# A Case Study of the Camp Fire –

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

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U.S. DEPARTMENT OF COMMERCE

Photo courtesy of Paradise Police Department

***Module 2: Notification Timeline, Evacuations, Traffic Flow and Road Closures***

NIST WUI DAYS 2023 – Session 1.7

November 1, 2023


Photo courtesy of CAL FIRE

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https://www.nist.gov/el/fire-research-division-73300/wildland-urban-interface-fire-73305/nist-investigation-california

# WUI Fire Days: Camp Fire NETTRA

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

- Module 1: Notification and Evacuation Pre-Fire Conditions and Planning
- *Module 2: Notification Timeline, Evacuations, Traffic Flow and Road Closures*
- Module 3: Burnovers and TRAs
- Module 4: Rescues
- Module 5: NETTRA Summary

next week, Nov 8

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# Module 2a

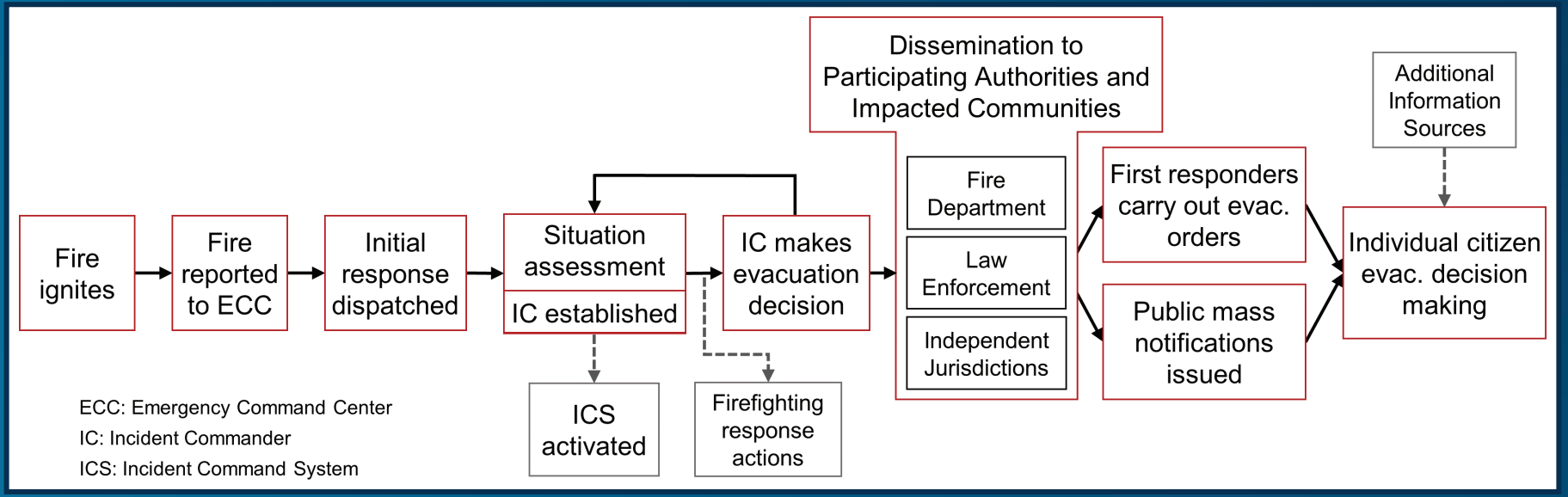
## *Notification*

# Module 2a Themes



- Notification Plan
  - Multiple platforms/methods used
- Evacuation Plan
- Relationship of Fire Progression to Notifications
- Impact of Fire on Evacuation/Traffic
  - fire significantly impacted egress arteries
  - active/extensive traffic management

# Notification Workflow and Complications




- Multiple emergency communication hubs
- Two interconnected reverse-911 (CodeRED) systems
- Three different 911 systems (Butte County, Paradise, and Chico)
- Shutdown of the Town of Paradise 911 system and PPD dispatch to evacuate
- Door-to-door notification prevalent

There is a non-zero *minimum* time from detection to *the start* of public notification

NIST TN 2252, Figure 12.

# Notification Methods Used

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## Notification Methods Used by First Responders:

- Door-to-door notification*
- Announcements via vehicle-mounted speakers*
- CodeRED reverse-911 call system(s)
- Social Media

## Other Methods:

- Neighbor-to-neighbor communication*
- Direct contact through 911 calls
- TV and radio news stations, and
- General internet use

* Methods that do not require operating (community-wide) internet, power or telephone systems

No sirens were in place at the time of the Camp Fire

# CodeRED from 07:57 to 09:30

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**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

- Combined BCSO and ToP CodeRED notifications *directly* delivered: 6573
- 31 % of attempted phone numbers

Only 17 % of the combined population of Paradise and Magalia were reached via CodeRED from 07:57 to 09:30

NIST TN 2252, Table 8.

# CodeRED Usage Considerations



- Phone mail, text, and email access require functioning (and powered) networks
- Landline answering machine messages may have been even more difficult to access
- *Opt-out* systems may reach more residents

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.

# Communication Challenges



- **Public notifications complications in Paradise** - both the ToP EOC and PPD had to be evacuated due to fire.
- **PPD: Communication was complicated, by the moving of the** PPD operations and dispatch to Chico
- **Cell phone coverage was reported to be "patchy"** near FRH and the Pearson Road/Pentz Road intersection on a normal basis before the fire.
- 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.

# Notification Timeline

***summary and analysis with respect to fire progression***

# Notification Timeline Data

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Data presented in four different ways:

1. Tabular form with details on events and data sources
2. Temporal Analysis – summary table
3. Spatial Analysis – summary figures
4. Graphical Analysis

# Notification Timeline



| Time of Day | Evacuation Sequence | Time from Ignition* (min) | Time from First Engine on Scene (min) |
|---|---|---|---|
| **06:25 to 07:31** | Evacuation orders and warnings requested for Pulga and Concow | 0 to +66 | -20 to +46 |
| **07:32 to 07:54** | Evacuation orders expanded to Concow, and warnings expanded to Pentz Road in Paradise | +67 to +84 | +47 to +64 |
| **07:55 to 08:03** | Evacuation orders expanded to Pentz Road in Paradise | +85 to +93 | +65 to +73 |
| **08:04 to 09:03** | Evacuation orders expanded to the entire town of Paradise and into Magalia and Butte Creek Canyon | +94 to +153 | +74 to +133 |

* time of first 911 call

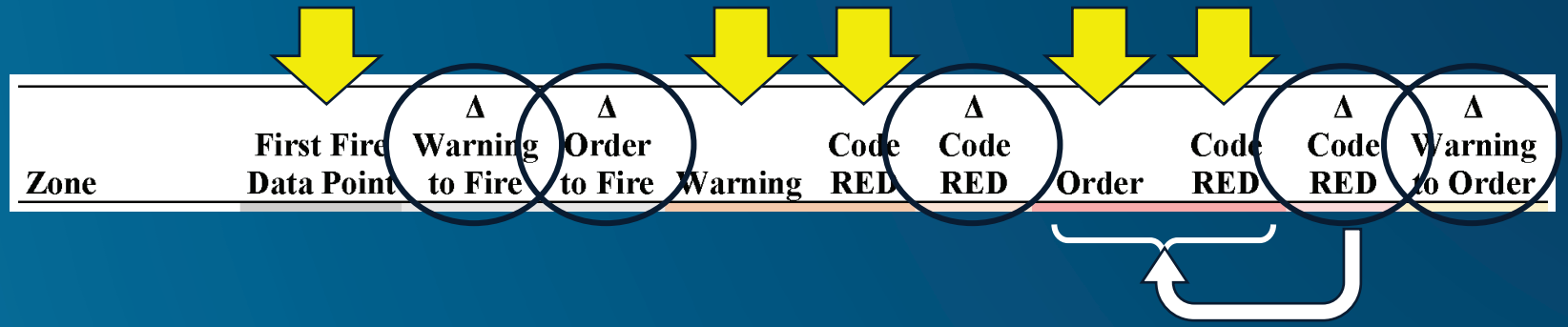
# Notification Summary Table 6:25 to 9:03



| 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 |
| 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 |

NIST TN 2252, Table 10.

# Notification Analysis
## Summary Table



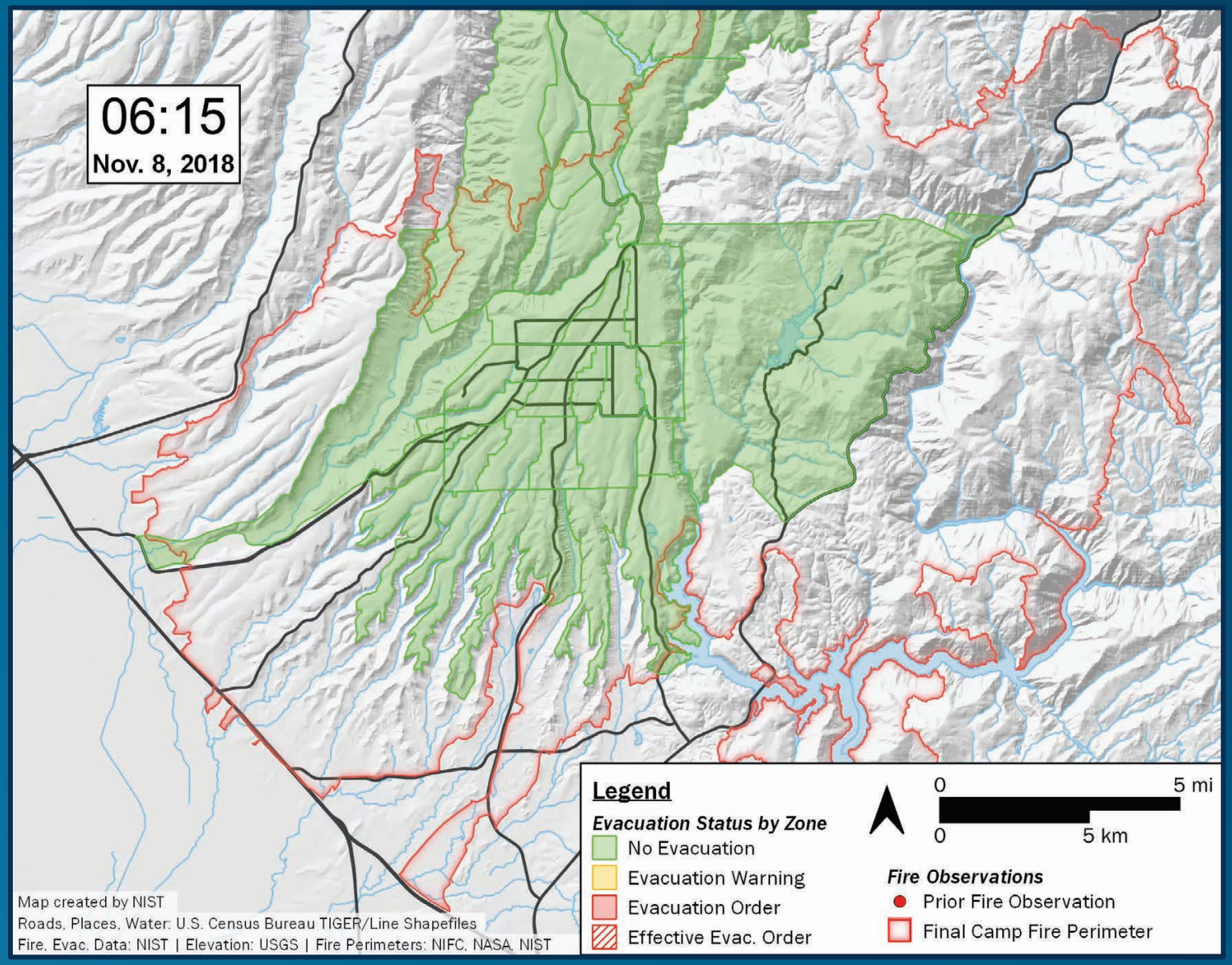

| Zone | First Fire Data Point | Δ Warning to Fire | Δ Order to Fire | Warning | Code RED | Δ Code RED | Order | Code RED | Δ Code RED | Δ Warning to Order |
|---|---|---|---|---|---|---|---|---|---|---|
| Pulga | 06:58 | | *00:03* | | | | 06:55 | 07:13 | *00:18* | |
| Concow | 06:45 | *-00:37* | *-00:52* | 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* |

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|
| 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 | | |

NIST TN 2252, Table 11.

