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Re: *City of Monterey,CA*
Evacuation Route Capacity Assessment
Monterey, California

Kimley-Horn and Associates, Inc. ("Kimley-Horn" or the "Consultant") is tasked to conduct an evacuation route capacity analysis for the City of Monterey General Plan Update. This provides an assessment of roadway capacity under the described wildfire and flood scenarios in compliance with SB99 and AB747.

Introduction and Purpose

This document is an assessment of the City of Monterey's roadway capacity during a variety of evacuation scenarios. It evaluates the ability of the roadway system to accommodate an evacuation event under a worse-case scenario in the City of Monterey. A worse-case scenario for this analysis is defined as two simultaneous natural events (wildfire and flooding). The purpose of this is to test the roadway under a worst-case scenario, that is a short-notice evacuation. During short notice evacuation worse case scenario, it wouldn't be reasonable to assume to coordinate complex instructions and or Presidio. Coordination with other agencies and establish required traffic controls. Under the circumstances, they are encouraged to navigate to well-established routes they know.

Background

Recent regulations related to emergency evacuation that are addressed in this assessment include the following bills and guidelines passed by the State of California.

- Assembly Bill (AB) 747: Local governments must update their safety elements to identify evacuation routes and their capacity, safety, and viability under a range of emergency scenarios. This requirement applies to all safety elements or updates to hazard mitigation plans completed after January 2022.
- Senate Bill (SB) 99: Local governments must update their safety elements to identify residential developments in hazard areas that do not have at least two emergency evacuation routes.
- State of California, Office of the Attorney General Best Practices for Analyzing and Mitigating Wildfire Impacts of Development Projects Under the California Environmental Quality Act (CEQA): This guidance document recommends that local governments use evacuation modeling and analysis to assess the impact of new development on evacuation and emergency access.

In other words, California law now requires local governments to consider evacuation routes and emergency access when planning and approving new developments in high wildfire-risk areas. This assessment uses evacuation modeling and analysis to assess the ability of the City's transportation system to provide adequate emergency evacuation capacity during a wildfire and flood evacuation, considering areas under very high wildfire and/or high flooding risk.

Evacuation analysis is done by evacuation modeling. This is a systematic approach used to simulate and plan the movement of people from areas at risk to places of safety. It involves the use of computer-based models and real-world data to predict how individuals and vehicles will respond and move during an evacuation.

Key Components of Evacuation Modeling:

- Geographical Data: Data about the area under threat, including road networks, population density, and hazard zones. This information helps us understand the physical layout of the region.
- Behavioral Data: Data about how people typically behave during evacuations. This includes factors like the time it takes for individuals to decide to leave, how they choose their evacuation routes, and their preferred modes of transportation.
- Transportation Infrastructure: Understanding the capacity of the roadways, bridges, and public transportation systems is critical.

One of the crucial indicators in evacuation modeling is the "volume over capacity ratio." This ratio indicates whether there are too many vehicles on the roads compared to what the roads can handle comfortably.

- Volume: This refers to the actual number of vehicles and people trying to evacuate.
- Capacity: Capacity represents the maximum number of vehicles and people that the transportation infrastructure can handle without causing congestion and delays.
- Ratio: When the volume exceeds the capacity, it results in a high volume over capacity ratio, indicating potential congestion and delays in the evacuation process.

SB 99 Accessibility Analysis

Kimley-Horn reviewed the evacuation routes and evacuation shelter area (Monterey Fairgrounds) provided by the city, which are attached to this report as Attachment 1. Under a short-notice evacuation condition, the shelter is not a consideration and is not being activated under the modeling scenarios. Monterey Fairgrounds would be used for long-notice evacuation destinations. The review process focused on identifying wildfire and flooding hazard zones and how these zones/areas would impact evacuation routes and evacuation capacity. From Monterey Bay, the City has steep slopes and constrained road access, and the Presidio of Monterey creates a major east-west barrier within the City for roadway access. These constraints limit the number of available evacuation routes, as described below:

- Topography and the Pacific Ocean limit access to the west such that emergency access is limited to the following roadway facilities such as:
    - Veterans Dr
    - Skyline Dr
    - Via Del Rey
    - Via Gayuba
    - Pacific St
    - Mar Vista Dr
    - Soledad Drive
- The Presidio of Monterey limits access to the northwest of the city such that emergency access is limited to:
    - Lighthouse Ave

A review of hazard zones shows that the city's south/southeast and west regions exhibit a very high risk of wildfire and

a high risk of floods (Attachment 1), as described below:

- Parts of Josselyn Canyon and the Flats (Wildfire)
- East of Holman Highway (Wildfire)
- East of Highway 1 and west of La Mesa Village (Wildfire)
- Monterey Bay Park, Del Monte Avenue, Camino El Estero, and Camino Aguajito (Floods). Based on FEMA hazard maps, and the adopted city of Monterey GP in 2019, Lighthouse Ave tunnel is not a high-risk flood zone area. However, it is understood that tunnel floods during heavy rain events. Fremont Street would continue to be the primary evacuation route for the designated areas. This analysis is only focusing on the worst-case scenario analysis for the highest-risk zones. Nevertheless, since Del Monte Ave is closed, the traffic is already being diverted to Fremont Ave. It means that Lighthouse Ave is not being used.

In a worst-case scenario, all southern conduits such as Highway 68 could be blocked for neighborhoods such as Skyline, and Monterey Vista, cutting off the northwest of the City such as New Monterey, Presidio, and Pacific Grove. Furthermore, during a short-notice evacuation, evacuees are encouraged to navigate to well-established routes they know and move away from the hazard areas as far as possible.

To address this risk, two destination points (shown in Attachment 2 and Attachment 3) have been identified on the east and northeast sides of the city in compliance with the available evacuation routes. The destination selected on the north is located at Highway 1 at the Fremont Blvd/Del Monte Blvd Interchange and Seaside The destination selected on the east is located on Highway 68 at York Road in Ryan Ranch. Evacuation access across the city was assessed by looking at how far people would possibly have to travel during an event. This methodology offers insights into evacuation accessibility and aids in pinpointing communities that might confront heightened risks amidst evacuation occurrences. To do this, we used the city parcels to evaluate the accessibility of the neighborhoods. The assessment, illustrated in Attachment 2 and Attachment 3, identifies the shortest distance to those two exit points.

Constrained Parcel Groups

The analysis was conducted to identify residential parcels in the city and within hazard zones that are restricted to a single emergency access route. Note, that the city's designated zones for wildfire and flood hazards are situated in contrasting locales, resulting in distinct clusters of constrained parcels and roadways pertinent to each type of hazard.

Having parcels with constrained access is highly detrimental during an evacuation, as it significantly impedes the swift and orderly movement of residents to safer locations. Such limitations can lead to congestion, delayed emergency response times, and heightened risk to life and property, especially in high-risk areas where rapid evacuation is imperative due to imminent threats. Attachment 4 delineates the mapped locations of all constrained residential parcel groups located in the city.

