

June 2015 | Pipeline Safety Hazard Assessment

Agricultural Education and Career Technical Center

for Santa Maria Joint Union High School District

Prepared for:

Santa Maria Joint Union High School District

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1. Introduction

1.1 PURPOSE

This report presents the results of a pipeline safety hazard assessment (PSHA) prepared for the proposed agricultural and career training center to be located at 1280 Founder Avenue, which is southeast of the City of Santa Maria in unincorporated Santa Barbara County, California. The PSHA evaluates potential exposure and fatality risk to students and staff from underground or at-grade natural gas or hazardous liquid pipeline releases and the potential for flooding from large volume water pipelines.

1.2 SCHOOL SITE LOCATION

The Santa Maria Joint Union High School District (SMJUHSD) is planning to purchase a 25.32-acre parcel at 1280 Founder Avenue in unincorporated Santa Barbara County, California, to construct an agricultural education and career technical center. Several structures would be constructed to house both students and livestock, including two workshop buildings and an animal barn. Pursuant to future local funding approval by voters, a second phase may add an agriculture pavilion/culinary arts/administration building/cafeteria.

The remainder of the 25,32 acres would be dedicated to pasture, truck crops, field crops, orchard use, pavilion parade ground, and parking areas. Livestock would be housed on-site with a total of 86 pens for steers, goats, sheep, and pigs. The program would operate between 9:30 am to 1:40 pm, with students coming in two shifts by bus. The total capacity for this program would be 198 students and 9 on-site employees.

The property is bounded on the north and east by agricultural land, on the south by the Santa Maria Elks Rodeo Facility, and on the west by undeveloped grazing land. To the east beyond the agricultural land is the Greka Oil and Gas Company (Greka) oil field facility consisting of several oil-gas wells, associated piping, and aboveground storage tanks. To the west beyond the undeveloped land is a pet grooming and boarding facility and Highway 101. Although Greka has no current development plans, Greka is reserving the right to drill future oil production wells at two potential drill sites within the proposed property. The location of the potential future drill sites and the proposed property are shown on Figure 1.

1.3 REGULATORY REQUIREMENTS

Under Education Code Section 17251, the California Department of Education (CDE) has authority to approve acquisition of proposed school sites. The school district must obtain CDE approval for sites to receive state funds under the state's School Facilities Program administered by the State Allocation Board. CDE standards and regulations for this process are presented in California Code of Regulations, Title 5, Sections 14010, 14011, and 14012. Information on assessing safety hazard related to pipelines is discussed in Section 14010 (h):

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The site shall not be located near an above-ground water or fuel storage tank or within 1,500 feet of the easement of an above-ground or underground pipeline that can pose a safety hazard as determined by a risk analysis study, conducted by a competent professional, which may include certification from a local public utility commission.

By CDE policy, “any pipeline that has a maximum operating capacity of at least 80 pounds per square inch (psi), including but not limited to those that carry natural gas, liquid petroleum, fuels or hazardous chemicals, shall be included in a pipeline survey, regardless if the pipeline is classified as a transmission or distribution line. Pipelines located within a railroad or other easement or those pipelines serving gas and oil well sites and fields shall also be included”.

Additional information on pipelines is contained in CDE’s School Site Selection and Approval Guide. This document states that CDE will not approve a proposed school site if the site "contains one or more pipelines, situated underground or aboveground, which carries hazardous substances, acutely hazardous materials, or hazardous wastes, unless the pipeline is a natural gas line which is used only to supply natural gas to that school or neighborhood" (CDE, 2004).

The CDE’s School Site Selection and Approval Guide also contain provisions for evaluating high-pressure water pipelines:

To ensure the protection of students, faculty, and school property if the proposed school site is within 1,500 feet of the easement of an aboveground or underground pipeline that can pose a safety hazard, the school district should obtain the following information from the pipeline owner and operator:

- *Pipeline alignment, size, type of pipe, depth of cover*
- *Operating water pressures in pipelines near the proposed school site*
- *Estimated volume of water that might be released from the pipeline should a rupture occur on the site*
- *Owner’s assessment of the structural condition of the pipeline.*

1.4 REPORT OBJECTIVES

To meet the requirements of CCR Title 5 Sections 14010 (d) and (h) and CDE’s policy on pipelines, this PSHA is designed to meet the following objectives:

- Identify all natural gas and hazardous liquid pipelines located within 1,500 feet of proposed or existing school sites
- Complete a Stage 1, Stage 2, or Stage 3 risk analysis for each identified pipeline to predict fatality risk
- Where appropriate, identify and develop mitigation measures to reduce predicted fatality risk to a level below an established significance threshold
- Identify all high pressure/large volume water pipelines within 1,500 feet of the proposed school site and evaluate the potential for flooding

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- Where appropriate, identify and develop mitigation measures to reduce flooding impacts to acceptable levels.

1.5 ASSESSMENT METHODOLOGY

The CDE has recently developed and published guidance procedures for evaluating safety hazards associated with natural gas and hazardous liquid releases from underground and aboveground pipelines. A detailed description of the procedures is provided in the Guidance Protocol for School Site Pipeline Risk Analysis (CDE, 2007). These procedures were used in conducting the PSHA.

The PSHA process is composed of two steps. The first step (Stage 1) is a risk screening analysis (RSA), based on the distance of the pipeline(s) from the school site and operating characteristics of the pipeline(s). If the screening criteria are met, the level of risk is acceptable and no further analysis is required.

If the screening criteria are not met, then the second step of the PSHA process is completion of a Stage 2 quantitative risk analysis (QRA). The Stage 2 risk analysis considers pipeline accident rates, school dimensions, conditional probabilities for ignition, school attendance time, and fatality probabilities for different exposure scenarios (pool fire, flash fire, and explosion) to estimate individual risk (IR). Pipelines located within 50 feet of a school site also are subject to a Stage 3 (more comprehensive) analysis to verify the results of the Stage 2 evaluation.

Individual fatality risk is compared to the significance threshold level of one in one million (1.0×10^{-6}). If the estimated risk is less than one in one million, then no significant safety hazard is predicted for the school site. If the estimated risk is greater than one in one million, mitigation measures are required to reduce risk to within acceptable limits or a more detailed Stage 3 risk analysis can be conducted.

In addition to individual risk, an estimate of the potential risk for the population present at the school site is determined by calculating the total individual risk (TIR) indicator ratio and the population risk indicator. These parameters add an additional perspective by taking into account the site configuration and school population. There is no significance threshold established by the CDE for this evaluation, and this does not replace the IR estimate as the primary decision criteria for evaluating risk at the school site. However, it does provide additional information regarding the magnitude of risk at the school.

The CDE also has developed risk analysis procedures for evaluating flooding associated with releases from large diameter water pipelines, as described in CDE's Guidance Protocol for School Site Pipeline Risk Analysis (CDE, 2007). A safety issue associated with large diameter water pipelines is the potential for flooding. Also, releases from underground water pipelines can cause subterranean erosion of saturated soil, leading to subsidence or formation of a sinkhole. The most likely cause of failure is a large magnitude earthquake and associated strong ground shaking.

Although no specific criteria have been established by the CDE as a threshold of significance for flooding at a school site, a water depth of 12 inches or greater is a trigger that could warrant further evaluation, (CDE, 2007).

2. Hazard Assessment

2.1 PIPELINE LOCATION AND OPERATIONAL DATA

There are two natural gas gathering pipelines and one crude oil gathering pipeline within 1,500 feet of the school site. No other hazardous liquid pipelines or natural gas transmission/distribution pipelines were within the 1,500-foot radius (NPMS and Southern California Gas Company, 2015). The locations of these pipelines are shown on Figure 1.

Pipeline data were obtained from Greka Oil and Gas Company (2015). Gathering pipelines are typically small-diameter pipes that run over relatively short distances, with sizes ranging from 2 to 8 inches. They transport gases and liquids from the producing oil wells to a nearby processing facility. They generally operate at relatively low pressures and flow. Two of the three pipelines within 1,500 feet of the school site typically operate at pressures of 10 to 40 psi, which would exempt them from CDE regulatory requirements because they are below CDE's definition of a high pressure pipeline (≥ 80 psi). However, because these pipelines could conceivably operate at higher pressures exceeding 80 psi, they are being analyzed in this report.

The 6-inch natural gas gathering pipeline north of the school site is currently the only pipeline that is active. The 4-inch crude oil and natural gas pipelines that transect the southeast corner of the school site have been installed but have never been operational up to this point in time. Greka is reserving the right to install production wells on two drill sites within the proposed property boundaries. Hypothetical future gathering pipelines associated with these production activities are also included in this analysis. It is assumed that the crude oil and natural gas pipelines would be of the same diameter (4 inches) and pressure as the installed pipelines.

There is a 6-inch wet gas (natural gas) gathering pipeline approximately 1,400 feet north from the proposed school site that connects to the Hopkins Tank Battery (TB). Natural gas exiting a production field is usually referred to as "wet gas" because it contains significant amounts of hydrocarbon liquids and contaminants prior to processing. The analysis used in this PHSA is conservative because it assumes that the natural gas in these "wet gas" pipelines would be dry and processed. This would remove any water vapor and the gas within the pipeline would have higher volatility and higher methane concentrations, resulting in impacts over a greater distance. The 6-inch wet gas pipeline is constructed of polypropylene, has a typical operating pressure of 10 to 20 psi, and a maximum operating pressure of 600 psi. To be conservative, the maximum operating pressure of 600 psi was used in the analysis. According to Mr. Ray Marroquin of Greka, there are plans to replace this 6-inch pipeline with a smaller 3-inch or 4-inch pipeline. However, there is no scheduled completion data for this replacement so a pipeline diameter of 6 inches was assumed for this analysis.

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There also are two 4-inch gathering pipelines that transect the southeast corner of the proposed school site. The pipelines are located along the south side of Founder Avenue. There are no plans for development of the portion of the school site in the corner of the property south of the pipelines and the proposed land use immediately north of Founder Avenue will be pasture.

The pipeline closest to the school site is a 4-inch crude oil gathering pipeline and is located approximately 30 feet from the northern edge of the access road (i.e., the nearest distance to the school's usable portion of the property, which will be pasture). The pipeline is constructed of Schedule 80 steel, has a normal operating pressure of 200 psi, and a maximum operating pressure of 500 psi. The pipeline originates near Breezy Glen Drive, parallels Morningside Drive, and then turns west and parallels the south side of Founder Avenue before terminating at the Hopkins Tank Battery. It is approximately 6,210 feet in length and has been installed but has never been operational due to permitting issues. However, for this analysis, it is assumed that the pipeline is operational. The pipeline contents were conservatively analyzed as n-hexane, as per the CDE protocol for liquid pipelines. This assumption is more appropriate for gasoline or petroleum product pipelines. Crude oil pipelines have much less volatility and the crude oil produced in this area has an API gravity of 13.4, characterizing it as "heavy crude". Per the CDE protocol, the distance of the hazard footprints was reduced by 30% to account for the decreased volatility of crude oil.

There also is a 4-inch natural gas ("wet gas") gathering pipeline that parallels the crude oil pipeline. This pipeline is approximately 31 feet from the northern edge of Founder Avenue (i.e., usable portion of the school site). The pipeline has a normal operating pressure of 20 to 40 psi; however, the maximum operating pressure is estimated to be 200 psi. This higher pressure was used in the analysis. The pipeline is constructed of Schedule 80 polyethylene.

Greka is also reserving the right for future development of oil production wells at two drill sites on the school property. The southern drill site could potentially have two very short 4-inch crude oil and wet gas gathering lines that connect to the existing pipelines along Founder Avenue. This scenario is accounted for in the evaluation of the existing but inactive pipelines that are present beneath Founder Avenue. If development were to occur on the northern drill site, it is assumed that a 4-inch crude oil gathering line and a 4-inch wet gas gathering line at the same operating pressures of the existing pipelines could be installed and operated in the future. Therefore, the same analysis conducted for the existing pipelines is appropriate for these pipelines. The risk for these potential future pipelines was added to the calculated risk for the existing pipelines to get a theoretical overall individual risk. There are two possible options for the location of these pipelines, as shown in Figure 1.

No large volume (≥ 12 inches in diameter) water pipelines were identified within 1,500 feet of the school site, according to the City of Santa Maria Public Works Department (2015), Santa Barbara County Flood Control and Water Conservation District (2015), and Golden State Water Company (2015). There is a 3-inch fresh water pipeline that parallels the 4-inch crude oil and natural gas gathering pipelines, but this does not meet the CDE criteria for a large volume water pipeline and further analysis is not required.

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2.2 LAND USE AND TERRAIN

Land surrounding the proposed school site is zoned agricultural and is primarily undeveloped land or cultivated crops. There is an oil production facility to the northeast and rodeo grounds to the south. There are no buildings or structures that could partially block or buffer vapor releases, jet flames, or a pool fire if an incident were to occur involving the natural gas gathering pipeline or crude oil gathering pipeline located beneath Founder Avenue. For the 6-inch natural gas gathering pipeline to the north, the hazard footprints for the 6-inch gathering pipeline would not reach the school site, as discussed in the following sections, and there is no risk from this pipeline. Due to the undeveloped nature of the school site and the surroundings, there currently are minimal potential ignition sources. However, motor vehicles traveling along the adjacent streets, overhead high voltage lines, and gas heating units could be potential emission sources if any of the pipelines were to catastrophically fail.

Topography does not affect releases from natural gas pipelines, because released methane is buoyant and would disperse into the air. However, topography is important for crude oil pipelines in determining the direction and location of released crude oil. The pipeline profile for the 4-inch crude oil gathering line was not available, so the topographic gradient along the pipeline was used to determine the drain down quantity. Drain down refers to the quantity of liquid in the pipeline after shutdown that would gravity flow from the high point of the pipeline to the low point, which is adjacent to the school site. This drain down quantity of crude oil was added to the amount of liquid released during the 15 minute period before shutdown to determine an overall spill release volume.

The general topographic gradient south of Founder Avenue in the vicinity of the school site is to the southwest. If a pipeline rupture or leak were to occur in the vicinity of the school site or where the pipeline transects the corner of the school site, the released crude oil would flow to the south and away from the school site. Therefore, the closest distance of a crude oil pool to the usable portion of the school site was assumed to be 30 feet (i.e., the distance from the pipeline to the north side of Founder Avenue and the usable portion of the school site).

