4.3 Safety, Risk of Upset, and Hazardous Materials

This section discusses potential risk of upset and hazardous materials impacts associated with the baseline and the Whittier Main Oil Field Development Project (proposed Project).

Risk of upset addresses scenarios that could immediately and adversely affect public safety. The information in this section outlines the environmental setting, regulatory setting, significance criteria, potential upset scenarios, the levels of risk to the public or the environment associated with these scenarios, and the significance of the upset scenarios. This section also analyzes the baseline and the proposed Project for oil spills, including the estimated frequency and volume of spills. Section 4.2, Biological Resources, and Section 4.8, Hydrology and Water Resources, discuss oil spill impacts. For a discussion of odor impacts and health risk impacts, see Section 4.1, Air Quality. Detailed risk calculation spreadsheets are included in Appendix D. This section also includes an overview of site soil and groundwater contamination issues.

4.3.1 Environmental Setting

For the proposed Project, the environmental setting or baseline conditions reflect the risks of upset associated with existing facilities. The Project is proposed in an area that does not currently have any oil and gas operations and, therefore, presents no risk associated with oil spills to the public or the environment.

In general, oil production fields and oil and gas facilities typically present hazards to employees and the public, depending on the type of facility, due to the presence of flammable gas, toxic gas, and gas processing by-products, such as flammable propane and butanes. Drilling operations present hazards, depending on reservoir characteristics, because placing a well-bore through potentially pressurized reservoirs could create blow-out situations and release flammable gases. Storing and transporting natural gas, propane, butane, and other gas liquids can also create a hazard.

In addition, storing and transporting crude oil presents hazards due to crude oil tank fires and environmental hazards due to crude oil spills. The impact section discusses the hazards, their associated estimated frequency of occurrence based on industry-wide experience, and their potential impacts and resulting risks.

4.3.1.1 Existing Site Hazards

A product pipeline, owned and operated by Kinder Morgan Pipeline Company, currently runs up Catalina Avenue, along the south side of the Preserve and across Colima Road. Signs for the pipeline run along the southern Preserve boundary. This pipeline is 24 inches in diameter and carries a range of products, possibly including jet fuel and gasoline. A rupture or leak of this existing pipeline could cause an explosion and fire that could impact nearby residences or the Preserve ecology.

4.3.1.2 Existing Site Contamination

The area has a long history of oilfield operations, including crude oil pumping, transportation by pipeline and truck, and storing crude oil in tanks. Natural gas was also produced at the site. There is a possibility that over time spills or leaks could have contaminated soil within the field. Figure 4.3-1 shows an aerial photograph of the project site in 1972 when facilities were at their peak level of development.

As part of the acquisition of the oilfield associated with the Measure A purchase (see Section 2.0, Project Description), a Phase 1 site assessment was conducted to determine the extent of any existing contamination.

In addition, in January 2010, Matrix contracted with PW Environmental to perform a soil sampling assessment of the site. Soil samples were taken at 17 locations at the proposed Project Site to a depth of 10 feet.

The results of the soil sampling by PW Environmental indicated that only one of the 17 samples contained contamination (see Figure 4.3-2). The concentration of total petroleum hydrocarbon (TPH) C13-22 detected in sample 11, the contaminated location, at 10 feet was 330 milligrams per kilogram (mg/kg). The concentration of TPH C23-32 detected in sample 11 at 10 feet was 1,500 mg/kg. The concentration of methylene chloride detected in sample 11 at 10 feet was 0.0053 mg/kg. TPH is most likely from spilled crude oil and the methylene chloride is most likely from degreasers or paint. These levels are below the Los Angeles Regional Water Quality Control Board (LARWQCB) screening level if the distance from the soil contamination to groundwater is greater than 20 feet (see Section 4.8, Hydrology and Water Resources, which indicates that groundwater at the Project Site is at least 60 feet).

4.3.1.3 Study Area and Scope

The study area is defined as any area that could be impacted by a release of materials, generally the area within 0.25 to 0.5 miles of the proposed Project Site. This distance includes all areas that could be acutely impacted by a release of flammable materials. The study area includes the proposed Project Site in the Puente Hills and any routes associated with proposed pipelines.

An upset condition from the proposed Project operations that subsequently releases hazardous materials at the facilities could adversely impact public safety or environmental resources in the study area. Potentially affected study areas include:

- Residences along Ocean View Avenue, Davista Drive, Catalina Avenue, San Lucas Drive, Lodosa Drive, Penn Street, and surrounding area streets;
- The Ocean View public school;
- Visitors to the Preserve, hiking trails, and amphitheater;
- The Ranger Residence near the Catalina Avenue entrance to the Preserve;
- Ecological resources of the Preserve;
- Visitors to the Murphy Ranch Baseball Fields;

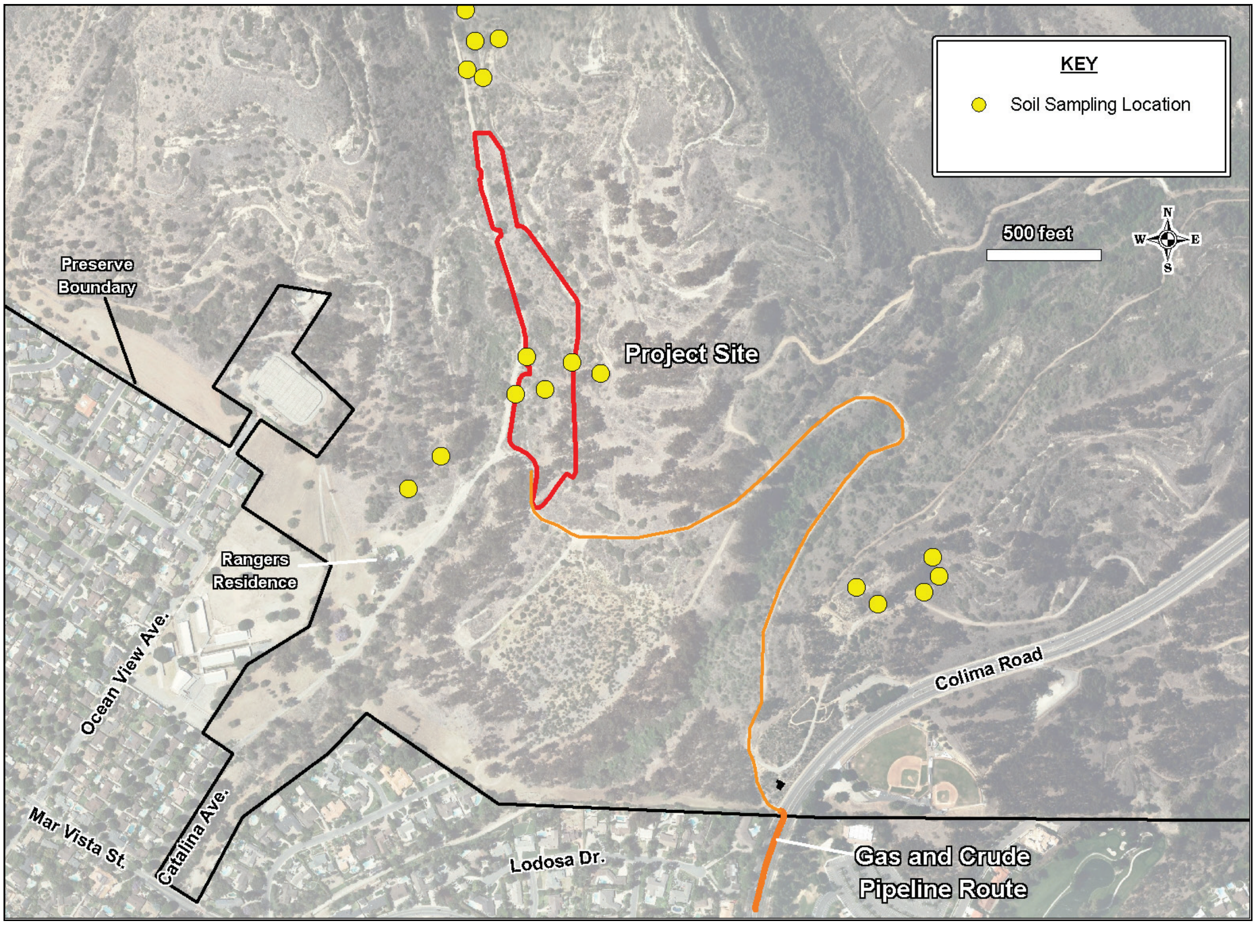
- Crude oil pipeline routes along Colima Road and La Mirada Boulevard;
- Traffic impacts associated with accidents along Mar Vista Street and Colima Road; and
- Traffic along Colima Road.

Figure 4.3-1 Historical Development at the Project Site: 1972

Source: Geopak 2010

Populations in the residential areas were estimated using the Census Bureau Year 2000 information for average populations per household. Specific population densities were calculated for the residential areas near the facilities by examining aerial photographs, structural densities, and estimating population densities by assuming the census average for persons per household. Vehicular traffic along area roadways is based on traffic counts from the County of Los Angeles and the City of Whittier.

Figure 4.3-2 Soil Sampling Locations in the Project Area



Note: Sampling locations outside of the Project Site were sampled for a previous project configuration.

4.3.1.4 Risk Assessment Methodology

Since there are no current operations at the proposed Project Site and consequently no existing risks associated with Matrix operations, no risk assessment has been conducted for the baseline. However, discussion of a Quantitative Risk Assessment (QRA) is included in this section since a QRA is conducted as part of the impact assessment.

Facility Quantitative Risk Assessment Approach

The QRA analyzes the risks presented by industrial operations on nearby populations. The assessment follows commonly accepted industry standards including the recommendations of the Center for Chemical Process Safety (CCPS), the Health and Safety Executive of the United Kingdom, and the County of Santa Barbara Environmental Threshold and Guidelines for Public Safety. The QRA examines the risks of immediate human safety impacts.

The main objective of the QRA is to assess the facility's risk of generating serious injuries or fatalities to members of the public, to assess the risks of spill events, and to develop mitigation measures that could reduce these risks. The development of the serious injury and fatality aspects of the QRA involves five major tasks:

- Identifying release scenarios;
- Developing frequencies of occurrence for each release scenario;
- Determining consequences of each release scenario;
- Developing estimates of risk, including risk profiles; and
- Developing risk-reducing mitigation measures.

Figure 4.3-3 shows the steps in developing a QRA.

A QRA computer model, developed by Marine Research Specialists, is used to calculate the risk profiles and, in conjunction with Geographic Information System software, to manage the data in accordance with CCPS guidelines for hazard assessments (CCPS 1989). The model is based on a polar coordinate grid of cells. The grid extends at least 0.5 miles from the facility in all directions and has varying cell sizes depending on the populations and ignition sources. Hazard zones are then laid over the grid to determine populations impacted. The following sections discuss information developed as inputs to the model.

Meteorological conditions at the site are represented by two stability classes: F stability/2 meters per second (m/s) and D stability/4 m/s. Wind conditions are divided into 16 directions and the probability of wind in each direction, at each stability class and speed, is entered. The meteorological conditions are based on wind data taken from the Pico Rivera station.

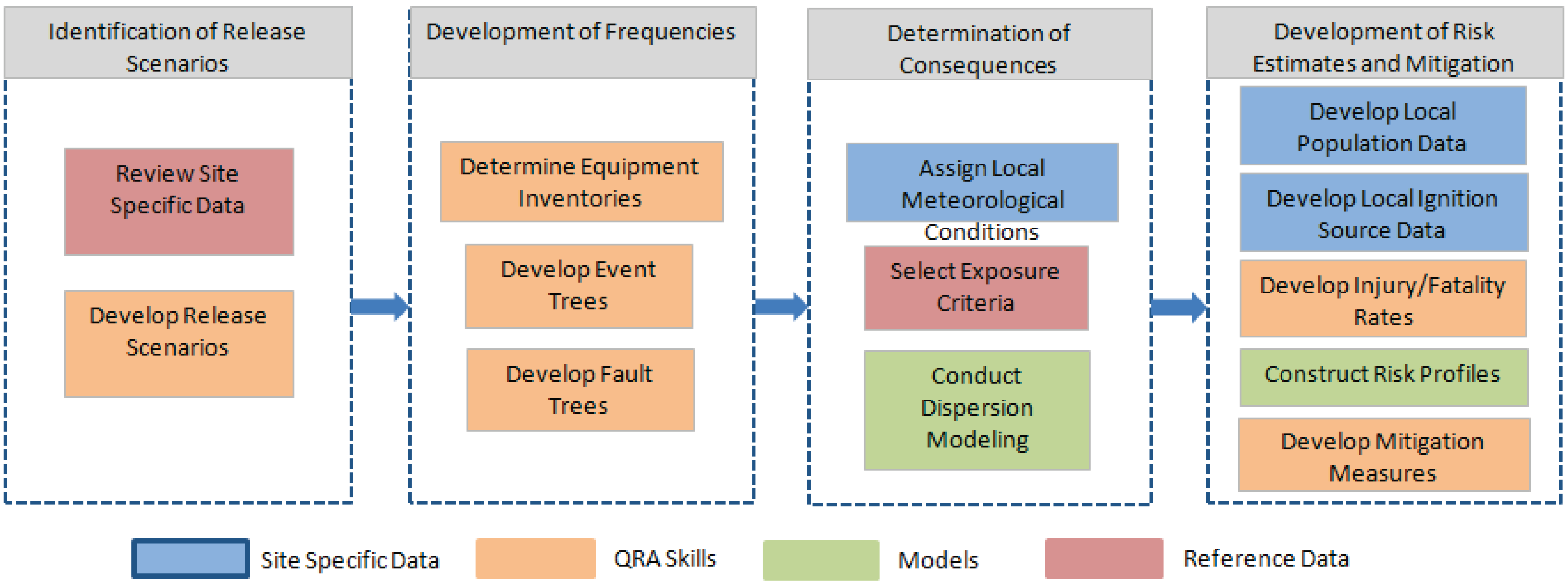
Fatality and serious injury probabilities are entered for each type of scenario (i.e., flame jets, fires, vapor clouds, including flammable and toxic clouds, explosions, and boiling liquid expanding vapor explosions), indicating the percentage of persons who are exposed to a scenario that would suffer serious injuries or fatalities.

Population density information developed for each receptor includes the number of persons present at each location, the area over which the persons are distributed, and the maximum number of persons that could be exposed. If a cloud covers only a portion of the area, the population density is used to determine the number of persons exposed.

A use factor is applied to each receptor based on the hours per day that persons are at the location. For example, a receptor that has persons at it 12 hours per day would have a use factor of 0.5. This factor reduces the frequency of a release scenario impacting persons.

An ignition probability at each receptor is applied, which defines the probability that a flammable cloud would reach the receptor and ignite and affect the receptor location. For example, if there are no ignition sources between the receptor and the release point and there is an ignition point at the receptor, such as a campfire, which has a high probability of igniting the cloud, then the ignition probability would be 1.0 at the receptor.

Figure 4.3-3 Steps Involved in Developing a Quantitative Risk Assessment



This would mean that any receptor farther from the release point would not be impacted. If there are ignition sources at the release location (such as flares or heaters), the ignition probability would be less than 1.0, meaning that part of the time the flammable cloud would not reach the receptors at all. The sum of ignition probabilities along any one path is equal to or less than 1.0.

A shielding factor is also applied to receptor locations. The shield factor is applicable to thermal scenarios only, such as flame jets, fires, or boiling liquid expanding vapor explosions. Thermal scenarios only produce impacts if the receptor is directly exposed to the flame and has a "line of sight." Buildings, vegetation, terrain, and other types of obstructions would prevent persons exposed to the fire from experiencing the full effects, and would reduce the probability that the person would suffer a serious injury or fatality.

Release scenario frequencies are determined though failure rate analysis and fault trees, which detail the general conditions and equipment-specific frequencies that could lead to a release. Event trees evaluate post-release behavior of the released material, such as whether it forms a flammable cloud, flame jet, toxic cloud, explosion, or a boiling liquid expanding vapor explosion.

The end products for the serious injury and fatality analysis are "risk profile" curves, one for fatalities and one for serious injuries, developed from the scenario frequencies and effected populations for each scenario. The risk profile curves estimate the risk that any existing population would suffer fatalities or serious injuries.

In general, a conservative (estimating more risk than would actually occur) approach is taken in conducting the analysis. Using a conservative approach ensures that risks are overestimated and ensures the focus of efforts are on the areas that produce the highest risk. Conservative assumptions include the following:

- Minimal piping friction effects. For flammable gas releases, consequence analysis assumed that release volumes were located at the break source and all releases were assumed to behave like a release from a short pipe length or a hole in a vessel. Piping lengths, which would increase the friction and reduce the release rates, were not included. For example, if a scenario includes two exchangers, nine vessels, two filters, and an estimated 240 meters of piping, it was assumed that this entire inventory was released as though it was contained within a single vessel at the unit temperature and pressure and released through a short pipe segment. In reality, the gas would have to travel through piping and equipment to get to the release point. This would reduce the release rate and the subsequent impact zone. In addition, for flammable releases, the peak release rate was used to determine the hazard zone. This approach produces larger hazard zones since the release rate would most likely decrease over time, thereby reducing the size of the impact zone over time.
- Minimum human intervention and shutdown systems included. It was assumed there would be no human intervention in the event of a crisis situation. Manual shutdown systems were assumed to not be activated, or activated only after a sufficient amount of material was released, which would allow the hazard zones to reach their maximum extents (given the dispersion and meteorological conditions at the time of the release). All automatic shutdown systems that can isolate portions of the plant were assumed to fail, and the failure rates of these automatic shutdown systems were included in the fault tree analysis. However, it was

assumed that compressor low pressure shutdown systems would prevent the system from continuing to operate and compressing additional gas from the wells in the event of an equipment failure.

- Maximum release volumes were assumed. All releases were assumed to release the entire volume of the facility or the entire volume of the gas gathering system. In reality, numerous valves and bottlenecks would prevent a release of the majority of the gas inventory in the field through a given pipe or equipment rupture.

Spill Risk Analysis Approach

The approach for the spill analysis involved estimating the frequency of release events from the facilities and the release volumes. Spill volumes from a pipeline system rupture are based on the pipeline diameter and the terrain profile, which would limit the amount of oil that could drain out of the pipeline. In addition, the pumping rate also affects the size of a release since oil pumped into the pipeline would contribute to the release size until the pumps are shut down.

Spills contained by the berms and drainage system valves and areas outside of berms would be directed to the drainage basins (tertiary containment). A spill would only be directed outside of the field after a subsequent failure in the drainage basin discharge procedure or equipment.

Security Risk

Effective and comprehensive site security programs are a prudent aspect of reducing the risk of chemical releases at a facility. Although the proposed Project area would not be considered a terrorist target on the order of New York or Washington, DC, it could be the subject of vandalism that could release hazardous materials.

The U.S. Department of Homeland Security established chemical facility anti-terrorism standards in 2007 (6 Code of Federal Regulations [CFR] Part 27). This rule established risk-based performance standards for the security of chemical facilities. It requires included chemical facilities to prepare security vulnerability assessments that identify facility security vulnerabilities and to develop and implement site security plans, which include measures that satisfy the identified risk-based performance standards.

The security vulnerability assessments include analysis related to asset characterization, threat assessment, vulnerability analysis, risk assessment, and countermeasure assessments. Generally, facilities covered by the Occupational Safety and Health Administration (OSHA) Process Safety Management and Environmental Protection Agency Risk Management Plan rules are required to comply with these standards.

A number of industry groups, including the American Petroleum Institute (API), the Center for Chemical Process Safety, the Synthetic Organic Chemical Manufacturers Association, American Chemistry Council, and the Chlorine Institute have developed approaches for assessing security risk. Each of these methods involves analyzing the security systems at the facility in combination with the hazards and determining a level of security risk.