# Notification Timeline



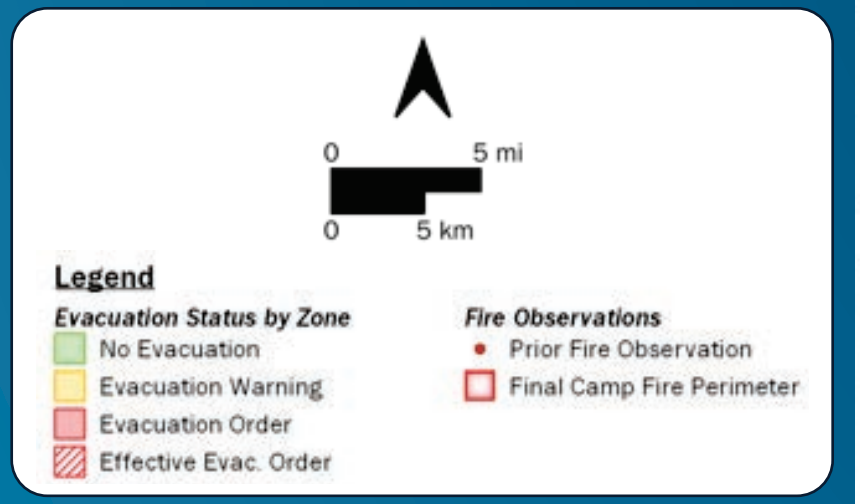


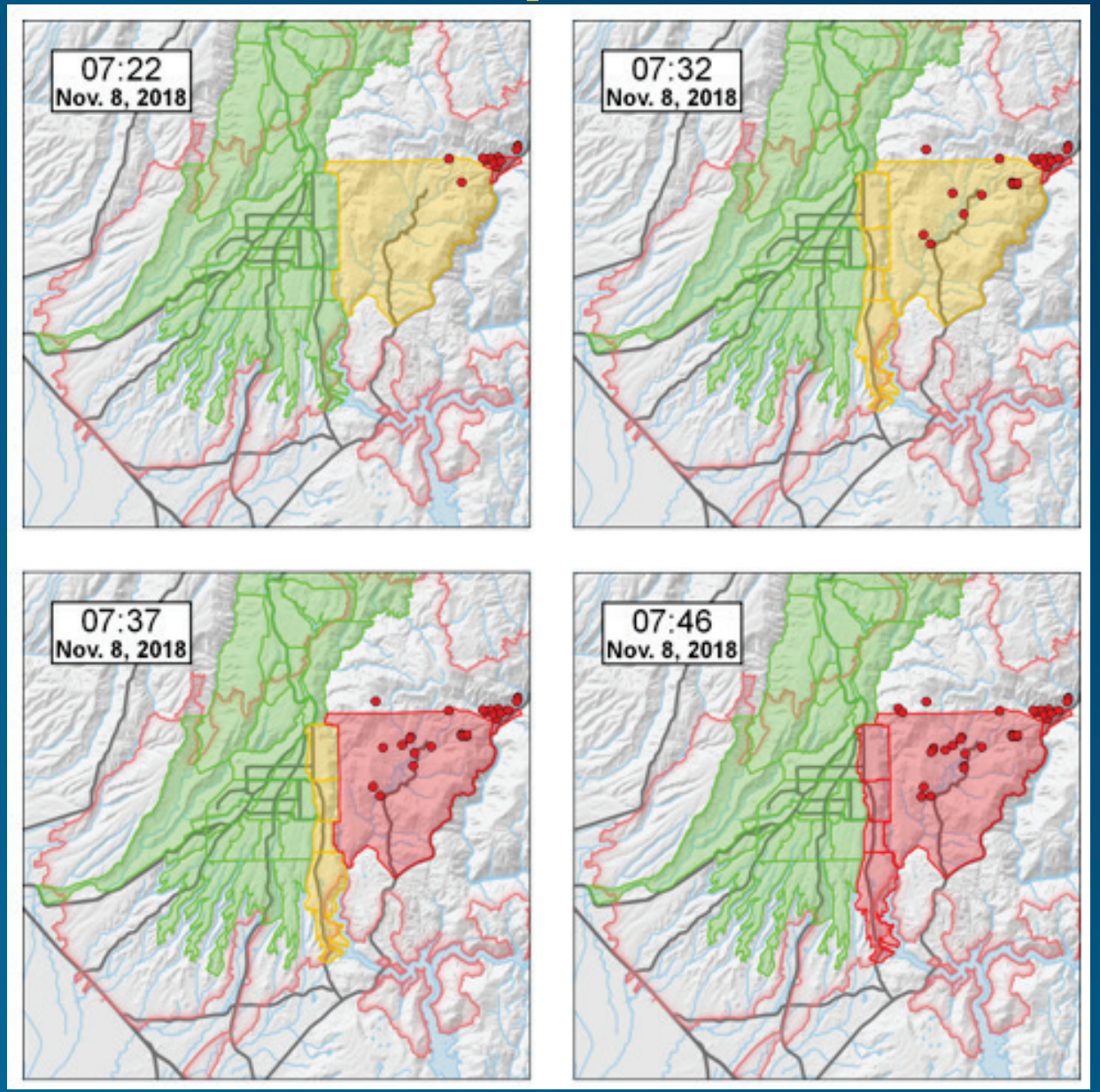

NIST TN 2252, Figure 13.

# Notification and Fire Relationships

## 7:22 to 7:46





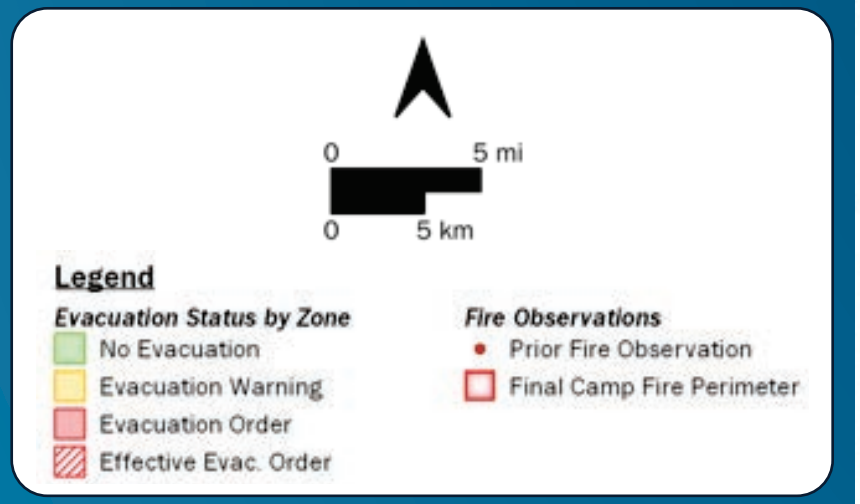



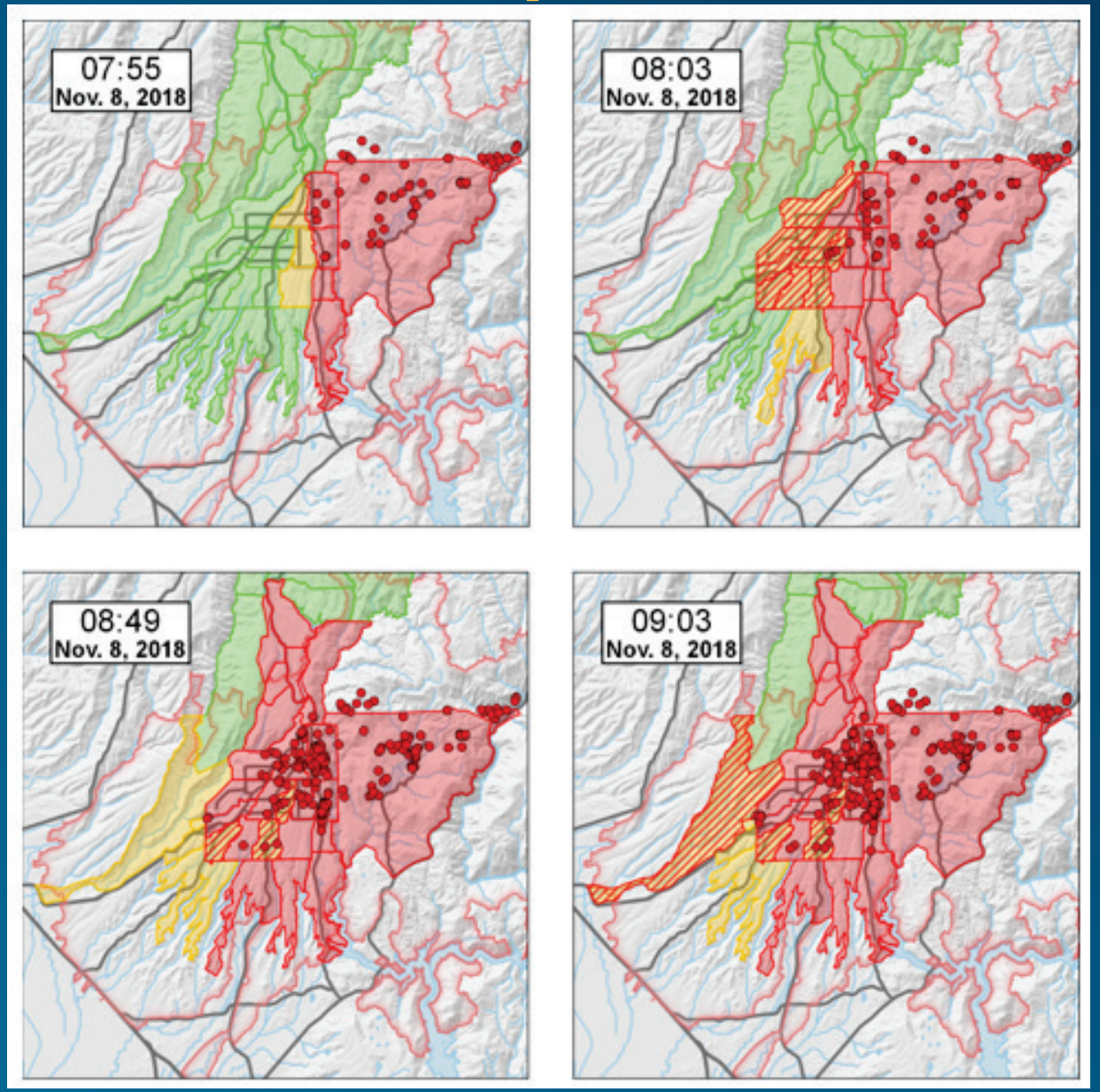

NIST TN 2252, Figure 13.

