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# Technical Memorandum

September 2, 2022

Project# 26453

To: Avalon Schultz
City of San Leandro
835 E 14th Street
San Leandro, CA 94577

From: Anusha Musunuru, PhD; Matt Braughton, RSP

CC: Eric Vaughan; Darcy Kremin; Rincon Consultants, Inc.

RE: City of San Leandro Evacuation Analysis – Methodology, Results and Considerations

# INTRODUCTION

This memorandum presents the evacuation analysis methodology, results, and considerations for the City of San Leandro (City). Kittelson & Associates, Inc. (Kittelson) modeled five (5) evacuation scenarios for the City as part of their Safety Element update. The analyses were conducted to provide the City with an estimate of roadway capacity constraints during evacuations. Specifically, the analysis helps identify locations where there is a greater potential for traffic congestion in the event of an evacuation. This evaluation is consistent with requirements outlined in Assembly Bill (AB) 747[1] and Senate Bill (SB) 99[2]. These laws require agencies to evaluate the resiliency of their transportation system, the capacity of evacuation routes, and identify key routes for community areas with only one access point.

The document is organized into four sections:

1. Roadway network baseline conditions;
2. Evacuation scenarios methodology and evaluation;
3. Evacuation scenario findings, including potential evacuation congestion; and,
4. Evacuation planning considerations and recommendations.

## Legislative Requirements

Recent California legislation, including AB 747 and SB 99, has been passed requiring all local agencies to review accessibility and evacuation routes when specific elements within the General Plan or other emergency planning documents are completed or updated by a local agency.

- **Senate Bill 99** requires review and update of Safety Element to include information to identify residential developments in hazard areas that do not have at least two emergency evacuation routes. This is intended to assist the city in identifying opportunities to improve the connectivity and resiliency of the transportation system.
- **Assembly Bill 747** requires that the Safety Element be reviewed and updated to identify evacuation routes and their capacity, safety, and viability under a range of emergency scenarios. This is a requirement for all Safety Elements or updates to Hazard Mitigation Plans completed after January 2022.

[1] https://openstates.org/ca/bills/20192020/AB747/
[2] https://openstates.org/ca/bills/20192020/SB99/

# ROADWAY NETWORK & BASELINE CONDITIONS

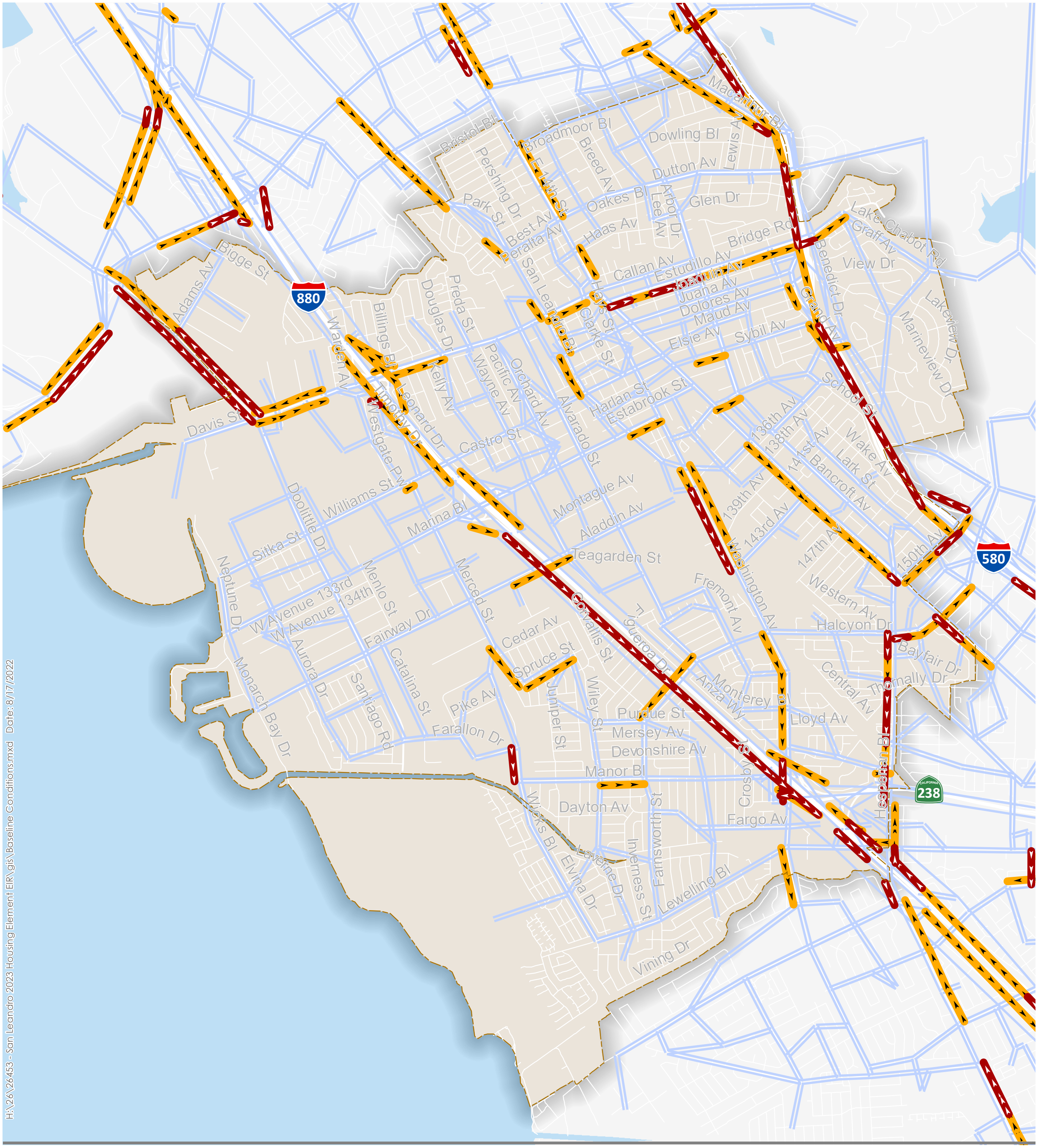
The City of San Leandro is centrally located in the San Francisco East Bay Area, bounded by Oakland to the north and San Lorenzo to the south. Communities and businesses are oriented along interstates and several state highway facilities. Evacuation trips from San Leandro are most likely to use the least congested route to Interstate-880 (I-880), Interstate 580 (I-580), or one of the other state routes (SR) – SR 238, SR 185, and SR 112. There are also several secondary routes that run parallel to the interstates and state highways that are also likely to be used for evacuation purposes, depending on the evacuation area. These secondary routes include Hesperian Boulevard, Washington Avenue, Halcyon Drive, Merced Street, Doolittle Drive, Aladdin Avenue, Estudillo Avenue, and Lake Chabot Road.