Security systems at the site could include:

- Security policies for employees and contractors including access control, pre-employment screening, information security, and post-employment issues;
- Appropriate signage preventing access;
- Fencing systems;
- Visitor sign-in and sign-out;
- Surveillance of hazardous material areas;
- Employee and contractor identification methods;
- Night lighting;
- Partnerships with local response agencies;
- System to report and collect security incidents;
- Communications equipment; or
- Employee vehicles and access keys, codes, and card security.

Release Scenarios

The approach to develop release scenarios is grouping the equipment and operations by operating parameters -- equipment with similar temperatures, pressure, and composition were grouped into one set of scenarios. This generally produced a set of release scenarios for each process. Each set of release scenarios contains at least one rupture release and one leak release. A rupture is defined as a large process inventory release over a short period of time caused, for example, by catastrophic equipment failure. Ruptures are generally associated with releases through holes larger than 1 inch. A leak is defined as a process inventory released due to a small valve failure or hole in a vessel, for example, generally less than 1 inch in diameter. This approach encompasses a range of risks by including a less frequent, more severe scenario, and a more frequent, less severe scenario. In some cases, the leak release actually produces a higher risk (i.e., combination of consequence and frequency) than the associated rupture release because leaks occur more frequently than ruptures.

The principal immediate hazards to public health at an oil field include:

- Releases of flammable gas causing vapor cloud explosions or thermal impacts from fire and flame jets;
- Releases of propane or butane causing vapor cloud explosions, thermal impacts from fire and flame jets, or thermal and overpressure impacts from explosions and boiling liquid expanding vapor explosions;
- Releases of odorant causing toxic impacts; and
- Releases of crude oil with subsequent fire causing impacts from thermal exposure to crude oil fires.

Failure Frequencies

Once the scenarios have been identified, the analysis attempts to estimate the frequency of each scenario. This is done by combining the series of events necessary for the scenario to be realized. These are called "fault trees." For example, a release from a simple pipe and valve system could be due to the pipe breaking or leaking, the valve breaking or leaking, or an operator leaving a valve open during a maintenance procedure. Any of these events would cause a release of the material. Failure rate databases quantify how often each of these events occurs.

Several failure rate databases are available that list failure rates for a long list of equipment types and operations. These databases are produced from a large dataset of industry-wide information from hundreds of facilities. Some rates are industry-specific, such as nuclear facilities, liquefied petroleum gas facilities, or oil and gas industries, whereas some are more general. The sources included the Center for Chemical Process Safety, Lees, WASH 1400, Hydrocarbon Leak and Ignition database, and the Rijnmond Public Authority reports, which include both equipment failures and failures due to human error. These industry-wide failure rate databases incorporate a range of equipment, differing in design standards and equipment age. Therefore, the failure rates are considered an average of a group of equipment that might include some older equipment and some relatively new equipment.

Failure rates are developed, for example, from a listing of valve breaks that have occurred in an industry. Dividing the number of breaks per year by an estimate of the number of valves in that industry can generate a failure rate. For example, this rate may be 0.003 leaks per year per valve, so that if there are 100 valves at a facility, 0.3 leaks per year or approximately one leak every 3 years could be expected. The same information is available per meter of pipe length as a function of pipe size, for example. Other examples of this type of information include the number of times per year a pump might be expected to fail or a pump seal would develop a leak.

Rates can also be based on what is called a demand basis, which is a probability that if the equipment is called upon, it will not work. Good examples of this are the probability that a switch will not operate if it is used, or that a fire pump will not operate if it is needed.

Failure rate databases also include human error rates. These would include the frequency that a valve is not closed correctly, or that a series of instructions are not followed correctly, or that a hose is not connected properly. These human error rates are based upon industry-wide data and have been incorporated into the fault trees where applicable.

Table 4.3-1 shows frequencies for some common events in everyday life taken from the databases. Appendix D includes the source and frequency calculations.

Table 4.3-1 Frequencies for Common Events

Event	Number	Type
Failure to follow instructions occurs once every	18	times it is done
Simple arithmetic error with self checking occurs once every	40	times it is done
Incorrect reading of a gauge occurs once every	222	times it is read
Fail to read a 10 digit number correctly occurs once every	167	times it is read
A switch fails to operate once every	3,333	times it is used
A welded connection leaks once every	1,142	years per weld
A computer fails to run once every	10.5	months
A propane tank explodes once every	10,000,000	years per tank

Sources: CCPS 1989b, R&MIP 1988

The failure rate databases that were used to estimate the base failure frequencies include a range of equipment types, services, and age. Many of the failure rates, for example, are based on services that are much more hazardous than oil and gas processing, such as boiler systems, piping, and refinery reactor equipment.

Industry data on the correlation between equipment age and failure rates is sparse; in fact, several studies indicate that there is no correlation. In one study, 50 percent of failures were attributable to pressure vessels that were less than 10 years old and 50 percent were attributed to vessels more than 10 years old (Lees 1996). This is primarily because failures occur during the first few years of equipment life due to manufacturing inadequacies. An examination of facilities regulated by the Bureau of Ocean Energy Management, Regulation, and Enforcement (BOEMRE) (formerly the Minerals Management Service) in the Gulf of Mexico over the past 10 years shows that equipment failure rates actually decrease even as the average equipment age increases.

However, other studies indicate an increase in failure rates with age. Thomas developed a quantitative method for determining the failure rates in process piping and vessels using empirical data from the process industry (Thomas 1981). That method involves examining the piping and vessel size, construction geometry, and number and length of welds, as well as the equipment age and maintenance practices. This method assigns an age factor as high as 1.4, meaning failure rates would increase by approximately 40 percent at the age of 20 years over the failure rate at 10 years. This method estimated that process piping leaks are due primarily to manufacture and materials selection (50 percent) and corrosion and erosion (25 percent), with fatigue, vibration, expansion, mal-operation, and shock making up the remainder (Medhekar 1993).

Since the Thomas report, a number of refinements and data development activities have occurred, mostly focused on the nuclear industry. The worldwide nuclear industry has developed "risk informed in-service inspection" techniques. A number of approaches to risk informed in-service inspection have been proposed, but most of them rely on assessing the severity of process degradation mechanics and assigning a level of risk to specific processes. Developed databases, namely the SKI-PIPE for the worldwide nuclear industry, allow for a comparison to the Thomas model and databases. A study examining the SKI-PIPE database indicates that the age factor can range as high as 2.0 for larger diameter pipes in facilities older than 25 years, and as high as 2.5 for pipes subject to stress corrosion cracking environments (Lydel 2000).

The California State Fire Marshal (CSFM) pipeline study indicates that pipeline leak rates are relatively constant during the 30- to 40-year timeframe, and then increase substantially (CSFM 1993). The failure rates of the oldest pipelines are 2.8 times greater than the average.

For this study, it was assumed that as equipment ages beyond the first 10 to 20 years, to the age of more than 40 years, lack of proper maintenance would substantially increase failure rates. However, if proper maintenance practices are employed and equipment is repaired or replaced proactively, it would be assumed that base failure rates would be similar to the average rates seen in the industry. Since all age-related degradation issues (e.g., corrosion) cannot be captured by even the best maintenance programs, a factor of 2.0 has been included in the base failure rates for equipment more than 20 years old. Since all equipment would be new for the Project, this factor would not be relevant.

The average base failure rate for a group of equipment was quantified by examining the range of failure rates between the different databases (WASH, Lees, HLID, Rijnmond, and Center for Chemical Process Safety) and assigning the higher failure rates to equipment in corrosive service and receiving less maintenance. For example, the failure rates for a rupture of process piping, from a number of reputable studies, range from a very high rate of once every 40,000 meter-years to a very low rate of once every 11 million meter-years (WASH1400, Lees, Center for Chemical Process Safety, and Rijnmond). This results in an average failure rate of about once every 1.9 million meter-years. The higher values are assumed to correlate to facilities that operate under corrosive service and below-standard maintenance. The lowest rates are assumed to correlate to facilities that have less- or non-corrosive service and the highest standards of maintenance. The proposed Project facilities were assumed to be new with less- or non-corrosive service because they are associated with relatively sweet gas, rather than very sour gas.

Appropriate maintenance was determined from the State of California Safety Orders, the Uniform Fire Code, National Fire Protection Association (NFPA), and API, as well as industry practice. Appropriate maintenance would include:

- An established computerized maintenance management system, including record keeping, design review, maintenance checklists, diagnostics recording, preventative scheduling, and monitoring.
- For piping and pipelines, visual and ultrasonic or non-destructive testing inspections for corrosion (per API 574) and cathodic potential inspections (for underground piping), as is conducted on many pipelines utilizing smart pigs and cathodic potential systems. Pipe coating would be maintained to protect against weathering, and pipe bracing should be maintained for seismic considerations. The frequency of non-destructive testing of process piping would be a function of the corrosiveness of the service. However, a baseline should be established for older piping.

- For vessels, external and internal visual and ultrasonic testing should be conducted every 5 years. Maintenance of vessel bracing and bolting for seismic considerations. Pressure relief to safe locations, preferably closed systems.
- For atmospheric tanks, ultrasonic wall testing every 5 years, bottom examination every 10 years, and appropriate seismic design considerations to prevent failure in an earthquake.
- For valves, checking for small leaks more than once per year, since small leaks are frequently precursors to larger leaks and ruptures. Valves should also be exercised at least annually to ensure operational effectiveness, and should be refurbished periodically, including seal and seat refurbishment or replacement, according to manufacturer's recommendations. Pressure relief valves should be pressure checked annually. Pressure relief valves that fail the annual test should be retested within 6 months.
- For rotating equipment, such as pumps and compressors, appropriate maintenance may involve replacing seals, oil maintenance, and a number of other operations according to the manufacturers' recommendations. Also, design issues are important, such as redundant systems that allow for more frequent maintenance activities, pressure relief systems that vent to a safe location, and seismic bracing for piping and equipment.
- For sensor equipment, such as lower explosion level, fire eyes, and H_2S sensors, appropriate maintenance would involve replacing sensors when new technology presents a significant improvement in reliability, and conducting quarterly inspections and testing to ensure operational effectiveness.
- For control systems, such as level, pressure, vibration, and temperature, annual testing including system actuation to ensure operation.
- Emergency shutdown systems should be checked and exercised annually.
- For fire water systems, testing and exercising annually, pressure testing water header, verification of flow alarms, fire pumps weekly inspection and annual performance test, foam system sampled and analyzed annually.

Pipelines

Transportation by pipeline is one of the safest forms of transportation. Nonetheless, failures do occur, resulting in fatalities, injuries, and property damage. The recent failure of a 30-inch gas transmission pipeline in a residential area of San Bruno, California, garnered extensive media coverage when it caused seven fatalities and numerous serious injuries and destroyed homes. The San Bruno release reportedly continued for more than 1 hour, which exposed the surrounding area to extensive thermal radiation damage. Spectators reported flames as high as 1,000 feet.

The gas pipeline installed along Colima Road as part of the proposed Project would operate at a higher pressure than the gas pipeline in San Bruno (up to 500 psi for the proposed Project compared to 375 psi at San Bruno), but would only be 6 inches in diameter for the proposed Project (compared to 30 inches in diameter for the San Bruno pipeline). However, it could still create significant risk levels.

Incidents associated with gas pipelines are compiled by the DOT, Pipeline and Hazardous Materials Safety Administration. Between 1990 and 2009, 1,764 total incidents on gas transmission pipelines caused 35 fatalities and 182 injuries. Gas pipeline failure frequencies utilized the DOT failure rates for gas pipelines. The base rate of pipeline failure is $2.83x10^{-4}$ incidents per mile. This rate is for transmission pipelines only and encompasses 5.6 million pipeline-operating years. Based on detailed data compiled by the OPS from 2002 to 2004, 63 percent of incidents produced leaks and 37 percent produced ruptures. This analysis used these leak and rupture rates.

The OPS database also lists incidents by cause, which are listed in Table 4.3-2. Corrosion, both internal and external, third-party excavation, equipment failures, and 'other' activities are the leading causes of gas pipeline incidents.

Table 4.3-2 DOT National Gas Transmission Pipelines Incident Causes

Cause	Percentage
Corrosion	22.1
Third party damage	19.3
Equipment failure	20.6
Other	23.8
Environmental	12.0
Operational Error	1.8

Source: DOT website, data from 1990-2009

PHMSA data for California indicates that the largest fraction of natural gas transmission pipeline failures (45 percent) was from third-party excavation activities that struck the pipeline and caused a release.

Earthquakes

During earthquakes, ground vibrations and subsequent liquefaction of the earth under structures can collapse and damage buildings and processing equipment. There is no exact correlation between earthquake Richter scale magnitude and ground acceleration values. Earthquakes measuring the same Richter scale value can generate different acceleration values, and thereby equipment damage, depending on the depth and type of ground shaking. For example, the 1994 Northridge earthquake had a magnitude of 6.7 and a peak ground acceleration of 0.94g (g being the acceleration of gravity), whereas the 1971 San Fernando earthquake had a magnitude of 6.7 and a peak ground acceleration of 1.25g.

The distance between the epicenter and the estimated peak acceleration location can also vary. The estimated distance to the peak ground acceleration in the Northridge earthquake was double the distance in the San Fernando earthquake. The distance to the peak acceleration value can be as much as 24 miles. This indicates that areas of damage are not limited to the epicenter of an earthquake.

Equipment damage can be understood by examining damage to equipment during past earthquakes.

This report examined reconnaissance reports published by the Earthquake Engineering Research Institute for these earthquakes (the reports are not available for all earthquakes):

- Imperial in 1979;
- Northridge in 1994;
- Coalinga in 1983;
- Santa Barbara in 1978;
- Whittier Narrows 1987; and
- Loma Prieta in 1989.

The 1987 Whittier Narrows earthquake damaged more than 10,000 buildings in the Whittier area and destroyed 123 single-family homes. The earthquake measured 5.9 on the Richter scale and produced a peak measured acceleration of 0.63g 6 miles from the epicenter. During the Whittier Narrows earthquake process equipment was damaged, including a large chlorine tank dislodged while being filled, releasing 240 gallons of chlorine. The reports do not state whether it was anhydrous (in a pressurized tank) or aqueous chlorine (in an atmospheric tank), although both could produce a toxic cloud of chlorine.

Among the earthquakes examined for this report, most process industry equipment damaged during the earthquakes was related to atmospheric oil or water storage tanks that ruptured or developed severe seam leaks. Piping connected to the atmospheric tanks often ruptured. Vessels that were not anchored showed some sliding and pipes leaked when the equipment shifted. However, no pressurized vessels failed and no gas liquids (e.g., propane or natural gas liquids) were released during any of the studied earthquakes.

The California Department of Conservation's Division of Oil, Gas and Geothermal Resources (DOGGR) 1984 annual report presents results of drill operator surveys in the Coalinga area to assess damage to drilling and processing equipment after the 1983 magnitude 6.3 Coalinga earthquake (with a peak ground acceleration of 0.54g measured 5 miles away, although no accelerometers were located in Coalinga). The survey indicated that more than 40 atmospheric tanks significantly leaked due to the earthquake. Impact to vessels, compressors, and processing equipment was limited to some shifting and failed equipment tie-downs and fittings, but there were no significant material releases. Some wells sustained damage to downhole casing, but no releases occurred.

Earthquakes are difficult to assess in a QRA. Earthquakes can have a range of magnitudes and ground acceleration values, and their impact on equipment is a function of the ground shaking characteristics as well as acceleration. The approach taken in this study is similar to that used as part of the Environmental Protection Agency (EPA) Resource Management Plan and the California Accidental Release Program. Seismic probability assessments are conducted on a facility to estimate the maximum credible earthquake, and seismic engineers assess the equipment to ensure that it can withstand an earthquake of the maximum credible magnitude. Any deficiencies are corrected to ensure that the facility is seismically safe. This approach essentially assumes that, given good seismic engineering practices and design, a rupture release would not occur in the event of the largest credible earthquake. This approach is supported by the earthquake damage reports discussed that provide evidence of the advantages of good engineering design. However, it is assumed that atmospheric storage tanks would fail given a large magnitude earthquake producing peak ground acceleration values exceeding 0.50g. A peak ground acceleration value of 0.50g would occur approximately once every 1,000 years for the Project Site location, based on the US Geological Survey analysis, and this value is included in the atmospheric tank failure frequency.

There are several sources of variation in the failure rate numbers. These sources include the equipment types and boundaries; the severity of the processes; the application and environment of the equipment; the equipment's age and maintenance history; construction suitability; and interpretations of data gathering at the facility levels.

It should be emphasized that the approach taken to estimate the equipment failure rates in this study is an approximation. The large number of variables involved and the relatively sparse information available, particularly related to age influences on equipment failure rates, necessitates a best estimate approach. Ideally, the most accurate data would be obtained from several facilities exactly like the proposed Project, using the same methods to gather data, the same type of equipment, and the same services over many years. Unfortunately, failure data is not gathered specifically enough to obtain statistically significant numbers for the exact variables that match the facility. For example, all of the databases include some equipment that is old and some that is relatively new, so there is some duplication in the approach to estimating equipment failure rates and the associated rates as a function of age.

The Center for Chemical Process Safety includes the variability in frequency numbers and provides a high, low, and a mean value for a range of equipment. These ranges show that frequency numbers for equipment average a high of 3.6 times the mean, and a low of 0.0042 times the mean failure rate value.

Consequence Analysis

The consequence analysis and hazard modeling consider the physical effects of a release and its damage to people. The analysis judges the severity of potential hazards associated with accidents and their possible consequences.

Risk assessments typically evaluate fire, flammability, explosion, and toxicity. Fire and flammability hazards are relevant for flammable vapors with relatively low flash points, such as propane and methane; their hazard is usually thermal radiation from vapor jet or pool fires. In addition, larger vapor jet fires can also lead to a loss of structural integrity of other storage or process vessels. The temperature in flame jets is usually high, and flame impingement onto nearby equipment is of the greatest concern.

The release and ignition of flammable vapors may also cause an explosion. The blast overpressure hazard depends on the nature of the chemical, the strength of the ignition source, and the degree of confinement. Finally, toxic chemicals can produce adverse effects to humans. The degree of these effects depends on the toxicity of the material and the duration of the exposure.

Performing state-of-the-art hazard assessment requires a combination of sophisticated analytical techniques and extensive professional experience. The models in this analysis are the result of more than two decades of development, and they have been validated using large-scale field tests. They have also been computerized for ease of use; they operate on personal computers. While a large number of consequence models are available, only a few specific models were needed to assess the hazards identified as part of this study.

The hazard assessment models used as part of this analysis can be categorized into two groups:

- Release rate models; and
- Vapor dispersion models.

The following sections discuss the general characteristics of each of the models used in this analysis. Specific models used in the analysis were selected based on the scenarios identified in the hazard identification task.

Release Rate Models

Several models were utilized to simulate potential releases of gas, liquefied petroleum gas, natural gas liquids, and crude vapor, and two-phase releases from pipes and vessels.

One of the first steps in consequence modeling is to establish the source terms (i.e., release rate, temperature, pressure, and velocity) associated with each scenario. The release rate is the rate at which the material is released from the pipe or vessel to the atmosphere. Before the source terms can be estimated for each scenario identified in the hazard analysis, the thermodynamic and physical properties of each hydrocarbon stream must be characterized. The thermodynamic and physical properties of the hydrocarbon streams were estimated using the IoMosaic SuperChems™ model, which utilizes numerous thermodynamic and physical property estimation techniques.

The SuperChems™ model simulates the release of multi-component liquid and vapor streams characteristic of the potential releases associated with the facility. For this study, these models are useful in assessing the effect of multi-component streams on vapor cloud flammability characteristics.

