Chapter 4. Risk Assessment

4.1 Introduction

Assessing risks is the second step in the four-step mitigation plan process. The risk assessment step includes four parts: identify hazards, profile hazard events, inventory assets, and estimate losses. Conducting a risk assessment is a way of asking and answering "what if . . ." questions. For instance, what if the Reservation receives several days of heavy rain?

The risk assessment answers questions regarding the history, location, frequency, probability, and impact of each hazard. These answers are used in the third step of mitigation planning: developing a mitigation plan. The risk assessment provides essential data to determine and prioritize mitigation measures.

The risk assessment update is formatted to meet the Federal Emergency Management Agency's (FEMA)'s tribal hazard mitigation planning regulations (as found in C.F.R. 44 201). FEMA requires the Pala Band of Mission Indians to include all possible natural hazard events, to assess vulnerability, and to estimate potential losses. Each hazard must include a description of the hazard, location, historical occurrences, extent (or magnitude), and vulnerability. In addition, all assets must be assessed for potential losses. Identified hazards and hazard profile details are described below.

4.2 Sources of Information

4.2.1 Local, State, and Federal Sources

Hazard information was collected for all hazards under consideration, using hazard studies, GIS data, and descriptions of previous events. This information is cited throughout the plan.

Local sources used in the risk and vulnerability assessment include:

- Information gleaned from interviews and meetings with Tribal officials
- Tribal reports, studies, plans, and memos
- Tribal insurance data
- Tribal geospatial data
- 2018 San Diego County Hazard Mitigation Plan
- Various County agencies (e.g., Public Health Services, Public Works)
- County studies and reports applicable to the planning area
- Local news sources

State sources used in the risk and vulnerability assessment include:

- 2018 California State Hazard Mitigation Plan
- California state agency studies, reports, web tools, and webpages applicable to the planning area (e.g., CalAdapt, CalFire)

Federal sources used in the risk and vulnerability assessment include:

- Agency studies, geospatial data, web tools, and reports applicable to the planning area, including but not limited to those from FEMA, the US Department of Agriculture (USDA) Forest Service, NOAA National Centers for Environmental Information (NCEI) Storm Events Database, the NWS, the US Drought Monitor, and the US Geological Survey (USGS)

4.3 Building Data

A total of 773 buildings were identified on the Pala Reservation. This total includes critical facilities that are buildings and several building types as shown in the table below. Building values were estimated using square footage and a regional multiplier for replacement value per square foot. Content values were estimated at 50% of building value for residential structures and 100% of estimated building value for other uses.

Table 6. Pala Reservation Building Types and Estimated Replacement Values.

Building Type	Number	Building Value	Content Value	Total
Agricultural	6	$1,576,308	$1,576,308	$3,152,616
Commercial	186	$94,771,445	$94,771,445	$189,542,890
Educational	6	$2,500,861	$2,500,861	$5,001,721
Religious	7	$5,467,004	$5,467,004	$10,934,008
Residential	566	$124,225,913	$62,112,957	$186,338,870
Other	2	$95,561	$143,342	$238,903
Total	773	$228,637,092	$166,571,916	$395,209,008

4.3.1 Critical Facilities

The following 66 assets have been deemed critical to the Pala Reservation. Critical facilities are considered structures or institutions necessary for the Reservation in terms of response and recovery from emergencies. These facilities must continue to operate during and following a disaster to reduce the severity of impacts and accelerate recovery.[12] Critical facilities typically include airports, emergency operation centers (EOCs), fire stations, hospitals, police stations, schools, government buildings, and railroad stations. The Pala Band of Mission Indians has identified several additional critical facilities

[12] Federal Emergency Management Agency, Local Mitigation Planning Handbook, Washington, Federal Emergency Management Agency, 2012. Available at: http://www.fema.gov/hazard-mitigation-planning-resources

because of their economic and cultural significance. Unfortunately, values could only be located for about half of the critical facilities. Of those critical facility building values identified, there is an approximate value of $394.7 million for building and/or contents at risk. This includes the Pala Casino Resort & Spa buildings. The table below lists the Tribe's critical facilities and associated values, when available. Critical facilities are presented in Table 7.

Table 7. Pala Reservation Critical Facilities.

Name	Building Value	Content Value	Total Value
Allers Lift Station	N/A	N/A	N/A
Avocado Groves (avocados)	N/A	N/A	N/A
Blacktooth House (Historical Property)	N/A	N/A	N/A
Casino Lift Station	N/A	N/A	N/A
Casino Well #1	N/A	N/A	N/A
Casino Well #2	N/A	N/A	N/A
Catalina Fields (alfalfa)	N/A	N/A	N/A
Catalina Well (North)	N/A	N/A	N/A
Cellular Communications Tower	N/A	N/A	N/A
Duker Grove (oranges)	N/A	N/A	N/A
Fallbrook Propane (Rental)	N/A	N/A	N/A
Fire Station Lift Station	$1,369,923	$0	$1,369,923
Fire Station Well (North)	N/A	N/A	N/A
Hanson Pond Conservation Easement	N/A	N/A	N/A
Highway Well	N/A	N/A	N/A
KOPA Radio Station	$359,091	$167,707	$526,798
Lilac East Well (South)	N/A	N/A	N/A
Lilac West Well (South)	N/A	N/A	N/A
McCament Grove (oranges)	N/A	N/A	N/A
Mission San Antonio de Pala	N/A	N/A	N/A
Oaks Booster Station (North)	N/A	N/A	N/A
Oaks Lilac Well (North)	N/A	N/A	N/A
Old Tribal Hall	$834,244	$39,667	$873,911
Pala (Fox) Raceway	$0	$29,797	$29,797
Pala Administration Building	$6,938,838	$1,263,309	$8,202,147
Pala Casino Warehouse	$2,645,110	$235,704	$2,880,814
Pala Casino, Resort and Spa	$265,726,548	$66,895,614	$332,622,162
Pala Child Care Center	$1,264,276	$51,020	$1,315,296
Pala Cultural Center	$854,982	$53,080	$908,062
Pala EOC and Training Center	$9,934,554	$2,051,973	$11,986,527
Pala Fire Station	$2,063,327	$76,760	$2,140,087
Pala Fitness Center	$4,202,988	$366,176	$4,569,164

Name	Building Value	Content Value	Total Value
Pala Fleet Department/Yard	$266,689	$3,473,147	$3,739,836
Pala Gateway (oranges)	N/A	N/A	N/A
Pala Learning Center and Library	$1,869,694	$308,808	$2,178,502
Pala Mini Mart, Gas Station and Canopies	$2,663,643	$538,519	$3,202,162
Pala Postal Annex	$245,046	$61,616	$306,662
Pala Rey Youth Camp	N/A	N/A	N/A
Pala RV Resort	$1,963,683	$216,718	$2,180,401
Pala Shooting Range	N/A	N/A	N/A
Pala Skatepark	$105,019	$123,996	$229,015
Pala Social Services Office	N/A	N/A	N/A
Pala Transfer Station	$1,263,678	$118,091	$1,381,769
Pala Tribal Law Enforcement	$418,848	$61,030	$479,878
Pala Tribal Services Department/Yard	$620,433	$84,499	$704,932
Pala Utilities Department/Yard	$1,054,022	$287,938	$1,341,960
Pala Vineyard (grapes)	N/A	N/A	N/A
Pala Wastewater Treatment Plant	$9,235,036	$0	$9,235,036
Pala Youth Center	$1,264,276	$24,412	$1,288,688
Rancho Luna Mia (animal husbandry)	$541,409	$0	$541,409
Riverbed East Well (South, new)	N/A	N/A	N/A
Riverbed West Well (South, west)	N/A	N/A	N/A
Robert's Ranch (oranges)	$511,903	$0	$511,903
San Juan Diego Center	N/A	N/A	N/A
TANF (Tribal Assistance for Needy Families) and TDV (Tribal Digital Village)	N/A	N/A	N/A
Trujillo Creek Well (North)	N/A	N/A	N/A
Valenzuela Well (South)	N/A	N/A	N/A
Vineyard Well (Raceway)	N/A	N/A	N/A
Vista Well (North)	N/A	N/A	N/A
Vivian Banks Charter School	N/A	N/A	N/A
Water Tank, Northeast Tank #1 (North)	N/A	N/A	N/A
Water Tank, Northeast Tank #2 (North)	N/A	N/A	N/A
Water Tank, Northwest Tank #3 (North)	N/A	N/A	N/A
Water Tank, Raceway (Raceway)	N/A	N/A	N/A
Water Tank, Southside Tanks #2 (South)	N/A	N/A	N/A
Water Tank, Southside Tanks #3 (South)	N/A	N/A	N/A

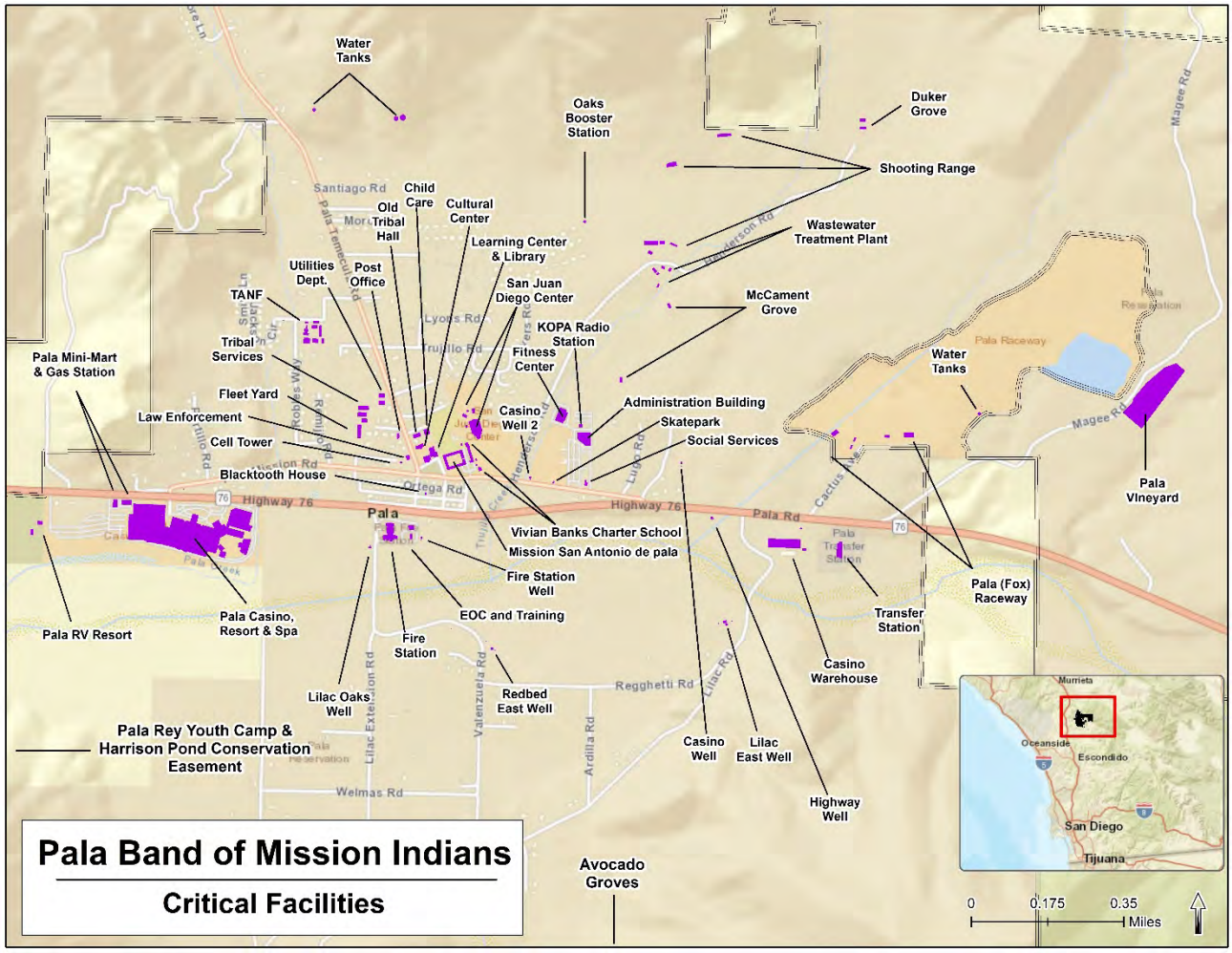


Figure 19. Pala Critical Facilities.

4.3.2 Changes in Development and Future Development

The risk assessment was updated to reflect changes in development. This included use of a revised parcel and building footprint data. New development on the Pala Reservation since the previous Plan includes a Skate Park and the Oaks Housing Subdivision. In addition, there is planned development including a new Housing Office (~6,000 sqft building near the training center) and a potential housing subdivision in the Allers area. Figure 20 denotes these locations as provided by Tribal officials.

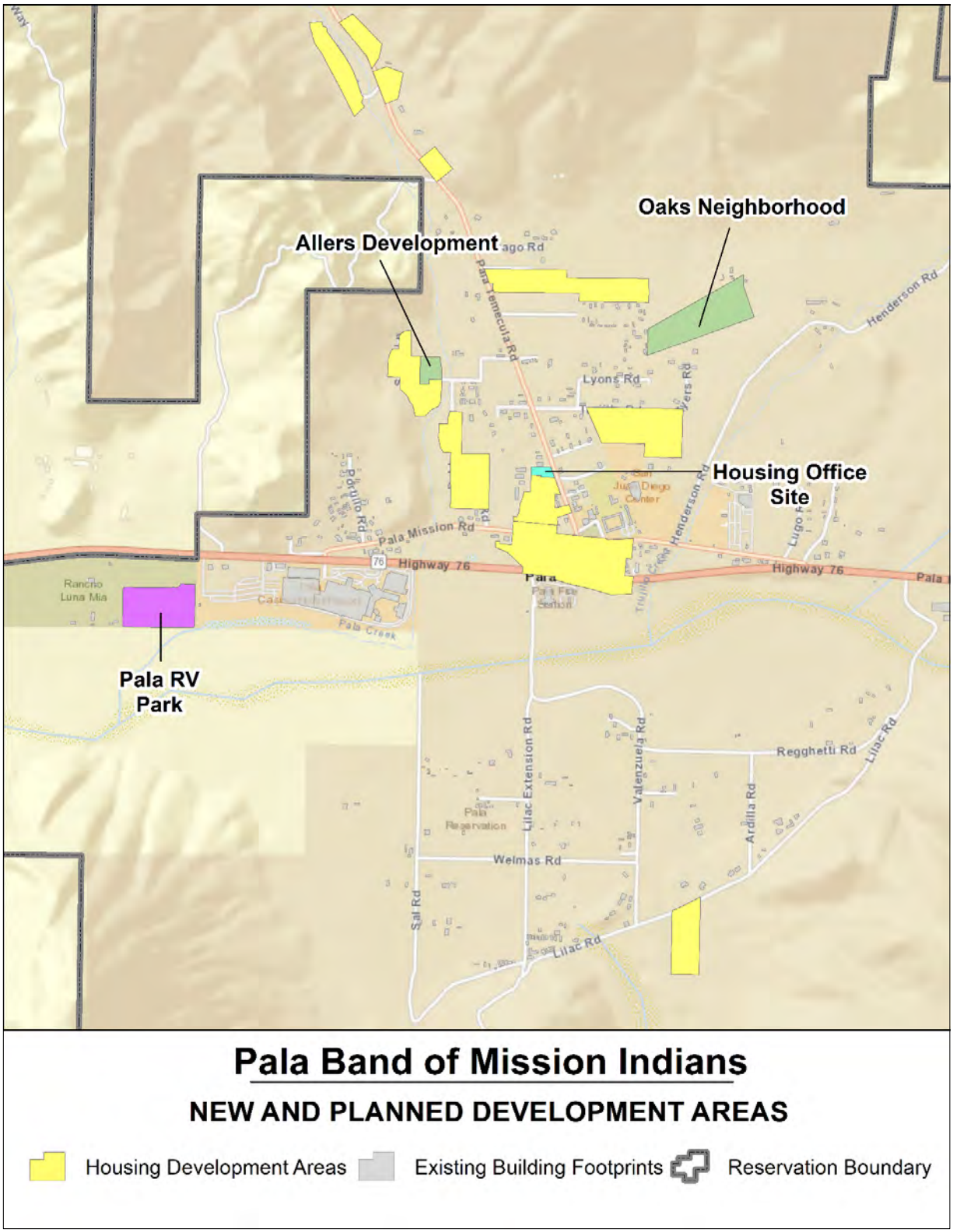


Figure 20. New and Planned Development on the Pala Reservation.

4.4 Risk Assessment Process and Tools

This risk assessment was conducted using both qualitative and quantitative approaches. The quantitative assessment utilizes a geographic information system (GIS)-based analysis. The qualitative approach draws on previous impacts in and near the planning area, as well as professional judgement, to determine vulnerability in the region and jurisdictions. More information on each approach is described below.

4.4.1 Quantitative Analysis

GIS

When possible, the vulnerability assessment for each hazard was completed utilizing a GIS-based analysis. Hazards that have specified geographic boundaries permit GIS analysis. These hazards include:

- Earthquake (Liquefaction)
- Flood
- Landslide
- Wildfire
- Dam failure

The objective of the GIS-based analysis was to determine the estimated vulnerability of critical facilities, cultural resources, and structures for the identified hazards on the Pala Reservation using the best available geospatial data. ESRI® ArcGIS™ 10.3 was used to assess hazard vulnerability utilizing digital hazard data, such as FEMA DFIRMs, building footprints, and building values based on insurance information. Digital data was collected from local, regional, state, and national sources for hazards. As described above, information was collected onsite to develop an asset database with building footprints for critical facilities and point data for cultural resources. Using these data layers, hazard vulnerability can be assessed by estimating the number and of type of assets, as well as potential dollar losses, determined to be in identified geographic hazard area boundaries.

Hazus-MH

FEMA's Hazus-MH uses ESRI's ArcGIS platform for the flood and earthquake hazards. Hazus-MH ("Hazus") is a standardized loss estimation software program developed by FEMA. It is built upon an integrated GIS platform to conduct analysis at a regional level or structure-specific level. The Hazus risk assessment methodology is parametric, in that distinct hazard and inventory parameters (e.g., wind speed and building types) can be modeled using the software to determine the impact (i.e., damages and losses) on the built environment.

The Risk and Vulnerability Assessment for the Pala Band of Mission Indians utilized Hazus-MH to produce hazard damage loss estimations. At the time this analysis was completed,

Hazus-MH 4.2 was used to estimate potential damages from earthquake and flood hazards using the Hazus-MH methodology.

4.4.2 Qualitative Analysis

A qualitative approach was employed for hazards that generally have the potential to impact, or occur within, the entire planning area. It was also used for such hazards that lack a geographic boundary or sufficient data to perform a reliable spatial analysis. This includes hazards considered atmospheric, including drought, extreme temperatures, extreme winds, lightning, and tornadoes. It also includes power outage. All of these hazards have the potential to affect all current and future buildings and all populations. Qualitative analyses were performed using available research, data, and risk expertise to draw conclusions on probability of occurrence and potential impacts across the entire planning area, rather than applying a structure-specific approach. All conclusions are presented in "Summary of Overall Risk" at the end of this chapter.

4.4.3 Priority Risk Index (PRI)

The prioritization and categorization of identified hazards for Pala Reservation is based principally on the Priority Risk Index (PRI), a tool used to measure the degree of risk for identified hazards in a particular planning area. The PRI was used to assist the PEDAG in identifying hazards that pose the most significant threats to the tribe and its assets.

PRI results provide a numerical value for each hazard, allowing hazards to be ranked against one another (i.e. the higher the PRI value, the greater the hazard risk). PRI values are obtained by assigning varying degrees of risk to five categories for each hazard: probability, impact, spatial extent, warning time, and duration. Each degree of risk has been assigned a value (1 to 4) and a weighting factor.

To calculate the PRI value for a given hazard, the assigned risk value for each category is multiplied by the weighting factor. The sum of all five categories equals the final PRI value, as demonstrated in the example equation below:

PRI VALUE = [(PROBABILITY x .30) + (IMPACT x .30) + (SPATIAL EXTENT x .20) + (WARNING TIME x .10) + (DURATION x .10)]

According to the weighting scheme applied, the highest possible PRI value is 4.0. Table 8 shows the weighting schemes for each category. By determining a value for each hazard that can be compared to other hazards threatening the planning area, hazards can be ranked with greater ease.

Many of the PRI categories are described within the hazard profiles. The final PRI results, including the calculated values for each hazard threatening the Pala Reservation, are found at the end of this chapter in the "Summary of Hazard Risks and Impacts" subsection.

Table 8. Priority Risk Index Scoring Criteria.

PRI Category	DEGREE OF RISK			Assigned Weighing Factor
	Level	Criteria	Index Value	
Probability	Unlikely	Less than 1% annual probability	1	30%
	Possible	Between 1 and 10% annual probability	2	
	Likely	Between 10 and 90% annual probability	3	
	Highly likely	90%+ annual probability	4	
Impact	Minor	Only minor property damage and minimal disruption to government functions and services. No shutdown of critical facilities.	1	30%
	Limited	Minor injuries are possible. More than 10% of buildings damaged or destroyed. Temporary shutdown of critical facilities (less than one week).	2	
	Critical	Multiple deaths/injuries possible. More than 25% of buildings damaged or destroyed. Complete shutdown of critical facilities for more than one week.	3	
	Catastrophic	High number of deaths/injuries possible. More than 50% of buildings damaged or destroyed. Complete shutdown of critical facilities for 30 days or more.	4	
Spatial Extent	Negligible	Limited to one specific area.	1	20%
	Small	Small areas affected.	2	
	Moderate	Large areas affected.	3	
	Large	All areas affected.	4	
Warning Time	More than 24 hours	Self-explanatory	1	10%
	12 to 24 hours	Self-explanatory	2	
	6 to 12 hours	Self-explanatory	3	
	less than 6 hours	Self-explanatory	4	
Duration	less than 6 hours	Self-explanatory	1	10%
	6 to 12 hours	Self-explanatory	2	
	12 to 24 hours	Self-explanatory	3	
	More than 24 hours	Self-explanatory	4	

4.5 Limitations

Although many different sources of data and information were collected, limitations in analysis did exist. Limitations include those associated with data availability specific to tribal boundaries, loss estimates, and unreported or underreported events as described below.

4.5.1 Data Availability

It should be noted that limited information was found regarding events directly impacting the Pala Reservation and its assets. When possible, information was supplemented with interview data from various Tribal officials, but detailed monetary losses for historic events impacting the Pala Reservation were not available. In many cases, data from San Diego County was used to demonstrate hazard probability, extent, and previous occurrences. In certain instances, data reported for the overlying county or National Weather Service (NWS) public forecast zone had to be used to determine instances of previous occurrences. The NWS issues watches and warnings for public forecast zones, which typically follow county or multi-county boundaries. When variables such as elevation differences or proximity to water bodies create differences in weather across a county, zones may differ from county boundaries in order to allow for more accurate forecasts.[13] Instances where forecast zones or county-level reporting were used to determine previous occurrences are noted in a hazard's profile. Without loss estimates from previous events impacting the Pala Reservation, it was not feasible to calculate accurate loss estimates for the Pala Reservation.

Further, asset values were not available for all Tribal assets, as indicated in Table 7**.** Therefore, estimates of Tribal asset value at risk to certain hazards may underrepresent the Tribe's true vulnerability.

4.5.2 Loss Estimates

Loss estimates provided in this vulnerability assessment are based on best available data and methodologies. The results are an approximation of risk. These estimates should be used to understand relative risk from hazards and potential losses. Uncertainties are inherent in any loss estimation methodology, arising in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from approximations and simplifications that are necessary for a comprehensive analysis (e.g., incomplete inventories, non-specific locations, lack of demographic information or economic parameters).

[13] NWS Public Forecast Zones. (2018). The National Weather Service. Retrieved March 12, 2018 from https://www.weather.gov/gis/PublicZones.

4.5.3 Unreported Events

In calculating annual probability estimates used in the Priority Risk Index, it should be noted that not all events for each hazard are reported, which can impact the probability assigned to each hazard, which in turn can affect index values.

4.6 Hazard Identification

> *B1. Does the plan include a description of the type, location, and extent of all natural hazards that can affect the tribal planning area? Requirement 201.7(c)(2)(i)*

Hazard identification is the process of identifying the types of natural hazards that can affect the mitigation plan study area – the Pala Band of Mission Indians Reservation. Technological and man-made hazards are also included in this plan. This is a plan update, so the previously identified hazards were reviewed and updated as follows for the 2020 plan update:

- The tribe opted to add several hazards to be aligned with the state hazard mitigation plan including agricultural pests and disease (including tree mortality), air pollution, epidemic/pandemic and freeze.
- Climate change was a consideration for each hazard;

Table 9 indicates each hazard studied in 2014 and includes the updated hazards for 2020. A justification for each hazard in the 2018 California State Hazard Mitigation Plan that was excluded can be found in Table 9.

Table 9. 2020 Pala Band Hazard Mitigation Plan Identified Hazards.

Pala Band of Mission Indians HMP Identified Hazards for 2020 HMP Update	2018 California SHMP Identified Hazard?	2018 San Diego County HMP Identified Hazard?	2014 Pala Band HMP Identified Hazard?
Natural Hazards			
Climate Change (included for each hazard)	X	X	-
Drought	X	X	X
Earthquake	X	X	X
Epidemic/Pandemic	X	-	-
Erosion	X (coastal)	X (coastal)	X
Extreme Freeze	X	-	-
Extreme Heat	X	X	X
Flood	X	X	X

Pala Band of Mission Indians HMP Identified Hazards for 2020 HMP Update	2018 California SHMP Identified Hazard?	2018 San Diego County HMP Identified Hazard?	2014 Pala Band HMP Identified Hazard?
High Wind	X (under Severe Weather)	-	X
Landslides	X	X	X
Lightning	X (under Severe Weather)	-	X
Tornado	X	-	X
Wildfire and Structural Fire	X	X	X
Non-Natural Hazards-			
Air Pollution	X	-	-
Agricultural Pests and Diseases	X	X	-
Dam Failure	X	X	X
Hazardous Materials Incidents	X	X	X
Lifeline Incident (Power Outage)	X	-	X

Table 10. Justification for Exclusion of Hazards.

Hazard	Justification for Exclusion
Aquatic Invasive Species	The Pala Reservation is not threatened by aquatic invasive species. Most waterways traversing the Pala Reservation are intermittent.
Avalanche	The Pala Reservation does not receive enough snowfall to be impacted by avalanches. There is no history of avalanches on the Reservation.
Civil Disorder	This hazard was considered to be outside of the scope of this plan (non-natural). There is no history of Civil Disorder on the Reservation.
Cyber Threats	This hazard was considered to be outside of the scope of this plan(non-natural). There is no history of Cyber Threats on the Reservation.
Hydraulic Fracturing Hazards	This hazard was considered to be outside of the scope of this plan (non-natural). There is no known history of hydraulic fracturing hazards on the Reservation.
Radiological Incidents	Nuclear Incident is no longer included as the San Onofre Nuclear Generating Station (SONGS) is no longer in operation. It has been shut down since 2012 and is in the full process of being fully decommissioned.[1]
Sea Level Rise/Coastal Flooding	The Pala Reservation is located inland (20 miles from the coast).
Terrorism	This hazard was considered to be outside of the scope of this plan(non-natural). There is no history of Terrorism on the Reservation.
Train Accidents Resulting in Explosions/Toxic Releases	The Pala Reservation does not have a railroad present. Further, toxic releases are covered under Hazardous Materials Incidents.

Hazard	Justification for Exclusion
Tsunami/Seiche	The Pala Reservation is located inland (20 miles from the coast).
Volcano	There are no active volcanoes in San Diego County.

4.6.1 Disaster Declarations

From 1965 to August 2020, 48 disasters were declared for San Diego County, including 24 major disaster declarations, 18 fire management disasters, and 6 emergency declarations. Federally declared disaster are the most severe and require Presidential approval. It should be noted that declared disasters did not necessarily impact Pala Reservation or its assets. However, reviewing historic disaster declarations provides an indication of what disasters have or could impact the planning area. Table 11 lists historic federal disaster declarations for San Diego County.[14]

Table 11. Historic Federally Declared Disasters for San Diego County.

Date	Disaster Number	Type	Title
12/7/1965	211	Flood	Heavy Rains and Flooding
1/2/1967	223	Flood	Severe Storms & Flooding
9/29/1970	295	Fire	Forest & Brush Fires
2/8/1973	364	Flood	Severe Storms, High Tides & Flooding
2/15/1978	547	Flood	Coastal Storms, Mudslides & Flooding
1/8/1980	615	Flood	Severe Storms, Mudslides & Flooding
1/21/1983	677	Coastal Storm	Coastal Storms, Floods, Slides & Tornadoes
6/26/1985	739	Fire	Grass, Wildlands, & Forest Fires
1/17/1988	812	Flood	Severe Storms, High Tides & Flooding
12/19/1990	894	Freezing	Severe Freeze
1/5/1993	979	Flood	Severe Winter Storm, Mud & Landslides, & Flooding
10/26/1993	1005	Fire	Fires, Mud/Landslides, Flooding, Soil Erosion
1/3/1995	1044	Severe Storm(s)	Severe Winter Storms, Flooding, Landslides, Mud Flows
2/13/1995	1046	Severe Storm(s)	Severe Winter Storms, Flooding Landslides, Mud Flow
2/2/1998	1203	Severe Storm(s)	Severe Winter Storms and Flooding
10/21/2003	1498	Fire	Wildfires, Flooding, Mudflow and Debris Flow
12/27/2004	1577	Severe Storm(s)	Severe Storms, Flooding, Debris Flows, And Mudslides
2/16/2005	1585	Severe Storm(s)	Severe Storms, Flooding, Landslides, And Mud and Debris Flows
1/11/2007	1689	Freezing	Severe Freeze
10/22/2007	1731	Fire	Wildfires, Flooding, Mud Flows, And Debris Flows

[14] Disaster Declarations for California. (2020). Federal Emergency Management Agency. Retrieved from https://www.fema.gov/disasters/grid/state-tribal-government/77?field_disaster_type_term_tid_1=All

Date	Disaster Number	Type	Title
12/17/2010	1952	Flood	Severe Winter Storms, Flooding, And Debris and Mud Flows
1/18/2017	4305	Flood	Severe Winter Storms, Flooding, And Mudslides
12/4/2017	4353	Fire	Wildfires, Flooding, Mudflows, And Debris Flows
1/20/2020	4482	Biological	Covid-19 Pandemic

4.7 Hazard Profiles

> *Requirement 201.7(c)(2)(i): A description of the type, location, and extent of all natural hazards that can affect the tribal planning area. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.*
>
> *Requirement 201.7(c)(2)(ii): A description of the Indian tribal government's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the tribe. The plan should describe vulnerability in terms of:*
>
> *(A) The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas;*
>
> *(B) An estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate;*
>
> *(C) A general description of land uses and development trends within the tribal planning area so that mitigation options can be considered in future land use decisions; and*
>
> *(D) Cultural and sacred sites that are significant, even if they cannot be valued in monetary terms*

Each identified hazard is profiled separately to describe the hazard and potential impacts to the Pala Reservation and its assets. The profile for each hazard includes:

- Hazard description: a scientific explanation of the hazard including potential magnitude (or severity) and impacts.
- Location: geographical extent of the hazard.

- Previous occurrences: the number of previous impacts from the hazard on Reservation (or surrounding area).
- Extent (or magnitude): the severity of the hazard in the past and potential severity in the future. Measures may include wind speed, wave height, or property damage.
- Probability of future events: The likelihood of future events impacting the Pala Reservation. Given an exact probability is often difficult to quantify, this characteristic is categorized into ranges.
    - Unlikely: Less than 1% annual probability
    - Possible: Between 1% and 10% annual probability
    - Likely: Between 10+% and 90% annual probability
    - Highly Likely: Greater than 90% annual probability
- Vulnerability Assessment and Estimated Losses: The vulnerability assessment addresses conditions that may increase or decrease vulnerability, such as topography, soil type, land use, and development trends. Potential impacts to hazards from climate change are also addressed in this section, including potential changes in hazard frequency, duration, and/or intensity. Estimated losses to assets are calculated using available data and resources. Methods utilized include GIS analysis and hazard modeling, for example. The number of structures at risk, critical facilities at risk, and cultural sacred sites at risk are analyzed using GIS analysis when possible.

Hazard profiles for the Pala Reservation are presented below in alphabetical order.

4.7.1 Air Pollution

4.7.1.1 Description

Air quality is an important factor for maintaining the public health of a community. Poor air quality is associated with health problems such as respiratory illnesses (e.g., asthma, infections), eye, nose and throat irritation, and cardiovascular problems (e.g., heart attacks).

Air quality is typically determined by two factors, ground ozone levels and particulate matter concentrations[15]:

Ground ozone (O3, or smog) forms when nitrogen oxides and volatile organic compounds (VOCs) react in the presence of heat and sunlight. These chemicals are released into the air by motor vehicle exhaust, factory emissions, gasoline vapors, and chemical solvents. Ground ozone is known to trigger lung and respiratory illnesses, such as asthma, lung inflammation, wheezing, and coughing.

Particulate matter, such as dust, dirt, soot, and smoke, are particles suspended in the air and breathed in by humans, livestock, and wildlife. Particles can be emitted into the air by motor vehicles, factory

[15] Why Air Quality is Important (n.d.) National Weather Service. Retrieved November 1, 2017 from http://www.nws.noaa.gov/airquality/.

emissions, and construction sites. Smoke from wildfires also contribute to particulate matter in the air. Particulate matter can cause chronic bronchitis, asthma, coughing, painful breathing, and cardiovascular problems.

4.7.1.2 Location

The entire San Diego Air Quality Basin, and thus the Pala Reservation, are impacted by poor air quality.

4.7.1.3 Previous Occurrences

Sources of pollution in the area include heavy truck traffic on Highway 76, tractors, and wildfires, for example.

The California Air Resources Board provides statistics on ground ozone and particulate matter concentrations. Because the Board reports air quality by basin, air quality measurements specific to the Pala Reservation could not be obtained. However, due to the regional nature of air quality issues, it can be assumed that when one or more areas in the basin was experiencing poor air quality, the Reservation and its assets were also experiencing similar air quality conditions. The California Air Resources Board reports data on air quality conditions from 1999 through 2018 for particulate matter concentrations[16] and from 1975 through 2018 for ground level ozone.[17]

Figure 21 shows the estimated number of days per year that particulate matter concentrations in the San Diego Air Quality Basin exceeded the national 24-hour standard of 35 micrograms per cubic meter, as well as state and national averages for comparison.

[16] California Air Quality Resources Board (2017). Trends Summary: PM2.5 Statistics. Retrieved November 1, 2017 from https://www.arb.ca.gov/adam/trends/trends2.php.
[17] California Air Quality Resources Board (2017). Trends Summary: State Ozone Statistics. Retrieved November 1, 2017 from https://www.arb.ca.gov/adam/trends/trends2.php.

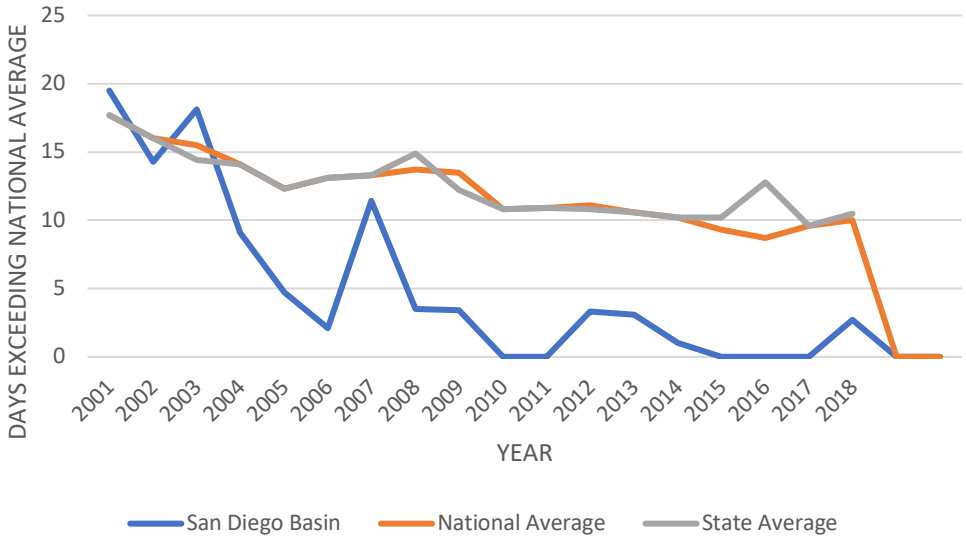


Figure 21. Number of Days Per Year Exceeding the National Standard for Particulate Matter in the Air.

Similarly, Figure 22 shows the number of days per year that the State of California 1-hour observation standard for ozone (0.09 parts per million (ppm)) was exceeded, as well as the number of days that the state 8-hour average standard (0.070 ppm) was exceeded in the San Diego Air Quality Basin.

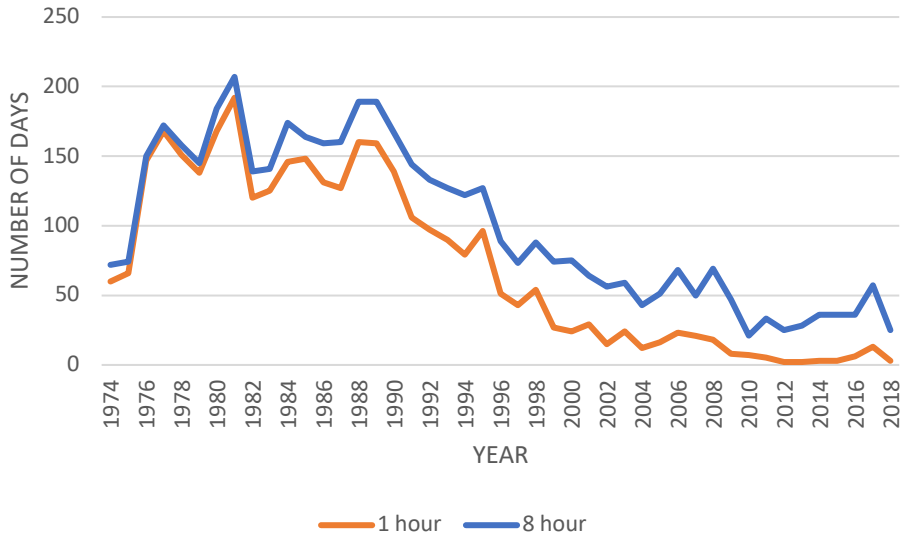


Figure 22. Number of Days Per Year Exceeding the California Standard for Ozone Levels.

Looking at the ppm data, the highest number of exceeding days was approximately 20 days (1991), 17 (2001), and 18 (1999) in the San Diego Air Quality Basin, state, and nation, respectively. However, there

is a notable decline in the San Diego Basin after approximately 2008, and there have been several years since 2010 with no days exceeding the national average.

For ozone standards, the basin experienced as few as 2 days (1-hour exceedance) or 21 days (8-hour exceedance) as many as 207 days per year where multiple air quality standards were exceeded, indicating a long-term air quality issue. However, in general the basin has shown signs of slowly improving air quality. Although the basin experienced peaks in particulate matter concentrations in 2002, 2008, and 2013, concentrations have been declining overall since data collection began in 1981. Specifically, data shows that the number of days per year where ozone exceeded federal standards has been declining since the early 1990s. Further, there has been a downward trend for both PPM and ozone air quality concerns. This steady decline in the concentration of ozone is possibly attributable to the 1970 Clean Air Act.

4.7.1.4 Extent

Air quality extent can be measured in terms of the number of days standards for air quality parameters are exceeded, or by the maximum concentration of pollutants in the air. The highest number of days per year in which the 1-hour standard for ozone was exceeded is 192 days (occurring in 1981). Likewise, the highest number of days per year in which the 8-hour standard was exceeded is 200 days (occurring in 1981). National figures were not reported. When reviewing particulate matter, the highest number of days reported in San Diego County Air Basin was 19.5 in 2001, compared to 18 for the national average and 17.1 for the state average in the same year. Further, the highest 98th percentile (national) reported was 52.7 in 2007. While there is a downward trend, it should be noted that higher levels of poor air quality are possible.

4.7.1.5 Probability of Future Events

Poor air quality conditions have been reported in every year on record for the air basin that contains the Pala Reservation and its assets. In addition, projected higher temperatures and more frequent high heat days projected for the future will likely have a negative impact on air quality in the planning area (see *Vulnerability Assessment*, below). Based on reported information, a probability of “highly likely” (greater than 90% annual probability) was assigned to the air quality hazard. It should be noted that while specific events may cause a peak in poor air quality measurements (e.g., a wildfire), general poor air quality conditions are likely to span several months, or even years, adding to the probability of occurrence.

4.7.1.6 Vulnerability Assessment and Estimation of Losses

Poor air quality is unlikely to have a direct impact on buildings and critical facilities; however, it may cause indirect impacts such as taxing HVAC systems at a higher than normal rate. Poor air quality does have significant impacts on public health. Therefore, all current and future populations on the Pala Reservation are considered at risk to poor air quality. Poor air quality, such as high concentrations of ground ozone and particulate matter, can cause the following health issues:

- Eye, nose, and throat irritation
- Wheezing, coughing, and breathing difficulties
- Respiratory ailments, such as asthma or other lung problems
- Increased risk of cardiovascular ailments and heart attack
- Increased risk of cancer (due to long-term exposure)

Some populations have increased vulnerability to poor air quality, including children, the elderly, and individuals with prior heart or lung diseases. When ground ozone levels and particulate matter concentrations are high, it is recommended that vulnerable populations take proper precautions (such as wearing a breathing mask or staying indoors) and that all individuals postpone outdoor exercise.

Estimated Losses

Loss estimates from poor air quality are difficult to determine, as no damage figures have been reported. Losses due to air quality issues would likely be indirect, such as individual medical costs or cancellation of outdoor events during periods of poor air quality.

Climate Change Impacts

Because ground ozone needs heat and sunlight to form, hot temperatures worsen air quality by exacerbating ground ozone levels. Pala is projected to have increases in average maximum temperature as well as the number of high heat days per year (see *Extreme Heat* profile). With projected higher temperatures and more frequent high heat days, it can be assumed that climate change will have a negative impact on air quality in the planning area. In addition, higher wildfire susceptibility due to increased drought and high temperatures could also negatively impact air quality, as smoke from wildfires worsens air quality.

4.7.2 Agricultural Pests and Diseases (including Tree Mortality)

4.7.2.1 Description

Countless species of insects and animals live in, on, or among crops and livestock; some are harmless, and some have the ability to cause damage. Damaging infestations can happen under certain conditions when relatively harmless pests can become hazardous. For example, trees may be weakened during a drought and become more susceptible to pests that would otherwise be relatively harmless. In addition, if unchecked by local predators, invasive species' populations can grow in numbers that are detrimental to crops the invasive species might use as a food source. Furthermore, some pests may cause a problem by carrying and spreading disease among crops or livestock. Agricultural pests and diseases can result in human and economic health disasters by impacting farmers, farm workers, and shippers of agricultural products. They can also result in an increase in food prices or in food shortages.

In addition, pests and diseases can contribute to increased tree mortality. Pests are capable of destroying large expanses of forest or woodland areas, which can increase wildfire risk due to increased fuel load. Tree mortality is the greatest concern among agricultural pest threats on the Pala Reservation.

Many different pests could impact the planning area, including different insect species. Chewing insects strip plants of leaves, boring insects bore into plant stem or roots, and sucking insects suck liquid out of leave of stems, and in doing so can excrete a liquid called "honeydew," which promotes the growth of mold.[18] Although not comprehensive of all pests that could impact the planning area, below are descriptions of certain agricultural pests and diseases that have been identified has a potential threat on or near the Pala Reservation:

Asian Citrus Psyllid and the Citrus Greening Disease (Huanglongbing):
The Asian citrus psyllid feeds on citrus trees and plants. The insect can damage plants by withdrawing large amounts of sap and by producing large amounts of "honeydew," which can coat leaves and cause mold to grow. More serious damage can occur as the Asian citrus psyllid is also capable of carrying and infecting citrus plants with a bacterium that causes a disease called Huanglongbing (HLB). HLB is also called Citrus Killing or Citrus Greening Disease, because the disease causes the citrus fruit to turn green and bitter tasting.

Glassy-Winger Sharpshooter
The glassy-winged sharpshooter was first reported in California in 1994 but is native the southwestern US and northeastern Mexico. This insect feeds on a large number of plants and is capable of spreading a bacterium that causes Pierce's Disease, which is fatal to grapevines.

Gold Spotted Oak Borer:
The gold spotted oak borer (GSOB) was introduced into San Diego County in the late 1990s or early 2000s. It was likely brought to the county via oak firewood from northern Mexico or southeastern Arizona, where the GSOB is native. GSOB prefer to attack mature oak trees in the red oak group but will attack smaller oaks or oaks outside the red oak group. Typical damage associated with GSOB-infested trees includes crown thinning and dieback, bark injury from woodpecker foraging, and bark staining and D-shaped emergence holes on the trunk of the tree. Following several years of extensive and repeated bouts of injury from GSOB larval feeding, tree health declines, and trees eventually die.[19]

Shot Hole Borer Beetles:
The polyphagous shot hole borer (PSHB) and Kuroshio shot hole borer (KSHB) (Euwallacea spp.) are insects native to Southeast Asia; PSHB is from Vietnam and KSHB is from Taiwan. Native California host species that can be infected by the shot hole borer include coast live oak and riparian species such as

[18] 2013 Imperial County Multi-Jurisdictional Hazard Mitigation Plan.
[19] Gold Spotted Oak Borer (2013). University of California. Retrieved from https://www.fs.fed.us/psw/publications/seybold/psw_2013_seybold004_flint.pdf.

California sycamore, Fremont cottonwood, red willow, box elder, maples, and white alder. Shot hole borers spread a fungus to host trees that cause die back and can eventually kill the host tree. The effects of PSHB and KSHB on oak woodland and riparian ecosystems have subsequently decreased rangeland and recreational value, and increased fire risk in Southern California. Urban shade trees including English oak, silk tree, coral tree, Titoki tree, and Liquidambar (sweetgum) also host the shot hole borer. Loss of shade trees can have serious aesthetic and health effects. Commercial agricultural hosts include avocado, persimmon, olive, macadamia, eastern mulberry, hazelnut, loquat, peach, grapevine, citrus, cassava, and crabapple. Damages to these important commercial crops can cause severe economic losses.[20]

Western Pine Bark Beetles:
The Western Pine Bark Beetle is known for causing tree death, especially in pine species. This beetle has a long lifespan and reproduces quickly, sometimes producing three generations in season. This exacerbates the damage caused by these pests.

4.7.2.2 Location

The California State Hazard Mitigation Plan identifies pest and disease as a hazard. It is assumed that all agricultural lands within the Pala Reservation are uniformly exposed to agricultural pests and diseases. However, because of the Reservation's reliance on agricultural products, it is assumed that the entire Reservation would be impacted by a pest infestation or agricultural disease outbreak.

4.7.2.3 Previous Occurrences

Information regarding historic agricultural pest infestations and diseases were gathered from the USDA, the California Department of Food and Agriculture (CDFA), the California State Hazard Mitigation Plan, and tribal officials.

Asian Citrus Psyllid and the Citrus Greening Disease (Huanglongbing):
The Asian citrus psyllid has been detected in San Diego County. The figure below shows detections of the Asian citrus psyllid and a quarantine map for the Asian citrus psyllid and HLB (citrus greening) in the southwestern US from June 2017. The map shows that San Diego County (including Reservation areas) had detected the Asian citrus psyllid as of 2017 and was under quarantine for the Asian citrus psyllid. California is actively working to eradicate the Asian citrus psyllid, and as of 2017 has only identified one plant with HLB.[21] However, data from USDA indicates that San Diego County is currently (as of August 2020) under federal quarantine for Asian Citrus Psyllid.[22]

[20] California State Hazard Mitigation Plan (2018). Chapter 9.1.1. Retrieved from https://www.caloes.ca.gov/HazardMitigationSite/Documents/012-2018%20SHMP_FINAL_Ch%209.pdf.
[21] California State Hazard Mitigation Plan (2018). Section 9.1. Retrieved from https://www.caloes.ca.gov/HazardMitigationSite/Documents/012-2018%20SHMP_FINAL_Ch%209.pdf.
[22] Asian Citrus Psyllid (2020). USDA. Retrieved from https://www.aphis.usda.gov/aphis/maps/plant-health/citrus-map.

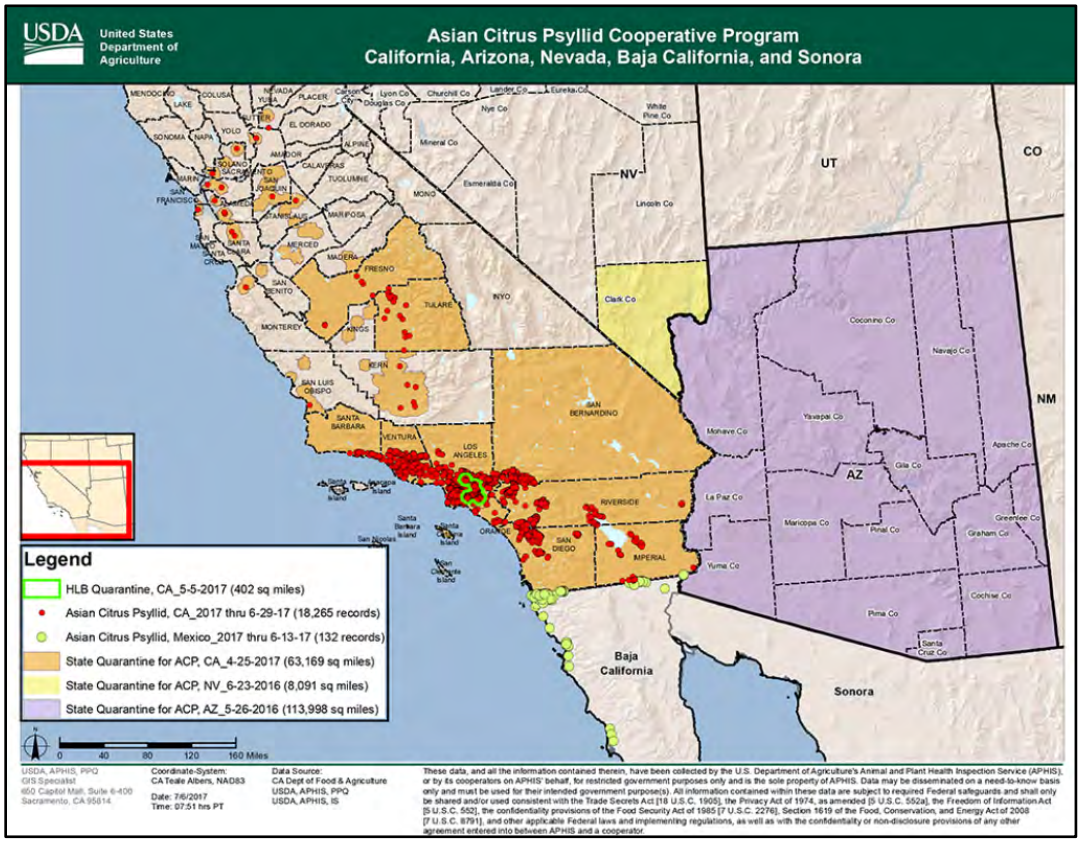


Figure 23. Asian Citrus Psyllid Infestations and Quarantines in the Southwestern U.S. [23]

Glassy-Winger Sharpshooter and Pierce's Disease

The first outbreak of Pierce's Disease, which is spread by the glassy-winged sharpshooter, occurred in Temecula, approximately 10 miles northwest the Pala Reservation, in 1999 when over 300 acres of grapevines were infected.[24] According to the CDFA, San Diego County is currently (as of April 2020) infested by the glassy-winged sharpshooter and there are active cases of Pierce's Disease within the county. The figure below shows counties with active glass-winged sharpshooter infestations in Southern California. Tribal officials did not report glassy-winged sharpshooter infestations or Pierce's Disease within the tribe's vineyard, but the presence of an infestation within the county indicates the tribe's vineyard may be at risk to future infestations.