The evacuation congestion analysis utilizes the Alameda County Transportation Commission (CTC) Countywide Travel Demand Model (model). The current model was completed in 2019 and includes Plan Bay Area 2040 land use assumptions. The model represents all land uses in the County grouped into traffic analysis zones (TAZs) and includes a representative roadway network (generally all streets except for very local residential streets). Each road segment is coded with functional classification, number of lanes, uncongested speed, and an estimate of the typical hourly capacity. The model estimates the vehicle trips generated by each land use, distributes the trips to a variety of likely destinations, and assigns each origin-destination pair to the best route. The model also assesses congestion and iteratively diverts some traffic to alternative routes until congestion is balanced between all available routes. For this analysis, Kittelson considered the land use associated with the future 2040 year plus the Housing Element scenario (this scenario includes land use assumptions from Plan Bay Area 2040, the 2035 San Leandro General Plan, and the addition of new housing and employment as part of the City's current (2022) Housing Element update.

Each evacuation scenario analyses compare results to the baseline 2040 year plus Housing Element weekday PM peak hour conditions to identify locations where traffic during evacuation might be expected to result in substantial congestion. The model estimates of baseline conditions indicate that congestion in 2040 will be present. Specifically, roadways where volumes are at/exceed capacity include:

- Southbound I-880 (towards San Jose);
- Southbound I-580 (towards Dublin and San Ramon);
- Southbound E 14th Street between San Leandro Boulevard and 150th Avenue;
- Washington Avenue between 143rd Avenue and San Leandro Boulevard;
- Hesperian Boulevard between Springlake Drive and Halcyon Drive;
- Doolittle Drive between Adams Avenue and Davis Street; and
- Estudillo Avenue between E 14th Street and Bancroft Avenue

This congestion reflects regular commute congestion in the Bay Area. The secondary roadways noted above, serve as parallel routes to freeways as well as east-west connections in the City. These congested roadways represent the usual commute traffic patterns and congestion, specifically in the City of San Leandro and generally in the Bay Area. Figure 1 shows the conditions for the City of San Leandro where the highest baseline 2040 PM peak hour volume to capacity conditions are estimated.




Over Capacity (V/C over 1)

Congested (V/C 0.9 to 1)

Uncongested (V/C under 0.9)

San Leandro Boundary

0 1 Miles

Figure 1

**2040 Baseline Conditions**
**San Leandro, California**

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# EVACUATION EVALUATION

Kittelson modeled evacuations for five emergency scenarios selected based on City staff and stakeholder input. These stakeholders included City's emergency services specialist, Alameda County Fire Department, and Alameda County Sheriff's Office. Through these discussions and the most likely emergency scenarios expected to impact the City, the scenarios identified for evacuation analysis include:

- Wildfire
- Tsunami
- Chabot Dam failure
- Hazardous materials explosion
- Pipeline failure

## Limitations

The results of this memo are intended to identify potential congested locations during modeled evacuation scenarios. These scenarios were developed based on conservative assumptions and modeling techniques that reflect current understanding of evacuation analysis. These scenarios are intended to model a potential range of different evacuation scenarios but not all possible scenarios.

The scenarios represent potential emergency occurring in a portion of the City. Actual emergencies may occur at other locations in the City and the specific conditions of an emergency evacuation could result in evacuation behavior that diverges from the definitions and assumptions used for this analysis. As a result, the identified scenarios and evacuation constraints represent informed estimates of the most likely potential evacuation scenario footprints and capacity constraints based on available data. For each scenario, a two-step process was conducted to create the scenario, noted below.

## Step 1: Identifying Travel Patterns

**Time Period:** Kittelson modeled transportation activity for one time period – PM peak hour for all evacuation scenarios. All evacuation traffic was assumed to occur during this period involving the specified area within the City. For the PM peak hour, Kittelson reviewed the model's TAZs and assigned each TAZ a combination of Baseline travel and Evacuation travel (25% and 75%, respectively), based on its presence in the evacuation area.

**Travel Type:** Baseline travel represents normal travel patterns during the PM peak hour as included in the travel model. Evacuation travel represents estimated evacuation trips from each evacuating TAZ. Evacuation travel replaces the normal travel patterns (discussed in Step 2 below). Kittelson modeled travel for each evacuating TAZ shifting to a mix of baseline and evacuation travel (i.e., 25% and 75%, respectively).

**Roadway Capacity:** Kittelson modeled trip patterns using the default capacities for each roadway within and outside the City. The scenarios represent conditions without implementation of any evacuation strategies, such as contraflow lanes, which could increase roadway capacity in one direction versus the other.

# Step 2: Estimating Evacuation Trips and Routing

**Number of Evacuation Trips**: In general, modeled trips are a function of several patterns, including the land uses in an area, the socio-economic characteristics of the population in the area (e.g., auto ownership, income, and household size), and the type and extent of transportation facilities in an area. Kittelson obtained the Citywide 2040 land use information by TAZ (including households, population, and employment information) from the Alameda CTC travel demand model as well as Citywide auto ownership information by Census Tract from the American Community Survey (ACS) data website. Kittelson estimated total evacuation trips by calculating the trips generated at the household level and trips generated at the non-residential level. Kittelson assumed 75% of the residents and 75% of the employees evacuated for each modeled scenario. The number of occupied households and employees by TAZ for each of the evacuation scenarios are summarized in the following evacuation results section for each scenario.

**Evacuation Destination and Route Choice:** For each evacuation TAZ, Kittelson assigned likely evacuation destinations based on the Red Cross emergency evacuation destinations. These include locations such as elementary, middle, and high schools, community colleges, public libraries, and community centers. Evacuation destinations were assigned based on the location and direction of the evacuation. These destinations are selected for each of the evacuation scenarios with a goal of identifying evacuation travel patterns and congestion throughout the City. The distribution of the destinations is not intended to reflect a precise distribution of the routes that would be taken during an evacuation. The trips were distributed from each of the evacuating TAZs to each of the destination TAZs, as appropriate. The locations for the evacuating TAZs and the destination TAZs for each of the evacuation scenarios are provided in the results section.

# EVACUATION RESULTS

Evacuation capacity analysis was conducted for the PM peak hour for the five (5) different evacuation scenarios. The results represent the peak hour conditions for an evacuation, when non-evacuation traffic would be at its highest levels. Each evacuation scenario's results are discussed below.

## Wildfire Scenario

Under this scenario, the fire starts in the Bay-O-Vista area (see Figure 2 for the modeled evacuated area for this scenario). The evacuation area extends to include San Leandro High School and the communities east of Bancroft Avenue up to Lake Chabot Road to the north and Fairmont Drive to the south. Evacuation is expected to be primarily directed west of the affected area, with evacuation traffic traveling west, north, and south. The fire would result in the entire neighborhood of Bay-O-Vista evacuating. Table 1 shows the number of occupied households and employees as well as the total estimated evacuation trips for the scenario.