<u>Two-Phase Flashing Flow Model</u>

This is a critical two-phase flashing flow and multi-component liquid discharge model based on methodology validated by experimental data in recent literature. The data have demonstrated that, for a pipe length exceeding approximately 4 inches, regardless of pipe diameter, there is enough residence time for a discharging flashing liquid to establish isentropic equilibrium in the pipe. Using an established method, the Slip Equilibrium Method, the model does a friction calculation based on average vapor and liquid mixture properties and sequentially solves the equilibrium and mechanical energy balance equations, accounting for the pressure reduction, and recalculating the mixture properties for adiabatic expansion. The output of the model gives a mass release rate and defines the properties of the exiting hydrocarbon aerosol mixture.

This model was used to estimate release rate characteristics for the scenarios where potential aerosol formation could occur as a result of rapid vessel or pipeline decompression and cooling, or where pressurized liquids (e.g., gas liquids) could be released.

Steady and Non-Steady Release from a Pressurized Vessel or Pipeline

These numerical steady and non-steady state flow models are used to compute multi-component liquid and vapor release rates from a ruptured valve or pipeline. The steady-choked and un-choked flow models compute a single release rate assuming uniform pressure and temperature in the vessel; in most blow-down processes from pressure vessels, the pressure inside is sufficiently high that choked flow (i.e., releases at sonic velocity) conditions exist during most of the blow-down period. However, in smaller pressure vessels, or for relatively larger release rates, the conditions inside the vessel are not steady. The pressure drop influences the flow velocity and, thus, the mass flow rate. In addition, the density and temperature inside the vessel are also changing. The unsteady state models compute a time-dependent release rate profile based on the chemical component properties.

The modeling method for release rate is to simulate the initial and the average release rate from a pipe or vessel rupture based on the operating conditions: the temperature, pressure, and composition. The initial release rate is then assumed to be steady for the duration of a flammable release (the average release rate is used for a toxic release) until the process inventory is expelled or a system shutdown intervenes.

Dispersion Models

Among the models required for hazard assessment, vapor dispersion models are perhaps the most complex. This is due to the varied nature of release scenarios, as well as the varied nature of the chemicals that may be released into the environment. The user must select the exposure limit carefully, to reflect both the impact of interest (e.g., fatality, serious injury, injury) and the scenario release conditions (particularly the duration of the release).

In dispersion analysis, gases and two-phase vapor-liquid mixtures are divided into three general classes:

- Positively buoyant;
- Neutrally buoyant; and
- Negatively buoyant.

These classifications are based on density differences between the released material and its surrounding medium (air) and are influenced by release temperature, molecular weight, ambient temperature, relative humidity, and the presence of aerosols.

Initially, density of the release affects the dispersion process. A buoyant release may increase the effective height of the source. By the same token, a heavier-than-air release will slump towards the ground. For heavier-than-air releases at or near ground level, the initial density determines the initial spreading rate. This is particularly true for large releases of liquefied or pressurized chemicals, where flashing of vapor and formation of liquid aerosols contributes to the initial effective vapor density and, therefore, to the density difference with the air. This is particularly true for gas releases where significant cooling of the released material occurs due to expansion of the gas from the pipe pressure to atmospheric pressure.

Results of recent research programs dramatically indicate the importance of heavy gas dispersion in the area of chemical hazard assessment:

- The initial rate of spreading is large and is dependent on the differences between the effective mean vapor density and the air density.
- The rapid mixing with ambient air due to slumping leads to lower concentrations at shorter distances than those predicted using neutral density dispersion models.
- There is very little mixing in the vertical direction and, thus, a vapor cloud hugging the ground is generated.
- When the mean density difference becomes small, the subsequent dispersion is governed by prevailing atmospheric conditions.

Since heavy gas dispersion occurs near the release, it is particularly important when considering large releases of pressurized flammable chemicals.

In addition, dispersion analysis is also a function of release modes, which are divided into several categories:

- Instantaneous release (puff);
- Continuous release (plume);
- Momentum-dominated continuous release (jet); and
- Time-dependent continuous releases (jet/plume).

For instance, a momentum-dominated jet will dilute much faster than a plume due to increased entrainment of air caused by the jet. This is especially important when simulating the release of compressed gases.

In addition to the effects of initial release density, the presence of aerosols, release rate and quantity, release duration, and mode of release, dispersion analysis also depends on:

- Prevailing atmospheric conditions;
- Limiting concentration;
- Elevation of the source;
- Surrounding roughness and terrain; and
- Source geometry.

Prevailing atmospheric conditions include a representative wind speed and an atmospheric stability class. Less stable atmospheric conditions result in shorter dispersion distances than more stable weather conditions. Wind speed affects the dispersion distance inversely. Because weather conditions at the time of an accident cannot be determined a priori, it is usually prudent to exercise the model, at a minimum, for both typical and worst-case weather conditions.

Limiting concentration is the concentration at which human health effects would begin to occur. It affects the dispersion distance inversely. Lower concentrations of concern lead to larger dispersion distances. As with source release rate, the effect is non-linear. For example, for steady state releases, a factor of 100 reduction in the limiting concentration results in an increase in the dispersion distance by a factor of approximately 10.

Source elevation is attributed to the physical height of the source (such as a tall stack). In general, the effect of source height is to increase dispersion in the vertical direction (since it is not ground restricted), and to reduce the concentration at ground level.

Surrounding roughness and terrain affect the dispersion process greatly. Roughness is defined as involving trees, shrubs, buildings, and structures, while terrain is defined as hills and general topology. Roughness usually enhances dispersion, leading to a shorter dispersion distance than predicted using a smoother, or lower, roughness factor.

Source geometry refers to the actual size and geometry of the source emission. For example, a release from a safety valve may be modeled as a point source. However, an evaporating pool may be very large in area and require an area source model. Source geometry effects are significant when considering near field dispersion (less than ten times the characteristic dimensions of the source). At farther distances, the source geometry effects are less significant and eventually negligible.

Plume Dispersion Models (Atmospheric)

For the estimation of hazard zones for low to zero velocity releases involving flammable or toxic materials, a set of neutrally buoyant Gaussian plume models are available. The effects of initial density are usually small in the computation of far field dispersion zones. The most relevant release characteristics affecting the extent of vapor dispersion are the release rate (or quantity), the release duration, the limiting concentration, and the ambient conditions.

Several mathematical variations are included in the models. They have also been computerized as part of the IoMosaic SuperChems™ modeling package for ease of use. Additional models, rigorously evaluated, are available in the public domain. These models have been validated using large-scale field tests and wind tunnel experiments. The variations in these models consider the details of the source effects (as opposed to the virtual source method). They include:

- A continuous line or plane source model (to approximate finite size source effects from evaporating pools, overflowing dikes, etc.);
- A continuous point source plume model (isolated stack) including effects of buoyancy and momentum (jets);
- A finite duration point source model for concentration;
- A finite source duration and receptor duration to model dose effects from a point source; and
- A finite duration "probit" model which accounts for a non-linear dose response relationship.

As a function of downwind distance, each of these models evaluates concentration and cloud width at both source and ground level.

Dense Gas Dispersion Model

The SLAB model for dense gas dispersion was used to model the high pressure gas releases and the gas liquids releases. This model has been validated against experimental data and is available in the public domain. It is appropriate for gas releases, which become cold when they expand from high pressure to atmospheric pressure upon escape from a pipe or vessel. The SLAB model includes the effects of air entrainment into high speed jets of gas, the gravity effects on cold dense gases which cause the cloud to slump and spread, the warming of the cloud and the transition to a passive Gaussian dispersion. NTIS publication DE91-008443, available from the EPA, contains more details on the SLAB model.

A number of sources discuss the effects of jet entrainment and momentum dominated jets, including Lees's "Loss Prevention in the Process Industries," and the CCPS's "The Use of Vapor Cloud Dispersion Models" and "Vapor Cloud Source Dispersion Models Workbook." The Center for Chemical Process Safety discusses jet entrainment and momentum dominated jets. For releases from pressurized pipes and vessels, if the pressure exceeds two times the ambient pressure, then the flows are generally sonic, with speeds up to 400 m/s, and produce significant jet entrainment issues.

Several studies have validated the jet models in large-scale controlled releases at the Burro trials, Coyote trials, Desert Tortoise, and the Goldfish trials (Chan and Ermak 1983, Koopman 1983, and Morgan 1983).

It should be noted that using a jet model for the near-field dispersion produces smaller hazard zones than a simplified Gaussian model because the jet effects of a gas released from a pressurized source entrain large amounts of air. This entrained air causes more rapid dilution of the streams and, in combination with temperature and density effects, subsequently smaller hazard zones. Jet effects can reduce hazard zone estimates by up to 50 times over the simplified Gaussian estimates (CCPS, Lee). Given the extensive field validation of the effects of jets and near-field air entrainment, it is believed that the jet models are a more realistic estimate of hazard distances than the simplified Gaussian models.

Flame Jet Model

This model is designed to simulate turbulent diffusion flames (flame jets) and can characterize the turbulent flame length, diameter, temperature, and thermal radiation effects. This model is capable of simulating inclined turbulent jets, radiation fields, and the aerodynamic effects on radiant energy and flame stability. This model was used for all scenarios where potential flammable vapor releases were identified.

Unconfined and Partially Confined Vapor Cloud Explosion Model

A partially confined deflagration model was used to estimate overpressure levels for each flammable vapor release considered. This model is a theoretical one-dimensional model for predicting overpressures within several geometric configurations, and it accounts for the non-ideal behavior of burnt and unburnt gaseous components during high-pressure venting and multi-reaction chemical equilibrium. The pressure-time histories within the explosion chamber (i.e., confined space or vapor cloud) are calculated by the model and are in generally good agreement with small- and large-scale experimental data on methane-air, propane-air, and hydrocarbon mixture vented and unvented explosions. Explosion potential is expressed in terms of trinitrotoluene (TNT) equivalence, and well-known shock wave propagation relationships are used to estimate overpressure levels at specified distances from the explosion.

The potential for unconfined vapor cloud fires and explosions were also assessed using the IoMosaic SuperChems™ model. The potential for a vapor cloud explosion versus a vapor cloud fire was assessed based on the physical characteristics of the hydrocarbon stream. Parameters that influence the potential for, and consequences of, a vapor cloud explosion include:

- Characteristics of ignition sources;
- Flame acceleration mechanisms;
- Deflagration to detonation transitions;
- Direct initiation of detonations;
- Overpressure levels within the combustion zone;
- Effects of pressure rise time dependency on structures versus TNT curves;
- Minimum amount of mass sufficient to sustain an unconfined vapor cloud explosion;
- Partial vapor cloud confinement and flame reflection characteristics; and
- Explosion efficiencies.

The SuperChems™ model was used to assess whether or not enough flammable mass could accumulate to sustain an unconfined vapor cloud explosion (a relatively large amount of flammable mass is required for the flame front in the vapor cloud to gain sufficient speed to result in a pressure wave within the vapor cloud). In most cases, the amount of flammable mass or the levels of confinement were not sufficient to sustain an unconfined vapor cloud explosion. In other cases, modeling results showed that vapor cloud ignition would be characterized by a deflagration (i.e., sub-sonic flame velocity) and would not transition to a full detonation (i.e., supersonic flame velocity).

Boiling Liquid Expanding Vapor Explosion Model

A boiling liquid expanding vapor explosion is a sudden loss of containment of a liquid that is above its boiling point (at atmospheric conditions). A boiling liquid expanding vapor explosion results in a sudden, vigorous liquid boiling and the production of a shock wave. Liquids stored under pressure (such as the gas liquids) fall into this category as well as any liquid that is stored at an elevated temperature above its boiling point. The main hazards presented by liquids stored under pressure are fireball and radiation.

Boiling liquid expanding vapor explosions were modeled using the SuperChems™ model for fireballs. The approach estimates the total energy that could be produced by the material combustion and the duration of the explosion. Impacts are estimated by integrating the energy flux over the time that the explosion occurs at different distances from the source of the explosion. Overpressure due to boiling liquid expanding vapor explosion was also estimated assuming the vessel fails due to overpressure, and the resulting shockwave is dissipated into the environment. The larger of the hazard zones pertaining to boiling liquid expanding vapor explosions (either overpressure or thermal radiation) was used to estimate risk.

Recent incidents indicate the extent to which gas liquid releases can cause impacts. In December 2006, a propane gas leak in a Milwaukee plant led to an explosion, killing three people and injuring 46 others. The explosion knocked workers off their feet, broke windows in nearby houses and businesses, and scattered burning debris over several blocks. Concussions from the blast were felt miles away (LA Times 2006).

A 1998 incident in Iowa provides valuable lessons regarding propane tank fires and boiling liquid expanding vapor explosions. Vehicle impact sheared ¾ liquid pipe off of an 18,000-gallon propane tank. The excess flow valve on the line was not sized correctly and did not close. The resulting fire engulfed the tank, subsequently causing a boiling liquid expanding vapor explosion. Fire department personnel set up too close to the tank (100 feet) and two people were killed. Fragments thrown from the blast caused additional fatalities.

An incident on October 6, 2007, in Tacoma, Washington, involved a propane tanker truck and propane storage vessels. Reports indicate that a propane-truck driver off-loaded propane that may have leaked. Nearby welding may have created sparks that ignited the fumes. The propane tanker subsequently exploded, apparently damaging the propane storage tanks. The thermal impacts to the propane storage tanks caused the pressure relief devices on the propane storage tanks to relieve, sending a flame jet high into the air. The tanks continued to vent propane and produce a flame jet for multiple hours. The explosion was so intense that part of the tanker truck landed on a nearby highway. Video of the explosion was available on the internet. Video taken approximately 0.25 miles from the explosion indicated a large fireball. However, no overpressure impacts were felt at the video location except for car alarms activated by the pressure wave.

This incident serves to highlight the type of impacts that external events can have on active firefighting equipment, such as deluge systems. The explosion of the propane truck or the flame jets and high thermal impacts of releases effectively would have destroyed any fire-fighting capability of the deluge system. This is why deluge systems are assigned a relatively high failure rate in the fault trees.

Fatality and Serious Injury Rates

Since the release streams are flammable, releases could potentially result in thermal radiation exposure from a fire, and also present an overpressure hazard due to explosions from flammable vapor clouds or boiling liquid expanding vapor explosions. Damage criteria were developed in order to quantify the potential consequences of an accidental release. Damage criteria are defined as the levels of exposure that could produce fatalities and produce serious injuries.

Serious injury is defined as an impact from the exposure that could require medical intervention and could produce effects that last significantly longer than the duration of the exposure. An injury such as lung damage that would require hospitalization and/or other types of therapy would be considered a serious injury.

Thermal Radiation Damage Criteria

The potential concern associated with large-scale compressed gas vapor jet fires is thermal radiation intensity, and its effects on persons, the surrounding structures, processes, and fire suppression equipment. Table 4.3-3 presents an overview of thermal radiation intensity and observed effects. Data presented in these tables show that no considerable physical effect would result from exposure to a radiation intensity between 1 and 1.6 kW/m^2 over extended periods. Exposure to a radiation intensity of 5 kW/m^2 would result in pain if the exposure period were to exceed 13 seconds, and it would result in second-degree burns after 40 seconds. Exposure to a radiation intensity of 10 kW/m^2 would result in pain (5 seconds) and second-degree burns after short exposure periods (i.e., 14 seconds), and death after longer periods.

Table 4.3-3 Thermal Radiation Serious Injury and Impacts

Intensity (kW/m^2)	Impact
1	Time for severe pain - 115 seconds Time for second-degree burns - 663 seconds [a]
1.6	No discomfort for long exposure [b]
2	Time for severe pain - 45 seconds Time for second-degree burns – 187 seconds [a]
3	Time for severe pain - 27 seconds Time for second-degree burns - 92 seconds [a]
4	Time for severe pain - 18 seconds Time for second-degree burns - 57 seconds [a]
5	Time for severe pain - 13 seconds Time for second-degree burns - 40 seconds [a]
10	Time for severe pain - 5 seconds Time for second-degree burns - 14 seconds Time for 100% fatality - 270 seconds [a c]
12.5	Melting of plastic tubing [b]
25	Minimum energy to ignite wood [b]
37.5	Damage to process equipment [b]
100	Time for severe pain - <1 seconds Time for second-degree burns - 1 sec Time for 100% fatality - 11 seconds [c]

a. Based on Handbook of Chemical Hazard Analysis Procedures, FEMA
b. CCPS Chemical Process Quantitative Risk Analysis
c. CCPS Chemical Process Quantitative Risk Analysis using probit equation by Eisenberg

The time required to reach pain, second-degree burn, and fatality thresholds were used to estimate radiation levels that would result in serious injury or fatality. Persons exposed to thermal radiation have the opportunity to move away from the hazard, unlike overpressure effects or vapor cloud fires and explosions, which are instantaneous. It was assumed in this analysis that some people not within the flame area would move away from the flame to get away from the heat. Analysis of the distances to various radiation levels indicates that this is feasible. Therefore, a less than 1 minute exposure was used as the basis for determining the damage criteria. Exposure to a thermal radiation level of 10 kW/m^2 could result in a serious injury (at least second-degree burns) if exposed for less than 1 minute, and it was, therefore, assumed that all persons exposed to 10 kW/m^2 would suffer serious injuries. Serious injuries would start to be realized at and above 5 kW/m^2. Exposure to thermal radiation levels in excess of 10 kW/m2 would likely begin to generate fatalities in less than 1 minute. All persons exposed to thermal radiation within the flame area were assumed to suffer fatalities regardless of exposure duration.

Flammable Vapor Criteria

A release of flammable material can produce impacts by producing a cloud of the flammable material that, if it encounters an ignition source, either explodes or burns (deflagration) back to the material source. Persons located within the cloud when it explodes or burns could be seriously impacted. Whether the cloud explodes or burns is a function of the material and the level of confinement in the environment in which the cloud is located (e.g., within pipe racks, between buildings).

All release scenarios from the proposed Project could contain flammable vapors. Potential ignition sources onsite are primarily located in the gas plant with fewer ignition sources throughout the field mostly associated with drilling or well workover operations or compressors or pumps.

Several biological and structural explosion damage criteria were reviewed, specifically the Center for Chemical Process Safety "Evaluating Process Plant Buildings for External Explosions and Fires" and Center for Chemical Process Safety "Chemical Process Quantitative Risk Analysis." This reference indicates that persons within a structure suffer considerably more damage than persons in the open due to overpressures. This is primarily due to secondary object impacts. Table 4.3-4 details the levels of impacts at various overpressure levels to buildings, equipment and persons.

An overpressure level of 0.3 psi would likely result in broken windows and some potential for serious injury. Complete structural damage and serious injury/fatality could occur for wooden buildings and unreinforced masonry as a result of exposure to an overpressure level of 1.0 psi. An overpressure level of 5.0 psi would result in structures being completely destroyed and an estimated 100 percent serious injury/fatality to building occupants.

Deflagration of the vapor cloud would produce impacts to persons located within the flammability limits of the vapor cloud. Persons located within the lower flammability limit would most likely suffer at least serious injuries. As there is some natural variability within the cloud, it is assumed that persons located within the area that would be encompassed by a level of concern equal to one-half the lower flammability limit (a larger area than the lower flammability limit area) would suffer serious injuries.

Table 4.3-4 Overpressure Damage

Overpressure Level	Impact
0.04	Loud noise, sonic boom (143 dBA)
0.15	Glass breakage
0.30	Center for Chemical Process Safety projectile limit, 10% broken window glass, 95% no serious damage
1.0	Wood trailer roof and walls collapse Unreinforced masonry building partial collapse Estimated 10% injury rate
5.0	Wood trailer completely destroyed Unreinforced masonry building completely destroyed Utility poles snapped Estimated 100% injury rate
6.0	Reinforced building major damage/collapse Estimated 40% fatality rate
7.0	Loaded train wagons overturned
12.0	Reinforced building completely destroyed Estimated 100% fatality rate
15.0	Lung hemorrhage, lower range of direct human fatalities

Source: CCPS 1989

Table 4.3-5 details the criteria selected for the risk analysis for both fatalities and serious injuries. In this table, the zero percent fatality or serious injury level is the level at which fatalities or serious injuries could begin to occur.