Attachment 5 outlines constrained parcels located in the areas of Skyline Forest, Monterey Vista, and smaller portions of Old Town neighborhoods which are at heightened risk of wildfires and are restricted to a single emergency access route. Attachment 6 indicates constrained parcels in The Flats neighborhood situated to the southeast of Monterey-Salinas Highway (SR 68), that are also under very high wildfire hazard risk and are restricted to a single emergency access route. Attachment 7 indicates the areas and parcel groups with limited access under potential high-flooding risk such as Del Monte Beach and Lake El Estro.

Evacuation Route Capacity Assessment

The assessment of route capacity was conducted consistent with AB 747 requirements, particularly focusing on its capability to facilitate an evacuation during wildfires and/or floods. The relevance of AB 747 lies in its mandate to ensure the optimal utilization of transportation systems during evacuations, and it attempts to provide a structured approach to analyzing and enhancing existing setups.

When undertaking this review, reasonable assumptions were made to facilitate the analysis and allow for more streamlined and focused research. The nature of evacuation scenarios is complicated and involves many of unpredictable and dynamic elements. With the abundance of variables, ranging from human behaviors to the suddenness of events, factoring every possible scenario is not possible. Given this complexity, it is pivotal to introduce assumptions to create a manageable framework that allows us to run specific scenarios and derive meaningful insights and conclusions that can guide further detailed investigations and refinements of our models.

Two distinct areas were identified in collaboration with city staff as

- Very High-Risk Fire Hazard Zones (VHFHZ) are indicated in the Attachment 8.
- High-Risk Flood Zone also indicated in Attachment 8.

For the very high-risk fire hazard zones (VHFHZ), evacuation analysis was only conducted for the area located in the Skyline, Monterey Vista, and parts of Old Monterey areas as discussed with city staff. The very high-risk wildfire area in the Flats has evacuation routes along Aguajito Road and Josselyn Canyon Road. Further evacuation analysis is not required for this area.

Modeling Assumptions

- The analysis focuses on the Skyline, Monterey Vista, Old Monterey area, and the high-risk flood zone area as depicted in Attachment 8. The Flats were assessed qualitatively.
- The analysis is based on a single, multi-hazard evacuation scenario, which represents a worst-case situation encompassing both very high fire hazard (Local Responsibility Area) and high -flood risk. The analysis aligns with the city of Monterey's 100-year flood zone and FEMA's 1% annual chance of flood hazard maps that estimate the high chance of flooding on Del Monte Ave, Camino El Estero, and Camino Aguajito. Note that FEMA flood maps show how likely it is for an area to flood. Any place with a 1% chance or higher chance of experiencing a flood each year is considered to have a high risk. Those areas have at least a one-in-four chance of flooding during a 30-year mortgage. FEMA’s 1% annual chance of flooding is used for evacuation analysis.
- The evacuation notice is a short notice, issued abruptly early in an off-peak when all residents are at home and evacuation demand traffic would be at its highest. The off-peak is defined as hours outside of the morning and afternoon peak periods that occurs 6 AM-9 AM and 4 PM-7 PM.
- Given the short notice for an evacuation, it is assumed that all evacuee traffic will enter the transportation network at the same time. Typically evacuation occurs in an S-curve in which most trips occur in a short time. In addition, the AMBAG Travel Demand model cannot simulate an S-curve evacuation. This analysis produces slightly conservative results, which is acceptable for the purposes of this analysis.
- No evacuation is assumed for Pacific Grove since the fire location poses a direct threat to Monterey only.
- For the purpose of this analysis, traffic is directed towards designated evacuation routes.
- This analysis does not account for "shadow evacuees" – individuals who depart even if not explicitly instructed to.
- All evacuees who head towards two exit destination points (shown in Attachments 2 and 3) have been

identified on the east and northeast sides of the city in compliance with the available evacuation routes. The destination selected on the north is located at Highway 1 at the Fremont Blvd/Del Monte Blvd Interchange and Seaside The easterly destination point selected is located on Highway-68 at York Road in Ryan Ranch. Given the short-notice evacuation, the evacuation shelter would have not been prepared in advance, so it is not related to short-notice evacuation.

- The number of evacuees per vehicle is determined using household size and vehicle ownership data based on the Association of Monterey Bay Area Governments (AMBAG) Travel Demand Model (TDM) which includes LEHD, Census, American Community Survey (ACS), and local data.
- Roadway capacities adhere to existing conditions.
- Background traffic which would be already on the network when an evacuation occurs compromises 15% of the capacity of the roadways in off-peak. This traffic is referred to as the unaffected background traffic for an evacuation event.
- This analysis does not assume any evacuation from people using boats or airlifts.
- Holman Highway is operating with 10% capacity as an evacuation route because of its location of proximity to high-risk wildfire. This 10% is only available for dispatch units as well as other operational vehicles. Local streets, collectors' streets, and arterials will be utilized to gain access to gain access to Highway 1 to evacuate to destination points. As shown in Attachment 8, the area notably lacks proximal evacuation routes.
- Due to flooding risks, Del Monte Boulevard is inaccessible between Camino El Estero and Camino Aguajito, as per the 100-year flood zone. The tunnel flooding also cuts of access to Del Monte Boulevard between the tunnel and the flood zone.
- The scenario analysis employs the most recent AMBAG model. This model, accommodating the Sixth Cycle RHNA projections for the City of Monterey and all other jurisdictions on the Monterey Peninsula, integrates the updated land use and accompanying projections Additionally, the model has been updated to account for actual 2015 employment levels in the City.

Land Use

The assessment was executed focusing on the scenario for emergency evacuation that evacuates all households and employment shown in Attachment 8. To approximate the number of vehicles involved in such evacuations, references were made to the number of inhabitants, expected vehicle ownership per household, and the number of employees within the designated area. The information regarding land use within the evacuation zone for the evacuation route capacity analysis is summarized in Table 1.

Table 1 Evacuation Zone Land Use

Households	1,506
Population	3,314
Employment	1,048
Source: AMBAG model 2031 Build-out Projections	

In creating this scenario, several key land use assumptions have been made. One such assumption is the notion that households without access to a personal vehicle would inherently depend on external support to evacuate. This element is crucial, and while it was not the main focus of this assessment, it raises a significant point of consideration for the City. The development of programs or initiatives, potentially involving public transit or community-based solutions, could be vital in ensuring the seamless evacuation of such households, contributing to the overall efficacy and inclusiveness of our evacuation strategy.

It is presumed that employment centers would undertake the responsibility of facilitating the evacuation of employees lacking personal vehicles to the extent that employees would be at their place of work at the early off-peak time of day assumed for the multi-hazard scenario. This assumption is integral to creating a comprehensive evacuation model that encompasses not only residents but also the working population within the area, ensuring that all individuals, regardless of their access to personal transportation, are accounted for and assisted during emergency evacuations.

Another layer of our assumptions delves into the practical utilization of vehicles within multi-vehicle households during an evacuation. Specifically, it is assumed that households possessing more vehicles than licensed drivers would inevitably face limitations in mobilizing all their vehicles when an evacuation is warranted. For instance, households with three or four vehicles, but inhabited by only two licensed drivers, are anticipated to leave some vehicles behind. This assumption is not a trivial one; it impacts the accuracy of our vehicle flow models and helps in refining the projections related to traffic volumes and congestion levels during evacuation events. Table 2 provides the total vehicle trips based on the assumptions discussed above.