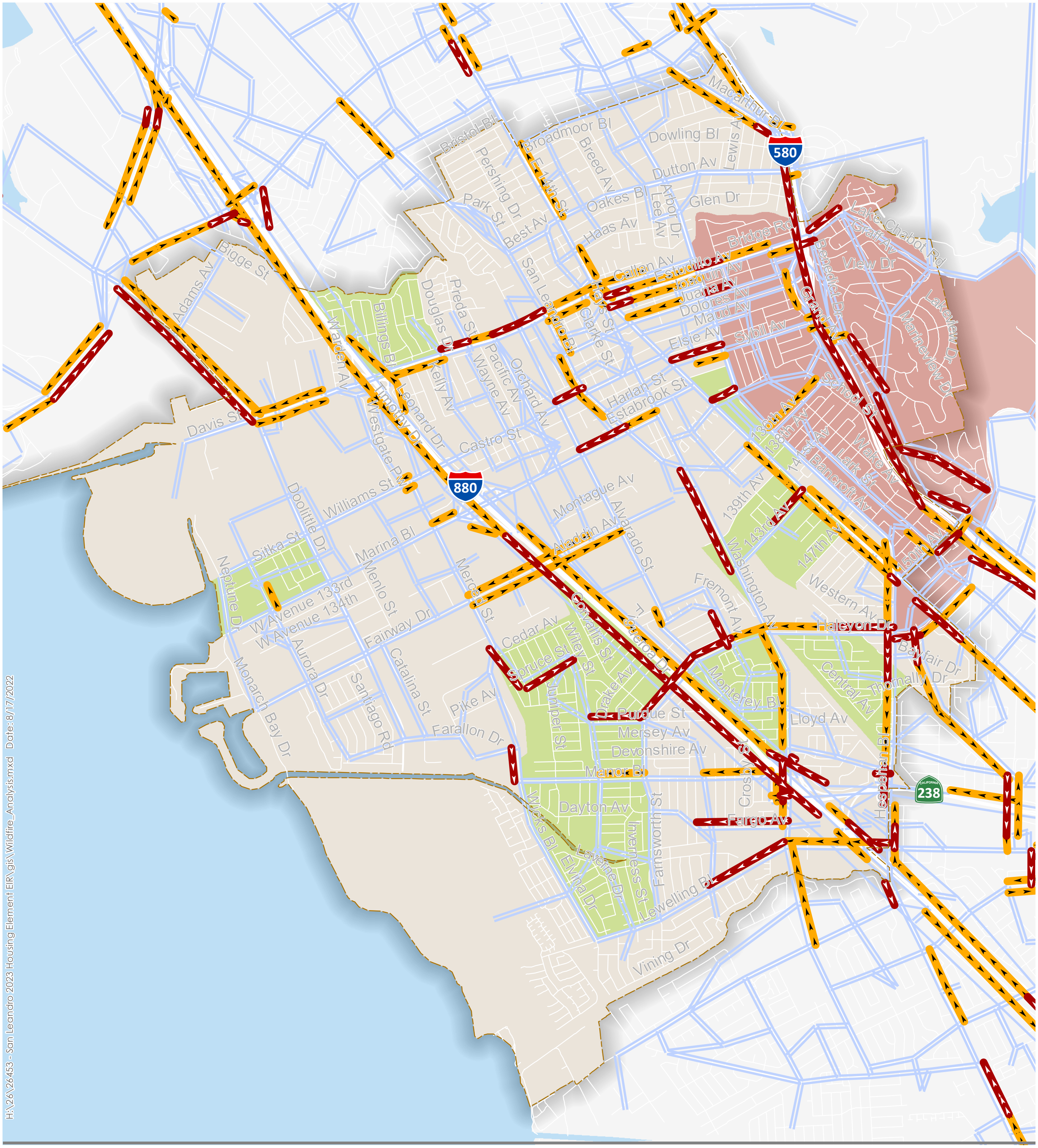
**Table 1: Modeled Wildfire Evacuation Trips for PM Peak Hour**

| Evacuating TAZs | Households | Population | Employment | Trips |
|---|---|---|---|---|
| 561 | 286 | 726 | 96 | 527 |
| 562 | 242 | 612 | 148 | 483 |
| 563 | 540 | 1,368 | 393 | 1,113 |
| 555 | 250 | 702 | 161 | 450 |
| 556 | 269 | 756 | 29 | 406 |
| 557 | 343 | 965 | 36 | 518 |
| 558 | 232 | 653 | 84 | 383 |
| 559 | 391 | 1,101 | 193 | 676 |
| 641 | 657 | 2,062 | 183 | 924 |
| 547 | 527 | 1,393 | 595 | 1,053 |
| 560 | 1,466 | 3,976 | 506 | 2,682 |
| 602 | 2 | 5 | 263 | 151 |

SOURCE: ALAMEDA COUNTY TRAVEL DEMAND MODEL; KITTELSON & ASSOCIATES, INC., 2022

The model indicates substantial and immediate over capacity conditions on several roadways in the City as shown in Figure 2. Specifically, the roadways where volumes are at/exceed capacity include:

- Southbound I-880 (towards San Jose) and northbound I-880 between south City limits to Marina Boulevard;
- Southbound I-580 (towards Dublin and San Ramon);
- Southbound E 14th Street between San Leandro Boulevard and south City limits;
- Benedict Drive and Vistagrand Drive in the Bay-O-Vista area;
- Washington Avenue between San Leandro Boulevard and Springlake Drive;
- Halcyon Drive/Floresta Boulevard between Lark Street to Purdue Street;
- Hesperian Boulevard between Bancroft Avenue and south City limits;
- Lewelling Boulevard between Hesperian Boulevard and Norton Street;
- Fairway Drive between Merced Street and Alvarado Street;
- Marina Boulevard between Washington Avenue and Alvarado Street;
- Doolittle Drive between Adams Avenue and Davis Street; and
- Davis Street from Doolittle Drive to E 14th Street.

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- Over Capacity (V/C over 1)
- Congested (V/C 0.9 to 1)
- Uncongested (V/C under 0.9)
- Destinations
- Origins
- San Leandro Boundary

0 — 1 Miles

Figure 2

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**Wildfire Analysis**
**San Leandro, California**

# Tsunami Scenario

Under this scenario, the potential flooding is assumed to affect portions of the shoreline area and Marina area located near San Francisco Bay (see Figure 3 for the potential affected area for this scenario). Evacuation is expected to be primarily directed east of the affected area, with evacuation traffic traveling east, north, and south. The flooding would result in the entire shoreline and Marina area evacuating. Table 2 shows the number of occupied households and employees as well as the total estimated evacuation trips for the tsunami scenario.