Odorant Toxic Vapor Criteria

Toxicological information on tetrahydrothiophene is sparse. However, the National Institute for Occupational Safety and Health (NIOSH) does indicate some toxicity levels for mice and rats, which can be extrapolated to human impacts based on factors of safety for other, better known materials.

A search of the National Library of Medicine's Hazardous Substance Data Bank (HSDB) produced information related to animal toxicity and reports of worker exposures as well as DOT emergency recommendations.

The Registry of Toxic Effects of Chemical Substances (RTECS) by NIOSH indicates that the lethal inhalation concentration of tetrahydrothiophene for a mouse is 27 grams/meter^3 for 2 hours. This is equivalent to approximately 7,300 parts per million (ppm). Using the probit method (with an estimated power factor [n] of 1.5, which defines the curve between lethal dosage and time) results in a lethal inhalation concentration for a mouse of approximately 11,800 ppm per hour exposure. For comparison, the lethal inhalation concentration for a rat for hydrogen sulfide, a well studied lethal and odiferous gas, is 713 ppm per hour. The comparison to hydrogen sulfide is made because of the number of detailed studies of hydrogen sulfide, not because of any similarity in chemical composition.

Using the same factors of safety for tetrahydrothiophene as for hydrogen sulfide, hydrogen sulfide would produce equivalent emergency response planning guideline-2 and emergency response planning guideline-3 values of approximately 500 ppm and 1,600 ppm, respectively (AIHA 2005). In addition, to assess more minor injuries, such as those associated with exposure to strong odors, the hydrogen sulfide Occupational Safety and Health Administration Permissible Exposure Limit (OSHA PEL) of 15 ppm for 15 minutes (or 6 ppm per hour) was also compared. This would be equivalent to 100 ppm per hour of tetrahydrothiophene exposure.

Given the lack of available toxicity data on tetrahydrothiophene, emergency response planning guideline values have been estimated based on the factors of safety applied to lethal levels of hydrogen sulfide exposure for rats and mice. This produces an estimated fatality level at 1,000 ppm per hour and an estimated serious injury level at 100 ppm per hour exposure for tetrahydrothiophene.

Risk Analysis

The results of the failure rate and consequence analysis are finally combined to develop risk profile curves (plots of frequency versus the number of fatalities or serious injuries). These risk profile curves are commonly called risk profiles and represent "societal risk." This is the risk that a person could sustain serious injury or fatality. In calculating the risk profiles, a computer model of the pipelines, facility and surrounding area was prepared. The population distribution and probabilities of ignition were specified across the area of the model; and the likelihood of an individual fatality or injury occurrence was calculated at each grid location in the model.

The analysis has assumed that the facilities are operating at their current levels and that the populations near the facility are at their current estimated levels.

To develop the risk profile, many factors were considered. Each release scenario was evaluated for all wind directions, and for each combination of stability and wind speed. In any given direction of travel, the chances of having the particular wind stability class, the cloud igniting on-site, and the cloud igniting offsite at every downwind location from the release site was evaluated. The frequency of attaining the maximum downwind distances for flammable vapor dispersion will be reduced if the vapor cloud encounters ignition sources at the point of release or at any point along its travel path.

Table 4.3-5 Fatality and Serious Injury Rates

Event	Fatality	Serious Injury	Reference
Vapor Cloud Fire	30% fatality within the lower flammability limit	100% injury within the lower flammability limit 50% injury within ½ lower flammability limit	Assumes 30% of the population is outdoors and would suffer 100% fatalities within the lower flammability limit. Assumes indoor population would not suffer more than serious injury due to subsequent fire and damage. Outdoor population percentage estimated.
Thermal Radiation Jet Fire or Pool Fire	100% fatality within flame jet area 10% fatalities at 10 kW/m^2	100% injury at 10 kW/m^2 10% injury at 5 kW/m^2	Based on Handbook of Chemical Hazards Analysis Procedures, exposure to 10 kW/m^2 produces second-degree burns in 14 seconds, 10% fatalities at 60 seconds based on Eisenberg Probit Equation (1975). Injury based on time to second-degree burns of less than 1 minute for 10 and 5 kW/m^2.
Boiling Liquid Expanding Vapor Explosion: Radiation Dosages	10% fatalities at 80 kJ/m^2	100% injury at 80 kJ/m^2 10% injury at 25 kJ/m^2	Based on total energy integration over boiling liquid expanding vapor explosion duration using the jet fire energy rate.
Explosion: Over Pressure	10% fatalities at 1 psi	5% injury at 0.3 psi	Based on Center for Chemical Process Safety Process Plant Buildings (Table 4.8) where occupants of a building experience 10% fatality at 1 psi for an unreinforced masonry or wood framed building. Injuries produced at 0.3 psi overpressure assumed to be 5% as per the probability of serious damage.
Toxic	1,000 ppm 10% fatality	100 ppm 10% injury	Estimated based on OSHA exposure limits and animal studies.

Notes: kW/m^2 = kilowatts per square meter; kJ/m^2 = kilojoules per square meter; psi = pounds per square inch; ppm = parts per million

The approach for general calculations followed these steps:

- Summarize meteorological data into representative wind direction, wind speed and stability conditions;
- Construct a model of the site and surrounding area, including populations and population densities;
- Identify the ignition sources and enter the ignition probabilities;
- Select the release events, along with the likelihood of release, consequence data and release locations;
- Determine the event trees; likelihood and consequences of immediate ignition, vapor cloud fires, jet fires, and explosions as appropriate, for each condition;

- Determine the probability of ignition at each point along the path of a dispersing vapor cloud.
- Select another release event and repeat the preceding three steps;
- Apply conditional probabilities of fatality given exposure, for each type of consequence (i.e., thermal exposure, vapor cloud exposure);
- Aggregate the likelihood of all probabilities of fatality at each location in the model for all the release scenarios; and
- Construct risk profiles, or frequency number, of fatality curves by summing the number of fatalities for each event outcome and plotting the results against the frequency. This was also done for serious injuries.

Meteorological Data

Meteorological data was gathered for the Pico Rivera monitoring location. Atmospheric stability classes D and F were selected as characteristic wind stability conditions. Based on wind speed conditions for these stability classes, a wind speed of 4.0 m/s was selected for stability class D (neutral atmospheric stability), while a wind speed of 2.0 m/s was selected for stability class F (stable atmospheric conditions). The predominant conditions are generally wind from the west and west-southwest direction, although wind frequencies from all directions were used in the analysis.

Population Data

Population information was gathered for locations within 0.25 miles of the field. These locations are listed, along with the estimated populations, population densities, and ignition probabilities.

Populations at these areas were entered into the Quantitative Risk Assessment Model. Information was gathered from site visits, estimates of populations from housing counts generated from aerial photographs, and from Census data.

Ignition Probabilities

Flammable vapor clouds have the potential to ignite anywhere within their flammable limits. Hence, it is necessary to identify potential ignition sources that a cloud may encounter, and to quantify the likelihood of ignition if the cloud encompasses these sources. When determining ignition probabilities, there are two factors to take into account; source duration and source intensity. Source duration is the fraction of time that the source is present or in operation. Source intensity is the chance of the source actually causing ignition if contacted by a flammable cloud. For example, if a ground level flare is operating, it will almost always ignite a cloud, but it may only operate ten percent of the time. This would generate an overall chance of ignition by the ground level flare of 0.1 (or 10 percent).

In general, when trying to identify ignition sources, the search is primarily for open flames, hot surfaces and electrical sparks, and, to a lesser extent, friction sparks from both continuous and intermittent activities. Extensive listings of potential ignition sources and estimates of ignition probabilities may be found in the literature (CCPS 1989, UK 2004).

Typical ignition probabilities that were used in the analysis include:

- Cars – 0.06 per car; although many potential ignition sources within a car, such as faulty wiring or backfires, are due to fuel rich mixtures in intake air, they are not always present nor guaranteed to cause ignition. This value was also applied to golf carts (CCPS).
- Houses – 0.01 per house; while there are many ignition sources within a home (switches, doorbells, faulty wiring, pilot lights, smoking materials, fireplaces, and stoves), the flammable vapors must first penetrate the house before these ignition sources pose a hazard. Typical residence times of clouds are brief enough that this is relatively unlikely (CCPS).
- Industrial Areas – 0.1 for light industrial, 0.25 for medium industrial and 0.5 for heavy industrial areas. Heavy industrial areas are classified as having large motors, high temperature surfaces and open flames (UKHSE 2004).

In order to estimate the number of vehicles, traffic counts for particular roads were used along with average speeds to determine the density of vehicles per mile and probabilities of ignition along roadways.

The onsite equipment that would most likely produce ignition would be the compressor motors or flare at the gas plant. Releases of materials that, due to wind direction, move over the gas plant are assumed to experience ignition and not travel offsite.

Post Accident Event Trees

Event trees are used to determine the fate of a released material after the release has occurred. A release of a flammable material, for example, could experience instantaneous ignition leading to a flame jet. It could also disperse downwind, encounter an ignition source and burn or explode, or it could disperse safely. Table 4.3-6 shows the probability of each of these scenarios for rupture and leak events. These probabilities are based on Center for Chemical Process Safety recommendations (CCPS 1989). Larger releases, which involve greater energies associated with metal failure and/or impacts, have a higher probability of igniting at the source and causing a flame jet than smaller releases.

Construction of Risk Profiles

Risk profiles display the frequency with which public safety impacts/consequences (e.g., fatalities or serious injuries) exceed a given magnitude. They can be used to show property damage (among others), but are generally used for public safety impacts. The risk profiles indicate accident size (based on numbers of persons affected) and display how the potential number of fatalities varies as a function of frequency. Risk profiles are generally plotted on logarithmic scales because they span multiple orders of magnitude.

Table 4.3-6 Event Tree Probabilities

Event Tree: Rupture Events (large releases > 50 kilograms per second)

Event	Probability
Immediate Ignition	0.25
Vapor Cloud with Flash Fire	0.75

Event Tree: Leak Events (smaller releases <50 kilograms per second)

Event	Probability
Immediate Ignition	0.10
Vapor Cloud with Flash Fire	0.90

Event Tree: Gas Liquids Releases

Event	Probability
Immediate Ignition	0.08
Vapor Cloud with Flash Fire	0.90
Explosion/boiling liquid expanding vapor explosion	0.002 - .07*

* - depends on configuration
Source: CCPS 1989

There are many sources of uncertainty that affect the risk profiles. These uncertainties include:

- Release frequency;
- Release size;
- Population impacts, including distribution and likelihood of fatality/serious injury;
- Behavior of the release (jet mixing versus passive dispersion);
- Accuracy of the hazard models; and
- Ignition sources and probabilities.

The release frequencies and sizes are the most important contributors to overall uncertainty. Changes in failure rates will directly influence the risk profile. A doubling of the event frequencies would double the probability of fatalities. Changes in the relative sizes of leaks and ruptures will influence the risk profile, but to a lesser extent. The assumptions concerning population distribution and ignition probability also influence the risk profiles.

4.3.2 Regulatory Setting

Many regulations and standards exist to ensure the safe operation of oil and gas facilities, pipelines, and hazardous materials. This section gives an overview of the Federal and State regulations.

4.3.2.1 Federal Laws and Regulations

Federal laws address gas and liquid pipelines and oil and gas facilities.

Gas Pipelines

Natural gas pipelines are under the jurisdiction of the US Department of Transportation (DOT) and must follow the regulations in 49 CFR Part 192, Transportation of Natural Gas by Pipeline. This regulation addresses the following areas:

- Classification of pipeline;
- Pipe type and marking of pipe;
- Pipeline materials and design issues;
- Pipeline fittings and connections;
- Inspection of pipelines;
- Compressor stations and vaults;
- Installation of pipelines;
- Corrosion control; and
- Emergency plans.

Section 49 CFR 192.179 addresses transmission pipeline valves, and requires that, for Class 3 areas (areas where there are more than 46 buildings within 220 yards of a 1 mile section of pipeline, generally residential areas), gas pipelines are required to have a manually controlled valve every 4 miles. Section 192.935c requires that, "if an operator determines, based on a risk analysis, that an [automatically or remotely controlled valve] would be an efficient means of adding protection to a high consequence area in the event of a gas release, an operator must install the [automatically or remotely controlled valve]. In making that determination, an operator must, at least, consider the following factors—swiftness of leak detection and pipe shutdown capabilities, the type of gas being transported, operating pressure, the rate of potential release, pipeline profile, the potential for ignition, and location of nearest response personnel."

Liquid Pipelines and Oil Facilities

Hazardous liquid pipelines are under the jurisdiction of the DOT and must follow the regulations in 49 CFR Part 195, Transportation of Hazardous Liquids by Pipeline, as authorized by the Hazardous Liquid Pipeline Safety Act of 1979 (49 USC 2004). Other applicable Federal requirements are contained in 40 CFR Parts 109, 110, 112, 113, and 114, pertaining to the need for Oil Spill Prevention Control & Countermeasures Plans; 40 CFR Parts 109–114 promulgated in response to the Oil Pollution Act of 1990.

Overview of the 49 CFR 195 Requirements

Part 195.30 incorporates many of the applicable national safety standards of the:

- American Petroleum Institute (API);
- American Society of Mechanical Engineers (ASME);
- American National Standards Institute (ANSI); and
- American Society for Testing and Materials (ASTM).

Part 195.50 requires reporting of accidents by telephone and in writing for:

- Explosion or fire not intentionally set by the operator;
- Spills of 5 gallons or more, or 5 barrels if confined to company property and cleaned up promptly;
- Daily loss of 5 barrels a day to the atmosphere;
- Death or injury necessitating hospitalization; or
- Estimated property damage, including cleanup costs, greater than $50,000.

The Part 195.100 series includes design requirements for the temperature environment, variations in pressure, internal design pressure for pipe specifications, external pressure and external loads, new and used pipe, valves, fittings, and flanges.

The Part 195.200 series provides construction requirements for standards such as compliance, inspections, welding, siting and routing, bending, welding and welders, inspection and nondestructive testing of welds, external corrosion and cathodic protection, installing in-ditch and covering, clearances and crossings, valves, pumping, breakout tanks, and construction records.

The Part 195.300 series prescribes minimum requirements for hydrostatic testing, compliance dates, test pressures and duration, test medium, and records.

The Part 195.400 series specifies minimum requirements for operating and maintaining steel pipeline systems, including:

- Correction of unsafe conditions within a reasonable time;
- Procedural manual for operations, maintenance, and emergencies;
- Training;
- Maps;
- Maximum operating pressure;
- Communication system;
- Cathodic protection system;
- External and internal corrosion control;
- Valve maintenance;
- Pipeline repairs;
- Overpressure safety devices;
- Firefighting equipment; and
- Public education program for hazardous liquid pipeline emergencies and reporting.

Overview of 40 CFR Parts 109, 110, 112, 113, and 114

The SPCC covered in these regulatory programs apply to oil storage and transportation facilities and terminals, tank farms, bulk plants, oil refineries, and production facilities, as well as bulk oil consumers, such as apartment houses, office buildings, schools, hospitals, farms, and state and federal facilities as follows:

- Part 109 establishes the minimum criteria for developing oil-removal contingency plans for certain inland navigable waters by State, local, and regional agencies in consultation with the regulated community, i.e., oil facilities.
- Part 110 prohibits discharge of oil such that applicable water quality standards would be violated, or that would cause a film or sheen upon or in the water. These regulations were updated in 1987 to adequately reflect the intent of Congress in section 311(b) (3) and (4) of the Clean Water Act, specifically incorporating the provision "in such quantities as may be harmful."
- Part 112 deals with oil spill prevention and preparation of Spill Prevention Control and Countermeasure Plans. These regulations establish procedures, methods, and equipment requirements to prevent the discharge of oil from onshore and offshore facilities into or upon the navigable waters of the United States. These regulations apply only to non-transportation-related facilities.
- Part 113 establishes financial liability limits; however, these limits were preempted by the Oil Pollution Act of 1990.
- Part 114 provides civil penalties for violations of the oil spill regulations.

Overview of Chemical Facility Anti-Terrorism Standards, 6 CFR Part 27

The Federal Department of Homeland Security established the chemical facility anti-terrorism standards in 2007. This rule established risk-based performance standards for the security of chemical facilities. It requires covered chemical facilities to prepare Security Vulnerability Assessments, which identify facility security vulnerabilities, and to develop and implement Site Security Plans, which include measures that satisfy the identified risk-based performance standards.

Hazardous Waste Handling Requirements

Resource Conservation and Recovery Act and Associated Hazardous and Solid Waste Amendments, 40 CFR 260

Implementation of the Resource Conservation and Recovery Act (RCRA) resulted in the creation of a major federal hazardous waste regulatory program that is administered by the EPA. Under RCRA, the EPA regulates the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA was amended by the Associated Hazardous and Solid Waste Amendments (HSWA), which affirmed and extended the concept of regulating hazardous wastes from generation through disposal. HSWA specifically prohibits the use of certain techniques for the disposal of some hazardous wastes. Under RCRA, individual states may implement their own hazardous waste programs instead of RCRA, as long as the state program is at least as stringent as the federal RCRA requirements. EPA approved California's program to implement federal hazardous waste regulations on August 1, 1992.

Asbestos and Lead

National Emissions Standards for Hazardous Air Pollutants, 40 CFR 61 Subpart M

Under Subpart M, an asbestos containing materials survey must be performed prior to renovation or demolition activities. Notification of the lead agency is required 14 days prior to the start of work (disturbance of asbestos containing materials). Additional federal and state asbestos requirements related to US Occupational Safety & Health Administration (OSHA) standards in 29 CFR 1926.1101 are covered by the Asbestos Construction Standard, Title 8, CCR Section 1529.

Worker Protection Rule, 40 CFR 763, Subpart G, and 29 CFR 1910.1001. This rule provides worker protection measures through engineering controls, worker training, labeling, respiratory protection, and waste management, and sets the permissible exposure level for asbestos. The definition of asbestos containing materials is also provided in these regulations.

Emergency Planning and Community Right-to-Know Act

Under the Emergency Planning and Community Right-to-Know Act, or Title III of the Superfund Amendments and Reauthorization Act of 1986, the EPA requires local agencies to regulate the storage and handling of hazardous materials and requires development of a plan to mitigate the release of hazardous materials. Businesses that handle any of the specified hazardous materials must submit to government agencies (i.e., fire departments), an inventory of the hazardous materials, an emergency response plan, and an employee training program. The business plans must provide a description of the types of hazardous materials and waste onsite and the location of these materials. The information in the business plan can then be used in the event of an emergency to determine the appropriate response action, the need for public notification, and the need for evacuation.

Hazardous Materials Management Planning

Section 112(r) of the Clean Air Act Amendments of 1990, 40 CFR 68

The USEPA requires facilities that handle listed regulated substances to develop Risk Management Programs to prevent accidental releases of these substances. Stationary sources with more than a threshold quantity of a regulated substance shall be evaluated to determine the potential for, and impacts of, accidental releases from that process. Under certain conditions, the owner or operator of a stationary source may be required to develop and submit a Risk Management Program. Risk Management Programs consist of three main elements: a hazard assessment that includes offsite consequences analyses and a five-year accident history; a prevention program; and an emergency response program. Risk Management Programs for existing facilities were required to be submitted in 1999 and must be updated every five years.

National Contingency Plan Requirements

Spill Prevention Control and Countermeasures Plans, 40 CFR 112.3 and 112.7

Facilities that store large volumes of hazardous materials are required to have a Spill Prevention Control and Countermeasures Plans (SPCCP), per the requirements of 40 CFR 112. The SPCCP is designed to prevent spills from onsite facilities and includes requirements for secondary containment, provides emergency response procedures, establishes training requirements, and so forth.