Table 2 Evacuation Demand

Zero Vehicle Households	1	64	64
One Vehicle Households	1	486	486
Two Vehicle Households	2	564	1,128
Three Vehicle or more Households	2.5	392	980
Employees	1	1,048	1,048
TOTAL			3,706

Model Analysis and Results

Based on the land use and modeling assumptions, Kimley-Horn has developed a model using a software called CUBE to simulate the evacuation scenario. The results of the model analysis are illustrated in evacuation volume over capacity plot shown on Attachment 9. The results reveal that the evacuation proceeded through three local corridors: Skyline-Veterans Drive, Via Gayuba-Martin Street-El Dorado Street, and Mar Vista Drive-Soledad Drive. Evacuees navigated these corridors to access the main evacuation routes: Highway 1, Munras Avenue, and Fremont Street.

The volume over capacity plot (Attachment 9) only shows the roadway segments with V/C ration higher than 0.08. The plot indicates that the evacuation-induced traffic volumes largely remained below the capacity within the evacuation zones and their immediate vicinities. However, volumes surpassed capacity as traffic approached Highway 1, specifically at the interchanges of Fremont Street-Highway 1, and Soledad Drive-Highway 1. Upon accessing the primary evacuation routes, the traffic conditions are favorable, with sufficient capacity to facilitate a smooth evacuation, as depicted in Table 3. The V/C indicates that evacuation does not impact traffic down Lighthouse Avenue On a systemwide basis, the roadways have adequate capacity for an evacuation. The analysis indicates that the overall capacity is 9,300, and the evacuation demand is 3,706 vehicles.

This analysis indicates that the existing roadways possess adequate capacity to accommodate evacuation traffic. However, it's pertinent to acknowledge the inherent unpredictability and potential irregularities in driver behavior during emergency scenarios.

Table 3 Evacuation Route Capacities

Highway 1	2	3,600
Munras Avenue	2	3,000
Fremont Street	2	2,700
Total		9,300
The evacuation capacity refers to the roadway capacity being reduced by 15% because of the background traffic		

Tsunami and Evacuation

In the event of an earthquake, it quickly generates a tsunami that reaches Monterey's coastline within minutes. This seismic event may also lead to a landslide in the Monterey Canyon. It is anticipated that earthquake sirens and tsunami warnings will be activated promptly.

Areas at risk of flooding (Attachment 10), including neighborhoods like Old Town, should be prepared for residents to move to higher ground which may be a few blocks away without delay. Unlike wildfire evacuations, there may not be enough time for a traditional evacuation process. If a tsunami is generated further out in the Pacific Ocean, the city will have a longer lead time for orderly evacuation utilizing all city streets before the tsunami wave arrives.

In the Canary Row-Lighthouse district, residents at risk of a tsunami's impact would need to move uphill, roughly beyond the Canary Row/Monterey Bay Scenic Trail. Attachment 10 also highlights that the Lighthouse curve would be prone to flooding, including the risk of the Lighthouse Tunnel submerging, along with several downtown blocks. In response, residents in these locations should promptly evacuate uphill upon hearing tsunami warning signals generated when the tsunami originates from the Monterey Canyon.

As for the Lake El Estero area, it is expected to suffer the most severe flooding during a tsunami event, affecting both Del Monte Ave and Fremont Street. Attachment 10 indicates evacuation patterns that are recommended due to a worst-case tsunami.

Engagement with at-risk communities should emphasize community-centric planning, focusing on those threatened by tsunamis. Simultaneously, an all-encompassing response and recovery strategy must be devised, encompassing the coordination of critical services such as law enforcement, rescue services, emergency medical services (EMS), and public utilities. This comprehensive approach ensures that essential functions are maintained, and recovery efforts are efficiently orchestrated in the aftermath of a tsunami.

Qualitative Assessment of Potential Evacuation Route Constraints in Adjacent Cities

When considering the potential evacuation route constraints for Monterey, CA, and its adjacent cities like Pacific Grove, Seaside, and Sand City, it is imperative to incorporate a qualitative discussion focusing on the unique geographical and infrastructural elements of each area. Below is a qualitative discussion examining various aspects and considerations regarding the adjacent cities:

- Pacific Grove:

Pacific Grove's proximity to the coastline and rugged terrain poses significant constraints to the development and utilization of evacuation routes. The limited road capacity and possible bottlenecks at key intersections could significantly hinder the flow of evacuation traffic, especially during a mass evacuation scenario. Additionally, the presence of residential areas intermingled with natural habitats can exacerbate the risk of wildfires, necessitating well-coordinated and effective evacuation plans.

- Seaside:

Seaside's urban density and potentially congested roadways can act as a bottleneck during evacuation, limiting the mobility of evacuating residents. The interaction between local and through traffic, especially during peak hours, can constrain the effectiveness of evacuation routes. Additionally, specific attention needs to be paid to the synchronization of traffic lights and effective traffic management to prevent gridlocks during evacuation.

- Sand City:

Given its smaller size and industrial character, Sand City might experience constraints due to limited egress points and road network capacity. The presence of industrial complexes and commercial centers logistical hubs may necessitate additional planning to manage the evacuation of large vehicles and freight traffic, which could obstruct regular vehicular movement.

- Carmel-by-the-Sea:

The city's intricate layout, characterized by winding roads and residential zones interspersed with wooded areas, presents substantial constraints during high-pressure evacuation scenarios, particularly during wildfires. Given Carmel-by-the-Sea's status as a tourist destination, there could be an influx of unfamiliar drivers during an emergency, complicating traffic management and potentially causing confusion and delays during evacuations.

- SR68 towards Salinas:

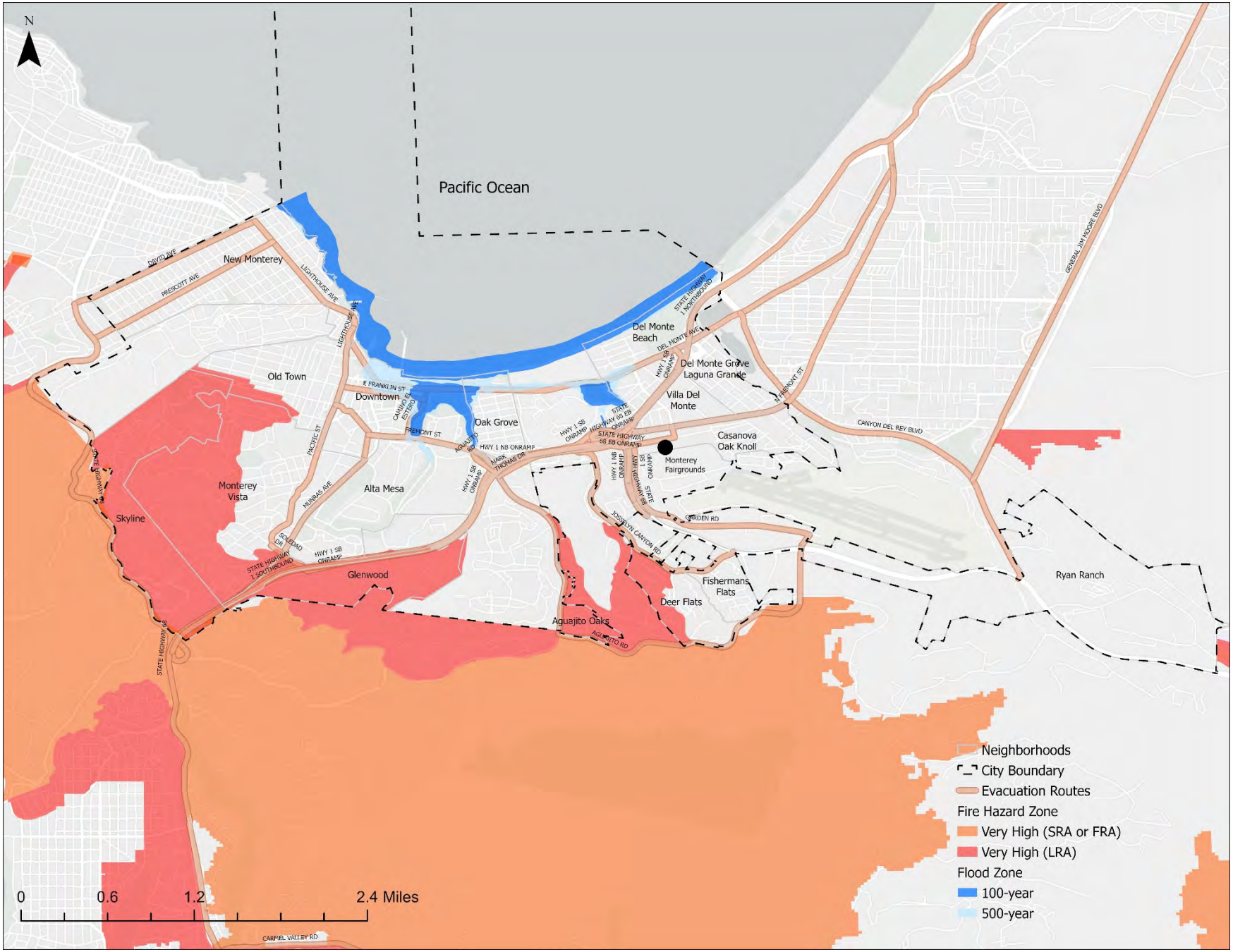
The SR68 corridor, serving as a critical connector between Monterey and Salinas, embodies various unique challenges that require thoughtful evacuation strategies. The corridor's significance as a primary artery for both daily commuters and freight transport elevates the importance of maintaining continuous traffic flow during evacuation scenarios. The existence of agricultural zones and the associated movement of agricultural vehicles and equipment require planning to prevent any obstruction to the evacuation traffic, ensuring a smooth transition of various traffic types during crises.

Recommendations

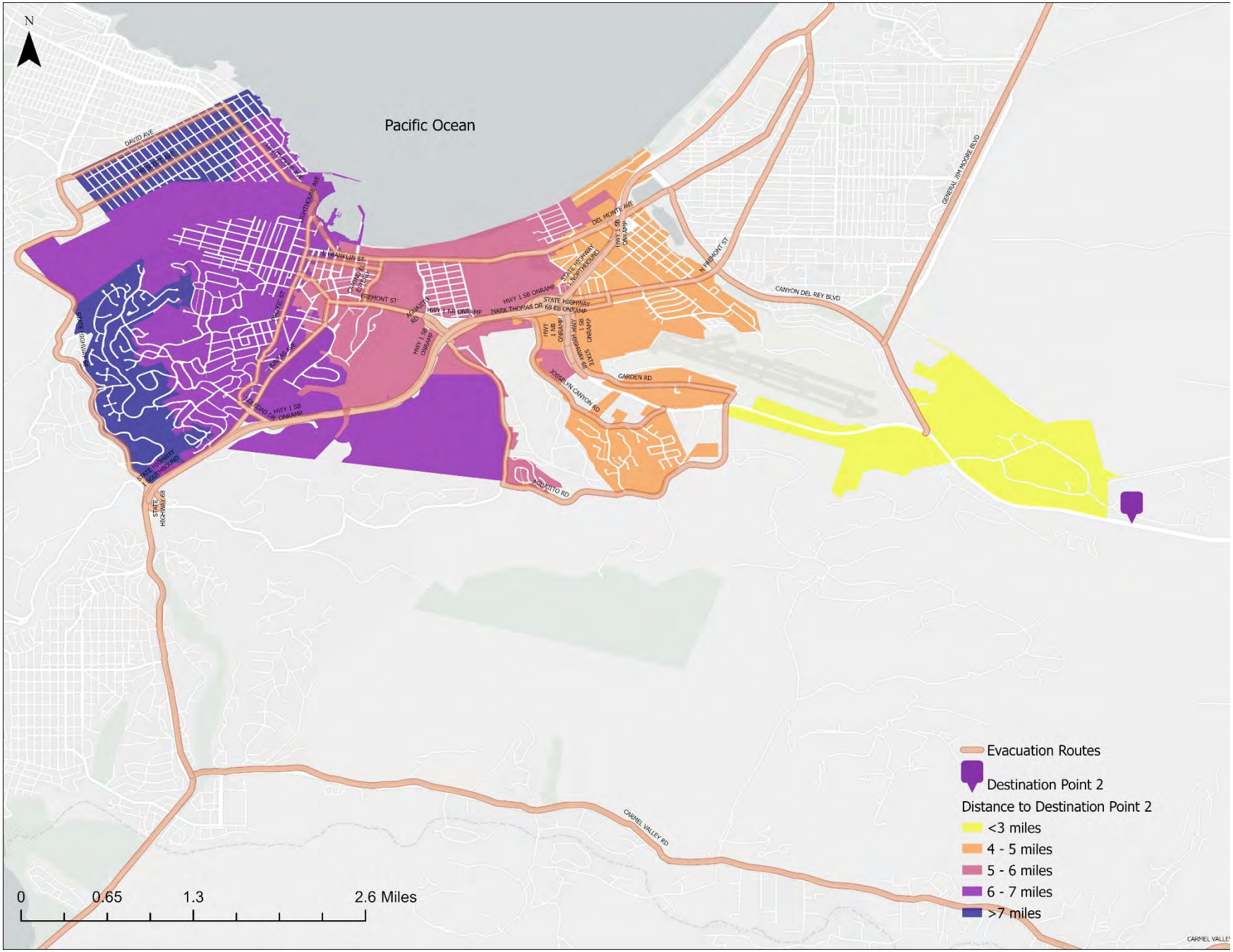
The City of Monterey is characterized by its diverse geographical features and unique neighborhoods. Given the importance of addressing evolving emergency evacuation needs, particularly in areas such as the southwestern neighborhoods, the following comprehensive recommendations can enhance evacuation strategies, focusing on addressing areas with high volume-to-capacity ratio, optimizing roadway designs, and fostering robust connectivity, all with an aim to ensure the safety and well-being of the residents.