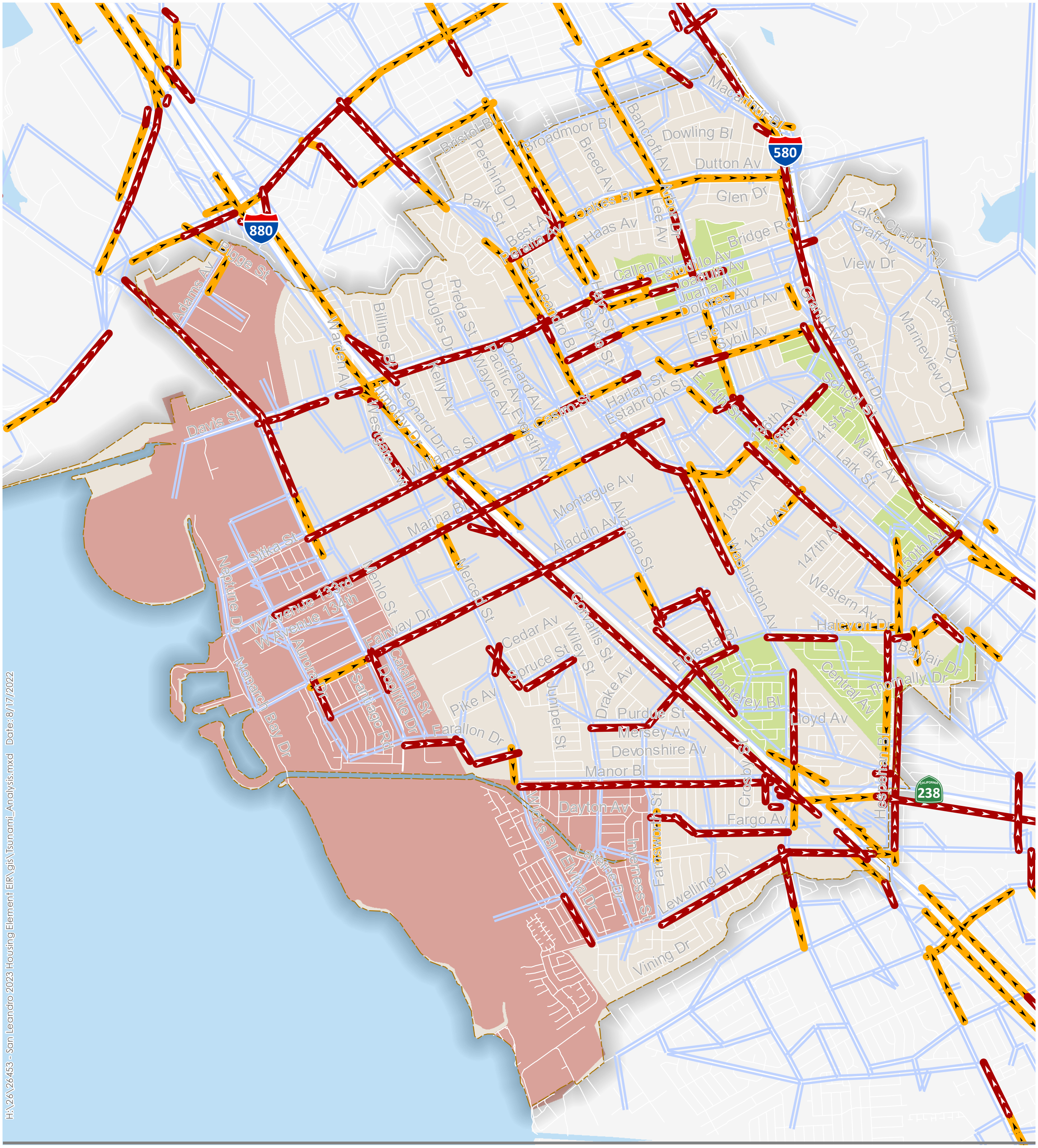
**Table 2: Modeled Tsunami Evacuation Trips for PM Peak Hour**

| Evacuating TAZs | Households | Population | Employment | Trips |
|---|---|---|---|---|
| 535 | 1,118 | 3,266 | 164 | 1,885 |
| 536 | 1,152 | 3,366 | 2,385 | 3,203 |
| 587 | 1,108 | 3,662 | 1,460 | 2,469 |
| 588 | 576 | 1,905 | 233 | 983 |
| 533 | 1,020 | 3,348 | 138 | 1,647 |
| 596 | 0 | 0 | 549 | 313 |
| 597 | 0 | 0 | 1,484 | 846 |
| 600 | 86 | 285 | 748 | 555 |
| 601 | 18 | 60 | 1,060 | 631 |

SOURCE: ALAMEDA COUNTY TRAVEL DEMAND MODEL; KITTELSON & ASSOCIATES, INC., 2022

The model indicates substantial and immediate over capacity conditions on several roadways in the City as shown in Figure 3. Specifically, the roadways where volumes are at/exceed capacity include:

- Southbound I-880 (towards San Jose);
- Southbound I-580 (towards Dublin and San Ramon);
- Southbound E 14th Street between San Leandro Boulevard and 150th Avenue;
- Washington Avenue between San Leandro Boulevard and 143rd Avenue; Halcyon Drive and Fargo Avenue;
- Lewelling Boulevard between Hesperian Boulevard and Farnsworth Avenue;
- Wicks Boulevard between Lewelling Boulevard and Burkhart Avenue;
- Hesperian Boulevard between Lewelling Boulevard and E 14th Street;
- Fairway Drive between Aurora Drive and Alvarado Street;
- Sybil Avenue between E 14th Street and Evergreen Avenue;
- Bancroft Avenue between Dolores Avenue and 140th Avenue;
- Juana Avenue between San Leandro Boulevard and Bancroft Avenue;
- Marina Boulevard between Aurora Drive and Washington Avenue;
- Williams street between Doolittle Drive and Washington Avenue;
- Dutton Avenue between I-580 and San Leandro Boulevard;
- Doolittle Drive between Adams Avenue and Marina Boulevard; and
- Davis Street from Doolittle Drive to E 14th Street.




Over Capacity (V/C over 1)

Congested (V/C 0.9 to 1)

Uncongested (V/C under 0.9)

Destinations

Origins

San Leandro Boundary

0 1 Miles

Figure 3

KITTELSON & ASSOCIATES

**Tsunami Analysis**
**San Leandro, California**

# Dam Failure Scenario

Under this scenario, the potential flooding from Chabot dam failure is assumed to affect the entire north and central portions of the City (see Figure 4 for the potential evacuation area for this scenario). Evacuation is expected to be primarily directed south of the City. The flooding would result in most of the City evacuating, and Table 3 shows the number of occupied households and employees and total estimated evacuation trips.

