area at 4:52 a.m. on July 21, 1952. It registered at magnitude 7.7 and was located on the White Wolf thrust fault, near the San Andreas fault, about 60 miles (95 km) northeast of Santa Barbara. This quake was felt over a wide area, including northern California, Nevada, Arizona, and Mexico. The Modified Mercalli intensity rating for this earthquake was X to XI (Richter, 1958). Widespread damage was evident in communities near the epicenter, and minor damage was even noted in cities well removed from the maximum shaking.

At 6:01 a.m. on the morning of February 9, 1971, a magnitude 6.6 earthquake struck in the eastern portion of the Santa Barbara-Ventura basin. This quake is known as the "San Fernando" or "Sylmar" earthquake, after the communities most seriously damaged. The earthquake occurred on a generally west-northwest to east-southeast trending, north-dipping thrust fault and ruptured to the surface (Jennings, 1994). The hypocenter of the earthquake is reported at a depth of over 5 miles (8.4 km) (SCEC website). The damage caused by this quake has been well reported and studied. Unusual phenomena were observed during this quake, including accelerometer readings greater than 1.0 (objects "thrown" into the air by forces greater than the downward force of gravity) (Bolt, 1971; K. Piper, personal communication; F. Langston, personal communication).

The 1971 earthquake occurred on the San Fernando fault. Although the fault had been recognized prior to the quake, it was not then considered important. Since that time, significant study has been made on the structural geology and seismic hazard potential in southern California (Petersen and Wesnousky, 1994). Subsequent studies have indicated that the recurrence interval for earthquakes on the San Fernando fault is about 200 years (SCEC website).

On January 17, 1994, another destructive earthquake hit the onshore portion of the Santa Barbara-Ventura basin. The quake, known as the "Northridge" earthquake, registered at magnitude of 6.7, with a hypocentral depth of 12 miles (18.4 km). Like the 1971 quake, it was felt over a wide area of southern California. This temblor broke on a previously "unknown" blind thrust, probably related to the Oakridge fault system (in fact, the fault had been imaged on proprietary CDP reflection data years earlier, although its earthquake potential was not assessable).

The 1994 quake was spatially related to the 1971 quake. Aftershock hypocentral data for the two earthquakes indicate that the "… Northridge aftershocks are cut-off by the San Fernando fault at depths of 5 to 8 km. The north-dipping San Fernando fault may have prevented the south-dipping Northridge rupture from reaching the surface" (SCEC website).

The Oakridge trend is well defined west of the Northridge epicenter. It follows an arcuate trace across Ventura County and out into the Santa Barbara Channel. The recurrence interval on the Oakridge system has not yet been determined.

4.1.2.2 TSUNAMIS

Tsunamis are potentially destructive ocean waves formerly called "tidal waves." A more appropriate description may be "seismic sea waves," because of their association with large earthquakes. It is generally believed that large-scale, underwater block movements, slumps, or slides are the mechanisms for generating these waves. (Certainly unusual events such as volcanic island explosions and meteorite impacts are known to have occurred; however, the likelihood of such a wave affecting the southern California coastline is remote.)

Tsunamis are usually apparent only at the coastline. Due to their long wavelength and low amplitude, they are rarely noted in deep water. However, in deepwater conditions they can travel at velocities of over 600 miles per hour (270 meters per second). As a tsunami approaches and strikes the coast, the wavelength becomes attenuated and the amplitude grows. The first sign of an impending tsunami is sometimes a sudden recession of the ocean away from the coast.

Most tsunamis are generated on the margins of the Pacific Ocean basin. Consequently, small, trans-Pacific tsunamis strike the California coastline with regularity. Large tsunamis striking the California coast are rare. Only three known tsunamis have been locally generated. The information below is provided from the National Weather Service website. The reader is directed there for greater detail.

Associated with the December 21, 1812 earthquake, a tsunami was described at several places along the north and south shores of the Santa Barbara Channel. Over the years, the height, run up, and damage caused by this tsunami has been exaggerated and misinterpreted. Little or no physical evidence remains from the 1812 event.