[23] Citrus Pest and Disease Prevention Program. Retrieved from http://www.californiacitrusthreat.org/pest-disease.
[24] Glassy-winged Sharpshooter. CDFA. Retrieved from https://www.cdfa.ca.gov/pdcp/Glassy-winged_Sharpshooter.html

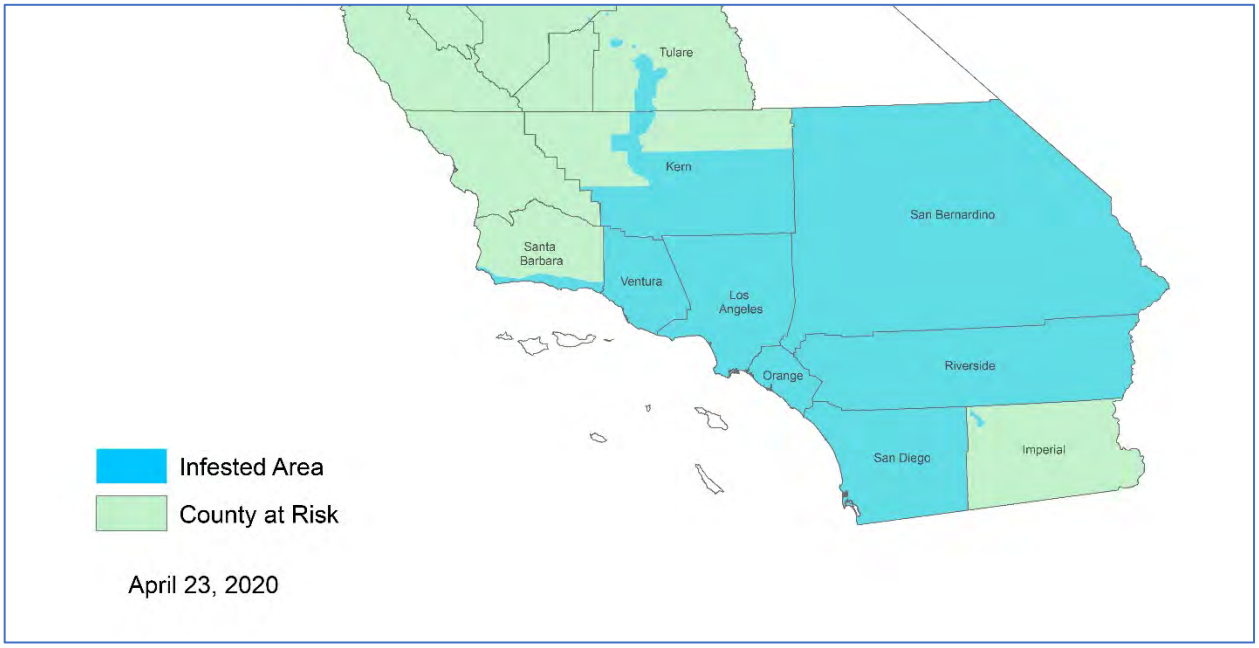


Figure 24. Glassy-winger Sharpshooter Infestations in Southern California. [25]

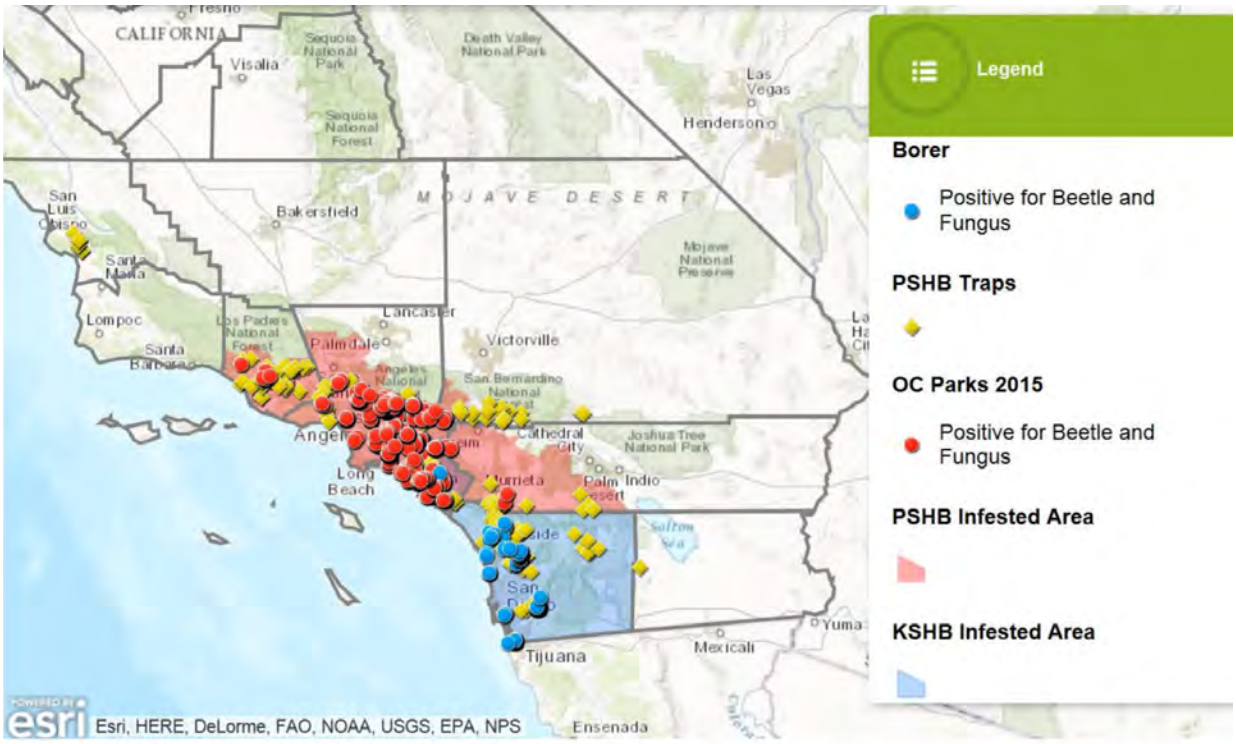
Gold Spotted Oak Borer:

According to tribal officials, gold spotted oak borers have been detected adjacent to the Pala Reservation. While the Reservation is not yet experiencing an infestation, the tribe expects to experience oak mortality in the next five to 10 years.

Shot Hole Borer Beetles:

Shot hole borer beetles were first detected in Southern California in the early 2000s and have been a growing problem since 2010.[26] Shot hole borers and the fungi they carry have been detected in the eastern half of San Diego County, including the Reservation area. Further, the entire county, including the Pala Reservation, is classified as a KSHB infested area as of 2016. The figure below shows shot hole borer detections in Southern California.

[25] Pierce's Disease Control Program Maps (2020). CDFA. Retrieved from https://www.cdfa.ca.gov/pdcp/map_index.html.
[26] Morrison, K. (2018). *Racing to stop the destructive shot hole borer.* California Native Plant Society. Retrieved from https://www.cnps.org/flora-magazine/racing-to-stop-the-destructive-shot-hole-borer-11489#:~:text=A%20type%20of%20beetle%2C%20the,What's%20more%2C%20it%20reproduces%20prolifically..



Source: Eskalen Lab, Department of Plant Pathology and Microbiology, University of California, Riverside (2016), https://ucanr.edu/sites/pshb/Map/.

Figure 25. PSHB and KSHB Detections in Southern California. [27]

Western Pine Bark Beetles are present in San Diego County and the known culprit for pine mortality.[28]

Other known pests impacting the Pala Reservation, as reported by tribal officials, include:

- Aphids (several species) – many are found only on certain plants; some have a wide range. Aphids damage plants through feeding (sucking juices) and can spread plant diseases.
- Oriental and American Cockroach – impact stored foods.
- Cochineal Bug – can damage or even kill native and ornamental cacti.
- Scale Insects – can damage ornamental and agricultural plants. Scale insects are less likely to damage native vegetation. Damage occurs through feeding (sucking juices) or through being farmed by ants.
- Fruit Fly (several species) – can damage stored foods and fruit trees.
- Whiteflies – damage various species of ornamental and agricultural plants through feeding (sucking juices), can facilitate mold growth.

[27] California State Hazard Mitigation Plan (2018). Section 9.1. Retrieved from https://www.caloes.ca.gov/HazardMitigationSite/Documents/012-2018%20SHMP_FINAL_Ch%209.pdf.
[28] USDA (2018). 2018 California Forest Pest Conditions. Retrieved from https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd617799.pdf

- Red Imported Fire Ants – dangerous sting to humans and animals, and can negatively impact yards and agricultural areas by eating seeds, attacking small animals, damaging plants, and having multiple nests.
- Mosquitoes (several species) – those of genus Aedes may transmit Zika virus and those of Culex may transmit encephalitis. West Nile virus and other diseases can be transmitted.
- Spider Mites – can damage ornamental plants by rupturing cells during feeding or webbing.
- Garden Snail – may damage plants, especially seedlings, flowers, or fruits.

Other pests with the potential to impact the Pala Reservation include:

- Light-brown Apple Moth – infects 2,000+ species of native and ornamentals including food crops.
- Mediterranean Fruit Fly –the Mediterranean Fruit Fly, or the Medfly, is considered a serious threat to California's agricultural industry, as it impacts 250 types of fruits and vegetables, including citrus, grapes, pitted fruits, and tomatoes. Once infested with larvae, the fruit or vegetable becomes unfit for consumption. The state of California spends millions of dollars annually to prevent the Medfly from infesting agricultural areas.[29]
- Brown Marmorated Stink Bug – can damage numerous species of native, ornamental, and agricultural plants, and also be found in large numbers in and around structures.

4.7.2.4 Extent

The extent of pest infestation and disease can be measured in terms of damages. No damage figures were available for the Pala Reservation at the time of this plan. However, devastating impacts to agriculture, particularly trees, are possible on the Pala Reservation. Studies on Northern California oak tree have estimated $135 million in lost property values in the state.[30] For instance, in Florida, the HLB disease is estimated to have caused over $3.6 billion in economic losses over five years.[31] Tree mortality is known to have caused hundreds of millions in indirect losses in industries such as tourism, further emphasizing the potential loss associated with tree mortality. The absence of trees also exacerbates other hazards such as flooding (less water absorption through trees), extreme heat, wildfire and landslides.

4.7.2.5 Probability of Future Events

Since detailed records of historical occurrences are limited, determining a probability based on past events is not feasible. However, noting the current outbreaks and infestations, along with the threat of

[29] Mohan, G. (2016, February 12). Medfly quarantine expands in San Fernando Valley. *Los Angeles Times*. Retrieved from http://www.latimes.com/business/la-fi-medfly-20161202-story.html.

[30] Kovacs, Kent; Václavík, Tomas; Haight, Robert G.; Pang, Arwin; Cunniffe, Nik J.; Gilligan, Christopher A.; Meentemeyer, Ross K. 2011. Predicting the economic costs and property value losses attributed to sudden oak death damage in California (2010-2020). Journal of Environmental Management. 92: 1292-1302. Retrieved from https://www.nrs.fs.fed.us/pubs/jrnl/2011/nrs_2011_kovacs_001.pdf

existing, new, or unknown pests and diseases, and increased likelihood of pest infestation due to climate change, the agricultural pests and diseases hazard was assigned a probability of highly likely (greater than 90% annual chance).

4.7.2.6 Vulnerability Assessment and Estimation of Losses

The Pala Reservation and its surrounding area contains agricultural holdings, including citrus, avocadoes, a vineyard, and animal husbandry. Pests, insects, and diseases will continue to be a threat to the economy and health of the Pala Reservation. In addition, pest infestations and diseases increase the need for pesticide usage on crops, which can impact the health of those on the Reservation by worsening air and/or water quality through agricultural application and runoff.

Estimated Losses

Although it is likely that the Reservation has incurred damages from agricultural insects, pests, and diseases, no specific damage amounts have been reported. Without reported damages, estimating accurate losses for the Pala Reservation is not possible. However, as noted in the *Extent* section, impacts from direct and indirect losses can easily rise into the millions of dollars.

Climate Change Impacts

As the climate changes, native species and agricultural crops will have to contend with a wide range of pests and diseases. Some existing species will adapt to changes, while others will not be able to thrive in new conditions. Milder winters could lead to the year-round survival of certain pests.[32] Climate change also brings about the threat of new species that could not exist in the previous climate but will thrive in future conditions. As temperatures in the planning area are expected to increase, and drought events are projected to become longer and more frequent, weakened crops may become more susceptible to pests and diseases.

Furthermore, while warming speeds up the lifecycles of many insects, suggesting that pest problems could increase, some insects may grow more slowly as elevated carbon dioxide levels decrease the protein content of the leaves on which they feed. Possible future strategies to address climate change influences on insect pests and diseases might include:[33]

- Inventory and monitor invasive species that threaten crops.
- Downscale climate change data to allow informed decisions on biodiversity planning by farmers and rural communities.
- Strengthen the dissemination of knowledge, appropriate technologies and tools to improve management practices related to agricultural biodiversity and ecosystem services.

[32] Pala Band of Mission Indians Climate Change Vulnerability Assessment (2019). Retrieved from http://ped.palatribe.com/wp-content/uploads/2019/07/Pala-Environmental-Department-Climate-Change-Vulnerability-Assessment-2019.pdf.
[33] California State Hazard Mitigation Plan (2018). Section 9.1. Retrieved from https://www.caloes.ca.gov/HazardMitigationSite/Documents/012-2018%20SHMP_FINAL_Ch%209.pdf

The above strategies were derived from Food and Agriculture Organization of the United Nations, Climate Change for Food and Agriculture, Technical Background Document from the Expert Consultation, 2008, available at: http://www.fao.org/uploads/media/FAO_2008a_climate_change_and_biodiversity_02.pdf.

4.7.3 Drought

4.7.3.1 Description

Drought is a normal occurrence in virtually all climatic regions, including areas with high and low average rainfall. Drought is the consequence of a natural reduction in precipitation expected over an extended period, usually lasting a season or more. High temperatures, high winds, and low humidity can exacerbate drought conditions. In addition, human actions and demands for water resources can hasten drought-related impacts.

The National Centers for Environmental Information (NCEI) identifies drought as a "creeping phenomenon that slowly sneaks up and impacts many sectors of the economy, and operates on many different time scales."[34] Thus, the National Drought Mitigation Center has classified droughts into five types: 1) meteorological, 2) hydrologic, 3) agricultural, 4) socioeconomic, or 5) ecological.[35] The definition for each of these drought classifications is shown in the table below:

Table 12. Drought Classification Definitions.

Drought Classification	Description
Meteorological Drought	The degree of dryness or departure of actual precipitation from an expected average or normal amount based on monthly, seasonal, or annual time scales. (Dry weather patterns dominate an area; can begin/end rapidly).
Hydrological Drought	The effects of precipitation shortfalls on stream flows and reservoir, lake, and groundwater levels. (Low water supply is evident; conditions take longer to develop and then recover.
Agricultural Drought	Soil moisture deficiencies relative to water demands of plant life, usually crops. (Crops significantly affected).
Socioeconomic Drought	The effect of demands for water exceeding the supply because of a weather-related supply shortfall.
Ecological Drought	A prolonged and widespread deficit in naturally available water supplies — including changes in natural and managed hydrology — that create multiple stresses across ecosystems

[34] National Centers for Environmental Information (2017). "Definition of Drought." *National Oceanic and Atmospheric Administration.* Retrieved from https://www.ncdc.noaa.gov/monitoring-references/dyk/drought-definition.
[35] The National Drought Mitigation Center, Types of Drought. (2017). Retrieved May 3, 2019, from https://drought.unl.edu/Education/DroughtIn-depth/TypesofDrought.aspx.

The U.S. Drought Monitor records drought in the U.S. and categorizes drought into five categories as shown in the table below.[36]

Table 13. Drought Monitor Categories.

D0	Abnormally Dry	Going into drought: short-term dryness slowing planting, growth of crops or pastures. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered
D1	Moderate Drought	Some damage to crops, pastures; streams, reservoirs, or wells low, some water shortages developing or imminent; voluntary water-use restrictions requested
D2	Severe Drought	Crop or pasture losses likely; water shortages common; water restrictions imposed
D3	Extreme Drought	Major crop/pasture losses; widespread water shortages or restrictions
D4	Exceptional Drought	Exceptional and widespread crop/pasture losses; shortages of water in reservoirs, streams, and wells creating water emergencies

Drought should not be viewed as merely a physical phenomenon or natural event. Its impacts on society result from the interplay between a natural event and the demand people place on water supply. Human activities often exacerbate the impact of drought. For example, excessive water use can deplete ground water supply.

One dry year does not amount to a drought in California, but it serves as a reminder of the need to plan for droughts. California's extensive water supply infrastructure — reservoirs, groundwater basins, and inter-regional conveyance facilities — mitigate the effect of short-term dry periods for most water users.[37] Defining when a drought begins is a function of drought impacts to water users. Hydrologic conditions constituting a drought for water users in one location may not constitute a drought for water users elsewhere, or for water users having a different water supply. Individual water suppliers may use criteria such as rainfall/runoff, amount of water in storage, or expected supply from a water wholesaler to define their water supply conditions.

The Pala Reservation utilizes groundwater for their domestic and commercial water needs.

[36] The National Drought Mitigation Center, U.S. Drought Monitor Classification Scheme. (n.d.). Retrieved May 3, 2019, from https://droughtmonitor.unl.edu/AboutUSDM/AbouttheData/DroughtClassification.aspx

[37] California State Hazard Mitigation Plan, Chapter 9 (2018). California Office of Emergency Services. Retrieved in May 2, 2019, from https://www.caloes.ca.gov/HazardMitigationSite/Documents/012-2018%20SHMP_FINAL_Ch%209.pdf

4.7.3.2 Location

A drought is a regional event that is not confined to geographic or political boundaries; it can affect several areas at once. It can also range in severity across those areas. All of the Pala Reservation is at risk to drought occurrence.

4.7.3.3 Previous Occurrences

In order to understand the conditions of past drought, it is helpful to understand the normal precipitation received each year. The Western Regional Climate Center reports an annual average of 13.08 inches of precipitation at the Vista 2 Monitoring Station (approximately 13 miles southwest of the Pala Reservation), and monthly precipitation averages are shown in the figure below.[38]

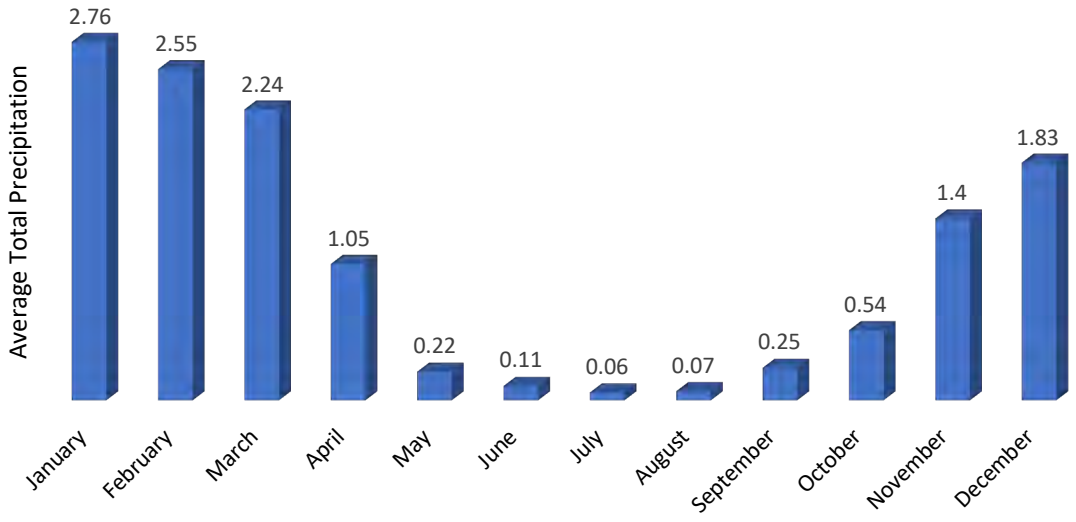


Figure 26. Average Monthly Precipitations at the Pala Reservation.

The U.S. Drought Monitor was used to ascertain historical drought levels for San Diego County. Because the U.S. Drought Monitor reports drought occurrences by county, drought occurrences specific to the Pala Reservation could not be obtained. However, due to the regional nature of drought occurrences, it can be assumed that when San Diego County was experiencing a drought, all or part of the Pala Reservation also experienced similar drought conditions. The U.S. Drought Monitor reports data on drought conditions from 2000 through 2020. Drought conditions are reported by category as percentages. Therefore, it is possible that more than one drought category was reported in each week. In such cases, the highest drought category reported was used. This information is compiled and presented in the table below.

[38] Western Regional Climate Center. Period of Record Monthly Climate Summaries, 1957-2016. Vista 2 NNE Monitoring Station (049378). Retrieved from https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca9378.

Table 14. Historic Drought Occurrences in San Diego County.

Abnormally Dry **Moderate Drought** **Severe Drought** **Extreme Drought** **Exceptional**

Year	San Diego County
2000	**Abnormal** (up to 27 weeks)
2001	**Abnormal** (up to 2 weeks)
2002	**Extreme** (up to 20 weeks)
2003	**Extreme** (up to 3 weeks)
2004	**Severe** (up to 19 weeks)
2005	**Abnormal** (up to 8 weeks)
2006	**Abnormal** (up to 47 weeks)
2007	**Extreme** (up to 38 weeks)
2008	**Severe** (up to 17 week)
2009	**Severe** (up to 28 weeks)
2010	**Moderate** (up to 3 weeks)
2011	**Abnormal** (up to 27 weeks)
2012	**Moderate** (up to 27 weeks)
2013	**Severe** (up to 36 weeks)
2014	**Extreme** (up to 46 weeks)
2015	**Extreme** (52 weeks)
2016	**Extreme** (up to 52 weeks)
2017	**Extreme** (up to 3 weeks)
2018	**Extreme (up to 13 weeks)**
2019	**Severe** (up to 2 weeks)
2020	**Abnormal** (up to 5 weeks, of 33 weeks of data)

In the study period, years 2002-2003, 2007-2009, and 2013-2019 reported the most intense droughts. However, another notable trend is that some level of drought was present in each of the 21 years studied, possibly indicating a long-term issue. No periods of Exceptional Drought were reported by the U.S. Drought Monitor data from January 2000 to August 2020.

Historic drought occurrences were gleaned from the 2018 California State hazard Mitigation Plan and the 2017 San Diego County Hazard Mitigation Plan:

2012-2017 Drought. California experienced five consecutive years of drought from 2012 through 2017 due to record low precipitation and snowpack levels. These included the driest four consecutive years of

statewide precipitation in the historical record.[39] The Governor proclaimed a Drought State of Emergency in January of 2014, which was lifted in April of 2017 after a wet winter and replenished snowpack. This event is one of the most intense and costliest droughts on record for the state, costing $6.6 billion in drought response and mitigation measures alone.[40] San Diego County experienced intense drought conditions during these years. For example, the county experienced extreme drought conditions for all or most of the year from 2014 through 2016. During this drought, San Diego County was listed at a Level 2 Drought Alert by the San Diego County Water Authority, subjecting the county to mandatory water conservation efforts. In April 2015, Governor Brown issued the state's first mandatory water reductions. These mandates did not apply to Pala, however, as they have their own water supply and are not subject to county laws.

1987-1992 Drought: This drought was extremely severe and resulted in the Metropolitan Water District ordering a 50% reduction in water use. The San Diego County Water Authority actually considered banning outdoor water use. As Pala manages its own water supply, these restrictions did not apply to the Reservation.[41]

4.7.3.4 Extent

Extent can be defined by the highest drought monitor classification: Exceptional Drought. Since the U.S. Drought Monitor began in 2000, there have been no reported weeks with an Exceptional Drought classification in San Diego County. However, it should be noted that this level of drought is possible in the area, and drought conditions in the planning area are expected to increase with climate change as temperatures rise. The next most severe classification, Extreme Drought, was reported in 2002, 2003, 2007, and 2014-2018. It is assumed that the Reservation is affected by these drought conditions.

4.7.3.5 Probability of Future Events

The U.S. Drought Monitor provides weekly drought status reporting which was used to project an approximate probability. There have been reported drought conditions in every year on record for San Diego County. Further, climate change information suggests that drier, more arid conditions may become more normal on the Pala Reservation, and Pala staff have noted that Pala Creek and the San Luis Rey River San Luis Rey River no longer have regular flow.[42] Based on reported information, a probability of "highly likely" (greater than 90% annual probability) was assigned to the drought hazard. It should be noted that drought events are likely to span several months, or even years, adding to the probability of occurrence. Further, there is evidence that drought may be more common during El Niño

[39] California Department of Water Resources. California Must Prepare for Flood and Drought. (2017, February 21). Retrieved June 28, 2017, from http://www.water.ca.gov/waterconditions/
[40] California Department of Water Resources. Governor's Drought Declaration. (2017, April 12). Retrieved June 28, 2017, from http://www.water.ca.gov/waterconditions/declaration.cfm
[41] San Diego County Multi-Jurisdictional hazard Mitigation Plan (2017). Section 4.3. Retrieved from https://www.sandiegocounty.gov/content/dam/sdc/oes/emergency_management/HazMit/2018/2018%20Hazard%20Mitigation%20Plan.pdf.
[42] Climate Change Vulnerability Assessment (2019). Pala Band of Mission Indians.

years, when summers are typically warmer and drier in the western United States. El Niño occurs approximately every two to seven years.[43]

4.7.3.6 Vulnerability Assessment and Estimated Losses

It is assumed that all current and future buildings, populations, critical facilities, and cultural resources on the Pala Reservation are at risk to drought. The atmospheric nature of drought and lack of specific boundaries make it more conducive to a qualitative assessment as opposed to a quantitative analysis, such as GIS analysis. The majority of drought impacts, however, are not structural but societal in nature.

Drought presents a major concern in terms of water supply for economic, household, safety, and landscaping. The tribe relies on wells for water and have designated 14 wells as critical facilities (Figure 27. Pala Reservation Water Wells. Water is then stored in one of the Tribe's six water storage tanks to be distributed to homes, the casino, and other facilities. Water is a very important component on the Pala Reservation and drought is one of the highest hazard concerns to the tribe. The Pala Casino Resort & Spa are the largest water consumers on the Reservation and are in jeopardy during times of drought. Without water, the casino and other area businesses could not operate. The Tribe is working to use reclaimed water for irrigation, and they are encouraging low-flow toilets and drought-resistant landscaping in new homes. In addition, they intend to abide by all state level recommendations and mandates.

Recent state level environmental legislation nearly jeopardized the tribe's ability to dig wells. However, the regulations were written to ensure the protection of tribal water rights. Yet it is possible that legislation could cause an issue in the future, providing further reasoning for the tribe to view drought as a permanent issue and a hazard of high concern.

Water is also needed to fight wildfires. A lack of, or limited, water supply presents wildfire management vulnerability. Substantial water is needed to fight wildfires, which are also more frequent in dry conditions. While water for firefighting is a priority and no restrictions are in place, a lack of availability could slow this capability. Drought may impact water supply, prompt water conservation measures, and damage agricultural crops and landscaping. During the 2014 drought, Tribal members noted that the drought was killing trees. Drought-stressed trees and crops are also more vulnerable to pest infestations. Drought may increase the rate of wind erosion or occurrence of dust storms if soils become dry and loosened. In addition, it should be noted that extended drought, followed by heavy rainfall can trigger landslides.

The Tribe engages in several measures to conserve and capture water. For example, low flow toilets and other low water usage features are encouraged in new homes, and trainings are conducted on drought-

[43] National Drought Mitigation Center. ENSO and Drought Forecasting. Retrieved March 30, 2014 http://drought.unl.edu/DroughtBasics/ENSOandForecasting.aspx

resistant gardens to conserve water used for landscaping. The Tribe intends to produce a drought plan in the near future.

Estimated Losses

Limited damage reported makes estimating dollar loss challenging. While some direct losses are possible (particularly to agriculture or landscaping), indirect losses may be more severe, e.g. impacts on tourism and restaurants. Without water supply, the Casino and other businesses would not be able to operate. There may also be increased damage in the event of a wildfire. These are just some examples of how indirect losses could easily exceed millions of dollars if drought affected the water supply.

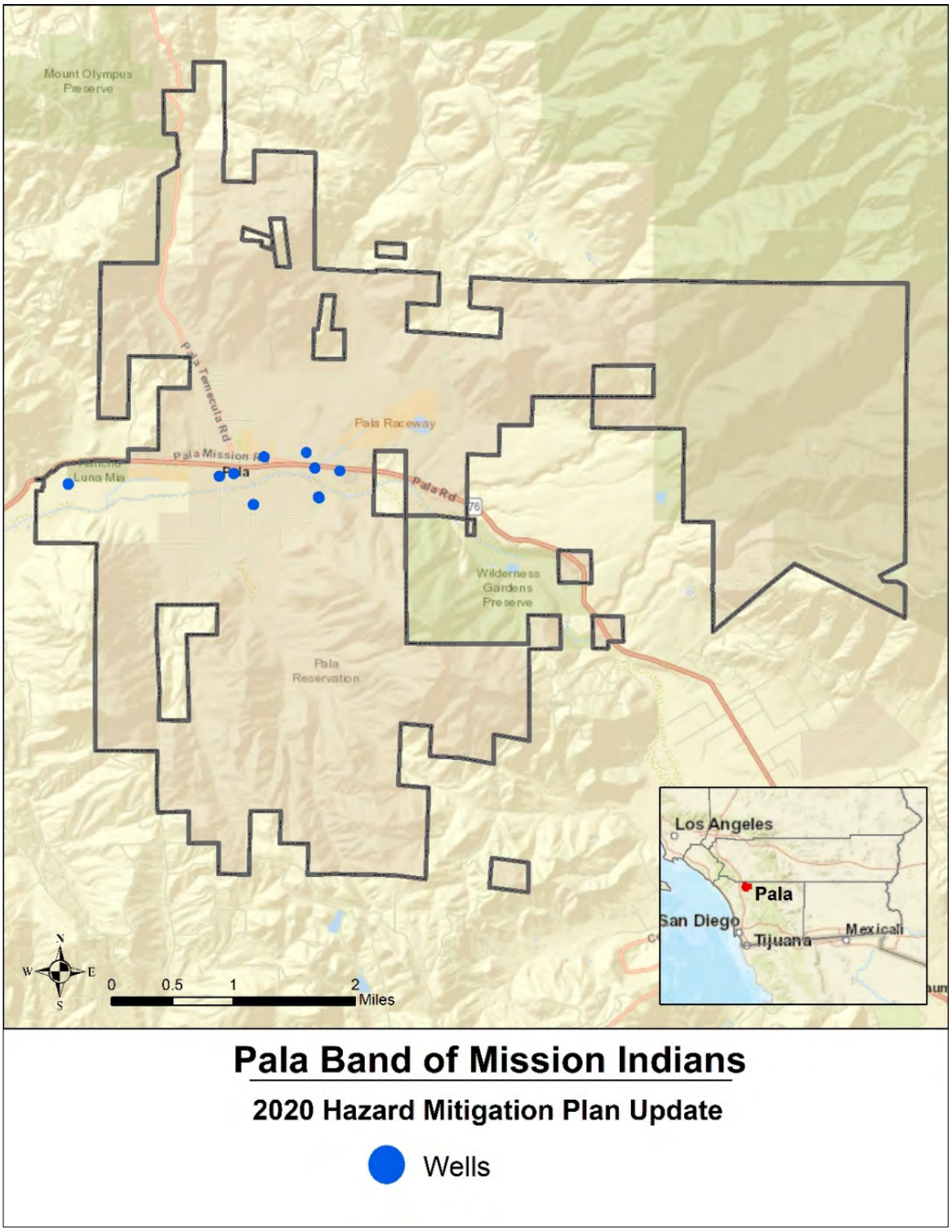


Figure 27. Pala Reservation Water Wells.

Climate Change Impacts

Climate change can be expected to increase drought frequency and severity on the Pala Reservation. Warmer temperatures cause drought conditions by reducing soil moisture. Average maximum temperatures on the Pala Reservation are projected to increase from an observed baseline of 75.8°F to upwards of 79.7 by 2050 and 84.5°F by 2099. Figure 44 located in the *Extreme Heat* hazard profile, **s**hows the projected increase in average maximum temperatures on the Reservation under different emissions scenarios and timelines). Further, it is unlikely that the effects of warmer temperatures on drought will be offset by increased precipitation, as precipitation is projected to have little change.[44]

This information indicates that droughts on the Pala Reservation could be more frequent and pronounced, which could lead to increased drought-related impacts on water quality and quantity, regional agriculture, local flora, and the local economy.

4.7.4 Earthquake and Liquefaction

4.7.4.1 Description

Earthquakes are scientifically defined as the sudden release of strain (or displacement of rock) in the earth's crust, resulting in waves of shaking that radiate outward from the earthquake source. They may result from crustal strain, volcanism, landslides or the collapse of caverns. Earthquakes can occur underwater or on land. Earthquakes can affect hundreds of thousands of square miles. Their intensity ranges from very minor (shaking not detected by humans without instruments) to very violent (catastrophic in nature). Damages follow this intensity ranging from minor to catastrophic. Earthquakes also occur without warning, resulting in deaths and injuries.

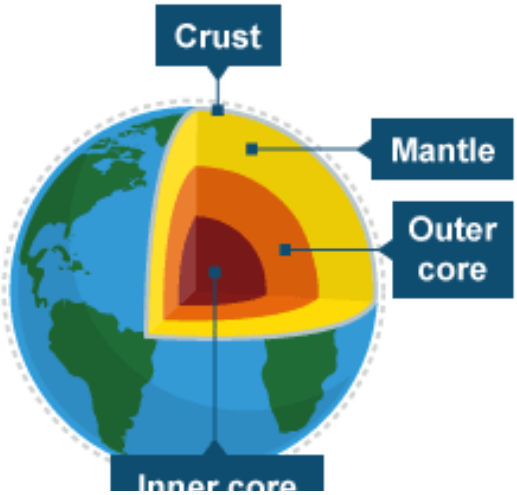


Figure 28. Earth's Sub Layers.

To understand the nature of earthquakes, the composition of the earth must be explored. The earth is made up of four major layers and several sub layers (Figure 28[45]): a solid inner core, a liquid outer core, a semi-molten mantle, and the rocky crust (the thin outermost layer of the earth). The upper portion of the mantle combined with the crust forms the lithosphere. This area is susceptible to fractures and is referred to as a shell. The lithosphere breaks up into large slabs, known as tectonic plates. This area is where earthquakes occur.

There are approximately twelve major plates and several dozen more minor plates on the earth's crust, as shown in

[44] Annual Averages. (2017). Cal Adapt. Retrieved from https://cal-adapt.org/tools/annual-averages/
[45] BBC. *Plate Tectonics*. Retrieved from http://www.bbc.co.uk/bitesize/ks3/geography/physical_processes/plate_tectonics/revision/2/.

Figure 29**.** Plates are regions of the crust that continually move over the mantle. Areas where these plates meet, grind past each other, dive under each other, or spread apart, are called plate boundaries. Most earthquakes are caused by the release of stresses accumulated due to the sudden displacement of rock along opposing plates in the Earth's crust. The areas bordering the Pacific Plate, also known as the "Pacific Ring of Fire", are at a particularly high risk since most of the largest earthquake events of the last century have occurred in the region.[46]

While earthquakes typically occur along plate boundaries, they can affect hundreds of thousands of square miles, causing damage to property (measured in the tens of billions of dollars), resulting in loss of life and injury to hundreds of thousands of persons, and disrupting the social and economic functioning of the affected area. The point where an earthquake starts is termed the focus or hypocenter and may be many miles to several hundred miles deep within the earth. The point at the surface directly above the focus is called the earthquake's epicenter. Earthquakes are measured in terms of their magnitude and intensity.

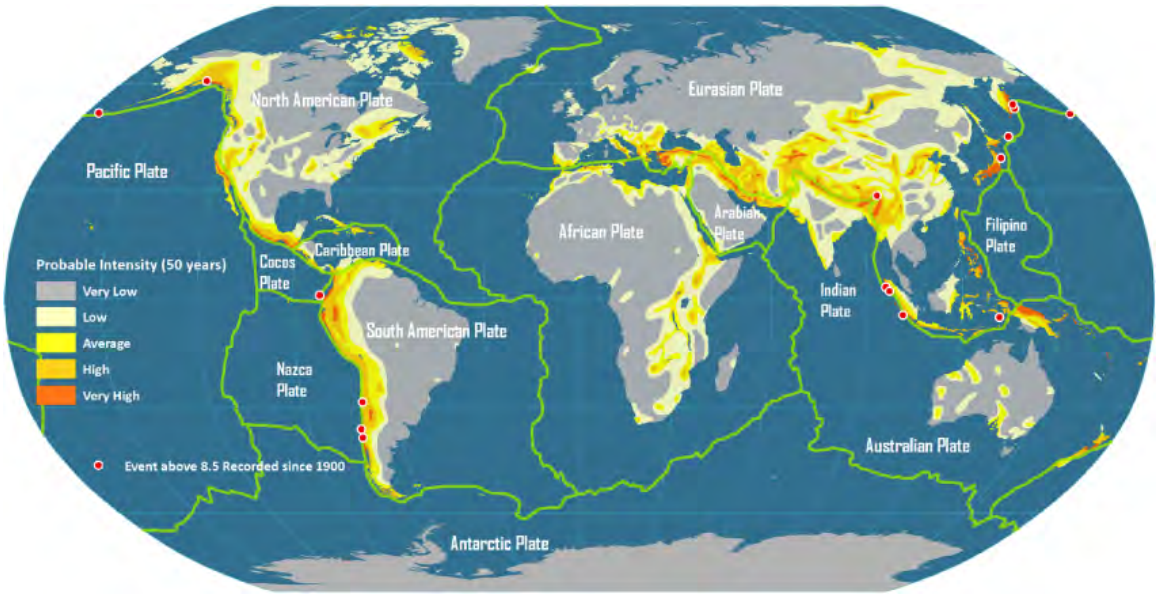


Figure 29. Global Plate Tectonics and Seismic Activity. [47]

Most property damage and earthquake-related deaths are caused by the failure and collapse of structures due to ground shaking. The level of damage depends upon the amplitude and duration of the shaking, which are directly related to the earthquake size, distance from the fault, site, and regional geology. Other damaging earthquake effects include landslides, the down-slope movement of soil and rock (mountain regions and along hillsides), and liquefaction, in which ground soil loses the ability to

[46] Canales, M. and Chwastyk, M. The Pacific's Fiery Ring. National Geographic. Retrieved from https://www.nationalgeographic.com/magazine/2019/06/pacific-ring-of-fire-volcanoes-earthquakes-threaten-millions/.
[47] Rodrigue, J.P. Global Plate Tectonics and Seismic Activity. (2017). Hofstra University. Retrieved from https://people.hofstra.edu/geotrans/eng/ch9en/conc9en/plate_tectonics.html.

resist shear and flows much like quicksand. In the case of liquefaction, anything relying on the substrata for support can shift, tilt, rupture, or collapse.

The greatest earthquake threat in the United States is along tectonic plate boundaries and seismic fault lines located in the central and western states; the Pala Reservation is located in one of the highest risk areas in the nation for earthquakes.

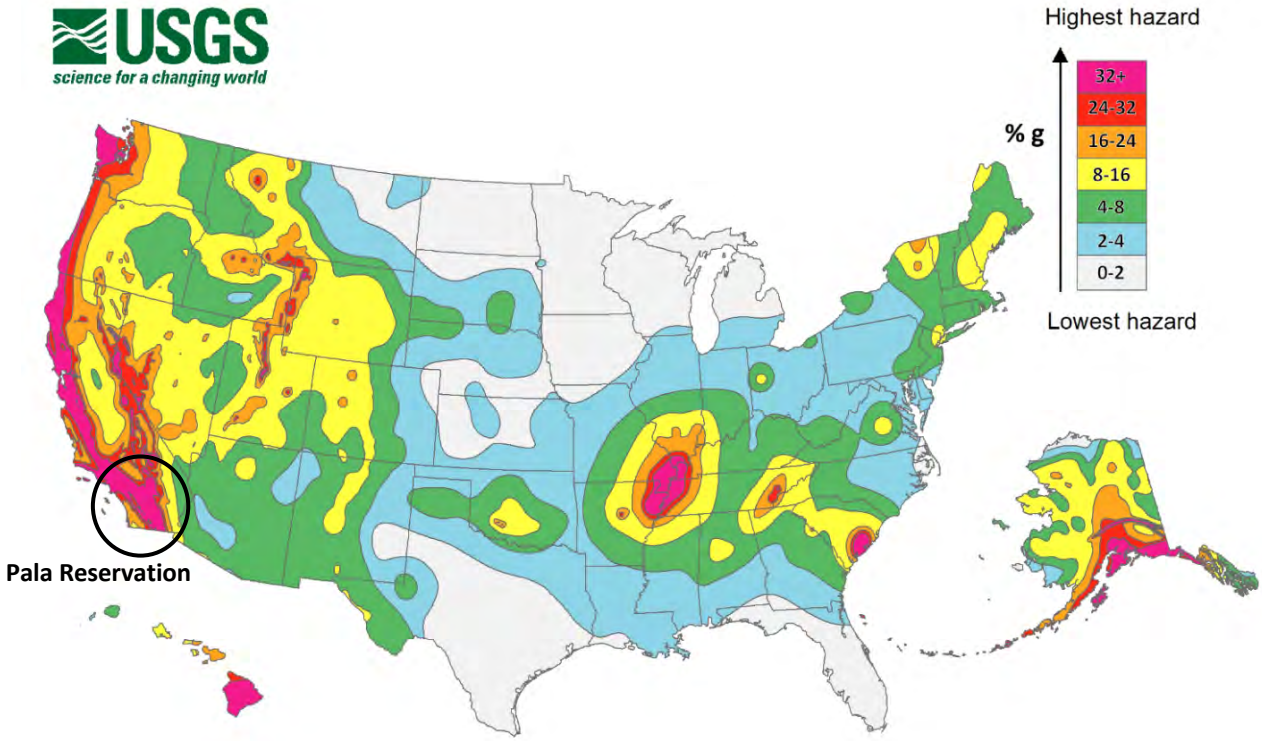


Figure 30. United States Earthquake Hazard Map. [48]

Earthquake magnitude is measured using the Richter Scale, an open-ended logarithmic scale that describes the energy release of an earthquake through a measure of shock wave amplitude (Table 15).[49] Each unit increase in magnitude on the Richter Scale corresponds to a 10-fold increase in wave amplitude, or a 32-fold increase in energy. Beginning in 2002, the USGS began using Moment Magnitude as the preferred measure of magnitude for all USGS earthquakes greater than magnitude 3.5. This was primarily due to the fact the Richter Scale has an upper bound, so large earthquakes were difficult to measure. Moment Magnitude also has a scale, but no instrument is used to measure it. Instead, factors such as the distance the earthquake travels, the area of the fault, and land that was

[48] Earthquake Hazards Program. USGS. Retrieved from https://www.usgs.gov/natural-hazards/earthquake-hazards/hazards.
[49] USGS. *Richter scale*. Retrieved from https://earthquake.usgs.gov/learn/glossary/?term=Richter%20scale.

displaced (also known as “slip”) are used to measure moment magnitude. Table 16 shows the Moment Magnitude Scale.

Table 15. Richter Scale.

RICHTER MAGNITUDES	EARTHQUAKE EFFECTS
<3.5	Generally, not felt but recorded.
3.5 - 5.4	Often felt, but rarely causes damage.
5.4 - 6.0	At most slight damage to well-designed buildings. Can cause major damage to poorly constructed buildings over small regions.
6.1 - 6.9	Can be destructive in areas up to about 100 kilometers across where people live.
7.0 - 7.9	Major earthquake. Can cause serious damage over larger areas.
8 or >	Great earthquake. Can cause serious damage in areas several hundred kilometers across.

Source: Federal Emergency Management Agency

Table 16. Moment Magnitude Scale.

SCALE VALUES	EARTHQUAKE EFFECTS
<3.5	Very weak; unlikely to be felt
3.5 - 5.4	Generally felt; rarely causes damage
5.4 - 6.0	Will not cause damage to well-designed buildings; will damage poorly designed ones
6.1 - 6.9	Considered a “major earthquake” that causes a lot of damage
7.0 - 7.9	Large and destructive earthquake that can destroy large cities
8 or >	Large and destructive earthquake that can destroy large cities

Source: Federal Emergency Management Agency

Intensity is most commonly measured using the Modified Mercalli Intensity (MMI) Scale based on direct and indirect measurements of seismic effects. The scale levels are typically described using roman numerals, ranging from “I” corresponding to imperceptible (instrumental) events to “XII” for catastrophic (total destruction). A detailed description of the Modified Mercalli Intensity Scale of earthquake intensity and its correspondence to the Richter Scale is given in Table 17. Table 18 compares the Richter scale magnitudes and MMI magnitudes for several well-known historic earthquakes in the U.S.

Table 17. Modified Mercalli Intensity Scale for Earthquakes. [50]

SCALE	INTENSITY	DESCRIPTION OF EFFECTS	CORRESPONDING RICHTER
I	INSTRUMENTAL	Detected only on seismographs.	
II	FEEBLE	Some people feel it.	< 4.2
III	SLIGHT	Felt by people resting; like a truck rumbling by.	
IV	MODERATE	Felt by people walking.	
V	SLIGHTLY STRONG	Sleepers awake; church bells ring.	< 4.8
VI	STRONG	Trees sway; suspended objects swing, objects fall off shelves.	< 5.4
VII	VERY STRONG	Mild alarm; walls crack; plaster falls.	< 6.1
VIII	DESTRUCTIVE	Moving cars uncontrollable; masonry fractures, poorly constructed buildings damaged.	
IX	RUINOUS	Some houses collapse; ground cracks; pipes break open.	< 6.9
X	DISASTROUS	Ground cracks profusely; many buildings destroyed; liquefaction and landslides widespread.	< 7.3
XI	VERY DISASTROUS	Most buildings and bridges collapse; roads, railways, pipes, and cables destroyed; general triggering of other hazards.	< 8.1
XII	CATASTROPHIC	Total destruction; trees fall; ground rises and falls in waves.	> 8.1

[50] Magnitude/Intensity Comparison. USGS. Retrieved from http://earthquake.usgs.gov/learn/topics/mag_vs_int.php Retrieved March 3, 2015.

Table 18. Richter v. Moment Magnitude Values.

Earthquake	Richter Scale	Moment Magnitude
New Madrid, MO 1812	8.7	8.1
San Francisco, CA 1906	8.3	7.7
Prince William, AK 1964	8.4	9.2
Northridge, CA 1994	6.4	6.7

Liquefaction

Liquefaction is the phenomenon that occurs when the strength and stiffness of a soil is reduced by earthquake shaking or other rapid loading.[51] Essentially, the soil temperature acts like a fluid, similar to wet sand near the beach, resulting in ground failure. According to the San Diego County Hazard Mitigation Plan, liquefaction causes two types of ground failure: lateral spread and loss of bearing strength. Lateral spread develops on gentle slopes and entails the sidelong movement of large masses of soil as an underlying layer liquefies. Loss of bearing strength results when the soil supporting structures liquefies and causes structures to collapse.

Liquefaction is not known to have occurred historically in San Diego County. [52] Liquefaction has occurred in the Imperial Valley, about 100 miles east of the reservation, in response to large earthquakes (Magnitude 6 or greater) originating in that area. Historically, seismic shaking levels have not been sufficient to trigger liquefaction in the area near Pala. However, it is important to recognize that liquefaction is possible. Paleoseismic indicators of liquefaction have been recognized locally, and several pre-instrumental (prior to common use of seismographs) earthquakes could have been severe enough to cause liquefaction.

4.7.4.2 Location

An earthquake event would impact the entire planning area. There are earthquake faults and earthquake risk areas that also help define location. There are several active faults in Southern California as well as faults known to have caused earthquakes over 6.0M in the last 1.6 million years (Figure 31**).** Active faults near the Pala Reservation include the Wildomar fault and the Elsinore Fault. The Wildomar Fault runs north-to-south through the Reservation and is classified as a Type B fault (not capable of producing magnitude 7.0 or greater earthquakes) by the 1997 Uniform Building Code. The Elsinore Fault lies approximately 20 miles southeast of the Pala Reservation and runs through Lake Henshaw. The Elsinore Fault is categorized as a Type A fault (capable of producing magnitude 7.0 earthquakes or greater) and has a high rate of seismic activity (a slip rate of at least 5 millimeters per

[51] University of Washington. What is soil liquefaction? Retrieved from http://www.ce.washington.edu/~liquefaction/html/what/what1.html.
[52] San Diego County, land Use and Environment Group (2007). *County of San Diego Guidelines for Determining Significance*. Retrieved from https://www.sandiegocounty.gov/dplu/docs/Geologic_Hazards_Guidelines.pdf

year). This is the most severe type of fault. It is also a branch of the San Andreas Fault System. The Earthquake Valley Fault lies just to the north of the Elsinore Fault and is a Type B fault. These faults are shown in Figure 31.

According to the Unified San Diego County Emergency Services Organization Operational Area Emergency Plan (2000), there are several additional active faults in San Diego County, including the Rose Canyon, La Nacion, San Jacinto, Coronado Bank, and San Clemente Fault Zones. The Rose Canyon Fault Zone is part of the Newport-Inglewood Fault Zone, which originates to the north in Los Angeles, and extends southward to the Vallecitos and San Miguel Fault Systems in Baja California. The Rose Canyon Fault extends inland from La Jolla Cove, south through Rose Canyon, along the east side of Mission Bay, and out into San Diego Bay. The Rose Canyon Fault is considered to be the greatest potential threat to San Diego as a region, due to its proximity to areas of high population. The La Nacion Fault Zone is located near National City and Chula Vista. The San Jacinto Fault is also a branch of the San Andreas Fault System. This fault branches off from the major fault as it passes through the San Bernardino Mountains. Traveling southeasterly, the San Jacinto Fault passes through Clark Valley, Borrego Springs, Ocotillo Wells, and then east toward El Centro in Imperial County. This fault is the most active large fault within the County of San Diego. The Coronado Bank Fault is located about 10 miles offshore. The San Clemente Fault lies about 40 miles off La Jolla and is the largest offshore fault at 110 miles or more in length.[53]

[53] Not pictured in Figure 9.