- Address potential bottlenecks by temporarily widening highway ramps by placing traffic cones to indicate two lanes to accommodate a higher volume of evacuating vehicles, mitigating congestion and delays.
- In high-risk areas, consider of evacuation capacity during roadway design and maintenance initiatives. For instance, considering painted medians over raised medians can significantly increase evacuation capacity and flexibility, however, roadway safety is paramount and careful consideration must be taken when determining how to design a median.

- Deploy adaptive traffic signal control systems that dynamically respond to real-time traffic conditions, giving priority to evacuation traffic, and ensuring efficient traffic flow during emergencies.
- Install clear and comprehensive signage and wayfinding to facilitate smoother traffic flow, directing residents effectively to evacuation routes.
- Employ dynamic message signs, roadway sensors, and other ITS tools to disseminate real-time traffic conditions, alternative routes, and delays to drivers, enhancing situational awareness and decision-making.
- For neighborhoods with limited access points, provide additional emergency access roads to facilitate smoother evacuation processes.
- Develop and improve connectivity between different neighborhoods to provide alternative evacuation routes, alleviating pressure on the primary access points.
- Ensure road surfaces can withstand all weather conditions and are maintained to accommodate increased traffic during evacuations.
- Coordinate with transit agencies and other bus operators to provide organized public transportation, like buses, to transport residents lacking personal vehicles, subsequently reducing the total number of vehicles on the road during evacuations.
- Work with adjacent cities like Pacific Grove, Seaside, and Sand City to synchronize evacuation efforts and manage regional traffic flows efficiently.
- Educate and train residents about evacuation preparedness.



Attachment 1



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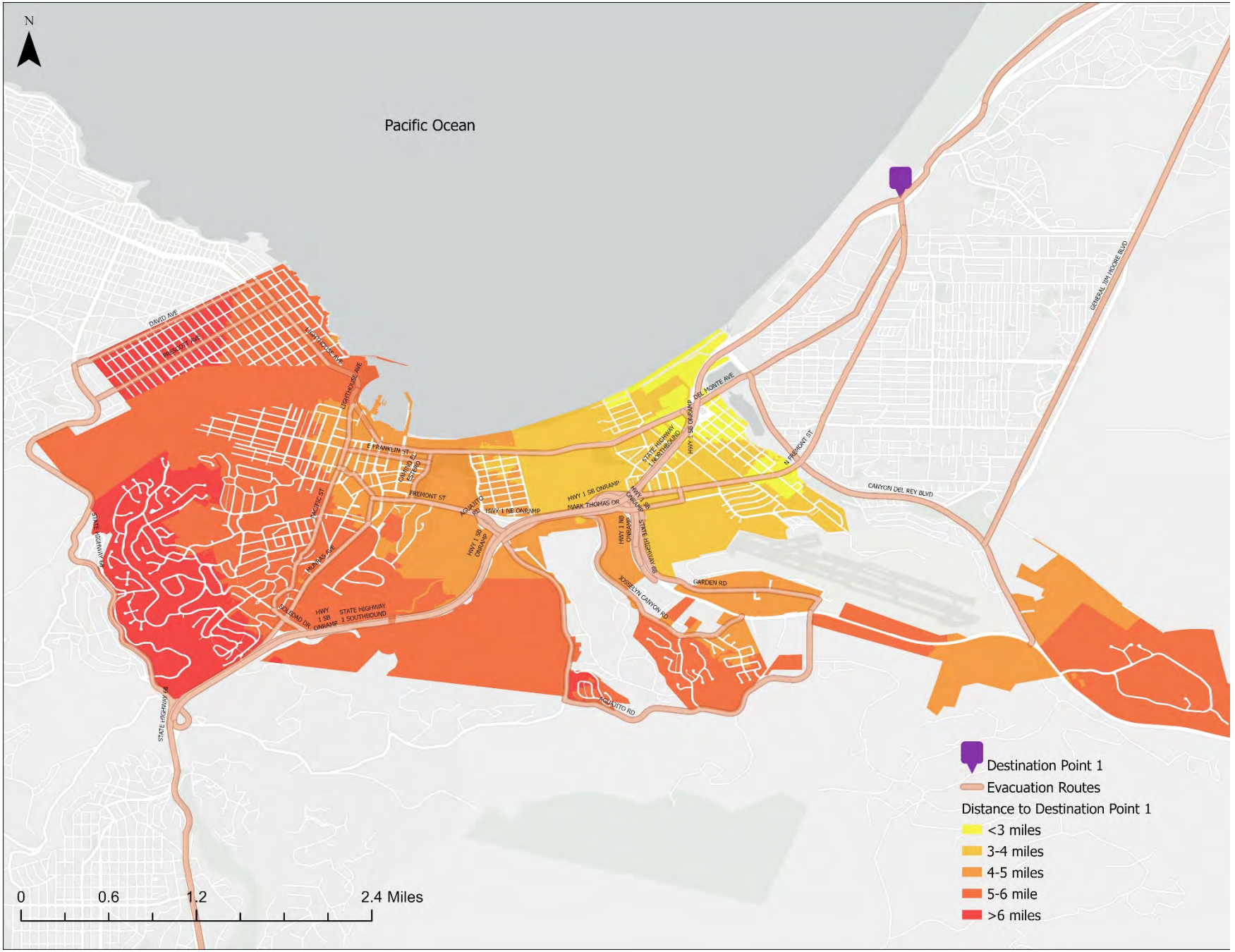

