchi E., *et al.* (2021) WUI-NITY2: the integration, verification, and validation of the wildfire evacuation platform WUI-NITY. *FPRF-2021-13*. (Fire Protection Research Foundation, Quincy, MA). Available at https://www.nfpa.org//-/media/Files/News-and-Research/Fire-statistics-and-reports/WUI/RFWUI-NITY2.pdf.

[22] Lovreglio R., Kuligowski E., Walpole E., Link E., Gwynne S. (2020) Calibrating the Wildfire Decision Model using hybrid choice modelling. *International Journal of Disaster Risk Reduction* 50:101770. https://doi.org/10.1016/j.ijdrr.2020.101770

[23] Maranghides A., *et al.* (2021) A Case Study of the Camp Fire — Fire Progression Timeline. *NIST Technical Note 2135*. (National Institute of Standards and Technology, Gaithersburg, MD). https://doi.org/10.6028/NIST.TN.2135

[24] Wallingford N. (2018) Camp Incident Damage Inspection Report. (CAL FIRE, Sacramento, CA).

[25] Butte County Sheriff (2019) *Camp Fire Update* [Press release, September 25, 2019]. Available at http://web.archive.org/web/20191119141523/https://www.buttecounty.net/sheriffcoroner/News-Center/ArtMID/4964/ArticleID/1370/Camp-Fire-Update.

[26] CAL FIRE (2019) *Top 20 Deadliest California Wildfires*. (Updated August 8, 2019). Available at http://web.archive.org/web/20190831091100/https://www.fire.ca.gov/media/5512/top20_deadliest.pdf.

[27] Butte County Grand Jury (2019) 2018–2019 Butte County Grand Jury Report. (Oroville, CA). Available at https://www.butte.courts.ca.gov/system/files?file=2018-2019_grand_jury_report.pdf.

[28] Butte County District Attorney (2020) The Camp Fire Public Report: A Summary of the Camp Fire Investigation. (Butte County District Attorney, Oroville, CA). Available at https://www.buttecounty.net/DocumentCenter/View/1881/Camp-Fire-Public-Report---Summary-of-the-Camp-Fire-Investigation-PDF?bidId=.

[29] CAL FIRE (2018) Informational Summary Report of Serious or Near Serious CAL FIRE Injuries, Illnesses and Accidents (Green Sheet). Available at https://www.firefighterclosecalls.com/wp-content/uploads/2018/12/18-CA-BTU-016737-Camp-Green-Sheet.pdf.

[30] Butte County Sheriff (2018) *Camp Fire Update* [Press release, December 19, 2018]. Available at http://web.archive.org/web/20190828160909/http://www.buttecounty.net/Portals/24/pdf/Press%20Releases%20sent%20during%20the%20Camp%20Fire%202.pdf?ver=2019-01-03-073238-227.

[31] Maranghides A., *et al.* (2020) Camp Fire Preliminary Reconnaissance. *NIST Technical Note 2105*. (National Institute of Standards and Technology, Gaithersburg, MD). https://doi.org/10.6028/NIST.TN.2105

[32] Maranghides A., *et al.* (2020) Preliminary Data Collected from the Camp Fire Reconnaissance. *NIST Technical Note 2128*. (National Institute of Standards and Technology, Gaithersburg, MD). https://doi.org/10.6028/NIST.TN.2128

[33] Taylor B.N., Kuyatt C.E. (1994) Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results. *NIST Technical Note 1297*. (National Institute of Standards and Technology, Gaithersburg, MD). https://doi.org/10.6028/NIST.TN.1297

[34] U.S. Census Bureau (2019) *2014–2018 ACS 5-Year Data Profile (place search: Paradise town, Magalia CDP, Concow CDP, California)*. Available at https://www.census.gov/acs/www/data/data-tables-and-tools/data-profiles/2018/.

[35] CAL FIRE (2018) *Camp Fire Structure Status*. (Updated January 12, 2019). Available at https://calfire-forestry.maps.arcgis.com/apps/webappviewer/index.html?id=5306cc8cf38c4252830a38d467d33728.

[36] Butte County (2018) Butte County Public Safety Agency Evacuation Plan. (CAL FIRE Butte Unit, Butte County, CA).

[37] CAL FIRE (n.d.) *Prepare for Wildfire – Ready, Set, Go!* Available at https://www.readyforwildfire.org/prepare-for-wildfire/ready-set-go/.

[38] Silva R. (2022) "Know your zone: Sheriff unveils countywide evacuation system." *Chico Enterprise-Record*, March 15, 2022. Available at https://www.chicoer.com/2022/03/15/know-your-zone-butte-county-sheriff-unveils-countywide-evacuation-system. Accessed:

[39] Town of Paradise (2011) Town of Paradise Emergency Operations Plan. (Paradise, CA). Available at https://www.townofparadise.com/sites/default/files/fileattachments/community/page/22311/2011_town_of_paradise_eop_w_supporting_docs-final_1-12.pdf.

[40] Ghilarducci M.S. (2020) Standard Statewide Evacuation Terminology. (California Governor's Office of Emergency Services [CalOES]). Available at https://calalerts.org/evacuations.html. Accessed: March 2023.