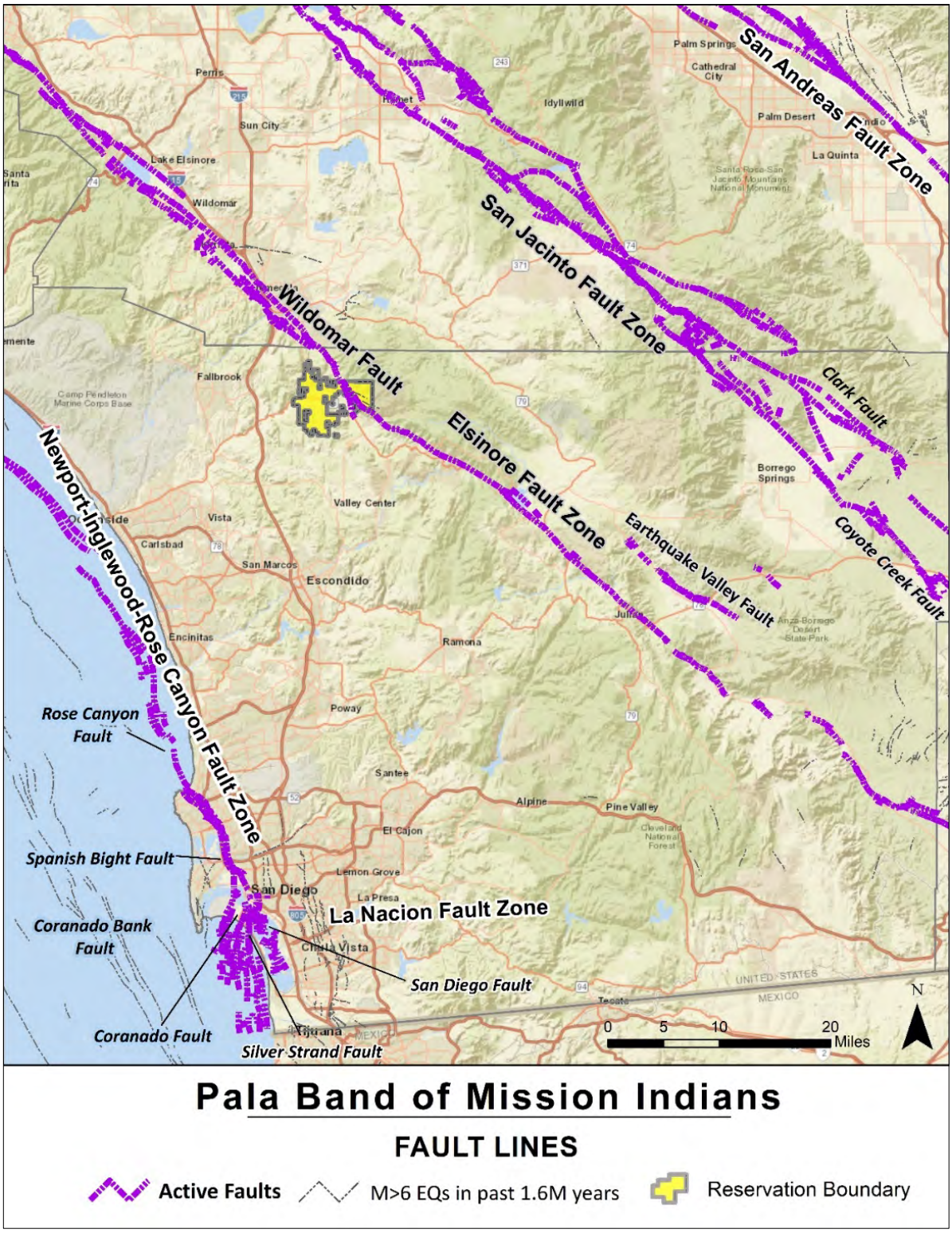


Figure 31. Active Fault Lines in Southern California. [54]

Liquefaction

The San Diego County Department of Planning and Land Use created a liquefaction GIS layer to be used for regional purposes. The layer was obtained from San Diego Association of Governments (SANDAG) Regional GIS Data Source website (SanGIS).[55] The metadata noted there "may be a potential for liquefaction in areas with loose sandy soils combined with a shallow groundwater table, which typically are located in alluvial river valleys/basins and floodplains." Further, the dataset used the following information to identify potential areas of liquefaction:

- Existing liquefaction areas from local maps
- National Earthquake Hazards Reduction Program (NEHRP) (soil ratings from hard to soft)
- USDA Soil Survey (known hydric soils)

Liquefaction risk areas for the Pala Reservation are shown in the figure below.

[54] Active Fault information was provided from the SANGIS and includes faults which are known to have been active during the last 11,000 years. Additional faults were provided by the California Geological Survey and obtained from the USGS. The data includes faults which are known to have produced M6.0+ earthquakes during the past 1,600,000 years (Quaternary period).: U.S. Geological Survey (and supporting agency if appropriate-see list below), 2006, Quaternary fault and fold database for the United States, accessed DATE, from USGS web site: http//earthquakes.usgs.gov/regional/qfaults/.

[55] SANDAG GIS Data Warehouse. Potential Liquefaction (2017). San Diego Planning and Development Services, LUEG-GIS Service and NEHRP. Retrieved from https://www.sandag.org/index.asp?subclassid=100&fuseaction=home.subclasshome.

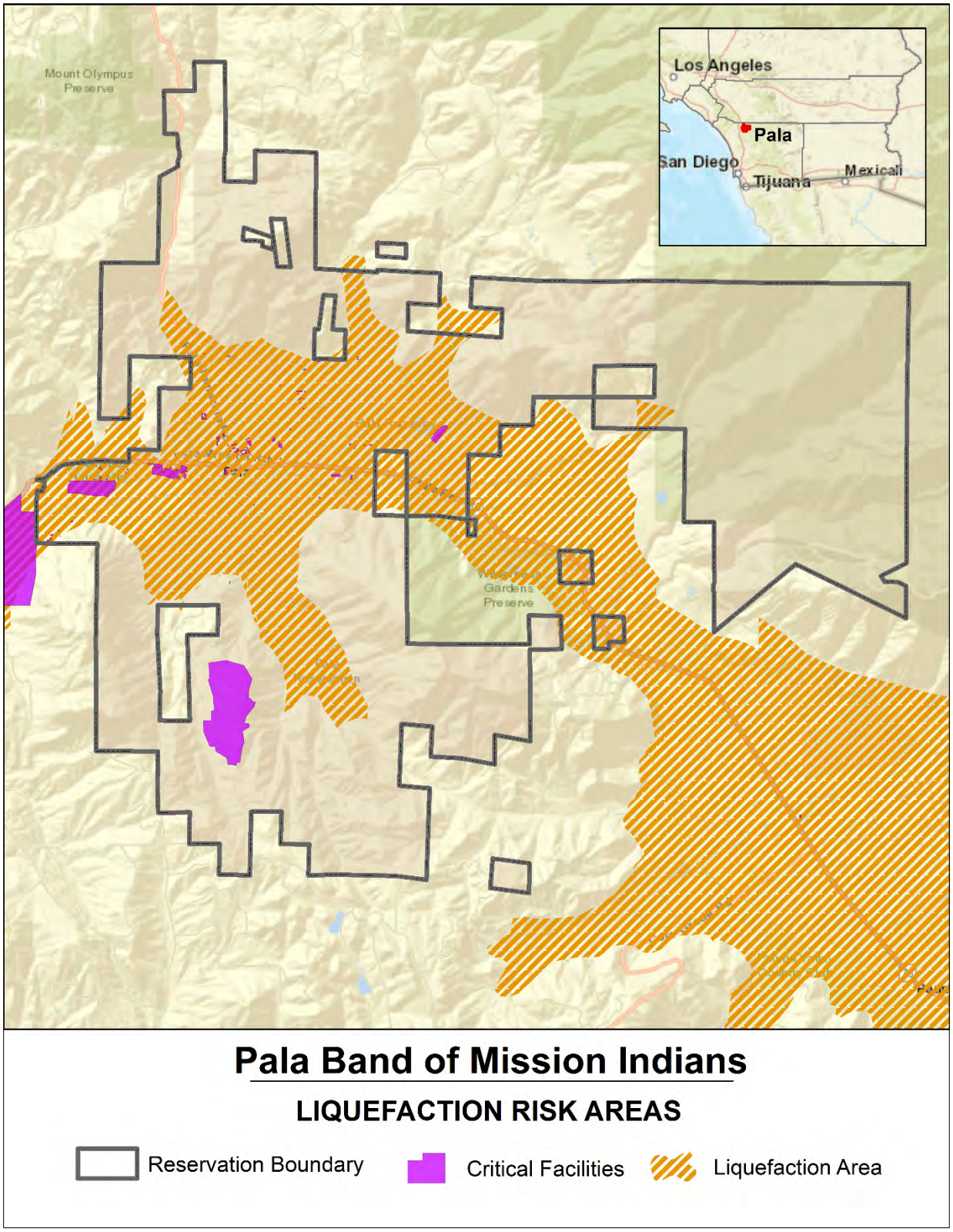


Figure 32. Liquefaction Risk Areas on the Pala Reservation.

4.7.4.3 Previous Occurrences

Given limited information about events on the reservation and the knowledge that earthquakes can impact vast areas, San Diego County data was used to investigate previous occurrences. San Diego County, including the Pala Reservation planning area, has less seismicity than other parts of California. However, earthquake activity in San Diego County has doubled since 1984, compared to the previous 50 years.[56] Further, the reservation is near a high-risk area – the Elsinore Fault Zone – which is capable of producing 7.0+ magnitude events. A variety of data sources were used to compile significant events which occurred between 1862 and 2014. Over 47 earthquakes (and many more aftershocks) are referenced between 1800 and 2020 in the county. These are listed below by source:

San Diego Hazard Mitigation Plan[57]

- May 27, 1862 (M6.0)
    - A strong earthquake struck San Diego on May 27, 1862, damaging buildings in Old Town and opening up cracks in the earth near the San Diego River mouth. This destructive earthquake was centered on either the Rose Canyon or Coronado Bank faults.
- July 13, 1986 (M5.3)
    - The strongest recently recorded earthquake in San Diego County was a M5.3 earthquake that occurred on July 13, 1986 on the Coronado Bank Fault, 25 miles west of Solana Beach. In recent years there have been several moderate earthquakes recorded within the Rose Canyon Fault Zone as it passes beneath the City of San Diego. Three temblors shook the city on June 17, 1985 (M3.9, 4.0, 3.9) and a stronger quake occurred on October 28, 1986 (M4.7) (Demere, SDNHM website 2003).
- June 15, 2004 (M5.3)
    - The most recent significant earthquake activity occurred on June 15, 2004 with a M5.3 on the San Diego Trough Fault Zone approximately 50 miles SW of San Diego. It was reported as a IV on the MMI (Southern California Seismic Network).

NOAA's Significant Earthquake Database[58]

Earthquakes in this database meet at least one of the following criteria:

- Moderate damage (approximately $1 million or more),
- 10 or more deaths,
- Magnitude 7.5 or greater,
- Modified Mercalli Intensity X or greater, or the

[56] Ready San Diego. Earthquake. Retrieved from https://www.readysandiego.org/earthquake/.
[57] San Diego County Multi-Jurisdiction Hazard Mitigation Plan (2018). Retrieved from https://www.sandiegocounty.gov/content/dam/sdc/oes/emergency_management/HazMit/2018/2018%20Hazard%20Mitigation%20Plan.pdf.
[58] National Geophysical Data Center / World Data Service (NGDC/WDS): Significant Earthquake Database. National Geophysical Data Center, NOAA.

- Earthquake generated a tsunami.

In addition, a minimum magnitude of 5.0 was selected to filter only those that likely caused damage. The Pala Reservation coordinates were used as a location indicator. Three earthquakes were reported:

- 1899: Large earthquake (no additional details provided)
- May 18, 1940 (M7.2, MMI 10), 49 after shocks
    - This event included two earthquakes in Imperial Valley, near El Centro, California. The main earthquake took nine lives and caused property damage estimated at $6 million ($100,595,000 inflated to 2015 dollars). Overall, $33 million ($553,270,000 inflated to 2015 dollars) in damage was reported. Damage from a strong aftershock near Brawley at 0551 UTC is included in the estimate. About 49 aftershocks occurred through the end of 1940.
- October 1979 (M6.9, MMI 9)
    - The October 1979 event caused several injuries and $30 million ($99,990,00 inflated to 2015 dollars) in damages. El Centro is about 100 miles east of the reservation.
    - In addition, several photos were taken:

This slumping resulted from the earth shaking near El Centro. The earthquake produced extensive lateral slope failure along many irrigation canals. Photo Credit: University of Colorado

A fault trace crosses a plowed field. The trace was produced by the October 1979 earthquake in the Imperial Valley. The agricultural industry suffered heavy losses from damage to canals, irrigation ditches, and subsurface drain tiles disturbed by the movement along the Imperial fault. Photo credit: G. Reagor, U.S. Geological Survey

San Diego Union-Tribune

The San Diego Union-Tribune lists 45 earthquakes between 1800 and 2008 that were felt in San Diego. [59] The earthquakes ranged from 3.0 (2008) to 7.3 (1992).

Southern Earthquake Data Center

The Southern Earthquake Data Center was also referenced to determine the activity of the Elsinore Fault Line. The last major rupture occurred on May 15, 1910. An interval of 250 years between major ruptures is predicted with expected magnitudes of 6.5-7.5 Mw.[60]

Liquefaction

No events of liquefaction were found to have occurred on the Pala Reservation based on extensive research of previous events. However, according to the San Diego County Hazard Mitigation Plan, Paleoseismic indicators of liquefaction have been recognized in the county, and several pre-instrumental (prior to common use of seismographs) earthquakes could have been severe enough to cause at least some liquefaction. Further, the San Diego liquefaction map indicates areas of concern on the Pala Reservation. This area roughly follows the 100-year floodplain.

4.7.4.4 Extent

There are several ways to measure the extent of an earthquake including fault type and peak acceleration.

Fault Type

San Diego County classified faults in the county as Type A or Type B (in accordance with information from the 1997 Uniform Building Code). Type A is more severe, defined as being capable of producing magnitude 7.0 earthquakes or greater, and have a high rate of seismic activity (a slip rate of at least 5 millimeters per year). Near-source velocity effects need to be considered within 15 kilometers (9 miles) of a Type A fault. The Elsinore Fault is categorized as a Type A fault and is within 20 miles of the Pala Reservation, just outside the assume near-source velocity effects range. Therefore, these impacts could still be experienced with an event centered on the Elsinore Fault, and severe impacts should be expected given the proximity.

[59] http://legacy.utsandiego.com/news/metro/20080729-1505-bn29quakesid.html
[60] http://www.data.scec.org/significant/elsinore.html

Peak Ground Acceleration

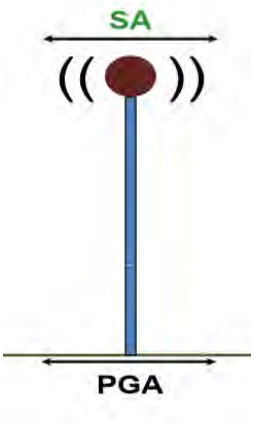


Figure 33. SA and PGA Comparison.

USGS peak ground acceleration (PGA) measures the intensity of an earthquake. It is the probability that ground motion will reach a certain level during an earthquake (the fastest measured change in speed, for a particle at ground level that is moving horizontally due to an earthquake). PGA is expressed as g (the acceleration of gravity, equivalent to g-force), where a higher level means higher shaking. It is frequently stated as "x percent probability of exceedance in C years," For data stating PGA (%g) as "10 percent probability of exceedance in 50 years," a map would indicated that there is a 10 percent probability of reaching that level of shaking (%g) in 50 years. (It is meant to show the upper bounds of possible shaking.)

In addition, spectral acceleration (SA) is presented and measured as %g. According to the USGS, SA can be described as "approximately what is experienced by a building, as modeled by a particle mass on a massless vertical rod having the same natural period of vibration as the building.[61]" It is the maximum acceleration in an earthquake on an object and approximates building motion during an earthquake. Further, PGA estimates ground motion versus object motion. SA is best used for taller buildings, while PGA is best used for shorter buildings (less than 7 stories). Figure 33[62] shows a comparative diagram.

The USGS Earthquake Hazards Program Unified Hazard Tool was consulted. PGA and SA were estimated for the Pala Reservation using the coordinates of the reservation. The estimated PGA and SA are presented in Table 19 and Figure 34 and Figure 35 show a map of PGA values for the Pala Reservation.

Table 19. PGA on the Pala Reservation. [63]

	Parameters/Chance of Exceedance	%g	Mercalli Scale Intensity	Perceived Shaking/Potential Damage
PGA	10% in 50 yrs.[64]	28.7	VII	Very strong/Moderate
PGA	2% in 50 yrs.	63.2	VIII	Moderate/Heavy
0.2 sec SA	10% in 50 yrs.	63.9	VIII	Moderate/Heavy
0.2 sec SA	2% in 50 yrs.	145.0	X	Extreme/Very Heavy
1.0 sec SA	10% in 50 yrs.	18.8	VII	Very strong/Moderate

[61] Earthquake Hazards 201 – Technical Q&A. USGS Retrieved from https://www.usgs.gov/natural-hazards/earthquake-hazards/science/earthquake-hazards-201-technical-qa?qt-science_center_objects=0#qt-science_center_objects.
[62] What is a ground shaking hazard map and who uses it? Retrieved from http://kula.geol.wwu.edu/rjmitch/pga_maps.pdf.
[63] USGS Unified Hazard Tool, NSHM 2014 Rev. 1. Retrieved from https://earthquake.usgs.gov/hazards/interactive/.
[64] According to the USGS, the approximate annual probability of exceedance is about 0.10(1.05)/50 = 0.0021. The calculated return period is about 476 years.

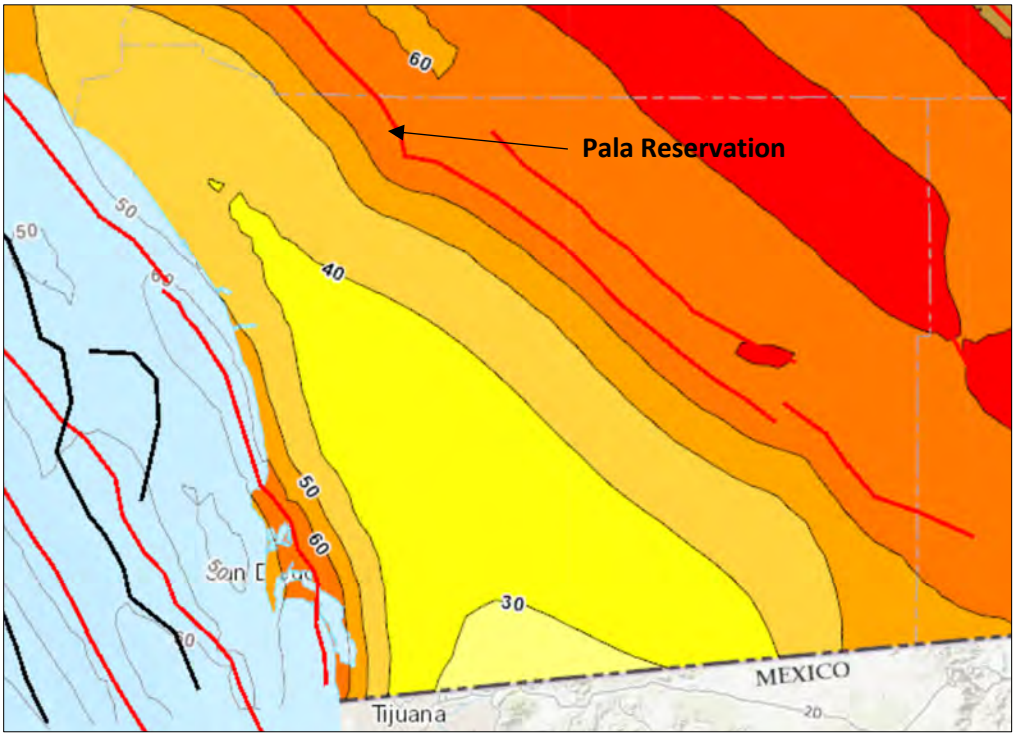


Figure 34. PGA (2% in 50 years) on the Pala Reservation.

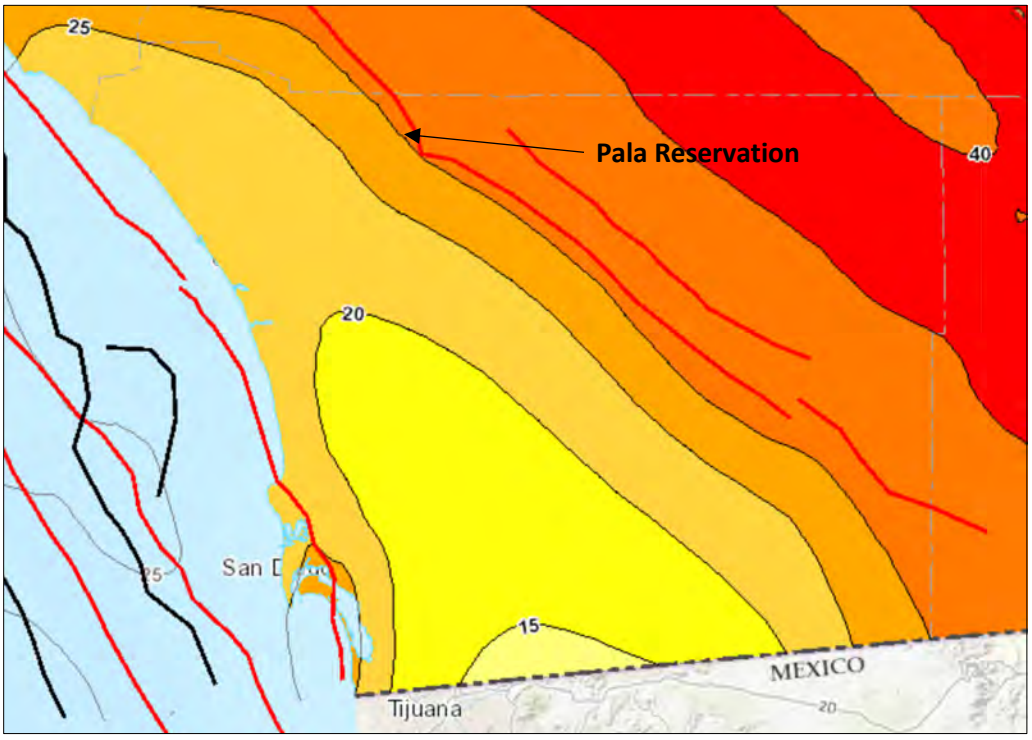


Figure 35. PGA (10% in 50 years) on the Pala Reservation.

In addition, the information presented in Figure 30 shows that the Pala Reservation is in the highest risk area for earthquakes in the United States.

Liquefaction

Liquefaction extent was determined by estimating the amount of land potentially at risk to soil failure. About 10 square miles (50%) of the Pala Reservation land is identified as having potential liquefaction risk.

4.7.4.5 Probability of Future Events

Earthquakes are a significant risk to the Pala Reservation. The probability of a very strong earthquake (Mercalli greater than IX) is about 10% over the next 50 years. This level of shaking would create considerable amounts of damage.

The probability of future earthquake events impacting the Pala Reservation was determined using historical occurrence information. Five major (damage-causing) events have been reported over a 152-year reporting period. This results in an approximate probability of 4% annually. A total of approximately 50 earthquakes that were felt are referenced between 1800 and 2020, an estimated 23% annual probability. Further, the county website notes the most credible earthquake predictions are a M7.2 on the Rose Canyon Fault or a M7.6 from either the Elsinore Fault or the San Jacinto Fault. Any of these events would have significant impacts on the Pala Reservation and all tribal assets. Given the rate of historic earthquake occurrences, a probability of "Possible" (1% to 10% annual chance) was assigned for a significant earthquake event on the Pala Reservation.

4.7.4.6 Vulnerability Assessment and Estimated Losses

It can be assumed that all existing and future buildings, critical facilities, cultural resources, and populations are at risk to the earthquake hazard. There are several factors that impact vulnerability to earthquake on the Pala reservation.

A moderate earthquake occurring could result in deaths, casualties, property damage, environmental damage and disruption of normal services and business activities. The effects could be aggravated by collateral emergencies such as fires, flooding, hazardous material spills, utility disruptions, and transportation emergencies. The Reservation does take several measures to reduce vulnerabilities. For example, all water pipes are built to earthquake standards, including flexible couplings and tie downs. Also, water profile water tanks are built to withstand earthquake effects. The following characterizes the earthquake vulnerability faced by the Pala Reservation:

- *USGS Hazard Location:* The USGS National Map indicates the Reservation is located in the highest risk category for earthquake occurrence (Figure 30).
- *Proximity to Elsinore Fault:* The Reservation is located less than 20 miles northwest of the actual fault (Figure 31). The strongest shaking and highest ground acceleration during an earthquake generally occur closest to the fault involved. As noted above, the Elsinore Fault is categorized as

a Type A fault by the 1997 Uniform Building Code, meaning it is capable of producing magnitude 7.0 earthquakes (or greater) and has a high rate of seismic activity (a slip rate of at least 5 millimeters per year). This is the most severe type of fault.

- *Building Construction*: Building codes are the minimum needed to prevent collapse and typically found in the Uniform Building Code. All structures—residential and non-residential—built by the Tribe must abide by the California standards for construction. Individuals, however, do not have to adhere to the standards, presenting possible vulnerabilities if buildings are not properly constructed. Any buildings below code have a higher probability of collapse. Measures beyond the code ("above-code") are encouraged. Pala has implemented several protective construction measures, such as the use of flexible piping systems. Additionally, the Pala Casino Resort & Spa is built to withstand a M8.3 event.

- *Building Type*: Certain building types, such as unreinforced masonry and concrete, are at a higher risk of damage.

- *Soil Type*: Softer soils may collapse or slide during an earthquake. Liquefaction risk areas, as demonstrated in Figure 32 present a higher risk to buildings. Nearly all of the developed property of the Pala Reservation resides in a liquefaction risk area. Specific buildings at risk are described below.

Hazus-MH Loss Estimates

Hazus-MH 4.2 SP3 was used to estimate the potential of complete structural damage due to an earthquake. A baseline of dollar exposure for all buildings and their contents on the Pala Reservation was reviewed, as detailed in Table 20**.** These dollar values reflect a combination of estimates and on-the-ground conditions, as detailed in data provided by the tribe. This information provides a baseline of how much property, in terms a dollar value, is at risk. Exposure for the identified buildings where a majority of Reservation residents reside is approximately $395 million.

Table 20. Hazus-MH 4.2 Dollar Exposure for the Pala Reservation.

	Building Exposure	Content Exposure	Total Exposure
Commercial	$94,771,000	$94,771,000	$189,542,000
Residential	$124,226,000	$62,113,000	$186,339,000
Religious	$5,467,000	$5,467,000	$10,934,000
Other (includes Agriculture, Education, Industrial)	$4,173,000	$4,221,000	$8,394,000
TOTAL	**$228,637,000**	**$166,572,000**	**$395,209,000**

A Level 2 Hazus-MH "Source Event" analysis was performed. One scenario was modeled - an event on the Elsinore Fault, near Pala, with a 7.5 Moment Magnitude (Table 21). The results presented in the

table below reflect the percent chance of physical damage to a structure. Results specific to each structure can be found in Appendix B.

Table 21. Hazus-MH 4.2 Earthquake Event Damages Per Percent Chance.

Elsinore Fault (Pala 7.5)		
Percent Chance	Physical Damage – None (# of Buildings)	Physical Damage – Complete (# of Buildings)
0 – 25%	761	703
25 – 50%	12	16
50 – 75%	0	41
75 – 100%	0	13
Total	**773**	**773**

The results indicate the probability of complete destruction for all buildings is low (0-25 percent) and a majority of buildings would not be damaged. However, some physical damage is likely. All buildings in this scenario are expected to sustain some damage. The figure below presents potential PGA values at the Pala Reservation under this scenario.

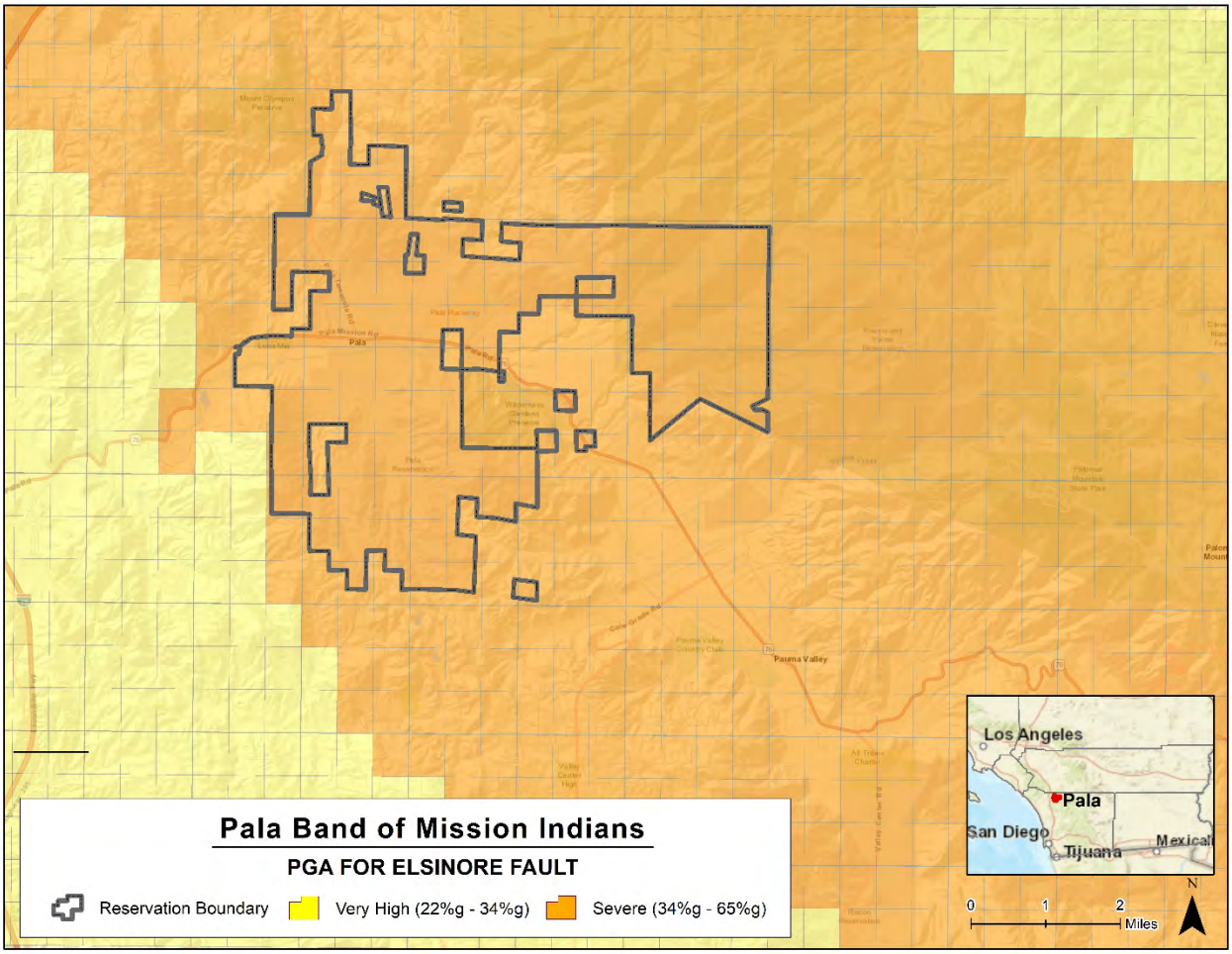


Figure 36. PGA for a M7.5 Earthquake on the Elsinore Fault.

Liquefaction

Losses to liquefaction were estimated using GIS analysis. The analysis revealed that nearly all of Pala's buildings, 768 of 773 buildings including those considered critical facilities, are potentially at risk to liquefaction. Combined, these buildings and their contents are valued at approximately $394 million. The number of buildings and associated value potentially at risk to liquefaction are presented in Table 22**.** Figure 37 shows Pala Reservation buildings within liquefaction risk areas.

Table 22. Buildings in Liquefaction Risk Areas on the Pala Reservation.

Building Type	Number of Buildings	Building Value	Content Value	Total Value
Agricultural	6	$1,576,308	$1,576,308	$3,152,616
Commercial	185	$94,741,120	$94,741,120	$189,482,239
Education	6	$2,500,861	$2,500,861	$5,001,721
Other	2	$95,561	$143,342	$238,903

Building Type	Number of Buildings	Building Value	Content Value	Total Value
Religious	7	$5,467,004	$5,467,004	$10,934,008
Residential	562	$123,472,032	$61,736,016	$185,208,048
TOTAL	**768**	**$227,852,886**	**$166,164,650**	**$394,017,536**

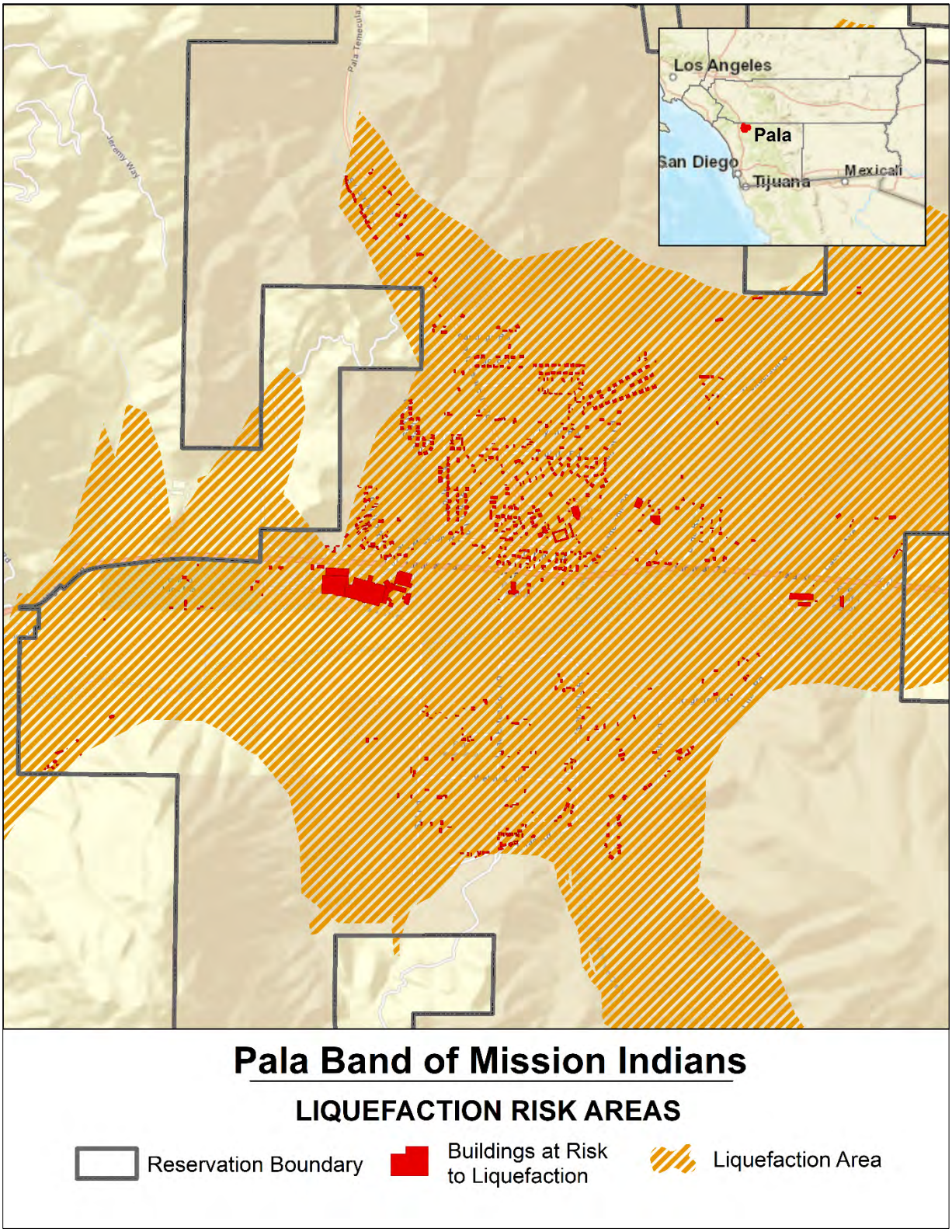


Figure 37. Pala Buildings at Risk to Liquefaction.

Sixty-three of the Tribe's 66 critical facilities are in areas at risk to liquefaction (all except the Southside Water Tanks #2 and #3, and the avocado groves). Table 23 lists the critical facilities at risk to liquefaction and their associated values. Figure 38 shows Pala Reservation critical facilities within liquefaction risk areas.

Table 23. Critical Facilities in Liquefaction Risk Areas on the Pala Reservation.

Critical Facility Name	Building Value	Content Value	Total Value
Pala Casino, Resort and Spa	$265,726,548	$66,895,614	$332,622,162
Pala Mini Mart, Gas Station and Canopies	$2,663,643	$538,519	$3,202,162
Pala RV Resort	$1,963,683	$216,718	$2,180,401
Pala Casino Warehouse	$2,645,110	$235,704	$2,880,814
Pala Administration Building	$6,938,838	$1,263,309	$8,202,147
Pala Fitness Center	$4,202,988	$366,176	$4,569,164
Pala Skatepark	$105,019	$123,996	$229,015
KOPA Radio Station	$359,091	$167,707	$526,798
Pala Social Services Office	N/A	N/A	N/A
Pala EOC and Training Center	$9,934,554	$2,051,973	$11,986,527
Pala Fire Station	$2,063,327	$76,760	$2,140,087
Pala Tribal Law Enforcement	$418,848	$61,030	$479,878
Cellular Communications Tower	N/A	N/A	N/A
Pala Postal Annex	$245,046	$61,616	$306,662
Pala Learning Center and Library	$1,869,694	$308,808	$2,178,502
Pala Youth Center	$1,264,276	$24,412	$1,288,688
Pala Child Care Center	$1,264,276	$51,020	$1,315,296
Old Tribal Hall	$834,244	$39,667	$873,911
Pala Cultural Center	$854,982	$53,080	$908,062
Blacktooth House (Historical Property)	N/A	N/A	N/A
Pala Utilities Department/Yard	$1,054,022	$287,938	$1,341,960
Pala Tribal Services Department/Yard	$620,433	$84,499	$704,932
Pala Fleet Department/Yard	$266,689	$3,473,147	$3,739,836
Pala Transfer Station	$1,263,678	$118,091	$1,381,769
Pala (Fox) Raceway	$0	$29,797	$29,797
Pala Shooting Range	N/A	N/A	N/A
Pala Rey Youth Camp	N/A	N/A	N/A
Hanson Pond Conservation Easement	N/A	N/A	N/A
Fallbrook Propane (Rental)	N/A	N/A	N/A
TANF (Tribal Assistance for Needy Families) and TDV (Tribal Digital Village)	N/A	N/A	N/A
Mission San Antonio de Pala	N/A	N/A	N/A
Vivian Banks Charter School	N/A	N/A	N/A
San Juan Diego Center	N/A	N/A	N/A
Rancho Luna Mia (animal husbandry)	541409	0	541409
Catalina Fields (alfalfa)	N/A	N/A	N/A

Critical Facility Name	Building Value	Content Value	Total Value
Duker Grove (oranges)	N/A	N/A	N/A
McCament Grove (oranges)	N/A	N/A	N/A
Robert's Ranch (oranges)	$511,903	$0	$511903
Pala Vineyard (grapes)	N/A	N/A	N/A
Pala Gateway (oranges)	N/A	N/A	N/A
Pala Wastewater Treatment Plant	$9,235,036	$0	$9,235,036
Casino Lift Station	N/A	N/A	N/A
Allers Lift Station	N/A	N/A	N/A
Fire Station Lift Station	$1,369,923	$0	$1,369,923
Oaks Lilac Well (North)	N/A	N/A	N/A
Fire Station Well (North)	N/A	N/A	N/A
Casino Well #1	N/A	N/A	N/A
Casino Well #2	N/A	N/A	N/A
Highway Well	N/A	N/A	N/A
Vista Well (North)	N/A	N/A	N/A
Vineyard Well (Raceway)	N/A	N/A	N/A
Riverbed East Well (South, new)	N/A	N/A	N/A
Riverbed West Well (South, west)	N/A	N/A	N/A
Valenzuela Well (South)	N/A	N/A	N/A
Water Tank, Northwest Tank #3 (North)	N/A	N/A	N/A
Water Tank, Northeast Tank #2 (North)	N/A	N/A	N/A
Water Tank, Northeast Tank #1 (North)	N/A	N/A	N/A
Water Tank, Raceway (Raceway)	N/A	N/A	N/A
Oaks Booster Station (North)	N/A	N/A	N/A
Trujillo Creek Well (North)	N/A	N/A	N/A
Catalina Well (North)	N/A	N/A	N/A
Lilac West Well (South)	N/A	N/A	N/A
Lilac East Well (South)	N/A	N/A	N/A

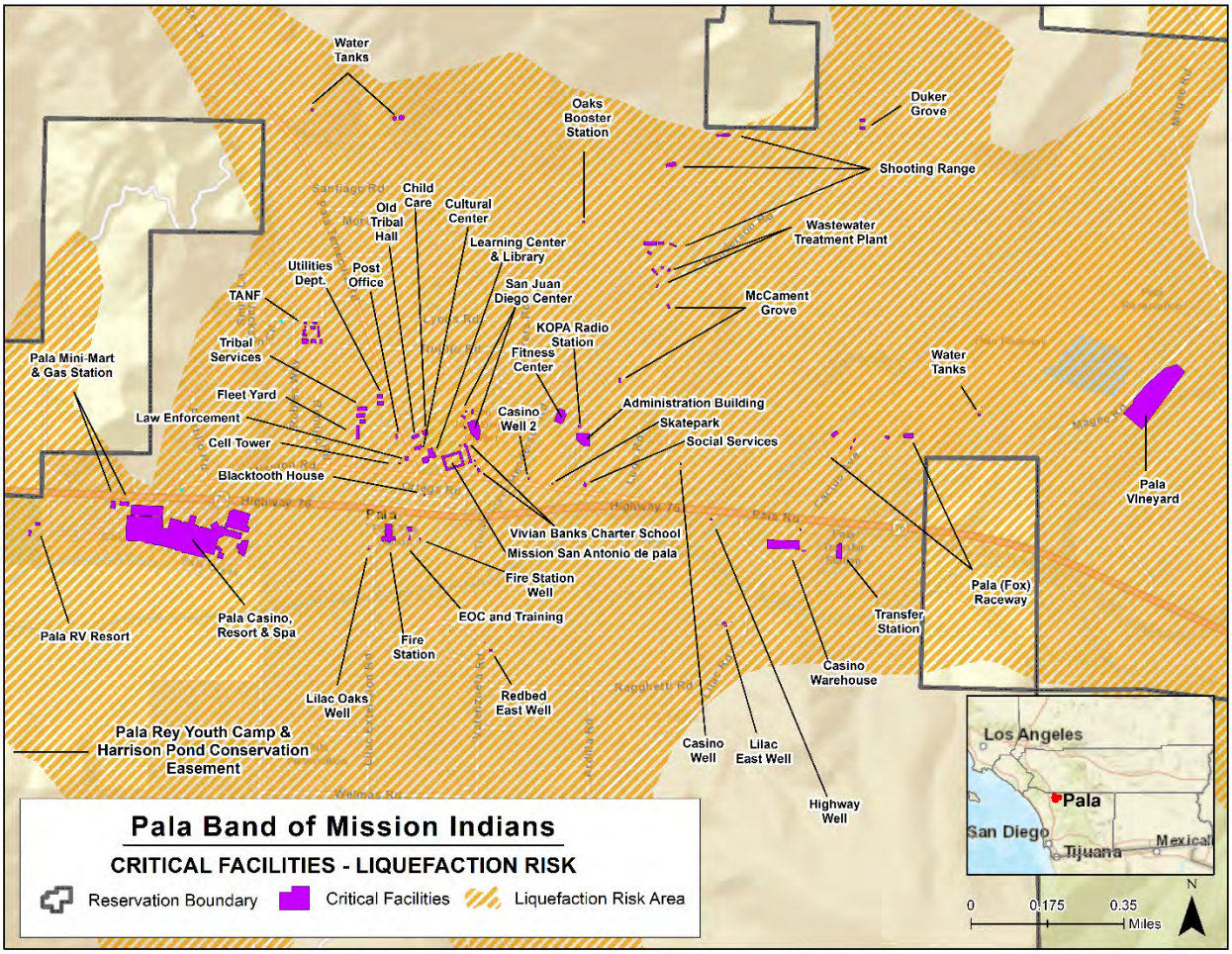


Figure 38. Critical Facilities at Risk to Liquefaction.

Climate Change Impacts

There are no known impacts from climate change on the frequency or intensity of earthquake/liquefaction events on the Reservation.

4.7.5 Epidemic/Pandemic

4.7.5.1 Description

Public health risks are present within every community and include:

- **Vector-borne Diseases**. A vector-borne disease is a disease transmitted to humans from living organisms or animals (e.g., Zika Virus).
- **Infectious Diseases**. Infectious diseases are caused by pathogens that can be spread, directly or indirectly, from person to person. Such diseases may be seasonal (seasonal influenza) or result, in the case of new diseases, in a global pandemic (e.g., COVID-19).

- **Non-Communicable Diseases (NCDs).** NCDs are diseases that are not transmissible directly from one person to another such as autoimmune diseases, diabetes, chronic kidney disease, Alzheimer's disease, cataracts, and others. Other public health risks include chronic diseases, such as diabetes, hypertension, and asthma, some of which are considered epidemics in the U.S.

The Centers for Disease Control and Prevention (CDC) provide the following definitions:[65]

- Epidemic refers to an increase, often sudden, in the number of cases of a disease above what is normally expected in that population in that area.
- Outbreak carries the same definition of epidemic, but it is often used for a more limited geographic area.
- Pandemic refers to an epidemic that has spread over several countries or continents, usually affecting a large number of people.

The degree to which communities are susceptible to or actively experiencing public health issues can impact a community's vulnerability to natural hazards, as well as its ability to respond to disasters. For instance, an infectious disease outbreak may complicate evacuations or/and mass sheltering required due to a natural hazard.

History reveals that in the absence of information about a public threat, treatments, and vaccines, infectious diseases can be extremely deadly. For example, the 14th-century bubonic plague, a pandemic, killed about 50 million people in Europe at a time well before modern medicine or an understanding of contagion existed. The plague did not submit for nearly 10 years and continued to reemerge every decade, or so, for nearly 400 years.[66] The plague was largely managed through trial and error and ultimately controlled through quarantine measures, the first use of it in history. In more recent history, the world has experienced the 1918 flu, a pandemic, which killed 50 million people globally and more than 600,000 Americans. Currently, the world is impacted by COVID-19 pandemic.

While major outbreaks are uncommon, public health emergencies can become stand-alone disasters that compound the threat of other natural hazards and exceed local and state capacity. There is precedent for federal assistance due to public health emergencies including West Nile Virus (2000), a mosquito-borne disease, for which a federal emergency declaration was made in New York and New Jersey,[67] and the COVID-19 pandemic, which resulted in a major disaster declaration in all states, tribal nations, territories, and the District of Columbia. Additionally, other natural disaster events can cascade into public health emergency such as wildfire's impacts due to degraded air quality, flood impacts due to

[65] Centers for Disease Control and Prevention (2020). *Lesson 1: Introduction to Epidemiology*. Retrieved from https://www.cdc.gov/csels/dsepd/ss1978/lesson1/section11.html#:~:text=Epidemic%20refers%20to%20an%20increase,a%20more%20limited%20geographic%20area.
[66] Ishack, Natasha. "The Black Death Was The Worst Pandemic In Human History, So How Did It Finally End?" All That is Interesting. 8 Apr 2020. Retrieved from https://allthatsinteresting.com/how-did-the-black-plague-end.
[67] FEMA (2000). *President Authorizes Emergency Funds For New Jersey Virus Threat.* Retrieved from https://www.fema.gov/news-release/2000/11/01/president-authorizes-emergency-funds-new-jersey-virus-threat.

mold and sanitation, and earthquakes due to impacts on potable water systems. In recent days, a public health emergency was declared in California due to the August 2020 wildfires.[68]

Vector-borne Diseases

Coccidioidomycosis (Valley Fever)

According to the California Department of Public Health, "Valley fever (also called coccidioidomycosis or "cocci") is a disease caused by a fungus that grows in the soil and dirt in some areas of California and the southwestern United States. People and animals can get sick when they breathe in dust that contains the Valley fever fungus. This fungus usually infects the lungs and can cause respiratory symptoms including cough, fever, chest pain, and tiredness." This disease has been on the rise in California in recent years.[69] Cases in California have risen from 840 in 2000 to more than 7,500 in 2018. It is not contagious from one person to another.

Angiostrongyliasis (Rat Lungworm Disease)

Rat Lungworm Disease is caused by a parasitic nematode, also known as a roundworm parasite. In humans, rat lungworm affects the brain and spinal cord, impacting the brain and nervous system. Infected rats can pass larvae of the roundworm in their feces to intermediate hosts, such as slugs, snails, and freshwater crustaceans. Humans can become infected by:

- eating raw or undercooked snails, slugs freshwater shrimp, land crabs, frogs, or crayfish;
- accidently eating produce with slugs, snails, or slime; or
- drinking improperly filtered catchment water with slugs or snails.

Symptoms of rat lungworm include severe headache, stiff neck, tingling skin, low-grade fever, and nausea or vomiting.[70]

Dengue

While uncommon in the continental US, outbreaks do occur. Dengue fever is transmitted to humans by Aedes aegypti and Aedes albopictus mosquitoes. Symptoms include headache, body aches, fever, and rash. In several cases, blood clotting problems can occur. Symptoms typically last one to two weeks. About half of cases present no symptoms. Prevention actions include avoiding mosquito bites (repellant and covering skin), and well as reducing mosquitos by emptying standing water.[71]

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[68] Health and Human Services. *"HHS Secretary Azar declares Public Health Emergency in California due to wildfires."* 26 Aug 2020. Retrieved from https://www.hhs.gov/about/news/2020/08/26/hhs-secretary-azar-declares-public-health-emergency-in-california-due-to-wildfires.html

[69] California Department of Public Health (2020). *Valley Fever is on the rise in California.* Retrieved from https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/Coccidioidomycosis.aspx

[70] MauiReady (n.d.). Emergency Preparedness Information for Maui Residents and Visitors. Retrieved from https://mauiready.org/ratlungworm/.

[71] Hawai'i Department of Health Disease Outbreak Control Division (2016). *Dengue Outbreak 2016-15*. Retrieved from https://health.Hawai'i.gov/docd/dengue-outbreak-2015/.