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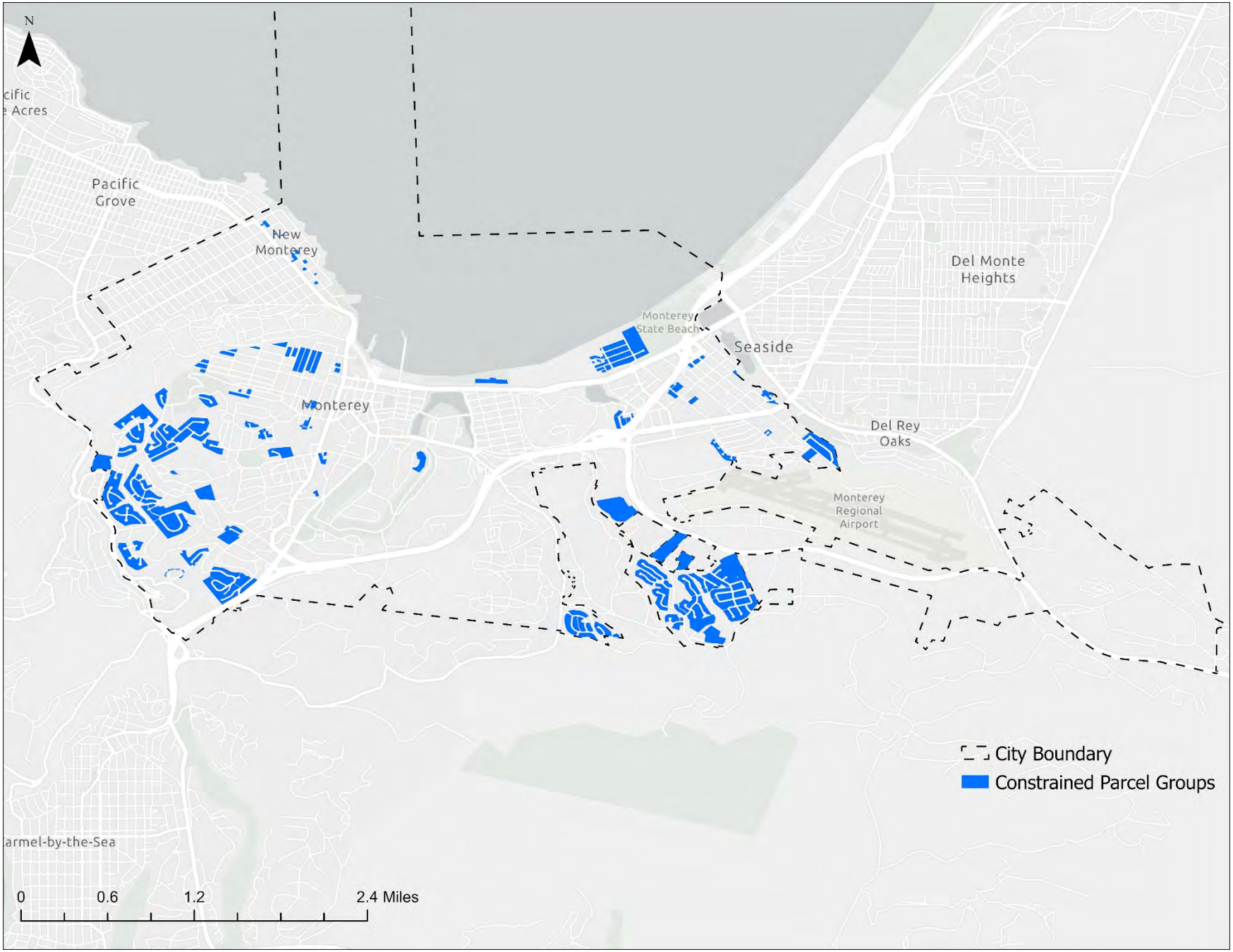

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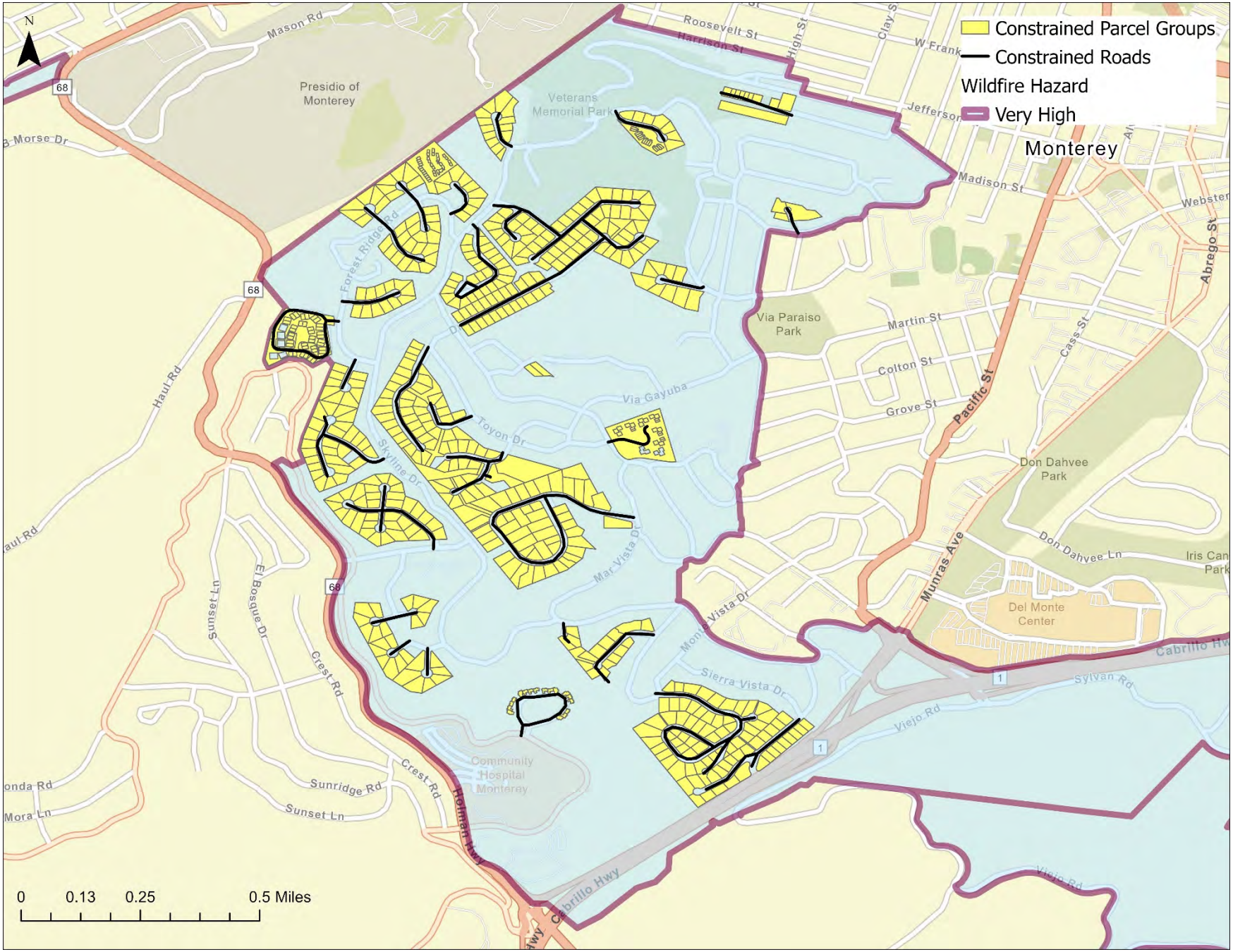