2.3 RELEASE AND CONSEQUENCE SCENARIOS

In accordance with the CDE Guidance Protocol, two conservative release scenarios were evaluated: 1) a rupture or large volume release equal to the pipeline's diameter, and 2) a leak or small volume release from a 1-inch diameter hole. Three potential consequences were evaluated for each release scenario: 1) jet flame, 2) flash fire, and 3) explosion. The results from the ALOHA computer model indicate that an explosion would not occur in open land (unconfined) conditions.

2.4 STAGE 2 RISK ANALYSIS

Because there are multiple pipelines located within 600 feet of the school site, the criteria for a Stage 1 analysis were not met. Therefore, a Stage 2 risk analysis was conducted to determine the cumulative individual risk (IR) to students and staff at the proposed school. The input data and risk calculations associated with this PSHA are provided in Appendix A; the pipeline input data are summarized herein.

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Description	Pipeline Operator	Pipeline Location	Status	Pipeline Diameter (inches)	Pipeline Pressure (psig)	Distance from Pipeline to School Property (feet)
6-inch natural gas gathering pipeline	Greka Oil and Gas Company	North of school site	Active	6	600 (maximum)	1,400
4-inch crude oil gathering pipeline	Greka Oil and Gas Company	Transects southeast corner of site	Idle	4	500 (maximum)	30 feet from usable portion of school site
4-inch natural gas gathering pipeline	Greka Oil and Gas Company	Transects southeast corner of site	Idle	4	200 (maximum)	31 feet from usable portion of school site
4-inch crude oil gathering pipeline	Greka Oil and Gas Company	Future northern drill site	Potential future line	4	500 (assumed)	30 feet from school site (within drill site)
4-inch natural gas gathering pipeline	Greka Oil and Gas Company	Future northern drill site	Potential future line	4	200 (assumed)	31 feet from school site (within drill site)

Only one of the pipelines is currently active and for this pipeline, the hazard footprints don't reach the school site and therefore, the estimated risk to students and staff is zero. For the two pipelines that transect the southeast corner of the school site, it is assumed that they will be active in the future. It also is assumed that Greka will reserve the right and start oil production at the two drill sites, so there is the potential for two future crude oil and natural gas gathering pipelines to be located at the northern site. It is possible that these pipelines will be located at distances greater than 30 or 31 feet from the school site, because the drill site has dimensions of 210 feet in width and the pipelines could originate from the middle of the site. However, for this analysis, it was conservatively assumed to be the same distance as the existing pipelines. For the southern site, two short connector lines will be linked to the existing pipelines beneath Founder Avenue.

2.5 STAGE 2 RISK CALCULATION RESULTS

There were some variations from CDE default parameters in preparing this analysis, because gathering pipelines have different operating parameters and the proposed school site would be an agricultural center with students and staff present for 4 hours per day with most of the activities occurring outdoors.

Because crude oil gathering pipelines typically do not flow full, the flow velocity was changed from the CDE default of 7 feet/sec to 3 feet/sec to account for the low flow rates from Greka wells in the area (20 barrels/day).

The probability of exposure is calculated as the probability of occupancy at the campus in a given year multiplied by the probability of being outdoors. The CDE default parameters are 0.16 for occupancy ((180 days/year times 8 hours/day)/8,670 hours/year) and 0.25 for outdoors (2 hours out of the 8 hours/day) for a total exposure probability of 0.04 (0.16 x 0.25). At this site students and staff would only be present 4 hours/day, so the probability of occupancy was calculated to be 0.08. However, the probability of being outdoors was assumed to be 100% for a total probability of exposure of 0.08.

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Risk calculation results for the pipelines are provided in Appendix A. As shown in Appendix A, the risk associated with the 6-inch natural gas gathering pipeline is zero, because the hazard footprints do not reach the school site. The calculated individual risk (IR) for the rest of the pipelines is provided below:

- 4-inch Crude Oil Gathering Pipeline – Founder Avenue – 1.3×10^{-8}
- 4-inch Natural Gas Gathering Pipeline – Founder Avenue – 1.9×10^{-9}
- Potential Future Crude Oil Gathering Pipeline – Northern Drill Site – 1.3×10^{-8}
- Potential Future Natural Gas Gathering Pipeline – Northern Drill Site – 1.9×10^{-9}

The total individual risk (TIR) for all pipelines is 3.0×10^{-8} . Since the calculated risk is less than one in a million (1.0×10^{-6}), which is the TIR criterion specified in the CDE manual, the risk is considered to be less than significant.

As part of the Stage 2 analysis, risk indicators also were determined for the existing pipelines, based on the protocol presented in the CDE manual. Since the exact configurations of the potential future pipelines at the northern drill site are not known at this time, the risk calculations for these pipelines will be provided at a future date, upon request by CDE. The school site was divided into three zones (Zones 1 through 3), with each zone approximately 445 feet wide. The TIR was calculated for each zone and compared to the TIR calculated for the nearest property boundary to the pipeline (i.e., TIR Indicator Ratio). As per the CDE protocol, the population risk indicator was calculated for this pipeline, based on the proposed new school layout and outdoor areas of use. The calculations for the TIR ratios and population risk indicator for the pipeline are provided in Appendix A and are summarized in the table below:

<i>Pipeline</i>	<i>TIR</i>	<i>TIR/IRC Ratio</i>	<i>TIR Indicator Ratio</i>	<i>Population Risk Indicator</i>
4-inch crude oil gathering pipeline – Founder Avenue	1.3E-08	0.01	0.00	31
4-inch natural gas gathering pipeline – Founder Avenue	1.9E-09	0.00	0.25	0

There are no significance thresholds established by CDE for the TIR/IRC ratio, TIR indicator ratio, or population risk indicator. These values are simply used by CDE reviewers as guidelines to determine the relative potential risk at a school site.

2.6 STAGE 3 RISK ANALYSIS AND RESULTS

Because the natural gas and crude oil gathering pipelines beneath Founder Avenue are located less than 50 feet from the school property boundary, a Stage 3 analysis was conducted for these pipelines. As per CDE guidance, the additional analysis was used to verify and validate the Stage 2 results, using different calculation methods. The CDE manual states that near-field modeling may not accurately apply within a distance of 50 feet and that “additional modeling should be applied, with checks by more than one estimation method”.

From a literature review on pipeline risk assessments and consequence modeling, it appears that ALOHA results from modeling natural gas releases within 50 feet of a receptor would be conservative for the following reasons:

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- ALOHA underestimates concentrations at distances of 200 meters or more and overestimates concentrations closer in, resulting in conservative results for near field analyses
- ALOHA is used extensively by local fire departments and hazmat teams to model immediate *near field* impacts of hazardous material releases
- ALOHA ignores initial plume or puff rise, resulting in conservative results for modeling natural gas (methane) releases
- ALOHA doesn't model initial momentum of release, which is conservative and results in higher ground level concentrations than with an elevated release
- ALOHA doesn't account for buoyancy due to heat, resulting in conservative results when modeling natural gas releases resulting from a jet fire or flash fire
- ALOHA treats released methane as being neutrally buoyant, when it is actually lighter than ambient air, resulting in conservative results
- Los Angeles Unified School District's (LAUSD's) pipeline risk assessment protocol uses ALOHA and other models without any distance restriction on model results for pipelines located within 50 feet of a school's property boundary

Based on the reasons listed above, using ALOHA to model releases from natural gas pipelines within 50 feet of a school site would result in conservative results. Nevertheless, a Stage 3 analysis, using alternative calculation methods, was conducted for this report.

For the Stage 3 analysis, the methodology used by LAUSD to evaluate natural gas pipeline risk was used. The LAUSD methodology typically has higher calculated risk values and is more conservative than the CDE methodology, based on the following reasons:

- The LAUSD methodology uses equations from AIChE instead of the ALOHA model to determine the radiant heat (jet flame) release scenario, which results in longer hazard footprints and higher risk values.
- The LAUSD methodology assumes a school attendance time of 8 hours per day for 240 days per calendar year, based on staff hours, and also assumes that all students and staff are outdoors for a total exposure probability of 22 percent. The CDE protocol uses an attendance time of 8 hours per day for 180 days, and assumes that students and staff are outdoors 25% of the time, for a total exposure probability of 4 percent. Therefore, the LAUSD methodology is very conservative because students and staff would be present at this school site only 180 days per year for 4 hours per day.

The LAUSD methodology uses equations from the American Institute of Chemical Engineers (AIChE)'s manual *Guidelines for Chemical Process Quantitative Risk Analysis* (AIChE, 2000) to determine jet flame length, flame width, and radiant heat levels for natural gas rupture and leak scenarios. The flammable vapor cloud (FVC) for a natural gas rupture or leak scenario is determined using the ALOHA model, which is consistent with the CDE methodology.

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The release scenarios are the same as those used in the CDE methodology: 1) a rupture equal to the pipeline's diameter, and 2) a leak from a 1-inch diameter hole. For this alternative analysis, two potential consequences were evaluated: 1) jet flame/radiant heat flux, and 2) flammable vapor cloud.

The LAUSD methodology also includes wind direction and frequency data for the nearest meteorological station (Santa Maria Airport) in the risk analysis (Lakes Environmental, 2015). The Santa Maria Airport meteorological station is located approximately 2.2 miles northwest of the school site. The monitoring station wind rose diagram for school attendance hours (9 am to 2 pm) is provided in Appendix A. In the vicinity of the school site during this time period, the predominant wind direction is to the east-southeast or away from the school site. Any wind directed from W to E, including the north vectors, was considered to be able to direct a release from the natural gas gathering pipeline beneath Founder Avenue toward the school site. For the time period of concern, the wind for all vectors from W to E blows toward the site 10% of the time.

The fatality probabilities for the radiant heat footprints were adjusted from the LAUSD default values of 0.1, based on the site-specific school configuration and per the instructions in the *PSHA User Manual*:

- Radiant Heat Fatality Probability – 4-Inch Natural Gas Gathering Pipeline - Rupture Scenario – 0.33

The results of the alternative Stage 3 analysis are provided in Appendix A, and the results are summarized herein:

- LAUSD Methodology - 4-inch Natural Gas Gathering Pipeline - 6.6×10^{-8}

Although the results show a higher risk than that calculated by the CDE methodology (i.e., 6.6×10^{-8} vs. 1.9×10^{-9}), this result is still much less than the significance threshold of one in a million (1.0×10^{-6}). Therefore, the results of the alternate Stage 3 analysis verify that in the unlikely event of a rupture or leak in the 4-inch natural gas gathering pipeline, the risk to students and staff at the school site would be less than significant.

The LAUSD methodology was also used to evaluate the 4-inch crude oil gathering pipeline. As described previously, the LAUSD methodology uses equations from the American Institute of Chemical Engineers (AIChE)'s manual *Guidelines for Chemical Process Quantitative Risk Analysis* (AIChE, 2000) to determine the amount of liquid released for the crude oil rupture and leak scenarios. Using the LAUSD methodology, the volume of liquid released for the crude oil rupture scenario was estimated to be 171 ft³ as compared to 123 ft³ for the CDE methodology before adding drain down. The results for the leak scenario were the same using the LAUSD and CDE methodology. The flammable vapor cloud (FVC) for the crude oil rupture or leak scenario is determined using the ALOHA model, which is consistent with the CDE methodology. As described previously, the LAUSD uses conservative assumptions for the exposure of students and staff and as considers wind direction and frequency in the calculations. The fatality probability for the radiant heat footprint for the rupture scenario was adjusted to 0.33 from the LAUSD default values of 0.1.

The results of the alternative Stage 3 analysis are provided in Appendix A, and the results are summarized herein:

- LAUSD Methodology - 4-inch Crude Oil Gathering Pipeline - 2.7×10^{-7}

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Although the results show a higher risk than that calculated by the CDE methodology (i.e., 2.7×10^{-7} vs. 1.3×10^{-8}), this result is still much less than the significance threshold of one in a million (1.0×10^{-6}). Therefore, the results of the alternate Stage 3 analysis verify that in the unlikely event of a rupture or leak for the 4-inch crude oil gathering pipeline, the risk to students and staff at the school site would be less than significant.

One of the conservative assumptions in the crude oil pipeline analyses is that the releases are modeled as n-hexane, as per the CDE protocol. However, crude oil typically is composed of only 1% hexane or less and a wide mixture of other chemicals. Because hexane is highly flammable and volatile as compared to crude oil, the analyses overestimate the formation of flammable vapor clouds and the amount of radiant heat generated by pool fires, thus overestimating impacts to nearby receptors (i.e., students and staff). In addition, the assumption is that there would be a student or staff standing at the edge of Founder Avenue at the time of the pipeline leak or rupture, when in actuality the site plan shows that this area would be dedicated to pasture. Also, the gathering pipelines that transect the southeast corner of the school site have never been operational and are currently idle, although they may be activated in the future.

2.7 SUMMARY AND RECOMMENDATIONS

Summary

The results of the CDE pipeline protocol analysis indicate a total individual risk of 3.0×10^{-8} , which is much less than the CDE significance threshold of one in a million (1.0×10^{-6}). Therefore, the risk to staff or students at the proposed school site is not considered to be significant and no mitigation measures are required. An additional Stage 3 analysis was conducted to verify the results of the Stage 2 analysis for the 4-inch natural gas and crude oil gathering pipelines. The risk was calculated to be 6.6×10^{-8} and 2.8×10^{-7} , respectively, which also are below the significance threshold.

Recommendations

Although the pipeline meets the CDE significance threshold and no mitigation measures are required, there are several measures that could be implemented to further reduce the potential risk in the unlikely event of a pipeline rupture or leak. It is recommended that the new school site layout locate buildings and structures as far as possible from the pipelines and include limited use areas near the pipelines. The proposed school layout incorporates these recommendations with the nearest building (an animal barn) approximately 300 feet from the pipeline and the area closest to the pipeline is dedicated to pasture.

Although the operation and management of each pipeline ultimately resides with the pipeline operator, there are certain actions that the Santa Maria Joint Union High School District could take to further protect the students and staff at the proposed school site, as deemed appropriate:

- Meet annually (or on a specified schedule) with Greka for periodic updates on their activities to activate the pipelines beneath Founder Avenue and/or start production activities at the drill sites. This meeting could be conducted in concert with emergency response drills for the area.