# Notification and Fire Relationships

## 7:55 to 9:03





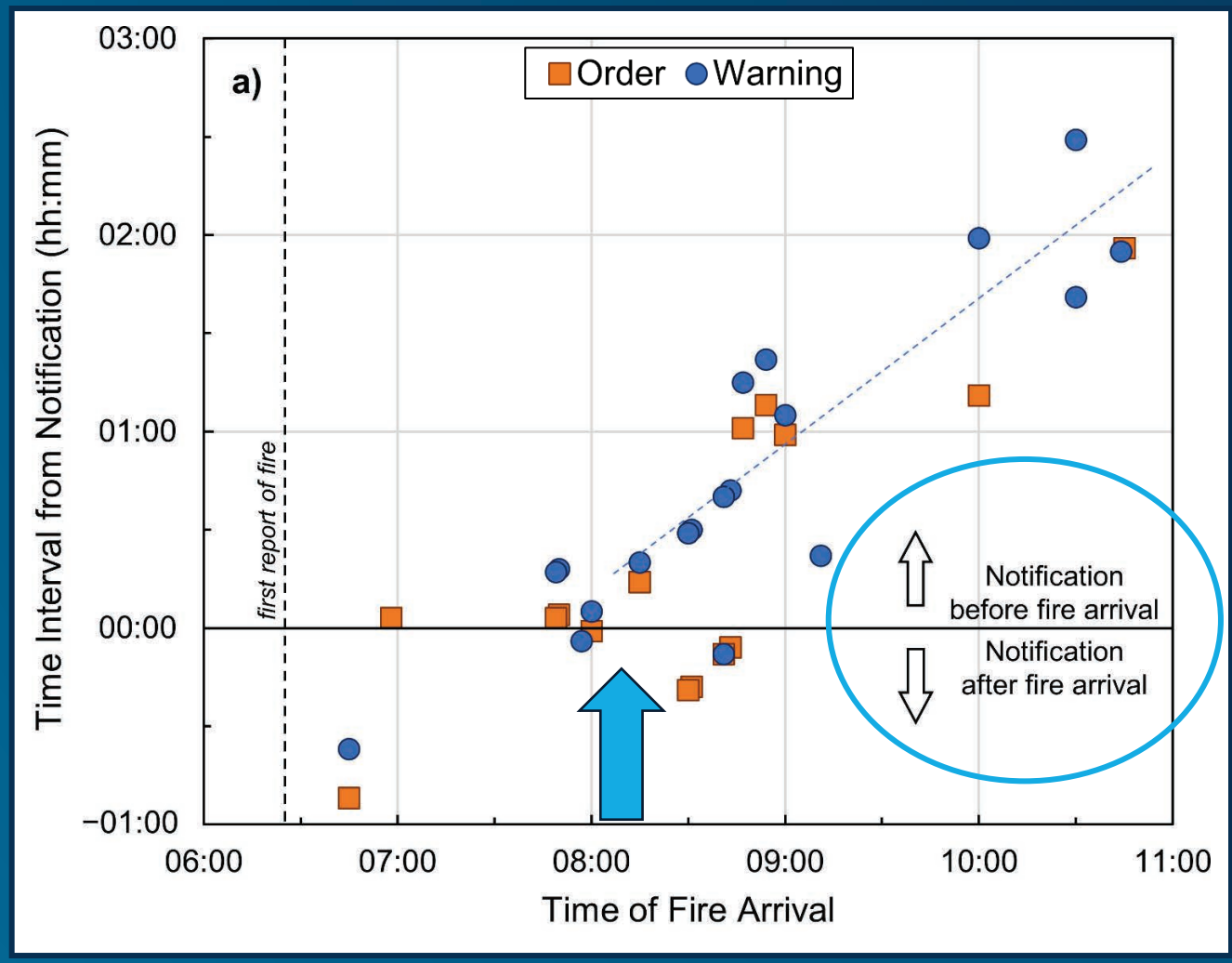




NIST TN 2252, Figure 13.

# Notification Analysis



Time between fire arrival and request for evacuation notification




Time lag between notification and fire becomes positive ~ 90 minutes after ignition

NIST TN 2252, Figure 15.

# Relationship to Burnovers

***timing & impact on evacuation***

# Temporal Relationship between Zone Notification and Burnovers



**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.

NIST TN 2252, Table 12.

# Concow Burnovers



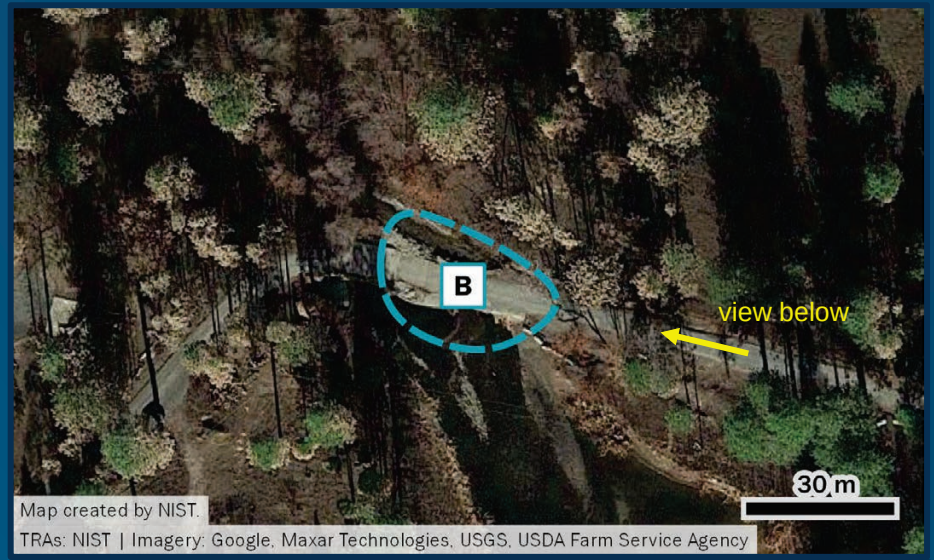
*Negative Attributes:*

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

*Fire Related*

*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 Wildfire Safety Zone




# Upper Skyway Burnovers



*Negative Attributes:*

1. Spot fire ignition next to egress artery with high fuel load (no fire history)
2. **Limited time to evacuate before burnover**
3. **Closure of major egress artery** impacted flow out of many zones to the north
4. CodeRED notifications were not started until 16:17
5. No siren notification system
6. CodeRED was an opt-in system

*Fire Related*

*Positive Attributes:*

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

Photo courtesy of TD-041, 10:49 (Nov 9). Used with permission.

# Pentz Road Burnovers



*Negative Attributes:*

1. **High civilian density areas** (e.g., school and hospital)
2. Multiple spot ignitions (fuel receptivity and fuel presence)
3. Limited situational awareness because of extent of fire front and burnovers to the north (Bille Rd) and south (Pearson Rd)
4. **Closure of major egress artery** impacted flow out of many zones to the north
5. No siren notification system
6. CodeRED was an opt-in system

*Fire Related*

*Positive Attributes:*

1. Available mass notification **(CodeRED) implemented quickly**
2. **Presence and large capacity of FRH parking lot**
3. **Availability of other parking lots** on Pentz Road

Photo courtesy of TD-209, 09:03. Used with permission.

Photo courtesy of TD-209, 09:07. Used with permission.

NIST TN 2252, Section 6.3.3.3.

# Pearson Road Burnover



*Negative Attributes:*

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

*Positive Attributes:*

1. Available mass notification **(CodeRED) implemented quickly**
2. **Presence of first responders** to create Pearson TRA and lead convoy to 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 Rd and reduce exposures

Photo courtesy of TD-122, 09:40. Used with permission.

# Bille Road Burnover



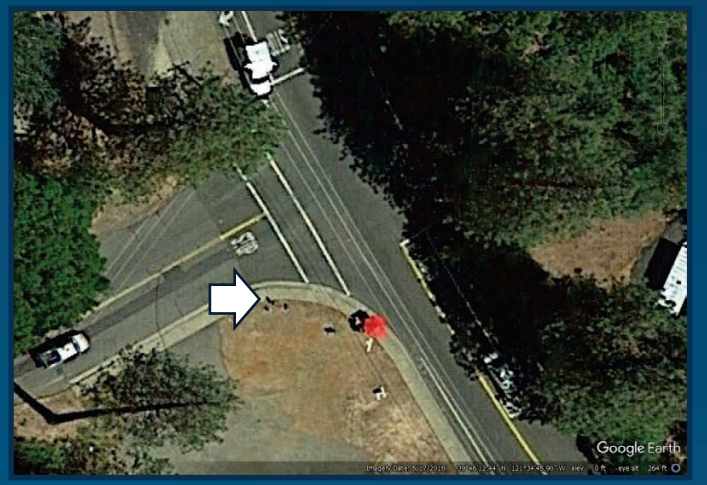
*Negative Attributes:*

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

*Fire Related*

*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




Hydrant at Bille Road and Pentz Road

# Notification

***technical findings & recommendations***

# Technical Findings
## Notifications

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Pre-Fire

TF-N1. The Town of Paradise had an established Emergency Operations Plan (EOP).

TF-N2. The Town of Paradise EOC staffing included town employees and volunteers trained to facilitate notification and evacuation efforts.

TF-N3. There were no sirens in place for emergency notification in Concow, Paradise or Magalia.

TF-N4. In preparation for a real wildfire/WUI fire, CAL FIRE and ToP worked with multiple local and state jurisdictions to conduct an extensive and detailed evacuation and WUI fire exercise.

TF-N5. 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.

# Technical Findings
## Notifications

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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 ECC to PPD impacted accuracy of information.

TF-N 9. Both 911 call centers (PPD and ECC) provided consistent information to callers.

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 mandatory 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 IC to first responders to the public.

# Technical Findings

## Notifications

TF-N12. It took approximately 10 minutes from IC request of evacuation warning for Pentz Road to when LE began notifications. The information went from IC to LE dispatch to LE officers on location.

TF-N13. PPD 911 began informing residents to evacuate as early as 07:49, right as the first spot fires ignited in Paradise (before evacuation orders were issued for those locations).

TF-N14. Butte County ECC and Paradise Police Department accelerated the evacuation of Paradise, communicating complete evacuation at 08:03, ahead of the multi-zone request from the IC at 08:49.

TF-N15. There was a communication gap between “all of Paradise” vs IC-selected zones. The communication gap lasted at least 46 minutes. BCSO and ToP opted to evacuate more zones than the ones requested by the IC.

TF-N16. 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-N17. 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. Wireless Emergency Alerts (WEA) and Integrated Public Alert and Warning System (IPAWS) were not used.

# Recommendations
## Notifications

In planning for WUI fire evacuations, communities should consider:

R-N1. Developing a notification plan and maintaining a resilient notification system.