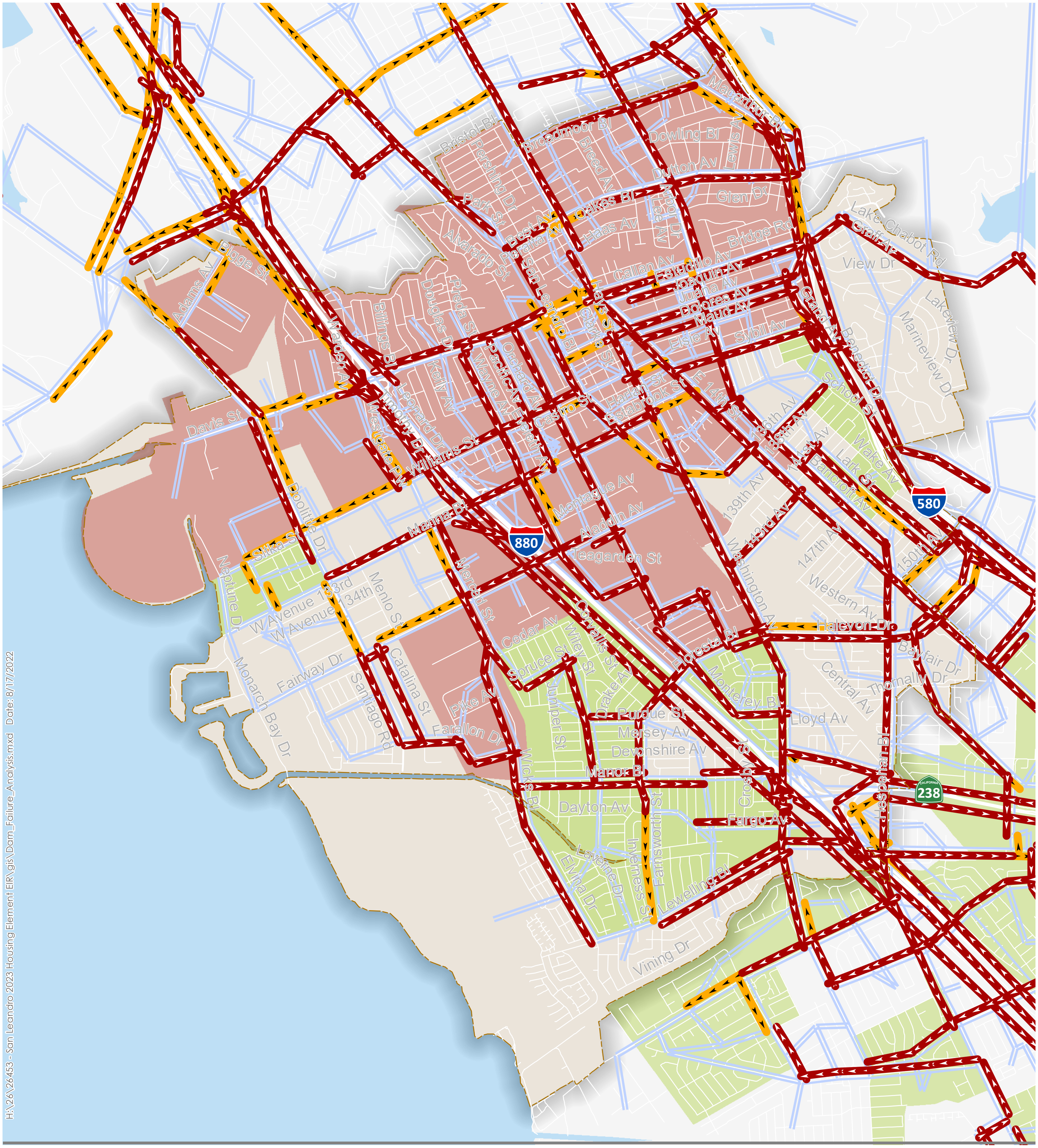
**Table 3: Modeled Dam Failure Evacuation Trips for PM Peak Hour**

| Evacuating TAZs | Households | Population | Employment | Trips |
|---:|---:|---:|---:|---:|
| 537 | 0 | 0 | 2,063 | 1,176 |
| 538 | 0 | 0 | 4,739 | 2,701 |
| 542 | 0 | 0 | 2,457 | 1,400 |
| 597 | 0 | 0 | 1,484 | 846 |
| 598 | 0 | 0 | 142 | 81 |
| 554 | 3 | 7 | 235 | 139 |
| 601 | 18 | 60 | 1,060 | 631 |
| 539 | 25 | 84 | 619 | 392 |
| 600 | 86 | 285 | 748 | 555 |
| 575 | 111 | 276 | 70 | 160 |
| 592 | 126 | 418 | 119 | 254 |
| 585 | 178 | 600 | 284 | 427 |
| 562 | 242 | 612 | 148 | 483 |
| 565 | 274 | 743 | 96 | 462 |
| 561 | 286 | 726 | 96 | 527 |
| 583 | 290 | 724 | 2,354 | 1,656 |
| 593 | 43 | 141 | 1,372 | 846 |
| 570 | 299 | 757 | 237 | 607 |
| 590 | 314 | 1,037 | 1,328 | 1,218 |
| 568 | 334 | 844 | 323 | 707 |
| 1471 | 356 | 1,203 | 460 | 794 |
| 566 | 361 | 980 | 211 | 655 |
| 1469 | 437 | 1,083 | 320 | 656 |
| 567 | 442 | 1,201 | 305 | 830 |
| 543 | 454 | 1,197 | 1,478 | 1,483 |
| 569 | 454 | 1,148 | 227 | 843 |
| 564 | 468 | 1,272 | 386 | 915 |
| 573 | 515 | 1,523 | 1,187 | 1,504 |
| 578 | 519 | 1,284 | 499 | 849 |
| 563 | 540 | 1,368 | 393 | 1,113 |
| 1468 | 559 | 1,888 | 26 | 846 |
| 577 | 598 | 1,482 | 845 | 1,132 |
| 550 | 689 | 1,675 | 306 | 1,053 |
| 580 | 689 | 1,710 | 1,449 | 1,575 |
| 574 | 701 | 2,076 | 182 | 1,227 |
| 572 | 714 | 2,101 | 1,142 | 1,795 |
| 581 | 758 | 1,876 | 1,055 | 1,426 |
| 1470 | 798 | 2,693 | 370 | 1,398 |
| 571 | 819 | 2,070 | 202 | 1,404 |

| Evacuating TAZs | Households | Population | Employment | Trips |
|---|---|---|---|---|
| 584 | 858 | 2,900 | 87 | 1,327 |
| 576 | 910 | 2,252 | 437 | 1,239 |
| 582 | 1,059 | 2,629 | 1,049 | 1,747 |
| 586 | 1,250 | 3,914 | 866 | 2,357 |
| 579 | 1,419 | 3,519 | 1,394 | 2,336 |
| 552 | 1,581 | 3,822 | 545 | 2,322 |

SOURCE: ALAMEDA COUNTY TRAVEL DEMAND MODEL; KITTELSON & ASSOCIATES, INC., 2022

Figure 4 shows the volume to capacity ratio for the PM peak hour. The model indicates substantial and immediate over capacity conditions throughout the City. This is because a greater number of evacuation trips travel out to the south of the City in this scenario, worsening the congestion over the entire roadway network.




Over Capacity (V/C over 1)
Congested (V/C 0.9 to 1)
Uncongested (V/C under 0.9)

Destinations
Origins
San Leandro Boundary

0 — 1 Miles

Figure 4

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**Dam Failure Analysis**
**San Leandro, California**

# Hazardous Materials Explosion Scenario

Under this scenario, a human-caused hazard event associated with industrial operations or utility infrastructure explosion is assumed to affect the industrial area west of I-880 near the Davis Tract (see Figure 5 for the evacuation area for this scenario). Evacuation is expected to be primarily directed east of the affected area, with evacuation traffic traveling east, north, and south. The explosion would result in an evacuation area extending west to Doolittle Drive and south to Manor Boulevard. Table 4 shows the number of occupied households and employees and total estimated evacuation trips.