Hazardous Materials Transportation

The Hazardous Materials Transportation Act, 49 CFR 171, Subchapter C

The DOT, Federal Highway Administration, and the Federal Railroad Administration regulate transportation of hazardous materials at the federal level. The Hazardous Materials Transportation Act requires that carriers report accidental releases of hazardous materials to DOT at the earliest practical moment. Other incidents that must be reported include deaths, injuries requiring hospitalization, and property damage exceeding $50,000.

Worker Health and Safety

Occupational Safety and Health Act, 29 CFR et seq.

Under the authority of the Occupational Safety and Health Act of 1970, OSHA has adopted numerous regulations pertaining to worker safety (29 CFR). These regulations set standards for safe workplaces and work practices, including the reporting of accidents and occupational injuries. Some OSHA regulations contain standards relating to hazardous materials handling, including workplace conditions, employee protection requirements, first aid, and fire protection, as well as material handling and storage.

<u>Hazard Communication, 29 CFR 1910.1200</u>

The purpose of the OSHA Hazard Communication law is to ensure that the hazards of all chemicals produced or imported are evaluated, and that information concerning any potential hazards is transmitted to employers and employees. This transmittal of information is to be accomplished by means of comprehensive hazard communication programs, which are to include container labeling and other forms of warning, material safety data sheets, and employee training.

<u>Process Safety Management, 29 CFR 1910.119</u>

Under this section, facilities that use, store, manufacture, handle, process, or move hazardous materials are required to:

- Conduct employee safety training;
- Have an inventory of safety equipment relevant to potential hazards;
- Have knowledge on use of the safety equipment;
- Prepare an illness prevention program;

- Provide hazardous substance exposure warnings;
- Prepare an emergency response plan; and
- Prepare a fire prevention plan.

In addition, 29 CFR 1910.119, Process Safety Management of Highly Hazardous Chemicals, specifically requires prevention program elements to protect workers at facilities that have toxic, flammable, reactive or explosive materials. Prevention program elements are aimed at preventing or minimizing the consequences of catastrophic releases of chemicals and include process hazard analyses, formal training programs for employees and contractors, investigation of equipment mechanical integrity, and an emergency response plan.

Emergency Action Plans, 29 CFR 1910.38

Under this section, facilities that are required to have fire extinguishers must also have an emergency action plan to ensure the safe response to emergencies. The purpose of an emergency action plan is to facilitate and organize employer and employee actions during workplace emergencies. At a minimum, the plan must include the following elements [29 CFR 1910.38(c)]:

- Means of reporting fires and other emergencies;
- Evacuation procedures and emergency escape route assignments;
- Procedures prior to evacuation for employees who remain to operate critical plant operations;
- Procedures to account for all employees after an emergency evacuation;
- Rescue and medical duties for responsible employees; and
- Identification of persons who can be contacted for further information or explanation of duties under the plan.

4.3.2.2 California Laws and Regulations

State laws address gas and liquid pipelines, oil and gas facilities, and hazardous materials and waste.

California Health and Safety Code

- Division 20, Chapter 6.5, §25100-25249, Hazardous Waste Control;
- Division 20, Chapter 6.95, §255500, et seq., Hazardous Materials Management Plan and Community Right-to-Know and Hazardous Materials Release Response Plans and Inventory (Business Plan Program);
- Proposition 65 Compliance, H&SC §25249.5 et seq.;
- H&SC §§25340-25392, Carpenter-Presley-Tanner Hazardous Substance Account Act; and
- H&SC §§25531-255413, California Accidental Release Prevention Program.

California Water Code

- Division 7, Water Quality (Porter-Cologne Water Quality Control Act)

California Code of Regulations

- Title 8, §1529, Asbestos Construction Standard;
- Title 8, §1532.1, Lead Construction Standard;
- Title 8, §5189, Accidental Release Plan;
- Title 8, §5192, Accidental Release Plan;
- Title 14, Division 2, Department of Conservation;
- Title 19, §2729, Employee Training Program;
- Title 22, Division 4, Chapter 30, Hazardous Wastes;
- Title 22, Division 4.5, §§66260-67786, Hazardous Waste Requirements; and
- Title 22, §66265.50-.56, Contingency/Emergency Response Plan.

Gas and Liquid Pipelines and Oil Facilities

Overview of California Pipeline Safety Regulations

State of California regulations Part 51010 through 51018 of the Government Code provide specific safety requirements that are more stringent than the Federal rules. These include:

- Periodic hydrostatic testing of pipelines, with specific accuracy requirements on leak rate determination;
- Hydrostatic testing by state-certified independent pipeline testing firms;
- Pipeline leak detection; and
- Reporting of all leaks required.

Recent amendments require pipelines to include means of leak prevention and cathodic protection, with acceptability to be determined by the State Fire Marshal. All new pipelines must also be designed to accommodate passage of instrumented inspection devices (smart pigs) through the pipeline.

California Public Resources Code Sections 30260, 30262, and 30265

The California Public Resources Code requires adverse environmental effects to be mitigated to the maximum extent feasible, that new and expanded oil and gas facilities be consolidated, and that platforms not be sited where a substantial hazard to vessel traffic might result from the facility or related operations.

Department of Conservation Division of Oil, Gas and Geothermal Resources

The DOGGR was formed in 1915 to regulate oil and gas activities with uniform laws and regulations. The Division supervises the drilling, operation, maintenance, and plugging and abandonment of onshore and offshore oil, gas, and geothermal wells, preventing damage to: (1)

life, health, property, and natural resources; (2) underground and surface waters suitable for irrigation or domestic use; and (3) oil, gas, and geothermal reservoirs.

Division responsibilities are detailed in Section 3000 of the California Public Resources Code and Title 14, Chapter 4 of the California Code of Regulations. These regulations address issues such as well spacing, blow-out prevention devices, casing requirements, plugging and abandonment of wells, maintenance of facilities and safety systems, inspection frequency and reporting requirements.

In addition, DOGGR publishes a number of instruction manuals related to testing of oil and gas wells (M06), blowout prevention requirements (M07), and drilling wells in a hydrogen sulfide environment (M10).

The DOGGR is mandated by Section 3106 of the Public Resources Code (PRC) to supervise the drilling, operation, maintenance, and abandonment of oil wells for the purpose of preventing: damage to life, health, property, and natural resources; damage to underground and surface waters suitable for irrigation or domestic use; loss of oil, gas, or reservoir energy; and damage to oil and gas deposits by infiltrating water and other causes.

Section 1774 of Title 14 CCR Division 2, chapter 4 specifies oilfield maintenance practices related to oil field facilities.

California Pipeline Safety Act of 1981

This Act gives regulatory jurisdiction to the State Fire Marshal for the safety of all intrastate hazardous liquid pipelines and all interstate pipelines used for the transportation of hazardous or highly volatile liquid substances. The law establishes the Federal Hazardous Liquid Pipeline Safety Act and federal pipeline safety regulations as the governing rules for interstate pipelines.

Oil Pipeline Environmental Responsibility Act (Assembly Bill 1868)

This Act requires every pipeline corporation qualifying as a public utility and transporting crude oil in a public utility oil pipeline system to be held strictly liable for any damages incurred by "any injured party which arise out of, or are caused by, the discharge or leaking of crude oil or any fraction thereof." The law applies only to public utility pipelines completed after January 1, 1996, or existing pipelines more than 3 miles in length and relocated after January 1, 1996. Signed into law in October 1995, the major features include:

- Each pipeline corporation that qualifies as a public utility that transports any crude oil in a public utility oil pipeline system shall be absolutely liable, without regard to fault, for any damages incurred by any injured party that arise out of, or are caused by, the discharge or leaking of crude oil.
- Damages for which a pipeline corporation is liable under this law are: all costs of response, containment, cleanup, removal, and treatment, including monitoring and administration cost; injury or economic losses resulting from destruction of, or injury to, real or personal property; injury to, destruction of, or loss of natural resources, including but not limited to, the reasonable cost of rehabilitating wildlife habitat, and other resources and the reasonable

cost of assessing that injury, destruction, or loss, in any action brought by the State, county, city, or district; loss of taxes, royalties, rents, use, or profit shares caused by the injury, destruction, loss, or impairment of use of real property, personal property, or natural resources; and loss of use and enjoyment of natural resources and other public resources or facilities in any action brought by the State, county, city, or district.

- A pipeline corporation shall immediately clean up all crude oil that leaks or is discharged from a pipeline.
- No pipeline system subject to this law shall be permitted to operate unless the State Fire Marshal certifies that the pipeline corporation demonstrates sufficient financial responsibility to respond to the liability imposed by this section. The minimum financial responsibility required by the State Fire Marshal shall be $750 times the maximum capacity of the pipeline in the number of barrels per day up to a maximum of $100,000,000 per pipeline system, or a maximum of $200,000,000 per multiple pipeline system. For the Pacific Pipeline, the bill specifically requires $100,000,000 for the financial responsibility (section l.h.(l)).
- Financial responsibility shall be demonstrated by evidence that is substantially equivalent to that required by regulations issued under section 8670.37.54 of the Government Code, including insurance, surety bond, letter of credit, guaranty, qualification as a self-insurer, or combination thereof or any other evidence of financial responsibility. The State Fire Marshal shall require that the documentation evidencing financial responsibility be placed on file with that office.
- The State Fire Marshal shall require evidence of financial responsibility to fund post-closure cleanup spots. The evidence of financial responsibility shall be 15 percent of the amount of financial responsibility.

California Accident Release Prevention

The California Accident Release Prevention program mirrors the Federal Risk Management program, except that it adds external events and seismic analysis to the requirements and includes facilities with lower inventories of materials. A California Accident Release Prevention or Risk Management Plan is a document prepared by the owner or operator of a stationary source containing detailed information including:

- Regulated substances held onsite at the stationary source;
- Offsite consequences of an accidental release of a regulated substance;
- The accident history at the stationary source;
- The emergency response program for the stationary source;
- Coordination with local emergency responders;
- Hazard review or process hazard analysis;
- Operating procedures at the stationary source;
- Training of the stationary source's personnel;
- Maintenance and mechanical integrity of the stationary source's physical plant; and
- Incident investigation.

Hazardous Materials and Hazardous Waste

Hazardous Waste Control Law

The Hazardous Waste Control Law is administered by the California Environmental Protection Agency, Department of Toxic Substances Control. Department of Toxic Substances Control has adopted extensive regulations governing the generation, transportation, and disposal of hazardous wastes. These regulations impose cradle-to-grave requirements for handling hazardous wastes in a manner that protects human health and the environment. The Hazardous Waste Control Law regulations establish requirements for identifying, packaging, and labeling hazardous wastes. They prescribe management practices for hazardous wastes; establish permit requirements for hazardous waste treatment, storage, disposal, and transportation; and identify hazardous wastes that cannot be disposed of in landfills. Hazardous waste is tracked from the point of generation to the point of disposal or treatment using hazardous waste manifests. The manifests list a description of the waste, its intended destination, and regulatory information about the waste.

Hazardous Materials Management Planning

The Office of Emergency Services, in support of local government, coordinates overall state agency response to major disasters. The office is responsible for assuring the State's readiness to respond to and recover from natural, manmade, and war-caused emergencies, and for assisting local governments in their emergency preparedness, response, and recovery efforts. During major emergencies, the Office of Emergency Services may call upon all State agencies to help provide support. Due to their expertise, the California National Guard, California Highway Patrol (CHP), Department of Forestry and Fire Protection, Conservation Corps, Department of Social Services, and the California Department of Transportation (CalTrans) are the agencies most often asked to respond and assist in emergency response activities.

Hazardous Materials Transportation in California

California regulates the transportation of hazardous waste originating or passing through the State in Title 13 of the California Code of Regulations. The CHP and CalTrans have primary responsibility for enforcing federal and State regulations and responding to hazardous materials transportation emergencies. The CHP enforces materials and hazardous waste labeling and packing regulations that prevent leakage and spills of material in transit and provide detailed information to cleanup crews in the event of an incident. Vehicle and equipment inspection, shipment preparation, container identification, and shipping documentation are all part of the responsibility of the CHP. The CHP conducts regular inspections of licensed transporters to ensure regulatory compliance. CalTrans has emergency chemical spill identification teams at locations throughout the State.

Hazardous waste must be regularly removed from generating sites by licensed hazardous waste transporters. Transported materials must be accompanied by hazardous waste manifests.

Hazardous Material Worker Safety, California Occupational Safety and Health Act

The California Occupational Safety and Health Administration (Cal/OSHA) is responsible for assuring worker safety in the handling and use of chemicals in the workplace. Cal/OSHA assumes primary responsibility for developing and enforcing workplace safety regulations in Title 8 CCR. Cal/OSHA hazardous materials regulations include requirements for safety training, availability of safety equipment, hazardous substance exposure warnings, and emergency action and fire prevention plan preparation.

Cal/OSHA also enforces hazard communication program regulations, which contain training and information requirements, including procedures for identifying and labeling hazardous substances. The hazard communication program also requires that Material Safety Data Sheets be available to employees and that employee information and training programs be documented.

Asbestos and Lead

Cal/OSHA defines asbestos-containing construction materials as any internal building component containing greater than 0.1 percent asbestos. This definition is more stringent than federal definitions of asbestos-containing materials, which contain asbestos in concentrations greater than 1 percent. Asbestos-containing materials regulations apply to all building components, including exterior materials and roofing. Lead-containing paint is defined as paint containing 0.006 milligrams per kilogram (mg/kg) lead by weight. Lead-based paint is defined as paint containing 0.05 mg/kg lead by weight. Asbestos and lead hazards associated with facility operations are subject to these rules. Existing asbestos containing materials and lead-based paint surveys cannot identify all materials, especially in or on internal building components. Compliance with 29 CFR 1926.1101, 40 CFR 61 Subpart M (NESHAPS) and similar state laws, requires sampling of suspect or presumed asbestos-containing materials before disturbance, if it is in a quantity of more than 260 linear feet on pipes, or 160 square feet on other facility components, or 35 cubic feet. Cal/OSHA requires registered asbestos abatement contractors to remove asbestos-containing construction materials in quantities greater than 100 square feet.

The Asbestos Construction Standard, Title 8 CCR Section 1529

The Cal/OSHA asbestos standard for construction activities applies to all asbestos work where asbestos-containing construction materials may be disturbed in threshold quantities.

The Asbestos Construction Standard regulates asbestos exposure in all construction work as defined in Title 8 CCR Section 1502, including, but not limited to, the following:

- Demolition or salvage of structures where asbestos is present;
- Removal or encapsulation of materials containing asbestos;
- Construction, alteration, repair, maintenance, or renovation of structures, substrates, or portions thereof, that contain asbestos;
- Installation of products containing asbestos;
- Asbestos spill and emergency cleanup;

- Transportation, disposal, storage, containment of, and housekeeping activities involving asbestos or products containing asbestos, on the site or location at which construction activities are performed;
- Excavation which may involve exposure to asbestos as a natural constituent that is not related to asbestos mining and milling activities;
- Routine facility maintenance; and
- Erection of new electric transmission and distribution lines and equipment, and alteration, conversion and improvement of the existing transmission and distribution lines and equipment.

Cal/OSHA Lead Construction Standard, Title 8 CCR Section 1532.1

The Lead Construction Standard applies to all construction work where an employee may be occupationally exposed to lead. The standard applies to any construction activity that may release dust or fumes including, but not limited to, manual scraping, manual sanding, heat gun applications, power tool cleaning, rivet busting, abrasive blasting, welding, cutting, or torch burning of lead based coatings. Unless otherwise determined by approved testing methods, all paints and other surface coatings are assumed to contain lead at prescribed concentrations, depending on the application date of the paint or coating.

All construction work excluded from coverage in the general industry standard for lead by Section 5198(a)(2) is covered by this standard. Construction work is defined as work for construction, alteration, and/or repair, including painting and decorating. It includes, but is not limited to, the following:

- Demolition or salvage of structures where lead or materials containing lead are present;
- Removal or encapsulation of materials containing lead;
- New construction, alteration, repair, or renovation of structures, substrates, or portions thereof, that contain lead, or materials containing lead;
- Installation of products containing lead;
- Lead contamination/emergency cleanup;
- Transportation, disposal, storage, or containment of lead or materials containing lead on the site or location at which construction activities are performed; and
- Maintenance operations associated with the construction activities.

4.3.2.3 Local Laws and Regulations

Los Angeles County

Los Angeles County has established a number of programs and plans to address oil and gas operations in the County.

Los Angeles Municipal Code (Fire Protection – Chapter 5, Section 57, Divisions 4 and 5)

These portions of the municipal fire code regulate the construction of buildings and other structures used to store flammable hazardous materials, and the storage of these same materials. These sections ensure that the business is properly equipped and operates in a safe manner and in accordance with all applicable laws and regulations. The Los Angeles County Fire Department issues these permits.

Los Angeles County Certified Unified Program Agency

The Certified Unified Program Agency is designed to consolidate, coordinate, and consistently administer permits, inspection activities, and enforcement activities throughout the County. The Los Angeles County Fire Department is the Certified Unified Program Agency for the entire County except in the cities of El Segundo, Glendale, Long Beach, Los Angeles, Santa Fe Springs, Santa Monica, and Vernon; these cities are Certified Unified Program Agencies within their own jurisdictions. The Los Angeles County Fire Department manages the hazardous materials disclosure program administered under Health and Safety Code Chapter 6.95 and California Code of Regulations Title 19 (19 CCR) and requires the submittal of a hazardous materials inventory and contingency plan if the business handles or stores hazardous materials.

Los Angeles County General Plan

The Board of Supervisors adopted the first Safety and Seismic Safety Elements as components of the Los Angeles County General Plan in 1975 and updates in 1990. The Safety Element addresses earthquake, landslides, flood and fire hazards; and potential hazardous materials incidents related to these hazards. The specific policies of the general plan (policy 20 and 21 of the safety element) state that the County should:

> Review proposed development projects involving the use or storage of hazardous materials, and disapprove proposals which cannot properly mitigate unacceptable threats to public health and safety to the satisfaction of responsible agencies. And promote the safe transportation of hazardous materials.

Los Angeles County Fire Department

The Los Angeles County Fire Department Hazardous Materials Section is the administrative agent for the California Health and Safety Code, California Code of Regulations related to Emergency Planning and Community Right to Know laws, and Federal Superfund Amendments and Reauthorization Act Title III.

The Los Angeles County Fire Department Hazardous Waste Control Program regulates the disposal, handling, and storage of hazardous and toxic materials. Its purpose is to protect the

County of Los Angeles from accidental spills or releases of hazardous materials. It accomplishes this through inspections, emergency response enforcement, and site mitigation.

City of Whittier

The City of Whittier has addressed oil and gas development in Resolution Number 4302, Ordinance Number 2047, and in agreements and permits for existing oil and gas projects (Matrix Honolulu Terrace). The City Public Works Department is responsible for conducting annual inspections of facilities to ensure compliance with these requirements as well as some other requirements (such as SCAQMD requirements).

Resolution 4302 was passed in 1970 and addresses permit fees, operations and drilling (such as roads, fencing, blow-out prevention requirements, and sound proofing), abandonment requirements, inspections, notices, storage facilities, and fire prevention.

Ordinance number 2047 was passed in 1975 specifically to regulate Seaboard Oil and Gas Company. It includes several requirements related to lighting, soundproofing, operations and maintenance of the well drilling operations, and landscaping. The ordinance is currently being updated.

The current agreement with Matrix, signed in 2006 and specific to the Honolulu Terrace operations, addresses issues such as aesthetics, fire safety, inspections, odor control, and noise control.