Contemporary accounts of the tsunami lack specific details. One 1856 account documents a fur-trading vessel being carried inland by the waves at Gaviota Canyon on the Refugio Rancho upwards to 2,500 feet, before being taken back out to sea with the receding water. Similar accounts have ocean water running up into the plaza at Santa Barbara. These stories might suggest a maximum height of 50 feet for the 1812 tsunami. A secondhand story from a memoir of an elderly resident of Ventura relates that an old church, 15 feet above sea level, was damaged in 1812. More recent analysis discounts the 50-foot reports and suggests a 10-15 foot wave was more likely.

Complicating the story of the November 21, 1812 tsunami is a report that a member of the Hawaiian royal family was killed by a tsunami on that date. Estimates of the Hawaiian tsunami run up are placed at 10 feet. If the California earthquake spawned this wave, then earlier accounts of large waves in the Santa Barbara Channel have more validity.

A small earthquake, felt only in the Santa Barbara area in late May, 1854, may have been responsible for a "heavy swell" which washed into the town very soon afterward. The quake quite possibly triggered a nearby submarine slide, which in turn, generated the wave.

On May 10, 1877, a destructive earthquake in northern Chile generated a tsunami that was monitored around the Pacific basin. At Gaviota, a series of three 12-foot waves were reported.

On November 22, 1878, a probable tsunami unrelated to any recorded earthquake struck the north Santa Barbara County and San Luis Obispo County coastline. This wave was reported to have severely damaged the Point Sal wharf and the Avila wharf, and to have washed over the sand bar at Morro Bay. Given that no earthquakes are reported on that date anywhere around the Pacific basin, this wave may likely have been locally generated by a large-scale submarine landslide.

On March 9, 1895, an unusual event in Cuyler's Harbor, at San Miguel Island, was responsible for the capsizing of a vessel anchored there. Apparently, a large portion of the bluffs on the west side of the harbor slumped in the ocean. The resultant wave rolled the vessel.

The 1927 earthquake off Point Arguello (see above) generated a small tsunami that was witnessed by several coastal residents and recorded on tide meters. The tsunami caused damage to train tracks at the former community of Surf, near the mouth of the Santa Ynez River. The waves measured a maximum of 6 feet at Surf, and 4 feet at Pismo Beach.

It is unclear if the 1927 tsunami was generated by the tectonic forces of the earthquake, or was a result of a submarine landslide associated with the quake. Two ships' captains, when interviewed about the "sea quake," indicated they had felt in their ships two distinct events about 20 minutes apart; the second even reported as being "more strongly felt." The first event was the main shock of the November 4 earthquake. Seismographs do not record a significant aftershock at the time of the second reported event. The captain of another vessel reported aftershocks at sea about 10:30 a.m. and noted large quantities of dead or stunned fish at the surface soon thereafter.

It is clear from the record that the 5:51 a.m. earthquake disrupted the ocean surface of an otherwise "smooth" sea. The evidence suggests that the main shock triggered an underwater landslide offshore from Surf. The fish kill may be related to the initial shock wave of the quake, or to the turbidity and violent turbulence caused by the postulated submarine landslide. The area of the earthquake is also known for submarine oil and gas seeps, and it is possible that a slide may have triggered a toxic release of shallow methane gas. The lack of a significant aftershock recorded at 6:10 a.m. was initially attributed to a shallow focus event (Byerly, 1930). In fact, the 6:10 event could have been the progression of a submarine slide near the ship that had reported its position as 14 miles north of Point Arguello.

In retrospect, the November 4, 1927 tsunami was very similar in appearance and location to the November 22, 1878 tsunami. The 1927 event was recorded by instruments and several witnesses, and remains the best analogue for a locally derived tsunami with the project area. Satake and Somerville (1992) suggest that the tsunami was spawned near the epicentral site of Helmberger (1992).

The deadly April 1, 1946 "Scotch Cap" tsunami became the textbook example for Pacific-wide tsunamis spawned by an Aleutian earthquake. This tsunami was recorded, by inference, at about 100 feet at the Scotch Cap Lightstation on Unimak Island. The progress of the tsunami was well recorded as it sped southward. Heavy damage was noted at other places in the Aleutian archipelago and in Hawaii. By the time the tsunami reached southern California it varied in height from 5 to 8 feet. At Point Arguello the tsunami was report as a "seven foot rise." It appears likely that the tsunami damage at Unimak Island was exacerbated by a large submarine landslide (Fryer, et al., 2000).