R-N2. 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.

R-N3. Accounting for the cumulative minimum time necessary for situational assessment, information transfer between the IC and LE, and communication to the public in the design of a community notification and evacuation plan.

R-N4. Including early evacuation programs like “Ready, Set, Go!”

# Recommendations
## Notifications

In planning for WUI fire evacuations, communities should consider (continued):

R-N5. Developing a distributed Wildfire Safety Zone System for sheltering within the community may provide the safest approach for civilians that may not have sufficient time to safely evacuate. Rapid fire progression and the proximity of a fire's origin to a community may reduce the time available for notification and evacuation.

R-N6. The use of social media 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-N7. That advertised use of social media channels for updates during emergency incidents that does not provide updated information can provide misleading information to the public.

R-N8. That 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 disinformation and negatively impact decisions and responses of civilians.

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# Module 2b

## *Evacuations, Traffic Flow, and Road Closures*

# Module 2b Themes



- Rapid accumulation of evacuation traffic
- Fire significantly impacted egress arteries
- Active/extensive traffic management
- Impact of bottlenecks inside and outside the evacuating community

# Evacuation Overview

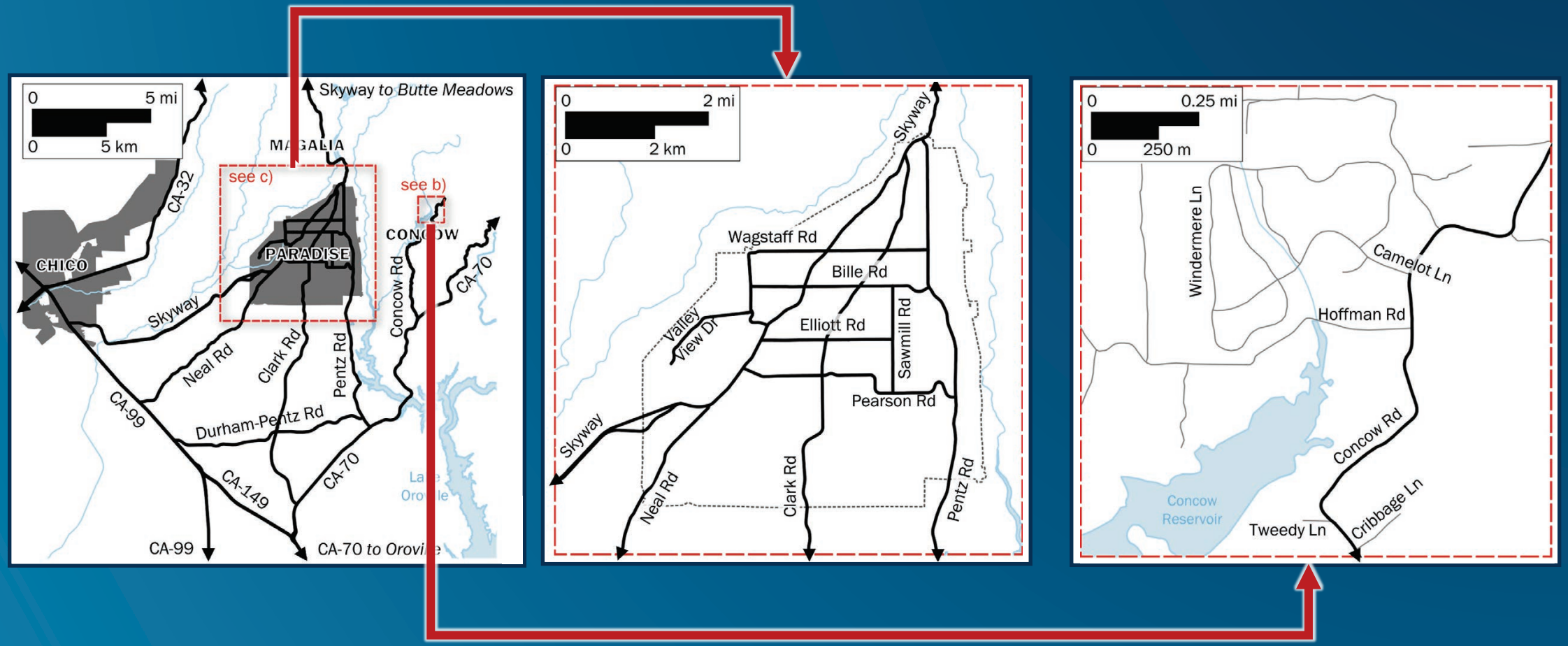


- Much of the evacuation was achieved through individual or small group travel (e.g., families, neighbors) using personal civilian vehicles.
- The quick onset of the evacuation for the entire town led to widespread gridlock.
- TRAs (module 3)
- Rescues (module 4)

Traffic management rapidly became essential for life safety

# Road System in and Around Paradise

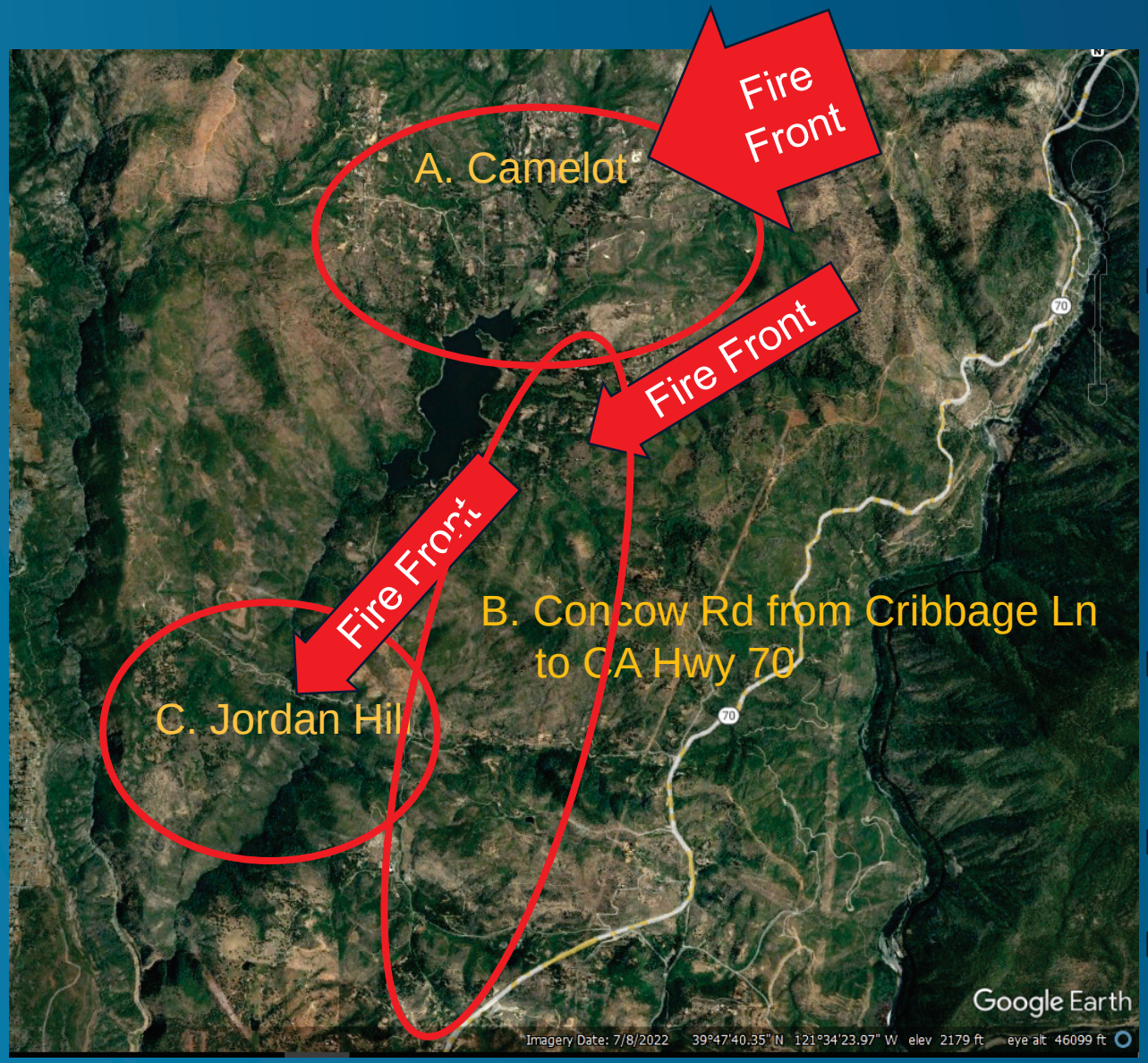





NIST TN 2252, Figure 7.

# Traffic Overview - Concow






## A. Camelot

- Single way out
- Traffic not an issue
- Fire reached area shortly after fire ignition
- Fire impacted evacuations – multiple burnovers and entrapments

## B. Concow Rd (Cribbage Ln to Hwy 70)

- Single way out
- Open for ingress of first responders until 10:00 am
- No entrapments

## C. Jordan Hill

- Single way out
- Notifications between 7:00 and 8:00 am with some civilian evacuating
- Rescues turn to Burnover at 11:00 am