4.3.2.4 Other Applicable Guidelines, National Codes, and Standards

Safety and Corrosion Prevention Requirements — American Society of Mechanical Engineers, National Association of Corrosion Engineers, American National Standards Institute, and API

- American Society of Mechanical Engineers (ASME) & American National Standards Institute (ANSI) B16.1 Cast Iron Pipe Flanges and Flanged Fittings;
- ASME & ANSI B16.9, Factory-Made Wrought Steel Butt Welding Fittings;
- ASME & ANSI B31.1a, Power Piping;
- ASME & ANSI B31.4a, addenda to ASME B31.4a, Liquid Transportation Systems for Hydrocarbons, Liquid Petroleum Gas, Anhydrous Ammonia, and Alcohols;
- National Association of Corrosion Engineers (NACE) Standard RP0190, Item No. 53071. Standard Recommended Practice External Protective Coatings for Joints, Fittings, and Valves on Metallic Underground or Submerged Pipelines and Piping Systems;
- NACE Standard RP0169, Item No. 53002. Standard Recommended Practice Control of External Corrosion on Underground or Submerged Metallic Piping Systems;
- API 49, Recommended Practice for Drilling and Well Service Operations Involving Hydrogen Sulfide;
- API 54, Recommended Practice for Occupational Safety for Oil and Gas Well Drilling and Servicing Operations;

- API 510 Pressure Vessel inspection Code;
- API 570 Piping Inspection Code, applies to in-service metallic piping systems used for the transport of petroleum products;
- API 572 Inspection of Pressure Vessels;
- API 574 Inspection Practices for Pipe System Components;
- API 575 API Guidelines and Methods for Inspection of Existing Atmospheric and Low-pressure Storage Tanks;
- API 576 Inspection of Pressure Relieving Devices;
- API 650 Welded Steel Tanks for Oil Storage;
- API 651 Cathodic Protection of Aboveground Storage Tanks;
- API 653 Tank Inspection, Repair, Alteration, and Reconstruction;
- API 2610, Design, Construction, Operation, Maintenance, and Inspection of Terminal & Tank Facilities; and
- API Spec 12B - Bolted Tanks for Storage of Production Liquids.

API 653, atmospheric tank inspection and repair, addresses the following issues:

- Tank suitability for service;
- Brittle fracture considerations;
- Inspections;
- Materials;
- Design considerations;
- Tank repair and alteration;
- Dismantling and reconstruction;
- Welding;
- Examination and testing;
- Marking and recordkeeping;
- Tank inspections;
- External inspections by an authorized inspector every 5 years;
- Ultrasonic inspections of shell thickness every 5 years (when corrosion rate not known); and
- Internal bottom inspection every 10 years, if corrosion rates not known.

Fire and Explosion Prevention and Control, National Fire Protection Agency Standards

- National Fire Protection Agency (NFPA) 30, Flammable and Combustible Liquids Code and Handbook;
- NFPA 11, Foam Extinguishing Systems;
- NFPA 12, A&B Halogenated Extinguishing Agent Systems;
- NFPA 15, Water Spray Fixed Systems;
- NFPA 20, Centrifugal Fire Pumps; and
- NFPA 70, National Electrical Code.

4.3.3 Significance Criteria

As defined in CEQA Appendix G (VII) (the Environmental Checklist Form), a significant safety effect is one in which the project "create[s] a potential health hazard or involve[s] the use, production or disposal of materials which pose a hazard to people, animal or plant populations in the area affected."

The CEQA Guidelines checklist defines significant risk impacts that "create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials" or "through reasonably foreseeable upset and accident conditions." However, "significant hazard" is not defined. To understand the definition of a significant hazard and to develop significance criteria, several Los Angeles-area Environmental Impact Reports (EIR) were examined, including the South Coast Association of Governments Regional Transportation Plan EIR (SCAG 2009), the Chevron Products Company - El Segundo Refinery Heavy Crude Project Final EIR (SCAQMD 2006a), the BP Carson Refinery Safety, Compliance and Optimization Project Final EIR (SCAQMD 2006b), and Industrial Services Oil Company, Inc. Hazardous Waste Facility Application EIR (DTSC 2006). Collectively the reports provided relatively general criteria, criteria based on distance from sensitive locations, or criteria based strictly on codes and standards.

For example, some of the general criteria included impacts that "create a hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment during transportation" or "create significant hazard to the public or environment through the routine transport, storage, use or disposal of hazardous materials" (SCAG 2009, DTSC 2006).

Sensitive receptor criteria include "be located within an airport land use plan or within two miles of an airport" or "emit hazardous emissions or involve handling hazardous or acutely hazardous materials, substances, or wastes within one-quarter mile of an existing or proposed school site" or "emit hazardous materials within one-quarter mile of a school" (DTSC 2006, SCAG 2009).

More specific criteria related to hazards exposure, not risk, include "exposure [of public] to hazardous chemicals in concentrations equal to or greater than the emergency response planning guideline-2 levels, radiant heat exposures in excess of 1,600 Btu/(hr-ft^2), overpressure exposure that exceeds 1 pounds per square inch, or flash fire hazard zones that exceed the lower flammable limit (lower flammability limit)" (SCAQMD 2006b).

Some criteria are related to compliance with codes, standards, or regulations, such as "non-compliance with any applicable design code or regulation" or "non-conformance to National Fire Protection Association standards" or "non-conformance to regulations or generally accepted industry practices related to operating policy and procedures concerning the design, construction, security, leak detection, spill containment or fire protection" (SCAQMD 2006b, SCAQMD 2006a).

Los Angeles County does not have quantitative criteria for assessing risk. Santa Barbara County established a more quantitative, risk-based criteria that have been utilized by various state agencies, including the California Coastal Commission and the California State Lands Commission. Santa Barbara County adopted Public Safety Thresholds in August 1999. The thresholds provide specific zones (i.e., green, amber, and red) on a risk profile curve to guide the determination of significance or insignificance based on the estimated probability and consequence of an accident. In general, risk levels in the green area would be less than significant and therefore acceptable, while risk levels in the amber and red zones would be significant. Risk profiles plot the frequency of an event against the consequence in terms of fatalities or injuries; frequent events with high consequence have the highest risk level.

None of the reviewed criteria, except the Santa Barbara County thresholds, address the issue of risk. The hazards criteria only address only whether the public is exposed to the material, not the frequency of the exposure. Many measures, such as automatic shutdown systems, vacuum operations, and fire deluge systems, reduce the frequency of events substantially so that the public might accept the level of risk as a combination of hazard and frequency. Materials are also sometimes minimally hazardous beyond a certain distance. For example, some materials, such as combustible liquids (like crude oil), are stored in tanks with minimal risks to the public beyond a few hundred feet.

The analysis used in this report is based on the quantitative risks associated with the facility. Since Los Angeles County nor the City of Whittier have risk criteria, the Santa Barbara County criteria have been utilized. Therefore, an impact would be significant if it would:

- Fall within the amber or red specific zones of the Santa Barbara County Public Safety Thresholds risk profile curves;
- Not comply with any applicable design code, regulation, NFPA standard, or generally acceptable industry practice;
- For site contamination, result in mobilization of contaminants currently existing in the soil and groundwater, creating potential pathways of exposure to humans or other sensitive receptors that would result in exposure to contaminant levels that would be expected to be harmful; or
- For site contamination, result in the presence of contaminated soils or groundwater within the Project Area, and as a result, expose workers and/or the public to contaminated or hazardous materials during construction activities at levels in excess of those permitted by Cal/OSHA in CCR Title B and the federal OSHA in Title 29 CFR Part 1910.

4.3.4 Impacts of the Proposed Project

The following sections discuss impacts and proposed mitigation measures. Impacts are limited to direct, immediate impacts to public health in the form of injuries and fatalities from accidental releases of oil and gas and increases in oil spill risks in the form of increased spill volumes or frequencies.

4.3.4.1 Public Safety Risk Analysis

The risk analysis involves developing release scenarios, conducting a frequency and consequence analysis, and then combining these analyses to present a risk analysis. The following subsections discuss each of these steps.

Characteristics of Crude Oil, Natural Gas, and Odorant

As it emerges from the wellhead, crude oil is a heterogeneous mixture of solids, liquids, and gases. This mixture includes sediments, water and water vapor, salts, and acid gases, including carbon dioxide and, sometimes, hydrogen sulfide. Flammable vapors that may emanate from crude oil include methane, propane, butane, and pentane.

Crude oil comes in many forms. Thin and volatile oils are "light," whereas thick and viscous ones are "heavy." Light oils have an American Petroleum Institute (API) gravity of 30 to 40 degrees, which means that the density is much less than the density of water, 1.0 gram per cubic centimeter (g/cc). These oils float easily on water. By contrast, some heavy oils have an API gravity of less than 12 degrees and are so dense that they sink in water. Oil with the same density of water has an API gravity of 10.

Crude oils are also characterized by Reid vapor pressure. Reid vapor pressure (ASTM Method D 323) is the absolute vapor pressure exerted by a liquid at 100 degrees Fahrenheit (°F). The higher the Reid vapor pressure, the more volatile the oil and the more readily it will evaporate.

Most oils are mixtures of many different compounds, most of which are hydrocarbons. There are a series of main hydrocarbon groups in petroleum. Saturates are hydrocarbons with straight chains of carbon atoms, while aromatics are hydrocarbons consisting of rings of carbon. Asphaltenes are complex polycyclic hydrocarbons that contain many complicated carbon rings and nitrogen-, sulfur-, and oxygen-containing compounds.

In most oils, the saturate fraction is the largest and contains two subgroups, paraffins and isoprenoids. Paraffins are simple, straight-chain hydrocarbons, whereas isoprenoids are hydrocarbon chains with branches. Waxes are long-chain paraffins that are solid at surface temperatures and may contain as many as 50 carbon atoms. Waxy oils tend to be thick and viscous, whereas aromatic oils tend to be light and volatile.

The major hydrocarbon constituents include:

- Alkanes (paraffins) are straight-chain normal alkanes and branched iso-alkanes with the general formula C_nH_{2n+2}. The major paraffinic components of most crude oils are in the C1 to C35 range.
- Cycloalkanes (naphthenes) are saturated hydrocarbons containing structures with carbon atoms linked in a ring. The cycloalkane composition in crude oil worldwide typically varies from 30 to 60 percent.
- Aromatic hydrocarbons are most commonly benzene, benzene derivatives, and fused benzene-ring compounds. The concentration of benzene in crude oil ranges between 0.01 and 1 percent.

Sulfur in crude oil occurs in many natural compounds including hydrogen sulfide. Total sulfur ranges from approximately one to four percent by weight in crude oils, and hydrogen sulfide concentrations can reach 100 ppm in "sour" crudes. Hydrogen sulfide is a toxic gas that can cause injuries or fatalities if released into the atmosphere and inhaled by persons. Its strong, pungent odor is detectable at a level substantially below that which causes health effects. It also causes paralysis of the olfactory functions at levels lower than those that cause health effects.

The crude oil potentially produced by the proposed Project most likely would be "sweet" crude oil, meaning it would not contain appreciable quantities of hydrogen sulfide. Crude oil and gas tests from the production fluids at Honolulu Terrace oil and gas wells indicate that those materials are sweet and the proposed Project wells would enter the same reservoir. Other constituents of crude oil include nitrogen and oxygen compounds, and water- and metal-containing compounds, such as iron, vanadium, and nickel.

Hydrocarbon gas is also produced from formations and would be processed at the proposed Project gas plant. The processed gas must conform to requirements established by Southern California Gas Company (SCGC) for use in their distribution system. The majority of the gas would be methane, with some smaller amounts of ethane, propane, butane, pentane, hexane+, and inert compounds (such as CO_2). Natural gas presents hazards due to its flammability in the form of vapor cloud fires and explosions, and thermal radiation impacts due to flame jet fires emanating from a gas leak or rupture.

The gas would be odorized at the proposed Project odorant station, most likely with 100 percent tetrahydrothiophene or an equivalent. Tetrahydrothiophene is a liquid at standard conditions (68°F and atmospheric pressure) and has a boiling point of approximately 247°F. It can produce a flammable vapor with explosion limits of 1.1 to 12.3 percent and is, therefore, somewhat volatile. It has a low flash point of approximately 54°F; meaning that, above this temperature, sufficient volatile vapors are produced to create a flash if brought in contact with an ignition source. If spilled, or opened to the atmosphere, the odorant produces a vapor that is approximately three times heavier than air. It is a colorless liquid with a stench and is insoluble in water. Because the odorant's molecular structure contains sulfur atoms, if exposed to flames or high temperatures, it can produce toxic sulfur oxides.

Release Scenarios

The approach taken to develop the release scenarios was to group the proposed equipment and operations by operating parameters; equipment that has a similar temperature, pressure and composition were grouped into one set of scenarios. This generally produced a set of release scenarios for each process. Each set of release scenarios contained at least one rupture release and one leak release. A rupture is defined as a large process inventory released over a short period of time caused, for example, by catastrophic equipment failure. Ruptures are generally associated with releases through hole sizes exceeding 1 inch. A leak is defined as a process inventory released due to a small valve failure or hole in a vessel, for example, generally less than 1 inch in diameter. This approach encompasses a range of risks by including a less frequent, more severe scenario, and a more frequent, less severe scenario. In some cases, the leak release actually produces a higher risk (i.e., combination of consequence and frequency) than the associated rupture release because leaks occur more frequently than ruptures.

The principal immediate hazards to public health at the Project Site include:

- Releases associated with drilling operations, resulting in pressured gas releases and subsequent fires or vapor clouds;
- Releases associated with the processing of flammable gas causing vapor cloud explosions or thermal impacts from fire and flame jets;
- Releases of odorant causing toxic impacts;
- Releases of crude oil with subsequent fire causing impacts from thermal exposure to crude oil fires.

Table 4.3-7 shows the characteristics of the potential release scenarios.

Scenario 1: Release During Drilling

It is anticipated that the wells drilled at the field would not be pressurized wells. They would all utilize down-hole pumping units in order to move the crude oil to the surface. Therefore, this type of well would not produce a “blowout” type scenario that has a sustained release of flammable materials with sufficient volume and duration to produce serious injuries or fatalities offsite. However, during drilling, initially during production for a period after the well has been drilled, there may be periods of time and zones of the reservoir where substantial pressures could be encountered, giving rise to the potential for wells that produce pressurized releases that could cause risks and/or substantial odors in the community. For issues related to odors, see Section 4.2, Air Quality.

Table 4.3-7 Whittier Oil Field Release Scenarios

#	Scenario	Pressure (psig)	Temperature (°F)	Composition	Line Size (inches)
1	Drilling blowout	2500	120	Produced Gas	3
2	Rupture or Leak of Pressurized Gas at the Well Heads	25	120	Produced Gas	4
3	Rupture of Gas Piping between Well Pad and Gas Plant, low pressure	25	100	Produced Gas	6
4	Release at gas plant, low pressure	100	120	Produced Gas	6
5	Release at gas plant, mid pressure	250	120	Produced Gas	3
6	Release at gas plant, high pressure	500	68	Natural Gas	3
7	Rupture of Gas Piping along Preserve Roadway and Metering	500	68	Natural Gas	3
8	Odorant Release	-	68	Odorant	1
9	Crude Oil Release with Fire	-	68	Crude Oil	-
10	Crude Oil Spill	-	68	Crude Oil	-
11	Release of Natural Gas from the Colima Road Gas Pipeline	500	68	Natural Gas	6

This scenario involves rupture of the drilling equipment upstream of the gas gathering system but before compression to higher pressures. The release location would be at the drilling site. Failures would be due to piping or valve breaks, vessel failures, pressure safety valve releases or high pressure "kicks" and losses of well control that are not controlled by the blowout prevention (BOP) system. It was modeled as a rupture with a sustained release of reservoir fluids. The rupture case conservatively assumed a break of 3 inches. The release was modeled at a conservative reservoir pressure of 2,500 psi. Possible consequences include flame jets and flammable vapor clouds.

On May 19, 2005, a fire occurred at the Honolulu Terrace facility owned by Matrix that was caused by gas coming up the well bore uncontrolled during a well workover operation. This incident would be similar to this scenario of a well blowout.

Scenario 2: Wellhead Release During Operations

This scenario involves rupture of the gas equipment at the wellheads during operations. Operational scenarios that could lead to a release would include wellhead or piping failures, value failures or releases during well workovers or re-drills. The release location would be at the well pad site. Failures would be due to piping, valve breaks, vessel failures, or pressure safety valve releases. It was modeled as both a rupture and a leak with the entire contents of the gas system being released along with the well-bore volume. The rupture case conservatively assumed a break of 4 inches, or the largest pipe diameter. The leak case assumed a hole size of 1 inch. The release was modeled at normal operating pressure and temperature. The gas composition was produced gas. Possible consequences include flame jets and flammable vapor clouds.

Scenario 3: Release of Production Piping

This scenario involves rupture of the gas piping between the well pad and at the gas plant before compression to higher pressures at the gas plant. The release location would be at the gas plant. Failure would be due to piping ruptures or leaks. It was modeled as both a rupture and a leak with the entire contents of the gas system being released. The rupture case conservatively assumed a break of 6 inches, or the largest pipeline diameter. The leak case assumed a hole size of 1 inch. The release was modeled at normal operating pressure and temperature, which would be at a relatively low pressure. The gas composition was produced gas. Possible consequences include flame jets and flammable vapor clouds.

Scenarios 4, 5, and 6: Release of Gas Plant Equipment

This scenario involves a rupture or leak of equipment within the gas plant located at the Processing Facility Area. Releases would be due to piping failures, vessels failures, valve failures, pressure safety valve releases, heat exchanger failures or compressor failures. The gas plant equipment was categorized into three operating groups, at 100, 250, and 500 psig.

Equipment inventories were based on the piping and instrument diagrams. It was modeled as both a rupture and a leak with the entire contents of the respective equipment groups being released. The rupture case assumed a break of between 3 and 6 inches, depending on the group. The leak case assumed a hole size of 1 inch. The release was modeled at normal operating pressure and temperature for each group. The gas composition was produced gas. Possible consequences include flame jets and flammable vapor clouds.

Scenario 7: Release of Natural Gas Piping and Metering

This scenario involves rupture of the gas piping after the natural gas has left the gas plant and is being transported to the SCGC system within the Preserve. It would occur at the gas metering location near Colima Road or along the Loop Road. Failure would be due to piping ruptures or leaks or valve ruptures or leaks. It was modeled as both a rupture and a leak with the entire contents of the gas system being released, including the gas pipeline that would be installed down Colima Road. The rupture case conservatively assumed a break of 3 inches, or the largest pipeline diameter. The leak case assumed a hole size of 1 inch. The release was modeled at a normal operating pressure and temperature (500 psig and 68°F). The gas composition was natural gas. Possible consequences include flame jets and flammable vapor clouds.

Scenario 8: Odorant Releases

This scenario includes the odorant facilities located at the gas plant. Releases would be due to equipment or tank failures or releases during tank filling operations if vapor control is not implemented or fails. Odorant could cause toxic impacts if inhaled at sufficiently high concentrations.

Scenario 9: Crude Oil Release with Fire at Storage

This scenario encompasses the crude oil storage systems at the Processing Facility Area. The equipment includes crude oil storage tanks and piping. The scenario assumes a catastrophic loss of the tank contents into the dike area with subsequent ignition and fire. Possible consequences include large crude oil fire and thermal radiation.

Scenario 10: Crude Oil Spill Outside Containment

This scenario involves a crude oil spill that could affect creeks and sensitive areas. It encompasses the crude oil pipelines around the site that are located outside of the Processing Facility Area or the Well Area where there is no containment, as well as equipment within berms that could spill and affect creeks if the drainage systems also fails. The frequency of the release is addressed in this scenario. Section 4.2, Biological Resources, addresses impacts to biology.