The very large May 22, 1960 earthquake of the coast of Chile (the strongest earthquake ever measured on a seismometer M=8.6) generated a long period tsunami that was recorded in southern California. At Santa Barbara Harbor, the initial swell rose 8 feet above the expected tide and then dropped 9 feet in the course of ten minutes.

The large March 28, 1964 "Good Friday" earthquake (M=8.4) in Alaska generated a series of seismic sea waves that were recorded around the Pacific basin. Substantial tsunami damage occurred in communities thousands of miles from the earthquake epicenter. At Morro Bay a ten-foot tide change occurred over a ten-minute interval. In Santa Barbara "five-foot surges on twenty-minute cycles" were noted.

Tsunamis, although not a common occurrence along the southern California coast, do pose a potential geologic hazard to coastal communities and facilities. Facilities located in offshore, deep-water areas (such as oil production platforms) are unlikely to be affected by tsunamis.

4.1.2.3 MASS WASTING

"Mass wasting" is a general term that describes the large-scale movement of rock or earth material down slope, by gravity, in either a sudden or slow process. Mass wasting can include soil or bedrock creep, rockfalls, landslides, flows and slumps, and avalanches. Submarine wasting processes are not well understood and are rarely witnessed. Prior to the 1960's, these processes were inferred to exist due to damage caused to submarine telephone and telegraph cables. Also, fishermen and divers reported changes in the ocean floor topography. These changes were sometimes associated with water discoloration and seismic activity.

More recently, the advent of side-scan sonar and multibeam technologies has allowed scientists to see modern submarine landforms. Greene, et al. (2000), have mapped large-scale slumps off the coast from Goleta. They conclude that failures such as these have the potential to generate local tsunamis. Scientists are not yet able to accurately assess the risks associated with submarine mass wasting. The ability of catastrophic slope failures to generate tsunamis, or tsunami-like waves, is recognized, as is a causal relationship with seismicity. However, identifying areas prone to this sort of failure, and determining the likelihood of such failure, is another matter.

4.1.2.4 SEEPAGE AND SHALLOW GAS

Seepage of oil, tar, or natural gas does not normally present a geologic hazard. Such seepage is evidence that thermally mature source rocks exist in the area. Seepage is also evidence of the migration of hydrocarbons from the source rock to the surface and is commonly associated with faulting (the fault acting as a conduit for the seepage). The seepage of hydrocarbons is usually attributed to the difference in density of oil and natural gas to the connate water that fills the pore spaces of rocks. The less dense hydrocarbons tend to "rise" through the rock column, through interconnected pores, along fractures, or by way of faults, until they are trapped in a sealed reservoir or emanate at the earth's surface.

In the Santa Barbara Channel area, seepage has been associated with both fault trends and anticlinal trends (Fischer, 1978). Some of the most prolific areas of oil, tar, and natural gas seepage occur in the vicinity of Coal Oil Point, near Santa Barbara. Several studies have attempted to measure or estimate the volume of seepage in the Santa Barbara Channel area (Emery, 1960; Vernon and Slater, 1963; Vedder, et al., 1969; Allen, et al., 1970; Wilkinson, 1972; Fischer, 1978; Hornafius, et al., 1999; Quigley, et al., 1999).

Fischer (1978), estimates that between 40 and 670 barrels of oil per day naturally seep into the Santa Barbara Channel. At one location, near Platform Holly, two submarine tents have been used since 1982 to trap gas and oil seepage emanating from the ocean floor. Since installation, the seep containment structures have captured in excess of 6 billion cubic feet of gas from an area of 20,000 square feet. There are no reliable estimates for the total amount of gas seeped into the Santa Barbara Channel, nor are there any reliable estimates for the volume of oil, tar, or gas seepage north of Point Arguello.

No active seeps of oil, tar, or natural gas have been identified on the specific leases included in the proposed action. However, geologic conditions favorable to the formation of hydrocarbon seeps (mature source rocks, faulting and folding of the strata, erosion of overburden, etc.), and the proximity of the project areas to known seeps, suggest that natural seepage can not be entirely ruled out. Reports of oil sheens and floating tar balls in or near the project areas may be attributable to several other sources other than local seepage.