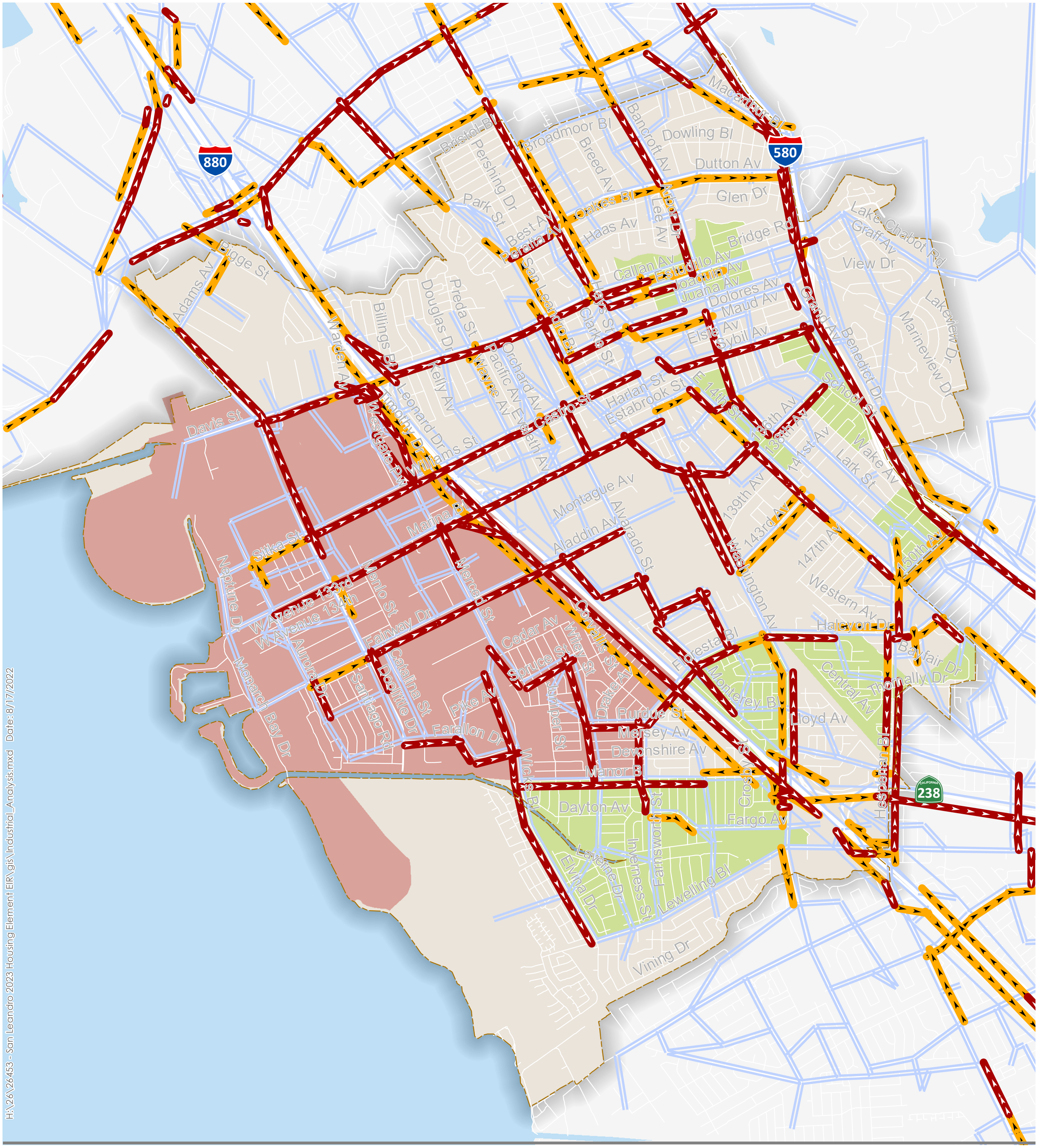
**Table 4: Modeled Hazardous Materials Explosion Evacuation Trips for PM Peak Hour**

| Evacuating TAZs | Households | Population | Employment | Trips |
|---|---|---|---|---|
| 536 | 1,152 | 3,366 | 2,385 | 3,203 |
| 537 | 0 | 0 | 2,063 | 1,176 |
| 538 | 0 | 0 | 4,739 | 2,701 |
| 539 | 25 | 84 | 619 | 395 |
| 541 | 1,643 | 5,403 | 525 | 2,941 |
| 587 | 1,108 | 3,662 | 1,460 | 2,469 |
| 588 | 576 | 1,905 | 233 | 983 |
| 589 | 4 | 13 | 232 | 138 |
| 591 | 0 | 0 | 910 | 519 |
| 592 | 126 | 418 | 119 | 254 |
| 593 | 43 | 141 | 1,372 | 846 |
| 594 | 0 | 0 | 440 | 251 |
| 595 | 0 | 0 | 519 | 296 |
| 598 | 0 | 0 | 142 | 81 |
| 599 | 0 | 0 | 529 | 302 |
| 600 | 86 | 285 | 748 | 555 |
| 601 | 18 | 60 | 1,060 | 631 |

SOURCE: ALAMEDA COUNTY TRAVEL DEMAND MODEL; KITTELSON & ASSOCIATES, INC., 2022

The model indicates substantial and immediate over capacity conditions on several roadways in the City as shown in Figure 5. Specifically, roadways where volumes are at/exceed capacity include:

- Southbound I-880 (towards San Jose);
- Southbound I-580 (towards Dublin and San Ramon);
- E 14th Street between Estabrook Street and 150th Avenue; north City limits to Callan Avenue;
- Washington Avenue between San Leandro Boulevard and 143rd Avenue; Halcyon Drive and Fargo Avenue;
- Wicks Boulevard between Fairway Drive and Lewelling Boulevard;
- Hesperian Boulevard between E 14th Street and SR 238;
- Manor Boulevard between Wicks Boulevard and Kesterson Street;
- Fairway Drive between Aurora Drive and Alvarado Street;
- Marina Boulevard between Aurora Drive and Washington Avenue;
- Davis Street between Doolittle Drive and Bancroft Avenue;
- Doolittle Drive between Adams Avenue and Marina Boulevard;
- Bancroft Avenue between north City limits and 136th Avenue;
- Juana Avenue between San Leandro Boulevard and Santa Maria Street;
- Williams street between Doolittle Drive and Washington Avenue; and
- Other collector streets near Davis tract area.




Over Capacity (V/C over 1)

Congested (V/C 0.9 to 1)

Uncongested (V/C under 0.9)

Destinations

Origins

San Leandro Boundary

0 1 Miles

Figure 5

**Industrial Analysis**
**San Leandro, California**

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# Pipeline Failure Scenario

Under this scenario, a gas pipeline explosion is assumed to affect the area south of Fairway Drive/Aladdin Avenue, west of Washington Avenue/San Leandro Boulevard, and east of Wicks Boulevard to the southern limits of the City (see Figure 6 for the evacuation area for this scenario). Evacuation is expected to be primarily directed north of the affected area, with evacuation traffic traveling east, west, and southeast. The pipeline failure is assumed to result in south central area of the City being evacuated. Table 5 shows the number of occupied households and employees and total estimated evacuation trips.