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- Include the possibility of a pipeline release as a scenario in the school's emergency preparedness planning and response plans, including potential evacuation routes or shelter-in-place, awareness of pipeline locations, contact information, and actions to follow in the event of a pipeline release.
- Have Santa Maria Joint Union High School District contact the One-Call Center for automatic notification of any excavation activities that are planned within the vicinity of the school site.
- Santa Maria Joint Union High School District also should immediately notify Greka if there are any odors or evidence of gas or fuel leakage from the pipelines once they are activated or activities that involve digging near the pipeline.
- Greka personnel are trained to respond to a release or threatened release by immediate notification to various agencies, including 911, the California Office of Emergency Services (OES), National Response Center (NRC), Consolidated Unified Program Agency (CUPA), and local agencies, as required by special agreement. If necessary, the Santa Maria Joint Union High School District could coordinate with CUPA or the local agency to ensure that they are notified if there is a release or threatened release in the vicinity of the school site.

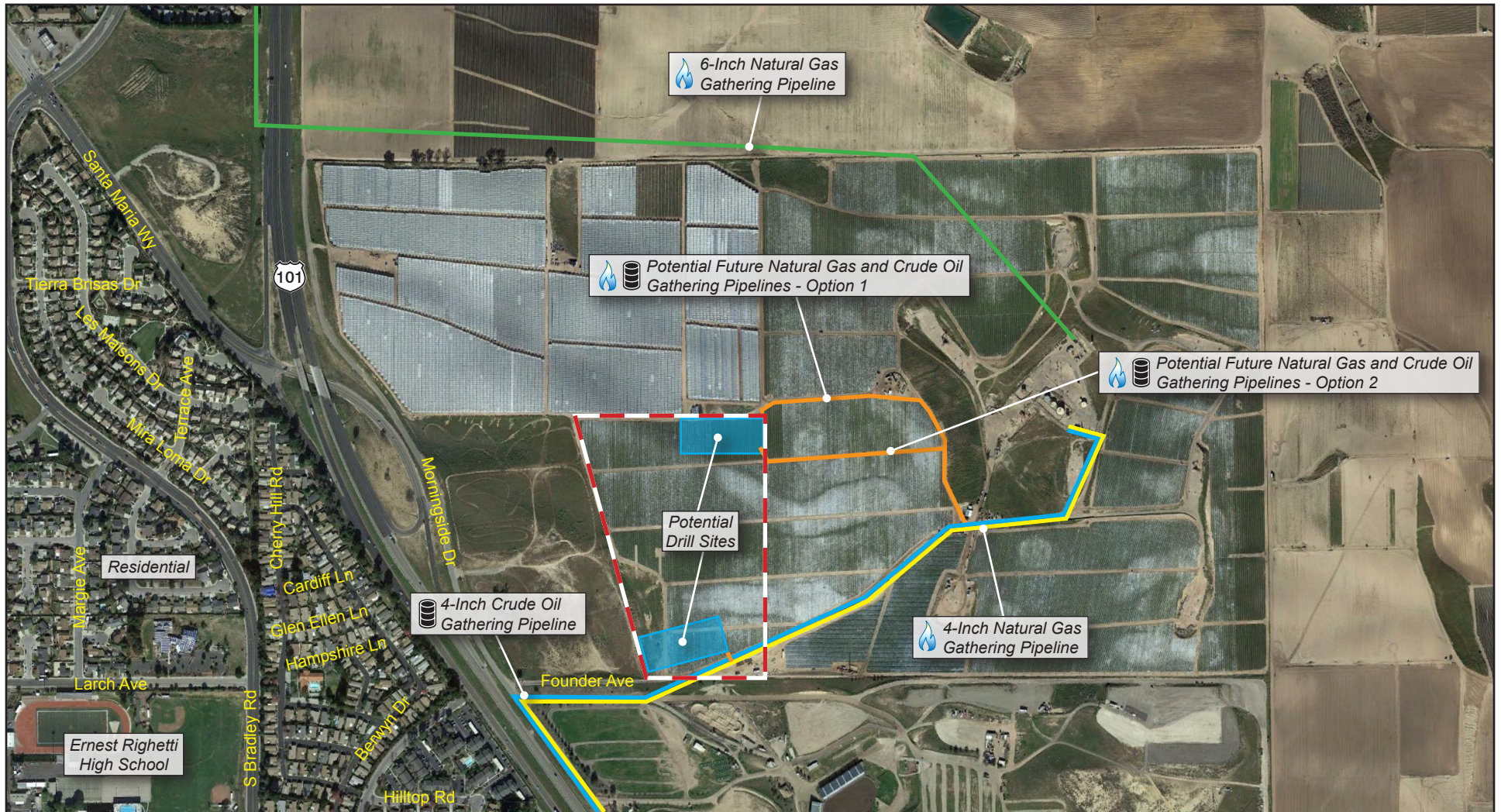
Any additional measures to ensure the safety of school students and staff and maintain the integrity of the pipelines can be discussed between representatives of Greka and District personnel, as deemed necessary. A map of the pipeline locations and emergency contact information should be kept with the school's emergency response plan.

3. References

1. American Institute of Chemical Engineering (AIChE), 2000. Guidelines for Chemical Process Quantitative Risk Analysis, Second Edition, AIChE, New York, New York, 754 pp.
2. Automated Resource for Chemical Hazard Incident Evaluation (ARCHIE) computer model, 1989. Developed by US Federal Emergency Management Agency (FEMA), US Department of Transportation (USDOT), and US Environmental Protection Agency (USEPA). Public domain model, web site – hazmat.dot.gov/risk_tools.htm.
3. Bay Area Air Quality Management District (BAAQMD), 2001. Meteorological data for Napa meteorological station for year 2001. Accessed at <http://hank.baaqmd.gov/tec/data/#>.
4. California Department of Education (CDE), 2000. Resources for School Facilities Planning, School Selection and Approval Guide. Prepared by School Facilities Planning Division, CDE, Sacramento, CA.
5. CDE, 2007. Guidance Protocol for School Site Pipeline Risk Analysis, Prepared by URS Corporation. February, 2007.
6. City of Santa Maria Public Works Department, 2015. Telephone conversation between Mr. Mark Mueller, Engineering Technician III, Santa Maria Public Works Department, Engineering Division, and Mr. Steve Bush, Project Engineer, PlaceWorks on June 2, 2015.
7. Franks, Donald L., 1990. User's Manual for SLAB: An Atmospheric Dispersion Model for Denser Than Air Releases. Physics Department, Atmospheric and Geophysical Sciences Division, University of California, Lawrence Livermore National Laboratory. Dated June 1990.
8. Golden State Water Company, 2015. Telephone conversation between Mr. Larry Dees, Operations Engineer, Golden State Water Company and Mr. Steve Bush, Project Engineer, PlaceWorks on June 15, 2015.
9. Greka Oil and Gas Company, 2015. Telephone conversation between Mr. Ray Marroquin, Gas Superintendent, Greka Energy and Mr. Steve Bush, Project Engineer, PlaceWorks, on June 12, 2015 and previous information reported in the Phase I Environmental Site Assessment (ESA) prepared by Padre Associates, dated May 2014.
10. Lakes Environmental, 2015. Met data in SAMSON format from Santa Maria Airport, one year – 1988. Input to Lakes Environmental WRPLOT View for wind rose.
11. National Pipeline Mapping System (2015). Hazardous liquids pipeline map produced by the NPMS Public Viewer at www.npms.phmsa.dot.gov. Accessed on June 10, 2015.
12. Santa Barbara County Flood Control & Water Conservation District, 2015. Telephone conversation between Mr. Jonathan Frye, Santa Barbara County Flood Control & Water Conservation District and Mr. Steve Bush, Project Engineer, PlaceWorks on June 12, 2015.
13. Southern California Gas Company, 2015. Online database of natural gas transmission and distribution pipelines. Accessed at <http://www.socalgas.com/safety/pipeline-maps/santa-barbara.shtml> on June 15, 2015.

Figures

Figure 1 - Site Location and Pipeline Map



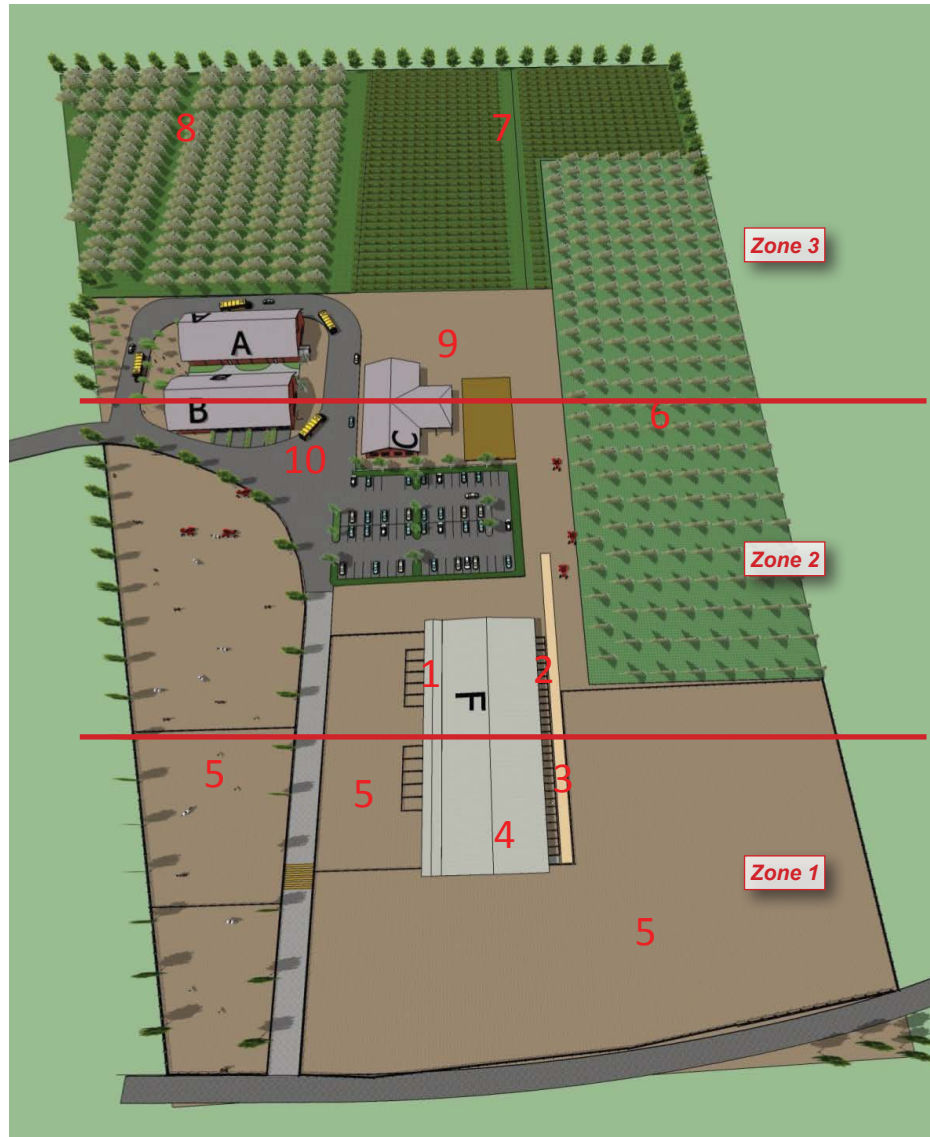
— Site Boundary

0 800
Scale (Feet)



Source: Google Earth Pro, 2015

Figure 2 - School Site Layout and Population Zones



SUMMARY OF STRUCTURES

Label	Description	Est. Size
A	Workshop Bldg 1	9,600 sq ft
B	Workshop Bldg 2	10350 sq ft
C	Ag Pavilion/Culinary Arts/Admin	5750 sq ft
F	Animal Barn	16000 sq ft

SUMMARY OF LIVESTOCK

Label	Livestock	Indoor Dimensions	Outdoor Dimensions	Est. Quantity
1	Steer	12' x 20'	12' x 20'	15 pens
2	Pig	8' x 24'	--	32 pens
3	Sow	8' x 12'	8' x 24'	4 pens
4	Goat/Sheep	8' x 18'	8' x 18'	8 pens
Estimated Total				59 pens

SUMMARY OF LAND USE

Label	Description	Est. Acreage
5	Divisible Pasture Area	5.3 acres
6	Truck Crop Area	4.4 acres
7	Field Crop Area	4.3 acres
8	Orchard Area	5.1 acres
9	Pavilion Parade Ground	2.2 acres
10	Structures and Vehicular Areas	4.0 acres
Estimated Total		25.3 acres



Appendix A. CDE Risk Analysis Summary Forms and Calculations

Appendix

<i>Local Educational Agency</i>	
Date:	June 16, 2015
Local Educational Agency	Santa Maria Joint Union High School District
Contact	Mr. Gary Wuitschick, Director of Support Services
Telephone Number	805.922.4573 x 4805
Street Address	2560 Skyway Drive
City	Santa Maria
County	Santa Barbara County
Zip Code	93455


<i>Proposed School Campus Site</i>	
Name	Proposed New School – Agricultural Education and Career Technical Center
Location Description	1280 Founder Avenue, SE of City of Santa Maria, unincorporated Santa Barbara County
Pipelines of Interest	One 6-inch natural gas gathering pipeline, two idle 4-inch natural gas and crude oil gathering pipelines, and two potential future 4-inch natural gas and crude oil pipelines
Operator/Owner	Greka Oil and Gas Company
Product Transported	Natural gas and crude oil
Pipeline Diameter (inches)	One 6-inch pipeline and two 4-inch pipelines
Operating Pressure (psig)	6-inch natural gas gathering pipeline (MAOP 600 psi); 4-inch crude oil gathering pipeline (MAOP 500 psi) and 4-inch natural gas gathering pipeline (MAOP 200 psi)
Closest Approach to Property Line	1,400 feet, 30 feet, and 31 feet, respectively

<i>Individual Risk Estimate Result</i>							
Type of Analysis (Check One)	Stage 1		Stage 2	X	Stage 3	X	
Individual Risk Estimate Value	3.0E-08						
Individual Risk Criterion	1.0E-06 (0.000001)						
IR Significance (check one)	Significant						
	Insignificant	X					

Certification and Signatures of Risk Analyst(s)

This analysis was conducted according to the 2007 CDE Protocol except as noted. All modifications within the Stage 2 framework, and Stage 3 analyses and exceptions to the data and processes established in the 2007 CDE Protocol, if any, were based upon my professional opinion and in a manner consistent with the standards of care and skill ordinarily exercised by professionals working on similar projects.