Hansen's Disease (Leprosy)

Although rare, approximately 150-250 cases are reported in the US each year. Hansen's disease (also known as leprosy) is an infection caused by slow-growing bacteria called *Mycobacterium leprae*. Leprosy was once feared as a highly contagious and devastating disease, but now we know it doesn't spread easily and treatment is very effective. With early diagnosis and treatment, the disease can be cured. Further, to transmit the disease, a person must be in close contact with someone with untreated Hansen's disease for many months or even years. People with Hansen's disease can continue to work and lead an active life during and after treatment. Hansen's Disease can affect the nerves, skin, eyes, and lining of the nose (nasal mucosa). However, if left untreated, the nerve damage can result in crippling of hands and feet, paralysis, and blindness.[72]

Leptospirosis[73]

Leptospirosis can be contracted when a person has contact with water, soil, or urine from an infected animal. Multiple types of animals may be infected including dogs, horses, pigs, wildlife and rodents. Symptoms generally include a combination of fever, diarrhea, muscle aches, vomiting, red eyes, and jaundice. Without treatment, Leptospirosis can lead to kidney damage, meningitis (inflammation of the membrane around the brain and spinal cord), liver failure, respiratory distress, and even death. According to the CDC, people should avoid floodwater as water may contain infected animal urine. The following factors increase risk to Leptospirosis:

- Drinking from potentially contaminated water sources, including floodwater, streams, rivers, or unsafe tap water.
- Bathing or wading in floodwater or contaminated fresh water, especially when putting your head under water or if you have an open wound or scratch.
- Eating food that has been exposed to contaminated water or potentially urinated on by rodents.

Approximately 100-150 new cases are reported annually though about half of them are in Puerto Rico.

West Nile Virus

West Nile Virus is a mosquito-borne virus that impacts people, horse, and birds. It can result in illness or death. It is considered one of the most serious vector-borne diseases in California.[74] The best way to prevent West Nile Virus is to prevent mosquito viruses.

Zika Virus

Zika virus is spread by *aedes* mosquitoes. Zika virus is also considered an infectious disease, as it can be sexually transmitted. Symptoms of Zika infection can include a fever, joint pain, rash, headache, and

[72] Centers for Disease Control and Prevention. *Hansen's Disease (Leprosy)*. Retrieved from https://www.cdc.gov/leprosy/index.html.
[73] Centers for Disease Control and Prevention (2018). *Hurricanes, Floods and Leptospirosis.* Retrieved from: https://www.cdc.gov/leptospirosis/exposure/hurricanes-leptospirosis.html
[74] California Department of Public Health (2020). *West Nile*. Retrieved from http://westnile.ca.gov/resources.php

conjunctivitis ("pink eye"). Only about 20% of people with Zika infection have symptoms. When symptoms occur, they can last several days to a week. Human fetuses are susceptible to severe birth defects if the mother is infected with Zika virus. Preventing the spread of Zika into new areas includes the following:

- Education of residents or visitors who are diagnosed with Zika to avoid mosquito bites and to use condoms or abstain from sex for up to 6 months.
- Education of the general public about mosquito borne and sexual transmission of Zika virus, and the importance of repellent and covering skin (long pants, long sleeves, and socks) to avoid mosquito bites.
- Reducing mosquito breeding by emptying standing water and other methods.[75]

Infectious Diseases

Coronavirus (COVID-19)

COVID-19 is a highly contagious, viral upper-respiratory illness that was first detected in China in late 2019. The virus quickly spread throughout the world and has resulted in a global pandemic ongoing at the time of this plan. As of August 28, 2020, there were 24.5 million cases of COVID-19 globally and 5.88 million cases in the U.S., resulting in over 832,000 deaths globally and 181,000 in the U.S. COVID-19 symptoms include cough, difficulty breathing, fever, muscle pain, and loss of taste or smell. Severe cases may result in death, especially in individuals over the age of 65 or with underlying medical conditions, such as diabetes, lung disease, asthma, obesity, or those who are immunocompromised. COVID-19 spreads from person to person through respiratory droplets in the air or on surfaces.[76]

To prevent the continued spread of the virus, many communities around the world have used stay-at-home orders, in which residents must remain home except to utilize essential services, such as grocery stores and health care services. Many schools have closed, and workers have switched to teleworking. Business closures have caused major economic losses in many countries.

Hepatitis B

Hepatitis B is an infectious liver disease caused by the hepatitis B virus. Hepatitis B infections can be acute (short-term illness occurring with six months of contraction) or chronic (long-term illness in which serious health problems can develop). About 90% of infants infected with Hepatitis B will develop a chronic infection, compared to only about 5% of adults. Symptoms can include fever, fatigue, loss of appetite, nausea, vomiting, joint pain, and jaundice. Hepatitis B is transmitted from person to person

[75] MauiReady (n.d.). *Emergency Preparedness Information for Maui Residents and Visitors*. Retrieved from https://mauiready.org/zika/.

[76] Centers for Disease Control (2020). *Coronavirus disease 2019 (COVID-19)*. Retrieved from https://www.cdc.gov/coronavirus/2019-ncov/faq.html.

through bodily fluids. There is no cure for Hepatitis B, but a vaccination is available to prevent against the virus.[77]

Measles[78]

Measles is a highly contagious respiratory disease caused by the Rubeola virus. Symptoms include high fever, rash and cough. The virus is spread through the air, primarily from coughing and sneezing. It can result in numerous complications including pneumonia and encephalitis (swelling of the brain) that can lead to seizures, deafness, brain damage or death. Approximately 1 in 5 people who contract measles will be hospitalized. Young children under the age of 5, pregnant women and those with compromised immune systems are most at risk to complications.

Prior to a vaccination, an estimated 3 to 4 million Americans were infected each year. A vaccine was developed in 1963, and most kids are vaccinated by the age of 15. The measles vaccine is usually combined with mumps and rubella, and commonly referred to as the "MMR," or combined with mumps, rubella and varicella ("MMRV"). Measles was declared eliminated (absence of continuous disease transmission for greater than 12 months) from the United States in 2000. However, in recent years the rate of vaccinations has dropped leading to a reemergence of the disease. According to the CDC, since 2010, cases reported have ranged between 55 cases in 2012 to 1,282 cases in 2019. Measles vaccination rates need to be at 93% to 95% of the population to prevent measles from spreading. COVID-19 is also impacting vaccination rates, which dropped by 40% year-over-year from April 2019 to April 2020.[79]

Tuberculosis

Tuberculosis (TB) is a bacterial infection that usually attacks the lungs but can also affect other parts of the body such as the spine, kidneys, or brain. Symptoms include a cough, fever, and weight loss. There are two types of tuberculosis – latent TB infection (LTBI), in which no symptoms are presented, and TB disease. TB disease can be infectious and is spread from person to person through droplets in the air, whereas LTBI is not infectious. Most cases of TB disease are treatable and curable but can be fatal if not properly treated. In some cases, TB infections are resistant to drugs, which is referred to as drug-resistant TB.[80] A vaccine exists but is rarely administered in the U.S., given a low rate of incidence. The national incidence rate was 2.8 cases per 100,000 persons (1.3% decrease from 2017), which has been declining since tracking started in the 1930s. However, rate of incidence is declining at a lower rate in recent years.

[77] Hawai'i Department of Health Disease Outbreak Control Division (2020). *Hepatitis B*. Retrieved from https://health.Hawai'i.gov/docd/disease_listing/hepatitis-b/

[78] Centers for Disease Control and Prevention (2020). Measles. Retrieved from: https://www.cdc.gov/measles/symptoms/complications.html.

[79] EdSource (2020). *California immunization rates drop 40% during pandemic Parents fearful of exposing kids to Covid-19 may be putting them at risk for other diseases.* Retrieved from https://edsource.org/2020/california-immunization-rates-drop-40-percent-during-pandemic/633594

[80] Centers for Disease Control (2020). *Basic TB facts*. Retrieved from https://www.cdc.gov/tb/topic/basics/default.htm.

4.7.5.2 Location

The entirety of the Pala Reservation is considered to be uniformly exposed to epidemics and pandemics. However, some locations may have a greater risk for certain vectors. For examples, areas where people congregate have an increased risk of spreading the highly contagious COVID-19 and seasonal influential. Similarly, outdoor locations where the ground is being disturbed, such as construction sites or archeological sites, carry a greater risk of exposing those nearby to Valley Fever when compared to indoor locations.

4.7.5.3 Previous Occurrences

The following presents an overview of recent or notable previous occurrences of the health risks described above. In most cases, information specific to Pala was not available, so county-level information was used:

- **COVID-19:** As of August 26, 2020, 70 cases of COVID-19 have been reported in the zip code where the Pala Reservation resides. Tribal officials reported no deaths during the August PEDAG meeting.[81] The Casino was closed for two months which resulted in significant economic loss for the tribe. In addition, tribal stakeholders noted the mental and emotional toll resulting from job loss or quarantine.
- **Mumps:** In November 2019, the county issued an alert reporting 60 mumps cases, which was the highest number reported in the county in 25 years.[82] A total of 66 were reported in 2019. An additional alert was issued in February 2020, noting 10 new cases in 2020. No additional alerts have been posted, suggesting the spread has been contained, likely due to COVID-19 stay at home orders.
- **Valley Fever:** As of 2019 (the latest available report), 273 were reported in San Diego County between January-December 2018, on the highest reported counties.[83]
- **West Nile:** As of August 2020, 35 human cases of West Nile Virus have been reported in the state. This is lower than the five-year average of 84.8 cases.

[81] County of San Diego Health and Human Services Agency (HHSA)/Live Well San Diego (2020). *County of San Diego Daily Coronavirus Disease 2019 (COVID-19) Summary of Cases by Zip Code of Residence.* Retrieved from https://www.sandiegocounty.gov/content/dam/sdc/hhsa/programs/phs/Epidemiology/COVID-19%20Summary%20of%20Cases%20by%20Zip%20Code.pdf

[82] California Health Alert Network San Diego (2019). *Health Advisory Update #2: Mumps in San Diego County.* Retrieved from https://www.sandiegocounty.gov/content/dam/sdc/hhsa/programs/phs/cahan/communications_documents/11-26-19-Mumps%20in%20San%20Diego.pdf

[83] California Department of Public Health. *2018 Year-end Monthly Summary Report of Selected California Reported Diseases (as of April 2, 2019).* Retrieved from https://www.cdph.ca.gov/Programs/CID/DCDC/CDPH%20Document%20Library/2018Year-endIDBCaseCountsbyMonthandLHJ.pdf

- **Zika virus**: There are aedes mosquitoes in California, but no locally acquired infections of Zika county have been reported in San Diego County. Rather, the 106 total reported cases as of December 31, 2018 are linked to those traveling in high risk areas.[84]
- **Hepatitis A:** The county experienced an outbreak between November 2016 and January 2018 that resulted in 592 cases and 20 deaths. A local health emergency was declared on September 1, 2017.[85]
- **Hepatitis B (chronic)**: An average of 888 cases were present annually between 2014 and 2018 in San Diego County.[86]
- **Leprosy**: One case was reported annually between 2014 and 2018 in San Diego County.
- **Dengue:** Cases ranged from 6 to 23 annually between 2014 and 2018 throughout San Diego County.
- **Tuberculosis:** More than 220 cases were reported annually between 2014 and 2018 in San Diego County, with the highest number reported in 2018 (258 cases).

4.7.5.4 Extent

As the severity of outbreaks, epidemics and pandemics is difficult to determine given the varying impacts associated with different health risks. COVID-19 has possibility had the largest overall impact on Pala overall in recent history when considering number of cases, deaths, and societal impacts including mental health and economic loss.

4.7.5.5 Probability of Future Events

Probability of outbreaks, epidemics and pandemics within the reservation is variable. Many public health risks occur seasonally and are ongoing, such as the common cold and influenza. Major outbreaks, such as the current COVID-19 pandemic, are less common. Based on the information available regarding historic or current events, this hazard was assigned a probability of likely (10% to 90% annual chance) for the reservation. Climate change will likely impact public health risks as discussed below in the vulnerability section.

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[84] San Diego County Health and Human Services Agency. Local Zika Activity (2018). *Table 2: Total Number of Zika Cases reported in San Diego (as of December 31, 2018).* Retrieved from https://www.sandiegocounty.gov/content/dam/sdc/hhsa/programs/phs/documents/Zika_Cases_Reported_SD_County.pdf

[85] San Diego Health and Human Services Agency (2018). *Hepatitis A Outbreak in San Diego County is Officially Over.* Retrieved from https://www.sandiegocounty.gov/content/sdc/hhsa/programs/phs/community_epidemiology/dc/Hepatitis_A/outbreak.html

[86] County of San Diego health and Human Services Agency (HHSA)/Live Well San Diego (2019). *Reported Diseases and Conditions by Year, 2014-2018*. Retrieved from https://www.sandiegocounty.gov/content/dam/sdc/hhsa/programs/phs/documents/Reportable_Diseases_and_Conditions_SDC_2014-2018.pdf

4.7.5.6 Vulnerability and Estimation of Losses

All current and future populations on the Pala Reservation are considered at risk to outbreaks, epidemics and pandemics. Health risks can include outbreaks of infectious illnesses, as well as rises or high incidences of chronic diseases or substance abuse. Vulnerable populations, such as elders or those with existing conditions may be more vulnerable to public health threats or complications. Further, some populations may face greater exposure to certain vectors. For example, those in construction or archeology are more likely to be exposed to Valley Fever and those working in health care or jobs requiring contact with other persons are more likely to be exposed to COVID-19.

While buildings and infrastructure are not typically impacted by health threats, they may need to be sterilized or decontaminated in some cases. Further, there can also be economic impacts. Mandatory closures and stay at home orders cause business interruptions, school closures, lost tourism and lay-offs all impact tribal revenue. Pala's casino and hotel attracts visitors, making it susceptible to contagious diseases brought to the reservation from other parts of the county and region. Further, the tribe may lose revenues from sales and hospitality taxes, while at the same time having to increase spending and divert resources to managing the spread of disease.

Of note, the COVID-19 pandemic has the potential to continue to some degree over the next several years, or until a vaccine is developed, making the tribe susceptible to ongoing illness, fatalities, and loss of economic revenue.

Estimated Losses

The Pala Band has experienced significant indirect losses from the epidemic/pandemic events, notably the ongoing COVID-19 pandemic. Indirect losses are caused by closures at the Pala Casino, job losses, and other business disruptions. Annualizing losses is not feasible without loss estimates. However, annualizing these losses overtime would likely result in negligible losses per year on the Reservation.

Climate Change Impacts

Climate change may have negative impacts on health risks. According to the Fourth National Climate Assessment, an increase in the incidence of vector-borne diseases is anticipated. Changing conditions (e.g., warmer or more humidity) may create for favorable (or more hostile) environments for vectors. For example, mosquitos will have a more favorable environment to thrive with increased precipitation. The California Governor's Office of Planning and Research also noted that 63% of people said they think climate change is bad for public health.[87]

[87] California Governor's Office of Planning and Research (2020). *Climate Change and Public Health*. Retrieved from https://opr.ca.gov/facts/climate-change-and-public-health.html

4.7.6 Erosion

4.7.6.1 Description

Erosion is the gradual breakdown and movement of land due to both physical and chemical processes of water, wind, and general meteorological conditions. Natural, or geologic, erosion has occurred since the Earth's formation and continues at a very slow and uniform rate each year. There are two types of soil erosion: wind erosion and water erosion. Wind erosion can cause significant soil loss. Winds blowing across sparsely vegetated or disturbed land can pick up soil particles and carry them through the air, thus displacing them. Water erosion can occur over land or in streams and channels. Water erosion that takes place over land may result from raindrops, shallow sheets of water flowing off the land, or shallow surface flow, which becomes concentrated in low spots. Stream channel erosion may occur as the volume and velocity of water flow increases enough to cause movement of the streambed and bank soils. Erosion can lead to collapsed banks and roads.

An area's potential for erosion is generally determined by four factors: soil characteristics, vegetative cover, topography climate or rainfall, and topography. Soils composed of a large percentage of silt and fine sand are most susceptible to erosion, whereas those with clay and more organic content are likely are less likely to erode. Well-drained and well-graded gravels and gravel-sand mixtures are the least likely to erode. Coarse gravel soils are highly permeable and have a good capacity for absorption, which can prevent or delay the amount of surface runoff. Vegetative cover can be very helpful in controlling erosion by shielding the soil surface from falling rain, absorbing water from the soil, and slowing the velocity of runoff. Runoff is also affected by the topography of the area including size, shape, and slope. The greater the slope length and gradient, the more potential an area has for erosion. Climate can affect the amount of runoff, especially the frequency, intensity, and duration of rainfall and storms. When rainstorms are frequent, intense, or of long duration, erosion risks are high. Seasonal changes in temperature and rainfall amounts define the period of highest erosion risk of the year. During the past 20 years, the importance of erosion control has gained the increased attention of the public.

Implementation of erosion control measures consistent with sound agricultural and construction operations is needed to minimize the adverse effects associated with harmful chemicals run-off due to wind or water events. The increase in government regulatory programs and public concern has resulted in a wide range of erosion control products, techniques, and analytical methodologies in the United States. The preferred method of erosion control in recent years has been the restoration of vegetation.

4.7.6.2 Location

Several sources were consulted for areas of erosion risk and previous occurrences including NOAA, USGS, California Department of Conservation and the San Diego County and State Hazard Mitigation Plans. While no substantive information was found from these resources, tribal officials and stakeholders were able to provide insight current areas of erosions which is shown in Figure 39**.** Erosion

occurs in several areas across the Reservation, particularly along the bank northern bank of the San Luis Rey River.

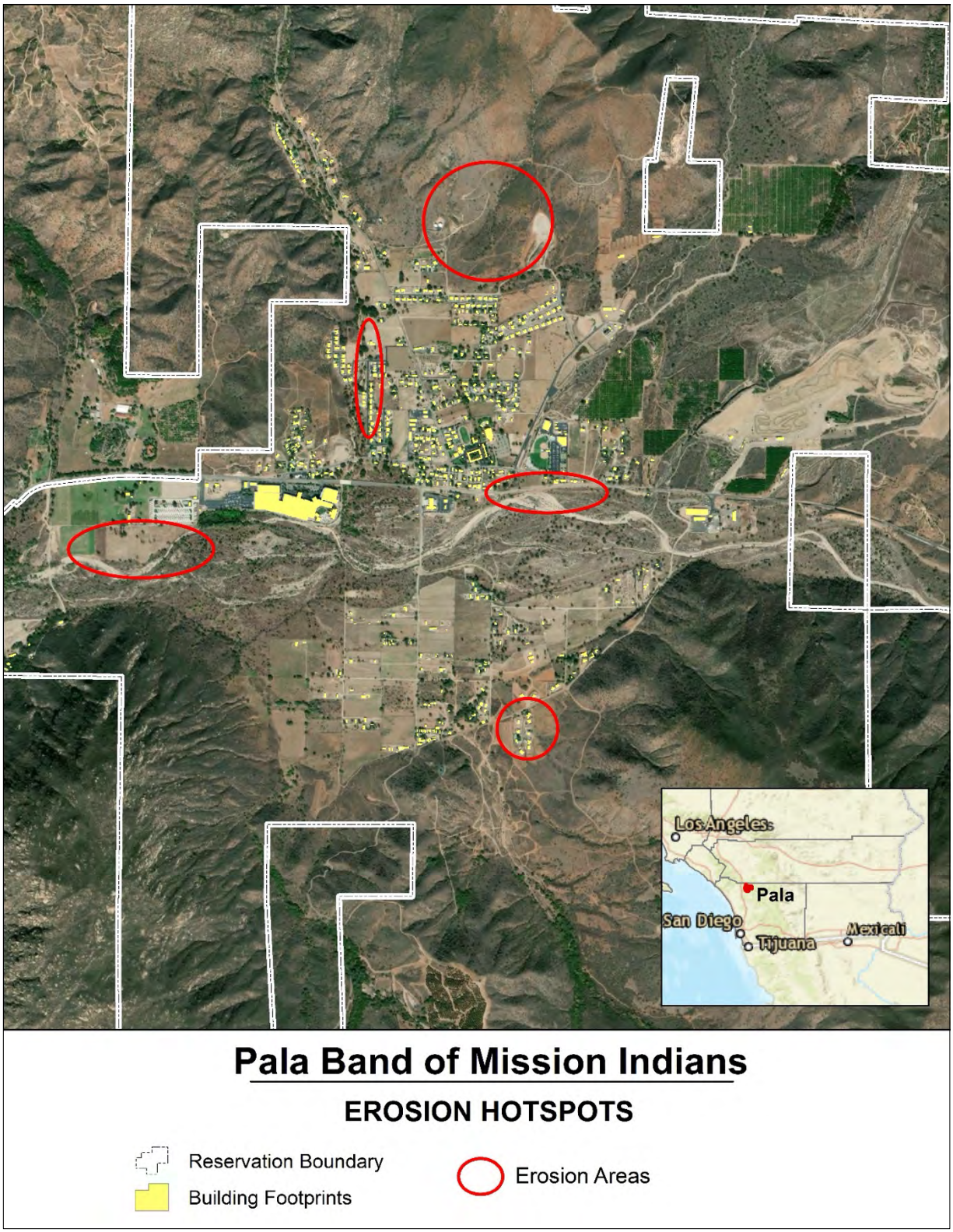

Figure 39. Erosion Hotspots Identified by Tribal Officials.

4.7.6.3 Previous Occurrences

As noted above, several sources were consulted for previous occurrences No structures have been historically impacted by erosion on the reservation, but the following areas were identified:

- South of the Pala Casino along the San Luis Rey River.
- Along Highway 76 (southside) along the San Luis Rey River (approximate east-west boundaries of Brittain Road and Lugo Road; due south of the Skate Park).
- Southern reservation boundary east of Bubble Up Creek.
- East of the Allers Development along Pala Temecula Road.
- North of the western-most portion of Oaks Road.

4.7.6.4 Extent

The extent of erosion can be defined by the measurable rate of erosion that occurs. Data was not available to show the exact erosion rate on the reservation or in San Diego County. (Of note, data is available for coastal areas, but it was not application the Reservation area.) Erosion typically happens slowly over time but may be accelerated by fast moving and/or high-water levels in the San Luis Rey River, its tributaries, or creeks on the reservation. In the most severe situations, erosion will result in a bank or road collapse.

4.7.6.5 Probability of Future Occurrences

Erosion remains a natural, dynamic, and continuous process for the Pala reservation, and it will continue to occur. The annual probability level assigned for erosion is “highly likely” (between 90 and 100% annually).

4.7.6.6 Vulnerability Assessment and Estimation of Losses

Given data limitations of defined erosion boundary, a qualitative assessment of vulnerability was conducted. All current and future buildings, populations, and critical facilities are at risk to this hazard. Erosion concerns are most prevalent around Highway 76 but could impacts other roads, community lifelines, or structures in the future. A collapse of the Highway 76 resulting in delays or closures could have significant impacts including:

- Disrupted emergency/life safety responses and evacuations;
- Economic ramifications as if the reservation in unreachable (including the Pala Casino);
- Agricultural impacts by depletion of the fertile layer of topsoil.

Mitigation measures for erosion have been added to the action plan.

Estimated Losses

It is difficult to determine an exact value for the Pala Reservation and its assets without detailed historic data, but losses would likely be negligible.

Climate Change Impacts

Erosion is likely to be exacerbated by climate change through more extreme weather events. This includes more severe droughts and more intense rain events. Wind erosion is exacerbated by hot temperatures and drought conditions, which can cause vegetation to die and soils to loosen.

4.7.7 Extreme Freeze

4.7.7.1 Description

The term "extreme cold" can have varying definitions in hazard identification. Further, what is considered an extreme cold event will vary greater by region. Generally, extreme cold events refer to a prolonged period (days) with extremely cold temperatures, which may or may not be associated with a winter storm. An extreme cold event to the National Weather Service can refer to a single day of extreme or record-breaking day of sub-zero temperatures. Extended or single day extreme cold events can be hazardous to people and animals, and cause problems with buildings, transportation, and agriculture.

The Wind Chill Index (Figure 40)[88] is a measure of the rate of heat loss from exposed skin caused by the combined effects of wind and cold. As the wind increases, heat is carried away from the body at a faster rate, driving down both the skin temperature and eventually the internal body temperature. Exposure to extreme wind chills can be life threatening. The NOAA chart shows the Wind Chill Index as it corresponds to various temperatures and wind speeds. As an example, if the air temperature is 5°F and the wind speed is 10 miles per hour, then the wind chill would be -10°F. As wind chills edge toward -19°F and below, there is an increased likelihood that continued exposure will lead to individuals developing cold-related health impacts.

[88] Safety-Winter Hazards. (2017). National Weather Service. Retrieved August 15, 2017 from https://www.weather.gov/apx/Day_6_Winter_Awareness.

WIND SPEED (mph) \ AIR TEMPERATURE (F)	50	45	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40
5	48	42	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57
10	46	40	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66
15	45	38	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71
20	44	37	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74
25	43	36	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78
30	42	35	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80
35	41	35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82
40	41	34	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84
45	40	33	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86
50	40	33	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88
55	40	32	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89
60	39	32	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91
65	39	32	24	17	10	2	-5	-12	-19	-27	-34	-41	-49	-56	-63	-70	-78	-85	-92
70	38	31	24	16	9	2	-6	-13	-20	-27	-35	-42	-49	-57	-64	-71	-79	-86	-93
75	38	31	23	16	9	1	-6	-13	-21	-28	-36	-43	-50	-58	-65	-72	-80	-87	-95
80	38	30	23	16	8	1	-7	-14	-21	-29	-36	-44	-51	-59	-66	-73	-81	-88	-96
85	38	30	23	15	8	0	-7	-15	-22	-30	-37	-44	-52	-59	-67	-74	-82	-89	-97
90	37	30	22	15	7	0	-8	-15	-23	-30	-38	-45	-53	-60	-68	-75	-83	-90	-98
95	37	29	22	14	7	-1	-8	-16	-23	-31	-38	-46	-53	-61	-68	-76	-84	-91	-99
100	37	29	22	14	6	-1	-9	-16	-24	-31	-39	-47	-54	-62	-69	-77	-84	-92	-100

Approx frostbite times | 30 min | 10 min | 5 min

Figure 40. National Weather Service (NWS) Wind Chill Index Chart.

Frostbite and **hypothermia** are both extreme cold-related impacts that result when individuals are exposed to extreme temperatures and wind chills, in many cases as a result of severe winter storms. The following describes the symptoms associated with each.

During exposure to extremely cold weather, the body reduces circulation to the extremities (e.g., feet, hands, nose, cheeks, ears, etc.) in order to maintain its core temperature. If the extremities are exposed, then this reduction in circulation coupled with the cold temperatures can cause the tissue to freeze. Frostbite is characterized by a loss of feeling and a white or pale appearance. At a wind chill of -19°F, exposed skin can freeze in as little as 30 minutes. Seek medical attention immediately if frostbite is suspected. It can permanently damage tissue and in severe cases can lead to amputation.

Hypothermia occurs when the body begins to lose heat faster than it can produce it. As a result, the body's temperature begins to fall. If an individual's body temperature falls below 95°F, then hypothermia has set in and immediate medical attention should be sought. Hypothermia is characterized by uncontrollable shivering, memory loss, disorientation, incoherence, slurred speech, drowsiness and exhaustion. Left untreated, hypothermia will lead to death. Hypothermia occurs most commonly at very cold temperatures but can occur at cool temperatures (above 40°F) if an individual isn't properly clothed or becomes chilled.

Frost/Freeze: Frost forms during freezing temperatures when the ground surface cools to a temperature colder than the dewpoint of adjacent air. When water vapor in the air above the ground surface condenses, it freezes due to low temperatures.

4.7.7.2 Location

Nearly the entire continental United States is susceptible to extreme cold and freeze events. Some freeze events may be large enough to affect several states, while others might affect limited, localized areas. The degree of exposure typically depends on the normal expected severity of local winter weather. In general, the Pala Band tribe is accustomed to cool winter with occasional freezing temperatures. Given the atmospheric nature of the hazard, the entire Pala Reservation has uniform exposure to extreme cold and freeze events.

4.7.7.3 Previous Occurrences

In order to understand cold temperature extremes, average cold temperatures were researched. In addition, previous occurrences from NCEI were reviewed. The nearest weather monitoring station with information was retrieved, which is located in the Palomar Mountains. It is likely that these averages are lower than what Pala typically experiences. Average low temperatures range from the mid-30s in the winter months to the low 60s in the summer months. Average high temperatures in the summer months are in the low 80s. Record lows were colder, ranging from the single digits in the winter months to the upper-30s in the summer months. Figure 41 below shows average monthly maximum and record temperatures.

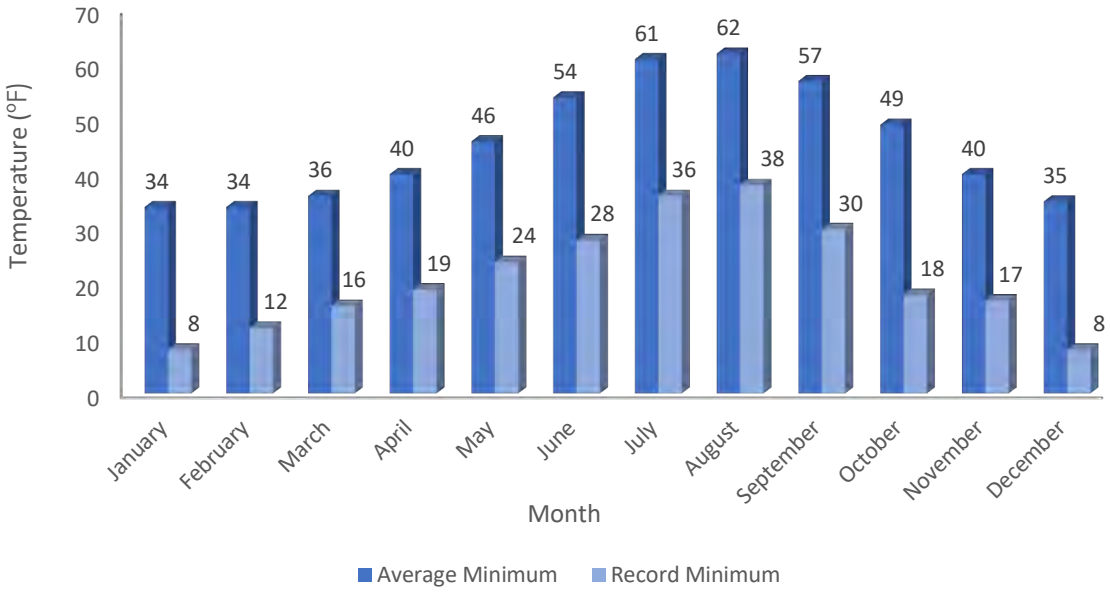

Figure 41. Average Minimum Temperatures in the Pala Reservation Vicinity, 1901-2016[89]

The NCEI Storm Events Database reports extreme cold and freeze events by county and NWS public forecast zone. Therefore, extreme cold and freeze event data solely for the Pala Reservation is not available. Due to the regional nature of cold/freeze events, events occurring in San Diego County were retrieved in order to indicate the number and severity of previous occurrences likely to have impacted the Pala Reservation.

From the average and record low temperatures presented above, it is known that below freezing temperatures, including temperatures dipping into the teens and single digits, are a possible occurrence during wintertime. Six extreme cold events in San Diego County from NCEI were reported (1996-2020). No deaths or injuries were reported. Details for extreme cold events are presented in Table 24.

Table 24. Previous Extreme Cold and Freeze Occurrences.

NWS Public Forecast Zone	Type	Date	Extreme Temperature Reported
San Diego County Mountains	Extreme Cold	1/30/2002	N/A
San Diego County Mountains	Extreme Cold	2/1/2002	Single digits
San Diego (zone)	Frost/Freeze	12/1/2004	20s

[89] Western Regional Climate Center, Palomar Mountain Observatory (046657). (2016). Retrieved August 28, 2020, from https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca6657.

NWS Public Forecast Zone	Type	Date	Extreme Temperature Reported
San Diego County Mountains	Frost/Freeze	1/13/2007	Teens
San Diego County Valleys	Frost/Freeze	12/18/2019	20s to mid-30s
San Diego County Valleys	Frost/Freeze	2/4/2020	20s to mid-30s

Event Descriptions from NCEI indicate that the majority of reported damages occurred from destroyed crops and burst pipes. Anecdotal information from tribal stakeholders indicated that pipe bursts do occur in extreme cold events.

4.7.7.4 Extent

The extent of extreme cold or freeze events can be measured in terms of record low temperatures. The lowest temperature reported from the Western Regional Climate Center at the Palomar Mountain Observatory Station was eight degrees Fahrenheit (occurring in January 1949), but lower temperatures are possible.

Extent of extreme cold can also be measured in terms of loss of human and animal life, or by economic costs imposed by property and infrastructure loss. Therefore, it is unlikely that an extreme cold/freeze event would cause significant property damage on the reservation beyond sporadic burst pipes.

4.7.7.5 Probability of Future Events

The NCEI Storm Events Database reported six extreme cold events and frost/freeze events in San Diego County since 1950, although those reported do not begin until 2002. Therefore, freeze events average approximately one event every three years. The frequency of cold/freeze events may decline in the future due to overall warming trends associated with climate change (see section below). Based on the above factors, the annual probability assigned for extreme cold/freeze events is “possible” (between 1 and 10% annual probability).

4.7.7.6 Vulnerability Assessment and Estimation of Losses

The entire Pala Reservation and associated properties, including all current and future buildings, populations, cultural resources, and critical facilities, are vulnerable to extreme cold/freeze events. The elderly or young children, or any individuals without access to an adequate heat source, may be at a greater risk during extreme cold events in which the temperatures dip into teens or single digits.

All structures, including critical facilities and cultural sites, are at risk to extreme cold and freeze events. Damages to structures are typically caused by burst pipes. Structure fires are also more common during extreme cold events, as alternative or unsafe heating sources are more likely to be employed (i.e., woodfires, space heaters).

Estimated Losses

It is difficult to determine an exact value for the Pala Reservation and its assets without detailed historic data, but losses would likely be negligible.

Climate Change Impacts

Extreme cold and freeze events are likely to become less frequent in California as temperatures increase.[90] While projections for extreme cold events are not available via CalAdapt, a tool provided by the California Energy Commission for obtaining localized climate change projections, the tool did provide projected changes in average minimum temperature for the reservation. While information was not available specific to the Pala Reservation, nearby Paloma, San Marcos was used. According to CalAdapt, average minimum temperature will rise from its baseline of 47.3°F to upwards of 55.0°F by 2099 under a high emissions scenario (representative concentration pathway (RCP) 8.5). Figure 42. Average Minimum Temperature Projections for Pala (Paloma location point).shows the projected changes in average minimum temperature for the Pala under different timeframes and emissions scenarios (RCPs).

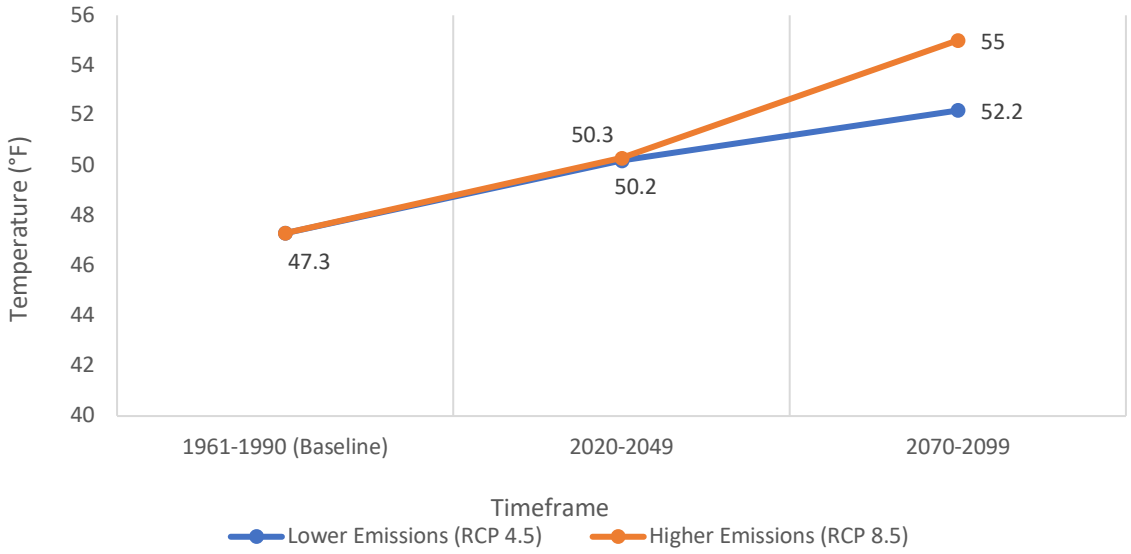

Figure 42. Average Minimum Temperature Projections for Pala (Paloma location point).

*RCP 4.5 is a scenario in which emissions peak around 2040, then decline
*RCP 8.5 is a scenario in which emissions continue to rise sharply through 2050 and plateau around 2100

[90] Chapter 6 - Other hazards: Risks and mitigation. (2103). California State Hazard Mitigation Plan. Retrieved October 9, 2017 from http://www.caloes.ca.gov/HazardMitigationSite/Documents/007-SHMP%202013%20Chapter%206.pdf

4.7.8 Extreme Heat

4.7.8.1 Description

Extreme heat, or a heat wave, is generally defined as temperatures that hover 10 degrees or more above the average high temperature for the region and last for an extended period. The actual temperature threshold depends on norms for the region.[91] CalAdapt (a tool provided by the California Energy Commission for obtaining localized climate change projections), defines an extreme heat day for the Pala Reservation as 103.6°F or above, which is well above the NWS threshold for "danger." This threshold was calculated using baseline data from 1960-1991.

Extreme heat events are usually a result of both high temperatures and high relative humidity. (Relative humidity refers to the amount of moisture in the air.) The higher the relative humidity or the more moisture in the air, the less likely that evaporation will take place. This becomes significant when high relative humidity is coupled with soaring temperatures. On hot days, the human body relies on the evaporation of perspiration or sweat to cool and regulate the body's internal temperature. Sweating does nothing to cool the body unless the water is removed by evaporation. When the relative humidity is high, then the evaporation process is hindered, robbing the body of its ability to cool itself.

NOAA's NWS devised the Heat Index as a mechanism to better inform the public of heat dangers. The Heat Index Chart, shown in Figure 43. NWS Heat Index Chart., uses air temperature and humidity to determine the heat index or apparent temperature.[92] In addition, information regarding the health dangers by temperature range is presented.

[91] University of Washington Emergency Management (2017). *Extreme heat*. Retrieved from https://www.washington.edu/uwem/preparedness/know-your-hazards/extreme-heat/

[92] NWS Heat Index (n.d.). NOAA. Retrieved May 3, 2019 from https://www.weather.gov/safety/heat-index.

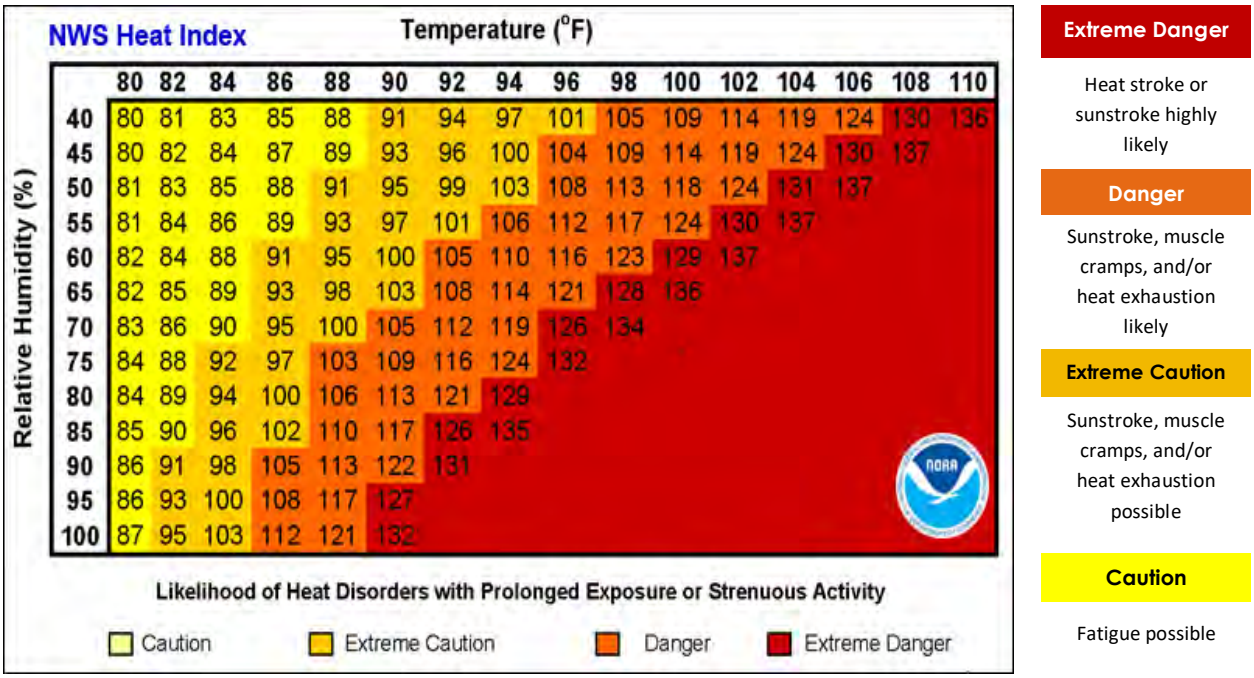

Figure 43. NWS Heat Index Chart.

Some populations, such as the elderly and young, are more susceptible to heat danger than other segments of the population.

Heat Disorders: Heat disorders are illnesses caused by prolonged exposure to hot temperatures and are characterized by the body's inability to shed excess heat. These disorders develop when the heat gain exceeds the level the body can remove or if the body cannot compensate for fluids and salt lost through perspiration. In either case, the body loses its ability to regulate its internal temperature. All heat disorders share one common feature: the individual has been overexposed to heat, or over exercised for their age and physical condition on a hot day. The following describes the symptoms associated with the different heat disorders.

Sunburn: Sunburn is characterized by redness and pain of skin exposed too long to the sun without proper protection. In severe cases it can cause swelling, blisters, fever and headaches. It can significantly retard the skin's ability to shed excess heat.

Heat Cramps: Heat cramps are characterized by heavy sweating and painful spasms, usually in the muscles of the legs and possibly the abdomen. The loss of fluid through perspiration leaves the body dehydrated resulting in muscle cramps. This is usually the first sign that the body is experiencing trouble dealing with heat.

Heat Exhaustion: Heat exhaustion is characterized by heavy sweating, weakness, nausea, exhaustion, dizziness and faintness. Breathing may become rapid and shallow and the pulse weak. The skin may

appear cool, moist and pale. Blood flow to the skin increases, causing blood flow to decrease to the vital organs. This results in a mild form of shock. If not treated, the victim's condition will worsen.

Heat Stroke (Sunstroke): Heat stroke is a life-threatening condition characterized by a high body temperature (106°F or higher). The skin appears to be dry and flushed with very little perspiration present. The individual may become mentally confused and aggressive. The pulse is rapid and strong. There is a possibility that the individual will faint or slip into unconsciousness. If the body is not cooled quickly, then brain damage and death may result.

Studies indicate that, all things being equal, the severity of heat disorders tend to increase with age. Heat cramps in a 17-year-old may be heat exhaustion in someone 40 and heat stroke in a person over 60. Elderly persons, small children, chronic invalids, those on certain medications and persons with weight or alcohol problems are particularly susceptible to heat reactions.

4.7.8.2 Location

The entire region, including all of the Pala Reservation planning area, will be impacted by extreme heat events.

4.7.8.3 Previous Occurrences

In order to understand extremes, the norms and record temperatures were researched. In addition, previous occurrences from the National Centers of Environmental Information (NCEI) were reviewed. The temperatures in inland San Diego County are not as moderate as the coastal areas. Averages stay below the high 80s, but record highs have topped 100 degrees in spring, summer, and fall months. Such temperatures, even with low humidity, can be extremely dangerous. The figure below shows average and record highs for a monitoring station near Pala, California.

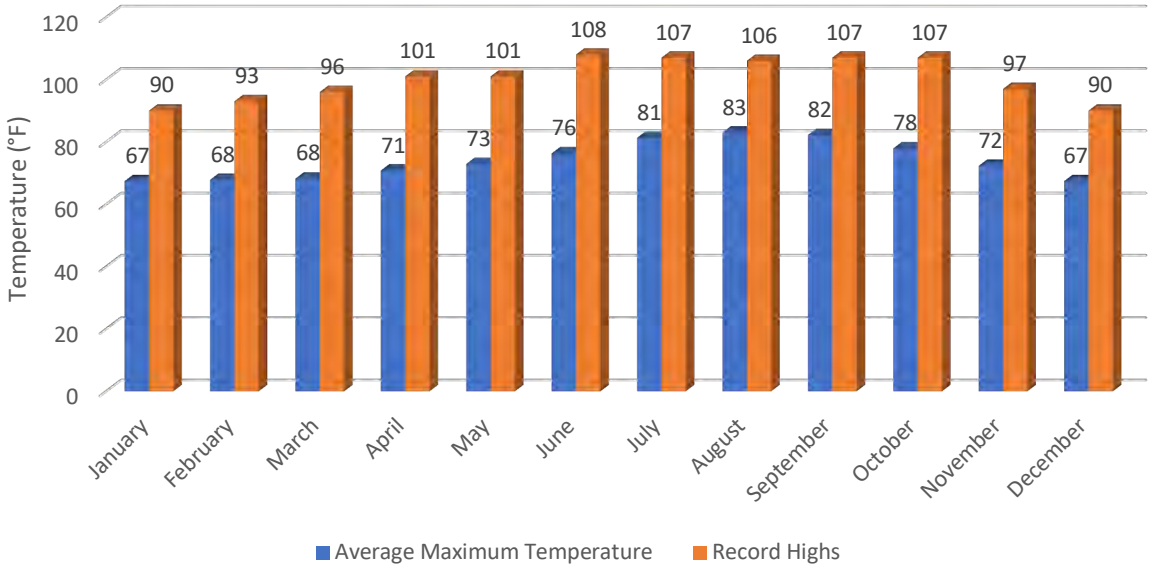

Figure 44. Average Maximum Temperatures in Pala, California. [93]

The NCEI Storm Events Database reports extreme heat events by county and NWS public forecast zone. Therefore, extreme heat event data solely for the Pala Reservation is not available. Due to the regional nature of extreme heat, events occurring in San Diego County were retrieved in order to indicate the number and severity of previous occurrences likely to have impacted the Pala Reservation. However, it is possible that not all events occurring in the county impacted the Pala Reservation. Likewise, it is possible that some events impacting the Pala Reservation were not reported to NCEI.

Forty-one excessive heat or heat wave events were reported by NCEI in San Diego County from 1996 to August of 2020. Details for these events are listed in Table 25**.** These events resulted in 36 deaths, 265 injuries, and $515,000 (2020 dollars) in damages. When available, details are provided for those events that resulted in deaths, injuries, or damages. It should be noted that deaths, injuries, and damages are reported for the event overall, and did not necessarily occur on the Pala Reservation.

Table 25. NCEI Extreme Heat Events (1996-2020).

Date	Location	Deaths	Injuries	Property Damage (2020 dollars)
8/2/1997	Southern California	0	1	$0
6/14/1999	Southern California	0	24	$0
5/20/2000	Southern California	3	0	$0
6/24/2000	Southern California	1	0	$0
5/7/2001 – 5/13/2001	Southern California	1	0	$0

[93] Western Regional Climate Center. Maximum Temperatures, 1957-2020. Retrieved from https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca9378.

Date	Location	Deaths	Injuries	Property Damage (2020 dollars)
7/16/2002	Southern California	1	0	$0
9/1/2002	Modjeska Canyon	1	0	$0
7/4/2003	Southern California	8	1	$0
7/19/2003	Southern California	0	0	$0
7/10/2005	Southern California	1	0	$0
7/21/2006-7/27/2006	Southern California	16	5	$0
7/04/2007 – 7/11/2007	San Diego County Mountains	0	0	$0
9/02/2007	Southern California	0	2	$0
6/29/2013	San Diego County Mountains	0	0	$0
10/4/2014	San Diego County Valleys	0	75	$0
6/19/2016	San Diego County Mountains	0	3	$0
9/25/2016	San Diego County Valleys	1	0	$0
6/17/2017	San Diego County Valleys	0	8	$0
6/20/2017	San Diego County Valleys and Deserts	0	9	$0
7/7/2017	San Diego County Valleys and Deserts	0	12	$0
8/28/2017	San Diego County Valleys	0	0	$0
9/1/2017	San Diego County Valleys and Coastal Areas	0	0	$0
10/23/2017 - 10/25/2017	San Diego County Valleys and Coastal Areas	0	0	$0
11/22/2017	San Diego County Valleys and Coastal Areas	0	0	$0
6/3/2018	San Diego County Deserts	1	0	$0
6/12/2018	San Diego County Deserts	0	0	$0
6/21/2018	San Diego County Deserts	1	0	$0
7/6/2018	San Diego County Valleys	1	50	$0
8/6/2018	San Diego County (all zones)	0	0	$0
6/9/2019	San Diego County Valleys and Deserts	0	0	$0
7/23/2019	San Diego County Valleys	0	0	$0
8/2/2019	San Diego County Deserts	0	0	$515,000
8/14/2019	San Diego County Valleys and Deserts	0	0	$0
8/21/2019	San Diego County Valleys	0	0	$0

Date	Location	Deaths	Injuries	Property Damage (2020 dollars)
9/13/2019	San Diego County Valleys	0	0	$0
10/21/2019	San Diego County Valleys	0	0	$0
10/22/2019	San Diego County Valleys and Coastal Areas	0	0	$0
4/24/2020	San Diego County Deserts	0	0	$0
5/5/2020	San Diego County Valleys	0	0	$0
5/26/2020	San Diego County Deserts	0	0	$0
TOTAL	**-**	**36**	**265**	**$515,000**

- **6/14/1999:** A group of men who had walked north from the Mexican Border near Tecate were found east of Julian suffering from dehydration. Skies were clear during their transit, daytime temperatures ranged between 100 and 117°F.

- **5/20/2000:** A record setting heat wave resulted in the one death and the injury of three others from heat related ailments as they walked north through the mountainous region of San Diego County.

- **6/24/2000:** One of three men traveling on foot through an isolated section of the Anza-Borrego Desert State Park was overcome by the excessive heat. Temperatures ranged between 110 and 120°F.

- **5/7 – 5/13/2001**: On 5/11/2001, emergency crews rescued 19 people suffering from heat exhaustion and dehydration on a freight train located near the city of Cabazon. The train was bound from Palm Springs to Los Angeles and it was unclear when the people had gotten on the train. On 5/13/2001, a man's body was discovered in Palm Canyon, located near the Dos Cabezas mine in extreme eastern San Diego County. Record high temperatures had been set in the Coachella Valley and San Diego County Deserts the previous week.

- **7/16/2002**: Daytime maximum temperatures over the desert areas ranged between 104 and 109°F with early morning minimum temperatures ranging between 81 and 92°F. One man, separated from his companions on or before July 16th, succumbed to heat exhaustion.

- **9/1/2002**: A hiker succumbed to heat exhaustion in Modjeska Canyon. Temperatures in the area were 109°F.

- **7/4 – 7/11/2003**: Nine people were overcome by heat exhaustion in narrow canyons. Eight people were rescued on July 4th from Cedar Falls, located 10 miles east of Ramona. The next day, a 58-year-old male was rescued from Hellhole Canyon Preserve, 7 miles east of Valley

Center. Temperatures at the times of rescue ranged were between 100 and 104°F. Sunday July 11th, another two hikers were overcome by heat exhaustion there, as well as by the Lake Poway dam. Event lasted at least a week.