[41] McCaffrey S., Wilson R., Konar A. (2018) Should I Stay or Should I Go Now? Or Should I Wait and See? Influences on Wildfire Evacuation Decisions. *Risk Analysis* 38(7):1390–1404. https://doi.org/10.1111/risa.12944

[42] Folk L.H., Kuligowski E.D., Gwynne S.M.V., Gales J.A. (2019) A Provisional Conceptual Model of Human Behavior in Response to Wildland-Urban Interface Fires. *Fire Technology* 55:1619–1647. https://doi.org/10.1007/s10694-019-00821-z

[43] McLennan J., Ryan B., Bearman C., Toh K. (2019) Should We Leave Now? Behavioral Factors in Evacuation Under Wildfire Threat. *Fire Technology* 55:487–516. https://doi.org/10.1007/s10694-018-0753-8

[44] Kuligowski E. (2021) Evacuation decision-making and behavior in wildfires: Past research, current challenges and a future research agenda. *Fire Safety Journal* 120:103129. https://doi.org/10.1016/j.firesaf.2020.103129

[45] Grajdura S., Qian X., Niemeier D. (2021) Awareness, departure, and preparation time in no-notice wildfire evacuations. *Safety Science* 139. https://doi.org/10.1016/j.ssci.2021.105258

[46] Sutton J., Kuligowski E.D. (2019) Alerts and Warnings on Short Messaging Channels: Guidance from and Expert Panel Process. *Natural Hazards Review* 20(2):04019002. https://doi.org/10.1061/(ASCE)NH.1527-6996.0000324

[47] Young C.E., Kuligowski E.D., Pradhan A. (2020) A Review of Social Media Use During Disaster Response and Recovery Phases. *NIST Technical Note 2086*. (National Institute of Standards and Technology, Gaithersburg, MD). https://doi.org/10.6028/NIST.TN.2086

[48] Su Y.S., Wardell C., III, Thorkildsen Z. (2013) Social Media in the Emergency Management Field: 2012 Survey Results. *IPP-2013-U-004984/Final*. (CNA, Arlington, VA).

[49] Butte County (2022) *Butte County Evacuation Zones*. Available at https://buttecountygis.maps.arcgis.com/apps/webappviewer/index.html?id=9c92e0a2d2e0415fa5248d70cd644a82.

[50] Mackey M. (2019) "New analytics show Camp Fire CodeRED alerts failed to reach more than half the residents." *KRCR-TV News*, May 6, 2019. Available at https://krcrtv.com/news/deprecated-camp-fire/new-analytics-show-camp-fire-code-red-alerts-failed-to-reach-more-than-half-the-residents. Accessed: March 2023.

[51] Genasys Inc. (2020) *Town of Paradise Advanced Planning for Early Warning Final Report*. Available at https://makeitparadise.org/wp-content/uploads/2022/04/Final-Advanced-Planning-for-Early-Warning-Plan-1.pdf.

[52] Wu A.*, et al.* (2022) Wildfire evacuation decision modeling using GPS data. *International Journal of Disaster Risk Reduction* 83:103373. https://doi.org/10.1016/j.ijdrr.2022.103373

[53] Zhao X.*, et al.* (2022) Estimating wildfire evacuation decision and departure timing using large-scale GPS data. *Transportation Research Part D: Transport and Environment* 107:103277. https://doi.org/10.1016/j.trd.2022.103277

[54] Ganga M.L.L. (2018) "California fire: If you stay, you're dead. How a Paradise nursing home evacuated." *Los Angeles Times*, November 17, 2018. Available at https://www.latimes.com/local/california/la-me-ln-nursing-home-fire-evac-20181117-story.html. Accessed: March 2023.

[55] National Wildfire Coordinating Group (2012) NWCG Glossary of Wildland Fire. *PMS 205*. Available at https://www.nwcg.gov/sites/default/files/data-standards/glossary/pms205.pdf.

[56] Page W.G., Freeborn P.H. (2019) Entrapment. In *Encyclopedia of Wildfires and Wildland-Urban Interface (WUI) Fires*, ed Manzello S (Springer, Cham). https://doi.org/10.1007/978-3-319-51727-8_183-1

[57] Butler B.W. (2020) Safety Zone. In *Encyclopedia of Wildfires and Wildland-Urban Interface (WUI) Fires*, ed Manzello SL (Springer, Cham). https://doi.org/10.1007/978-3-319-51727-8_25-1

[58] Gouette K.*, et al.* (2014) *Wildland Urban Interface Operating Principles* (California Department of Forestry and Fire Protection, Sacramento, CA), First Ed. Available at https://www.iaff.org/wp-content/uploads/2019/05/CAL-FIRE-Wildland-Urban-Interface-Book.pdf. Accessed: March 2023.

[59] FIRESCOPE California (2013) Wildland Urban Interface (WUI) Structure Defense. Available at https://firescope.caloes.ca.gov/ICS%20Documents/WUI-SD.pdf.

[60] California Air Resources Board (2021) Camp Fire Air Quality Data Analysis. (California Air Resources Board, Sacramento, CA). Available at https://ww2.arb.ca.gov/sites/default/files/2021-07/Camp_Fire_report_July2021.pdf.

[61] Reid C.E.*, et al.* (2016) Critical review of health impacts of wildfire smoke exposure. *Environmental Health Perspectives* 124(9):1334–1343. https://doi.org/10.1289/ehp.1409277

[62] Kochi I., Champ P.A., Loomis J.B., Donovan G.H. (2012) Valuing mortality impacts of smoke exposure from major southern California wildfires. *Journal of Forest Economics* 18:61–75. https://doi.org/10.1016/j.jfe.2011.10.002

[63] Chico Enterprise-Record (2019) *Camp Fire Remembrances: 85 lives, 85 stories*. (Updated November 7, 2019). Available at https://extras.chicoer.com/campfireremembrances/.