I certify that the estimated risk levels were derived based upon the 2007 CDE Protocol, unless otherwise noted, and that these levels demonstrate, with reasonable expectations of uncertainties for such estimates, that the estimated Individual Risk for the school site, as the site was planned at the time of this analysis, including mitigation measures, if any, meets the Individual Risk Criterion stated in the 2007 CDE Protocol, based on the information provided to me.

<i>Printed Name</i>	<i>Signature</i>	<i>Position or Title</i>
Dr. Cathleen M. Fitzgerald, P.E.		Senior Engineer

Notice: In the event that the Individual Risk Criterion could not be met, at the option of the LEA, CDE will still accept a report for review and consultation with the LEA.

6-INCH NATURAL GAS GATHERING PIPELINE

Input Data		
Product	natural gas	
Diameter	6	inches
Pressure	600	psig
R0	1400	ft

XSEG	RX(1%)	Units
XSEG(LJF)	0	ft
XSEG(RJF)	0	ft
XSEG(LFF)	0	ft
XSEG(RFF)	0	ft
XSEG(LEX)	0	ft
XSEG(REX)	0	ft

Base and Conditional Probability Calculations							
	Base	Leak	Rupture	Exposure			
F0	2.1E-04	PC(L)	0.8	PC(R)	0.2	PC(OCC)	0.08
P0	2.1E-04	PC(LIG)	0.3	PC(RIG)	0.45	PC(OUT)	1
PAF	1.0	PC(FIG)	0.99	PC(FIG)	0.99		
PA	2.1E-04	PC(JF)	0.98	PC(JF)	0.98		
		PC(FF)	0.01	PC(FF)	0.01		
		PC(EIG)	0.01	PC(EIG)	0.01		
Calculated Values:							
PA(LJF)	0.0E+00	PCI(LJF)	0.233	PCI(RJF)	0.087		
PA(RJF)	0.0E+00	PCI(LFF)	0.002	PCI(RFF)	0.001		
PA(LFF)	0.0E+00	PCI(LEX)	0.002	PCI(REX)	0.001	PC(EXPO)	0.08
PA(RFF)	0.0E+00						
PA(LEX)	0.0E+00						
PA(REX)	0.0E+00						

Impact Probability Calculations							
Probability Term				Values			
PC(LJF) =	PA(LJF) x	PCI(LJF) x	PC(EXPO) =	0.0E+00	0.23	0.080	0.0E+00
PC(RJF) =	PA(RJF) x	PCI(RJF) x	PC(EXPO) =	0.0E+00	0.09	0.080	0.0E+00
PC(LFF) =	PA(LFF) x	PCI(LFF) x	PC(EXPO) =	0.0E+00	0.002	0.080	0.0E+00
PC(RFF) =	PA(RFF) x	PCI(RFF) x	PC(EXPO) =	0.0E+00	0.001	0.080	0.0E+00
PC(LEX) =	PA(LEX) x	PCI(LEX) x	PC(EXPO) =	0.0E+00	0.002	0.080	0.0E+00
PC(REX) =	PA(REX) x	PCI(REX) x	PC(EXPO) =	0.0E+00	0.001	0.080	0.0E+00

Based on data from impact distance figures in Section 4.6 and mortality figures in Section 4.5, enter the maximum impact probability at receptor location for each hazard in MAX PF(X) column.

IR Calculation				
	MAX PF(X)		PC(X)	IR(X)
IR(LJF) =	1.00		0.0E+00	0.0E+00
IR(RJF) =	1.00		0.0E+00	0.0E+00
IR(LFF) =	1.00		0.0E+00	0.0E+00
IR(RFF) =	1.00		0.0E+00	0.0E+00
IR(LEX) =	0.00		0.0E+00	0.0E+00
IR(REX) =	0.00		0.0E+00	0.0E+00
TOTAL INDIVIDUAL RISK, TIR				0.0E+00
CDE INDIVIDUAL RISK CRITERION, IRC				1.0E-06
TIR/IRC RATIO				0.00
PROTOCOL TIR INDICATOR RATIO				0.00

Hazard footprints do not reach school site

6-Inch Natural Gas Gathering Pipeline

XSEG Calculations														
Pipe Size, Pressure, and Hazard Type			Front Property Line - Begin Zone 1			Begin Zone 2			Begin Zone 3			End Zone 3 -Back Property Line		
Pipe Size	Press.	Hazard X	RX (1%)	R0	XSEG	RX (1%)	R0	XSEG	RX (1%)	R0	XSEG	RX (1%)	R0	XSEG
(in)	(psig)		(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
6	600	LJF	33	1400	0	33	1845	0	33	2290	0	33	2735	0
6	600	RJF	72	1400	0	72	1845	0	72	2290	0	72	2735	0
6	600	LFF	159	1400	0	159	1845	0	159	2290	0	159	2735	0
6	600	RFF	345	1400	0	345	1845	0	345	2290	0	345	2735	0
6	600	LEX	0	1400	0	0	1845	0	0	2290	0	0	2735	0
6	600	REX	0	1400	0	0	1845	0	0	2290	0	0	2735	0



Text Summary

SITE DATA:

Location: SANTA MARIA, CALIFORNIA
Building Air Exchanges Per Hour: 0.67 (unsheltered single storied)
Time: June 15, 2015 0948 hours PDT (using computer's clock)

CHEMICAL DATA:

Chemical Name: METHANE Molecular Weight: 16.04 g/mol
PAC-1: 2900 ppm PAC-2: 2900 ppm PAC-3: 17000 ppm
LEL: 50000 ppm UEL: 150000 ppm
Ambient Boiling Point: -259.0° F
Vapor Pressure at Ambient Temperature: greater than 1 atm
Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)

Wind: 3 meters/second from N at 3 meters
Ground Roughness: open country Cloud Cover: 5 tenths
Air Temperature: 77° F Stability Class: C
No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:

Flammable gas is burning as it escapes from pipe
Pipe Diameter: 6 inches Pipe Length: 7000 feet
Unbroken end of the pipe is connected to an infinite source
Pipe Roughness: smooth Hole Area: 28.3 sq in
Pipe Press: 615 psia Pipe Temperature: 77° F
Max Flame Length: 16 yards
Burn Duration: ALOHA limited the duration to 1 hour
Max Burn Rate: 16,900 pounds/min
Total Amount Burned: 97,962 pounds

THREAT ZONE:

Threat Modeled: Thermal radiation from jet fire
Red : 24 yards --- (15.77 kW/(sq m))

6-Inch Natural Gas Gathering Pipeline
Rupture - Flammable Vapor Cloud

ALOHA® 5.4.3



Text Summary

SITE DATA:

Location: SANTA MARIA, CALIFORNIA
Building Air Exchanges Per Hour: 0.67 (unsheltered single storied)
Time: June 15, 2015 0948 hours PDT (using computer's clock)

CHEMICAL DATA:

Chemical Name: METHANE Molecular Weight: 16.04 g/mol
PAC-1: 2900 ppm PAC-2: 2900 ppm PAC-3: 17000 ppm
LEL: 50000 ppm UEL: 150000 ppm
Ambient Boiling Point: -259.0° F
Vapor Pressure at Ambient Temperature: greater than 1 atm
Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)

Wind: 3 meters/second from N at 3 meters
Ground Roughness: open country Cloud Cover: 5 tenths
Air Temperature: 77° F Stability Class: C
No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:

Flammable gas escaping from pipe (not burning)
Pipe Diameter: 6 inches Pipe Length: 7000 feet
Unbroken end of the pipe is connected to an infinite source
Pipe Roughness: smooth Hole Area: 28.3 sq in
Pipe Press: 615 psia Pipe Temperature: 77° F
Release Duration: ALOHA limited the duration to 1 hour
Max Average Sustained Release Rate: 1,980 pounds/min
(averaged over a minute or more)
Total Amount Released: 97,962 pounds

THREAT ZONE:

Threat Modeled: Flammable Area of Vapor Cloud
Model Run: Gaussian
Red : 115 yards --- (50000 ppm = LEL)



SITE DATA:

Location: SANTA MARIA, CALIFORNIA
Building Air Exchanges Per Hour: 0.67 (unsheltered single storied)
Time: June 15, 2015 0948 hours PDT (using computer's clock)

CHEMICAL DATA:

Chemical Name: METHANE Molecular Weight: 16.04 g/mol
PAC-1: 2900 ppm PAC-2: 2900 ppm PAC-3: 17000 ppm
LEL: 50000 ppm UEL: 150000 ppm
Ambient Boiling Point: -259.0° F
Vapor Pressure at Ambient Temperature: greater than 1 atm
Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)

Wind: 3 meters/second from N at 3 meters
Ground Roughness: open country Cloud Cover: 5 tenths
Air Temperature: 77° F Stability Class: C
No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:

Flammable gas is burning as it escapes from pipe
Pipe Diameter: 6 inches Pipe Length: 7000 feet
Unbroken end of the pipe is closed off
Pipe Roughness: smooth Hole Area: 0.785 sq in
Pipe Press: 615 psia Pipe Temperature: 77° F
Max Flame Length: 2 yards Burn Duration: 45 minutes
Max Burn Rate: 470 pounds/min
Total Amount Burned: 2,299 pounds

THREAT ZONE:

Threat Modeled: Thermal radiation from jet fire
Red : less than 10 meters(10.9 yards) --- (15.77 kW/(sq m))

4-INCH CRUDE OIL GATHERING PIPELINE (IDLE)

Input Data		
Product	Crude Oil	
Diameter	4	inches
Pressure	500	psig
R0	30	ft

XSEG	RX(1%)	Units
XSEG(LJF)	0	ft
XSEG(RJF)	70	ft
XSEG(LFF)	0	ft
XSEG(RFF)	0	ft
XSEG(LEX)	0	ft
XSEG(REX)	0	ft

Base and Conditional Probability Calculations							
	Base	Leak	Rupture	Exposure			
F0	2.3E-03	PC(L)	0.8	PC(R)	0.2	PC(OCC)	0.08
P0	2.3E-03	PC(LIG)	0.09	PC(RIG)	0.03	PC(OUT)	1
PAF	1.0	PC(FIG)	0.95	PC(FIG)	0.95		
PA	2.3E-03	PC(JF)	0.95	PC(JF)	0.95		
		PC(FF)	0.05	PC(FF)	0.05		
		PC(EIG)	0.05	PC(EIG)	0.05		
Calculated Values:							
PA(LJF)	0.0E+00	PCI(LJF)	0.065	PCI(RJF)	0.005		
PA(RJF)	3.0E-05	PCI(LFF)	0.003	PCI(RFF)	0.000		
PA(LFF)	0.0E+00	PCI(LEX)	0.003	PCI(REX)	0.000	PC(EXPO)	0.08
PA(RFF)	0.0E+00						
PA(LEX)	0.0E+00						
PA(REX)	0.0E+00						

Impact Probability Calculations							
Probability Term				Values			
PC(LJF) =	PA(LJF) x	PCI(LJF) x	PC(EXPO) =	0.0E+00	0.06	0.080	0.0E+00
PC(RJF) =	PA(RJF) x	PCI(RJF) x	PC(EXPO) =	3.0E-05	0.01	0.080	1.3E-08
PC(LFF) =	PA(LFF) x	PCI(LFF) x	PC(EXPO) =	0.0E+00	0.003	0.080	0.0E+00
PC(RFF) =	PA(RFF) x	PCI(RFF) x	PC(EXPO) =	0.0E+00	0.000	0.080	0.0E+00
PC(LEX) =	PA(LEX) x	PCI(LEX) x	PC(EXPO) =	0.0E+00	0.003	0.080	0.0E+00
PC(REX) =	PA(REX) x	PCI(REX) x	PC(EXPO) =	0.0E+00	0.000	0.080	0.0E+00

Based on data from impact distance figures in Section 4.6 and mortality figures in Section 4.5, enter the maximum impact probability at receptor location for each hazard in MAX PF(X) column.

IR Calculation				
	MAX PF(X)		PC(X)	IR(X)
IR(LJF) =	1.00		0.0E+00	0.0E+00
IR(RJF) =	1.00		1.3E-08	1.32E-08
IR(LFF) =	1.00		0.0E+00	0.00E+00
IR(RFF) =	1.00		0.0E+00	0.00E+00
IR(LEX) =	0.00		0.0E+00	0.00E+00
IR(REX) =	0.00		0.0E+00	0.00E+00
TOTAL INDIVIDUAL RISK, TIR				1.3E-08
CDE INDIVIDUAL RISK CRITERION, IRC				1.0E-06
TIR/IRC RATIO				0.01
PROTOCOL TIR INDICATOR RATIO				0.00

4-Inch Crude Oil Gathering Pipeline

XSEG Calculations														
Pipe Size, Pressure, and Hazard Type			Front Property Line - Begin Zone 1			Begin Zone 2			Begin Zone 3			End Zone 3 -Back Property Line		
Pipe Size	Press.	Hazard X	RX (1%)	R0	XSEG	RX (1%)	R0	XSEG	RX (1%)	R0	XSEG	RX (1%)	R0	XSEG
(in)	(psig)		(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
4	500	LJF	23	30	0	23	475	0	23	920	0	23	1365	0
4	500	RJF	46	30	70	46	475	0	46	920	0	46	1365	0
4	500	LFF	23	30	0	23	475	0	23	920	0	23	1365	0
4	500	RFF	23	30	0	23	475	0	23	920	0	23	1365	0
4	500	LEX	0	30	0	0	475	0	0	920	0	0	1365	0
4	500	REX	0	30	0	0	475	0	0	920	0	0	1365	0

4-INCH CRUDE OIL GATHERING PIPELINE - IDLE

POPULATION RISK INDICATOR

Zone	Distance from Pipeline (ft)		Zone Boundary Mortality (RJF) (%)		Average Zone Mortality RJF (%)	Zone Population	Population Risk Indicator
	Begin	End	Begin	End			
1	30	475	100	0	50	62	31
2	475	920	0	0	0	62	0
3	920	1365	0	0	0	83	0
Population Risk Indicator						207	31

Total campus population = 207 (198 students and 9 staff)

Assume 100% of population outdoors at any given time - outdoor population of 207

Based on the school configuration, assume outdoor population is 30% in Zone 1, 30% in Zone 2, and 40% in Zone 3