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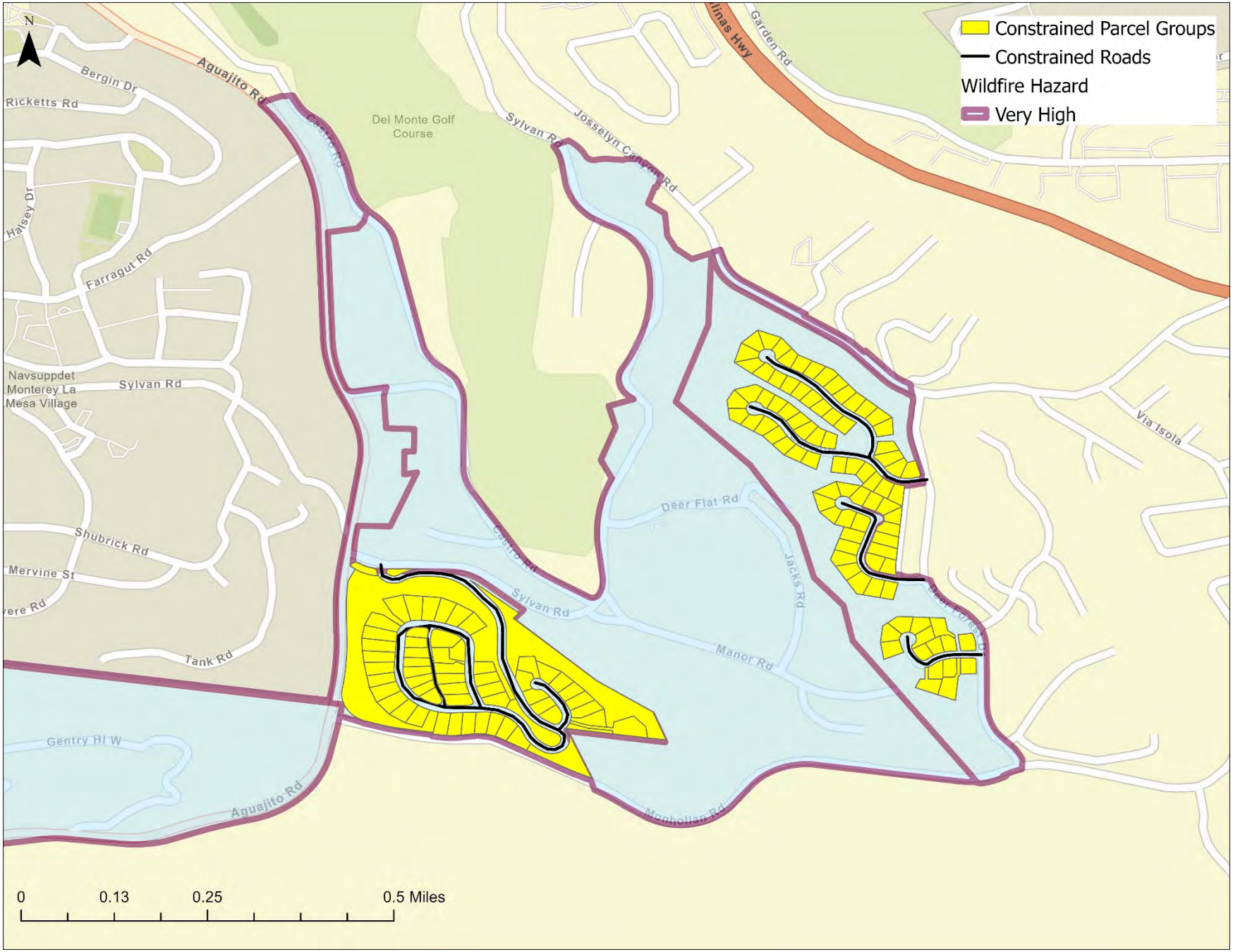

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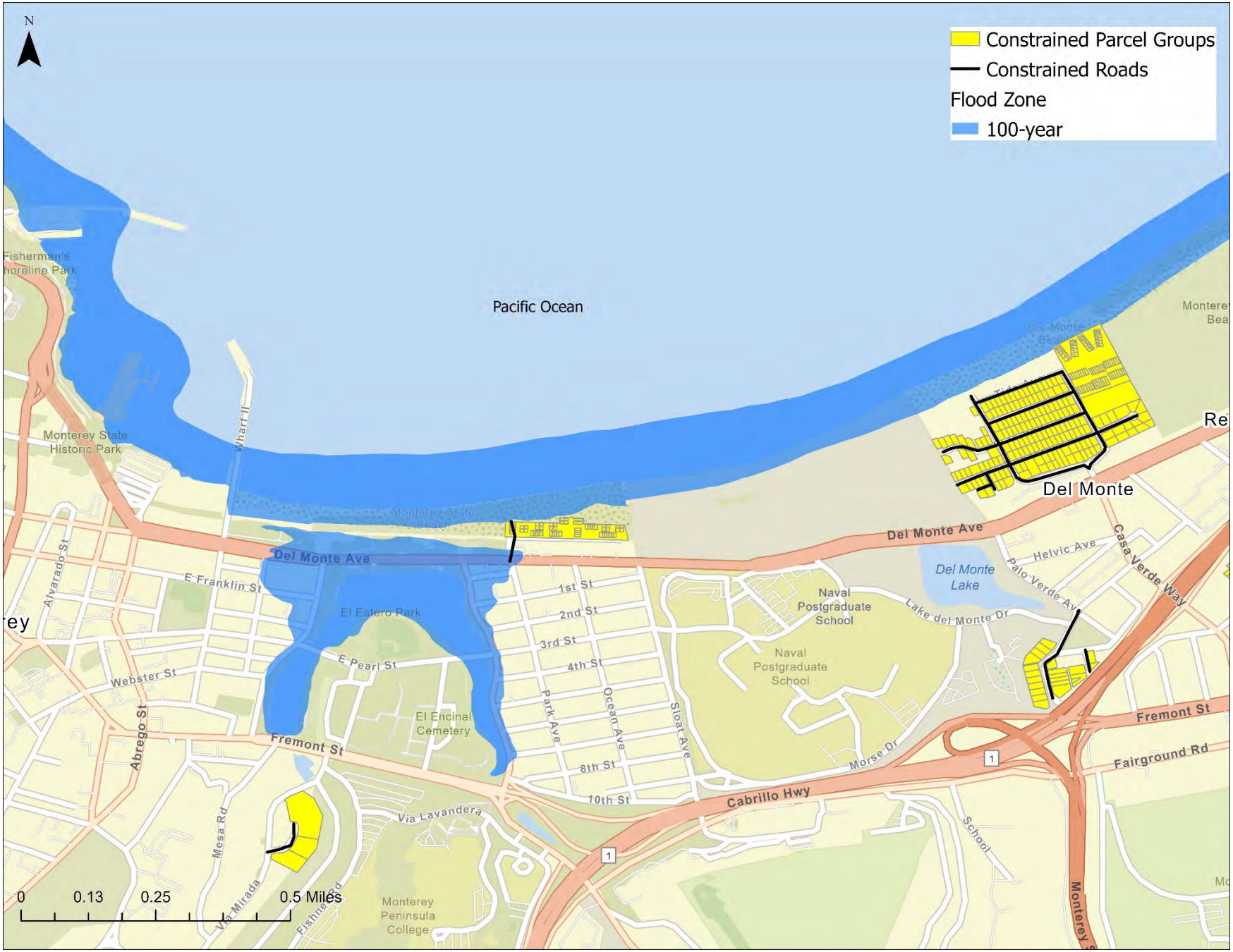