# Traffic Overview – Paradise (1 of 2)

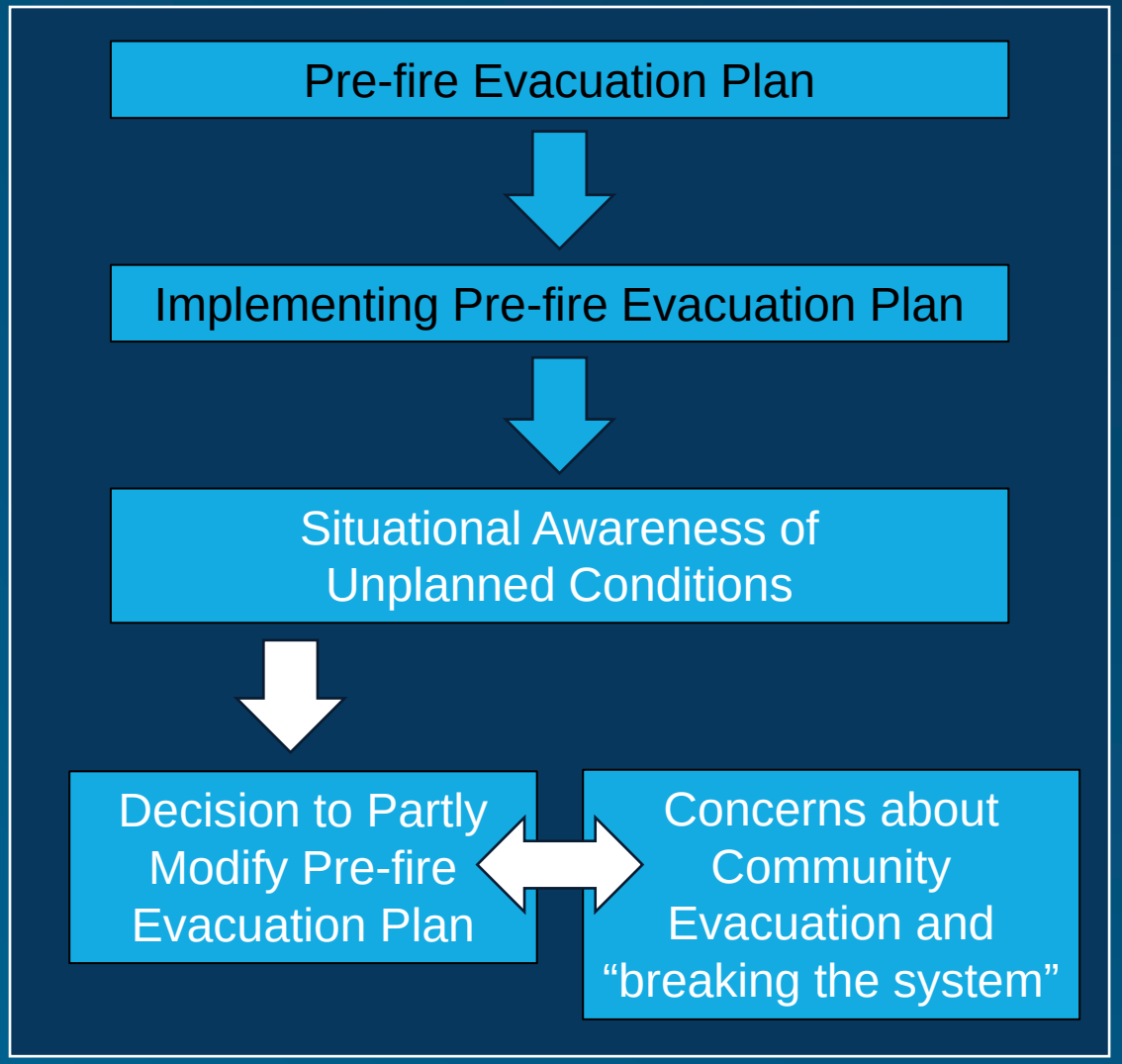


The Paradise evacuation plan was ***designed*** to be implemented ***for a few zones*** of Paradise at a time rather than the entire town all at once.

The IC initiated evacuation orders for the eastern zones first.

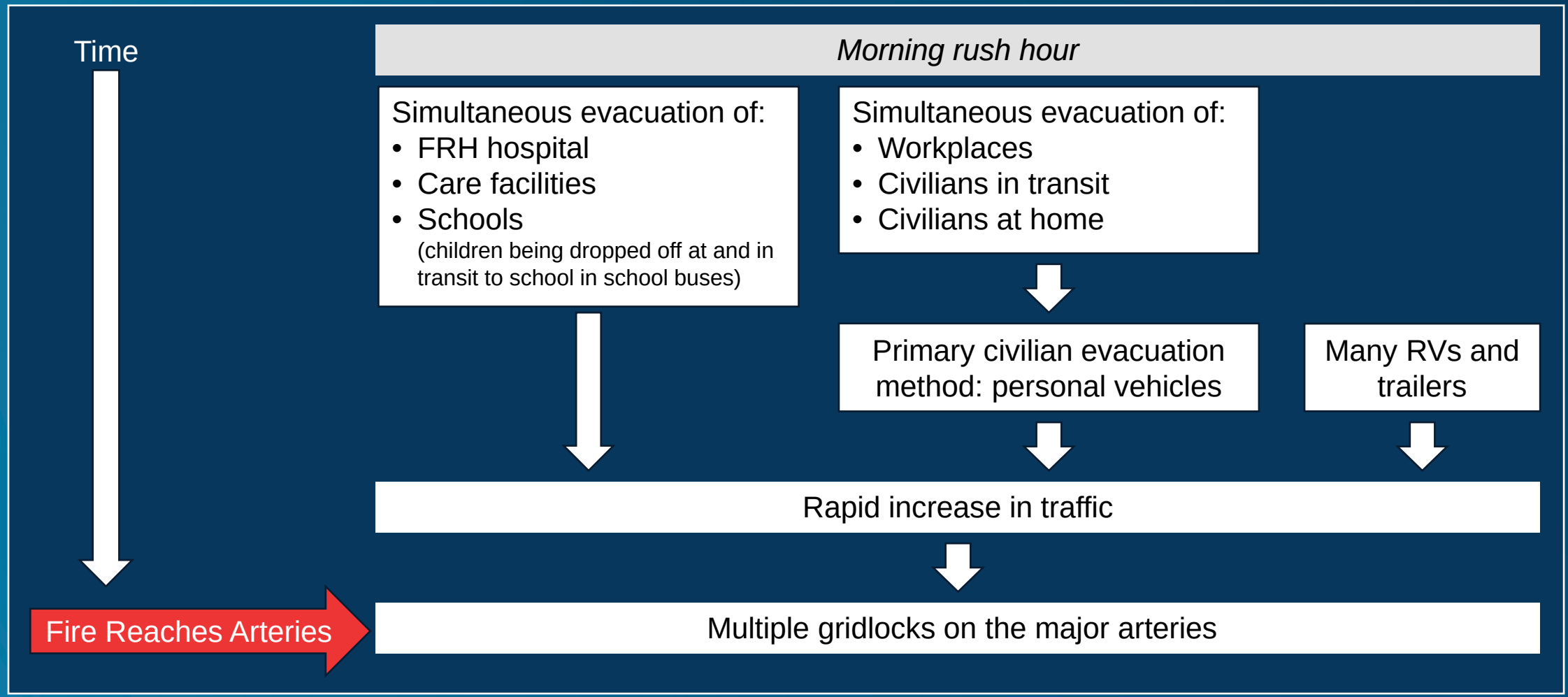
The ***ember cast ahead of the fire front*** and reports of multiple simultaneous ignitions instigated discussions between the IC, BCSO, PPD, and Paradise Town Hall about the evacuation of all of Paradise as the progressive evacuation approach from east to west was being implemented;

There was concern of ***"breaking the system"*** if the entire town were to be evacuated at once.



# Traffic Overview – Paradise (2 of 2)



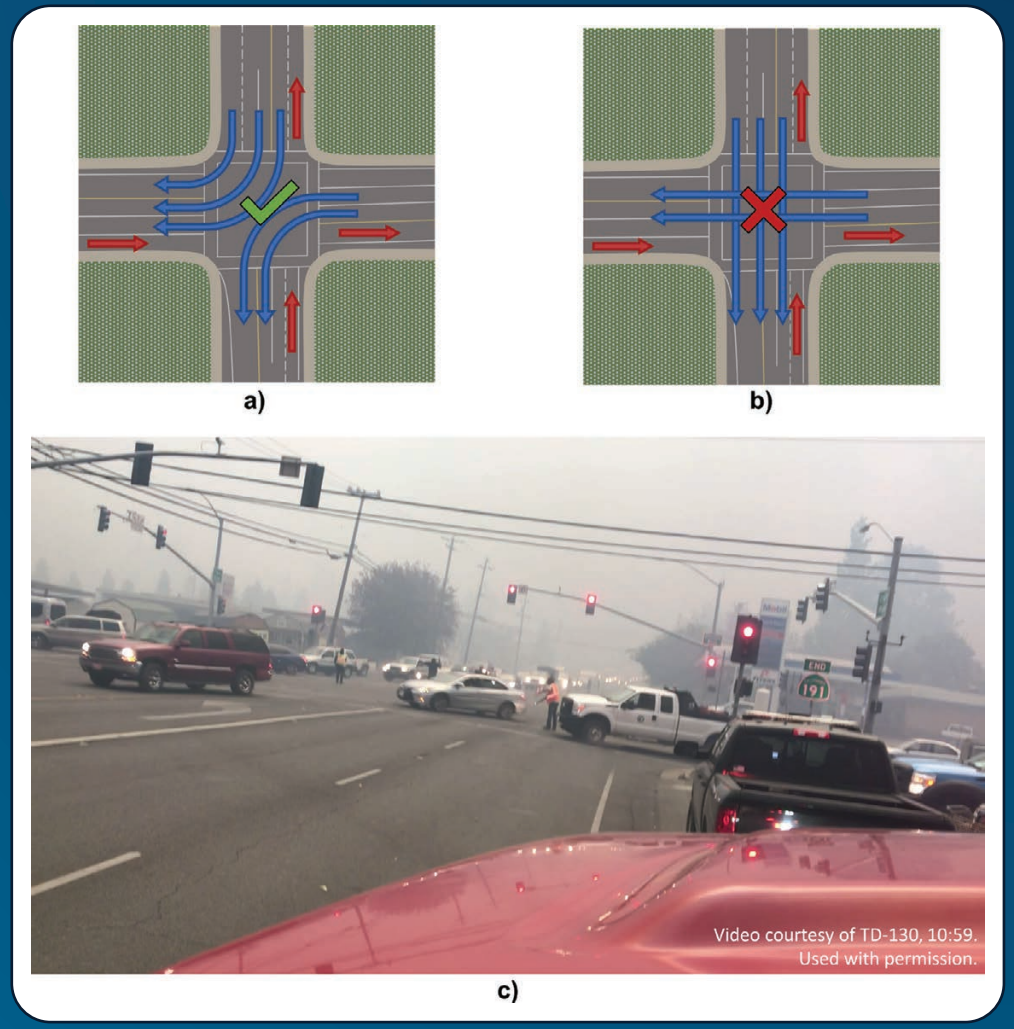



Rapidly advancing fire hit gridlocked arteries

# Traffic Management Strategies



- Traffic direction/management at intersections
- Traffic re-direction to account for continuously changing conditions (traffic and fire)
- Filling up road space that is not burning
- Use of parking lots and other open spaces as traffic overflow accumulators and TRAs.




Situational awareness was essential to adapt to the changing fire conditions and availability of safe egress routes.

NIST TN 2252, Figure 17.

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# Traffic Timeline

***traffic progression and impacts by fire***

# Paradise Evacuation Traffic Summary



Photo courtesy of TD-076, 10:57. Used with permission.

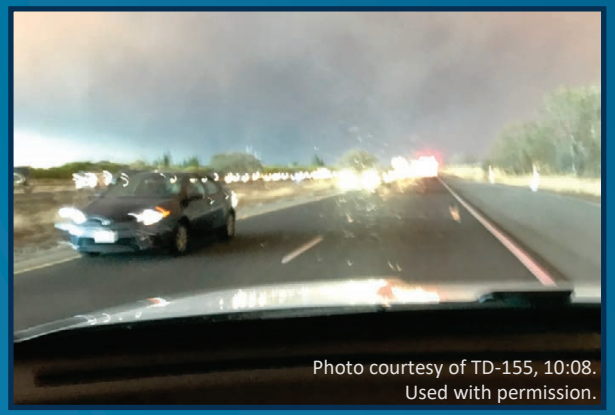


Photo courtesy of TD-155, 10:08. Used with permission.

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. |


Photo courtesy of TD-076, 10:57. Used with permission.


Video courtesy of TD-130, 10:59. Used with permission.

NIST TN 2252, Table 13.

# Paradise Traffic Summary



| | | |
|---|---|---|
| 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. |

Between 8:30 and 10:15 burnovers affect:

3 out of 4 North-South and
3 out of 3 East-West arteries

NIST TN 2252, Table 13.