Hornafius, et al. (1999) has suggested that the annual amount of hydrocarbon seepage in the Santa Barbara Channel has decreased over time and that the decrease is associated with sustained offshore oil and gas production. According to this model, local oil and gas seepage is due, in part, to hydrocarbons expelled under pressure from subterranean reservoirs. As compared to the density separation model, this model contemplates active reservoir recharge, piezometric connectivity, leaky reservoir seals, and ample conduits from the reservoir to the earth's surface. As reservoir pressure is decreased through the production of oil and gas, the driving energy behind the abundant seepage is also decreased, and therefore the amount of oil and gas emanating at the surface decreases. The result of such a decrease in seepage could have profound impacts on the amount of natural tar on local beaches and of reactive hydrocarbons in the atmosphere.

The Hornafius, et al. (1999) model attempts to explain the apparent decrease in seepage volumes in the Santa Barbara Channel over the past 40 years. Data from the South Ellwood seep containment project collected since 1982 confirms the decrease at that location. Additional study needs to be conducted to determine whether this is a localized phenomenon, or whether this model describes a more widespread process.

Shallow gas can present a geologic hazard. This type of accumulation is often imaged on high-resolution seismic data. Generally, shallow gas accumulations, especially those formed from the natural process of organic decay (biogenic methane), are contained in low pressure sand reservoirs or surfacial sediments. However, thermogenic gas (gas produced by time, temperature, and organic maturation) has the potential to accumulate in "over-pressured" zones that present a drilling hazard. High pressure, shallow gas has been noted in several areas in the Santa Barbara-Ventura Basin. The giant Ventura Avenue field was discovered on the basis of shallow gas reservoirs. Hazards posed by high-pressure shallow gas have been mitigated in the drilling process by the use of casing and weighted drilling mud.

4.2 CLIMATE AND METEOROLOGICAL CONDITIONS

GENERAL DESCRIPTION

The proposed exploration projects are located in the Outer Continental Shelf (OCS), offshore of Santa Barbara County within the South Central Coast Air Basin. Santa Barbara County is considered to be a Mediterranean climate. It is characterized by partly cloudy, cool summers without significant precipitation and mostly clear, mild winters during which precipitation falls with seasonal storms. The climate is strongly influenced by a persistent high-pressure area which lies off the Pacific Coast referred to as the Pacific High. The combination of the Pacific High over the ocean to the west, thermal contrasts between land and the adjacent ocean, and topographic factors result in the mild temperatures experienced throughout the year.

The topography plays a factor in the wind flows observed in the county. The change in orientation of the eastward turn in the coastline at Point Conception and the mountains along the coast, results in a wind regime characterized by relatively light sea breezes in the afternoon and strong downslope winds at night. These terrain features can cause counterclockwise circulation (eddies) to form east of the Point and may often lead to highly variable winds along the southern coastal strip. The coastline mountain range causes a decrease in the occurrence of northwest winds in the channel as compared with Point Conception, which marks the change in the prevailing surface winds from northwesterly to southwesterly.

Transport of cool, humid marine air onshore by these northwest winds cause fog and low clouds near the coast, primarily during the night and early morning hours in the late spring and early summer. This fog also typically forms on the coast and inland valleys during the evening. Fog usually lifts and low clouds evaporate as land areas are warmed in the morning. Afternoon conditions are generally characterized by fair skies, cool temperatures, and a sea breeze. The Pacific High diverts extratropical storms to the north, and precipitation occurs infrequently when tropical moisture is transported into the region.

The Pacific High weakens and migrates southward during winter. During the winter season, three weather regimes generally prevail:

(1) periods of low clouds/fog associated with dominance of the Pacific High;

(2) periods of clear skies, cool nights, and warm days associated with continental flow; and

(3) periods of variable cloudiness, shifting and gusty winds, and precipitation associated with extratropical storms.