A release from the drainage basin could occur if an operator opened the drain valve or left a drain valve open during a subsequent inspection. This scenario assumes that all tank and piping areas at the Processing Facility Area would drain to a bermed area.

Scenario 11: Release of Natural Gas from the Colima Gas Pipeline

This scenario involves a rupture of the gas pipeline after leaving the Colima Road metering station, within the SCGC system. It would occur at any point along Colima Road between the Preserve and the pipeline tie-in into the main transmission pipeline along Lambert Road. Failures would be due to piping ruptures or leaks or valve ruptures or leaks at the tie-in point. It was modeled as both a rupture and a leak with the entire contents of the gas pipeline released. The rupture case conservatively assumed a break of 6 inches, the largest pipeline diameter. The release was modeled at normal operating pressure and temperature (500 psig and 68°F). The gas composition was natural gas. Possible consequences include flame jets and flammable vapor clouds.

There are additional release scenarios that could cause localized impacts, but would not cause offsite impacts at area residences, so they were not included in the analysis. These include a release of gas liquids from the 3-phase separator (50 gallons) and a release of refrigerant from the refrigeration skid. The small volumes of these releases would not produce impacts to nearby residences.

Drilling Releases

Releases during drilling activities can occur due to equipment failures, such as ruptured piping or value structural failures, or can be due to over pressurization of the drilling system due to the lack of well control and control of reservoir pressures, or blowouts. Blowouts release large amounts of pressurized gas and liquid that can ignite, causing a large fire with associated thermal radiation, or the gas can form a vapor cloud, which can cause a vapor cloud explosion if it encounters an ignition source.

Blowouts occur when the drilling encounters an area of sufficient pressure and the drilling muds and cement cannot contain the reservoir fluids, and the reservoir pressure causes oil and gas to flow back up the well to the surface. The flow can occur through the drilling pipe and casing. This is what happened recently in the Gulf of Mexico at the British Petroleum Deepwater Horizon.

The use of blow out prevention devices (BOPD) can reduce the frequency of uncontrolled blowouts that occur through the drill pipe and casing. These devices are installed on the top of the well and can close the well hole by shutting a valve or “shearing” off the drilling pipe if the drilling pipe is in the hole. Regulating agencies require the use of BOPD when wells are being drilled or serviced. However, like all equipment, there are times when BOPD do not function properly or the configuration is such that the BOPD does not stop the well flow. To understand the frequency of BOPD failures, databases of accidents were examined.

A number of different agencies compile data on well blowouts and releases. These include the BOEMRE, the California Department of Conservation, Division of Oil and Gas and the Texas Division of Oil and Gas. The BOEMRE maintains the most detailed database and accident reports, enabling the frequency of BOPD failures to be defined. Although most of the BOEMRE data is for offshore environment, it does provide a conservative estimate of BOP failure and well blowout frequencies.

The BOEMRE maintains safety reports that are required to be filed for every “loss of well control” incident. The BOEMRE uses the term “loss of well control” which includes blowouts as well as more minor incidents related to a loss of control of well fluids. From 1992 to 2005, there were 67 “loss of well control” incidents in the U.S. Outer Continental Shelf (four in the Pacific Outer Continental Shelf and 63 in the Gulf of Mexico).

In order to estimate the frequency of blowouts and subsequent events, the BOEMRE incident database was examined for all incidents listed as “loss of well control” (BOEMRE 2007). In the BOEMRE database, each incident has a detailed incident report detailing the events leading up to the incident and the resulting consequences and actions taken. Of the 67 “loss of well control” incidents in the BOEMRE incident database from 1992 to 2005, approximately 10 percent produced fires, approximately 7 percent were sub-surface blowouts, and in 46 percent of incidents a BOPD stopped the flow. In 33 percent of the releases, the BOPD did not function (due to either equipment failures or the incorrect implementation of procedures) or was not present, resulting in a sustained release for a period of time exceeding 15 minutes, and the release required evacuations from the facility. Table 4.3-8 summarizes the BOEMRE incident reports.

Table 4.3-8 also shows the estimated frequency of well blowouts from a number of different studies and agencies. These include data from DOGGR from 1950 to 1990, when more than 100,000 wells were drilled with a total of 140 blowouts. Well blowout rates from 1980 through 1990 are also shown. The table also shows blowout data from the Texas Division of Oil and Gas; for approximately 250,000 wells drilled from 1990 to 2006, there were 373 well blowouts. The blowout rates for drilling range from 0.33 blowouts to 5.2 blowouts per 1,000 wells drilled. Blowout rates during production are substantially lower than during drilling at approximately 0.14 blowouts per well-year.

For a blowout to occur, the reservoir must be pressurized. During drilling, the drill hole must pass into or through an area that is pressurized. It is unclear at this time the extent to which the Whittier reservoir will be pressurized or the drilling will pass through areas that are pressurized. If the wells do not have pressure to allow for sufficient flow of crude oil and gas, then the wells would utilize pumps placed down the well hole to pump up the crude oil. The Applicant is currently proposing the use of this technology. A well that does not have sufficient pressure to free flow cannot have a blowout. It is possible that the Whittier reservoir could have some pressure during initial drilling, but this pressure would diminish as the wells went into production over several months.

Due to the uncertainty of the levels of pressure that would be encountered in the wells during drilling and production, in this analysis it was assumed that the reservoir or areas the drill hole passes through are pressurized and that blowouts could occur. The rate used for blowouts during drilling was the BOEMRE rate, which is the most conservative. The rates used for blowouts during workovers and production were the HLID rates (see Table 4.3-8) (HLID 1992).

Frequency Analysis Results

Table 4.3-9 shows the failure rates for each of the release scenarios. The sources used in developing the failure rates for this study are listed in the references. The tables located in Appendix D provide the fault trees and the rationale for each selected failure rate and information on the data sources used. The highest frequency events are associated with leaks. The highest frequency for rupture scenario is associated with well blowouts.

Table 4.3-8 Blowout and Loss of Well Control Frequencies

Well Blowouts – BOEMRE Incident Reports Database	
Number of "loss of well control" incidents from 1992 to 2005	67
Fraction occurring during drilling	60%
Fraction occurring during production	9%
Fraction occurring during workovers	15%
Fraction occurring during abandonment, completions, other	16%
Fraction of "loss of well control" incidents producing fires	10%
Fraction of "loss of well control" incidents that were sub-surface	7%
Fraction of "loss of well control" incidents where a BOPD was present	78%
Fraction of "loss of well control" incidents where the BOPD stopped the flow	46%
Fraction of "loss of well control" producing sustained releases	33%
Well Blowouts – Frequency of Blowouts	
HLID (HLID 1992) frequency of blowouts during drilling, per 1,000 wells drilled	1.6
HLID frequency of blowouts during production, per 1,000 well years	0.14
HLID frequency of blowouts during well workovers, per 1,000 well workovers	0.73
MMS loss of well control incident rate with sustained release, 1996 to 2005, per 1,000 wells drilled	1.7
California DOGGR, well blowouts all activities, 1950 to 1990, per 1,000 wells drilled	1.4
California DOGGR, well blowouts during drilling & completion only, 1950 to 1990, per 1,000 wells drilled	0.68
California DOGGR, well blowouts during drilling only, 1980 to1990, per 1,000 wells drilled	0.33
Texas DOG, well blowouts, 1990 to 2006, per 1,000 wells drilled	1.5

Note: BOEMRE rate based on BOEMRE published Performance Measures (BOEMRE 2005). BOEMRE formerly MMS.

Table 4.3-9 Scenario Failure Rates

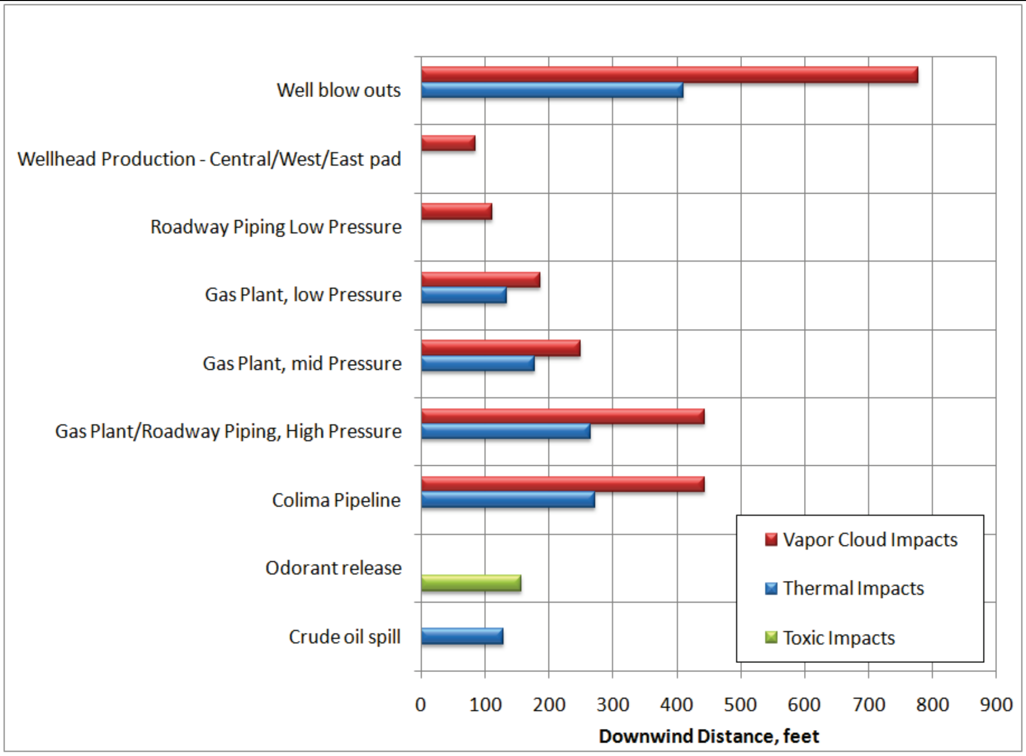
Scenario		Failure Rate, per Year	Years Between Failures
1	Wellhead Area Rupture during drilling, per pad	3.1×10^{-2}	33
1b	Wellhead area leak during drilling	6.2×10^{-2}	16
2	Wellhead Area Rupture during production, per pad	1.0×10^{-2}	100
2	Wellhead Area Leak during production, per pad	5.3×10^{-4}	1,902
2	Wellhead Area Rupture during production , non-pressurized wells, per pad	8.0×10^{-7}	1,252,536
2b	Wellhead area leak during production -pressurized and non-pressurized wells	2.8×10^{-3}	356
3	Rupture at produced gas pipelines at Well pad and Gas plant	1.0×10^{-5}	95,256
3b	Leak at produced gas pipelines at Well pad and Gas plant	2.3×10^{-5}	43,100
4	Rupture at Gas Plant separators, scrubbers to compressors - low pressure	3.1×10^{-4}	3,255
4b	Leak at Gas Plant through inlet scrubbers to compressors - low pressure	3.0×10^{-3}	328
5	Rupture at Gas Plant LTS, scrubbers and compressors - mid pressure	3.9×10^{-4}	2,568
5b	Leak at Gas Plant LTS, scrubbers and compressors - mid pressure	4.2×10^{-3}	240
6	Rupture at Gas Plant scrubbers and compressors - high pressure	1.0×10^{-4}	9,670
6b	Leak at Gas Plant scrubbers and compressors - high pressure	1.1×10^{-3}	889
7	Rupture at natural gas pipeline along Loop Road and at meter	8.2×10^{-5}	12,152
7b	Leak at natural gas pipeline along Loop Road and at meter	1.6×10^{-4}	6,406
8	Loss of Containment from odorant storage/transfer	8.4×10^{-2}	12
9	Release of Crude Oil and Subsequent Fire	1.8×10^{-4}	5,624
10a	Release of Crude Oil Storage/Pumping with spill outside containment	9.4×10^{-7}	1,068,795
10b	Release of Crude Oil from Piping/Equipment outside of containment within Preserve (rupture or leak)	3.4×10^{-3}	298
11	Release of natural gas along the Colima Road pipeline - rupture	$1.9E^{-04}$	5,285

Source: See Risk Appendix D

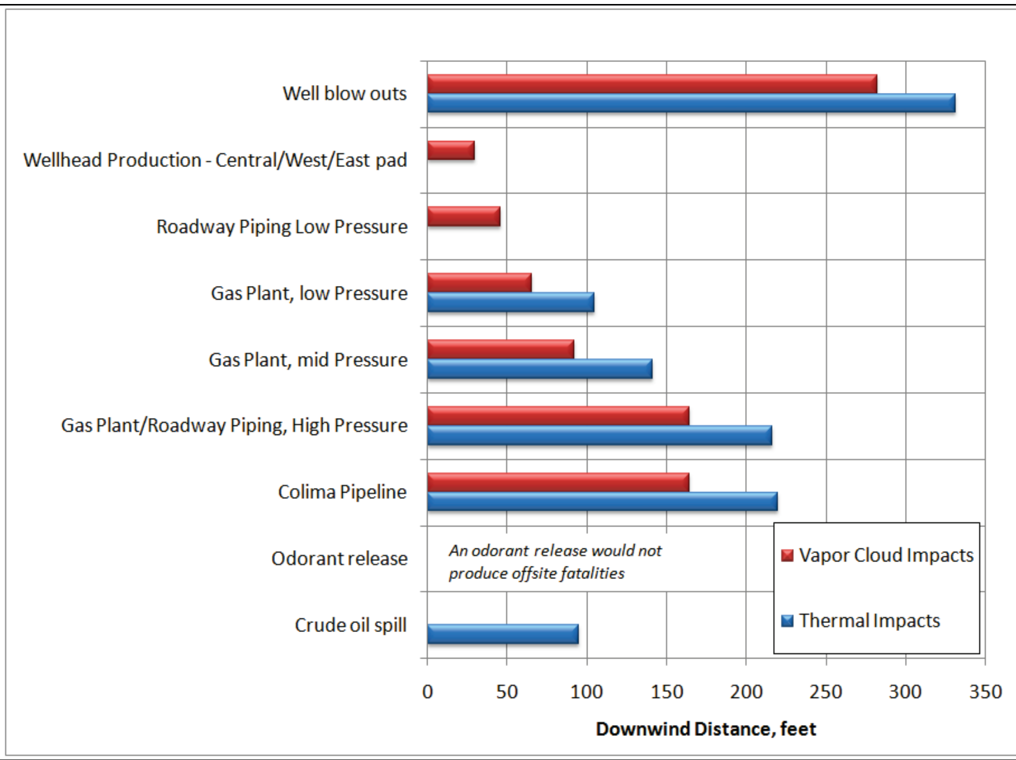
Consequence Analysis Results

Figure 4.3-4 and Appendix D show the results of the consequence modeling. The appendix includes the inputs to the modeling, the results of the release rate models, and results of the dispersion, overpressure, flammable vapor, and thermal radiation modeling.

Figure 4.3-4 Consequence Modeling Results



Injuries



Fatalities

Note: Impact distances based on worst-case meteorological conditions

A well blowout would create the worst-case impact distances. This would only occur when the well was pressurized.

A release from the Colima Road pipeline could impact nearby residences. However, due to the smaller pipe diameter and relatively short distance, the release would only last for 2 to 5 minutes before pipeline pressure dissipated, assuming that the pipeline rupture location is not also fed by the main gas transmission pipeline along Lambert Ave. If the release is also fed by the gas main, the release duration would be longer in duration. Impact distances would be approximately 150 feet for thermal impacts. This differs from the San Bruno 30-inch pipeline release in 2010, which the model estimates would produce hazard zones of 1000 feet due to thermal impacts and would continue for an extended period of time.

Risk Analysis Results

The results of the failure rate and consequence analysis were combined to develop risk profile curves. A risk profile is a plot of the frequency of an event versus the number of fatalities or serious injuries it could produce. This is the risk that a person could experience serious injury or fatality. In calculating the risk profiles, a computer model of the pipelines, facility, and surrounding area was prepared. The population distribution and probabilities of ignition were specified across the area of the model, and the likelihood of an individual fatality or injury occurrence was calculated for each grid location in the model.

The analysis assumed the facilities were operating at their proposed levels and that the populations near the facility were at their current levels with no additional development.

To develop the risk profile, many factors were considered. Each release scenario was evaluated for all wind directions and for every combination of stability and wind speed. In any given direction of travel, the chances of the particular wind stability class, the cloud igniting onsite, and the cloud igniting offsite at every downwind location from the release site were evaluated. The frequency of attaining the maximum downwind distances for flammable vapor dispersion would be reduced if the vapor cloud encountered ignition sources at the point of release or at any point along its travel path.

The approach for general calculations followed these steps:

- Summarize meteorological data into representative wind direction, wind speed, and stability conditions;
- Construct a model of the site and surrounding area, including populations and population densities;
- Identify the ignition sources and ignition probabilities;
- Select the release events, along with the likelihood of release, consequence data, and release locations;
- Determine the likelihood and consequences of immediate ignition, vapor cloud fires, jet fires, and explosions as appropriate for each condition;
- Determine the probability of ignition at each point along the path of a dispersing vapor cloud.

- Apply conditional probabilities of fatality given exposure, for each type of consequence (i.e., thermal exposure, vapor cloud exposure);
- Aggregate the likelihood of all probabilities of fatality at each location in the model for all the release scenarios; and
- Construct risk profiles or frequency number of fatality curves by summing the number of fatalities for each event outcome and plotting the results against the frequency, which was also done for serious injuries.

Meteorological Data

Meteorological data were gathered for the SCAQMD Pico Rivera monitoring location. Atmospheric stability classes D and F were selected as characteristic wind stability conditions. Based on wind speed conditions for these stability classes, a wind speed of 8.6 mph was selected for stability class D (neutral atmospheric stability), and a wind speed of 2.0 meters per second was selected for stability class F (stable atmospheric conditions). The predominant conditions are generally wind from the west and west-southwest direction, although wind frequencies from all directions were used in the analysis.

Population Data

Population information was gathered for locations within 3,000 feet of the proposed Project Site. Table 4.3-10 lists these locations and the estimated populations, population densities, and ignition probabilities.

Populations at these locations were entered into the Quantitative Risk Assessment Model. Information was gathered from site visits, estimated populations from housing counts generated from aerial photographs, and from census data of 2.9 persons per housing unit for this census block group.

Risk Profiles

Risk profiles display the frequency with which public safety impacts and consequences (e.g., fatalities or serious injuries) exceed a given magnitude. They can be used to show property damage, but are generally used for public safety impacts. The risk profiles indicate accident size, based on numbers of persons affected, and display how potential fatalities vary as a function of frequency. Risk profiles are generally plotted on logarithmic scales because they span multiple orders of magnitude.

There are many sources of uncertainty that affect the risk profiles, including:

- Release frequency;
- Release size;
- Population impacts, including distribution and likelihood of fatality or serious injury;
- Behavior of the release (jet mixing versus passive dispersion);
- Accuracy of the hazard models; and
- Ignition sources and probabilities.

The release frequencies and sizes are the most important contributors to overall uncertainty. Changes in failure rates will directly influence the risk profile. A doubling of the event frequencies would double the probability of fatalities. Changes in the relative sizes of leaks and ruptures will influence the risk profile, but to a lesser extent. The assumptions concerning population distribution and ignition probability also influence the risk profiles. Figure 4.3-5 shows the risk profile curves.

Impacts that could produce a fatality involve higher concentrations of material or higher levels of thermal radiation than the levels that could produce injuries. Therefore, fatality zones are smaller than injury zones; they do not reach as far. The highest risk scenarios for fatality are principally generated by rupture releases from the high pressure gas pipeline at the metering building. Other releases, such as a well blowout, would not reach residences. Impacts from the Colima Road gas pipeline also present significant risk levels for fatalities due to the potential for longer duration events caused by the connection to the gas main along Lambert Avenue.