# Summary of Road Conditions



## Traffic conditions documentation and analysis

- On major egress arteries and cross streets in Paradise
- Expanded beyond Paradise to identity flow restrictions
- Intersection/segment-based
- Seven distinct categories developed to capture different conditions
- Traffic analysis by roadway also included in report after summary table

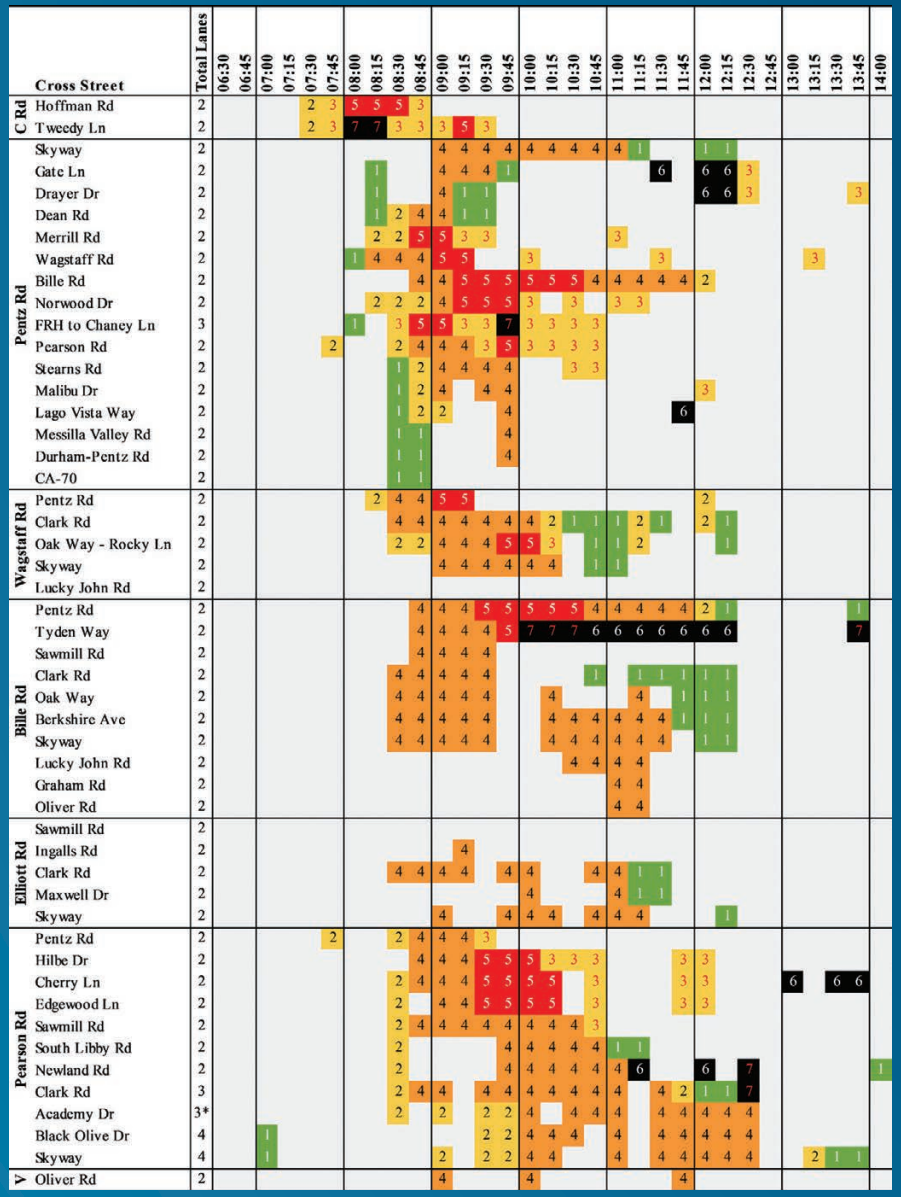
**Table 17.** Definition key of traffic flow conditions.

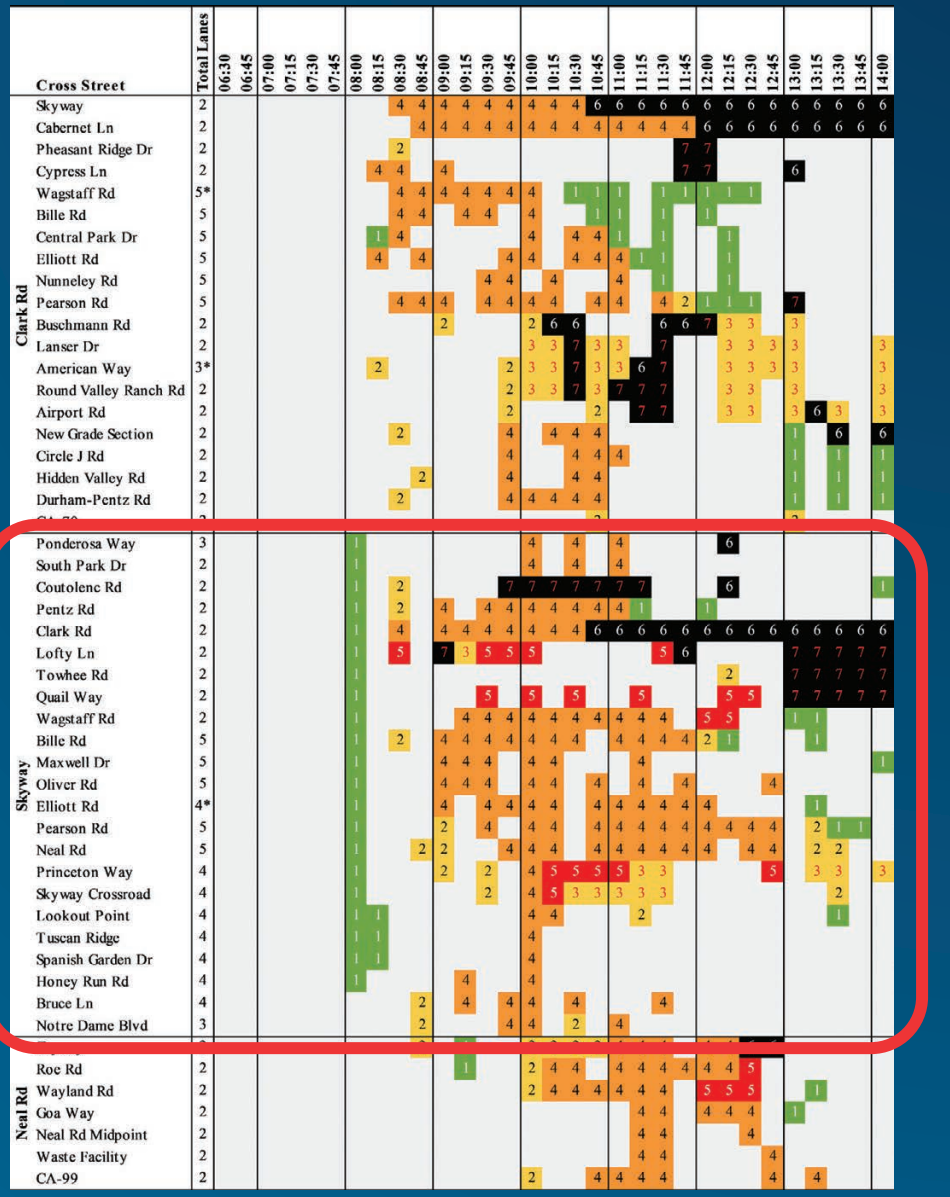
| Category | Description | Notes |
|---|---|---|
| | no data | |
| 1 | no traffic / flowing | Roadway may be smoky and/or dark, but there is no hazard to the roadway from fire. |
| 2 | congested / slowed (traffic) | |
| 3 | obstructed / slowed (fire-power lines-visibility) | Not all 3's are equal. Some 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. |

NIST TN 2252, Section 7.5.

# Evolution of Traffic Conditions



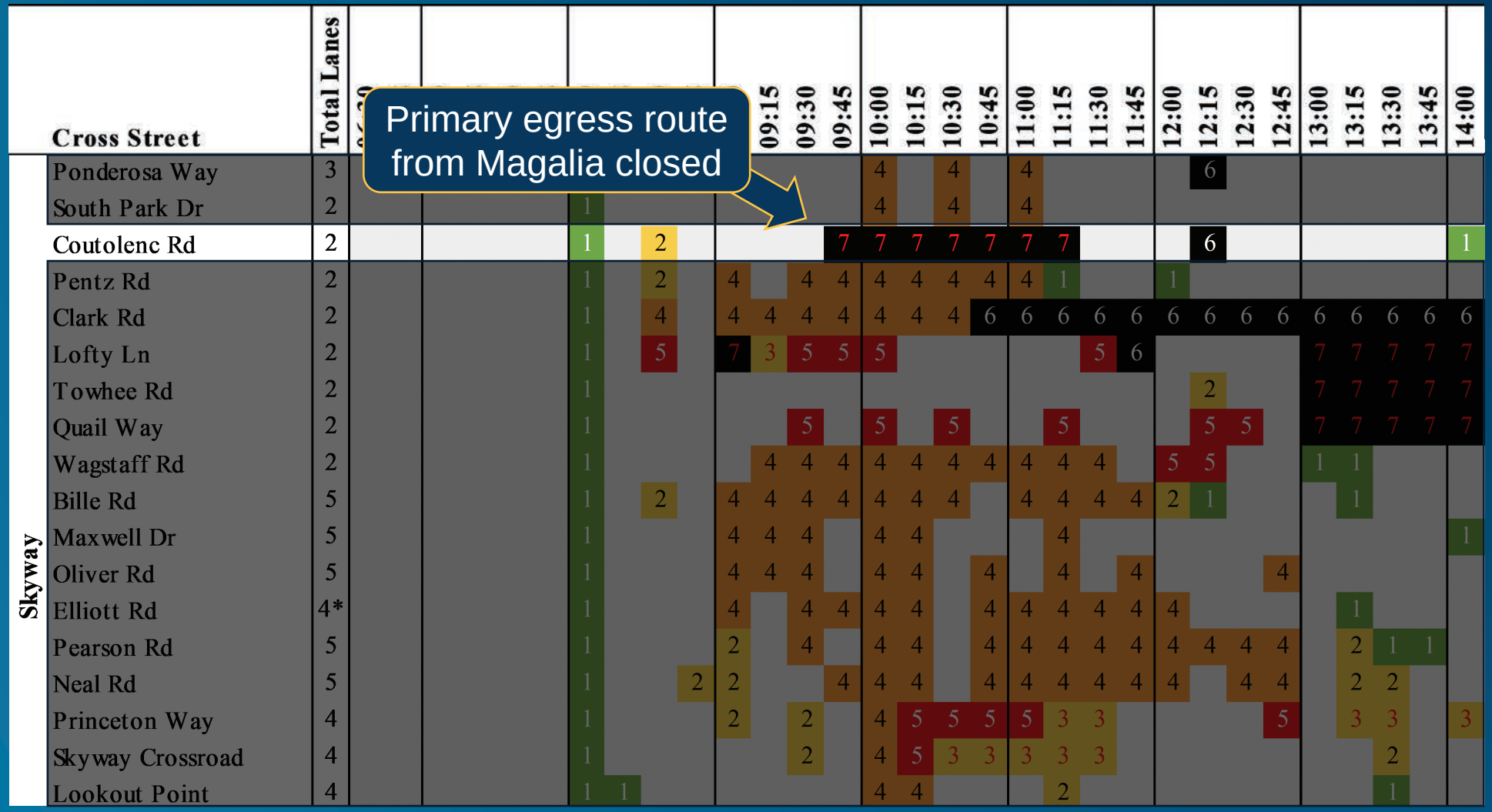



NIST TN 2252, Figure 16.