- **7/10/2005**: Record heat resulted in near record power consumption and one death. High temperatures soared to 121 at Thermal, 120 at Palm Springs, 120 at Borrego Springs, and 116 at Hesperia. One teen died from heat exposure when he and his father went looking for help after their dune buggy broke down in Anza-Borrego Desert State Park.

- **7/21 – 7/26/2006**: Prolonged high temperatures were particularly problematic for residents who do not have air conditioning and were unable to cool their homes at night. There were 16 heat related deaths reported during the heat wave. Further, the number of people treated for heat related illnesses was pulled from various media reports and is likely an underestimate of the total value.

- **9/2/2007:** Temperatures exceeded 95 along the coast and in the mountains, 105 in the Orange and San Diego County valleys, 110 in the Inland Empire and high deserts, and 115 in the lower deserts. Humidity levels were quite high for the region, especially in the lower deserts where periodic gulf surges would raise the dew point into the 70s. At least 2 people died of heat related causes within San Diego County, however the actual number of deaths is probably higher than indicated.

- **4/13/2008:** Unseasonably hot weather settled over Southern California resulting in several days of record high temperatures. The heat peaked on April 13th with temperatures in the 90s along the coast and in the valleys. At least 5 people were treated for heat-related illnesses, including a woman at a Santee swap meet, three hikers on El Capitan Mountain, and one hiker in Los Penasquitos Canyon Preserve. At least one hiker at Torrey Pines was treated for a heat-related illness.

- **9/15/2012:** There were 11 heat-related injuries requiring hospitalization at a 5K run in Balboa Park. Temperatures ranged between 92 and 99°F during that time. High temperatures reached 104 at Rancho Bernardo, 105 at El Cajon, and 106 at Ramona. The ages of the injured ranged from 15 to 17 years old. A 45-year-old woman apparently suffered heat exhaustion and was airlifted from a hiking trail near Lake Hodges in Rancho Bernardo. Temperatures in the area were in the 90s at the time.

- **10/4/2014:** One of the local television stations and San Diego County Health Department reported 50-75 people were treated for heat-related injuries at the Miramar air show.

- **6/19/2016:** Three hikers were airlifted from 3 Sisters Falls Trail near Julian due to heat related illness.

- **9/25/2016:** A survey of 19 local hospitals indicated 20 heat-related 911 calls over two days, with one death in San Diego County. This number does not include urgent care facilities and is therefore likely under-representative.

- **6/17/2017:** Eight people suffered heat related illnesses hiking Three Sister Trail, two had to be airlifted to the hospital, and a third was transported to the hospital via ambulance. The high temperature in the nearby town of Ramona was 95°F.

- **6/20/2017:** Three Sister Hiking trail was closed on the 20th and 21st after 5 hikers suffering from heat related illnesses were rescued from the tail on the 20th. The high temperature in the nearby town of Ramona was 101°F. A helicopter rescue and 3 vehicle rescues were conducted for heat related illnesses at El Capitan County Preserve. Park staff also had to do extra patrols of the area to share safety information and bottled water.

- **7/7/2017:** Three Sisters Trail in San Diego County was closed due to heat on the 7th and 8th. The trail reopened on the 9th, and four hikers with heat related illnesses were rescued. The high temperature in the nearby town of Ramona was 96°F on the 9th. EMS reported 8 calls for heat related illnesses on the 7th and 8th, with 4 hospitalizations.

- **6/21/2018:** An emergency official reported that one person died in Ocotillo Wells Recreational State Park due to a heat-related illness.

- **7/16/2018:** At Escondido the high was 112°F and Santee 110°F; these temperatures were just shy of all-time highs. San Diego Public Health and 211 services showed a sharp jump in heat related information calls. 211 San Diego provides vouchers for those in need of cool shelter during heat waves. The destructive West Fire also occurred in Alpine, San Diego County on July 6th.

- **8/18/2020:** One of the longest and most severe heat waves on record was reported in mid-August. Temperatures of 105 were reported in Pala. Lasting approximately 10 days. The event strained the state which was enduring rolling brownouts as it dealt with heat and wildfire events. Tribal stakeholders noted their power stayed on, likely as a result of the extreme heat.[94]

[94] Robbins, Gary. The San Diego Union-Tribune. Aug 18 2020. " 'Monster' heat wave raised temperatures to 100 or higher in 50 San Diego County communities on Tuesday." Retrieved from https://www.sandiegouniontribune.com/weather/story/2020-08-18/temperature-hits-or-exceeds-100-degrees-in-21-spots-tuesday-just-before-noon

4.7.8.4 Extent

Extreme heat extent can be defined with record highs and the NWS Heat Index. Record temperatures in San Diego County have been well above 100 degrees Fahrenheit and well into the extreme danger level (Figure 43. NWS Heat Index Chart. The highest temperature reported was 108 degree (June), but higher temperatures are possible.

4.7.8.5 Probability of Future Events

An exact probability is difficult to quantify given limited data. Based on 41 heat-related events occurring between 1997 and August 2020, approximately two extreme heat events are reported within the county every year. It is assumed that many of these events impacted the Pala Reservation due to the regional nature of extreme heat events. Further, extreme heat events are projected to become more frequent on the Pala Reservation due to climate change. Therefore, a probability of "highly likely" (greater than 90% annual probability) was assigned to the extreme heat hazard.

4.7.8.6 Vulnerability Assessment and Estimated Losses

As the extreme heat hazard is atmospheric and does not have a geographic boundary, all current and future populations and structures, including critical facilities and cultural sites, are considered at risk. Extreme heat events generally have limited impact on buildings. However, in some rare cases, extreme heat can cause structures to collapse or buckle. Power consumption for air conditioning can increase during heat events, causing blackouts or brownouts. Loss of power during an extreme heat event can necessitate evacuations and rescues, cause schools to close, and impact tourism. Aside from the potential for damages, there are serious health risks to the population due to heat.

Vulnerable populations, such as the elderly, young children, mentally ill, disabled, or homeless persons, are at greatest risk to the impacts of extreme heat. Another population vulnerable to extreme heat events includes outdoor laborers. In addition, families or individuals living in housing without air conditioning or proper ventilation are at higher risk during heat events.

Impacts and preparedness tips for heat-related hazards are listed below.

Extreme heat can result in an array of heat illnesses described above. Heat is particularly deadly when temperatures remain elevated for long periods, or when individuals who are outdoors do not take proper precautions. Dehydration is a common health effect of extreme heat. Preparedness reduces the risks associated with this hazard. In cases of extreme heat:[95]

- Stay indoors as much as possible to limit exposure (consider public buildings such as libraries, schools, movie theaters, or cooling centers if you do not have air conditioning).
- Limit alcoholic intake.
- Drink plenty of water, even if you do not feel thirsty.

[95] Extreme Heat. (n.d.). US Department of Homeland Security. Retrieved October 9, 2017 from http://www.ready.gov/heat.

- Do not leave children or pets in vehicles.
- Check on vulnerable populations.
- Arrange your day to avoid strenuous work during the warmest part of the day, if possible.
- Use an electric fan to vent hot air out or bring cool air in.
- Wear loose-fitting clothing.

Estimated Losses

Known losses have been reported one extreme heat event, but losses specific to the Reservation are unknown for this hazard. Future losses would likely associated with indirect losses due to business interruption from power outages. Annualized losses would likely be negligible when assessed overtime.

Climate Change Impacts

Extreme heat events are likely to become more frequent and more intense in the planning area as temperatures rise due to climate change. Projections for extreme heat days and annual average maximum temperatures were obtained for the planning area using CalAdapt. According to CalAdapt, average maximum temperature on the Pala Reservation will rise from its baseline of 75.8°F to upwards of 84.5°F by 2099 under a high emissions scenario (RCP 8.5). **Figure X** shows the projected changes in average maximum temperature for the Pala Reservation under different timeframes and emissions scenarios (RCPs).

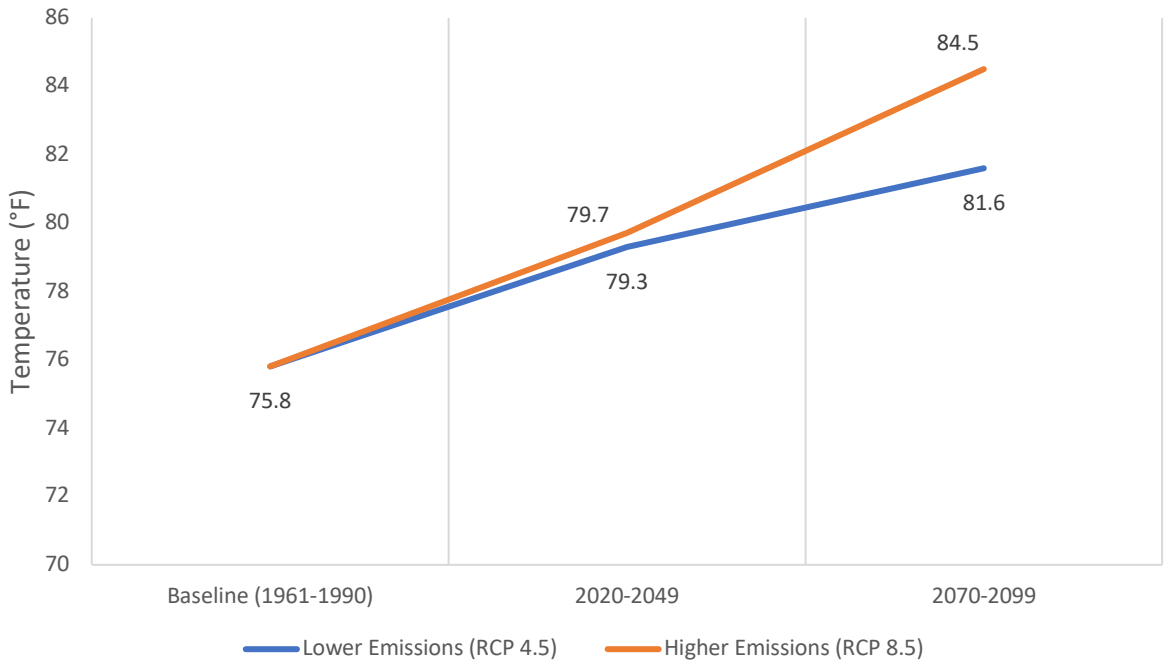

Figure 45. Average Maximum Temperature Projections for the Pala Reservation.

*RCP 4.5 is a scenario in which emissions peak around 2040, then decline
*RCP 8.5 is a scenario in which emissions continue to rise sharply through 2050 and plateau around 2100

In addition, CalAdapt provides projections for extreme heat days under the different climate scenarios. The tool describes an extreme heat day as a day in April through October where the maximum temperature exceeds the 98th historical percentile based on data from 1961-1990. According to CalAdapt, the extreme heat threshold for the Pala Reservation is 103.9°F, and the Pala Reservation experienced an average of four extreme heat days per year during the baseline period (1961-1990). According to projections, the Pala Reservation could experience up to 46 extreme heat days under a high emissions scenario by 2070-2099, which means over 13% of the entire year could consist of extreme heat days in the future.[96] Figure 46 shows the projected changes for extreme heat days for the Pala Reservation under different timeframes and emissions scenarios.

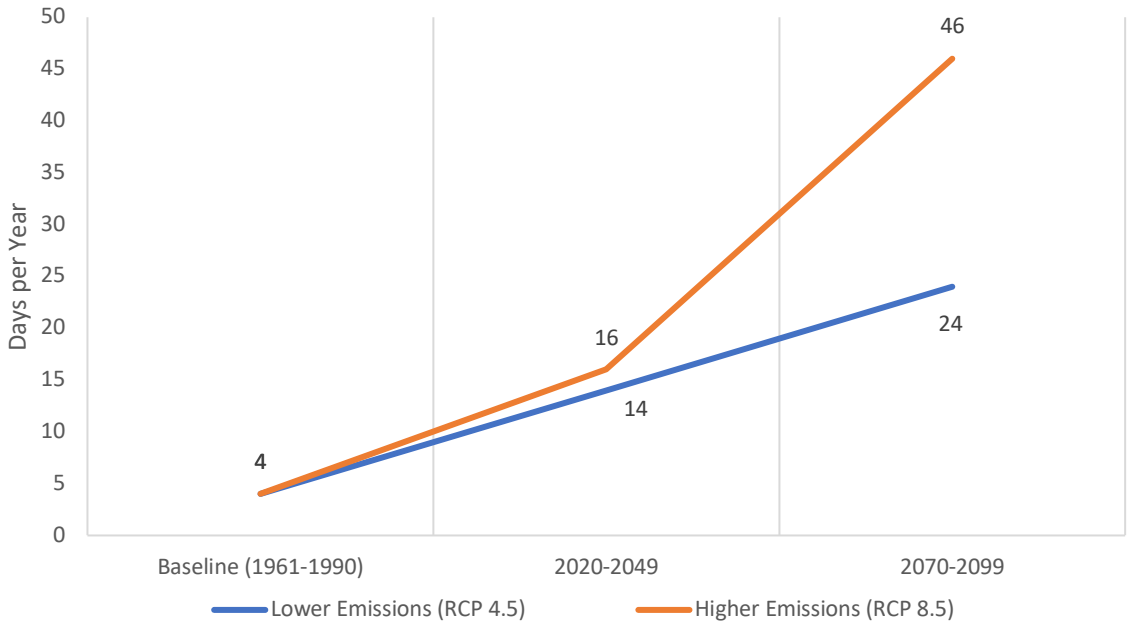

Figure 46. Projected Extreme Heat Days per Year for the Pala Reservation.

*RCP 4.5 is a scenario in which emissions peak around 2040, then decline
*RCP 8.5 is a scenario in which emissions continue to rise sharply through 2050 and plateau around 2100

Significant increases in the number of extreme heat days could have severe health impacts, especially for vulnerable populations such as the elderly, young, outdoor workers, and impoverished households. An increase in extreme heat days could also contribute to more frequent and severe droughts and wildfires.

[96] Number of Extreme Heat Days. (2017). CalAdapt. Retrieved October 4, 2017 from http://cal-adapt.org/tools/extreme-heat/#climatevar=tasmax&scenario=rcp45&lat=37.21875&lng=-119.53125&boundary=locagrid&units=fahrenheit.

4.7.9 Flood

4.7.9.1 Description

Flooding is a very frequent, dangerous, and costly hazard. Globally, it accounts for 40% of all natural disasters, and results in an average of over 6,500 deaths annually.[97] In the U.S., flooding results in an average of 86 deaths annually.[98] Nearly 90% of all presidential disaster declarations result from natural events where flooding was a major component.

Due to the widespread geographical distribution of valleys and coastal areas and the population density in these areas, flooding is the most common environmental hazard. The severity of a flooding event is typically determined by a combination of several major factors, including stream and river basin topography and physiography; precipitation and weather patterns; recent soil moisture conditions; and the degree of vegetative clearing and impervious surface. Flooding events can be brought on by severe (heavy) rain. There are several types of flooding.

- *Flash Flooding*
  Flash floods occur within a few minutes or hours of heavy amounts of rainfall, and can destroy buildings, uproot trees, and scour out new drainage channels. Heavy rains that produce flash floods can also trigger mudslides and landslides. Most flash flooding is caused by slow-moving thunderstorms or cyclones, repeated thunderstorms in the same area, or heavy rains from hurricanes and tropical storms. Although flash flooding often occurs in mountainous areas, it is also common in urban centers where much of the ground is covered by impervious surfaces.

- *Sheet Flooding*
  Sheet flooding is a condition where storm water runoff forms a sheet of water at a depth of six inches or more. Sheet flooding and ponding are often found in areas where there are no clearly defined channels, and the path of flooding is unpredictable. It is also more common in flat areas. Most floodplains are adjacent to streams or oceans, although almost any area can flood under the right conditions where water accumulates.

- *Urban Flooding*
  Urban flooding is usually caused by heavy rain over a short period of time. As land is converted from fields or woodlands to roads and parking lots, it loses its ability to absorb rainfall. Since sidewalks and roads are non-absorbent, rivers of water flow down streets and into sewers. Roads and buildings generate more runoff than tropical forestland. Fixed drainage channels in urban areas may be unable to contain the runoff generated by relatively small but intense rainfall events. Urbanization increases runoff two to six times over what would occur on natural

[97] Data from 1980-2008. http://www.preventionweb.net/english/hazards/statistics/?hid=62
[98] http://www.nws.noaa.gov/om/hazstats/resources/weather_fatalities.pdf

terrain. This high volume of water can turn parking lots into lakes, flood basements and businesses, and cause lakes to form in roads where drainage is poor or overwhelmed.

Urban flooding occurs where there has been development within stream floodplains. This is partly a result of the use of waterways for transportation in earlier times. Sites adjacent to rivers and coastal inlets provided convenient places to ship and receive commodities. The price of this accessibility has been increased flooding in the ensuing urban areas. Urbanization intensifies the magnitude and frequency of floods by increasing impermeable surfaces, amplifying the speed of drainage collection, reducing the carrying capacity of the land and, occasionally, overwhelming sewer systems.

- *Riverine Flooding*
  Periodic flooding of lands adjacent to non-tidal rivers and streams is a natural and inevitable occurrence. When stream flow exceeds the capacity of the normal watercourse, some of the above-normal stream flows onto adjacent lands within the floodplain. Riverine flooding is a function of precipitation levels and water runoff volumes within the watershed of a stream or river. The recurrence interval of a flood is defined as the average time interval, in years, expected to take place between the occurrence of a flood of a particular magnitude and an equal or larger flood. Flood magnitude increases with increasing recurrence intervals.

In addition to types of flooding, there are several types of floodplains. All the flood types described above may occur within or outside of a designated floodplain.

As noted above, the periodic flooding of land adjacent to rivers, streams, and shorelines (land known as a floodplain) is a natural process that has some chance of occurrence each year. Flood frequencies such as the "100-year flood" are determined by plotting a graph of the size of all known floods for an area and determining how often floods of a particular size occur. Another way of expressing flood frequency is the chance, or percentage of the probability, of flooding in a given year. For example, the 100-year flood has a 1.0-percent chance of occurring in any given year, and the 500-year flood drops to a 0.2-percent chance of occurring in any given year. Therefore, they are commonly referred to as the 1.0-percent annual chance flood and 0.2-percent annual flood, respectively. It should be noted that flooding is possible every year and even multiple times each year.

Floodplains are designated by the frequency (and severity) of the flood that is large enough to cover them. For example, the 10-percent annual chance floodplain (10-year floodplain) will be covered by the 1.0-percent annual chance floodplain (100-year floodplain) and the 1.0-percent annual chance floodplain by the 0.2-percent annual chance floodplain and 0.1-percent annual chance floodplains (500-year and 1,000-year floodplains).

The U.S. Army Corp of Engineers and FEMA have a role in defining floodplain. The U.S. Army Corps of Engineers calls a 100-year flood (1.0-percent annual chance flood) an Intermediate Regional Flood, while

a Standard Project Flood describes a major flood that could be expected to occur from a combination of severe meteorological and hydrologic conditions. FEMA develops Flood Insurance Rate Maps (FIRMs) to indicate areas within the 100-year floodplain where mandatory flood insurance requirements apply. They are also used to identify hazard areas. The FIRM, a paper document, has been digitized to permit mapping (known as a digital FIRM, or DFIRM). The entire Reservation is with FEMA Zone D, indicating flood studies have not yet been completed for area. The Zone D designation is used for areas where there are possible but undetermined flood hazards, as no analysis of flood hazards has been conducted. The designation of Zone D is also used when a community incorporates portions of another community's area, where no map has been prepared. Flood insurance is available in Zone D and property owners are encouraged to purchase it but is not mandatory.

The flood hazard area information presented in this risk assessment reflects FIRMs for San Diego County (effective 2019) and locally produced data. As the Pala Band of Mission of Indians Reservation is located in a Zone D area on FIRMs, geospatial information developed by San Diego County that maps the 100-year floodplain was used to assess flood risk on the Reservation.

El Niño–Southern Oscillation (ENSO Cycle) and Flooding

El Niño can be described as warmer-than-normal sea temperatures in the equatorial Pacific. Southern Oscillation is defined as a "seesaw of atmospheric pressure between the eastern equatorial Pacific and Indo–Australian areas." The two are closely linked, and together called El Niño–Southern Oscillation (ENSO) events.[99] El Niño is the sea temperature component, while Southern Oscillation is the atmospheric pressure component. The systems can impact weather patterns throughout the globe when in effect.

In the western U.S., El Niño is known to cause very wet winters. In general, the effect of El Niño on California, and thus the Pala Reservation, is increased rainfall with accompanying floods and landslides. (Coastal erosion is also anticipated, but not applicable to the tribal area. Riverine erosion, however, may be an associated impact of increased flooding).[100]

4.7.9.2 Location

According to information provided by the Tribe, the Pala Reservation is located in the center portion of the Pala Groundwater Basin. The Pala Groundwater Basin is one of four groundwater basins that form the San Luis Rey River/Watershed. Surface waters within the Reservation portion of the Pala Basin, are mostly non-perennial (intermittent or ephemeral), occurring during and right after storm events. The San Luis Rey River flows intermittently through the center of the Pala Basin from East to West. Pala Creek is the major tributary within Pala Basin and runs through the Reservation.

[99] http://drought.unl.edu/DroughtBasics/ENSOandForecasting.aspx
[100] Creating an Earth System: El Niño. Retrieved September 3, 2020 from http://www.ucmp.berkeley.edu/education/dynamic/session4/sess4_hydroatmo3.htm.

The Pala Reservation has not been studied under the FEMA floodplain mapping program; the Reservation is classified as Zone D, which corresponds to possible but undetermined flood hazards. Flood insurance is not mandatory, but is recommended, in Zone D areas.

The tribe provided 100-year floodplain data produced by San Diego County. Figure 47 shows the 100-year flood zones on the Pala Reservation along with USGS streams. Since flooding is possible and often occurs outside of hazard areas, understanding stream locations can help determine hazard locations. For example, a more severe event, such as one greater than the 500-year flood, could easily exceed the boundaries shown. While not major streams, each of these has the potential to flood. Many are intermittent but Bubble-Up Creek and Pala Creek are perennial (always running). Several roads were also mentioned as areas subject to flooding during heavy rains. These areas are described in detail in the previous occurrence sections and in the figures below.

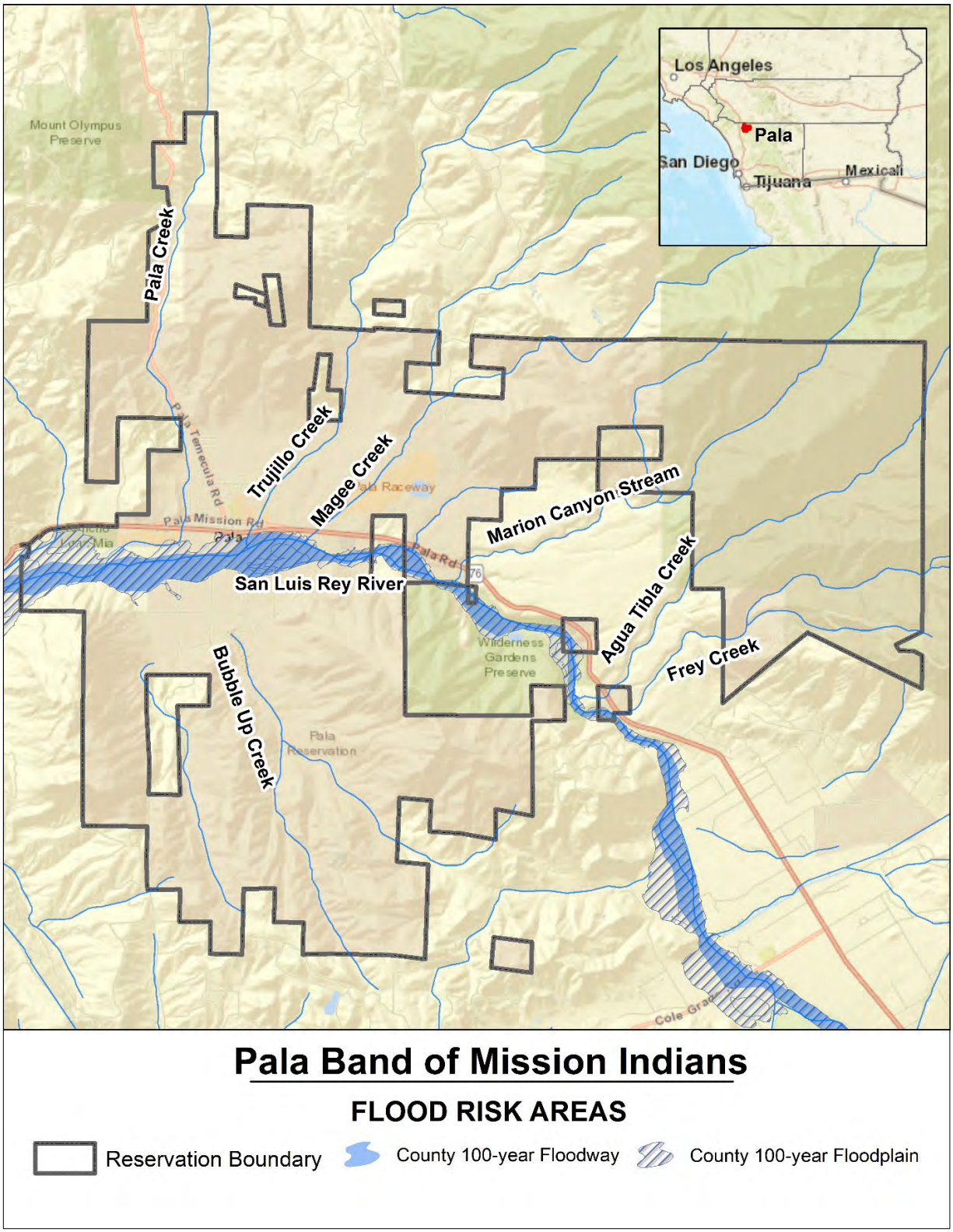

Figure 47. San Diego County Flood Hazard Areas and USGS Streams.

In addition to mapped flood areas, the tribe has recognized low areas, or “Arizona Crossings,” at road-water crossings that frequently flood during heavy rain events. The Tribe provided a map of these areas which is shown below.

Figure 48. Arizona (Low-Water) Crossings.

South side crossings, shown in the figure below, include:

- (A) Lilac Extension / San Luis Rey River (dirt).
- (B) Lilac Road / Bubble Up Creek (dirt).
- (C) Valenzuela and Welmas / Bubble Up Creek (dirt).

Figure 49. South Side Low-Water Crossings.

North side crossings, shown in the figure below, include:

- (A) Pala Temecula Road and Robles Way / overland flow/Trujillo Creek branch (paved).
- (B) Henderson Road at the Wastewater Treatment Plant / Trujillo Creek (dirt).
- (C) Youth Camp Road and Entrance / San Luis Rey River (dirt).
- (D) Oaks Road and Michac Lane / Trujillo Creek (only when it jumps its banks).

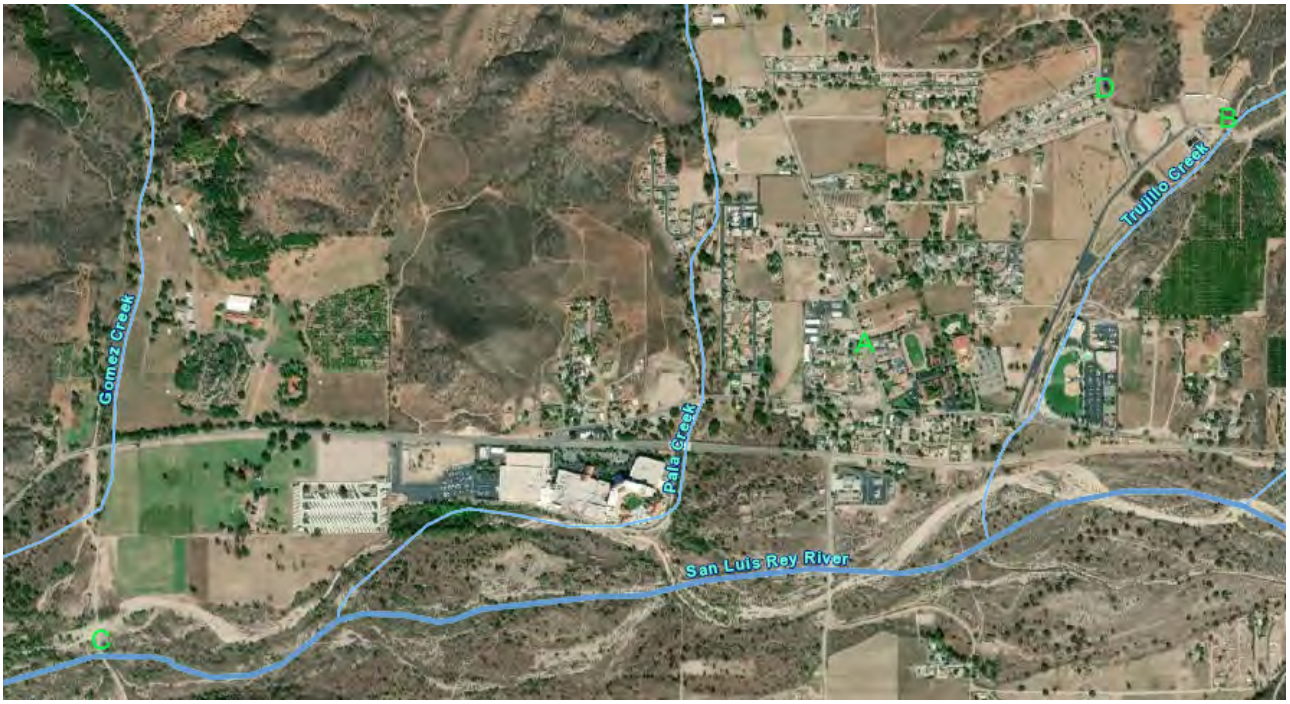

Figure 50. North Side Low-Water Crossings.

Other crossings that have culverts, but are routinely flooded, are shown in the figure below and include:

- (A) Pala Mission Road / Pala Creek - 4 culverts (paved).
- (B) Pala Mission Road / Trujillo Creek - 3 culverts (paved).
- (C) Sycamore Lane / Pala Creek - 4 culverts (paved).
- (D) Pala Temecula Road / Pala Creek - 3 culverts (paved).
- (E) Henderson Road behind Pala Gym / Trujillo Creek - 2 culverts (dirt).
- (F) Youth Camp Road and Entrance / Gomez Creek - 2 culverts (dirt).

Figure 51. Low-Water Crossings that Frequently Flood.

Pala Tribe is intensely aware of the possibility of flooding and has worked to reduce future hazard impacts. For example, stream monitoring gages were added to the Lilac, Pala, and Trujillo Creeks, following the 2007 wildfire, for early warning. A detention basin in the Morro areas helps prevent flooding. Pala has also completed structural projects. Figure 53. Allers Development Retaining Wall.shows one of the retaining walls built at the Allers Development to prevent flooding, landslides, and possible erosion from rain events. Since 2006, the tribe has built retaining walls in several places. They have also worked to mitigate risk to the Pala Casino Resort & Spa by building a retaining wall along the river. In addition, many of the roads on the Reservation have been retrofitted with culverts as seen in Figure 52. Culvert Built to Prevent Flooding.

Figure 53. Allers Development Retaining Wall.

Figure 52. Culvert Built to Prevent Flooding.

4.7.9.3 Previous Occurrences

The San Diego County Hazard Mitigation Plan, 2015 Pala Band of Mission Indians Hazard Mitigation Plan, the NCEI Storm Events Database, and data from the tribe were consulted to review previous flood events. Storm logs provided by the tribe indicate that minor flooding is prevalent on the Pala Reservation anytime a moderate to heavy rain event occurs, but the tribe did note several flood occurrences with major impacts. Ten significant flood events between 1916 and 2020 were reported as shown in Table 26**.** Events prior to 2015 were gleaned from the previous plan. In addition, some ongoing flood problems were noted by tribal officials.

Table 26. Flood Occurrences Impacting the Pala Reservation.

Date	Details
1916	Extent and impact details are not available. However, this was noted as the last major storm, which brought down trees from Palomar Mountain all the way to the coast.
1980	Major flooding on the Reservation caused closure of all main roads, leaving most residents trapped. Water from the San Luis Rey River actually reached the Pala Mission. Some cattle were lost.
1988	Major flooding on the Reservation caused closure of all main roads, leaving most residents trapped. Also, one of the Pala fire engines was swept away while responding to an emergency call.
February 1998	Serious flooding caused road closures that left some residents stranded on the reservation. According to NCEI reports, flooding occurred on February 14, 1998. Rapid runoff forced the San Louis Rey River out of its banks in Pauma Valley, and closed numerous roads due to high water. Mud slides washed out or undermined bridges. Flooded intersections prompted several rescues. In northern San Diego County, previously torched hillsides gave way under the torrential downpours, sending rivers of mud onto many roads.

Date	Details
January 2005	Sustained rain caused major flooding on the reservation, closing roads and causing thousands of dollars in property damage and cleanup. According to NCEI, The San Luis Rey River surpassed flood stage on the 9th, crested at 19.25 feet at 8:15 AM on the 10th, and then fell below flood stage late on the 10th. The river again hit flood stage on the 11th, crested at 20.7 feet by 600 PM that evening, and then fell below flood stage the morning of the 12th. Further, the heavy rains resulted in widespread mudslides throughout the county. No deaths or injuries were reported.
December 2010	The Arizona Crossing in the San Louis Rey Watershed is known to be a hot spot for flooding. A car was stuck in Pala Creek where Pala Temecula Road crosses over the creek. A disaster declaration was declared due to flooding.
January 2017	On the 22nd, Pala Temecula Road in Pala was closed due to flooding and rocks in the roadway. Approximately $5,000 in damages were reported. No deaths or injuries were reported.[101] In storm logs, the tribe reported major flooding from the 19th through the 25th.
February 2017	The tribe reported flood-related road closures on Pala Temecula Road and Pala Mission Road from the 26th to the 28th.
February 2019	A total of 5 to 10 inches of rain occurred on the Palomar mountain slopes in 12 hours. This led to flash flooding in Pala with road damage and swift water rescues. Approximately $40,000 in damages were reported. No deaths or injuries were reported.[102] The tribe noted many damages from this event. A car got stuck trying to cross the San Luis Rey River the morning of the 14th, and the Oaks neighborhood flooded due to runoff from the shooting range area, and major flooding from Bubble Up Creek was reported at the corner of Welmas Road and Valenzuela, including a house.
April 2020	According to tribal storm logs, on the 10th Pala Creek overtopped culverts causing Pala Temecula Road to close. A large amount of sediment was deposited on the road. Pala Mission Road was also closed due to flooding. The Oaks neighborhood experienced flooding due to water flowing down from the hills/shooting range area. Lilac Extension Road was closed at its crossing with the San Luis Rey River and part of the road was washed away. Lilac Road at Bubble Up Creek flooded, and Rice Canyon Road was closed in both directions near Highway 76 due to mudslides/rockfalls.

San Diego County Hazard Mitigation Plan

The county's hazard mitigation plan mentions 40 significant flood events between 1770 until 2017. Between 1950 and 2017, flooding prompted 11 Proclaimed States of Emergency in the County of San Diego. Some flooding events have been very significant resulting in millions of dollars of damage such as

[101] NCEI Storm Events Database. Retrieved from https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=6%2CCALIFORNIA.
[102] NCEI Storm Events Database. Retrieved from https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=6%2CCALIFORNIA.

the 1916 Hatfield Flood, which destroyed the Sweetwater and Lower Otay Dams, causing 22 deaths. In the 1980 floods, the San Diego River at Mission Valley peaked at 27,000 cubic feet per second (cfs) and caused $120 million in damage (Bainbridge, 1997).

Flood Problem Areas noted by Tribal Members

Several areas were noted as having previous, and even continuous, occurrences of flooding. These risk areas are in or near developed areas of residential and commercial buildings including the Pala Casino. General flood problem areas noted by tribal members are shown below in Figure 54**.**

- When Bubble-up Creek floods, it carries sewage through some of the houses creating a sanitation issue. In addition, urban flooding and sheet flooding are possible throughout the Reservation.
- The Bridge on Lilac Road floods, causing a build-up of sand and debris. This bridge is the county's responsibility to maintain, but it poses a risk to the Reservation. However, a gate can be closed to block off the Lilac Extension over the San Luis Rey River (just past the fire house).
- Flooding occurs on Pala Mission Road, which leads to the Casino and Travers development.
- A small culvert causes the Post Office and Quashish Road to flood.
- Road flooding occurs on Pala Temecula Road floods causing closures or causing people to hydroplane.
- The west end of Apapas Road floods.
- Salvador Road floods.
- Sheet flow from the shooting range area flow downhill and floods the Oaks neighborhood.
- There is a concern of flooding on the hillsides as it may lead to landslides.

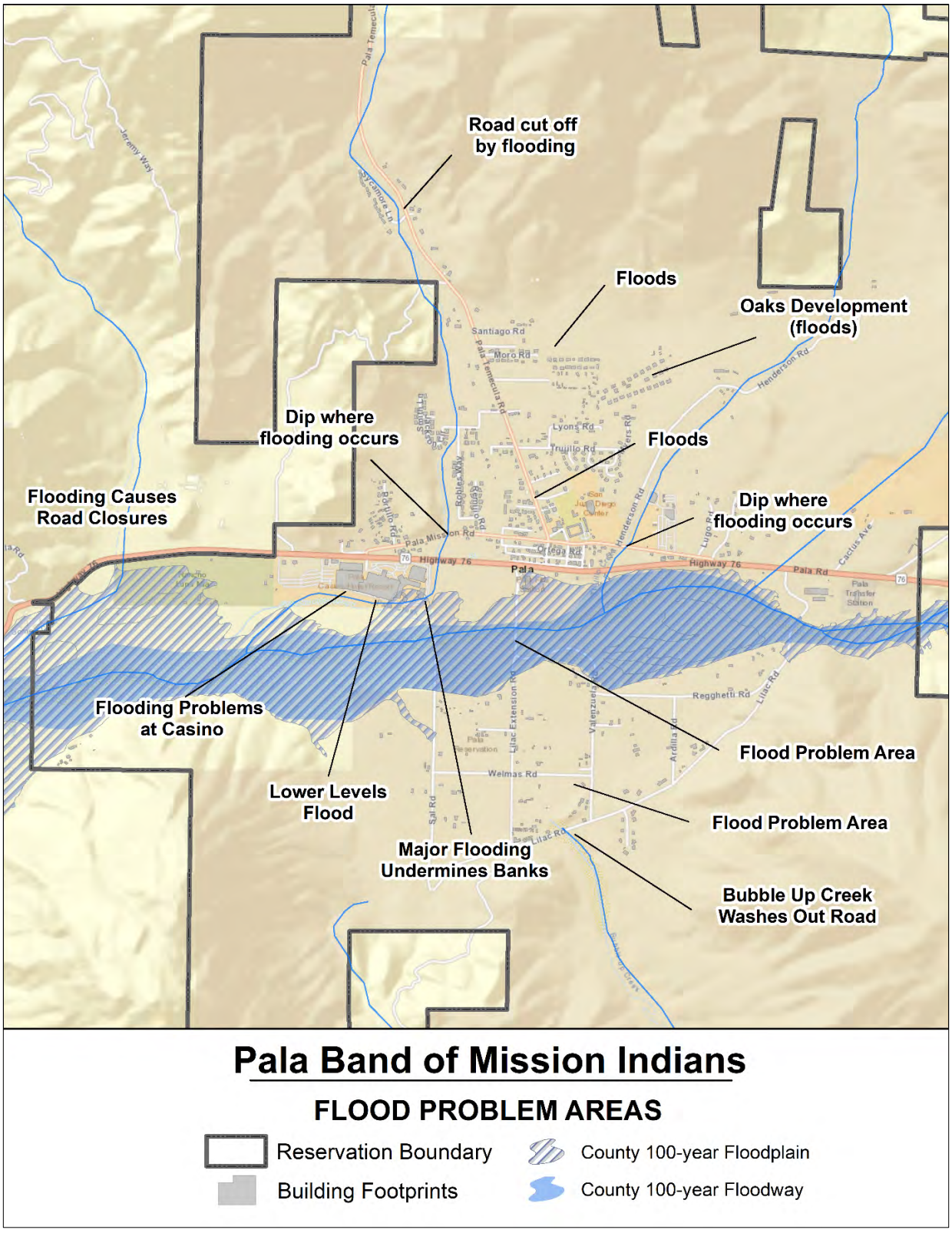

Figure 54. Areas Subject to Flooding.

4.7.9.4 Extent

Flood extent can be measured in terms of damage, gage height, or return period. USGS gage information was collected from a nearby gage in Temecula (11 miles north of Pala) on the Santa Margarita River.[103] A maximum discharge of 31,000 cubic feet/second was recorded in January 1993. For reference, peak flows in the previous year were between 3.1 and 217 cubic feet/second.[104] The highest recorded gage height was 22.50 feet in 1993 (currently 1.64 feet).[105]

In addition to USGS gage information, the tribe provided stream level information for streams on the Pala Reservation for water years 2016-2020. During this period, the highest stream height recorded for Trujillo Creek was 2.47 inches, and the highest stream level recorded for the San Luis River (taken at Lilac Road) was 4.31 inches. Both of these peaks occurred during the February 2019 flood event. Deaths and injury are possible, particularly to people driving through moving water.

4.7.9.5 Probability of Future Events

Flooding is one of the tribe's biggest hazard concerns. Minor flooding and road closures due to flooding occur throughout the year, especially during winter months when the Reservation receives more rain. Significant flooding events are less common. Based on previous occurrences reported from various sources, a probability of "highly likely" was assigned to the flood hazard on the Reservation.

4.7.9.6 National Flood Insurance Program (NFIP) Participation

The Tribe does not currently have FEMA regulatory maps and are shown as in Zone D. As a result, the tribe does not participate in the NFIP and there are no FEMA Repetitive Loss or Severe Repetitive Loss properties.

4.7.9.7 Vulnerability Assessment and Estimated Losses

All current and future buildings, critical facilities, populations, and cultural resources are considered at risk from flooding. Flooding can result in a variety of impacts, such as death and injury, property damage, inability to access areas and road closures.

Flooding also saturates the ground and may lead to increased landsliding. In addition, business interruption may occur due to flooding. In the wake of a flood, flooded buildings can develop mold or wood rot, posing a health risk. Those located within mapped flood hazard areas are considered at an elevated risk to flooding; however, flooding can certainly occur outside of these areas. This is true for flash flooding, which also poses a danger to people and property across the entire planning area.

[103] http://ca.water.usgs.gov/data/waterconditionsmap.html
[104] http://wdr.water.usgs.gov/wy2013/pdfs/11044000.2013.pdf
[105] USGS WaterWatch. Retrieved September 1, 2020 from http://waterwatch.usgs.gov/?id=wwchart_ftc&site_no=11044000.

The Pala Casino Resort & Spa, which is located in a floodplain, may be affected in flooding events. However, several measures have been taken to protect the structure. Since 2006, the tribe has built retaining walls in several places. They have also worked to mitigate risk to the Pala Casino Resort & Spa by building a retaining wall along the river. In addition, many of the roads on the reservation have been retrofitted with culverts.

The area of Bubble-up Creek, when flooding, can carry floodwater over independent septic systems on the south side of the tribe, causing sewage to flow into homes. This is not an issue on the north side (north of Highway 76) as there is a large treatment plant for water. There are limited storm drains on the Reservation, which leads to drainage issues during rainfall events.

A GIS analysis using 100-year flood data developed by San Diego County was used to determine the number of buildings and critical facilities at risk to the flood hazard, which indicated a total of 15 buildings at risk to flood on the Pala Reservation. Combined, these buildings and their contents are valued at approximately $35 million. These structures are summarized in Table 27 and shown in Figure 55**.**

Table 27. Buildings in Flood Risk Areas (100-year Floodplain) on the Pala Reservation.

Building Type	Number of Buildings	Building Value	Content Value	Total Value
Commercial	12	$34,784,977	$34,784,977	$69,569,953
Residential	3	$442,171	$221,086	$663,257
TOTAL	**15**	**$35,227,148**	**$35,006,062**	**$70,233,210**

Twelve of the Tribe's 66 critical facilities are the 100-year floodplain. Table 28 lists these critical facilities and their associated values. Figure 56 shows Pala Reservation critical facilities within flood risk areas. The fire station and fire station accessory building appear to be at risk but are actually built on a pad for protection. Measures have also been taken to protect the Casino buildings as mentioned above.

Table 28. Critical Facilities in Flood Risk Areas (100-year Floodplain) on the Pala Reservation.

Critical Facility Name	Building Value	Content Value	Total Value
Catalina Fields (alfalfa)	N/A	N/A	N/A
Catalina Well (North)	N/A	N/A	N/A
Fire Station Well (North)	N/A	N/A	N/A
Hanson Pond Conservation Easement	N/A	N/A	N/A
Pala Casino, Resort and Spa	$265,726,548	$66,895,614	$332,622,162
Pala EOC and Training Center	$9,934,554	$2,051,973	$11,986,527
Pala Fire Station	$2,063,327	$76,760	$2,140,087
Pala Gateway (oranges)	N/A 0	N/A	N/A
Rancho Luna Mia (animal husbandry)	$541,409	$0	$541,409
Riverbed East Well (South, new)	N/A	N/A	N/A

Critical Facility Name	Building Value	Content Value	Total Value
Riverbed West Well (South, west)	N/A	N/A	N/A
Valenzuela Well (South)	N/A	N/A	N/A

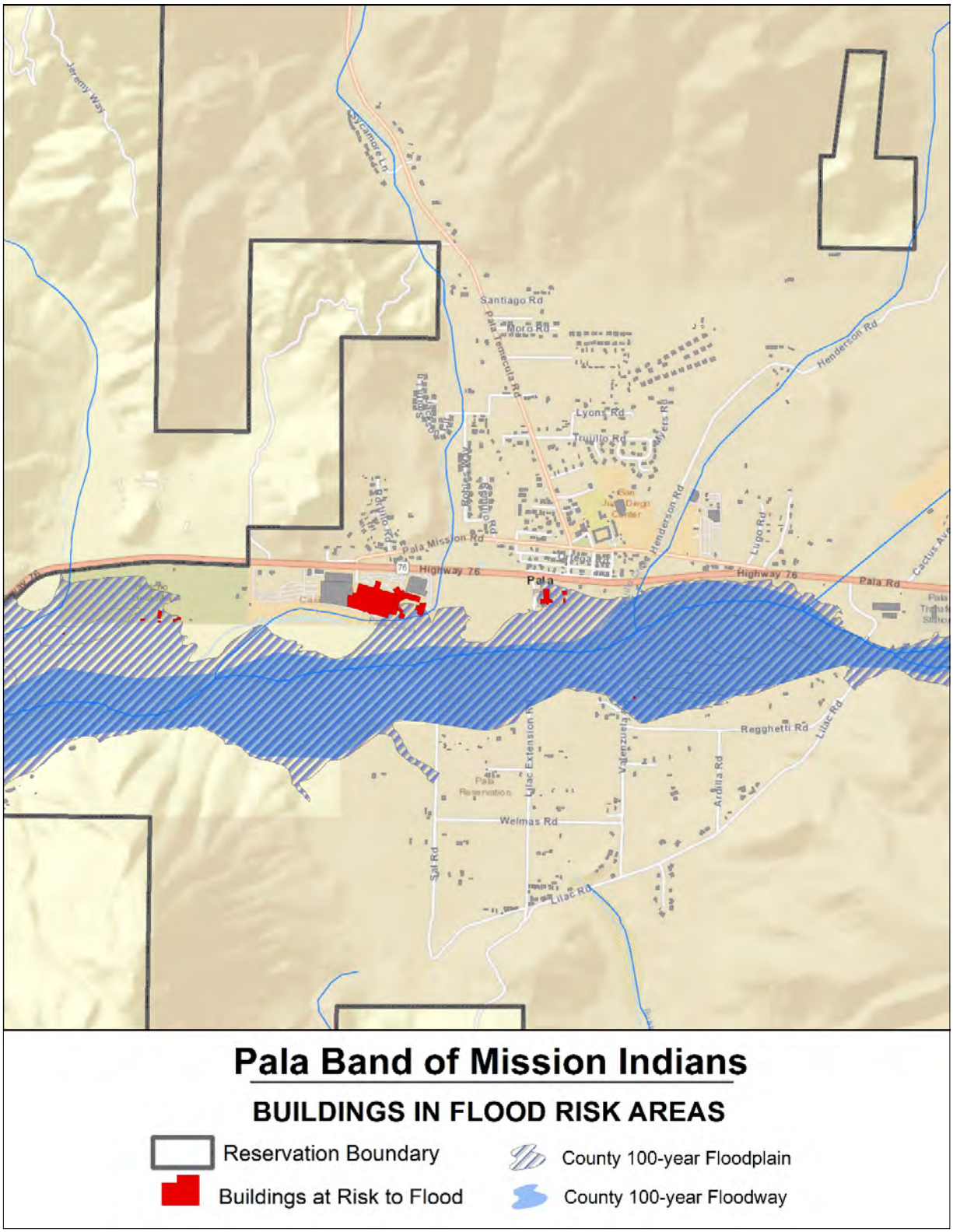

Figure 55. Pala Buildings in the 100-year Floodplain.

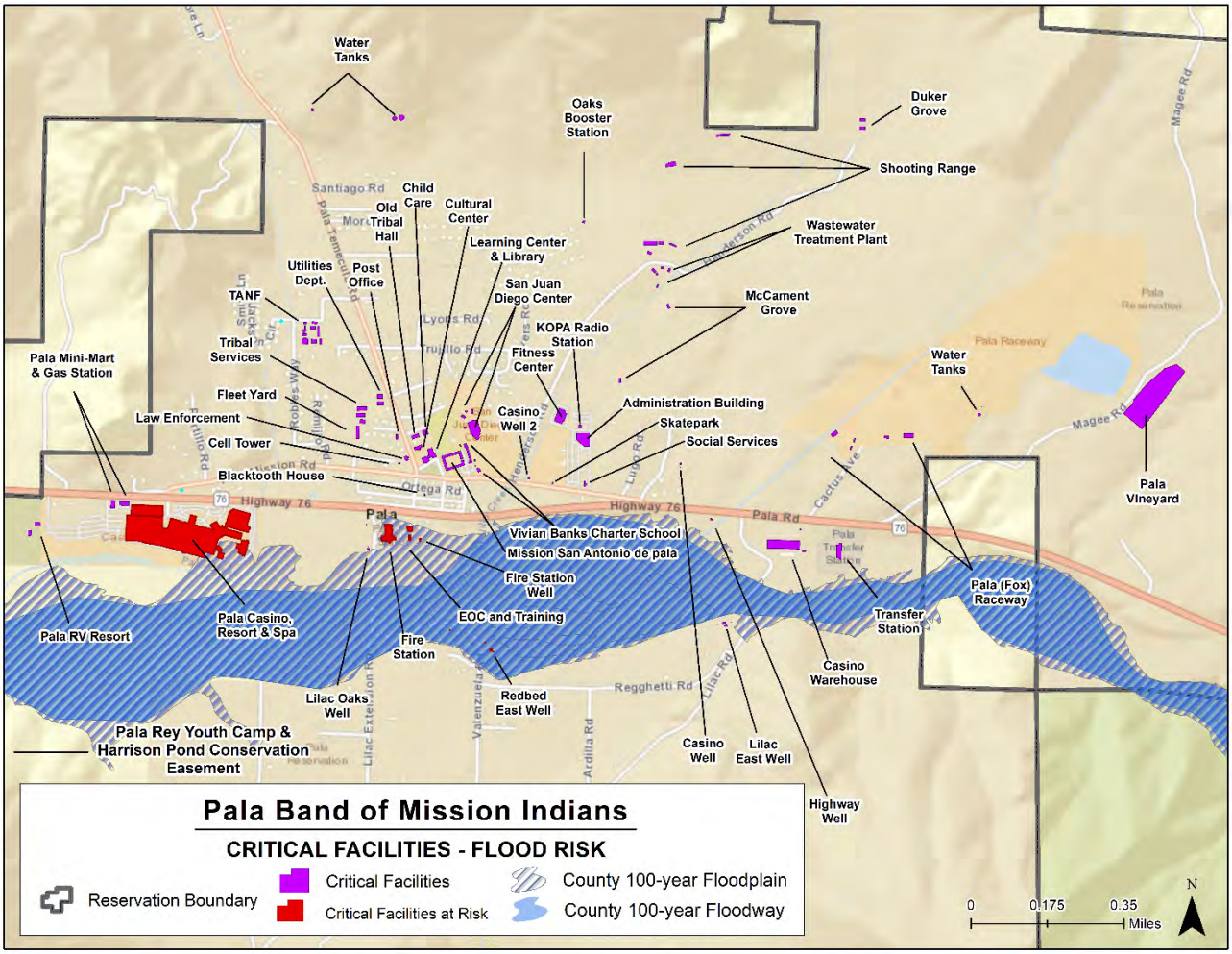

Figure 56. Critical Facilities and the Flood Risk Area (100-year Floodplain).