Each zone for developed school property is approximately 445 feet long

4-INCH GREKA CRUDE OIL PIPELINE

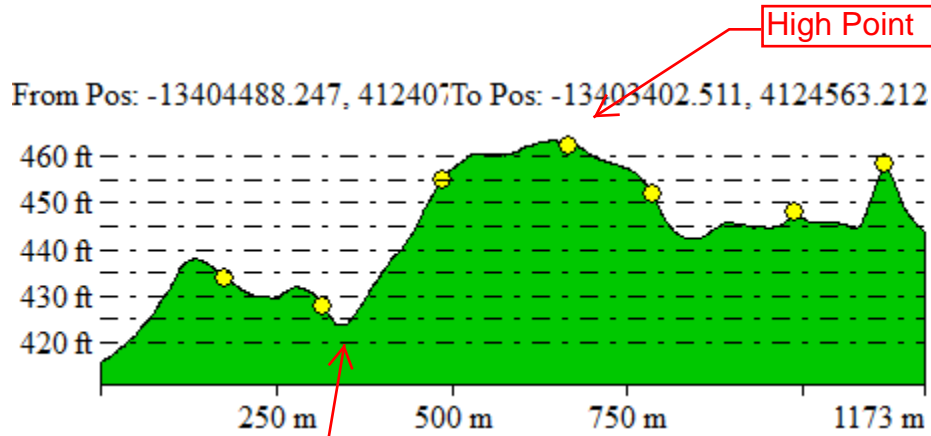
INPUT TABLE

Input Data	Value	Units	Data Source
Product	Crude Oil		Greka Oil & Gas
Diameter	4	inches	Same as above
Pressure	500	psig	Same as above
R0	30	ft	Google Earth and Greka pipeline maps
Release Rate - Rupture	63	ft ³ /min	CDE Protocol - Pipeline area x flow velocity (0.087 ft ² x 180 ft/min ¹)
Release Rate - Leak	0.90	ft ³ /min	CDE Protocol - 1-inch hole (.005 ft ²) x flow velocity of 180 ft/min
Release Period	15	min	CDE default value
Release Volume - Rupture	123	ft ³	Release rate x release period + drain down ²
Release Volume - Leak	14	ft ³	Release rate x release period
Pool Area - Rupture	491	ft ²	Assume depth of pool is 3 inches (0.25 feet)
Pool Area - Leak	54	ft ²	Assume depth of pool is 3 inches (0.25 feet)
Pool Diameter - Rupture	25	ft	Effective diameter = $[4(\text{pool area})/\pi]^{0.5}$
Pool Diameter - Leak	8	ft	Effective diameter = $[4(\text{pool area})/\pi]^{0.5}$
RX(LJF)	23		Pool fire - leak - uncontained spread and ALOHA run
RX(RJF)	46		Pool fire - rupture - uncontained spread and ALOHA run
RX(LFF)	23		Flammable vapor cloud - leak - uncontained spread and ALOHA run
RX(RFF)	23		Flammable vapor cloud - rupture - uncontained spread and ALOHA run
RX(LEX)	0		ALOHA - no VCE explosion - uncongested setting
RX(REX)	0		ALOHA - no VCE explosion - uncongested setting
XSEG(LJF)	0		Calculated via CDE Manual
XSEG(RJF)	70		Calculated via CDE Manual
XSEG(LFF)	0		Calculated via CDE Manual
XSEG(RFF)	0		Calculated via CDE Manual
XSEG(LEX)	0		Calculated via CDE Manual
XSEG(REX)	0		Calculated via CDE Manual

¹Because the flow rates from Greka wells in the area are very low (20 bbl/day), a minimum velocity of 3 ft/sec was used instead of the default of 7 ft/sec

²Based on the pipeline profile, the drain down amount is the distance from the pipeline high point to the school site = 1,230 feet x .087²(pipeline area) = 107 ft³

4-INCH CRUDE OIL PIPELINE PROFILE



Low Point Next to
School Site

$$\begin{aligned} \text{Drain down distance} &= 689 \text{ m} - 314 \text{ m} \\ &= 375 \text{ m} = 1,230 \text{ feet} \end{aligned}$$

$$\begin{aligned} \text{Drain down quantity} &= 1,230 \text{ feet} \times 0.087 \text{ ft}^2 \\ &= 107 \text{ cubic feet} \end{aligned}$$

SITE DATA:

Location: SANTA MARIA, CALIFORNIA
Building Air Exchanges Per Hour: 0.67 (unsheltered single storied)
Time: June 16, 2015 1154 hours PDT (using computer's clock)

CHEMICAL DATA:

Chemical Name: N-HEXANE Molecular Weight: 86.18 g/mol
AEGL-1 (60 min): N/A AEGL-2 (60 min): 3300 ppm AEGL-3 (60 min): 8600 ppm
IDLH: 1100 ppm LEL: 12000 ppm UEL: 72000 ppm
Ambient Boiling Point: 154.8° F
Vapor Pressure at Ambient Temperature: 0.20 atm
Ambient Saturation Concentration: 203,117 ppm or 20.3%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)

Wind: 3 meters/second from N at 3 meters
Ground Roughness: open country Cloud Cover: 5 tenths
Air Temperature: 77° F Stability Class: C
No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:

Burning Puddle / Pool Fire
Puddle Diameter: 25 feet Average Puddle Depth: 3 inches
Initial Puddle Temperature: Air temperature
Flame Length: 20 yards Burn Duration: 8 minutes
Burn Rate: 623 pounds/min
Total Amount Burned: 5,026 pounds

THREAT ZONE:

Threat Modeled: Thermal radiation from pool fire
Red : 22 yards --- (15.77 kW/(sq m))
x 3 = 66 feet x 0.7 to account for crude oil = 46 feet

4-INCH NATURAL GAS GATHERING PIPELINE (IDLE)

Input Data		
Product	natural gas	
Diameter	4	inches
Pressure	200	psig
R0	31	ft

XSEG	RX(1%)	Units
XSEG(LJF)	23	ft
XSEG(RJF)	23	ft
XSEG(LFF)	156	ft
XSEG(RFF)	232	ft
XSEG(LEX)	0	ft
XSEG(REX)	0	ft

Base and Conditional Probability Calculations							
Base		Leak		Rupture		Exposure	
F0	2.1E-04	PC(L)	0.8	PC(R)	0.2	PC(OCC)	0.08
P0	2.1E-04	PC(LIG)	0.3	PC(RIG)	0.45	PC(OUT)	1
PAF	1.0	PC(FIG)	0.99	PC(FIG)	0.99		
PA	2.1E-04	PC(JF)	0.98	PC(JF)	0.98		
		PC(FF)	0.01	PC(FF)	0.01		
		PC(EIG)	0.01	PC(EIG)	0.01		
Calculated Values:							
PA(LJF)	9.0E-07	PCI(LJF)	0.233	PCI(RJF)	0.087		
PA(RJF)	9.0E-07	PCI(LFF)	0.002	PCI(RFF)	0.001		
PA(LFF)	6.2E-06	PCI(LEX)	0.002	PCI(REX)	0.001	PC(EXPO)	0.08
PA(RFF)	9.2E-06						
PA(LEX)	0.0E+00						
PA(REX)	0.0E+00						

Impact Probability Calculations							
Probability Term				Values			
PC(LJF) =	PA(LJF) x	PCI(LJF) x	PC(EXPO) =	9.0E-07	0.23	0.080	1.7E-08
PC(RJF) =	PA(RJF) x	PCI(RJF) x	PC(EXPO) =	9.0E-07	0.09	0.080	6.3E-09
PC(LFF) =	PA(LFF) x	PCI(LFF) x	PC(EXPO) =	6.2E-06	0.002	0.080	1.2E-09
PC(RFF) =	PA(RFF) x	PCI(RFF) x	PC(EXPO) =	9.2E-06	0.001	0.080	6.6E-10
PC(LEX) =	PA(LEX) x	PCI(LEX) x	PC(EXPO) =	0.0E+00	0.002	0.080	0.0E+00
PC(REX) =	PA(REX) x	PCI(REX) x	PC(EXPO) =	0.0E+00	0.001	0.080	0.0E+00

Based on data from impact distance figures in Section 4.6 and mortality figures in Section 4.5, enter the maximum impact probability at receptor location for each hazard in MAX PF(X) column.

IR Calculation				
	MAX PF(X)		PC(X)	IR(X)
IR(LJF) =	0.00		1.7E-08	0.0E+00
IR(RJF) =	0.01		6.3E-09	6.29E-11
IR(LFF) =	1.00		1.2E-09	1.18E-09
IR(RFF) =	1.00		6.6E-10	6.57E-10
IR(LEX) =	0.00		0.0E+00	0.00E+00
IR(REX) =	0.00		0.0E+00	0.00E+00
TOTAL INDIVIDUAL RISK, TIR				1.9E-09
CDE INDIVIDUAL RISK CRITERION, IRC				1.0E-06
TIR/IRC RATIO				0.00
PROTOCOL TIR INDICATOR RATIO				0.25

Rupture - jet flame - at distance of 31 feet = $15.77 \text{ kW/m}^2 = 5,000 \text{ BTU/hr-ft}^2 = 1\%$ mortality
 Leak - jet flame - at distance of 31 feet = 0% mortality

4-Inch Natural Gas Gathering Pipeline

XSEG Calculations														
Pipe Size, Pressure, and Hazard Type			Front Property Line - Begin Zone 1			Begin Zone 2			Begin Zone 3			End Zone 3 -Back Property Line		
Pipe Size	Press.	Hazard X	RX (1%)	R0	XSEG	RX (1%)	R0	XSEG	RX (1%)	R0	XSEG	RX (1%)	R0	XSEG
(in)	(psig)		(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
4	200	LJF	33	31	23	33	476	0	33	921	0	33	1366	0
4	200	RJF	33	31	23	33	476	0	33	921	0	33	1366	0
4	200	LFF	84	31	156	84	476	0	84	921	0	84	1366	0
4	200	RFF	120	31	232	120	476	0	120	921	0	120	1366	0
4	200	LEX	0	31	0	0	476	0	0	921	0	0	1366	0
4	200	REX	0	31	0	0	476	0	0	921	0	0	1366	0

4-INCH NATURAL GAS GATHERING PIPELINE (IDLE)

POPULATION RISK INDICATOR

Zone	Distance from Pipeline (ft)		Zone Boundary Mortality (RJF) (%)		Average Zone Mortality RJF (%)	Zone Population	Population Risk Indicator
	Begin	End	Begin	End			
1	31	476	1	0	0.5	62	0
2	476	921	0	0	0	62	0
3	921	1366	0	0	0	83	0
Population Risk Indicator						207	0

Total campus population = 207 (198 students and 9 staff)

Assume 100% of population outdoors at any given time - outdoor population of 207

Based on the school configuration, assume outdoor population is 30% in Zone 1, 30% in Zone 2, and 40% in Zone 3

Each zone for developed school property is approximately 445 feet long



Text Summary

SITE DATA:

Location: SANTA MARIA, CALIFORNIA
Building Air Exchanges Per Hour: 0.67 (unsheltered single storied)
Time: June 11, 2015 1708 hours PDT (using computer's clock)

CHEMICAL DATA:

Chemical Name: METHANE Molecular Weight: 16.04 g/mol
PAC-1: 2900 ppm PAC-2: 2900 ppm PAC-3: 17000 ppm
LEL: 50000 ppm UEL: 150000 ppm
Ambient Boiling Point: -259.0° F
Vapor Pressure at Ambient Temperature: greater than 1 atm
Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)

Wind: 3 meters/second from N at 3 meters
Ground Roughness: open country Cloud Cover: 5 tenths
Air Temperature: 77° F Stability Class: C
No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:

Flammable gas is burning as it escapes from pipe
Pipe Diameter: 4 inches Pipe Length: 6207 feet
Unbroken end of the pipe is connected to an infinite source
Pipe Roughness: smooth Hole Area: 12.6 sq in
Pipe Press: 215 psia Pipe Temperature: 77° F
Max Flame Length: 9 yards
Burn Duration: ALOHA limited the duration to 1 hour
Max Burn Rate: 2,520 pounds/min
Total Amount Burned: 12,638 pounds

THREAT ZONE:

Threat Modeled: Thermal radiation from jet fire
Red : 11 yards --- (15.77 kW/(sq m))

4-Inch Natural Gas Gathering Pipeline
Rupture - Flammable Vapor Cloud



Text Summary

ALOHA® 5.4.3

SITE DATA:

Location: SANTA MARIA, CALIFORNIA
Building Air Exchanges Per Hour: 0.67 (unsheltered single storied)
Time: June 11, 2015 1708 hours PDT (using computer's clock)

CHEMICAL DATA:

Chemical Name: METHANE Molecular Weight: 16.04 g/mol
PAC-1: 2900 ppm PAC-2: 2900 ppm PAC-3: 17000 ppm
LEL: 50000 ppm UEL: 150000 ppm
Ambient Boiling Point: -259.0° F
Vapor Pressure at Ambient Temperature: greater than 1 atm
Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)

Wind: 3 meters/second from N at 3 meters
Ground Roughness: open country Cloud Cover: 5 tenths
Air Temperature: 77° F Stability Class: C
No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:

Flammable gas escaping from pipe (not burning)
Pipe Diameter: 4 inches Pipe Length: 6207 feet
Unbroken end of the pipe is connected to an infinite source
Pipe Roughness: smooth Hole Area: 12.6 sq in
Pipe Press: 215 psia Pipe Temperature: 77° F
Release Duration: ALOHA limited the duration to 1 hour
Max Average Sustained Release Rate: 249 pounds/min
(averaged over a minute or more)
Total Amount Released: 12,638 pounds

THREAT ZONE:

Threat Modeled: Flammable Area of Vapor Cloud
Model Run: Gaussian
Red : 40 yards --- (50000 ppm = LEL)
Note: Threat zone was not drawn because effects of near-field patchiness
make dispersion predictions less reliable for short distances.