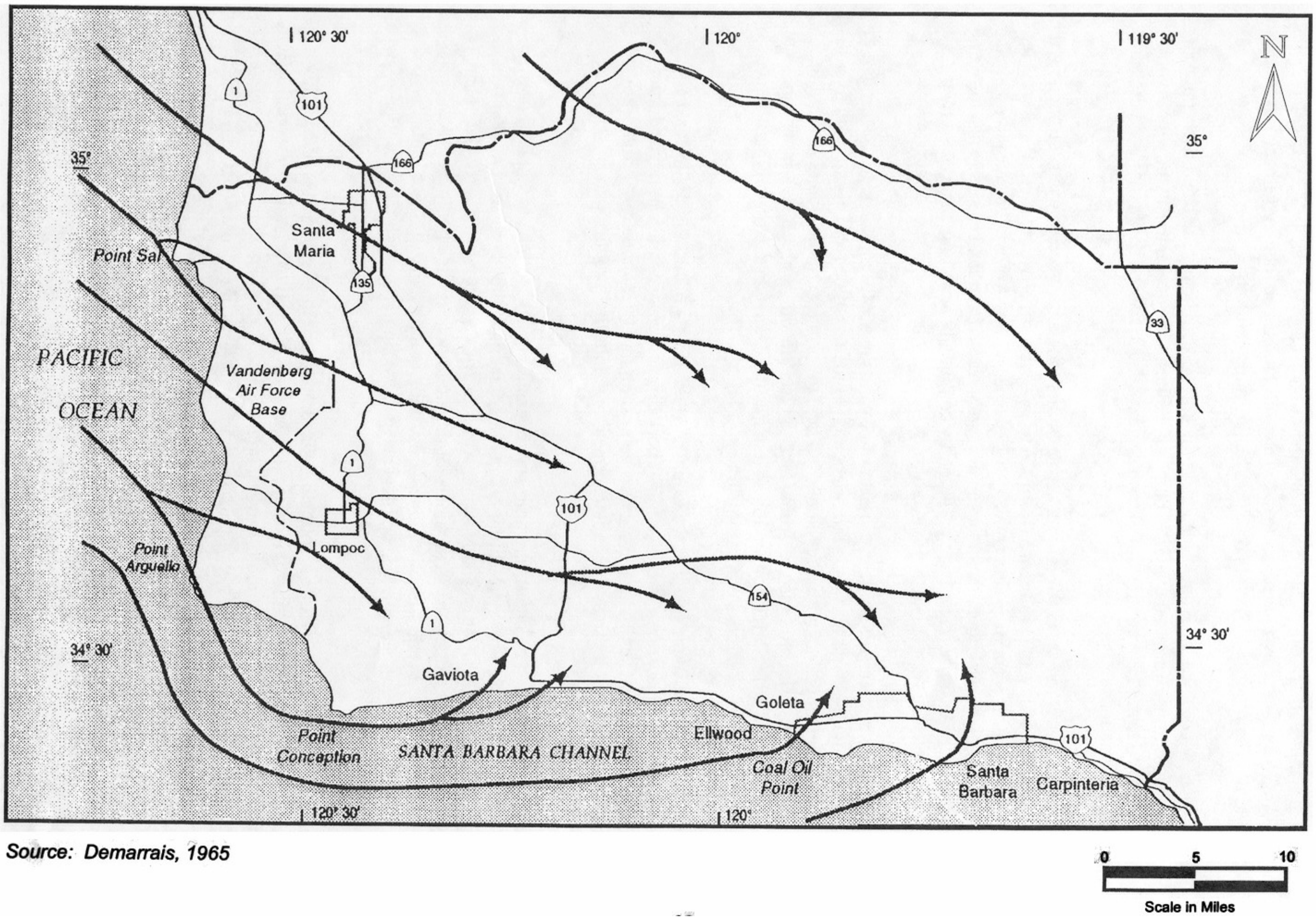
An additional component in providing air flow up the channel from Los Angeles is the eddy low which is often present in the Southern California Bight. Under certain conditions this eddy, often referred to as the Catalina Eddy, will expand and/or shift northward producing a southeasterly gradient in the channel. This may result in a short duration sea breeze appearing for a short time during the afternoon. However, with a well developed eddy low, surface winds will remain from the southeast all day.

WIND SPEED AND DIRECTION

The airflow around Santa Barbara county plays an important role in the movement of pollutants. In the northern portion of Santa Barbara County (considered north of the ridgeline of the Santa Ynez Mountains), the sea breeze is typically northwesterly throughout the year while the prevailing sea breeze in the southern portion are typically from the southwest. During summer months, these winds are stronger and persist later into the night. The sea breeze weakens during the evening hours as air adjacent to the surface cools, descending down the coastal mountains resulting in light land breezes (from land to sea). This land/sea breeze cycle combined with local topography greatly influence the direction and speed of the winds throughout the county. In addition, the alternation of the land-sea breeze cycle can sometimes produce a “sloshing” effect, where pollutants are swept offshore at night and subsequently carried back onshore during the day. This effect may be exacerbated during periods when wind speeds are low.