While known losses have occurred, specific values were not provided. Therefore, Hazus-MH 4.2 was used to estimate potential losses.

Hazus-MH Loss Estimates

Hazus-MH 4.2SP3 was used to estimate the potential of complete structural damage due to flooding. A baseline of dollar exposure for all buildings and their contents within the Pala Reservation was developed. These dollar values reflect a combination of estimates and values provided by the tribe. (A full review of assumptions can be found in Appendix B.) This information provides a baseline of how much property, in terms a dollar value, is at risk. Exposure for the identified buildings where a majority of Pala Reservation residents reside is approximately $395 million.

Hazus-MH floodplains were generated for the 1.0-percent annual chance flood and 0.2-percent annual chance flood using a digital elevation model (DEM). It should be noted that the Hazus-MH generated model differs from the FEMA-regulatory DFIRM. FEMA-regulatory data is quite sophisticated, typically

developed by engineers, and undergoes and thorough review process. Hazus-MH automates the floodplain development process primarily based on terrain inputs. However, Hazus-HM employs more sophisticated analysis than simply considering whether the building is "in or out" of the floodplain as performed via GIS analysis above. Hazus-MH considers structure elevation, also known as first floor height, and it uses different depth damage functions for different building types. This means that damages are determined based on the height of flooding at the building location and the building type. This is helpful in determining more accurate dollar loss estimates and relative risk to flooding on the Reservation. Losses are presented in terms of building losses and content losses. The results are presented for the 1.0-percent annual chance floodplain areas and 0.2-percent annual chance floodplain areas in Table 30 and Table 31, respectively. According to the model, losses are estimated at between 0 percent and 2% of total value exposure. Building level results and annualized losses can be found in Appendix B. Annual chance floodplain areas generated in Hazus are presented in Figure 57 along with critical facilities.

Table 29. Hazus-MH 4.2SP3 Building Value Exposure.

Occupancy Type	Building Exposure	Content Exposure	Total Exposure
Commercial	$94,771,000	$94,771,000	$189,542,000
Residential	$124,226,000	$62,113,000	$186,339,000
Religious	$5,467,000	$5,467,000	$10,934,000
Other (includes Agriculture, Education, Industrial)	$4,173,000	$4,221,000	$8,394,000
TOTAL	**$228,637,000**	**$166,572,000**	**$395,209,000**

Table 30. Hazus-MH Estimated Losses from the 1.0-percent Annual Chance Flood.

Building Type	Building Loss	Content Loss	Total Loss	Percent of Total Exposure
Commercial	$3,490,000	$16,256,000	$19,746,000	10.4%
Residential - Single Family Dwelling	$84,000	$49,000	$133,000	0.1%
TOTAL	**$3,574,000**	**$16,305,000**	**$19,879,000**	**5.0%**

Table 31. Hazus-MH Estimated Losses from the 0.2-percent Annual Chance Flood.[106]

Building Type	Building Loss	Content Loss	Total Loss	Percent of Total Exposure
Residential - Mobile Home	$152,000	$46,000	$198,000	0.1%
Residential - Single Family Dwelling	$730,000	$414,000	$1,144,000	0.6%

[106] Combined 100-year and 500-year flood losses.

Building Type	Building Loss	Content Loss	Total Loss	Percent of Total Exposure
Commercial	$8,819,000	$36,217,000	$45,036,000	23.8%
Industrial	$8,000	$16,000	$24,000	10%
TOTAL	**$9,709,000**	**$36,693,000**	**$46,402,000**	**11.7%**

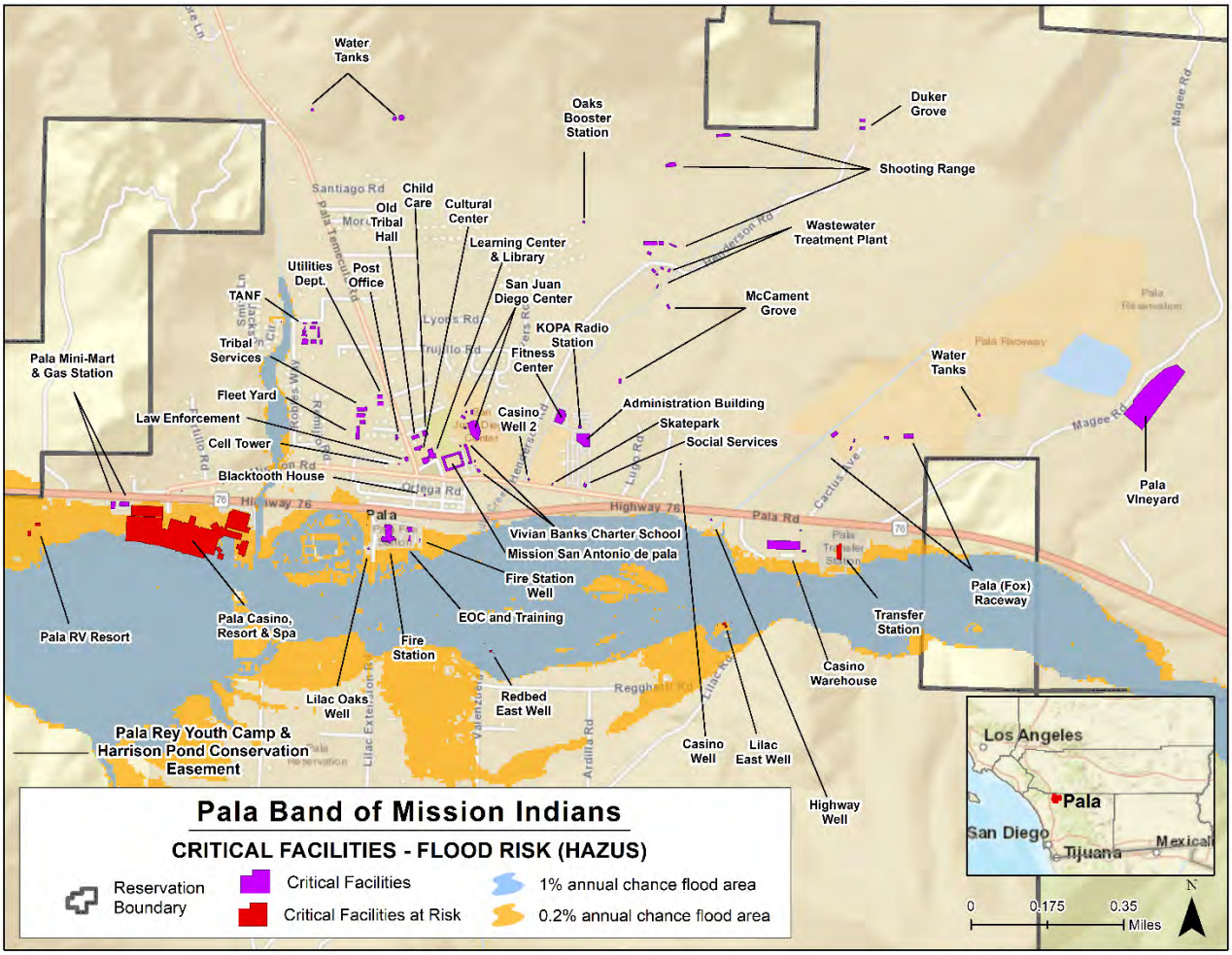

Figure 57. Critical Facilities in Hazus-Generated Flood Areas.

Climate Change Impacts

Changes in temperature and precipitation can impact the frequency and severity of localized flood events. According to data from CalAdapt, under both the lower and higher emissions scenarios,[107] annual average precipitation on the Pala Reservation is projected to vary little from the current

[107] Annual Averages. (2019). Cal Adapt. Retrieved May 3, 2019 from https://cal-adapt.org/tools/annual-averages/#climatevar=pr&scenario=rcp85&lat=34.53125&lng=-114.40625&boundary=locagrid&units=inches%20per%20day.

historical baseline average. However, climate change is projected to result in precipitation extremes (i.e., wetter wet periods and drier dry periods).[108] More extreme precipitation could contribute to increased flooding if rain events are more intense

In addition, the Pala Reservation is projected to experience an increase in annual average temperature, which could lead to drier conditions and increased drought frequency and severity (detailed projections can be found in this section's equivalent under the *Extreme Heat* profile). Research suggests that under drought conditions, soils may develop hydrophobic characteristics leading to decreased rainfall infiltration rates.[109] This, in turn, could increase runoff volumes and lead to flooding.

4.7.10 High Wind

4.7.10.1 Description

There are several types of wind hazards that affect the planning area. These include high or strong wind events and thunderstorms. Tornadoes are also wind events that have the potential to impact the Pala Reservation, but due to special hazards associated with these types of events, tornadoes are listed as a separate hazard.

High wind definitions can vary by region. In general, high wind events are those events greater than normal averages and have damage potential. Wind events are common throughout the United States, including Southern California. However, the severity of high wind events varies depending on location. Figure 58 below shows wind zones in the U.S. based on ASCE 7-98 criteria. Based on assigned wind zones, the Pala Reservation is located in Wind Zone I, which experiences winds up to 130 miles per hour.

[108] California State Hazard Mitigation Plan (2018). *Section 4.3: Risk Factor: Climate Change*. Retrieved from https://www.caloes.ca.gov/HazardMitigationSite/Documents/002-2018%20SHMP_FINAL_ENTIRE%20PLAN.pdf.
[109] Burch, G.J. et al. (1989). Soil hydrophobic effects on infiltration and catchment runoff. Hydrologic Processes. Vol 3 (3). Retrieved October 26, 2017 from http://onlinelibrary.wiley.com/doi/10.1002/hyp.3360030302/full.

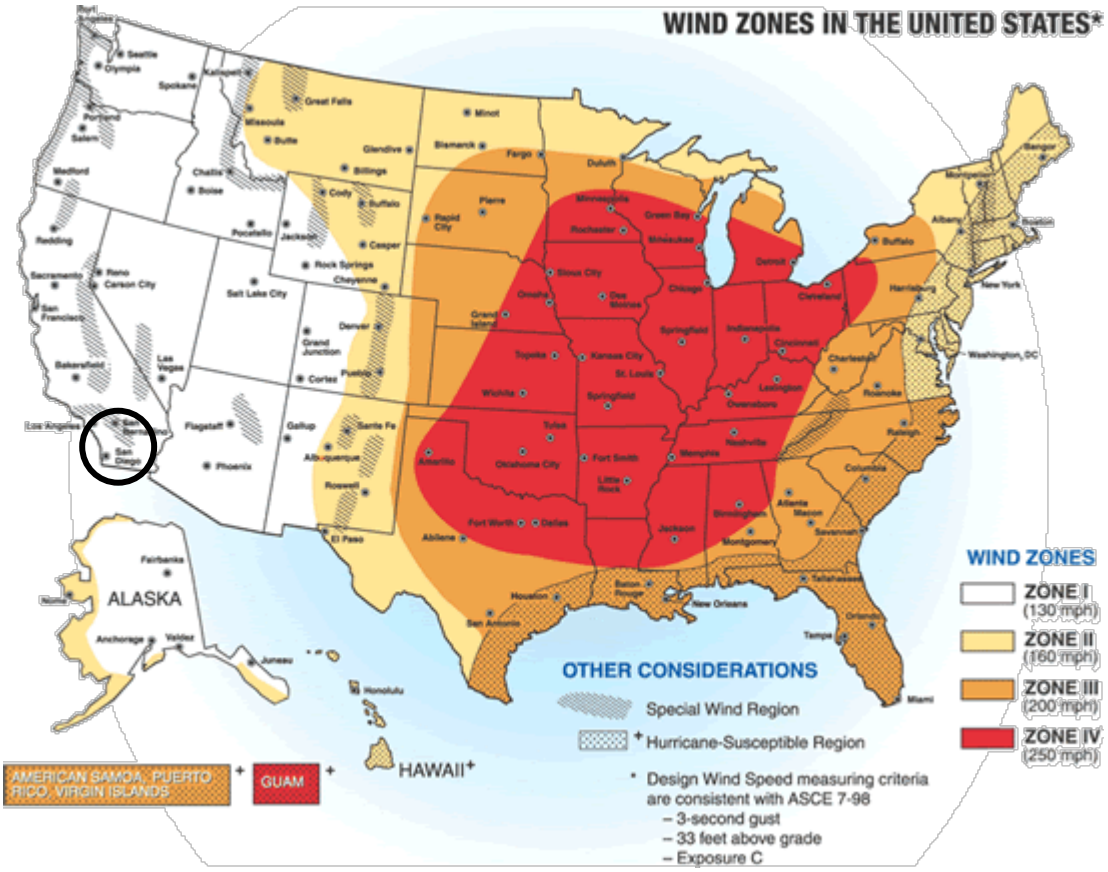

Figure 58. ASCE 7-98 U.S. Wind Zone. [110]

The National Weather Service Center can issue a high wind advisory or warning. A wind *advisory* is issued when conditions are favorable for the development of high winds over all or part of the forecast area, but the occurrence is still uncertain. The criteria of a wind advisory are sustained winds of 31 to 39 mph and/or gusts of 46 to 57 mph for any duration. A high wind *warning* is issued when sustained winds from 40 mph or higher are expected for at least one hour, or any wind gusts are expected to reach 58 mph or more.[111] The definitions vary from state to state. Areas that frequently experience high winds will not issue the advisory or warning. A Beaufort Wind Scale may also be used to describe wind severity as shown in Table 32 below.

[110] University of Missouri Extension. Weather-related Resources. http://extension.missouri.edu/webster/weather.aspx
[111] National Weather Service. https://www.weather.gov/lwx/WarningsDefined#High Wind Watch

Table 32. Beaufort Wind Scale. [112]

Beaufort Number	Wind (Knots)	Description	On the Water	On Land
0	Less than 1	Calm	Sea surface smooth and mirror-like	Calm, smoke rises vertically
1	1-3	Light Air	Scaly ripples, no foam crests	Smoke drift indicates wind direction, still wind vanes
2	4-6	Light Breeze	Small wavelets, crests glassy, no breaking	Wind felt on face, leaves rustle, vanes begin to move
3	7-10	Gentle Breeze	Large wavelets, crests begin to break, scattered whitecaps	Leaves and small twigs constantly moving, light flags extended
4	11-16	Moderate Breeze	Small waves 1-4 ft. becoming longer, numerous whitecaps	Dust, leaves, and loose paper lifted, small tree branches move
5	17-21	Fresh Breeze	Moderate waves 4-8 ft. taking longer form, many whitecaps, some spray	Small trees in leaf begin to sway
6	22-27	Strong Breeze	Larger waves 8-13 ft., whitecaps common, more spray	Larger tree branches moving, whistling in wires
7	28-33	Near Gale	Sea heaps up, waves 13-19 ft., white foam streaks off breakers	Whole trees moving, resistance felt walking against wind
8	34-40	Gale	Moderately high (18-25 ft.) waves of greater length, edges of crests begin to break into spindrift, foam blown in streaks	Twigs breaking off trees, generally impedes progress
9	41-47	Strong Gale	High waves (23-32 ft.), sea begins to roll, dense streaks of foam, spray may reduce visibility	Slight structural damage occurs, slate blows off roofs
10	48-55	Storm	Very high waves (29-41 ft.) with overhanging crests, sea white with densely blown foam, heavy rolling, lowered visibility	Seldom experienced on land, trees broken or uprooted, "considerable structural damage"
11	56-63	Violent Storm	Exceptionally high (37-52 ft.) waves, foam patches cover sea, visibility more reduced	N/A
12	64+	Hurricane	Air filled with foam, waves over 45 ft., sea completely white with driving spray, visibility greatly reduced	N/A

[112] Beaufort Wind Scale. http://www.spc.noaa.gov/faq/tornado/beaufort.html

Thunderstorms are associated with high wind because wind is typically one component of thunderstorms. Thunderstorms are very dangerous because of their ability to generate tornadoes, hailstorms, strong winds, flash flooding, and damaging lightning. While thunderstorms can occur in all regions of the United States, they are most common in the central and southern states because atmospheric conditions in those regions are ideal for generating these powerful storms.

Three conditions need to occur for a thunderstorm to form. First, there needs to be moisture present to form clouds and rain. Second, it needs unstable air, such as warm air that can rise rapidly (this often referred to as the "engine" of the storm). Third, thunderstorms need lift, which comes in the form of cold or warm fronts, sea breezes, mountains, or the sun's heat. When these conditions occur simultaneously, air masses of varying temperatures meet, and a thunderstorm is formed. These storm events can occur singularly, in lines, or in clusters. Further, they can move through an area very quickly or linger for several hours.

Straight-line winds, which in extreme cases have the potential to cause wind gusts that exceed 100 miles per hour, are responsible for most thunderstorm wind damage. One type of straight-line wind, the downburst, can cause damage equivalent to a strong tornado and can be extremely dangerous to aviation.

According to the National Weather Service, more than 100,000 thunderstorms occur each year, though only about 10 percent of these storms are classified as "severe." A severe thunderstorm occurs when the storm produces one of three elements: 1) Hail of three-quarters of an inch; 2) Tornado; 3) Winds of at least 58 miles per hour.

Figure 58 illustrates thunderstorm hazard severity based on the annual average number of days with a thunderstorm event. According to the map, the Pala Reservation is in a location that experiences approximately 9-18 thunderstorm days per year.

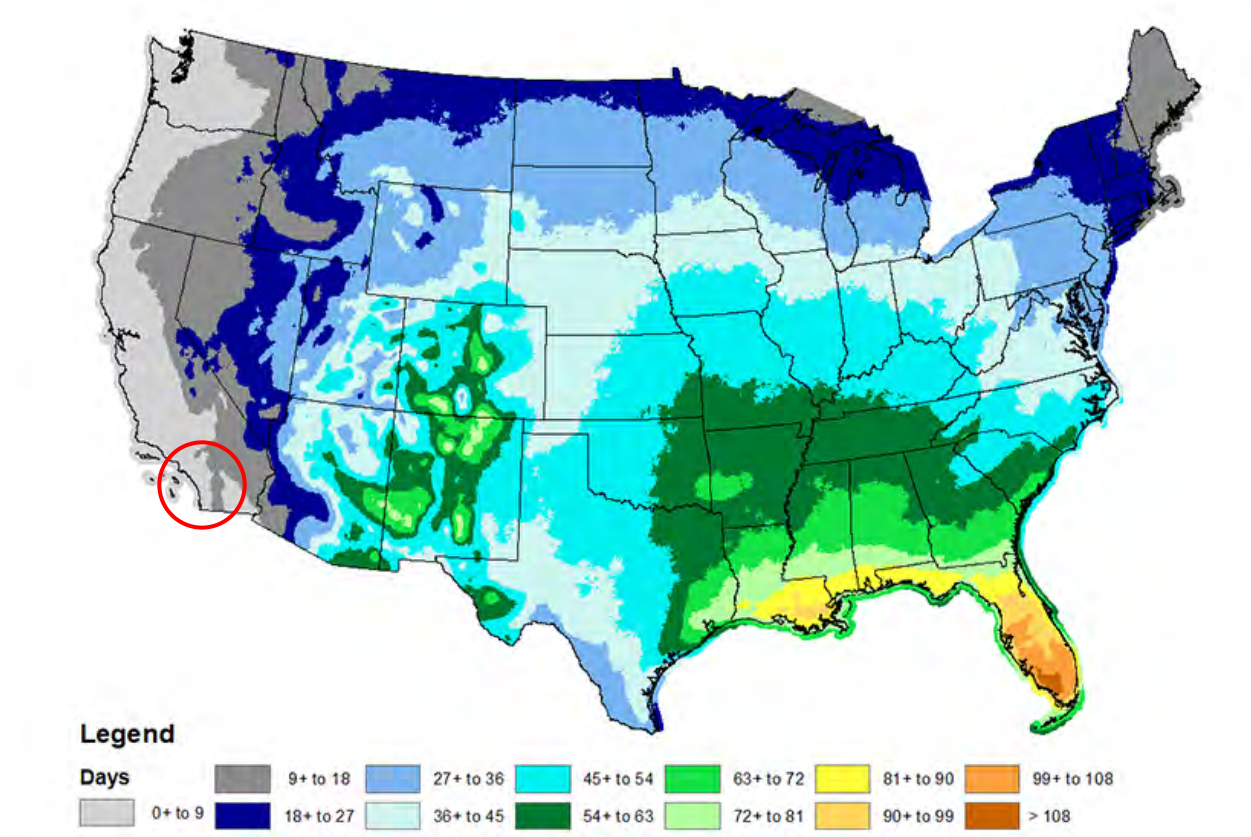

Figure 59. Average Number of Days with Thunderstorms (1993-2018). [113]

4.7.10.2 Location

High winds, including thunderstorm wind, can impact the entire Reservation. The Pala Reservation resides in a Zone I wind zone area (the lowest level, indicated structures are recommended to be designed to withstand winds up to 130 miles per hour) as shown in Figure 59 in the thunderstorm description subsection.

4.7.10.3 Previous Occurrences

Tribal officials were consulted regarding previous wind damage, but no notable occurrences were provided. NOAA's NCEI Storm Events Database was investigated for past high wind and thunderstorm wind events. Wind events were researched for high wind, strong wind, and thunderstorm wind categories. These events may not have impacted the Pala Reservation. However, the data provides a general sense of frequency and magnitude for the Pala Reservation. A total of 115 wind events and

[113] Koehler, Thomas L., 2019: Cloud-to-Ground Lightning Flash Density and Thunderstorm Day Distributions over the Contiguous United States Derived from NLDN Measurements: 1993-2018. Retrieved from https://www.weather.gov/jetstream/tstorms_intro.

approximately $10.3 million in damages were reported for the general area. In addition, four deaths and 16 injuries were reported. A summary of each NCEI wind category is provided below, followed by detailed information for deaths, injuries, or high damage events.

High Winds

Between 1996 and August 2020, 49 high wind events were reported in the San Diego County Valley zone (where Pala is located). These events resulted in $3.8 million in damages (not inflated). Wind speed (magnitude) ranged from 40 knots (46 MPH) to 96 knots (110 MPH). Eight injuries were also reported from these events.

Strong Winds

Between 2005 and August 2020, 19 strong wind events were reported in the San Diego County Valley zone. The events resulted in a combined damage total of $741,000 (not inflated). Wind speeds ranged from 26 knots (30 MPH) to 49 knots (56 MPH). Additionally, four injuries were reported.

Thunderstorm Winds

Between 1955 and August 2020, the NCEI storm database reported 62 thunderstorm wind events for San Diego County. The events resulted in a combined damage total of $7.41 million (not inflated). Wind speeds ranged from 30 knots (35 MPH) to 64 knots (74 MPH). Additionally, five deaths and five injuries were reported.

Significant events are described in more detail below as found on the NCEI Database Center website:

December 6, 1997 (thunderstorm wind): 2 injuries[114]

Slow moving low-pressure winds began at the center of the coast, spawned late night showers and thunderstorms. The showers continuously developed off the coast and moved inland over central portions of Orange County. The showers began before daybreak on the 6th and lasted until the early morning hours on the 7th. Rainfall generally ranged from 4 to 8 inches across the area, resulting in widespread flooding. One observer in Mission Viejo reported 10 inches of rain from this event.

The hardest hit area was the coastal plain southwest of the Santa Ana Mountains. It was the heaviest rain recorded in at least 70 years. Collapsing hillsides and raging water triggered flooding that forced scores of people to flee their homes. Others climbed atop stalled automobiles to escape the rising waters.

A Local State of Emergency was declared in Orange County, as mud and debris flow damaged hundreds of homes and businesses, and halted transportation services. Storm debris littered the coastline. In

[114] NOAA National Climatic Data Center: http://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5626263

some areas, like the Rhine Channel in Newport Bay, were clogged to the point where they resembled a landfill.

During the evening of the sixth, two teenage lobster fishermen were caught in a storm a mile west of the beach at North Island Naval Air Station. Swells more than 6 feet high capsized their 18-foot skiff. They were rescued several hours later with cuts and bruises.

In addition, 50 knot winds were recorded in San Diego County.

January 7, 2003 (high winds): 7 injuries[115]

Throughout this three-day Santa Ana wind event, numerous trees and power poles were blown down. During this event, at least 60 communities were affected. Interstates 8, 10, and 15 were blocked for several hours by large trucks that had been blown over. Blowing dust and sand reduced visibility to zero, leading to the closing of Interstate 215. Planes were diverted from landing at Ontario International Airport as winds gusted to 90 mph. One large commercial transport plane sustained damage. A commuter train was delayed for several hours in Orange County when power poles were blown down onto the track. A brush fire whipped by the winds, damaged 5 houses and burned 150 acres. Sparks from downed power lines started numerous small brush fires, but these were quickly contained. Many houses and at least 300-parked automobiles were damaged by falling trees.

In Riverside, wind caused debris to smash into a vehicle, killing the front seat passenger. In San Diego, a woman was killed by a falling tree. Three others in San Diego County were also struck by falling trees and sustained broken bones. Six people riding in a commuter bus were injured when a tree fell on it. The avocado crop in San Diego County lost about 20 million pounds of fruit.

December 29, 2004 (thunderstorm wind): $5 million in damages[116]

San Diego Lindbergh Field recorded a wind gust of 58 mph ahead of an approaching squall line. This was the highest wind gust, for the month of December, ever measured at Lindbergh Field. Just south of the airport in National City, the top 200 feet of the KSON broadcast tower snapped off as a result of the wind gusts. A portion of the tower fell on 20 parked cars. Winds gusts over 60 mph blew down many trees and caused damage to houses, cars, and power poles.

March 22, 2007 (thunderstorm wind): 3 deaths[117]

A closed low pressure system over northern Baja created conditions favorable for the formation of high-based convection across southern California. Thunderstorms initiated over the deserts in the afternoon and quickly moved westward over the mountains, towards the coast. An inverted “V” signature was noted above the 950 mb level on the 00Z KNKX sounding that afternoon, indicative of the potential for

[115] NOAA National Climatic Data Center: http://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5339495
[116] NOAA National Climatic Data Center: http://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5431412
[117] NOAA National Climatic Data Center: http://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=22302

thunderstorms to produce microbursts. Three elderly fishermen drowned after their overloaded, 12-foot motorboat capsized on Lake Henshaw while trying to outrun an approaching thunderstorm. Eyewitness accounts and observations support the idea that this thunderstorm may have produced a minor, sub-severe microburst. This was probably all that was needed to capsize the small, overloaded boat. A friend of the fishermen was the first to notice the capsized boat; however, he did not actually see the boat flip over. It is still not completely known if the boat capsized before or after the thunderstorm moved across the lake.

October 27, 2009 (Strong Winds): 2 injuries[118]

A strong onshore flow behind a cold front brought gusty winds to the mountains and deserts of Southern California on November 27th. The wind blew down several eucalyptus trees and caused a few power outages in the region.

Winds gusting around 30 mph caused a eucalyptus tree to fall on a car driving along Rancheros Drive in San Marcos. The tree trapped the driver and one passenger in the car. The couple sustained only minor injuries. Damages of $20,000 were reported.

January 19, 2010 (thunderstorm wind): 1 death[119]

A narrow band of thunderstorms moved through San Diego County at approximately 1500 PST. In Santee, winds tore off the roofs of three mobile homes, with some parts of the roofs flying as far as 75 feet away. In Flinn Springs, a 10-foot diameter tree fell on a mobile home, killing a woman. The San Miguel remote automatic weather station (RAWS) measured a peak wind gust of 59 MPH during this time.

December 26, 2015 (strong wind): 2 injuries[120]

A girl and her father were injured by a falling tree at Big Rock Park.

January 31, 2016 (thunderstorm wind): 1 death, 2 injuries[121]

A pine tree 8 feet in diameter succumbed to strong winds, falling on four cars and killing a 48-year-old woman who was driving down Ingraham Street. An additional tree fell during the cleanup operations, injuring 2 reporters.

[118] NOAA National Climatic Data Center: http://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=200090
[119] NOAA National Climatic Data Center: http://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=211235.
[120] NOAA NCEI Storm Events Database. Retrieved from https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=6%2CCALIFORNIA
[121] NOAA NCEI Storm Events Database. Retrieved from https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=6%2CCALIFORNIA.

January 20, 2017 (thunderstorm wind): $1 million in damages; 1 injury[122]

A severe squall produced a swath of 60-70 mph winds from Imperial Beach to Lawson Creek. At least 6 mesonet stations reported peak wind gusts in excess of 58 mph including a 68-mph gust at Lawson Creek and 64 mph gust at Boarder Field. Hundreds of trees were downed. Roof damage was also reported. One person was injured when a tree fell on their car in Lakeside.

February 17, 2017 (high wind): $2 million in damages[123]

Numerous trees were downed across the western valleys of San Diego County. Peak wind gusts generally ranged between 35 and 50 mph, though a peak gust of 58 mph was reported at Otay Mountain.

In addition, information from Windfinder reported wind speed data for Lake Wohlford, California, the closest data available to Pala (about twenty miles south), as follows:

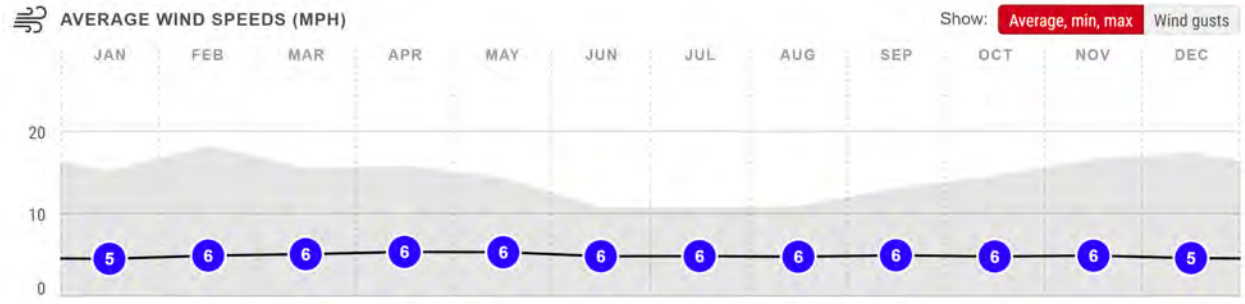

Figure 60. Wind Statistics for Lake Wohlford, CA. [124]

This data indicates an average wind speed of 6 knots (1.15 miles per hours) for most months of the year.

4.7.10.4 Extent

Wind speeds between 26 knots (30 mph) and 96 knots (110 mph) have been reported in the planning area. Sustained wind speeds of 110 miles per hour are on par with a Category 3 hurricane and can cause substantial damage to buildings. Further, more severe winds are possible. The wind speed building design criteria for San Diego County is 85 mph.[125] These regulations do not apply to all buildings on the reservation, as individuals who build homes do not have to adhere to the state or county building

[122] NOAA NCEI Storm Events Database. Retrieved from https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=6%2CCALIFORNIA.
[123] NOAA NCEI Storm Events Database. Retrieved from https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=6%2CCALIFORNIA.
[124] Yearly wind and weather averages for Lake Wohlford. Windfinder. Retrieved from https://www.windfinder.com/windstatistics/lake_wohlford.
[125] http://www.iccsandiego.org/text/CRC%20Committee/R602_10_Wall-Bracing2013.pdf

standards. All buildings constructed by the tribe do follow the San Diego County design criteria. Average wind speeds range from 5 to 6 knots (light breeze).

4.7.10.5 Probability of Future Events

Figure 60 above reports that the Pala Reservation area receives an average of 5-10 days of thunderstorms each year. Previous occurrences noted 115 wind events between 1955 and 2020, a 65-year period. This indicates more than one wind event annually for the forecast zone the Pala Reservation is within. Probability was then defined as "highly likely" (greater than 90% chance of future occurrence) on the PRI scale.

4.7.10.6 Vulnerability Assessment and Estimated Losses

All current and future buildings, populations, cultural resources, and critical facilities are at risk from wind. During a time of extreme heat and high winds, wildfire threat significantly increases.

All structures, including critical facilities, are considered at risk from extreme wind. Severe wind has the potential to blow shingles, siding, awnings, and other features off buildings. Falling trees and tree limbs can damage structures. Objects picked up by wind can be hurled through the air, damaging structures and breaking windows when contact is made. Power outages can occur when utility lines or poles are downed. When combined with extreme heat or cold, relocations or sheltering may be necessary until power is restored. Further, in the planning area, wind events can pick up loose sediment and dust, impacting air quality and reducing visibility, leading to dangerous driving conditions.

In extreme cases, wind can blow structures off foundations. Mobile homes and structures not built to the California Uniform Building Code are considered at a higher risk. The Pala Reservation has several mobile home communities, as well as an RV Park. Proper anchoring can make mobile homes more resilient to severe wind.

Estimated Losses

Annualizing the losses from wind damage overtime, results in an approximate value of $519,300 annually. However, this value is for the entire San Diego County valley zone, including Pala. It is difficult to determine an exact value for the reservation without detailed historic data. Annualizing losses to the Reservation overtime would likely result in a negligible value.

Climate Change

Climate change projections for high wind events, such as thunderstorms, are not definitive. While there is stronger evidence that thunderstorm activity will likely increase in the U.S. Southeast, projections for the West Coast are less certain. Based on data provided by NASA, there is little expected increase in days with conditions conducive to severe thunderstorm formation.[126] Climate changes impacts on other

[126] Severe thunderstorms and Climate Change (2013). NASA. Retrieved from https://climate.nasa.gov/news/897/severe-thunderstorms-and-climate-change/.

types of wind events impacting the Reservation are also uncertain. One study suggests Santa Ana winds, which impact the Reservation, may decrease in frequency or shift to occurring later in the year.[127]

4.7.11 Landslide

4.7.11.1 Description

A landslide is the downward and outward movement of slope-forming soil, rock, and vegetation driven by gravity. Landslides can be deep-seated, meaning the bulk of the slide plane is below tree roots (typically 10 feet to several hundred feet deep), or shallow-seated, meaning slides are typically earth and debris that occur within the forest rooting zone. Both natural and human-induced changes in the environment can trigger landslides. These changes include heavy rain, rapid snow melt, steepening of slopes due to construction or erosion, earthquakes, volcanic eruptions, and changes in groundwater levels. Deep-seated landslides are more likely to be triggered by geologic and hydrologic processes such as seismic shaking, volcanic activity, or changes in groundwater. Shallow landslides are more likely to be triggered by soil saturation from heavy rainfall or rapid snowmelt.[128]

Both deep-seated and shallow landslides can be further categorized into several types of landslides.

- **Rock falls** are rapid movements of bedrock which result in bouncing or rolling.
- A **topple** is a section or block of rock that rotates or tilts before falling to the slope below.
- **Slides** are movements of soil or rock along a distinct surface of rupture, which separates the slide material from more stable underlying material.
- **Mudflows**, sometimes referred to as mudslides, mudflows, lahars, or debris avalanches, are fast-moving rivers of rock, earth, and other debris saturated with water. They develop when water rapidly accumulates in the ground, such as heavy rainfall or rapid snowmelt, changing the soil into a flowing river of mud or "slurry."
- **Slurry** can flow rapidly down slopes or through channels and can strike with little or no warning at avalanche speeds. Slurry can travel several miles from its source, growing larger as it picks up trees, cars, and other materials along the way. As the flows reach flatter ground, the mudflow spreads over a broad area where it accumulates in thick deposits.

In areas burned by forest and brush fires, a lower threshold of precipitation may initiate landslides. Some landslides move slowly and cause damage gradually, whereas others move so rapidly that they can destroy property and take lives suddenly and unexpectedly.

[127] Guzman-Morales, J. and Gershunov, A. (2019). Climate Change Suppresses Santa Ana Winds of Southern California and Sharpens Their Seasonality. AGU. Retrieved from https://doi.org/10.1029/2018GL080261.
[128] Deep Seated and Shallow-Rapid Landslides: Know the Difference. (2017). Washington Forest Protection Association. Retrieved from http://www.wfpa.org/news-resources/blog/deep-seated-landslides-shallow-landslides-washington/.

Among the most destructive types of debris flows are those that accompany volcanic eruptions. A spectacular example in the United States was a massive debris flow resulting from the 1980 eruptions of Mount St. Helens, Washington. Areas near the bases of many volcanoes in the Cascade Mountain Range of California, Oregon, and Washington are at risk from the same types of flows during future volcanic eruptions.

Areas that are generally prone to landslide hazards include previous landslide areas, the bases of steep slopes, the bases of drainage channels, and developed hillsides where leach-field septic systems are used. Areas that are typically considered safe from landslides include areas that have not moved in the past, relatively flat-lying areas away from sudden changes in slope, and areas at the top or along ridges set back from the tops of slopes.

According to the United States Geological Survey, landslides cause nearly $6.5 billion (2017 dollars) in damage and between 25 and 50 deaths in the United States each year.[129]

4.7.11.1 Location

The slopes bordering Route 76 and the Pala Reservation are steep and prone to potential rock falls and landslides. A landslide on this road could significantly impact the Reservation by trapping motorists where they occur by blocking the roads. The dry climate combined with the steep slopes creates a condition that could also cause mudslides.

Landslides are possible but are not a frequent occurrence on the Pala Reservation. According to 2002 USGS Landslide Incident and Susceptibility Index, the entire reservation resides in an area of low incidence (less than 1.5 % of the area is involved in landsliding). The figure below shows this area. Generally, landslides are more prevalent in western San Diego County (coastal plain) and in the mountains of eastern San Diego County.

[129] United States Geological Survey (USGS). United States Department of the Interior. “Landslide Hazards – A National Threat.” 2005.

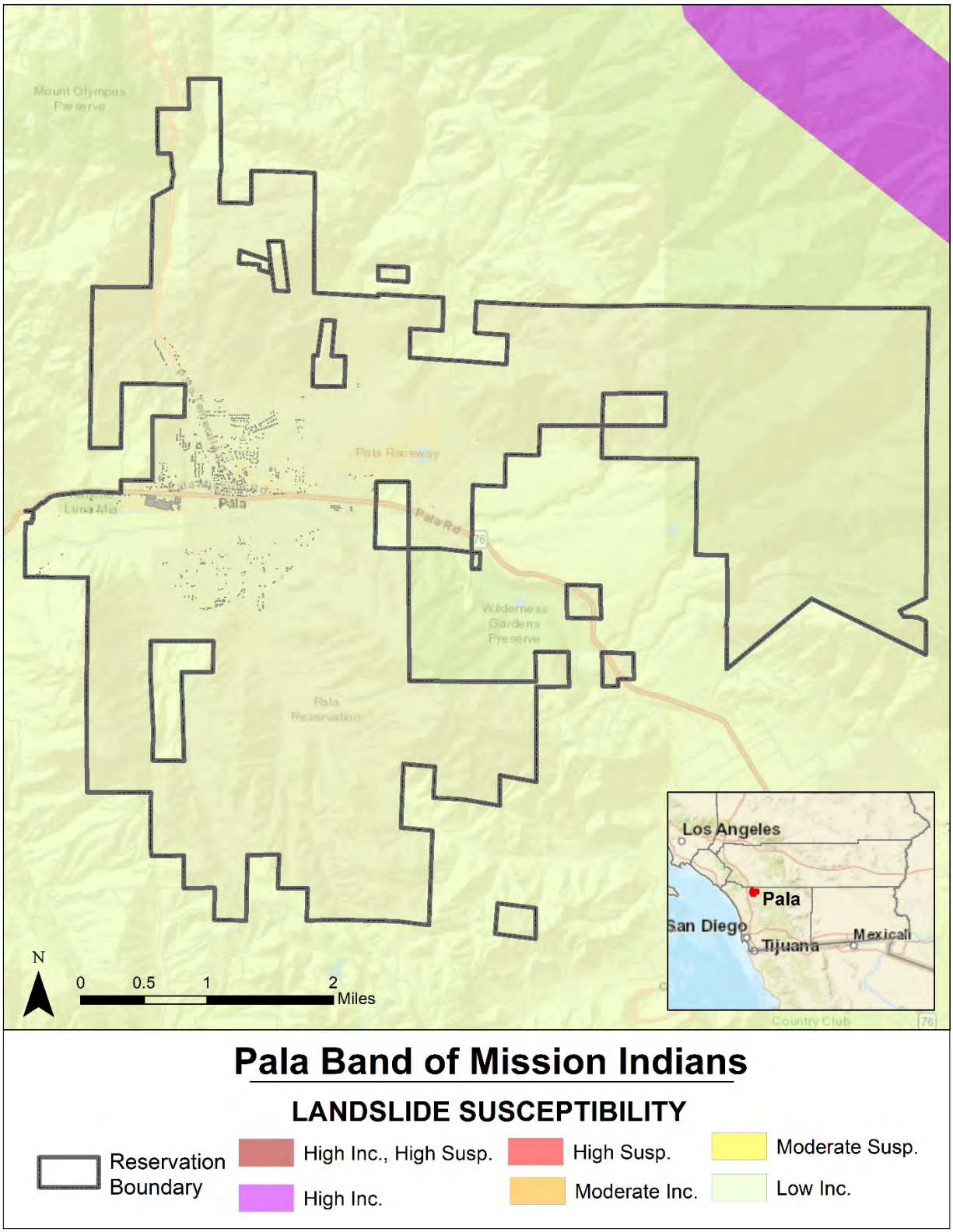

Figure 61. USGS Landslide Susceptibility Index.

4.7.11.3 Previous Occurrences

There have been no known reported events in the planning area. The following sources were investigated:

- USGS Landslide Inventory Web Application.[130]
- NOAA NCEI: No events reported near planning area.
- San Diego County Hazard Mitigation Plan: No events reported near planning area.

Tribal officials reported a mudslide/rockfall incident approximately two miles east of the Pala Reservation, on Rice Canyon Road near Highway 76.

4.7.11.4 Extent

Extent can be defined using the USGS Landslide Susceptibility Index. The greatest extent possible is "high incident, high susceptibly". However, the entire planning area resides in an area of "low Incident" (less than 1.5 % of the area is involved in landsliding). Landslide extent can also be measured in terms of size (width of slide or tonnage of debris generated). However, since no events have been reported, this measure could not be utilized.

4.7.11.5 Probability of Future Events

There are no reported previous landslide occurrences and the Pala Reservation resides in a USGS low susceptibility risk area. However, there is steep terrain, which could become unsettled following earthquake, heavy rain and/or wildfire. Therefore, probability can best be defined as "possible" (between 0% and 10% annual chance of occurrence). El Niño may also result in increased landslides as winters bring increased rainfall.

4.7.11.6 Vulnerability Assessment and Estimated Losses

All current and future buildings, critical facilities, populations, and cultural resources on the Pala Reservation are assumed to be at risk from landslides. Structures or other assets location on or at the base of steep slopes may be at a higher risk to landslides.

According to the 2018 California State Hazard Mitigation Plan Update, landslides directly damage structures by disrupting structural foundations caused by deformation of the ground upon which the structure sits, and by the physical impact of debris moving down-slope against structures located in the travel path. As a landslide breaks away from a slope and moves, it deforms the ground into an uneven surface.

[130] U.S. Landslide Inventory. USGS. Retrieved from https://usgs.maps.arcgis.com/apps/webappviewer/index.html?id=ae120962f459434b8c904b456c82669d.

When situated on top of a landslide, the deformation distresses structural foundations and the structures themselves by settlement, cracking, and tilting. This can occur slowly, over years, or rapidly, within days or even hours. A water-saturated, fast-moving debris flow (or "mudslide") can destroy all in its path, collapsing walls and shifting structures off their foundations.

In addition to buildings, utilities and roads are vulnerable to the impact and ground deformation caused by landslides and other earth movements. Because of their geographic extent, roads and utility lines have a greater chance of being impacted by landslide events. Further, if any section of a road or utility line is damaged by a landslide, the entire system may be impacted. For instance, a landslide that results in one area of a road being impassible may block accessibility to other roads or locations, preventing evacuations, precluding delivery of goods and services, and disrupting schools and businesses. When utility lines are damages by landslides, functionality of water, sewer, gas, and electricity systems may be compromised.[131]

Landslides are most likely to occur during winter when more rain is received and would impact the Pala Reservation because of the many steep slopes that border Route 76 and the other roads throughout the Reservation. The worst-case scenario of a landslide event would be one that is triggered by a major earthquake when the soil is saturated due to heavy rains and following a major wildfire. In this case, mudslides become a possibility as well. The tribe is aware of this risk and is working both to develop safe areas and to make sure that effective preventative measures, such as flood walls, are in place.

The entire reservation resides in an area of low incident (less than 1.5 % of the area is involved in landsliding). This corresponds to low susceptibility. No known losses have been reported with landslides on the Pala Reservation. Although the risk is low, all current and future buildings, populations, and critical facilities should be considered at risk.

Estimated Losses

No known losses have been reported for this hazard on the Pala Reservation from landslides. Minimal losses are expected for facilities that are impacted by landslide, and these losses would be negligible if the rates were annualized over time.

Climate Change Impacts

Climate change is projected to result in precipitation extremes (i.e., wetter wet periods and drier dry periods).[132] The planning area is not projected to see substantial increases in average annual precipitation under either low or a high emissions scenario (see this section's equivalent under *Flood*). Therefore, increased overall rainfall is unlikely to contribute to increased landslide events on the

[131] 2018 California State Hazard Mitigation Plan, Public Review Draft, pg. 312. Cal EOS. Retrieved from http://www.caloes.ca.gov/HazardMitigationSite/Documents/009-2018%20SHMP_Public%20Review%20Draft_April%202018_CH6.pdf.

[132] California State Hazard Mitigation Plan (2018). *Section 4.3: Risk Factor: Climate Change*. Retrieved from https://www.caloes.ca.gov/HazardMitigationSite/Documents/002-2018%20SHMP_FINAL_ENTIRE%20PLAN.pdf.

Reservation. However, more extreme precipitation could contribute to increased landsliding if rain events are more intense. In addition, wildfires, which are frequent precursors to landslides, are projected to increase in the planning area due to climate change, as drought and high temperatures increase.

4.7.12 Lightning

7.7.12.1 Description

Lightning is a discharge of electrical energy resulting from the buildup of positive and negative charges within a thunderstorm, creating a "bolt" when the buildup of charges becomes strong enough. This flash of light usually occurs within the clouds or between the clouds and the ground. A bolt of lightning can reach temperatures approaching 50,000 degrees Fahrenheit. Lightning rapidly heats the sky as it flashes but the surrounding air cools following the bolt. This rapid heating and cooling of the surrounding air causes the thunder, which often accompanies lightning strikes. While most often affiliated with thunderstorms, lightning may also strike outside of heavy rain and might occur as far as 10 miles away from any rainfall.

Lightning strikes occur in very small, localized areas. For example, they may strike a building, electrical transformer, or even a person. According to FEMA, lightning injures an average of 300 people and kills 80 people each year in the United States. Direct lightning strikes can also cause significant damage to buildings, critical facilities, and infrastructure largely by igniting a fire. Lightning is also responsible for igniting wildfires that can result in widespread damages to property.

7.7.12.2 Location

Lightning occurs randomly, therefore it is impossible to predict where and with what frequency it will strike. It is assumed the Pala Reservation is uniformly exposed to lightning. The figure below was compiled with data from 2008-2017 to show the frequency of cloud-to-ground lightning flashes per square mile per year. This can be used to demonstrate location and measure extent. Lightning can occur anywhere, though it is less frequent near water. The Pala Reservation area receives approximately 0 to 1.5 strikes per square mile per year.

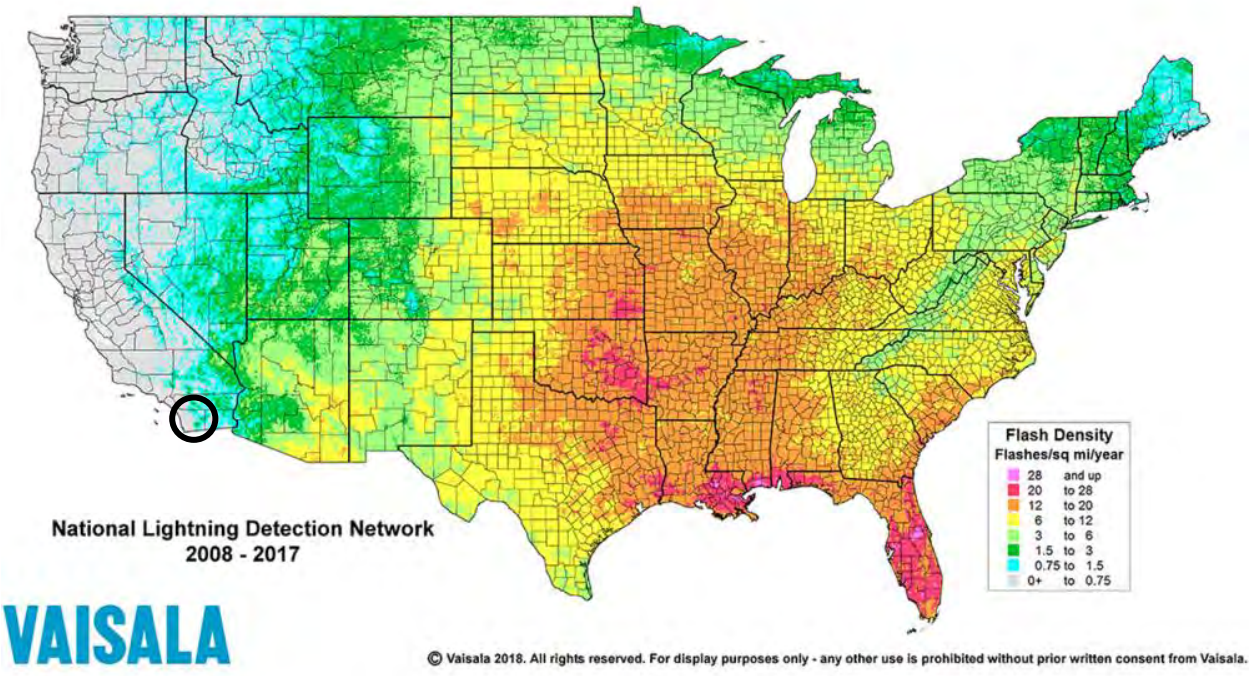

Figure 62. Average Lightning Strikes per square mile per year. [133]

7.7.12.3 Previous Occurrences

The NCEI Storm Events Database reports lightning events by county and NWS public forecast zone. Therefore, lightning event data solely for the Pala Reservation is not available, and events occurring in San Diego County were retrieved in order to indicate the number and severity of previous occurrences likely to have impacted the Pala Reservation. However, it is possible that not all events occurring in the county impacted the Pala Reservation. Likewise, it is possible that some events impacting the Pala Reservation were not reported to NCEI.