4-Inch Natural Gas Gathering Pipeline
Leak - Jet Flame



Text Summary

ALOHA® 5.4.3

SITE DATA:

Location: SANTA MARIA, CALIFORNIA
Building Air Exchanges Per Hour: 0.67 (unsheltered single storied)
Time: June 11, 2015 1708 hours PDT (using computer's clock)

CHEMICAL DATA:

Chemical Name: METHANE Molecular Weight: 16.04 g/mol
PAC-1: 2900 ppm PAC-2: 2900 ppm PAC-3: 17000 ppm
LEL: 50000 ppm UEL: 150000 ppm
Ambient Boiling Point: -259.0° F
Vapor Pressure at Ambient Temperature: greater than 1 atm
Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)

Wind: 3 meters/second from N at 3 meters
Ground Roughness: open country Cloud Cover: 5 tenths
Air Temperature: 77° F Stability Class: C
No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:

Flammable gas is burning as it escapes from pipe
Pipe Diameter: 4 inches Pipe Length: 6207 feet
Unbroken end of the pipe is closed off
Pipe Roughness: smooth Hole Area: .785 sq in
Pipe Press: 215 psia Pipe Temperature: 77° F
Max Flame Length: 2 yards Burn Duration: 19 minutes
Max Burn Rate: 157 pounds/min
Total Amount Burned: 303 pounds

THREAT ZONE:

Threat Modeled: Thermal radiation from jet fire
Red : less than 10 meters(10.9 yards) --- (15.77 kW/(sq m))



Text Summary

SITE DATA:

Location: SANTA MARIA, CALIFORNIA
Building Air Exchanges Per Hour: 0.67 (unsheltered single storied)
Time: June 11, 2015 1708 hours PDT (using computer's clock)

CHEMICAL DATA:

Chemical Name: METHANE Molecular Weight: 16.04 g/mol
PAC-1: 2900 ppm PAC-2: 2900 ppm PAC-3: 17000 ppm
LEL: 50000 ppm UEL: 150000 ppm
Ambient Boiling Point: -259.0° F
Vapor Pressure at Ambient Temperature: greater than 1 atm
Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)

Wind: 3 meters/second from N at 3 meters
Ground Roughness: open country Cloud Cover: 5 tenths
Air Temperature: 77° F Stability Class: C
No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:

Flammable gas escaping from pipe (not burning)
Pipe Diameter: 4 inches Pipe Length: 6207 feet
Unbroken end of the pipe is closed off
Pipe Roughness: smooth Hole Area: .785 sq in
Pipe Press: 215 psia Pipe Temperature: 77° F
Release Duration: 19 minutes
Max Average Sustained Release Rate: 122 pounds/min
(averaged over a minute or more)
Total Amount Released: 303 pounds

THREAT ZONE:

Threat Modeled: Flammable Area of Vapor Cloud
Model Run: Gaussian
Red : 28 yards --- (50000 ppm = LEL)
Note: Threat zone was not drawn because effects of near-field patchiness
make dispersion predictions less reliable for short distances.

**4-inch Natural Gas Gathering Pipeline
Pipeline Safety Hazard Assessment - Fatality Risk
LAUSD Methodology**

Natural Gas Pipeline: 4-inch diameter, 500 psig operating pressure
School Hours - 8 am to 4 pm - Atmospheric Stability Class D

Accident Scenario	Footprint Length (ft)	Pipeline Segment ¹ (ft)	Pipeline Accident Rate (per mile-yr)	Adjusted Accident Rate ² (per year)	Leak or Rupture Probability	Probability of Initial Ignition or No Ignition	Stability Class/Flow Vector Percent	Probability of Flash Fire or UVCE at School	Probability of HF Reaching School	Annual ³ Student Attendance Percent	Probability of Student/Staff Exposure	Probability of Fatality	Fatality Risk
Leak - jet flame width *	4	0	3.80E-05	0.00E+00	0.80	0.10			0.00E+00	0.22	0.00E+00	1.0	0.00E+00
Leak - radiant heat	36	682	3.80E-05	4.91E-06	0.80	0.10			3.92E-07	0.22	8.63E-08	0.1	8.63E-09
Leak - FVC	84	801	3.80E-05	5.77E-06	0.80	0.90	0.10	0.30	1.25E-07	0.22	2.74E-08	1.0	2.74E-08
Leak - FVC & UVCE	0	0	3.80E-05	0.00E+00	0.80	0.90	0.10	0.10	0.00E+00	0.22	0.00E+00	0.1	0.00E+00
Total Leak									5.17E-07		1.14E-07		3.60E-08
Rupture - jet flame width*	16	0	3.80E-05	0.00E+00	0.20	0.25			0.00E+00	0.22	0.00E+00	1.0	0.00E+00
Rupture - radiant heat	135	908	3.80E-05	6.53E-06	0.20	0.25			3.27E-07	0.22	7.19E-08	0.3	2.37E-08
Rupture - FVC	120	877	3.80E-05	6.31E-06	0.20	0.75	0.10	0.30	2.84E-08	0.22	6.25E-09	1.0	6.25E-09
Rupture - FVC & UVCE	0	0	3.80E-05	0.00E+00	0.20	0.75	0.10	0.10	0.00E+00	0.22	0.00E+00	0.1	0.00E+00
Total Rupture									3.55E-07		7.81E-08		3.00E-08
TOTAL													6.60E-08

Notes:

- Distance from pipeline to school **31 ft**
- School frontage length along pipeline **645 ft**
- HF - hazard footprint
- * Jet flame width is 25 percent of its height
- 1 Calculated using So Cal Gas map to determine segment distances
- 2 Adjusted AR = AR x (L/ 5,280 ft/mile)
- 3 8 hours/day, 180 days/year

Conditional Probability - Ignition

- Ignition of gas at pipeline - leak **0.10**
- Ignition of gas at pipeline- rupture **0.25**
- No ignition of gas at pipeline - leak **0.90**
- No ignition of gas at pipeline - rupture **0.75**
- Delayed ignition of FVC at school - leak **0.40**
- Delayed ignition at FVC school - rupture **0.40**
- Flash Fire **0.75**
- UVCE **0.25**

Delayed Ignition - Large Diameter Pipeline

- For FVC length 1,000 to 1,500 feet **0.50**
- For FVC length 1,501 to 1,700 feet **0.70**
- For FVC length > 1,700 feet **0.90**

Conditional Probability - Fatality - Leak

- Jet flame **1.0** Default
- Radiant heat **0.10** Default
- Flammable vapor cloud **1.0** Default
- UVCE **0.10** Default

Conditional Probability - Fatality - Rupture

- Jet flame **1.0** Default
- Radiant heat **0.33** Calculated
- Flammable vapor cloud **1.0** Default
- UVCE **0.10** Default

Pipeline Safety Hazard Assessment- Hazard Footprint Calculation
NGW-1
Natural Gas Pipeline Rupture
Jet Flame Height, Jet Flame Width & Radiant Heat

Input Parameter	Data	Units	Data	Units
Distance from flame	135	ft	41.15	m
Hole diameter	4	in	0.1016	m
Release height above ground	0	ft	0	m
Gas pressure	500	psig	3,447,380	Pa
Ambient temperature	298	°K		
Relative humidity	50	%		
Heat capacity ratio for gas	1.32			
Heat of combustion for gas	50,000	kJ/kg		
Molecular weight of gas	16.74	grams		
Flame temperature	2,200	°K		
Discharge coefficient for hole	0.62			
Ambient pressure	101,325	Pa		
Fuel mole fraction at stoichiometric	0.095			
Moles of reactant per mole of product	1			
Molecular weight of air	29	grams		
Fraction of total energy converted	0.2			
Calculated Results	Data	Units		
Area of hole	0.01	m²		
Gas discharge rate	30.216	kg/s		
L/d ratio for flame	195.5			
Flame height	19.86	m	65	ft
Flame width	4.96	m	16	ft
Location of flame center above ground	9.93	m		
Radiation path length	42.33	m		
Point source view factor	4.44E-05	m²		
Water vapor partial pressure	1,580	Pa		
Atmospheric transmissivity	0.743			
Radiant Heat Flux	10.0	kW/m²		
10 kW/m² = 3200 BTU/hr-ft²				

Note:
Equations from AIChE (2000)

Pipeline Safety Hazard Assessment - Hazard Footprint Calculation
NGW-2
Natural Gas Pipeline Leak
Jet Flame Height, Jet Flame Width & Radiant Heat

Input Parameter	Data	Units	Data	Units
Distance from flame	36	ft	10.9728	m
Hole diameter	1	in	0.0254	m
Release height above ground	0	ft	0	m
Gas pressure	500	psig	3,447,380	Pa
Ambient temperature	298	°K		
Relative humidity	50	%		
Heat capacity ratio for gas	1.32			
Heat of combustion for gas	50,000	kJ/Kg		
Molecular weight of gas	16.74	grams		
Flame temperature	2,200	°K		
Discharge coefficient for hole	0.62			
Ambient pressure	101,325	Pa		
Fuel mole fraction at stoichiometric	0.095			
Moles of reactant per mole of product	1			
Molecular weight of air	29	grams		
Fraction of total energy converted	0.2			
Calculated Results	Data	Units		
Area of hole	0.0005	m²		
Gas discharge rate	1.889	Kg/s		
L/d ratio for flame	195.5			
Flame height	4.96	m	16	ft
Flame width	1.24	m	4	ft
Location of flame center above ground	2.48	m		
Radiation path length	11.25	m		
Point source view factor	0.0006	m²		
Water vapor partial pressure	1,580	Pa		
Atmospheric transmissivity	0.837			
Radiant Heat Flux	9.9	kW/m²		
10 kW/m² = 3200 BTU/hr-ft²				

Note:
Equations from AIChE (2000)

4-Inch Crude Oil Gathering Pipeline
Pipeline Safety Hazard Assessment - Fatality Risk
LAUSD Methodology

Crude Oil Pipeline: 4-inch, 500 psig, 20 bbl/hr flow rate
School Hours - 8 AM to 4 PM - Atmospheric Stability Class D

Accident Scenario	Footprint Length (ft)	Pipeline Segment ¹ (ft)	Pipeline Accident Rate (per mile-yr)	Adjusted Accident Rate ² (per year)	Leak or Rupture Probability	Probability of Initial Ignition or No Ignition	Stability Class/Flow Vector Percent	Probability of Flash Fire or UVCE at School	Probability of HF Reaching School	Annual ³ Student Attendance Percent	Probability of Student/Staff Exposure	Probability of Fatality	Fatality Risk
Leak - flame width*	8	0	3.20E-03	0.00E+00	0.80	0.02			0.00E+00	0.16	0.00E+00	1	0.00E+00
Leak - radiant heat	23	0	3.20E-03	0.00E+00	0.80	0.02			0.00E+00	0.16	0.00E+00	0.1	0.00E+00
Leak - FVC	23	0	3.20E-03	0.00E+00	0.80	0.985	0.10	0.15	0.00E+00	0.16	0.00E+00	1	0.00E+00
Leak - FVC & UVCE	0	0	3.20E-03	0.00E+00	0.80	0.985	0.10	0.05	0.00E+00	0.16	0.00E+00	0.1	0.00E+00
Total Leak									0.00E+00		0.00E+00		0.00E+00
Rupture - flame width*	38	692	3.20E-03	4.19E-04	0.20	0.02			1.26E-06	0.16	2.01E-07	1	2.01E-07
Rupture - radiant heat	65	760	3.20E-03	4.61E-04	0.20	0.02			1.38E-06	0.16	2.21E-07	0.33	7.30E-08
Rupture - FVC	23	0	3.20E-03	0.00E+00	0.20	0.985	0.10	0.15	0.00E+00	0.16	0.00E+00	1	0.00E+00
Rupture - FVC & UVCE	0	0	3.20E-03	0.00E+00	0.20	0.985	0.10	0.05	0.00E+00	0.16	0.00E+00	0.1	0.00E+00
Total Rupture									2.64E-06		4.22E-07		2.74E-07
TOTAL													2.74E-07

Notes:

Distance from pipeline to school
School frontage length along pipeline
HF - hazard footprint

30 ft
645 ft

- * May be equal to or less than burning pool width
- 1 Calculated using equation in User Manual
- 2 Adjusted AR = AR x (L / 5,280 ft/mile)
- 3 8 hours/day, 180 days per year

Conditional Probability - Ignition

Ignition of crude oil pool - leak 0.015
Ignition of crude oil pool - rupture 0.015
No ignition of liquid at pipeline - leak 0.99
No ignition of liquid at pipeline - rupture 0.99
Delayed ignition of FVC at school - leak 0.20
Delayed ignition of FVC at school - rupture 0.20
Flash Fire 0.75
UVCE 0.25

Conditional Probability - Fatality

Jet flame 1
Radiant heat 0.33 For rupture
Flammable vapor cloud 1
UVCE 0.1

Pipeline Safety Hazard Assessment - Input Data

PPW-1

Petroleum Product Pipeline -Rupture

Physiochemical Properties of Crude Oil - California Crude for Gathering Lines

Normal Boiling Point

Liquid Properties	Data	Units
Normal Boiling Point	607	⁰ F
Molecular Weight	231	grams
Specific Gravity	0.9522	
Vapor Pressure at Container Temp.	0.50	psi(a)
	25.9	mm Hg
Vapor Pressure at Ambient Temp.	0.50	psi(a)
	25.9	mm Hg
Lower Flammable Limit	1.1	%
Lower Heat of Combustion	17,449	Btu/lb
Gas Explosion Yield Factor	0.03	
Temperature of Liquid	68	⁰ F
Pipeline Properties	Data	Units
Pipeline Diameter	4	inches
Pipeline Length	2,000	feet
Operating Pressure	515	psi(a)
Pipeline Flow Rate	20	bbbl/hr
	111	lb/min
Liquid Height in Pipe	0.33	ft
Shutdown Time	5	min
Location of Pipe Break	middle	
Discharge Coefficient	0.62	
Discharge Hole Diameter	4	inches
Calculated Volume & Weight	Data	Units
Volume of Liquid in Container	171.1	ft ³
	1,280	gal
Weight of Liquid in Container	10,169	lbs
Environmental Conditions	Data	Units
Ambient Temperature	68	⁰ F
Wind Velocity	5	mph
Liquid Confinement Area	None	
Stability Class	D	