# Traffic Conditions along Skyway

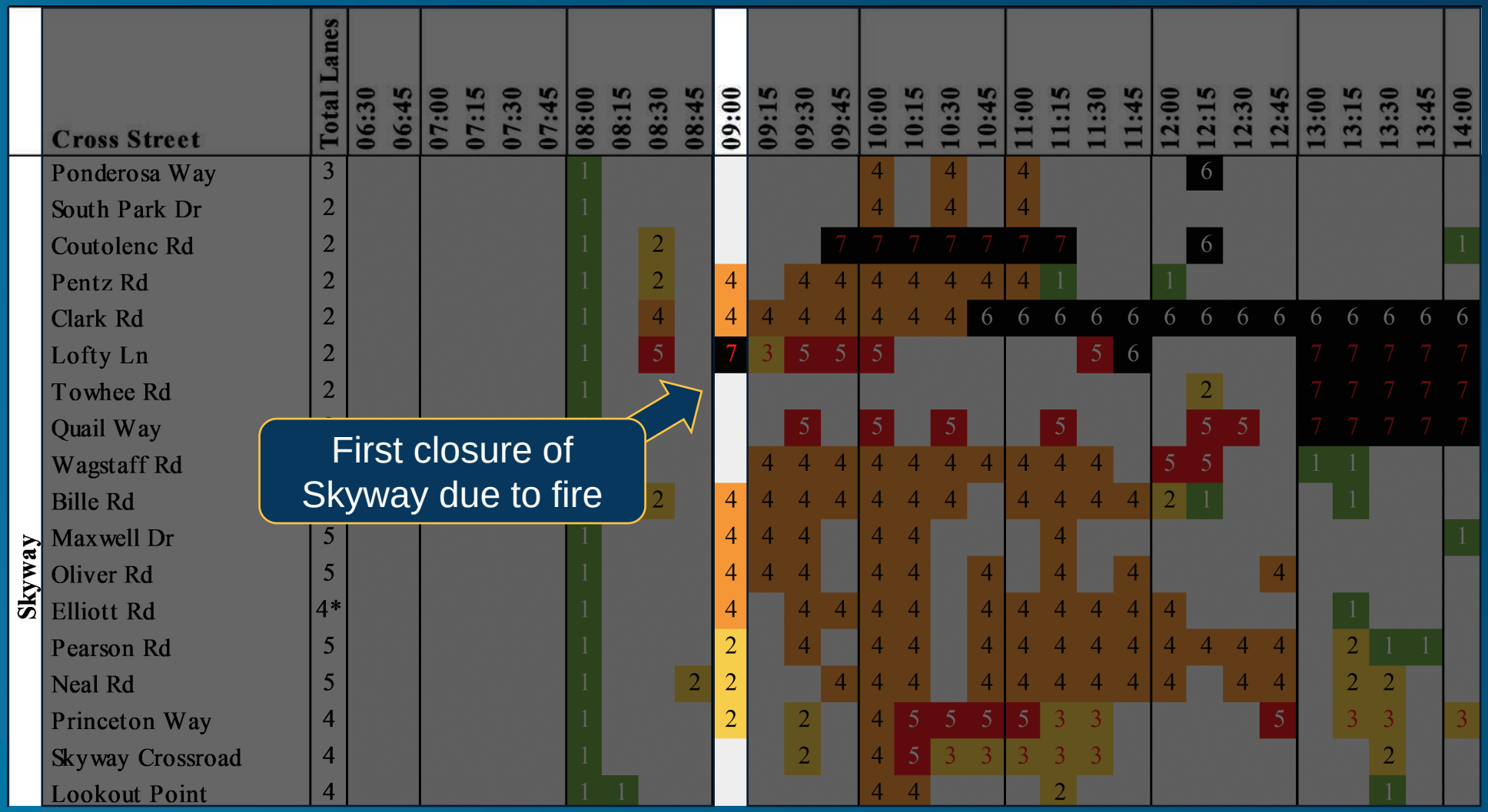





NIST TN 2252, Figure 16b.

# Traffic Conditions along Skyway






NIST TN 2252, Figure 16b.

# Traffic Conditions along Skyway



| | 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Skyway | Ponderosa Way | 3 | | | | | | | 1 | | | | | | | | 4 | | 4 | | 4 | | | | | 6 | | | | | | | |
| | South Park Dr | 2 | | | | | | | 1 | | | | | | | | 4 | | 4 | | 4 | | | | | | | | | | | | |
| | Coutolenc Rd | 2 | | | | | | | 1 | | 2 | | | | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | | | | 6 | | | | | | | 1 |
| | Pentz Rd | 2 | | | | | | | 1 | | 2 | | 4 | | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 1 | | | 1 | | | | | | | | |
| | Clark Rd | 2 | | | | | | | 1 | | 4 | | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| | Lofty Ln | 2 | | | | | | | 1 | | 5 | | 7 | 3 | 5 | 5 | 5 | | | | | | 5 | 6 | | | | | 7 | 7 | 7 | 7 | 7 |
| | Towhee Rd | 2 | | | | | | | 1 | | | | | | | | | | | | | | | | | 2 | | | 7 | 7 | 7 | 7 | 7 |
| | Quail Way | 2 | | | | | | | 1 | | | | | | 5 | | 5 | | 5 | | | 5 | | | | 5 | 5 | | 7 | 7 | 7 | 7 | 7 |
| | Wagstaff Rd | 2 | | | | | | | 1 | | | | | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | | 5 | 5 | | | 1 | 1 | | | |
| | Bille Rd | 5 | | | | | | | 1 | | 2 | | 4 | 4 | 4 | 4 | 4 | 4 | 4 | | 4 | 4 | 4 | 4 | 2 | 1 | | | | 1 | | | |
| | Maxwell Dr | 5 | | | | | | | 1 | | | | 4 | 4 | 4 | | 4 | 4 | | | | 4 | | | | | | | | | | | 1 |
| | Oliver Rd | 5 | | | | | | | 1 | | | | 4 | 4 | 4 | | 4 | 4 | | 4 | | 4 | | 4 | | | | 4 | | | | | |
| | Elliott Rd | 4* | | | | | | | 1 | | | | 4 | | 4 | 4 | 4 | 4 | | 4 | 4 | 4 | 4 | 4 | 4 | | | | | 1 | | | |
| | Pearson Rd | 5 | | | | | | | 1 | | | | 2 | | 4 | | 4 | 4 | | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | | 2 | 1 | 1 | |
| | Neal Rd | 5 | | | | | | | 1 | | | 2 | 2 | | | 4 | 4 | 4 | | 4 | 4 | 4 | 4 | 4 | 4 | | 4 | 4 | | 2 | 2 | | |
| | Princeton Way | 4 | | | | | | | 1 | | | | 2 | | 2 | | 4 | 5 | 5 | 5 | 5 | 3 | 3 | | | | | 5 | | 3 | 3 | | 3 |
| | Skyway Crossroad | 4 | | | | | | | 1 | | | | | | 2 | | 4 | 5 | 3 | 3 | 3 | 3 | 3 | | | | | | | | 2 | | |
| | Lookout Point | 4 | | | | | | | 1 | 1 | | | | | | | 4 | 4 | | | | 2 | | | | | | | | | 1 | | |

NIST TN 2252, Figure 16b.

# Flow Restrictions

***bottlenecks* | *fire* | *abandoned vehicles***

# Paradise Southern Egress Closures 08:00 to 14:00

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**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 |

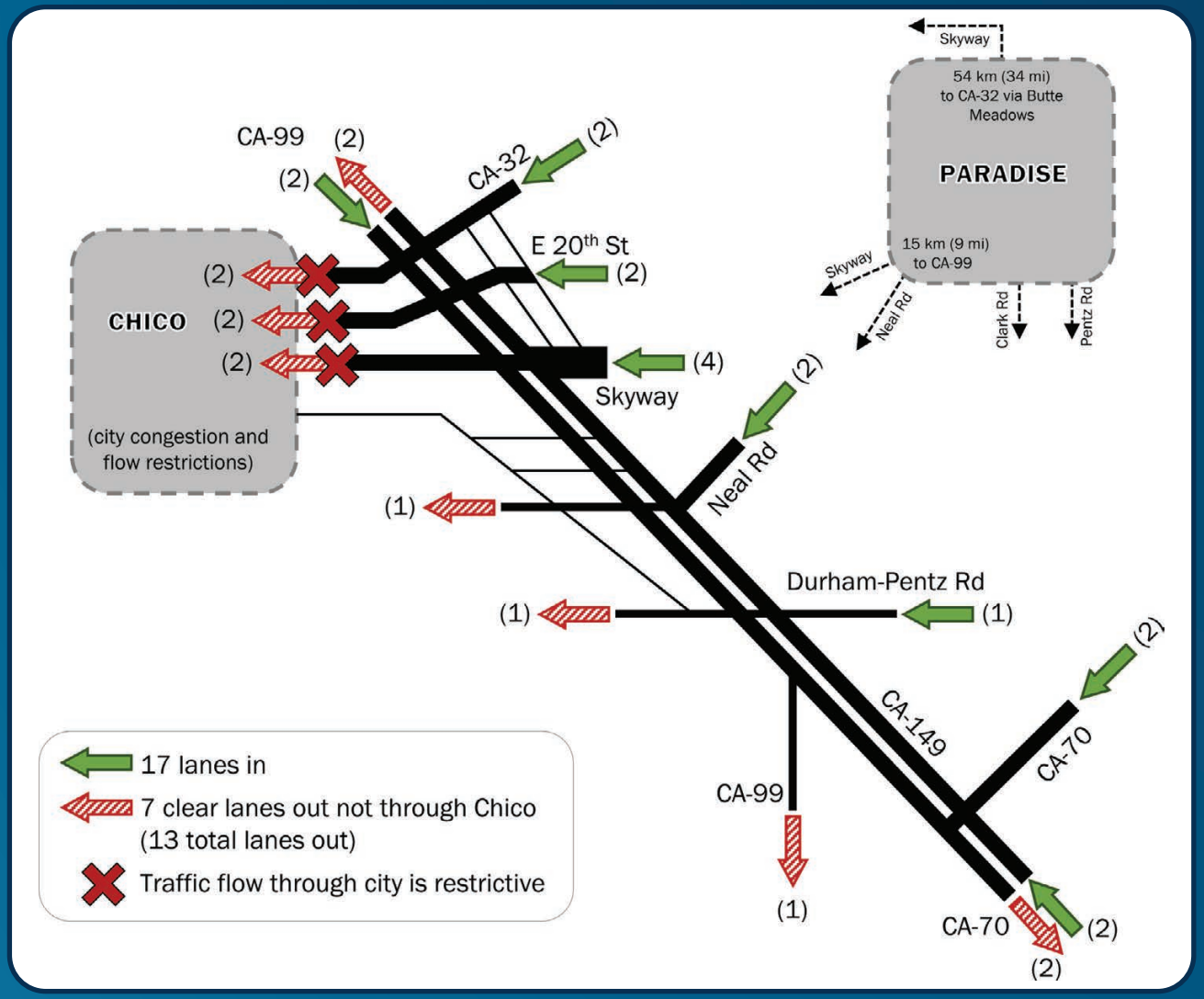
[a] Blocked by fire or other reasons with no civilians present (categories 6 and 7) as defined in Table 17.
[b] Intersections/segments identified in Fig. 16.