Data from all the meteorological stations within the area indicate a general northwesterly flow with higher wind speeds occurring offshore and at Point Conception and Point Arguello. The data in the channel generally show a greater westerly component than do winds at Point Arguello and north, because of the effects of the east-west oriented Santa Ynez Mountains. Wind data measured at Point Conception, Point Arguello and Vandenberg all show generally similar

Figure 4.2-1. Typical prevaling afternoon summer wind flows.



Source: Demarrais, 1965

directional distributions. The data generally reflect conditions at the proposed exploration locations. However, the average speeds at Vandenberg are somewhat lower. Therefore, it is reasonable to expect a higher frequency of pollution events in the southern portion of the county where light winds are frequently observed, in relation to the North County where the prevailing winds are strong and persistent.

Figure 4.2-1 displays typical prevailing wind flows during the summer months for the region. The diagram shows that the generally northwesterly airflow associated with the Pacific High is significantly modified by interaction with the terrain. The flow becomes modified at particular times of the day due to temperature contrasts between the land and the ocean, resulting in the typical sea breeze experienced during summer days. The sea-breeze experienced in Santa Barbara County is common to all of California. These winds generally carry pollutants generated in the coastal areas to areas well inland. Typically, the air quality measured in the coastal areas of California is much better than that experienced inland.

Upper-level winds in the atmosphere are also important in the air quality of Santa Barbara County. These winds are routinely measured at Vandenberg Air Force Base once each morning and afternoon. The winds at 1,000 feet and 3,000 feet are generally from the north or northwest throughout the year. Occurrences of southerly and easterly winds are most frequent in winter, especially in the morning. Upper-level winds from the southeast are infrequent during the summer, though when they do occur, they are usually associated with periods of high ozone levels. As with the surface winds, upper-level winds can move pollutants that originate in other areas into the county.

During the fall and winter months, Santa Barbara County is occasionally subjected to Santa Ana winds. These are warm, dry, strong, and blustery winds blown from the high inland desert, through mountain valleys and eventually out to sea. Wind speeds associated with Santa Ana conditions are generally 15-20 mph, though speeds in excess of 60 mph have been registered. During these Santa Ana conditions, pollutants emitted in the Los Angeles region, Ventura and Santa Barbara Counties are moved out to sea. These pollutants can then be transported back onshore into Santa Barbara County (via the Santa Barbara Channel) in what is called a "post Santa Ana condition".

"Sundowner" winds are a local condition inherent to the coastal strip below the Santa Ynez Mountains in Santa Barbara." These winds are similar in effect to Santa Ana winds as the condition can produce high intensity, hot northerly winds down canyons and out to sea. While this condition can affect the local climate (usually for short periods of time), Sundowners are contrasted by the Santa Ana condition in that the winds are more localized and are caused by diurnal and land/sea temperature variations.

STABILITY AND MIXING HEIGHT

Stability is an atmospheric trait that influences the mixing of air. In general, when the atmosphere becomes less stable, increased turbulence and mixing of the upper and lower atmosphere are prevalent. The mixing height is the height of the atmospheric layer measured from the ground upward in which convection and turbulence promote mixing. Good ventilation and dispersion result from a high mixing height, unstable conditions, and moderate to high wind speeds within the mixed layer.

Atmospheric stability is the primary factor that affects the concentrations of pollutants in the region. Atmospheric stability regulates the amount of mixing of air, both horizontally and vertically. An increased level of atmospheric stability that restricts mixing and low wind speeds are generally associated with higher pollutant concentrations. These conditions are typically related to temperature inversions that cap the pollutants that are emitted below. Inversions are characterized by a layer of warmer air above cooler air near the ground surface. In an inversion, the temperature of the air layer atypically increases with altitude acting like a cap on the cooler air mass below, preventing the dispersion of pollutants that are trapped in the lower air mass. Ozone concentrations are generally higher directly below the base of elevated inversions than they are at the ground surface. For this reason, elevated monitoring sites will occasionally record higher ozone concentrations than sites at lower elevations.

Atmospheric soundings at Vandenberg Air Force Base demonstrate that surface inversions (0-500 ft) are most frequent during the winter, and subsidence inversions (1000-2000 ft) are most frequent during the summer. Vertical dispersion of pollutants will generally be the most inhibited with a lower inversion base height and the greater the rate of temperature increase from the base to the top. The subsidence inversion is common during summer months along the California coast, and is one of the principle causes of air stagnation and poor air quality.