PPW-2
Petroleum Product Pipeline - Leak
Discharge Rate and Duration

Parameter	Data	Units
Discharge coefficient (C_d)	0.62	
Hole diameter	1	inch
Hole area (A)	0.785	in ²
Specific gravity (S_G)	0.9522	
Weight density (ρ)	59.4	lb/ft ³
Gravitational acceleration (g)	32.2	ft/sec ²
Differential head of liquid	0.33	ft
Conversion factor for area	0.00694444	ft ² /in ²
Calculated Results	Data	Units
delta P ($P_1 - P_2$)	0.1362	psi
Liquid discharge rate (Q_L)	0.93	lb/sec
	55.6	lb/min
Discharge duration	15	min
Weight of Liquid Release	834	lbs
Volume of Liquid Release	14	ft ³
Volume of Liquid Release	105	gal

Liquid Discharge Rate Equation (AIChE 2000)

$$Q_L = (C_d)(A)\text{SQRT}[(2)(\rho)(\text{delta } P)(g/144)]$$

Q_L = liquid discharge rate (lb/sec)

C_d = discharge coefficient

A = cross sectional area (in²)

g = gravitational acceleration (32.2 ft/s²)

ρ - weight density (lb/ft³)

delta P = static pressure head (psi) = $S_G(\text{delta } h)(K)$

Where:

S_G = specific gravity

delta h = differential head (ft)

K = conversion from psf to psi

1 ft² = 144 in²



Text Summary

SITE DATA:

Location: SANTA MARIA, CALIFORNIA
Building Air Exchanges Per Hour: 0.67 (unsheltered single storied)
Time: June 16, 2015 1154 hours PDT (using computer's clock)

CHEMICAL DATA:

Chemical Name: N-HEXANE Molecular Weight: 86.18 g/mol
AEGL-1 (60 min): N/A AEGL-2 (60 min): 3300 ppm AEGL-3 (60 min): 8600 ppm
IDLH: 1100 ppm LEL: 12000 ppm UEL: 72000 ppm
Ambient Boiling Point: 154.8° F
Vapor Pressure at Ambient Temperature: 0.20 atm
Ambient Saturation Concentration: 203,117 ppm or 20.3%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)

Wind: 3 meters/second from N at 3 meters
Ground Roughness: open country Cloud Cover: 5 tenths
Air Temperature: 77° F Stability Class: C
No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:

Burning Puddle / Pool Fire
Puddle Diameter: 38 feet Average Puddle Depth: 3 inches
Initial Puddle Temperature: Air temperature
Flame Length: 27 yards Burn Duration: 8 minutes
Burn Rate: 1,440 pounds/min
Total Amount Burned: 11,612 pounds

THREAT ZONE:

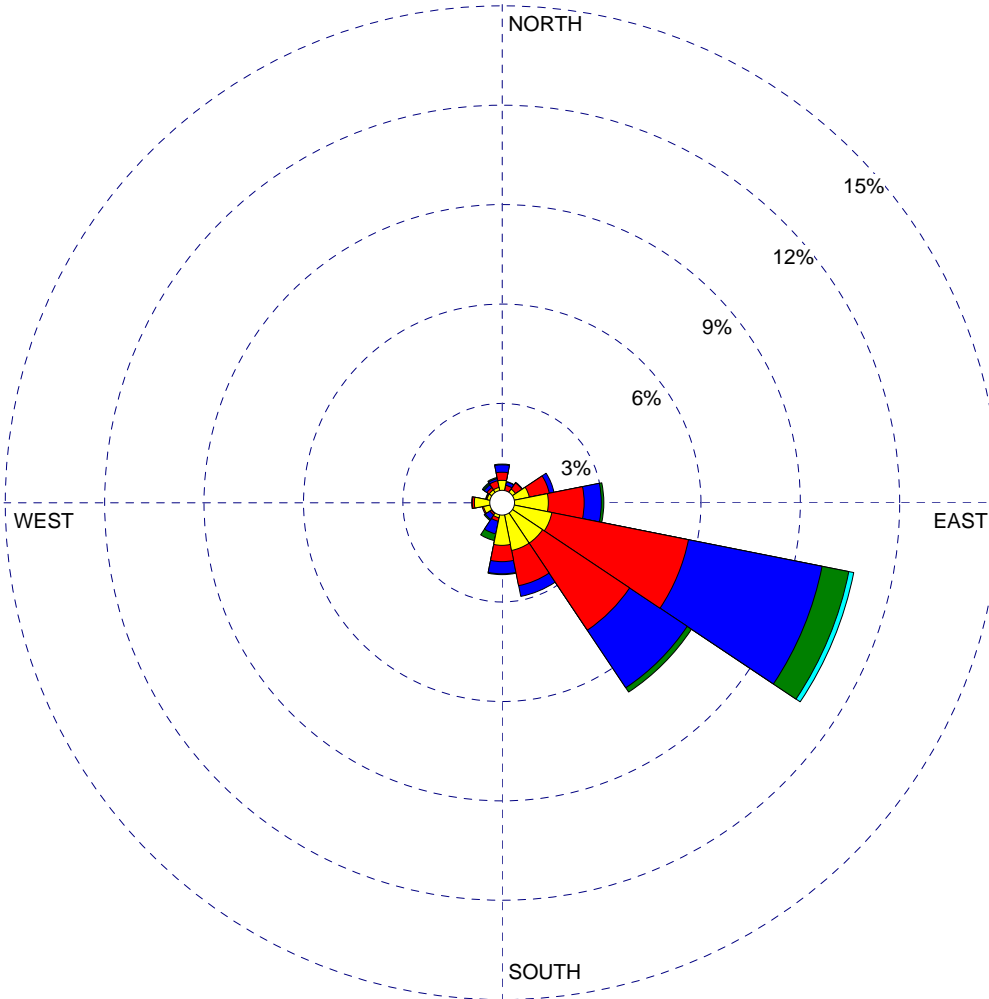
Threat Modeled: Thermal radiation from pool fire
Red : 31 yards --- (15.77 kW/(sq m))
x 3 = 93 feet x 0.7 to account for crude = 65 feet

WIND ROSE PLOT:

**Santa Maria Met Station
Wind Rose**

DISPLAY:

**Wind Speed
Flow Vector (blowing to)**



**WIND SPEED
(m/s)**

- >= 11.10
- 8.80 - 11.10
- 5.70 - 8.80
- 3.60 - 5.70
- 2.10 - 3.60
- 0.50 - 2.10

Calms: 2.11%

COMMENTS:

DATA PERIOD:

**Start Date: 1/1/1988 - 09:00
End Date: 12/31/1988 - 13:00**

COMPANY NAME:

MODELER:

CALM WINDS:

2.11%

TOTAL COUNT:

1829 hrs.

AVG. WIND SPEED:

4.18 m/s

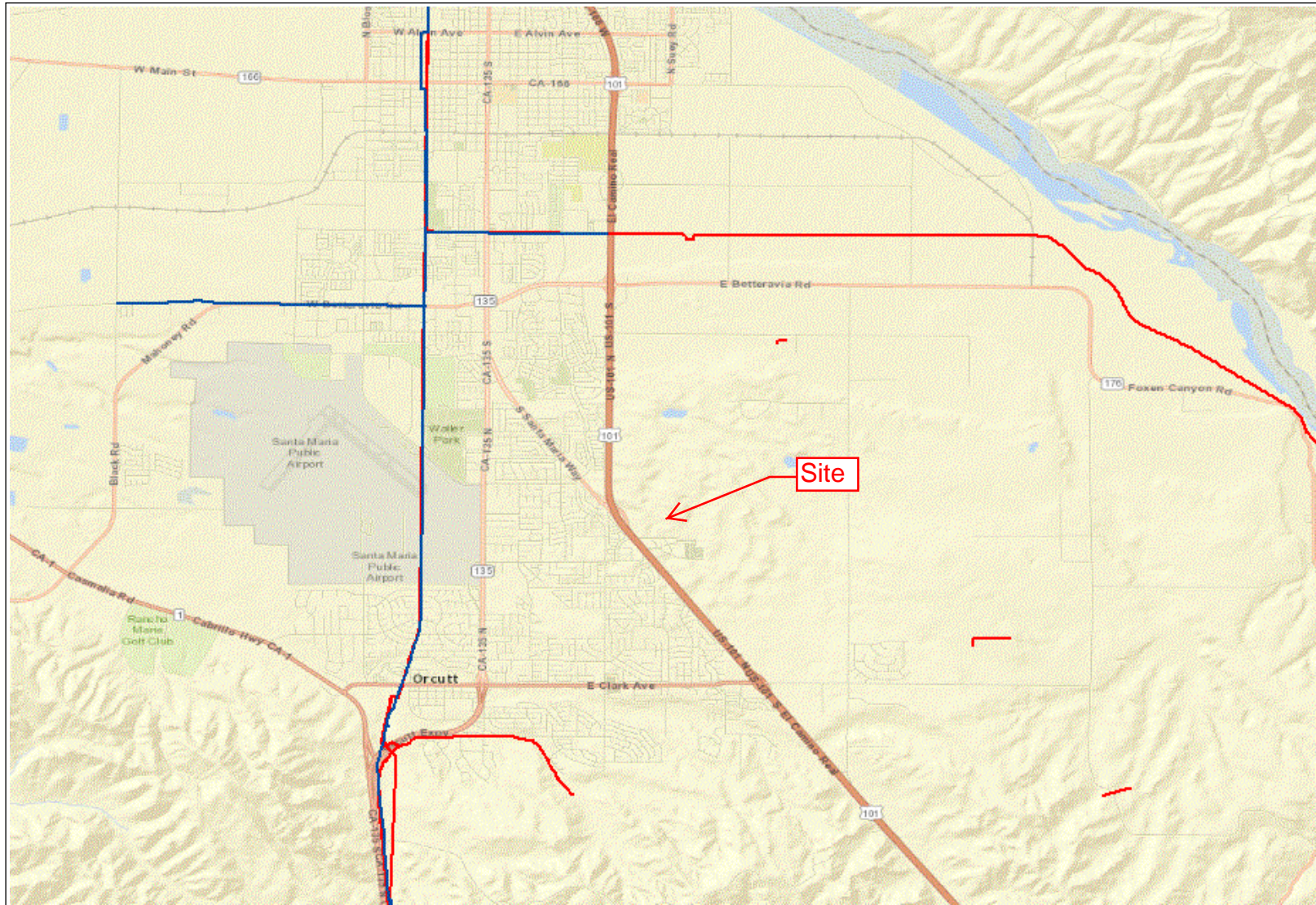
DATE:

6/16/2015

PROJECT NO.:

Appendix B. Agency Correspondence

NATIONAL PIPELINE MAPPING SYSTEM



Legend

- Gas Transmission Pipelines
- Hazardous Liquid Pipelines



Pipelines depicted on this map represent gas transmission and hazardous liquid lines only. Gas gathering and gas distribution systems are not represented.

This map should never be used as a substitute for contacting a one-call center prior to excavation activities. Please call 811 before any digging occurs.

Questions regarding this map or its contents can be directed to npms-nr@mbakercorp.com.