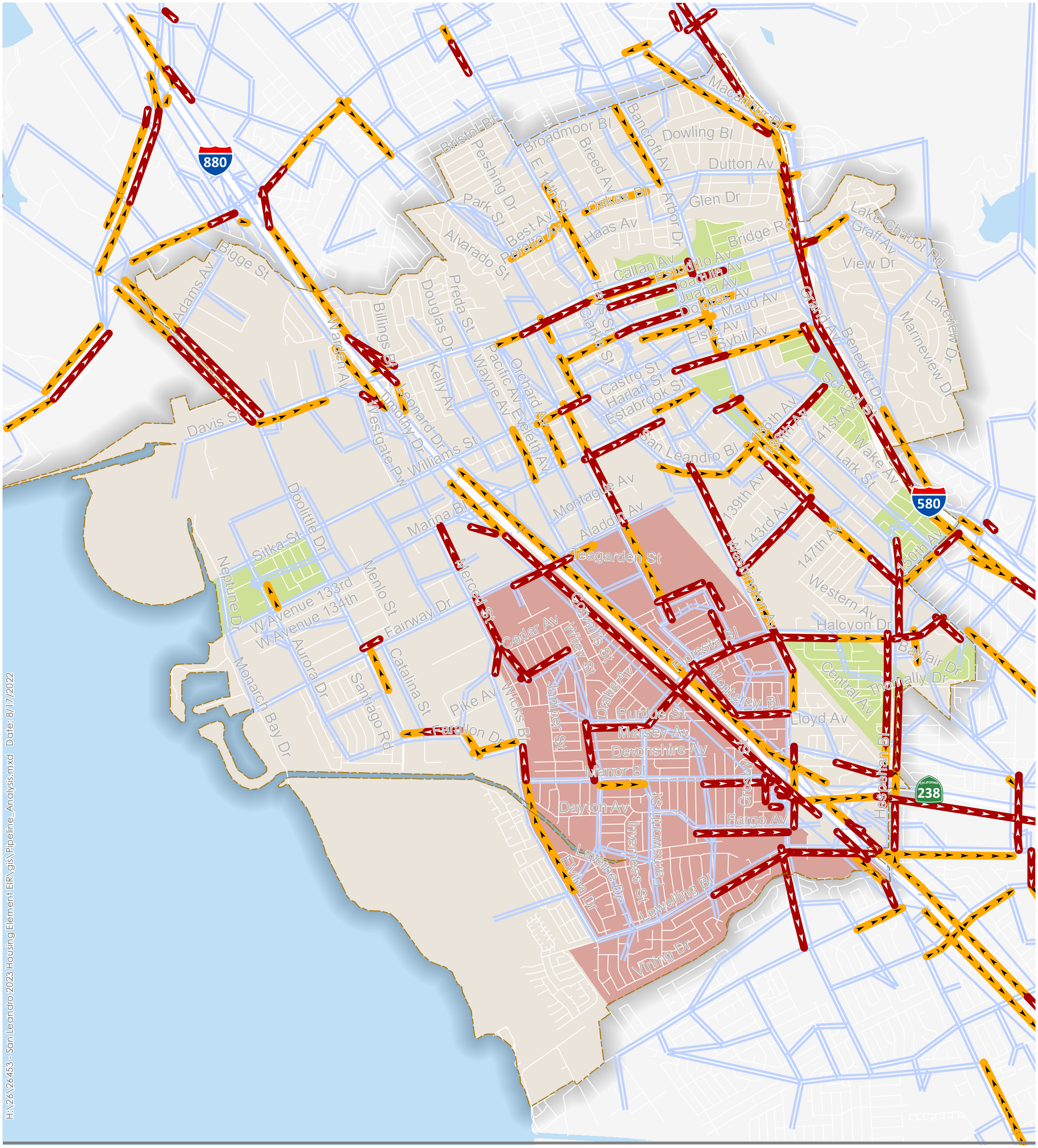
**Table 5: Modeled Pipeline Failure Evacuation Trips for PM Peak Hour**

| Evacuating TAZs | Households | Population | Employment | Trips |
|---|---|---|---|---|
| 531 | 1,357 | 4,090 | 676 | 2,021 |
| 532 | 796 | 2,401 | 204 | 1,077 |
| 533 | 1,020 | 3,348 | 138 | 1,714 |
| 534 | 382 | 1,254 | 22 | 627 |
| 539 | 25 | 84 | 619 | 392 |
| 540 | 529 | 1,740 | 174 | 903 |
| 541 | 1,643 | 5,403 | 525 | 2,794 |
| 543 | 454 | 1,197 | 1,478 | 1,483 |
| 545 | 694 | 1,826 | 465 | 1,241 |

SOURCE: ALAMEDA COUNTY TRAVEL DEMAND MODEL; KITTELSON & ASSOCIATES, INC., 2022

The model indicates substantial and immediate over capacity conditions on several roadways in the City as shown in Figure 6. Specifically, roadways where volumes are at/exceed capacity include:

- Southbound I-880 (towards San Jose) and northbound I-880 between SR 238 and Williams Street;
- Southbound I-580 (towards Dublin and San Ramon);
- Eastbound SR 238 between I-880 and I-580;
- E 14th Street between San Leandro Boulevard and 150th Avenue;
- Lewelling Boulevard between Ashland Avenue and Norton Street;
- Hesperian Boulevard between E 14th Street and Lewelling Boulevard;
- Washington Avenue between San Leandro Boulevard and I-880;
- Halcyon Drive/Floresta Boulevard between E 14th Street and Purdue Street;
- Doolittle Drive between Adams Avenue and Callan Avenue;
- Davis Street between Orchard Avenue and Bancroft Avenue;
- Juana Avenue between San Leandro Boulevard and Santa Maria Street; and
- Other east-west collector streets near downtown area.




Over Capacity (V/C over 1)

Congested (V/C 0.9 to 1)

Uncongested (V/C under 0.9)

Destinations

Origins

San Leandro Boundary

0 1 Miles

Figure 6

**Pipeline Analysis**
**San Leandro, California**

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# EVACUATION PLANNING CONSIDERATIONS

This section describes evacuation planning considerations and strategies for improving the capacity and resilience of the City's roadway network to support future evacuation events. The strategies and considerations were identified based on previous congestion and evacuation studies, review of recent evacuation efforts, effective evacuation planning practices identified by US Department of Transportation (USDOT)[3] and Federal Highway Administration (FHWA)[4] , and staff feedback. The strategies are organized into five (5) categories:

1. Traffic Management
2. Communications
3. Vulnerable Populations
4. Public Education
5. Resource Management

## Traffic Management

This section includes infrastructure-related strategies that will aid in efficient and expeditious flow of evacuation traffic, which is the most critical and challenging element in a successful evacuation. For each infrastructure-related treatments, it is necessary to consider downstream capacity limitations and identify if those limits nullify the potential benefits of the treatment. Table 6 outlines each of these strategies and provides a brief description of the strategy and desired outcomes.