TEMPERATURE

The Mediterranean climate characteristic of Santa Barbara County result in mild temperatures occurring throughout the year, particularly adjacent to the coastal regions. Maximum summer temperatures average 70 degrees Fahrenheit near the coast and in the high 80s to low 90s inland. During winter, average minimum temperatures range from the 40s along the coast to the 30s inland. Temperatures within the coastal region are influenced by the marine dominance of the Pacific Ocean, while more inland areas of the county exhibit a more continental influence.

Santa Barbara and Santa Barbara Airport, on the south-facing coast between the ocean and the south slopes of the Santa Ynez Mountains, experience higher maximum temperatures, lower minimum temperatures, and more continental influence than those experienced at offshore Platforms and Islands dominated by marine influences (Table 4.2-1). At Santa Barbara, the highest mean maximum temperature (79°F) occurs in September, and the lowest mean minimum temperature (40°F) occurs in January. Temperatures

Table 4.2-1. Temperature and precipitation data for selected Santa Barbara locations.

Location	**Temperature** (F)		**Precipitation** (inches)
	Average Maximum	*Average Minimum*	*Average Annual*
Santa Barbara	71.2	50.1	17.0
Santa Barbara Airport	69.5	48.7	15.9
Lake Cachuma	76.9	45.3	18.7
Lompoc	69.9	46.8	14.0
Santa Maria	68.7	45.8	12.4

Source: Western Regional Climate Center

Table 4.2-2. El Niño 1997 - 1998 precipitation data for Santa Barbara county.

Location	**’97 - ’98 Rainfall** (inches)	**Seasonal Record (year)** (inches)	**Normal Rainfall** (inches)	**Percent Of Normal**
Cuyama	21.50*	15.56 (68-69)	8.01	268
Gibraltar Dam	68.85*	64.79 (82-83)	25.37	271
Lake Cachuma	53.39*	43.90 (82-83)	18.73	285
Lompoc	37.25*	32.78 (82-83)	13.95	267
San Marcos Pass	73.87	78.48 (82-83)	26.62	277
Santa Barbara	46.99*	45.21 (40-41)	16.98	277
Santa Maria	32.58*	30.73 (40-41)	12.36	264

Source: National Weather Service
* seasonal record

at Santa Barbara Airport are slightly cooler. Cold air drainage off the mountain slopes contributes to the lower minimum temperature during the winter.

PRECIPITATION

The climate of Santa Barbara is strongly influenced by a persistent high pressure area which lies off the Pacific Coast. As a result, sunny skies are common throughout most of the area. The majority of the annual precipitation amounts occur mostly from October to April, when the Pacific High pressure system has shifted south. Annual rainfall amounts range from about 10 to 18 inches along the coast, with more substantial amounts in the higher elevations. On occasion, tropical air masses produce rainfall during the summer. Cool, humid, marine air causes frequent fog and low clouds along the coast, generally during the night and morning hours in the late spring and early summer. The fog and low clouds can persist for several days at a time until broken up by a change in the weather pattern.

Average annual precipitation varies markedly over relatively short distances within the region, primarily because of topographic effects. Relatively high elevation stations (San Marcos Pass, Gibraltar) in the Santa Ynez Mountains receive an average of more than 25 inches of precipitation per year (Table 4.2-2). Santa Barbara receives slightly more precipitation (17.0 inches) than Santa Barbara Airport (15.9 inches).

Historical precipitation levels in the region may vary widely from year to year. At Santa Barbara, annual precipitation is 8.7 inches or less about once every 10 years; it can also be more than 28 inches one year in 10 (National Regional Climate Center, 2000).

SEVERE WEATHER

Thunderstorms in the project area are infrequent. Fewer than three occur annually at Santa Barbara Airport (U.S. Naval Weather Service, 1969). Thunderstorms in the area are generally associated with active cold fronts or cold lows in winter or with the transport of tropical moisture into the region in late summer or early fall.

The winter of 1997-1998 was one of the most severe winters in local history as the effects of the El Nino were felt across Southern California. Rainfall totals resulting from the El Nino for Santa Barbara County were 273% of normal rainfall for the county with many stations recording new seasonal records (National Weather Service, 2000). Table 4.2-2 depicts a precipitation summary for meteorological stations in Santa Barbara County as a result of the 1997 -1998 El Nino severe storm cycle.