Projection: Geographic

Datum: NAD83

Map produced by the NPMS Public Viewer at www.npms.phmsa.dot.gov

Date Printed: Jun 15, 2015





Safety

Safety at Home and Work

Safety for Public Officials

Contractor Safety

Emergency Information

Pipeline Safety

Aliso Canyon Storage Facility Project

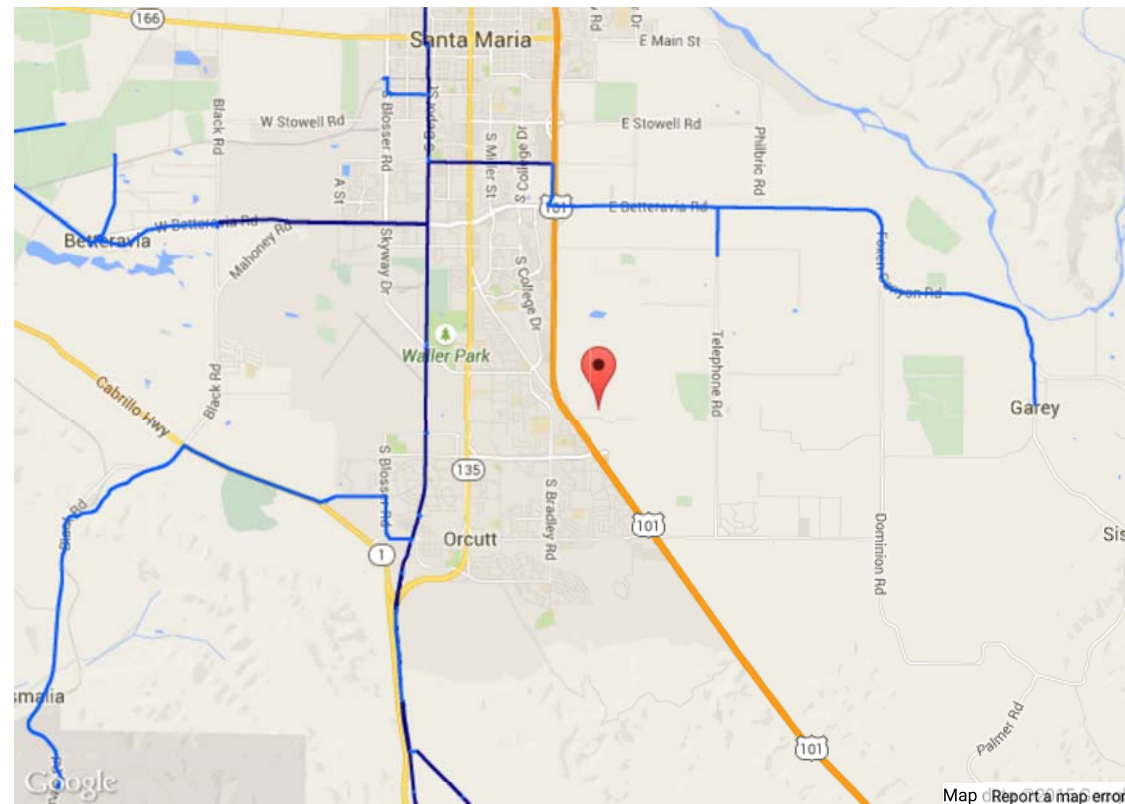
Playa del Rey Storage Operations

Safety Brochures

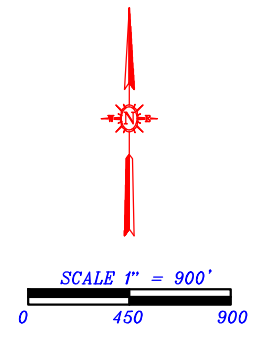
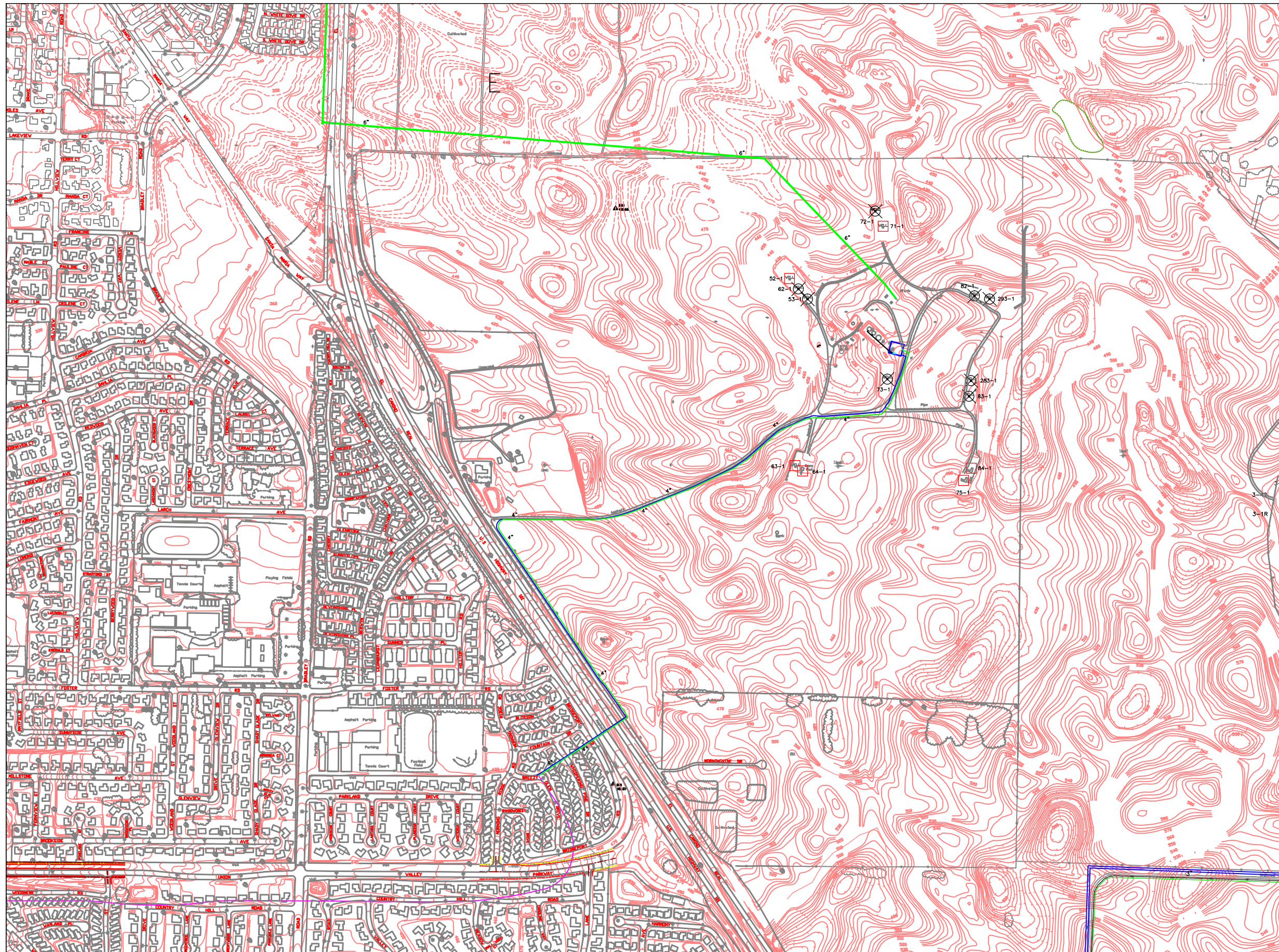
Scam Alert!

Gas Transmission and High Pressure Distribution Pipeline Interactive Map - Santa Barbara

1280 Founder Avenue. Enter your zip code or address.



Dark Blue Transmission Lines: Generally large diameter pipelines that operate at pressures above 200 psi and transport gas from supply points to the gas distribution system.



- LEGEND**
- IDLE WELL
 - ◻ ACTIVE WELL
 - ◻ INJECTION WELL
 - INJECTION LINE
 - OIL PRODUCTION LINE
 - FUEL GAS LINE
 - WET GAS LINE

NUMBER	REFERENCE DRAWINGS
09009-F01	VPR & FWFO P&ID's
09009-F02	TANK BATTERY P&ID's
09009-F03	GAS CATERING SYSTEM P&ID's
09009-F04	BOILER, POND & INJECTION P&ID's

JIM HOPKINS

DCN: 10020-C3

REV. NO.	DATE	TITLE AND UPGRADE REVISIONS	BY	CHKD	APD
A	05-06-10	FIRST RELEASE FOR REVIEW	LRM	ASP	ASP

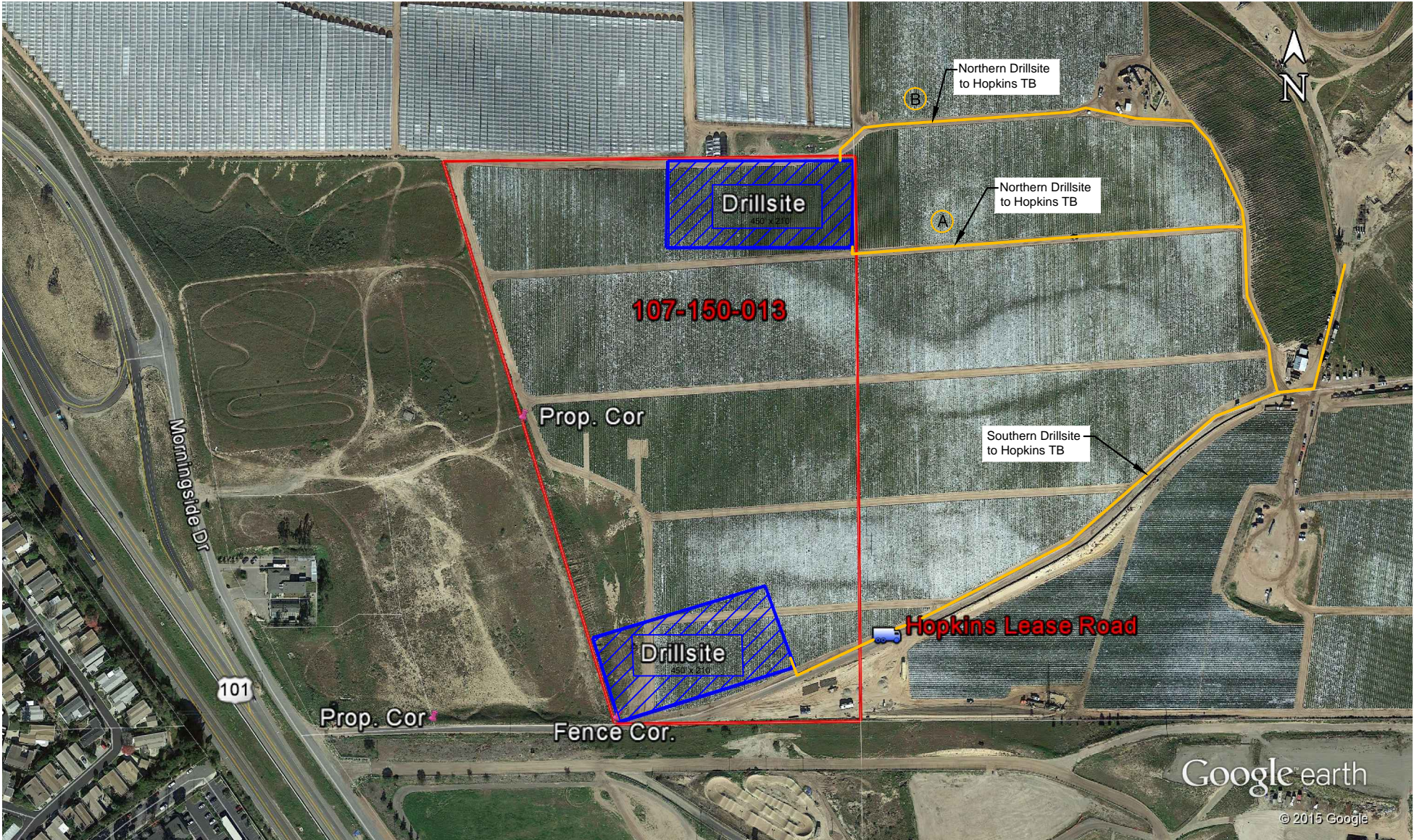


DRAWN BY:	LUIS MATA	DATE:	03-26-2010
DESIGN:	LUIS MATA	DATE:	03-26-2010
CHECK:	ALEX PINON	DATE:	03-26-2010
ENGINEER:		DATE:	
APPROVED:		DATE:	
TECH. SUPP.:		DATE:	
UPDATED:		DATE:	

JIM HOPKINS
OIL & GAS PIPELINES
4000 SOUTH HIGHWAY 101
SANTA MARIA, CA 93454

SCALE: 1" = 900'

DWG NO: 10020-C3 SH: 1 OF 1 REV. NO. A



107-150-013

Drillsite
450' x 210'

Drillsite
450' x 210'

Northern Drillsite
to Hopkins TB

Northern Drillsite
to Hopkins TB

Southern Drillsite
to Hopkins TB

Hopkins Lease Road

Morningside Dr

101

Prop. Cor.

Prop. Cor.

Fence Cor.

Google earth

© 2015 Google

From: Jim Buttery
Sent: Tuesday, May 19, 2015 3:12 PM
To: 'Braiden Chadwick'
Cc: Sandra Felt
Subject: RE: Information Needed

Thank you for providing this information. I will share not only with my clients but also with the SMJUHSD. Before I do that and just to make sure that we're on the same page, the map you attached outlines in red the 25+ acre parcel owned by my client on which you propose to have HVI reserve two drill sites and access routes, right?

Jim

From: Braiden Chadwick [<mailto:BChadwick@mitchellchadwick.com>]
Sent: Tuesday, May 19, 2015 2:51 PM
To: Jim Buttery
Subject: RE: Information Needed

Jim:

1. As to the three pipelines currently located on the southern boundary of the Blanckenburg parcel that cross Hopkins to the tank battery, please note the specifications:
 - Oil and water PL – 4" schedule 80 steel line; 200 psi normal operation, 500 psi maximum allowed operation
 - Gas PL – 4" schedule 80 poly line; 20-40 psi normal operation, 200 psi maximum allowed operation
 - Fresh water PL – 3" schedule 80 steel line / 2" schedule 80 poly line; 60-80 psi normal operation

2. As to the drillsites and road/pipeline corridors that Greka needs to reserve, a conceptual drawing is attached.
 - Southern Drillsite on Blanckenburg - crossing the Hopkins surface parcel westerly to the Hopkins tank battery using our current road/pipeline corridor.

 - Northern Drillsite on Blanckenburg – crossing the Hopkins surface parcel westerly to the Hopkins tank battery using either route (A) from the SE corner of the drillsite or route (B) from the NE corner of the drillsite, then connecting to the north-south farm road

Please feel free to respond to this email or call at your convenience.

Best regards,

Braiden

CONTACT REPORT FORM

DATE: 6/12/2015 JOB No.: SMJU-01.0
CONTACT: Ray Marroquin Phone No.: 805-937-2976
AGENCY/CO.: Greka Oil & Gas CONTACT BY: Steve Bush
SUBJECT: Pipeline Safety Hazard Assessment for Proposed School Site

KEY POINTS DISCUSSED: Over the phone, Mr. Ray Marroquin clarified that in reference to Greka map 10020-C3 John Hopkins Pipelines, the blue fuel gas lines are natural gas distribution lines and green wet gas lines are natural gas gathering lines. He also verified that the 4-inch blue fuel gas line along Founder Avenue has been replaced with a 4-inch oil and water line that is currently not in service. In regards to the 6-inch gas gathering line 1,350-feet north of the site, the maximum allowable pressure is approximately 600 psi. There are plans to replace the 6-inch line with a smaller 3 or 4-inch pipeline, but no expected construction completion date is known at this time.

REQUIRED ACTION: No further action is required.

CC: _____

CONTACT REPORT FORM

DATE:	<u>6/2/2015</u>	JOB No.:	<u>SMJU-01.0</u>
CONTACT:	<u>Mark Mueller, Engineering Technician III</u>	Phone No.:	<u>805-925-0951 ext. 225</u>
AGENCY/CO.:	<u>City of Santa Maria Public Works Department, Engineering Division</u>	CONTACT BY:	<u>Alex Lopez</u>
SUBJECT:	<u>Pipeline Safety Hazard Assessment for Proposed School Site</u>		

KEY POINTS DISCUSSED: Via email, a representative of the Engineering Division of the City of Santa Maria Public Works Department confirmed that the Public Works Department did not own or operate any water lines in the Project area.

REQUIRED ACTION: No further action is required.

CC: _____

CONTACT REPORT FORM

DATE: 6/15/2015 JOB No.: SMJU-01.0
CONTACT: Larry Dees, Operations Engineer Phone No.: 805-349-7407, ext. 114
AGENCY/CO.: Golden State Water Company CONTACT BY: Steve Bush
SUBJECT: Pipeline Safety Hazard Assessment for Proposed School Site

KEY POINTS DISCUSSED: Over the phone, Mr. Larry Dees of the Golden State Water Company confirmed that the Company does not own or operate any 12-inch or larger water lines in the Project area.

REQUIRED ACTION: No further action is required.

CC: _____

CONTACT REPORT FORM

DATE:	<u>6/12/2015</u>	JOB No.:	<u>SMJU-01.0</u>
CONTACT:	<u>Jonathan Frye</u>	Phone No.:	<u>805-568-3440</u>
AGENCY/CO.:	<u>Santa Barbara County Flood Control & Water Conservation District</u>	CONTACT BY:	<u>Steve Bush</u>
SUBJECT:	<u>Pipeline Safety Hazard Assessment for Proposed School Site</u>		

KEY POINTS DISCUSSED: Over the phone, Mr. Jonathan Frye of the County Public Works confirmed that the County is not a water purveyor and thus does not own or operate any water lines in the Project area.

REQUIRED ACTION: No further action is required.

CC: _____