Injury impacts are principally generated by a release from the Colima Road pipeline and rupture releases from the high pressure gas pipeline at the metering building that would impact residences along Lodosa Road. The school and other residences are located beyond the injury zones and fatality zones.

Spill Risk

Table 4.3-9 lists spill frequencies. Scenario 10a is a crude oil release from the tanks at the Processing Facility Area and a subsequent failure of the berm and drain system to contain the release. This is a low frequency event since the subsequent failure of the berm system is a low frequency event. Scenario 10b, however, is a release, either a leak of a few barrels or a rupture spilling into uncontained areas along the Loop Road within the Preserve between the processing site and Colima Road.

In addition, Scenario 1 is a release at the wellhead area, which includes a blowout (if the wells are pressurized). A blowout could send crude oil up into the air, which could cause impacts outside of the pad area as well as spill crude oil into the pad area.

Rupture volumes within the Preserve could be as large as the entire contents of a tank (11,000 barrels) if the system does not have appropriate check valves or if the valve systems fail. This release volume would be associated with a release at the lowest point (lowest elevation) along the crude oil pipeline between the Processing Facility Area and the Colima Road crude oil pipeline.

Sections 4.2, Biological Resources, and 4.8, Hydrology and Water Resources, discuss impacts associated with a release of crude oil within the Preserve.

Rupture volumes along the Colima Road pipeline would depend on the location of the rupture and the associated draindown volume. A rupture at the tie-in along Leffingwell Avenue could potentially drain the entire contents of the pipeline, approximately 3,700 barrels. Since the Leffingwell Avenue tie-in is lower in elevation than the Preserve, the crude oil would drain down towards Leffingwell Avenue.

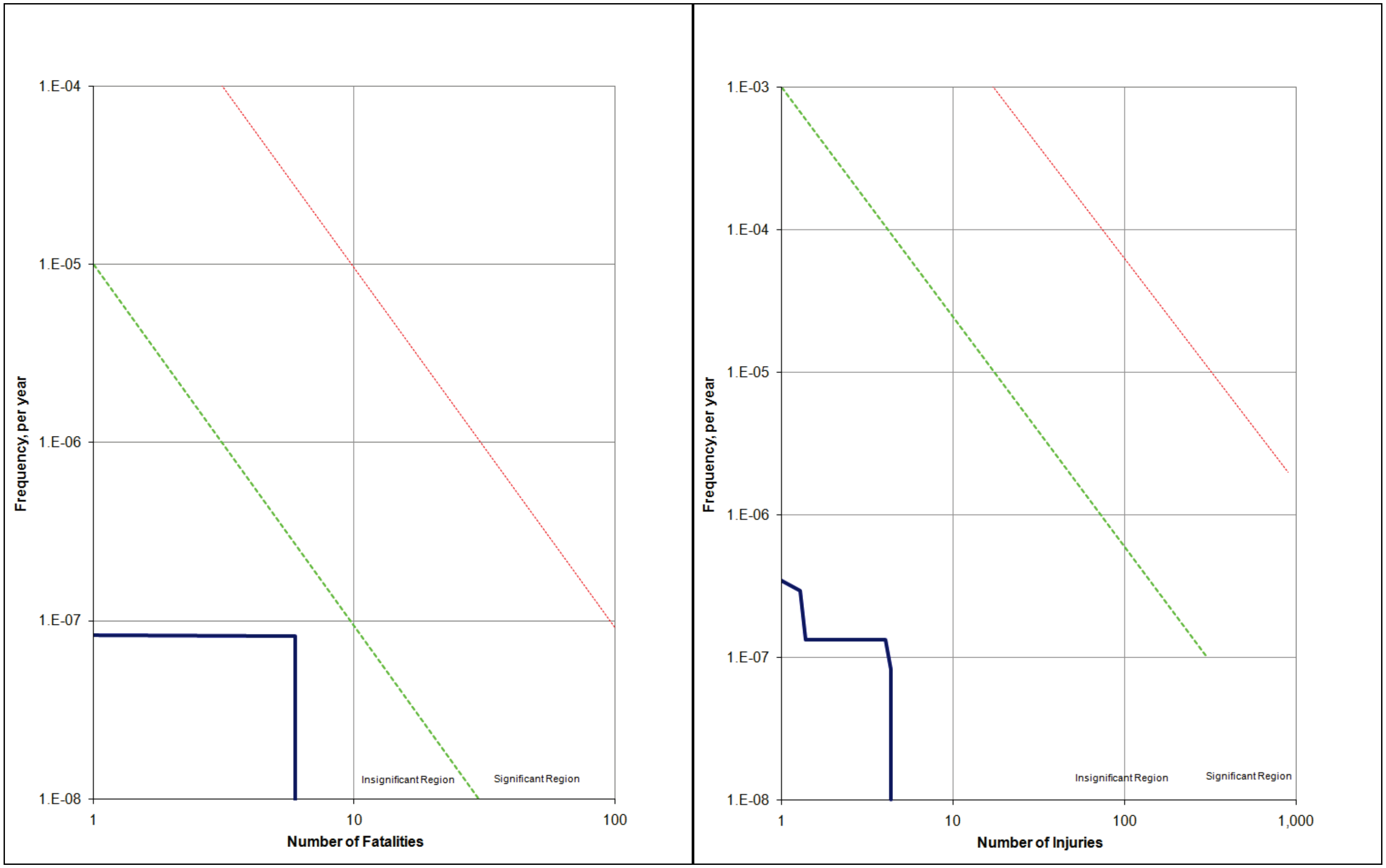
Since crude oil would be temporarily transported by truck, crude oil and water mixture could spill if an accident , such as a rollover, caused a rupture of the tank. A spill of crude oil would produce environmental impacts if the spill drained into culverts or drainage areas that lead to creeks of other sensitive areas. Spills of crude oil would be odiferous, but generally would not present a serious health impact to area residences. There is a possibility that the spilled crude oil could ignite and burn, similar to the possibility that the truck diesel fuel could spill, ignite, and burn. However, the crude oil vapors would not collect to the extent that they could produce a flammable cloud and subsequent explosion, unlike spilled gasoline, for example.

Table 4.3-10 Population Information

Location	Population Density (persons per square mile)	Use Factor	Primarily Indoors (I) or Outdoors (O)	Ignition Probability	Notes
Catalina Block	7,660	1	I	1	Use factor assumes persons home at all times, ignition probability based on multiple home water heaters stove pilots, BBQs, etc.
Lodosa Block	3,298	1	I	1	Same as Catalina
Ocean View Block	5,484	1	I	1	Same as Catalina
Schoolyard Playground	69,223	0.06	O	0	Density assumes 500 persons on playground. Use assumes 2-hour recess per day, 5 days per week.
School Buildings	99,384	0.18	I	0.01	Density assumes 500 persons. Use assumes 6 hours per day, 5 days per week. 1% ignition probability associated with residences.
Preserve Hiking Trails	227	0.5	O	0	Density assumes 6870 visitors per month, 19% at Arroyo Pescadero, visit time of 1.8 hours and trail areas of 0.03 miles. Use factor assumes daylight hours only.
Ranger Residence	8,207	1	I	0.01	Assumes 3 persons in the house and yard. 1% ignition probability associated with residences.
Baseball Fields	35,412	0.18	O	0	Density assumes 2 fields, 2 teams each field, 15 players per team, 2 parents each player. Use assumes 8 hours each weekend, 3 hours on weekdays.
Church Area	26,042	0.02	I	0.01	Density assumes 500 persons on Sunday for 4 hours. Residential ignition.
Preserve Parking Lot	567	0.5	O	0.06	Same as preserve visitors, but only 15 minutes in parking lot per viewing area. Ignition probability as per cars.
Colima Road	57[a]	1	O	0.06	Assumes 50,000 AADT, 1.5 persons per car, 55 mph. Ignition probability as per cars.
Colima Road - residential	2500 - 7500	1	I	1	2500 persons per square mile north of Whittier Boulevard, 7500 south.

a. Persons per mile

Figure 4.3-5 Risk Profiles



Notes: The fatalities curve for no pressurized wells is the same as the proposed Project.

4.3.5 Project Impacts and Mitigation Measures

Impacts from the proposed Project on public safety are associated with well drilling operations at the Well Pad and operations at the Processing Pad affecting the residences, the school and other receptors. These are due to both thermal and vapor cloud scenarios.

Impact #	Impact Description	Phase	Residual
SR.1	The proposed Project could introduce risk to the public associated with accidental releases from well drilling and processing operations.	Drilling, Operations	Less Than Significant with Mitigation

Releases of flammable gas from the proposed Project Well Pad and Processing Pad facilities would not impact nearby residences or public trails as the facilities are located too far away from receptors. Releases from the metering station located near Colima Road, however, could impact nearby residences. However, these releases are estimated to occur at a low frequency and would therefore not produce unacceptable risk levels.

The proposed pipeline that would be installed between the Processing Pad and the Savage Canyon landfill to supply gas to City properties could introduce some risk to the area. The pipeline is proposed to be installed above ground and could release gas by an earthquake, or by impacts from a vehicle as the pipeline would travel along the roadway. However, the pipeline is sufficient distance away from residences and public trails that a release of gas would not cause serious injuries or fatalities to members of the public. Increased utilization of the City natural gas system would not introduce additional risk as the system would continue to operate that the same pipeline pressure, thereby introducing the same risk to the surroundings.

Some releases at facilities are caused by vandalism, such as opening of valves or sabotaging of equipment integrity. This could increase the frequency of releases. These impacts can be reduced by securing the facilities to reduce the probability of vandalism. Risks could also be increased if the facilities are not built and maintained to current codes and standards. This impact could be reduced by ensuring that audits are conducted periodically to ensure code and standards compliance. Failure to implement appropriate site security measures or to ensure that the facilities are designed and operated and maintained according to applicable codes and standards would be a significant impact.

Mitigation Measure

SR-1a The Applicant shall implement site security methods, including but not limited to: (1) enclosing all wells and equipment (including the metering station) with 8-foot block walls with barbed wire on the inside at 7 feet; (2) Secure gates located at all entrances with automatic opening/closing and secure access; (3) Limitation of climbable landscaping near the facility; (4) Installation of video surveillance systems and burglar/intrusion alarm systems; (5) Contact information and site access limitations shall be posted in specific locations easily visible to the public, shall be provided to *neighboring residents within a set radius, and shall be placed in Preserve information kiosks and on the Habitat Authority and City websites; (6) Visitor sign-in/sign-out and security policies for employees regarding access control, pre-employment screening, post-employment issues, vehicles, access keys, codes, and card security.*

SR-1b *The Applicant shall conduct a third-party audit of the gas and crude oil plants and pipelines, once constructed, including the well pads, to ensure compliance with Fire Code, applicable API and NFPA codes, EPA RMP, OSHA PSM, and SPCC and emergency response plans requirements. The review shall include a seismic assessment of equipment to withstand earthquakes prepared by a seismic engineer in compliance with Local Emergency Planning Committee Region 1 CalARP guidance. All audit items shall be implemented in a timely fashion, and the audit shall be updated periodically, as directed by the City and the Los Angeles County Fire Department.*

Residual Impacts

Site security issues could increase the likelihood of vandalism and subsequent failure of equipment resulting in spills or releases of material. Appropriate site security would minimize these incidents to less than a significant impact.

The risk curves in Figure 4.3-5 associated with the proposed Project operations would be the same even if the wells are never pressurized, since releases from pressurized well are not estimated to reach receptors.

Impact #	Impact Description	Phase	Residual
SR.2	The proposed Project could introduce risk to the public associated with the transportation of natural gas along Colima Road.	Drilling, Operations	Less Than Significant With Mitigation

Pipeline failures and releases of natural gas can cause significant impacts to nearby residences. Although the proposed Project gas pipeline (6 inches) is substantially smaller than the San Bruno pipeline (30 inches) that ruptured and caused extensive damage in 2010, it could produce impacts to nearby residences and cause fatalities that would exceed significance levels. Impacts from pipeline releases are generally produced when the natural gas ignites, thereby causing large flame jets or fires and the resulting radiation impacts to nearby populations, particularly if the release continues for an extended period of time.

These impacts can be reduced by installing automatic shutdown valves, which reduce the release duration to only a few minutes, installing warning tape above the pipeline to reduce the probability of third-party impacts, and ensuring that the pipeline can be inspected.

Mitigation Measure

SR-2a *The Applicant shall install automatic valves that will automatically shut down under a low pressure scenario at the Processing Facility Area for all pipelines leaving the processing plant (Colima Road and the pipeline to the landfill), and a backflow prevention device or shut-down valve at the tie-in location at Lambert Road, to prevent the release of gas from the main transmission pipeline in the event of a rupture in the Colima Road pipeline.*

SR-2b *The Applicant shall ensure that warning tape is installed above the pipeline within the pipeline trench to warn third parties that a pipeline is located below the warning tape and that the pipeline is capable of utilizing a smartpig.*

Residual Impacts

Installation of automatic shutoff valves and backflow prevention valves would reduce the duration that a release occurs. In the event that a pipeline rupture occurs, the Colima Road pipeline would release the majority of its gas inventory in a short time, within 2 to 5 minutes. However, if gas were to flow from the main transmission pipeline along Lambert Road back into the Colima Road pipeline, this would be a large source of gas that could substantially extend the length of time of the release causing more impacts. The installation of a backflow prevention device (a check valve or a shut-down valve) at the tie-in location would prevent this scenario and would reduce the duration of the release and the fraction of persons that would be exposed to radiation or flammable gas above the levels of concern.

Installing an automatic valve at the Processing Facility Area that automatically shuts down on low pressure would ensure that the Processing Facility Area does not continue to feed a break in the Colima Road pipeline or the landfill pipeline and extend the duration of the release.

Third party impacts to pipelines, caused by construction projects that accidentally excavate and damage the pipeline, are a large contributor to pipeline failures. Nationwide accidental third-party impacts are responsible for nearly 20 percent of pipeline failures and within California they cause up to 45 percent of pipeline failures. The installation of warning tape within the Colima Road pipeline trench would help to warn people that a pipeline is present and reduce the number of pipeline failures due to third-party activities.

Ensuring that the Colima Road pipeline is constructed in a manner that allows for the pipeline to be inspected by instruments, or “smart-pigged,” would ensure that the pipeline integrity is checked in the future and would reduce the frequency of releases.

After mitigation, impacts would be less than significant.

Impact #	Impact Description	Phase	Residual
SR.3	The proposed Project could mobilize soil contamination that could affect groundwater and environmental and public health.	Construction	Less Than Significant With Mitigation

Excavation and construction at the drilling site, or associated with the new processing facility or truck loading area installation, could encounter contaminated soils and mobilize them, affecting surface and groundwater quality and thereby environmental and public health. An aerial photo suggests that previous owners used the area as tank and equipment areas (see Figure 4.3-1). This would be considered a significant impact.

Implementing assessments of the sites so that contaminated soils are indentified and dealt with appropriately before construction would reduce the potential for mobilizing contaminated soils. Site assessments are an established practice in site remediation projects.

Mitigation Measures

SR-3 The Applicant shall conduct a site assessment of the Project Site before commencing Project construction and shall sample soils and excavated materials associated with construction to ensure that the soils are not contaminated. Contaminated soils shall be completely excavated and the contaminated areas cleaned to LARWQCB specifications before moving forward with construction of the proposed Project components.

Residual Impact

Soil could be contaminated in areas affected by Project components. Although some areas have been sampled, there are areas of planned construction that have not been tested, including the truck loading area. Ensuring appropriate assessments and cleanup would ensure that existing site contamination does not adversely affect ground and surface waters. After implementing this mitigation measure, the impact would be less than significant with mitigation.

4.3.5.1 Other Issue Area Mitigation Measure Impacts

Mitigation measures proposed for other issues areas could increase impacts to safety, risk of upset, and hazardous materials if they are implemented. This section discusses those potential mitigation measure impacts.

None of the mitigation measures proposed for other issue areas would change the impacts discussed in this section. Therefore, the mitigation measures would not result in additional significant impacts, and additional analysis or mitigation is not required.

4.3.6 Cumulative Impacts and Mitigation Measures

Cumulative projects that could impact the current analysis include those projects listed in Section 3.0, Cumulative Projects Description. Impacts of cumulative projects are realized by either increasing the frequency or volume of oil spills into the same environment as the proposed Project, increasing the public safety risks to the same populations as the proposed Project, or increasing the risks due to an increase in the receptor populations within the proposed Project impact zones. None of the cumulative projects would affect the same populations or increase the number of populations that could be exposed to the proposed Project scenarios. The Matrix Cit of La Habra Heights project is a proposed oil development project south of the Preserve in the City La Habra Heights, which is 1.6 miles from the proposed Project Site, too far to create cumulative impacts). A fire or explosion at the City of La Habra Heights site, or any currently operating oil and gas developments, such as Honolulu Terrace or Sycamore Canyon, would not impact the same areas as a release from the Project Site. Therefore, there are no cumulative significant impacts.

4.3.7 Mitigation Monitoring Plan

Mitigation Measure	Requirements	Compliance Verification		
		Method	Timing	Responsible Party
SR-1a The Applicant shall implement site security methods, including but not limited to: (1) enclosing all wells and equipment (including the metering station) with 8-foot block walls with barbed wire on the inside at 7 feet; (2) Secure gates located at all entrances with automatic opening/closing and secure access; (3) Limitation of climbable landscaping near the facility; (4) Installation of video surveillance systems and burglar/intrusion alarm systems; (5) Contact information and site access limitations shall be posted in specific locations easily visible to the public, shall be provided to neighboring residents within a set radius, and shall be placed in Preserve information kiosks and on the Habitat Authority and City websites; (6) Visitor sign-in/sign-out and security policies for employees regarding access control, pre-employment screening, post-employment issues, vehicles, access keys, codes, and card security.	Site security	Review of site security measures and plan	Before construction and operations	City of Whittier
SR-1b The Applicant shall conduct a third-party audit of the gas and crude oil plants and pipelines, once constructed, including the well pads, to ensure compliance with Fire Code,	Site audit	Facility walkdowns and audit reports and recommendations	Within first year of operations	City and LA County Fire Department

Mitigation Measure	Requirements	Compliance Verification		
		Method	Timing	Responsible Party
applicable API and NFPA codes, EPA RMP, OSHA PSM, and SPCC and emergency response plans requirements. The review shall include a seismic assessment of equipment to withstand earthquakes prepared by a seismic engineer in compliance with Local Emergency Planning Committee Region 1 CalARP guidance. All audit items shall be implemented in a timely fashion, and the audit shall be updated periodically, as directed by the City and the Los Angeles County Fire Department.				
SR-2a The Applicant shall install automatic valves that will automatically shut down under a low pressure scenario at the Processing Facility Area for all pipelines leaving the processing plant (Colima Road and the pipeline to the landfill), and a backflow prevention device or shut-down valve at the tie-in location at Lambert Road, to prevent the release of gas from the main transmission pipeline in the event of a rupture in the Colima Road pipeline.	Design documents and plans showing valves	Inspection of construction design plans and in-field equipment	Before construction and operations	City of Whittier
SR-2b The Applicant shall ensure that warning tape is installed above the pipeline within the pipeline trench to warn third parties that a pipeline is located below the warning tape and that the pipeline is capable of utilizing a smartpig.	Warning tape and smartpig capable	Inspection of construction design plans and during construction before backfilling pipeline trench	Before construction	City of Whittier
SR-3 The Applicant shall conduct site assessments of the Project Site before commencing Project construction and shall sample soils and excavated materials associated with construction to ensure that the soils are not contaminated. Contaminated soils shall be completely excavated and the contaminated areas cleaned to LARWQCB specifications before moving forward with construction of the proposed Project components.	Site sampling	Review of sampling results	Before construction and operations	City of Whittier and RWQCB