There were 18 events reported over a 23-year period throughout San Diego County; however, none were reported on the Pala Reservation. The events reported resulted in 2 deaths, 7 injuries, and over $76,000 (2020 dollars) in damages. All damages were not reported in the estimates. It is very likely damages were much higher given several structural fires. Details for these events are listed in Table 33**.** When available, details are provided for those events that resulted in deaths, injuries, or damages. It should be noted that deaths, injuries, and damages are reported for the event overall, and did not necessarily occur on the Pala Reservation.

[133] National Lightning Detection Network (2018). Visalia. Retrieved from https://www.vaisala.com/en/products/data-subscriptions-and-reports/data-sets/nldn.

Table 33. NCEI Lightning Events (1996-2020).

Date	Location	Deaths	Injuries	Property Damage (2020 dollars)
4/2/1997	San Diego County	0	0	$0
8/2/2000	Coronado	0	0	$0
9/7/2000	Chula Vista	0	3	$28,982
9/2/2001	San Diego County	1	1	$0
9/3/2001	San Diego County	1	1	$0
11/29/0202	San Diego County	0	0	$0
8/24/2003	Alpine, Palomar Mountains	0	0	$0
9/2/2003	La Mesa	0	0	$0
3/2/2004	San Diego County	0	0	$17,389
7/23/2005	San Diego County	0	0	$11,593
7/31/2005	San Diego County	0	0	$0
9/19/2005	San Diego County	0	0	$1,391
9/2/2006	San Diego County	0	0	$0
6/3/2009	San Diego County	0	2	$0
4/13/2012	San Diego County	0	0	$2,319
6/30/2015	Lemon Grove	0	0	$5,796
10/24/2016	Rainbow	0	0	$3,492
11/19/2019	Ramona	0	0	$5,150 (crop)
TOTAL	-	**2**	**7**	**$76,112**

- **4/2/1997:** A cold upper-level, low pressure center spawned an area of thunderstorms that affected much of southern San Diego County with gusty winds, small hail, and power outages. Lightning associated with the storm system struck a palm tree in the skyline district of San Diego, shearing off the top twenty feet. The resulting shock wave shattered all the windows of the home on the property, sent dishes and glasses cascading from cupboards, and knocked pictures off the walls. Windows were broken in fifteen nearby homes, an elementary school, and a high school two blocks away. Also, a nearby utility pole caught fire, and the top of a wood and concrete fence was destroyed.

- **8/2/2000:** Lightning knocked out power and started several fires in the High Desert. About 17,000 customers were affected briefly. Traffic signals were knocked out in Hesperia, and a garage and two cars were destroyed by a fire started from a lightning strike on the nearby power pole. Several small fires were also started by lightning strikes in the back-country areas

near Lake Arrowhead, Big Bear Lake, and Silverwood. Lightning strikes on the beach and in the water along the south San Diego County coast, forced lifeguards to close the beaches briefly.

- **9/7/2000:** Lightning struck the ground next to a basketball hoop at the Oceanside High School as about 200 students were assembling outside for their sixth period physical education class. Two students closest to where the bolt hit were knocked down and briefly lost consciousness. They later reported sensations that felt like being hit with a rock, needles going through their skin, and their hair being pulled. Another 100 students standing nearby reported feeling a mild jolt and the hair on their arms and heads standing on end. Lightning occurred throughout San Diego County the entire day, striking several homes and power poles, as well as starting brush and tree fires. Most of the blazes were quickly extinguished by the rainfall.

- **9/1/2001:** Frequent lightning was recorded, with lightning detection sensors indicating about 60 strikes per hour. Numerous small fires were started in the National Forests. A group of four hikers climbing Stonewall Peak in the San Diego County Mountains encountered lightning and heavy rain. Two of the hikers stopped short of the peak and took shelter. Two others continued on to the lookout area which is surrounded by a metal railing. The 53-year-old man was struck in the head by lightning and died. The other, a 13-year-old boy, was knocked unconscious but survived.

- **9/3/2001**: Two boys in an open field in Apple Valley were hit by lightning. One boy died, and the other suffered burn injuries.

- **7/23/2005:** Lightning sparked about 15 fires across the county and burned 150 acres.

- **9/19/2005**: During widespread thunderstorms, one lightning strike caused damage to a few homes in Alpine.

- **6/3/2009**: Over 1,500 cloud-to-ground lightning strikes were recorded during the event, resulting in one death and multiple injuries. The lightning also started approximately 70 fires, most of which were small and did not result in any damage or injuries. A 31-year-old male suffered serious injuries while doing landscape work at a home on Camden Place in San Marcos when lightning struck a palm tree nearby. He was transported to the hospital in critical condition. His 48-year-old brother was treated for minor injuries.

- **4/13/2012**: NBC San Diego reported a lightning strike to the Unified Port of San Diego building, resulting in part of the roof getting peeled back. The strike also took out power to the building, but no injuries were reported.

- **6/30/2015**: Several small fires were started by lightning strikes. In Vista lightning struck the hillside and started a fire. Lightning started a fire at Poway Road near Community Road. Lightning also struck a hillside which started a fire near Bancroft Drive and Campo Road in La Mesa. A power line and pole were reported down across the roadway at Dye Road and Ramona Street due to lightning.

- **11/19/2019:** Lightning struck a pine tree near Ramona, catching it on fire. The fire then spread to many nearby palm trees. The fire departments had to suppress the fires.

7.7.12.4 Extent

According to Figure 62, Southern California, including the Pala Reservation, receives approximately 0-1.5 lightning strikes per square mile per year (though additional lightning flashes that do not strike or are not recorded are likely). Lightning can also be measured in terms of damaged caused. The greatest amount of damage reported from lightning was just under $29,000 (2020 dollars) in Chula Vista. However, costlier events are possible and likely have occurred in the past (particularly due to structural fires).

7.7.12.5 Probability of Future Events

When looking at the 18 reported events over the 23-year period, there is an approximate annual chance of 78 percent for damaging lightning in the area. However, these events refer to events across all of San Diego County, and no events were reported on the Reservation. Therefore, a probability of "possible" (between 1% and 10% annual probability) was assigned to the lightning hazard.

7.7.12.6 Vulnerability Assessment and Estimated Losses

Given that lightning may strike anywhere, all current and future buildings, critical facilities, populations, and cultural resources are assumed to be at risk from lightning.

It is possible that lightning-related damage or injuries have gone unreported. Lightning may result in electrical damage (including electrical systems and electronics), fires, injury, or death. In addition, falling limbs caused by lightning strikes to trees may damage buildings or vehicles.

Estimated Losses

No known losses have been reported for this hazard on the Pala Reservation. Losses due to lightning are possible including structure fire and electrical damage. However, these losses would likely be negligible if amounts were annualized over time. The potential for damage puts all current and future buildings, populations, and critical facilities at risk.

Climate Change

Climate change projections for severe weather events, such as thunderstorms, are not definitive. While there is stronger evidence that thunderstorm activity will likely increase in the U.S. Southeast, projections for the West Coast are less certain. Based on data provided by NASA, there is little expected increase in days with conditions conducive to severe thunderstorm formation.[134]

4.7.13 Tornado

4.7.13.1 Description

A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud extending to the ground. Tornadoes are most often generated by thunderstorm activity (but sometimes result from hurricanes and other tropical storms) when cool, dry air intersects and overrides a layer of warm, moist air, forcing the warm air to rise rapidly. The damage caused by tornado results from high wind velocity and wind-blown debris, which can be accompanied by lightning or large hail. According to the NWS, tornado wind speeds normally range from 40 to more than 300 miles per hour. The most violent tornadoes have rotating winds of 250 miles per hour or more, and are capable of causing extreme destruction, turning normally harmless objects into deadly missiles.

Each year, an average of over 800 tornadoes are reported nationwide, resulting in an average of 80 deaths and 1,500 injuries.[135] According to the NOAA Storm Prediction Center (SPC), the highest concentration of tornadoes in the United States has been in Oklahoma, Texas, Kansas, and Florida. Although the Great Plains region of the Central United States does favor the development of the largest and most dangerous tornadoes (earning the designation “tornado alley”), Florida experiences the greatest number of tornadoes per square mile of all U.S. states. The figure below shows tornado activity in the United States based on the number of recorded tornadoes between 1955 and 2014.

[134] Severe thunderstorms and Climate Change (2013). NASA. Retrieved from https://climate.nasa.gov/news/897/severe-thunderstorms-and-climate-change/.
[135] NOAA Storm Prediction Center (2014). Retrieved from https://www.spc.noaa.gov/wcm/.

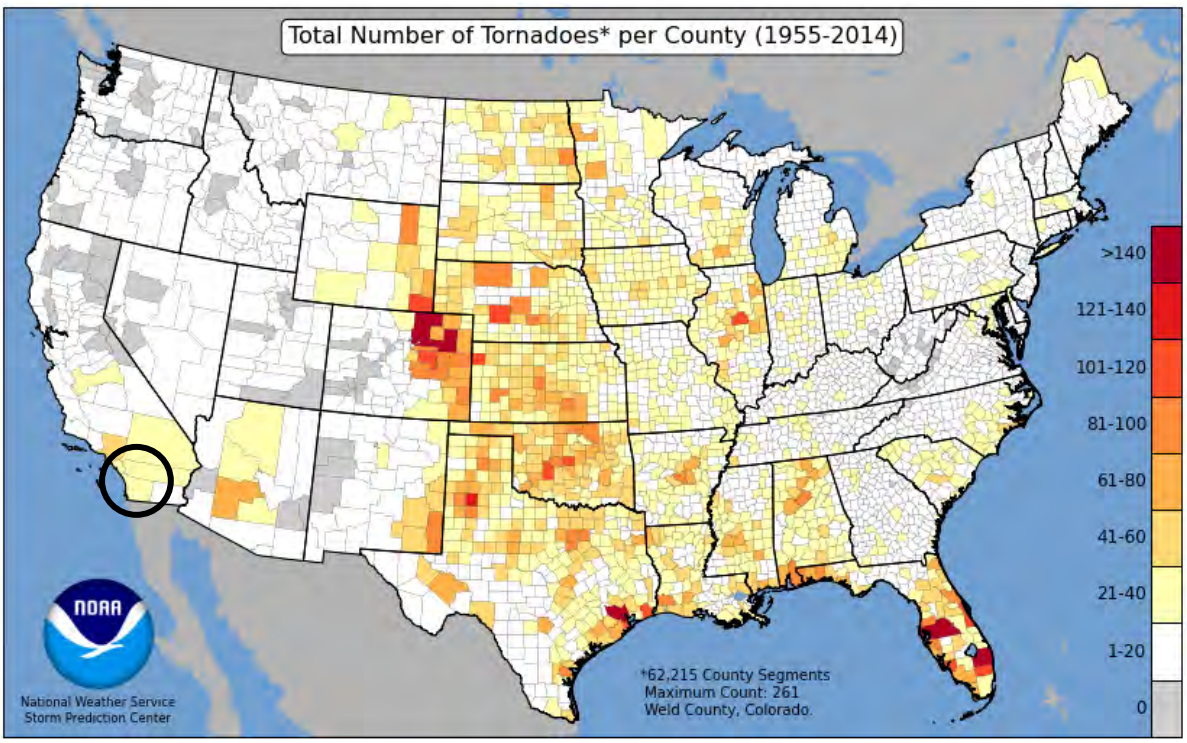

Figure 63. United States Tornado Activity. [136]

Tornadoes are most likely to form in late afternoon and early evening. Most tornadoes are a few dozen yards wide and touch down briefly, but even small, short-lived tornadoes can inflict tremendous damage. Highly destructive tornadoes may carve out a path over a mile wide and several miles long.

The destruction caused by tornadoes ranges from light to inconceivable, depending on the intensity, size, and duration of the storm. Typically, tornadoes cause the greatest damage to structures of light construction, including residential dwellings, and particularly mobile homes. Tornadic magnitude is reported according to the Fujita and Enhanced Fujita Scales. Tornado magnitudes prior to 2005 were determined using the traditional version of the Fujita Scale (Table 34). Tornado magnitudes in 2005 and later were determined using the Enhanced Fujita Scale (Table 35).

[136] National Weather Service Storm Prediction Center. Retrieved from http://www.weather.gov/images/hgx/swa/2013_graphs/tornadoes_county.png.

Table 34. The Fujita Scale (Effective Prior to 2005). [137]

F-SCALE NUMBER	INTENSITY	WIND SPEED	TYPE OF DAMAGE DONE
F0	GALE TORNADO	40–72 MPH	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages to sign boards.
F1	MODERATE TORNADO	73–112 MPH	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2	SIGNIFICANT TORNADO	113–157 MPH	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
F3	SEVERE TORNADO	158–206 MPH	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted.
F4	DEVASTATING TORNADO	207–260 MPH	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
F5	INCREDIBLE TORNADO	261–318 MPH	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles fly through the air in excess of 100 meters; trees debarked; steel re-enforced concrete structures badly damaged.
F6[138]	INCONCEIVABLE TORNADO	319–379 MPH	These winds are very unlikely. The small area of damage they might produce would probably not be recognizable along with the mess produced by F4 and F5 wind that would surround the F6 winds. Missiles, such as cars and refrigerators would do serious secondary damage that could not be directly identified as F6 damage. If this level is ever achieved, evidence for it might only be found in some manner of ground swirl pattern, for it may never be identifiable through engineering studies.

[137] NOAA. Fujita Tornado Damage Scale. Retrieved from https://www.spc.noaa.gov/faq/tornado/f-scale.html.
[138] F6 is not always included but has been used to describe extremely strong tornadoes that far surpass F5 levels.

Table 35. The Enhanced Fujita Scale (Effective 2005 and Later). [139]

EF-SCALE NUMBER	INTENSITY PHRASE	3 SECOND GUST (MPH)	TYPE OF DAMAGE DONE
F0	GALE	65–85	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages to sign boards.
F1	MODERATE	86–110	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2	SIGNIFICANT	111–135	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
F3	SEVERE	136–165	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted.
F4	DEVASTATING	166–200	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
F5	INCREDIBLE	Over 200	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles fly through the air in excess of 100 meters; trees debarked; steel re-enforced concrete structures badly damaged.

4.7.13.2 Location

Tornadoes have the potential to strike anywhere. They are more common in open spaces (such as the plains in Tornado Alley). Tornadoes are rarer in areas where there are lots of hills or mountains, such as the Reservation. Once a touchdown occurs, it may only affect a small area or travel for miles, leaving

[139] NOAA National Weather Service (2020). *The Enhanced Fujita Scale.* Retrieved from https://www.weather.gov/oun/efscale.

substantial destruction in its path. Further, it is impossible to predict where and with what magnitude a tornado will strike. Therefore, the entire Reservation is assumed to be at risk from tornadoes.

4.7.13.3 Previous Occurrences

No tornadoes have been reported on the Pala Reservation. Research on events was conducted using the NCEI Storm Events Database. Historical occurrences were investigated from 1950 to August 2020 throughout San Diego County. Twenty-five events were reported beginning in 1956 as shown in the table below. These events resulted in four injuries and over $1 million in property damage. A majority of these events occurred near the coast or an unidentified location in San Diego County. When available, details are provided for those events that resulted in deaths, injuries, or damages. It should be noted that deaths, injuries, and damages are reported for the event overall, and did not necessarily occur on the Pala Reservation.

Location	Date	Magnitude	Deaths/ Injuries	Damage
San Diego County	4/13/1956	F1	0/1	$25,000
San Diego County	10/08/1961	F1	0/3	$25,000
San Diego County	2/23/1971	F0	0/0	N/A
Encinitas	10/29/1974	F0	0/0	N/A
San Diego County	1/18/1979	F0	0/0	N/A
San Diego County	2/20/1980	F1	0/0	$25,000
San Diego County	3/17/1982	F0	0/0	N/A
Mission Gorge	2/04/1985	F0	0/0	$250,000
San Diego County	1/14/1990	F0	0/0	$250,000
San Carlos	3/19/9191	F1	0/0	$250,000
San Diego County	3/27/1991	F1	0/0	
Camp Pendleton	2/15/1992	F0	0/0	$25,000
San Diego County	12/07/1992	F0	0/0	$2,500
Borrego Springs	5/20/1997	F0	0/0	N/A
Encinitas	1/29/1998	F1	0/0	N/A

Location	Date	Magnitude	Deaths/ Injuries	Damage
Cardiff by the Sea	2/09/1998	F0	0/0	N/A
Julian	7/12/1999	F0	0/0	$25,000
Poway	11/10/2000	F1	0/0	$73,000
Oceanside	10/17/2004	F0	0/0	$20,000
Fallbrook	2/19/2005	F0	0/0	50,000
Rainbow	2/19/2005	F0	0/0	$25,000
Chula Vista	2/23/2005	F0	0/0	N/A
Encinitas	3/10/2006	F0	0/0	1,500
Ramona	3/11/2006	F0	0/0	$25,000
Cardiff by the Sea	9/22/2007	EF0	0/0	N/A
Lake Morena	4/22/2019	Unknown	0/0	$0
TOTAL	-	-	**0/4**	**$1,072,000**

Figure 64. Tornadoes in San Diego County (1950-2020).

- **2/4/1985**: In Mission Gorge, localized damaged in the form of torn roofs and awnings in a mobile park. Other funnels were sited.

- **3/19/1991**: An F1 tornado in San Carlos damaged at least 20 homes, toppled trees, damaged cars, and littered streets with debris and glass.

- **2/15/1992**: A tornado hit San Onofre Mobile Home Park near Camp Pendleton. Damage was limited to a two-block area. One home was knocked off of its foundation and several others lost awnings.

- **12/7/1992**: A waterspout moved on shore as a tornado. It blew down two carports and downed a power pole.

- **7/12/1999**: A building under construction and a 15-foot water tower were destroyed by a tornado in Julian. Shingles were torn off and a chimney damaged on four other buildings.

Several shallow rooted trees were pushed over. A nearby anemometer recorded wind speeds of 40 and 43 miles per hour.

- **11/10/2000**: Several roofs had composite shingles, clay tiles, and underlying sheathing pulled off. Wooden fences were blown down. One small car and one full-size pickup were lifted and moved 2 to 4 feet sideways.

- **10/17/2004**: A waterspout came ashore in Oceanside and caused minor damage to structures, blew over some trees, and broke windows. The roof of an elementary school was partially torn off by the strong winds. The event was brief, and the tornado dissipated when it reached Pacific Coast Highway. Another funnel cloud was spotted that afternoon south of Carlsbad near Moon Beach.

- **2/19/2005**: A supercell thunderstorm came ashore in northern Oceanside and produced two tornadoes as it moved northwest from near Camp Pendleton to Temecula. The first tornado was spotted just northeast of Oceanside in rural Fallbrook. The tornado knocked out power, blew down trees and fences, ripped off roof tiles, shredded a boat cover, tossed a swing set, and sent patio furniture flying. Another tornado in Rainbow tore tiles off of the roofs of several buildings along Old U.S. 395, overturned a large truck on I-15, and sent palm tree crowns and a shed flying across the freeway. The tornado then crossed into Riverside County near Rainbow Gap, where it damaged some small water towers, a fence, and a car. The most severe damage occurred as the tornado made its descent from Rainbow Gap to the Temecula Creek Golf Couse Inn and Rainbow Canyon Villages in far southwestern Temecula. At least 100 trees, some 100 years old, were blown over in and around the golf course. Most fences and trees in the residential area of Rainbow Canyon Villages were blown over, and several homes had roof shingles blown off.

- **3/10/2006**: A waterspout came ashore in Encinitas and blew down a few trees before dissipating. One of the trees fell across some railroad tracks and temporarily halted train traffic.

- **3/11/2006**: This tornado touched down along Highway 78 just northwest of Ramona before moving into a rural neighborhood on the outskirts of town. The tornado knocked downed dozens of trees, snapped a few pines in half, tossed a child's fort, damaged some solar panels, bent or distorted a couple of rolling garage doors, ripped off the metal roofing from a storage shed or barn, and blew off a number of tiles from a roof.

- **9/22/2007**: A waterspout came ashore at Cardiff State Beach. Several tents were thrown into the air. The waterspout dissipated rapidly upon coming ashore.

4.7.13.4 Extent

The most severe tornado reported in the county was an F1. However, stronger events are possible in the planning area and beyond. Damages are unlikely to be catastrophic based on previous occurrences though injury and even death area possible.

4.7.13.5 Probability of Future Events

Based on 25 events over 70 years, a tornado event is reported in San Diego County every 2 to 3 years, on average. However, this is calculated based on all events in San Diego County. There have been no tornadoes reported on the Pala Reservation. Therefore, a probability of "possible" (between 1% and 10% annual probability) is assigned for the tornado hazard.

4.7.13.6 Vulnerability Assessment and Estimated Losses

All current and future buildings, critical facilities, cultural resources, and populations on the Pala Reservation are considered at risk from tornadoes. A majority of the tornadoes that impact San Diego are weaker events, such as EF0 and EF1 tornadoes. However, even weaker events pose a danger. Further, a tornado can strike anywhere.

Tornadoes are likely to cause damage to trees, billboards, mobile homes and roofs. Some roofs may be partially blown off and shingles are likely to be blown off. In addition, loose objects, such as patio furniture, are likely to be displaced or blown away. People are at risk to projectile debris, falling objects, and collapsing structures.

Building design, including construction type and roof type, also vary in their ability to mitigate wind, thus impacting their vulnerability. Mobile homes are particularly at risk to any wind event and face high risk if not properly anchored. Further, their infrequency creates a vulnerability in that people may not how to react (seek shelter) in the event of a tornado.

Tornadoes have resulted in over $1 million in damages over the previous 70 years throughout San Diego County. However, no tornadoes have been reported or resulted in damage on the Pala Reservation and they are considered a rare occurrence.

Estimated Losses
While damage is possible, annualizing any damage over time would likely result in a negligible average annual loss value.

Climate Change Impacts
Tornadoes are often formed during thunderstorm events. Climate change projections for thunderstorms in the planning area are not definitive. While there is stronger evidence that thunderstorm activity will likely increase in the U.S. Southeast, projections for the West Coast are less certain. Based on data provided by NASA, there is little expected increase in days with conditions conducive to severe

thunderstorm formation.[140] Therefore, under current projections tornado frequency is not expected to increase on the Pala Reservation due to climate change.

4.7.14 Wildfire and Structural Fire

4.7.14.1 Description

A wildfire is any fire occurring in a wildland area (i.e. grassland, forest, brush land) except for prescription fires.[141] Wildfires are part of the natural management of forest ecosystems but may also be caused by human factors.

Nationally, over 80 percent of forest fires are started by negligent human behavior, such as smoking in wooded areas or improperly extinguishing campfires. The second most common cause for wildfire is lightning. In the planning area, brush fires caused by dry vegetation and desert heat are common.

There are three classes of wildland fires: surface, ground, and crown fires. A surface fire is the most common of these three classes. It burns slowly along the floor of a forest, killing or damaging trees. A ground fire (or muck fire) is usually started by lightning or human carelessness and burns on or below the forest floor. Crown fires spread rapidly by wind and move quickly by jumping along the tops of trees. Wildland fires are usually signaled by dense smoke that fills the area for miles around. In the planning area, brush fires are known to jump from place to place due to patches of vegetation and winds.

Wildfire probability depends on local weather conditions, outdoor activities such as camping, debris burning, construction, and the degree of public cooperation with fire prevention measures. Drought conditions and other natural hazards (such as tornadoes, hurricanes, etc.) increase the probability of wildfire by creating fuel in both urban and rural settings. Cyclical climate events, such as El Niño-La Niña, can also have a dramatic effect on the risk of wildfires. Fewer fires are typically seen during El Niño (when more rain is present) and larger, more frequent fires during La Niña events.

Many individual homes, subdivisions, resorts, recreational areas, organizational camps, businesses and industries are located within high wildfire hazard areas. Further, the increasing demand for outdoor recreation places more people in wildland areas during holiday, weekend, and vacation periods. Unfortunately, wildland residents and visitors are rarely educated or prepared for wildfire events that can sweep through the brush or timber and destroy property.

Wildfires can result in severe economic losses as well. Businesses that depend on timber, such as paper mills and lumber companies, experience losses that are often passed along to consumers through higher prices, and sometimes jobs are lost. The high cost of responding to and recovering from wildfires can

[140] Severe thunderstorms and Climate Change (2013). NASA. Retrieved from https://climate.nasa.gov/news/897/severe-thunderstorms-and-climate-change/.

141 Prescription burning, or "controlled burns," are undertaken by land management agencies. It is the process of igniting fires under select conditions in accordance with strict parameters.

deplete fiscal resources and increase insurance rates. The economic impact of wildfires can also be felt in the tourism industry, if roads and tourist attractions are closed due to health and safety concerns.

In addition to wildfires, structural fires are generally defined as fire originating in and burning any part or all of any building, shelter, or other structure, which may include residential, commercial, or industrial buildings. Structural fires affecting single family dwellings may be the most common type of structural fire occurring both in California and the United States as a whole. These types of fires are usually contained effectively with local fire suppression resources. While they may result in casualties, impacts tend to be limited to the immediate area surrounding the burning structure. Larger, more destructive fires may occur the structural fires originating in dense urban areas spread quickly (known as urban conflagrations), or when industrial fires of explosions associated with natural gas pipelines ignite structures.[142]

4.7.14.2 Location

The Pala Reservation is predominantly characterized by brush, desert shrubs, and tree groves, which are susceptible to wildfires. In order to best portray the potential for fire locations, the USDA Wildfire Hazard Potential (WHP) data was consulted.[143] The objective of the WHP map is to "depict the relative potential for wildfire that would be difficult for suppression resources to contain."[144] This data source integrates several measures.

> "The WHP map builds upon spatial estimates of wildfire likelihood and intensity generated in 2014 with the Large Fire Simulator (FSim) for the Fire Program Analysis system (FPA), as well as spatial fuels and vegetation data from LANDFIRE 2010 and point locations of fire occurrence from FPA (ca. 1992 - 2012). With these datasets as inputs, the USDA Forest Service produced an index of WHP for all of the conterminous United States at a 270-meter resolution. The WHP map is represented in two forms: 1) continuous integer values, and 2) five WHP classes of very low, low, moderate, high, and very high. *Areas mapped with higher WHP values represent fuels with a higher probability of experiencing torching, crowning, and other forms of extreme fire behavior under conducive weather conditions, based primarily on 2010 landscape conditions."* [145]

The data for the Pala Reservation can be seen in Figure 65. A majority of the Pala Reservation is categorized as having "very high," "high," or "moderate" wildfire potential.

[142] California State Hazard Mitigation Plan 92018). Chapter 8.3. Retrieved from https://www.caloes.ca.gov/HazardMitigationSite/Documents/011-2018%20SHMP_FINAL_Ch%208.pdf.
[143] Note: State level sources such as the California Fire and Resource Assessment Program (FRAP) data were investigated. Unfortunately, tribal lands were not included. However, all surrounding land was categorized as very high risk (the highest risk ranking).
[144] Wildfire Hazard Potential. (2014). USDA. Retrieved from https://www.firelab.org/project/wildfire-hazard-potential.
[145] Wildfire Hazard Potential. (2014). USDA. Retrieved from https://www.firelab.org/project/wildfire-hazard-Potential.

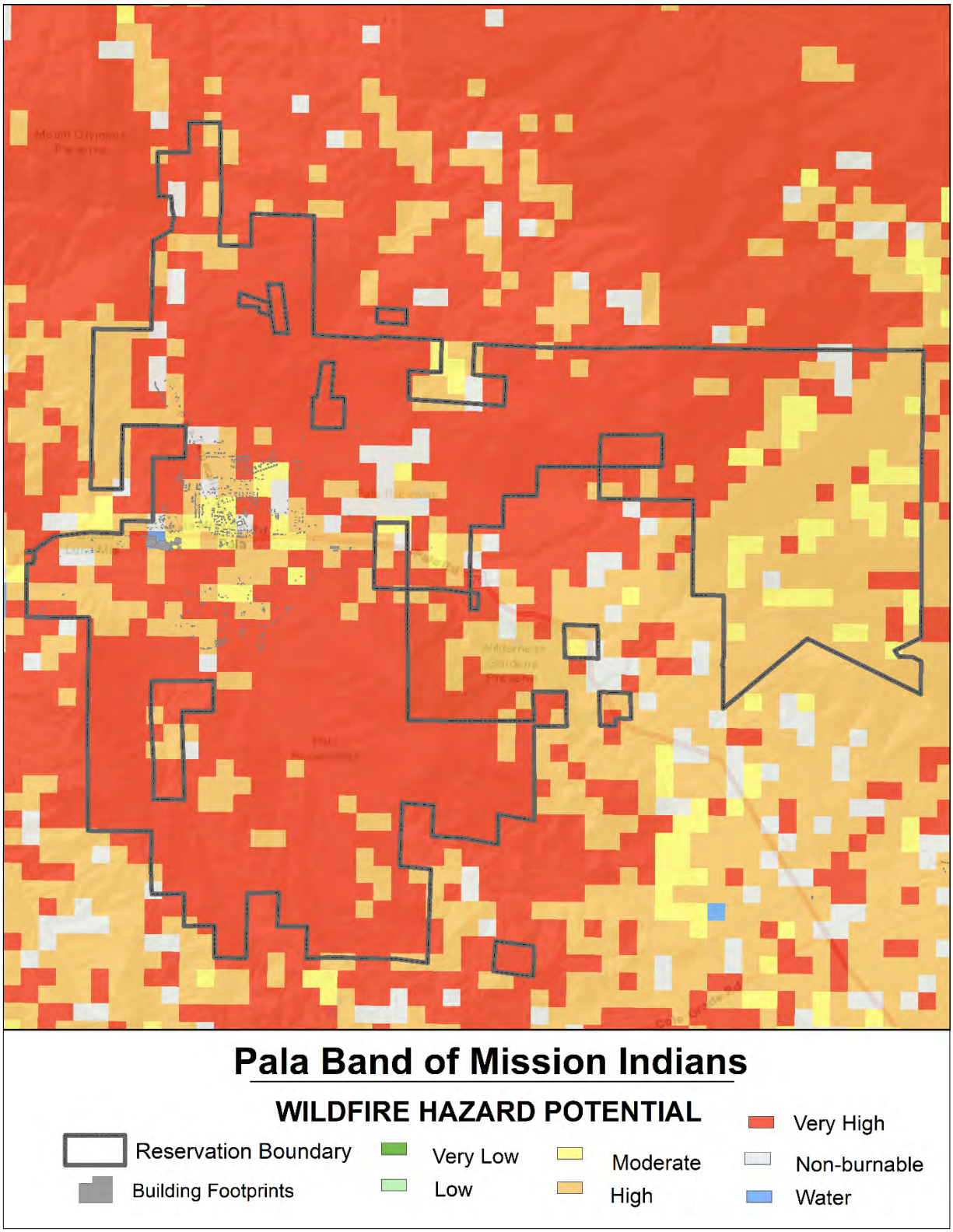

Figure 65. USDA Wildfire Hazard Potential (Wildfire Hazard Location).

In addition, wildfire location may be determined by investigating areas where development is near undeveloped areas. The area where urban development meets vegetated, wildfire-prone undeveloped lands is known as the Wildland Urban Interface (WUI). The University of Wisconsin Spatial Analysis for Conservation and Sustainability (SILVIS) Lab produces Wildland Urban Interface data for the nation. This data was used to map WUI areas on the Pala Reservation.

The SILVIS Lab defines the Wildland-Urban Interface as:

> "WUI is composed of both interface and intermix communities. In both interface and intermix communities, housing must meet or exceed a minimum density of one structure per 40 acres (16 ha). Intermix communities are places where housing and vegetation intermingle. In intermix, wildland vegetation is continuous, more than 50 percent vegetation, in areas with more than 1 house per 16 ha. Interface communities are areas with housing in the vicinity of contiguous vegetation. Interface areas have more than 1 house per 40 acres, have less than 50 percent vegetation, and are within 1.5 mi of an area (made up of one or more contiguous Census blocks) over 1,325 acres (500 ha) that is more than 75 percent vegetated. The minimum size limit ensures that areas surrounding small urban parks are not classified as interface WUI." [146]

Examples of interface versus intermix areas are shown in the figure below.

Source: California Department of Forestry and Fire Protection (CAL FIRE), California's Forests and Rangelands 2017 Assessment

Figure 66. Example of Wildland Urban Interface and Intermix Areas. [147]

Figure 66 shows the WUI for the Pala Reservation.

[146] Radeloff, V.C., R.B. Hammer, S.I Stewart, J.S. Fried, S.S. Holcomb, and J.F. McKeefry. 2005. The Wildland Urban Interface in the United States. Ecological Applications 15: 799-805. Retrieved from http://silvis.forest.wisc.edu/maps/wui

[147] California State hazard Mitigation Plan (2018). Chapter 8. Retrieved from https://www.caloes.ca.gov/HazardMitigationSite/Documents/011-2018%20SHMP_FINAL_Ch%208.pdf.

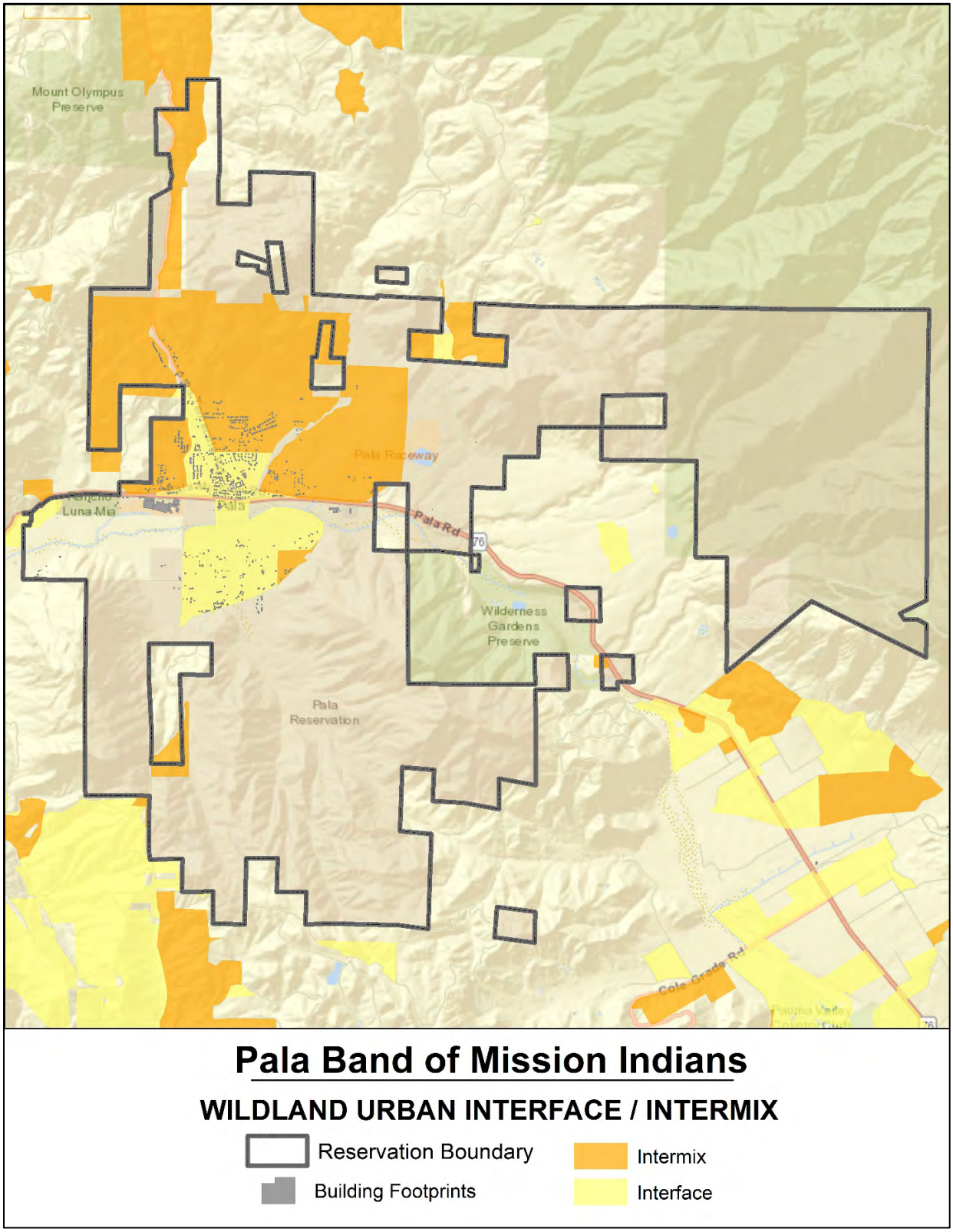

Figure 67. WUI Areas (Silvis Lab).

Structure fires may occur anywhere structures are located. More densely developed areas or structures not built to code may be at a higher risk for structural fires.

4.7.14.3 Previous Occurrences

Based on information from tribe officials, no structures have been lost to wildfires. There have been several major fires in recent history, including the Poomacha Fire that burned land but not structures.

Figure 68 shows the historical burn areas and fire locations on the Pala Reservation beginning in 1910 through 2019. Name and/or date is provided as available. This map shows the large Poomacha Wildfire in thatching. In addition, these fires are listed in Figure 69.[148] Costs and acreage reported in the table reflect the fire total and not the totals incurred to the tribe. However, tribal information was used to supplement details where possible. A total of 39 events were reported totaling nearly $23.5 million (non-inflated) in losses, as defined in Table 36.

[148] The information source was the SANDAG GIS Fire Burn History GIS shapefile.

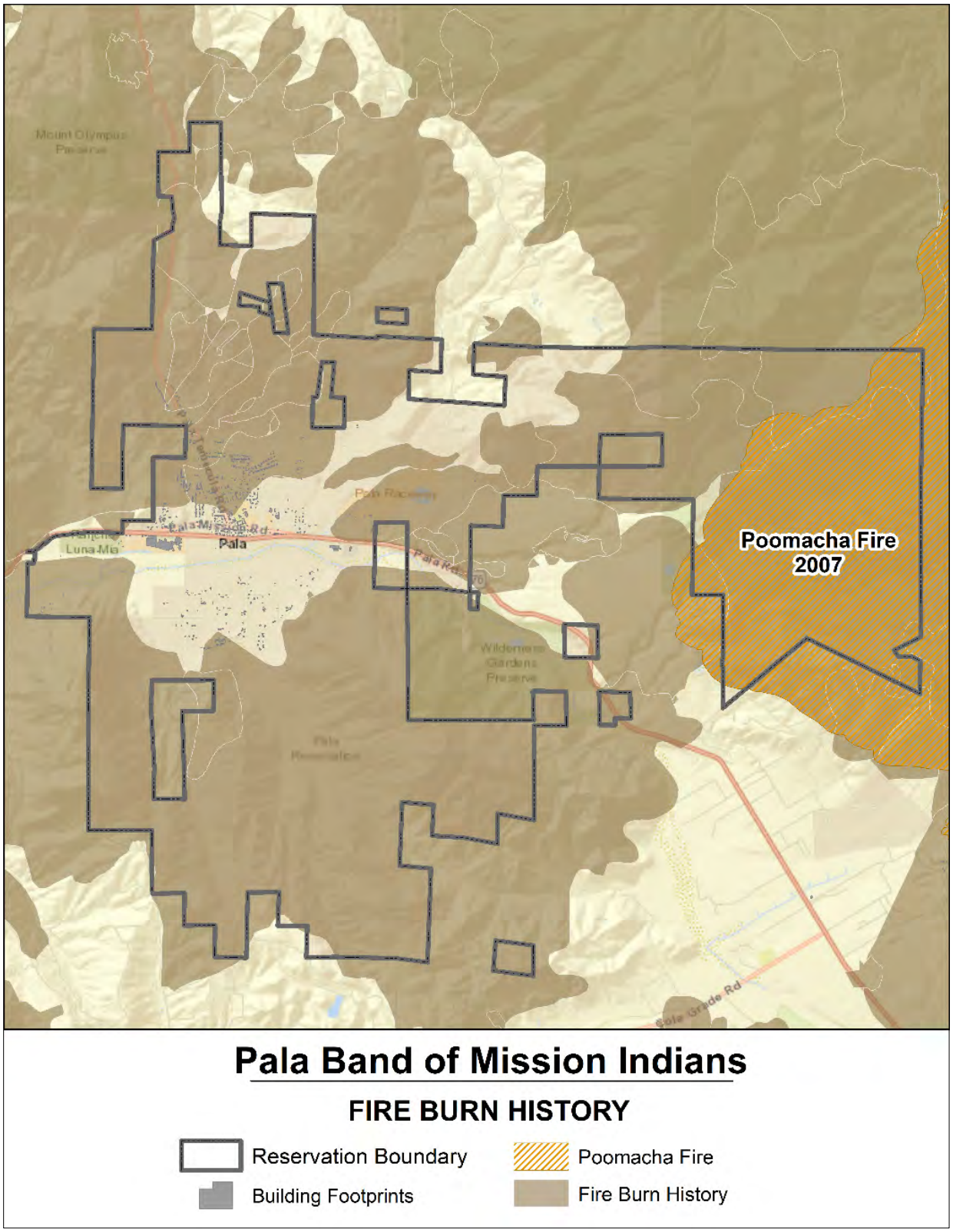

Figure 68. Pala Wildfire Burn History (SANDAG GIS Data).

Table 36. Historic Fires Impacting the Pala Band Reservation (1920-2019).

Date	Name	Total Costs	Details	Acres (GIS)	Cause
1910	-	$0	-	850	Miscellaneous
1914	-	$0	-	141	Unknown / Unidentified
1919	-	$0	-	301	Unknown / Unidentified
1919	-	$0	-	113	Unknown / Unidentified
1920	-	$0	-	918	Miscellaneous
1923	-	$0	-	399	Miscellaneous
1923	-	$0	-	530	Miscellaneous
1924	-	$0	-	690	Miscellaneous
1927	-	$0	-	1,364	Unknown / Unidentified
1931	-	$0	-	718	
1942	-	$0	-	295	Miscellaneous
1942	-	$0	-	1,260	Miscellaneous
1942	-		-	7,082	Unknown / Unidentified
1947	-	$0	-	7,082	Miscellaneous
9/3/1950	AGUA TIBIA	$0	-	225	Lightning
1951	-	$0	-	1,942	Miscellaneous
1953	-	$0	Fire burned approximately 4,000 acres on the reservation, threatening life and property and undoubtedly causing property damage.	115	Miscellaneous
1953	-	$0	-	9,226	Unknown / Unidentified
1953	Aqueduct	$0	-	1,007	Unknown / Unidentified
9/18/1958	PALA	$0	-	130	Miscellaneous
1962	-	$0	-	1,682	Miscellaneous
8/8/1968	MAGEE	$0	-	100	Miscellaneous
1970		$0	-	2,332	Miscellaneous
8/2/1970	MARION	$3,500	-	102	Arson
1970	-	$0	-	23	Miscellaneous
1970	-	$0	-	162	Miscellaneous

Date	Name	Total Costs	Details	Acres (GIS)	Cause
9/7/1970	SAND PLANT	$15,000	-	82	Arson
9/13/1980	PALA	$0	-	25	Equipment Use
7/19/1981	PALA #3	$0	-	106	Playing with fire
4/16/1984	FREY	$0		104	Miscellaneous
10/3/1987	PALOMAR	$2,800,000	Local Number 113	103	Debris
8/20/1997	PALA	$0	-	15,582	Unknown / Unidentified
7/29/2000	PECHANGA	$0	Burned approximately 1,000 Acres on the reservation.	458	Unknown / Unidentified
7/1/2004	WARNER	$0	Burned approximately 100 Acres on the reservation and threatened homes.	11,734	Equipment Use
7/5/2005	PAUMA	$0	-	570	Unknown / Unidentified
6/19/2006	LILAC	$0	-	65	Miscellaneous
10/23/2007	POOMACHA	$20,658,000	The Poomacha Wildfire burned 17% of the total reservation, all of which was outlying, remote, and uninhabited area.	15	Miscellaneous
6/23/2010	PALA 5	$0	-	49,411	Unknown / Unidentified
8/29/2011	PALA	$0	-	101	Powerline
TOTAL	-	$23,476,500	-	-	-

2007 Poomacha Fire

While the Rincon and La Jolla Reservations experienced major damage to structures, infrastructure, and subsequent economic impacts, the Pala Reservation experienced no direct damage to its assets. The Poomacha Wildfire burned about 17 percent of the total reservation area. The fire burned several thousand acres of outlying undeveloped land within the reservation boundary and on the Robert's Ranch Property (about 1,800 acres), owned by the tribe, resulting in significant environmental consequences. In all, approximately 2,230 acres of wild vegetation were burned on the northeastern edge of the reservation of which 1,240 acres were on the Robert's Ranch property. On the Robert's Ranch property, the fire threatened—but did not burn—several citrus orchards. There was also concern about landslides after the fire, but to date none have occurred. Finally, there were indirect impacts of

the fire on the community as residents were displaced for a several days due to a mandatory evacuation. About 400 Pala tribal members were first evacuated to the Pala Casino but later needed to be evacuated to the Pechanga Band of Luiseño Mission Indians (in Temecula). Evacuees were sent to homes of relatives, free hotel rooms, or RV spaces offered by the Pechanga Band of Luiseno Mission Indians.[149] As a result of the evacuation, the Pala Casino Resort & Spa was also closed, creating a significant economic impact on the Reservation.

In addition to the wildfire events noted in the table above, approximately 150 vegetation fires were reported on the Reservation in 2018 and 2019, according to tribal records.

No information on previous structural fires on the Reservation was available.

4.7.14.4 Extent

Extent can be determined by size. Large fires, spanning several square miles are possible in the area. Events in 1997 (Pala Wildfire), 2004 (Warner Wildfire), and 2010 (Pala 5 Wildfire) burned more than 10,000 acres on the reservation. The highest number of reported fires in a year that directly impacted the reservation was five fires in 1970, according to SANDAG fire reporting data. This was followed by three fires in 1942. Structures fires, which may be caused by wildfires, can destroy buildings, in the most severe cases burn multiple structures or results in injuries/fatalities.

4.7.14.5 Probability of Future Events

Fire data pulled from SANDAG GIS indicated 39 fires directly impacted the reservation between 1910 and 2019. On average, this results in a fire every 2-3 fires years on the Reservation. Santa Ana winds are strongest in September and October, which results in an increased risk for large fires. Structure fires may also occur at any time due to accidents, malfunctions, or arson. A probably of “likely” (between 10 and 90% annual chance) was assigned.

4.7.14.6 Vulnerability Assessment and Estimated Losses

It is assumed that all current and future buildings, critical facilities, cultural resources, and populations on the Pala Reservation are at risk from wildfire. The Pala Reservation and its assets are located in a valley climate, with vegetation characterized by shrubland and small trees. Some areas of the Reservation have steep slopes, which are particularly vulnerable to wildfires.

Wildfires can result in property damages, infrastructure damages (such as damaged power lines and utility poles), decreased air quality, injuries, and death. Areas that do not experience burning may still experience damages or injuries due to smoke. Fires also interrupt business, and/or result in road closures, impacting accessibility. Wildfires also interrupt business on the Pala Reservation which can

[149] Rahimi, Shadi. “Raging Wildfire Burning Up Southern California Reservation.” Indian County Today Media Network. Retrieved 1/28/15. Available at: http://indiancountrytodaymedianetwork.com/2007/10/26/raging-wildfires-burning-southern-california-reservations-91637

cause thousands of dollars in lost revenue. An event in recent years (exact date unknown) took out several AT&T lines, resulting in phone outages for several days and disrupted internet services for a month. Officials noted that it hampered the Tribe's ability to do business. In addition, the limited access in and out of the Reservation increases the danger to residents when wildfires are threatening the area.

It is assumed that very high fire risk exists on the Pala Reservation. Fire season in California was historically contained to summer and fall months. However, many cite that the season is becoming year-round, and there is agreement that the season has expanded. It is starting earlier, sometimes in April and ending later, often in late fall. This is largely due to earlier snow melt caused by rising temperatures and warmer summer temperatures. In general, wildfires in the western U.S. are increasing in size and frequency.[150] The severity of wildfires largely depends on fuel, weather, and terrain.

Fuel varies on the Reservation, but the primary sources are grasses and trees. Lighter fuels, such as grasses, tend to catch fire and spread fast. However, they are typically easier to contain than fires that have started to ignite larger fuel sources, such as trees. Tree mortality, due to drought and pest infestations, creates increased fuel for wildfires. Further, increased fuel potentially due to lack of wild or prescribed fire or down trees from wind events, can also impact wildfire severity. The weather can have a major influence on wildfire risk. Wind makes it very difficult to fight fires. Rain can work in the favor of fighting wildfires, helping to quell flames and moisten fuel sources. Terrain, including slopes and barrier features, can impact the spread of fire. Fire tends to move faster uphill. Barriers such as lakes and highways (e.g., Highway 76) can slow the spread of wildfires. Lastly, drought can impact the severity of wildfire and the ability to fight it.

Some areas or structures may be more vulnerable than others. Buildings that are not up to the California Uniform Building Code may be more vulnerable to wildfires. Building material and landscaping around the buildings can also impact vulnerability. For example, wood shakes can ignite quickly due to embers. Pine needles may also catch roofs on fire if there are blowing embers in the area. The vegetation around a structure can also impact risk. Keeping a buffer area of defensible space between vegetation and structures can decrease risk. In addition, there are proactive landscaping schemes that can be used in fire-prone areas, such as avoiding pine straw and mulch.

Burned areas are subject to increased erosion, resulting in the siltation of creeks, streams, and rivers. This can result in channel aggradation (wider, slower channels). Steeps slopes are also destabilized due to the burning of vegetation. Burned areas combined with heavy rain present a serious risk of landsliding and rockfalls. Highest risks areas are on or adjacent to steep slopes.

The tribe is determined to implement mitigation strategies to lessen the wildfire threat. They currently have a defensible space program (encouraging 100-feet of space) and their Insurance Service Office

[150]Dennison, P. E., S. C. Brewer, J. D. Arnold, and M. A. Moritz (2014), Large wildfire trends in the western United States, 1984–2011, Geophys. Res. Lett., 41, 2928–2933, doi:10.1002/2014GL059576. http://onlinelibrary.wiley.com/doi/10.1002/2014GL059576/abstract

rating has increased (a measure of wildfire suppression capability). They are clearing areas to further reduce the risk. Additional activities can be found in the Capability Assessment Chapter.

Perhaps the most at-risk areas are those that reside in the WUI areas. A GIS analysis using WUI data was used to determine the number of buildings and critical facilities WUI interface or intermix areas, which indicated a total of 693 buildings in WUI areas on the Pala Reservation. Combined, these buildings and their contents are valued at approximately $245 million. These structures are summarized in Table 37 and shown in Figure 69.