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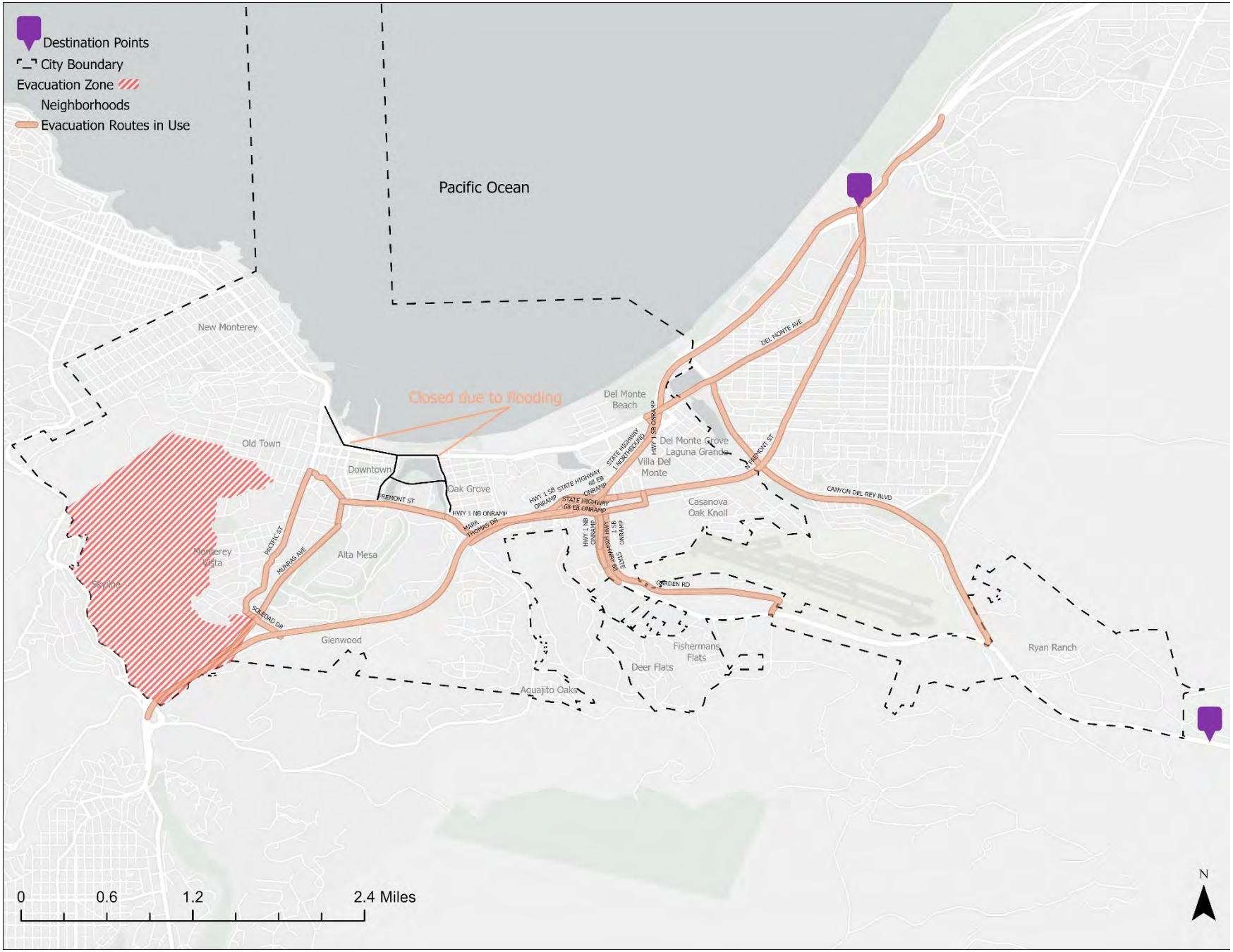
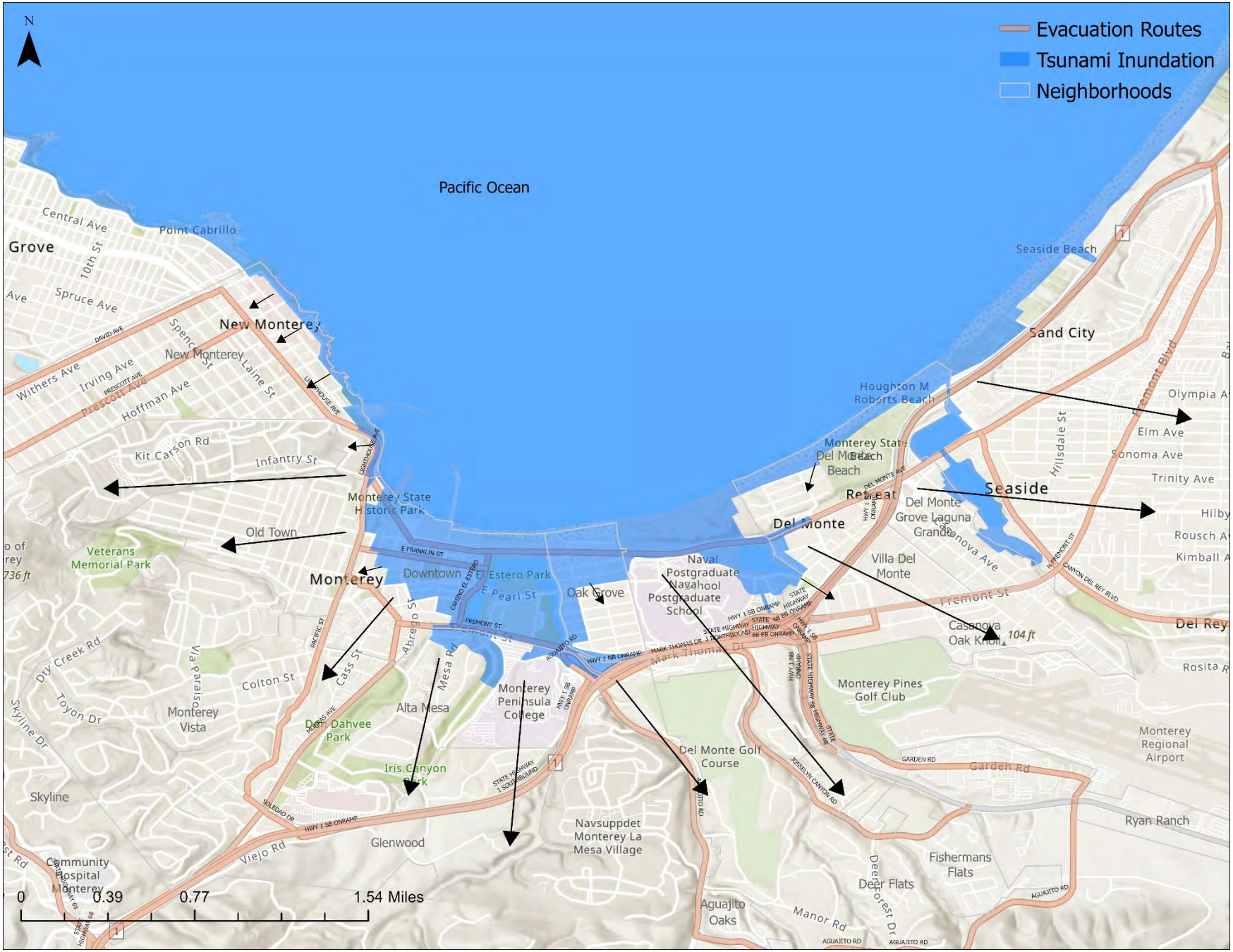


Attachment 8

Evacuation Volume / Roadway Capacity Ratio

Attachment 9



Attachment 10