**Table 6: Roadway and Intersection Capacity and Resilience Related Strategies**

| Strategy | Description and Outcome |
|---|---|
| Limited contra flow on highways | Reverse one or more lanes of highway to accommodate an increased flow of traffic in one direction. |
| Unlimited contra flow on highways | Redirect of all lanes of a designated evacuation route to accommodate rapid evacuation from a City or region. |
| Limited/unlimited contra flow on unlimited access arterials | Temporarily close inbound travel lanes on selected unlimited access arterials (such as parkways and boulevards) to allow outbound traffic to utilize these lanes during evacuation. |
| Phased releases at major parking centers | Implement a coordinated release of evacuation traffic from parking facilities that would reduce congestion on evacuation routes, especially in the downtown area. A phased release protocol would be developed for each parking facility, depending on size, location, and other relevant factors. |

[3] *Using Highways During Evacuation Operations for Events with Advance Notice*, Routes to Effective Evacuation Planning Primer Series, USDOT, FHWA, Accessed August 2022.
[4] *Using Highways for No-Notice Evacuations: Five Planning Considerations*, FHWA, Accessed August 2022.

| Strategy | Description and Outcome |
|---|---|
| Closure of inbound lanes on selected roads and highways | Close inbound lanes on highways utilized for evacuation routes to prevent drivers on these routes from entering the City while evacuation is underway. |
| Restrict left-turn movements | Minimize left-turn movements along evacuation routes and on roads leading to evacuation routes. |
| Suspension of tolls | Consider coordinating suspension of tolls to encourage people to use toll roads to reduce bottlenecks at toll collection booths. |
| Signage | Use variable message board equipment and targeted installation of permanent dynamic message signs on evacuation routes to improve communication and reduce public confusion. |
| Stage tow trucks | Considers how to stage tow trucks at key bottleneck locations along evacuation routes to help detect and clear minor crashes and maintain traffic flow. |
| Adjust signal timing | Increase the green time and/or progression band for through movements leading out of an evacuation zone. |
| Signal operation during power outage | Install signal battery backups in case signal operations need to be maintained during a power outage. Consider using channeling devices, static signs, and coning strategies to manage intersection flow during power outage if the signals lack power. |
| Additional access routes | Identify and communicate with communities that have at least two access points. Prioritize adding additional access to communities which are currently served by only one or two access points. |
| Bus system | Develop transportation solutions such as the use of a bus system for evacuating individuals with special needs (such as those with mobility limitations). |
| Traffic control points | Establish traffic control points (i.e., locations along designated evacuation routes with emergency management personnel) to maintain a greater degree of evacuation management. These locations could enhance the efficiency of an evacuation, reduce public confusion, and allow increased operational flexibility during an evacuation. |

# Communications

This section describes communication strategies that address how information may be shared among agencies, organizations, and the general public for evacuations. During an emergency evacuation event, two types of communication take place: (1) communication among entities involved in the management of response, and (2) communication between the City and the general public. Table 7 outlines each of these strategies and provides a brief description of the strategy and desired outcomes.

**Table 7: Communications Related Strategies**

| Strategy | Description and Outcome |
| --- | --- |
| Establish and maintain communications | Strengthen and maintain communication among coordinating emergency event agencies. This could be achieved through systems such as the Public Information Emergency System and Emergency Satellite Communications. |
| Traffic Control Center | Implement a traffic control center to coordinate all evacuation activities. This center would have up to the minute reports on traffic patterns and can communicate directly with the broadcast media to let drivers know about roadway congestion and conditions and direct them to alternate routes. |
| Traffic counters/CCTV cameras | Install counters and/or CCTV cameras to assess traffic flow, volume of vehicles evacuating, and monitor incidents. |
| Highway Advisory Radio | Develop communication plan to provide information regarding primary and secondary evacuation routes and incidents to the public. |

# Vulnerable Populations

This section identifies strategies specifically for evacuation of vulnerable populations[5]. The City can use demographic data and U.S. Census data to identify vulnerable population locations and communities. City staff and emergency response teams may work with specialized organizations such as hospitals, medical associations, public service organizations, public health staff, and other providers or community groups to identify relevant population segments and the types of assistance needed. Table 8 outlines considerations by need.

**Table 8: Additional Steps for Evacuation of Vulnerable Populations**

| Special Need | Additional Steps/Considerations |
|---|---|
| Visually impaired | May be reluctant to leave familiar surroundings when the request for evacuation comes from a stranger. People who are blind or partially-sighted may have to depend on their guide dogs and/or others to lead them to safety. |
| Hearing impaired | May need to make special arrangements to receive evacuation warnings. |
| Mobility impaired | May need special assistance such as paratransit. |
| People without vehicles | May need information provided about public transit routes and services for evacuation, or other private sector transit services. |
| Non-English-speaking persons | Translated materials should be prepared to support communication to Non-English-speaking populations including during evacuation. |
| People with medical conditions | May need help responding to emergencies and getting to an evacuation shelter. Should know the location and availability of more than one facility if dependent on dialysis machine or other life-sustaining equipment. |
| Unhoused (Homeless) population | May need to leverage pre-existing unhouse (homeless) shelter expertise in finding adequate housing and transportation. May need to provide resources for free to unhoused populations during evacuation. |

# Public Education

This section discusses the information that will be most beneficial in helping the general public preparing in advance of an evacuation. The public education process by the City should consider covering the following topics:

- Meaning of different types of evacuation orders;
- How evacuation orders are declared and communicated to the public;
- Provide information on preparations to carry out in advance (such as emergency "go" kits or family evacuation plans);

[5] *Using Highways for No-Notice Evacuations: Five Planning Considerations*, FHWA, Accessed August 2022.

- Conduct a public affair campaign to distribute easy-to-read evacuation maps with alternate routes;
- Provide information on available transportation options, including for vulnerable populations; and
- Provide information on evacuation shelters and support services offered during evacuation.

## Resource Management

Evacuations are extremely resource-intensive events that require significant personnel, facilities, and equipment to implement successfully. The City should determine what resources they have available as well as what resources they will need to perform their allotted roles during an evacuation successfully, which can include the following:

- Clarity on staff personnel's roles and expertise available;
- Facilities available (e.g., traffic operations center, shelters, etc.);
- Available information systems to support the evacuation (e.g., ITS, computer networks, ancillary hardware such as cameras, road sensor loops, etc.);
- Communication systems (e.g., landline, mobile phones, radio system, email, sirens);
- Vehicles/transports (e.g., staff transport, tow trucks, transit vehicles, heavy equipment); and,
- Miscellaneous materials to support implementation of evacuation strategies (e.g., traffic cones, channeling devices, static signs).

If critical resource gaps are identified, the City is recommended to work with other evacuation entities to determine additional resources and needs. The City may also work with private sector to expand the resource base. Private service companies such as ambulance operators, and towing companies can provide additional assets during evacuation. These companies can clarify what is expected of them during a potential evacuation event to ensure their services are available, when needed.

# NEXT STEPS

This memorandum describes the results of the evacuation analysis as well as evacuation planning considerations and strategies to help improve the capacity and resilience of the City's roadway network to support future evacuation events. This information will be used to frame supportive policies for the Safety Element update. These strategies and policies can be used to identify potential evacuation resiliency improvements throughout the City.