Table 37. Buildings in the WUI (Interface and Intermix) on the Pala Reservation.

Building Type	Number of Buildings	Building Value	Content Value	Total Value
Agricultural	5	$766,578	$766,578	$1,533,156
Commercial	145	$26,441,550	$26,441,550	$52,883,100
Educational	6	$2,500,861	$2,500,861	$5,001,721
Religious	6	$5,083,126	$5,083,126	$10,166,251
Residential	530	$116,959,607	$58,479,803	$175,439,410
Other	1	$29,579	$44,369	$73,948
TOTAL	**693**	**$151,751,722**	**$93,271,918**	**$245,023,640**

Forty-five of the Tribe's 66 critical facilities are WUI areas. Table 38 lists these critical facilities and their associated values. Figure 70 shows Pala Reservation critical facilities within WUI areas. These include the Pala Administration Building and Pala Fitness Center which are typically used for community evacuation shelters. Additionally, the tribe is trying to maintain 100 feet of defensible space around the Pala Casino Resort & Spa but there are currently trees growing in the San Luis Rey River floodway. The trees cannot be cut down due to a protected species in the area.

Table 38. Critical Facilities in Liquefaction Risk Areas on the Pala Reservation.

Critical Facility Name	Building Value	Content Value	Total Value
Allers Lift Station	N/A	N/A	N/A
Blacktooth House (Historical Property)	N/A	N/A	N/A
Casino Lift Station	N/A	N/A	N/A
Casino Well #1	N/A	N/A	N/A
Casino Well #2	N/A	N/A	N/A
Cellular Communications Tower	N/A	N/A	N/A
Duker Grove (oranges)	N/A	N/A	N/A
Fire Station Well (North)	N/A	N/A	N/A
Hanson Pond Conservation Easement	N/A	N/A	N/A
KOPA Radio Station	$359,091	$167,707	$526,798
Lilac East Well (South)	N/A	N/A	N/A
Lilac West Well (South)	N/A	N/A	N/A
McCament Grove (oranges)	N/A	N/A	N/A

Critical Facility Name	Building Value	Content Value	Total Value
Mission San Antonio de Pala	N/A	N/A	N/A
Oaks Booster Station (North)	N/A	N/A	N/A
Old Tribal Hall	$834,244	$39,667	$873,911
Pala (Fox) Raceway	$0	$29,797	$29,797
Pala Administration Building	$6,938,838	$1,263,309	$8,202,147
Pala Child Care Center	$1,264,276	$51,020	$1,315,296
Pala Cultural Center	$854,982	$53,080	$908,062
Pala EOC and Training Center	$9,934,554	$2,051,973	$11,986,527
Pala Fire Station	$2,063,327	$76,760	$2,140,087
Pala Fitness Center	$4,202,988	$366,176	$4,569,164
Pala Fleet Department/Yard	$266,689	$3,473,147	$3,739,836
Pala Learning Center and Library	$1,869,694	$308,808	$2,178,502
Pala Postal Annex	$245,046	$61,616	$306,662
Pala Shooting Range	N/A	N/A	N/A
Pala Skatepark	$105,019	$123,996	$229,015
Pala Social Services Office	N/A	N/A	N/A
Pala Tribal Law Enforcement	$418,848	$61,030	$479,878
Pala Tribal Services Department/Yard	$620,433	$84,499	$704,932
Pala Utilities Department/Yard	$1,054,022	$287,938	$1,341,960
Pala Youth Center	$1,264,276	$24,412	$1,288,688
Riverbed East Well (South, new)	N/A	N/A	N/A
Riverbed West Well (South, west)	N/A	N/A	N/A
San Juan Diego Center	N/A	N/A	N/A
TANF (Tribal Assistance for Needy Families) and TDV (Tribal Digital Village)	N/A	N/A	N/A
Trujillo Creek Well (North)	N/A	N/A	N/A
Valenzuela Well (South)	N/A	N/A	N/A
Vineyard Well (Raceway)	N/A	N/A	N/A
Vivian Banks Charter School	N/A	N/A	N/A
Water Tank, Northeast Tank #1 (North)	N/A	N/A	N/A
Water Tank, Northeast Tank #2 (North)	N/A	N/A	N/A
Water Tank, Northwest Tank #3 (North)	N/A	N/A	N/A
Water Tank, Raceway (Raceway)	N/A	N/A	N/A
TOTAL	**$ 32,296,327**	**$ 8,524,935**	**$ 40,821,262**

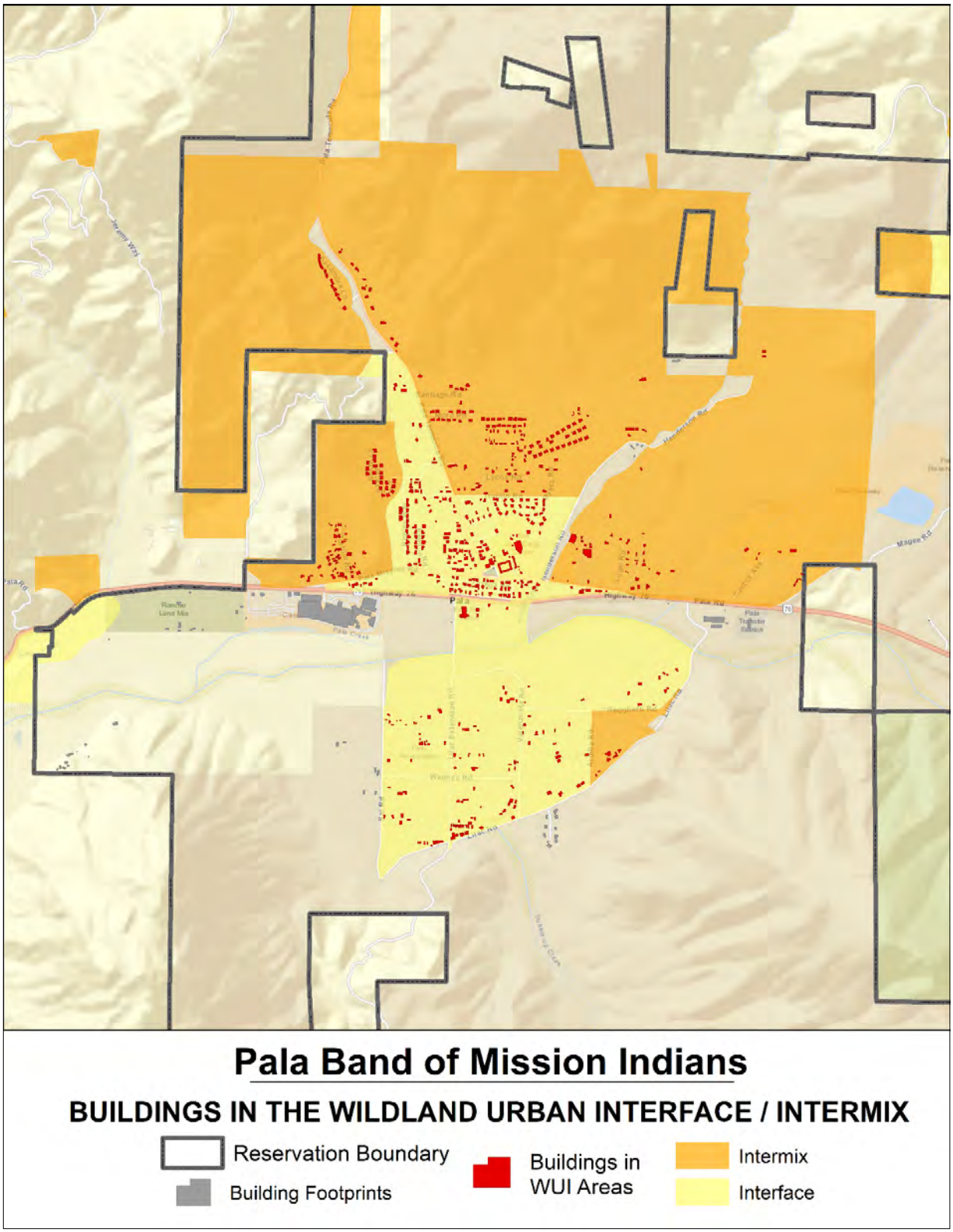

Figure 69. Pala Buildings in the Wildland Urban Interface or Intermix.

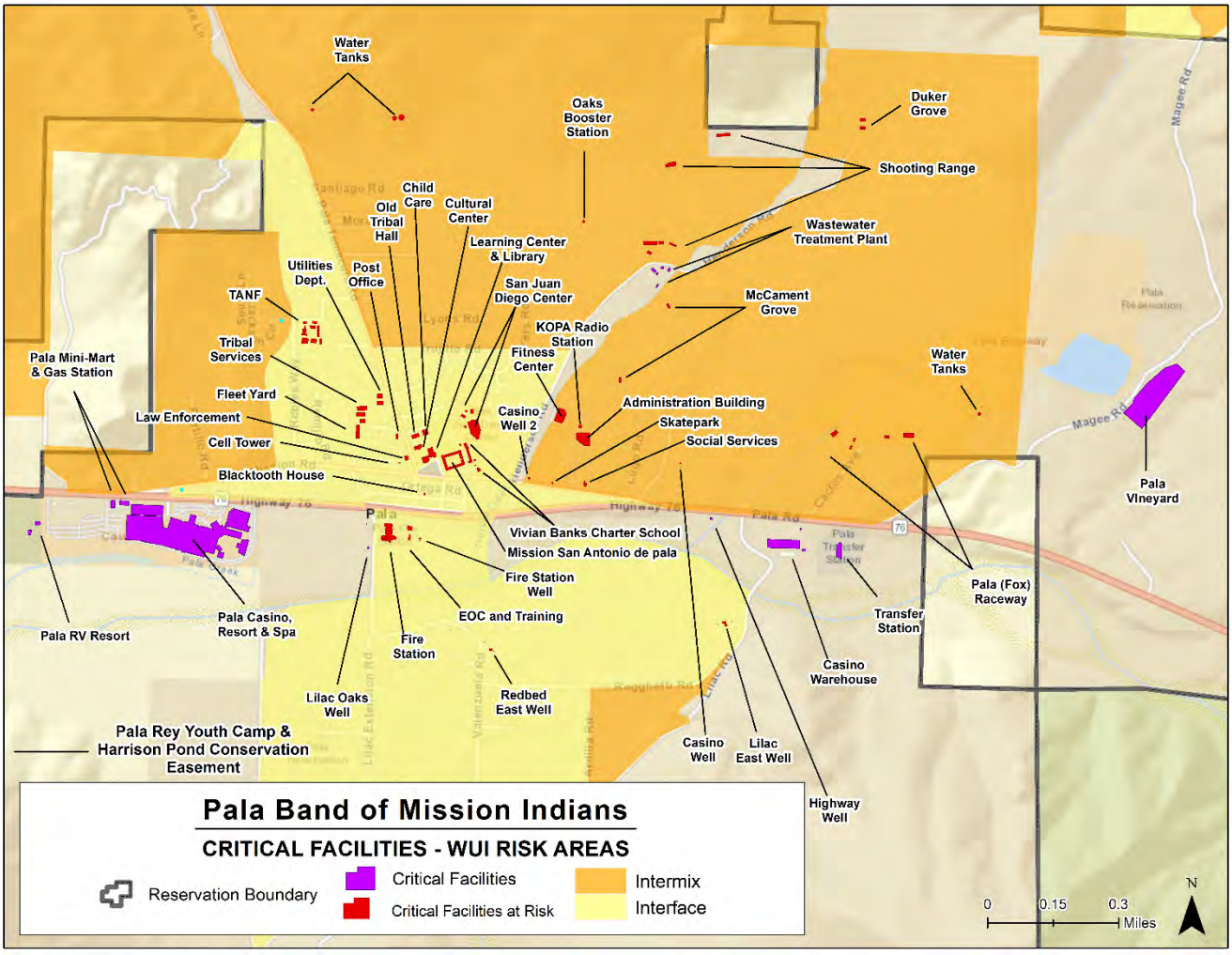

Figure 70. Critical Facilities and the Wildland Urban Interface/Intermix.

Estimated Losses

No direct losses have been reported for this hazard. However, given major fires, it is assumed that some losses may have occurred. Further, indirect losses, such as economic losses due to Reservation evacuation or downed communication infrastructure (phones, internet) are also possible and have occurred in the past. Evacuations off of the Reservation have been necessary in the past but typically residents can shelter in place. The potential for wildfire and damage puts all current and future buildings, populations, and critical facilities at risk.

Climate Change Impacts

Climate change can be expected to increase wildfire frequency and severity on the Pala Reservation. Warmer temperatures cause drought conditions by reducing soil moisture, which in turn is conducive to wildfires. Average maximum temperatures on the Reservation are projected to increase (Figure 42 located in the *Extreme Heat* hazard profile, shows the projected increase in average maximum

temperatures on the Reservation under different emissions scenarios and timelines.) Generally, increased rainfall associated with climate change can increase the amount of vegetation, and therefore the amount of fuel for wildfires. However, climate projects show little change in precipitation for the Pala Reservation under either high or low emissions scenarios.

4.7.15 Dam Failure (redact for public consumption)

4.7.15.1 Description

A dam is an artificial barrier constructed across a stream channel or a man-made basin for the purpose of storing, controlling, or diverting water. Dams are typically constructed of earth, rock, concrete, or mine tailings. The area directly behind the dam where water is impounded or stored is referred to as a reservoir.

A dam failure is the partial or total collapse, breach, or other failure of a dam that causes flooding downstream. Dam failures can result from natural events, such as a flood, earthquake, or landslide; human-induced events, such as improper maintenance; or a combination of both. In the event of a dam failure, the people, property and infrastructure downstream could be subject to devastating damage.

Dam failures can result from one or more of the following:

- Prolonged periods of rainfall and flooding (the cause of most failures)
- Inadequate spillway capacity, resulting in excess flow overtopping the dam
- Internal erosion caused by embankment or foundation leakage
- Improper maintenance, including failure to remove trees; repair internal seepage problems; maintain gates, valves, and other operational components, etc.
- Improper design, including use of improper construction materials and practices
- Negligent operation, including failure to remove or open gates or valves during high flow periods
- Failure of an upstream dam on the same waterway
- Landslides into reservoirs, which cause surges that result in water overtopping the dam
- High winds, which can cause significant wave action and result in substantial erosion
- Earthquakes, which can cause longitudinal cracks at the tops of embankments that can weaken entire structures

4.7.15.2 Location

The Lake Henshaw Dam is the only dam that could impact the Pala Reservation if breached. It is located southeast of the Reservation along the San Luis Rey River (also known as Quechla) near Warner Springs. The Lake Henshaw Dam was built in 1922 to a height of 123 feet (Figure 71).

Originally constructed to hold 200,000 acre-feet of water, the Lake Henshaw Dam is maintained at levels below 50,000 acre-feet of water due to concern of a breach during an earthquake. Despite the lower

water capacity, dam inundation data indicates a failure would impact the Pala Reservation, as shown in Figure 72**.**

Figure 71. Lake Henshaw Dam in 1932. [151]

[151] Temecula Historical Society (2011). *An Early Area Water Project.* Retrieved from http://www.temeculahistoricalsociety.org/publications/TVHS-News/2007%20thru%202012/2011-06_TVHS_Newsletter.pdf.

Figure 72. Lake Henshaw Dam and Inundation Area.

4.7.15.3 Previous Occurrences

A 1971 study by the California Division of Dam Safety deemed the Lake Henshaw Dam prone to failure in the event of seismic activity.[152] Given the known risk, forced water releases ensued, which caused a loss of more than $3 million in 1978 and 1979. Today, the dam functions at less than 40% capacity because it lies adjacent to the Elsinore Fault System. A reinforced flow suppression structure was built immediately downstream from the existing dam, though risk still exists as is evident in the inundation boundaries.[153]

4.7.15.4 Extent

The extent of dam failure is infeasible to determine given minimal historic incidents and limited details associated with the historic events. However, failure of the Lake Henshaw would have catastrophic impacts on the Pala Reservation.

4.7.15.5 Probability of Future Events

The probability of dam failure in normal conditions is low. However, an earthquake on the Elsinore Fault system would greatly increase the risk of failure. Therefore, probability may be associated with earthquake risk. Given there is no history of an unplanned release at the dam, and the probability assigned to the earthquake hazard, the probability assigned the dam failure was “possible” (1% to 10% annual chance).

4.7.15.6 Vulnerability Assessment and Estimated Losses

All current and future buildings, critical facilities, cultural resources, and populations in dam inundation areas are considered at risk from dam failure on the Pala Reservation.

A GIS analysis was performed using dam inundation data from SANDAG to determine the number of buildings and critical facilities at risk to dam failure, which indicated a total of 152 buildings at risk to flood on the Pala Reservation. Combined, these buildings and their contents are valued at approximately $170 million. These structures are summarized in Table 39 and shown in Figure 73**.**

Table 39. Buildings in the Lake Henshaw Dam Inundation Area on the Pala Reservation.

Building Type	Number of Buildings	Building Value	Content Value	Total Value
Commercial	61	$71,906,761	$71,906,761	$143,813,522
Residential	90	$17,565,723	$8,782,862	$26,348,585
Other	1	$65,982	$98,973	$164,956
TOTAL	**152**	**$89,538,466**	**$80,788,596**	**$170,327,063**

[152] National Park Service. “A History of American Indians in California, Quechla.” http://www.cr.nps.gov/history/online_books/5views/5views1h67.htm

[153]Temecula Historical Society (2011). An Early Area Water Project. Retrieved from http://www.temeculahistoricalsociety.org/publications/TVHS-News/2007%20thru%202012/2011-06_TVHS_Newsletter.pdf.

Twenty-four of the Tribe's 66 critical facilities are the Lake Henshaw Dam inundation area. Table 40 lists these critical facilities and their associated values. Figure 74 shows Pala Reservation critical facilities within dam inundation areas.

Table 40. Critical Facilities in Dam Inundation Areas on the Pala Reservation.

Critical Facility Name	Building Value	Content Value	Total Value
Casino Lift Station	N/A	N/A	N/A
Catalina Fields (alfalfa)	N/A	N/A	N/A
Catalina Well (North)	N/A	N/A	N/A
Fallbrook Propane (Rental)	N/A	N/A	N/A
Fire Station Lift Station	$1,369,923	$0	$1,369,923
Fire Station Well (North)	N/A	N/A	N/A
Hanson Pond Conservation Easement	N/A	N/A	N/A
Lilac East Well (South)	N/A	N/A	N/A
Lilac West Well (South)	N/A	N/A	N/A
Oaks Lilac Well (North)	N/A	N/A	N/A
Pala Casino Warehouse	$2,645,110	$235,704	$2,880,814
Pala Casino, Resort and Spa	$265,726,548	$66,895,614	$332,622,162
Pala EOC and Training Center	$9,934,554	$2,051,973	$11,986,527
Pala Fire Station	$2,063,327	$76,760	$2,140,087
Pala Gateway (oranges)	N/A	N/A	N/A
Pala Mini Mart, Gas Station and Canopies	$2,663,643	$538,519	$3,202,162
Pala Rey Youth Camp	N/A	N/A	N/A
Pala RV Resort	$1,963,683	$216,718	$2,180,401
Pala Transfer Station	$1,263,678	$118,091	$1,381,769
Rancho Luna Mia (animal husbandry)	$541,409	$0	$541,409
Riverbed East Well (South, new)	N/A	N/A	N/A
Riverbed West Well (South, west)	N/A	N/A	N/A
Trujillo Creek Well (North)	N/A	N/A	N/A
Valenzuela Well (South)	N/A	N/A	N/A
Total	**$288,171,875**	**$70,133,379**	**$358,305,254**

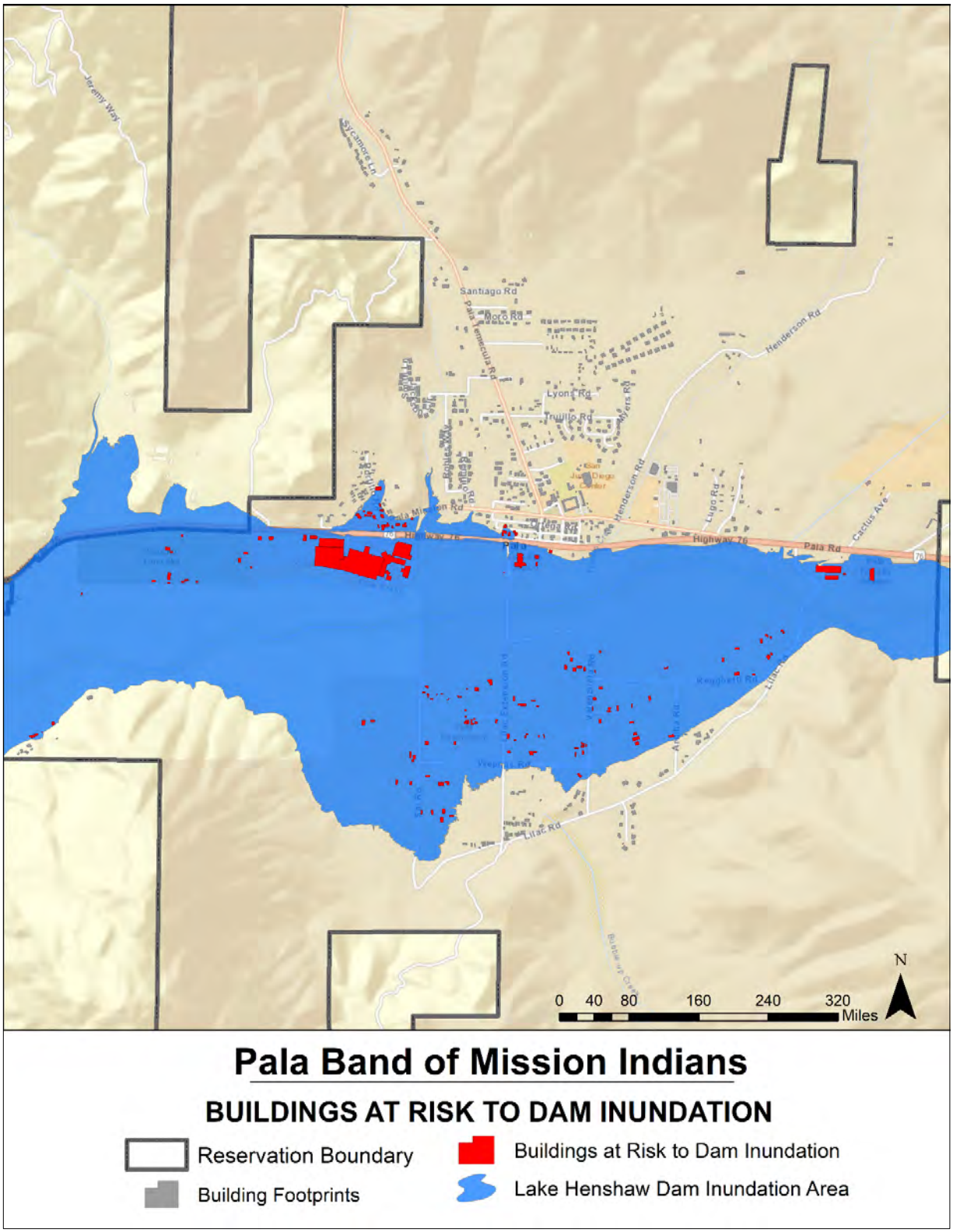

Figure 73. Pala Buildings in the Lake Henshaw Dam Inundation Area.

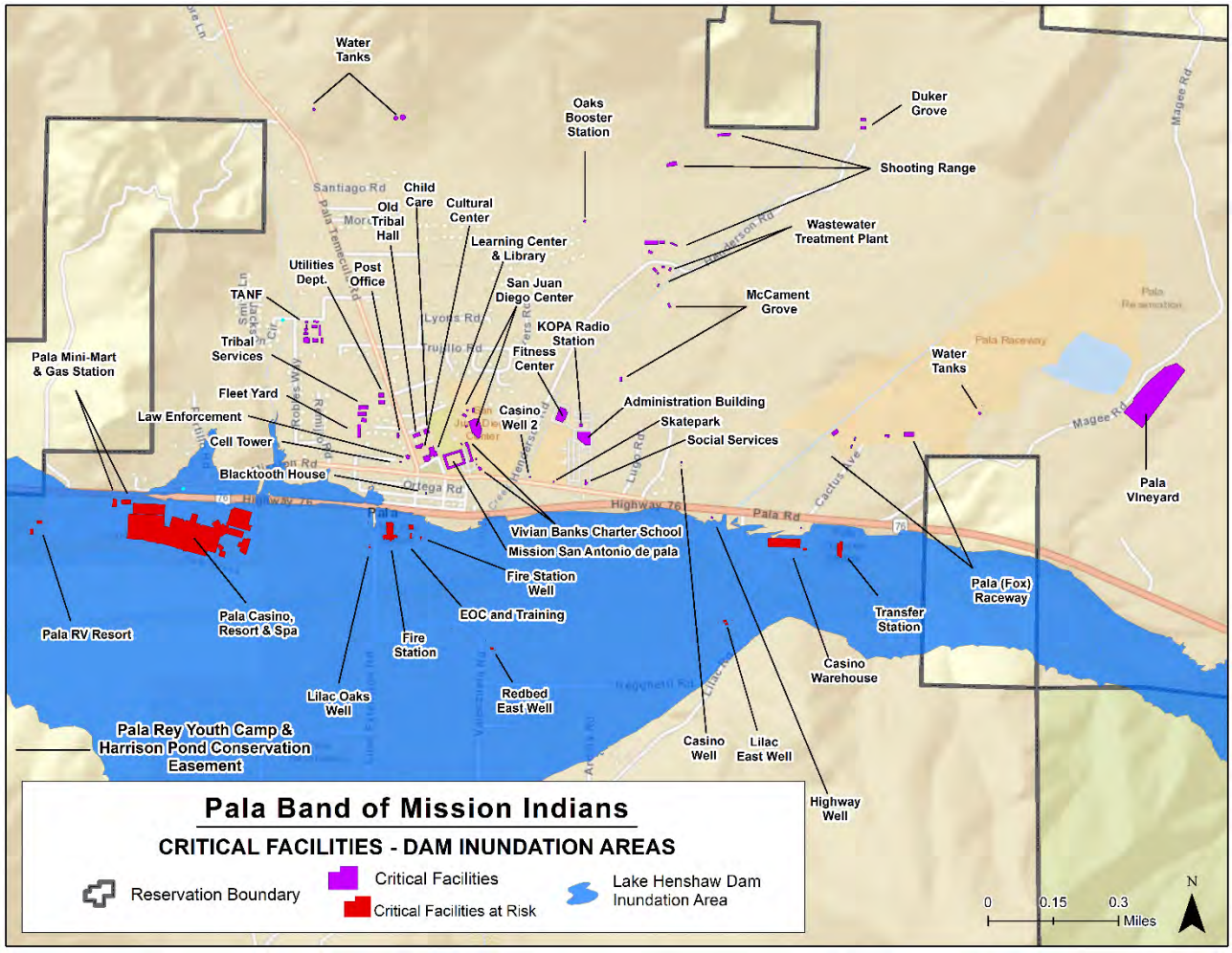

Figure 74. Pala Critical Facilities in the Lake Henshaw Dam Inundation Area.

Estimated Losses

Without a history of losses, it is difficult to determine a reliable loss estimate. A single event, particularly with the number of buildings and types of buildings at risk (such as the Pala Casino, Resort & Spa) could easily exceed millions of dollars in direct damages, with millions more in indirect damages due to business interruption and displacement of the population. However, given the low frequency of an event, losses would likely be negligible overtime.

Climate Change Impacts

Climate change is not expected to have a significant impact on the dam failure hazard. While some models predict precipitation events to become heavier in the future (little change overall, with wetter wet periods and drier dry periods), the Lake Henshaw dam is only filled to 40% capacity and heavy rainfall alone is unlikely to cause a failure. The Lake Henshaw Dam is vulnerable to seismic events in terms of failure, however little is known about the impact of climate change, if any, on earthquakes and seismic events.

4.7.16 Hazardous Materials Incident (HazMat)

4.7.16.1 Description

Hazardous materials can be found in many forms and quantities that can potentially cause death, serious injury, long-lasting health effects, and damage to buildings, homes, and other property in varying degrees. Such materials are routinely used and stored in many homes and businesses, and are also shipped daily on the nation's highways, railroads, waterways, and pipelines. This subsection on hazardous material is intended to provide a general overview of the hazard. The threshold for identifying fixed and mobile sources of hazardous materials is limited to general information on rail, highway, and local and FEMA-identified fixed HAZMAT sites determined to be of greatest significance as appropriate for the purposes of this plan.

Hazardous material (HAZMAT) incidents can apply to fixed facilities as well as mobile, transportation-related accidents in the air, by rail, on the nation's highways, and on the water. Approximately 6,774 HAZMAT events occur each year, of which 5,517 are highway incidents, 991 are railroad incidents, and 266 are due to other causes.[154] In essence, HAZMAT incidents consist of solid, liquid, and/or gaseous contaminants that are released from fixed or mobile containers, whether by accident or by design (as with an intentional terrorist attack). A HAZMAT incident can last hours to days, while some chemicals can be corrosive or otherwise damaging over longer periods of time. In addition to the primary release, explosions and/or fires can result from a release, and contaminants can extend beyond the initial area by persons, vehicles, water, wind, and possibly wildlife as well.

HAZMAT incidents can also occur as a result of or in tandem with natural hazard events, such as floods, hurricanes, tornadoes, and earthquakes, which, in addition to causing incidents, can also hinder response efforts. In the case of Hurricane Floyd in September 1999, communities along the Eastern United States were faced with flooded junkyards, disturbed cemeteries, deceased livestock, floating propane tanks, uncontrolled fertilizer spills, and a variety of other environmental pollutants that caused widespread toxological concern. Wildfires, too, create a tremendous amount of toxic waste that must be removed following the event, in addition to emissions that impact air quality.

Hazardous material incidents can include the spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment of a hazardous material, but exclude: (1) any release which results in exposure to poisons solely within the workplace, with respect to claims which such persons may assert against the employer of such persons; (2) emissions from the engine exhaust of a motor vehicle, rolling stock, aircraft, vessel, or pipeline pumping station engine; (3) release of source, byproduct, or special nuclear material from a nuclear incident; and (4) the normal application of fertilizer.

[154] Technological Hazards (1997). Chapter 22 Hazardous Materials Events. FEMA. Retrieved from https://www.fema.gov/media-library-data/20130726-1545-20490-2423/mhira_te.pdf.

4.7.16.2 Location

The location of hazardous materials incidents can impact the entire Reservation but is largely dependent on the location of the hazardous materials source, type of event and weather conditions. For example, a propane tank failure is most likely to impact the immediate area but could have greater impacts if the water supply is contaminated. The impact area for transportation incidents is dependent on the chemical. A gas release could easily travel through the air. Weather events, such as high wind, could exacerbate the speed of the spread.

According to the U.S. Department of Transportation's National Pipeline Mapping System, there are no pipelines on or adjacent to the Pala Reservation. The closest pipeline is a gas transmission pipeline that along Rice Canyon Road, approximately 2 miles west of the Reservation.[155]

Similarly, the National Hazard Materials Route Registry was used to determine if hazardous materials are transported through the Pala Reservation. The area the Reservation is located in is classified as an area where transportation of hazardous materials is restricted to pickup and delivery of commodities (via the shortest-distance route). The closest road to the Reservation that is classified for the transport of hazardous materials in Interstate 15, approximately four miles west of the Reservation, which is classified for Non-Radioactive Hazardous Materials (NRHM).[156] Highway 76 also runs through the Reservation, but is not designated for the transport of hazardous materials.

Further, as a result of the 1986 Emergency Planning and Community Right to Know Act (EPCRA), the Environmental Protection Agency provides public information on hazardous materials. One facet of this program collects information from industrial facilities on the releases and transfers of certain toxic agents. This information is then reported in the Toxic Release Inventory (TRI). TRI sites indicate where such activity is occurring. There are no TRI sites located on or adjacent to the Pala Reservation.

However, other sources of hazardous materials have the potential to impact the Pala Reservation. With regards to propane tanks, the entire Reservation is fueled by propane as there are no gas utility lines to the area. Three 30,000 capacity tanks to the east belong to Fallbrook Propane, the company that supplies all the propane on the Reservation. Two 30,000 capacity tanks to the west provide storage for propane that supplies the Pala Casino Resort & Spa. In addition, two 1,150 capacity tanks supply the admin building, gym, and wastewater treatment plant. Fallbrook Propane assures the tribe all their tanks have safeguards that exceed code. The figure below shows the propane tanks on the west side of the Pala Reservation.

[155] National Pipeline Management System Public Viewer. USDOT. Retrieved from https://pvnpms.phmsa.dot.gov/PublicViewer/.
[156] Federal Motor Carrier safety Administration (FMCSA) National Hazardous Material Materials Route Registry. USDOT. Retrieved from https://www.fmcsa.dot.gov/regulations/hazardous-materials/national-hazardous-materials-route-registry-state.

Figure 75. Propane Tanks on Pala Reservation.

4.7.16.3 Previous Occurrences

The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration Office's Hazardous Material Safety Incident Reports Database was researched but no previous occurrences were reported for mobile incidents for the zip code the Pala Reservation is within (92059). Tribal officials did not report any additional incidents.

4.7.16.4 Extent

The extent of hazardous materials incidents on the Reservation is difficult to determine without reports of previous incidents. A hazardous materials incident may result in death or injury of population, damage to structure, or contamination of water supply. Residents may also be required to evacuation an area or shelter in place.

4.7.16.5 Probability of Future Events

Since there are no reports of previous occurrences, determining a probability based on past events is not feasible. However, the presence of propane storage tanks with hazardous materials and possibility

of mobile incidents given proximity to Highway 76 indicates that an event could happen in the future. Therefore, a probability of "possible" (1% to 10% annual chance) was assigned to this hazard.

4.7.16.6 Vulnerability Assessment and Estimated Losses

All current and future buildings, critical facilities, cultural resources, and populations are considered at risk from hazardous materials incidents on the Pala Reservation. Most hazardous materials incidents are contained and suppressed before destroying property or threatening lives. However, they can have a significant negative impact. Such events can cause deaths or injuries, or result in the closing of roadways, buildings, or facilities. In a hazardous materials incident, solid, liquid, and/or gaseous contaminants may be released from fixed or mobile containers. Weather conditions will directly affect how the hazard develops. Certain chemicals may travel through the air or water, affecting a much larger area than the point of the incidence itself. Released chemicals can spontaneously combust and start fires. They can also leach into soil and groundwater, run off into water, and disburse into the air. Leeched chemicals present a public health hazard, as exposure can result in immediate or long-term health effects.

Non-compliance with fire and building codes, as well as failure to maintain existing fire and containment features, can substantially increase the damage from a hazardous materials release. The duration of a hazardous materials incident can range from hours to days. Warning time is minimal to none.

In addition, the Reservation may be indirectly affected by hazardous materials incidents on Interstate 15, which could impede access to the Reservation (or cause lengthy detours or delays) and result in business interruptions.

Estimated Losses

Future losses are possible but difficult to estimate. Potential losses vary greatly based on type of event and extent of impact. For example, an event that impacted water supplies could easily cost millions and will impact businesses. Conversely, a HAZMAT spill that is quickly contained may cost a few thousand for cleanup supplies and labor. Annualizing these losses overtime, however, would likely result in negligible losses per year on the Reservation.

Climate Change

There are no known direct impacts of climate change on hazardous materials incidents. More frequent flood and wildfire events, which can cause hazardous materials releases, may cause can increase in hazardous materials incidents in the future.

4.7.17 Lifeline Incident (Power Outage)

4.7.17.1 Description

An adequate supply of power is critical for the Pala Band to maintain its daily processes and functions. Electric power outages occur when the reliable, uninterrupted supply of power to all or part of the reservation is disrupted, causing detriment to the reservation's economic and social well-being. According to the 2018 California State Hazard Mitigation Plan, power outages can be intentional or unintentional. Intentional outages include:

- *Planned:* Scheduled outages for maintenance or upgrading;
- *Unscheduled:* Outages conducted in response to an emergency;
- *Demand-side Management*: Outages occurring when a customer has entered into an agreement with the supplier to curtail their demand during peak system usage; and
- *Load Shedding*: An outage occurring when the power system is under extreme stress due to heavy demand, so service to some customers is disrupted to prevent the entire system from collapsing (i.e., rolling blackouts)

Unintentional power outages occur with little to no advance notice. Types of unintentional outages include:

- An accident by the utility or its contractors;
- Malfunction or equipment failure;
- Equipment overload;
- Reduced capability (equipment that cannot operate within its design criteria);
- Vandalism or sabotage;
- Weather, including lightning, wind, earthquakes, flood, and broken tree limbs downing power lines); and
- Wildfires that damage transmission lines

4.7.17.2 Location

It is assumed that the entire Pala Reservation is exposed to power outages. Buildings without solar power or backup generators are more likely to be impacted by power outages.

4.7.17.3 Previous Occurrences

The Pala Band of Mission Indians has experienced numerous routine power outages over the years, but detailed records of these incidents were not recorded. Power outages have been both planned and unintentional.

4.7.17.4 Extent

Without detailed records of major outages on the Reservation, the severity of power outages is difficult to determine. While most outages last a few hours, they can last for several days. Power outages are of particular concern during extreme heat or extreme cold events, and for those requiring powered medical devices, all of which increase the severity of power outages.

4.7.17.5 Probability of Future Events

Power outages are an annual occurrence on the Pala reservation, as they are in most places. An outage of just a few hours can have a substantial impact on the reservation, especially in the summer months when temperatures are high. Therefore, the probability assigned to this hazard is "highly likely" (90 percent or greater annual chance).

4.7.17.6 Vulnerability Assessment and Estimation of Losses

All current and future buildings (including critical facilities), infrastructure, and populations are potentially at risk to power outages. Power outages on the Reservation can be caused by several other hazards, including lightning, wind, flood, fire, and earthquakes. Outages can also be caused by motor vehicle accidents, such as a vehicle hitting a substation.

Power outages are a major concern during warm weather months, especially for vulnerable populations such as young children and the elderly. Outages can also have impacts to tribal members, such as the economic cost of spoiled food or impacts to those with medical equipment.

In addition, the Tribe's water tanks require power and currently do not have generators, meaning a power outage can impact the Tribe's ability to access potable water. This not only impacts the residents, it can impacts those at the Casino, creating an economic ripple effect.

Many buildings are outfitted with backup power (i.e., generators). However, many structures, including some critical facilities, are not yet equipped with backup power, leaving the Tribe vulnerable to power outages. For example, the Casino Hotel, which is a muster point/shelter location for several types of hazards does not have backup power for its air conditioning system. Therefore, using the Hotel as a shelter during summer months may not be feasible if temperatures are high.

Estimated Losses

It is difficult to determine an exact annualized loss value for the Pala Reservation and its assets without detailed historic data, but losses would likely be negligible over time.

Climate Change Impacts

As the climate changes, hotter temperatures on the reservation will lead to more demand for electrical power to run air conditioning, placing more demand and stress on the power system. Further, hotter

temperatures and more frequency high heat days mean that an outage is more likely to have an adverse impact, including heat-related conditions (e.g., heat stroke) or requiring closing and evacuations.

4.8 Summary of Overall Risk

> *Requirement 201.7(c)(2)(ii): A description of the Indian tribal government's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the tribe.*

This section summarizes overall vulnerability by looking at several measures including overall risk to critical facilities, PRI and a ranking of hazards, and key points on vulnerability.

4.8.1 Critical Facility Analysis

All critical facilities are assumed to be at risk to air pollution, agricultural pests (agricultural holdings), drought, lightning, earthquake, epidemic/pandemic, erosion, extreme heat, extreme freeze, high winds, landslide, tornado, wildfire, HAZMAT, and lifeline incidents. Limited structural damage is expected from air pollution, agricultural pests, drought, epidemic/pandemic, and extreme temperatures. The table below shows critical facility exposure to hazards with defined boundaries including dam failure, liquefaction, flood, and wildfire.

Table 41. Critical Facility Potential Risk Analysis.

Name	Dam Failure	Liquefaction	Flood (100-year)	Wildfire (WUI)
Allers Lift Station		X		X
Avocado Groves (avocados)				
Blacktooth House (Historical Property)		X		X
Casino Lift Station	X	X		X
Casino Well #1		X		X
Casino Well #2		X		X
Catalina Fields (alfalfa)	X	X	X	
Catalina Well (North)	X	X	X	
Cellular Communications Tower		X		X
Duker Grove (oranges)		X		X
Fallbrook Propane (Rental)	X	X		
Fire Station Lift Station	X	X		
Fire Station Well (North)	X	X	X	X
Hanson Pond Conservation Easement	X	X	X	X

Name	Dam Failure	Liquefaction	Flood (100-year)	Wildfire (WUI)
Highway Well		X		
KOPA Radio Station		X		X
Lilac East Well (South)	X	X		X
Lilac West Well (South)	X	X		X
McCament Grove (oranges)		X		X
Mission San Antonio de Pala		X		X
Oaks Booster Station (North)		X		X
Oaks Lilac Well (North)	X	X		
Old Tribal Hall		X		X
Pala (Fox) Raceway		X		X
Pala Administration Building		X		X
Pala Casino Warehouse	X	X		
Pala Casino, Resort and Spa	X	X	X	
Pala Child Care Center		X		X
Pala Cultural Center		X		X
Pala EOC and Training Center	X	X	X	X
Pala Fire Station	X	X	X	X
Pala Fitness Center		X		X
Pala Fleet Department/Yard		X		X
Pala Gateway (oranges)	X	X	X	
Pala Learning Center and Library		X		X
Pala Mini Mart, Gas Station and Canopies	X	X		
Pala Postal Annex		X		X
Pala Rey Youth Camp	X	X		
Pala RV Resort	X	X		
Pala Shooting Range		X		X
Pala Skatepark		X		X
Pala Social Services Office		X		X
Pala Transfer Station	X	X		
Pala Tribal Law Enforcement		X		X
Pala Tribal Services Department/Yard		X		X
Pala Utilities Department/Yard		X		X
Pala Vineyard (grapes)		X		
Pala Wastewater Treatment Plant		X		
Pala Youth Center		X		X

Name	Dam Failure	Liquefaction	Flood (100-year)	Wildfire (WUI)
Rancho Luna Mia (animal husbandry)	X	X	X	
Riverbed East Well (South, new)	X	X	X	X
Riverbed West Well (South, west)	X	X	X	X
Robert's Ranch (oranges)		X		
San Juan Diego Center		X		X
TANF (Tribal Assistance for Needy Families) and TDV (Tribal Digital Village)		X		X
Trujillo Creek Well (North)	X	X		X
Valenzuela Well (South)	X	X	X	X
Vineyard Well (Raceway)		X		X
Vista Well (North)		X		
Vivian Banks Charter School		X		X
Water Tank, Northeast Tank #1 (North)		X		X
Water Tank, Northeast Tank #2 (North)		X		X
Water Tank, Northwest Tank #3 (North)		X		X
Water Tank, Raceway (Raceway)		X		X
Water Tank, Southside Tanks #2 (South)				
Water Tank, Southside Tanks #3 (South)				

4.8.2 Priority Risk Index Results

The PRI results are presented in the table below, in alphabetical order by hazard.

Table 42. Summary of PRI Results for Pala Band of Mission Indians.

Hazard	Category/Degree of Risk					
	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Air Pollution	Highly Likely	Minor	Large	More than 24 hours	Less than one week	**2.7**
Agricultural Pests and Diseases	Highly Likely	Limited	Small	More than 24 hours	More than 1 week	**2.7**
Drought	Highly Likely	Minor	Large	More than 24 hours	More than 1 week	**2.8**
Earthquake and Liquefaction	Possible	Catastrophic	Large	Less than 6 hours	Less than 6 hours	**3.1**
Epidemic/Pandemic	Likely	Limited	Large	More than 24 hours	More than 1 week	**2.8**
Erosion	Highly Likely	Minor	Small	More than 24 hours	More than 1 week	**2.6**
Extreme Freeze	Possible	Minor	Negligible	More than 24 hours	Less than 24 hours	**1.4**
Extreme Heat	Highly Likely	Minor	Large	6 to 12 hours	Less than one week	**2.9**
Flood	Highly Likely	Critical	Moderate	Less than 6 hours	Less than 24 hours	**3.3**
High Wind	Highly Likely	Limited	Moderate	More than 24 hours	Less than 24 hours	**2.7**
Landslide	Possible	Minor	Small	Less than 6 hours	Less than 6 hours	**1.8**
Lightning	Possible	Minor	Negligible	Less than 6 hours	Less than 6 hours	**1.6**
Tornado	Possible	Minor	Small	Less than 6 hours	Less than 6 hours	**1.8**
Wildfire and Structural Fire	Likely	Critical	Moderate	6 to 12 hours	Less than one week	**3**
Dam Failure	Possible	Catastrophic	Large	Less than 6 hours	Less than one week	**3.3**
Hazardous Materials Incident	Possible	Minor	Negligible	Less than 6 hours	Less than 24 hours	**2.1**
Lifeline Incident (Power Outage)	Highly Likely	Minor	Moderate	Less than 6 hours	Less than one week	**2.8**

4.8.3 Hazard Ranking

The ranking of hazards was based on the PRI results. These were then reviewed by tribal officials. Rankings are presented in the table below.

Table 43. Ranking of Hazards.

Ranking	Hazard
High	Drought Earthquake and Liquefaction Flood Wildfire and Structural Fire Dam Failure
Moderate	Air Pollution Agricultural Pests and Diseases Epidemic/Pandemic Erosion Extreme Heat High Wind Lifeline Incident (Power Outage)
Low	Extreme Freeze Landslide Lightning Tornado Hazardous Materials Incident

4.8.4 Key Points on Vulnerability

All of the hazards addressed in this plan pose a threat to the Pala Reservation, including assets and population within. The hazards of greatest concern are drought, flood, wildfire, earthquake, and dam failure. Each of these hazards has the potential for high consequence losses, including wide-spread damages and/or loss of life. Other hazards still pose a recognizable risk.

- **Air Pollution –** Air quality in the San Diego Air Quality Basin, which includes the Pala Reservation, has shown signs of slowly improving since the 1970s as observed through declines in number of days exceeding standards for ground ozone and particulate matter. Climate change has the potential to worsen air quality has warmer temperatures are conducive to the formation of ground ozone and increased wildfires can worsen air quality.

- **Agricultural Pests and Diseases –** The Pala Band has several agricultural holdings, including orange groves, avocado groves, a vineyard, and animal husbandry. Pests such as the Asian Citrus Psyllid and the Glass-winged Sharpshooter pose a threat to those holdings. Further, borer beetles present a threat to trees and crops. Swaths of dead trees present a wildfire hazard.

- **Drought**: Extended drought has and will continue to have severe consequences for the tribe. Since 2000, Extreme Drought (the second most severe classification) has occurred in 2002, 2003, 2007, and 2014-2018, indicating droughts may be trending towards a long-term issue rather than occasional occurrence. The Tribe relies on wells for water. Drought may impact water supply, potentially affecting business operations (including the Casino and Hotel) and wildfire fighting capacity. Climate change is projected to increase drought frequency and intensity of the Reservation.

- **Earthquake**: The Pala Reservation resides less than 20 miles from the Elsinore Fault, which is capable of producing M7.0+ events; such an event is noted as one of the most credible earthquake predictions by San Diego County officials. A strong earthquake event could immobilize the Pala Casino Resort & Spa operations, damage houses and infrastructure, overwhelm response capabilities, and pose a substantial risk for fire following earthquake (due to propane leaks). A strong earthquake could also have a cascading impact by causing a failure at the Lake Henshaw Dam.

- **Earthquake (Liquefaction)**: Liquefaction risk is widespread on the reservation – 99% of buildings, and nearly all critical facilities (except Southside Water Towers 2 and 3, and the avocado groves) are located in a liquefaction risk area.

- **Epidemic/Pandemic –** The ongoing COVID-19 pandemic has had substantial health impacts (over 70 cases reported in the tribal zip code as of September 2020) and economic impacts on the Reservation. The Pala Casino had to close for two months, and many Tribal members are experiencing job loss.

- **Erosion –** Erosion is on ongoing problem in several spots around the Reservation. Erosion can undermine structure or roadways. Further, erosion from heavy rain events on the Pala Reservation often results in large sediment deposits on roadways.

- **Extreme Freeze –** Extreme cold and freeze events do occur on the Pala Reservation, but are unlikely to significantly impact the Pala Band or its assets. Typical impacts include burst pipes. Freeze events during unexpected times (e.g., mid to late spring) could have negative impacts on the Pala band's agricultural holdings.

- **Extreme Heat –** Extreme heat events can have severe health impacts, cause blackouts or brownouts, and exacerbate drought and wildfire events. Extreme heat events are expected to increase in frequency and intensity on the Pala Reservation as the climate changes. For example, the number of extreme heat days on the Reservation is projected to increase from a baseline of 4 days per year to upwards of 46 days by 2099.

- **Flood:** Flooding is the highest concern hazard on the Reservation. Minor flooding, often along Pala Temecula Road, occurs frequently during rainfall events. The tribe has reported several events in recent years that have caused major damages on the Reservation, including road closures at stream crossings, on Pala Temecula Road and Pala Mission Road, and repeated flooding in the Oaks neighborhood. Riverine flooding, sheet flooding, flash flooding, and flooding due to lack of drainage infrastructure are all problems on the Pala Reservation.

- **High Wind –** High winds are an annual occurrence on the Pala Reservation, but no specific damages from events have been reported. High winds have the potential to damage structures, cause injuries when objects are moved through the air, or cause power outages and downed trees. Wind events can also accelerate the spread of wildfires.

- **Landslide**: There are several steep slopes along Highway 76 that could experience landsliding or rockfalls. There is an elevated risk following heavy rain or extended drought.

- **Lightning –** Lightning strikes are not frequent on the Reservation but have the potential to occur. Lightning strikes have the potential to cause structure fires or wildfires.

- **Tornado –** Tornadoes are not frequent on the Reservation. A potential tornado on the Reservation would likely be weak (EF0 or EF1) but could still cause significant damage to buildings and infrastructure. Since tornadoes are infrequent, there could be limited public awareness on the Reservation for how to respond during a tornado event.

- **Wildfire**: A major wildfire event would disrupt business and could potentially destroy large portions of the Reservation. It is a serious threat to all residents and visitors as wildfires become more frequent and severe. The majority of structures on the Reservation are within Wildland Urban Interface/Intermix areas.

- **Dam Failure:** Although the Lake Henshaw Dam is maintained at level below capacity due to earthquake risk, a breach could have significant impacts on the tribe. Analysis indicated that there are over 152 buildings (including critical facilities) potentially located in the dam inundation zone. Over half are residential properties. Potentially impacted facilities include the Pala Casino Resort & Spa, which would have devastating economic consequences on the Tribe.

- **Hazardous Materials Incident –** Hazardous materials incidents are not common on the Reservation but have the potential to occur. The presence of propane storage tanks in several places around the Reservation present a risk for a hazardous materials incident.
- **Lifeline Incident (Power Outage)**: All wells supplying residential and commercial areas on the reservation need power to operate and would not function during a power outage; however, they are generator ready. Power outages have the potential to cause business disruptions on the Reservation, and they present a problem when coupled with extreme heat events.

In the following sections, a mitigation strategy to reduce the risks to current and future populations and structures will be presented.