Rosenthal [1972] reported on occurrences of other types of severe weather in the region. He indicated that tornadoes are rare in California, with an estimated return period for a tornado striking the same location of 1 in 20,000 years for the Los Angeles area and about the same in other parts of the State. He also reported that water spouts, though infrequent, have been sighted over the Santa Barbara Channel.

Remnants of tropical storms formed off the West Coast of Central America have affected this region on more than one occasion. However, winds and precipitation associated with these storms have been only moderate (National Oceanic and Atmospheric Administration, 1976-1978).

Table 4.3-1. Ambient Air Standards

Pollutant	**Averaging Time**	**California Standards**	**Federal Standards**	
			Primary	**Secondary**
Ozone (O_3)	1 hour	0.09 ppm (180 μg/m^3)	0.12 ppm (235 μg/m^3)	Same as Primary Standard
	8 hour	--	0.08 ppm (157 μg/m^3)	Same as Primary Standard
Carbon Monoxide (CO)	1 hour	20.0 ppm (23 mg/m$^{3)}$	35.0 ppm (40 mg/ m$^{3)}$	--
	8 hour	9.0 ppm (10 mg/m$^{3)}$	9.0 ppm (10 mg/ m$^{3)}$	--
Nitrogen Dioxide (NO_2)	1 hour	0.25 ppm (470 μg/m$^{3)}$	--	Same as Primary Standard
	Annual Avg.	--	0.053 ppm (100 μg/m$^{3)}$	
Sulfur Dioxide (SO_2)	1 hour	0.25 ppm (655 μg/m$^{3)}$	--	--
	3 hour	--	--	0.5 ppm (1300 μg/m$^{3)}$
	24 hour	0.04 ppm (104 μg/m$^{3)}$	0.14 ppm (365 μg/m$^{3)}$	--
	Annual Avg.	--	0.030 ppm (80 μg/m$^{3)}$	--
Lead	30 day avg.	1.5 μg/m^3	--	--
	Calendar qtr.	--	1.5 μg/m^3	Same as Primary Standard
Particulate Matter (PM_{10})	24 hour avg.	50 μg/m^3	150 μg/m^3	Same as Primary Standard
	Annual Avg.	30 μg/m^3	50 μg/m^3	
Particulate Matter ($PM_{2.5}$)	24 hour	None	65 μg/m^3	Same as Primary Standard
	Annual Avg.	None	15 μg/m^3	
Sulfates	24 hour	25 μg/m^3	--	--
Hydrogen Sulfide	1 hour	0.03 ppm (42 μg/m$^{3)}$	--	--
Vinyl Chloride	24 hour	0.010 ppm (26 μg/m$^{3)}$	--	--

Table 4.3-2. Ozone Monitoring Summary of Representative Monitoring Sites In Ventura and Santa Barbara Counties

	1997			**1998**			**1999**		
Location	**Maximum Conc.**	**Days Above Standard** [a]		**Maximum Conc.**	**Days Above Standard**		**Maximum Conc.**	**Days Above Standard**	
		State	*Fed.*		*State*	*Fed.*		*State*	*Fed.*
Ventura	0.108	2	0	0.091	0	0	0.090	0	0
Ojai	0.106	10	0	0.112	13	0	0.113	7	0
Santa Barbara - West Carillo St.	0.098	2	0	0.094	0	0	0.098	1	0
Goleta - Fairview	0.091	0	0	0.095	1	0	0.103	1	0
Las Flores Canyon - #1	0.137	5	1	0.130	5	1	0.135	1	1
Gaviota - West	0.087	0	0	0.054	0	0			0
Santa Ynez - Airport Rd.	0.099	1	0	0.104	2	0	0.090	0	0
El Capitan Beach	0.087	0	0	0.099	1	0	0.088	0	0
Santa Maria - Broadway	0.069	0	0	0.073	0	0	0.070	0	0
Santa Rosa Island	0.081	0	0	0.082	0	0	0.093	0	0

National Standard 0.12 ppm, California Standard 0.09 ppm.

[a] The number of days that at least one measurement was greater than the level of the hourly standard. The number of days above the standard is not necessarily the number of violations of the standard for the year.

Source: California Air Resources Board