During the evacuation of Paradise ¼ of the time only one southbound artery was fully open

NIST TN 2252, Table 29.

# Bottlenecks Outside Paradise






17 into 7 lanes, *9+ miles away*, resulted in significant backups all the way *into Paradise*

NIST TN 2252, Figure 20.

# Traffic Flow Restrictions



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.

# Traffic Flow Restrictions



## *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 though spotting.
  b) Burnovers can entrap local evacuees and limit evacuation options.
  c) Burnovers in several locations can result in abandoned and burned vehicles that may further extend flow restrictions well after the fire intensity decreases.
- 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

# Traffic Flow Restrictions



Photo courtesy of TD-101, 15:28. Used with permission.

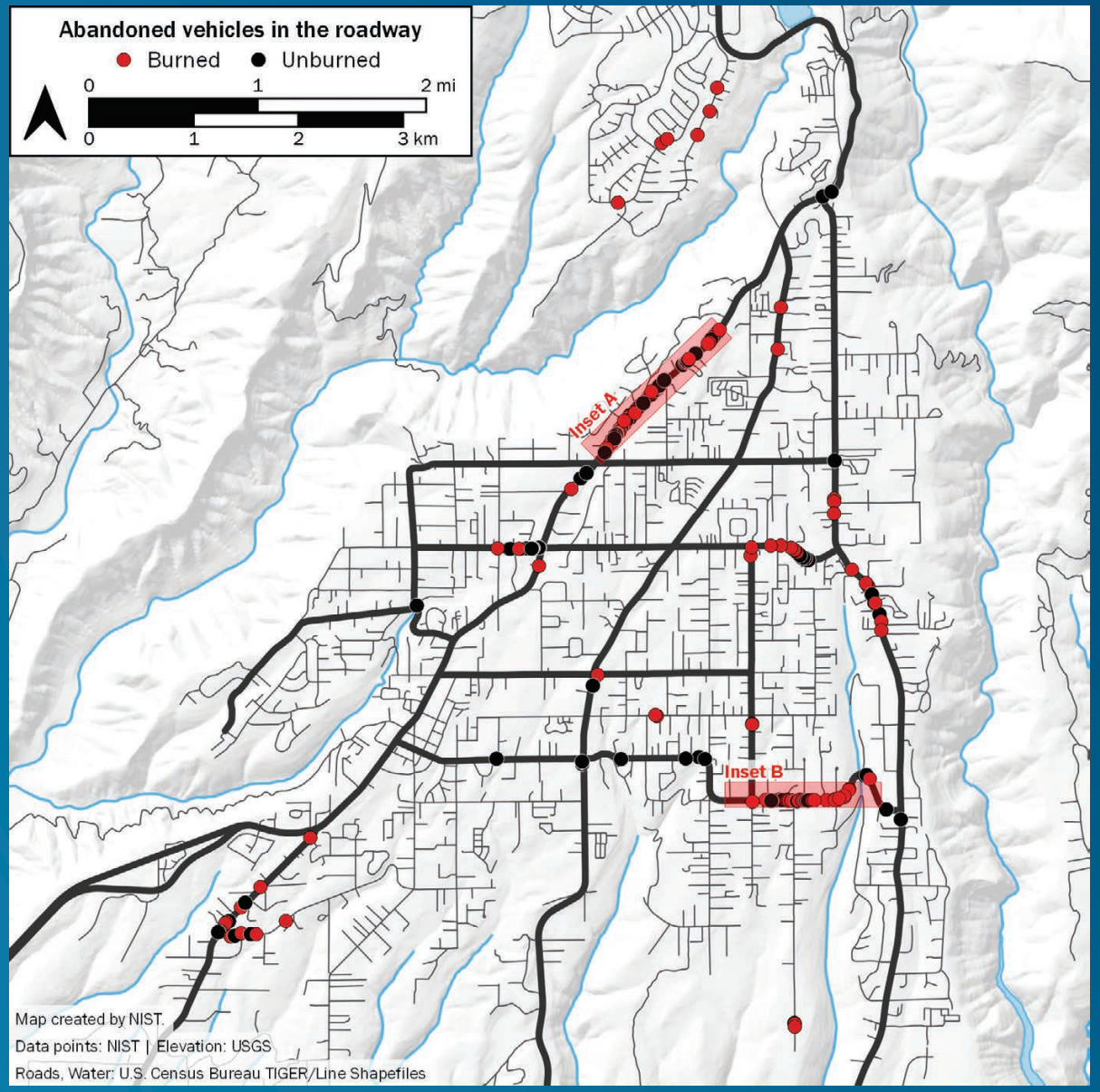
*Non-fire related traffic flow restrictions*

- 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

Photo courtesy of TD-036, 10:23. Used with permission.

# Abandoned Vehicles





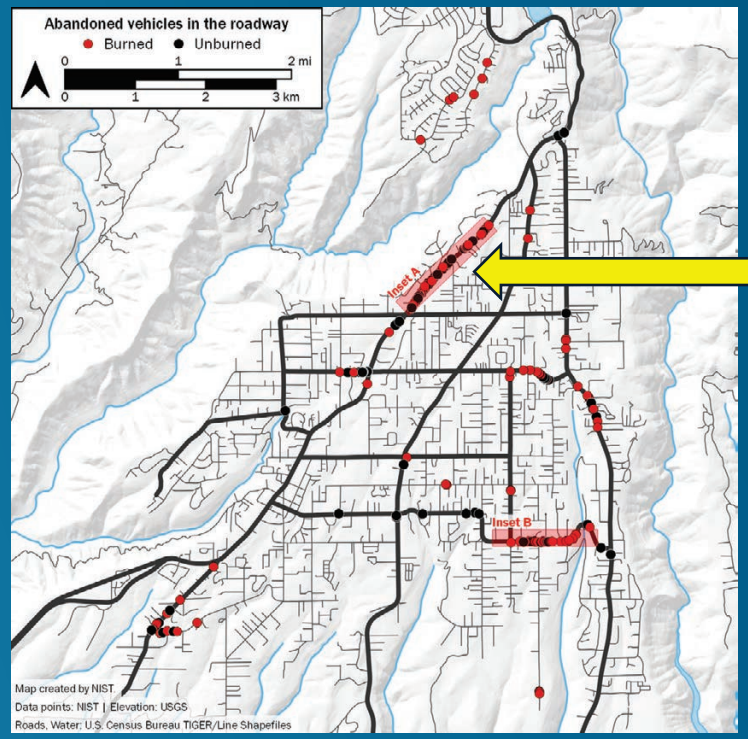

- 235 vehicles were identified
- 58% burned (red points)
- 42% did not burn (black points)

Abandoned vehicles impacted both civilian egress and first responder access

NIST TN 2252, Figure 23.

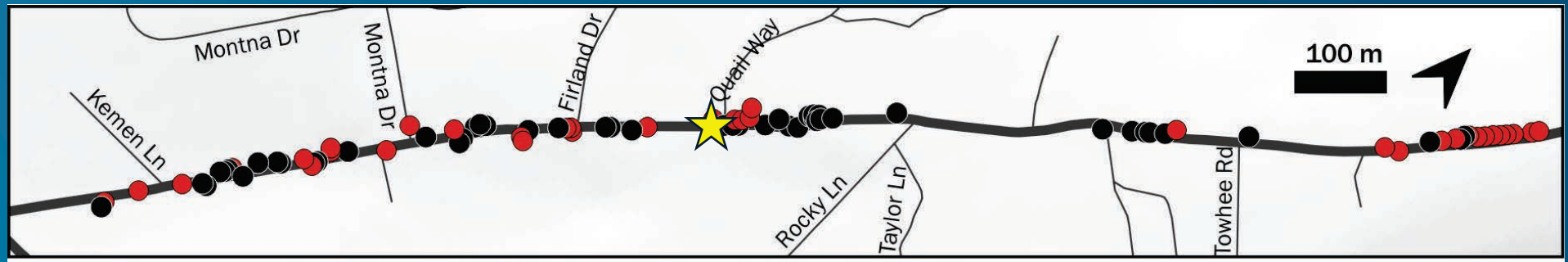
# Abandoned Vehicles







Post-fire view north on Skyway at Quail Way. ★




**Inset A** Skyway north of Wagstaff Rd: 85 vehicles, 1.6 km (1.0 mi)

**NIST TN 2252, Figure 22 and Figure 23.**

# Evacuation and Traffic

***technical findings & recommendations***

# Technical Findings
## Evacuation and Traffic



TF–ET1. Preplanning and training for traffic management and contraflow significantly enhanced life safety of evacuees.

TF–ET2. The majority of the evacuation of Paradise took place between 08:00 and 13:45.

TF–ET3. First responders took extensive actions to enhance evacuee life safety including creating TRAs and escorting civilians to safety in numerous convoys.

TF–ET4. Five key tactics were used to mitigate life safety issues during evacuation:

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 of contraflow to increase traffic flow out of town
e) Use of parking lots as TRAs to accumulate overflow traffic was an essential traffic management tool allowing first responders to keep hundreds of civilians out of high hazard areas

# Technical Findings
## Evacuation and Traffic

TF-ET5. Burnovers significantly impacted civilian and first responder life safety by exposing evacuees to high hazard conditions and locally closing roadways.

TF-ET6. Egress arteries blocked by fire significantly impacted civilian evacuation by increasing traffic delays throughout the community.

TF-ET7. 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-ET8. Two or more of the four egress arteries out of Paradise experienced closures due to fire 68 % of the time between 08:00 and 14:15.

TF-ET9. 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 over 15 km (9 mi) away from Paradise.

TF-ET10. 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.

# Recommendations
## Evacuation and Traffic

In planning for WUI fire evacuations, communities should consider:

R-ET1. Preplanning community evacuation scenarios and communicate them to residents and first responder, government, and infrastructure agencies.

R-ET2. Developing preplanned evacuation scenarios that consider factors including fire history, prevailing winds, proximity of ignition to the community, and road capacity.

R-ET3. Practicing evacuation scenarios with first responder, government, and infrastructure agencies from the community and associated surrounding jurisdictions

R-ET4. Utilizing programs such as “Ready, Set, Go!” to develop and communicate evacuation preparation and timeline

R-ET5. Developing alternative evacuation plans for situations when there is insufficient time to evacuate.

R-ET6. Using crosswalks with painted patterns, overhead flashing lights, and/or removable posts to reduce impact on flow compared to immovable fixtures within the roadway.

# WUI Fire Days: Camp Fire NETTRA

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

- *Module 1: Notification and Evacuation Pre-Fire Conditions and Planning*
- *Module 2: Notification Timeline, Evacuations, Traffic Flow and Road Closures*
- Module 3: Burnovers and TRAs
- Module 4: Rescues
- Module 5: NETTRA Summary

next week, Nov 8

# Thank You

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

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**Camp Fire**

https://www.nist.gov/el/fire-research-division-73300/wildland-urban-interface-fire-73305/nist-investigation-california

Direct links to NETTRA reports:

**https://doi.org/10.6028/NIST.TN.2252**

**https://doi.org/10.6028/NIST.TN.2252sup**